ORNL/TM-10505

ornl

OAK RIDGE
NATIONAL
LABORATORY

MARTIN MARIETTA

Final Report of the HFIR Irradiation Facilities Improvement Project

B. H. Montgomery
K. R. Thoms
C. D. West

OPERATED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
NTIS price codes—Printed Copy: A15 Microfiche A01

ORNL/TM-10505

Engineering Technology Division

FINAL REPORT OF THE HFIR IRRADIATION FACILITIES IMPROVEMENT PROJECT

B. H. Montgomery
K. R. Thoms
C. D. West

Date Published - September 1987

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC05-84OR21400

CONTENTS

	Page
LIST OF FIGURES	v
LIST OF TABLES	vii
ACKNOWLEDGMENTS	ix
ABSTRACT	1
1. BACKGROUND	1
2. HFIR IRRADIATION FACILITIES IMPROVEMENT PROJECT	4
2.1 Phase 1	4
2.2 Phase 2	14
2.3 Project Reporting	14
2.4 Project Milestones	14
3. NEUTRON FLUX, FUEL CYCLE LENGTH, AND DOSIMETRY MEASUREMENTS	19
4. FUNDING AND COSTING	22
REFERENCES	25
APPENDIX A — DESIGN REPORT FOR REDESIGN OF QUICK-OPENING HATCH AND TARGET HOLE PLUG FOR THE HIGH FLUX ISOTOPE REACTOR	27
HFIR MODEL-E REMOVABLE REFLECTOR HYDRAULICS	149
APPENDIX B — HIFI PROJECT MONTHLY PROGRESS REPORTS FOR SEPTEMBER 1985 THROUGH JUNE 1987	169
APPENDIX C — PROJECT MILESTONES — ACHIEVEMENT REPORTING FORMS	305
APPENDIX D — DOE APPROVAL OR-638-86-ORNL-2-MOD 1	309
APPENDIX E — REPORT ON CORE-LIFE EXPERIMENT: "HAFNIUM SHIELDS IN THE RB POSITIONS ARE OK"	315

LIST OF FIGURES

Figure		Page
1	Plan view of HFIR showing reactor components, fuel, and beam tubes	2
2	Old experimental facilities in HFIR	3
3	New experimental facilities in HFIR	5
4	Fuel grid	6
5	Target holder	7
6	Outer shroud	8
7	Target tower	9
8	Target hole plug	10
9	Quick-access hatch	11
10	Rabbit facility U-bend	12
11	Target tower lifting tool	13
12	General arrangement of core target tower and quick-access hatch	15
13	Removable beryllium reflector	16
14	Track assembly	17
15	Shroud flange	18
16	Results of 100-kW runs with hafnium sleeves in various RB positions	21

LIST OF TABLES

Table		Page
1	Change in flux at the HFIR beam tubes as a 3.8-mm-thick, 31.6-mm-diam hafnium shield is placed in RB irradiation positions	19
2	Estimated vs actual costs for the HFIR irradiation facilities upgrade	22
3	HIFI Project reactor components fabrication and assembly dates and final costs	23

ACKNOWLEDGMENTS

The HIFI Project was a team effort comprising personnel from several different ORNL Divisions, including their Associate Directors and Division Directors. The authors wish to thank all of those people who contributed their efforts toward this project. We should especially like to single out the contributions made by G. R. Hicks, S. E. Burnette (Research Reactors Division), D. L. AuBuchon, B. J. Ward (Quality Department), and F. W. Leon (Engineering Technology Division). Some of the material in this final report is taken from publications* prepared during the course of the project, and we are grateful to the authors for permission to reference their work.

---

*C. W. Alexander, J. A. Conlin, S. S. Hurt, R. M. Moon, Jr., E. Newman, Jr., A. F. Rowcliffe, K. R. Thoms, and C. D. West, *Report of the Materials Irradiation Facilities Improvements Committee*, ORNL/TM-9709, Oak Ridge Natl. Lab., October 1985; and G. R. Hicks, B. H. Montgomery, K. R. Thoms, and C. D. West, "HFIR Irradiation Facilities Improvements — The HIFI Project," *J. Nucl. Mater.*, 141–43 (1986), pp. 1018–24, Elsevier Science Publishers B. V., North-Holland, Amsterdam.

FINAL REPORT OF THE HFIR IRRADIATION FACILITIES IMPROVEMENT PROJECT

B. H. Montgomery
K. R. Thoms
C. D. West

ABSTRACT

The High-Flux Isotope Reactor (HFIR) has outstanding neutronics characteristics for materials irradiation, but some relatively minor aspects of its mechanical design severely limited its usefulness for that purpose. In particular, though the flux trap region in the center of the annular fuel elements has a very high neutron flux, it had no provision for instrumentation access to irradiation capsules. The irradiation positions in the beryllium reflector outside the fuel elements also have a high flux; however, although instrumented, they were too small and too few to replace the facilities of a materials testing reactor.

To address these drawbacks, the HFIR Irradiation Facilities Improvement Project consisted of modifications to the reactor vessel cover, internal structures, and reflector. Two instrumented facilities were provided in the flux trap region, and the number of materials irradiation positions in the removable beryllium (RB) was increased from four to eight, each with almost twice the available experimental space of the previous ones. The instrumented target facilities were completed in August 1986, and the RB facilities were completed in June 1987. This report covers only the tasks mentioned above that were funded by the Office of Fusion Energy and the Basic Energy Sciences Program through a Department of Energy approved OR-638-86-ORNL-2, Mod 1; it does not cover the HFIR experimental control room upgrade nor the Fusion materials irradiation experiments.

1. BACKGROUND

The High-Flux Isotope Reactor (HFIR) is a pressurized, light-water-cooled, beryllium-reflected, 100-MW reactor. It was designed for the production of isotopes, particularly transuranium isotopes, which requires high thermal and epithermal neutron fluxes; indeed, the HFIR target region (the cylindrical space inside the two concentric annular fuel elements) has the highest steady state thermal-neutron flux in the world. The high thermal flux also makes the reactor a good source of neutrons for scattering experiments, and a number of beam tubes exist for that purpose (Fig. 1). The relatively high reactor power and power density leads to a high fast-neutron flux, so that the HFIR is also used

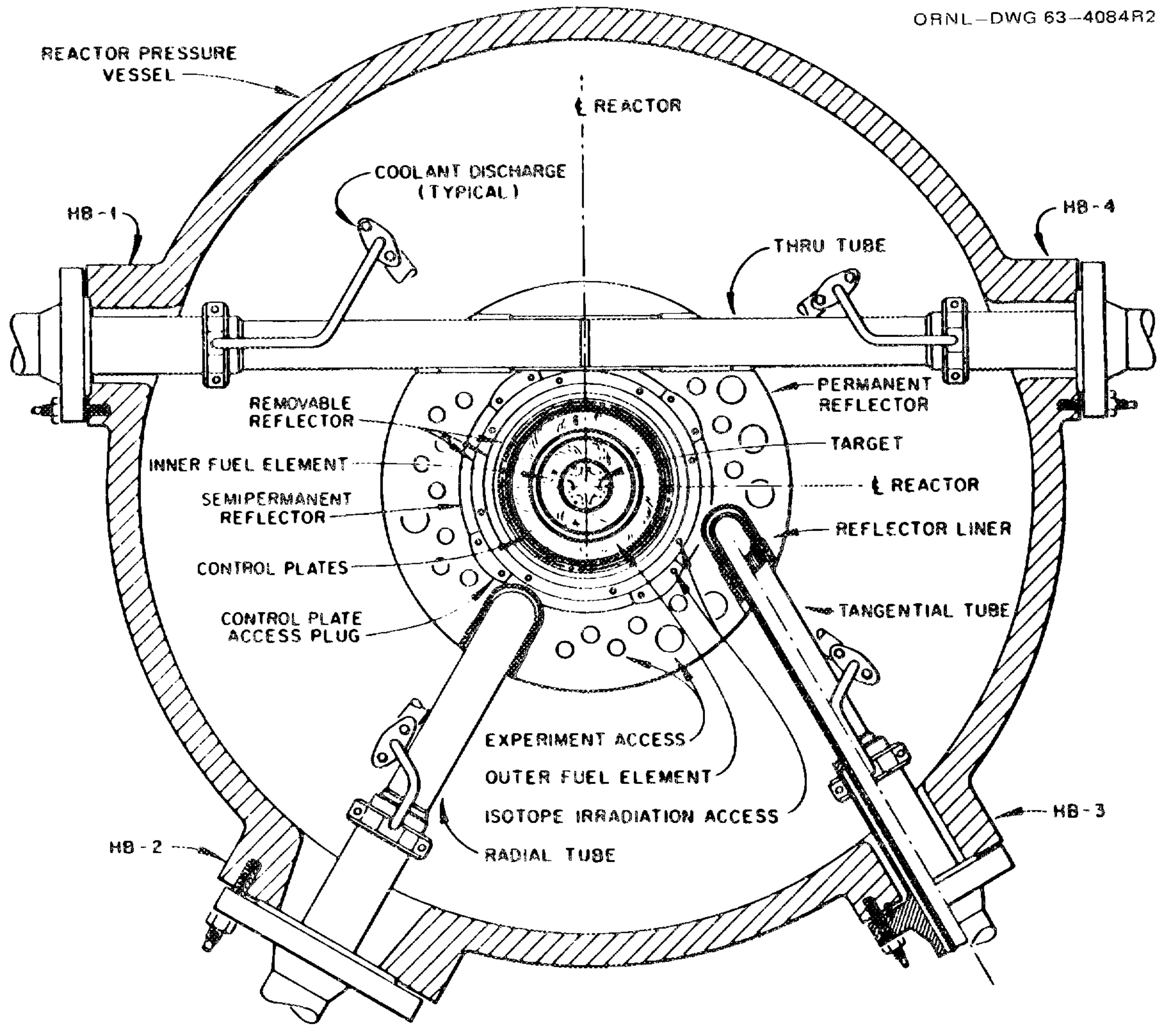


Fig. 1. Plan view of HFIR showing reactor components, fuel, and beam tubes.

for materials irradiation experiments. The HFIR is thus a multipurpose facility, but the fixed loading of the aluminum-clad, U_3O_8 fuel element — consisting of involute plates — is much less flexible than a general-purpose materials test reactor in which the loading and arrangement of the fuel elements can be varied within quite wide limits.

Small (16-mm-diam) irradiation capsules can be placed in the target region, but with no pressure vessel penetrations provided for access, these experiments could not be instrumented. It was possible to irradiate somewhat larger (37-mm-diam) capsules in four positions in the beryllium reflector surrounding the control plates outside the outer fuel element. This part of the reflector is designed to be readily removable because radiation damage necessitates frequent replacement (every 2.5 years); thus, the irradiation facilities in it are called the removable beryllium (RB) positions. Penetrations through the pressure vessel allow access for capsule instrumentation and temperature-control gas lines in the RB positions, but the access flanges are not directly above the irradiation facilities so that in situ vertical and rotational adjustments of the instrumented irradiation capsules using these penetrations are difficult (Fig. 2).

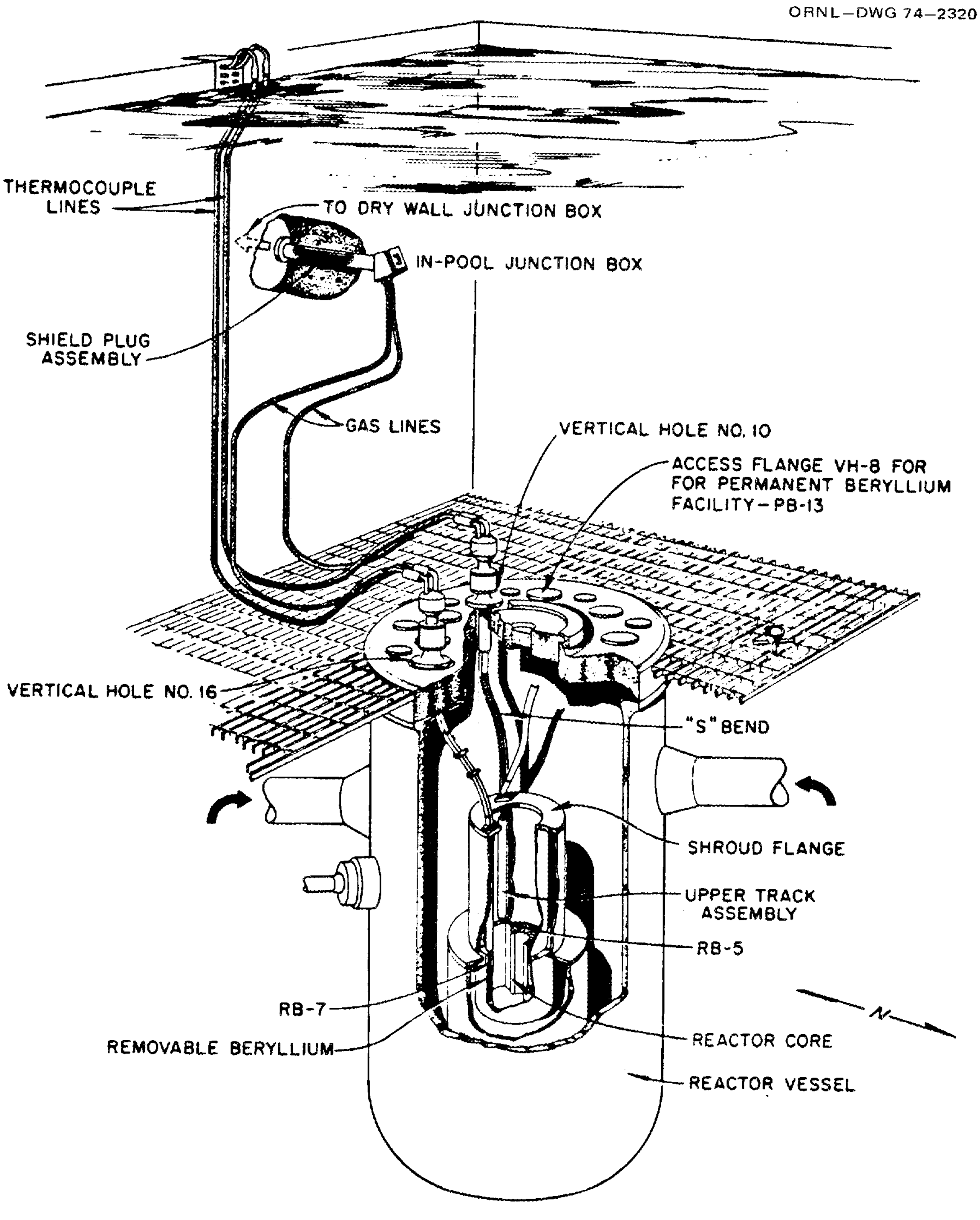


Fig. 2. Old experimental facilities in HFIR.

2. HFIR IRRADIATION FACILITIES IMPROVEMENT PROJECT

In 1984, an ad hoc committee was established by the Oak Ridge National Laboratory (ORNL) Executive Committee to "...consider and recommend changes and improvements to the Laboratory's facilities for materials irradiation testing."[1] The committee's report[1] included recommendations for certain modifications to the HFIR that would significantly enhance the number and value of materials irradiation experiments that could be accommodated by the reactor. The HFIR Irradiation Facilities Improvement (HIFI) Project was established to implement these recommendations with support from the Office of Fusion Energy (OFE), the Basic Energy Sciences (BES) Program, and the Laboratory's General Purpose Equipment (GPE) funds. The GPE funds are currently being used to upgrade the experiment control room containing the utilities for the instrumented experiments; this report does not cover that work.

The HIFI Project efforts were divided into two phases: phase 1 — to provide at least two instrumented target region facilities and phase 2 — to provide larger and additional irradiation positions in the RB with straight-line access penetrations through the pressure vessel.

A conceptual design showing the new components in the reactor was completed in September 1985. A design report containing finite-element stress analyses of the pressure boundary components (issued on November 5, 1985, by C. W. Collins) and a hydraulics analysis of the new reflector (issued on June 15, 1987, by W. E. Thomas) are attached as Appendix A. Figure 3 shows the new experimental facilities layout.

2.1 Phase 1

The instrumented target facilities required newly designed and fabricated components from the bottom to the top of the reactor "stack." These components included a fuel grid, target holder, outer shroud, target tower, target hole plug, quick-access hatch, rabbit facility U-bend, and several in-pool tools for removing and replacing each component. Photographs were taken of each item and are shown in Figs. 4—11. A diagrammatic side view of the HFIR components is shown in Fig. 11. The target tower extends upward from the target region to a quick-access hatch and target hole plug in the pressure vessel lid. The tower houses three guide tubes — one for the hydraulic rabbit facility and the other two for the instrumented target facilities.

To utilize funds allocated by the U.S./Japan fusion materials program to measure temperatures in the target region experiments, the project scheduled these facilities to be ready for an instrumented target capsule experiment by August 1986. Even with a delay in funding (over 3 months) during FY 1986, the commitment was met. The first instrumented target capsule was inserted on August 14; the reactor went to power on August 17, 1986; and the experiment was successfully completed.[2]

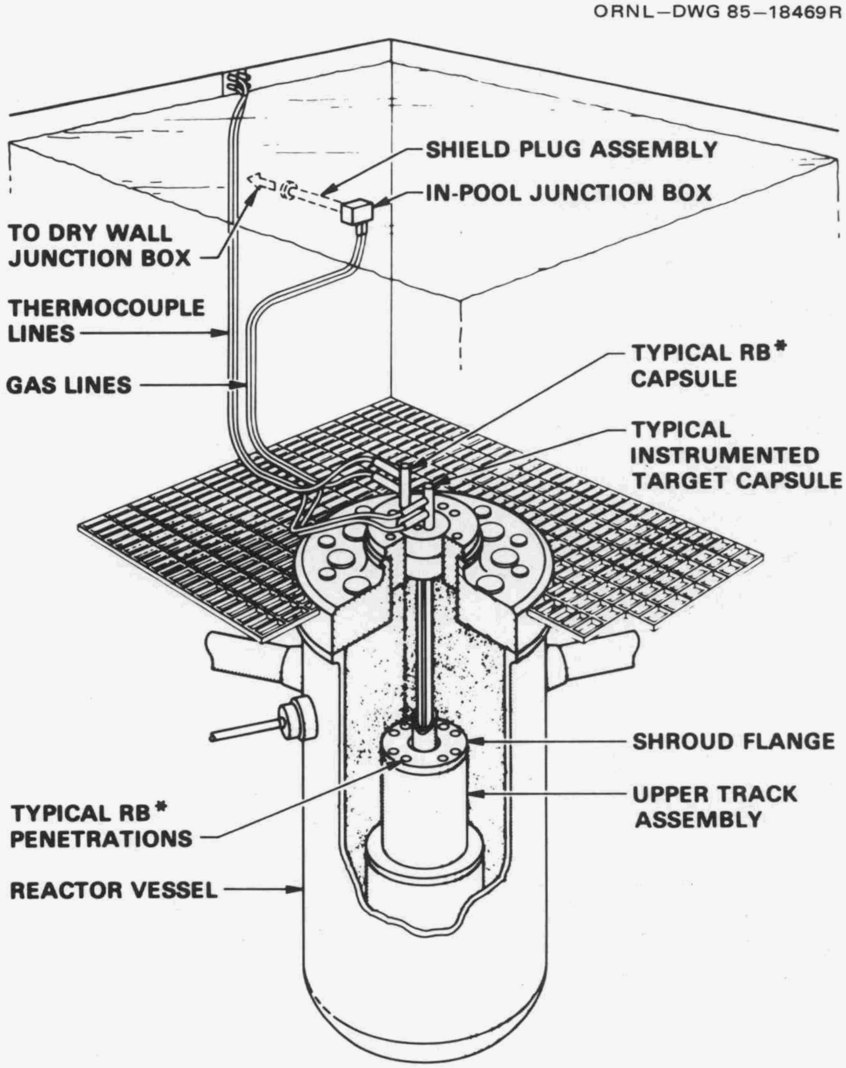


Fig. 3. New experimental facilities in HFIR.

ORNL—PHOTO 3942—86

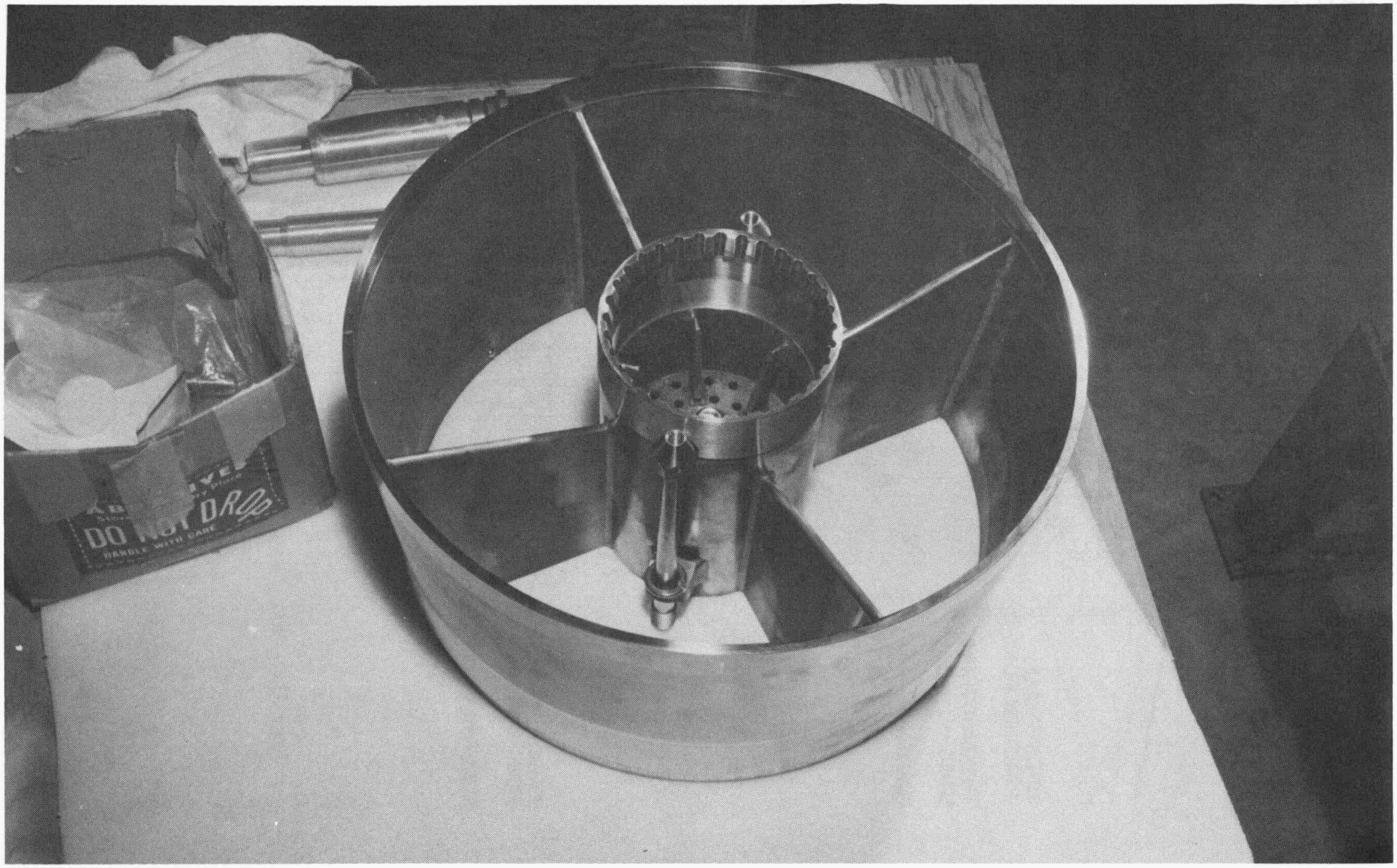


Fig. 4. Fuel grid.

ORNL–PHOTO 3939–86

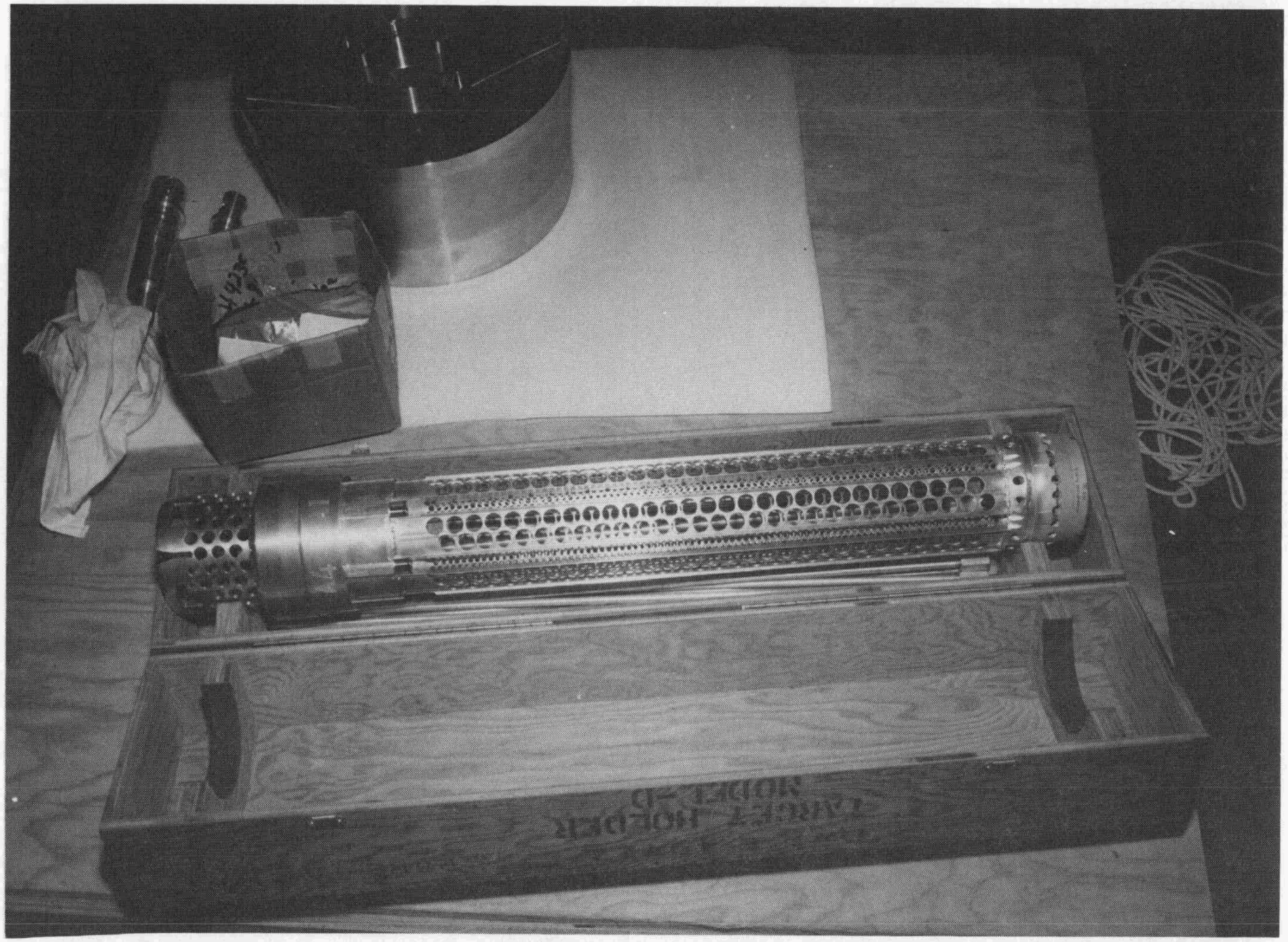


Fig. 5. Target holder.

ORNL–PHOTO 4175–86

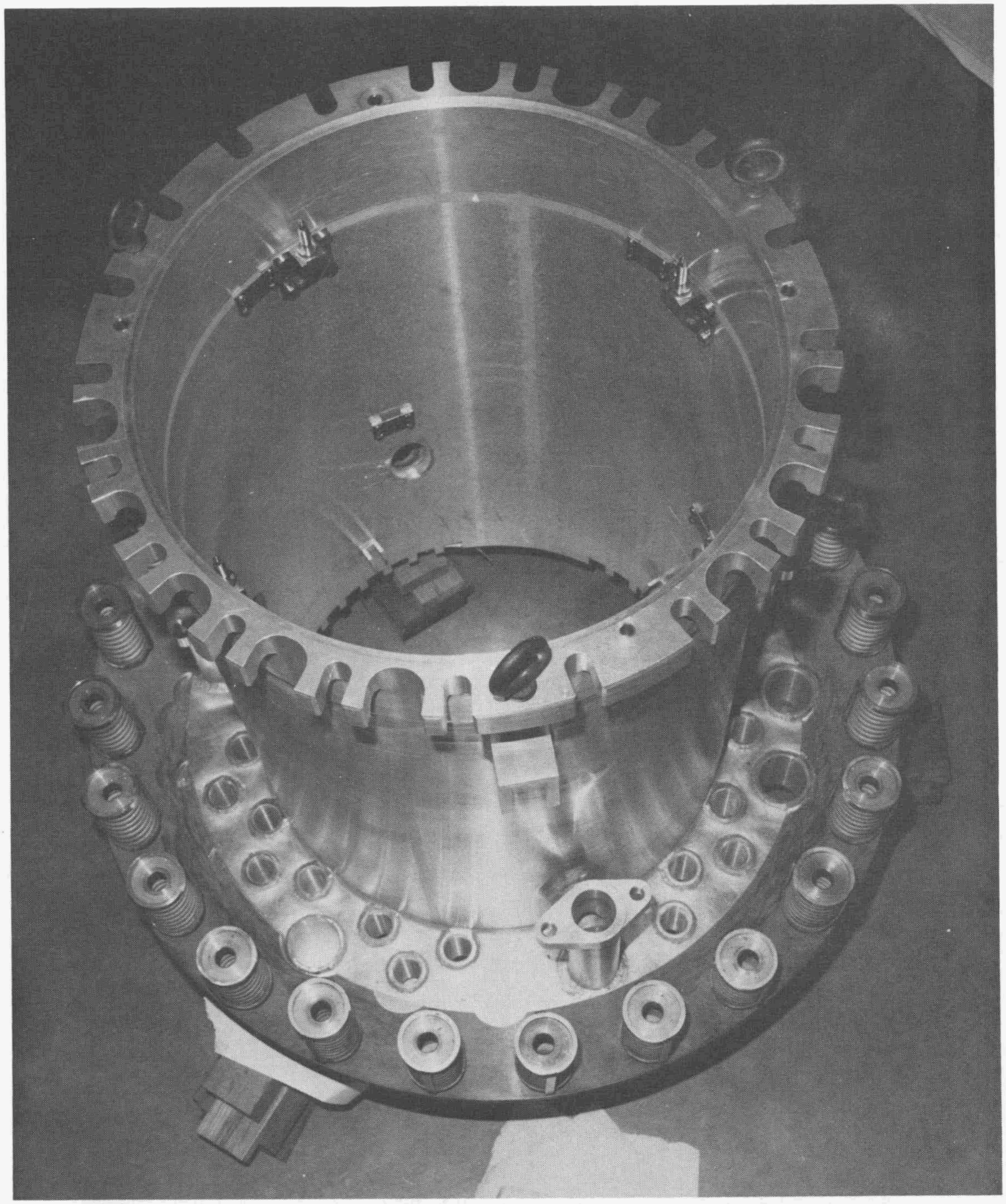


Fig. 6. Outer shroud.

ORNL–PHOTO 3937–86

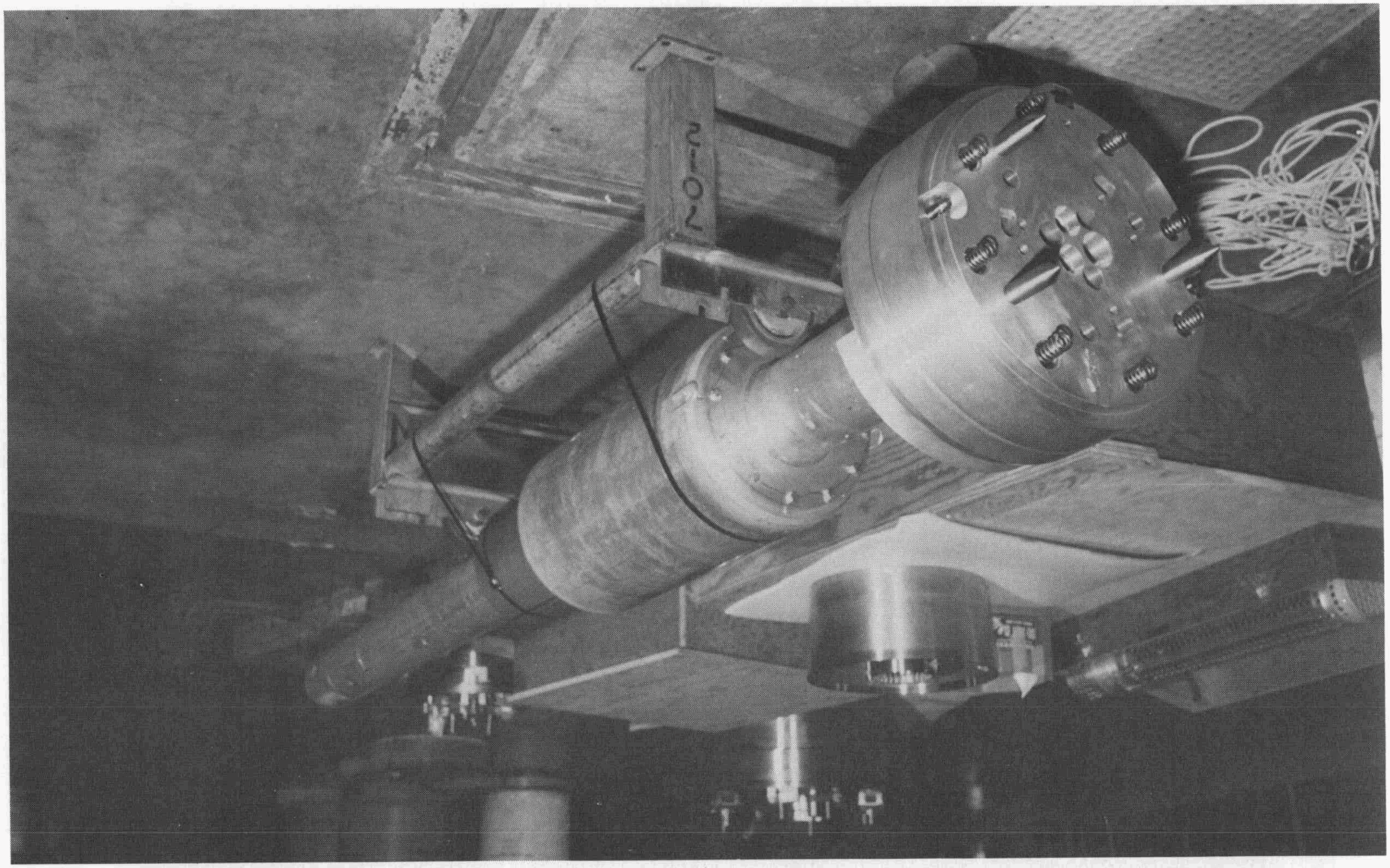


Fig. 7. Target tower.

ORNL—PHOTO 3941—86

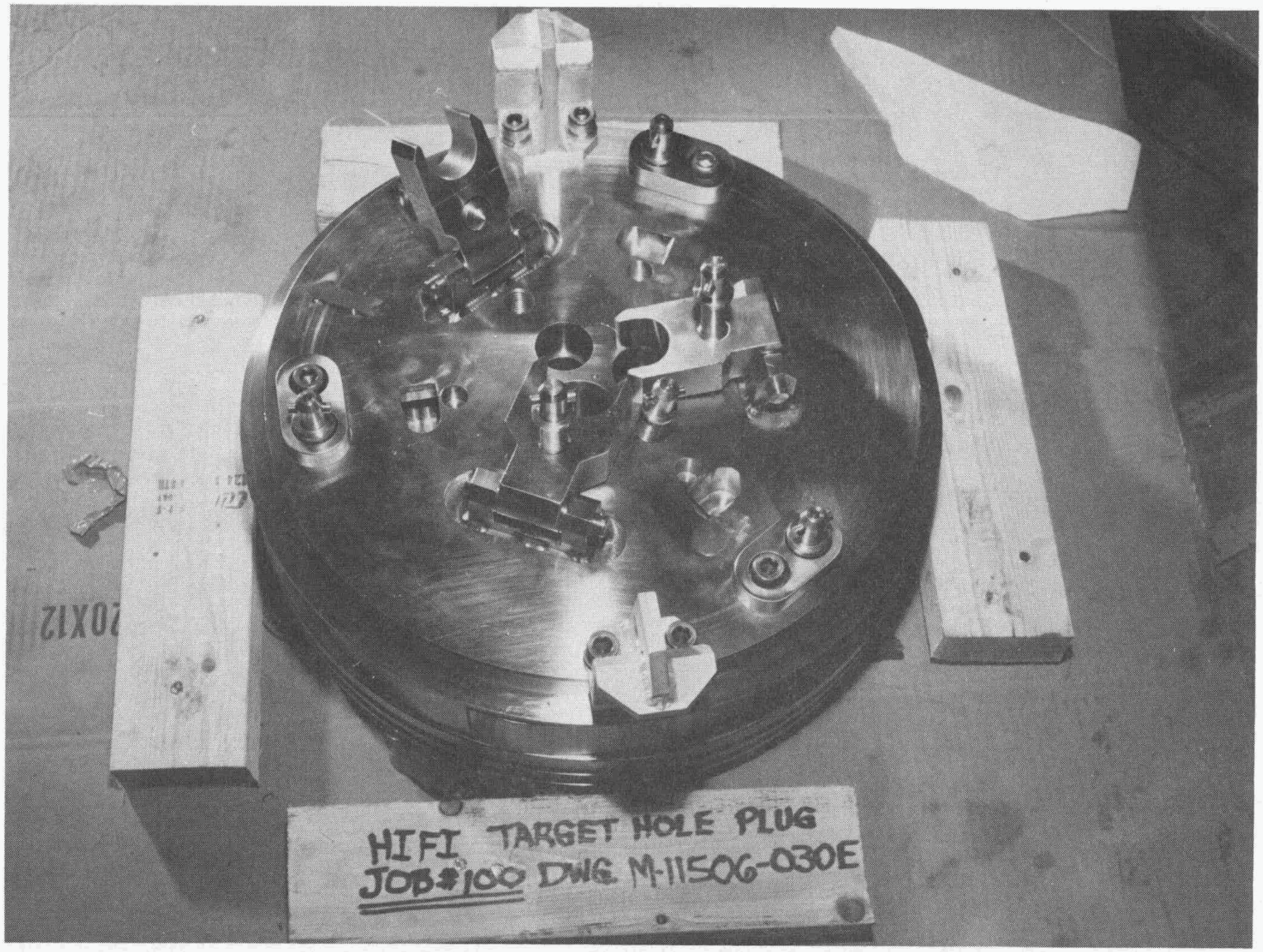


Fig. 8. Target hole plug.

ORNL–PHOTO 3935–86

Fig. 9. Quick-access hatch.

ORNL—PHOTO 5266–86

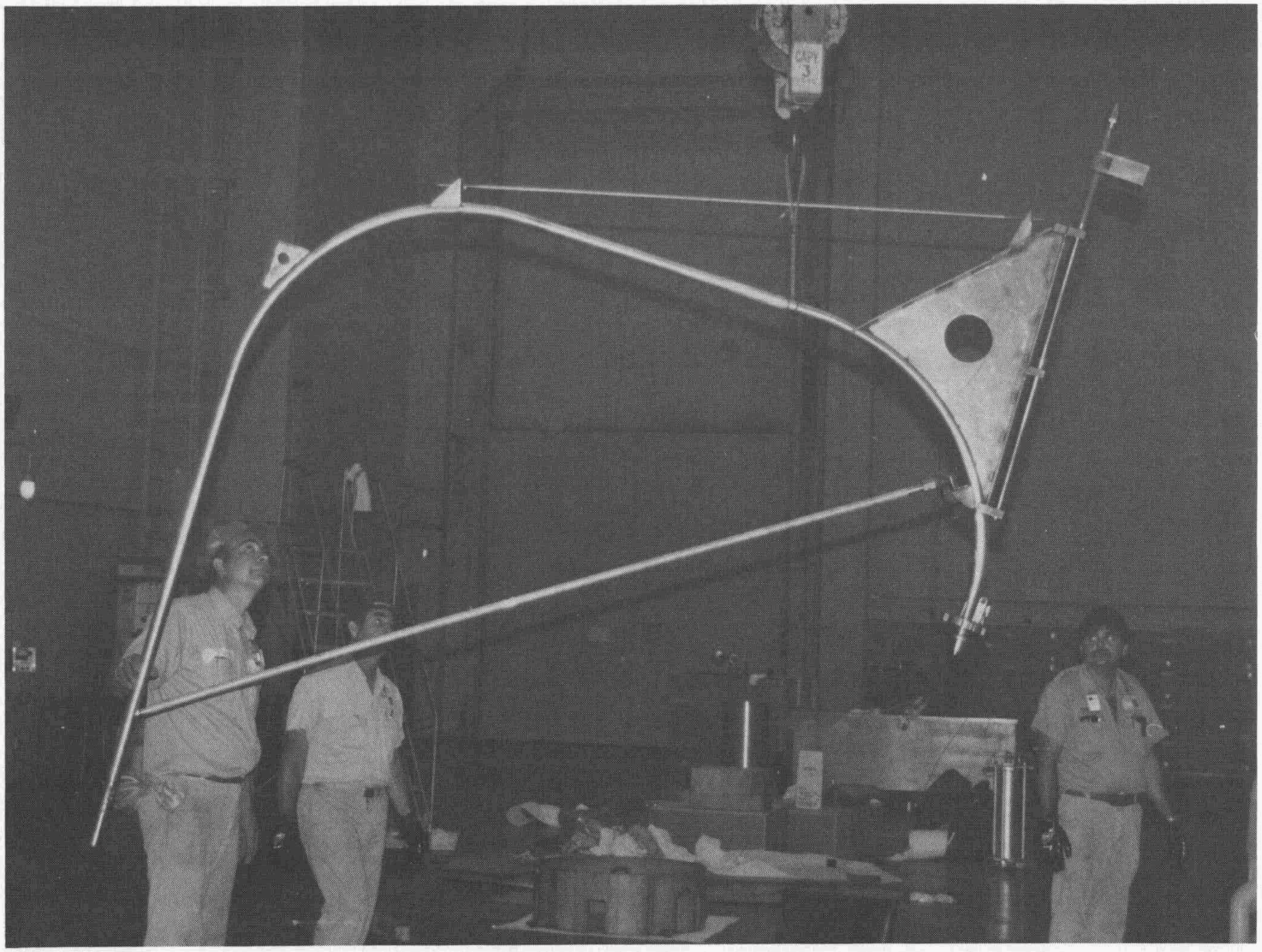


Fig. 10. Rabbit facility U-bend.

ORNL–PHOTO 5251–86

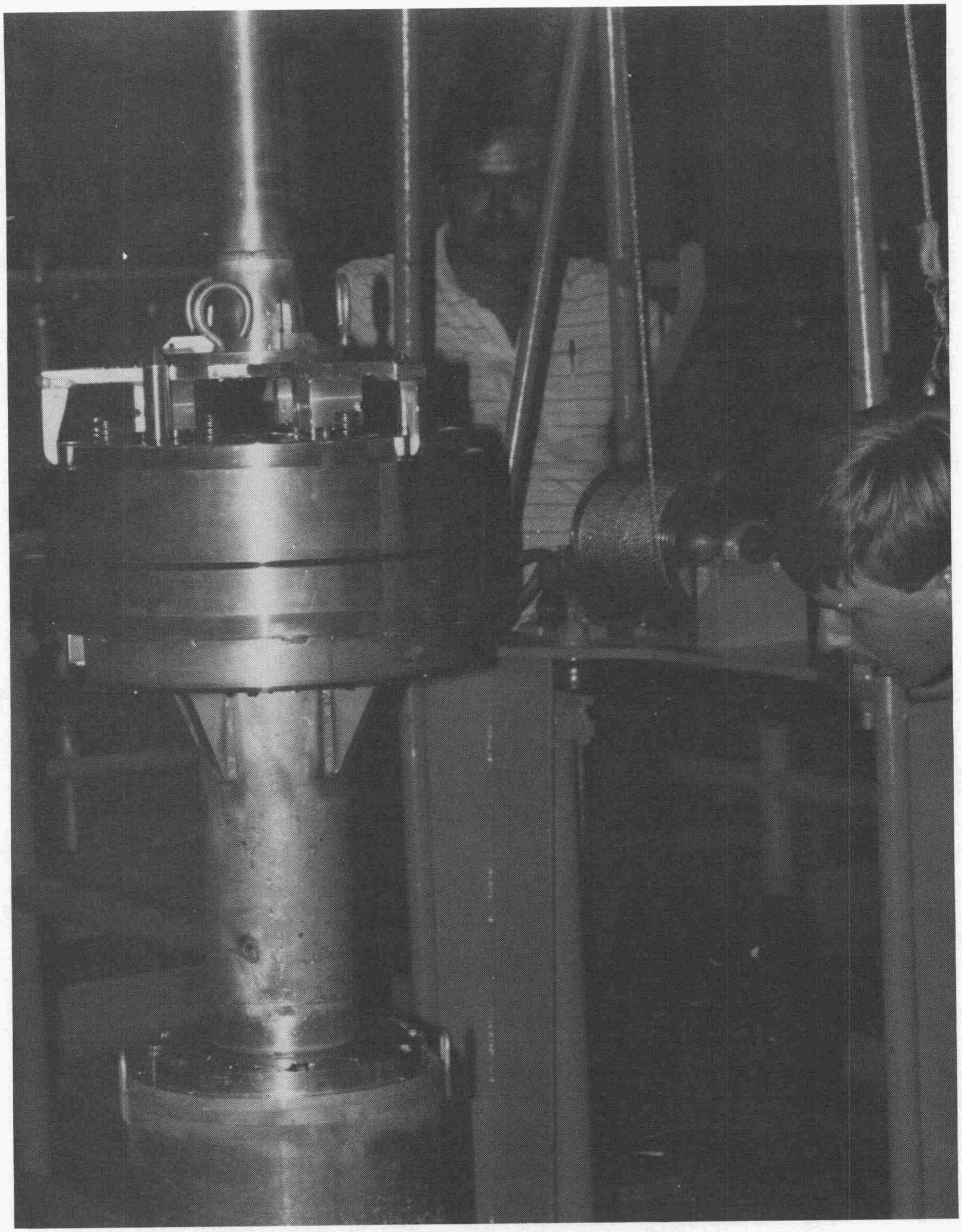


Fig. 11. Target tower lifting tool.

2.2 Phase 2

The new RB facilities required a new design for the reflector, replacing the four 37-mm-diam positions with eight holes, each with a diameter of 48 mm. This change increased the total experimental volume available within the RB by a factor of 3 to 4. The new positions are referred to as the RB Star (RB*) facilities, and they can accommodate most of the irradiation work previously undertaken in the core of the Oak Ridge Research Reactor (ORR), taking only one-third to one-half the time to accumulate the same damage level.

Some other components mounted above the beryllium reflector were also replaced with new designs. Specifically, the track assembly and the shroud flange (part of the systems that locate and guide the control plates) were replaced to provide clearance for the new facilities. In addition, the new quick-access hatch (Fig. 12) with more penetrations provides straight-line instrumentation access to each of the RB* positions. The straight-line access will permit rotation (for radial flattening of the flux) and vertical relocation of irradiation capsules during the course of an experiment as well as allowing capsules to be interchanged among any of the eight positions. Photographs of the RB reflector, track assembly, and shroud flange are shown in Figs. 13–15.

2.3 Project Reporting

Monthly progress reports beginning in September 1985 and continuing through June 1987 were written and distributed to all interested personnel. All of these reports are attached as a record of the conduct of the project (Appendix B). Also, monthly costs and schedule assessment reports were transmitted to DOE (copies attached to the progress reports).

2.4 Project Milestones

During the August 13–17, 1986, refueling shutdown of the HFIR, Phase 1 of the project was completed on schedule with the installation of the equipment necessary to operate instrumented irradiation experiments in the target region. At the same time the first capsule was installed to utilize this facility. This capsule insertion, one of the U.S. Japan Fusion Materials Collaboration Program milestones, had been planned for this shutdown period since mid-1985. The Martin Marietta Energy Systems Achievement Report forms, recording successful completion of the milestone, are attached as Appendix C.

In October 1986, Phase 2 of the project was established as a DOE milestone for Martin Marietta Energy Systems: "Complete HFIR modifications to allow conduct of instrumented experiments in the RB positions — June 1987." The milestone was met with optical alignment completed on June 19, 1987, confirming the functional use of all components. The notification of completion is also attached in Appendix C.

ORNL–DWG 85–18470

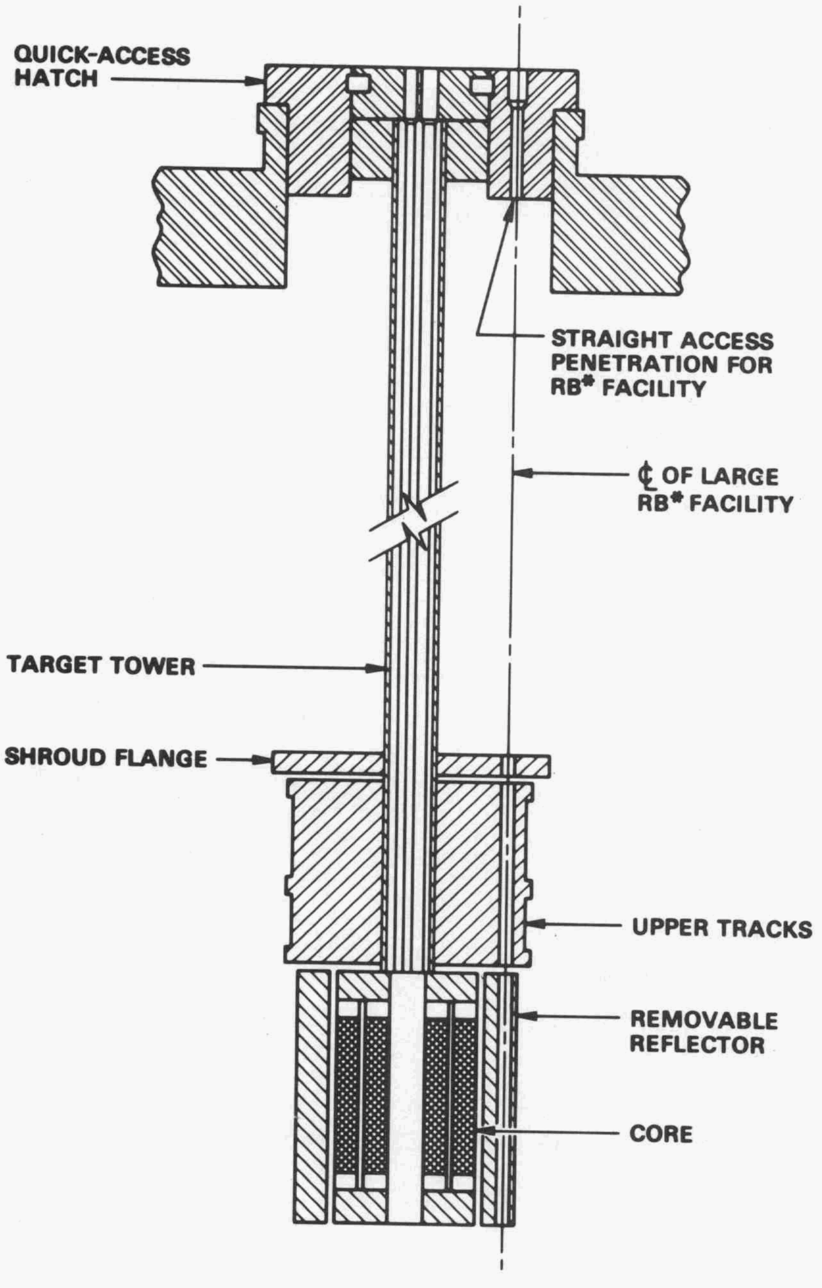


Fig. 12. General arrangement of core target tower and quick-access hatch.

ORNL–PHOTO 4853–87

Fig. 13. Removable beryllium reflector.

ORNL–PHOTO 4851–87

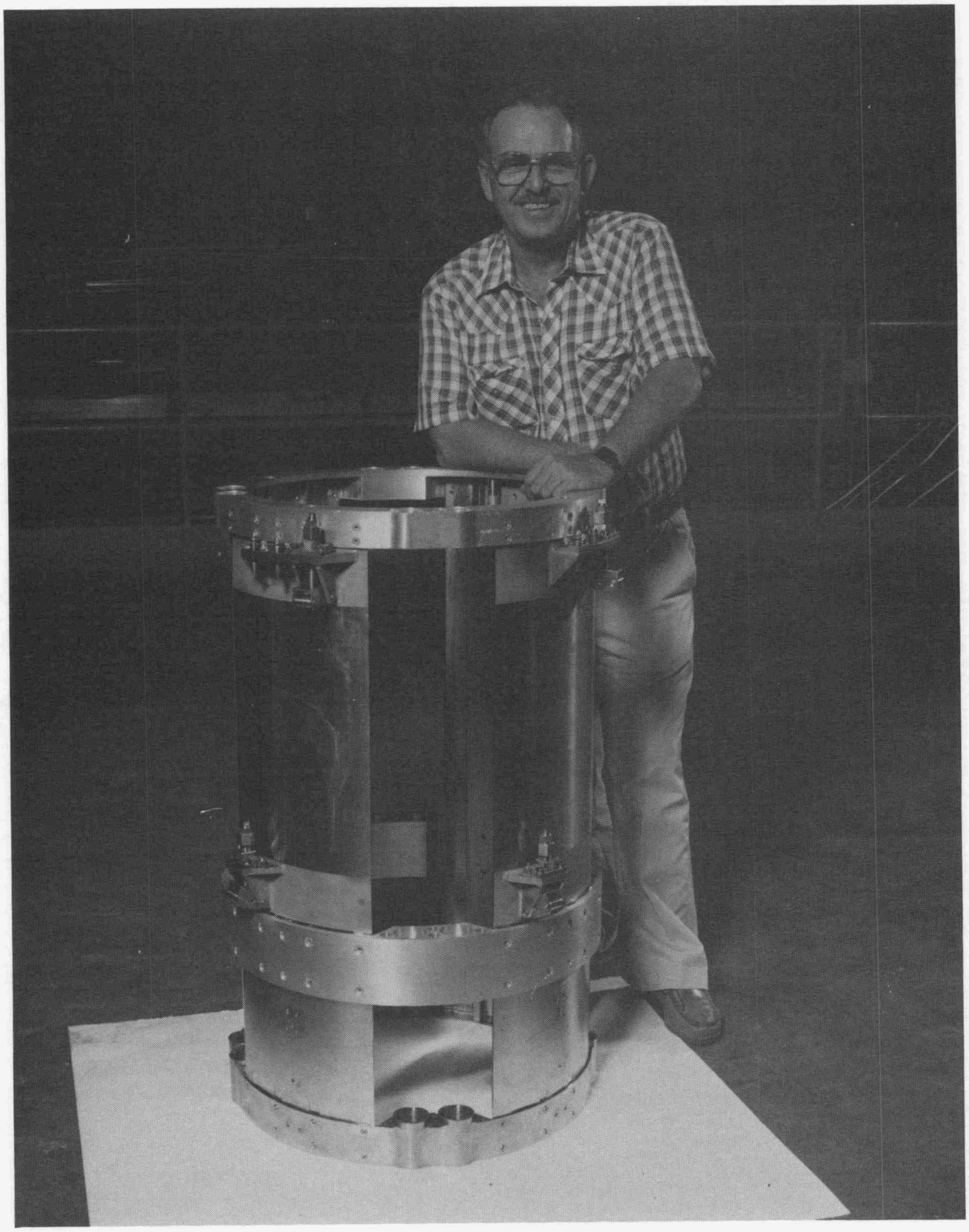


Fig. 14. Track assembly.

ORNL—PHOTO 4852—87

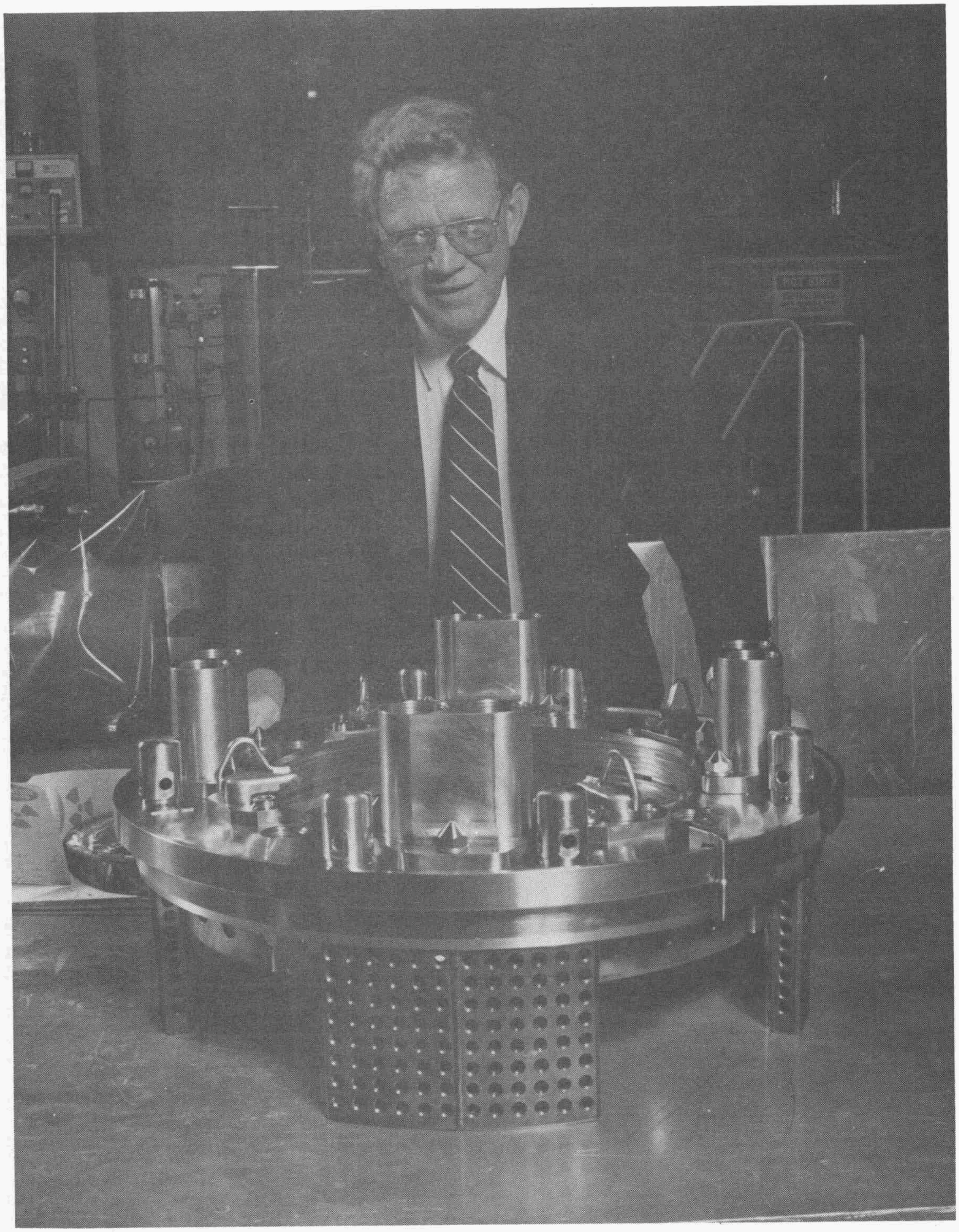


Fig. 15. Shroud flange.

3. NEUTRON FLUX, FUEL CYCLE LENGTH, AND DOSIMETRY MEASUREMENTS

As indicated earlier, the HFIR is a multipurpose reactor, and there was a natural concern about the possible effects of more and larger materials irradiation experiments on other users. Two important questions concern the effect of neutron absorbers in the RB positions on beam-tube thermal flux and on the fuel cycle duration. To answer these questions, a series of experiments and flux measurements was carried out.

As a worst-case experiment, the effect of a 3.8-mm-thick hafnium sleeve placed in each of the four RB positions, in turn, was investigated. Such a thickness of hafnium should be adequate for most spectral-tailored irradiation experiments and will absorb almost all of the thermal neutrons falling on it; it is, therefore, a nearly complete absorber and represents the most extreme case to be encountered in practice. The change in the flux in typical neutron-scattering experiment positions at the various beam tubes was measured as the hafnium was placed in each RB position in turn. The results are shown in Table 1. The effect is less

Table 1. Change in flux at the HFIR beam tubes as a 3.8-mm-thick, 31.6-mm-diam hafnium shield is placed in RB irradiation positions

Hafnium position	Change[a] in thermal flux at beam tubes HB-1 through HB-4[b]			
	HB-1	HB-2	HB-3	HB-4
RB-1[c]	−3	0	+1	+2
RB-2	+4	*d*	+1	+4
RB-3[c]	+1	−1	−6	+2
RB-4[c]	+1	0	+2	−4

[a]The base case has the usual iridium (isotope production) capsules at all RB positions except RB-3.

[b]Measurements taken at a reactor power of 100 kW.

[c]The iridium in each of these positions in turn was replaced by the hafnium sleeve to make the measurements.

[d]This combination is considered impractical for heavily absorbing materials irradiation experiments because of the very close proximity of RB-3 to the HB-2 beam tube (100-mm separation). The loss of flux was actually 13%.

than about ±5% in all cases likely to be permitted in practice. The increase in flux that is observed in some positions may merit a further explanation. Putting an absorber close to the fuel reduces the thermal flux in that region and, therefore, the local power level in that part of the core. With the same overall power, the local power density on the opposite side of the core must increase to compensate, leading to a higher local flux in that zone. The results are presented graphically in Fig. 16.

Measurements of the effect on fuel cycle length are more difficult or at least less accurate, because of the core-to-core variations introduced by manufacturing tolerances and because the loading of experiments and isotope production capsules is changed from cycle to cycle; these and other effects introduce a cycle-to-cycle length variation of up to ~1 d. Reactor time is too valuable to perform a controlled experiment with no other experiments allowed to change their loadings over many cycles. Careful measurements and comparison with historical data on the relationship between initial core reactivity and fuel cycle length have resulted in calculations showing that the effect of the hafnium absorber is to shorten the fuel cycle by 21 ±7 h or 4% of a typical cycle. The corresponding additional fuel costs are only about $100,000/year.

Dosimetry experiments were carried out to provide data on the materials damage rate to be expected in the new RB facilities. Analysis of the flux showed that the displacements-per-atom (dpa) rate expected in 316 stainless steel in the RB positions is 10.5 dpa/year. Even within the shielding provided by a 3.8-mm hafnium sleeve, the rate is 8.3 dpa/year.

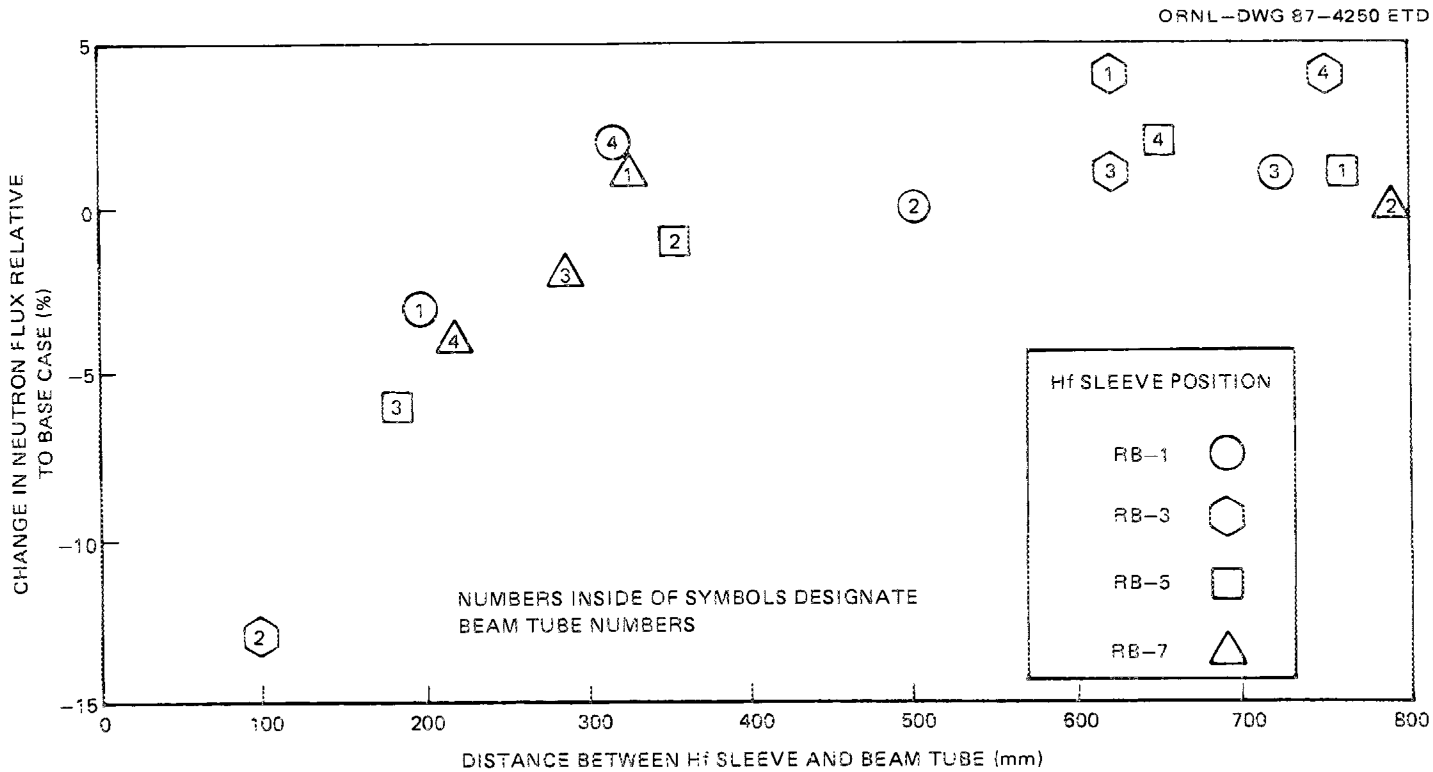


Fig. 16. Results of 100-kW runs with hafnium sleeve in various RB positions.

4. FUNDING AND COSTING

The HIFI Project was capital funded by the OFE and the BES Program through a DOE-approved OR-638-86-ORNL-2 Mod 1 (attached as Appendix D). The initial OR-638 only covered the funds that were available for FY 1986 ($710,000), whereas the revised Mod 1 included the additional funds ($242,000) needed to complete the project in FY 1987 for a total of $952,000, which is $160,000 under the initial estimate. The estimated costs vs the actual costs are shown in Table 2. The gamma heat experiment, listed under Neutronic Analysis, will avoid the need for gamma heat calculations that were previously required under this task.

Table 2. Estimated vs actual costs for the HFIR irradiation facilities upgrade

Discipline	Cost ($K)		
	10/29/85 Estimate	Actual	Underrun/ (overrun)
Design	233.0	182.8	50.2
Procurement/Fabrication[a]	603.0	424.5	178.5
Assembly	63.0	83.5	(20.5)
Inspection	0	40.2	(40.2)
Surveillance	144.0	162.9	(18.9)
Neutronic analysis	69.0	27.1	11.0
Gamma heat capsule[b]		30.9	
Total	$1,112.0	$952.0	$160.0

[a]Does not include the cost associated with the scheduled RB replacement that was, as always, funded by Operations/ Research Reactors Division operating funds.

[b]These funds are to be used to design, fabricate, and assemble a proposed experiment to measure gamma heating rates in the new RB* facilities. These experimental results will avoid the need for gamma heat calculations that were previously required under Neutronic Analysis funding.

The $160,000 underrun resulted from the project staff being able to reduce the estimated fabrication costs of parts and assemblies through innovative procurement from outside vendors. A tabulation of costs associated with fabrication is shown in Table 3. One item exceeded not only the estimated cost, but also the estimated delivery time; HFIR Job

Table 3. HIFI Project reactor components fabrication and assembly dates and final costs

HFIR job	Assembly/parts fabrication	Fabrication Start	Fabrication Complete	IN-HS cost ($K)	Vendor cost ($K)	7012 cost ($K)	Final cost ($K)	Remarks
			Phase 1					
84	Target holder	3/17/86	5/9/86	5.0		7.6	12.6	*a,b*
91	Fuel grid	4/7/86	6/6/86		17.4	2.9	20.3	*a*
93	Outer shroud	1/20/86	6/6/86	1.5	24.8	41.7	68.0	*a*
93B	Shroud drill J16	4/16/86	5/9/86		1.5		1.5	
96	Rabbit facility	4/7/86	5/7/86	6.0	9.5		15.5	*a,b*
96B	Rabbit hydro fixture	4/17/86	6/1/86		0.5		0.5	
96C	dP Target facility	4/30/86	5/8/86		0.7		0.7	*b*
98	Target tower	3/7/86	6/16/86		9.5	29.0	38.5	*a*
99	Quick-opening hatch	3/4/86	6/25/86	1.0	27.2	5.1	33.3	*a*
100	Target hole plug	3/4/86	6/25/86	0.2	9.1	2.0	11.3	*a*
101	Tool — in-pile	6/17/86	7/1/86	0.6	0.9		1.5	
	Tool — target hole	6/17/86	7/1/86		6.7		6.7	
	Stand — target storage	6/17/86	7/1/86	0.7	5.4		6.1	
	Tool — target holder	6/23/86	7/15/86	0.7	2.7		3.4	*b*
	Stand — exp. storage	7/15/86	8/15/86		1.3		1.3	
	Tools — miscellaneous		8/15/86		1.9		1.9	
	Reactor mockup	8/2/86	8/20/86	43.8			43.8	
	Reactor in-pool	8/21/86	8/23/86					
	Total			59.5	119.1	88.3	266.9	
			Phase 2					
94	Shroud flange	6/30/86	9/16/86		26.1		26.1	*a*
95	Removable reflector	8/15/86	5/8/87		184.0		184.0	*a,c*
95B	Reflector parts	11/15/86	1/5/87		5.4		5.4	
97	Track assembly	9/2/86	5/13/87		150.4		150.4	*d*
97B	Track assembly parts	8/15/86	9/5/86	2.0	12.8		14.8	*a*
116	Dummy quick-access hatch	3/3/87	5/7/87		7.2		7.2	
117	Dummy target hole plug	3/3/87	5/7/87		6.4		6.4	
118	Stand — exp. storage	5/20/87	6/10/87		4.0		4.0	
119	Miscellaneous pins and fixtures	5/20/87	6/15/87		2.0	3.0	5.0	
121	Reactor mockup	5/15/87	6/22/87	22.0			22.0	
	Reactor in-pool	(unknown)						
	Total			24.0	398.3	3.0	425.3	
	Fabrication and assembly grand total			83.5	517.4	91.3	692.2	

[a] Excludes material cost.

[b] Modified existing components.

[c] Costed by Operations Division; not included in the HIFI Project funding.

[d] Fabricated by Y-12 General Machine Shop using existing segments (six segments partially finished).

No. 97, Track Assembly, was estimated at $102,000 with a delivery date of March 1987 by the Y-12 General Machine Shop. The actual cost was $150,000, and the assembly was delivered on May 13, 1987. This was the exception, and careful planning and rescheduling of other tasks allowed timely completion of the project despite the delay.

REFERENCES

1. C. W. Alexander, J. A. Conlin, S. S. Hurt, R. M. Moon, Jr., E. Newman, Jr., A. F. Rowcliffe, K. R. Thoms, and C. D. West, *Report of the Materials Irradiation Facilities Improvements Committee*, ORNL/TM-9709, Oak Ridge Natl. Lab., October 1985.

2. I. I. Siman-Tov, "Instrumented HFIR Target Capsule," *Fusion Reactor Materials Semiannual Progress Report*, DOE/ER-0313/1, March 31, 1987.

APPENDIX A

DESIGN REPORT FOR REDESIGN OF QUICK-OPENING HATCH AND TARGET HOLE PLUG FOR THE HIGH FLUX ISOTOPE REACTOR

Design Report

for

Redesign of Quick Opening Hatch
and Target Hole Plug

for the

High Flux Isotope Reactor
Martin-Marietta Energy Systems
Oak Ridge, Tennessee

C. W. Collins
Registered Professional Engineer
Oak Ridge, Tennessee

November 5, 1985

CERTIFICATION

I,the undersigned, being a Registered Professional Engineer competent in the applicable field of design and using the Design Specification and the drawings identified below as the basis for design, do hereby certify that to the best of my knowledge and belief this Design Report complies with the requirements of the ASME Boiler and Pressure Vessel Code, Section III, 1983 Edition with Addenda to and including Summer 1985.

Drawing and Revision:

M 11506-OH-020 Rev. 0	Quick Opening Hatch
021 Rev. 0	Details
030 Rev. 0	Target Hole Plug
031 Rev. 0	Details
032 Rev. 0	Details
033 Rev. 0	Details
Allis Chalmers 43-501-063	Quick Opening Hatch

Certified by *Charles W. Collins* P.E.

Registration No. *4028* State: *Tennessee*

Date *James E Rutenber Jan 17, 1986*

I. Introduction

Installation of the HIFI Experiment into the High Flux Isotope Reactor requires more holes through the Target Hole Plug and the Quick Opening hatch for insertion of experiments into the reactor. These two pressure components were analyzed for the new configureation. It was originally planned to modify the Quick Opening Hatch Ring, but it was subsequently found this was not necessary. Since the analysis of the basic Hatch Ring was completed, the results are included in the report for reference.

II. Design Specification

The High Flux Isotope Reactor Vessel was designed and fabricated by the Allis-Chalmers Manufacturing Company. The Design Specification and the Design Report are included in their "Structural Design Report" dated October 5, 1962. This design and fabrication was prior to the existance of the ASME Boiler and Pressure Vessel Code - Section III for Nuclear Components. However, it was designed and constructed to Sectioin VIII of the Code, supplemented by the requirements of Code Cases 1270N, 1271N, 1273N, and the "Tentative Structural Design Basis for Reactor Vessels and Directly Associated Components", the so called "Navy Code". These requirements are the anticedents of the current requirements for ASME Section III - Class 1 Components used for the current design.

The High Flux Isotope Research Reactor, being a relatively low power, pool type, research reactor is not subject to any significant transient conditions as are power reactors. Therefore, Service Loadings A, B, C, and D are not specified and the analyses are based on the loadings for the the Design Conditions as listed below:

Design Conditions

Design Pressure	1000psi
Design Temperature	200 F
Seismic Requirements	None
Service Loadings	None
Cyclic Loadings	1000 Startups and Shutdowns to Design Pressure and Temperature
Thermal Cycle Loadings	None
Thermal Cycle Loadings	None

Codes and Standards

ASME Boiler and Pressure Vessel Code - Section III - Class 1, 1983 Edition with Addenda through Summer of 1985

Code Boundaries

The Code boundary of the components extends to the outer surface of each of the components but does not include the brackets or attachments.

Applicable Drawings

The stress analyses are based on information on the following drawings:

M 11506-OH-020 E Rev.0	Quick Opening Hatch
M 11506-OH-021 E Rev.0	Details
M 11506-OH-030 E Rev.0	Target Hole Plug
M 11506-OH-031 E Rev.0	Details
M 11506-OH-032 E Rev.0	Details
M 11506-OH-033 E Rev.0	Details
Allis-Chalmers 43-501-063	Quick Opening Hatch

IV. Stress Analysis

A finite element stress analysis was made for each of the components using the "SAP 86 Finite Element Computer Program" which is a Personal Computer version of the SAP IV Program. SAP 86 was developed by Number Cruncher Microsystems, Inc., San Francisco, California. SAP IV is a thoroughly documented and tested program and the SAP 86 version has demonstrated comparable performance on the documented benchmark problems.

Results of the stress analysis indicate that all stresses in the components under the specified loading conditions are well within the limits established by the Code. In fact, the design is so conservative, that in some instances the analysis procedures were simplified because some complex stress categories which are permitted to have higher allowable stress limits could meet the lower limits of simple membrane stresses. This eliminated the tedious chore of assigning the finite element stress output into primary, local, bending and secondary stress classifications, each of which has its allowable stress level.

The computer outputs, nodal point and element layouts, and component sketches have been relegated to Appendicies A, B, and C. The computer models are axisymmetric solid elements of revolution about the longitudinal or vertical axis. The relationship between the various axes referred to in the computer output and in this report are as follows:

Common Useage	Translation Coordinates	Stress Designation
Radial	Y	S11
Longitudinal	Z	S22
Tangential	X	S33

In addition to the SAP 86 finite element analysis, an independent analysis was done using the PATRAN three dimensional finite element analysis. This method used larger sized elements than SAP 86. For this reason, it is felt that most of the calculated stresses were not quite as accurate as the SAP 86 calculated stresses. However, the stresses around the holes in the components are probably more accurate than the method used, which was to apply a stress intensifacation factor to the SAP 86 stresses which were calculated without modeling the holes. The PATRAN program calculated stresses were lower than those from applying stress intensification to the SAP 86 rersults, indicating conservatism in the analytical approach employed.

V. Evaluation of Stresses

Target Hole Plug - Drawing M-11506-OH-030-E-Rev.0 *JER*

The Target Hole Plug is a 17.5" diameter disc, 6" thick, with three experimental holes near the center and a shear bar latching mechanism located within the plug to couple it to the Quick Opening Hatch. To simplify the finite element analysis, the center region is represented by one 4" diameter hole and the metal above the latching mechanism has been eliminated and this portion of the plug analyzed by a simple hand calculation. The 1000 psi design pressure acts on the bottom face of the plug with an additional pressure on the first element to account for the pressure transferred to the plug from the components in the center holes.

Examination of the finite element analysis shows the highest stresses occur at three predictable places, elements 1,67, and 72, as shown in the table below. The tabulated Smax and Smin values are the principal stresses acting on the 2 plane, while S33 is the third principal stress.

Table 1 - Stresses in Target Hole Plug

Element Numbers

	1	7	36	67	69	72	104	197
S11	- 725	-5150	- 163	8276	4739	1842	542	73
S22	-2486	- 839	-3051	2739	193	-9117	- 108	15
S33	-6430	-5187	-1752	5265	3970	233	2887	1927
S12	- 64	- 134	-1062	- 243	- 269	-2631	- 241	- 251
Smax	- 723	- 889	186	9189	4755	2441	662	297
Smin	-2488	-5154	-3400	1826	177	-9716	187	- 208
S Int	-5707	-5154	-3400	9189	4755	-9716	2700	2135

PLANT	OAK RIDGE, TENNESSEE	
JOB		REF. DWG. NO.
SUBJECT Target Hole Plug		PAGE 1 OF
COMPUTATION		NO.
COMPUTED BY C H Collins	CHECKED BY J E Rutenton	DATE 11-5-85

TARGET HOLE PLUG - Primary Plus Secondary Stresses

Material - 304 Stainless Steel

$S_m = 20,000$ psi

From the finite element stress analysis it is seen that all of the stresses, regardless of category, are below this value, thus are acceptable.

Peak Stresses - Fatigue stresses at Element 67

Use a stress concentration factor of 2 because some stress concentration is included in the finite element analysis because of the fine mesh.

$F = 2 \times 9189 = 18,378$ psi

$S_A = 9189$ psi - No fatigue analysis is required because the number of cycles permitted at this stress amplitude is much greater than the required 10^3 cycles.

Ligaments between 3 Center Holes

Use smallest size hole for pressure load.

$A = \frac{1}{2} bh - \text{Hole area} = 0.5 \times 1.995^2 \cos 30° - 0.333 \times 0.7854 (1.187)^2 - 0.167 \times 0.7854 (1.375)^2$

$= 1.723 - 0.2618 - 0.247$

$= 1.214 \text{ in}^2$

$P = 1000 \times 1.214 = 1214^{\#}$

$\text{Shear Area} = [(1.995 - 1.750) + 2(1.995 - 1.375)] \times 6$

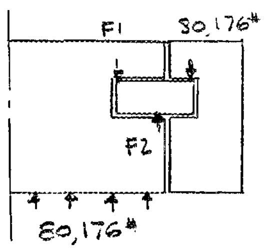
$= 8.91 \text{ in}^2$

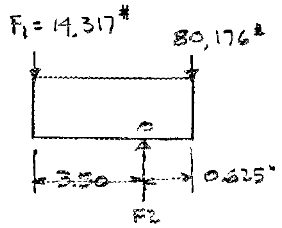
$\tau = \frac{1214}{8.91} = 136$ psi - Shear stress in ligaments OK

PLANT	OAK RIDGE, TENNESSEE	
JOB		REF. DWG. NO.
SUBJECT Target Hole Plug		PAGE 2 OF
COMPUTATION		NO.
COMPUTED BY [signature]	CHECKED BY J E Ritenber	DATE 11-5-85

<u>Shear Stress on Plug from Lock Mechanism</u>

The finite element model was simplified by ignoring the upper outside piece which is used to contain the upper gear bearings and transfer the shear force of the locking plate to the plug. The shear stress from this load to the plug will be calculated manually. There are three of these mechanisms to transfer the shear load to the target plug.





Freebody of Shear Plate

P/Sector = 1000 × 17.5² × 0.333
= 30,176#

$\Sigma M_o = 30{,}176 \times 0.625 - 3.5F1 = 0$
F1 = 14,137#
F2 = 14,137 + 30,176 = 44,313#

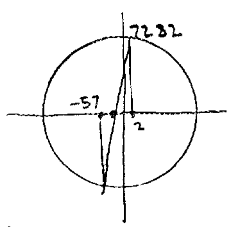
Shear Area on Plug = 2 × 5.25π × 1/3 = 11 in²

$\tau = \frac{30{,}176}{11} = 7{,}289$ psi

Combining this shear stress with the stress at element 108

S12 + 7289 = −11 + 7289 = 7278 psi < 0.7×20,000 = 14,000 psi OK

in the 1-2 Plane



Mohr's Circle

Center of Circle at −29.5

Radius of Circle = $\sqrt{(32)^2 + (7278)^2}$ = 7278

Max S = 7278 − 30 = 7248 psi

Min S = −7278 − 30 = −7308 psi

S33 = 1354 psi

Max Stress Intensity = 1354 + 7308 = 8662 psi

UCN-1070A (1 9-83)

PLANT	OAK RIDGE, TENNESSEE	
JOB		REF. DWG. NO.
SUBJECT Target Hole Plug		PAGE 3 OF
COMPUTATION		NO.
COMPUTED BY [signature]	CHECKED BY [signature]	DATE 11-5-85

Stresses at Gear Shaft Opening in Plug - Element 69

Apply Elastic Stress Concentration Factor of 3 to stresses S11 and S33

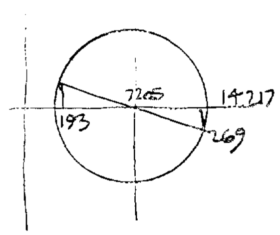
S11 × 3 = 4739 × 3 = 14,217

S33 × 3 = 3970 × 3 = 11,910

S22 = 193

S12 = -269

Principal Stresses in Plane 1-2



Center of Circle at $\frac{14,217+193}{2} = 7205$

R of Circle = $\sqrt{(269)^2 + (14217-7205)^2} = 7017$

Max S = 7205 + 7017 = 14,222 psi

Min S = 7205 - 7017 = 188 psi

Max Stress Intensity = 14,222 psi OK

Stresses at Spring Recess - Element 7

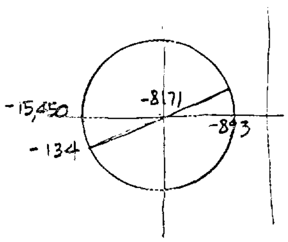
Apply Elastic Stress Concentration of 3 to stresses S11 and S33

S11 × 3 = -5150 × 3 = -15,450

S33 × 3 = -5187 × 3 = -15,561

S22 = -893

S12 = -134



Center of Circle = $\frac{-15,450-893}{2} = -8171$

R of Circle = $\sqrt{(134)^2 + (8171-893)^2} = 7279$

Max S = 7279 - 8171 = -892 psi

Min S = -7279 - 8171 = -15,450 psi

Max Stress Intensity = -15,450 psi OK

PLANT OAK RIDGE, TENNESSEE

JOB REF. DWG. NO.

SUBJECT Target Hole Plug PAGE 4 OF

COMPUTATION NO.

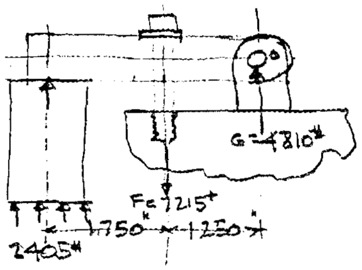
COMPUTED BY CW Collins CHECKED BY J E Peterkin DATE 11-5-85

Brackets for Plug

Area of Largest Hole Plug

$A = 0.7854(1.750)^2 = 2.405 \, in^2$

Load = 1000 × 2.405 = 2405#



$\Sigma M_o = 2405 \times 3 - F = 0$

$F = 7215\#$

$\Sigma F_y = -7215 + 2405 + G = 0$

$G = 4810\#$

Shear Stress in Plug from 3/4" UNC Bolt, $A_s = 0.750 \pi \times 1 = 2.356 \, in^2$

$\tau = \frac{F}{A} = \frac{7215}{2.356} = 3062$ psi < 14,000 psi OK

Compressive Stress in Plug From Bracket

$\sigma = \frac{G}{A} = \frac{4810}{1 \times 2.5} = 1924$ psi OK.

Tensile Stress in Bolt, $A = 0.302 \, in^2$

$\sigma = \frac{7215}{0.302} = 23,891$ psi Use High Strength Bolt B193-P7 (17-4 PH)

Shear Stress in 1/2" Dia. Pin

$\tau = \frac{4810}{2 \times 0.7854(0.5)^2} = 12,249$ psi < 14,000 psi OK.

Bearing Stress in Bracket at Hole

$\sigma = \frac{4810}{2 \times 0.5 \times 1} = 4810$ psi OK

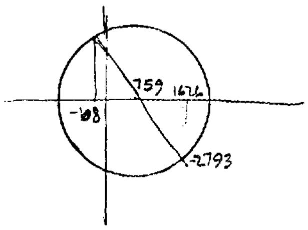
PLANT	OAK RIDGE, TENNESSEE	
JOB		REF. DWG. NO.
SUBJECT Target Hole Plug		PAGE 5 OF
COMPUTATION		NO.
COMPUTED BY C H Ellis	CHECKED BY J E Rutenber	DATE 11-5-85

Stresses In Tapped Hole - Element 104

Apply Elastic Stress Concentration Factor of 3 to stresses S11 and S33

S11 × 3	= 542 × 3	= 1626
S33 × 3	= 2887 × 3	= 8661
S22		= -108
S12		= -241 -2552 = -2793

Principal Stresses in Plane 1-2



Center of Circle at $\frac{1626-108}{2} = 759$

R of Circle = $\sqrt{(2793)^2+(1626-759)^2} = 2924$

Max S = 2924 + 759 = 3683 psi

Min S = 759 - 2924 = -2165 psi

Max Stress Intensity = 8661 + 2165 = 10,826 psi

Stresses Under Bracket - Element 106

The Bracket adds a compressive stress to the Target Hole Plug in direction 3 equal to -1443 psi. This makes S33 equal

S33 = 1927 - 1443 = 484 psi. Adding this stress by superposition to the finite element output gives a maximum stress intensity of:

484 + 208 = 692 psi   OK

UCN-1070A
(1 9-63)

PLANT	OAK RIDGE, TENNESSEE	
JOB		REF. DWG. NO.
SUBJECT Target Hole Plug		PAGE 6 OF
COMPUTATION		NO.
COMPUTED BY C.W. Collins	CHECKED BY J.E. Rutenber	DATE 11-5-85

Peak Stresses

Calculate peak stresses using a fatigue stress concentration factor of 4, which Paragraph NB-3232.3(c) requires for threads, applied to the maximum stress intensity.

Location	Element No.	Max. Stress Intensity	Peak Stress
Corner	1	-5707	-22,828
Spring Hole	7	-15,450	-61,800
O-Ring Groove	36	-3460	-13,600
Corner	67	9189	36,756
Gear Shaft Hole	69	14,222	56,885
Corner	72	-9,716	-38,864
Tapped Hole	104	10,826	43,304

The maximum peak stress of 61,800 psi occurs at the spring hole. S_A = 61,800/2 = 30,900 psi. At this stress level, more than 10^6 cycles are allowed, while only 10^3 cycles are required.

UCN-1070A
(1 9-63)

PLANT — OAK RIDGE, TENNESSEE

JOB — REF. DWG. NO.

SUBJECT Target Hole Plug — PAGE 7 OF

COMPUTATION — NO.

COMPUTED BY C H Collins — CHECKED BY J E [illegible] — DATE 11-5-85

Strength of Tapped Holes for Dummy Plugs–Target Plug & Quick Opening Hatch

Required Length of Thread Engagement – $\frac{3}{4}$" UNC, 304 SS Internal Threads.

From "Machinery's Handbook" – 20th Edition, p 1168.

$$L_e = \frac{2A_t}{3.1416\, K_{n\,max}\left[\frac{1}{2} + 0.57735\, n(E_{s\,min} - K_{n\,max})\right]}$$

$$= \frac{2 \times 0.334}{3.1416 \times 0.6255\left[0.5 + 0.57735 \times 10(0.6773 - 0.6255)\right]}$$

$$= 0.425''$$

Adjust for Reduced Shank Dia Bolt $= \frac{0.130 \times 0.425}{0.334} = 0.165''$

$$A_s = 3.1415\, n\, L_e\, K_{n\,max}\left[\frac{1}{2n} + 0.57735(E_{s\,min} - K_{n\,max})\right)$$

$$= 3.1415 \times 10 \times 0.425 \times 0.6255\left[\frac{1}{2\times 10} + 0.57735(0.6773 - 0.6255)\right)$$

$$= 0.6673\ in^2$$

$$A_n = 3.1416 \times n\, L_e\, D_{s\,min}\left[\frac{1}{2n} + 0.57735(D_{s\,min} - E_{n\,max})\right]$$

$$= 3.1416 \times 10 \times 0.425 \times 0.7353\left[\frac{1}{2\times 10} + 0.57735(0.7353 - 0.6927)\right)$$

$$= 0.7323''$$

$$J = \frac{A_s \times S_t\ screw}{A_n \times S_t\ nut} = \frac{0.6673 \times 76{,}600}{0.7323 \times 20{,}000} = 3.490$$

For Reduced Shank Bolt

$Q = 0.163 \times 3.490 = 0.577''$ Thread Engagement – 1" Provided

UCN-1070A (1 9-63)

Quick Opening Hatch - Drawing M-11506-OH-020-E-Rev.0

The Quick Opening Hatch is a 36.25" diameter disc, 15.875" thick, with a 17.7" diameter central hole which contains the target plug. Experimental holes, 1.875" diameter, are located very near the central hole, in closely spaced pairs at four equally spaced positions. Loads on the Quick Opening Hatch are a 240,528 lb load applied tio the inner groove by the Target Plug and an additional pressure load on the bottom of the hatch, resulting in a total load of 706,860 lb resisted by the Hatch Ring load applied to the top outer surface of the hatch.

The finite element analysis indicates the highest stresses at the upper corner at the junction of the hatch body and flange, element 110, and the restraint at the outer corner, element 197.

Table 2

Stresses in Quick Opening Hatch

Element Numbers

	3	110	112	139	185	186	197
S11	-1446	- 2953	427	1342	141	512	1194
S22	- 972	- 9093	3217	5968	186	203	-10977
S33	-1536	- 3342	1146	3343	4728	4478	291
S12	- 70	- 2786	- 47	-1095	- 122	203	- 3394
Smax	- 139	- 1878	3218	6214	287	612	2076
Smin	- 977	-10169	427	1096	40	102	-11859
Sint	-1397	-10169	3218	6214	4688	4376	-11859

PLANT	OAK RIDGE, TENNESSEE	
JOB		REF. DWG. NO.
SUBJECT Quick Opening Hatch		PAGE 1 OF
COMPUTATION		NO.
COMPUTED BY C H Collins	CHECKED BY J E Rutenber	DATE 11-5-85

STRESSES IN QUICK OPENING HATCH

Inner Ring Load from Target Dia

Load = 0.7854×(17.5)²×1000 = 240,528#

Area of Element 153 = π(9.375² - 8.750²) = 35.588 in²

$P = \frac{240,528}{35,588}$ = 6730 psi (Add as load on Finite Element Model)

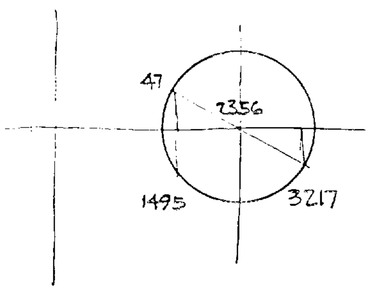
Stresses at 1.875" Dia. Longitudinal Holes - Element 112

Apply Elastic Stress Concentration Factor from Roark - 4th Edition, p384 Case 5(b) with hole near edge of wide plate to stresses S11 and S33.

For $\frac{h}{a}$ = 1 , K = 3.5

S11 × 3.5	= 427 × 3.5	=	1495
S33 × 3.5	= 1146 × 3.5	=	4011
S22		=	3217
S12		=	− 47

Principal Stresses in Plane 12



Center of Circle = $\frac{3217+1495}{2}$ = 2356

R of Circle = $\sqrt{(47)^2+(3217-2356)^2}$ = 862

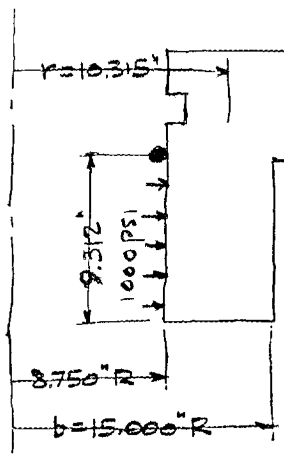
Max S = 2356 + 862 = 3218 psi

Min S = 2356 − 862 = 1494 psi

Max Stress Intensity = 3218 psi OK

PLANT	OAK RIDGE, TENNESSEE
JOB	REF. DWG. NO.
SUBJECT Quick Opening Hatch	PAGE 2 OF
COMPUTATION	NO.
COMPUTED BY CHCollins CHECKED BY JC Deitenbach	DATE 11-5-85

Stresses on Plug from Internal Pressure



Stresses in Thick Wall Cylinder-Roark, Table XIII, p308, Case 33

S_1(Longitudinal) = 0

Tangential Stress S_2-To be added to S33 Stresses from Finite Element Analysis

At Inner Surface $= p\frac{b^2+a^2}{b^2-a^2} = 1000\left(\frac{15^2+8.75^2}{15^2-8.75^2}\right) = 2032$ psi

At Outer Surface $= p\frac{a^2(b^2+r^2)}{r^2(b^2-a^2)} = 1000\frac{8.75^2(15^2+15^2)}{15^2(15^2-8.75^2)} = 1032$ psi

These stresses are due to the 1000psi pressure exerted on the inside diameter of the Quick Opening Hatch below the O-Ring seal and they act in the tangential direction (S33). It is seen by inspection of the Finite Element Analysis results that the addition of these stresses is of no consequence. These stresses were calculated manually because the Finite Element Program does not accept pressure loading applied in this direction.

PLANT OAK RIDGE, TENNESSEE

JOB REF. DWG. NO.

SUBJECT Quick Opening Hatch PAGE 3 OF

COMPUTATION NO.

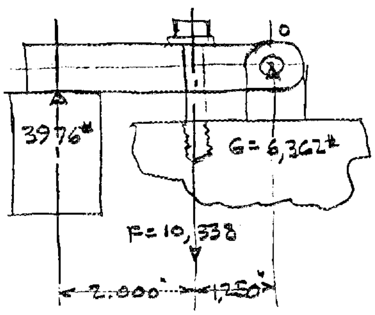
COMPUTED BY CHCollins CHECKED BY JC Rutecher DATE 11-5-85

Quick Opening Hatch - Plug Brackets

Load from Hole Plug

Area of Hole $= (2.25)^2 \times 0.7854 = 3.976 \text{ in}^2$

Load $= 1000 \times 3.976 = 3976^{\#}$



$\Sigma M_0 = 3.25 \times 3976 - 1.25F = 0$

$F = 10,338^{\#}$

$\Sigma F_y = 3976 - 10,338 + G = 0$

$G = 6362^{\#}$

Shear Stress in Hatch from $\frac{3}{4}$" UNC Bolt, $A_s = 0.750 \times \pi \times 1 = 2.356 \text{ in}^2$

$\tau = \frac{F}{A} = \frac{10,338}{2.356} = 4388$ psi OK

Compressive Stress in Hatch from Bracket

$\sigma = \frac{G}{A} = \frac{6362}{1 \times 2.875} = 2213$ psi OK

Tensile Stress in Bolt, $A = 0.302 \text{ in}^2$

$\sigma = \frac{10,338}{0.302} = 34,232$ psi OK

Shear Stress in $\frac{1}{2}$" Dia. Pin

$\tau = \frac{6362}{2 \times 0.7854 \times (0.5)^2} = 16,200$ psi OK

Bearing Stress in Bracket at Hole

$\sigma = \frac{6362}{2 \times 0.5 \times 1} = 6362$ psi

Minimum Required Area in Shank of Bolt for $\frac{3}{4}$" UNC - SA 564-Gr-630

$A = \frac{10,338}{76,600} = 0.135 \text{ in}^2$

Diameter for this area $= \sqrt{\frac{0.135}{0.7854}} = 0.415$"

PLANT OAK RIDGE, TENNESSEE

JOB REF. DWG. NO.

SUBJECT Quick Opening Hatch PAGE 4 OF

COMPUTATION NO.

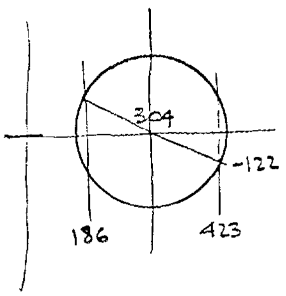
COMPUTED BY [signature] CHECKED BY [signature] DATE 11-5-85

Stresses in Tapped Hole - Element 185

Apply Elastic Stress Concentration Factor of 3 to Stresses S11 and S33.

S11 × 3	= 141 × 3	= 423
S33 × 3	= 4728 × 3	= 14,184
S22 × 3	=	186
S12	=	-122

Principal Stresses in Plane 12



Center of Circle at $\frac{186+423}{2} = 304$

R of Circle $= \sqrt{(122)^2 + (423-304)^2} = 170$

Max S = 304 + 170 = 474 psi

Min S = 304 - 170 = 134 psi

Max Stress Intensity = 14,184 - 134 = 14,050 psi ok

Stresses Under Bracket - Element 186

The Bracket adds a compressive stress to the Quick Opening Hatch at the top surface in direction 3 equal to -2074 psi. This makes S33 = 4478 - 2074 = 2404 psi. Adding this stress by superposition to the finite element output gives a maximum stress intensity of:

2404 - 102 = 2302 psi ok.

PLANT	OAK RIDGE, TENNESSEE	
JOB		REF. DWG. NO.
SUBJECT Quick Opening Hatch		PAGE 5 OF
COMPUTATION		NO.
COMPUTED BY C.H. Collins	CHECKED BY J. E. Reitenbucher	DATE 11-5-85

Quick Opening Hatch

Peak Stresses

Calculate peak stresses using a fatigue stress concentration factor of 4, which Paragraph NB-3232.3(c) requires for threads, applied to the the maximum stress intensity.

Location	Element No	Max. Stress Intensity	Peak Stress
Corner	110	-10,169	-40,676
Longitudinal Hole	112	3,218	12,872
Groove	139	6,214	24,856
Tapped Hole	185	14,050	56,200
Corner	197	-11,859	-47,436

The maximum peak stress of 56,200 psi occurs at the tapped hole. S_a = 56,200/2 = 28,100 psi. At this stress level, more than 10^6 cycles are allowed, while only 10^3 are required.

Quick Opening Hatch-Hatch Ring - Drawing-Allis Chalmers 43-501-063

The Hatch Ring is a bayonet ring 43.5" in diameter and 13.75" high which transfers the load from the hatch to the top head of the reactor vessel through a flange on the top head.

The finite element stress analysis indicated the two areas of highest stress to be the inside corner of the ring at elements 21 and 57.

Table 3

Stresses in Quick Opening Hatch - Hatch Ring

	Element Numbers		
	21	56	57
S11	1254	147	3099
S22	8031	-4810	11182
S33	802	-2915	3197
S12	1048	80	- 2302
Smax	8190	148	11791
Smin	1095	-4811	2490
Sint	8190	-4811	11791

PLANT	OAK RIDGE, TENNESSEE		
JOB		REF. DWG. NO.	
SUBJECT Quick Opening Hatch-Hatch Ring		PAGE 1 OF	
COMPUTATION		NO.	
COMPUTED BY C.H. Collins	CHECKED BY J. E. Batcher	DATE	11-5-85

STRESSES IN QUICK OPENING HATCH-HATCH RING

Inner Ring Load from Quick Opening Hatch

Load = $0.7854 \times 30^2 \times 1000 = 706,860$#

Area of Element 16 = $\pi(19.250^2 - 18.625^2) = 74.367$ in²

$P = \frac{706,860}{74.367}$ = 9505 psi (To be applied as a load to Finite Element Model)

There are no holes or other local discontinuities to which elastic stress concentrations need be applied. There are several corners and grooves where Peak Stresses will be evaluated.

Peak Stresses

Calculate Peak Stresses using a fatigue stress concentration factor of 4, which Paragraph NB-3232.3(c) requires for threads, applied to the maximum stress intensity.

Location	Element No.	Max. Stress Intensity	Peak Stress
Corner	21	8190	32,760
Groove	56	-4811	-19,244
Corner	57	11,791	47,160

* Evaluation of Peak Stresses

Paragraph NB-3222.4(d) of the Code exempts components from analysis for cyclic service if certain conditions are met.

(1) Atmospheric to Service Pressure Cycle

There are to be 1000 Startup and Shutdown cycles from atmospheric pressure to operating pressure. For the Design Condition, 3 Sm for the material at the Design Condition is 3×20,000 = 60,000 psi. Using this value for S_A, from Fig. I-9.2.1, 14,000 cycles could be allowed.

* It was shown in previous calculations that more than 10^6 cycles are allowable at these stress levels. As a matter of interest, an NB-3222.4(d) evaluation is made.

PLANT	OAK RIDGE, TENNESSEE
JOB	REF. DWG. NO.
SUBJECT Quick Opening Hatch - Hatch Ring	PAGE 2 OF
COMPUTATION	NO.
COMPUTED BY CW Collins CHECKED BY J E Rutenber	DATE 11-5-85

(2) Normal Service Pressure Fluctuations - For 10^6 Cycles

Allowable Pressure Fluctuations $= \text{Design } P \times \frac{1}{3} \times \frac{S_a}{S_m}$

$$= 1000 \times \frac{1}{3} \times \frac{28{,}200}{20{,}000}$$

$$= 470 \text{ psi}$$

All normal pressure fluctuations are below this level, so this requirement is satisfied.

(3) Temperature Differences - Startup and Shutdown - For 10^3 Cycles

$$\Delta t = \frac{S_a}{2E\alpha} = \frac{130{,}000}{2 \times 28.3 \times 10^6 \times 9.3 \times 10^{-6}} = 247°F \quad \text{OK}$$

(4) Temperature Difference - Normal Service - For 10^6 Cycles

$$\Delta t = \frac{S_a}{2E\alpha} = \frac{28{,}200}{2 \times 28.3 \times 10^6 \times 9.3 \times 10^{-6}} = 54°F \quad \text{OK}$$

All temperature differences during startup and shutdown, and during normal operation are well within these limits for adjacent points as follows:

(a) Target Plug

$$2\sqrt{Rt} = 2\sqrt{5.375 \times 6.75} = 6.96''$$

(b) Quick Opening Hatch

$$2\sqrt{Rt} = 2\sqrt{13.75 \times 8.75} = 9.49''$$

(c) Quick Opening Hatch - Hatch Ring

$$2\sqrt{Rt} = 2\sqrt{19.56 \times 4.375} = 9.78''$$

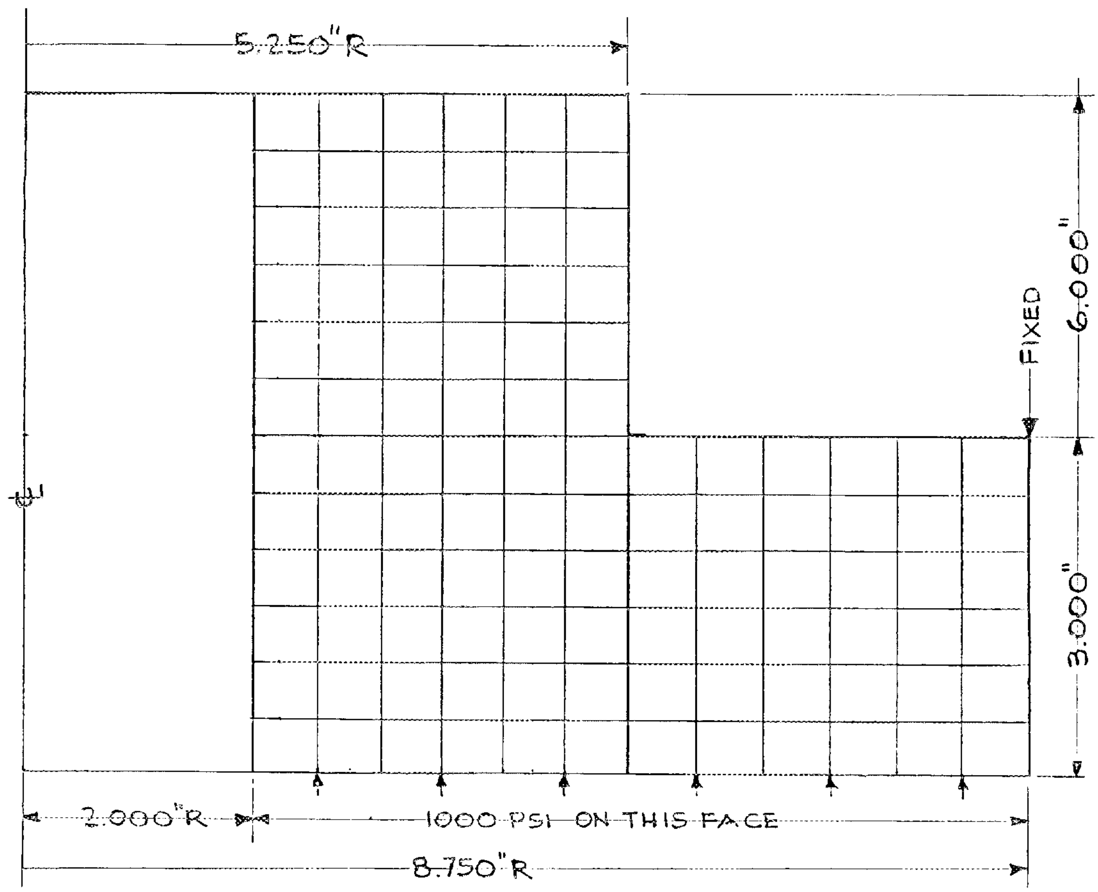
PLANT OAK RIDGE, TENNESSEE

JOB HIFI EXPERIMENT REF. DWG. NO. M11506-OH-003E

SUBJECT TARGET HOLE PLUG PAGE 1 OF

COMPUTATION NO.

COMPUTED BY C.W. COLLINS CHECKED BY J E Rutaber DATE 9-5-85



FINITE ELEMENT MODEL

FIG. A-1

UCN-1070A
(1 2-83)

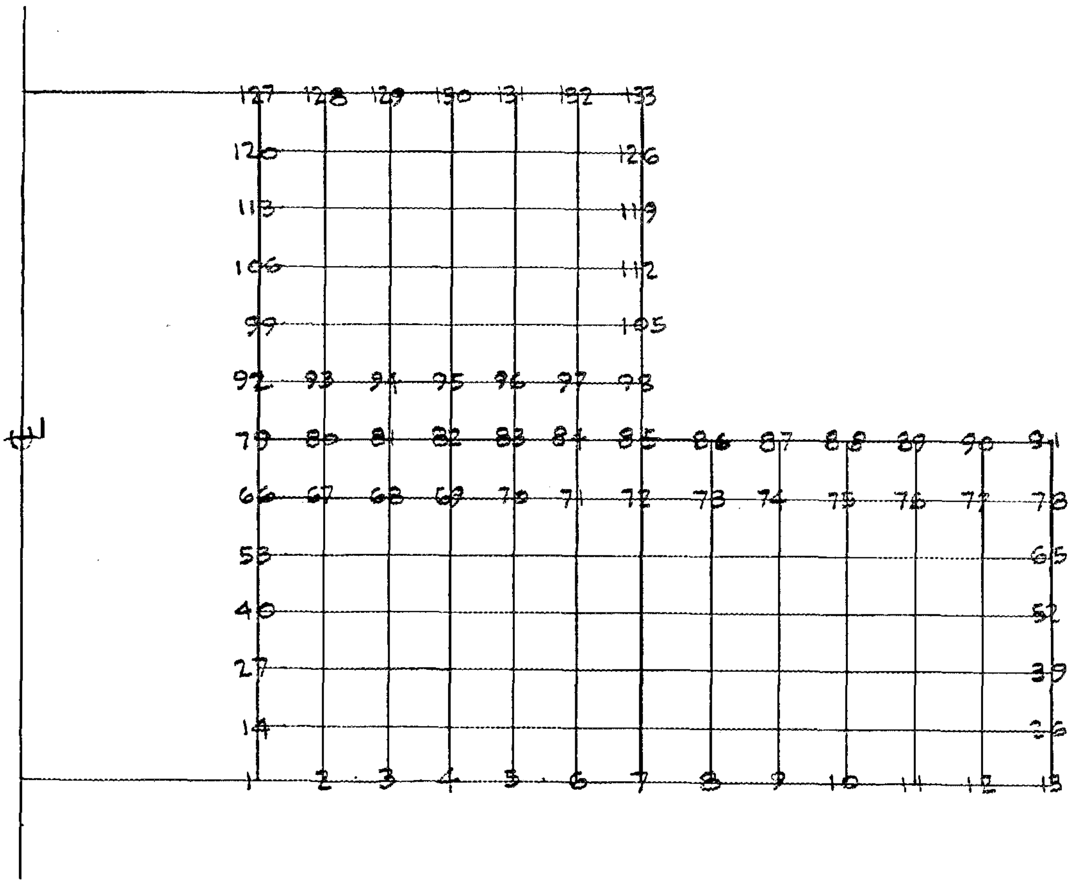
PLANT OAK RIDGE, TENNESSEE

JOB HIFI EXPERIMENT REF. DWG. NO. M11506-OH-003

SUBJECT TARGET HOLE PLUG PAGE 1 OF

COMPUTATION NO.

COMPUTED BY C.W. COLLINS CHECKED BY [signature] DATE 9-5-85



NODAL POINT NUMBERS

FIG. A-2

UCN-1070A
(1 9-83)

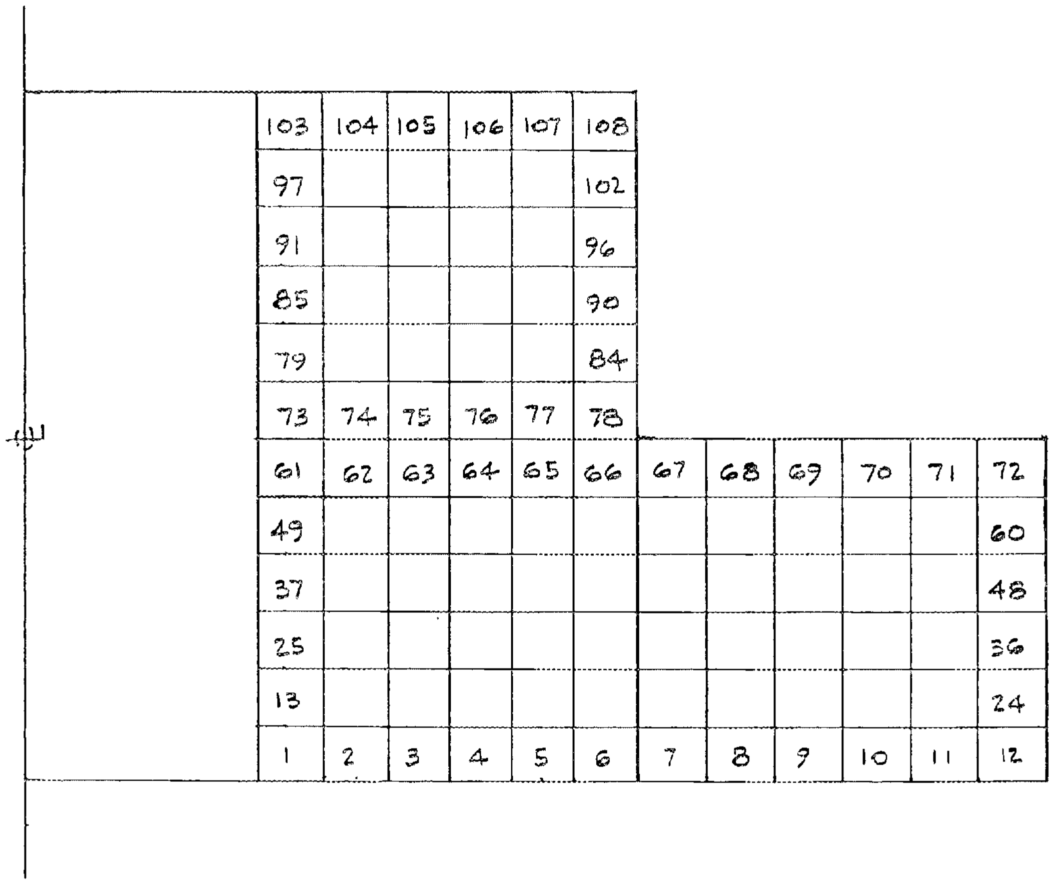
PLANT OAK RIDGE, TENNESSEE

JOB HIFI EXPERIMENT REF. DWG. NO. M11506-OH-003E

SUBJECT TARGET HOLE PLUG PAGE 1 OF

COMPUTATION NO.

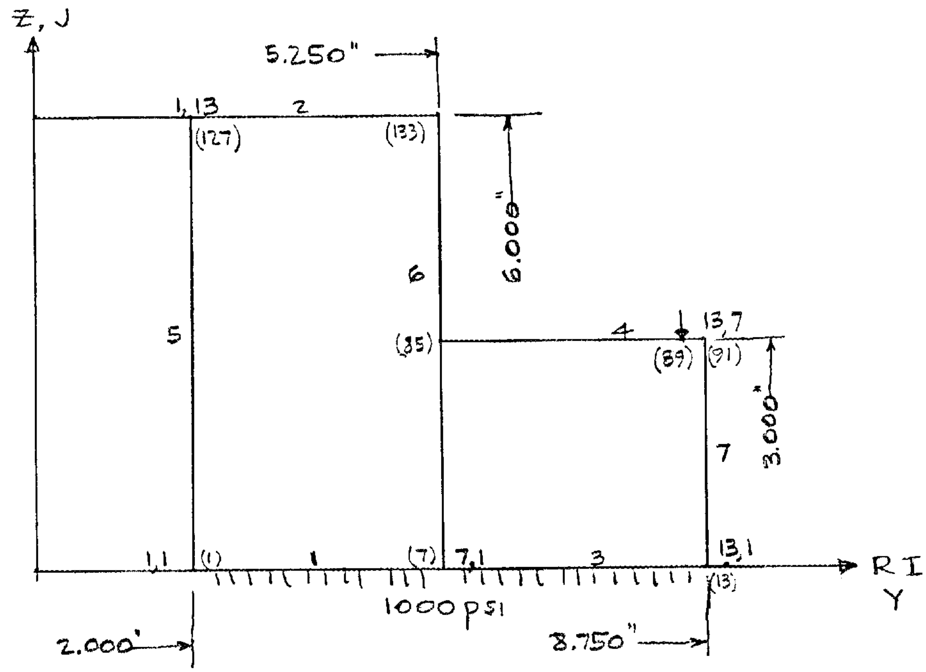
COMPUTED BY C.W. COLLINS CHECKED BY James E Rutenber DATE 9-5-85



ELEMENT NUMBERS

FIG. A-3

PLANT	OAK RIDGE, TENNESSEE		
JOB	HIFI EXPERIMENT	REF. DWG. NO.	M11506-0H-003E
SUBJECT	TARGET HOLE PLUG	PAGE	1 OF
COMPUTATION		NO.	
COMPUTED BY	C W COLLINS	CHECKED BY	J E Autenber — DATE 9-5-85



```
1          ************************************
          *                                  *
          *              SAP86               *
          *                                  *
          *   (C) Copyright 1983, 1984       *
          *                                  *
          *               by                 *
          *                                  *
          *        NUMBER CRUNCHER           *
          *        MICROSYSTEMS, INC.        *
          *                                  *
          *                                  *
          *       All Rights Reserved        *
          *                                  *
          *          Version 1.03            *
          *                                  *
          ************************************
1HFIR TARGET HOLE PLUG
```

```
 C O N T R O L   I N F O R M A T I O N

     NUMBER OF NODAL POINTS   =  133
     NUMBER OF ELEMENT TYPES  =    1
     NUMBER OF LOAD CASES     =    1
     NUMBER OF FREQUENCIES    =    0
     ANALYSIS CODE (NDYN)     =    0
       EQ.0,  STATIC
       EQ.1,  MODAL EXTRACTION
       EQ.2,  FORCED RESPONSE
       EQ.3,  RESPONSE SPECTRUM
       EQ.4,  DIRECT INTEGRATION
     SOLUTION MODE (MODEX)    =    0
       EQ.0,  EXECUTION
       EQ.1,  DATA CHECK
     NUMBER OF SUBSPACE
     ITERATION VECTORS (NAD)  =    0
     EQUATIONS PER BLOCK      =    0
     TAPE10 SAVE FLAG (N10SV) =    0
```

NODAL POINT INPUT DATA

0NODE	BOUNDARY CONDITION CODES						NODAL POINT COORDINATES				
NUMBER	X	Y	Z	XX	YY	ZZ	X	Y	Z		T
1	1	0	0	1	1	1	.000	2.000	.000	0	.000
2	1	0	0	1	1	1	.000	2.542	.000	0	.000
3	1	0	0	1	1	1	.000	3.083	.000	0	.000
4	1	0	0	1	1	1	.000	3.625	.000	0	.000
5	1	0	0	1	1	1	.000	4.167	.000	0	.000
6	1	0	0	1	1	1	.000	4.708	.000	0	.000
7	1	0	0	1	1	1	.000	5.250	.000	0	.000
8	1	0	0	1	1	1	.000	5.833	.000	0	.000
9	1	0	0	1	1	1	.000	6.417	.000	0	.000
10	1	0	0	1	1	1	.000	7.000	.000	0	.000
11	1	0	0	1	1	1	.000	7.583	.000	0	.000
12	1	0	0	1	1	1	.000	8.167	.000	0	.000
13	1	0	0	1	1	1	.000	8.750	.000	0	.000
14	1	0	0	1	1	1	.000	2.000	.500	0	.000
15	1	0	0	1	1	1	.000	2.542	.500	0	.000
16	1	0	0	1	1	1	.000	3.083	.500	0	.000
17	1	0	0	1	1	1	.000	3.625	.500	0	.000
18	1	0	0	1	1	1	.000	4.167	.500	0	.000

19	1	0	0	1	1	1	.000	4.708	.500	0	.000
20	1	0	0	1	1	1	.000	5.250	.500	0	.000
21	1	0	0	1	1	1	.000	5.833	.500	0	.000
22	1	0	0	1	1	1	.000	6.417	.500	0	.000
23	1	0	0	1	1	1	.000	7.000	.500	0	.000
24	1	0	0	1	1	1	.000	7.583	.500	0	.000
25	1	0	0	1	1	1	.000	8.167	.500	0	.000
26	1	0	0	1	1	1	.000	8.750	.500	0	.000
27	1	0	0	1	1	1	.000	2.000	1.000	0	.000
28	1	0	0	1	1	1	.000	2.542	1.000	0	.000
29	1	0	0	1	1	1	.000	3.083	1.000	0	.000
30	1	0	0	1	1	1	.000	3.625	1.000	0	.000
31	1	0	0	1	1	1	.000	4.167	1.000	0	.000
32	1	0	0	1	1	1	.000	4.708	1.000	0	.000
33	1	0	0	1	1	1	.000	5.250	1.000	0	.000
34	1	0	0	1	1	1	.000	5.833	1.000	0	.000
35	1	0	0	1	1	1	.000	6.417	1.000	0	.000
36	1	0	0	1	1	1	.000	7.000	1.000	0	.000
37	1	0	0	1	1	1	.000	7.583	1.000	0	.000
38	1	0	0	1	1	1	.000	8.167	1.000	0	.000
39	1	0	0	1	1	1	.000	8.750	1.000	0	.000
40	1	0	0	1	1	1	.000	2.000	1.500	0	.000
41	1	0	0	1	1	1	.000	2.542	1.500	0	.000
42	1	0	0	1	1	1	.000	3.083	1.500	0	.000
43	1	0	0	1	1	1	.000	3.625	1.500	0	.000
44	1	0	0	1	1	1	.000	4.167	1.500	0	.000
45	1	0	0	1	1	1	.000	4.708	1.500	0	.000
46	1	0	0	1	1	1	.000	5.250	1.500	0	.000
47	1	0	0	1	1	1	.000	5.833	1.500	0	.000
48	1	0	0	1	1	1	.000	6.417	1.500	0	.000
49	1	0	0	1	1	1	.000	7.000	1.500	0	.000
50	1	0	0	1	1	1	.000	7.583	1.500	0	.000
51	1	0	0	1	1	1	.000	8.167	1.500	0	.000
52	1	0	0	1	1	1	.000	8.750	1.500	0	.000
53	1	0	0	1	1	1	.000	2.000	2.000	0	.000
54	1	0	0	1	1	1	.000	2.542	2.000	0	.000
55	1	0	0	1	1	1	.000	3.083	2.000	0	.000
56	1	0	0	1	1	1	.000	3.625	2.000	0	.000
57	1	0	0	1	1	1	.000	4.167	2.000	0	.000
58	1	0	0	1	1	1	.000	4.708	2.000	0	.000
59	1	0	0	1	1	1	.000	5.250	2.000	0	.000
60	1	0	0	1	1	1	.000	5.833	2.000	0	.000
61	1	0	0	1	1	1	.000	6.417	2.000	0	.000
62	1	0	0	1	1	1	.000	7.000	2.000	0	.000
63	1	0	0	1	1	1	.000	7.583	2.000	0	.000
64	1	0	0	1	1	1	.000	8.167	2.000	0	.000
65	1	0	0	1	1	1	.000	8.750	2.000	0	.000
66	1	0	0	1	1	1	.000	2.000	2.500	0	.000
67	1	0	0	1	1	1	.000	2.542	2.500	0	.000
68	1	0	0	1	1	1	.000	3.083	2.500	0	.000
69	1	0	0	1	1	1	.000	3.625	2.500	0	.000
70	1	0	0	1	1	1	.000	4.167	2.500	0	.000
71	1	0	0	1	1	1	.000	4.708	2.500	0	.000
72	1	0	0	1	1	1	.000	5.250	2.500	0	.000
73	1	0	0	1	1	1	.000	5.833	2.500	0	.000
74	1	0	0	1	1	1	.000	6.417	2.500	0	.000
75	1	0	0	1	1	1	.000	7.000	2.500	0	.000
76	1	0	0	1	1	1	.000	7.583	2.500	0	.000
77	1	0	0	1	1	1	.000	8.167	2.500	0	.000
78	1	0	0	1	1	1	.000	8.750	2.500	0	.000
79	1	0	0	1	1	1	.000	2.000	3.000	0	.000
80	1	0	0	1	1	1	.000	2.542	3.000	0	.000
81	1	0	0	1	1	1	.000	3.083	3.000	0	.000
82	1	0	0	1	1	1	.000	3.625	3.000	0	.000
83	1	0	0	1	1	1	.000	4.167	3.000	0	.000
84	1	0	0	1	1	1	.000	4.708	3.000	0	.000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

85	1	0	0	1	1	1	.000	5.250	3.000	0	.000
86	1	0	0	1	1	1	.000	5.833	3.000	0	.000
87	1	0	0	1	1	1	.000	6.417	3.000	0	.000
88	1	0	0	1	1	1	.000	7.000	3.000	0	.000
89	1	0	0	1	1	1	.000	7.583	3.000	0	.000
90	1	0	0	1	1	1	.000	8.167	3.000	0	.000
91	1	0	1	1	1	1	.000	8.750	3.000	0	.000
92	1	0	0	1	1	1	.000	2.000	3.500	0	.000
93	1	0	0	1	1	1	.000	2.542	3.500	0	.000
94	1	0	0	1	1	1	.000	3.083	3.500	0	.000
95	1	0	0	1	1	1	.000	3.625	3.500	0	.000
96	1	0	0	1	1	1	.000	4.167	3.500	0	.000
97	1	0	0	1	1	1	.000	4.708	3.500	0	.000
98	1	0	0	1	1	1	.000	5.250	3.500	0	.000
99	1	0	0	1	1	1	.000	2.000	4.000	0	.000
100	1	0	0	1	1	1	.000	2.542	4.000	0	.000
101	1	0	0	1	1	1	.000	3.083	4.000	0	.000
102	1	0	0	1	1	1	.000	3.625	4.000	0	.000
103	1	0	0	1	1	1	.000	4.167	4.000	0	.000
104	1	0	0	1	1	1	.000	4.708	4.000	0	.000
105	1	0	0	1	1	1	.000	5.250	4.000	0	.000
106	1	0	0	1	1	1	.000	2.000	4.500	0	.000
107	1	0	0	1	1	1	.000	2.542	4.500	0	.000
108	1	0	0	1	1	1	.000	3.083	4.500	0	.000
109	1	0	0	1	1	1	.000	3.625	4.500	0	.000
110	1	0	0	1	1	1	.000	4.167	4.500	0	.000
111	1	0	0	1	1	1	.000	4.708	4.500	0	.000
112	1	0	0	1	1	1	.000	5.250	4.500	0	.000
113	1	0	0	1	1	1	.000	2.000	5.000	0	.000
114	1	0	0	1	1	1	.000	2.542	5.000	0	.000
115	1	0	0	1	1	1	.000	3.083	5.000	0	.000
116	1	0	0	1	1	1	.000	3.625	5.000	0	.000
117	1	0	0	1	1	1	.000	4.167	5.000	0	.000
118	1	0	0	1	1	1	.000	4.708	5.000	0	.000
119	1	0	0	1	1	1	.000	5.250	5.000	0	.000
120	1	0	0	1	1	1	.000	2.000	5.500	0	.000
121	1	0	0	1	1	1	.000	2.542	5.500	0	.000
122	1	0	0	1	1	1	.000	3.083	5.500	0	.000
123	1	0	0	1	1	1	.000	3.625	5.500	0	.000
124	1	0	0	1	1	1	.000	4.167	5.500	0	.000
125	1	0	0	1	1	1	.000	4.708	5.500	0	.000
126	1	0	0	1	1	1	.000	5.250	5.500	0	.000
127	1	0	0	1	1	1	.000	2.000	6.000	0	.000
128	1	0	0	1	1	1	.000	2.542	6.000	0	.000
129	1	0	0	1	1	1	.000	3.083	6.000	0	.000
130	1	0	0	1	1	1	.000	3.625	6.000	0	.000
131	1	0	0	1	1	1	.000	4.167	6.000	0	.000
132	1	0	0	1	1	1	.000	4.708	6.000	0	.000
133	1	0	0	1	1	1	.000	5.250	6.000	0	.000

1GENERATED NODAL DATA

ONODE	BOUNDARY CONDITION CODES						NODAL POINT COORDINATES			
NUMBER	X	Y	Z	XX	YY	ZZ	X	Y	Z	T
1	1	0	0	1	1	1	.000	2.000	.000	.000
2	1	0	0	1	1	1	.000	2.542	.000	.000
3	1	0	0	1	1	1	.000	3.083	.000	.000
4	1	0	0	1	1	1	.000	3.625	.000	.000
5	1	0	0	1	1	1	.000	4.167	.000	.000
6	1	0	0	1	1	1	.000	4.708	.000	.000
7	1	0	0	1	1	1	.000	5.250	.000	.000
8	1	0	0	1	1	1	.000	5.833	.000	.000
9	1	0	0	1	1	1	.000	6.417	.000	.000
10	1	0	0	1	1	1	.000	7.000	.000	.000
11	1	0	0	1	1	1	.000	7.583	.000	.000
12	1	0	0	1	1	1	.000	8.167	.000	.000

13	1	0	0	1	1	1	.000	8.750	.000	.000
14	1	0	0	1	1	1	.000	2.000	.500	.000
15	1	0	0	1	1	1	.000	2.542	.500	.000
16	1	0	0	1	1	1	.000	3.083	.500	.000
17	1	0	0	1	1	1	.000	3.625	.500	.000
18	1	0	0	1	1	1	.000	4.167	.500	.000
19	1	0	0	1	1	1	.000	4.708	.500	.000
20	1	0	0	1	1	1	.000	5.250	.500	.000
21	1	0	0	1	1	1	.000	5.833	.500	.000
22	1	0	0	1	1	1	.000	6.417	.500	.000
23	1	0	0	1	1	1	.000	7.000	.500	.000
24	1	0	0	1	1	1	.000	7.583	.500	.000
25	1	0	0	1	1	1	.000	8.167	.500	.000
26	1	0	0	1	1	1	.000	8.750	.500	.000
27	1	0	0	1	1	1	.000	2.000	1.000	.000
28	1	0	0	1	1	1	.000	2.542	1.000	.000
29	1	0	0	1	1	1	.000	3.083	1.000	.000
30	1	0	0	1	1	1	.000	3.625	1.000	.000
31	1	0	0	1	1	1	.000	4.167	1.000	.000
32	1	0	0	1	1	1	.000	4.708	1.000	.000
33	1	0	0	1	1	1	.000	5.250	1.000	.000
34	1	0	0	1	1	1	.000	5.833	1.000	.000
35	1	0	0	1	1	1	.000	6.417	1.000	.000
36	1	0	0	1	1	1	.000	7.000	1.000	.000
37	1	0	0	1	1	1	.000	7.583	1.000	.000
38	1	0	0	1	1	1	.000	8.167	1.000	.000
39	1	0	0	1	1	1	.000	8.750	1.000	.000
40	1	0	0	1	1	1	.000	2.000	1.500	.000
41	1	0	0	1	1	1	.000	2.542	1.500	.000
42	1	0	0	1	1	1	.000	3.083	1.500	.000
43	1	0	0	1	1	1	.000	3.625	1.500	.000
44	1	0	0	1	1	1	.000	4.167	1.500	.000
45	1	0	0	1	1	1	.000	4.708	1.500	.000
46	1	0	0	1	1	1	.000	5.250	1.500	.000
47	1	0	0	1	1	1	.000	5.833	1.500	.000
48	1	0	0	1	1	1	.000	6.417	1.500	.000
49	1	0	0	1	1	1	.000	7.000	1.500	.000
50	1	0	0	1	1	1	.000	7.583	1.500	.000
51	1	0	0	1	1	1	.000	8.167	1.500	.000
52	1	0	0	1	1	1	.000	8.750	1.500	.000
53	1	0	0	1	1	1	.000	2.000	2.000	.000
54	1	0	0	1	1	1	.000	2.542	2.000	.000
55	1	0	0	1	1	1	.000	3.083	2.000	.000
56	1	0	0	1	1	1	.000	3.625	2.000	.000
57	1	0	0	1	1	1	.000	4.167	2.000	.000
58	1	0	0	1	1	1	.000	4.708	2.000	.000
59	1	0	0	1	1	1	.000	5.250	2.000	.000
60	1	0	0	1	1	1	.000	5.833	2.000	.000
61	1	0	0	1	1	1	.000	6.417	2.000	.000
62	1	0	0	1	1	1	.000	7.000	2.000	.000
63	1	0	0	1	1	1	.000	7.583	2.000	.000
64	1	0	0	1	1	1	.000	8.167	2.000	.000
65	1	0	0	1	1	1	.000	8.750	2.000	.000
66	1	0	0	1	1	1	.000	2.000	2.500	.000
67	1	0	0	1	1	1	.000	2.542	2.500	.000
68	1	0	0	1	1	1	.000	3.083	2.500	.000
69	1	0	0	1	1	1	.000	3.625	2.500	.000
70	1	0	0	1	1	1	.000	4.167	2.500	.000
71	1	0	0	1	1	1	.000	4.708	2.500	.000
72	1	0	0	1	1	1	.000	5.250	2.500	.000
73	1	0	0	1	1	1	.000	5.833	2.500	.000
74	1	0	0	1	1	1	.000	6.417	2.500	.000
75	1	0	0	1	1	1	.000	7.000	2.500	.000
76	1	0	0	1	1	1	.000	7.583	2.500	.000
77	1	0	0	1	1	1	.000	8.167	2.500	.000
78	1	0	0	1	1	1	.000	8.750	2.500	.000

79	1	0	0	1	1	1	.000	2.000	3.000	.000
80	1	0	0	1	1	1	.000	2.542	3.000	.000
81	1	0	0	1	1	1	.000	3.083	3.000	.000
82	1	0	0	1	1	1	.000	3.625	3.000	.000
83	1	0	0	1	1	1	.000	4.167	3.000	.000
84	1	0	0	1	1	1	.000	4.708	3.000	.000
85	1	0	0	1	1	1	.000	5.250	3.000	.000
86	1	0	0	1	1	1	.000	5.833	3.000	.000
87	1	0	0	1	1	1	.000	6.417	3.000	.000
88	1	0	0	1	1	1	.000	7.000	3.000	.000
89	1	0	0	1	1	1	.000	7.583	3.000	.000
90	1	0	0	1	1	1	.000	8.167	3.000	.000
91	1	0	1	1	1	1	.000	8.750	3.000	.000
92	1	0	0	1	1	1	.000	2.000	3.500	.000
93	1	0	0	1	1	1	.000	2.542	3.500	.000
94	1	0	0	1	1	1	.000	3.083	3.500	.000
95	1	0	0	1	1	1	.000	3.625	3.500	.000
96	1	0	0	1	1	1	.000	4.167	3.500	.000
97	1	0	0	1	1	1	.000	4.708	3.500	.000
98	1	0	0	1	1	1	.000	5.250	3.500	.000
99	1	0	0	1	1	1	.000	2.000	4.000	.000
100	1	0	0	1	1	1	.000	2.542	4.000	.000
101	1	0	0	1	1	1	.000	3.083	4.000	.000
102	1	0	0	1	1	1	.000	3.625	4.000	.000
103	1	0	0	1	1	1	.000	4.167	4.000	.000
104	1	0	0	1	1	1	.000	4.708	4.000	.000
105	1	0	0	1	1	1	.000	5.250	4.000	.000
106	1	0	0	1	1	1	.000	2.000	4.500	.000
107	1	0	0	1	1	1	.000	2.542	4.500	.000
108	1	0	0	1	1	1	.000	3.083	4.500	.000
109	1	0	0	1	1	1	.000	3.625	4.500	.000
110	1	0	0	1	1	1	.000	4.167	4.500	.000
111	1	0	0	1	1	1	.000	4.708	4.500	.000
112	1	0	0	1	1	1	.000	5.250	4.500	.000
113	1	0	0	1	1	1	.000	2.000	5.000	.000
114	1	0	0	1	1	1	.000	2.542	5.000	.000
115	1	0	0	1	1	1	.000	3.083	5.000	.000
116	1	0	0	1	1	1	.000	3.625	5.000	.000
117	1	0	0	1	1	1	.000	4.167	5.000	.000
118	1	0	0	1	1	1	.000	4.708	5.000	.000
119	1	0	0	1	1	1	.000	5.250	5.000	.000
120	1	0	0	1	1	1	.000	2.000	5.500	.000
121	1	0	0	1	1	1	.000	2.542	5.500	.000
122	1	0	0	1	1	1	.000	3.083	5.500	.000
123	1	0	0	1	1	1	.000	3.625	5.500	.000
124	1	0	0	1	1	1	.000	4.167	5.500	.000
125	1	0	0	1	1	1	.000	4.708	5.500	.000
126	1	0	0	1	1	1	.000	5.250	5.500	.000
127	1	0	0	1	1	1	.000	2.000	6.000	.000
128	1	0	0	1	1	1	.000	2.542	6.000	.000
129	1	0	0	1	1	1	.000	3.083	6.000	.000
130	1	0	0	1	1	1	.000	3.625	6.000	.000
131	1	0	0	1	1	1	.000	4.167	6.000	.000
132	1	0	0	1	1	1	.000	4.708	6.000	.000
133	1	0	0	1	1	1	.000	5.250	6.000	.000

1EQUATION NUMBERS

N	X	Y	Z	XX	YY	ZZ
1	0	1	2	0	0	0
2	0	3	4	0	0	0
3	0	5	6	0	0	0
4	0	7	8	0	0	0
5	0	9	10	0	0	0
6	0	11	12	0	0	0
7	0	13	14	0	0	0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

8	0	15	16	0	0	0
9	0	17	18	0	0	0
10	0	19	20	0	0	0
11	0	21	22	0	0	0
12	0	23	24	0	0	0
13	0	25	26	0	0	0
14	0	27	28	0	0	0
15	0	29	30	0	0	0
16	0	31	32	0	0	0
17	0	33	34	0	0	0
18	0	35	36	0	0	0
19	0	37	38	0	0	0
20	0	39	40	0	0	0
21	0	41	42	0	0	0
22	0	43	44	0	0	0
23	0	45	46	0	0	0
24	0	47	48	0	0	0
25	0	49	50	0	0	0
26	0	51	52	0	0	0
27	0	53	54	0	0	0
28	0	55	56	0	0	0
29	0	57	58	0	0	0
30	0	59	60	0	0	0
31	0	61	62	0	0	0
32	0	63	64	0	0	0
33	0	65	66	0	0	0
34	0	67	68	0	0	0
35	0	69	70	0	0	0
36	0	71	72	0	0	0
37	0	73	74	0	0	0
38	0	75	76	0	0	0
39	0	77	78	0	0	0
40	0	79	80	0	0	0
41	0	81	82	0	0	0
42	0	83	84	0	0	0
43	0	85	86	0	0	0
44	0	87	88	0	0	0
45	0	89	90	0	0	0
46	0	91	92	0	0	0
47	0	93	94	0	0	0
48	0	95	96	0	0	0
49	0	97	98	0	0	0
50	0	99	100	0	0	0
51	0	101	102	0	0	0
52	0	103	104	0	0	0
53	0	105	106	0	0	0
54	0	107	108	0	0	0
55	0	109	110	0	0	0
56	0	111	112	0	0	0
57	0	113	114	0	0	0
58	0	115	116	0	0	0
59	0	117	118	0	0	0
60	0	119	120	0	0	0
61	0	121	122	0	0	0
62	0	123	124	0	0	0
63	0	125	126	0	0	0
64	0	127	128	0	0	0
65	0	129	130	0	0	0
66	0	131	132	0	0	0
67	0	133	134	0	0	0
68	0	135	136	0	0	0
69	0	137	138	0	0	0
70	0	139	140	0	0	0
71	0	141	142	0	0	0
72	0	143	144	0	0	0
73	0	145	146	0	0	0

74	0	147	148	0	0	0
75	0	149	150	0	0	0
76	0	151	152	0	0	0
77	0	153	154	0	0	0
78	0	155	156	0	0	0
79	0	157	158	0	0	0
80	0	159	160	0	0	0
81	0	161	162	0	0	0
82	0	163	164	0	0	0
83	0	165	166	0	0	0
84	0	167	168	0	0	0
85	0	169	170	0	0	0
86	0	171	172	0	0	0
87	0	173	174	0	0	0
88	0	175	176	0	0	0
89	0	177	178	0	0	0
90	0	179	180	0	0	0
91	0	181	0	0	0	0
92	0	182	183	0	0	0
93	0	184	185	0	0	0
94	0	186	187	0	0	0
95	0	188	189	0	0	0
96	0	190	191	0	0	0
97	0	192	193	0	0	0
98	0	194	195	0	0	0
99	0	196	197	0	0	0
100	0	198	199	0	0	0
101	0	200	201	0	0	0
102	0	202	203	0	0	0
103	0	204	205	0	0	0
104	0	206	207	0	0	0
105	0	208	209	0	0	0
106	0	210	211	0	0	0
107	0	212	213	0	0	0
108	0	214	215	0	0	0
109	0	216	217	0	0	0
110	0	218	219	0	0	0
111	0	220	221	0	0	0
112	0	222	223	0	0	0
113	0	224	225	0	0	0
114	0	226	227	0	0	0
115	0	228	229	0	0	0
116	0	230	231	0	0	0
117	0	232	233	0	0	0
118	0	234	235	0	0	0
119	0	236	237	0	0	0
120	0	238	239	0	0	0
121	0	240	241	0	0	0
122	0	242	243	0	0	0
123	0	244	245	0	0	0
124	0	246	247	0	0	0
125	0	248	249	0	0	0
126	0	250	251	0	0	0
127	0	252	253	0	0	0
128	0	254	255	0	0	0
129	0	256	257	0	0	0
130	0	258	259	0	0	0
131	0	260	261	0	0	0
132	0	262	263	0	0	0
133	0	264	265	0	0	0

4 108 1 1 0 0 0 0 0 0 0 0 0 0

1AXISYMMETRIC ANALYSIS

NUMBER OF ELEMENTS = 108
NUMBER OF MATERIALS = 1

```
MAXIMUM TEMPERATURES
PER MATERIAL          =    1
ANALYSIS CODE         =    0
CODE FOR INCLUSION
OF BENDING MODES      =    0
  EQ.0, INCLUDE
  GT.0, SUPPRESS
```

```
MATERIAL I.D. NUMBER   =    1
NUMBER OF TEMPERATURES =    1
WEIGHT DENSITY         =    .0000E+00
MASS   DENSITY         =    .0000E+00
BETA ANGLE             =    .000
```

TEMPERATURE	E(N)	E(S)	E(T)	NU(NS)	NU(NT)	NU(ST)	G(NS)	ALPHA(N)	ALPHA(S)	ALPHA(T)
.00	.2830E+08	.2830E+08	.2830E+08	.3000	.3000	.3000	.1200E+08	.9300E-05	.9300E-05	.9300E-05

ELEMENT LOAD MULTIPLIERS

LOAD CASE	TEMPERATURE	PRESSURE	X-GRAVITY	Y-GRAVITY	Z-GRAVITY
A	.000	1.000	.000	.000	.000
B	.000	.000	.000	.000	.000
C	.000	.000	.000	.000	.000
D	.000	.000	.000	.000	.000

1ELEMENT NUMBER	I	J	K	L	MATL TYPE	REFERENCE TEMPERATURE	I-J FACE PRESSURE	STRESS OPTION	KG	THICKNESS
1	1	2	15	14	1	.000	.263E+04	4	1	.0000
2	2	3	16	15	1	.000	.100E+04	4	1	.0000
3	3	4	17	16	1	.000	.100E+04	4	1	.0000
4	4	5	18	17	1	.000	.100E+04	4	1	.0000
5	5	6	19	18	1	.000	.100E+04	4	1	.0000
6	6	7	20	19	1	.000	.100E+04	4	1	.0000
7	7	8	21	20	1	.000	.100E+04	4	1	.0000
8	8	9	22	21	1	.000	.100E+04	4	1	.0000
9	9	10	23	22	1	.000	.100E+04	4	1	.0000
10	10	11	24	23	1	.000	.100E+04	4	1	.0000
11	11	12	25	24	1	.000	.100E+04	4	1	.0000
12	12	13	26	25	1	.000	.100E+04	4	1	.0000
13	14	15	28	27	1	.000	.000E+00	4	1	.0000
14	15	16	29	28	1	.000	.000E+00	4	1	.0000
15	16	17	30	29	1	.000	.000E+00	4	1	.0000
16	17	18	31	30	1	.000	.000E+00	4	1	.0000
17	18	19	32	31	1	.000	.000E+00	4	1	.0000
18	19	20	33	32	1	.000	.000E+00	4	1	.0000
19	20	21	34	33	1	.000	.000E+00	4	1	.0000
20	21	22	35	34	1	.000	.000E+00	4	1	.0000
21	22	23	36	35	1	.000	.000E+00	4	1	.0000
22	23	24	37	36	1	.000	.000E+00	4	1	.0000
23	24	25	38	37	1	.000	.000E+00	4	1	.0000
24	25	26	39	38	1	.000	.000E+00	4	1	.0000
25	27	28	41	40	1	.000	.000E+00	4	1	.0000
26	28	29	42	41	1	.000	.000E+00	4	1	.0000
27	29	30	43	42	1	.000	.000E+00	4	1	.0000
28	30	31	44	43	1	.000	.000E+00	4	1	.0000
29	31	32	45	44	1	.000	.000E+00	4	1	.0000
30	32	33	46	45	1	.000	.000E+00	4	1	.0000

31	33	34	47	46	1	.000	.000E+00	4	1	.0000
32	34	35	48	47	1	.000	.000E+00	4	1	.0000
33	35	36	49	48	1	.000	.000E+00	4	1	.0000
34	36	37	50	49	1	.000	.000E+00	4	1	.0000
35	37	38	51	50	1	.000	.000E+00	4	1	.0000
36	38	39	52	51	1	.000	.000E+00	4	1	.0000
37	40	41	54	53	1	.000	.000E+00	4	1	.0000
38	41	42	55	54	1	.000	.000E+00	4	1	.0000
39	42	43	56	55	1	.000	.000E+00	4	1	.0000
40	43	44	57	56	1	.000	.000E+00	4	1	.0000
41	44	45	58	57	1	.000	.000E+00	4	1	.0000
42	45	46	59	58	1	.000	.000E+00	4	1	.0000
43	46	47	60	59	1	.000	.000E+00	4	1	.0000
44	47	48	61	60	1	.000	.000E+00	4	1	.0000
45	48	49	62	61	1	.000	.000E+00	4	1	.0000
46	49	50	63	62	1	.000	.000E+00	4	1	.0000
47	50	51	64	63	1	.000	.000E+00	4	1	.0000
48	51	52	65	64	1	.000	.000E+00	4	1	.0000
49	53	54	67	66	1	.000	.000E+00	4	1	.0000
50	54	55	68	67	1	.000	.000E+00	4	1	.0000
51	55	56	69	68	1	.000	.000E+00	4	1	.0000
52	56	57	70	69	1	.000	.000E+00	4	1	.0000
53	57	58	71	70	1	.000	.000E+00	4	1	.0000
54	58	59	72	71	1	.000	.000E+00	4	1	.0000
55	59	60	73	72	1	.000	.000E+00	4	1	.0000
56	60	61	74	73	1	.000	.000E+00	4	1	.0000
57	61	62	75	74	1	.000	.000E+00	4	1	.0000
58	62	63	76	75	1	.000	.000E+00	4	1	.0000
59	63	64	77	76	1	.000	.000E+00	4	1	.0000
60	64	65	78	77	1	.000	.000E+00	4	1	.0000
61	66	67	80	79	1	.000	.000E+00	4	1	.0000
62	67	68	81	80	1	.000	.000E+00	4	1	.0000
63	68	69	82	81	1	.000	.000E+00	4	1	.0000
64	69	70	83	82	1	.000	.000E+00	4	1	.0000
65	70	71	84	83	1	.000	.000E+00	4	1	.0000
66	71	72	85	84	1	.000	.000E+00	4	1	.0000
67	72	73	86	85	1	.000	.000E+00	4	1	.0000
68	73	74	87	86	1	.000	.000E+00	4	1	.0000
69	74	75	88	87	1	.000	.000E+00	4	1	.0000
70	75	76	89	88	1	.000	.000E+00	4	1	.0000
71	76	77	90	89	1	.000	.000E+00	4	1	.0000
72	77	78	91	90	1	.000	.000E+00	4	1	.0000
73	79	80	93	92	1	.000	.000E+00	4	1	.0000
74	80	81	94	93	1	.000	.000E+00	4	1	.0000
75	81	82	95	94	1	.000	.000E+00	4	1	.0000
76	82	83	96	95	1	.000	.000E+00	4	1	.0000
77	83	84	97	96	1	.000	.000E+00	4	1	.0000
78	84	85	98	97	1	.000	.000E+00	4	1	.0000
79	92	93	100	99	1	.000	.000E+00	4	1	.0000
80	93	94	101	100	1	.000	.000E+00	4	1	.0000
81	94	95	102	101	1	.000	.000E+00	4	1	.0000
82	95	96	103	102	1	.000	.000E+00	4	1	.0000
83	96	97	104	103	1	.000	.000E+00	4	1	.0000
84	97	98	105	104	1	.000	.000E+00	4	1	.0000
85	99	100	107	106	1	.000	.000E+00	4	1	.0000
86	100	101	108	107	1	.000	.000E+00	4	1	.0000
87	101	102	109	108	1	.000	.000E+00	4	1	.0000
88	102	103	110	109	1	.000	.000E+00	4	1	.0000
89	103	104	111	110	1	.000	.000E+00	4	1	.0000
90	104	105	112	111	1	.000	.000E+00	4	1	.0000
91	106	107	114	113	1	.000	.000E+00	4	1	.0000
92	107	108	115	114	1	.000	.000E+00	4	1	.0000
93	108	109	116	115	1	.000	.000E+00	4	1	.0000
94	109	110	117	116	1	.000	.000E+00	4	1	.0000
95	110	111	118	117	1	.000	.000E+00	4	1	.0000
96	111	112	119	118	1	.000	.000E+00	4	1	.0000

97	113	114	121	120	1	.000	.000E+00	4	1	.0000
98	114	115	122	121	1	.000	.000E+00	4	1	.0000
99	115	116	123	122	1	.000	.000E+00	4	1	.0000
100	116	117	124	123	1	.000	.000E+00	4	1	.0000
101	117	118	125	124	1	.000	.000E+00	4	1	.0000
102	118	119	126	125	1	.000	.000E+00	4	1	.0000
103	120	121	128	127	1	.000	.000E+00	4	1	.0000
104	121	122	129	128	1	.000	.000E+00	4	1	.0000
105	122	123	130	129	1	.000	.000E+00	4	1	.0000
106	123	124	131	130	1	.000	.000E+00	4	1	.0000
107	124	125	132	131	1	.000	.000E+00	4	1	.0000
108	125	126	133	132	1	.000	.000E+00	4	1	.0000

1E Q U A T I O N   P A R A M E T E R S

TOTAL NUMBER OF EQUATIONS = 265
BANDWIDTH = 30
NUMBER OF EQUATIONS IN A BLOCK = 124
NUMBER OF BLOCKS = 3

1N O D A L   L O A D S   (S T A T I C)   O R   M A S S E S   (D Y N A M I C)

NODE NUMBER	LOAD CASE	X-AXIS FORCE	Y-AXIS FORCE	Z-AXIS FORCE	X-AXIS MOMENT	Y-AXIS MOMENT	Z-AXIS MOMENT

STRUCTURE LOAD CASE	ELEMENT A	LOAD B	MULTIPLIERS C	D
1	1.000	.000	.000	.000

1N O D E   D I S P L A C E M E N T S / R O T A T I O N S

	NODE NUMBER	LOAD CASE	X-TRANSLATION	Y-TRANSLATION	Z-TRANSLATION	X-ROTATION	Y-ROTATION	Z-ROTATION
0	133	1	.00000E+00	.24415E-03	.30322E-02	.00000E+00	.00000E+00	.00000E+00
0	132	1	.00000E+00	.25364E-03	.30469E-02	.00000E+00	.00000E+00	.00000E+00
0	131	1	.00000E+00	.26643E-03	.30674E-02	.00000E+00	.00000E+00	.00000E+00
0	130	1	.00000E+00	.27823E-03	.30969E-02	.00000E+00	.00000E+00	.00000E+00
0	129	1	.00000E+00	.28605E-03	.31321E-02	.00000E+00	.00000E+00	.00000E+00
0	128	1	.00000E+00	.29210E-03	.31662E-02	.00000E+00	.00000E+00	.00000E+00
0	127	1	.00000E+00	.30775E-03	.31998E-02	.00000E+00	.00000E+00	.00000E+00
0	126	1	.00000E+00	.23224E-03	.30397E-02	.00000E+00	.00000E+00	.00000E+00
0	125	1	.00000E+00	.24054E-03	.30531E-02	.00000E+00	.00000E+00	.00000E+00
0	124	1	.00000E+00	.24974E-03	.30756E-02	.00000E+00	.00000E+00	.00000E+00
0	123	1	.00000E+00	.25746E-03	.31094E-02	.00000E+00	.00000E+00	.00000E+00
0	122	1	.00000E+00	.26279E-03	.31497E-02	.00000E+00	.00000E+00	.00000E+00
0	121	1	.00000E+00	.26789E-03	.31887E-02	.00000E+00	.00000E+00	.00000E+00
0	120	1	.00000E+00	.28118E-03	.32193E-02	.00000E+00	.00000E+00	.00000E+00
0	119	1	.00000E+00	.22544E-03	.30462E-02	.00000E+00	.00000E+00	.00000E+00

0	118	1	.00000E+00	.23455E-03	.30562E-02	.00000E+00	.00000E+00	.00000E+00
0	117	1	.00000E+00	.24499E-03	.30818E-02	.00000E+00	.00000E+00	.00000E+00
0	116	1	.00000E+00	.25143E-03	.31221E-02	.00000E+00	.00000E+00	.00000E+00
0	115	1	.00000E+00	.25388E-03	.31697E-02	.00000E+00	.00000E+00	.00000E+00
0	114	1	.00000E+00	.25491E-03	.32147E-02	.00000E+00	.00000E+00	.00000E+00
0	113	1	.00000E+00	.26324E-03	.32445E-02	.00000E+00	.00000E+00	.00000E+00
0	112	1	.00000E+00	.22589E-03	.30478E-02	.00000E+00	.00000E+00	.00000E+00
0	111	1	.00000E+00	.23971E-03	.30535E-02	.00000E+00	.00000E+00	.00000E+00
0	110	1	.00000E+00	.25049E-03	.30852E-02	.00000E+00	.00000E+00	.00000E+00
0	109	1	.00000E+00	.25521E-03	.31368E-02	.00000E+00	.00000E+00	.00000E+00
0	108	1	.00000E+00	.25170E-03	.31958E-02	.00000E+00	.00000E+00	.00000E+00
0	107	1	.00000E+00	.24726E-03	.32484E-02	.00000E+00	.00000E+00	.00000E+00
0	106	1	.00000E+00	.24889E-03	.32817E-02	.00000E+00	.00000E+00	.00000E+00
0	105	1	.00000E+00	.24144E-03	.30414E-02	.00000E+00	.00000E+00	.00000E+00
0	104	1	.00000E+00	.25486E-03	.30417E-02	.00000E+00	.00000E+00	.00000E+00
0	103	1	.00000E+00	.26824E-03	.30876E-02	.00000E+00	.00000E+00	.00000E+00
0	102	1	.00000E+00	.26004E-03	.31596E-02	.00000E+00	.00000E+00	.00000E+00
0	101	1	.00000E+00	.24749E-03	.32302E-02	.00000E+00	.00000E+00	.00000E+00
0	100	1	.00000E+00	.23629E-03	.32923E-02	.00000E+00	.00000E+00	.00000E+00
0	99	1	.00000E+00	.23047E-03	.33340E-02	.00000E+00	.00000E+00	.00000E+00
0	98	1	.00000E+00	.26137E-03	.30121E-02	.00000E+00	.00000E+00	.00000E+00
0	97	1	.00000E+00	.30185E-03	.30165E-02	.00000E+00	.00000E+00	.00000E+00
0	96	1	.00000E+00	.27975E-03	.31070E-02	.00000E+00	.00000E+00	.00000E+00
0	95	1	.00000E+00	.25353E-03	.31925E-02	.00000E+00	.00000E+00	.00000E+00
0	94	1	.00000E+00	.23073E-03	.32744E-02	.00000E+00	.00000E+00	.00000E+00
0	93	1	.00000E+00	.21290E-03	.33457E-02	.00000E+00	.00000E+00	.00000E+00
0	92	1	.00000E+00	.19972E-03	.34008E-02	.00000E+00	.00000E+00	.00000E+00
0	91	1	.00000E+00	.11433E-02	.00000E+00	.00000E+00	.00000E+00	.00000E+00
0	90	1	.00000E+00	.98934E-03	.97095E-03	.00000E+00	.00000E+00	.00000E+00
0	89	1	.00000E+00	.87402E-03	.14047E-02	.00000E+00	.00000E+00	.00000E+00
0	88	1	.00000E+00	.78865E-03	.18145E-02	.00000E+00	.00000E+00	.00000E+00
0	87	1	.00000E+00	.70283E-03	.21862E-02	.00000E+00	.00000E+00	.00000E+00
0	86	1	.00000E+00	.59450E-03	.25333E-02	.00000E+00	.00000E+00	.00000E+00

0	85	1	.00000E+00	.39650E-03	.29163E-02	.00000E+00	.00000E+00	.00000E+00
0	84	1	.00000E+00	.31471E-03	.30383E-02	.00000E+00	.00000E+00	.00000E+00
0	83	1	.00000E+00	.25969E-03	.31391E-02	.00000E+00	.00000E+00	.00000E+00
0	82	1	.00000E+00	.22118E-03	.32367E-02	.00000E+00	.00000E+00	.00000E+00
0	81	1	.00000E+00	.19158E-03	.33253E-02	.00000E+00	.00000E+00	.00000E+00
0	80	1	.00000E+00	.16928E-03	.34057E-02	.00000E+00	.00000E+00	.00000E+00
0	79	1	.00000E+00	.14986E-03	.34771E-02	.00000E+00	.00000E+00	.00000E+00
0	78	1	.00000E+00	.52276E-03	.36291E-03	.00000E+00	.00000E+00	.00000E+00
0	77	1	.00000E+00	.49105E-03	.95220E-03	.00000E+00	.00000E+00	.00000E+00
0	76	1	.00000E+00	.50805E-03	.14551E-02	.00000E+00	.00000E+00	.00000E+00
0	75	1	.00000E+00	.46477E-03	.18545E-02	.00000E+00	.00000E+00	.00000E+00
0	74	1	.00000E+00	.40680E-03	.22317E-02	.00000E+00	.00000E+00	.00000E+00
0	73	1	.00000E+00	.32472E-03	.25970E-02	.00000E+00	.00000E+00	.00000E+00
0	72	1	.00000E+00	.28067E-03	.28993E-02	.00000E+00	.00000E+00	.00000E+00
0	71	1	.00000E+00	.23738E-03	.30657E-02	.00000E+00	.00000E+00	.00000E+00
0	70	1	.00000E+00	.19060E-03	.31807E-02	.00000E+00	.00000E+00	.00000E+00
0	69	1	.00000E+00	.15254E-03	.32833E-02	.00000E+00	.00000E+00	.00000E+00
0	68	1	.00000E+00	.12399E-03	.33777E-02	.00000E+00	.00000E+00	.00000E+00
0	67	1	.00000E+00	.10078E-03	.34665E-02	.00000E+00	.00000E+00	.00000E+00
0	66	1	.00000E+00	.76995E-04	.35553E-02	.00000E+00	.00000E+00	.00000E+00
0	65	1	.00000E+00	.19247E-03	.55892E-03	.00000E+00	.00000E+00	.00000E+00
0	64	1	.00000E+00	.15458E-03	.98368E-03	.00000E+00	.00000E+00	.00000E+00
0	63	1	.00000E+00	.15857E-03	.14539E-02	.00000E+00	.00000E+00	.00000E+00
0	62	1	.00000E+00	.16153E-03	.18745E-02	.00000E+00	.00000E+00	.00000E+00
0	61	1	.00000E+00	.13674E-03	.22568E-02	.00000E+00	.00000E+00	.00000E+00
0	60	1	.00000E+00	.11443E-03	.26030E-02	.00000E+00	.00000E+00	.00000E+00
0	59	1	.00000E+00	.97139E-04	.28848E-02	.00000E+00	.00000E+00	.00000E+00
0	58	1	.00000E+00	.87258E-04	.30763E-02	.00000E+00	.00000E+00	.00000E+00
0	57	1	.00000E+00	.69417E-04	.32126E-02	.00000E+00	.00000E+00	.00000E+00
0	56	1	.00000E+00	.47543E-04	.33235E-02	.00000E+00	.00000E+00	.00000E+00
0	55	1	.00000E+00	.27270E-04	.34239E-02	.00000E+00	.00000E+00	.00000E+00
0	54	1	.00000E+00	.73028E-05	.35213E-02	.00000E+00	.00000E+00	.00000E+00
0	53	1	.00000E+00	-.18930E-04	.36266E-02	.00000E+00	.00000E+00	.00000E+00

0	52	1	.00000E+00	-.87592E-04	.66472E-03	.00000E+00	.00000E+00	.00000E+00
0	51	1	.00000E+00	-.11697E-03	.10312E-02	.00000E+00	.00000E+00	.00000E+00
0	50	1	.00000E+00	-.12404E-03	.14551E-02	.00000E+00	.00000E+00	.00000E+00
0	49	1	.00000E+00	-.11787E-03	.18725E-02	.00000E+00	.00000E+00	.00000E+00
0	48	1	.00000E+00	-.11116E-03	.22556E-02	.00000E+00	.00000E+00	.00000E+00
0	47	1	.00000E+00	-.10678E-03	.25935E-02	.00000E+00	.00000E+00	.00000E+00
0	46	1	.00000E+00	-.97697E-04	.28723E-02	.00000E+00	.00000E+00	.00000E+00
0	45	1	.00000E+00	-.89632E-04	.30731E-02	.00000E+00	.00000E+00	.00000E+00
0	44	1	.00000E+00	-.85079E-04	.32263E-02	.00000E+00	.00000E+00	.00000E+00
0	43	1	.00000E+00	-.86536E-04	.33485E-02	.00000E+00	.00000E+00	.00000E+00
0	42	1	.00000E+00	-.93145E-04	.34570E-02	.00000E+00	.00000E+00	.00000E+00
0	41	1	.00000E+00	-.10673E-03	.35642E-02	.00000E+00	.00000E+00	.00000E+00
0	40	1	.00000E+00	-.13401E-03	.36836E-02	.00000E+00	.00000E+00	.00000E+00
0	39	1	.00000E+00	-.35214E-03	.71842E-03	.00000E+00	.00000E+00	.00000E+00
0	38	1	.00000E+00	-.37522E-03	.10650E-02	.00000E+00	.00000E+00	.00000E+00
0	37	1	.00000E+00	-.38427E-03	.14603E-02	.00000E+00	.00000E+00	.00000E+00
0	36	1	.00000E+00	-.37590E-03	.18626E-02	.00000E+00	.00000E+00	.00000E+00
0	35	1	.00000E+00	-.35720E-03	.22414E-02	.00000E+00	.00000E+00	.00000E+00
0	34	1	.00000E+00	-.33207E-03	.25764E-02	.00000E+00	.00000E+00	.00000E+00
0	33	1	.00000E+00	-.30372E-03	.28549E-02	.00000E+00	.00000E+00	.00000E+00
0	32	1	.00000E+00	-.27677E-03	.30614E-02	.00000E+00	.00000E+00	.00000E+00
0	31	1	.00000E+00	-.25376E-03	.32234E-02	.00000E+00	.00000E+00	.00000E+00
0	30	1	.00000E+00	-.23684E-03	.33548E-02	.00000E+00	.00000E+00	.00000E+00
0	29	1	.00000E+00	-.22842E-03	.34722E-02	.00000E+00	.00000E+00	.00000E+00
0	28	1	.00000E+00	-.23366E-03	.35911E-02	.00000E+00	.00000E+00	.00000E+00
0	27	1	.00000E+00	-.26170E-03	.37229E-02	.00000E+00	.00000E+00	.00000E+00
0	26	1	.00000E+00	-.62300E-03	.73883E-03	.00000E+00	.00000E+00	.00000E+00
0	25	1	.00000E+00	-.64281E-03	.10818E-02	.00000E+00	.00000E+00	.00000E+00
0	24	1	.00000E+00	-.65077E-03	.14597E-02	.00000E+00	.00000E+00	.00000E+00
0	23	1	.00000E+00	-.63975E-03	.18488E-02	.00000E+00	.00000E+00	.00000E+00
0	22	1	.00000E+00	-.61037E-03	.22201E-02	.00000E+00	.00000E+00	.00000E+00
0	21	1	.00000E+00	-.56692E-03	.25515E-02	.00000E+00	.00000E+00	.00000E+00
0	20	1	.00000E+00	-.51547E-03	.28296E-02	.00000E+00	.00000E+00	.00000E+00

0	19	1	.00000E+00	-.46679E-03	.30388E-02	.00000E+00	.00000E+00	.00000E+00
0	18	1	.00000E+00	-.42324E-03	.32059E-02	.00000E+00	.00000E+00	.00000E+00
0	17	1	.00000E+00	-.38967E-03	.33430E-02	.00000E+00	.00000E+00	.00000E+00
0	16	1	.00000E+00	-.36873E-03	.34673E-02	.00000E+00	.00000E+00	.00000E+00
0	15	1	.00000E+00	-.36632E-03	.35998E-02	.00000E+00	.00000E+00	.00000E+00
0	14	1	.00000E+00	-.39732E-03	.37482E-02	.00000E+00	.00000E+00	.00000E+00
0	13	1	.00000E+00	-.90623E-03	.74270E-03	.00000E+00	.00000E+00	.00000E+00
0	12	1	.00000E+00	-.93257E-03	.10849E-02	.00000E+00	.00000E+00	.00000E+00
0	11	1	.00000E+00	-.94829E-03	.14511E-02	.00000E+00	.00000E+00	.00000E+00
0	10	1	.00000E+00	-.93497E-03	.18273E-02	.00000E+00	.00000E+00	.00000E+00
0	9	1	.00000E+00	-.88865E-03	.21884E-02	.00000E+00	.00000E+00	.00000E+00
0	8	1	.00000E+00	-.81626E-03	.25136E-02	.00000E+00	.00000E+00	.00000E+00
0	7	1	.00000E+00	-.73033E-03	.27898E-02	.00000E+00	.00000E+00	.00000E+00
0	6	1	.00000E+00	-.64972E-03	.30010E-02	.00000E+00	.00000E+00	.00000E+00
0	5	1	.00000E+00	-.57918E-03	.31728E-02	.00000E+00	.00000E+00	.00000E+00
0	4	1	.00000E+00	-.52718E-03	.33163E-02	.00000E+00	.00000E+00	.00000E+00
0	3	1	.00000E+00	-.50143E-03	.34458E-02	.00000E+00	.00000E+00	.00000E+00
0	2	1	.00000E+00	-.50646E-03	.35926E-02	.00000E+00	.00000E+00	.00000E+00
0	1	1	.00000E+00	-.55014E-03	.37674E-02	.00000E+00	.00000E+00	.00000E+00

1T W O - D I M E N S I O N A L   F I N I T E   E L E M E N T S

1. CENTROID STRESSES REFERENCED TO LOCAL Y-Z COORDINATES.
2. MID-SIDE STRESSES ARE NORMAL AND PARALLEL TO ELEMENT EDGES.

0ELEMENT (1)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.72479E+03	-.24856E+04	-.64295E+04	-.63499E+02	-.72250E+03	-.24879E+04	-2.06

0
0ELEMENT (2)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.19136E+04	-.13410E+04	-.52657E+04	.17662E+03	-.12909E+04	-.19637E+04	74.17

0
0ELEMENT (3)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.30000E+04	-.10120E+04	-.49249E+04	.43242E+03	-.92199E+03	-.30900E+04	78.25

0
0ELEMENT (4)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE

```
    1  CEN   -.40207E+04   -.99937E+03   -.49561E+04    .41626E+03   -.94307E+03   -.40770E+04    82.30
0
0ELEMENT (    5)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN   -.47933E+04   -.95349E+03   -.50775E+04    .30735E+03   -.92904E+03   -.48178E+04    85.45
0
0ELEMENT (    6)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN   -.52034E+04   -.91778E+03   -.51758E+04    .11915E+03   -.91447E+03   -.52067E+04    88.41
0
0ELEMENT (    7)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN   -.51499E+04   -.89295E+03   -.51586E+04   -.13395E+03   -.88874E+03   -.51541E+04   -88.20
0
0ELEMENT (    8)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN   -.45587E+04   -.88331E+03   -.49564E+04   -.41402E+03   -.83725E+03   -.46047E+04   -83.65
0
0ELEMENT (    9)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN   -.34741E+04   -.90299E+03   -.45534E+04   -.65546E+03   -.74553E+03   -.36316E+04   -76.49
0
0ELEMENT (   10)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN   -.20812E+04   -.97157E+03   -.39963E+04   -.76335E+03   -.58271E+03   -.24700E+04   -63.00
0
0ELEMENT (   11)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN   -.78283E+03   -.11035E+04   -.34186E+04   -.59790E+03   -.32415E+03   -.15622E+04   -37.49
0
0ELEMENT (   12)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN   -.10098E+03   -.11141E+04   -.29565E+04   -.17573E+03   -.71367E+02   -.11437E+04    -9.57
0
0ELEMENT (   13)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN   -.65967E+03   -.25848E+04   -.47520E+04    .11572E+03   -.65274E+03   -.25917E+04     3.43
0
0ELEMENT (   14)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN   -.16554E+04   -.17940E+04   -.39710E+04    .48845E+03   -.12314E+04   -.22181E+04    40.96
0
0ELEMENT (   15)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN     ANGLE
```

```
    1 CEN   -.22246E+04   -.12702E+04   -.35900E+04    .84123E+03   -.78024E+03   -.27146E+04    59.78
0
0ELEMENT (   16)

  LOAD  LOC         S11          S22          S33          S12          S-MAX         S-MIN     ANGLE

    1 CEN   -.26471E+04   -.99573E+03   -.34337E+04    .89606E+03   -.60294E+03   -.30399E+04    66.33
0
0ELEMENT (   17)

  LOAD  LOC         S11          S22          S33          S12          S-MAX         S-MIN     ANGLE

    1 CEN   -.29847E+04   -.77314E+03   -.33729E+04    .66426E+03   -.58896E+03   -.31689E+04    74.50
0
0ELEMENT (   18)

  LOAD  LOC         S11          S22          S33          S12          S-MAX         S-MIN     ANGLE

    1 CEN   -.31488E+04   -.58685E+03   -.33284E+04    .21857E+03   -.56833E+03   -.31673E+04    85.16
0
0ELEMENT (   19)

  LOAD  LOC         S11          S22          S33          S12          S-MAX         S-MIN     ANGLE

    1 CEN   -.30499E+04   -.46832E+03   -.32414E+04   -.36906E+03   -.41660E+03   -.31016E+04   -82.02
0
0ELEMENT (   20)

  LOAD  LOC         S11          S22          S33          S12          S-MAX         S-MIN     ANGLE

    1 CEN   -.27260E+04   -.44454E+03   -.31034E+04   -.98998E+03   -.74865E+02   -.30956E+04   -69.52
0
0ELEMENT (   21)

  LOAD  LOC         S11          S22          S33          S12          S-MAX         S-MIN     ANGLE

    1 CEN   -.22052E+04   -.54442E+03   -.29161E+04   -.15150E+04    .35281E+03   -.31025E+04   -59.36
0
0ELEMENT (   22)

  LOAD  LOC         S11          S22          S33          S12          S-MAX         S-MIN     ANGLE

    1 CEN   -.15485E+04   -.87307E+03   -.27200E+04   -.17802E+04    .60115E+03   -.30227E+04   -50.37
0
0ELEMENT (   23)

  LOAD  LOC         S11          S22          S33          S12          S-MAX         S-MIN     ANGLE

    1 CEN   -.77772E+03   -.14482E+04   -.25183E+04   -.15352E+04    .45845E+03   -.26843E+04   -38.84
0
0ELEMENT (   24)

  LOAD  LOC         S11          S22          S33          S12          S-MAX         S-MIN     ANGLE

    1 CEN   -.16731E+03   -.17784E+04   -.22490E+04   -.63526E+03    .53044E+02   -.19987E+04   -19.13
0
0ELEMENT (   25)

  LOAD  LOC         S11          S22          S33          S12          S-MAX         S-MIN     ANGLE

    1 CEN   -.40222E+03   -.29544E+04   -.32002E+04    .27478E+03   -.37297E+03   -.29837E+04     6.08
0
0ELEMENT (   26)

  LOAD  LOC         S11          S22          S33          S12          S-MAX         S-MIN     ANGLE
```

1	CEN	-.95295E+03	-.22476E+04	-.25710E+04	.63897E+03	-.69071E+03	-.25098E+04	22.31

0
0ELEMENT (27)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.11815E+04	-.16132E+04	-.21672E+04	.92587E+03	-.44667E+03	-.23481E+04	38.44

0
0ELEMENT (28)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.12799E+04	-.10434E+04	-.18770E+04	.10198E+04	-.13508E+03	-.21882E+04	48.31

0
0ELEMENT (29)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.13714E+04	-.49962E+03	-.16690E+04	.77551E+03	-.45911E+02	-.18252E+04	59.67

0
0ELEMENT (30)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.13783E+04	-.40955E+02	-.15064E+04	.20817E+03	-.92997E+01	-.14099E+04	81.35

0
0ELEMENT (31)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.12758E+04	.17585E+03	-.13995E+04	-.56010E+03	.36683E+03	-.14668E+04	-71.17

0
0ELEMENT (32)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.10535E+04	.18035E+03	-.13092E+04	-.12569E+04	.96360E+03	-.18368E+04	-58.07

0
0ELEMENT (33)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.10216E+04	-.21548E+02	-.13282E+04	-.17923E+04	.13392E+04	-.23823E+04	-52.79

0
0ELEMENT (34)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.96480E+03	-.59232E+03	-.14469E+04	-.22169E+04	.14461E+04	-.30032E+04	-47.40

0
0ELEMENT (35)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.63868E+03	-.17892E+04	-.16418E+04	-.21951E+04	.10552E+04	-.34831E+04	-37.66

0
0ELEMENT (36)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.16270E+03	-.30508E+04	-.17517E+04	-.10624E+04	.18599E+03	-.33995E+04	-18.17

0
0ELEMENT (37)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE

```
    1  CEN   -.16300E+03   -.34130E+04   -.17870E+04    .26355E+03   -.14176E+03   -.34342E+04     4.61
0
0ELEMENT (   38)

  LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN    ANGLE

    1  CEN   -.28030E+03   -.26111E+04   -.12485E+04    .54287E+03   -.16006E+03   -.27313E+04    12.49
0
0ELEMENT (   39)

  LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN    ANGLE

    1  CEN   -.12130E+03   -.19280E+04   -.81575E+03    .74167E+03    .14415E+03   -.21935E+04    19.69
0
0ELEMENT (   40)

  LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN    ANGLE

    1  CEN    .14129E+03   -.11696E+04   -.38976E+03    .88224E+03    .58492E+03   -.16132E+04    26.70
0
0ELEMENT (   41)

  LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN    ANGLE

    1  CEN    .29149E+03   -.20378E+03    .16833E+02    .76683E+03    .84969E+03   -.76197E+03    36.05
0
0ELEMENT (   42)

  LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN    ANGLE

    1  CEN    .32236E+03    .62744E+03    .28918E+03    .11762E+03    .66752E+03    .28228E+03    71.18
0
0ELEMENT (   43)

  LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN    ANGLE

    1  CEN    .63128E+03    .95777E+03    .48230E+03   -.77678E+03    .15883E+04    .77759E+00   -50.93
0
0ELEMENT (   44)

  LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN    ANGLE

    1  CEN    .77693E+03    .67518E+03    .46697E+03   -.13990E+04    .21260E+04   -.67386E+03   -43.96
0
0ELEMENT (   45)

  LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN    ANGLE

    1  CEN    .68547E+03    .41713E+03    .40414E+03   -.15494E+04    .21065E+04   -.10039E+04   -42.53
0
0ELEMENT (   46)

  LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN    ANGLE

    1  CEN   -.24289E+03   -.54491E+02   -.15723E+02   -.18811E+04    .17348E+04   -.20322E+04   -46.43
0
0ELEMENT (   47)

  LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN    ANGLE

    1  CEN   -.67386E+03   -.17923E+04   -.70241E+03   -.25357E+04    .13636E+04   -.38297E+04   -38.78
0
0ELEMENT (   48)

  LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN    ANGLE
```

```
    1  CEN   -.24728E+03   -.48445E+04   -.14389E+04   -.15259E+04    .21308E+03   -.53049E+04   -16.79
0
0ELEMENT (   49)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN      ANGLE

    1  CEN    .24687E+02   -.37265E+04   -.54393E+03    .12492E+03    .28843E+02   -.37306E+04     1.91
0
0ELEMENT (   50)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN      ANGLE

    1  CEN    .25774E+03   -.28101E+04   -.94911E+02    .21699E+03    .27302E+03   -.28254E+04     4.03
0
0ELEMENT (   51)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN      ANGLE

    1  CEN    .73971E+03   -.21189E+04    .33570E+03    .26454E+03    .76398E+03   -.21432E+04     5.24
0
0ELEMENT (   52)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN      ANGLE

    1  CEN    .14165E+04   -.13558E+04    .86168E+03    .35053E+03    .14601E+04   -.13994E+04     7.10
0
0ELEMENT (   53)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN      ANGLE

    1  CEN    .21290E+04   -.97960E+02    .15606E+04    .46845E+03    .22235E+04   -.19249E+03    11.41
0
0ELEMENT (   54)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN      ANGLE

    1  CEN    .25185E+04    .15350E+04    .22330E+04    .42670E+02    .25204E+04    .15331E+04     2.48
0
0ELEMENT (   55)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN      ANGLE

    1  CEN    .27316E+04    .17712E+04    .23710E+04   -.12856E+04    .36238E+04    .87898E+03   -34.76
0
0ELEMENT (   56)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN      ANGLE

    1  CEN    .35414E+04    .91938E+03    .24552E+04   -.15460E+04    .42574E+04    .20339E+03   -24.85
0
0ELEMENT (   57)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN      ANGLE

    1  CEN    .26807E+04    .15455E+03    .20852E+04   -.93625E+03    .29898E+04   -.15461E+03   -18.27
0
0ELEMENT (   58)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN      ANGLE

    1  CEN    .17417E+04    .58114E+03    .19625E+04   -.60743E+03    .20015E+04    .32136E+03   -23.16
0
0ELEMENT (   59)

  LOAD  LOC          S11           S22           S33           S12         S-MAX         S-MIN      ANGLE
```

```
    1  CEN   -.51044E+03   -.77675E+03    .77074E+03   -.17663E+04    .11277E+04   -.24149E+04    -42.84
0
0ELEMENT (   60)

  LOAD  LOC           S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN   -.83640E+03   -.70883E+04   -.13309E+04   -.24350E+04    .72215E-01   -.79248E+04    -18.96
0
0ELEMENT (   61)

  LOAD  LOC           S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN    .15939E+03   -.37324E+04    .50370E+03   -.76695E+02    .16090E+03   -.37339E+04     -1.13
0
0ELEMENT (   62)

  LOAD  LOC           S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN    .60763E+03   -.27717E+04    .82937E+03   -.24334E+03    .62506E+03   -.27892E+04     -4.10
0
0ELEMENT (   63)

  LOAD  LOC           S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN    .12657E+04   -.20586E+04    .12169E+04   -.39016E+03    .13108E+04   -.21038E+04     -6.61
0
0ELEMENT (   64)

  LOAD  LOC           S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN    .21134E+04   -.13447E+04    .17261E+04   -.56441E+03    .22032E+04   -.14345E+04     -9.04
0
0ELEMENT (   65)

  LOAD  LOC           S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN    .33844E+04   -.16568E+03    .25719E+04   -.63667E+03    .34951E+04   -.27640E+03     -9.87
0
0ELEMENT (   66)

  LOAD  LOC           S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN    .52528E+04    .25138E+04    .41105E+04   -.87369E+03    .55077E+04    .22588E+04    -16.27
0
0ELEMENT (   67)

  LOAD  LOC           S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN    .82761E+04    .27388E+04    .52654E+04   -.24263E+04    .91888E+04    .18261E+04    -20.61
0
0ELEMENT (   68)

  LOAD  LOC           S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN    .57843E+04   -.14209E+03    .40451E+04   -.52846E+03    .58311E+04   -.18884E+03     -5.06
0
0ELEMENT (   69)

  LOAD  LOC           S11           S22           S33           S12         S-MAX         S-MIN     ANGLE

    1  CEN    .47388E+04    .19305E+03    .39701E+04   -.26856E+03    .47546E+04    .17723E+03     -3.37
0
0ELEMENT (   70)

  LOAD  LOC           S11           S22           S33           S12         S-MAX         S-MIN     ANGLE
```

```
    1 CEN    .41949E+04   -.17653E+03    .37511E+04   -.50372E+02    .41955E+04   -.17711E+03     -.66
0
0ELEMENT (   71)

  LOAD  LOC        S11          S22          S33          S12          S-MAX        S-MIN     ANGLE

    1 CEN    .41942E+04    .16714E+04    .43682E+04    .74792E+03    .43993E+04    .14663E+04    15.33
0
0ELEMENT (   72)

  LOAD  LOC        S11          S22          S33          S12          S-MAX        S-MIN     ANGLE

    1 CEN    .18417E+04   -.91171E+04    .23341E+03   -.26310E+04    .24407E+04   -.97160E+04   -12.82
0
0ELEMENT (   73)

  LOAD  LOC        S11          S22          S33          S12          S-MAX        S-MIN     ANGLE

    1 CEN    .23952E+03   -.33815E+04    .13427E+04   -.27798E+03    .26074E+03   -.34027E+04    -4.36
0
0ELEMENT (   74)

  LOAD  LOC        S11          S22          S33          S12          S-MAX        S-MIN     ANGLE

    1 CEN    .76818E+03   -.24537E+04    .15153E+04   -.69056E+03    .90995E+03   -.25955E+04   -11.60
0
0ELEMENT (   75)

  LOAD  LOC        S11          S22          S33          S12          S-MAX        S-MIN     ANGLE

    1 CEN    .13777E+04   -.17457E+04    .17782E+04   -.10286E+04    .16860E+04   -.20540E+04   -16.69
0
0ELEMENT (   76)

  LOAD  LOC        S11          S22          S33          S12          S-MAX        S-MIN     ANGLE

    1 CEN    .20933E+04   -.86864E+03    .22132E+04   -.13989E+04    .26495E+04   -.14248E+04   -21.68
0
0ELEMENT (   77)

  LOAD  LOC        S11          S22          S33          S12          S-MAX        S-MIN     ANGLE

    1 CEN    .28995E+04    .17482E+03    .27668E+04   -.20349E+04    .39860E+04   -.91169E+03   -28.10
0
0ELEMENT (   78)

  LOAD  LOC        S11          S22          S33          S12          S-MAX        S-MIN     ANGLE

    1 CEN    .37638E+04    .45454E+04    .44054E+04   -.31750E+04    .73535E+04    .95569E+03   -48.51
0
0ELEMENT (   79)

  LOAD  LOC        S11          S22          S33          S12          S-MAX        S-MIN     ANGLE

    1 CEN    .27647E+03   -.27225E+04    .19899E+04   -.42272E+03    .33491E+03   -.27809E+04    -7.87
0
0ELEMENT (   80)

  LOAD  LOC        S11          S22          S33          S12          S-MAX        S-MIN     ANGLE

    1 CEN    .76908E+03   -.19398E+04    .19723E+04   -.99797E+03    .10970E+04   -.22678E+04   -18.19
0
0ELEMENT (   81)

  LOAD  LOC        S11          S22          S33          S12          S-MAX        S-MIN     ANGLE
```

1 CEN .11900E+04 -.11978E+04 .20887E+04 -.14090E+04 .18429E+04 -.18507E+04 -24.86
0
0ELEMENT (82)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.14700E+04	-.35958E+03	.22645E+04	-.18034E+04	.25774E+04	-.14669E+04	-31.55

0
0ELEMENT (83)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.14389E+04	.13899E+04	.26464E+04	-.22147E+04	.36292E+04	-.80048E+03	-44.68

0
0ELEMENT (84)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.14028E+03	.21274E+04	.20952E+04	-.85543E+03	.24139E+04	-.42678E+03	-71.48

0
0ELEMENT (85)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.28459E+03	-.18953E+04	.24786E+04	-.47780E+03	.38472E+03	-.19954E+04	-11.84

0
0ELEMENT (86)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.69083E+03	-.13272E+04	.22670E+04	-.10894E+04	.11667E+04	-.18031E+04	-23.60

0
0ELEMENT (87)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.86404E+03	-.70323E+03	.21851E+04	-.14433E+04	.17227E+04	-.15619E+04	-30.75

0
0ELEMENT (88)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.80111E+03	.18381E+03	.21840E+04	-.16380E+04	.21593E+04	-.11744E+04	-39.66

0
0ELEMENT (89)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.23744E+03	.92907E+03	.19696E+04	-.12566E+04	.18865E+04	-.72003E+03	-52.69

0
0ELEMENT (90)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.12174E+03	.10664E+04	.17098E+04	-.43402E+03	.12356E+04	-.47385E+02	-68.71

0
0ELEMENT (91)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.28137E+03	-.10628E+04	.28671E+04	-.43392E+03	.40927E+03	-.11907E+04	-16.42

0
0ELEMENT (92)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE

```
    1  CEN    .59357E+03   -.77724E+03    .24589E+04   -.96350E+03    .10906E+04   -.12743E+04    -27.29
0
OELEMENT (   93)

  LOAD  LOC          S11          S22          S33          S12          S-MAX        S-MIN      ANGLE

    1  CEN    .60088E+03   -.30794E+03    .22183E+04   -.12002E+04    .14298E+04   -.11369E+04    -34.63
0
OELEMENT (   94)

  LOAD  LOC          S11          S22          S33          S12          S-MAX        S-MIN      ANGLE

    1  CEN    .36234E+03    .19278E+03    .19858E+04   -.11276E+04    .14084E+04   -.85325E+03    -42.85
0
OELEMENT (   95)

  LOAD  LOC          S11          S22          S33          S12          S-MAX        S-MIN      ANGLE

    1  CEN    .13226E+03    .54558E+03    .17459E+04   -.76422E+03    .11306E+04   -.45275E+03    -52.57
0
OELEMENT (   96)

  LOAD  LOC          S11          S22          S33          S12          S-MAX        S-MIN      ANGLE

    1  CEN   -.34757E+02    .45082E+03    .14286E+04   -.24032E+03    .54965E+03   -.13358E+03    -67.65
0
OELEMENT (   97)

  LOAD  LOC          S11          S22          S33          S12          S-MAX        S-MIN      ANGLE

    1  CEN    .28083E+03   -.39630E+03    .32141E+04   -.29737E+03    .39288E+03   -.50835E+03    -20.65
0
OELEMENT (   98)

  LOAD  LOC          S11          S22          S33          S12          S-MAX        S-MIN      ANGLE

    1  CEN    .52716E+03   -.34995E+03    .26407E+04   -.66850E+03    .88812E+03   -.71091E+03    -28.37
0
OELEMENT (   99)

  LOAD  LOC          S11          S22          S33          S12          S-MAX        S-MIN      ANGLE

    1  CEN    .43263E+03   -.12406E+03    .22441E+04   -.79489E+03    .99650E+03   -.68793E+03    -35.35
0
OELEMENT (  100)

  LOAD  LOC          S11          S22          S33          S12          S-MAX        S-MIN      ANGLE

    1  CEN    .24025E+03    .11097E+03    .19214E+04   -.69017E+03    .86880E+03   -.51757E+03    -42.32
0
OELEMENT (  101)

  LOAD  LOC          S11          S22          S33          S12          S-MAX        S-MIN      ANGLE

    1  CEN    .42919E+02    .23322E+03    .16226E+04   -.40486E+03    .55396E+03   -.27782E+03    -51.61
0
OELEMENT (  102)

  LOAD  LOC          S11          S22          S33          S12          S-MAX        S-MIN      ANGLE

    1  CEN   -.10668E+02    .12818E+03    .13507E+04   -.10544E+03    .18500E+03   -.67482E+02    -61.68
0
OELEMENT (  103)

  LOAD  LOC          S11          S22          S33          S12          S-MAX        S-MIN      ANGLE
```

1	CEN	.30887E+03	-.26551E+02	.35748E+04	-.10168E+03	.33728E+03	-.54965E+02	-15.61

0
0ELEMENT (104)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.54239E+03	-.10791E+03	.28870E+04	-.24064E+03	.62175E+03	-.18727E+03	-18.25

0
0ELEMENT (105)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.35698E+03	-.32902E+02	.23683E+04	-.30840E+03	.52689E+03	-.20281E+03	-28.85

0
0ELEMENT (106)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.73157E+02	.15370E+02	.19268E+04	-.25109E+03	.29701E+03	-.20848E+03	-41.72

0
0ELEMENT (107)

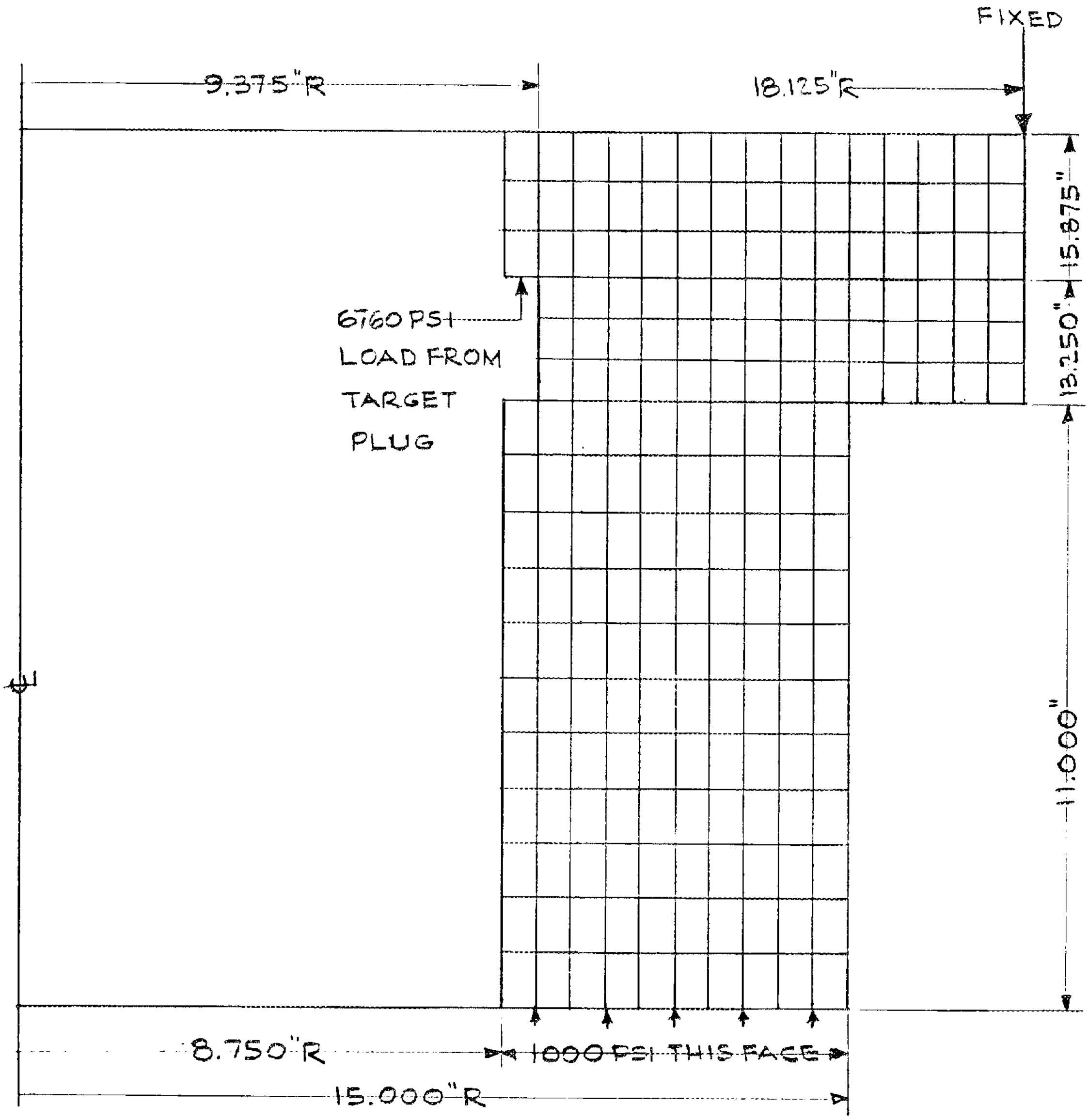
LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.83608E+02	.46715E+02	.15920E+04	-.11903E+03	.11725E+03	-.15414E+03	-59.35

0
0ELEMENT (108)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.57270E+02	.20097E+01	.13544E+04	-.11231E+02	.40662E+01	-.59326E+02	-79.62

0

PLANT	OAK RIDGE, TENNESSEE		
JOB HIFI EXPERIMENT		REF. DWG. NO. M11506-OH-002E	
SUBJECT QUICK OPENING HATCH		PAGE	OF
COMPUTATION		NO.	
COMPUTED BY C.W.COLLINS	CHECKED BY J E Rutenber	DATE 9-5-85	



FINITE ELEMENT MODEL

FIG. E-1

UCN-1070A (1 9-83)

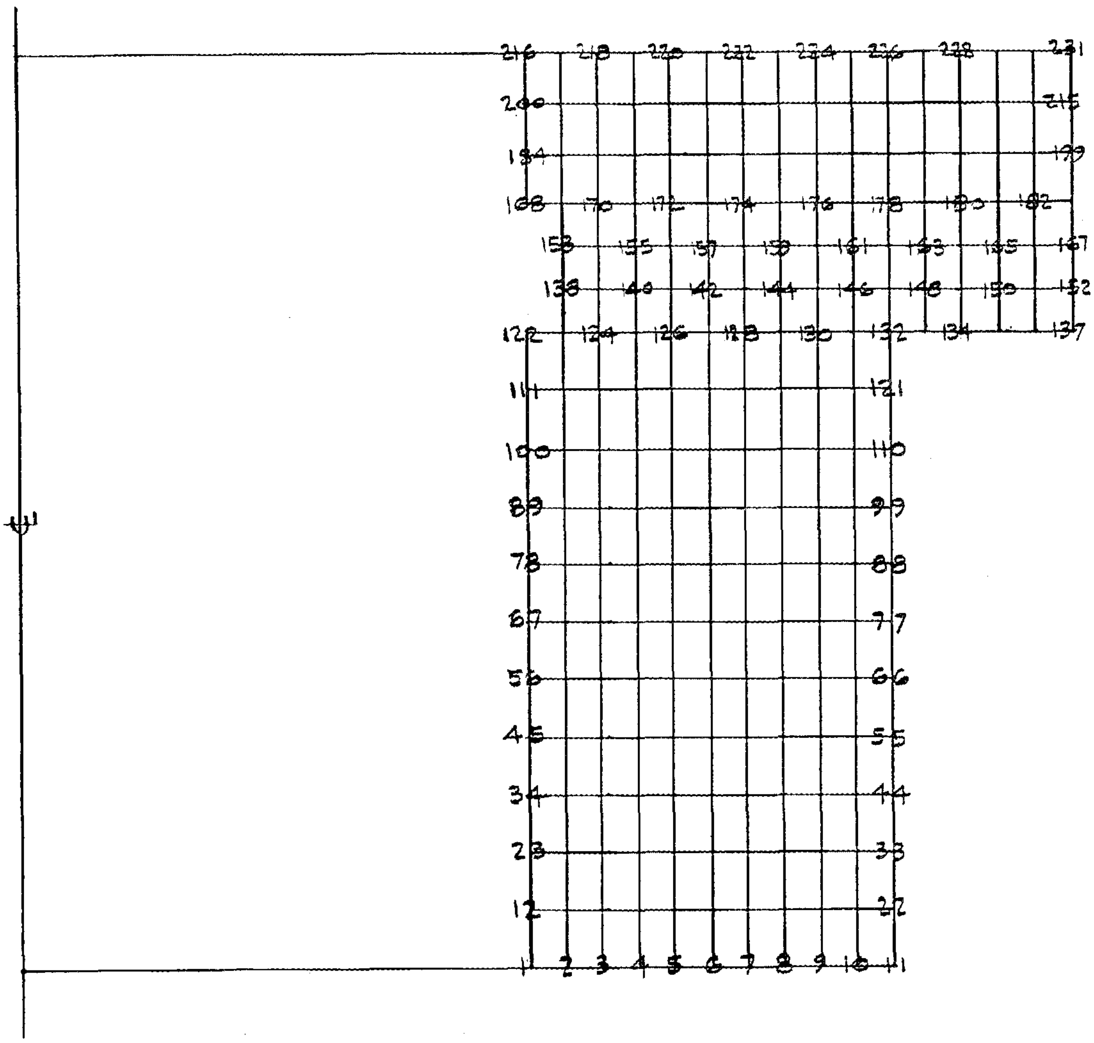
PLANT OAK RIDGE, TENNESSEE

JOB HIFI EXPERIMENT REF. DWG. NO. M11506-OH-002E

SUBJECT QUICK OPENING HATCH PAGE OF

COMPUTATION NO.

COMPUTED BY C.W. COLLINS CHECKED BY J.E. Rubeler DATE 9-5-85



NODAL POINT NUMBERS

FIG. B-2

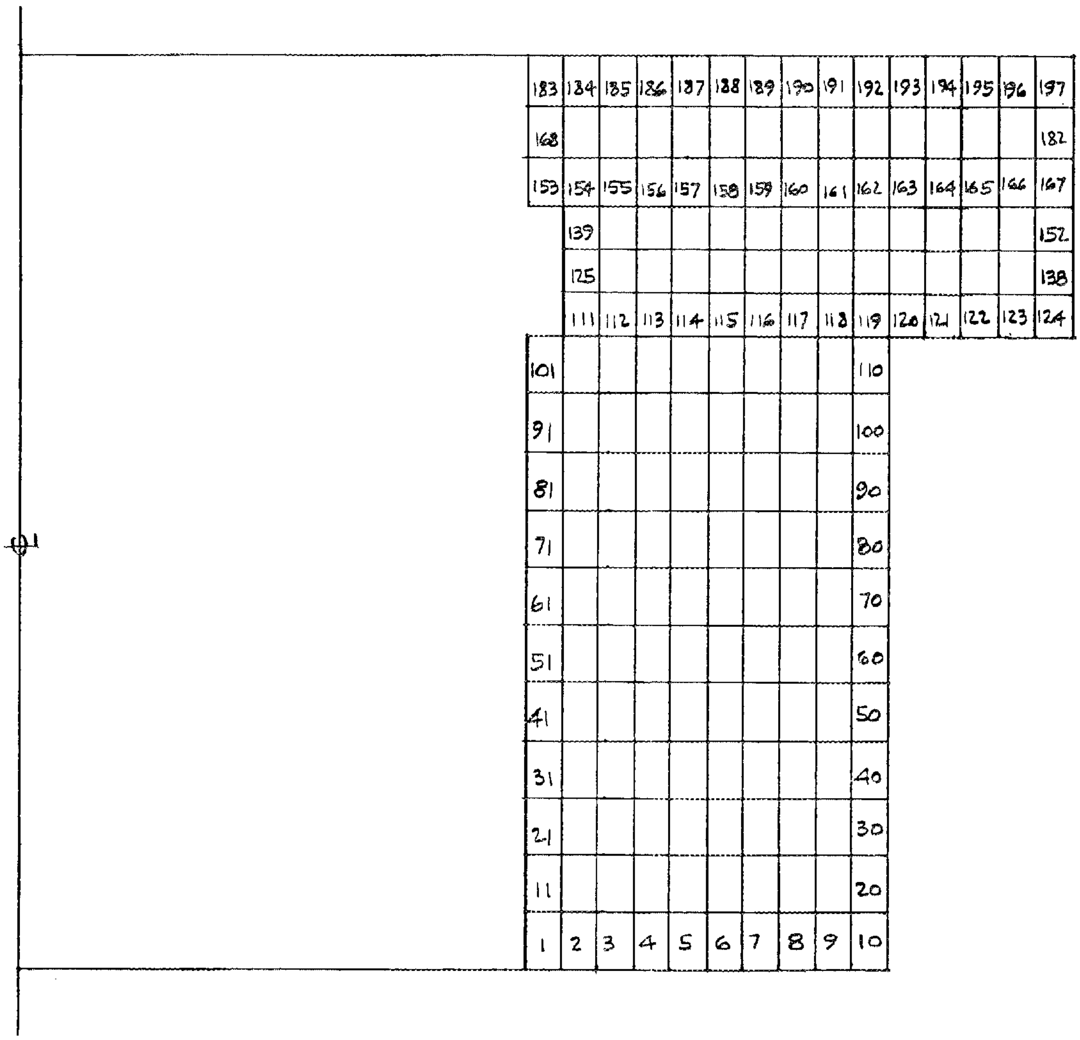
PLANT OAK RIDGE, TENNESSEE

JOB HIFI EXPERIMENT REF. DWG. NO. M11506-OH-002E

SUBJECT QUICK OPENING HATCH PAGE OF

COMPUTATION NO.

COMPUTED BY C.W.COLLINS CHECKED BY J E Ruteuber DATE 9-5-85



ELEMENT NUMBERS

FIG. B-3

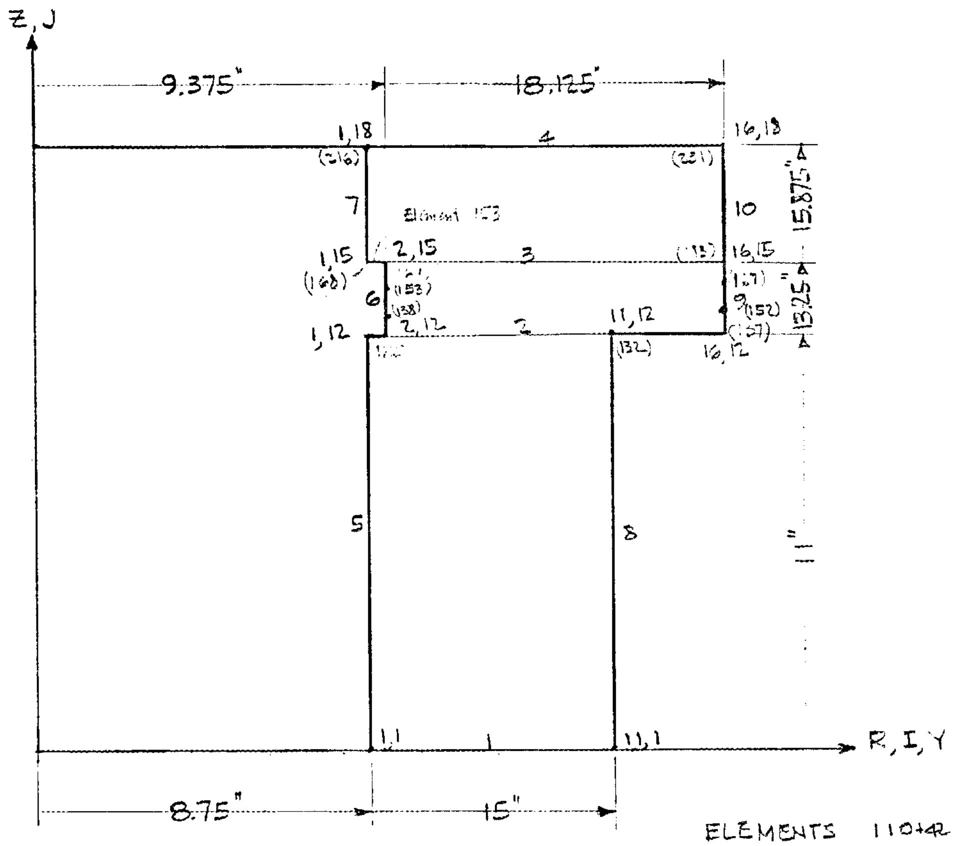
PLANT OAK RIDGE, TENNESSEE

JOB HIFI EXPERIMENT REF. DWG. NO. M11506-OH002E

SUBJECT QUICK OPENING HATCH PAGE 1 OF

COMPUTATION NO.

COMPUTED BY C.W COLLINS CHECKED BY J E Rietatbier DATE 9-5-85



ELEMENTS 110+42+45
= 197

NODES = 132+46+48
= 226 231

```
*                                 *
*            SAP86                *
*                                 *
*  (C) Copyright 1983, 1984       *
*                                 *
*             by                  *
*                                 *
*       NUMBER CRUNCHER           *
*      MICROSYSTEMS, INC.         *
*                                 *
*                                 *
*     All Rights Reserved         *
*                                 *
*        Version 1.03             *
*                                 *
***********************************
```

1HFIR QUICK OPENING HATCH

C O N T R O L   I N F O R M A T I O N

```
NUMBER OF NODAL POINTS   =  231
NUMBER OF ELEMENT TYPES  =    1
NUMBER OF LOAD CASES     =    1
NUMBER OF FREQUENCIES    =    0
ANALYSIS CODE (NDYN)     =    0
  EQ.0,  STATIC
  EQ.1,  MODAL EXTRACTION
  EQ.2,  FORCED RESPONSE
  EQ.3,  RESPONSE SPECTRUM
  EQ.4,  DIRECT INTEGRATION
SOLUTION MODE (MODEX)    =    0
  EQ.0,  EXECUTION
  EQ.1,  DATA CHECK
NUMBER OF SUBSPACE
ITERATION VECTORS (NAD)  =    0
EQUATIONS PER BLOCK      =    0
TAPE10 SAVE FLAG (N10SV) =    0
```

NODAL POINT INPUT DATA

ONODE	BOUNDARY CONDITION CODES						NODAL POINT COORDINATES				
NUMBER	X	Y	Z	XX	YY	ZZ	X	Y	Z		T
1	1	0	0	1	1	1	.000	8.750	.000	0	.000
2	1	0	0	1	1	1	.000	9.375	.000	0	.000
3	1	0	0	1	1	1	.000	10.000	.000	0	.000
4	1	0	0	1	1	1	.000	10.630	.000	0	.000
5	1	0	0	1	1	1	.000	11.250	.000	0	.000
6	1	0	0	1	1	1	.000	11.880	.000	0	.000
7	1	0	0	1	1	1	.000	12.500	.000	0	.000
8	1	0	0	1	1	1	.000	13.130	.000	0	.000
9	1	0	0	1	1	1	.000	13.750	.000	0	.000
10	1	0	0	1	1	1	.000	14.380	.000	0	.000
11	1	0	0	1	1	1	.000	15.000	.000	0	.000
12	1	0	0	1	1	1	.000	8.750	1.000	0	.000
13	1	0	0	1	1	1	.000	9.375	1.000	0	.000
14	1	0	0	1	1	1	.000	10.000	1.000	0	.000
15	1	0	0	1	1	1	.000	10.630	1.000	0	.000
16	1	0	0	1	1	1	.000	11.250	1.000	0	.000
17	1	0	0	1	1	1	.000	11.880	1.000	0	.000

18	1	0	0	1	1	1	.000	12.500	1.000	0	.000
19	1	0	0	1	1	1	.000	13.130	1.000	0	.000
20	1	0	0	1	1	1	.000	13.750	1.000	0	.000
21	1	0	0	1	1	1	.000	14.380	1.000	0	.000
22	1	0	0	1	1	1	.000	15.000	1.000	0	.000
23	1	0	0	1	1	1	.000	8.750	2.000	0	.000
24	1	0	0	1	1	1	.000	9.375	2.000	0	.000
25	1	0	0	1	1	1	.000	10.000	2.000	0	.000
26	1	0	0	1	1	1	.000	10.630	2.000	0	.000
27	1	0	0	1	1	1	.000	11.250	2.000	0	.000
28	1	0	0	1	1	1	.000	11.880	2.000	0	.000
29	1	0	0	1	1	1	.000	12.500	2.000	0	.000
30	1	0	0	1	1	1	.000	13.130	2.000	0	.000
31	1	0	0	1	1	1	.000	13.750	2.000	0	.000
32	1	0	0	1	1	1	.000	14.380	2.000	0	.000
33	1	0	0	1	1	1	.000	15.000	2.000	0	.000
34	1	0	0	1	1	1	.000	8.750	3.000	0	.000
35	1	0	0	1	1	1	.000	9.375	3.000	0	.000
36	1	0	0	1	1	1	.000	10.000	3.000	0	.000
37	1	0	0	1	1	1	.000	10.630	3.000	0	.000
38	1	0	0	1	1	1	.000	11.250	3.000	0	.000
39	1	0	0	1	1	1	.000	11.880	3.000	0	.000
40	1	0	0	1	1	1	.000	12.500	3.000	0	.000
41	1	0	0	1	1	1	.000	13.130	3.000	0	.000
42	1	0	0	1	1	1	.000	13.750	3.000	0	.000
43	1	0	0	1	1	1	.000	14.380	3.000	0	.000
44	1	0	0	1	1	1	.000	15.000	3.000	0	.000
45	1	0	0	1	1	1	.000	8.750	4.000	0	.000
46	1	0	0	1	1	1	.000	9.375	4.000	0	.000
47	1	0	0	1	1	1	.000	10.000	4.000	0	.000
48	1	0	0	1	1	1	.000	10.630	4.000	0	.000
49	1	0	0	1	1	1	.000	11.250	4.000	0	.000
50	1	0	0	1	1	1	.000	11.880	4.000	0	.000
51	1	0	0	1	1	1	.000	12.500	4.000	0	.000
52	1	0	0	1	1	1	.000	13.130	4.000	0	.000
53	1	0	0	1	1	1	.000	13.750	4.000	0	.000
54	1	0	0	1	1	1	.000	14.380	4.000	0	.000
55	1	0	0	1	1	1	.000	15.000	4.000	0	.000
56	1	0	0	1	1	1	.000	8.750	5.000	0	.000
57	1	0	0	1	1	1	.000	9.375	5.000	0	.000
58	1	0	0	1	1	1	.000	10.000	5.000	0	.000
59	1	0	0	1	1	1	.000	10.630	5.000	0	.000
60	1	0	0	1	1	1	.000	11.250	5.000	0	.000
61	1	0	0	1	1	1	.000	11.880	5.000	0	.000
62	1	0	0	1	1	1	.000	12.500	5.000	0	.000
63	1	0	0	1	1	1	.000	13.130	5.000	0	.000
64	1	0	0	1	1	1	.000	13.750	5.000	0	.000
65	1	0	0	1	1	1	.000	14.380	5.000	0	.000
66	1	0	0	1	1	1	.000	15.000	5.000	0	.000
67	1	0	0	1	1	1	.000	8.750	6.000	0	.000
68	1	0	0	1	1	1	.000	9.375	6.000	0	.000
69	1	0	0	1	1	1	.000	10.000	6.000	0	.000
70	1	0	0	1	1	1	.000	10.630	6.000	0	.000
71	1	0	0	1	1	1	.000	11.250	6.000	0	.000
72	1	0	0	1	1	1	.000	11.880	6.000	0	.000
73	1	0	0	1	1	1	.000	12.500	6.000	0	.000
74	1	0	0	1	1	1	.000	13.130	6.000	0	.000
75	1	0	0	1	1	1	.000	13.750	6.000	0	.000
76	1	0	0	1	1	1	.000	14.380	6.000	0	.000
77	1	0	0	1	1	1	.000	15.000	6.000	0	.000
78	1	0	0	1	1	1	.000	8.750	7.000	0	.000
79	1	0	0	1	1	1	.000	9.375	7.000	0	.000
80	1	0	0	1	1	1	.000	10.000	7.000	0	.000
81	1	0	0	1	1	1	.000	10.630	7.000	0	.000
82	1	0	0	1	1	1	.000	11.250	7.000	0	.000
83	1	0	0	1	1	1	.000	11.880	7.000	0	.000

84	1	0	0	1	1	1	.000	12.500	7.000	0	.000
85	1	0	0	1	1	1	.000	13.130	7.000	0	.000
86	1	0	0	1	1	1	.000	13.750	7.000	0	.000
87	1	0	0	1	1	1	.000	14.380	7.000	0	.000
88	1	0	0	1	1	1	.000	15.000	7.000	0	.000
89	1	0	0	1	1	1	.000	8.750	8.000	0	.000
90	1	0	0	1	1	1	.000	9.375	8.000	0	.000
91	1	0	0	1	1	1	.000	10.000	8.000	0	.000
92	1	0	0	1	1	1	.000	10.630	8.000	0	.000
93	1	0	0	1	1	1	.000	11.250	8.000	0	.000
94	1	0	0	1	1	1	.000	11.880	8.000	0	.000
95	1	0	0	1	1	1	.000	12.500	8.000	0	.000
96	1	0	0	1	1	1	.000	13.130	8.000	0	.000
97	1	0	0	1	1	1	.000	13.750	8.000	0	.000
98	1	0	0	1	1	1	.000	14.380	8.000	0	.000
99	1	0	0	1	1	1	.000	15.000	8.000	0	.000
100	1	0	0	1	1	1	.000	8.750	9.000	0	.000
101	1	0	0	1	1	1	.000	9.375	9.000	0	.000
102	1	0	0	1	1	1	.000	10.000	9.000	0	.000
103	1	0	0	1	1	1	.000	10.630	9.000	0	.000
104	1	0	0	1	1	1	.000	11.250	9.000	0	.000
105	1	0	0	1	1	1	.000	11.880	9.000	0	.000
106	1	0	0	1	1	1	.000	12.500	9.000	0	.000
107	1	0	0	1	1	1	.000	13.130	9.000	0	.000
108	1	0	0	1	1	1	.000	13.750	9.000	0	.000
109	1	0	0	1	1	1	.000	14.380	9.000	0	.000
110	1	0	0	1	1	1	.000	15.000	9.000	0	.000
111	1	0	0	1	1	1	.000	8.750	10.000	0	.000
112	1	0	0	1	1	1	.000	9.375	10.000	0	.000
113	1	0	0	1	1	1	.000	10.000	10.000	0	.000
114	1	0	0	1	1	1	.000	10.630	10.000	0	.000
115	1	0	0	1	1	1	.000	11.250	10.000	0	.000
116	1	0	0	1	1	1	.000	11.880	10.000	0	.000
117	1	0	0	1	1	1	.000	12.500	10.000	0	.000
118	1	0	0	1	1	1	.000	13.130	10.000	0	.000
119	1	0	0	1	1	1	.000	13.750	10.000	0	.000
120	1	0	0	1	1	1	.000	14.380	10.000	0	.000
121	1	0	0	1	1	1	.000	15.000	10.000	0	.000
122	1	0	0	1	1	1	.000	8.750	11.000	0	.000
123	1	0	0	1	1	1	.000	9.375	11.000	0	.000
124	1	0	0	1	1	1	.000	10.000	11.000	0	.000
125	1	0	0	1	1	1	.000	10.630	11.000	0	.000
126	1	0	0	1	1	1	.000	11.250	11.000	0	.000
127	1	0	0	1	1	1	.000	11.880	11.000	0	.000
128	1	0	0	1	1	1	.000	12.500	11.000	0	.000
129	1	0	0	1	1	1	.000	13.130	11.000	0	.000
130	1	0	0	1	1	1	.000	13.750	11.000	0	.000
131	1	0	0	1	1	1	.000	14.380	11.000	0	.000
132	1	0	0	1	1	1	.000	15.000	11.000	0	.000
133	1	0	0	1	1	1	.000	15.630	11.000	0	.000
134	1	0	0	1	1	1	.000	16.250	11.000	0	.000
135	1	0	0	1	1	1	.000	16.880	11.000	0	.000
136	1	0	0	1	1	1	.000	17.500	11.000	0	.000
137	1	0	0	1	1	1	.000	18.130	11.000	0	.000
138	1	0	0	1	1	1	.000	9.375	11.750	0	.000
139	1	0	0	1	1	1	.000	10.000	11.750	0	.000
140	1	0	0	1	1	1	.000	10.630	11.750	0	.000
141	1	0	0	1	1	1	.000	11.250	11.750	0	.000
142	1	0	0	1	1	1	.000	11.880	11.750	0	.000
143	1	0	0	1	1	1	.000	12.500	11.750	0	.000
144	1	0	0	1	1	1	.000	13.130	11.750	0	.000
145	1	0	0	1	1	1	.000	13.750	11.750	0	.000
146	1	0	0	1	1	1	.000	14.380	11.750	0	.000
147	1	0	0	1	1	1	.000	15.000	11.750	0	.000
148	1	0	0	1	1	1	.000	15.630	11.750	0	.000
149	1	0	0	1	1	1	.000	16.250	11.750	0	.000

150	1	0	0	1	1	1	.000	16.880	11.750	0	.000
151	1	0	0	1	1	1	.000	17.500	11.750	0	.000
152	1	0	0	1	1	1	.000	18.130	11.750	0	.000
153	1	0	0	1	1	1	.000	9.375	12.500	0	.000
154	1	0	0	1	1	1	.000	10.000	12.500	0	.000
155	1	0	0	1	1	1	.000	10.630	12.500	0	.000
156	1	0	0	1	1	1	.000	11.250	12.500	0	.000
157	1	0	0	1	1	1	.000	11.880	12.500	0	.000
158	1	0	0	1	1	1	.000	12.500	12.500	0	.000
159	1	0	0	1	1	1	.000	13.130	12.500	0	.000
160	1	0	0	1	1	1	.000	13.750	12.500	0	.000
161	1	0	0	1	1	1	.000	14.380	12.500	0	.000
162	1	0	0	1	1	1	.000	15.000	12.500	0	.000
163	1	0	0	1	1	1	.000	15.630	12.500	0	.000
164	1	0	0	1	1	1	.000	16.250	12.500	0	.000
165	1	0	0	1	1	1	.000	16.880	12.500	0	.000
166	1	0	0	1	1	1	.000	17.500	12.500	0	.000
167	1	0	0	1	1	1	.000	18.130	12.500	0	.000
168	1	0	0	1	1	1	.000	8.750	13.250	0	.000
169	1	0	0	1	1	1	.000	9.375	13.250	0	.000
170	1	0	0	1	1	1	.000	10.000	13.250	0	.000
171	1	0	0	1	1	1	.000	10.630	13.250	0	.000
172	1	0	0	1	1	1	.000	11.250	13.250	0	.000
173	1	0	0	1	1	1	.000	11.880	13.250	0	.000
174	1	0	0	1	1	1	.000	12.500	13.250	0	.000
175	1	0	0	1	1	1	.000	13.130	13.250	0	.000
176	1	0	0	1	1	1	.000	13.750	13.250	0	.000
177	1	0	0	1	1	1	.000	14.380	13.250	0	.000
178	1	0	0	1	1	1	.000	15.000	13.250	0	.000
179	1	0	0	1	1	1	.000	15.630	13.250	0	.000
180	1	0	0	1	1	1	.000	16.250	13.250	0	.000
181	1	0	0	1	1	1	.000	16.880	13.250	0	.000
182	1	0	0	1	1	1	.000	17.500	13.250	0	.000
183	1	0	0	1	1	1	.000	18.130	13.250	0	.000
184	1	0	0	1	1	1	.000	8.750	14.130	0	.000
185	1	0	0	1	1	1	.000	9.375	14.130	0	.000
186	1	0	0	1	1	1	.000	10.000	14.130	0	.000
187	1	0	0	1	1	1	.000	10.630	14.130	0	.000
188	1	0	0	1	1	1	.000	11.250	14.130	0	.000
189	1	0	0	1	1	1	.000	11.880	14.130	0	.000
190	1	0	0	1	1	1	.000	12.500	14.130	0	.000
191	1	0	0	1	1	1	.000	13.130	14.130	0	.000
192	1	0	0	1	1	1	.000	13.750	14.130	0	.000
193	1	0	0	1	1	1	.000	14.380	14.130	0	.000
194	1	0	0	1	1	1	.000	15.000	14.130	0	.000
195	1	0	0	1	1	1	.000	15.630	14.130	0	.000
196	1	0	0	1	1	1	.000	16.250	14.130	0	.000
197	1	0	0	1	1	1	.000	16.880	14.130	0	.000
198	1	0	0	1	1	1	.000	17.500	14.130	0	.000
199	1	0	0	1	1	1	.000	18.130	14.130	0	.000
200	1	0	0	1	1	1	.000	8.750	15.000	0	.000
201	1	0	0	1	1	1	.000	9.375	15.000	0	.000
202	1	0	0	1	1	1	.000	10.000	15.000	0	.000
203	1	0	0	1	1	1	.000	10.630	15.000	0	.000
204	1	0	0	1	1	1	.000	11.250	15.000	0	.000
205	1	0	0	1	1	1	.000	11.880	15.000	0	.000
206	1	0	0	1	1	1	.000	12.500	15.000	0	.000
207	1	0	0	1	1	1	.000	13.130	15.000	0	.000
208	1	0	0	1	1	1	.000	13.750	15.000	0	.000
209	1	0	0	1	1	1	.000	14.380	15.000	0	.000
210	1	0	0	1	1	1	.000	15.000	15.000	0	.000
211	1	0	0	1	1	1	.000	15.630	15.000	0	.000
212	1	0	0	1	1	1	.000	16.250	15.000	0	.000
213	1	0	0	1	1	1	.000	16.880	15.000	0	.000
214	1	0	0	1	1	1	.000	17.500	15.000	0	.000
215	1	0	0	1	1	1	.000	18.130	15.000	0	.000

216	1	0	0	1	1	1	.000	8.750	15.880	0	.000
217	1	0	0	1	1	1	.000	9.375	15.880	0	.000
218	1	0	0	1	1	1	.000	10.000	15.880	0	.000
219	1	0	0	1	1	1	.000	10.630	15.880	0	.000
220	1	0	0	1	1	1	.000	11.250	15.880	0	.000
221	1	0	0	1	1	1	.000	11.880	15.880	0	.000
222	1	0	0	1	1	1	.000	12.500	15.880	0	.000
223	1	0	0	1	1	1	.000	13.130	15.880	0	.000
224	1	0	0	1	1	1	.000	13.750	15.880	0	.000
225	1	0	0	1	1	1	.000	14.380	15.880	0	.000
226	1	0	0	1	1	1	.000	15.000	15.880	0	.000
227	1	0	0	1	1	1	.000	15.630	15.880	0	.000
228	1	0	0	1	1	1	.000	16.250	15.880	0	.000
229	1	0	0	1	1	1	.000	16.880	15.880	0	.000
230	1	0	0	1	1	1	.000	17.500	15.880	0	.000
231	1	0	1	1	1	1	.000	18.130	15.880	0	.000

1GENERATED NODAL DATA

0NODE	BOUNDARY CONDITION CODES						NODAL POINT COORDINATES			
NUMBER	X	Y	Z	XX	YY	ZZ	X	Y	Z	T
1	1	0	0	1	1	1	.000	8.750	.000	.000
2	1	0	0	1	1	1	.000	9.375	.000	.000
3	1	0	0	1	1	1	.000	10.000	.000	.000
4	1	0	0	1	1	1	.000	10.630	.000	.000
5	1	0	0	1	1	1	.000	11.250	.000	.000
6	1	0	0	1	1	1	.000	11.880	.000	.000
7	1	0	0	1	1	1	.000	12.500	.000	.000
8	1	0	0	1	1	1	.000	13.130	.000	.000
9	1	0	0	1	1	1	.000	13.750	.000	.000
10	1	0	0	1	1	1	.000	14.380	.000	.000
11	1	0	0	1	1	1	.000	15.000	.000	.000
12	1	0	0	1	1	1	.000	8.750	1.000	.000
13	1	0	0	1	1	1	.000	9.375	1.000	.000
14	1	0	0	1	1	1	.000	10.000	1.000	.000
15	1	0	0	1	1	1	.000	10.630	1.000	.000
16	1	0	0	1	1	1	.000	11.250	1.000	.000
17	1	0	0	1	1	1	.000	11.880	1.000	.000
18	1	0	0	1	1	1	.000	12.500	1.000	.000
19	1	0	0	1	1	1	.000	13.130	1.000	.000
20	1	0	0	1	1	1	.000	13.750	1.000	.000
21	1	0	0	1	1	1	.000	14.380	1.000	.000
22	1	0	0	1	1	1	.000	15.000	1.000	.000
23	1	0	0	1	1	1	.000	8.750	2.000	.000
24	1	0	0	1	1	1	.000	9.375	2.000	.000
25	1	0	0	1	1	1	.000	10.000	2.000	.000
26	1	0	0	1	1	1	.000	10.630	2.000	.000
27	1	0	0	1	1	1	.000	11.250	2.000	.000
28	1	0	0	1	1	1	.000	11.880	2.000	.000
29	1	0	0	1	1	1	.000	12.500	2.000	.000
30	1	0	0	1	1	1	.000	13.130	2.000	.000
31	1	0	0	1	1	1	.000	13.750	2.000	.000
32	1	0	0	1	1	1	.000	14.380	2.000	.000
33	1	0	0	1	1	1	.000	15.000	2.000	.000
34	1	0	0	1	1	1	.000	8.750	3.000	.000
35	1	0	0	1	1	1	.000	9.375	3.000	.000
36	1	0	0	1	1	1	.000	10.000	3.000	.000
37	1	0	0	1	1	1	.000	10.630	3.000	.000
38	1	0	0	1	1	1	.000	11.250	3.000	.000
39	1	0	0	1	1	1	.000	11.880	3.000	.000
40	1	0	0	1	1	1	.000	12.500	3.000	.000
41	1	0	0	1	1	1	.000	13.130	3.000	.000
42	1	0	0	1	1	1	.000	13.750	3.000	.000
43	1	0	0	1	1	1	.000	14.380	3.000	.000
44	1	0	0	1	1	1	.000	15.000	3.000	.000
45	1	0	0	1	1	1	.000	8.750	4.000	.000

46	1	0	0	1	1	1	.000	9.375	4.000	.000
47	1	0	0	1	1	1	.000	10.000	4.000	.000
48	1	0	0	1	1	1	.000	10.630	4.000	.000
49	1	0	0	1	1	1	.000	11.250	4.000	.000
50	1	0	0	1	1	1	.000	11.880	4.000	.000
51	1	0	0	1	1	1	.000	12.500	4.000	.000
52	1	0	0	1	1	1	.000	13.130	4.000	.000
53	1	0	0	1	1	1	.000	13.750	4.000	.000
54	1	0	0	1	1	1	.000	14.380	4.000	.000
55	1	0	0	1	1	1	.000	15.000	4.000	.000
56	1	0	0	1	1	1	.000	8.750	5.000	.000
57	1	0	0	1	1	1	.000	9.375	5.000	.000
58	1	0	0	1	1	1	.000	10.000	5.000	.000
59	1	0	0	1	1	1	.000	10.630	5.000	.000
60	1	0	0	1	1	1	.000	11.250	5.000	.000
61	1	0	0	1	1	1	.000	11.880	5.000	.000
62	1	0	0	1	1	1	.000	12.500	5.000	.000
63	1	0	0	1	1	1	.000	13.130	5.000	.000
64	1	0	0	1	1	1	.000	13.750	5.000	.000
65	1	0	0	1	1	1	.000	14.380	5.000	.000
66	1	0	0	1	1	1	.000	15.000	5.000	.000
67	1	0	0	1	1	1	.000	8.750	6.000	.000
68	1	0	0	1	1	1	.000	9.375	6.000	.000
69	1	0	0	1	1	1	.000	10.000	6.000	.000
70	1	0	0	1	1	1	.000	10.630	6.000	.000
71	1	0	0	1	1	1	.000	11.250	6.000	.000
72	1	0	0	1	1	1	.000	11.880	6.000	.000
73	1	0	0	1	1	1	.000	12.500	6.000	.000
74	1	0	0	1	1	1	.000	13.130	6.000	.000
75	1	0	0	1	1	1	.000	13.750	6.000	.000
76	1	0	0	1	1	1	.000	14.380	6.000	.000
77	1	0	0	1	1	1	.000	15.000	6.000	.000
78	1	0	0	1	1	1	.000	8.750	7.000	.000
79	1	0	0	1	1	1	.000	9.375	7.000	.000
80	1	0	0	1	1	1	.000	10.000	7.000	.000
81	1	0	0	1	1	1	.000	10.630	7.000	.000
82	1	0	0	1	1	1	.000	11.250	7.000	.000
83	1	0	0	1	1	1	.000	11.880	7.000	.000
84	1	0	0	1	1	1	.000	12.500	7.000	.000
85	1	0	0	1	1	1	.000	13.130	7.000	.000
86	1	0	0	1	1	1	.000	13.750	7.000	.000
87	1	0	0	1	1	1	.000	14.380	7.000	.000
88	1	0	0	1	1	1	.000	15.000	7.000	.000
89	1	0	0	1	1	1	.000	8.750	8.000	.000
90	1	0	0	1	1	1	.000	9.375	8.000	.000
91	1	0	0	1	1	1	.000	10.000	8.000	.000
92	1	0	0	1	1	1	.000	10.630	8.000	.000
93	1	0	0	1	1	1	.000	11.250	8.000	.000
94	1	0	0	1	1	1	.000	11.880	8.000	.000
95	1	0	0	1	1	1	.000	12.500	8.000	.000
96	1	0	0	1	1	1	.000	13.130	8.000	.000
97	1	0	0	1	1	1	.000	13.750	8.000	.000
98	1	0	0	1	1	1	.000	14.380	8.000	.000
99	1	0	0	1	1	1	.000	15.000	8.000	.000
100	1	0	0	1	1	1	.000	8.750	9.000	.000
101	1	0	0	1	1	1	.000	9.375	9.000	.000
102	1	0	0	1	1	1	.000	10.000	9.000	.000
103	1	0	0	1	1	1	.000	10.630	9.000	.000
104	1	0	0	1	1	1	.000	11.250	9.000	.000
105	1	0	0	1	1	1	.000	11.880	9.000	.000
106	1	0	0	1	1	1	.000	12.500	9.000	.000
107	1	0	0	1	1	1	.000	13.130	9.000	.000
108	1	0	0	1	1	1	.000	13.750	9.000	.000
109	1	0	0	1	1	1	.000	14.380	9.000	.000
110	1	0	0	1	1	1	.000	15.000	9.000	.000
111	1	0	0	1	1	1	.000	8.750	10.000	.000

112	1	0	0	1	1	1	.000	9.375	10.000	.000
113	1	0	0	1	1	1	.000	10.000	10.000	.000
114	1	0	0	1	1	1	.000	10.630	10.000	.000
115	1	0	0	1	1	1	.000	11.250	10.000	.000
116	1	0	0	1	1	1	.000	11.880	10.000	.000
117	1	0	0	1	1	1	.000	12.500	10.000	.000
118	1	0	0	1	1	1	.000	13.130	10.000	.000
119	1	0	0	1	1	1	.000	13.750	10.000	.000
120	1	0	0	1	1	1	.000	14.380	10.000	.000
121	1	0	0	1	1	1	.000	15.000	10.000	.000
122	1	0	0	1	1	1	.000	8.750	11.000	.000
123	1	0	0	1	1	1	.000	9.375	11.000	.000
124	1	0	0	1	1	1	.000	10.000	11.000	.000
125	1	0	0	1	1	1	.000	10.630	11.000	.000
126	1	0	0	1	1	1	.000	11.250	11.000	.000
127	1	0	0	1	1	1	.000	11.880	11.000	.000
128	1	0	0	1	1	1	.000	12.500	11.000	.000
129	1	0	0	1	1	1	.000	13.130	11.000	.000
130	1	0	0	1	1	1	.000	13.750	11.000	.000
131	1	0	0	1	1	1	.000	14.380	11.000	.000
132	1	0	0	1	1	1	.000	15.000	11.000	.000
133	1	0	0	1	1	1	.000	15.630	11.000	.000
134	1	0	0	1	1	1	.000	16.250	11.000	.000
135	1	0	0	1	1	1	.000	16.880	11.000	.000
136	1	0	0	1	1	1	.000	17.500	11.000	.000
137	1	0	0	1	1	1	.000	18.130	11.000	.000
138	1	0	0	1	1	1	.000	9.375	11.750	.000
139	1	0	0	1	1	1	.000	10.000	11.750	.000
140	1	0	0	1	1	1	.000	10.630	11.750	.000
141	1	0	0	1	1	1	.000	11.250	11.750	.000
142	1	0	0	1	1	1	.000	11.880	11.750	.000
143	1	0	0	1	1	1	.000	12.500	11.750	.000
144	1	0	0	1	1	1	.000	13.130	11.750	.000
145	1	0	0	1	1	1	.000	13.750	11.750	.000
146	1	0	0	1	1	1	.000	14.380	11.750	.000
147	1	0	0	1	1	1	.000	15.000	11.750	.000
148	1	0	0	1	1	1	.000	15.630	11.750	.000
149	1	0	0	1	1	1	.000	16.250	11.750	.000
150	1	0	0	1	1	1	.000	16.880	11.750	.000
151	1	0	0	1	1	1	.000	17.500	11.750	.000
152	1	0	0	1	1	1	.000	18.130	11.750	.000
153	1	0	0	1	1	1	.000	9.375	12.500	.000
154	1	0	0	1	1	1	.000	10.000	12.500	.000
155	1	0	0	1	1	1	.000	10.630	12.500	.000
156	1	0	0	1	1	1	.000	11.250	12.500	.000
157	1	0	0	1	1	1	.000	11.880	12.500	.000
158	1	0	0	1	1	1	.000	12.500	12.500	.000
159	1	0	0	1	1	1	.000	13.130	12.500	.000
160	1	0	0	1	1	1	.000	13.750	12.500	.000
161	1	0	0	1	1	1	.000	14.380	12.500	.000
162	1	0	0	1	1	1	.000	15.000	12.500	.000
163	1	0	0	1	1	1	.000	15.630	12.500	.000
164	1	0	0	1	1	1	.000	16.250	12.500	.000
165	1	0	0	1	1	1	.000	16.880	12.500	.000
166	1	0	0	1	1	1	.000	17.500	12.500	.000
167	1	0	0	1	1	1	.000	18.130	12.500	.000
168	1	0	0	1	1	1	.000	8.750	13.250	.000
169	1	0	0	1	1	1	.000	9.375	13.250	.000
170	1	0	0	1	1	1	.000	10.000	13.250	.000
171	1	0	0	1	1	1	.000	10.630	13.250	.000
172	1	0	0	1	1	1	.000	11.250	13.250	.000
173	1	0	0	1	1	1	.000	11.880	13.250	.000
174	1	0	0	1	1	1	.000	12.500	13.250	.000
175	1	0	0	1	1	1	.000	13.130	13.250	.000
176	1	0	0	1	1	1	.000	13.750	13.250	.000
177	1	0	0	1	1	1	.000	14.380	13.250	.000

178	1	0	0	1	1	1	.000	15.000	13.250	.000
179	1	0	0	1	1	1	.000	15.630	13.250	.000
180	1	0	0	1	1	1	.000	16.250	13.250	.000
181	1	0	0	1	1	1	.000	16.880	13.250	.000
182	1	0	0	1	1	1	.000	17.500	13.250	.000
183	1	0	0	1	1	1	.000	18.130	13.250	.000
184	1	0	0	1	1	1	.000	8.750	14.130	.000
185	1	0	0	1	1	1	.000	9.375	14.130	.000
186	1	0	0	1	1	1	.000	10.000	14.130	.000
187	1	0	0	1	1	1	.000	10.630	14.130	.000
188	1	0	0	1	1	1	.000	11.250	14.130	.000
189	1	0	0	1	1	1	.000	11.880	14.130	.000
190	1	0	0	1	1	1	.000	12.500	14.130	.000
191	1	0	0	1	1	1	.000	13.130	14.130	.000
192	1	0	0	1	1	1	.000	13.750	14.130	.000
193	1	0	0	1	1	1	.000	14.380	14.130	.000
194	1	0	0	1	1	1	.000	15.000	14.130	.000
195	1	0	0	1	1	1	.000	15.630	14.130	.000
196	1	0	0	1	1	1	.000	16.250	14.130	.000
197	1	0	0	1	1	1	.000	16.880	14.130	.000
198	1	0	0	1	1	1	.000	17.500	14.130	.000
199	1	0	0	1	1	1	.000	18.130	14.130	.000
200	1	0	0	1	1	1	.000	8.750	15.000	.000
201	1	0	0	1	1	1	.000	9.375	15.000	.000
202	1	0	0	1	1	1	.000	10.000	15.000	.000
203	1	0	0	1	1	1	.000	10.630	15.000	.000
204	1	0	0	1	1	1	.000	11.250	15.000	.000
205	1	0	0	1	1	1	.000	11.880	15.000	.000
206	1	0	0	1	1	1	.000	12.500	15.000	.000
207	1	0	0	1	1	1	.000	13.130	15.000	.000
208	1	0	0	1	1	1	.000	13.750	15.000	.000
209	1	0	0	1	1	1	.000	14.380	15.000	.000
210	1	0	0	1	1	1	.000	15.000	15.000	.000
211	1	0	0	1	1	1	.000	15.630	15.000	.000
212	1	0	0	1	1	1	.000	16.250	15.000	.000
213	1	0	0	1	1	1	.000	16.880	15.000	.000
214	1	0	0	1	1	1	.000	17.500	15.000	.000
215	1	0	0	1	1	1	.000	18.130	15.000	.000
216	1	0	0	1	1	1	.000	8.750	15.880	.000
217	1	0	0	1	1	1	.000	9.375	15.880	.000
218	1	0	0	1	1	1	.000	10.000	15.880	.000
219	1	0	0	1	1	1	.000	10.630	15.880	.000
220	1	0	0	1	1	1	.000	11.250	15.880	.000
221	1	0	0	1	1	1	.000	11.880	15.880	.000
222	1	0	0	1	1	1	.000	12.500	15.880	.000
223	1	0	0	1	1	1	.000	13.130	15.880	.000
224	1	0	0	1	1	1	.000	13.750	15.880	.000
225	1	0	0	1	1	1	.000	14.380	15.880	.000
226	1	0	0	1	1	1	.000	15.000	15.880	.000
227	1	0	0	1	1	1	.000	15.630	15.880	.000
228	1	0	0	1	1	1	.000	16.250	15.880	.000
229	1	0	0	1	1	1	.000	16.880	15.880	.000
230	1	0	0	1	1	1	.000	17.500	15.880	.000
231	1	0	1	1	1	1	.000	18.130	15.880	.000

1EQUATION NUMBERS

N	X	Y	Z	XX	YY	ZZ
1	0	1	2	0	0	0
2	0	3	4	0	0	0
3	0	5	6	0	0	0
4	0	7	8	0	0	0
5	0	9	10	0	0	0
6	0	11	12	0	0	0
7	0	13	14	0	0	0
8	0	15	16	0	0	0

9	0	17	18	0	0	0
10	0	19	20	0	0	0
11	0	21	22	0	0	0
12	0	23	24	0	0	0
13	0	25	26	0	0	0
14	0	27	28	0	0	0
15	0	29	30	0	0	0
16	0	31	32	0	0	0
17	0	33	34	0	0	0
18	0	35	36	0	0	0
19	0	37	38	0	0	0
20	0	39	40	0	0	0
21	0	41	42	0	0	0
22	0	43	44	0	0	0
23	0	45	46	0	0	0
24	0	47	48	0	0	0
25	0	49	50	0	0	0
26	0	51	52	0	0	0
27	0	53	54	0	0	0
28	0	55	56	0	0	0
29	0	57	58	0	0	0
30	0	59	60	0	0	0
31	0	61	62	0	0	0
32	0	63	64	0	0	0
33	0	65	66	0	0	0
34	0	67	68	0	0	0
35	0	69	70	0	0	0
36	0	71	72	0	0	0
37	0	73	74	0	0	0
38	0	75	76	0	0	0
39	0	77	78	0	0	0
40	0	79	80	0	0	0
41	0	81	82	0	0	0
42	0	83	84	0	0	0
43	0	85	86	0	0	0
44	0	87	88	0	0	0
45	0	89	90	0	0	0
46	0	91	92	0	0	0
47	0	93	94	0	0	0
48	0	95	96	0	0	0
49	0	97	98	0	0	0
50	0	99	100	0	0	0
51	0	101	102	0	0	0
52	0	103	104	0	0	0
53	0	105	106	0	0	0
54	0	107	108	0	0	0
55	0	109	110	0	0	0
56	0	111	112	0	0	0
57	0	113	114	0	0	0
58	0	115	116	0	0	0
59	0	117	118	0	0	0
60	0	119	120	0	0	0
61	0	121	122	0	0	0
62	0	123	124	0	0	0
63	0	125	126	0	0	0
64	0	127	128	0	0	0
65	0	129	130	0	0	0
66	0	131	132	0	0	0
67	0	133	134	0	0	0
68	0	135	136	0	0	0
69	0	137	138	0	0	0
70	0	139	140	0	0	0
71	0	141	142	0	0	0
72	0	143	144	0	0	0
73	0	145	146	0	0	0
74	0	147	148	0	0	0

75	0	149	150	0	0	0
76	0	151	152	0	0	0
77	0	153	154	0	0	0
78	0	155	156	0	0	0
79	0	157	158	0	0	0
80	0	159	160	0	0	0
81	0	161	162	0	0	0
82	0	163	164	0	0	0
83	0	165	166	0	0	0
84	0	167	168	0	0	0
85	0	169	170	0	0	0
86	0	171	172	0	0	0
87	0	173	174	0	0	0
88	0	175	176	0	0	0
89	0	177	178	0	0	0
90	0	179	180	0	0	0
91	0	181	182	0	0	0
92	0	183	184	0	0	0
93	0	185	186	0	0	0
94	0	187	188	0	0	0
95	0	189	190	0	0	0
96	0	191	192	0	0	0
97	0	193	194	0	0	0
98	0	195	196	0	0	0
99	0	197	198	0	0	0
100	0	199	200	0	0	0
101	0	201	202	0	0	0
102	0	203	204	0	0	0
103	0	205	206	0	0	0
104	0	207	208	0	0	0
105	0	209	210	0	0	0
106	0	211	212	0	0	0
107	0	213	214	0	0	0
108	0	215	216	0	0	0
109	0	217	218	0	0	0
110	0	219	220	0	0	0
111	0	221	222	0	0	0
112	0	223	224	0	0	0
113	0	225	226	0	0	0
114	0	227	228	0	0	0
115	0	229	230	0	0	0
116	0	231	232	0	0	0
117	0	233	234	0	0	0
118	0	235	236	0	0	0
119	0	237	238	0	0	0
120	0	239	240	0	0	0
121	0	241	242	0	0	0
122	0	243	244	0	0	0
123	0	245	246	0	0	0
124	0	247	248	0	0	0
125	0	249	250	0	0	0
126	0	251	252	0	0	0
127	0	253	254	0	0	0
128	0	255	256	0	0	0
129	0	257	258	0	0	0
130	0	259	260	0	0	0
131	0	261	262	0	0	0
132	0	263	264	0	0	0
133	0	265	266	0	0	0
134	0	267	268	0	0	0
135	0	269	270	0	0	0
136	0	271	272	0	0	0
137	0	273	274	0	0	0
138	0	275	276	0	0	0
139	0	277	278	0	0	0
140	0	279	280	0	0	0

141	0	281	282	0	0	0
142	0	283	284	0	0	0
143	0	285	286	0	0	0
144	0	287	288	0	0	0
145	0	289	290	0	0	0
146	0	291	292	0	0	0
147	0	293	294	0	0	0
148	0	295	296	0	0	0
149	0	297	298	0	0	0
150	0	299	300	0	0	0
151	0	301	302	0	0	0
152	0	303	304	0	0	0
153	0	305	306	0	0	0
154	0	307	308	0	0	0
155	0	309	310	0	0	0
156	0	311	312	0	0	0
157	0	313	314	0	0	0
158	0	315	316	0	0	0
159	0	317	318	0	0	0
160	0	319	320	0	0	0
161	0	321	322	0	0	0
162	0	323	324	0	0	0
163	0	325	326	0	0	0
164	0	327	328	0	0	0
165	0	329	330	0	0	0
166	0	331	332	0	0	0
167	0	333	334	0	0	0
168	0	335	336	0	0	0
169	0	337	338	0	0	0
170	0	339	340	0	0	0
171	0	341	342	0	0	0
172	0	343	344	0	0	0
173	0	345	346	0	0	0
174	0	347	348	0	0	0
175	0	349	350	0	0	0
176	0	351	352	0	0	0
177	0	353	354	0	0	0
178	0	355	356	0	0	0
179	0	357	358	0	0	0
180	0	359	360	0	0	0
181	0	361	362	0	0	0
182	0	363	364	0	0	0
183	0	365	366	0	0	0
184	0	367	368	0	0	0
185	0	369	370	0	0	0
186	0	371	372	0	0	0
187	0	373	374	0	0	0
188	0	375	376	0	0	0
189	0	377	378	0	0	0
190	0	379	380	0	0	0
191	0	381	382	0	0	0
192	0	383	384	0	0	0
193	0	385	386	0	0	0
194	0	387	388	0	0	0
195	0	389	390	0	0	0
196	0	391	392	0	0	0
197	0	393	394	0	0	0
198	0	395	396	0	0	0
199	0	397	398	0	0	0
200	0	399	400	0	0	0
201	0	401	402	0	0	0
202	0	403	404	0	0	0
203	0	405	406	0	0	0
204	0	407	408	0	0	0
205	0	409	410	0	0	0
206	0	411	412	0	0	0

207	0	413	414	0	0	0							
208	0	415	416	0	0	0							
209	0	417	418	0	0	0							
210	0	419	420	0	0	0							
211	0	421	422	0	0	0							
212	0	423	424	0	0	0							
213	0	425	426	0	0	0							
214	0	427	428	0	0	0							
215	0	429	430	0	0	0							
216	0	431	432	0	0	0							
217	0	433	434	0	0	0							
218	0	435	436	0	0	0							
219	0	437	438	0	0	0							
220	0	439	440	0	0	0							
221	0	441	442	0	0	0							
222	0	443	444	0	0	0							
223	0	445	446	0	0	0							
224	0	447	448	0	0	0							
225	0	449	450	0	0	0							
226	0	451	452	0	0	0							
227	0	453	454	0	0	0							
228	0	455	456	0	0	0							
229	0	457	458	0	0	0							
230	0	459	460	0	0	0							
231	0	461	0	0	0	0							
4	197	1	1	0	0	0	0	0	0	0	0	0	0

1AXISYMMETRIC ANALYSIS

NUMBER OF ELEMENTS = 197
NUMBER OF MATERIALS = 1
MAXIMUM TEMPERATURES
PER MATERIAL = 1
ANALYSIS CODE = 0
CODE FOR INCLUSION
OF BENDING MODES - 0
EQ.0, INCLUDE
GT.0, SUPPRESS

MATERIAL I.D. NUMBER = 1
NUMBER OF TEMPERATURES = 1
WEIGHT DENSITY = .0000E+00
MASS DENSITY = .0000E+00
BETA ANGLE = .000

TEMPERATURE	E(N)	E(S)	E(T)	NU(NS)	NU(NT)	NU(ST)	G(NS)	ALPHA(N)	ALPHA(S)	ALPHA(T)
.00	.2830E+08	.2830E+08	.2830E+08	.3000	.0000	.3000	.1200E+08	.9300E-05	.9300E-05	.9300E-05

ELEMENT LOAD MULTIPLIERS

LOAD CASE	TEMPERATURE	PRESSURE	X-GRAVITY	Y-GRAVITY	Z-GRAVITY
A	.000	1.000	.000	.000	.000
B	.000	.000	.000	.000	.000
C	.000	.000	.000	.000	.000
D	.000	.000	.000	.000	.000

1ELEMENT NUMBER	I	J	K	L	MATL TYPE	REFERENCE TEMPERATURE	I-J FACE PRESSURE	STRESS OPTION	KG	THICKNESS

1	1	2	13	12	1	.000	.100E+04	4	1	.0000
2	2	3	14	13	1	.000	.100E+04	4	1	.0000
3	3	4	15	14	1	.000	.100E+04	4	1	.0000
4	4	5	16	15	1	.000	.100E+04	4	1	.0000
5	5	6	17	16	1	.000	.100E+04	4	1	.0000
6	6	7	18	17	1	.000	.100E+04	4	1	.0000
7	7	8	19	18	1	.000	.100E+04	4	1	.0000
8	8	9	20	19	1	.000	.100E+04	4	1	.0000
9	9	10	21	20	1	.000	.100E+04	4	1	.0000
10	10	11	22	21	1	.000	.100E+04	4	1	.0000
11	12	13	24	23	1	.000	.000E+00	4	1	.0000
12	13	14	25	24	1	.000	.000E+00	4	1	.0000
13	14	15	26	25	1	.000	.000E+00	4	1	.0000
14	15	16	27	26	1	.000	.000E+00	4	1	.0000
15	16	17	28	27	1	.000	.000E+00	4	1	.0000
16	17	18	29	28	1	.000	.000E+00	4	1	.0000
17	18	19	30	29	1	.000	.000E+00	4	1	.0000
18	19	20	31	30	1	.000	.000E+00	4	1	.0000
19	20	21	32	31	1	.000	.000E+00	4	1	.0000
20	21	22	33	32	1	.000	.000E+00	4	1	.0000
21	23	24	35	34	1	.000	.000E+00	4	1	.0000
22	24	25	36	35	1	.000	.000E+00	4	1	.0000
23	25	26	37	36	1	.000	.000E+00	4	1	.0000
24	26	27	38	37	1	.000	.000E+00	4	1	.0000
25	27	28	39	38	1	.000	.000E+00	4	1	.0000
26	28	29	40	39	1	.000	.000E+00	4	1	.0000
27	29	30	41	40	1	.000	.000E+00	4	1	.0000
28	30	31	42	41	1	.000	.000E+00	4	1	.0000
29	31	32	43	42	1	.000	.000E+00	4	1	.0000
30	32	33	44	43	1	.000	.000E+00	4	1	.0000
31	34	35	46	45	1	.000	.000E+00	4	1	.0000
32	35	36	47	46	1	.000	.000E+00	4	1	.0000
33	36	37	48	47	1	.000	.000E+00	4	1	.0000
34	37	38	49	48	1	.000	.000E+00	4	1	.0000
35	38	39	50	49	1	.000	.000E+00	4	1	.0000
36	39	40	51	50	1	.000	.000E+00	4	1	.0000
37	40	41	52	51	1	.000	.000E+00	4	1	.0000
38	41	42	53	52	1	.000	.000E+00	4	1	.0000
39	42	43	54	53	1	.000	.000E+00	4	1	.0000
40	43	44	55	54	1	.000	.000E+00	4	1	.0000
41	45	46	57	56	1	.000	.000E+00	4	1	.0000
42	46	47	58	57	1	.000	.000E+00	4	1	.0000
43	47	48	59	58	1	.000	.000E+00	4	1	.0000
44	48	49	60	59	1	.000	.000E+00	4	1	.0000
45	49	50	61	60	1	.000	.000E+00	4	1	.0000
46	50	51	62	61	1	.000	.000E+00	4	1	.0000
47	51	52	63	62	1	.000	.000E+00	4	1	.0000
48	52	53	64	63	1	.000	.000E+00	4	1	.0000
49	53	54	65	64	1	.000	.000E+00	4	1	.0000
50	54	55	66	65	1	.000	.000E+00	4	1	.0000
51	56	57	68	67	1	.000	.000E+00	4	1	.0000
52	57	58	69	68	1	.000	.000E+00	4	1	.0000
53	58	59	70	69	1	.000	.000E+00	4	1	.0000
54	59	60	71	70	1	.000	.000E+00	4	1	.0000
55	60	61	72	71	1	.000	.000E+00	4	1	.0000
56	61	62	73	72	1	.000	.000E+00	4	1	.0000
57	62	63	74	73	1	.000	.000E+00	4	1	.0000
58	63	64	75	74	1	.000	.000E+00	4	1	.0000
59	64	65	76	75	1	.000	.000E+00	4	1	.0000
60	65	66	77	76	1	.000	.000E+00	4	1	.0000
61	67	68	79	78	1	.000	.000E+00	4	1	.0000
62	68	69	80	79	1	.000	.000E+00	4	1	.0000
63	69	70	81	80	1	.000	.000E+00	4	1	.0000
64	70	71	82	81	1	.000	.000E+00	4	1	.0000
65	71	72	83	82	1	.000	.000E+00	4	1	.0000

66	72	73	84	83	1	.000	.000E+00	4	1	.0000
67	73	74	85	84	1	.000	.000E+00	4	1	.0000
68	74	75	86	85	1	.000	.000E+00	4	1	.0000
69	75	76	87	86	1	.000	.000E+00	4	1	.0000
70	76	77	88	87	1	.000	.000E+00	4	1	.0000
71	78	79	90	89	1	.000	.000E+00	4	1	.0000
72	79	80	91	90	1	.000	.000E+00	4	1	.0000
73	80	81	92	91	1	.000	.000E+00	4	1	.0000
74	81	82	93	92	1	.000	.000E+00	4	1	.0000
75	82	83	94	93	1	.000	.000E+00	4	1	.0000
76	83	84	95	94	1	.000	.000E+00	4	1	.0000
77	84	85	96	95	1	.000	.000E+00	4	1	.0000
78	85	86	97	96	1	.000	.000E+00	4	1	.0000
79	86	87	98	97	1	.000	.000E+00	4	1	.0000
80	87	88	99	98	1	.000	.000E+00	4	1	.0000
81	89	90	101	100	1	.000	.000E+00	4	1	.0000
82	90	91	102	101	1	.000	.000E+00	4	1	.0000
83	91	92	103	102	1	.000	.000E+00	4	1	.0000
84	92	93	104	103	1	.000	.000E+00	4	1	.0000
85	93	94	105	104	1	.000	.000E+00	4	1	.0000
86	94	95	106	105	1	.000	.000E+00	4	1	.0000
87	95	96	107	106	1	.000	.000E+00	4	1	.0000
88	96	97	108	107	1	.000	.000E+00	4	1	.0000
89	97	98	109	108	1	.000	.000E+00	4	1	.0000
90	98	99	110	109	1	.000	.000E+00	4	1	.0000
91	100	101	112	111	1	.000	.000E+00	4	1	.0000
92	101	102	113	112	1	.000	.000E+00	4	1	.0000
93	102	103	114	113	1	.000	.000E+00	4	1	.0000
94	103	104	115	114	1	.000	.000E+00	4	1	.0000
95	104	105	116	115	1	.000	.000E+00	4	1	.0000
96	105	106	117	116	1	.000	.000E+00	4	1	.0000
97	106	107	118	117	1	.000	.000E+00	4	1	.0000
98	107	108	119	118	1	.000	.000E+00	4	1	.0000
99	108	109	120	119	1	.000	.000E+00	4	1	.0000
100	109	110	121	120	1	.000	.000E+00	4	1	.0000
101	111	112	123	122	1	.000	.000E+00	4	1	.0000
102	112	113	124	123	1	.000	.000E+00	4	1	.0000
103	113	114	125	124	1	.000	.000E+00	4	1	.0000
104	114	115	126	125	1	.000	.000E+00	4	1	.0000
105	115	116	127	126	1	.000	.000E+00	4	1	.0000
106	116	117	128	127	1	.000	.000E+00	4	1	.0000
107	117	118	129	128	1	.000	.000E+00	4	1	.0000
108	118	119	130	129	1	.000	.000E+00	4	1	.0000
109	119	120	131	130	1	.000	.000E+00	4	1	.0000
110	120	121	132	131	1	.000	.000E+00	4	1	.0000
111	123	124	139	138	1	.000	.000E+00	4	1	.0000
112	124	125	140	139	1	.000	.000E+00	4	1	.0000
113	125	126	141	140	1	.000	.000E+00	4	1	.0000
114	126	127	142	141	1	.000	.000E+00	4	1	.0000
115	127	128	143	142	1	.000	.000E+00	4	1	.0000
116	128	129	144	143	1	.000	.000E+00	4	1	.0000
117	129	130	145	144	1	.000	.000E+00	4	1	.0000
118	130	131	146	145	1	.000	.000E+00	4	1	.0000
119	131	132	147	146	1	.000	.000E+00	4	1	.0000
120	132	133	148	147	1	.000	.000E+00	4	1	.0000
121	133	134	149	148	1	.000	.000E+00	4	1	.0000
122	134	135	150	149	1	.000	.000E+00	4	1	.0000
123	135	136	151	150	1	.000	.000E+00	4	1	.0000
124	136	137	152	151	1	.000	.000E+00	4	1	.0000
125	138	139	154	153	1	.000	.000E+00	4	1	.0000
126	139	140	155	154	1	.000	.000E+00	4	1	.0000
127	140	141	156	155	1	.000	.000E+00	4	1	.0000
128	141	142	157	156	1	.000	.000E+00	4	1	.0000
129	142	143	158	157	1	.000	.000E+00	4	1	.0000
130	143	144	159	158	1	.000	.000E+00	4	1	.0000
131	144	145	160	159	1	.000	.000E+00	4	1	.0000

132	145	146	161	160	1	.000	.000E+00	4	1	.0000
133	146	147	162	161	1	.000	.000E+00	4	1	.0000
134	147	148	163	162	1	.000	.000E+00	4	1	.0000
135	148	149	164	163	1	.000	.000E+00	4	1	.0000
136	149	150	165	164	1	.000	.000E+00	4	1	.0000
137	150	151	166	165	1	.000	.000E+00	4	1	.0000
138	151	152	167	166	1	.000	.000E+00	4	1	.0000
139	153	154	170	169	1	.000	.000E+00	4	1	.0000
140	154	155	171	170	1	.000	.000E+00	4	1	.0000
141	155	156	172	171	1	.000	.000E+00	4	1	.0000
142	156	157	173	172	1	.000	.000E+00	4	1	.0000
143	157	158	174	173	1	.000	.000E+00	4	1	.0000
144	158	159	175	174	1	.000	.000E+00	4	1	.0000
145	159	160	176	175	1	.000	.000E+00	4	1	.0000
146	160	161	177	176	1	.000	.000E+00	4	1	.0000
147	161	162	178	177	1	.000	.000E+00	4	1	.0000
148	162	163	179	178	1	.000	.000E+00	4	1	.0000
149	163	164	180	179	1	.000	.000E+00	4	1	.0000
150	164	165	181	180	1	.000	.000E+00	4	1	.0000
151	165	166	182	181	1	.000	.000E+00	4	1	.0000
152	166	167	183	182	1	.000	.000E+00	4	1	.0000
153	168	169	185	184	1	.000	.676E+04	4	1	.0000
154	169	170	186	185	1	.000	.000E+00	4	1	.0000
155	170	171	187	186	1	.000	.000E+00	4	1	.0000
156	171	172	188	187	1	.000	.000E+00	4	1	.0000
157	172	173	189	188	1	.000	.000E+00	4	1	.0000
158	173	174	190	189	1	.000	.000E+00	4	1	.0000
159	174	175	191	190	1	.000	.000E+00	4	1	.0000
160	175	176	192	191	1	.000	.000E+00	4	1	.0000
161	176	177	193	192	1	.000	.000E+00	4	1	.0000
162	177	178	194	193	1	.000	.000E+00	4	1	.0000
163	178	179	195	194	1	.000	.000E+00	4	1	.0000
164	179	180	196	195	1	.000	.000E+00	4	1	.0000
165	180	181	197	196	1	.000	.000E+00	4	1	.0000
166	181	182	198	197	1	.000	.000E+00	4	1	.0000
167	182	183	199	198	1	.000	.000E+00	4	1	.0000
168	184	185	201	200	1	.000	.000E+00	4	1	.0000
169	185	186	202	201	1	.000	.000E+00	4	1	.0000
170	186	187	203	202	1	.000	.000E+00	4	1	.0000
171	187	188	204	203	1	.000	.000E+00	4	1	.0000
172	188	189	205	204	1	.000	.000E+00	4	1	.0000
173	189	190	206	205	1	.000	.000E+00	4	1	.0000
174	190	191	207	206	1	.000	.000E+00	4	1	.0000
175	191	192	208	207	1	.000	.000E+00	4	1	.0000
176	192	193	209	208	1	.000	.000E+00	4	1	.0000
177	193	194	210	209	1	.000	.000E+00	4	1	.0000
178	194	195	211	210	1	.000	.000E+00	4	1	.0000
179	195	196	212	211	1	.000	.000E+00	4	1	.0000
180	196	197	213	212	1	.000	.000E+00	4	1	.0000
181	197	198	214	213	1	.000	.000E+00	4	1	.0000
182	198	199	215	214	1	.000	.000E+00	4	1	.0000
183	200	201	217	216	1	.000	.000E+00	4	1	.0000
184	201	202	218	217	1	.000	.000E+00	4	1	.0000
185	202	203	219	218	1	.000	.000E+00	4	1	.0000
186	203	204	220	219	1	.000	.000E+00	4	1	.0000
187	204	205	221	220	1	.000	.000E+00	4	1	.0000
188	205	206	222	221	1	.000	.000E+00	4	1	.0000
189	206	207	223	222	1	.000	.000E+00	4	1	.0000
190	207	208	224	223	1	.000	.000E+00	4	1	.0000
191	208	209	225	224	1	.000	.000E+00	4	1	.0000
192	209	210	226	225	1	.000	.000E+00	4	1	.0000
193	210	211	227	226	1	.000	.000E+00	4	1	.0000
194	211	212	228	227	1	.000	.000E+00	4	1	.0000
195	212	213	229	228	1	.000	.000E+00	4	1	.0000
196	213	214	230	229	1	.000	.000E+00	4	1	.0000
197	214	215	231	230	1	.000	.000E+00	4	1	.0000

1E Q U A T I O N   P A R A M E T E R S

TOTAL NUMBER OF EQUATIONS = 461
BANDWIDTH = 36
NUMBER OF EQUATIONS IN A BLOCK = 105
NUMBER OF BLOCKS = 5

1N O D A L   L O A D S   (S T A T I C)   O R   M A S S E S   (D Y N A M I C)

NODE NUMBER	LOAD CASE	X-AXIS FORCE	Y-AXIS FORCE	Z-AXIS FORCE	X-AXIS MOMENT	Y-AXIS MOMENT	Z-AXIS MOMENT

STRUCTURE LOAD CASE	ELEMENT LOAD MULTIPLIERS A	B	C	D
1	1.000	.000	.000	.000

1N O D E   D I S P L A C E M E N T S / R O T A T I O N S

	NODE NUMBER	LOAD CASE	X- TRANSLATION	Y- TRANSLATION	Z- TRANSLATION	X- ROTATION	Y- ROTATION	Z- ROTATION
0	231	1	.00000E+00	.30148E-02	.00000E+00	.00000E+00	.00000E+00	.00000E+00
0	230	1	.00000E+00	.28322E-02	.12825E-02	.00000E+00	.00000E+00	.00000E+00
0	229	1	.00000E+00	.26699E-02	.18247E-02	.00000E+00	.00000E+00	.00000E+00
0	228	1	.00000E+00	.25379E-02	.23245E-02	.00000E+00	.00000E+00	.00000E+00
0	227	1	.00000E+00	.24281E-02	.27462E-02	.00000E+00	.00000E+00	.00000E+00
0	226	1	.00000E+00	.23226E-02	.31382E-02	.00000E+00	.00000E+00	.00000E+00
0	225	1	.00000E+00	.22230E-02	.34876E-02	.00000E+00	.00000E+00	.00000E+00
0	224	1	.00000E+00	.21287E-02	.38098E-02	.00000E+00	.00000E+00	.00000E+00
0	223	1	.00000E+00	.20471E-02	.40983E-02	.00000E+00	.00000E+00	.00000E+00
0	222	1	.00000E+00	.19806E-02	.43695E-02	.00000E+00	.00000E+00	.00000E+00
0	221	1	.00000E+00	.19349E-02	.46239E-02	.00000E+00	.00000E+00	.00000E+00
0	220	1	.00000E+00	.19095E-02	.48817E-02	.00000E+00	.00000E+00	.00000E+00
0	219	1	.00000E+00	.19002E-02	.51451E-02	.00000E+00	.00000E+00	.00000E+00
0	218	1	.00000E+00	.18957E-02	.54230E-02	.00000E+00	.00000E+00	.00000E+00
0	217	1	.00000E+00	.18903E-02	.56989E-02	.00000E+00	.00000E+00	.00000E+00
0	216	1	.00000E+00	.18891E-02	.59762E-02	.00000E+00	.00000E+00	.00000E+00
0	215	1	.00000E+00	.18906E-02	.71389E-03	.00000E+00	.00000E+00	.00000E+00
0	214	1	.00000E+00	.18734E-02	.12790E-02	.00000E+00	.00000E+00	.00000E+00
0	213	1	.00000E+00	.19123E-02	.19031E-02	.00000E+00	.00000E+00	.00000E+00
0	212	1	.00000E+00	.18942E-02	.23845E-02	.00000E+00	.00000E+00	.00000E+00
0	211	1	.00000E+00	.18527E-02	.28159E-02	.00000E+00	.00000E+00	.00000E+00

0	210	1	.00000E+00	.17989E-02	.32091E-02	.00000E+00	.00000E+00	.00000E+00
0	209	1	.00000E+00	.17415E-02	.35592E-02	.00000E+00	.00000E+00	.00000E+00
0	208	1	.00000E+00	.16834E-02	.38791E-02	.00000E+00	.00000E+00	.00000E+00
0	207	1	.00000E+00	.16306E-02	.41632E-02	.00000E+00	.00000E+00	.00000E+00
0	206	1	.00000E+00	.15848E-02	.44280E-02	.00000E+00	.00000E+00	.00000E+00
0	205	1	.00000E+00	.15495E-02	.46751E-02	.00000E+00	.00000E+00	.00000E+00
0	204	1	.00000E+00	.15254E-02	.49249E-02	.00000E+00	.00000E+00	.00000E+00
0	203	1	.00000E+00	.15150E-02	.51824E-02	.00000E+00	.00000E+00	.00000E+00
0	202	1	.00000E+00	.15157E-02	.54651E-02	.00000E+00	.00000E+00	.00000E+00
0	201	1	.00000E+00	.15151E-02	.57547E-02	.00000E+00	.00000E+00	.00000E+00
0	200	1	.00000E+00	.15092E-02	.60266E-02	.00000E+00	.00000E+00	.00000E+00
0	199	1	.00000E+00	.13478E-02	.99766E-03	.00000E+00	.00000E+00	.00000E+00
0	198	1	.00000E+00	.13106E-02	.14257E-02	.00000E+00	.00000E+00	.00000E+00
0	197	1	.00000E+00	.13022E-02	.19198E-02	.00000E+00	.00000E+00	.00000E+00
0	196	1	.00000E+00	.13170E-02	.24204E-02	.00000E+00	.00000E+00	.00000E+00
0	195	1	.00000E+00	.13131E-02	.28588E-02	.00000E+00	.00000E+00	.00000E+00
0	194	1	.00000E+00	.12937E-02	.32624E-02	.00000E+00	.00000E+00	.00000E+00
0	193	1	.00000E+00	.12639E-02	.36166E-02	.00000E+00	.00000E+00	.00000E+00
0	192	1	.00000E+00	.12294E-02	.39359E-02	.00000E+00	.00000E+00	.00000E+00
0	191	1	.00000E+00	.11958E-02	.42153E-02	.00000E+00	.00000E+00	.00000E+00
0	190	1	.00000E+00	.11653E-02	.44726E-02	.00000E+00	.00000E+00	.00000E+00
0	189	1	.00000E+00	.11409E-02	.47104E-02	.00000E+00	.00000E+00	.00000E+00
0	188	1	.00000E+00	.11238E-02	.49488E-02	.00000E+00	.00000E+00	.00000E+00
0	187	1	.00000E+00	.11167E-02	.51914E-02	.00000E+00	.00000E+00	.00000E+00
0	186	1	.00000E+00	.11270E-02	.54692E-02	.00000E+00	.00000E+00	.00000E+00
0	185	1	.00000E+00	.11507E-02	.57982E-02	.00000E+00	.00000E+00	.00000E+00
0	184	1	.00000E+00	.11591E-02	.61077E-02	.00000E+00	.00000E+00	.00000E+00
0	183	1	.00000E+00	.83249E-03	.11390E-02	.00000E+00	.00000E+00	.00000E+00
0	182	1	.00000E+00	.81754E-03	.15379E-02	.00000E+00	.00000E+00	.00000E+00
0	181	1	.00000E+00	.81198E-03	.19828E-02	.00000E+00	.00000E+00	.00000E+00
0	180	1	.00000E+00	.81441E-03	.24537E-02	.00000E+00	.00000E+00	.00000E+00
0	179	1	.00000E+00	.82019E-03	.29029E-02	.00000E+00	.00000E+00	.00000E+00
0	178	1	.00000E+00	.81400E-03	.33174E-02	.00000E+00	.00000E+00	.00000E+00

0	177	1	.00000E+00	.79935E-03	.36765E-02	.00000E+00	.00000E+00	.00000E+00
0	176	1	.00000E+00	.78013E-03	.39918E-02	.00000E+00	.00000E+00	.00000E+00
0	175	1	.00000E+00	.76234E-03	.42608E-02	.00000E+00	.00000E+00	.00000E+00
0	174	1	.00000E+00	.74730E-03	.45050E-02	.00000E+00	.00000E+00	.00000E+00
0	173	1	.00000E+00	.73473E-03	.47293E-02	.00000E+00	.00000E+00	.00000E+00
0	172	1	.00000E+00	.72350E-03	.49513E-02	.00000E+00	.00000E+00	.00000E+00
0	171	1	.00000E+00	.71469E-03	.51782E-02	.00000E+00	.00000E+00	.00000E+00
0	170	1	.00000E+00	.70463E-03	.54269E-02	.00000E+00	.00000E+00	.00000E+00
0	169	1	.00000E+00	.69130E-03	.57852E-02	.00000E+00	.00000E+00	.00000E+00
0	168	1	.00000E+00	.61865E-03	.63528E-02	.00000E+00	.00000E+00	.00000E+00
0	167	1	.00000E+00	.39744E-03	.11900E-02	.00000E+00	.00000E+00	.00000E+00
0	166	1	.00000E+00	.39351E-03	.15891E-02	.00000E+00	.00000E+00	.00000E+00
0	165	1	.00000E+00	.39873E-03	.20221E-02	.00000E+00	.00000E+00	.00000E+00
0	164	1	.00000E+00	.41686E-03	.24918E-02	.00000E+00	.00000E+00	.00000E+00
0	163	1	.00000E+00	.42695E-03	.29499E-02	.00000E+00	.00000E+00	.00000E+00
0	162	1	.00000E+00	.43171E-03	.33785E-02	.00000E+00	.00000E+00	.00000E+00
0	161	1	.00000E+00	.42393E-03	.37403E-02	.00000E+00	.00000E+00	.00000E+00
0	160	1	.00000E+00	.41746E-03	.40426E-02	.00000E+00	.00000E+00	.00000E+00
0	159	1	.00000E+00	.41729E-03	.42933E-02	.00000E+00	.00000E+00	.00000E+00
0	158	1	.00000E+00	.41915E-03	.45215E-02	.00000E+00	.00000E+00	.00000E+00
0	157	1	.00000E+00	.41880E-03	.47319E-02	.00000E+00	.00000E+00	.00000E+00
0	156	1	.00000E+00	.41520E-03	.49401E-02	.00000E+00	.00000E+00	.00000E+00
0	155	1	.00000E+00	.40910E-03	.51450E-02	.00000E+00	.00000E+00	.00000E+00
0	154	1	.00000E+00	.40650E-03	.53782E-02	.00000E+00	.00000E+00	.00000E+00
0	153	1	.00000E+00	.43964E-03	.55921E-02	.00000E+00	.00000E+00	.00000E+00
0	152	1	.00000E+00	-.62820E-04	.12011E-02	.00000E+00	.00000E+00	.00000E+00
0	151	1	.00000E+00	-.60487E-04	.16089E-02	.00000E+00	.00000E+00	.00000E+00
0	150	1	.00000E+00	-.47328E-04	.20366E-02	.00000E+00	.00000E+00	.00000E+00
0	149	1	.00000E+00	-.13370E-04	.24994E-02	.00000E+00	.00000E+00	.00000E+00
0	148	1	.00000E+00	.46865E-04	.30034E-02	.00000E+00	.00000E+00	.00000E+00
0	147	1	.00000E+00	.58374E-04	.34659E-02	.00000E+00	.00000E+00	.00000E+00
0	146	1	.00000E+00	.70174E-04	.38222E-02	.00000E+00	.00000E+00	.00000E+00
0	145	1	.00000E+00	.92620E-04	.40901E-02	.00000E+00	.00000E+00	.00000E+00

0	144	1	.00000E+00	.11809E-03	.43157E-02	.00000E+00	.00000E+00	.00000E+00
0	143	1	.00000E+00	.13744E-03	.45271E-02	.00000E+00	.00000E+00	.00000E+00
0	142	1	.00000E+00	.15003E-03	.47231E-02	.00000E+00	.00000E+00	.00000E+00
0	141	1	.00000E+00	.15691E-03	.49147E-02	.00000E+00	.00000E+00	.00000E+00
0	140	1	.00000E+00	.16021E-03	.51009E-02	.00000E+00	.00000E+00	.00000E+00
0	139	1	.00000E+00	.17097E-03	.52738E-02	.00000E+00	.00000E+00	.00000E+00
0	138	1	.00000E+00	.20382E-03	.54530E-02	.00000E+00	.00000E+00	.00000E+00
0	137	1	.00000E+00	-.54688E-03	.11963E-02	.00000E+00	.00000E+00	.00000E+00
0	136	1	.00000E+00	-.54804E-03	.16092E-02	.00000E+00	.00000E+00	.00000E+00
0	135	1	.00000E+00	-.54623E-03	.20304E-02	.00000E+00	.00000E+00	.00000E+00
0	134	1	.00000E+00	-.52760E-03	.24916E-02	.00000E+00	.00000E+00	.00000E+00
0	133	1	.00000E+00	-.46672E-03	.29664E-02	.00000E+00	.00000E+00	.00000E+00
0	132	1	.00000E+00	-.27746E-03	.36086E-02	.00000E+00	.00000E+00	.00000E+00
0	131	1	.00000E+00	-.20784E-03	.39080E-02	.00000E+00	.00000E+00	.00000E+00
0	130	1	.00000E+00	-.14985E-03	.41262E-02	.00000E+00	.00000E+00	.00000E+00
0	129	1	.00000E+00	-.11153E-03	.43314E-02	.00000E+00	.00000E+00	.00000E+00
0	128	1	.00000E+00	-.82375E-04	.45245E-02	.00000E+00	.00000E+00	.00000E+00
0	127	1	.00000E+00	-.60999E-04	.47049E-02	.00000E+00	.00000E+00	.00000E+00
0	126	1	.00000E+00	-.44337E-04	.48798E-02	.00000E+00	.00000E+00	.00000E+00
0	125	1	.00000E+00	-.29603E-04	.50402E-02	.00000E+00	.00000E+00	.00000E+00
0	124	1	.00000E+00	-.16430E-04	.51890E-02	.00000E+00	.00000E+00	.00000E+00
0	123	1	.00000E+00	-.36604E-05	.52771E-02	.00000E+00	.00000E+00	.00000E+00
0	122	1	.00000E+00	-.15605E-04	.52488E-02	.00000E+00	.00000E+00	.00000E+00
0	121	1	.00000E+00	-.24994E-03	.39956E-02	.00000E+00	.00000E+00	.00000E+00
0	120	1	.00000E+00	-.30968E-03	.40302E-02	.00000E+00	.00000E+00	.00000E+00
0	119	1	.00000E+00	-.31045E-03	.41969E-02	.00000E+00	.00000E+00	.00000E+00
0	118	1	.00000E+00	-.29417E-03	.43582E-02	.00000E+00	.00000E+00	.00000E+00
0	117	1	.00000E+00	-.27373E-03	.45223E-02	.00000E+00	.00000E+00	.00000E+00
0	116	1	.00000E+00	-.25295E-03	.46773E-02	.00000E+00	.00000E+00	.00000E+00
0	115	1	.00000E+00	-.23116E-03	.48257E-02	.00000E+00	.00000E+00	.00000E+00
0	114	1	.00000E+00	-.20777E-03	.49598E-02	.00000E+00	.00000E+00	.00000E+00
0	113	1	.00000E+00	-.17753E-03	.50738E-02	.00000E+00	.00000E+00	.00000E+00
0	112	1	.00000E+00	-.14210E-03	.51552E-02	.00000E+00	.00000E+00	.00000E+00

0	111	1	.00000E+00	-.11385E-03	.52480E-02	.00000E+00	.00000E+00	.00000E+00
0	110	1	.00000E+00	-.30783E-03	.41628E-02	.00000E+00	.00000E+00	.00000E+00
0	109	1	.00000E+00	-.33622E-03	.42164E-02	.00000E+00	.00000E+00	.00000E+00
0	108	1	.00000E+00	-.36759E-03	.42921E-02	.00000E+00	.00000E+00	.00000E+00
0	107	1	.00000E+00	-.37753E-03	.44077E-02	.00000E+00	.00000E+00	.00000E+00
0	106	1	.00000E+00	-.37464E-03	.45331E-02	.00000E+00	.00000E+00	.00000E+00
0	105	1	.00000E+00	-.36385E-03	.46577E-02	.00000E+00	.00000E+00	.00000E+00
0	104	1	.00000E+00	-.34748E-03	.47787E-02	.00000E+00	.00000E+00	.00000E+00
0	103	1	.00000E+00	-.32694E-03	.48868E-02	.00000E+00	.00000E+00	.00000E+00
0	102	1	.00000E+00	-.30402E-03	.49812E-02	.00000E+00	.00000E+00	.00000E+00
0	101	1	.00000E+00	-.28455E-03	.50654E-02	.00000E+00	.00000E+00	.00000E+00
0	100	1	.00000E+00	-.26628E-03	.51437E-02	.00000E+00	.00000E+00	.00000E+00
0	99	1	.00000E+00	-.35121E-03	.43036E-02	.00000E+00	.00000E+00	.00000E+00
0	98	1	.00000E+00	-.37738E-03	.43363E-02	.00000E+00	.00000E+00	.00000E+00
0	97	1	.00000E+00	-.39841E-03	.43946E-02	.00000E+00	.00000E+00	.00000E+00
0	96	1	.00000E+00	-.41533E-03	.44678E-02	.00000E+00	.00000E+00	.00000E+00
0	95	1	.00000E+00	-.42277E-03	.45586E-02	.00000E+00	.00000E+00	.00000E+00
0	94	1	.00000E+00	-.42191E-03	.46529E-02	.00000E+00	.00000E+00	.00000E+00
0	93	1	.00000E+00	-.41465E-03	.47475E-02	.00000E+00	.00000E+00	.00000E+00
0	92	1	.00000E+00	-.40353E-03	.48343E-02	.00000E+00	.00000E+00	.00000E+00
0	91	1	.00000E+00	-.39065E-03	.49141E-02	.00000E+00	.00000E+00	.00000E+00
0	90	1	.00000E+00	-.37654E-03	.49824E-02	.00000E+00	.00000E+00	.00000E+00
0	89	1	.00000E+00	-.35974E-03	.50359E-02	.00000E+00	.00000E+00	.00000E+00
0	88	1	.00000E+00	-.37809E-03	.44127E-02	.00000E+00	.00000E+00	.00000E+00
0	87	1	.00000E+00	-.39874E-03	.44339E-02	.00000E+00	.00000E+00	.00000E+00
0	86	1	.00000E+00	-.41810E-03	.44728E-02	.00000E+00	.00000E+00	.00000E+00
0	85	1	.00000E+00	-.43285E-03	.45263E-02	.00000E+00	.00000E+00	.00000E+00
0	84	1	.00000E+00	-.44338E-03	.45905E-02	.00000E+00	.00000E+00	.00000E+00
0	83	1	.00000E+00	-.44806E-03	.46604E-02	.00000E+00	.00000E+00	.00000E+00
0	82	1	.00000E+00	-.44770E-03	.47325E-02	.00000E+00	.00000E+00	.00000E+00
0	81	1	.00000E+00	-.44346E-03	.48005E-02	.00000E+00	.00000E+00	.00000E+00
0	80	1	.00000E+00	-.43609E-03	.48625E-02	.00000E+00	.00000E+00	.00000E+00
0	79	1	.00000E+00	-.42633E-03	.49127E-02	.00000E+00	.00000E+00	.00000E+00

0	78	1	.00000E+00	-.41440E-03	.49466E-02	.00000E+00	.00000E+00	.00000E+00
0	77	1	.00000E+00	-.39115E-03	.44989E-02	.00000E+00	.00000E+00	.00000E+00
0	76	1	.00000E+00	-.40811E-03	.45111E-02	.00000E+00	.00000E+00	.00000E+00
0	75	1	.00000E+00	-.42415E-03	.45380E-02	.00000E+00	.00000E+00	.00000E+00
0	74	1	.00000E+00	-.43783E-03	.45758E-02	.00000E+00	.00000E+00	.00000E+00
0	73	1	.00000E+00	-.44834E-03	.46230E-02	.00000E+00	.00000E+00	.00000E+00
0	72	1	.00000E+00	-.45510E-03	.46746E-02	.00000E+00	.00000E+00	.00000E+00
0	71	1	.00000E+00	-.45812E-03	.47289E-02	.00000E+00	.00000E+00	.00000E+00
0	70	1	.00000E+00	-.45759E-03	.47802E-02	.00000E+00	.00000E+00	.00000E+00
0	69	1	.00000E+00	-.45404E-03	.48261E-02	.00000E+00	.00000E+00	.00000E+00
0	68	1	.00000E+00	-.44818E-03	.48613E-02	.00000E+00	.00000E+00	.00000E+00
0	67	1	.00000E+00	-.44074E-03	.48807E-02	.00000E+00	.00000E+00	.00000E+00
0	66	1	.00000E+00	-.39511E-03	.45661E-02	.00000E+00	.00000E+00	.00000E+00
0	65	1	.00000E+00	-.40882E-03	.45728E-02	.00000E+00	.00000E+00	.00000E+00
0	64	1	.00000E+00	-.42237E-03	.45913E-02	.00000E+00	.00000E+00	.00000E+00
0	63	1	.00000E+00	-.43428E-03	.46187E-02	.00000E+00	.00000E+00	.00000E+00
0	62	1	.00000E+00	-.44423E-03	.46534E-02	.00000E+00	.00000E+00	.00000E+00
0	61	1	.00000E+00	-.45133E-03	.46920E-02	.00000E+00	.00000E+00	.00000E+00
0	60	1	.00000E+00	-.45563E-03	.47325E-02	.00000E+00	.00000E+00	.00000E+00
0	59	1	.00000E+00	-.45705E-03	.47706E-02	.00000E+00	.00000E+00	.00000E+00
0	58	1	.00000E+00	-.45605E-03	.48040E-02	.00000E+00	.00000E+00	.00000E+00
0	57	1	.00000E+00	-.45330E-03	.48280E-02	.00000E+00	.00000E+00	.00000E+00
0	56	1	.00000E+00	-.44996E-03	.48385E-02	.00000E+00	.00000E+00	.00000E+00
0	55	1	.00000E+00	-.39451E-03	.46180E-02	.00000E+00	.00000E+00	.00000E+00
0	54	1	.00000E+00	-.40562E-03	.46220E-02	.00000E+00	.00000E+00	.00000E+00
0	53	1	.00000E+00	-.41698E-03	.46353E-02	.00000E+00	.00000E+00	.00000E+00
0	52	1	.00000E+00	-.42733E-03	.46556E-02	.00000E+00	.00000E+00	.00000E+00
0	51	1	.00000E+00	-.43628E-03	.46817E-02	.00000E+00	.00000E+00	.00000E+00
0	50	1	.00000E+00	-.44310E-03	.47107E-02	.00000E+00	.00000E+00	.00000E+00
0	49	1	.00000E+00	-.44779E-03	.47412E-02	.00000E+00	.00000E+00	.00000E+00
0	48	1	.00000E+00	-.45027E-03	.47697E-02	.00000E+00	.00000E+00	.00000E+00
0	47	1	.00000E+00	-.45100E-03	.47942E-02	.00000E+00	.00000E+00	.00000E+00
0	46	1	.00000E+00	-.45073E-03	.48111E-02	.00000E+00	.00000E+00	.00000E+00

0	45	1	.00000E+00	-.45076E-03	.48169E-02	.00000E+00	.00000E+00	.00000E+00
0	44	1	.00000E+00	-.39357E-03	.46576E-02	.00000E+00	.00000E+00	.00000E+00
0	43	1	.00000E+00	-.40265E-03	.46613E-02	.00000E+00	.00000E+00	.00000E+00
0	42	1	.00000E+00	-.41225E-03	.46719E-02	.00000E+00	.00000E+00	.00000E+00
0	41	1	.00000E+00	-.42120E-03	.46877E-02	.00000E+00	.00000E+00	.00000E+00
0	40	1	.00000E+00	-.42916E-03	.47080E-02	.00000E+00	.00000E+00	.00000E+00
0	39	1	.00000E+00	-.43550E-03	.47304E-02	.00000E+00	.00000E+00	.00000E+00
0	38	1	.00000E+00	-.44027E-03	.47539E-02	.00000E+00	.00000E+00	.00000E+00
0	37	1	.00000E+00	-.44341E-03	.47757E-02	.00000E+00	.00000E+00	.00000E+00
0	36	1	.00000E+00	-.44543E-03	.47945E-02	.00000E+00	.00000E+00	.00000E+00
0	35	1	.00000E+00	-.44707E-03	.48074E-02	.00000E+00	.00000E+00	.00000E+00
0	34	1	.00000E+00	-.44972E-03	.48121E-02	.00000E+00	.00000E+00	.00000E+00
0	33	1	.00000E+00	-.39574E-03	.46881E-02	.00000E+00	.00000E+00	.00000E+00
0	32	1	.00000E+00	-.40338E-03	.46932E-02	.00000E+00	.00000E+00	.00000E+00
0	31	1	.00000E+00	-.41166E-03	.47028E-02	.00000E+00	.00000E+00	.00000E+00
0	30	1	.00000E+00	-.41947E-03	.47160E-02	.00000E+00	.00000E+00	.00000E+00
0	29	1	.00000E+00	-.42656E-03	.47324E-02	.00000E+00	.00000E+00	.00000E+00
0	28	1	.00000E+00	-.43246E-03	.47505E-02	.00000E+00	.00000E+00	.00000E+00
0	27	1	.00000E+00	-.43727E-03	.47695E-02	.00000E+00	.00000E+00	.00000E+00
0	26	1	.00000E+00	-.44095E-03	.47871E-02	.00000E+00	.00000E+00	.00000E+00
0	25	1	.00000E+00	-.44397E-03	.48025E-02	.00000E+00	.00000E+00	.00000E+00
0	24	1	.00000E+00	-.44705E-03	.48138E-02	.00000E+00	.00000E+00	.00000E+00
0	23	1	.00000E+00	-.45156E-03	.48196E-02	.00000E+00	.00000E+00	.00000E+00
0	22	1	.00000E+00	-.40303E-03	.47132E-02	.00000E+00	.00000E+00	.00000E+00
0	21	1	.00000E+00	-.40998E-03	.47202E-02	.00000E+00	.00000E+00	.00000E+00
0	20	1	.00000E+00	-.41751E-03	.47294E-02	.00000E+00	.00000E+00	.00000E+00
0	19	1	.00000E+00	-.42467E-03	.47411E-02	.00000E+00	.00000E+00	.00000E+00
0	18	1	.00000E+00	-.43133E-03	.47553E-02	.00000E+00	.00000E+00	.00000E+00
0	17	1	.00000E+00	-.43706E-03	.47709E-02	.00000E+00	.00000E+00	.00000E+00
0	16	1	.00000E+00	-.44197E-03	.47872E-02	.00000E+00	.00000E+00	.00000E+00
0	15	1	.00000E+00	-.44603E-03	.48024E-02	.00000E+00	.00000E+00	.00000E+00
0	14	1	.00000E+00	-.44975E-03	.48158E-02	.00000E+00	.00000E+00	.00000E+00
0	13	1	.00000E+00	-.45361E-03	.48267E-02	.00000E+00	.00000E+00	.00000E+00

0	12	1	.00000E+00	-.45904E-03	.48346E-02	.00000E+00	.00000E+00	.00000E+00
0	11	1	.00000E+00	-.41500E-03	.47363E-02	.00000E+00	.00000E+00	.00000E+00
0	10	1	.00000E+00	-.42201E-03	.47448E-02	.00000E+00	.00000E+00	.00000E+00
0	9	1	.00000E+00	-.43021E-03	.47537E-02	.00000E+00	.00000E+00	.00000E+00
0	8	1	.00000E+00	-.43858E-03	.47644E-02	.00000E+00	.00000E+00	.00000E+00
0	7	1	.00000E+00	-.44643E-03	.47773E-02	.00000E+00	.00000E+00	.00000E+00
0	6	1	.00000E+00	-.45283E-03	.47913E-02	.00000E+00	.00000E+00	.00000E+00
0	5	1	.00000E+00	-.45769E-03	.48058E-02	.00000E+00	.00000E+00	.00000E+00
0	4	1	.00000E+00	-.46108E-03	.48195E-02	.00000E+00	.00000E+00	.00000E+00
0	3	1	.00000E+00	-.46390E-03	.48317E-02	.00000E+00	.00000E+00	.00000E+00
0	2	1	.00000E+00	-.46738E-03	.48419E-02	.00000E+00	.00000E+00	.00000E+00
0	1	1	.00000E+00	-.47303E-03	.48528E-02	.00000E+00	.00000E+00	.00000E+00

1T W O - D I M E N S I O N A L   F I N I T E   E L E M E N T S

1. CENTROID STRESSES REFERENCED TO LOCAL Y-Z COORDINATES.
2. MID-SIDE STRESSES ARE NORMAL AND PARALLEL TO ELEMENT EDGES.

0ELEMENT (1)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.52811E+02	-.10123E+04	-.17410E+04	-.14500E+02	-.52592E+02	-.10125E+04	-.87

0
0ELEMENT (2)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.12377E+03	-.96647E+03	-.16244E+04	-.34961E+02	-.12233E+03	-.96792E+03	-2.37

0
0ELEMENT (3)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.14463E+03	-.97157E+03	-.15361E+04	-.69560E+02	-.13882E+03	-.97738E+03	-4.77

0
0ELEMENT (4)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.12395E+03	-.98031E+03	-.14593E+04	-.94156E+02	-.11372E+03	-.99054E+03	-6.20

0
0ELEMENT (5)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.77971E+02	-.99168E+03	-.13897E+04	-.10484E+03	-.66097E+02	-.10036E+04	-6.46

0
0ELEMENT (6)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.24149E+02	-.10030E+04	-.13246E+04	-.10095E+03	-.13846E+02	-.10133E+04	-5.83

0
0ELEMENT (7)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.22025E+02	-.10133E+04	-.12632E+04	-.84063E+02	.28806E+02	-.10201E+04	-4.61

0
0ELEMENT (8)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.48240E+02	-.10206E+04	-.12050E+04	-.56733E+02	.51242E+02	-.10236E+04	-3.03

0
0ELEMENT (9)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.46604E+02	-.10226E+04	-.11498E+04	-.24960E+02	.47186E+02	-.10232E+04	-1.34

0
0ELEMENT (10)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.19473E+02	-.99642E+03	-.10912E+04	-.53465E+01	.19501E+02	-.99645E+03	-.30

0
0ELEMENT (11)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.48709E+02	-.91287E+03	-.16794E+04	-.48486E+02	-.45997E+02	-.91558E+03	-3.20

0
0ELEMENT (12)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.10414E+03	-.87119E+03	-.15664E+04	-.13825E+03	-.79979E+02	-.89534E+03	-9.91

0
0ELEMENT (13)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.11344E+03	-.88228E+03	-.14825E+04	-.20919E+03	-.60209E+02	-.93551E+03	-14.28

0
0ELEMENT (14)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.99545E+02	-.92111E+03	-.14160E+04	-.25889E+03	-.24769E+02	-.99588E+03	-16.11

0
0ELEMENT (15)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.72072E+02	-.96802E+03	-.13582E+04	-.27952E+03	.79824E+01	-.10481E+04	-15.98

0
0ELEMENT (16)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.39506E+02	-.10159E+04	-.13057E+04	-.26998E+03	.30175E+02	-.10856E+04	-14.47

0
0ELEMENT (17)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.87117E+01	-.10588E+04	-.12558E+04	-.23274E+03	.40563E+02	-.11080E+04	-11.95

0
0ELEMENT (18)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.14618E+02	-.10907E+04	-.12065E+04	-.17426E+03	.41440E+02	-.11175E+04	-8.75

0
0ELEMENT (19)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.25630E+02	-.10977E+04	-.11536E+04	-.10477E+03	.35317E+02	-.11074E+04	-5.28

0
0ELEMENT (20)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.15115E+02	-.10599E+04	-.10919E+04	-.33249E+02	.16142E+02	-.10610E+04	-1.77

0
0ELEMENT (21)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.45069E+02	-.69051E+03	-.16013E+04	-.90450E+02	-.32634E+02	-.70295E+03	-7.83

0
0ELEMENT (22)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.98191E+02	-.68381E+03	-.15033E+04	-.24072E+03	-.11945E+02	-.77006E+03	-19.71

0
0ELEMENT (23)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.10800E+03	-.73735E+03	-.14353E+04	-.34904E+03	.47269E+02	-.89263E+03	-23.98

0
0ELEMENT (24)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.91904E+02	-.82505E+03	-.13855E+04	-.41503E+03	.95264E+02	-.10122E+04	-24.27

0
0ELEMENT (25)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.63348E+02	-.92860E+03	-.13455E+04	-.44030E+03	.12130E+03	-.11132E+04	-22.75

0
0ELEMENT (26)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.30836E+02	-.10332E+04	-.13096E+04	-.42601E+03	.12576E+03	-.11898E+04	-20.18

0
0ELEMENT (27)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.27415E+00	-.11276E+04	-.12740E+04	-.37564E+03	.11342E+03	-.12413E+04	-16.84

0
0ELEMENT (28)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.22577E+02	-.12002E+04	-.12352E+04	-.29540E+03	.90200E+02	-.12678E+04	-12.89

0
0ELEMENT (29)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.30688E+02	-.12362E+04	-.11891E+04	-.19112E+03	.58890E+02	-.12644E+04	-8.39

0
0ELEMENT (30)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.16274E+02	-.12182E+04	-.11314E+04	-.67555E+02	.19960E+02	-.12219E+04	-3.12

0
0ELEMENT (31)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.42582E+02	-.34365E+03	-.15016E+04	-.12959E+03	.55183E+01	-.39175E+03	-20.36

0
0ELEMENT (32)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.91668E+02	-.40921E+03	-.14305E+04	-.34070E+03	.12544E+03	-.62632E+03	-32.51

0
0ELEMENT (33)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.98758E+02	-.53549E+03	-.13876E+04	-.48697E+03	.21657E+03	-.85081E+03	-32.92

0
0ELEMENT (34)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.80929E+02	-.69713E+03	-.13614E+04	-.57332E+03	.26183E+03	-.10399E+04	-30.87

0
0ELEMENT (35)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.50043E+02	-.87503E+03	-.13437E+04	-.60477E+03	.26951E+03	-.11946E+04	-27.85

0
0ELEMENT (36)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.15319E+02	-.10523E+04	-.13283E+04	-.58580E+03	.24848E+03	-.13161E+04	-24.24

0
0ELEMENT (37)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.15455E+02	-.12144E+04	-.13107E+04	-.52115E+03	.20659E+03	-.14055E+04	-20.14

0
0ELEMENT (38)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.36139E+02	-.13478E+04	-.12872E+04	-.41554E+03	.15132E+03	-.14630E+04	-15.49

0
0ELEMENT (39)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.39285E+02	-.14382E+04	-.12542E+04	-.27356E+03	.88308E+02	-.14872E+04	-10.16

0
0ELEMENT (40)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.18992E+02	-.14730E+04	-.12089E+04	-.97976E+02	.25399E+02	-.14794E+04	-3.74

0
0ELEMENT (41)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.38151E+02	.12282E+03	-.13496E+04	-.16717E+03	.22787E+03	-.14320E+03	-57.85

0
0ELEMENT (42)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.82330E+02	-.46847E+02	-.13366E+04	-.43754E+03	.37331E+03	-.50249E+03	-46.16

0
0ELEMENT (43)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.88246E+02	-.27351E+03	-.13277E+04	-.62307E+03	.44904E+03	-.81080E+03	-40.77

0
0ELEMENT (44)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.70564E+02	-.53233E+03	-.13326E+04	-.73206E+03	.46616E+03	-.10691E+04	-36.25

0
0ELEMENT (45)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.39388E+02	-.80433E+03	-.13432E+04	-.77244E+03	.44008E+03	-.12838E+04	-31.83

0
0ELEMENT (46)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.43742E+01	-.10736E+04	-.13541E+04	-.75060E+03	.38255E+03	-.14605E+04	-27.27

0
0ELEMENT (47)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.27682E+02	-.13230E+04	-.13601E+04	-.66964E+03	.30340E+03	-.15987E+04	-22.38

0
0ELEMENT (48)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.46405E+02	-.15390E+04	-.13579E+04	-.53620E+03	.21072E+03	-.17033E+04	-17.04

0
0ELEMENT (49)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.46919E+02	-.17074E+04	-.13441E+04	-.35342E+03	.11544E+03	-.17759E+04	-10.97

0
0ELEMENT (50)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.21276E+02	-.18178E+04	-.13170E+04	-.12637E+03	.29919E+02	-.18265E+04	-3.91

0

0ELEMENT (51)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.33679E+02	.70110E+03	-.11902E+04	-.20107E+03	.75253E+03	-.85104E+02	-75.65

0

0ELEMENT (52)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.75130E+02	.39898E+03	-.12063E+04	-.52468E+03	.73767E+03	-.41382E+03	-57.16

0

0ELEMENT (53)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.87261E+02	.50437E+02	-.12402E+04	-.74743E+03	.73219E+03	-.76901E+03	-47.63

0

0ELEMENT (54)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.76651E+02	-.32325E+03	-.12835E+04	-.88343E+03	.69205E+03	-.10919E+04	-41.03

0

0ELEMENT (55)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.48694E+02	-.71027E+03	-.13307E+04	-.94003E+03	.61705E+03	-.13760E+04	-35.31

0

0ELEMENT (56)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.11196E+02	-.10918E+04	-.13754E+04	-.91935E+03	.51485E+03	-.16179E+04	-29.78

0

0ELEMENT (57)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.23180E+02	-.14547E+04	-.14139E+04	-.82756E+03	.39369E+03	-.18252E+04	-24.12

0

0ELEMENT (58)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.50638E+02	-.17783E+04	-.14404E+04	-.66299E+03	.26568E+03	-.19934E+04	-17.97

0

0ELEMENT (59)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.50085E+02	-.20478E+04	-.14523E+04	-.43718E+03	.13754E+03	-.21353E+04	-11.31

0

0ELEMENT (60)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.24284E+02	-.22518E+04	-.14478E+04	-.15547E+03	.34854E+02	-.22624E+04	-3.89

0

0ELEMENT (61)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.28522E+02	.13665E+04	-.94661E+03	-.22303E+03	.14013E+04	-.63313E+02	-81.13

0
0ELEMENT (62)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.80083E+02	.91176E+03	-.10214E+04	-.57970E+03	.11787E+04	-.34705E+03	-65.27

0
0ELEMENT (63)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.11379E+03	.43790E+03	-.11035E+04	-.83575E+03	.10421E+04	-.71804E+03	-54.13

0
0ELEMENT (64)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.12575E+03	-.55440E+02	-.11916E+04	-.10074E+04	.91745E+03	-.10986E+04	-46.00

0
0ELEMENT (65)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.11065E+03	-.56819E+03	-.12837E+04	-.10989E+04	.78304E+03	-.14619E+04	-39.12

0
0ELEMENT (66)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.67243E+02	-.10947E+04	-.13766E+04	-.11033E+04	.63606E+03	-.17980E+04	-32.52

0
0ELEMENT (67)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.75249E+01	-.16000E+04	-.14583E+04	-.10027E+04	.47660E+03	-.20841E+04	-25.77

0
0ELEMENT (68)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.27347E+02	-.20717E+04	-.15278E+04	-.81677E+03	.30772E+03	-.23520E+04	-18.95

0
0ELEMENT (69)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.54243E+02	-.24699E+04	-.15732E+04	-.53366E+03	.16243E+03	-.25781E+04	-11.46

0
0ELEMENT (70)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.23014E+02	-.27837E+04	-.15956E+04	-.18927E+03	.35719E+02	-.27964E+04	-3.84

0
0ELEMENT (71)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.34488E+02	.20532E+04	-.62640E+03	-.21195E+03	.20745E+04	-.55788E+02	-84.26

0
0ELEMENT (72)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.10332E+03	.14568E+04	-.76239E+03	-.56629E+03	.16407E+04	-.28720E+03	-72.01

0
0ELEMENT (73)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.18998E+03	.88232E+03	-.89146E+03	-.83788E+03	.13409E+04	-.64857E+03	-61.31

0
0ELEMENT (74)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.25918E+03	.30501E+03	-.10222E+04	-.10604E+04	.11202E+04	-.10743E+04	-52.45

0
0ELEMENT (75)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.26825E+03	-.32392E+03	-.11664E+04	-.12323E+04	.93653E+03	-.15287E+04	-44.35

0
0ELEMENT (76)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.21866E+03	-.10193E+04	-.13233E+04	-.13082E+04	.74909E+03	-.19871E+04	-36.49

0
0ELEMENT (77)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.12506E+03	-.17616E+04	-.14850E+04	-.12480E+04	.54902E+03	-.24357E+04	-28.37

0
0ELEMENT (78)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.24443E+01	-.24171E+04	-.16079E+04	-.10021E+04	.35925E+03	-.27788E+04	-19.85

0
0ELEMENT (79)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.83159E+01	-.29971E+04	-.17060E+04	-.67973E+03	.15490E+03	-.31437E+04	-12.17

0
0ELEMENT (80)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.35727E+02	-.34421E+04	-.17599E+04	-.23211E+03	.51149E+02	-.34575E+04	-3.80

0
0ELEMENT (81)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.60708E+01	.26265E+04	-.23341E+03	-.15191E+03	.26353E+04	-.14807E+02	-86.71

0
0ELEMENT (82)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.17628E+03	.19460E+04	-.41537E+03	-.39308E+03	.20164E+04	-.24674E+03	-79.84

0
0ELEMENT (83)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.38141E+03	.14091E+04	-.56216E+03	-.67986E+03	.16379E+04	-.61030E+03	-71.39

0
0ELEMENT (84)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.47578E+03	.82258E+03	-.72910E+03	-.10231E+04	.13851E+04	-.10383E+04	-61.20

0
0ELEMENT (85)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.50788E+03	.76423E+02	-.93629E+03	-.13013E+04	.11180E+04	-.15494E+04	-51.33

0
0ELEMENT (86)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.50459E+03	-.79578E+03	-.11711E+04	-.14817E+04	.83868E+03	-.21390E+04	-42.19

0
0ELEMENT (87)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.42803E+03	-.17674E+04	-.14225E+04	-.15442E+04	.58542E+03	-.27808E+04	-33.28

0
0ELEMENT (88)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.25383E+03	-.28890E+04	-.17044E+04	-.14146E+04	.36176E+03	-.35046E+04	-23.52

0
0ELEMENT (89)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.73020E+02	-.36806E+04	-.18530E+04	-.84417E+03	.25413E+03	-.38617E+04	-12.11

0
0ELEMENT (90)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.41127E+02	-.42868E+04	-.19532E+04	-.32825E+03	-.15898E+02	-.43121E+04	-4.39

0
0ELEMENT (91)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.23427E+03	.27308E+04	.17829E+03	.12761E+03	.27363E+04	-.23975E+03	87.54

0
0ELEMENT (92)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.50703E+03	.24525E+04	.73771E+02	.23856E+02	.24527E+04	-.50723E+03	89.54

0
0ELEMENT (93)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.54508E+03	.21631E+04	-.60270E+02	-.51152E+03	.22565E+04	-.63847E+03	-79.65

0
0ELEMENT (94)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.57198E+03	.14357E+04	-.30399E+03	-.93052E+03	.18007E+04	-.93692E+03	-68.59

0
0ELEMENT (95)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.68865E+03	.56137E+03	-.57679E+03	-.12025E+04	.12916E+04	-.14189E+04	-58.73

0
0ELEMENT (96)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.83665E+03	-.38732E+03	-.86478E+03	-.14348E+04	.84035E+03	-.20643E+04	-49.45

0
0ELEMENT (97)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.97517E+03	-.15041E+04	-.11970E+04	-.16517E+04	.43314E+03	-.29124E+04	-40.45

0
0ELEMENT (98)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.98957E+03	-.28163E+04	-.15746E+04	-.18365E+04	.14817E+03	-.39540E+04	-31.78

0
0ELEMENT (99)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.73335E+03	-.48507E+04	-.21587E+04	-.18062E+04	-.53292E+02	-.55307E+04	-20.63

0
0ELEMENT (100)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.33996E+03	-.55711E+04	-.22391E+04	-.34717E+03	.36028E+03	-.55914E+04	-3.35

0
0ELEMENT (101)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.21032E+03	.19323E+04	.44855E+03	.80152E+03	.22476E+04	-.10501E+03	68.52

0
0ELEMENT (102)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.12250E+02	.35965E+04	.82339E+03	.17041E+03	.36045E+04	-.20279E+02	87.30

0
0ELEMENT (103)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.10461E+03	.29014E+04	.55133E+03	-.46728E+03	.29723E+04	-.17557E+03	-81.37

0
0ELEMENT (104)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.30768E+03	.18751E+04	.21459E+03	-.66078E+03	.20595E+04	-.49213E+03	-74.40

0
0ELEMENT (105)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.57651E+03	.95697E+03	-.88009E+02	-.80623E+03	.13028E+04	-.92238E+03	-66.78

0
OELEMENT (106)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.95727E+03	.15896E+02	-.39697E+03	-.94594E+03	.59306E+03	-.15344E+04	-58.61

0
OELEMENT (107)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.14114E+04	-.99154E+03	-.73132E+03	-.11573E+04	-.25230E+02	-.23777E+04	-50.14

0
OELEMENT (108)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.19397E+04	-.23122E+04	-.11688E+04	-.14877E+04	-.62663E+03	-.36253E+04	-41.43

0
OELEMENT (109)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.24809E+04	-.39853E+04	-.17084E+04	-.20907E+04	-.10112E+04	-.54550E+04	-35.11

0
OELEMENT (110)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.29534E+04	-.90929E+04	-.33424E+04	-.27862E+04	-.18775E+04	-.10169E+05	-21.11

0
OELEMENT (111)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.67627E+03	.56968E+04	.19150E+04	.59408E+03	.57662E+04	.60693E+03	83.34

0
OELEMENT (112)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.42747E+03	.32168E+04	.11463E+04	-.46620E+02	.32176E+04	.42669E+03	-89.04

0
OELEMENT (113)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.21844E+03	.20998E+04	.77358E+03	-.22632E+03	.21266E+04	.19160E+03	-83.24

0
OELEMENT (114)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.20772E+03	.10708E+04	.43629E+03	-.19098E+03	.10987E+04	-.23564E+03	-81.68

0
OELEMENT (115)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.70785E+03	.22444E+03	.14382E+03	-.19643E+03	.26414E+03	-.74754E+03	-78.58

0
OELEMENT (116)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.12963E+04	-.68994E+03	-.18056E+03	-.25706E+03	-.59563E+03	-.13906E+04	-69.85

0
0ELEMENT (117)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.19770E+04	-.17373E+04	-.55567E+03	-.39186E+03	-.14474E+04	-.22669E+04	-53.50

0
0ELEMENT (118)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.28595E+04	-.35095E+04	-.11687E+04	-.46597E+03	-.26164E+04	-.37526E+04	-27.55

0
0ELEMENT (119)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.36610E+04	-.60090E+04	-.19936E+04	-.14340E+04	-.29817E+04	-.66883E+04	-25.35

0
0ELEMENT (120)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.57595E+04	-.41674E+04	-.14843E+04	-.37253E+04	-.11540E+04	-.87729E+04	-51.03

0
0ELEMENT (121)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.28066E+04	-.14147E+03	-.47866E+03	-.12502E+04	.35322E+03	-.33012E+04	-68.41

0
0ELEMENT (122)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.12677E+04	-.28850E+03	-.57138E+03	-.69546E+03	.72419E+02	-.16286E+04	-62.57

0
0ELEMENT (123)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.39238E+03	-.16944E+03	-.54722E+03	-.32346E+03	.61214E+02	-.62304E+03	-54.51

0
0ELEMENT (124)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.50889E+02	-.81426E+02	-.50642E+03	-.42737E+02	-.20774E+02	-.11154E+03	-35.17

0
0ELEMENT (125)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.11749E+03	.53714E+04	.24787E+04	-.23219E+01	.53714E+04	.11749E+03	-89.98

0
0ELEMENT (126)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.90386E+03	.36240E+04	.18402E+04	.73524E+01	.36240E+04	.90384E+03	89.85

0
0ELEMENT (127)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.63115E+03	.18907E+04	.12943E+04	.27268E+03	.19472E+04	.57465E+03	78.29

0
0ELEMENT (128)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.22993E+03	.10129E+04	.99285E+03	.40978E+03	.11881E+04	.54687E+02	66.85

0
0ELEMENT (129)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.21695E+03	.20770E+03	.70821E+03	.47074E+03	.51178E+03	-.52104E+03	57.14

0
0ELEMENT (130)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.65665E+03	-.60096E+03	.41501E+03	.45963E+03	-.16833E+03	-.10893E+04	46.73

0
0ELEMENT (131)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.10642E+04	-.16229E+04	.53317E+02	.38378E+03	-.86890E+03	-.18183E+04	26.98

0
0ELEMENT (132)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.12370E+04	-.29270E+04	-.38553E+03	-.18635E+01	-.12370E+04	-.29270E+04	-.06

0
0ELEMENT (133)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.12179E+04	-.37537E+04	-.65372E+03	-.11320E+04	-.78611E+03	-.41855E+04	-20.88

0
0ELEMENT (134)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.13277E+04	-.32082E+04	-.50550E+03	-.24593E+04	.36497E+03	-.49008E+04	-34.54

0
0ELEMENT (135)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.21583E+04	-.19442E+04	-.14903E+03	-.28286E+04	.83171E+03	-.48343E+04	-46.59

0
0ELEMENT (136)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.14156E+04	-.81898E+03	.74223E+02	-.18712E+04	.77758E+03	-.30121E+04	-49.53

0
0ELEMENT (137)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.67202E+03	-.84172E+03	.27431E+02	-.11285E+04	.37484E+03	-.18886E+04	-42.85

0
0ELEMENT (138)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.14428E+03	-.60085E+03	.87353E+02	-.37034E+03	.62477E+02	-.80762E+03	-29.17

0
0ELEMENT (139)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.13419E+04	.59678E+04	.33430E+04	-.10947E+04	.62138E+04	.10959E+04	-77.34

0
0ELEMENT (140)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.10480E+04	.25461E+04	.22848E+04	.24087E+03	.25838E+04	.10102E+04	81.09

0
0ELEMENT (141)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.84365E+03	.16777E+04	.19528E+04	.73277E+03	.21038E+04	.41755E+03	59.82

0
0ELEMENT (142)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.58161E+03	.82876E+03	.16422E+04	.89602E+03	.16097E+04	-.19932E+03	48.93

0
0ELEMENT (143)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.34173E+03	.15602E+03	.13855E+04	.94635E+03	.11998E+04	-.70202E+03	42.20

0
0ELEMENT (144)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.13210E+03	-.54660E+03	.11234E+04	.88635E+03	.74184E+03	-.11563E+04	34.53

0
0ELEMENT (145)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.16875E+02	-.13099E+04	.85025E+03	.63228E+03	.26992E+03	-.15630E+04	21.81

0
0ELEMENT (146)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.18446E+02	-.19844E+04	.61691E+03	.22901E+02	-.18179E+02	-.19847E+04	.67

0
0ELEMENT (147)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.16443E+03	-.22543E+04	.51326E+03	-.91420E+03	.17903E+03	-.25978E+04	-20.59

0
0ELEMENT (148)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.58345E+03	-.20530E+04	.53988E+03	-.18250E+04	.64914E+03	-.32856E+04	-34.03

0
0ELEMENT (149)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.86878E+03	-.16882E+04	.59583E+03	-.24546E+04	.12101E+04	-.37671E+04	-40.26

0
0ELEMENT (150)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.93275E+03	-.15697E+04	.57109E+03	-.24725E+04	.12417E+04	-.37442E+04	-41.33

0
0ELEMENT (151)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.50714E+03	-.17166E+04	.47769E+03	-.17975E+04	.78458E+03	-.30093E+04	-35.70

0
0ELEMENT (152)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.12874E+03	-.18425E+04	.41641E+03	-.72665E+03	.13788E+03	-.21092E+04	-20.15

0
0ELEMENT (153)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.57867E+03	-.29250E+04	.21073E+04	-.16037E+04	.12018E+04	-.35482E+04	-21.24

0
0ELEMENT (154)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.36105E+03	.19856E+04	.32867E+04	-.58519E+03	.21744E+04	.17220E+03	-72.12

0
0ELEMENT (155)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.59426E+03	.19985E+04	.30879E+04	.60726E+03	.22247E+04	.36808E+03	69.57

0
0ELEMENT (156)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.72356E+03	.12060E+04	.27264E+04	.92625E+03	.19219E+04	.76398E+01	52.30

0
0ELEMENT (157)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.82966E+03	.64058E+03	.24568E+04	.11132E+04	.18523E+04	-.38207E+03	42.57

0
0ELEMENT (158)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.87443E+03	.10428E+03	.22197E+04	.11489E+04	.17010E+04	-.72233E+03	35.74

0
0ELEMENT (159)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.90912E+03	-.37537E+03	.20153E+04	.10288E+04	.14797E+04	-.94597E+03	29.01

0
0ELEMENT (160)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.93368E+03	-.79895E+03	.18418E+04	.71024E+03	.11876E+04	-.10529E+04	19.67

0
0ELEMENT (161)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.88375E+03	-.10797E+04	.17210E+04	.18707E+03	.90141E+03	-.10974E+04	5.39

0
0ELEMENT (162)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.67031E+03	-.11457E+04	.16650E+04	-.46425E+03	.78211E+03	-.12575E+04	-13.54

0
0ELEMENT (163)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.27050E+03	-.10166E+04	.16564E+04	-.11595E+04	.95307E+03	-.16991E+04	-30.48

0
0ELEMENT (164)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.29516E+03	-.84106E+03	.16428E+04	-.18022E+04	.12546E+04	-.23908E+04	-40.69

0
0ELEMENT (165)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.79792E+03	-.13698E+04	.13905E+04	-.24827E+04	.14152E[illegible]	-.[illegible]+04	-41.72

0
0ELEMENT (166)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.48867E+03	-.26855E+04	.92273E+03	-.23829E+04	.10368E+04	-.42110E+04	-32.63

0
0ELEMENT (167)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.40887E+01	-.39198E+04	.52516E+03	-.10004E+04	.23668E+03	-.41605E+04	-13.53

0
0ELEMENT (168)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.34554E+03	-.96563E+03	.38853E+04	-.65429E+03	.68446E+02	-.13796E+04	-32.32

0
0ELEMENT (169)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.43704E+03	.28486E+03	.39740E+04	-.74569E+03	.75236E+03	-.90455E+03	-57.91

0
0ELEMENT (170)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.43730E+02	.96655E+03	.38950E+04	.89151E+02	.97508E+03	.35197E+02	84.53

0
0ELEMENT (171)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.61865E+03	.73576E+03	.36201E+04	.67526E+03	.13550E+04	-.58804E+00	47.48

0
0ELEMENT (172)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.10346E+04	.35718E+03	.33616E+04	.93929E+03	.16944E+04	-.30259E+03	35.09

0
0ELEMENT (173)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.13795E+04	.64868E+02	.31673E+04	.10183E+04	.19342E+04	-.48988E+03	28.58

0
0ELEMENT (174)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.16644E+04	-.16781E+03	.30205E+04	.91942E+03	.20462E+04	-.54962E+03	22.55

0
0ELEMENT (175)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.18720E+04	-.33342E+03	.29153E+04	.67744E+03	.20635E+04	-.52488E+03	15.78

0
0ELEMENT (176)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.19559E+04	-.41485E+03	.28488E+04	.33779E+03	.20031E+04	-.46204E+03	7.95

0
0ELEMENT (177)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.18721E+04	-.39371E+03	.28173E+04	-.38414E+02	.18727E+04	-.39436E+03	-.97

0
0ELEMENT (178)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.15696E+04	-.24835E+03	.28176E+04	-.38360E+03	.16472E+04	-.32597E+03	-11.44

0
0ELEMENT (179)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.99072E+03	-.14843E+03	.27857E+04	-.71580E+03	.13359E+04	-.49361E+03	-25.75

0
0ELEMENT (180)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.73432E+02	-.96199E+01	.27455E+04	-.11646E+04	.11973E+04	-.11335E+04	-43.98

0
0ELEMENT (181)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.14636E+04	-.25509E+04	.18225E+04	-.27323E+04	.77867E+03	-.47931E+04	-39.37

0
0ELEMENT (182)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.92976E+03	-.71750E+04	.35355E+03	-.18327E+04	-.43167E+03	-.76731E+04	-15.20

0
0ELEMENT (183)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.13512E+03	-.88164E+02	.52640E+04	-.12341E+03	.18989E+03	-.14293E+03	-23.93

0
0ELEMENT (184)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.12023E+03	-.49357E+02	.49573E+04	-.27876E+03	.32681E+03	-.25594E+03	-36.54

0
0ELEMENT (185)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.14111E+03	.18578E+03	.47284E+04	-.12166E+03	.28714E+03	.39752E+02	-50.20

0
0ELEMENT (186)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.51169E+03	.20290E+03	.44776E+04	.20293E+03	.61228E+03	.10231E+03	26.37

0
0ELEMENT (187)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.11432E+04	.99646E+02	.42505E+04	.41382E+03	.12874E+04	-.44530E+02	19.21

0
0ELEMENT (188)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.18503E+04	.15984E+02	.40860E+04	.47270E+03	.19649E+04	-.98666E+02	13.63

0
0ELEMENT (189)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.25131E+04	-.36682E+02	.39790E+04	.43415E+03	.25850E+04	-.10858E+03	9.40

0
0ELEMENT (190)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.30457E+04	-.70901E+02	.39143E+04	.33332E+03	.30809E+04	-.10615E+03	6.04

0
0ELEMENT (191)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.33984E+04	-.83244E+02	.38813E+04	.20370E+03	.34103E+04	-.95120E+02	3.34

0
0ELEMENT (192)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.35636E+04	-.61555E+02	.38720E+04	.83399E+02	.35655E+04	-.63472E+02	1.32

0
0ELEMENT (193)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.35702E+04	-.28445E+02	.38697E+04	.15918E+02	.35703E+04	-.28516E+02	.25

```
0
0ELEMENT (  194)

 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN    .34927E+04   .13518E+03   .39077E+04   .56453E+02   .34936E+04   .13423E+03      .96
0
0ELEMENT (  195)

 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN    .33511E+04  -.75194E+02   .38178E+04   .20988E+03   .33639E+04  -.88002E+02     3.49
0
0ELEMENT (  196)

 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN    .31072E+04   .96976E+03   .41381E+04   .41535E+03   .31851E+04   .89189E+03    10.62
0
0ELEMENT (  197)

 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN    .11937E+04  -.10977E+05   .29117E+03  -.33937E+04   .20760E+04  -.11859E+05   -14.57
0
1O V E R A L L   T I M E   L O G

     NODAL POINT INPUT            =     .00
     ELEMENT STIFFNESS FORMATION  =     .00
     NODAL LOAD INPUT             =     .00
     TOTAL STIFFNESS FORMATION    =     .00
     STATIC ANALYSIS              =********
     EIGENVALUE EXTRACTION        =     .00
     FORCED RESPONSE ANALYSIS     =     .00
     RESPONSE SPECTRUM ANALYSIS   =     .00
     STEP-BY-STEP INTEGRATION     =     .00

+      TOTAL SOLUTION TIME          =********
```

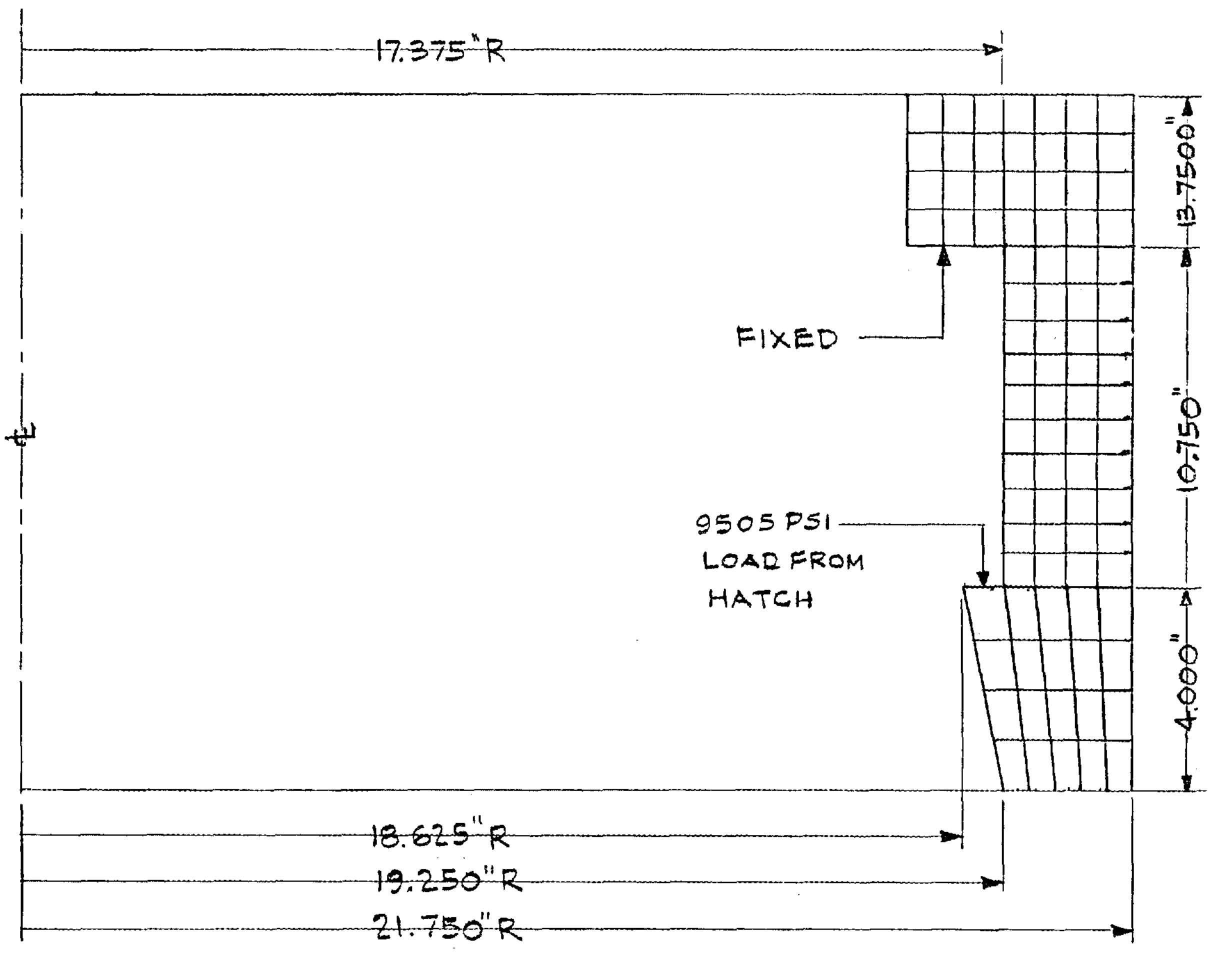
PLANT OAK RIDGE, TENNESSEE

JOB HIFI EXPERIMENT REF. DWG. NO.

SUBJECT QUICK OPENING HATCH - BAYONET RING PAGE 1 OF

COMPUTATION NO.

COMPUTED BY C. W. COLLINS CHECKED BY S E Outerbr DATE 9-13-85



FINITE ELEMENT MODEL

FIG. C-1

UCN-1070A
(1 9-63)

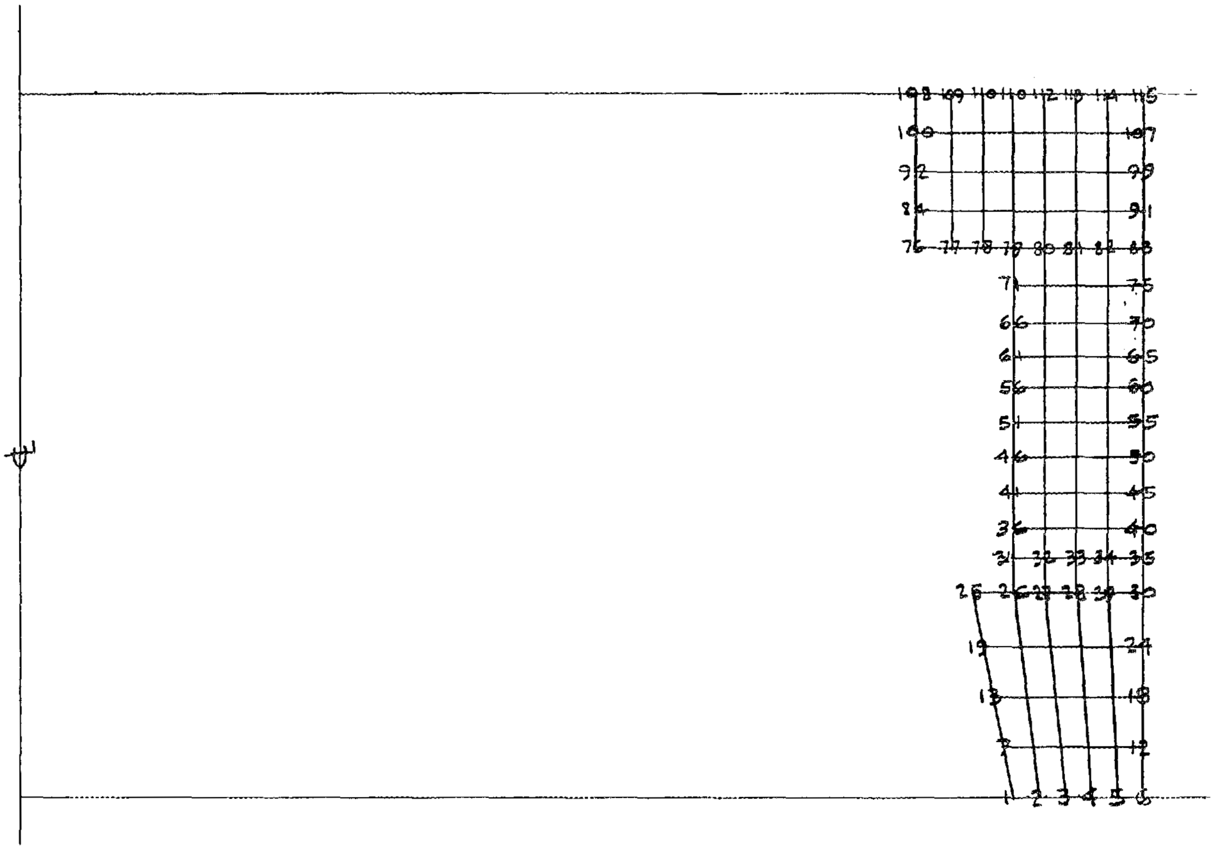
PLANT OAK RIDGE, TENNESSEE

JOB HIFI EXPERIMENT REF. DWG. NO.

SUBJECT QUICK OPENING HATCH - BAYONET RING PAGE 1 OF

COMPUTATION NO.

COMPUTED BY C. W. COLLINS CHECKED BY J. E. Ritenber DATE 9-13-85



NODAL POINT NUMBERS

FIG. C-2

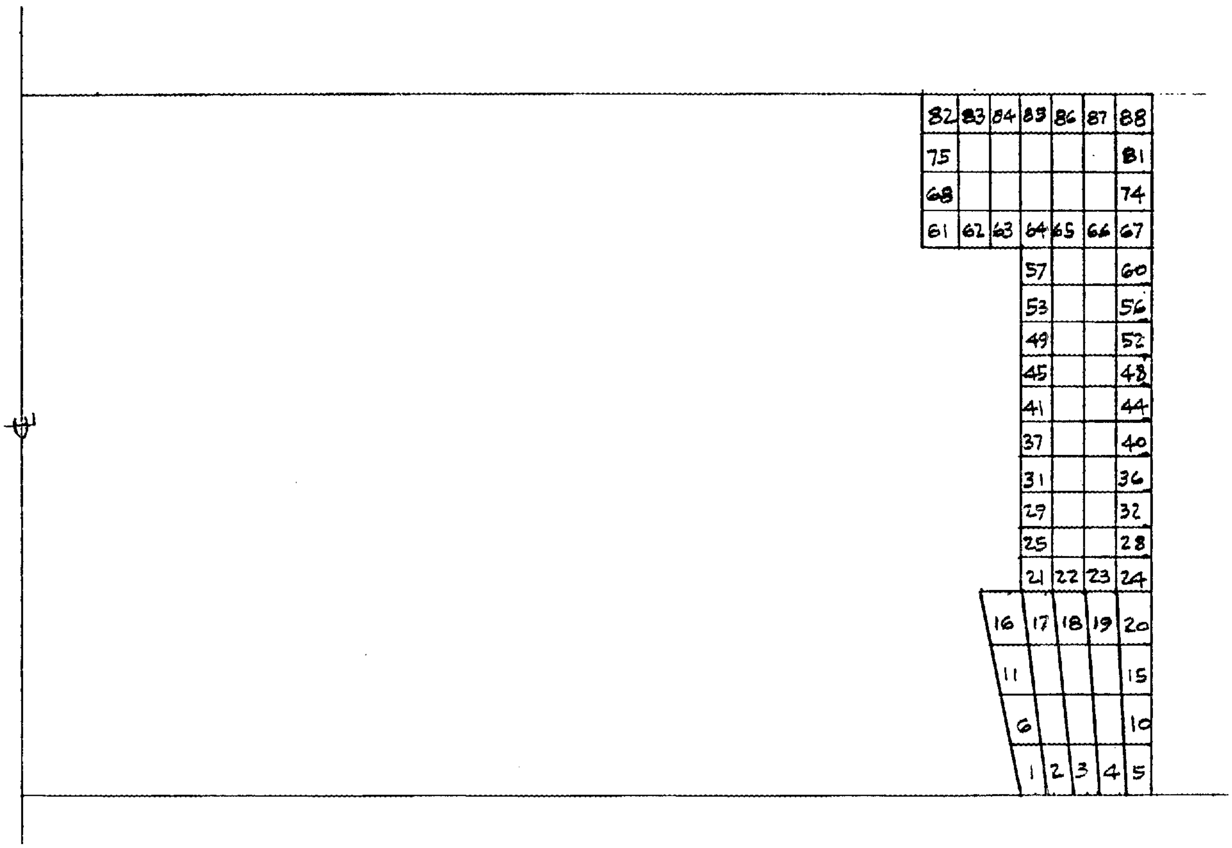
PLANT OAK RIDGE, TENNESSEE

JOB HIFI EXPERIMENT REF. DWG. NO.

SUBJECT QUICK OPENING HATCH - BAYONET RING PAGE 1 OF

COMPUTATION NO.

COMPUTED BY C.W. COLLINS CHECKED BY J.E. Rutenber DATE 9-13-85



ELEMENT NUMBERS

FIG. C-3

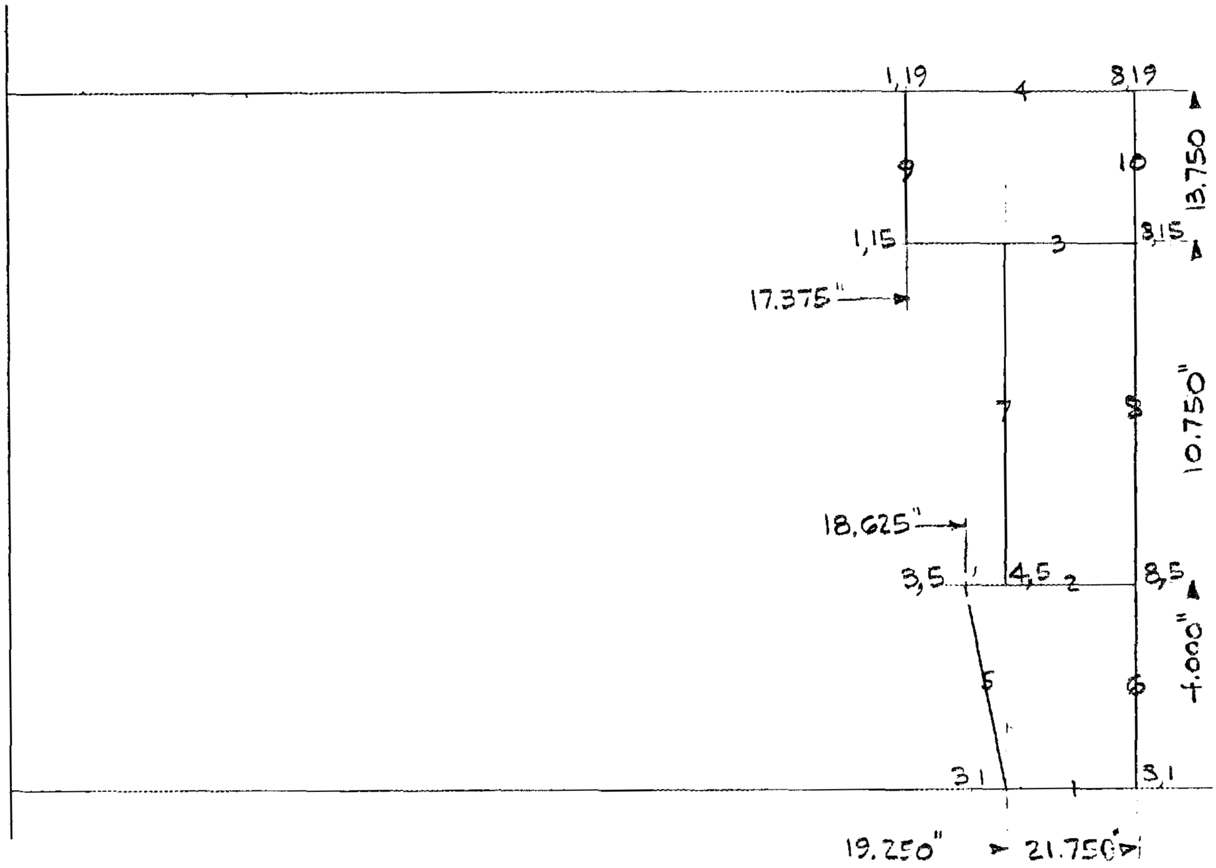
PLANT OAK RIDGE, TENNESSEE

JOB REF. DWG. NO.

SUBJECT PAGE OF

COMPUTATION NO.

COMPUTED BY CHECKED BY J E Rutenber DATE



ELEMENTS
5x4 = 20
4x10 = 40
7x4 = 28
88

NODES
6x5 = 30
5x9 = 45
8x5 = 40
115

UCN-1070A
(1 9-63)

1HFIR QUICK OPENING HATCH-BAYONET RING

C O N T R O L   I N F O R M A T I O N

NUMBER OF NODAL POINTS = 115
NUMBER OF ELEMENT TYPES = 1
NUMBER OF LOAD CASES = 1
NUMBER OF FREQUENCIES = 0
ANALYSIS CODE (NDYN) = 0
  EQ.0, STATIC
  EQ.1, MODAL EXTRACTION
  EQ.2, FORCED RESPONSE
  EQ.3, RESPONSE SPECTRUM
  EQ.4, DIRECT INTEGRATION
SOLUTION MODE (MODEX) = 0
  EQ.0, EXECUTION
  EQ.1, DATA CHECK
NUMBER OF SUBSPACE
ITERATION VECTORS (NAD) = 0
EQUATIONS PER BLOCK = 0
TAPE10 SAVE FLAG (N10SV) = 0

NODAL POINT INPUT DATA

ONODE	BOUNDARY CONDITION CODES						NODAL POINT COORDINATES				
NUMBER	X	Y	Z	XX	YY	ZZ	X	Y	Z		T
1	1	0	0	1	1	1	.000	19.250	.000	0	.000
2	1	0	0	1	1	1	.000	19.750	.000	0	.000
3	1	0	0	1	1	1	.000	20.250	.000	0	.000
4	1	0	0	1	1	1	.000	20.750	.000	0	.000
5	1	0	0	1	1	1	.000	21.250	.000	0	.000
6	1	0	0	1	1	1	.000	21.750	.000	0	.000
7	1	0	0	1	1	1	.000	19.090	1.000	0	.000
8	1	0	0	1	1	1	.000	19.630	1.000	0	.000
9	1	0	0	1	1	1	.000	20.160	1.000	0	.000
10	1	0	0	1	1	1	.000	20.690	1.000	0	.000
11	1	0	0	1	1	1	.000	21.220	1.000	0	.000
12	1	0	0	1	1	1	.000	21.750	1.000	0	.000
13	1	0	0	1	1	1	.000	18.940	2.000	0	.000
14	1	0	0	1	1	1	.000	19.500	2.000	0	.000
15	1	0	0	1	1	1	.000	20.060	2.000	0	.000
16	1	0	0	1	1	1	.000	20.630	2.000	0	.000
17	1	0	0	1	1	1	.000	21.190	2.000	0	.000
18	1	0	0	1	1	1	.000	21.750	2.000	0	.000
19	1	0	0	1	1	1	.000	18.780	3.000	0	.000
20	1	0	0	1	1	1	.000	19.380	3.000	0	.000

21	1	0	0	1	1	1	.000	19.970	3.000	0	.000
22	1	0	0	1	1	1	.000	20.560	3.000	0	.000
23	1	0	0	1	1	1	.000	21.160	3.000	0	.000
24	1	0	0	1	1	1	.000	21.750	3.000	0	.000
25	1	0	0	1	1	1	.000	18.630	4.000	0	.000
26	1	0	0	1	1	1	.000	19.250	4.000	0	.000
27	1	0	0	1	1	1	.000	19.880	4.000	0	.000
28	1	0	0	1	1	1	.000	20.500	4.000	0	.000
29	1	0	0	1	1	1	.000	21.130	4.000	0	.000
30	1	0	0	1	1	1	.000	21.750	4.000	0	.000
31	1	0	0	1	1	1	.000	19.250	4.675	0	.000
32	1	0	0	1	1	1	.000	19.880	4.675	0	.000
33	1	0	0	1	1	1	.000	20.500	4.675	0	.000
34	1	0	0	1	1	1	.000	21.130	4.675	0	.000
35	1	0	0	1	1	1	.000	21.750	4.675	0	.000
36	1	0	0	1	1	1	.000	19.250	5.350	0	.000
37	1	0	0	1	1	1	.000	19.880	5.350	0	.000
38	1	0	0	1	1	1	.000	20.500	5.350	0	.000
39	1	0	0	1	1	1	.000	21.130	5.350	0	.000
40	1	0	0	1	1	1	.000	21.750	5.350	0	.000
41	1	0	0	1	1	1	.000	19.250	6.025	0	.000
42	1	0	0	1	1	1	.000	19.880	6.025	0	.000
43	1	0	0	1	1	1	.000	20.500	6.025	0	.000
44	1	0	0	1	1	1	.000	21.130	6.025	0	.000
45	1	0	0	1	1	1	.000	21.750	6.025	0	.000
46	1	0	0	1	1	1	.000	19.250	6.700	0	.000
47	1	0	0	1	1	1	.000	19.880	6.700	0	.000
48	1	0	0	1	1	1	.000	20.500	6.700	0	.000
49	1	0	0	1	1	1	.000	21.130	6.700	0	.000
50	1	0	0	1	1	1	.000	21.750	6.700	0	.000
51	1	0	0	1	1	1	.000	19.250	7.375	0	.000
52	1	0	0	1	1	1	.000	19.880	7.375	0	.000
53	1	0	0	1	1	1	.000	20.500	7.375	0	.000
54	1	0	0	1	1	1	.000	21.130	7.375	0	.000
55	1	0	0	1	1	1	.000	21.750	7.375	0	.000
56	1	0	0	1	1	1	.000	19.250	8.050	0	.000
57	1	0	0	1	1	1	.000	19.880	8.050	0	.000
58	1	0	0	1	1	1	.000	20.500	8.050	0	.000
59	1	0	0	1	1	1	.000	21.130	8.050	0	.000
60	1	0	0	1	1	1	.000	21.750	8.050	0	.000
61	1	0	0	1	1	1	.000	19.250	8.725	0	.000
62	1	0	0	1	1	1	.000	19.880	8.725	0	.000
63	1	0	0	1	1	1	.000	20.500	8.725	0	.000
64	1	0	0	1	1	1	.000	21.130	8.725	0	.000
65	1	0	0	1	1	1	.000	21.750	8.725	0	.000
66	1	0	0	1	1	1	.000	19.250	9.400	0	.000
67	1	0	0	1	1	1	.000	19.880	9.400	0	.000
68	1	0	0	1	1	1	.000	20.500	9.400	0	.000
69	1	0	0	1	1	1	.000	21.130	9.400	0	.000
70	1	0	0	1	1	1	.000	21.750	9.400	0	.000
71	1	0	0	1	1	1	.000	19.250	10.080	0	.000
72	1	0	0	1	1	1	.000	19.880	10.080	0	.000
73	1	0	0	1	1	1	.000	20.500	10.080	0	.000
74	1	0	0	1	1	1	.000	21.130	10.080	0	.000
75	1	0	0	1	1	1	.000	21.750	10.080	0	.000
76	1	0	0	1	1	1	.000	17.380	10.750	0	.000
77	1	0	1	1	1	1	.000	18.000	10.750	0	.000
78	1	0	0	1	1	1	.000	18.630	10.750	0	.000
79	1	0	0	1	1	1	.000	19.250	10.750	0	.000
80	1	0	0	1	1	1	.000	19.880	10.750	0	.000
81	1	0	0	1	1	1	.000	20.500	10.750	0	.000
82	1	0	0	1	1	1	.000	21.130	10.750	0	.000
83	1	0	0	1	1	1	.000	21.750	10.750	0	.000
84	1	0	0	1	1	1	.000	17.380	11.500	0	.000
85	1	0	0	1	1	1	.000	18.000	11.500	0	.000
86	1	0	0	1	1	1	.000	18.630	11.500	0	.000

87	1	0	0	1	1	1	.000	19.250	11.500	0	.000
88	1	0	0	1	1	1	.000	19.880	11.500	0	.000
89	1	0	0	1	1	1	.000	20.500	11.500	0	.000
90	1	0	0	1	1	1	.000	21.130	11.500	0	.000
91	1	0	0	1	1	1	.000	21.750	11.500	0	.000
92	1	0	0	1	1	1	.000	17.380	12.250	0	.000
93	1	0	0	1	1	1	.000	18.000	12.250	0	.000
94	1	0	0	1	1	1	.000	18.630	12.250	0	.000
95	1	0	0	1	1	1	.000	19.250	12.250	0	.000
96	1	0	0	1	1	1	.000	19.880	12.250	0	.000
97	1	0	0	1	1	1	.000	20.500	12.250	0	.000
98	1	0	0	1	1	1	.000	21.130	12.250	0	.000
99	1	0	0	1	1	1	.000	21.750	12.250	0	.000
100	1	0	0	1	1	1	.000	17.380	13.000	0	.000
101	1	0	0	1	1	1	.000	18.000	13.000	0	.000
102	1	0	0	1	1	1	.000	18.630	13.000	0	.000
103	1	0	0	1	1	1	.000	19.250	13.000	0	.000
104	1	0	0	1	1	1	.000	19.880	13.000	0	.000
105	1	0	0	1	1	1	.000	20.500	13.000	0	.000
106	1	0	0	1	1	1	.000	21.130	13.000	0	.000
107	1	0	0	1	1	1	.000	21.750	13.000	0	.000
108	1	0	0	1	1	1	.000	17.380	13.750	0	.000
109	1	0	0	1	1	1	.000	18.000	13.750	0	.000
110	1	0	0	1	1	1	.000	18.630	13.750	0	.000
111	1	0	0	1	1	1	.000	19.250	13.750	0	.000
112	1	0	0	1	1	1	.000	19.880	13.750	0	.000
113	1	0	0	1	1	1	.000	20.500	13.750	0	.000
114	1	0	0	1	1	1	.000	21.130	13.750	0	.000
115	1	0	0	1	1	1	.000	21.750	13.750	0	.000

1GENERATED NODAL DATA

0NODE	BOUNDARY CONDITION CODES						NODAL POINT COORDINATES			
NUMBER	X	Y	Z	XX	YY	ZZ	X	Y	Z	T
1	1	0	0	1	1	1	.000	19.250	.000	.000
2	1	0	0	1	1	1	.000	19.750	.000	.000
3	1	0	0	1	1	1	.000	20.250	.000	.000
4	1	0	0	1	1	1	.000	20.750	.000	.000
5	1	0	0	1	1	1	.000	21.250	.000	.000
6	1	0	0	1	1	1	.000	21.750	.000	.000
7	1	0	0	1	1	1	.000	19.090	1.000	.000
8	1	0	0	1	1	1	.000	19.630	1.000	.000
9	1	0	0	1	1	1	.000	20.160	1.000	.000
10	1	0	0	1	1	1	.000	20.690	1.000	.000
11	1	0	0	1	1	1	.000	21.220	1.000	.000
12	1	0	0	1	1	1	.000	21.750	1.000	.000
13	1	0	0	1	1	1	.000	18.940	2.000	.000
14	1	0	0	1	1	1	.000	19.500	2.000	.000
15	1	0	0	1	1	1	.000	20.060	2.000	.000
16	1	0	0	1	1	1	.000	20.630	2.000	.000
17	1	0	0	1	1	1	.000	21.190	2.000	.000
18	1	0	0	1	1	1	.000	21.750	2.000	.000
19	1	0	0	1	1	1	.000	18.780	3.000	.000
20	1	0	0	1	1	1	.000	19.380	3.000	.000
21	1	0	0	1	1	1	.000	19.970	3.000	.000
22	1	0	0	1	1	1	.000	20.560	3.000	.000
23	1	0	0	1	1	1	.000	21.160	3.000	.000
24	1	0	0	1	1	1	.000	21.750	3.000	.000
25	1	0	0	1	1	1	.000	18.630	4.000	.000
26	1	0	0	1	1	1	.000	19.250	4.000	.000
27	1	0	0	1	1	1	.000	19.880	4.000	.000
28	1	0	0	1	1	1	.000	20.500	4.000	.000
29	1	0	0	1	1	1	.000	21.130	4.000	.000
30	1	0	0	1	1	1	.000	21.750	4.000	.000
31	1	0	0	1	1	1	.000	19.250	4.675	.000
32	1	0	0	1	1	1	.000	19.880	4.675	.000

33	1	0	0	1	1	1	.000	20.500	4.675	.000
34	1	0	0	1	1	1	.000	21.130	4.675	.000
35	1	0	0	1	1	1	.000	21.750	4.675	.000
36	1	0	0	1	1	1	.000	19.250	5.350	.000
37	1	0	0	1	1	1	.000	19.880	5.350	.000
38	1	0	0	1	1	1	.000	20.500	5.350	.000
39	1	0	0	1	1	1	.000	21.130	5.350	.000
40	1	0	0	1	1	1	.000	21.750	5.350	.000
41	1	0	0	1	1	1	.000	19.250	6.025	.000
42	1	0	0	1	1	1	.000	19.880	6.025	.000
43	1	0	0	1	1	1	.000	20.500	6.025	.000
44	1	0	0	1	1	1	.000	21.130	6.025	.000
45	1	0	0	1	1	1	.000	21.750	6.025	.000
46	1	0	0	1	1	1	.000	19.250	6.700	.000
47	1	0	0	1	1	1	.000	19.880	6.700	.000
48	1	0	0	1	1	1	.000	20.500	6.700	.000
49	1	0	0	1	1	1	.000	21.130	6.700	.000
50	1	0	0	1	1	1	.000	21.750	6.700	.000
51	1	0	0	1	1	1	.000	19.250	7.375	.000
52	1	0	0	1	1	1	.000	19.880	7.375	.000
53	1	0	0	1	1	1	.000	20.500	7.375	.000
54	1	0	0	1	1	1	.000	21.130	7.375	.000
55	1	0	0	1	1	1	.000	21.750	7.375	.000
56	1	0	0	1	1	1	.000	19.250	8.050	.000
57	1	0	0	1	1	1	.000	19.880	8.050	.000
58	1	0	0	1	1	1	.000	20.500	8.050	.000
59	1	0	0	1	1	1	.000	21.130	8.050	.000
60	1	0	0	1	1	1	.000	21.750	8.050	.000
61	1	0	0	1	1	1	.000	19.250	8.725	.000
62	1	0	0	1	1	1	.000	19.880	8.725	.000
63	1	0	0	1	1	1	.000	20.500	8.725	.000
64	1	0	0	1	1	1	.000	21.130	8.725	.000
65	1	0	0	1	1	1	.000	21.750	8.725	.000
66	1	0	0	1	1	1	.000	19.250	9.400	.000
67	1	0	0	1	1	1	.000	19.880	9.400	.000
68	1	0	0	1	1	1	.000	20.500	9.400	.000
69	1	0	0	1	1	1	.000	21.130	9.400	.000
70	1	0	0	1	1	1	.000	21.750	9.400	.000
71	1	0	0	1	1	1	.000	19.250	10.080	.000
72	1	0	0	1	1	1	.000	19.880	10.080	.000
73	1	0	0	1	1	1	.000	20.500	10.080	.000
74	1	0	0	1	1	1	.000	21.130	10.080	.000
75	1	0	0	1	1	1	.000	21.750	10.080	.000
76	1	0	0	1	1	1	.000	17.380	10.750	.000
77	1	0	1	1	1	1	.000	18.000	10.750	.000
78	1	0	0	1	1	1	.000	18.630	10.750	.000
79	1	0	0	1	1	1	.000	19.250	10.750	.000
80	1	0	0	1	1	1	.000	19.880	10.750	.000
81	1	0	0	1	1	1	.000	20.500	10.750	.000
82	1	0	0	1	1	1	.000	21.130	10.750	.000
83	1	0	0	1	1	1	.000	21.750	10.750	.000
84	1	0	0	1	1	1	.000	17.380	11.500	.000
85	1	0	0	1	1	1	.000	18.000	11.500	.000
86	1	0	0	1	1	1	.000	18.630	11.500	.000
87	1	0	0	1	1	1	.000	19.250	11.500	.000
88	1	0	0	1	1	1	.000	19.880	11.500	.000
89	1	0	0	1	1	1	.000	20.500	11.500	.000
90	1	0	0	1	1	1	.000	21.130	11.500	.000
91	1	0	0	1	1	1	.000	21.750	11.500	.000
92	1	0	0	1	1	1	.000	17.380	12.250	.000
93	1	0	0	1	1	1	.000	18.000	12.250	.000
94	1	0	0	1	1	1	.000	18.630	12.250	.000
95	1	0	0	1	1	1	.000	19.250	12.250	.000
96	1	0	0	1	1	1	.000	19.880	12.250	.000
97	1	0	0	1	1	1	.000	20.500	12.250	.000
98	1	0	0	1	1	1	.000	21.130	12.250	.000

99	1	0	0	1	1	1	.000	21.750	12.250	.000
100	1	0	0	1	1	1	.000	17.380	13.000	.000
101	1	0	0	1	1	1	.000	18.000	13.000	.000
102	1	0	0	1	1	1	.000	18.630	13.000	.000
103	1	0	0	1	1	1	.000	19.250	13.000	.000
104	1	0	0	1	1	1	.000	19.880	13.000	.000
105	1	0	0	1	1	1	.000	20.500	13.000	.000
106	1	0	0	1	1	1	.000	21.130	13.000	.000
107	1	0	0	1	1	1	.000	21.750	13.000	.000
108	1	0	0	1	1	1	.000	17.380	13.750	.000
109	1	0	0	1	1	1	.000	18.000	13.750	.000
110	1	0	0	1	1	1	.000	18.630	13.750	.000
111	1	0	0	1	1	1	.000	19.250	13.750	.000
112	1	0	0	1	1	1	.000	19.880	13.750	.000
113	1	0	0	1	1	1	.000	20.500	13.750	.000
114	1	0	0	1	1	1	.000	21.130	13.750	.000
115	1	0	0	1	1	1	.000	21.750	13.750	.000

1EQUATION NUMBERS

N	X	Y	Z	XX	YY	ZZ
1	0	1	2	0	0	0
2	0	3	4	0	0	0
3	0	5	6	0	0	0
4	0	7	8	0	0	0
5	0	9	10	0	0	0
6	0	11	12	0	0	0
7	0	13	14	0	0	0
8	0	15	16	0	0	0
9	0	17	18	0	0	0
10	0	19	20	0	0	0
11	0	21	22	0	0	0
12	0	23	24	0	0	0
13	0	25	26	0	0	0
14	0	27	28	0	0	0
15	0	29	30	0	0	0
16	0	31	32	0	0	0
17	0	33	34	0	0	0
18	0	35	36	0	0	0
19	0	37	38	0	0	0
20	0	39	40	0	0	0
21	0	41	42	0	0	0
22	0	43	44	0	0	0
23	0	45	46	0	0	0
24	0	47	48	0	0	0
25	0	49	50	0	0	0
26	0	51	52	0	0	0
27	0	53	54	0	0	0
28	0	55	56	0	0	0
29	0	57	58	0	0	0
30	0	59	60	0	0	0
31	0	61	62	0	0	0
32	0	63	64	0	0	0
33	0	65	66	0	0	0
34	0	67	68	0	0	0
35	0	69	70	0	0	0
36	0	71	72	0	0	0
37	0	73	74	0	0	0
38	0	75	76	0	0	0
39	0	77	78	0	0	0
40	0	79	80	0	0	0
41	0	81	82	0	0	0
42	0	83	84	0	0	0
43	0	85	86	0	0	0
44	0	87	88	0	0	0
45	0	89	90	0	0	0

46	0	91	92	0	0	0
47	0	93	94	0	0	0
48	0	95	96	0	0	0
49	0	97	98	0	0	0
50	0	99	100	0	0	0
51	0	101	102	0	0	0
52	0	103	104	0	0	0
53	0	105	106	0	0	0
54	0	107	108	0	0	0
55	0	109	110	0	0	0
56	0	111	112	0	0	0
57	0	113	114	0	0	0
58	0	115	116	0	0	0
59	0	117	118	0	0	0
60	0	119	120	0	0	0
61	0	121	122	0	0	0
62	0	123	124	0	0	0
63	0	125	126	0	0	0
64	0	127	128	0	0	0
65	0	129	130	0	0	0
66	0	131	132	0	0	0
67	0	133	134	0	0	0
68	0	135	136	0	0	0
69	0	137	138	0	0	0
70	0	139	140	0	0	0
71	0	141	142	0	0	0
72	0	143	144	0	0	0
73	0	145	146	0	0	0
74	0	147	148	0	0	0
75	0	149	150	0	0	0
76	0	151	152	0	0	0
77	0	153	0	0	0	0
78	0	154	155	0	0	0
79	0	156	157	0	0	0
80	0	158	159	0	0	0
81	0	160	161	0	0	0
82	0	162	163	0	0	0
83	0	164	165	0	0	0
84	0	166	167	0	0	0
85	0	168	169	0	0	0
86	0	170	171	0	0	0
87	0	172	173	0	0	0
88	0	174	175	0	0	0
89	0	176	177	0	0	0
90	0	178	179	0	0	0
91	0	180	181	0	0	0
92	0	182	183	0	0	0
93	0	184	185	0	0	0
94	0	186	187	0	0	0
95	0	188	189	0	0	0
96	0	190	191	0	0	0
97	0	192	193	0	0	0
98	0	194	195	0	0	0
99	0	196	197	0	0	0
100	0	198	199	0	0	0
101	0	200	201	0	0	0
102	0	202	203	0	0	0
103	0	204	205	0	0	0
104	0	206	207	0	0	0
105	0	208	209	0	0	0
106	0	210	211	0	0	0
107	0	212	213	0	0	0
108	0	214	215	0	0	0
109	0	216	217	0	0	0
110	0	218	219	0	0	0
111	0	220	221	0	0	0

```
 112    0  222  223    0    0    0
 113    0  224  225    0    0    0
 114    0  226  227    0    0    0
 115    0  228  229    0    0    0
   4   88    1    1    0    0    0    0    0    0    0    0    0    0
1AXISYMMETRIC ANALYSIS


 NUMBER OF ELEMENTS   =    88
 NUMBER OF MATERIALS  =     1
 MAXIMUM TEMPERATURES
 PER MATERIAL         =     1
 ANALYSIS CODE        =     0
 CODE FOR INCLUSION
 OF BENDING MODES     =     0
   EQ.0, INCLUDE
   GT.0, SUPPRESS



 MATERIAL I.D. NUMBER   =    1
 NUMBER OF TEMPERATURES =    1
 WEIGHT DENSITY         =    .0000E+00
 MASS   DENSITY         =    .0000E+00
 BETA ANGLE             =    .000
```

TEMPERATURE	E(N)	E(S)	E(T)	NU(NS)	NU(NT)	NU(ST)	G(NS)	ALPHA(N)	ALPHA(S)	ALPHA(T)
.00	.2830E+08	.2830E+08	.2830E+08	.3000	.3000	.3000	.1200E+08	.9300E-05	.9300E-05	.9300E-05

ELEMENT LOAD MULTIPLIERS

LOAD CASE	TEMPERATURE	PRESSURE	X-GRAVITY	Y-GRAVITY	Z-GRAVITY
A	.000	1.000	.000	.000	.000
B	.000	.000	.000	.000	.000
C	.000	.000	.000	.000	.000
D	.000	.000	.000	.000	.000

1ELEMENT

NUMBER	I	J	K	L	MATL TYPE	REFERENCE TEMPERATURE	I-J FACE PRESSURE	STRESS OPTION	KG	THICKNESS
1	1	2	8	7	1	.000	.000E+00	4	1	.0000
2	2	3	9	8	1	.000	.000E+00	4	1	.0000
3	3	4	10	9	1	.000	.000E+00	4	1	.0000
4	4	5	11	10	1	.000	.000E+00	4	1	.0000
5	5	6	12	11	1	.000	.000E+00	4	1	.0000
6	7	8	14	13	1	.000	.000E+00	4	1	.0000
7	8	9	15	14	1	.000	.000E+00	4	1	.0000
8	9	10	16	15	1	.000	.000E+00	4	1	.0000
9	10	11	17	16	1	.000	.000E+00	4	1	.0000
10	11	12	18	17	1	.000	.000E+00	4	1	.0000
11	13	14	20	19	1	.000	.000E+00	4	1	.0000
12	14	15	21	20	1	.000	.000E+00	4	1	.0000
13	15	16	22	21	1	.000	.000E+00	4	1	.0000
14	16	17	23	22	1	.000	.000E+00	4	1	.0000
15	17	18	24	23	1	.000	.000E+00	4	1	.0000
16	19	20	26	25	1	.000	-.951E+04	4	1	.0000
17	20	21	27	26	1	.000	.000E+00	4	1	.0000
18	21	22	28	27	1	.000	.000E+00	4	1	.0000
19	22	23	29	28	1	.000	.000E+00	4	1	.0000
20	23	24	30	29	1	.000	.000E+00	4	1	.0000

21	26	27	32	31	1	.000	.000E+00	4	1	.0000
22	27	28	33	32	1	.000	.000E+00	4	1	.0000
23	28	29	34	33	1	.000	.000E+00	4	1	.0000
24	29	30	35	34	1	.000	.000E+00	4	1	.0000
25	31	32	37	36	1	.000	.000E+00	4	1	.0000
26	32	33	38	37	1	.000	.000E+00	4	1	.0000
27	33	34	39	38	1	.000	.000E+00	4	1	.0000
28	34	35	40	39	1	.000	.000E+00	4	1	.0000
29	36	37	42	41	1	.000	.000E+00	4	1	.0000
30	37	38	43	42	1	.000	.000E+00	4	1	.0000
31	38	39	44	43	1	.000	.000E+00	4	1	.0000
32	39	40	45	44	1	.000	.000E+00	4	1	.0000
33	41	42	47	46	1	.000	.000E+00	4	1	.0000
34	42	43	48	47	1	.000	.000E+00	4	1	.0000
35	43	44	49	48	1	.000	.000E+00	4	1	.0000
36	44	45	50	49	1	.000	.000E+00	4	1	.0000
37	46	47	52	51	1	.000	.000E+00	4	1	.0000
38	47	48	53	52	1	.000	.000E+00	4	1	.0000
39	48	49	54	53	1	.000	.000E+00	4	1	.0000
40	49	50	55	54	1	.000	.000E+00	4	1	.0000
41	51	52	57	56	1	.000	.000E+00	4	1	.0000
42	52	53	58	57	1	.000	.000E+00	4	1	.0000
43	53	54	59	58	1	.000	.000E+00	4	1	.0000
44	54	55	60	59	1	.000	.000E+00	4	1	.0000
45	56	57	62	61	1	.000	.000E+00	4	1	.0000
46	57	58	63	62	1	.000	.000E+00	4	1	.0000
47	58	59	64	63	1	.000	.000E+00	4	1	.0000
48	59	60	65	64	1	.000	.000E+00	4	1	.0000
49	61	62	67	66	1	.000	.000E+00	4	1	.0000
50	62	63	68	67	1	.000	.000E+00	4	1	.0000
51	63	64	69	68	1	.000	.000E+00	4	1	.0000
52	64	65	70	69	1	.000	.000E+00	4	1	.0000
53	66	67	72	71	1	.000	.000E+00	4	1	.0000
54	67	68	73	72	1	.000	.000E+00	4	1	.0000
55	68	69	74	73	1	.000	.000E+00	4	1	.0000
56	69	70	75	74	1	.000	.000E+00	4	1	.0000
57	71	72	80	79	1	.000	.000E+00	4	1	.0000
58	72	73	81	80	1	.000	.000E+00	4	1	.0000
59	73	74	82	81	1	.000	.000E+00	4	1	.0000
60	74	75	83	82	1	.000	.000E+00	4	1	.0000
61	76	77	85	84	1	.000	.000E+00	4	1	.0000
62	77	78	86	85	1	.000	.000E+00	4	1	.0000
63	78	79	87	86	1	.000	.000E+00	4	1	.0000
64	79	80	88	87	1	.000	.000E+00	4	1	.0000
65	80	81	89	88	1	.000	.000E+00	4	1	.0000
66	81	82	90	89	1	.000	.000E+00	4	1	.0000
67	82	83	91	90	1	.000	.000E+00	4	1	.0000
68	84	85	93	92	1	.000	.000E+00	4	1	.0000
69	85	86	94	93	1	.000	.000E+00	4	1	.0000
70	86	87	95	94	1	.000	.000E+00	4	1	.0000
71	87	88	96	95	1	.000	.000E+00	4	1	.0000
72	88	89	97	96	1	.000	.000E+00	4	1	.0000
73	89	90	98	97	1	.000	.000E+00	4	1	.0000
74	90	91	99	98	1	.000	.000E+00	4	1	.0000
75	92	93	101	100	1	.000	.000E+00	4	1	.0000
76	93	94	102	101	1	.000	.000E+00	4	1	.0000
77	94	95	103	102	1	.000	.000E+00	4	1	.0000
78	95	96	104	103	1	.000	.000E+00	4	1	.0000
79	96	97	105	104	1	.000	.000E+00	4	1	.0000
80	97	98	106	105	1	.000	.000E+00	4	1	.0000
81	98	99	107	106	1	.000	.000E+00	4	1	.0000
82	100	101	109	108	1	.000	.000E+00	4	1	.0000
83	101	102	110	109	1	.000	.000E+00	4	1	.0000
84	102	103	111	110	1	.000	.000E+00	4	1	.0000
85	103	104	112	111	1	.000	.000E+00	4	1	.0000
86	104	105	113	112	1	.000	.000E+00	4	1	.0000

87	105	106	114	113	1	.000	.000E+00	4	1	.0000
88	106	107	115	114	1	.000	.000E+00	4	1	.0000

1E Q U A T I O N   P A R A M E T E R S

TOTAL NUMBER OF EQUATIONS = 229
BANDWIDTH = 20
NUMBER OF EQUATIONS IN A BLOCK = 181
NUMBER OF BLOCKS = 2

1N O D A L   L O A D S   (S T A T I C)   O R   M A S S E S   (D Y N A M I C)

NODE NUMBER	LOAD CASE	X-AXIS FORCE	Y-AXIS FORCE	Z-AXIS FORCE	X-AXIS MOMENT	Y-AXIS MOMENT	Z-AXIS MOMENT

STRUCTURE LOAD CASE	ELEMENT LOAD MULTIPLIERS A	B	C	D
1	1.000	.000	.000	.000

1N O D E   D I S P L A C E M E N T S / R O T A T I O N S

	NODE NUMBER	LOAD CASE	X-TRANSLATION	Y-TRANSLATION	Z-TRANSLATION	X-ROTATION	Y-ROTATION	Z-ROTATION
0	115	1	.00000E+00	.27699E-02	-.47561E-02	.00000E+00	.00000E+00	.00000E+00
0	114	1	.00000E+00	.27976E-02	-.40774E-02	.00000E+00	.00000E+00	.00000E+00
0	113	1	.00000E+00	.28418E-02	-.33876E-02	.00000E+00	.00000E+00	.00000E+00
0	112	1	.00000E+00	.29048E-02	-.26927E-02	.00000E+00	.00000E+00	.00000E+00
0	111	1	.00000E+00	.29798E-02	-.19538E-02	.00000E+00	.00000E+00	.00000E+00
0	110	1	.00000E+00	.30457E-02	-.11935E-02	.00000E+00	.00000E+00	.00000E+00
0	109	1	.00000E+00	.30936E-02	-.40600E-03	.00000E+00	.00000E+00	.00000E+00
0	108	1	.00000E+00	.31282E-02	.36717E-03	.00000E+00	.00000E+00	.00000E+00
0	107	1	.00000E+00	.19456E-02	-.47247E-02	.00000E+00	.00000E+00	.00000E+00
0	106	1	.00000E+00	.19626E-02	-.40523E-02	.00000E+00	.00000E+00	.00000E+00
0	105	1	.00000E+00	.19951E-02	-.33770E-02	.00000E+00	.00000E+00	.00000E+00
0	104	1	.00000E+00	.20421E-02	-.26893E-02	.00000E+00	.00000E+00	.00000E+00
0	103	1	.00000E+00	.20937E-02	-.19491E-02	.00000E+00	.00000E+00	.00000E+00
0	102	1	.00000E+00	.21432E-02	-.11777E-02	.00000E+00	.00000E+00	.00000E+00
0	101	1	.00000E+00	.21797E-02	-.36943E-03	.00000E+00	.00000E+00	.00000E+00
0	100	1	.00000E+00	.22015E-02	.40876E-03	.00000E+00	.00000E+00	.00000E+00
0	99	1	.00000E+00	.11189E-02	-.46739E-02	.00000E+00	.00000E+00	.00000E+00
0	98	1	.00000E+00	.11158E-02	-.40233E-02	.00000E+00	.00000E+00	.00000E+00
0	97	1	.00000E+00	.11335E-02	-.33809E-02	.00000E+00	.00000E+00	.00000E+00
0	96	1	.00000E+00	.11755E-02	-.27170E-02	.00000E+00	.00000E+00	.00000E+00

0	95	1	.00000E+00	.12322E-02	-.19679E-02	.00000E+00	.00000E+00	.00000E+00
0	94	1	.00000E+00	.12643E-02	-.11733E-02	.00000E+00	.00000E+00	.00000E+00
0	93	1	.00000E+00	.12844E-02	-.33373E-03	.00000E+00	.00000E+00	.00000E+00
0	92	1	.00000E+00	.12805E-02	.48784E-03	.00000E+00	.00000E+00	.00000E+00
0	91	1	.00000E+00	.32723E-03	-.45827E-02	.00000E+00	.00000E+00	.00000E+00
0	90	1	.00000E+00	.30139E-03	-.39826E-02	.00000E+00	.00000E+00	.00000E+00
0	89	1	.00000E+00	.29492E-03	-.33968E-02	.00000E+00	.00000E+00	.00000E+00
0	88	1	.00000E+00	.31371E-03	-.27864E-02	.00000E+00	.00000E+00	.00000E+00
0	87	1	.00000E+00	.36179E-03	-.20551E-02	.00000E+00	.00000E+00	.00000E+00
0	86	1	.00000E+00	.41397E-03	-.11660E-02	.00000E+00	.00000E+00	.00000E+00
0	85	1	.00000E+00	.34047E-03	-.24663E-03	.00000E+00	.00000E+00	.00000E+00
0	84	1	.00000E+00	.26309E-03	.60672E-03	.00000E+00	.00000E+00	.00000E+00
0	83	1	.00000E+00	-.37741E-03	-.44486E-02	.00000E+00	.00000E+00	.00000E+00
0	82	1	.00000E+00	-.42255E-03	-.39307E-02	.00000E+00	.00000E+00	.00000E+00
0	81	1	.00000E+00	-.44918E-03	-.34118E-02	.00000E+00	.00000E+00	.00000E+00
0	80	1	.00000E+00	-.47271E-03	-.28835E-02	.00000E+00	.00000E+00	.00000E+00
0	79	1	.00000E+00	-.50378E-03	-.22054E-02	.00000E+00	.00000E+00	.00000E+00
0	78	1	.00000E+00	-.63582E-03	-.11611E-02	.00000E+00	.00000E+00	.00000E+00
0	77	1	.00000E+00	-.66684E-03	.00000E+00	.00000E+00	.00000E+00	.00000E+00
0	76	1	.00000E+00	-.64411E-03	.54762E-03	.00000E+00	.00000E+00	.00000E+00
0	75	1	.00000E+00	-.89852E-03	-.43073E-02	.00000E+00	.00000E+00	.00000E+00
0	74	1	.00000E+00	-.95236E-03	-.38786E-02	.00000E+00	.00000E+00	.00000E+00
0	73	1	.00000E+00	-.98151E-03	-.34404E-02	.00000E+00	.00000E+00	.00000E+00
0	72	1	.00000E+00	-.98786E-03	-.29762E-02	.00000E+00	.00000E+00	.00000E+00
0	71	1	.00000E+00	-.90296E-03	-.25530E-02	.00000E+00	.00000E+00	.00000E+00
0	70	1	.00000E+00	-.13086E-02	-.41612E-02	.00000E+00	.00000E+00	.00000E+00
0	69	1	.00000E+00	-.13628E-02	-.38335E-02	.00000E+00	.00000E+00	.00000E+00
0	68	1	.00000E+00	-.13837E-02	-.34845E-02	.00000E+00	.00000E+00	.00000E+00
0	67	1	.00000E+00	-.13574E-02	-.31475E-02	.00000E+00	.00000E+00	.00000E+00
0	66	1	.00000E+00	-.12962E-02	-.28227E-02	.00000E+00	.00000E+00	.00000E+00
0	65	1	.00000E+00	-.16007E-02	-.40290E-02	.00000E+00	.00000E+00	.00000E+00
0	64	1	.00000E+00	-.16521E-02	-.37978E-02	.00000E+00	.00000E+00	.00000E+00
0	63	1	.00000E+00	-.16663E-02	-.35511E-02	.00000E+00	.00000E+00	.00000E+00

0	62	1	.00000E+00	-.16447E-02	-.33098E-02	.00000E+00	.00000E+00	.00000E+00
0	61	1	.00000E+00	-.15843E-02	-.30755E-02	.00000E+00	.00000E+00	.00000E+00
0	60	1	.00000E+00	-.17902E-02	-.39127E-02	.00000E+00	.00000E+00	.00000E+00
0	59	1	.00000E+00	-.18385E-02	-.37729E-02	.00000E+00	.00000E+00	.00000E+00
0	58	1	.00000E+00	-.18541E-02	-.36190E-02	.00000E+00	.00000E+00	.00000E+00
0	57	1	.00000E+00	-.18345E-02	-.34674E-02	.00000E+00	.00000E+00	.00000E+00
0	56	1	.00000E+00	-.17804E-02	-.33222E-02	.00000E+00	.00000E+00	.00000E+00
0	55	1	.00000E+00	-.18879E-02	-.38109E-02	.00000E+00	.00000E+00	.00000E+00
0	54	1	.00000E+00	-.19345E-02	-.37539E-02	.00000E+00	.00000E+00	.00000E+00
0	53	1	.00000E+00	-.19501E-02	-.36871E-02	.00000E+00	.00000E+00	.00000E+00
0	52	1	.00000E+00	-.19332E-02	-.36206E-02	.00000E+00	.00000E+00	.00000E+00
0	51	1	.00000E+00	-.18826E-02	-.35606E-02	.00000E+00	.00000E+00	.00000E+00
0	50	1	.00000E+00	-.19014E-02	-.37183E-02	.00000E+00	.00000E+00	.00000E+00
0	49	1	.00000E+00	-.19457E-02	-.37396E-02	.00000E+00	.00000E+00	.00000E+00
0	48	1	.00000E+00	-.19608E-02	-.37552E-02	.00000E+00	.00000E+00	.00000E+00
0	47	1	.00000E+00	-.19445E-02	-.37698E-02	.00000E+00	.00000E+00	.00000E+00
0	46	1	.00000E+00	-.18967E-02	-.37908E-02	.00000E+00	.00000E+00	.00000E+00
0	45	1	.00000E+00	-.18332E-02	-.36307E-02	.00000E+00	.00000E+00	.00000E+00
0	44	1	.00000E+00	-.18760E-02	-.37285E-02	.00000E+00	.00000E+00	.00000E+00
0	43	1	.00000E+00	-.18899E-02	-.38234E-02	.00000E+00	.00000E+00	.00000E+00
0	42	1	.00000E+00	-.18740E-02	-.39155E-02	.00000E+00	.00000E+00	.00000E+00
0	41	1	.00000E+00	-.18270E-02	-.40131E-02	.00000E+00	.00000E+00	.00000E+00
0	40	1	.00000E+00	-.16839E-02	-.35461E-02	.00000E+00	.00000E+00	.00000E+00
0	39	1	.00000E+00	-.17250E-02	-.37173E-02	.00000E+00	.00000E+00	.00000E+00
0	38	1	.00000E+00	-.17417E-02	-.38899E-02	.00000E+00	.00000E+00	.00000E+00
0	37	1	.00000E+00	-.17257E-02	-.40581E-02	.00000E+00	.00000E+00	.00000E+00
0	36	1	.00000E+00	-.16807E-02	-.42282E-02	.00000E+00	.00000E+00	.00000E+00
0	35	1	.00000E+00	-.14535E-02	-.34660E-02	.00000E+00	.00000E+00	.00000E+00
0	34	1	.00000E+00	-.14913E-02	-.37056E-02	.00000E+00	.00000E+00	.00000E+00
0	33	1	.00000E+00	-.15114E-02	-.39439E-02	.00000E+00	.00000E+00	.00000E+00
0	32	1	.00000E+00	-.15117E-02	-.41978E-02	.00000E+00	.00000E+00	.00000E+00
0	31	1	.00000E+00	-.14603E-02	-.44432E-02	.00000E+00	.00000E+00	.00000E+00
0	30	1	.00000E+00	-.11489E-02	-.33976E-02	.00000E+00	.00000E+00	.00000E+00

0	29	1	.00000E+00	-.11777E-02	-.36947E-02	.00000E+00	.00000E+00	.00000E+00
0	28	1	.00000E+00	-.11942E-02	-.39866E-02	.00000E+00	.00000E+00	.00000E+00
0	27	1	.00000E+00	-.12033E-02	-.42961E-02	.00000E+00	.00000E+00	.00000E+00
0	26	1	.00000E+00	-.11925E-02	-.46986E-02	.00000E+00	.00000E+00	.00000E+00
0	25	1	.00000E+00	-.11903E-02	-.52416E-02	.00000E+00	.00000E+00	.00000E+00
0	24	1	.00000E+00	-.59519E-03	-.33333E-02	.00000E+00	.00000E+00	.00000E+00
0	23	1	.00000E+00	-.60715E-03	-.36713E-02	.00000E+00	.00000E+00	.00000E+00
0	22	1	.00000E+00	-.60693E-03	-.40039E-02	.00000E+00	.00000E+00	.00000E+00
0	21	1	.00000E+00	-.58894E-03	-.43514E-02	.00000E+00	.00000E+00	.00000E+00
0	20	1	.00000E+00	-.55645E-03	-.47906E-02	.00000E+00	.00000E+00	.00000E+00
0	19	1	.00000E+00	-.53212E-03	-.52018E-02	.00000E+00	.00000E+00	.00000E+00
0	18	1	.00000E+00	.15106E-04	-.33121E-02	.00000E+00	.00000E+00	.00000E+00
0	17	1	.00000E+00	.16077E-04	-.36539E-02	.00000E+00	.00000E+00	.00000E+00
0	16	1	.00000E+00	.24088E-04	-.39937E-02	.00000E+00	.00000E+00	.00000E+00
0	15	1	.00000E+00	.40422E-04	-.43538E-02	.00000E+00	.00000E+00	.00000E+00
0	14	1	.00000E+00	.50161E-04	-.47080E-02	.00000E+00	.00000E+00	.00000E+00
0	13	1	.00000E+00	.42036E-04	-.50589E-02	.00000E+00	.00000E+00	.00000E+00
0	12	1	.00000E+00	.62871E-03	-.33086E-02	.00000E+00	.00000E+00	.00000E+00
0	11	1	.00000E+00	.63458E-03	-.36338E-02	.00000E+00	.00000E+00	.00000E+00
0	10	1	.00000E+00	.64143E-03	-.39632E-02	.00000E+00	.00000E+00	.00000E+00
0	9	1	.00000E+00	.64730E-03	-.42912E-02	.00000E+00	.00000E+00	.00000E+00
0	8	1	.00000E+00	.65267E-03	-.46185E-02	.00000E+00	.00000E+00	.00000E+00
0	7	1	.00000E+00	.66080E-03	-.49508E-02	.00000E+00	.00000E+00	.00000E+00
0	6	1	.00000E+00	.12374E-02	-.32974E-02	.00000E+00	.00000E+00	.00000E+00
0	5	1	.00000E+00	.12460E-02	-.36037E-02	.00000E+00	.00000E+00	.00000E+00
0	4	1	.00000E+00	.12535E-02	-.39112E-02	.00000E+00	.00000E+00	.00000E+00
0	3	1	.00000E+00	.12608E-02	-.42198E-02	.00000E+00	.00000E+00	.00000E+00
0	2	1	.00000E+00	.12687E-02	-.45286E-02	.00000E+00	.00000E+00	.00000E+00
0	1	1	.00000E+00	.12768E-02	-.48390E-02	.00000E+00	.00000E+00	.00000E+00

1T W O - D I M E N S I O N A L   F I N I T E   E L E M E N T S

1. CENTROID STRESSES REFERENCED TO LOCAL Y-Z COORDINATES.
2. MID-SIDE STRESSES ARE NORMAL AND PARALLEL TO ELEMENT EDGES.

0ELEMENT (1)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.17836E+02	.10445E+02	.14006E+04	-.32470E+01	.10813E+02	-.18204E+02	-83.53

0
0ELEMENT (2)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.34477E+02	-.29436E+02	.13587E+04	.17738E+02	.39070E+02	-.34029E+02	14.52

0
0ELEMENT (3)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.21127E+02	-.35221E+02	.13101E+04	.52464E+02	.52503E+02	-.66598E+02	30.88

0
0ELEMENT (4)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.13849E+02	.36175E+01	.12706E+04	.71164E+02	.66582E+02	-.76814E+02	48.50

0
0ELEMENT (5)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.10256E+02	.47836E+02	.12439E+04	.34764E+02	.64091E+02	-.26511E+02	64.94

0
0ELEMENT (6)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.10474E+03	-.15435E+03	.50325E+03	.12434E+03	.15475E+03	-.20437E+03	21.91

0
0ELEMENT (7)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.30859E+03	-.97260E+02	.37684E+03	.22726E+03	.47701E+02	-.45355E+03	57.47

0
0ELEMENT (8)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.43990E+03	.75176E+02	.36231E+03	.14264E+03	.11204E+03	-.47676E+03	75.51

0
0ELEMENT (9)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.22726E+03	.11934E+03	.40930E+03	-.54970E+02	.12785E+03	-.23577E+03	-81.20

0
0ELEMENT (10)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.36866E+02	.41999E+02	.42702E+03	-.50257E+02	.66447E+02	-.61314E+02	-64.06

0
0ELEMENT (11)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.10757E+04	-.12232E+04	-.10453E+04	.77533E+03	-.37064E+03	-.19283E+04	42.28

0
0ELEMENT (12)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.10754E+04	.42870E+03	-.54931E+03	.81662E+03	.78681E+03	-.14335E+04	66.32

0
0ELEMENT (13)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.62615E+03	.99583E+03	-.29174E+03	-.27023E+03	.10397E+04	-.66999E+03	-80.79

0
0ELEMENT (14)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.25757E+03	.22786E+03	-.41681E+03	-.57383E+03	.60820E+03	-.63791E+03	-56.46

0
0ELEMENT (15)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.32790E+02	-.46774E+03	-.54301E+03	-.30540E+03	.12465E+03	-.62518E+03	-27.27

0
0ELEMENT (16)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.66342E+03	.40876E+04	.17536E+03	.15838E+04	.47079E+04	.43197E+02	68.61

0
0ELEMENT (17)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.34090E+03	.43684E+04	.11525E+03	.72961E+03	.44965E+04	.21281E+03	80.04

0
0ELEMENT (18)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.24291E+03	.20794E+04	-.57762E+03	-.70042E+03	.23160E+04	.62653E+01	-71.33

0
0ELEMENT (19)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.11340E+03	.25683E+03	-.11238E+04	-.84720E+03	.10353E+04	-.66512E+03	-47.42

0
0ELEMENT (20)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.16408E+02	-.15021E+04	-.16267E+04	-.44100E+03	.13519E+03	-.16209E+04	-15.07

0
0ELEMENT (21)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.12535E+04	.80312E+04	.80227E+03	.10483E+04	.81896E+04	.10951E+04	81.41

0
0ELEMENT (22)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.89218E+03	.29997E+04	-.74585E+03	-.10861E+03	.30053E+04	.88660E+03	-87.06

0
0ELEMENT (23)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.42792E+03	.30975E+03	-.16181E+04	-.55736E+03	.92931E+03	-.19165E+03	-41.97

0

0ELEMENT (24)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.78666E+02	-.23694E+04	-.24397E+04	-.30134E+03	.11521E+03	-.24059E+04	-6.92

0

0ELEMENT (25)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.32910E+02	.74189E+04	-.90997E+02	.96550E+02	.74202E+04	.31648E+02	89.25

0

0ELEMENT (26)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.54002E+03	.39381E+04	-.95271E+03	.13585E+03	.39435E+04	.53460E+03	87.71

0

0ELEMENT (27)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.34456E+03	.39282E+03	-.19932E+04	-.21185E+03	.58191E+03	.15548E+03	-48.25

0

0ELEMENT (28)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.97308E+02	-.27691E+04	-.29137E+04	-.14860E+03	.10499E+03	-.27768E+04	-2.96

0

0ELEMENT (29)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.48236E+02	.74074E+04	-.35258E+03	-.67610E+02	.74080E+04	.47615E+02	-89.47

0

0ELEMENT (30)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.80511E+02	.40108E+04	-.13257E+04	-.11646E+03	.40142E+04	.77063E+02	-88.30

0

0ELEMENT (31)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.16353E+03	.52905E+03	-.22689E+04	-.11194E+03	.56061E+03	.13198E+03	-74.26

0

0ELEMENT (32)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.57986E+02	-.29609E+04	-.32363E+04	-.65811E+02	.59420E+02	-.29623E+04	-1.25

0

0ELEMENT (33)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.22290E+01	.75716E+04	-.47673E+03	-.11585E+03	.75734E+04	-.40007E+01	-89.12

0

0ELEMENT (34)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.36509E+02	.40477E+04	-.14816E+04	-.22482E+03	.40602E+04	.23948E+02	-86.80

0
0ELEMENT (35)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.50189E+02	.46842E+03	-.24709E+04	-.19708E+03	.54665E+03	-.28044E+02	-68.35

0
0ELEMENT (36)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.34611E+02	-.30874E+04	-.34266E+04	-.73641E+02	.36347E+02	-.30891E+04	-1.35

0
0ELEMENT (37)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.31245E+01	.78209E+04	-.44298E+03	-.14551E+03	.78236E+04	.41713E+00	-88.93

0
0ELEMENT (38)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.20576E+02	.41100E+04	-.15104E+04	-.30691E+03	.41329E+04	-.23299E+01	-85.73

0
0ELEMENT (39)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.43196E+02	.38070E+03	-.25405E+04	-.29225E+03	.54942E+03	-.12552E+03	-60.00

0
0ELEMENT (40)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.28147E+02	-.32898E+04	-.35270E+04	-.12656E+03	.32968E+02	-.32946E+04	-2.18

0
0ELEMENT (41)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.67183E+01	.81293E+04	-.26879E+03	-.16979E+03	.81328E+04	.31706E+01	-88.80

0
0ELEMENT (42)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.11827E+02	.42206E+04	-.14050E+04	-.37932E+03	.42545E+04	-.22087E+02	-84.89

0
0ELEMENT (43)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.38774E+02	.29160E+03	-.24970E+04	-.39511E+03	.58002E+03	-.24965E+03	-53.87

0
0ELEMENT (44)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.23196E+02	-.35909E+04	-.35479E+04	-.18375E+03	.32513E+02	-.36002E+04	-2.90

0
0ELEMENT (45)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.16173E+02	.84816E+04	.41005E+02	-.18328E+03	.84855E+04	-.20124E+02	-88.77

0
0ELEMENT (46)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.36174E+02	.43918E+04	-.11472E+04	-.44533E+03	.44369E+04	-.88908E+01	-84.22

0
0ELEMENT (47)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.28751E+02	.20738E+03	-.23343E+04	-.48846E+03	.61462E+03	-.37849E+03	-50.18

0
0ELEMENT (48)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.34677E+02	-.39944E+04	-.34796E+04	-.24892E+03	.49997E+02	-.40097E+04	-3.52

0
0ELEMENT (49)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.10105E+03	.88977E+04	.54804E+03	-.20981E+03	.89027E+04	.96052E+02	-88.63

0
0ELEMENT (50)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.62141E+02	.45933E+04	-.74865E+03	-.53148E+03	.46549E+04	.63720E+00	-83.40

0
0ELEMENT (51)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.23211E+03	.12438E+03	-.19791E+04	-.58844E+03	.76914E+03	-.41266E+03	-42.38

0
0ELEMENT (52)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.72701E+02	-.44869E+04	-.33014E+04	-.24142E+03	.85448E+02	-.44996E+04	-3.02

0
0ELEMENT (53)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.86413E+02	.94977E+04	.11531E+04	-.39301E+03	.95138E+04	-.10250E+03	-87.66

0
0ELEMENT (54)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.10028E+04	.48011E+04	.57503E+02	-.94410E+03	.50228E+04	.78109E+03	-76.78

0
0ELEMENT (55)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.57215E+03	-.30912E+03	-.15336E+04	-.32684E+03	.68014E+03	-.41710E+03	-18.28

0
0ELEMENT (56)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.14668E+03	-.48098E+04	-.29147E+04	-.80043E+02	.14797E+03	-.48111E+04	-.92

0
0ELEMENT (57)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.30991E+04	.11182E+05	.31786E+04	-.23015E+04	.11791E+05	.24897E+04	-75.17

0
0ELEMENT (58)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.18021E+04	.32483E+04	.48541E+03	-.22351E+03	.32821E+04	.17683E+04	-81.41

0
0ELEMENT (59)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.83952E+03	-.50474E+03	-.87277E+03	.39609E+03	.94754E+03	-.61276E+03	15.26

0
0ELEMENT (60)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.16852E+03	-.47101E+04	-.22580E+04	.25112E+03	.18141E+03	-.47230E+04	2.94

0
0ELEMENT (61)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.57980E+03	-.42608E+04	-.18295E+04	.17583E+04	.12513E+03	-.49657E+04	21.85

0
0ELEMENT (62)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.34218E+03	-.51142E+04	-.15698E+04	-.33578E+04	.19404E+04	-.67124E+04	-25.45

0
0ELEMENT (63)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.39827E+04	.46897E+04	.25102E+04	-.33872E+04	.77418E+04	.93061E+03	-47.98

0
0ELEMENT (64)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.21059E+04	.59896E+04	.23039E+04	-.20678E+03	.60006E+04	.20949E+04	-86.96

0
0ELEMENT (65)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.12897E+04	.28332E+04	.11041E+04	.12254E+04	.35096E+04	.61326E+03	61.10

0
0ELEMENT (66)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	.53457E+03	-.57321E+03	-.12270E+03	.12232E+04	.13235E+04	-.13621E+04	32.82

0
0ELEMENT (67)

```
 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN   .11129E+03  -.38347E+04  -.11942E+04   .60932E+03   .20324E+03  -.39266E+04      8.58
0
OELEMENT (   68)

 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN   .9[illegible]142E+03  -.34246E+04   .54700E+03  -.51820E+03   .10514E+04  -.34846E+04     -6.60
0
OELEMENT (   69)

 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN   .13385E+04  -.95350E+03   .14147E+04  -.23974E+04   .28498E+04  -.24647E+04    -32.23
0
OELEMENT (   70)

 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN  -.99767E+03   .16437E+04   .14427E+04  -.25277E+04   .31749E+04  -.25289E+04    -58.79
0
OELEMENT (   71)

 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN  -.82604E+03   .32589E+04   .18385E+04  -.24170E+03   .32732E+04  -.84029E+03    -86.63
0
OELEMENT (   72)

 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN  -.35810E+03   .19466E+04   .14834E+04   .12715E+04   .25103E+04  -.92173E+03     66.09
0
OELEMENT (   73)

 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN  -.59398E+02  -.22608E+03   .86617E+03   .15257E+04   .13852E+04  -.16707E+04     43.44
0
OELEMENT (   74)

 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN  -.93078E+01  -.24334E+04   .19890E+03   .74501E+03   .20135E+03  -.26441E+04     15.79
0
OELEMENT (   75)

 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN  -.19091E+03  -.15418E+04   .22701E+04  -.95179E+03   .30075E+03  -.20335E+04    -27.32
0
OELEMENT (   76)

 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN  -.60976E+03  -.21657E+03   .24142E+04  -.15004E+04   .11001E+04  -.19264E+04    -48.73
0
OELEMENT (   77)

 LOAD  LOC          S11          S22          S33          S12        S-MAX        S-MIN     ANGLE

    1  CEN  -.89718E+03   .74361E+03   .24743E+04  -.12316E+04   .14031E+04  -.15567E+04    -61.83
0
OELEMENT (   78)
```

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.14041E+04	.11445E+04	.22893E+04	-.35887E+03	.11941E+04	-.14537E+04	-82.14

0
0ELEMENT (79)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.11133E+04	.90914E+03	.21546E+04	.74642E+03	.11548E+04	-.13589E+04	71.78

0
0ELEMENT (80)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.57771E+03	-.76780E+02	.19036E+04	.11172E+04	.81764E+03	-.14721E+04	51.32

0
0ELEMENT (81)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.12767E+03	-.10429E+04	.16695E+04	.58440E+03	.15697E+03	-.13275E+04	25.97

0
0ELEMENT (82)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.13719E+03	-.28178E+03	.41134E+04	-.28836E+03	.87799E+02	-.50676E+03	-37.96

0
0ELEMENT (83)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.78704E+03	-.88227E+02	.37824E+04	-.66674E+03	.31512E+03	-.11904E+04	-58.83

0
0ELEMENT (84)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.15552E+04	.17434E+03	.34200E+04	-.51437E+03	.31575E+03	-.16966E+04	-74.63

0
0ELEMENT (85)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.18266E+04	.24284E+03	.31465E+04	-.97190E+02	.24739E+03	-.18312E+04	-87.32

0
0ELEMENT (86)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.15566E+04	.17164E+03	.30091E+04	.29509E+03	.22064E+03	-.16056E+04	80.57

0
0ELEMENT (87)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.82819E+03	-.19813E+02	.30021E+04	.45280E+03	.18296E+03	-.10310E+04	65.88

0
0ELEMENT (88)

LOAD	LOC	S11	S22	S33	S12	S-MAX	S-MIN	ANGLE
1	CEN	-.18166E+03	-.21724E+03	.30041E+04	.19867E+03	.19149E-01	-.39892E+03	42.44

0
1O V E R A L L T I M E L O G

NODAL POINT INPUT	=	.00
ELEMENT STIFFNESS FORMATION	=	.00
NODAL LOAD INPUT	=	.00
TOTAL STIFFNESS FORMATION	=	.00
STATIC ANALYSIS	=	.00
EIGENVALUE EXTRACTION	=	.00
FORCED RESPONSE ANALYSIS	=	.00
RESPONSE SPECTRUM ANALYSIS	=	.00
STEP-BY-STEP INTEGRATION	=	.00

* TOTAL SOLUTION TIME = .00

HFIR MODEL-E REMOVABLE REFLECTOR HYDRAULICS

A HYDRAULICS ANALYSIS OF THE HFIR MODEL-D VERSUS MODEL-E REMOVABLE REFLECTOR

Introduction

The "current" or "present" removable reflector is the Model-D design. The Model-E, "modified" removable reflector was designed to accommodate future experiments planned for the HFIR. Basically, the modification consisted of replacing the four 1.5-in.-diam experiment facilities with eight larger (2-in.-diam) facilities. Each of the four pairs of larger facilities are located adjacent to a control rod access plug (CRAP).

A reflector coolant inlet temperature of 120°F and a nominal 40°F coolant temperature rise across the reflector was assumed. Fluid specific volume was obtained from the Fourth Edition of the ASME Steam Tables (1979); dynamic viscosity of water was taken from Table 23, Section 9.1, of the Nuclear Engineers Handbook.

Reflector coolant redistribution within the removable reflector and the effects of the reflector modification on access plug flow rates are subjects discussed below. Experiment coolant requirements are excluded from the calculations.

The figures and tables of data have been placed at the end of the report.

Removable Reflector Hydraulics

Coolant enters the removable reflector by passing across the eight bellville springs and flowing through the orifice located at the back of each spring (shown by the arrows in Fig. 1). The "groove coolant passage" shown on the right side of Fig. 1 is located at the interface between the removable reflector and the access plug. Those coolant passages are discussed later.

Test results from a flow calibration of the "spring" orifices was reported in a letter from R. M. Hill, Jr., to J. R. McWherter (April 8, 1964). These orifices are 0.5 in. wide and 2.2 in. long. We used the method of least squares to fit Hill's data, from those mockup flow tests, to the following equation for this analysis:

$$Q = 20.0\ (\Delta P)^{0.5018} \quad ,$$

where:

Q = orifice flow rate, gpm, and
ΔP = orifice pressure differential, psi.

The aluminum upper containment ring and its proximity to the beryllium of the reflector is also shown in Fig. 1. Figure 2.1 is a horizontal section through that upper containment ring, looking down on the various coolant passages within the removable reflector. Although not shown in Fig. 2.1, the "spring" orifices are located radially inward from each thru-bolt. Each orifice straddles a containment ring cross-member, and each orifice admits coolant into two adjacent plena. For example, one "spring" orifice allows coolant to enter plenum A and plenum B, and a second "spring" orifice passes coolant to plenum C and plenum D. Horizontal flow from plenum B to plenum C is virtually zero since the cross-member which separates those plena contacts the top surface of the beryllium and because there is no orifice at that location. The coolant inside a plenum flows downward through the various passages to cool the removable reflector beryllium. The coolant passages of plenum A consists of 18 "standard grooves" plus a 0.005-in. annulus which surrounds the 1/2-in. experiment facility liner tube; plenum C has 13 grooves plus a 0.020-in. annulus around the 1 1/2-in. expriment facility liner; plenum B and plenum D each have 18 standard grooves.

Each "standard groove" has a countersink at the inlet (top of passage) to minimize the coolant entrance losses. Mockup flow tests for the reflector 1/8-in. coolant passages was reported May 1, 1963, in a letter by R. M. Hill, Jr., and also in a subsequent letter from R. J. Kedl to J. R. McWherter on August 27, 1964. Those experimental results, corrected for difference in fluid properties and equivalent diameters was used to obtain the entrance and exit loss coefficients for the "standard grooves." Standard groove flow rates, using those coefficients, was also compared against H. A. McLain's unpublished design calculations for agreement.

Aluminum liner tubes for the current large (1.5-in.) and small (0.5-in.) experiment facilities extend vertically upward through their respective plena to the region above the upper containment ring. Hence, coolant for an experiment is obtained from a separate source, above the removable reflector, rather than from a plenum. Notice that the diameter of the liner tube in plenum C is smaller than the radial thickness of that plenum (Fig. 2.1). Hence, water can flow horizontally around the 1.5-in. liner tubes to reach those standard grooves located adjacent to the upper containment ring cross-member. The modified reflector (Fig. 2.2) has dual, larger, experiment facility liner tubes. Those liner tubes are so large (2-in.-diam) that they essentially blocked the horizontal coolant flow into the grooved passages next to the cross-member. That is, without an alternate coolant flow path there would be a small, essentially uncooled, beryllium region between the dual large facility liner tubes of the modified reflector. Two small (0.414-in.-diam) orifices were sized to admit water from above the reflector into the region between the liner tubes (Fig. 3). Space limitation precludes specifying a single, larger, orifice for that region. Each orifice is positioned directly above a containment ring cross-member; therefore, it was necessary to reshape that cross-member to efficiently admit coolant into the region (Fig. 3). Orifice pressure drop is given by the following derived equation:

$$\Delta P = 0.0263(Q')^2$$

The constant includes a 0.6 orifice coefficient and the quantity Q' is the total flow rate (gpm) through both orifices. Orifice pressure drop (ΔP) is expressed in units of psi. Once the coolant has passed the orifice, it is then redistributed among the following flow passages: (1) four standard grooves, (2) the 0.020-in. annulus which surrounds the facility liner tubes, and (3) two triangular "groove" passages. The top of the beryllium has been recessed to ensure unrestricted coolant flow into the two standard grooves located at the inner radius of the reflector (Fig. 2.2).

Notice that there are two 1/4-in.-wide slots shown at the outer radius of the reflector (Fig. 2.2). These slots are machined in the beryllium only. The slots were added to satisfy a strength of materials problem and not fluid flow. A slot width of 1/4 in. was the smallest which would guarantee at least 1/8 in. minimum beryllium thickness. Beryllium is a brittle metal, and the concern was that small fragments might break off the reflector and become wedged in the clearance between the reflector and a control rod access plug. Metal fragments in that region could make access plug removal difficult. Access plug removal is necessary to disengage the upper control plates. It is <u>not</u> necessary to remove the access plugs to replace the following reactor components: (1) the target, (2) the inner fuel assembly, (3) the outer fuel assembly, (4) the shroud flange, (5) the inner shroud, and (6) the inner control cylinder. Furthermore, all experiments can be removed from the reflector and the access plug independent of CRAP removal.

With the experiment liner tubes centered, there is a 0.020-in. clearance between each tube and the reflector. Hence, it is possible for coolant from a plenum to enter the 0.020-in. annulus, flow circumferentially around the annulus, and empty into one of the 1/4-in. slots along the reflector outer surface. To prevent this undesired loss of plenum coolant, full length labyrinths have been machined in the beryllium. As illustrated in Fig. 2.2, the labyrinths are on both sides of each 1/4-in.-wide slot. Coolant flow paths at the reflector outside radius and the access plug flow rates are discussed in the next section. At this point, it should be sufficient to state: (1) access plug coolant is obtained by a separate flow path and (2) our calculations indicate that during normal reactor operation a small differential pressure may exist across the labyrinths and in the direction to promote plenum to access plug flow.

Reflector differential pressure versus orifice pressure drop for the various "orifices" are shown in Fig. 4. There is approximately a 10-psi pressure difference across the removable reflector during normal reactor operation, i.e., when three primary coolant pumps are in-service. Pressure inside a plenum is equal to the pressure above the reflector minus the orifice pressure drop. The inlet pressure is identical for all "orifices" illustrated in Fig. 4, and the reflector coolant passages also discharge to a common location below the reflector. At a given reflector differential pressure, there is expected to be less than about 0.1 psi difference in plenum pressures (see curves 1, 2, and 3). In other words, there should be very little cross flow from plenum B or plenum C into the region between the liner tubes (via circumferential flow in a liner tube annulus) or vice versa. The "spring" orifices (curves 1 and 2) are identical. The small pressure difference is caused by a slight difference in the flow rate through the two orifices. The flow rates are different because plenum A contains the small experiment facility, i.e., has slightly more flow area than its counterpart, plenum D. The magnitude of the pressure difference across a labyrinth, at the top of the reflector, is indicated by comparing the data in curve 4 (Fig. 4) with the other three curves.

Average coolant velocities in the various coolant passages of the modified reflector is given in Fig. 5. Turbulent flow exists in all of these coolant passages during normal reactor operation. A control room alarm sounds (annunciator A-13) if the reflector differential pressure should decrease below 6.5 psi. Procedures require the operator to immediately shut down the reactor when a reflector low pressure alarm occurs during power operation. The location of the bolt coolant passage (curve 4) is shown on Fig. 1.

Total flow rates for the current (Model-D) reflector and the modified (Model-E) reflector are compared in Table 1. All flow passages except the grooves on the outside surface of the reflector, the thru-bolt (1/8 in.) coolant passages, and experiment coolant requirements are included in the Table 1 data. Notice that the coolant flow rates for the modified reflector are within 1% of the flow rates for the current design reflector, i.e., they have decreased only about 1%. Changing the size and number of experiment facilities involved about 10% of the reflector volume. Now, since what goes into a facility tube will be cooled by a separate flow path and since the heat source is proportional to the reflector volume, one can infer that the coolant flow rates for the modified reflector have decreased 1% but the heat to be removed by this coolant has been reduced approximately 10%. Remember, only the coolant passages which previously were located in the volume now occupied by the large facilities, and in the region between those facilities, were affected by the modification. All other coolant passages remained unchanged.

Access Plug Hydraulics

HFIR has four control rod access plugs. Each beryllium access plug (Fig. 6.2) is suspended from the outer shroud by a component called the access plug hanger. The hanger is accurately positioned by two locating pins, as illustrated in Fig. 6.1. The hanger and its access plug is separated by spacers and held together, as a unit, with a bolt. Access plenum is the name given that volume between the plug and its hanger. There are two 1/2-in.-diam experiment facilities in each access plug. Although not shown in Fig. 6.1, the bolt and each experiment assembly penetrates the hanger. Experiment assemblies have an outer tube which is concentric with the inner tube that contains the experiment material. The annulus between the inner and outer tube forms the coolant passage for cooling the experiment material. Water enters the annulus from above the hanger. Hence, experiment coolant is obtained by a separate, independent, flow path and is not included in this analysis.

All coolant which flows into the access plenum must first pass through either the clearance between the hanger and outer shroud, or the clearance between the hanger and the outer surface of the upper containment ring (Fig 6.1). No coolant was assumed to enter the access plenum where the experiments, and the bolt, penetrate the hanger. The top edge of the hanger has been rounded, and there is a countersink at the entrance to each "standard" groove of the upper containment ring, both for the purpose of minimizing the coolant entrance losses.

Figures 6.1 and 6.2 were drawn for the current (Model-D) reflector. As can be seen in Fig. 6.1, there are 11 "standard" grooves which interfere with the hanger. Enlarging the removable reflector experiment facilities made it necessary to delete two of these grooves. Material stress consideration was the reason for the change. As a result of deleting two grooves, the hanger pressure drop (curve 4, Fig. 4) is approximately 0.1 psi or about 5%, higher with the modified reflector. This change is not serious, since the hanger pressure drop is only about 20% of the overall reflector differential pressure and, as shown later, makes very little difference in access plug total flow rate.

Coolant inside the access plenum is redistributed (Fig. 6.2) among the following parallel flow paths:

1. the annulus formed by an experiment outer tube and the beryllium,

2. the 0.062-in. gap between the access plug and the permanent and semipermanent reflectors,

3. the four segments between the circular hole through the beryllium and the access plug square bolt, and

4. the clearance between the outer surface of the removable reflector and the inner surface of the access plug.

Modification to the removable reflector affects only Item 4 above. The original 11 groves in the reflector beryllium (Fig. 6.2) was changed to 5 grooves plus two 1/4-in. wide slots for the modified reflector. The nominal 0.062-in. clearance remained unchanged. Total interface flow cross-sectional area is only about 1% less than it was with the Model-D reflector.

The beryllium of the access plug is the same length as the reflector beryllium (24 in.). Notice that the upper containment ring (Fig. 1) overlaps the reflector beryllium about 1/2 in. Also notice that there is a small circumferential gap where the containment ring joins the reflector beryllium at the outside radius (right-hand side of Fig. 1). From the above discussion, it should be apparent that the access plug beryllium interfaces with a short length of the upper containment ring. A similar arrangement also exists at the bottom with the lower containment ring, however, there were no changes made to the lower containment ring which would affect the coolant passages, i.e., there are still 11 grooves in the lower containment ring which interface an access plug. An allowance of about 1 1/2 velocity head has been included in the calculations to specifically account for flow area discontinuities for the flow passages along the reflector-access plug interface.

Average coolant velocities in the various coolant passages of an access plug are shown in Fig. 7. These data were calculated for an access plug interfacing a modified reflector. The difference in average velocities of curves 2, 3, and 4 result, principally, from the difference in flow area along the reflector and access plug interface, discussed above. The hanger velocities are the highest and also there is more coolant flowing through the hanger passage than any other on the figure. Refer to Fig. 6.2 for the location of the remaining coolant passages (curves 5, 6, and 7).

As stated prior, only the coolant passages formed by the access plug to reflector interface was affected by the modification. Coolant flow rates for that passage are compared with the present (Model-D) reflector design in Fig. 8. Note that during normal reactor operation (10 psi), there is only about 0.3 gpm difference (or about 1.3% change) in flow rate between the two reflector designs. Total flow rate for all passages of the access plug (excluding experiment coolant) is compared in Fig. 9. These results indicate that access plug coolant flow rates are expected to change no more than approximately 0.6% (0.3 gpm per plug) as a result of the reflector modification. Roughly, this translates into an increase of bulk coolant temperature of about 0.2°F, which is insignificant.

Coolant Flow Rates - Removable Reflector and Access Plugs

Gross coolant flow rates for the current (Model-D) and the modified (Model-E) design removable reflectors are compared in Table.2. Coolant passages on the outside surface of the removable reflector which interface with the semipermanent reflector were unaffected by the modification. Likewise, the 1/8-in. thru-bolt passages were unchanged.

The analysis based on nominal dimensions, indicate that the reflector modification to accommodate the larger experimental facilities is expected to cause only a minor difference in the coolant flow rates external to the experiments. No reflector cooling problems are evident from the analysis.

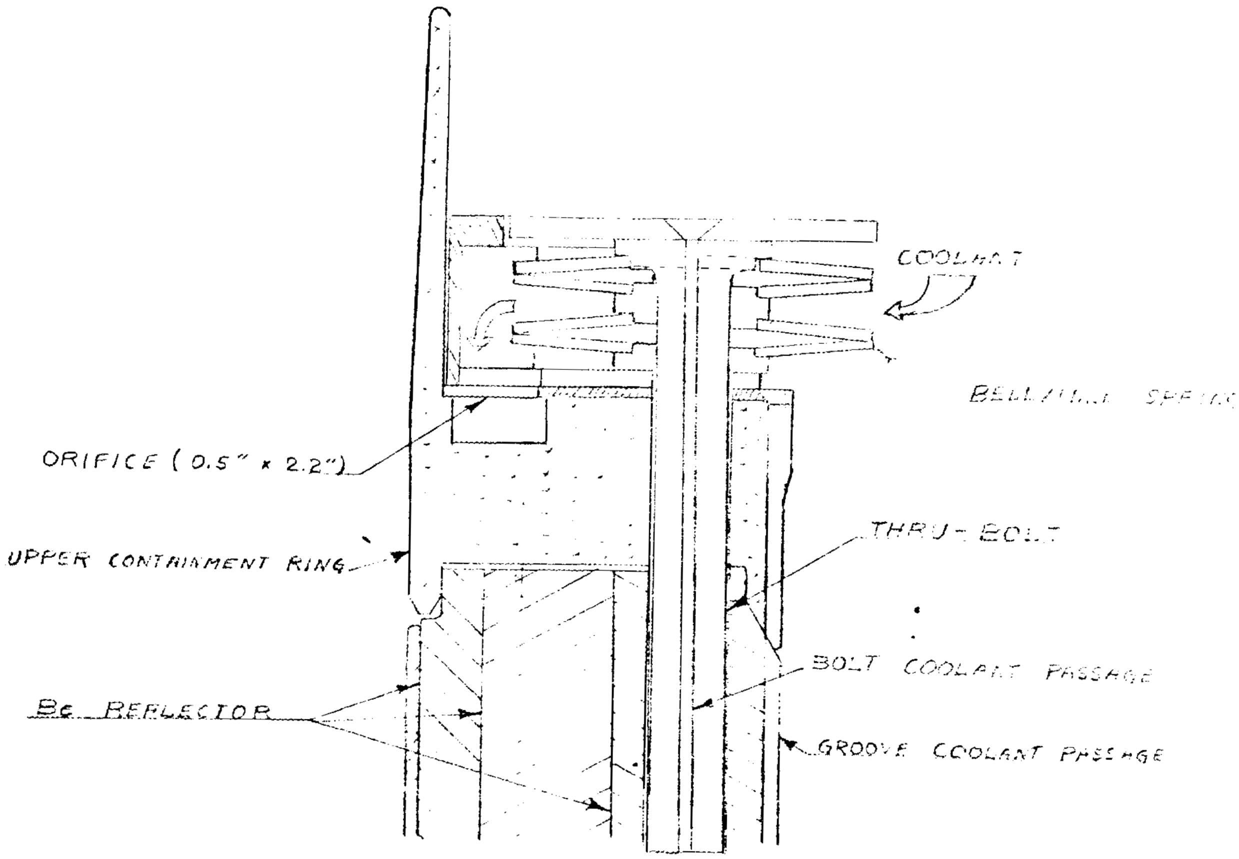
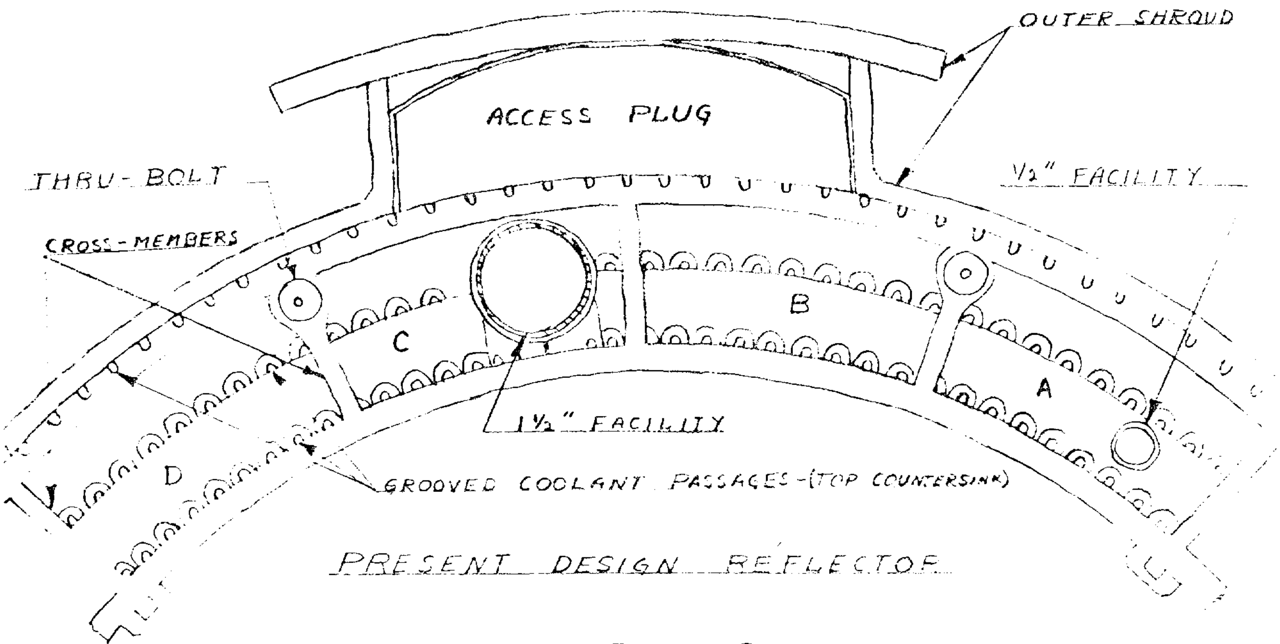


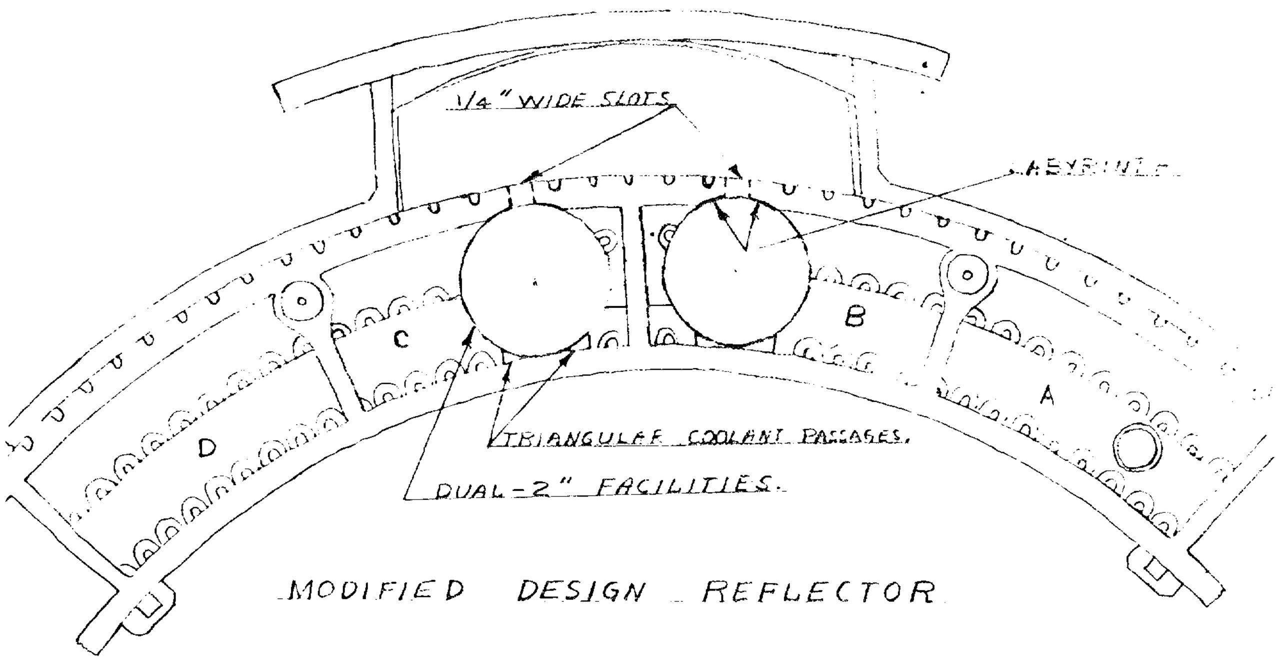
FIGURE - 1

COOLANT FLOW PATH INTO
UPPER REFLECTOR REGION



PRESENT DESIGN REFLECTOR

FIGURE - 2.1



MODIFIED DESIGN REFLECTOR

FIGURE - 2.2

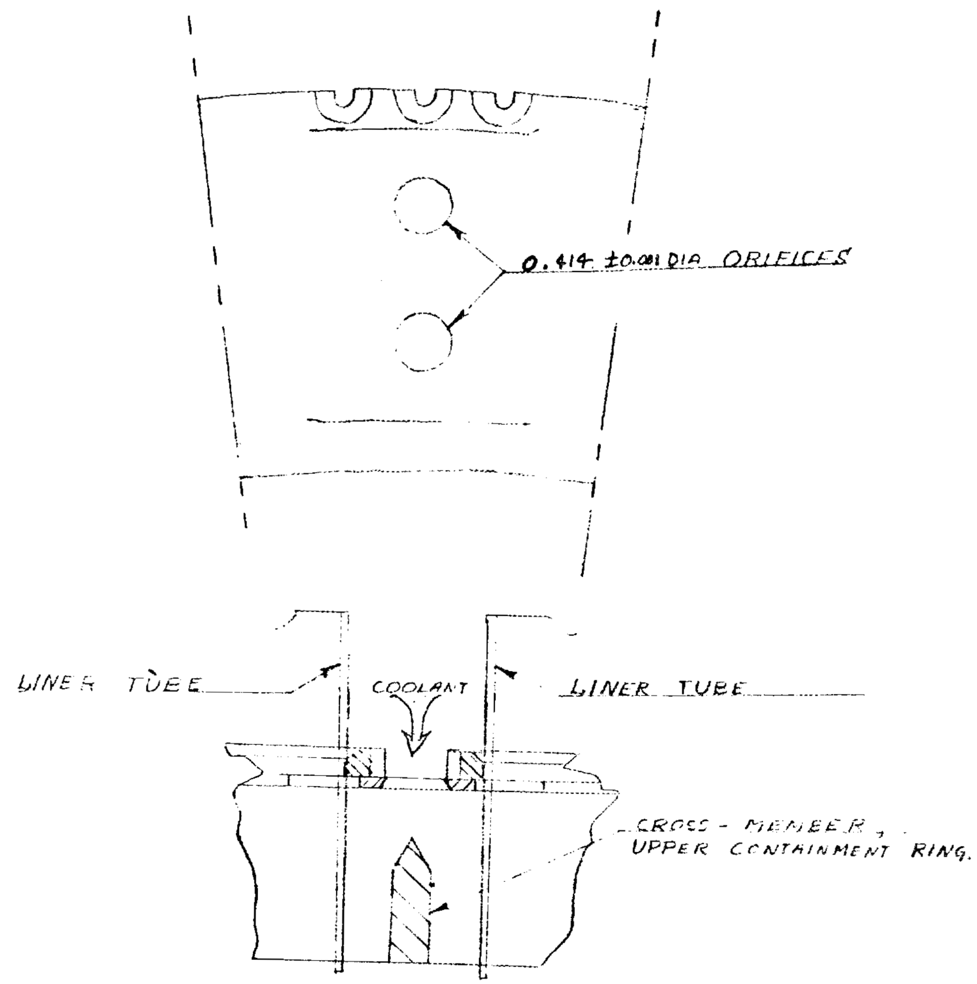


FIGURE - 3

LOCATION OF AUXILIARY ORIFICES

MODIFIED REFLECTOR

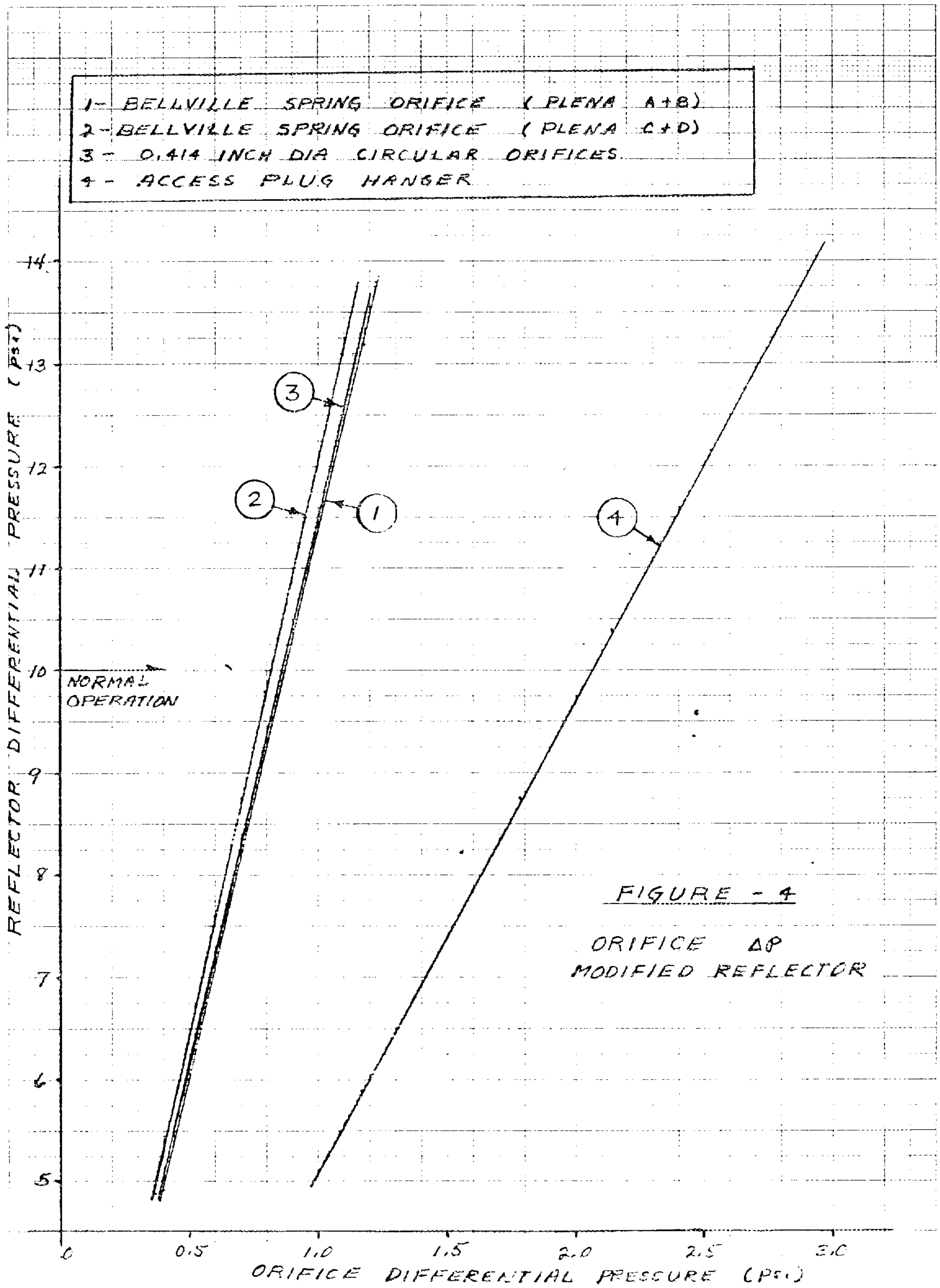


FIGURE - 4

ORIFICE ΔP
MODIFIED REFLECTOR

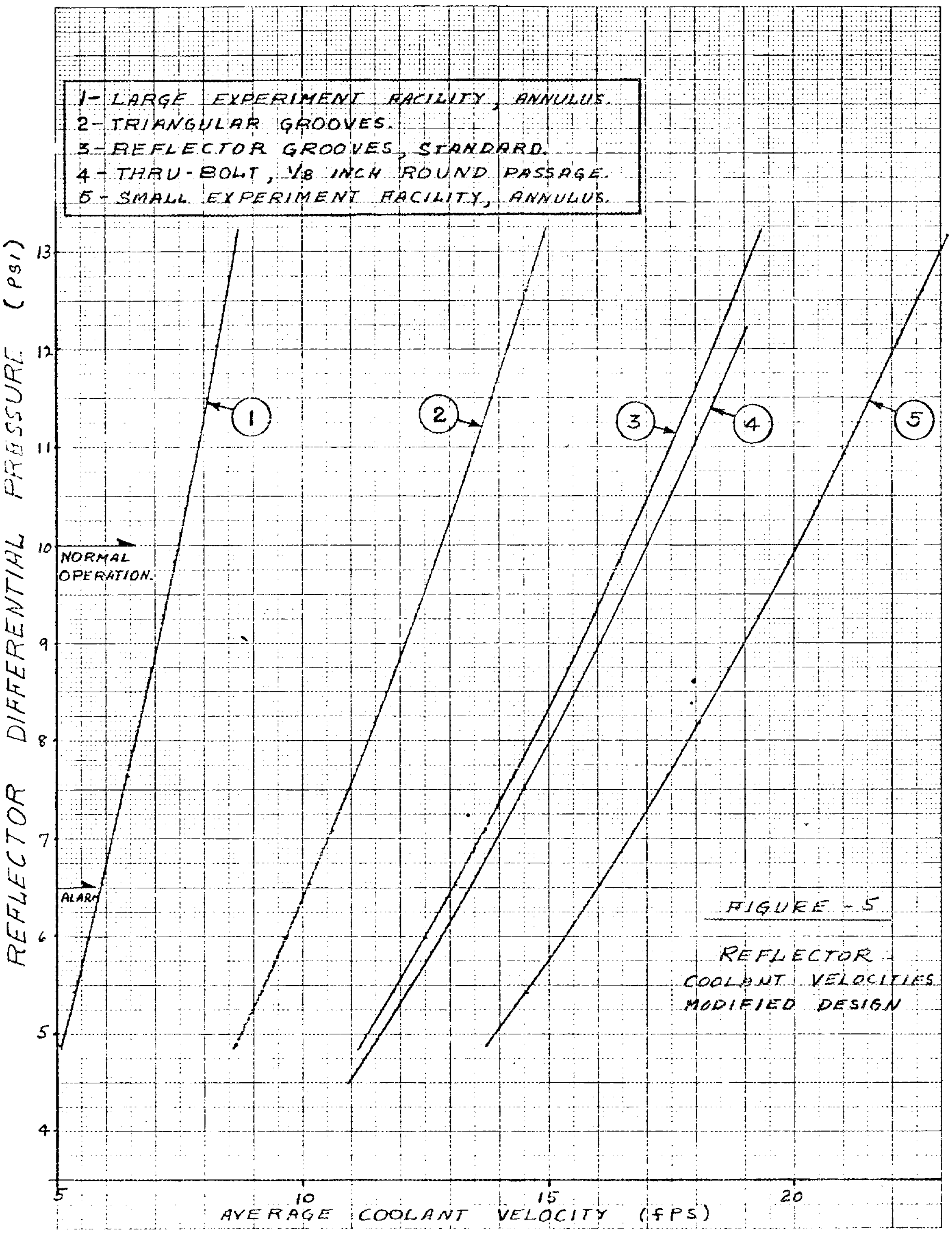


FIGURE - 5

REFLECTOR COOLANT VELOCITIES MODIFIED DESIGN

TABLE - 1

PLENA FLOW RATES - REMOVABLE REFLECTOR

A - MODIFIED DESIGN REFLECTOR (gpm)

Reflector DP(psi)	Plena A+B	Between Exp.Fac.	Plena C+D	Total (gpm)
13.0	86.52	26.45	83.45	196.42
12.0	82.81	25.31	79.86	187.98
11.0	78.95	24.13	76.12	179.20
10.0	74.91	22.70	72.43	170.04
9.0	70.71	21.62	68.16	160.49
8.0	66.28	20.27	63.89	150.44
7.0	61.59	18.84	57.36	137.79
6.0	56.60	17.31	54.54	128.45

B - CURRINT DESIGN REFLECTOR (gpm)

Reflector DP(psi)	Plena A+B	Plena C+D	Total (gpm)
13.0	104.81	95.99	197.80
12.0	97.45	91.87	189.32
11.0	92.91	87.59	180.50
10.0	88.19	83.13	171.32
9.0	83.25	78.46	161.71
8.0	78.06	73.55	151.61
7.0	72.55	68.35	140.90
6.0	66.67	62.81	129.48

C - FLOW DIFFERENCE (Modified vs Present)

Reflector DP(psi)	Delta Q (gpm)
13.0	-1.38
12.0	-1.34
11.0	-1.30
10.0	-1.28
9.0	-1.22
8.0	-1.17
7.0	-1.11
6.0	-1.03

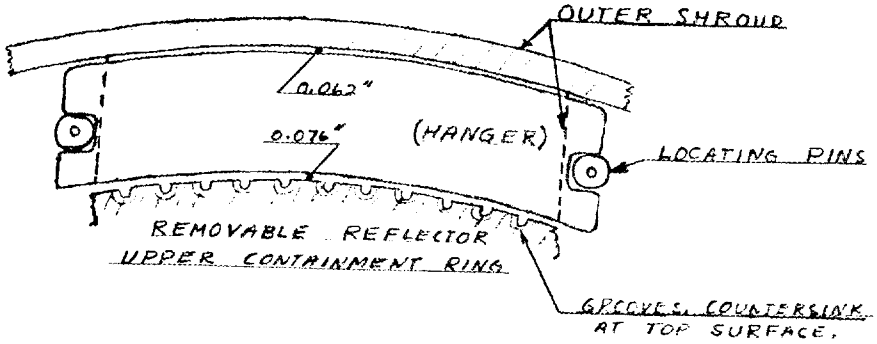


FIGURE - 6.1

ACCESS PLUG HANGER - PRESENT DESIGN.

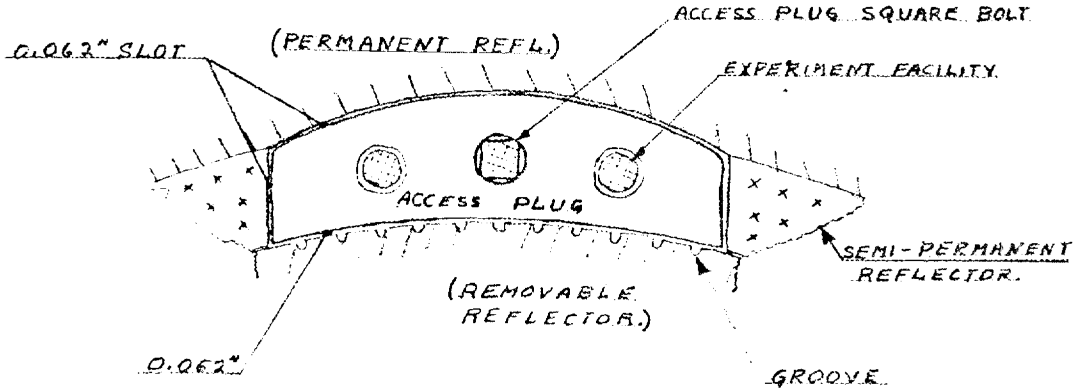


FIGURE - 6.2

ACCESS PLUG COOLANT FLOW PATHS - PRESENT DESIGN

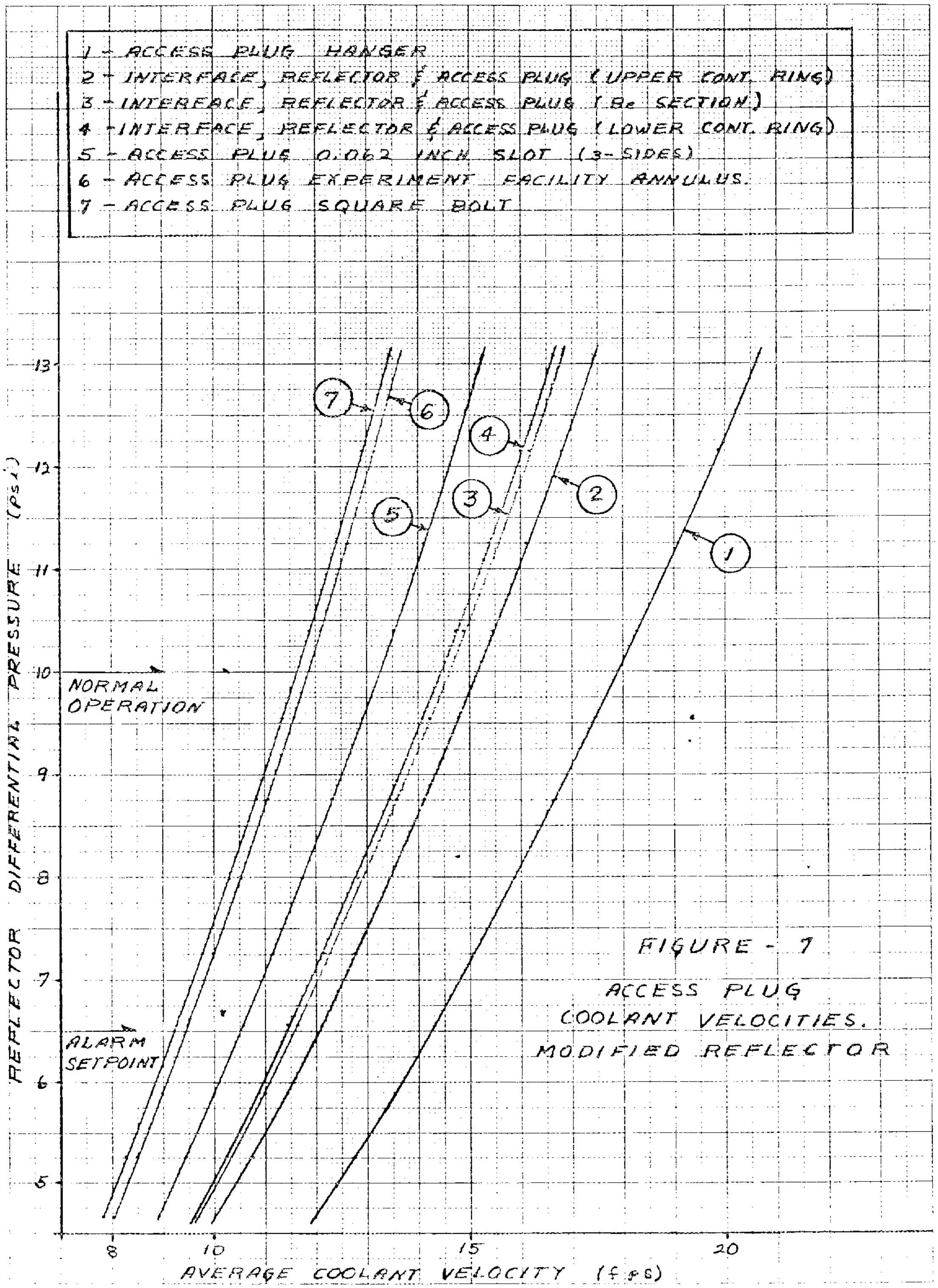


FIGURE - 7

ACCESS PLUG COOLANT VELOCITIES. MODIFIED REFLECTOR

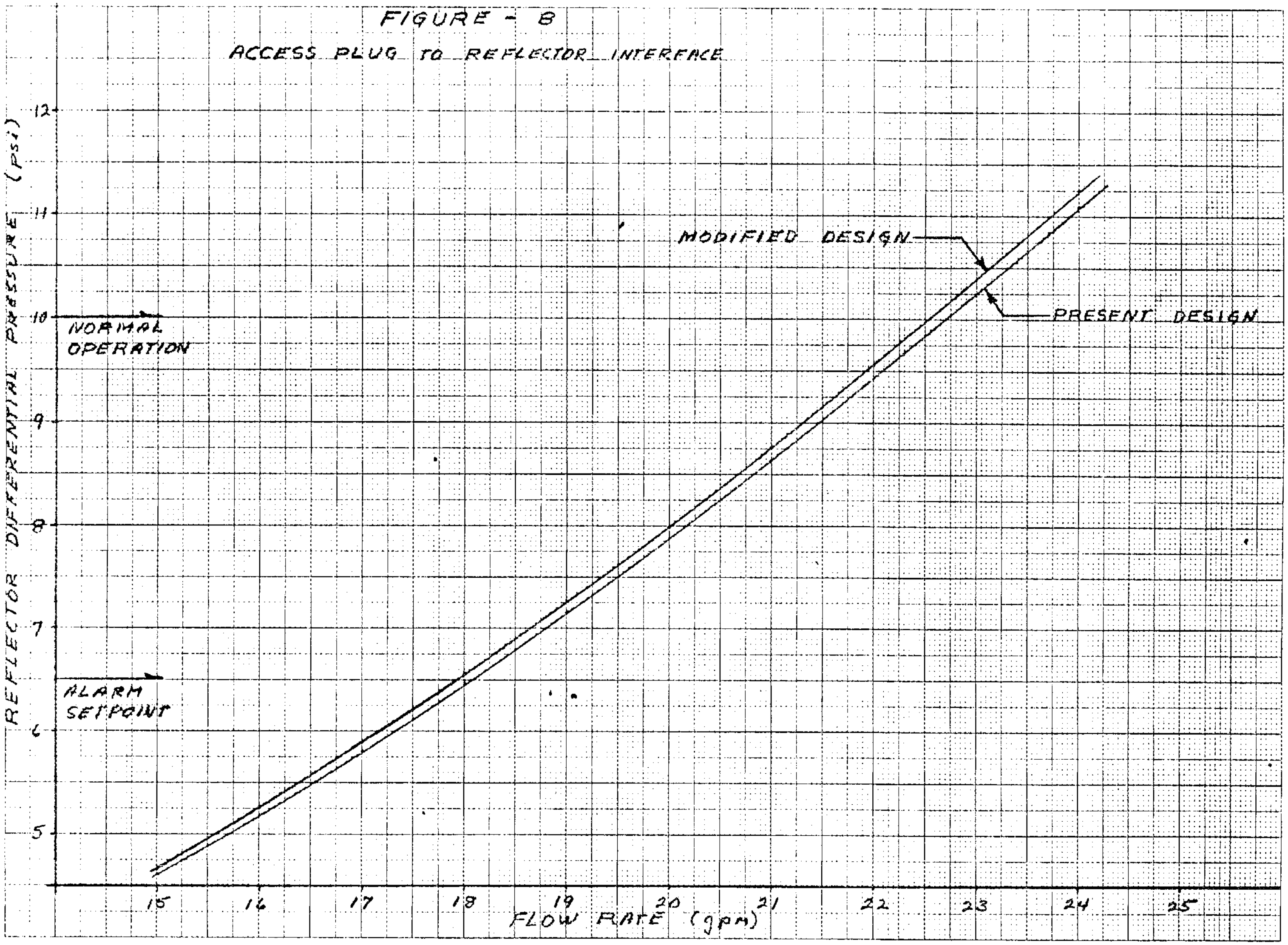


FIGURE - 8

ACCESS PLUG TO REFLECTOR INTERFACE

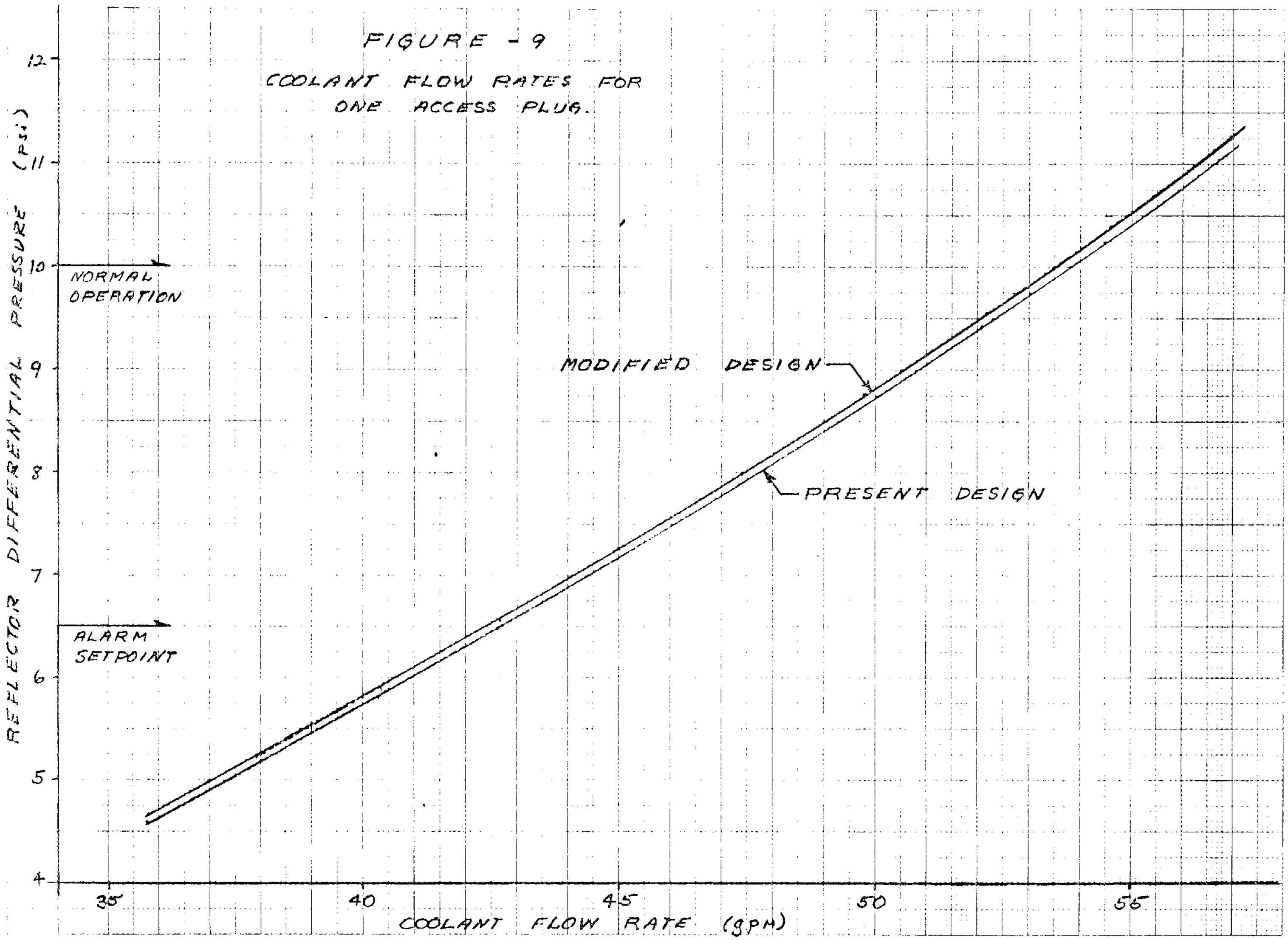


FIGURE - 9
COOLANT FLOW RATES FOR ONE ACCESS PLUG.

TABLE - 2

FLOW RATES FOR THE REMOVABLE REFLECTOR

A - MODIFIED DESIGN REFLECTOR (gpm)

Reflector DP(psi)	Thru. bolts	Semiperm interface	Access plugs	Reflector plena	Total (gpm)
13.0	6.02	251.71	246.07	196.42	700.22
12.0	5.76	241.06	235.80	187.98	670.60
11.0	5.49	229.98	225.06	179.20	639.73
10.0	5.21	218.44	213.82	170.04	607.51
9.0	4.91	206.34	202.06	160.49	573.80
8.0	4.60	193.61	189.74	150.44	538.39
7.0	4.27	180.12	176.96	139.79	501.14
6.0	3.92	165.71	162.96	128.45	461.04

B - CURRENT DESIGN REFLECTOR (gpm)

Reflector DP(psi)	Thru. bolts	Semiperm. interface	Access plugs	Reflector plena	Total (gpm)
13.0	6.02	251.71	247.60	197.80	703.13
12.0	5.76	241.06	237.29	189.32	673.43
11.0	5.49	229.98	226.48	180.50	642.45
10.0	5.21	218.44	215.15	171.32	610.12
9.0	4.91	206.34	203.29	161.71	576.25
8.0	4.60	193.61	190.75	151.61	540.57
7.0	4.27	180.12	177.75	140.90	503.04
6.0	3.92	165.71	163.89	129.48	463.00

C - FLOW DIFFERENCE (Modified vs Present)

Reflector DP(psi)	Delta Q (gpm)
13.0	-2.91
12.0	-2.83
11.0	-2.72
10.0	-2.61
9.0	-2.45
8.0	-2.18
7.0	-1.90
6.0	-1.96

APPENDIX B

HIFI PROJECT MONTHLY PROGRESS REPORTS FOR SEPTEMBER 1985 THROUGH JUNE 1987

Internal Correspondence

October 2, 1985

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

HIFI Project Monthly Progress Report for September 1985

On September 3, 1985, A. Zucker chaired a meeting with L. A. Berry, E. E. Bloom, B. H. Montgomery, M. W. Rosenthal, J. H. Swanks, K. R. Thoms, R. S. Wiltshire, and C. D. West to discuss a proposal, prepared at the request of ORNL's fusion program, for accelerating the HFIR modifications. Minutes of that meeting, along with main issues relating to the project and a sign-off agreement sheet, are attached as Appendix A. To date, only J. H. Swanks has signed off.

L. R. Greenwood of ANL completed analysis of the flux dosimetry experiments performed in early August at low power in the RB positions. The experiments were to be conducted at 10 MW reactor power and were analyzed under that belief. Upon independent investigation by Ken Thoms of the actual operating conditions recorded by Operations Division personnel for the dosimetry runs, it was discovered that the reactor had actually been at 10.8 MW for the first pair of dosimeters and 11.0 MW for the second pair. While it was not necessary that the reactor run at exactly 10.0 MW, it was of course critical that the actual power be known by the experimenters so that the data could be properly extrapolated to 100 MW operation. Since the information was not volunteered to us either at the time of the experiment or later, the analysis of results has had to be redone to account for the 10% difference between the actual and the nominal power.

The dosimeter experiments were very worthwhile and indicate that the dpa rate in 316 stainless steel in the RB facilities is an excellent 10.4 dpa/year in an unshielded facility, and 8.7 dpa/year even inside a 3.8-mm-thick hafnium sleeve. Each of these values assumes the usual 92% on-stream time for HFIR operation. At 8.7 dpa/year, it would require only 30 weeks to achieve 5 dpa in a spectral tailored RB* position. The HIFI Project accelerated schedule has now been revised accordingly; our original version, prepared before the measured dosimetry data were available, had been based on a conservative estimate of 7.9 dpa/year which would have resulted in an eight month irradiation schedule for each type of MFE specimen capsule to obtain by July 1988 the 10 dpa needed to fulfill the OFE US/Japan agreement. With this change, and certain other improvements in our planning, the revised schedule (Fig. 1) allows until June 1987 for the new HFIR RB facilities to be available, an extra, and welcome, allowance of three months over the first proposal for accelerating the project. In fact the accelerated schedule can be achieved with the same beryllium changeout date as the original, more relaxed, proposal.

The HIFI project, and certain other RB facility users, suffered some undeserved verbal abuse from other experimenters at the HFIR during this reporting period. First, the SANS facility in HB-4 complained of a 20% reduction in flux, blaming an HTGR experiment (HRB-18) placed in RB-7 at the same time the hafnium was placed in RB-1. Further investigation by the HB-2 users revealed

that the problem was actually caused by air leaking into their beam tube; when the tube was evacuated and backfilled with helium, the flux returned to normal expected values. The experimenters apologized handsomely.
Second, the users of the pneumatic facility in VXF-7 reported a 20% reduction in thermal flux after the hafnium and HRB experiments were placed in the reactor. However, according to our calculations our experiments, if they had any effect at all on VXF-7, should actually have increased the flux there because they are on the opposite side of the reactor, so that the resultant flux tilt should have increased the flux in VXF-7. More than likely, the reduced flux in VXF-7 is really due to the unpublicized placement by Operations of 588 grams of Cobalt in VXF-8, which is only about 3.3 cm from VXF-7 - this placement was discovered accidentally by Ken Thoms.

Reactor components design is on schedule. Thirteen of fifteen design drawings for the target tower and access hatch (Items 1.2.1 & 1.2.2 in Fig. 1) have been completed except for final checking and signatures. A design report showing that all the pressure boundary components are within the ASME Boiler and Pressure Vessel Code, Section 3, Class 1, is in preparation.

The Reactor Operations Review Committee requested a briefing on the intended modifications to the HFIR that were outlined in the MIFIC report (ORNL/TM-9709, in press) and discussed in the various meetings on the HIFI Project. During the briefing given on September 26, C. D. West presented the MIFIC background and recommendations, and B. H. Montgomery and C. W. Collins presented the HIFI project schedule with a present design update. One of the questions that evolved from this meeting was the effect of reactivity when both fuel elements are withdrawn from the reactor through a smaller stainless steel access hatch. This question will have to be investigated.

B. H. Montgomery

BHM:kfr

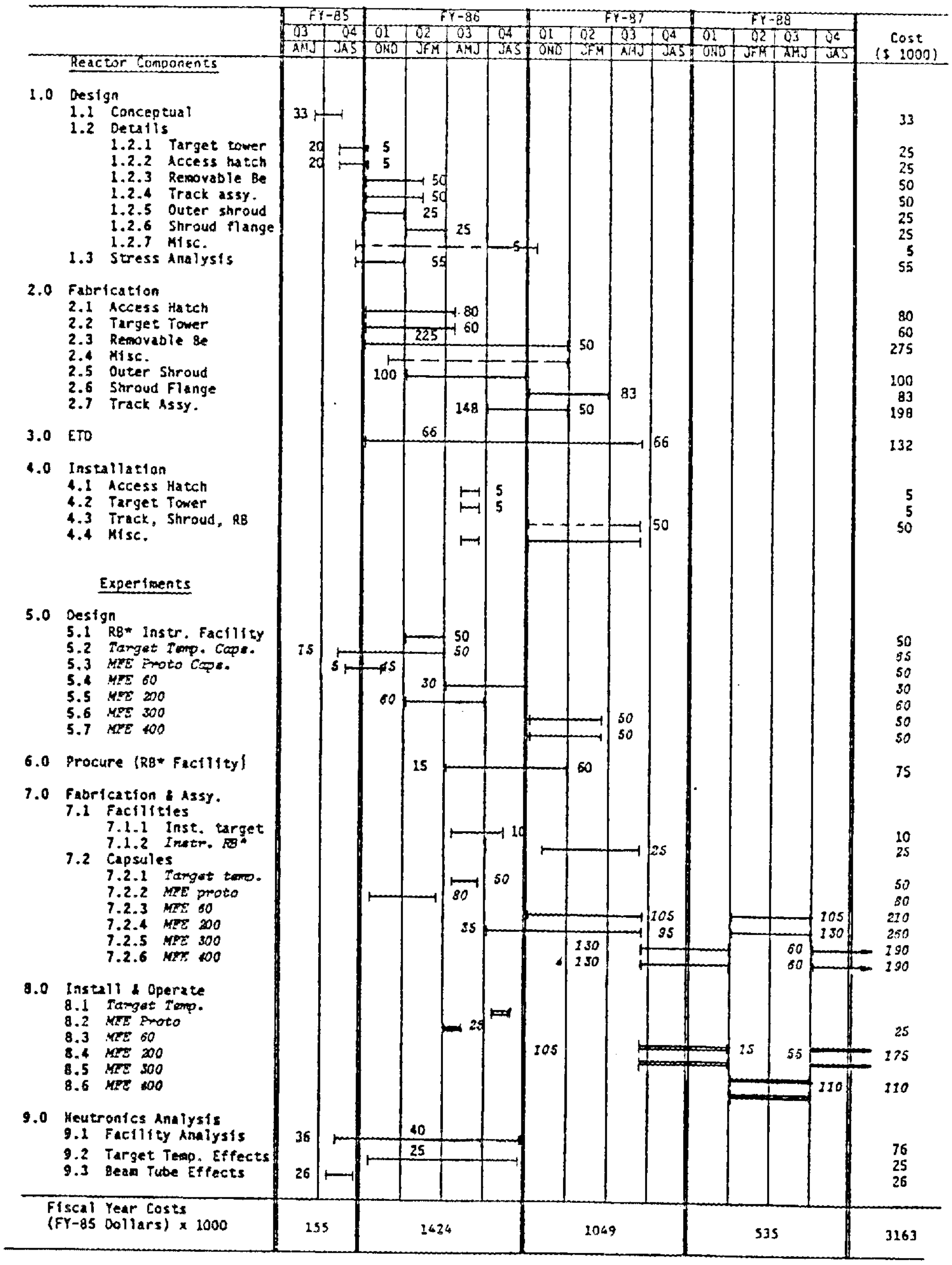
Attachments

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
D. W. Burton
B. L. Corbett
G. R. Hicks
S. S. Hurt
R. V. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
M. W. Rosenthal
J. L. Scott
J. H. Swanks
W. E. Thomas
K. R. Thoms
C. D. West
R. S. Wiltshire
A. Zucker

FIGURE 1

HIFI PROJECT - COST & SCHEDULE ESTIMATES



Italicized portion refers to experimental code

Rev.
BHM/9-30-85

APPENDIX A

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

September 6, 1985

L. A. Berry
M. W. Rosenthal
J. H. Swanks
R. S. Wiltshire
A. Zucker

In addition to the original schedule and cost estimate for HFIR modifications, which is still believed to be valid, a new proposal has been prepared at the request of ORNL's fusion program. The new proposal removes the U.S./Japan fusion experiments from the ORR in September 1986, when the specimens will have been irradiated to 5 dpa, and then transfers them to the new HFIR removable beryllium positions. Irradiation of the U.S./Japan specimens would be resumed, at the HFIR, beginning March 1987 on a schedule leading to all specimens receiving 10 dpa by July 1988, as indeed they must to fulfill the milestones of the agreement between the United States and Japan. Table 1 shows the funding assumptions associated with the original schedule. Table 2 gives the same information for the accelerated schedule. The plan and schedules for getting the work done are also attached (Tables 3, 4 and figures 1, 2).

Our present estimate, based on an initial experiment, is that the operation of a single hafnium shielded capsule shortens the HFIR fuel cycle by less than 5%. On that basis, the additional HFIR fuel costs for two continuously operating hafnium shielded capsules would amount to less than $175,000 per year.

The cost savings to the fusion program for FY 1987 and 1988 are almost certainly underestimated in Table 5 and Figure 3 because the actual cost to OFE of ORR operations in those years is expected to be higher, by $0.5 million to $1.0 million, than the $2.0 million figure taken from the current fusion Field Task Proposals. These increased ORR cost savings will more than offset any possible charges to OFE for HFIR irradiations (the present rate for an RB position, to those programs that must pay for irradiations at the HFIR, is typically $350,000 per year). The major remaining uncertainty is the cost of shutting down the ORR and of maintaining surveillance on it. This is true whichever schedule is chosen but is a matter of particular urgency under the accelerated schedule in which the ORR would close down about one year from now.

A decision about whether to proceed with the accelerated schedule needs to be made immediately, if the schedule is to be met, although the additional funds (over and above the funds for the initial schedule, which are needed on October 1) do not need to be in hand until April.

At the September 3 meeting, there seemed to be a consensus on the main issues related to this project, and I was asked to draft a letter listing those issues and the steps needed to resolve them; this is that letter and the list is appended. I was directed to send it to you and ask you to indicate (by sign-off) your agreement - or, of course, to identify alternatives.

C. D. West

Attachments

pc: E. E. Bloom   B. H. Montgomery   K. R. Thoms

APPENDIX

Issue	Action
1986 and 1987 ARIM funding of $250,000 in each year is essential for either schedule	J. H. Swanks to get DOE commitment by October 4
New 1986 OFE funding of $380,000 is essential for the original schedule, and spending must begin on Oct. 1	M. W. Rosenthal to obtain money in the financial plan through John Clarke (by Oct. 1)
Additional new 1986 OFE funding of $299,000 is needed for the accelerated schedule	M. W. Rosenthal to seek John Clarke's commitment for this additional money to be available no later than Apr. 1, 1986 (Note net savings to the fusion programs in 1987 are approximately $1.6 million)
OFE funds of $238,000 (1987 dollars are needed in 1987 for the accelerated schedule	M. W. Rosenthal to seek John Clarke's commitment
$80,000 of GPE funding is needed in 1986, on either schedule	C. D. West to submit a formal request by Oct. 31 for funding to be available by Jan. 1
Additional Japanese funds of $246,000 (1987 dollars) - or an alternative source - are needed in FY 1987 for the accelerated schedule	E. E. Bloom to discuss with Japanese
The cost of mothballing the ORR and keeping it under surveillance must be estimated, on either schedule	J. H. Swanks to prepare a plan by November 1
The expected neutron charges to OFE for operating experiments in the HFIR must be estimated (OFE is not presently charged for HFIR irradiations)	J. H. Swanks to propose a cost schedule by October 1
In order to meet the accelerated schedule, the project must be given a high priority for resources, especially in the Operations and P&E Divisions	Monthly progress reports to be copied to R. S. Wiltshire and appropriate Division Directors by the Project Manager
The mechanism and funding for continued operation of the BSR must be worked out, on either schedule	J. H. Swanks to prepare a plan by November 1

Approved: L. A. Berry ____________________

M. W. Rosenthal ____________________

J. H. Swanks ____________________

R. S. Wiltshire ____________________

A. Zucker ____________________

Table 1

Initial Funding Prospectus for HFIR Upgrade on Original Schedule

	Current year $,000	
	1986	1987
Reactor facility modifications		
ARIM	250	250
ORNL-GPE	80	
U.S./Japan collaboration	70	
New BES funds	54	57
New Japanese funds		86
New OFE funds	380 843	393
Fusion experiments		
U.S./Japan collaboration	134	
New Japanese funds	___	162
Subtotal	977	555
BES beryllium	225	___
Total	1202	555

BHM/9-4-85

Table 2

Funding Prospectus for HFIR Upgrade on Accelerated Schedule

	Current year $,000		
	1986	1987	1988
Reactor facility modifications			
ARIM	250	249	
ORNL-GPE	80		
U.S./Japan collaboration	70*		
New BES funds	54	58	
New Japanese funds		69*	
New OFE funds	395* 849	376	
Fusion experiments			
U.S./Japan collaboration	134	374	607
New OFE funds	284	238	48
New Japanese funds	___	177	___
Subtotal	1267	1165	655
BES beryllium	225	___	___
Total	1492	1165	655

* Should be capital funding

BHM/9-4-85

Fig. 1

HIFI PROJECT - COST & SCHEDULE ESTIMATES

	FY-85		FY-86				FY-87				
	Q3 AMJ	Q4 JAS	Q1 OND	Q2 JFM	Q3 AMJ	Q4 JAS	Q1 OND	Q2 JFM	Q3 AMJ	Q4 JAS	Cost ($ 1000)
Reactor Components											
1.0 Design											
1.1 Conceptual	33										33
1.2 Details											
1.2.1 Target tower	20		30								50
1.2.2 Access hatch	20		30								50
1.2.3 Removable Be				25							25
1.2.4 Track assy.				25							25
1.2.5 Outer shroud						25					25
1.2.6 Shroud flange						25					25
1.2.7 Misc.						5					5
1.3 Stress Analysis				55							55
2.0 Fabrication											
2.1 Access Hatch					80						80
2.2 Target Tower					60						60
2.3 Removable Be			275								275
2.4 Misc.											
2.5 Outer Shroud									100		100
2.6 Shroud Flange									83		83
2.7 Track Assy.				198							198
3.0 ETD				52					67		119
4.0 Installation											
4.1 Access Hatch						5					5
4.2 Target Tower						5					5
4.3 Track, Shroud, RB									50		50
4.4 Misc.											
Experiments											
5.0 Design											
5.1 RB* Instr. Facility						50					50
5.2 *Target Temp. Caps.*	*15*				*50*						*65*
5.3 *MFE Proto Caps.*									*150*		*150*
6.0 Procure (RB* Facility)					25				50		75
7.0 Fabrication & Assy.											
7.1 Facilities											
7.1.1 Inst. target						10					10
7.1.2 *Instr. RB**									*25*		*25*
7.2 Capsules											
7.2.1 *Target temp.*						*50*					*50*
7.2.2 *MFE proto*											
8.0 Install & Operate											
8.1 *Target Temp.*											
8.2 *MFE Proto*											
9.0 Neutronics Analysis											
9.1 Facility Analysis	36			40							76
9.2 Target Temp. Effects				25							25
9.3 Beam Tube Effects	26										26
Fiscal Year Costs (FY-85 Dollars) x 1000	150		1145				525				1820

Italicized portion refers to experimental costs

BHM/8-29-85

Table 3

Funding of Tasks from Original Schedule

FY 1986

(FY 85 $,000)

Task	Cost	ARIM	GPE	U.S./J	New BES	New J	New OFE
1.2.1	30						30
1.2.2	30						30
1.2.3	25						25
1.2.4	25						25
1.2.5	25						25
1.2.6	25						25
1.2.7	5			5.			
1.3	55						55
2.1	80						80
2.2	60			60			
2.3	50*				50		
2.7	198	198					
3.0	52	52					
4.1	5						5
4.2	5						5
5.1	50		50				
5.2	50			50			
6.0	25		25				
7.1.1	10						10
7.2.1	50			50			
9.1	40						40
9.2	25			25			
	920*	250	75	190	50	0	~~355~~ 380
				FY 1987			
2.5	100	100					
2.6	83	83					
3.0	67	67					
4.3	50				50		
5.3	150					150	
6.0	50					50	
7.1.2	25					25	
7.2.2							
8.2							
	525	250	0	0	50	225	0

* Plus $225 K for removable Be

BHM/8-29-85

Fig. 2

HIFI PROJECT - COST & SCHEDULE ESTIMATES
ACCELERATED MFE SCHEDULE

	FY-85		FY-86				FY-87				FY-88				Cost
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	($ 1000)
Reactor Components															
1.0 Design															
1.1 Conceptual	33														33
1.2 Details															
1.2.1 Target tower	20		30												50
1.2.2 Access hatch	20		30												50
1.2.3 Removable Be				25											25
1.2.4 Track assy.				25											25
1.2.5 Outer shroud						25									25
1.2.6 Shroud flange						25									25
1.2.7 Misc.						5									5
1.3 Stress Analysis				55											55
2.0 Fabrication															
2.1 Access Hatch					80										80
2.2 Target Tower					60										60
2.3 Removable Be			275												275
2.4 Misc.															
2.5 Outer Shroud									100						100
2.6 Shroud Flange									83						83
2.7 Track Assy.				198											198
3.0 ETD				66					66						132
4.0 Installation															
4.1 Access Hatch						5									5
4.2 Target Tower						5									5
4.3 Track, Shroud, RB									50						50
4.4 Misc.															
Experiments															
5.0 Design															
5.1 RB* Instr. Facility					50										50
5.2 *Target Temp. Caps.*	*15*				*50*										*65*
5.3 *MFE Proto Caps.*		*5*	*45*												*50*
5.4 *MFE 60*				*30*											*30*
5.5 *MFE 200*			*60*												*60*
5.6 *MFE 300*									*50*						*50*
5.7 *MFE 400*									*50*						*50*
6.0 Procure (RB* Facility)				15				60							75
7.0 Fabrication & Assy.															
7.1 Facilities															
7.1.1 Inst. target						10									10
7.1.2 *Instr. RB**									*25*						*25*
7.2 Capsules															
7.2.1 *Target temp.*						*50*									*50*
7.2.2 *MFE proto*					*80*										*80*
7.2.3 *MFE 60*									*105*					*105*	*210*
7.2.4 *MFE 200*					*35*				*95*					*130*	*260*
7.2.5 *MFE 300*								*130*					*60*		*190*
7.2.6 *MFE 400*								*130*					*60*		*190*
8.0 Install & Operate															
8.1 *Target Temp.*															
8.2 *MFE Proto*					*25*										*25*
8.3 *MFE 60*							*105*				*15*		*55*		*175*
8.4 *MFE 200*															
8.5 *MFE 300*														*110*	*110*
8.6 *MFE 400*															
9.0 Neutronics Analysis															
9.1 Facility Analysis	36			40											76
9.2 Target Temp. Effects				25											25
9.3 Beam Tube Effects	26														26
Fiscal Year Costs (FY-85 Dollars) x 1000	155		1424				1049				535				3163

Italicized portion refers to experimental code

BHM/9-4-85

Table 4

Funding of Tasks from Accelerated Schedule

FY 1986

(FY 85 $,000)

Task	Cost	ARIM	GPE	U.S./J	New BES	New J	New OFE
1.2.1	30						30
1.2.2	30						30
1.2.3	25						25
1.2.4	25						25
1.2.5	25						25
1.2.6	25						25
1.2.7	5			5			
1.3	55						55
2.1	80						80
2.2	60			60			
2.3	50*				50		
2.7	198	198					
3.0	66	52					14
4.1	5						5
4.2	5						5
5.1	50		50				
5.2	50			50			
5.3	45						45
5.4	30						30
5.5	60						60
6.0	15		15				
7.1.1	10		10				
7.2.1	50			50			
7.2.2	80						80
7.2.4	35						35
8.2	25						25
9.1	40						40
9.2	25			25			
	1199*	250	75	190**	50	0	634

* Plus $225 K for RB

** From U.S./J Program Agreement (footnotes 9 through 13)

BHM/9-4-85

Table 4 (cont'd)

Funding of Tasks from Accelerated Schedule

FY 1987

(FY 85 $,000)

Task	Cost	ARIM	GPE	U.S./J	New BES	New J	New OFE
2.5	100	100					
2.6	83	83					
3.0	66	66					
4.3	50				50		
5.6	50			50			
5.7	50			50			
6.0	60					60	
7.1.2	25					25	
7.2.3	105			97			8
7.2.4	95						95
7.2.5	130					130	
7.2.6	130			130			
8.3&.4	105						105
	1049	249	0	327**	50	215	208

FY 1988

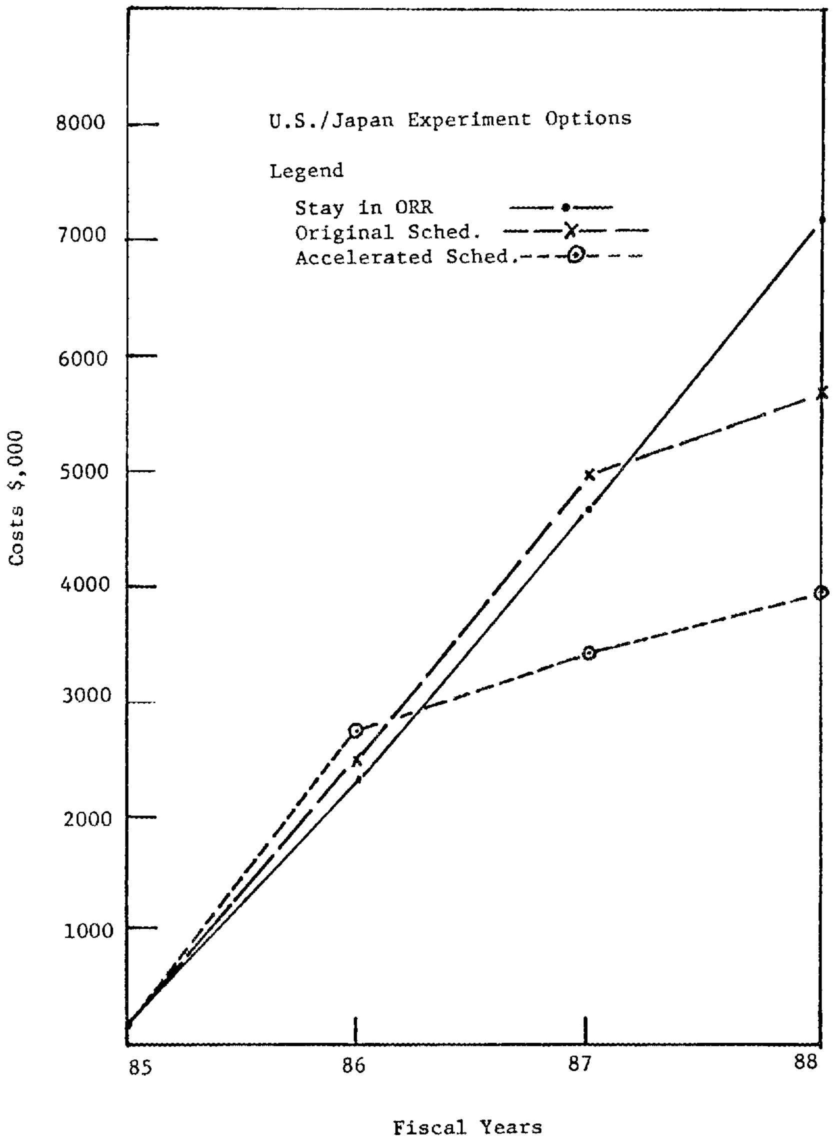
Task	Cost	ARIM	GPE	U.S./J	New BES	New J	New OFE
7.2.3	105			105			
7.2.4	130			130			
7.2.5	60			60			
7.2.6	60			60			
8.3&.4	70			70			
8.5&.6	110			71			39
	535			496**			39
3-yr. total	2783*	499	75	1013	100	215	881

* Plus $225 K for removable beryllium

** From U.S./J Program Agreement (footnotes 9 through 13)

BHM/9-4-85

Fig. 3



BHM/8-29-85

Table 5

U.S./Japan Capsule Irradiation Options and Costs

	All figures in 1985 $,000			
	1986	1987	1988	1986 - 1988
HFIR Modifications				
Original schedule	795[a]	375	0	1,170
Accelerated schedule	809[a]	374	0	1,183
U.S./Japan Experiment Options				
Continue in ORR	2,342[b]	2,342[b]	257[c] + 2,255[d]	7,196
Original HFIR mod. schedule	125 + 2,342[b]	150 + 2,342[b]	405[g] + 291[e]	5,655
Accelerated HFIR mod.	390 + 2,342[b]	675[f]	535[f]	3,942

[a] Excluding BES beryllium ($225,000)

[b] $2.0 million ORR operation + $342,000 ORR experiment surveillance as projected in U.S./Japan program plan

[c] Reincapsulation at the ORR after 10 dpa

[d] $2.0 million ORR operation + $255,000 ORR experiment surveillance

[e] ORR operation in early part of FY 1988

[f] All of this funding is for reincapsulation and surveillance at HFIR of specimens presently in the ORR

[g] Includes HFIR capsule design, reincapsulation and surveillance (based on J. L. Scott's estimates)

C. D. West/8-29-85

MARTIN MARIETTA

Internal Correspondence

November 4, 1985

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

HIFI Project Monthly Progress Report for October 1985

As word of the HIFI Project spreads, additional potential users of the enlarged removable beryllium facilities are coming forward. The HTGR program has expressed an interest in designing new HRB capsules; a conceptual design for performing graphite creep experiments, similar to the OC series performed at the ORR, has been developed for them. The Fusion Energy program has decided to postpone the start of their copper irradiation experiments to utilize the larger RB* positions, which will allow 60% more specimens per capsule than the present RB facilities.

A revised cost and schedule estimate for the accelerated MFE schedule, with costs expressed in FY 1986 dollars, is shown in Fig. 1. Table 1 shows the funding for each of the tasks in this schedule. The US/Japan and New BES funds are in hand. A formal request for GPE funding was submitted on October 29, 1985. The ARIM funding, that was originally scheduled for the criticality facility, has been verbally dedicated to the HIFI Project, but is not yet in hand.

The Office of Fusion Energy requested a technical review of the project on November 1, 1985. As a result of this meeting the OFE is transferring the funding for work on the original schedule and enough additional money to work on the accelerated schedule at least until January: the remaining funding for the accelerated schedule is expected to be sent by February of this fiscal year.

The issues and actions that were included in the Appendix of the September monthly report are shown in Table 2 and include the status of each item. Thus far, only L. A. Berry, M. W. Rosenthal, and J. H. Swanks have signed off.

Some additional data have been obtained on the effect that the 3.8-mm-thick hafnium sleeve had on the HFIR fuel cycle lifetime. This sleeve was in the RB-1 facility during cycle 269 which was also the first cycle that the HTGR capsules (HRB-17/-18 in RB-5/-7) were operated. The expected cycle time, based on reactivity measurements of the core, used for cycle 269 was 22.4 (±0.3) full power days (FPD's). The actual measured cycle lifetime was 20.8 FPD's, a net reduction (due to the Hf, the HRB's, and other poisons that were in the reactor at that time) of 1.6 (± 0.3) days. Cycle 270 was purposely reduced so that the shutdown could be more efficiently coordinated with normal craft hours thus making it impossible accurately to determine the effects of HRB-17/-18 on cycle lifetime. The core used in cycle 271 (completed on October 22) was expected, on the basis of reactivity measurements, to operate for 21.9 (± 0.3) FPD's. It actually ran for 21.2 FPD's - a net reduction of 0.7 (± 0.3) days. If we assume that this reduction in cycle 271 length was due solely to the HRB-17/-18 capsules (because the hafnium was not present), we can estimate that the effect of the Hf sleeve in cycle 269 was 1.6-0.7 or

0.9 (± 0.3) days. If we assume an average cycle lifetime of 22 days the Hf sleeve should result in ∿4% reduction, very close to the 5% estimate made at the beginning of the HIFI project.

Engineering design and analysis for the target tower and access hatch (Tasks 1.2.1, 1.2.2, and a major portion of 1.3) are considered to be 70% complete. A purchase requisition has been submitted for the access-hatch forged material.

It was noted in the previous monthly that a question was raised in the RORC briefing concerning the effect of reactivity when both fuel elements are withdrawn from the reactor through a small stainless steel access hatch. Operations Division's solution to this problem under the present configuration is to add strips of cadmium, coated with aluminum, between the inner and outer fuel elements thus poisoning the fuel. This would also be their solution for the new design.

BH Montgomery

B. H. Montgomery, Y-12, 9108, MS-1 (4-0258)

BHM:kfr

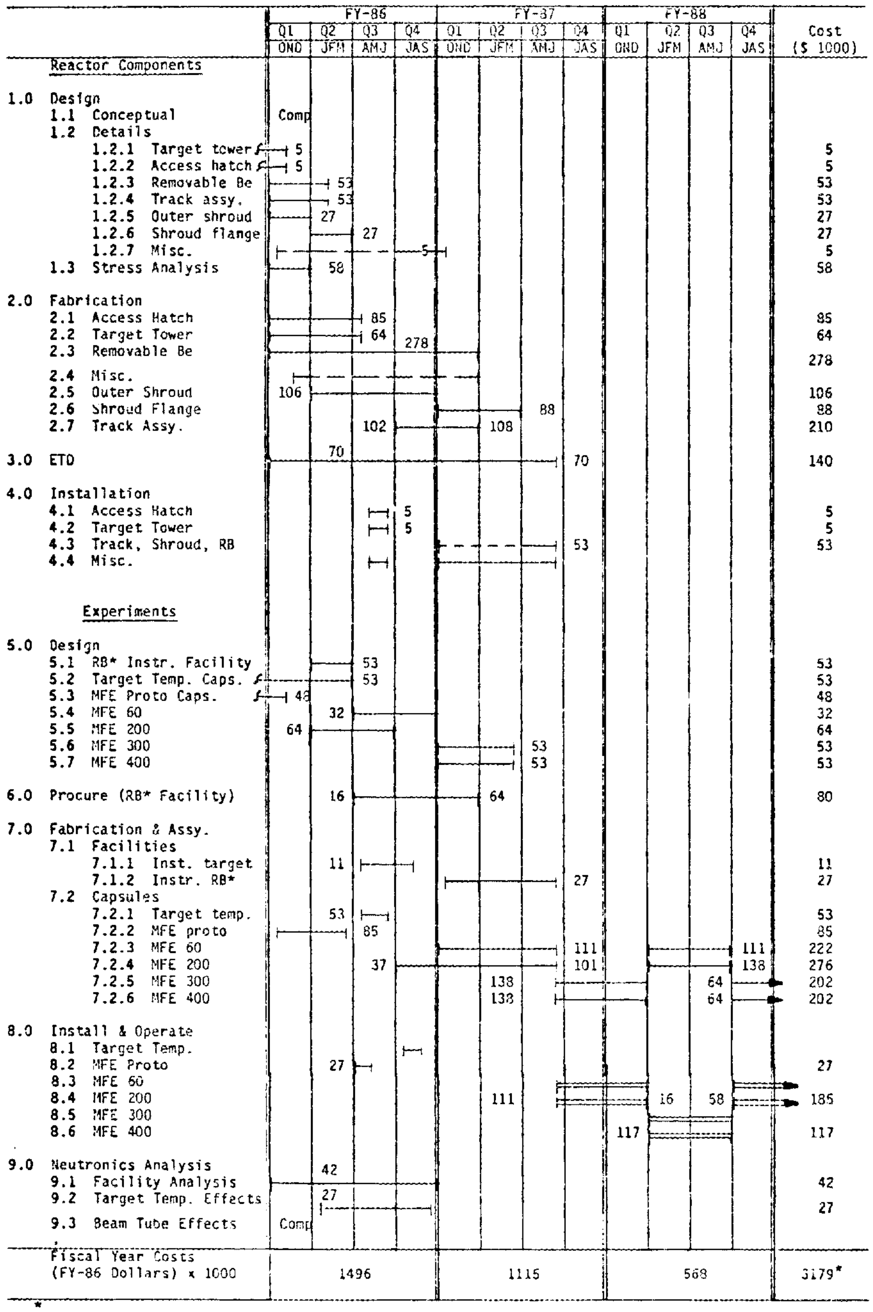
Attachments

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
D. W. Burton
B. L. Corbett
G. R. Hicks
S. S. Hurt
R. V. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
M. W. Rosenthal
J. L. Scott
J. H. Swanks
W. E. Thomas
K. R. Thoms
C. D. West
R. S. Wiltshire
A. Zucker

FIGURE 1

HIFI PROJECT - COST & SCHEDULE ESTIMATES
ACCELERATED MFE SCHEDULE



* Plus $155 K spent in FY-1985 on design and neutronic analysis

Rev.
BHM/10-29-85

Table 1

Funding of Tasks from Accelerated Schedule

FY 1986

(FY 86 $,000)

Task	Cost	ARIM	GPE	U.S./J	New BES	New J	New OFE
1.2.1	5						5
1.2.2	5						5
1.2.3	53						53
1.2.4	53						53
1.2.5	27						27
1.2.6	27						27
1.2.7	5			5			
1.3	58						58
2.1	85						85
2.2	64			64			
2.3	53				53		
2.5	106	106					
2.7	102	102					
3.0	70	42					28
4.1	5						5
4.2	5						5
5.1	53		53				
5.2	53			53			
5.3	48						48
5.4	32						32
5.5	64						64
6.0	16		16				
7.1.1	11		11				
7.2.1	53			53			
7.2.2	85						85
7.2.4	37						37
8.2	27						27
9.1	42						42
9.2	27			27			
	1271*	250	80	202**	53	0	686

* Plus $225 K for RB

** From U.S./J Program Agreement (footnotes 9 through 13)

BHM/10-29-85

Table 1 (cont'd)

Funding of Tasks from Accelerated Schedule

FY 1987

(FY 86 $,000)

Task	Cost	ARIM	GPE	U.S./J	New BES	New J	New OFE
2.6	88	88					
2.7	108	108					
3.0	70	54					16
4.3	53				53		
5.6	53			53			
5.7	53			53			
6.0	64					64	
7.1.2	27					27	
7.2.3	111			103			8
7.2.4	101						101
7.2.5	138					138	
7.2.6	138			138			
8.3&.4	111						111
	1115	250	0	347**	53	229	236
FY 1988							
7.2.3	111			111			
7.2.4	138			138			
7.2.5	64			64			
7.2.6	64			64			
8.3&.4	74			74			
8.5&.6	117			76			41
	568			527**			41
3-yr. total	2954*	500	80	1076	106	229	963

* Plus $225 K for removable beryllium

** From U.S./J Program Agreement (footnotes 9 through 13)

BHM/10-29-85

TABLE 2

Item	Issue	Action	Comment
1	1986 and 1987 ARIM funding of $250,000 in each year is essential for either schedule	J. H. Swanks to get DOE commitment by October 4	Under advisement
2	New 1986 OFE funding of $380,000 is essential for the original schedule, and spending must begin on Oct. 1	M. W. Rosenthal to obtain money in the financial plan through John Clarke (by Oct. 1)	Letter sent to John Clarke
3	Additional new 1986 OFE funding of $299,000 is needed for the accelerated schedule	M. W. Rosenthal to seek John Clarke's commitment for this additional money to be available no later than Apr. 1, 1986 (Note net savings to the fusion programs in 1987 are approximately $1.6 million)	Same as Item 2
4	OFE funds of $238,000 (1987 dollars are needed in 1987 for the accelerated schedule	M. W. Rosenthal to seek John Clarke's commitment	
5	$80,000 of GPE funding is needed in 1986, on either schedule	C. D. West to submit a formal request by Oct. 31 for funding to be available by Jan. 1	Request submitted
6	Additional Japanese funds of $246,000 (1987 dollars) - or an alternative source - are needed in FY 1987 for the accelerated schedule	E. E. Bloom to discuss with Japanese	
7	The cost of mothballing the ORR and keeping it under surveillance must be estimated, on either schedule	J. H. Swanks to prepare a plan by November 1	Estimate being prepared
8	The expected neutron charges to OFE for operating experiments in the HFIR must be estimated (OFE is not presently charged for HFIR irradiations)	J. H. Swanks to propose a cost schedule by October 1	Cost schedule being prepared
9	In order to meet the accelerated schedule, the project must be given a high priority for resources, especially in the Operations and P&E Divisions	Monthly progress reports to be copied to R. S. Wiltshire and appropriate Division Directors by the Project Manager	Second in the series
10	The mechanism and funding for continued operation of the BSR must be worked out, on either schedule	J. H. Swanks to prepare a plan by November 1	Plan being prepared

Approved: L. A. Berry Signed off 10/23/85

M. W. Rosenthal Signed off 10/8/85

J. H. Swanks Signed off 9/19/85

R. S. Wiltshire ____________

A. Zucker ____________

MARTIN MARIETTA

Internal Correspondence

December 3, 1985

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

HIFI Project Monthly Progress Report for November 1985

As a result of the technical review with the Office of Fusion Energy (DOE Headquarters) on November 1, 1985, the fusion program is transfering $610,000 (capital) for the HIFI Project work. This money will be in the December 1985 financial plan. Already on hand is $100,000 (capital) from BES. A Request and Approval for Equipment, Maintenance, and Experimental Projects (OR-638) was submitted on November 19, 1985, for $710,000 total capital funding. The attached table shows the funding committed to the HIFI Project this year with the shortfall for which funding sources are still to be found.

With the commitment to the HFIR modification project made, the Irradiation Engineering Group is in need of additional manpower to oversee the design and construction of the fusion materials irradiation experiments that will be performed in the new facilities. Also, additional potential sponsors, such as the HTGR program, have expressed interest in some new HFIR experiments and have requested conceptual designs and estimates. A request for another engineer has been submitted, locally, and a job listing posted. At this time, the limiting resource has changed from money to effort in the Irradiation Engineering Group.

Design of the target tower and access hatch is 95% complete. Preliminary drawings have been sent out for review and comment with minor changes expected. The engineering design and analysis report has been approved and issued. Design is continuing on other reactor components at an accelerated rate to maintain schedule. Material orders have been placed for the forging for access hatch and aluminum for the target tower.

The RERTR Program Managers at ANL, in discussion with their sponsors at DOE, now feel that it will not be possible to meet their program goals for irradiation by mid-FY 1987 even if the reactor is dedicated to their work after the end of FY 1986. The reason for this is that the original idea held by ANL of an accelerated schedule was based on an assumption that the limiting factor is the number of core measurements to be taken, and the out-of-pile time needed to make them. It has now been realized that the limitation is in fact the number of different fuel elements that are, in the present program plan, to be taken to high burnup. Unless a reduced number is accepted, the RERTR full-core irradiation series will not be completed until sometime in (early) FY 1988. Presumably, DOE must decide whether to change the program goals or, if not, how to fund continued operation of the ORR after the US/Japan fusion experiments are removed.

BHM

B. H. Montgomery, Y-12, 9108, MS-1 (4-0258)

BHM:kfr

Attachment

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
D. W. Burton
B. L. Corbett
G. R. Hicks
S. S. Hurt
R. V. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
J. H. Swanks
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. D. West
R. S. Wiltshire
A. Zucker

HIFI Project Funding for FY 1986

Source	Capital	Expense	Total
OFE	$610,000[1]		610,000
BES	100,000[1]	54,000	154,000
US/Japan		202,000	202,000
GPE	80,000[2]		80,000
Total	790,000	256,000	1,046,000
	Funding needed in FY-86		$1,271,000[3]
	Funding committed		1,046,000[3]
	Shortfall		225,000

[1] OR-638 submitted 11/19/85

[2] GPE request submitted 10/29/85

[3] Excluding costs of new removable beryllium, scheduled for replacement at this time independently of the HIFI project.

12/3/85

Internal Correspondence

January 2, 1986

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

HIFI Project Monthly Progress Report for December 1985

The Request and Approval for Equipment, Maintenance, and Experimental Projects (OR-638, Project 86-ORNL-2, HFIR Irradiation Facilities Upgrade) was approved on December 20, 1985, and was received by the Project Leader on December 31, 1985. Instead of the $710 K that was scheduled, only $610 K was provided in the December FY 86 Financial Plan ($510 K Program AT (Fusion) and $100 K Program KC (Basic Energy Sciences) with the remaining $100 K to be provided by the Office of Fusion Energy in a future financial plan. The late approval and delivery of this document caused a delay in opening work orders pertinent to the project schedule: the effect on the schedule (which was dependent on funding being available on October 1) will be further analyzed following the placement of purchase orders for certain fabricated items.

The General Purpose Equipment funds of $80 K for the facility instrument and control package were approved by the Laboratory Executive Committee in December 1985. Word of this approval was not received by the Project Leader until December 31, 1985. and therefore, no procurement action has yet taken place.

The neutronics analysis, which was deemed a very important task in the HIFI Project, will be delayed for some unknown time due to lack of available personnel in Operations Division. As previously found by the Materials Irradiation Facilities Improvement Committee (MIFIC), the Operations Division and reactor experimenters will be severely handicapped by the lack of a neutronic computational capability to calculate the effect on the reactor and on other experiments of introducing neutron absorbers, especially spectral tailoring shields, if this task is not completed.

The issue and actions that were agreed to at the beginning of this project are shown in Table 1 and include an updated status of each item. Please note that there is no ARIM funding designated for this project in 1986 or 1987 and also, according to E. E. Bloom, there will be no additional Japanese funds available in 1987.

A revised cost and schedule estimate is shown in Fig. 1. Table 2 shows the funding for each task in the schedule.

Engineering design of the reactor components is continuing. The target tower design was revised following thermal hydraulic calculations to allow additional cooling water flow. The target tower and access hatch drawings are scheduled to be released at the end of January.

B. H. Montgomery, Project Leader, 9108, MS-1 (4-0258)

BHM:kfr

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
D. W. Burton
B. L. Corbett
G. R. Hicks
S. S. Hurt
R. V. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
J. H. Swanks
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. D. West
R. S. Wiltshire
A. Zucker

TABLE 1

Item	Issue	Action	Status
1	1986 and 1987 ARIM funding of $250,000 in each year is essential for either schedule	J. H. Swanks to get DOE commitment by October 4	No ARIM funding for 1986 or 1987
2	New 1986 OFE funding of $380,000 is essential for the original schedule, and spending must begin on Oct. 1	M. W. Rosenthal to obtain money in the financial plan through John Clarke (by Oct. 1)	See Note 1
3	Additional new 1986 OFE funding of $299,000 is needed for the accelerated schedule	M. W. Rosenthal to seek John Clarke's commitment for this additional money to be available no later than Apr. 1, 1986 (Note net savings to the fusion programs in 1987 are approximately $1.6 million)	See Note 1
4	OFE funds of $238,000 (1987 dollars are needed in 1987 for the accelerated schedule	M. W. Rosenthal to seek John Clarke's commitment	See Note 2
5	$80,000 of GPE funding is needed in 1986, on either schedule	C. D. West to submit a formal request by Oct. 31 for funding to be available by Jan. 1	Request approved by Executive Committee
6	Additional Japanese funds of $246,000 (1987 dollars) - or an alternative source - are needed in FY 1987 for the accelerated schedule	E. E. Bloom to discuss with Japanese	No additional Japanese funds
7	The cost of mothballing the ORR and keeping it under surveillance must be estimated, on either schedule	J. H. Swanks to prepare a plan by November 1	See Note 3
8	The expected neutron charges to OFE for operating experiments in the HFIR must be estimated (OFE is not presently charged for HFIR irradiations)	J. H. Swanks to propose a cost schedule by October 1	See Note 3
9	In order to meet the accelerated schedule, the project must be given a high priority for resources, especially in the Operations and P&E Divisions	Monthly progress reports to be copied to R. S. Wiltshire and appropriate Division Directors by the Project Manager	Fourth in the series
10	The mechanism and funding for continued operation of the BSR must be worked out, on either schedule	J. H. Swanks to prepare a plan by November 1	See Note 3

Approved: L. A. Berry Signed off 10/23/85

M. W. Rosenthal Signed off 10/8/85

J. H. Swanks Signed off 9/19/85

R. S. Wiltshire ______________

A. Zucker ______________

Note 1: (Items 2&3) Received $510 K (capital) from OFE with an additional $100 K promised.

Note 2: Requested $465 K ($358 K expense & $107 K capital) in the Fusion Energy Mini-189 for FY 87. This includes Items 4&6.

Note 3: Per telecon with J. H. Swanks on 12-31-85, estimates have been prepared for Items 7&8 and are awaiting discussion. On Item 10, several plans have been prepared, including a cost estimate for remote operation of the BSR by HFIR personnel. The plan implemented will depend on when the ORR is shut down.

Figure 1

HIFI PROJECT - COST & SCHEDULE ESTIMATES
ACCELERATED MFE SCHEDULE

	FY-86				FY-87				FY-88				Cost
	Q1 OND	Q2 JFM	Q3 AMJ	Q4 JAS	Q1 OND	Q2 JFM	Q3 AMJ	Q4 JAS	Q1 OND	Q2 JFM	Q3 AMJ	Q4 JAS	($ 1000)
Reactor Components													
1.0 Design													
1.1 Conceptual	Comp												
1.2 Details													
1.2.1 Target tower		5	Comp										5
1.2.2 Access hatch		5	Comp										5
1.2.3 Removable Be		53											53
1.2.4 Track assy.		53											53
1.2.5 Outer shroud		27	Comp										27
1.2.6 Shroud flange			27										27
1.2.7 Misc.				5									5
1.3 Stress Analysis		58	Comp										58
2.0 Fabrication													
2.1 Access Hatch			85										85
2.2 Target Tower			64										64
2.3 Removable Be				204		135							339
2.4 Misc.													
2 5 Outer Shroud	105												105
2.6 Shroud Flange							88						88
2.7 Track Assy.		102				108							210
3.0 ETD		70						70					140
4.0 Installation													
4.1 Access Hatch				5									5
4.2 Target Tower				5									5
4.3 Track, Shroud, RB								53					53
4.4 Misc.													
Experiments													
5.0 Design													
5.1 RB* Instr. Facility			53										53
5.2 Target Temp. Caps.			53										53
5.3 MFE Proto Caps.	48												48
5.4 MFE 60		32											32
5.5 MFE 200	64												64
5.6 MFE 300							53						53
5.7 MFE 400							53						53
6.0 Procure (RB* Facility)		16				64							80
7.0 Fabrication & Assy.													
7.1 Facilities													
7.1.1 Inst. target		11											11
7.1.2 Instr. RB*								27					27
7.2 Capsules													
7.2.1 Target temp.		53											53
7.2.2 MFE proto			85										85
7.2.3 MFE 60								111				111	222
7.2.4 MFE 200			37					101				138	276
7.2.5 MFE 300						138					64		202
7.2.6 MFE 400						138					64		202
8.0 Install & Operate													
8.1 Target Temp.													
8.2 MFE Proto		27											27
8.3 MFE 60													
8.4 MFE 200						111				16	58		185
8.5 MFE 300													
8.6 MFE 400									117				117
9.0 Neutronics Analysis													
9.1 Facility Analysis		42											42
9.2 Target Temp. Effects		27											27
9.3 Beam Tube Effects	Comp												
Fiscal Year Costs (FY-86 Dollars) x 1000	1421				1250				568				3239*

* Plus $155 K spent in FY-1985 on design and neutronic analysis

Rev.
BHM/12-17-85

Table 2

Funding of Tasks from Accelerated Schedule

FY 1986

(FY 86 $,000)

Task	Cost	GPE	U.S./J	New BES	New OFE	Shortfall
1.2.1	5				5	
1.2.2	5				5	
1.2.3	53				53	
1.2.4	53				53	
1.2.5	27				27	
1.2.6	27				27	
1.2.7	5				5	
1.3	58				58	
2.1	85				85	
2.2	64				64	
2.3	54[1]			54		
2.5	105			100[c]		5
2.7	102				102	
3.0	70				47	23
4.1	5				5	
4.2	5				5	
5.1	53	53				
5.2	53		53			
5.3	48					48
5.4	32		32			
5.5	64		64			
6.0	16	16				
7.1.1	11	11				
7.2.1	53		53			
7.2.2	85					85
7.2.4	37					37
8.2	27					27
9.1	42				42	
9.2	27				27	
	1271[1]	80[c]	202[2]	154	610[3]	225

[1] Plus $150 K for removable beryllium material (expenditure costed to Operations Division).

[2] From U.S./J Program Agreement (Tasks 9 through 13).

[3] $510 K (capital) received in December Financial Plan with $100 K promised in a future plan.

[c] Capital

BHM/1-2-86

Table 2 (continued)

Funding of Tasks from Accelerated Schedule

FY 1987

(FY 86 $,000)

Task	Cost	GPE	U.S./J	New BES	New OFE	Shortfall
2.3	3					
2.6	88					88[c]
2.7	108					108[c]
3.0	70				16[c]	54[c]
4.3	53			53		
5.6	53		53			
5.7	53		53			
6.0	64				64[c]	
7.1.2	27				27[c]	
7.2.3	111		103		8	
7.2.4	101				101	
7.2.5	138				138	
7.2.6	138		138			
8.3&.4	111				111	
	1115[3]	0	347[2]	53	465[4]	250
FY 1988						
7.2.3	111		111			
7.2.4	138		138			
7.2.5	64		64			
7.2.6	64		64			
8.3&.4	74		74			
8.5&.6	117		76		41	
	568		527[2]		41	
3-yr. total	2954[1]	80[c]	1076	207	1116	475

[1] Plus 285 K for removable beryllium.

[2] From U.S./J Program Agreement (Tasks 9 through 13).

[3] Plus $135 K for removable beryllium fabrication (expenditure costed to Operations Division).

[4] Fusion Energy Mini-189.

[c] Capital.

BHM/1-2-86

MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

January 31, 1986

Distribution

HIFI Project Monthly Progress Report for January 1986

Revisions have been completed on design drawings for the target tower following the fluid flow calculations which showed that more coolant flow paths were required. The drawings are now awaiting review and approval. Release of these drawings for fabrication is expected by February 14. Materials for construction have been ordered and are expected to be on hand prior to that date. Approved drawings for the quick opening hatch and the target hole plug were issued on January 31. The forged material needed for these two items was shipped from the vendor's plant on January 23. Fabrication orders will be submitted as soon as the material is in hand. Fabrication is continuing on the upper plenum and outer shroud assembly. Design is continuing on other reactor components.

There has been a change in the funding expected for FY 1986 from the US/Japan agreement. Originally, $202,000 was shown as the amount expected, but this is now known to be (including the effect of Gramm Rudman) $180,000 thus increasing our shortfall by $22,000 (as shown in Table 1). There are no other changes in the funding since the last report period.

The HIFI Project Schedule (Figure 1) has been revised to show some minor changes in the reactor component design effort and delays in the experimental tasks. Table 2 shows the funding for each of the tasks listed in the schedule with revisions from Table 1.

A suitable applicant from outside Martin Marietta Energy Systems, who is working at the Laboratory as a contractor, responded to the job listing for an additional engineer for the Irradiation Engineering Group. No suitable internal applicant having come forward, a requisition was submitted but was not approved, thus ending the second attempt to acquire additional manpower in the Group for this task. With increased pressure on laboratory budgets, candidates from within Martin Marietta Energy Systems have since been proposed and will be considered. Meanwhile, shortage of effort has forced a four-month delay in beginning Task 5.3, a three-month delay in beginning Task 7.2.2, and a one-month delay in beginning Task 5.5 (although not all of this work could have been accomplished anyway with the delays in making funding available to the project). All of these are tasks associated with RB* capsule design and fabrication; tasks related to the reactor modifications and the temperature experiment remain within schedule (and within budget).

B H Montgomery

B. H. Montgomery, Project Leader, 9108, MS-1 (4-0258)

BHM:kfr

Attachments(3)

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
D. W. Burton
B. L. Corbett
G. R. Hicks
S. S. Hurt
R. V. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
J. H. Swanks
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. D. West
R. S. Wiltshire
A. Zucker

FIGURE 1

HIFI PROJECT - COST & SCHEDULE ESTIMATES
ACCELERATED MFE SCHEDULE

Schedule columns: FY-86 (Q1 OND, Q2 JFM, Q3 AMJ, Q4 JAS); FY-87 (Q1 OND, Q2 JFM, Q3 AMJ, Q4 JAS); FY-88 (Q1 OND, Q2 JFM, Q3 AMJ, Q4 JAS)

Item	Schedule annotations	Cost ($ 1000)
Reactor Components		
1.0 Design		
1.1 Conceptual	Comp	
1.2 Details		
1.2.1 Target tower	5	5
1.2.2 Access hatch	5 Comp	5
1.2.3 Removable Be	53	53
1.2.4 Track assy.	53	53
1.2.5 Outer shroud	27 Comp	27
1.2.6 Shroud flange	27	27
1.2.7 Misc.	5	5
1.3 Stress Analysis	58	58
2.0 Fabrication		
2.1 Access Hatch	85	85
2.2 Target Tower	64	64
2.3 Removable Be	204 / 135	339
2.4 Misc.		
2.5 Outer Shroud	105	105
2.6 Shroud Flange	88	88
2.7 Track Assy.	102 / 108	210
3.0 ETD	70 / 70	140
4.0 Installation		
4.1 Access Hatch	5	5
4.2 Target Tower	5	5
4.3 Track, Shroud, RB	53	53
4.4 Misc.		
Experiments		
5.0 Design		
5.1 RB* Instr. Facility	53	53
5.2 Target Temp. Caps.	53	53
5.3 MFE Proto Caps.	48 Delayed	48
5.4 MFE 60	32	32
5.5 MFE 200	64 Delayed	64
5.6 MFE 300	53	53
5.7 MFE 400	53	53
6.0 Procure (RB* Facility)	16 / 64	80
7.0 Fabrication & Assy.		
7.1 Facilities		
7.1.1 Inst. target	11	11
7.1.2 Instr. RB*	27	27
7.2 Capsules		
7.2.1 Target temp.	53	53
7.2.2 MFE proto	85 Delayed	85
7.2.3 MFE 60	111 / 111	222
7.2.4 MFE 200	37 / 101 / 138	276
7.2.5 MFE 300	138 / 64	202
7.2.6 MFE 400	138 / 64	202
8.0 Install & Operate		
8.1 Target Temp.		
8.2 MFE Proto	27 Delayed	27
8.3 MFE 60		
8.4 MFE 200	111 / 16 / 58	185
8.5 MFE 300		
8.6 MFE 400	117	117
9.0 Neutronics Analysis	42	
9.1 Facility Analysis	Delayed	42
9.2 Target Temp. Effects	27 Delayed	27
9.3 Beam Tube Effects	Comp	
Fiscal Year Costs (FY-86 Dollars) x 1000	FY-86: 1421; FY-87: 1250; FY-88: 568	3239*

* Plus $155 K spent in FY-1985 on design and neutronic analysis

Rev.
BHM/1-29-86

Table 1

HIFI PROJECT FUNDING

(FY 86 $,000)

Source of committed funding	FY 1986 Capital	FY 1986 Expense		FY 1987 Capital	FY 1987 Expense	
OFE	610[1]			107[2]	358[2]	
US/Japan		180[3]			347[3]	
BES	100	54		53		
GPE	80					
Total	790 +	234	= 1024	160 +	705	= 865

	FY 1986	FY 1987
Funding committed	1,024	865
Funding needed	1,271 (excluding beryllium)	1115
Shortfall	247[4]	250[5]

[1] $510,000 in December Financial Plan - short $100,000, which has been promised in an FY 1986 financial plan.

[2] As shown in the mini-189 dated 12/20/85.

[3] As shown in the US/Japan Agreement (tasks 2, 9 and 12).

[4] Expense money needed. (Was originally to have been ARIM money; in the event ARIM funding was not made available, but OFE funding was switched from operating to capital.)

[5] Capital money needed. (Was originally committed from ARIM funds; commitment subsequently withdrawn.)

BHM-1/29/86

Table 2

Funding of Tasks from Accelerated Schedule

FY 1986

(FY 86 $.000)

Task	Cost	GPE	U.S./J	New BES	New OFE	Shortfall
1.2.1	5				5	
1.2.2	5				5	
1.2.3	53				53	
1.2.4	53				53	
1.2.5	27				27	
1.2.6	27				27	
1.2.7	5				5	
1.3	58				58	
2.1	85				85	
2.2	64				64	
2.3	54[1]			54		
2.5	105			100[c]		5
2.7	102				102	
3.0	70				47	23
4.1	5				5	
4.2	5				5	
5.1	53	53				
5.2	53		53			
5.3	48					48
5.4	32					
5.5	64		42			22
6.0	16	16				
7.1.1	11	11				
7.2.1	53		53			
7.2.2	85					85
7.2.4	37					37
8.2	27					27
9.1	42				42	
9.2	27				27	
	1271[1]	80[c]	180[2]	154	610[3]	247

[1] Plus $150 K for removable beryllium material (expenditure costed to Operations Division).

[2] From U.S./J Program Agreement (Tasks 9 through 13).

[3] $510 K (capital) received in December Financial Plan with $100 K promised in an FY 1986 financial plan.

[c] Capital

BHM/1-29-86

Table 2 (continued)

Funding of Tasks from Accelerated Schedule

FY 1987

(FY 86 $.000)

Task	Cost	GPE	U.S./J	New BES	New OFE	Shortfall
2.3	3					
2.6	88					88[c]
2.7	108					108[c]
3.0	70				16[c]	54[c]
4.3	53			53		
5.6	53		53			
5.7	53		53			
6.0	64				64[c]	
7.1.2	27				27[c]	
7.2.3	111		103		8	
7.2.4	101				101	
7.2.5	138				138	
7.2.6	138		138			
8.3&.4	111				111	
	1115[3]	0	347[2]	53	465[4]	250[c]
FY 1988						
7.2.3	111		111			
7.2.4	138		138			
7.2.5	64		64			
7.2.6	64		64			
8.3&.4	74		74			
8.5&.6	117		76		41	
	568		527[2]		41	
3-yr. total	2954[1]	80[c]	1054	207	1116	497

[1] Plus 285 K for removable beryllium.

[2] From U.S./J Program Agreement (Tasks 9 through 13).

[3] Plus $135 K for removable beryllium fabrication (expenditure costed to Operations Division).

[4] Fusion Energy Mini-189.

[c] Capital.

BHM/1-29-86

MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

March 5, 1986

Distribution

HIFI Project Monthly Progress Report for February 1986

Engineering design of all the reactor components necessary for the instrumented target capsule facilities has been completed and an engineering design report has been approved and issued.

Design of the remaining reactor components associated with the RB* facilities is on schedule and within costs.

Fabrication continues on the Outer Shroud and Upper Plenum Assembly and no problems are foreseen in meeting the scheduled delivery date. Fabrication of the Quick Opening Hatch and Target Hole Plug will begin next week with a delivery date of May 1, 1986, for both of these items. The Target Tower fabrication will begin by mid-March.

An engineer has been added to the Irradiation Engineering Group for the HIFI Project tasks associated with material irradiation capsules. The transfer will be effective on March 1, 1986, and work on these tasks will begin immediately.

Owing to the earlier delays in obtaining funding and staff, the MFE prototype capsule has been canceled, with the concurrence of MFE sponsors, which will result in an MFE capsule design completely dependent on additional thermal and neutronic analyses of the RB* positions. The net saving realized from the cancelation of Tasks 5.3, 7.2.2, and 8.2, with the addition of Task 5.8 (the additional analysis), will be $113,000. The shortfall for FY 1986 has therefore been reduced from $247,000 to $134,000 (as shown in Table 1). A revised schedule, shown in Figure 1, reflects these changes and Table 2 shows the funding for each of the tasks listed in the schedule.

In response to the requirements set forth in the approval letter for the OR-638 from DOE-ORO, a brief monthly cost/schedule assessment report was sent to M. J. Gouge, ORO, on February 12, 1986 (letter attached). The "bad charge" mentioned in the letter was found to be costs incurred by Engineering Design in November 1985, that could not be transferred to the capital work order until the work orders were opened. This did not occur until January of this year. Mr. Gouge was informed of this finding on February 19, 1986, by telephone, and raised no objections.

B H Montgomery

B. H. Montgomery, Project Leader, 9108, MS-1 (4-0258)

BHM:rlt

Attachments(4)

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
D. W. Burton
B. L. Corbett
G. R. Hicks
S. S. Hurt
A. W. Longest
R. Y. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
J. H. Swanks
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. D. West
R. S. Wiltshire
A. Zucker

Table 1

HIFI PROJECT FUNDING

(FY 86 $,000)

Source of committed funding	FY 1986 Capital		FY 1986 Expense		FY 1987 Capital		FY 1987 Expense	
OFE	610[1]				107[2]		358[2]	
US/Japan			180[3]				347[3]	
BES	100		54		53			
GPE	80							
Total	790	+	234	= 1024	160	+	705	= 865

	FY 1986		FY 1987
Funding committed	1,024		865
Funding needed	1,158	(excluding beryllium)	1115
Shortfall	134[4]		250[5]

[1]$510,000 in December Financial Plan - short $100,000, which has been promised in an FY 1986 financial plan.

[2]As shown in the mini-189 dated 12/20/85.

[3]As shown in the US/Japan Agreement (tasks 2, 9 and 12).

[4]Expense money needed. (Was originally to have been ARIM money; in the event ARIM funding was not made available, but OFE funding was switched from operating to capital.)

[5]Capital money needed. (Was originally committed from ARIM funds; commitment subsequently withdrawn.)

Rev. BHM/2-28-86

FIGURE 1

HIFI PROJECT - COST & SCHEDULE ESTIMATES
ACCELERATED MFE SCHEDULE

	FY-86 Q1 OND	FY-86 Q2 JFM	FY-86 Q3 AMJ	FY-86 Q4 JAS	FY-87 Q1 OND	FY-87 Q2 JFM	FY-87 Q3 AMJ	FY-87 Q4 JAS	FY-88 Q1 OND	FY-88 Q2 JFM	FY-88 Q3 AMJ	FY-88 Q4 JAS	Cost ($ 1000)
Reactor Components													
1.0 Design													
1.1 Conceptual	Comp												
1.2 Details													
1.2.1 Target tower		5	Comp										5
1.2.2 Access hatch		5	Comp										5
1.2.3 Removable Be			53										53
1.2.4 Track assy.			53										53
1.2.5 Outer shroud		27	Comp										27
1.2.6 Shroud flange			27										27
1.2.7 Misc.				5									5
1.3 Stress Analysis		58											58
2.0 Fabrication													
2.1 Access Hatch				85									85
2.2 Target Tower				64									64
2.3 Removable Be				204		135							339
2.4 Misc.													
2.5 Outer Shroud	105												105
2.6 Shroud Flange							88						88
2.7 Track Assy.		102				108							210
3.0 ETD		70						70					140
4.0 Installation													
4.1 Access Hatch				5									5
4.2 Target Tower				5									5
4.3 Track, Shroud, RB								53					53
4.4 Misc.													
Experiments													
5.0 Design													
5.1 RB* Instr. Facility			53										53
5.2 Target Temp. Caps.			53										53
5.3 MFE Proto Caps.	Canceled												
5.4 MFE 60	Delayed	32											32
5.5 MFE 200	64												64
5.6 MFE 300							53						53
5.7 MFE 400							53						53
5.8 Thermal & Gamma Anal.**		47			NEW								47
6.0 Procure (RB* Facility)		16				64							80
7.0 Fabrication & Assy.													
7.1 Facilities													
7.1.1 Inst. target		11											11
7.1.2 Instr. RB*								27					27
7.2 Capsules													
7.2.1 Target temp.		53											53
7.2.2 MFE proto	Canceled												
7.2.3 MFE 60								111				111	222
7.2.4 MFE 200	Delayed		37					101				138	276
7.2.5 MFE 300						138					64		202
7.2.6 MFE 400						138					64		202
8.0 Install & Operate													
8.1 Target Temp.													
8.2 MFE Proto		Canceled											
8.3 MFE 60													
8.4 MFE 200						111				16	58		185
8.5 MFE 300													
8.6 MFE 400									117				117
9.0 Neutronics Analysis		42											
9.1 Facility Analysis					Delayed								42
9.2 Target Temp. Effects		27			Delayed								27
9.3 Beam Tube Effects	Comp												
Fiscal Year Costs (FY-86 Dollars) x 1000	1308				1250				568				3126*

* Plus $155 K spent in FY-1985 on design and neutronic analysis

**Additional neutronics, gamma heating, and thermal analyses in the absense of the Prototype capsule.

Rev.
BHM/2-28-86

Table 2

Funding of Tasks from Accelerated Schedule

FY 1986

(FY 86 $.000)

Task	Cost	GPE	U.S./J	New BES	New OFE	Shortfall
1.2.1	5				5	
1 2.2	5				5	
1.2.3	53				53	
1.2.4	53				53	
1.2.5	27				27	
1.2.6	27				27	
1.2.7	5				5	
1.3	58				58	
2.1	85				85	
2.2	64				64	
2.3	54[1]			54		
2.5	105			100[c]		5
2.7	102				102	
3.0	70				47	23
4.1	5				5	
4.2	5				5	
5.1	53	53				
5.2	53		53			
5.3	canceled					
5.4	32					
5.5	64		42			22
5.8	47					47
6.0	16	16				
7.1.1	11	11				
7.2.1	53		53			
7.2.2	canceled					
7.2.4	37					37
8.2	canceled					
9.1	42				42	
9.2	27				27	
	1158[1]	80[c]	180[2]	154	610[3]	134

[1]Plus $150 K for removable beryllium material (expenditure costed to Operations Division).

[2]From U.S./J Program Agreement (Tasks 9 through 13).

[3]$510 K (capital) received in December Financial Plan with $100 K promised in an FY 1986 financial plan.

[c]Capital

Rev. BHM/2-28-86

Table 2 (continued)

Funding of Tasks from Accelerated Schedule

FY 1987

(FY 86 $.000)

Task	Cost	GPE	U.S./J	New BES	New OFE	Shortfall
2.3	3					
2.6	88					88[c]
2.7	108					108[c]
3.0	70				16[c]	54[c]
4.3	53			53		
5.6	53		53			
5.7	53		53			
6.0	64				64[c]	
7.1.2	27				27[c]	
7.2.3	111		103		8	
7.2.4	101				101	
7.2.5	138				138	
7.2.6	138		138			
8.3&.4	111				111	
	1115[3]	0	347[2]	53	465[4]	250[c]
FY 1988						
7.2.3	111		111			
7.2.4	138		138			
7 2.5	64		64			
7.2.6	64		64			
8.3&.4	74		74			
8 5&.6	117		76		41	
	568		527[2]		41	
3-yr. total	2841[1]	80[c]	1054	207	1116	384

[1]Plus 285 K for removable beryllium.

[2]From U.S./J Program Agreement (Tasks 9 through 13).

[3]Plus $135 K for removable beryllium fabrication (expenditure costed to Operations Division).

[4]Fusion Energy Mini-189.

[c]Capital.

Rev. BHM/2-28-86

MARTIN MARIETTA

Internal Correspondence

March 31, 1986

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

HIFI Project Monthly Progress Report for March 1986

All engineering design drawings for the instrumented target capsule facilities have been issued, and all fabrication orders for the parts and assemblies have now been submitted with a requested delivery date of May 1, 1986. This delivery date is necessary to devote time for assembly of the reactor components in the HFIR mockup stand prior to installing in the reactor in late July. Design of the remaining reactor components associated with the RB* facilities is continuing on schedule.

The HIFI Project Funding (shown on Table 1) has been revised to show that all of the OFE funding for FY 1986 - $610 K capital - has been received (the remaining $100 K was in the March Financial Plan). The shortfall of $134 K has been identified as needed by July 1, 1986, to maintain the Project schedule.

A revised schedule, shown in Figure 1, reflects the cancellation of the MFE Prototype capsule (see February monthly), and Table 2 shows the funding for each of the tasks listed in the schedule.

The Operations Division is actively pursuing additional manpower for Tasks 9.1 and 9.2 (Neutronics Analyses). Interviews have been held and are continuing.

The OR-638 monthly cost/schedule report was sent to M. J. Gouge, DOE-ORO, on March 12, 1986. A copy of this report is attached for your information.

B. H. Montgomery

B. H. Montgomery, Project Leader, 9108, MS-1 (4-0258)

BHM:kfr

Attachments(4)

Distribution

S. J. Ball	M. W. Rosenthal
L. A. Berry	J. L. Scott
E. E. Bloom	R. L. Senn
D. W. Burton	I. I. Siman-Tov
B. L. Corbett	J. H. Swanks
G. R. Hicks	W. E. Thomas
S. S. Hurt	K. R. Thoms
A. W. Longest	H. E. Trammell
R. V. McCord	C. D. West
D. M. McGinty	R. S. Wiltshire
F. R. Mynatt	A. Zucker
E. Newman, Jr.	File(2)

Table 1

HIFI PROJECT FUNDING

(FY 86 $,000)

Source of Committed Funding	FY 1986 Capital	FY 1986 Expense	FY 1987 Capital	FY 1987 Expense
OFE	610		107[1]	358[1]
US/Japan		180[2]		347[2]
BES	100	54	53	
GPE	80			
Total	790	234	160	705
Funding committed	1,024		865	
Funding needed	1,158		1,115	
Shortfall	134[3]		250[4]	

[1]-As shown in the mini-189 dated 12/20/85.

[2]-As shown in the US/Japan Agreement (tasks 2, 9, and 12).

[3]-Expense money needed. NOTE: Was originally to have been ARIM money; ARIM funding not available but OFE funding was switched from operating to capital.

[4]-Capital money needed. NOTE: Was originally committed from ARIM funding; commitment subsequently with drawn.

Rev. BHM/3-31-86

Figure 1

HIFI PROJECT
ACCELERATED MFE SCHEDULE

SCHED.CAL

	FY-86 Q1 OND	FY-86 Q2 JFM	FY-86 Q3 AMJ	FY-86 Q4 JAS	FY-87 Q1 OND	FY-87 Q2 JFM	FY-87 Q3 AMJ	FY-87 Q4 JAS	FY-88 Q1 OND	FY-88 Q2 JFM	FY-88 Q3 AMJ	FY-88 Q4 JAS	COST ($1000)
REACTOR COMPONENTS													
1.0 DESIGN													
1.1 CONCEPTUAL	completed												
1.2 DETAILS													
1.2.1 TARGET TOWER	--- ----	--]	5	completed									5
1.2.2 ACCESS HATCH	-- ---	--]	5	completed									5
1.2.3 REMOV BE	[-	---	-]	53									53
1.2.4 TRACK ASSY	[-	---	-]	53									53
1.2.5 OUTER SHROUD	--]	27	completed										27
1.2.6 SHROUD FLANGE		[---	--]	27									27
1.2.7 MISC	[---	---	-5-	---]									5
1.3 STRESS ANALYSIS	[---	---	-58	---]									58
2.0 FABRICATION													
2.1 ACCESS HATCH	[	---	--]	85									85
2.2 TARGET TOWER	[	---	--]	64									64
2.3 REMOV BE	[	---	204	---	---	-]	135						339
2.4 OUTER SHROUD	105[	---	--]										105
2.5 SHROUD FLANGE					[---	---]	88						88
2.6 TRACK ASSY		102	[---	---	---	-]	108						210
2.7 MISC		[-	---	---	---	---]							
3.0 ETD SURVEL.	[---	---	-70	---	---	---	-70	-]					140
4.0 INSTALLLATION													
4.1 ACCESS HATCH		5	[-	-]									5
4.2 TARGET TOWER		5	[-	-]									5
4.3 TRACK, SHROUD, RB					[---	---	--]	53					53
4.4 MISC			[-	-]	[---	---	--]						
EXPERIMENTS													
5.0 DESIGN													
5.1 RB* INST FACILITY		[---]	53	delayed									53
5.2 TARGET TEMP CAP	[-	---]	53	delayed									53
5.3 MFE 60		32	[---	---]									32
5.4 MFE 200		64[-	---	---]									64
5.5 MFE 300					[---	---	-] 53						53
5.6 MFE 400					[---	---	-] 53						53
5.7 ADD ANALYSES		47[-	---	---]									47
6.0 PROCURE RB*INST FACILITY		16	[---	---	---]	64							80
7.0 FABRICATION & ASSY													
7.1 FACILITIES													
7.1.1 INST TARGET		11	[--	-]									11
7.1.2 INST RB*					[---	---	-]	27					27
7.2 CAPSULES													
7.2.1 TARGET TEMP		53	[---]										53
7.2.2 MFE 60					[---	---	-]	111		[---	---]	111	222
7.2.3 MFE 200			37	[---	---	---	-]	101		[---	---]	138	276
7.2.4 MFE 300						138	[-	---	---]		64 [---	->	202
7.2.5 MFE 400						138	[-	---	---]		64 [---	->	202
8.0 INSTALL & OPERATE													
8.1 TARGET TEMP				[=]									
8.2 MFE 60							[=	===	===]		[===	=>	
8.3 MFE 200						111	[=	===	===]	16	59[===	=>	185
8.4 MFE 300										[===	===]		
8.5 MFE 400									117	[===	===]		117
9.0 NEUTRONICS ANALYSES													
9.1 FACILITY	[---	-42	---	---]delayed									42
9.2 TARGET TEMP EFFECTS	[---	-27	---	---]delayed									27
9.3 BEAM TUBE EFFECTS	completed												
FISCAL YEAR COSTS (FY-86 DOLLARS) X 1000	1308				1250				568				3126*

* Plus $155 K spent in FY-1985 on design and neutronic analysis.

Rev. BHM

Table 2

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
FY 1986

(FY 86 $000)

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
1.2.1	5				5	
1.2.2	5				5	
1.2.3	53				53	
1.2.4	53				53	
1.2.5	27				27	
1.2.6	27				27	
1.2.7	5				5	
1.3	58				58	
2.1	85				85	
2.2	64				64	
2.3	54a			54		
2.4	105			100c		5
2.7	102				102	
3.0	70				47	23
4.1	5				5	
4.2	5				5	
5.1	53	53				
5.2	53		53			
5.3	32		32			
5.4	64		42			22
5.7	47					47
6.0	16	16				
7.1.1	11	11				
7.2.1	53		53			
7.2.3	37					37
9.1	42				42	
9.2	27				27	
	1158a	80c	180b	154	610	134

a-Plus $150 K for removable beryllium material (expenditure costed to Operations Division).

b-From U.S./J Program Agreement (Tasks 9 through 13).

c-Capital

FUND1.CAL
Rev/BHM
3-31-86

Table 2 (continued)

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
FY 1987

(FY 86 $000)

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
2.3	d					
2.5	88					88c
2.6	108					108c
3.0	70				16c	54c
4.3	53			53		
5.5	53		53			
5.6	53		53			
6.0	64				64c	
7.1.2	27				27c	
7.2.2	111		103		8	
7.2.3	101				101	
7.2.4	138				138	
7.2.5	138		138			
8.3&.4	111				111	
	1115d	0	347b	53	465e	250cx

FY 1988

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
7.2.2	111		111			
7.2.3	138		138			
7.2.4	64		64			
7.2.5	64		64			
8.3&.4	74		74			
8.5&.6	117		76		41	
	568		527b		41	
3-Yr TOTAL	2841a	80c	1054b	207	1116	384

a-Plus $285 K for removable beryllium.

b-From U.S./J Program Agreement (Tasks 9 through 13).

d-Plus $135 K for removable beryllium fabrication (expenditure costed to Operations Division).

e-Fusion Energy Mini-189.

c-Capital

cx-Capital (formerly planned as ARIM money)

FUND2.CAL
Rev/BHM
3-31-86

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37831

March 12, 1986

Mr. M. J. Gouge
Nuclear Research and Development
Department of Energy, Oak Ridge
Operations
Post Office Box E
Oak Ridge, Tennessee 37831

Dear Mr. Gouge:

Attached is the February monthly costs and schedule assessment report on the OR-638-86-ORNL-2, HIFI Project. The schedule and costs only pertain to those items covered by this funding.

If further information is needed please contact me at 574-0258.

Sincerely,

B. H. Montgomery

B. H. Montgomery

BHM:kfr

Attachment

cc/att: D. W. Burton
K. R. Thoms
C. D. West

HIFI PROJECT SCHEDULE
(OR-638-86-ORNL-2 Only)

HIFI1.CAL
Last Update= 3/12/86 BHM

```
---------------------------------------------------------------------------------------------
                          |             FY-1986               |             FY-1987           |
                          | O N D | J F M | A M J | J A S | O N D | J F M | A M J | J A S |
--------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
                          |       |       |       |       |       |       |       |       |
TARGET TOWER(99)     ------DDDDDDDDxFFFFFFFFFIIIIII       |       |       |       |       |
                          |       |       |       |       |       |       |       |       |
QUICK OPENING HATCH(99) ------DDDDDDDxFFFFFFFFFFIIIIII    |       |       |       |       |
                          |       |       |       |       |       |       |       |       |
TARGET HOLE PLUG(100) ------DDDDDDDxFFFFFFFFFFIIIIII      |       |       |       |       |
                          |       |       |       |       |       |       |       |       |
RABBIT "U" BEND(96)       |     DDDDDDDxFFFFFFFIIIIII     |       |       |       |       |
                          |       |       |       |       |       |       |       |       |
RABBIT INPILE SECTION(96) |     DDDDDDDxFFFFFFFIIIIII     |       |       |       |       |
                          |       |       |       |       |       |       |       |       |
OUTER SHROUD(93)          |  DDDx|  FFFFFFFFFFFIIIIII     |       |       |       |       |
                          |       |       |       |       |       |       |       |       |
SHROUD FLANGE(94)         |       | DDDDDDDDD - - -| - - - -FFFFFFFFFFFFFFF  |IIII   |       |
                          |       |       |       |       |       |       |       |       |
UPPER TRACK(97)           |       | DDDDDDDDFFFFFFFFFFFFFFFFFFFFFFFF| - - - -|IIII   |       |
                          |       |       |       |       |       |       |       |       |
MISC. TOOLS(101)          |       |DDDDDDDDDDDDDDDFFFF - - -| - - - -| - - - -|IIII   |       |
                          |       |       |       |       |       |       |       |       |
ASSEMBLY DRAWINGS         |       |       |  DDDDDDDDDDDDDD|       |       |       |       |
                          |       |       |       |       |       |       |       |       |
---------------------------------------------------------------------------------------------
```

(D=Design; F=Fabricate; I=Install; x=Completed)
Numbers in ( ) are HFIR Job numbers

HIFI PROJECT COSTS (OR-638-86-ORNL-2 Only)

	ESTIMATE	FEBRUARY COSTS	SPENT TO DATE	TO BE SPENT
DESIGN	$136,000	$20,403	$65,248	$ 70,752
FABRICATION	370,300	12,123	12,302	357,998
INSPECTION	42,600	1,538	2,584	40,016
SURVEILLANCE	98,100	3,025	12,780	85,320
INSTALLATION	63,000	3,505	4,151	58,849
TOTAL	$710,000	$40,594	$97,065	$612,935

MARTIN MARIETTA

Internal Correspondence

May 2, 1986

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

HIFI Project Monthly Progress Report for April 1986

Shop fabrication of reactor components, parts and assemblies, for the target instrumented facilities is approximately 75% complete with no problems foreseen in making their scheduled delivery dates. The reactor mockup installation is scheduled to begin in mid-May with installation in the reactor at the end of July. The design and fabrication of all remaining reactor components for the RB* facilities remains on schedule and within costs.

Photographs taken during fabrication of some of the assemblies are attached (Figures 1 through 4). Figure 1 shows the quick-access hatch during the preheat prior to stellite overlay. Figures 2 and 3 show the target tower flange and tower tube prior to assembly. Figure 4 shows the outer shroud during assembly. It is nice to see some actual hardware.

The HIFI Project Funding (shown on Table 1) has been revised to show a decrease in the Shortfall for FY 1986 with an increase in Shortfall for FY 1987. This change is necessary due to the delay in MFE 200 capsule design, and the consequential delay in parts fabrication and assembly (Task 7.2.3 on Figure 5, HIFI Project Schedule). It should be noted that the $37 K expenditure has only been POSTPONED, from July 1, 1986 to October 1, 1986 - any delays beyond October 1 would immediately have serious effects on the Project Schedule. Table 2 shows the funding for each of the tasks on Figure 5 and reflects these changes.

Operations Division has been actively pursuing additional manpower for the delay of Tasks 9.1 and 9.2 (Neutronics Analyses). Interviews have been held and are continuing. One job offer has been refused. Task 5.7, additional thermal analysis, is contingent upon obtaining this manpower for this fiscal year, and it will be remembered that these analytical tasks have assumed even greater importance and urgency following the cancellation of the prototype capsule.

The OR-638 monthly cost/schedule report was sent to M. J. Gouge, DOE-ORO, on April 10, 1986. A copy of this report is attached for your information.

B. H. Montgomery

B. H. Montgomery, Project Leader, 9108, MS-1 (4-0258)

Attachments(8)

cc/att:

S. J. Ball	R. V. McCord	J. H. Swanks
L. A. Berry	D. M. McGinty	W. E. Thomas
E. E. Bloom	F. R. Mynatt	K. R. Thoms
D. W. Burton	E. Newman, Jr.	H. E. Trammell
B. L. Corbett	M. W. Rosenthal	C. D. West
G. R. Hicks	J. L. Scott	R. S. Wiltshire
S. S. Hurt	R. L. Senn	A. Zucker
A. W. Longest	I. I. Siman-Tov	File-BHM(2)

ORNL—PHOTO 2565—86

Fig. 1. Quick-Access Hatch.

ORNL–PHOTO 2322–86

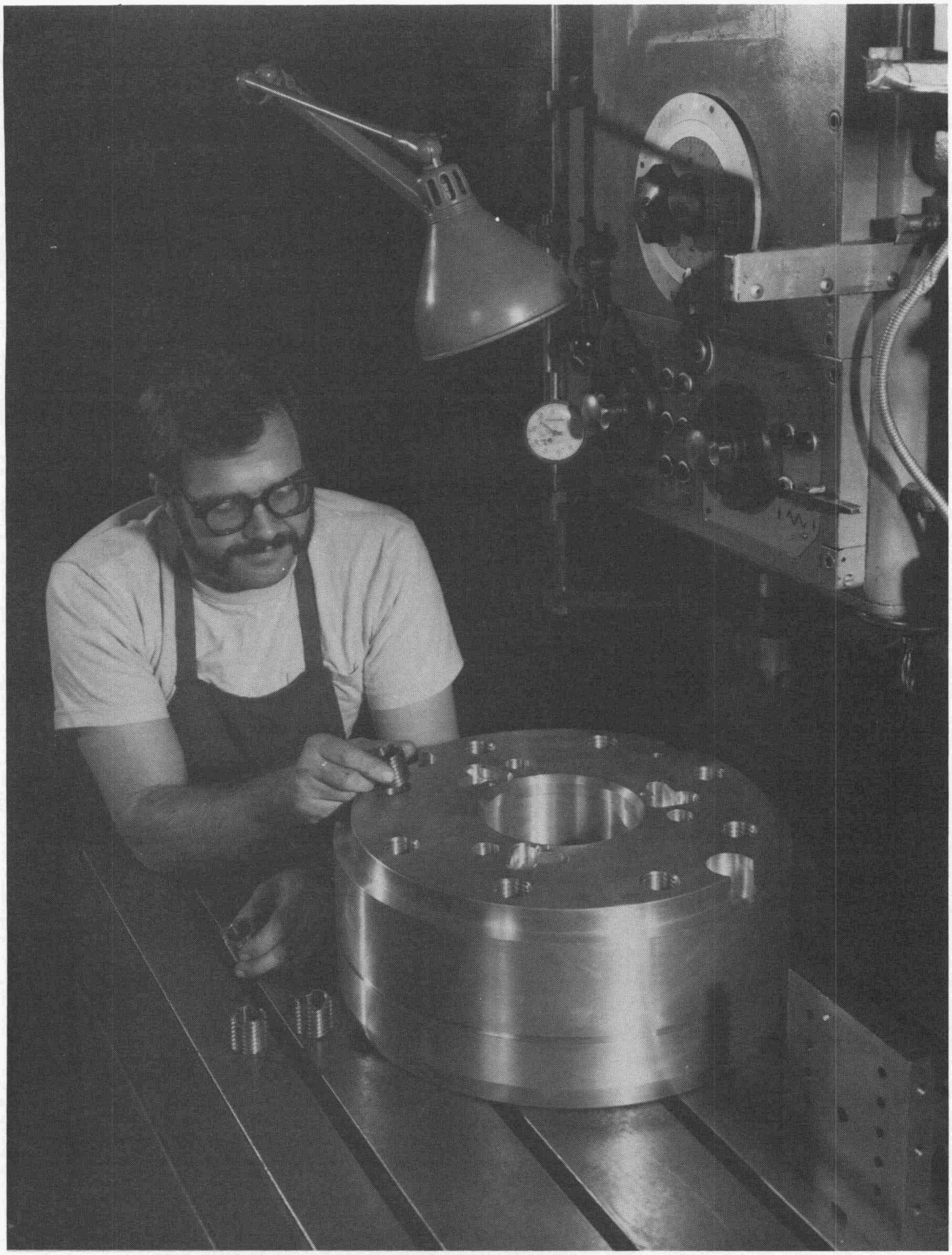


Fig. 2. Target Tower Flange.

ORNL–PHOTO 2566–86

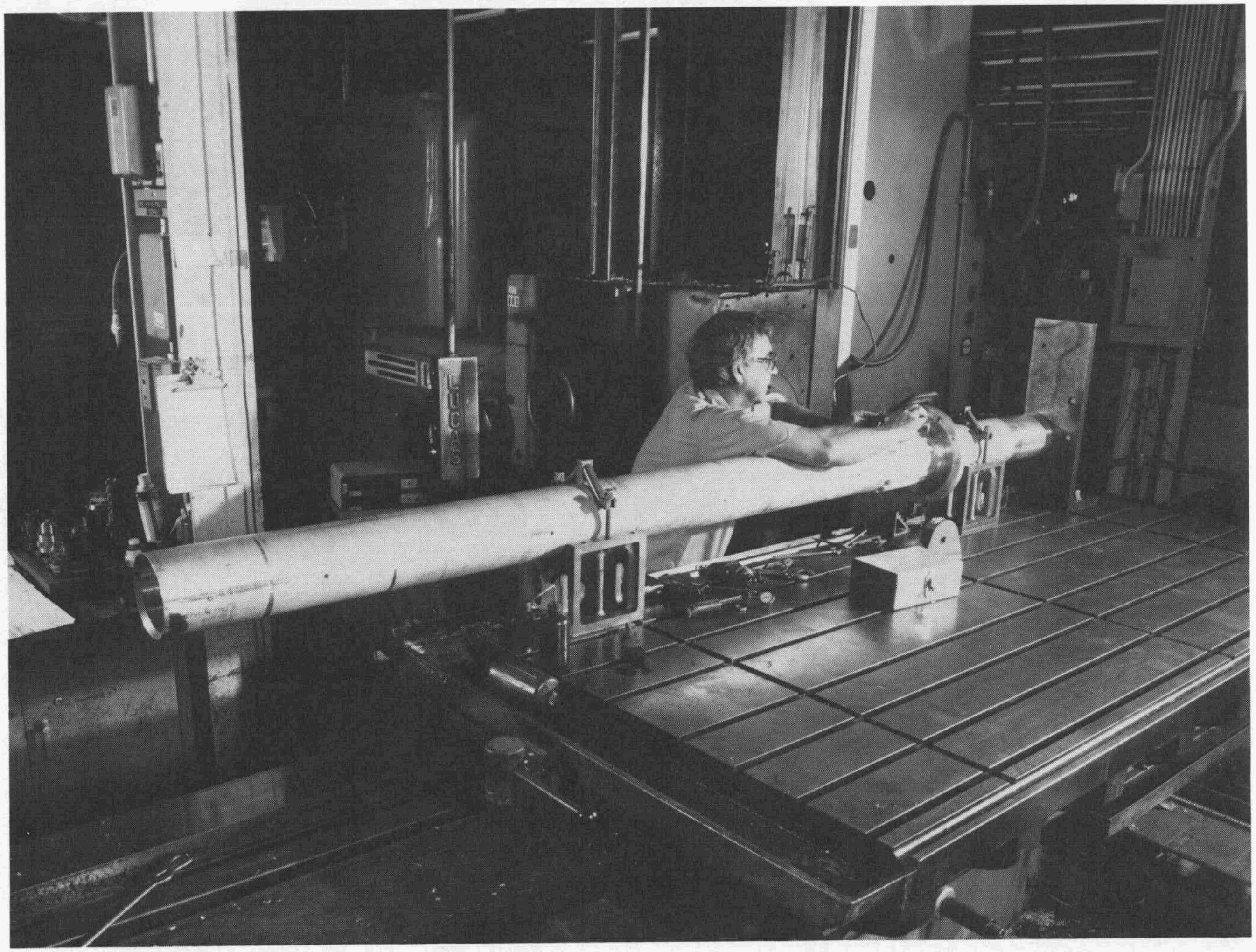


Fig. 3. Target Tower Tube.

ORNL–PHOTO 2321–86

Fig. 4. Outer Shroud.

Table 1

HIFI PROJECT FUNDING

(FY 86 $,000)

Source of Committed Funding	FY 1986 Capital	FY 1986 Expense	FY 1987 Capital	FY 1987 Expense
OFE	610		107[1]	358[1]
US/Japan		180[2]		347[2]
BES	100	54	53	
GPE	80			
Total	790	234	160	705
Funding committed	1,024		865	
Funding needed	1,121		1,152	
Shortfall	97[3]		287[4]	

[1]-As shown in the mini-189 dated 12/20/85.

[2]-As shown in the US/Japan Agreement (tasks 2, 9, and 12).

[3]-Expense money needed. NOTE: Was originally to have been ARIM money; ARIM funding not available - OFE funding was switched from operating to capital.

[4]-$250 K of Capital money and $37 K of Expense money needed. NOTE: The Capital money was originally committed from ARIM funding; commitment subsequently withdrawn.

Rev. BHM/5-1-86

Figure 5

HIFI PROJECT
ACCELERATED MFE SCHEDULE

SCHED.CAL

```
-------------------------------------------------------------------------------------
                              |     FY-86       |      FY-87      |      FY-88      |
                              | Q1| Q2| Q3| Q4| Q1| Q2| Q3| Q4| Q1| Q2| Q3| Q4|  COST
                              |OND|JFM|AMJ|JAS|OND|JFM|AMJ|JAS|OND|JFM|AMJ|JAS|($1000)
------------------------------|___|___|___|___|___|___|___|___|___|___|___|___|-------

   REACTOR COMPONENTS         |   |   |   |   |   |   |   |   |   |   |   |   |

1.0 DESIGN                    |   |   |   |   |   |   |   |   |   |   |   |   |
   1.1 CONCEPTUAL             |completed  |   |   |   |   |   |   |   |   |   |
   1.2 DETAILS                |   |   |   |   |   |   |   |   |   |   |   |   |
    1.2.1 TARGET TOWER      --|---|--]| 5 |completed  |   |   |   |   |   |   |     5
    1.2.2 ACCESS HATCH      --|---|--]| 5 |completed  |   |   |   |   |   |   |     5
    1.2.3 REMOV BE            | [-|---|-] | 53|   |   |   |   |   |   |   |   |    53
    1.2.4 TRACK ASSY          | [-|---|-] | 53|   |   |   |   |   |   |   |   |    53
    1.2.5 OUTER SHROUD        |--]| 27|completed  |   |   |   |   |   |   |   |    27
    1.2.6 SHROUD FLANGE       |   [---|] 27 completed |   |   |   |   |   |   |    27
    1.2.7 MISC                [---|---|-5-|---]   |   |   |   |   |   |   |   |     5
   1.3 STRESS ANALYSIS        [---|---|-58|---]   |   |   |   |   |   |   |   |    58
                              |   |   |   |   |   |   |   |   |   |   |   |   |
2.0 FABRICATION               |   |   |   |   |   |   |   |   |   |   |   |   |
   2.1 ACCESS HATCH           |  [|---|--]| 85|   |   |   |   |   |   |   |   |    85
   2.2 TARGET TOWER           |  [|---|--]| 64|   |   |   |   |   |   |   |   |    64
   2.3 REMOV BE               |  [|---|204|---|---|-] |135|   |   |   |   |   |   339
   2.4 OUTER SHROUD           |105[---|--]|   |   |   |   |   |   |   |   |   |   105
   2.5 SHROUD FLANGE          |   |   |   [---|---] 88|   |   |   |   |   |   |    88
   2.6 TRACK ASSY             |  102 [---|---|---|-] |108|   |   |   |   |   |   210
   2.7 MISC                   |   | [-|---|---|---|---]   |   |   |   |   |   |
                              |   |   |   |   |   |   |   |   |   |   |   |   |
3.0 ETD SURVEL.               [---|---|-70|---|---|---|-70|-] |   |   |   |   |   140
                              |   |   |   |   |   |   |   |   |   |   |   |   |
4.0 INSTALLLATION             |   |   |   |   |   |   |   |   |   |   |   |   |
   4.1 ACCESS HATCH           |   | 5| [-|-] |   |   |   |   |   |   |   |   |     5
   4.2 TARGET TOWER           |   | 5| [-|-] |   |   |   |   |   |   |   |   |     5
   4.3 TRACK, SHROUD, RB      |   |   |   [---|---|--]| 53|   |   |   |   |   |    53
   4.4 MISC                   |   |   | [-|-] [---|---|--]|   |   |   |   |   |
                              |   |   |   |   |   |   |   |   |   |   |   |   |

   EXPERIMENTS                |   |   |   |   |   |   |   |   |   |   |   |   |

5.0 DESIGN                    |   |   |   |   |   |   |   |   |   |   |   |   |
   5.1 RB* INST FACILITY      |  [---] 53| delayed |   |   |   |   |   |   |   |    53
   5.2 TARGET TEMP CAP        | [-|---] 53| completed |   |   |   |   |   |   |    53
   5.3 MFE 60                 |   |32 [---|---]   |   |   |   |   |   |   |   |    32
   5.4 MFE 200                |  64[-|---|---]    |   |   |   |   |   |   |   |    64
   5.5 MFE 300                |   |   |   [---|---|-] 53  |   |   |   |   |   |    53
   5.6 MFE 400                |   |   |   [---|---|-] 53  |   |   |   |   |   |    53
   5.7 ADD ANALYSES           |  47[-|---|---]    |   |   |   |   |   |   |   |    47
                              |   |   |   |   |   |   |   |   |   |   |   |   |
6.0 PROCURE RB*INST FACILITY  |   |16 [---|---|---] 64|   |   |   |   |   |   |    80
                              |   |   |   |   |   |   |   |   |   |   |   |   |
7.0 FABRICATION & ASSY        |   |   |   |   |   |   |   |   |   |   |   |   |
   7.1 FACILITIES             |   |   |   |   |   |   |   |   |   |   |   |   |
    7.1.1 INST TARGET         |   | 11|[--|-] |   |   |   |   |   |   |   |   |    11
    7.1.2 INST RB*            |   |   |   |   |[--|---|-] |27 |   |   |   |   |    27
   7.2 CAPSULES               |   |   |   |   |   |   |   |   |   |   |   |   |
    7.2.1 TARGET TEMP         |   |53 [---]   |   |   |   |   |   |   |   |   |    53
    7.2.2 MFE 60              |   |   |   |   [---|---|-] |111|   [---|---]111|   222
    7.2.3 MFE 200             |   |  delayed  [---|---|-] |138|   [---|---]138|   276
    7.2.4 MFE 300             |   |   |   |   |   |138| [-|---|---]   |64 [---|->202
    7.2.5 MFE 400             |   |   |   |   |   |138| [-|---|---]   |64 [---|->202
                              |   |   |   |   |   |   |   |   |   |   |   |   |
8.0 INSTALL & OPERATE         |   |   |   |   |   |   |   |   |   |   |   |   |
   8.1 TARGET TEMP            |   |   |   |[=]|   |   |   |   |   |   |   |   |
   8.2 MFE 60                 |   |   |   |   |   |   | [=|===|===]   |   [===|=>
   8.3 MFE 200                |   |   |   |   |   |111| [=|===|===] 16| 58[===|=>185
   8.4 MFE 300                |   |   |   |   |   |   |   |   |   [===|===]   |
   8.5 MFE 400                |   |   |   |   |   |   |   |   |117[===|===]   |   117
                              |   |   |   |   |   |   |   |   |   |   |   |   |
9.0 NEUTRONICS ANALYSES       |   |   |   |   |   |   |   |   |   |   |   |   |
   9.1 FACILITY               [---|-42|---|---]delayed|   |   |   |   |   |   |    42
   9.2 TARGET TEMP EFFECTS    [---|-27|---|---]delayed|   |   |   |   |   |   |    27
   9.3 BEAM TUBE EFFECTS      |completed  |   |   |   |   |   |   |   |   |   |
------------------------------|___|___|___|___|___|___|___|___|___|___|___|___|-------
    FISCAL YEAR COSTS         |               |               |               |
    (FY-86 DOLLARS) X 1000    |     1271      |     1287      |      568      | 3126*
------------------------------|_______________|_______________|_______________|-------
    * Plus $155 K spent in FY-1985 on design and neutronic analysis.
```

Rev. BHM
5-1-86

Table 2

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
FY 1986

(FY 86 $000) FUND1.CAL

TASK	COST	GPE	U.S./J	NEW BES	NEW OPE	SHORTFALL
1.2.1	5				5	
1.2.2	5				5	
1.2.3	53				53	
1.2.4	53				53	
1.2.5	27				27	
1.2.6	27				27	
1.2.7	5				5	
1.3	58				58	
2.1	85				85	
2.2	64				64	
2.3	54a			54		
2.4	105			100c		5
2.7	102				102	
3.0	70				47	23
4.1	5				5	
4.2	5				5	
5.1	53	53				
5.2	53		53			
5.3	32		32			
5.4	64		42			22
5.7	47					47
6.0	16	16				
7.1.1	11	11				
7.2.1	53		53			
9.1	42				42	
9.2	27				27	
	1121a	80c	180b	154	610c	97

a-Plus $150 K for removable beryllium material (expenditure costed to Operations Division).

b-From U.S./J Program Agreement (Tasks 9 through 13).

c-Capital

Rev/BHM
5-1-86

Table 2 (continued)

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
FY 1987

(FY 86 $000) FUND2.CAL

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
2.3	d					
2.5	88					88cx
2.6	108					108cx
3.0	70				16c	54cx
4.3	53			53		
5.5	53		53			
5.6	53		53			
6.0	64				64c	
7.1.2	27				27c	
7.2.2	111		103		8	
7.2.3	138				101	37
7.2.4	138				138	
7.2.5	138		138			
8.3&.4	111				111	
	1152d	0	347b	53	465e	287

FY 1988

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
7.2.2	111		111			
7.2.3	138		138			
7.2.4	64		64			
7.2.5	64		64			
8.3&.4	74		74			
8.5&.6	117		76		41	
	568		527b		41	
3-Yr TOTAL	2841a	80c	1054b	207	1116	384

a-Plus $285 K for removable beryllium.

b-From U.S./J Program Agreement (Tasks 9 through 13).

d-Plus $135 K for removable beryllium fabrication (expenditure costed to Operations Division).

e-Fusion Energy Mini-189.

c-Capital

cx-Capital (formerly planned as ARIM money)

Rev/BHM
5-1-86

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37831

April 10, 1986

Mr. M. J. Gouge
Nuclear Research and Development
Department of Energy, Oak Ridge
  Operations
Post Office Box E
Oak Ridge, Tennessee 37831

Dear Mr. Gouge:

Attached is the March monthly costs and schedule assessment report on the OR-638-86-ORNL-2, HIFI Project. The schedule and costs only pertain to those items covered by this funding.

If further information is required please contact me at 574-0258.

Sincerely,

B.H. Montgomery

B. H. Montgomery

BHM:kfr

Attachment

cc/att: D. W. Burton
K. R. Thoms
C. D. West

HIFI PROJECT SCHEDULE
(OR-638-86-ORNL-2 Only)

HIFI1.CAL
Last Update= 4/10/86 BHM

```
-------------------------------------------------------------------------------------------------
                           !              FY-1986              !              FY-1987              !
                           ! O N D ! J F M ! A M J ! J A S ! O N D ! J F M ! A M J ! J A S !
---------------------------!-------!-------!-------!-------!-------!-------!-------!-------!
                           !       !       !       !       !       !       !       !       !
TARGET TOWER(98)     ------DDDDDDDDxFFFFFFFFFFIIIIII       !       !       !       !       !
                           !       !       !       !       !       !       !       !       !
QUICK OPENING HATCH(99) ------DDDDDDDxFFFFFFFFFFFIIIIII    !       !       !       !       !
                           !       !       !       !       !       !       !       !       !
TARGET HOLE PLUG(100)  ------DDDDDDDxFFFFFFFFFFFIIIIII     !       !       !       !       !
                           !       !       !       !       !       !       !       !       !
RABBIT "U" BEND(96)        !    DDDDDDDDxFFFFFFFIIIIII     !       !       !       !       !
                           !       !       !       !       !       !       !       !       !
RABBIT INPILE SECTION(96)  !    DDDDDDDDxFFFFFFFIIIIII     !       !       !       !       !
                           !       !       !       !       !       !       !       !       !
OUTER SHROUD(93)           !   DDDx!  FFFFFFFFFFFFIIIIII   !       !       !       !       !
                           !       !       !       !       !       !       !       !       !
SHROUD FLANGE(94)          !       ! DDDDDDDDD - - -! - - - -FFFFFFFFFFFFFFF !IIII   !       !
                           !       !       !       !       !       !       !       !       !
UPPER TRACK(97)            !       ! DDDDDDDDDFFFFFFFFFFFFFFFFFFFFFFFFF! - - - -!IIII  !       !
                           !       !       !       !       !       !       !       !       !
MISC. TOOLS(101)           !       ! DDDDDDDDDDDDDDDDFFFF - - -! - - - -! - - - -!IIII   !       !
                           !       !       !       !       !       !       !       !       !
ASSEMBLY DRAWINGS          !       !       ! DDDDDDDDDDDDDD!       !       !       !       !
                           !       !       !       !       !       !       !       !       !
-------------------------------------------------------------------------------------------------
```

(D=Design; F=Fabricate; I=Install; x=Completed)
Numbers in ( ) are HFIR Job numbers

HIFI PROJECT COSTS (OR-638-86-ORNL-2 Only)

	ESTIMATE	MARCH COSTS	SPENT TO DATE	TO BE SPENT
DESIGN	$136,000	$23,806	$89,054	$ 46,946
FABRICATION	370,300	8,079	20,381	349,919
INSPECTION	42,600	3,937	6,521	36,079
SURVEILLANCE	98,100	9,453	22,233	75,867
INSTALLATION	63,000		4,151	58,849
TOTAL	$710,000	$45,275	$142,340	$567,660

MARTIN MARIETTA

Internal Correspondence

May 30, 1986

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

HIFI Project Monthly Progress Report for May 1986

There are ten new reactor component items associated with the instrumented target facilities that were out for fabrication - five have been completed and the remaining parts are scheduled to be complete by June 10, 1986. Work is progressing on modifying the existing spare parts for use. Design is continuing on the RB* facilities and some material has been ordered.

Operations Division had allocated $150 K for the purchase of the raw material for their scheduled replacement of the beryllium. However, a cost increase of 470% over the last purchase (eight years ago) has made it necessary for Operations to seek additional funding before the requisition can be released: the delay in the delivery of the beryllium can have a definite impact on the HIFI Project schedule as well as the operation of the HFIR so that their additional funding requirements must be addressed urgently.

Operations Division is internally shifting personnel in order to put manpower on the delayed tasks 9.1 and 9.2 (Neutronics Analyses - see schedule of tasks in the April 1986 Monthly Progress Report). Work on these tasks should begin in approximately three weeks. They are still actively pursuing additional manpower for their own needs, but the immediate concern from the HIFI Project viewpoint has somewhat eased.

The target temperature capsule, scheduled for insertion in the new instrumented target facility in August of this year, has been designed, parts fabricated, and is currently being assembled. It is scheduled to be delivered to the HFIR by the first of July for a trial insertion in the reactor mockup prior to actual testing.

The HFIR reactor operators have been given briefings on the HIFI Project. Discussions were held pertaining to the new component designs and how they would effect a change in the current procedures. These briefings were held once a week over a period of five weeks in order to cover all shifts.

The OR-538 monthly cost/schedule report was sent to M. J. Gouge, DOE-ORO, on May 13, 1986. A copy of this report is attached for your information.

BHMontgomery

B. H. Montgomery, Project Leader, Y-12, 9108, MS-1 (4-0258)

BHM:kfr

Attachment

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
D. W. Burton
B. L. Corbett
G. R. Hicks
S. S. Hurt
A. W. Longest
R. V. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
J. H. Swanks
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. D. West
R. S. Wiltshire
A. Zucker
File-BHM(2)

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37831

May 13, 1986

Mr. M. J. Gouge
Nuclear Research and Development
Department of Energy, Oak Ridge
Operations
Post Office Box E
Oak Ridge, Tennessee 37831

Dear Mr. Gouge:

Attached is the April monthly costs and schedule assessment report on the OR-638-86-ORNL-2, HIFI Project. The schedule and costs only pertain to those items covered by this funding.

If further information is required please contact me at 574-0258.

Sincerely,

B H Montgomery

B. H. Montgomery

BHM:kfr

Attachment

cc/att: D. W. Burton
K. R. Thoms
C. D. West

HIFI PROJECT SCHEDULE
(OR-638-86-ORNL-2 Only)

HIFI1.CAL
Last Update= 5/13/86 BHM

```
--------------------------------------------------------------------------------------------
                         |              FY-1986              |              FY-1987              |
                         | O N D | J F M | A M J | J A S | O N D | J F M | A M J | J A S |
-------------------------|_______|_______|_______|_______|_______|_______|_______|_______|
                         |       |       |       |       |       |       |       |       |
TARGET TOWER(98)     ------DDDDDDDDDxFFFFFFFFFFIIIIII    |       |       |       |       |
                         |       |       |       |       |       |       |       |       |
QUICK OPENING HATCH(99) ------DDDDDDDDxFFFFFFFFFFFFIIIIII |       |       |       |       |
                         |       |       |       |       |       |       |       |       |
TARGET HOLE PLUG(100) ------DDDDDDDDxFFFFFFFFFFFFIIIIII  |       |       |       |       |
                         |       |       |       |       |       |       |       |       |
RABBIT "U" BEND(96)      |    DDDDDDDDxFFFFFFFIIIIII     |       |       |       |       |
                         |       |       |       |       |       |       |       |       |
RAEBIT INPILE SECTION(96)|    DDDDDDDDxFFFFFFFIIIIII     |       |       |       |       |
                         |       |       |       |       |       |       |       |       |
OUTER SHROUD(93)         |   DDDx| FFFFFFFFFFFFFIIIIII   |       |       |       |       |
                         |       |       |       |       |       |       |       |       |
SHROUD FLANGE(94)        |       | DDDDDDDDDDDD- -| - - - -FFFFFFFFFFFFFFF |IIII  |       |
                         |       |       |       |       |       |       |       |       |
UPPER TRACK(97)          |       | DDDDDDDDDDDDFFFFFFFFFFFFFFFFFFFF| - - - -|IIII  |       |
                         |       |       |       |       |       |       |       |       |
MISC. TOOLS(101)         |       |DDDDDDDDDDDDDDDDFFFF - - -| - - - -| - - - -|IIII  |       |
                         |       |       |       |       |       |       |       |       |
ASSEMBLY DRAWINGS        |       |       |  DDDDDDDDDDDDDD|       |       |       |       |
                         |       |       |       |       |       |       |       |       |
--------------------------------------------------------------------------------------------
```

(D=Design; F=Fabricate; I=Install; x=Completed)
Numbers in ( ) are HFIR Job numbers

HIFI PROJECT COSTS (OR-638-86-ORNL-2 Only)

	ESTIMATE	APRIL COSTS	SPENT TO DATE	TO BE SPENT
DESIGN	$136,000	$26,197	$115,251	$ 20,749
FAERICATION	370,300	35,130	55,511	314,789
INSPECTION	42,600	4,803	11,324	31,276
SURVEILLANCE	98,100	24,973	47,206	50,894
INSTALLATION	63,000		4,151	58,849
TOTAL	$710,000	$91,103	$233,443	$476,557

MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

July 2, 1986

Distribution

HIFI Project Monthly Progress Report for June 1986

Fabrication of all the reactor components necessary for first phase of the project (the instrumented target facility) has been completed on time and within costs. Fitting and checking of the parts in the reactor mockup is proceeding. Installation of the components in the reactor is scheduled during the mid-August shutdown. The target temperature capsule itself, scheduled for insertion in the new instrumented target facility in August of this year, is in the final stages of assembly. A trial insertion in the reactor mockup prior to actual installation is scheduled for mid-July.

Design is continuing on the RB* facilities and some fabrication has already been initiated. Operations Division has released the purchase requisition for the raw material for their scheduled replacement of the beryllium. No delay in delivery is foreseen at this time.

Work has begun, by Bill Thomas of Operations Division, on the neutronics analyses (Tasks 9.1 and 9.2 - Figure 1), with emphasis on the RB* facilities: these calculations are necessary to complete the thermal analysis for the capsules scheduled for installation in June 1987.

The HIFI Project Funding (shown in Table 1) has been revised to show a decrease in the Shortfall for FY 1986 with an increase in Shortfall in FY 1987. This change was caused by the earlier delay in providing manpower to be costed this fiscal year and a consequential delay in fabrication scheduling of RB* capsule parts. It should be noted that the $27 K expenditure is only postponed from July 1, 1986 to October 1, 1986 - delays beyond October 1 would have serious effects on the Project Schedule. It should also be noted that the revised $70 K Shortfall for this fiscal year should really have been made available by now (July 1). Table 2 shows the funding for each of the tasks on Figure 1 and reflects these changes. In addition, of the $610,000 capital allocated by OFE, only $590,000 has yet been placed in the HIFI Project financial plan.

The OR-638 monthly cost/schedule report was sent to M. J. Gouge, DOE-ORO, on June 10, 1986. A copy of this report is attached for your information.

B H Montgomery

B. H. Montgomery, Y-12, 9108, MS-1 (4-0258)

BHM:kfr

Attachments

cc/att: S. J. Ball
L. A. Berry
E. E. Bloom
B. L. Corbett
W. G. Craddick
G. R. Hicks
S. S. Hurt
A. W. Longest
R. V. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
J. H. Swanks
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. D. West
R. S. Wiltshire
A. Zucker
File-BHM

Table 1

HIFI PROJECT FUNDING

(FY 86 $,000)

Source of Committed Funding	FY 1986 Capital	FY 1986 Expense	FY 1987 Capital	FY 1987 Expense
OFE	610[1]		107[2]	358[2]
US/Japan		180[3]		347[3]
BES	100	54	53	
GPE	80			
Total	790	234	160	705
Funding committed	1,024		865	
Funding needed	1,094		1,179	
Shortfall	70[4]		314[5]	

[1]-Only $590,000 has actually been made available to the Project at this time.

[2]-As shown in the mini-189 dated 12/20/85.

[3]-As shown in the US/Japan Agreement (tasks 2, 9, and 12).

[4]-Expense money needed. NOTE: Was originally to have been ARIM money; ARIM funding not available - OFE funding was switched from operating to capital.

[5]-$250 K of Capital money and $64 K of Expense money needed. NOTE:The Capital money was originally committed from ARIM funding; commitment subsequently withdrawn.

Rev. BHM/6-30-86

Figure 1

HIFI PROJECT
ACCELERATED MFE SCHEDULE

SCHED.CAL BHM
Rev. 7/1/86

	FY-86 Q1¦ Q2¦ Q3¦ Q4 OND¦JFM¦AMJ¦JAS	FY-87 Q1¦ Q2¦ Q3¦ Q4 OND¦JFM¦AMJ¦JAS	FY-88 Q1¦ Q2¦ Q3¦ Q4 OND¦JFM¦AMJ¦JAS	EST COST ($1000)
REACTOR COMPONENTS				
1.0 DESIGN				
1.1 CONCEPTUAL	completed			
1.2 DETAILS				
1.2.1 TARGET TOWER	completed			5
1.2.2 ACCESS HATCH	completed			5
1.2.3 REMOV BE	[-¦---¦-53¦-]			53
1.2.4 TRACK ASSY	[-¦---¦-53¦-]			53
1.2.5 OUTER SHROUD	completed			27
1.2.6 SHROUD FLANGE	completed			27
1.2.7 MISC	[---¦---¦-5-¦---]			5
1.3 STRESS ANALYSIS	completed			58
2.0 FABRICATION				
2.1 ACCESS HATCH	completed			85
2.2 TARGET TOWER	completed			64
2.3 REMOV BE	[¦---¦204¦---	---¦-] ¦135¦		339
2.4 OUTER SHROUD	completed			105
2.5 SHROUD FLANGE	[---]	88¦		88
2.6 TRACK ASSY	102 [---¦---	---¦-] ¦108¦		210
2.7 MISC	[-¦---¦---	---¦---]		
3.0 ETD SURVEL.	[---¦---¦-70¦---	---¦---¦-70¦-]		140
4.0 INSTALLLATION				
4.1 ACCESS HATCH	5¦ [--]			5
4.2 TARGET TOWER	5¦ [--]			5
4.3 TRACK & RB		[---¦---¦--]¦ 53		53
4.4 MISC	[-¦-]	[---¦---¦--]¦		
EXPERIMENTS				
5.0 DESIGN				
5.1 RB* INST FACILITY	[---] 53¦	delayed		53
5.2 TARGET TEMP CAP	completed			53
5.3 MFE 60	¦32 [---¦---]			32
5.4 MFE 200	delayed 42[---¦---	---] 22¦		64
5.5 MFE 300		[---¦---¦-] 53		53
5.6 MFE 400		[---¦---¦-] 53		53
5.7 ADD ANALYSES	delayed[--42---	---] 5		47
6.0 PROCURE RB*INST FACILITY	¦16 [---¦---	---] 64¦		80
7.0 FABRICATION & ASSY				
7.1 FACILITIES				
7.1.1 INST TARGET	11¦[--¦-]			11
7.1.2 INST RB*		[--¦---¦-] ¦27		27
7.2 CAPSULES				
7.2.1 TARGET TEMP	¦53 [---]			53
7.2.2 MFE 60		[---¦---¦-] ¦111	[---¦---]111	222
7.2.3 MFE 200	delayed	[---¦---¦-] ¦138	[---¦---]138	276
7.2.4 MFE 300		¦138¦ [-¦---	---] ¦64 [---	->202
7.2.5 MFE 400		¦138¦ [-¦---	---] ¦64 [---	->202
8.0 INSTALL & OPERATE				
8.1 TARGET TEMP	[-]			
8.2 MFE 60		[=¦===	===] [===	=>
8.3 MFE 200		¦111¦ [=¦===	===] 16¦ 58[===	=>185
8.4 MFE 300			[===¦===]	
8.5 MFE 400			117[===¦===]	117
9.0 NEUTRONICS ANALYSES				
9.1 FACILITY	delayed [¦-42	---¦--]¦		42
9.2 TARGET TEMP EFFECTS	delayed [¦-27	---¦--]¦		27
9.3 BEAM TUBE EFFECTS	completed			
FISCAL YEAR COSTS (FY-86 DOLLARS) X 1000	1244	1314	568	3126*

* Plus $155 K spent in FY-1985 on design and neutronic analysis.

Table 2

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
(FY 86 $000)

FY 1986

FUND1.CAL BHM
Rev. 6/30/86

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
1.2.1	5				5	
1.2.2	5				5	
1.2.3	53				53	
1.2.4	53				53	
1.2.5	27				27	
1.2.6	27				27	
1.2.7	5				5	
1.3	58				58	
2.1	85				85	
2.2	64				64	
2.3	54a			54		
2.4	105			100c		5
2.6	102				102	
3.0	70				47	23
4.1	5				5	
4.2	5				5	
5.1	53	53				
5.2	53		53			
5.3	32		32			
5.4	42		42			
5.7	42					42
6.0	16	16				
7.1.1	11	11				
7.2.1	53		53			
9.1	42				42	
9.2	27				27	
	1094a	80c	180b	154	610c	70

a-Plus $150 K for removable beryllium material (expenditure costed to Operations Division).

b-From U.S./J Program Agreement (Tasks 9 through 13).

c-Capital

Table 2 (continued)

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
(FY 86 $000)

FY 1987

FUND2.CAL BHM
Rev. 6/30/86

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
2.3	d					
2.5	88					88cx
2.6	108					108cx
3.0	70				16c	54cx
4.3	53			53		
5.4	22					22
5.5	53		53			
5.6	53		53			
5.7	5					5
6.0	64				64c	
7.1.2	27				27c	
7.2.2	111		103		8	
7.2.3	138				101	37
7.2.4	138				138	
7.2.5	138		138			
8.3&.4	111				111	
	1179d	0	347b	53	465e	314

FY 1988

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
7.2.2	111		111			
7.2.3	138		138			
7.2.4	64		64			
7.2.5	64		64			
8.2&.3	74		74			
8.4&.5	117		76		41	
	568		527b		41	
3-Yr TOTAL	2841a	80c	1054b	207	1116	384

a-Plus $285 K for removable beryllium.

b-From U.S./J Program Agreement (Tasks 9 through 13).

d-Plus $135 K for removable beryllium fabrication (expenditure costed to Operations Division).

e-Fusion Energy Mini-189.

c-Capital

cx-Capital (formerly planned as ARIM money)

OAK RIDGE NATIONAL LABORATORY

OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37831

June 10, 1986

Mr. M. J. Gouge
Nuclear Research and Development
Department of Energy, Oak Ridge
  Operations
Post Office Box E
Oak Ridge, Tennessee 37831

Dear Mr. Gouge:

Attached is the May monthly costs and schedule assessment report on the OR-638-86-ORNL-2, HIFI Project. The schedule and costs only pertain to those items covered by this funding.

If further information is required please contact me at 574-0258.

Sincerely,

B. H. Montgomery

BHM:kfr

Attachment

cc/att: D. W. Burton
K. R. Thoms
C. D. West

HIFI PROJECT SCHEDULE
(OR-638-86-ORNL-2 Only)

HIFI1.CAL
Last Update= 6/10/86 BHM

```
---------------------------------------------------------------------------------------------
                          !              FY-1986              !              FY-1987              !
                          ! O N D  ! J F M  ! A M J  ! J A S  ! O N D  ! J F M  ! A M J  ! J A S  !
--------------------------!--------!--------!--------!--------!--------!--------!--------!--------!
                          !        !        !        !        !        !        !        !        !
TARGET TOWER(98)        ------DDDDDDDDDxFFFFFFFFFFIIIIII      !        !        !        !        !
                          !        !        !        !        !        !        !        !        !
QUICK OPENING HATCH(99) ------DDDDDDDDxFFFFFFFFFFFIIIIII      !        !        !        !        !
                          !        !        !        !        !        !        !        !        !
TARGET HOLE PLUG(100)   ------DDDDDDDDxFFFFFFFFFFFIIIIII      !        !        !        !        !
                          !        !        !        !        !        !        !        !        !
RABBIT "U" BEND(96)       !      DDDDDDDDxFFFFFFFxIIIII       !        !        !        !        !
                          !        !        !        !        !        !        !        !        !
RABBIT INPILE SECTION(96) !      DDDDDDDDxFFFFFFFxIIIII       !        !        !        !        !
                          !        !        !        !        !        !        !        !        !
OUTER SHROUD(93)          !    DDDx!  FFFFFFFFFFFFxIIIII      !        !        !        !        !
                          !        !        !        !        !        !        !        !        !
SHROUD FLANGE(94)         !        !  DDDDDDDDDDDx- -! - - - -FFFFFFFFFFFFFFFF  !IIII    !        !
                          !        !        !        !        !        !        !        !        !
UPPER TRACK(97)           !        !  DDDDDDDDDDDDFFFFFFFFFFFFFFFFFFFFF! - - - -!IIII    !        !
                          !        !        !        !        !        !        !        !        !
MISC. TOOLS(101)          !        ! DDDDDDDDDDDDDDxFFFF - - -! - - - -! - - - -!IIII    !        !
                          !        !        !        !        !        !        !        !        !
ASSEMBLY DRAWINGS         !        !        !   DDDDDDDDDDDDDD!        !        !        !        !
                          !        !        !        !        !        !        !        !        !
---------------------------------------------------------------------------------------------
```

(D=Design; F=Fabricate; I=Install; x=Completed)
Numbers in ( ) are HFIR Job numbers

HIFI PROJECT COSTS (OR-638-86-ORNL-2 Only)

	ESTIMATE	MAY COSTS	SPENT TO DATE	TO BE SPENT
DESIGN	$136,000	$17,511	$132,762	$ 3,238
FABRICATION	370,300	42,949	98,707	271,593
INSPECTION	42,600	4,060	15,384	27,216
SURVEILLANCE	98,100	9,982	57,188	40,912
INSTALLATION	63,000	230	4,381	58,619
TOTAL	$710,000	$74,732	$308,422	$401,578

MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

July 31, 1986

Distribution

HIFI Project Monthly Progress Report for July 1986

All of the new reactor components for the first phase of the Project (the instrumented target facilities) have been fitted and checked out in the reactor mockup. A video tape was made as each part was installed and removed. This tape can be used to train operators as well as assist in the preparation of installation and removal procedures for the revised HFIR Operating Manual. Assembly of the target temperature capsule was completed and a trial insertion in the reactor mockup proved the alignment of the facility to be correct. The reactor components and the capsule will be installed during the next shutdown, which is scheduled in mid-August.

The beryllium reflector design was completed this month and design is continuing on the track assembly and miscellaneous parts and tools. Fabrication is continuing on the shroud flange with delivery scheduled in early September. Design of the Fusion Energy RB* capsules is continuing. There has been a change made in the operational schedule of these four MFE capsules: the first pair of capsules will be the 60°C and 300°C instead of the 60°C and 200°C. This switch was made to give extra time for design and development work on the more difficult 200°C capsule (on which development work was earlier delayed). No overall delays are foreseen due to this change in the order of irradiations.

A new funding prospectus for 1987 was distributed on July 23, 1986 (copy attached). By redirecting some of the funding to other tasks and requesting GPE funds, the 1987 shortfall would be greatly reduced. The HIFI Project Funding (shown in Table 1), the MFE Accelerated Schedule (shown in Figure 1), and the Funding of Tasks (shown in Table 2) have been revised to reflect these changes. Please note that the tables and figure have been changed from constant FY 1986 dollars to current dollars to agree with the funding prospectus and the fusion energy mini-189 - a 5% escalation per year was used.

It is also noted that the arrival of the new removable beryllium reflector is behind schedule, so that the machining work planned for this year cannot now be done until FY 1987, reducing the funding shortfall in FY 1986 from $70,000 to only $16,000.

The OR-638 monthly cost/schedule report was sent to M. J. Gouge, DOE-ORO, on July 4, 1986. A copy of this report is attached for your information.

P. P. B. H. Montgomery, Y-12, 9108, MS-1 (4-0258)

BHM:kfr

Attachments

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
B. L. Corbett
W. G. Craddick
C. J. Cromwell
J. R. Hickey
G. R. Hicks
S. S. Hurt
A. W. Longest
R. V. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
J. H. Swanks
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. A. Watson
C. D. West
R. S. Wiltshire
A. Zucker
File-BHM(2)

MARTIN MARIETTA

Internal Correspondence

July 23, 1986

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

The HIFI Project - A New Funding Prospectus and Some Good News

The funding for additional machining of the removable reflector to the new design will not be needed by Operations Division this financial year because delivery of the beryllium material will be delayed. That reduces the shortfall of funding for FY 1986 from the $70,000 previously reported to only $16,000 (assuming that the $54,000 of operating funds already available and presently allocated for the machining is redirected).

In the meantime, much progress has been made in obtaining the new reactor components for the project. The access hatch, target tower and outer shroud have been received, and an outside contract is in place for the shroud flange with delivery expected in September. These items are within budget and have not needed the contingency funding included in the original estimates for them. As a result, the $710,000 of capital already committed and covered by our OR-638 is expected to complete all those components as well as some installation and related work although completing the installation and machining the track assembly at Y-12 will still require, as previously planned, some FY 1987 funding. This all has two very good consequences: first, the new capital requirements for FY 1987 are reduced by some $93,000 and second, that new capital funding will not now be needed before the December 1986 financial plan.

By rescheduling some expenditure on fabrication of the second pair of RB* capsules (Tasks 7.2.4 and 7.2.5) from late FY 1987 into early FY 1988, the funding shortfall for FY 1987 can be still further reduced without adverse effect on the overall project schedule.

The spending projections, taking into account all of these changes, are as shown in Table 1. These figures are completely consistent with previous estimates or with actual experience, but if you want to make a direct comparison with the tables in past monthly reports you must convert the figures shown in those reports from FY 1986 dollars to current dollars: on the advice of John Hickey, we used a 5% escalation from FY 1986 to FY 1987.

Table 1. Updated HIFI Project Cost Estimates, $000

		1987		1988	
		Previous est.	New est.	Previous est.	New est.
Reactor mods.	(Cap.)	335	242	0	0
" "	(Op.)	0	54[a]	0	0
Instrument facility	(Cap.)	96	96	0	0
Capsule work	(Op.)	807	717	626	726
Total		1,238	1,109	626	726

[a] For Operations Division extra machining costs on the new beryllium reflector (part of Task 2.3).

These new estimates provide considerable relief from the FY 1987 shortfall (the "shortfall" is the difference between the planned expenditures and the funding sources already committed). Specifically, the previous capital shortfall of $268,000 (including escalation), representing ARIM money that was originally considered but then dropped, is reduced to $175,000. The projected operating shortfall is reduced from $90,000 to $54,000, all of which is for the beryllium machining.

These changes prompt a new prospectus for funding, in which GPE money is sought for completion of the instrumentation facility work in FY 1987. If the laboratory management supports and grants a request for GPE, and assuming that the capital money already allocated by the fusion program can be redirected from facility work to reactor components, the 1987 capital shortfall would be reduced to only $79,000 - see Table 2 for a description of these changes.

Table 2. New Funding Proposal for the HIFI Project in FY 1987

All figures in thousands of 1987 dollars

	Previous figures		New prospectus	
	Need	Source	Need	Source
Capital	431		338	
GPE		0		96?
OFE		107[a]		107[a]
BES		56		56
Shortfall	268		79?	
Operating	807		771	
US/Japan fusion		359[b]		359[b]
OFE		358[a]		358[a]
Shortfall	90		54[c]	
Total shortfall	358		133?	

[a] Source: Fusion Energy Mini-189.

[b] Source: Tasks 9 and 11 from US/Japan fusion materials program plan.

[c] For beryllium machining by Operations Division.

Colin D. West, Y-12, 9108, MS-1 (4-0370)

CDW:kfr

Table 1

HIFI PROJECT FUNDING

(Current year $000)

Source of Committed Funding	FY 1986 Capital	FY 1986 Expense	FY 1987 Capital	FY 1987 Expense	FY 1988 Expense
OFE	610[1]		107[2]	358[2]	41[2]
US/Japan[3]		180		359	585
BES	100	54	56		
GPE	80		96		
Total	790	234	259	717	626
Funding committed	1,024		976		626
Funding needed	1,040		1,109		726
Shortfall	16		133[4]		100

[1]-Only $590,000 has actually been made available to the Project at this time.

[2]-As shown in the mini-189 dated 12/20/85.

[3]-As shown in the US/Japan Agreement (tasks 2, 9, and 12).

[4]-$79 K of Capital money and $54 K of Expense money needed.
NOTE: The $54 K is for additional beryllium machining by Operations Division.

Rev. BHM 7/23/86

Figure 1

HIFI PROJECT
ACCELERATED MFE SCHEDULE
(Current year $000)

SCHED1.CAL BHM
Rev. 7/25/86

	FY-86 (Q1 OND ¦ Q2 JFM ¦ Q3 AMJ ¦ Q4 JAS) ¦ FY-87 (Q1 OND ¦ Q2 JFM ¦ Q3 AMJ ¦ Q4 JAS) ¦ FY-88 (Q1 OND ¦ Q2 JFM ¦ Q3 AMJ ¦ Q4 JAS)	EST COST ($1000)
REACTOR COMPONENTS		
1.0 DESIGN		
1.1 CONCEPTUAL	completed	
1.2 DETAILS		
1.2.1 TARGET TOWER	completed 5	5
1.2.2 ACCESS HATCH	completed 5	5
1.2.3 REMOV BE	completed 53	53
1.2.4 TRACK ASSY	[-¦---¦-53¦-]	53
1.2.5 OUTER SHROUD	completed 27	27
1.2.6 SHROUD FLANGE	completed 27	27
1.2.7 MISC	[---¦---¦-5-¦---]	5
1.3 STRESS ANALYSIS	completed 58	58
2.0 FABRICATION		
2.1 ACCESS HATCH	completed 85	85
2.2 TARGET TOWER	completed 64	64
2.3 EXTRA BE MACH.	[¦---¦---¦---¦---¦-] ¦ 54	54
2.4 OUTER SHROUD	completed 105	105
2.5 SHROUD FLANGE	[---]	
2.6 TRACK ASSY	102 [---¦---¦---¦---] 54	156
2.7 MISC	[-¦---¦---¦---¦---] 73	73
3.0 ETD SURVEL.	[---¦---¦-70¦---¦---¦---¦-59¦-]	129
4.0 INSTALLLATION		
4.1 ACCESS HATCH	5¦ [--]	5
4.2 TARGET TOWER	5¦ [--]	5
4.3 TRACK & RB	[---¦---¦--]¦ 56	56
4.4 MISC	[-¦-] [---¦---¦--]	
EXPERIMENTS		
5.0 DESIGN		
5.1 RB* INST FACILITY	[---] 53¦ delayed	53
5.2 TARGET TEMP CAP	completed 53	53
5.3 MFE 60	¦32 [---¦---]	32
5.5 MFE 300	delayed 42[---¦---¦---] 23	65
5.4 MFE 200	[---¦---¦-] 56	56
5.6 MFE 400	[---¦---¦-] 56	56
5.7 ADD ANALYSES	delayed[--42---¦---] 5	47
6.0 PROCURE RB*INST FACILITY	¦16 [---¦---¦---] 67	83
7.0 FABRICATION & ASSY		
7.1 FACILITIES		
7.1.1 INST TARGET	11¦[--¦-]	11
7.1.2 INST RB*	¦[--¦---¦-] ¦29	29
7.2 CAPSULES		
7.2.1 TARGET TEMP	completed 53	53
7.2.2 MFE 60	[---¦---¦-] ¦117¦ [---¦---]123	240
7.2.4 MFE 300	delayed [---¦---¦-] ¦147¦ [---¦---]152	299
7.2.3 MFE 200	98¦ [-¦---¦---] ¦120[---¦->218	
7.2.5 MFE 400	98¦ [-¦---¦---] ¦120[---¦->218	
8.0 INSTALL & OPERATE		
8.1 TARGET TEMP	[-]	
8.2 MFE 60	[=¦===¦===] [===¦=>	
8.4 MFE 300	¦117¦ [=¦===¦===] 82 [===¦=>199	
8.3 MFE 200	[===¦===]	
8.5 MFE 400	¦129[===¦===]	129
9.0 NEUTRONICS ANALYSES		
9.1 FACILITY	delayed [¦-42¦---¦--]	42
9.2 TARGET TEMP EFFECTS	delayed [¦-27¦---¦--]	27
9.3 BEAM TUBE EFFECTS	completed	
FISCAL YEAR TOTALS	FY-86: 1040 ¦ FY-87: 1109 ¦ FY-88: 726	2875*

* Plus $155 K spent in FY-1985 on design and neutronic analysis.

Table 2

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
(FY 86 $000)

FY 1986

FUND10.CAL BHM
Rev. 7/25/86

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
1.2.1	5				5	
1.2.2	5				5	
1.2.3	53				53	
1.2.4	53				53	
1.2.5	27				27	
1.2.6	27				27	
1.2.7	5				5	
1.3	58				58	
2.1	85				85	
2.2	64				64	
2.4	105			100c		5
2.6	102				102	
3.0	70			12	47	11
4.1	5				5	
4.2	5				5	
5.1	53	53				
5.2	53		53			
5.3	32		32			
5.5	42		42			
5.7	42			42		
6.0	16	16				
7.1.1	11	11				
7.2.1	53		53			
9.1	42				42	
9.2	27				27	
	1040a	80c	180b	154	610c	16

a-Does not include funding for removable beryllium material. (Expenditure costed to Operations Division).

b-From U.S./J Program Agreement (Tasks 9 through 13).

c-Capital

Table 2 (continued)

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
(Current Year $000)

FY 1987

FUND20.CAL BHM
Rev. 7/25/86

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
2.3	54a					54
2.5	*					*
2.6	54				54c	
2.7	73				53c	20c
3.0	59					59c
4.3	56			56c		
5.4	56		56			
5.5	23		23			
5.6	56		56			
5.7	5		5			
6.0	67	67c				
7.1.2	29	29c				
7.2.2	117		117			
7.2.3	98				98	
7.2.4	147		4		143	
7.2.5	98		98			
8.2&.4	117				117	
	1109	96c	359b	56c	465d	133

FY 1988

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
7.2.2	123		123			
7.2.3	120		71			49
7.2.4	152		152			
7.2.5	120		71			49
8.2&.4	82		82			
8.3&.5	129		86		41	2
	726		585b		41	100
3-Yr TOTAL	2875	176c	1124b	210	1116	249

a-Cost for extra machining of new removable beryllium design (old design expenditure costed to Operations Division).

b-From U.S./J Program Agreement (Tasks 9 through 13).

d-Fusion Energy Mini-189.

c-Capital

*-Costed during FY-1986.

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37831

July 14, 1986

Mr. M. J. Gouge
Nuclear Research and Development
Department of Energy, Oak Ridge
Operations
Post Office Box E
Oak Ridge, Tennessee 37831

Dear Mr. Gouge:

Attached is the June monthly costs and schedule assessment report on the OR-638-86-ORNL-2, HIFI Project. The schedule and costs only pertain to those items covered by this funding. As relayed in our telephone conversation, the engineering design estimate was increased to cover additional costs for operating procedures and manual, and for changes required in the plant assembly drawings.

At the same time, the fabrication cost estimate was reduced; costing experience has shown that this new estimate should cover the remaining reactor components. These two changes compensate each other, and the original overall cost estimate is unchanged.

If further information is required please contact me at 574-0258.

Sincerely,

B H Montgomery

B. H. Montgomery

BHM:kfr

Attachment

cc/att: W. G. Craddick
K. R. Thoms
C. D. West

HIFI PROJECT SCHEDULE
(OR-638-86-ORNL-2 Only)

HIFI1.CAL
Last Update= 7/14/86 BHM

```
-------------------------------------------------------------------------------------------------
                           |            FY-1986                |             FY-1987             |
                           | O N D | J F M | A M J | J A S | O N D | J F M | A M J | J A S |
                           |       |       |       |       |       |       |       |       |
-------------------------------------------------------------------------------------------------
                           |       |       |       |       |       |       |       |       |
TARGET TOWER(98)        ------DDDDDDDDxFFFFFFFFFFxIIIIII   |       |       |       |       |
                           |       |       |       |       |       |       |       |       |
QUICK OPENING HATCH(99) ------DDDDDDDxFFFFFFFFFFFFxIIIIII  |       |       |       |       |
                           |       |       |       |       |       |       |       |       |
TARGET HOLE PLUG(100)   ------DDDDDDDxFFFFFFFFFFFFxIIIIII  |       |       |       |       |
                           |       |       |       |       |       |       |       |       |
RABBIT "U" BEND(96)        |     DDDDDDDDxFFFFFFFxIIIIIII  |       |       |       |       |
                           |       |       |       |       |       |       |       |       |
RABBIT INPILE SECTION(96)  |     DDDDDDDDxFFFFFFFxIIIIIII  |       |       |       |       |
                           |       |       |       |       |       |       |       |       |
OUTER SHROUD(93)           |  DDDx- -FFFFFFFFFFFFxIIIII - - -|- - - - |- - - - |IIII   |       |
                           |       |       |       |       |       |       |       |       |
SHROUD FLANGE(94)          |       | DDDDDDDDDDx----FFFFFFFFF|- - - - |- - - - |IIII   |       |
                           |       |       |       |       |       |       |       |       |
UPPER TRACK(97)            |       | DDDDDDDDDDDDDDDFFFFFFFFFFFFFFFFFFFFFFFFFFF|IIII   |       |
                           |       |       |       |       |       |       |       |       |
MISC. TOOLS(101)           |       | DDDDDDDDDDDDDDxF-F-F-F-F-F-F-F-F-F| - - - -|IIII   |       |
                           |       |       |       |       |       |       |       |       |
ASSEMBLY DRAWINGS          |       |       |   DDDDDDDDDDDDDD|       |       |       |       |
                           |       |       |       |       |       |       |       |       |
-------------------------------------------------------------------------------------------------
```

(D=Design; F=Fabricate; I=Install; x=Completed)
Numbers in ( ) are HFIR Job numbers

HIFI PROJECT COSTS (OR-638-86-ORNL-2 Only)

	ESTIMATE	JUNE COSTS	SPENT TO DATE	TO BE SPENT
DESIGN	$179,500a	$13,250	$146,012	$ 33,488
FABRICATION	326,800b	84,546	183,253	143,547
INSPECTION	42,600	3,691	19,075	23,525
SURVEILLANCE	98,100	9,377	66,565	31,535
INSTALLATION	63,000	4,944	9,325	53,675
TOTAL	$710,000	$115,808	$424,230	$285,770

a - Increased design estimate for additional engineering costs associated with Operating Procedures, Operating Manual, and changes required in the assembly drawings (as-built drawings).
b - Reduced estimate on fabrication costs.

MARTIN MARIETTA

Internal Correspondence

September 2, 1986

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

HIFI Project Monthly Progress Report for August 1986

Phase 1 of the HIFI Project has been completed on schedule and under costs. The new components and the target temperature capsule were installed during the reactor's refueling shutdown in mid-August thanks in large measure to the perseverance of Gene Hicks of the Operations Division. The first-ever instrumented experiment in the target region of the HFIR continues to operate smoothly yielding data that are largely confirming expectations.

Work is continuing on Phase 2 (the RB* facilities). Design of the track assembly should be completed in early September. Purchase orders for fabrication of some of the parts have already been let with delivery expected in early September. The final assembly of the tracks will be done in Y-12 General Machine Shop because of the specialized equipment located there and required for this job. Design of the Fusion Energy RB* capsules continues on the new, delayed schedule.

Funding from the U.S. Fusion Materials Program is available to complete certain ETD tasks relating to the HFIR modifications. This, together with the recent allocation of the last $20,000 of the planned $610,000 of capital funding for the Project, provides sufficient funding for our FY 1986 needs. Figure 1 and Tables 1 and 2 reflect these changes.

It should be noted that FY 1986 funding for the reactor components has been estimated to be sufficient to continue work on the Project through the end of November 1986. If the additional funds for FY 1987 are not available in the December financial plan, all work will have to cease thus delaying the RB* facilities.

The OR-638 monthly cost/schedule report for July 1986 was sent to M. J. Gouge, DOE-ORO, on August 13, 1986. A copy of this report is attached for your information.

B. H. Montgomery

B. H. Montgomery, Project Leader, Y-12, 9108, MS-1 (4-0258)

BHM:kfr

Attachments

cc/att:

S. J. Ball	G. R. Hicks	B. W. Patton	K. R. Thoms
L. A. Berry	S. S. Hurt	M. W. Rosenthal	H. E. Trammell
E. E. Bloom	A. W. Longest	J. L. Scott	C. A. Watson
B. L. Corbett	R. V. McCord	R. L. Senn	C. D. West
W. G. Craddick	D. M. McGinty	I. I. Siman-Tov	R. S. Wiltshire
C. Cromwell	F. R. Mynatt	J. H. Swanks	A. Zucker
J. Hickey	E. Newman, Jr.	W. E. Thomas	File(2)

Table 1

HIFI PROJECT FUNDING

(Current year $000)

Source of Committed Funding	FY 1986 Capital	FY 1986 Expense	FY 1987 Capital	FY 1987 Expense	FY 1988 Expense
OFE	610		107[1]	358[1]	41[1]
US/Japan[2]		196		359	585
BES	100	54	56		
GPE	80		96		
Total	790	250	259	717	626
Funding committed	1,040		976		626
Funding needed	1,040		1,109		726
Shortfall			133[3]		100

[1]-As shown in the mini-189 dated 12/20/85.

[2]-As shown in the US/Japan Agreement (tasks 2, 9, and 12).

[3]-$79 K of Capital money and $54 K of Expense money needed.
NOTE: The $54 K is for additional beryllium machining by Operations Division.

Rev. BHM 8/22/86

Figure 1

HIFI PROJECT
ACCELERATED MFE SCHEDULE
(Current year $000)

SCHED1.CAL BHM
Rev. 8/22/86

	FY-86 Q1 OND · Q2 JFM · Q3 AMJ · Q4 JAS / FY-87 Q1 OND · Q2 JFM · Q3 AMJ · Q4 JAS / FY-88 Q1 OND · Q2 JFM · Q3 AMJ · Q4 JAS	EST COST ($1000)
REACTOR COMPONENTS		
1.0 DESIGN		
1.1 CONCEPTUAL	completed FY-1985	
1.2 DETAILS		
1.2.1 TARGET TOWER	completed 5	5
1.2.2 ACCESS HATCH	completed 5	5
1.2.3 REMOV BE	completed 53	53
1.2.4 TRACK ASSY	[-¦---¦-53¦---]	53
1.2.5 OUTER SHROUD	completed 27	27
1.2.6 SHROUD FLANGE	completed 27	27
1.2.7 MISC	[---¦---¦-5-¦---]	5
1.3 STRESS ANALYSIS	completed 58	58
2.0 FABRICATION		
2.1 ACCESS HATCH	completed 85	85
2.2 TARGET TOWER	completed 64	64
2.3 EXTRA BE MACH.	delayed [---¦--]¦ 54	54
2.4 OUTER SHROUD	completed 80	80
2.5 SHROUD FLANGE	25[---]	25
2.6 TRACK ASSY	102 [---¦---¦---¦---] 54	156
2.7 MISC	[-¦---¦---¦---¦---] 73	73
3.0 ETD SURVEL.	[---¦---¦-70¦---¦---¦---¦-59¦-]	129
4.0 INSTALLLATION		
4.1 ACCESS HATCH	completed 5	5
4.2 TARGET TOWER	completed 5	5
4.3 TRACK & RB	[---]¦ 56	56
4.4 MISC	[-¦-] [---¦---¦--]	
EXPERIMENTS		
5.0 DESIGN		
5.1 RB* INST FACILITY	delayed[--53---]	53
5.2 TARGET TEMP CAP	completed 53	53
5.3 MFE 60	¦32 [---¦---]	32
5.5 MFE 300	delayed 42[---¦---¦---] 23	65
5.4 MFE 200	[---¦---¦-] 56	56
5.6 MFE 400	[---¦---¦-] 56	56
5.7 ADD ANALYSES	delayed[--42---¦---] 5	47
6.0 PROCURE RB*INST FACILITY	¦16 [---¦---¦---] 67	83
7.0 FABRICATION & ASSY		
7.1 FACILITIES		
7.1.1 INST TARGET	completed 11	11
7.1.2 INST RB*	¦[--¦---¦-] ¦29	29
7.2 CAPSULES		
7.2.1 TARGET TEMP	completed 53	53
7.2.2 MFE 60	[---¦---¦-] ¦117¦ [---¦---]123	240
7.2.4 MFE 300	delayed [---¦---¦-] ¦147¦ [---¦---]152	299
7.2.3 MFE 200	¦ 98¦ [-¦---¦---]60 ¦ 60[---¦->	218
7.2.5 MFE 400	¦ 98¦ [-¦---¦---]60 ¦ 60[---¦->	218
8.0 INSTALL & OPERATE		
8.1 TARGET TEMP	completed ¦ [-]	
8.2 MFE 60	[=¦===¦===] ¦ [===¦=>	
8.4 MFE 300	¦117¦ [=¦===¦===]18 ¦ 64[===¦=>	199
8.3 MFE 200	[===¦===]	
8.5 MFE 400	¦129[===¦===]	129
9.0 NEUTRONICS ANALYSES		
9.1 FACILITY	delayed [¦-42¦---¦--]	[illegible]
9.2 TARGET TEMP EFFECTS	delayed [¦-27¦---¦--]	
9.3 BEAM TUBE EFFECTS	completed FY-1985	
FISCAL YEAR TOTALS	FY-86: 1040 / FY-87: 1109 / FY-88: 726	2[illegible]

* Plus $155 K spent in FY-1985 on design and neutronic analysis.

Table 2

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
(FY 86 $000)

FY 1986

FUND10.CAL BHM
Rev. 8/22/86

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
1.2.1	5				5	
1.2.2	5				5	
1.2.3	53				53	
1.2.4	53				53	
1.2.5	27				27	
1.2.6	27				27	
1.2.7	5				5	
1.3	58				58	
2.1	85				85	
2.2	64				64	
2.4	80		5	75c		
2.5	25			25c		
2.6	102				102	
3.0	70		11	12	47	
4.1	5				5	
4.2	5				5	
5.1	53	53				
5.2	53		53			
5.3	32		32			
5.5	42		42			
5.7	42			42		
6.0	16	16				
7.1.1	11	11				
7.2.1	53		53			
9.1	42				42	
9.2	27				27	
	1040a	80c	196b	154	610c	

a-Does not include funding for removable beryllium material. (Expenditure costed to Operations Division).

b-From U.S./J Program Agreement (Tasks 9 through 13).

c-Capital

Table 2 (continued)

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
(Current Year $000)

FY 1987

FUND20.CAL BHM
Rev. 8/22/86

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
2.3	54a					54
2.6	54				54c	
2.7	73				53c	20c
3.0	59					59c
4.3	56			56c		
5.4	56		56			
5.5	23		23			
5.6	56		56			
5.7	5		5			
6.0	67	67c				
7.1.2	29	29c				
7.2.2	117		117			
7.2.3	98				98	
7.2.4	147		4		143	
7.2.5	98		98			
8.2&.4	117				117	
	1109	96c	359b	56c	465d	133

FY 1988

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
7.2.2	123		123			
7.2.3	120		71			49
7.2.4	152		152			
7.2.5	120		71			49
8.2&.4	82		82			
8.3&.5	129		86		41	2
	726		585b		41	100
3-Yr TOTAL	2875	176c	1124b	210	1116	249

a-Cost for extra machining of new removable beryllium design (old design expenditure costed to Operations Division).

b-From U.S./J Program Agreement (Tasks 9 through 13).

d-Fusion Energy Mini-189.

c-Capital

*-Costed during FY-1986.

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37831

August 13, 1986

Mr. M. J. Gouge
Nuclear Research and Development
Department of Energy, Oak Ridge
Operations
Post Office Box E
Oak Ridge, Tennessee 37831

Dear Mr. Gouge:

Attached is the July monthly costs and schedule assessment report on the OR-638-86-ORNL-2, HIFI Project. The schedule and costs only pertain to those items covered by this funding.

If further information is required please contact me at 574-0258.

Sincerely,

B. H. Montgomery

BHM:kfr

Attachment

cc/att: W. G. Craddick
K. R. Thoms
C. D. West

HIFI PROJECT SCHEDULE
(OR-638-86-ORNL-2 Only)

HIFI1.CAL
Last Update= 8/13/86 BHM

```
----------------------------------------------------------------------------------------------------
                          |             FY-1986                 |               FY-1987           |
                          | O N D | J F M | A M J | J A S | O N D | J F M | A M J | J A S |
--------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
                          |       |       |       |       |       |       |       |       |
TARGET TOWER(98)          ------DDDDDDDDDxFFFFFFFFFFFxIIIIII  |       |       |       |       |
                          |       |       |       |       |       |       |       |       |
QUICK OPENING HATCH(99)   ------DDDDDDDDxFFFFFFFFFFFFxIIIIII  |       |       |       |       |
                          |       |       |       |       |       |       |       |       |
TARGET HOLE PLUG(100)     ------DDDDDDDDxFFFFFFFFFFFFxIIIIII  |       |       |       |       |
                          |       |       |       |       |       |       |       |       |
RABBIT "U" BEND(96)       |       DDDDDDDDxFFFFFFFxIIIIIII    |       |       |       |       |
                          |       |       |       |       |       |       |       |       |
RABBIT INPILE SECTION(96) |       DDDDDDDDxFFFFFFFxIIIIIII    |       |       |       |       |
                          |       |       |       |       |       |       |       |       |
OUTER SHROUD(93)          |    DDDx- -FFFFFFFFFFFFxIIIII - - -|- - - -|- - - -|IIII   |       |
                          |       |       |       |       |       |       |       |       |
SHROUD FLANGE(94)         |       | DDDDDDDDDDx----FFFFFFFFF|- - - -|- - - -|IIII   |       |
                          |       |       |       |       |       |       |       |       |
UPPER TRACK(97)           |       | DDDDDDDDDDDDDDDDFFFFFFFFFFFFFFFFFFFFFFFFFFF|IIII   |       |
                          |       |       |       |       |       |       |       |       |
MISC. TOOLS(101)          |       | DDDDDDDDDDDDDDxF-F-F-F-F-F-F-F-F-F| - - - -|IIII   |       |
                          |       |       |       |       |       |       |       |       |
ASSEMBLY DRAWINGS         |       |       |   DDDDDDDDDDDDDD|       |       |       |       |
                          |       |       |       |       |       |       |       |       |
----------------------------------------------------------------------------------------------------
```

(D=Design; F=Fabricate; I=Install; x=Completed)
Numbers in ( ) are HFIR Job numbers

HIFI PROJECT COSTS (OR-638-86-ORNL-2 Only)

	ESTIMATE	JULY COSTS	SPENT TO DATE	TO BE SPENT
DESIGN	$179,500	$ 8,639	$154,651	$ 24,849
FABRICATION	326,800	40,571	223,824	102,976
INSPECTION	42,600	3,138	22,213	20,387
SURVEILLANCE	98,100	11,651	78,216	19,884
INSTALLATION	63,000	18,881	28,206	34,794
TOTAL	$710,000	$ 82,880	$507,110	$202,890

MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

September 30, 1986

Distribution

HIFI Project Monthly Progress Report for September 1986

The instrumented target capsule continues to operate smoothly. Reactor operations personnel removed and reinserted the capsule during the last scheduled refueling shutdown in early September without any problems or any special tools.

Work is continuing on Phase II (the RB* facilities). Design of the track assembly has been completed, and fabrication has already begun in the Y-12 General Machine Shop. Fabrication of the outer shroud flange was completed, and it has been delivered to the HFIR. Purchase orders for additional miscellaneous parts and tooling are awaiting the arrival of FY 1987 money. Initiation of these purchase orders must be started in December in order to stay on schedule.

A DOE/ORNL Award Fee Milestone has been placed on the completion of the HIFI Project Phase II (RB* facilities). The milestone date was set as July 1987, which is actually one month too late for our US/Japan milestone (June) on beginning irradiation of the Fusion Energy RB* capsules. The June date has been comfortably in the project's schedule for over a year now, and the only foreseeable delay that could affect the schedule would be the late delivery of the removable reflector.

A request for GPE funds has been submitted through Alex Zucker's office for $96 K as part of the HIFI Project funding for FY 1987. No action has been taken on the $133 K "shortfall" for the coming year (see figure 1), although it is understood that Zucker will be arranging a meeting between himself, Rosenthal and others to discuss the issue shortly.

The neutronics analysis schedule (Tasks 9.1 and 9.2 in Table 1) has been further delayed due to other work in the Operations Division (including the new HFIR safety analysis). A new schedule is being prepared that will take account of the urgent need for heating and neutronics data to design the new RB* experiments scheduled to begin operation next summer; this need remains urgent and important because of the deletion of the prototype test capsule from the program (see April Monthly Progress Report), and the new schedule for neutronics work will reflect this critical path.

Programmatic funding for each of the tasks is shown in Table 2.

The OR-638 monthly cost/schedule report for August 1986 was sent to M. J. Gouge, DOE-ORO, on September 16, 1986. A copy of this report is attached for your information.

B. H. Montgomery

B. H. Montgomery, Project Leader, Y-12, 9108, MS-1 (4-0258)

BHM:kfr

Attachments

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
B. L. Corbett
W. G. Craddick
C. Cromwell
G. R. Hicks
M. A. Holtzclaw
S. S. Hurt
A. W. Longest
R. V. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
B. W. Patton
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
J. H. Swanks
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. A. Watson
C. D. West
R. S. Wiltshire
A. Zucker
File-BHM(2)

Table 1

HIFI PROJECT FUNDING

(Current year $000)

Source of Committed Funding	FY 1986 Capital	FY 1986 Expense	FY 1987 Capital	FY 1987 Expense	FY 1988 Expense
OFE	610		107[1]	358[1]	41[1]
US/Japan[2]		196		359	585
BES	100	54	56		
GPE	80		96		
Total	790	250	259	717	626
Funding committed	1,040		976		626
Funding needed	1,040		1,109		726
Shortfall			133[3]		100

[1]-As shown in the mini-189 dated 12/20/85.

[2]-As shown in the US/Japan Agreement (tasks 2, 9, and 12).

[3]-$79 K of Capital money and $54 K of Expense money needed.
NOTE: The $54 K is for additional beryllium machining by Operations Division.

Rev. BHM 9/16/86

Figure 1

HIFI PROJECT
ACCELERATED MFE SCHEDULE
(Current year $000)

SCHED1.CAL BHM
Rev. 9/26/86

	FY-86 Q1: Q2: Q3: Q4 OND:JFM:AMJ:JAS	FY-87 Q1: Q2: Q3: Q4 OND:JFM:AMJ:JAS	FY-88 Q1: Q2: Q3: Q4 OND:JFM:AMJ:JAS	EST COST ($1000)
REACTOR COMPONENTS				
1.0 DESIGN				
1.1 CONCEPTUAL	completed FY-1985			
1.2 DETAILS				
1.2.1 TARGET TOWER	completed 5			5
1.2.2 ACCESS HATCH	completed 5			5
1.2.3 REMOV BE	completed 53			53
1.2.4 TRACK ASSY	completed 53			53
1.2.5 OUTER SHROUD	completed 27			27
1.2.6 SHROUD FLANGE	completed 27			27
1.2.7 MISC	completed 5			5
1.3 STRESS ANALYSIS	completed 58			58
2.0 FABRICATION				
2.1 ACCESS HATCH	completed 85			85
2.2 TARGET TOWER	completed 64			64
2.3 EXTRA BE MACH.	: delayed	[---:--]: 54		54
2.4 OUTER SHROUD	completed 80			80
2.5 SHROUD FLANGE	completed 25			25
2.6 TRACK ASSY	:50 [---:---	---:---] 54		104
2.7 MISC	52 [-:---:---	---:---] 73		125
3.0 ETD SURVEL.	[---:---:-70:---	---:---:-59:-]		129
4.0 INSTALLATION				
4.1 ACCESS HATCH	completed 5			5
4.2 TARGET TOWER	completed 5			5
4.3 TRACK & RB		[---]: 56		56
4.4 MISC	[-:-]	[---:---:--]		
EXPERIMENTS				
5.0 DESIGN				
5.1 RB* INST FACILITY	delayed[--53---	--]		53
5.2 TARGET TEMP CAP	completed 53			53
5.3 MFE 60	delayed 32[---:---	-]		32
5.5 MFE 300	delayed 42[---:---	---] 23		65
5.4 MFE 200		[---:---:-] 56		56
5.6 MFE 400		[---:---:-] 56		56
5.7 ADD ANALYSES	delayed[--42---	---] 5		47
6.0 PROCURE RB*INST FACILITY	:16 [---:---	---] 67		83
7.0 FABRICATION & ASSY				
7.1 FACILITIES				
7.1.1 INST TARGET	completed 11			11
7.1.2 INST RB*		[--:---:-] :29		29
7.2 CAPSULES				
7.2.1 TARGET TEMP	completed 53			53
7.2.2 MFE 60		[---:---:-] :117	[---:---]123	240
7.2.4 MFE 300	delayed	[---:---:-] :147	[---:---]152	299
7.2.3 MFE 200		: 98: [-:---	---]60 : 60[---	->218
7.2.5 MFE 400		: 98: [-:---	---]60 : 60[---	->218
8.0 INSTALL & OPERATE				
8.1 TARGET TEMP	completed : [-]			
8.2 MFE 60		[=:===	===] : [===	=>
8.4 MFE 300		:117: [=:===	===]18 : 64[===	=>199
8.3 MFE 200			[===:===]	
8.5 MFE 400			129[===:===]	129
9.0 NEUTRONICS ANALYSES				
9.1 FACILITY	delayed [:-42	---:--]		42
9.2 TARGET TEMP EFFECTS	delayed [:-27	---:---]		27
9.3 BEAM TUBE EFFECTS	completed FY-1985			
FISCAL YEAR TOTALS	1040	1109	726	2875*

* Plus $155 K spent in FY-1985 on design and neutronic analysis.

Table 2

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
(FY 86 $000)

FY 1986

FUND10.CAL BHM
Rev. 9/26/86

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
1.2.1	5				5	
1.2.2	5				5	
1.2.3	53				53	
1.2.4	53				53	
1.2.5	27				27	
1.2.6	27				27	
1.2.7	5				5	
1.3	58				58	
2.1	85				85	
2.2	64				64	
2.4	80		5	75c		
2.5	25			25c		
2.6	50				50	
2.7	52				52	
3.0	70		11	12	47	
4.1	5				5	
4.2	5				5	
5.1	53	53				
5.2	53		53			
5.3	32		32			
5.5	42		42			
5.7	42			42		
6.0	16	16				
7.1.1	11	11				
7.2.1	53		53			
9.1	42				42	
9.2	27				27	
	1040a	80c	196b	154	610c	

a-Does not include funding for removable beryllium material. (Expenditure costed to Operations Division).

b-From U.S./J Program Agreement (Tasks 9 through 13).

c-Capital

Table 2 (continued)

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
(Current Year $000)

FY 1987

FUND20.CAL BHM
Rev. 9/26/86

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
2.3	54a					54
2.6	54				54c	
2.7	73				53c	20c
3.0	59					59c
4.3	56			56c		
5.4	56		56			
5.5	23		23			
5.6	56		56			
5.7	5		5			
6.0	67	67c				
7.1.2	29	29c				
7.2.2	117		117			
7.2.3	98				98	
7.2.4	147		4		143	
7.2.5	98		98			
8.2&.4	117				117	
	1109	96c	359b	56c	465d	133

FY 1988

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
7.2.2	123		123			
7.2.3	120		71			49
7.2.4	152		152			
7.2.5	120		71			49
8.2&.4	82		82			
8.3&.5	129		86		41	2
	726		585b		41	100
3-Yr TOTAL	2875	176c	1124b	210	1116	249

a-Cost for extra machining of new removable beryllium design (old design expenditure costed to Operations Division).

b-From U.S./J Program Agreement (Tasks 9 through 13).

d-Fusion Energy Mini-189.

c-Capital

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37831

September 16, 1986

Mr. M. J. Gouge
Nuclear Research and Development
Department of Energy, Oak Ridge
Operations
Post Office Box E
Oak Ridge, Tennessee 37831

Dear Mr. Gouge:

Attached is the August monthly costs and schedule assessment report on the OR-638-86-ORNL-2, HIFI Project. The schedule and costs only pertain to those items covered by this funding.

For your information, the first phase of the project, providing two instrumented target facilities, was completed on August 17, 1986, and the first-ever instrumented experiment in the HFIR target region was installed and continues to operate smoothly. This phase of work was completed on schedule and within costs, thus meeting an internal milestone. The attached schedule reflects this completion of work.

If further information is required please contact me at 574-0258.

Sincerely,

B. H. Montgomery

B. H. Montgomery
Project Leader

BHM:kfr

Attachment

cc/att: W. G. Craddick
K. R. Thoms
C. D. West
File-BHM

HIFI PROJECT SCHEDULE
(OR-638-86-ORNL-2 Only)

HIFI1.CAL
Last Update= 9/16/86 BHM

	FY-1986: O N D | J F M | A M J | J A S | FY-1987: O N D | J F M | A M J | J A S
TARGET TOWER(98)	------DDDDDDDDDxFFFFFFFFFFFxIIIIIx
QUICK OPENING HATCH(99)	------DDDDDDDDxFFFFFFFFFFFFxIIIIIx
TARGET HOLE PLUG(100)	------DDDDDDDDxFFFFFFFFFFFFxIIIIIx
RABBIT "U" BEND(96)	DDDDDDDDxFFFFFFFxIIIIIIx
RABBIT INPILE SECTION(96)	DDDDDDDDxFFFFFFFxIIIIIIx
OUTER SHROUD(93)	DDDx- -FFFFFFFFFFFFxIIIII - - -|- - - - |- - - - |IIII
SHROUD FLANGE(94)	DDDDDDDDDDx----FFFFFFFFF|- - - - |- - - - |IIII
UPPER TRACK(97)	DDDDDDDDDDDDDDDDFFFFFFFFFFFFFFFFFFFFFFFFFFF|IIII
MISC. TOOLS(101)	DDDDDDDDDDDDDDxF-F-F-F-F-F-F-F-F| - - - -|IIII
ASSEMBLY DRAWINGS	DDDDDDDDDDDDDD

(D=Design; F=Fabricate; I=Install; x=Completed)
Numbers in ( ) are HFIR Job numbers

HIFI PROJECT COSTS (OR-638-86-ORNL-2 Only)

	ESTIMATE	AUGUST COSTS	SPENT TO DATE	TO BE SPENT
DESIGN	$179,500	$12,347	$166,998	$ 12,502
FABRICATION	326,800	3,241	227,065	99,735
INSPECTION	42,600	5,045	27,258	15,342
SURVEILLANCE	98,100	10,738	88,954	9,146
INSTALLATION	63,000	18,282	46,488	16,512
TOTAL	$710,000	$ 49,653	$556,763	$153,237

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

October 30, 1986

Distribution

HIFI Project Monthly Progress Report for October 1986

The instrumented target capsule continues to operate smoothly. The capsule is currently in the fourth of a scheduled five cycle irradiation with removal expected during the first week of December.

Work is continuing on Phase two (the RB* facilities). There are two major assemblies still outstanding for this phase: (1) the removable reflector assembly and (2) the upper track assembly. A contract for the removable reflector machining has been placed by Operations Division through Purchasing with Speedring Division of the Rexham Corporation. In order to obtain a delivery date of April 17, 1987, the contract contains a premium charge and a penalty clause which was agreeable to both the vendor and the company. An Operations Division representative is currently at the vendor's plant reviewing the manufacturing plan. The vendor has agreed to submit a monthly progress report with milestone dates.

The upper track assembly work is in the Y-12 General Machine Shop. The manufacturing plan has been written and approved, and machining has begun. The shop has agreed to submit a monthly status report with milestone dates. A project representative will provide surveillance during the fabrication.

The DOE/ORNL Award Fee Milestone to "Complete HFIR modifications to allow conduct of instrumented experiments in the RB positions" in July 1987 has been officially moved up to June 1987 as stated in a letter to J. Lenhard (DOE) from H. Postma, dated September 29, 1986. This June date is necessary to meet the US/Japan milestone to complete the irradiation of the Fusion Energy materials capsules by July 1988.

The schedule, shown in Figure 1, has been revised to show the actual costs of the tasks during FY 1986 along with the carryover money to be spent in FY 1987. Table 1 shows the funding support dedicated to each of the tasks in the schedule. A summary of all HIFI Project costs and sources for the three-year period is shown in Table 2. It must be noted again that the shortfall for FY 1987 still exists, and no action has been taken to date.

A new schedule for neutronics analysis by Operations Division has been prepared with expected completion of the gamma heating rate estimates by January 1, 1987. While this is much later than desired, it should provide sufficient time to make last minute changes to the 330°C capsule which will be in the fabrication stage at that time and, more importantly, will provide input to the 200°C capsule which is much more sensitive to accurate knowledge of gamma heating rates. The originally established schedule of completing development of the capability to predict effects that proposed experiments have on other experiments and core power distribution remains at April 1, 1987.

The OR-638 monthly cost/schedule report for September 1986 was sent to M. J. Gouge, DOE-ORO, on October 15, 1986. A copy of this report is attached for your information.

B. H. Montgomery, Y-12, 9108, MS-1 (4-0258)

BHM:kfr

Attachments

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
B. L. Corbett
W. G. Craddick
C. Cromwell
G. R. Hicks
M. A. Holtzclaw
S. S. Hurt
A. W. Longest
R. V. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
B. W. Patton
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
J. H. Swanks
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. A. Watson
C. D. West
R. S. Wiltshire
A. Zucker
File(2)

Figure 1

HIFI PROJECT
SCHEDULE
(CURRENT YEAR $000)

SCHED10.CAL BHM
Rev. 11/3/86

	FY-86 # ACTUAL COSTS	FY-87 Q1 OND	FY-87 Q2 JFM	FY-87 Q3 AMJ	FY-87 Q4 JAS	FY-88 Q1 OND	FY-88 Q2 JFM	FY-88 Q3 AMJ	FY-88 Q4 JAS	TOTAL EST COSTS
REACTOR COMPONENTS										
1.0 DESIGN	233.3									233
2.0 FABRICATION	270.2									356
2.3 EXTRA BE MACH.		[---	---	] 54						54
2.6 TRACK ASSY	(47)	----	---]	54c						54
2.7 MISC		[---	---]	73c						73
3.0 ETD SURVEILLANCE	72.5	----	---	-59c-]						129
	(13)									
4.0 INSTALLATION	71.0									10
4.3 TRACK & RB				[---]	56c					56
4.4 MISC		[---	---	--]						
EXPERIMENTS										
5.0 DESIGN	149.0									222
5.1 RB* INST FACILITY	(53)	---]								
5.3 MFE 60		--]								
5.5 MFE 300		----]	23							23
5.4 MFE 200		[---	---	-] 56						56
5.6 MFE 400		[---	---	-] 56						56
5.7 ADD. ANALYSES		----]	5							5
6.0 PROCURE RB*INST.FAC.	(16)	[---	---]	67c						83
7.0 FABRICATION & ASSY	53.0									64
7.1.2 RB* INST.FAC.	(11)	[--	---	-]	29c					29
7.2 CAPSULES										
7.2.2 MFE 60		[---	---	-]	117		[---	---]123		240
7.2.4 MFE 300		[---	---	-]	147		[---	---]152		299
7.2.3 MFE 200			98	[-	---	---]60		60[---	->218	
7.2.5 MFE 400			98	[-	---	---]60		60[---	->218	
8.0 INSTALL & OPERATE										
8.2 MFE 60				[=	===	===]		[===	=>	
8.4 MFE 300			117	[=	===	===]18		64[===	=>199	
8.3 MFE 200							[===	===]		
8.5 MFE 400						129	[===	===]		129
9.0 NEUTRONICS ANALYSES	20.0									69
9.1 FACILITY	(20)	----	---]							
9.2 TARGET TEMP EFFECTS	(11)	----	---]							
FISCAL YEAR TOTALS	869.0 (171)	1109 + (171)				726				2875*

* - Plus $155 K spent in FY-1985 on design and neutronic analyses.
( ) - Capital money carryover: $80 K of GPE and $91 K of OR-638 funds.
c - Capital funding.

Table 1

FY-1986
ACTUAL COSTS OF TASKS
FROM ACCELERATED SCHEDULE

FUND12.CAL BHM
Rev.10/30/86

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	CARRYOVER
REACTOR MOD.						
1.2.1	5				5c	
1.2.2	5				5c	
1.2.3	33				33c	
1.2.4	53				53c	
1.2.5	27				27c	
1.2.6	27				27c	
1.2.7	25			20	5c	
1.3	58				58c	
2.1	43				43c	
2.2	39				39c	
2.4	67			67c		
2.5	26			26c		
2.6	23				70c	47c
2.7	71				71c	
3.0	73			28	58c	13c
4.1	30				30c	
4.2	42			7c	35c	
9.1	10				30c	20c
9.2	10				21c	11c
TOTAL	667			148	610	91
INSTR. FAC.						
5.1		53c				53c
6.0		16c				16c
7.1.1		11c				11c
TOTAL		80				80
EXPERIMENTS						
5.2	53		53			
5.3	32		32			
5.5	42		42			
5.7	22		16	6		
7.2.1	53		53			
TOTAL	202		196	6		
GRAND TOTAL	869a	80	196b	154	610	171

a-Does not include funding for removable beryllium material. (Expenditure costed to Operations Division).
b-From U.S./J Program Agreement (Tasks 9 through 13).
c-Capital

Table 1 (continued)

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
(Current Year $000)

FUND21.CAL BHM
Rev.10/30/86

FY 1987

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
REACTOR MOD.						
2.3	54a					54
2.6	54				54c	
2.7	73				53c	20c
3.0	59					59c
4.3	56			56c		
INSTR. FAC.						
6.0	67	67c				
7.1.2	29	29c				
EXPERIMENTS						
5.4	56		56			
5.5	23		23			
5.6	56		56			
5.7	5		5			
7.2.2	117		117			
7.2.3	98				98	
7.2.4	147		4		143	
7.2.5	98		98			
8.2&.4	117				117	
	1109	96c	359b	56c	465d *358*	133

FY 1988

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
EXPERIMENTS						
7.2.2	123		123			
7.2.3	120		71			49
7.2.4	152		152			
7.2.5	120		71			49
8.2&.4	82		82			
8.3&.5	127		86		41	2
	726		585b		41	100
3-Yr TOTAL	2875	176c	1140b	210	1116	233

a-Cost for extra machining of new removable beryllium design (old design expenditure costed to Operations Division).
b-From U.S./J Program Agreement (Tasks 9 through 13).
d-Fusion Energy Mini-189.
c-Capital

Table 2
HIFI PROJECT COSTS
AND SOURCES ($000)

ACTCOST.CAL BHM
Rev. 10/30/86

FY-1986 *

TASKS	COST	GPE	U.S./J	NEW OFE	NEW BES	CARRYOVER
REACTOR MOD.	758			610c	100 + 48	85c
INSTR. FAC.	80	80c				80c
EXPERIMENTS	202		196		6	
TOTAL	1040	80	196	610	154	165

FY-1987

TASKS	COST	GPE	U.S./J	NEW OFE	NEW BES	SHORTFALL
REACTOR MOD.	296			107c	56c	79c + 54
INSTR. FAC.	96	96c				
EXPERIMENTS	717		359	358		
TOTAL	1109	96	359	465	56	133

FY-1988

TASKS	COST	GPE	U.S./J	NEW OFE	NEW BES	SHORTFALL
REACTOR MOD.						
INSTR. FAC.						
EXPERIMENTS	726		585	41		100
TOTAL	726		585	41		100

3-YEAR TOTAL

TASKS	COST	GPE	U.S./J	NEW OFE	NEW BES	SHORTFALL
REACTOR MOD.	1054			717c	156c + 48	79c + 54
INSTR. FAC.	176	176c				
EXPERIMENTS	1645		1140	399	6	100
TOTALS	2875	176	1140	1116	210	233

* - Actual costs.
c - Capital funding.

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37831

October 15, 1986

Mr. M. J. Gouge
Nuclear Research and Development
Department of Energy, Oak Ridge
Operations
Post Office Box E
Oak Ridge, Tennessee 37831

Dear Mr. Gouge:

Attached is the September monthly costs and schedule assessment report on the OR-638-86-ORNL-2, HIFI Project. The schedule and costs only pertain to those items covered by this funding.

If further information is required, please contact me at 574-0258.

Sincerely,

B H Montgomery

B. H. Montgomery
Project Leader

BHM:kfr

Attachment

cc/att: W. G. Craddick
K. R. Thoms
C. D. West
File-BHM

HIFI PROJECT SCHEDULE
(OR-638-86-ORNL-2 Only)

HIFI1.CAL
Last Update=10/15/86 BHM

```
-------------------------------------------------------------------------------------------
                           :               FY-1986             :              FY-1987              :
                           : O N D : J F M : A M J : J A S : O N D : J F M : A M J : J A S :
---------------------------:-------:-------:-------:-------:-------:-------:-------:-------:
                           :       :       :       :       :       :       :       :       :
TARGET TOWER(98)           ------DDDDDDDDxFFFFFFFFFFxIIIIIx   :       :       :       :       :
                           :       :       :       :       :       :       :       :       :
QUICK OPENING HATCH(99)    ------DDDDDDDxFFFFFFFFFFFFxIIIIIx   :       :       :       :       :
                           :       :       :       :       :       :       :       :       :
TARGET HOLE PLUG(100)      ------DDDDDDDxFFFFFFFFFFFFxIIIIIx   :       :       :       :       :
                           :       :       :       :       :       :       :       :       :
RABBIT "U" BEND(96)        :    DDDDDDDDxFFFFFFFxIIIIIIx       :       :       :       :       :
                           :       :       :       :       :       :       :       :       :
RABBIT INPILE SECTION(96)  :    DDDDDDDDxFFFFFFFxIIIIIIx       :       :       :       :       :
                           :       :       :       :       :       :       :       :       :
OUTER SHROUD(93)           :  DDDx- -FFFFFFFFFFFFxIIIII - - -:- - - - :- - - - :IIII   :       :
                           :       :       :       :       :       :       :       :       :
SHROUD FLANGE(94)          :       : DDDDDDDDDDx----FFFFFFFFx:- - - - :- - - - :IIII   :       :
                           :       :       :       :       :       :       :       :       :
UPPER TRACK(97)            :       : DDDDDDDDDDDDDDDDDDDDDDDDDxFFFFFFFFFFFFFFFFF:IIII   :       :
                           :       :       :       :       :       :       :       :       :
MISC. TOOLS(101)           :       : DDDDDDDDDDDDDDxF-F-F-F-F-F-F-F-F-F: - - - -:IIII   :       :
                           :       :       :       :       :       :       :       :       :
ASSEMBLY DRAWINGS          :       :       :  DDDDDDDDDDDDDDx      :       :       :       :
                           :       :       :       :       :       :       :       :       :
-------------------------------------------------------------------------------------------
```

(D=Design; F=Fabricate; I=Install; x=Completed)
Numbers in ( ) are HFIR Job numbers

HIFI PROJECT COSTS (OR-638-86-ORNL-2 Only)

	ESTIMATE	SEPTEMBER COSTS	SPENT TO DATE	TO BE SPENT
DESIGN	$179,500	$10,827	$177,825	$ 1,675
FABRICATION	326,800	38,882	265,947	60,853
INSPECTION	42,600	3,014	30,272	12,328
SURVEILLANCE	98,100	7,561	96,515	1,585
INSTALLATION	63,000	1,822	48,310	14,690
TOTAL	$710,000	$ 62,106	$618,869	$ 91,131

MARTIN MARIETTA

Internal Correspondence

December 1, 1986

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

HIFI Project Monthly Progress Report for November 1986

Work is continuing on Phase II (the RB* facilities). The manufacturing plan for the machining of the removable beryllium assembly has been submitted for approval: Operations Division personnel have already approved the preliminary machining plans. The track assembly work in the Y-12 General Machine Shop is continuing on schedule.

A review of the capsule work planned for FY 1988 revealed that the schedule for reencapsulation of the MFE-200 and MFE-400 specimens for their second irradiation in the RB* positions had been unnecessarily accelerated. The two capsules are scheduled to be reinserted after the second irradiation period of the MFE-60 and MFE-300 capsules, but that second irradiation is a 14-month one as originally assumed (10 dpa), and not a 7-months (5 dpa). In fact, the second reencapsulation need not be performed in FY 1988 but can be carried out entirely in FY 1989, reducing the funding needed in FY 1988 by $120,000. On this corrected schedule, there is no funding shortfall in FY 1988, and the new OFE funding needed in 1988 is reduced from $41,000 to only $21,000. The schedule shown in Figure 1 and the funding for each task (Table 1) reflect these changes.

Partial funding for FY 1987 has been received or promised. Most of the expense money (excepting only the $54,000, part of the shortfall, needed by Operations Division for beryllium machining) has been committed.

With regard to the capital money, we have been told that the $107,000 capital expected from OFE is in the November financial plan. The $96,000 GPE funding has also been approved, although it has not yet appeared in the accounts. This still leaves $56,000 capital expected from BES, for installation of the track and RB assemblies, and the shortfall of $79,000 capital which must be addressed in the near future. With the funds available at present, the project can continue until February 1987; the remainder of the capital funding must be available no later than the January 1987 financial plan if work is not to stop. Table 2 shows the support funding for the reactor modifications, instrumentation facility, and US/Japan experiments over the three-year period.

The OR-638 monthly cost/schedule report for October 1986 was sent to M. J. Gouge, DOE-ORO, on November 18, 1986; a copy of that report is attached for your information.

B H Montgomery

B. H. Montgomery, Project Leader, Y-12, 9108, MS-1 (4-0258)

BHM:kfr

Attachments

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
B. L. Corbett
W. G. Craddick
C. J. Cromwell
G. R. Hicks
M. A. Holtzclaw
S. S. Hurt
A. W. Longest
R. V. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
J. H. Swanks
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. A. Watson
C. D. West
R. S. Wiltshire
A. Zucker
File-BHM

Figure 1

HIFI PROJECT
SCHEDULE
(CURRENT YEAR $000)

SCHED10.CAL BHM
Rev.11/20/86

	FY-86 * ACTUAL COSTS	FY-87 Q1 OND	FY-87 Q2 JFM	FY-87 Q3 AMJ	FY-87 Q4 JAS	FY-88 Q1 OND	FY-88 Q2 JFM	FY-88 Q3 AMJ	FY-88 Q4 JAS	TOTAL EST COSTS
REACTOR COMPONENTS										
1.0 DESIGN	233.3									233
2.0 FABRICATION	270.2									356
2.3 EXTRA BE MACH.		[---	---	] 54						54
2.6 TRACK ASSY	(47)	----	---]	54c						54
2.7 MISC		[---	---]	73c						73
3.0 ETD SURVEILLANCE	72.5 (13)	----	---	-59c-]						129
4.0 INSTALLATION	71.0									10
4.3 TRACK & RB				[---]	56c					56
4.4 MISC		[---	---	--]						
EXPERIMENTS										
5.0 DESIGN	149.0									222
5.1 RB* INST FACILITY	(53)	---]								
5.3 MFE 60		--]								
5.5 MFE 300		----]	23							23
5.4 MFE 200		[---	---	-]	56					56
5.6 MFE 400		[---	---	-]	56					56
5.7 ADD. ANALYSES		----]	5							5
6.0 PROCURE RB*INST.FAC.	(16)	[---	---]	67c						83
7.0 FABRICATION & ASSY	53.0									64
7.1.2 RB* INST.FAC.	(11)	[--	---	-]	29c					29
7.2 CAPSULES										
7.2.2 MFE 60		[---	---	-]	117		[---	---]	123	240
7.2.4 MFE 300		[---	---	-]	147		[---	---]	152	299
7.2.3 MFE 200			98	[-	---	---]	60			158
7.2.5 MFE 400			98	[-	---	---]	60			158
8.0 INSTALL & OPERATE										
8.2 MFE 60				[=	===	===]			[===	=>
8.4 MFE 300			117	[=	===	===]	18	64	[===	=>199
8.3 MFE 200							[===	===]		
8.5 MFE 400						129	[===	===]		129
9.0 NEUTRONICS ANALYSES	20.0									69
9.1 FACILITY	(20)	----	---]							
9.2 TARGET TEMP EFFECTS	(11)	----	---]							
FISCAL YEAR TOTALS	869.0 (171)	1109 + (171)				606				2755*

* - Plus $155 K spent in FY-1985 on design and neutronic analyses.
( ) - Capital money carryover: $80 K of GPE and $91 K of OR-638 funds.
c - Capital funding.

Table 1

FY-1986
ACTUAL COSTS OF TASKS
FROM ACCELERATED SCHEDULE

FUND12.CAL BHM
Rev.10/30/86

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	CARRYOVER
REACTOR MOD.						
1.2.1	5				5c	
1.2.2	5				5c	
1.2.3	33				33c	
1.2.4	53				53c	
1.2.5	27				27c	
1.2.6	27				27c	
1.2.7	25			20	5c	
1.3	58				58c	
2.1	43				43c	
2.2	39				39c	
2.4	67			67c		
2.5	26			26c		
2.6	23				70c	47c
2.7	71				71c	
3.0	73			28	58c	13c
4.1	30				30c	
4.2	42			7c	35c	
9.1	10				30c	20c
9.2	10				21c	11c
TOTAL	667			148	610	91
INSTR. FAC.						
5.1		53c				53c
6.0		16c				16c
7.1.1		11c				11c
TOTAL		80				80
EXPERIMENTS						
5.2	53		53			
5.3	32		32			
5.5	42		42			
5.7	22		16	6		
7.2.1	53		53			
TOTAL	202		196	6		
GRAND TOTAL	869a	80	196b	154	610	171

a-Does not include funding for removable beryllium material. (Expenditure costed to Operations Division).
b-From U.S./J Program Agreement (Tasks 9 through 13).
c-Capital

Table 1 (continued)

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
(Current Year $000)

FY 1987 FUND21.CAL BHM
Rev.11/20/86

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
REACTOR MOD.						
2.3	54a					54
2.6	54				54c	
2.7	73				53c	20c
3.0	59					59c
4.3	56			56c		
INSTR. FAC.						
6.0	67	67c				
7.1.2	29	29c				
EXPERIMENTS						
5.4	56		56			
5.5	23		23			
5.6	56		56			
5.7	5		5			
7.2.2	117		117			
7.2.3	98				98	
7.2.4	147		4		143	
7.2.5	98		98			
8.2&.4	117				117	
	1109	96c	359b	56c	465d	133

FY 1988

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
EXPERIMENTS						
7.2.2	123		123			
7.2.3	60		60			
7.2.4	152		152			
7.2.5	60		60			
8.2&.4	82		82			
8.3&.5	129		108		21	
	606		585b		21d	
3-Yr TOTAL	2755	176c	1140b	210	1096	133

a-Cost for extra machining of new removable beryllium design (old design expenditure costed to Operations Division).
b-From U.S./J Program Agreement (Tasks 9 through 13).
d-Fusion Energy Mini-189.
c-Capital

Table 2
HIFI PROJECT COSTS
AND SOURCES ($000)

ACTCOST.CAL BHM
Rev. 12/1/86

FY-1986 (act)

TASKS	COST	GPE	U.S./J	NEW OFE	NEW BES	CARRYOVER
REACTOR MOD.	758			610c	100c + 48	85c
INSTR. FAC.	80	80c				80c
EXPERIMENTS	202		196		6	
TOTAL	1040	80	196	610	154	165

FY-1987 (est)

TASKS	COST	GPE	U.S./J	NEW OFE	NEW BES	SHORTFALL
REACTOR MOD.	296			107c	56c	79c + 54
INSTR. FAC.	96	96c				
EXPERIMENTS	717		359	358		
TOTAL	1109	96	359	465	56	133

FY-1988 (est)

TASKS	COST	GPE	U.S./J	NEW OFE	NEW BES	SHORTFALL
REACTOR MOD.						
INSTR. FAC.						
EXPERIMENTS	606		585	21		
TOTAL	606		585	21		

3-YEAR TOTAL (est)

TASKS	COST	GPE	U.S./J	NEW OFE	NEW BES	SHORTFALL *
REACTOR MOD.	1054			717c	156c + 48	79c + 54
INSTR. FAC.	176	176c				
EXPERIMENTS	1525		1140	379	6	
TOTALS	2755	176	1140	1096	210	133

c - Capital funding.
* - Shorfall is all in FY 1987.

MARTIN MARIETTA

Internal Correspondence

January 30, 1987

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

HIFI Project Monthly Progress Report for January 1987

Work is continuing on Phase II (the RB* facilities). Final machining on the beryllium segments and inner cylinder has begun. The complete manufacturing and inspection plans have been submitted by the vendor for approval. The manufacturing and inspection plan for the track assembly has already been approved and fabrication has begun. All components for Phase II are on schedule to meet the June Award Fee Milestone.

The OR-638-86-ORNL-2 has been revised to include fiscal year 1987 capital funding and has been submitted for approval. The previously mentioned capital shortfall of $79,000 has been eliminated through funding provided by BES and is reflected as such in Tables 1 and 2. As soon as DOE approval has been granted for the OR-638 request, revised work orders will be issued to reflect the estimated total costs for completion of the project. The expense shortfall of $54,000 for additional machining of the removable beryllium, followed by Operations Division, has not been addressed at this time.

The Phase II schedule could be impacted by the work involved in Operations Division participation in the various committees concerned with the HFIR pressure vessel integrity problem. Some of the vessel problem work is being done by the same people responsible for the HIFI Project design and installation, in particular, Gene Hicks and his staff. This additional work, added on to an already heavy work load, will have an impact on the project schedule. A decision will have to be made in the very near future as to what work load can be maintained to meet all the required schedules, keeping in mind that HIFI Phase II is a Martin Marietta Energy Systems Award Fee Milestone.

As reported in the last monthly report, the experiment schedule has already been impacted by the HFIR shutdown. A revised schedule will not be issued until reactor startup is known. The old schedule, shown in Fig. 1, is attached for information only.

The OR-638 monthly cost/schedule report for December 1986 was sent to M. J. Gouge, DOE-ORO, on January 20, 1987. A copy of this report is attached for your information.

B. H. Montgomery

B. H. Montgomery, Project Leader, FEDC, Rm. 146 (4-0258)

BHM:kfr

Attachments

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
B. L. Corbett
W. G. Craddick
C. J. Cromwell
G. R. Hicks
M. A. Holtzclaw
S. S. Hurt
A. W. Longest
R. V. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
B. W. Patton
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
J. H. Swanks
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. A. Watson
C. D. West
R. S. Wiltshire
A. Zucker
File-BHM

Figure 1

HIFI PROJECT
SCHEDULE
(CURRENT YEAR $000)

SCHED10.CAL BHM
Rev.11/20/86

	FY-86 ACTUAL COSTS	FY-87 Q1 OND	FY-87 Q2 JFM	FY-87 Q3 AMJ	FY-87 Q4 JAS	FY-88 Q1 OND	FY-88 Q2 JFM	FY-88 Q3 AMJ	FY-88 Q4 JAS	TOTAL EST COSTS
REACTOR COMPONENTS										
1.0 DESIGN	233.3									233
2.0 FABRICATION	270.2									356
2.3 EXTRA BE MACH.		[---	---	] 54						54
2.6 TRACK ASSY	(47)	----	---]	54c						54
2.7 MISC		[---	---]	73c						73
3.0 ETD SURVEILLANCE	72.5 (13)	----	---	-59c-]						129
4.0 INSTALLATION	71.0									10
4.3 TRACK & RB				[---]	56c					56
4.4 MISC		[---	---	--]						
EXPERIMENTS										
5.0 DESIGN	149.0									222
5.1 RB* INST FACILITY	(53)	---]								
5.3 MFE 60		--]								
5.5 MFE 300		----]	23							23
5.4 MFE 200		[---	---	-] 56						56
5.6 MFE 400		[---	---	-] 56						56
5.7 ADD. ANALYSES		----]	5							5
6.0 PROCURE RB*INST.FAC.	(16)	[---	---]	67c						83
7.0 FABRICATION & ASSY	53.0									64
7.1.2 RB* INST.FAC.	(11)	[--	---	-]	29c					29
7.2 CAPSULES										
7.2.2 MFE 60		[---	---	-]	117		[---	---]	123	240
7.2.4 MFE 300		[---	---	-]	147		[---	---]	152	299
7.2.3 MFE 200			98	[-	---	---]	60			158
7.2.5 MFE 400			98	[-	---	---]	60			158
8.0 INSTALL & OPERATE										
8.2 MFE 60				[=	===	===]			[===	=>
8.4 MFE 300			117	[=	===	===]	18	64	[===	=>199
8.3 MFE 200							[===	===]		
8.5 MFE 400						129	[===	===]		129
9.0 NEUTRONICS ANALYSES	20.0									69
9.1 FACILITY	(20)	----	---]							
9.2 TARGET TEMP EFFECTS	(11)	----	---]							
FISCAL YEAR TOTALS	869.0 (171)	1109 + 171				606				2755*

* - Plus $155 K spent in FY-1985 on design and neutronic analyses.
( ) - Capital money carryover: $80 K of GPE and $91 K of OR-638 funds.
c - Capital funding.

Table 1

FUNDING OF TASKS FROM ACCELERATED SCHEDULE
(Current Year $000)

FY 1987

FUND21.CAL BHM
Rev. 1/26/87

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
REACTOR MOD.						
2.3	54a					54
2.6	54				54c	
2.7	73			20c	53c	
3.0	59			59c		
4.3	56			56c		
INSTR. FAC.						
6.0	67	67c				
7.1.2	29	29c				
EXPERIMENTS						
5.4	56		56			
5.5	23		23			
5.6	56		56			
5.7	5		5			
7.2.2	117		117			
7.2.3	98				98	
7.2.4	147		4		143	
7.2.5	98		98			
8.2&.4	117				117	
	1109	96c	359b	135c	465d	54

FY 1988

TASK	COST	GPE	U.S./J	NEW BES	NEW OFE	SHORTFALL
EXPERIMENTS						
7.2.2	123		123			
7.2.3	60		60			
7.2.4	152		152			
7.2.5	60		60			
8.2&.4	82		82			
8.3&.5	129		108		21	
	606		585b		21d	
3-Yr TOTAL	2755	176c	1140b	289	1096	54

a-Cost for extra machining of new removable beryllium design (old design expenditure costed to Operations Division).
b-From U.S./J Program Agreement (Tasks 9 through 13).
d-Fusion Energy Mini-189.
c-Capital

Table 2
HIFI PROJECT COSTS
AND SOURCES ($000)

ACTCOST.CAL BHM
Rev. 1/26/87

FY-1986 (act)

TASKS	COST	GPE	U.S./J	NEW OFE	NEW BES	CARRYOVER
REACTOR MOD.	758			610c	100c + 48	85c
INSTR. FAC.	80	80c				80c
EXPERIMENTS	202		196		6	
TOTAL	1040	80	196	610	154	165

FY-1987 (est)

TASKS	COST	GPE	U.S./J	NEW OFE	NEW BES	SHORTFALL
REACTOR MOD.	296			107c	135c	54
INSTR. FAC.	96	96c				
EXPERIMENTS	717		359	358		
TOTAL	1109	96	359	465	135	54

FY-1988 (est)

TASKS	COST	GPE	U.S./J	NEW OFE	NEW BES	SHORTFALL
REACTOR MOD.						
INSTR. FAC.						
EXPERIMENTS	606		585	21		
TOTAL	606		585	21		

3-YEAR TOTAL (est)

TASKS	COST	GPE	U.S./J	NEW OFE	NEW BES	SHORTFALL *
REACTOR MOD.	1054			717c	235c + 48	54
INSTR. FAC.	176	176c				
EXPERIMENTS	1525		1140	379	6	
TOTALS	2755	176	1140	1096	289	54

c - Capital funding.
* - Shorfall is all in FY 1987.

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37831

January 20, 1987

Mr. M. J. Gouge
Nuclear Research and Development
Department of Energy, Oak Ridge
Operations
Post Office Box E
Oak Ridge, Tennessee 37831

Dear Mr. Gouge:

Attached is the December monthly costs and schedule assessment report on the OR-638-86-ORNL-2, HIFI Project. The schedule and costs only pertain to those items covered by this funding.

If further information is required, please contact me at 574-0258.

Sincerely,

B H Montgomery

B. H. Montgomery
Project Leader

BHM:kfr

Attachment

cc/att: W. G. Craddick
K. R. Thoms
C. D. West
File-BHM

HIFI PROJECT SCHEDULE
(OR-638-86-ORNL-2 Only)

HIFI1.CAL
Last Update= 1/20/87 BHM

```
-----------------------------------------------------------------------------------------------
                          :            FY-1986                :            FY-1987               :
                          : O N D  : J F M  : A M J  : J A S  : O N D  : J F M  : A M J  : J A S  :
--------------------------:--------:--------:--------:--------:--------:--------:--------:--------:
                          :        :        :        :        :        :        :        :        :
TARGET TOWER(98)     ------DDDDDDDDDxFFFFFFFFFFFxIIIIIx       :        :        :        :        :
                          :        :        :        :        :        :        :        :        :
QUICK OPENING HATCH(99) ------DDDDDDDDxFFFFFFFFFFFFxIIIIIx    :        :        :        :        :
                          :        :        :        :        :        :        :        :        :
TARGET HOLE PLUG(100) ------DDDDDDDDxFFFFFFFFFFFFxIIIIIx      :        :        :        :        :
                          :        :        :        :        :        :        :        :        :
RABBIT "U" BEND(96)       :    DDDDDDDDxFFFFFFFxIIIIIIx       :        :        :        :        :
                          :        :        :        :        :        :        :        :        :
RABBIT INPILE SECTION(96) :    DDDDDDDDxFFFFFFFxIIIIIIx       :        :        :        :        :
                          :        :        :        :        :        :        :        :        :
OUTER SHROUD(93)          : DDDx- -FFFFFFFFFFFFxIIIII - - -:- - - - :- - - - :IIIIIII :        :
                          :        :        :        :        :        :        :        :        :
SHROUD FLANGE(94)         :        : DDDDDDDDDDx----FFFFFFFFx:- - - - :- - - - :IIIIIII :        :
                          :        :        :        :        :        :        :        :        :
UPPER TRACK(97)           :        : DDDDDDDDDDDDDDDDDDDDDDDDDxFFFFFFFFFFFFFFFFFFFFFFFIIII :        :
                          :        :        :        :        :        :        :        :        :
MISC. TOOLS(101)          :        : DDDDDDDDDDDDDDxF-F-F-F-F-F-F-F-F-F-F-F-F-F-:IIIIIII :        :
                          :        :        :        :        :        :        :        :        :
ASSEMBLY DRAWINGS         :        :        : DDDDDDDDDDDDDDDD- - - DDDDx    :        :        :
                          :        :        :        :        :        :        :        :        :
-----------------------------------------------------------------------------------------------
```

(D=Design; F=Fabricate; I=Install; x=Completed)
Numbers in ( ) are HFIR Job numbers

HIFI PROJECT COSTS (OR-638-86-ORNL-2 Only)

	ESTIMATE	DECEMBER COSTS	SPENT TO DATE	TO BE SPENT
DESIGN	$179,500		$182,058	$ -2,558
FABRICATION	326,800	16,515	295,964	30,836
INSPECTION	42,600	949	31,727	10,873
SURVEILLANCE	98,100	3,114	116,989	-18,889
INSTALLATION	63,000		48,310	14,690
TOTAL	$710,000	$ 20,578	$675,048	$ 34,952

MARTIN MARIETTA

Internal Correspondence

March 2, 1987

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

HIFI Project Monthly Progress Report for February 1987

Work is continuing on Phase II (the RB* facilities). The final machining of the removable beryllium assembly is continuing on schedule. Components for the reactor mock-up have been designed and are currently in the Purchasing chain for awarding contracts. All of these items are on schedule to meet the June Award Fee Milestone. The track assembly, being fabricated at the Y-12 General Machine Shop, is not on schedule, contrary to the assertion in the previous monthly. On February 19, 1987, a meeting was held with the Y-12 Shop personnel to discuss the schedule. Following that meeting, a letter was written on February 23 (copy attached) asking Rosenthal and Wiltshire for assistance in dealing with Y-12. As of this date, no action has been reported.

The revised OR-638-86-ORNL-2, which includes the FY 87 capital funding to complete the HIFI Project, was received at DOE-ORO on February 13, 1987. According to Susan Waddle (DOE), it is in the signature approval chain and should be received at ORNL early next month. The delayed approval will present no funding problem if the final approval is indeed received at ORNL in March.

The OR-638 monthly cost/schedule report for January 1987 was sent to S. S. Waddle, DOE-ORO, on February 12, 1987. A copy of this report is attached for your information.

B H Montgomery

B. H. Montgomery, Project Leader, FEDC, Rm. 146 (4-0258)

BHM:kfr

Attachment

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
B. L. Corbett
W. G. Craddick
C. J. Cromwell
G. R. Hicks
M. A. Holtzclaw
S. S. Hurt
A. W. Longest
R. V. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
B. W. Patton
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
J. H. Swanks
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. A. Watson
C. D. West
R. S. Wiltshire
A. Zucker

MARTIN MARIETTA

Internal Correspondence

February 23, 1987

MARTIN MARIETTA ENERGY SYSTEMS, INC.

M. W. Rosenthal
R. S. Wiltshire
A. Zucker

Fabrication Delay of HIFI Track Assembly by Y-12 Shops

A meeting was held on February 19, 1987 in the Y-12 General Machine Shop (9201-1) concerning a three-month delay on the delivery of the track assembly for the HIFI Project. Attendees at this meeting were: T. R. Webber, R. L. McIlwain, C. H. Linginfelter (all from the Y-12 General Machine Shop), S. E. Burnette, G. R. Hicks, S. S. Hurt (all from ORNL Operations Division), D. L. Aubuchon (ORNL Quality Department), and myself. A new schedule was presented by the shop's supervision that stated a revised delivery date of June 1, 1987, three months past the original scheduled date of March 1, 1987 as estimated on August 29, 1986.

For background information, the following past events have taken place: (1) telephone calls and personal contacts between G. R. Hicks and T. W. Compton, Y-12 Shops, were initiated requesting an estimate for the track assembly followed by a letter dated August 26, 1986 (Attachment A); (2) a General Shops Work Request, No. 2841, dated August 29, 1986 with a scheduled delivery date of March 1, 1987, was received by Hicks (Attachment B); (3) a letter from Hicks to Compton, dated October 9, 1986, advising him of the Award Fee Milestone and urging him to maintain schedule to deliver by April 1, 1987 - giving a one-month relaxation from requested date (Attachment C); (4) discussions by the Project Staff were held on February 4, 1987 concerning work loads imposed on the HFIR staff as a result of the vessel integrity problems and the impending HIFI Project milestone. It was decided to request the services of D. L. Aubuchon to serve as liaison between the Y-12 Shops and the HFIR in an effort to minimize any fabrication delays due to lack of communication. This was documented in a letter to Compton from Hicks dated February 9, 1987 (Attachment D); and (5) Hicks received a Completion Date Revision form with no date and no signature stating the three-month delay because of "not enough working hours until March 2 to work 2100 hours" (Attachment E). Hicks called T. R. Webber, Department Superintendent of the Y-12 General Shops, to ask about this "form" and was told that as soon as Webber got his people together and worked out a critical path schedule, a meeting would be called. This was the first notification that the Project Staff had that there was a scheduling problem. As you may recall in the last HIFI Project monthly dated January 30, 1987, I related that the track assembly was on schedule.

The February 19 meeting with Y-12 personnel progressed with discussions as to how we could speed up delivery. The most feasible solution is this: four segments out of a cylinder are required for this assembly. Gene Hicks suggested using two existing segments thereby reducing machining time as well as accelerating the inspection time. This should reduce the delay by 4-5 weeks - 18 days of machining and accelerating inspection by a few days. Therefore, on an optimistic schedule, delivery could be accelerated to approximately May 1, 1987. Shop personnel and Hicks were all very pessimistic about this date because of the unknown problems which could be encountered during the preassembly.

In order to complete the Award Fee Milestone in June, a "drop-dead" delivery date was determined to be May 15, 1987. This would allow for the necessary hardware to be added to the assembly and the mockup work prior to installation in the reactor. There is no contingency - should there be a conflict in the work load of the HFIR staff because of the vessel problem or a problem in obtaining the necessary crafts, we would miss the June milestone.

It seems that the Y-12 Shops have control over the one item that will cause us to be delinquent: you will recall that at the meeting in Wiltshire's office on October 7, 1986 to discuss this Award Fee Milestone, I was instructed to contact you for assistance in resolving such problems with Y-12.

BH Montgomery
B. H. Montgomery, HIFI Project Leader, FEDC, Rm. 146 (4-0258)

BHM:kfr

Attachments(5)

cc/att: D. L. Aubuchon
L. A. Dean
G. R. Hicks
K. R. Thoms
H. E. Trammell
T. R. Webber
C. D. West
File-BHM

Attachment A

MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

August 26, 1986

T. W. Compton, Jr., Building 9201-1, Y-12

Fabrication of HFIR Upper Tracks Set No. 7

Please fabricate one HFIR upper track assembly in accordance with drawings and specifications listed on Document Control Tabulation OP-RO-JN-5-1-97.

Material for this fabrication will be supplied to you as specified on Bill of Material OP-RO-BM-5-1-97.

Each group of parts is to be serialized beginning with 86-1.

Your technical contacts for this fabrication will be the writer (6-4993), S. E. Burnette (6-0214), or B. J. Ward (6-4994).

This work is to be charged to K-8883W-41 and must be completed by March 1, 1987.

GRHicks

G. R. Hicks, 7910, ORNL (6-4993) - RC

GRH:mca

cc: S. E. Burnette
E. E. Hill
R. V. McCord
B. H. Montgomery
B. J. Ward

Attachment B

GENERAL SHOPS WORK REQUEST

WORK ORDER	WORK REQUEST	DATE
K-8883W-AI 31	2841	3-29-86

SHOP ORDER	SHOP IN CHARGE	CUSTOMER/DIVISION
A1194-68	MS	15 HFIR

DELIVER TO	M. & P. STATION	BLDG. NO.	PHONE
G. R. Hicks		7910	6-4993

REQUESTER	PHONE	COORDINATOR	PHONE
G. R. Hicks	6-4993	R. L. McIlwain	4-3421

REQUESTED COMPLETION	SCHEDULED COMP./ACTUAL COMP.	JOB CODE	JOB FILE
3-1-87	3-1-87	999 404	X86241

SHOP	Estimated Hours	Effective Hours/Week	PL. Code	Start Date	Actual Hours	SHOP	Estimated Hours	Effective Hours/Week	PL. Code	Start Date	Actual Hours
17 Graphite Shop						29 Weld Shop	390		X	11-20	
20 Main Shop	2792	80	X	10-27		32 Aux. Serv.					
21 Spec. Mat'ls.						33 T. & C. Grinds					
22 Spec. Serv.						34 Field Shops					
23 Tool Fab. L						86 Can Fab.					
25 Metal Fab	121		X	10-27		TOTAL					
27 Foundry	24		X	11-3		NC Tapes Ordered:		Delivered:			
28 Prec. Shop						Foreman in Charge:					

SHORT DESCRIPTION OF WORK FOR IBM USE: HFIR UPPER TRACKS SET NO 7

PRINCIPAL DRAWING: M11506OH100E

DESCRIPTION OF WORK AUTHORIZED (GIVE DWG. NO'S. & NOTES AS TO SPECIAL MATERIALS OR INSTRUCTIONS)

Fabricate one (1) HFIR Upper Track Assembly in accordance with drawings and specifications listed on document control tabulation OP-RO-JN-5-1-97.

Material will be furnished by G. R. Hicks as specified on B.M. OP-RO-BM-5-1-97 drawings M-11506-OH-100-E, 102-E, 103-E, 104-E, 106-E, 108-E, 109-E, 110-E, 111-E, 112-E, 113-E & 114-E.

Fabrication and inspection procedures will be required.

NOTE: Drawing M-11506-OH-102-E is with order--other will be furnished as completed.

MATERIAL IS ON SKID IN THE HFIR STORAGE AREA

GENERAL INSTRUCTIONS TO SHOP

Mat'l (assy) 1 card

Sched: 1st mach

1 - insp K1A1 (insp. to follow)

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Attachment C

October 9, 1986

T. W. Compton, Jr., 9201-1, Y-12

HFIR Upper Tracks

This is to advise you of the urgency of the upper track fabrication you are now performing. To meet a Martin Marietta Energy Systems milestone, it is necessary to have your part of the fabrication completed by April 1, 1987.

Your assistance in maintaining this schedule will be appreciated.

GRHicks

G. R. Hicks, 7910, MS-387, ORNL (6-4993)

GRH:rc

cc: S. E. Burnette
E. E. Hill
R. V. McCord
R. L. McIlwain, 9201-1, Y-12
B. H. Montgomery
B. J. Ward
File

MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

February 9, 1987

Attachment D

T. W. Compton, Jr.

HFIR Upper Track Fabrication

Mr. D. L. Aubuchon (Don) is hereby authorized to serve as ORNL's liaison between the Y-12 Fabrication Shop and the HFIR on the HIFI upper track assembly. This represents an effort to minimize any fabrication delays due to lack of communication between ORNL and Y-12. In this capacity, Mr. Aubuchon will assist with both on-site quality and fabrication surveillance. He can be reached at Building 9201-3, MS-002, phone 4-0401.

The upper track fabrication must be complete by April 1987, to meet a Martin Marietta Energy Systems, Inc., Awards Fee Milestone.

G R Hicks

G. R. Hicks, 7910, MS-387, ORNL (6-4993) - RC

GRH:mca

cc: D. L. Aubuchon
P. B. Burn
S. E. Burnette
S. S. Hurt
C. H. Linginfelter
B. H. Montgomery
B. J. Ward
T. R. Webber

Attachment E

COMPLETION DATE REVISIONS KHO

SCHEDULED DATE 3-2-87	FOREMAN MAIN SHOP
W.O. K-8883W-31	S.O. 1194-68 / W.B. # 2841
JOB TITLE UPPER TRACK	
NEW COMPLETION DATE 6-2-87	

REASON FOR NEW DATE

NOT ENOUGH WORKING HOURS
TILL 3-2 TO WORK 2100 HOURS.

CUSTOMER G. D. HICKS	PHONE 64993

UCN-4039 (2 11-79)

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37831

February 12, 1987

Ms. Susan S. Waddle
Fusion and Basic Sciences Branch
Department of Energy
Oak Ridge Operations
Post Office Box E
Oak Ridge, Tennessee 37831

Dear Ms. Waddle:

Attached is the January monthly costs and schedule assessment report on OR-638-86-ORNL-2, HIFI Project. The schedule and costs only pertain to those items covered by this funding.

A revised OR-638 was submitted from my office on January 6, 1987, which will cover the remaining costs associated with this project. When approval has been granted, the attached table will be revised.

If further information is required, please contact me at 574-0258.

Sincerely,

BH Montgomery
B. H. Montgomery
Project Leader

BHM:kfr

Attachment

cc/att: W. G. Craddick
K. R. Thoms
C. D. West
File-BHM

HIFI PROJECT SCHEDULE
(OR-638-86-ORNL-2 Only)

HIFI1.CAL
Last Update= 2/12/87 BHM

```
----------------------------------------------------------------------------------------------------------
                          :               FY-1986               :               FY-1987              :
                          : O N D : J F M : A M J : J A S : O N D : J F M : A M J : J A S :
--------------------------:_______:_______:_______:_______:_______:_______:_______:_______:
                          :       :       :       :       :       :       :       :       :
TARGET TOWER(98)      ------DDDDDDDDDxFFFFFFFFFFFxIIIIIx   :       :       :       :       :
                          :       :       :       :       :       :       :       :       :
QUICK OPENING HATCH(99) ------DDDDDDDDxFFFFFFFFFFFFxIIIIIx :       :       :       :       :
                          :       :       :       :       :       :       :       :       :
TARGET HOLE PLUG(100) ------DDDDDDDDxFFFFFFFFFFFFxIIIIIx   :       :       :       :       :
                          :       :       :       :       :       :       :       :       :
RABBIT "U" BEND(96)       :     DDDDDDDDxFFFFFFFxIIIIIIx   :       :       :       :       :
                          :       :       :       :       :       :       :       :       :
RABBIT INPILE SECTION(96) :     DDDDDDDDxFFFFFFFxIIIIIIx   :       :       :       :       :
                          :       :       :       :       :       :       :       :       :
OUTER SHROUD(93)          :   DDDx- -FFFFFFFFFFFFxIIIII - - -:- - - - :- - - - :IIIIIII :       :
                          :       :       :       :       :       :       :       :       :
SHROUD FLANGE(94)         :       : DDDDDDDDDDx----FFFFFFFFx:- - - - :- - - - :IIIIIII :       :
                          :       :       :       :       :       :       :       :       :
UPPER TRACK(97)           :       : DDDDDDDDDDDDDDDDDDDDDDDDxFFFFFFFFFFFFFFFFFFFFFFFIIII :       :
                          :       :       :       :       :       :       :       :       :
MISC. TOOLS(101)          :       : DDDDDDDDDDDDDDxF-F-F-F-F-F-F-F-F-F-F-F-F-F-:IIIIIII :       :
                          :       :       :       :       :       :       :       :       :
ASSEMBLY DRAWINGS         :       :       :  DDDDDDDDDDDDDDDD- - - DDDDx  :       :       :
                          :       :       :       :       :       :       :       :       :
----------------------------------------------------------------------------------------------------------
```

(D=Design; F=Fabricate; I=Install; x=Completed)
Numbers in ( ) are HFIR Job numbers

HIFI PROJECT COSTS (OR-638-86-ORNL-2 Only)

	ESTIMATE	JANUARY COSTS	SPENT TO DATE	TO BE SPENT
DESIGN	$179,500		$182,058	$ -2,558
FABRICATION	326,800	19,368	315,332	11,468
INSPECTION	42,600	569	32,296	10,304
SURVEILLANCE	98,100	3,262	120,251	-22,151
INSTALLATION	63,000		48,310	14,690
TOTAL	$710,000	$ 23,199	$698,247	$ 11,753

MARTIN MARIETTA

Internal Correspondence

March 31, 1987

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

HIFI Project Monthly Progress Report for March 1987

Fabrication of the reactor components for Phase II (the RB* facilities) is continuing. The vendor for the removable beryllium assembly presently projects a completion date of May 19, 1987. While this is a month later than originally scheduled, the new delivery date will still allow sufficient time for mockup installation.

The problems associated with fabrication of the track assembly by Y-12 General Machine Shops have hopefully been resolved. They now project a completion date of May 15, 1987, which will still meet the mockup installation schedule. They have revised their original estimate from 3327 hours to 4530 hours, an increase of 36% or $35,000. We are currently looking at ways to fund this additional cost, probably by redirecting some of the funds Operations Division have been unable to spend on neutronics analysis due to reassignment of their staff.

The revised OR-638-86-ORNL-2 was approved by DOE on March 23, 1987 and received at ORNL on March 26. The delayed approval, almost three months, caused a bit of concern due to continuing costs being accrued on overrun accounts during the month of March. Work orders will be revised early next month.

The OR-638 monthly cost/schedule report to DOE-ORO has been discontinued at the request of Susan Waddle, DOE.

B. H. Montgomery

B. H. Montgomery, Project Leader, FEDC, Rm. 146 (4-0258)

BHM:kfr

cc: S. J. Ball
L. A. Berry
E. E. Bloom
B. L. Corbett
W. G. Craddick
C. J. Cromwell
G. R. Hicks
M. A. Holtzclaw
S. S. Hurt
A. W. Longest
R. V. McCord
D. M. McGinty
F. R. Mynatt
E. Newman, Jr.
B. W. Patton
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
J. H. Swanks
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. A. Watson
C. D. West
R. S. Wiltshire
A. Zucker
File-BHM (2)

MARTIN MARIETTA

Internal Correspondence

May 1, 1987

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

HIFI Project Monthly Progress Report for April 1987

Fabrication of all the removable beryllium reflector parts is completed. Inspection documents have been reviewed and approved, and the reflector is currently in the final stages of assembly at the vendor site. A delivery date of May 20, 1987 (i.e., on schedule) has now been projected.

The problem associated with timely fabrication of the track assembly by the Y-12 General Machine Shop to meet a completion date of May 15 appears to have been resolved during the last month.

The problem in the Y-12 shops is now with money, not schedule. Their original estimate was $102,000. A revised, and sharply increased, estimate of $137.000 was received in March. Now, on May 1, another large increase has been requested, to $181,000.

The project had, only last month, reallocated $35,000 to cover the increased cost ($137,000) estimated at that time. By stopping work on the replacement segments that were "borrowed" from the HFIR stockpile, we can save $25,000, but even so we are faced with finding an additional $19,000 for the job. We are currently looking at ways to allocate this funding. Note that this strategy also leaves the HFIR without spare segments for the track assembly.

B H Montgomery

B. H. Montgomery, Project Leader, FEDC, Rm. 146 (4-0258)

BHM:kfr

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
B. L. Corbett
W. G. Craddick
C. J. Cromwell
T. L. Dahl
G. R. Hicks
M. A. Holtzclaw
S. S. Hurt
A. W. Longest
A. L. Lotts
R. V. McCord
D. M. McGinty
F. R. Mynatt
B. W. Patton
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. A. Watson
C. D. West
A. Zucker

MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

May 29, 1987

Distribution

HIFI Project Monthly Progress Report for May 1987

All hardware and components associated with the second and final phase of work on the HIFI Project have been delivered to the HFIR and are currently being installed in the mockup. The removable beryllium reflector was delivered on May 8, 1987 (one week earlier than scheduled); the track assembly was delivered on May 13, 1987 (two days earlier than scheduled); and the mockup stand dummy access hatch and hole plug were delivered on May 6, 1987 (on schedule). The track assembly required additional hardware (bearings, pins, etc.) to be installed at the HFIR site. This was accomplished in less time than estimated and, as a result, mockup work began at an earlier date.

Visual alignment and fit in the mockup will confirm the functional use of all items. Optical alignment equipment is in place, but its use has been delayed because of room temperature fluctuations due to a lack of building air conditioning. The temperature variations cause movement (expansion and contraction) of the components in the mockup making precise alignment difficult to achieve. Repair of the A/C is underway.

Optical alignment is an additional confirmation of the functional use of the two components (track assembly and reflector assembly) needed to complete phase 2 of the HIFI Project. We could, in all honesty, report that the award fee milestone is met as soon as the mockup installation is complete; however, the additional confirmation using optical alignment is double assurance. That work will proceed and should be completed in June, thus meeting the DOE/ORNL award fee milestone.

The two instrument and control cabinets required for the experimental control room upgrade were checked out and delivered in April. Craft work to tie in instruments and hardware has begun. Sound proofing and other environmental control hardware is scheduled for delivery and installation in June.

On a personal note, I should like to congratulate Gene Hicks on his retirement and thank him for the support he gave the HIFI Project. If it were not for Gene's knowledge, early support, and diligent work on this project we would still be looking at ways to complete the job. He will be missed by all people associated with the HFIR.

BH Montgomery

B. H. Montgomery, Project Leader, FEDC, Rm. 146 (4-0258)

BHM:kfr

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
B. L. Corbett
W. G. Craddick
C. J. Cromwell
T. L. Dahl
G. R. Hicks
M. A. Holtzclaw
S. S. Hurt
A. W. Longest
A. L. Lotts
R. V. McCord
D. M. McGinty
J. R. Merriman
F. R. Mynatt
B. W. Patton
M. W. Rosenthal
J. L. Scott
R. L. Senn
I. I. Siman-Tov
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. A. Watson
C. D. West
A. Zucker
File-BHM(2)

MARTIN MARIETTA

Internal Correspondence

July 10, 1987

MARTIN MARIETTA ENERGY SYSTEMS, INC.

Distribution

HIFI Project Monthly Progress Report for June 1987 - Final Report

This is the final monthly progress report on the HIFI Project - the 22nd in a series that began in September 1985. On June 19, 1987, optical alignment of the new reactor components was completed in the HFIR mockup. This was additional confirmation of the functional use of the components needed to complete the modifications for the eight new removable beryllium (RB*) facilities. The reactor components are now ready for installation in the reactor thus meeting the DOE award fee milestone and completing Phase 2 of the HIFI Project.

Phase 1 and Phase 2 of the project were capital funded by the Office of Fusion Energy and the Basic Energy Sciences Program through a Department of Energy approved OR-638-86-ORNL-2, Mod. 1, for a total of $952,000 which is $160,000 under the initial estimate. The estimated costs vs the actual costs are shown in Table 1. The funds remaining ($31,000) are allocated to the design, fabrication, and assembly of an experiment to measure gamma heating rates in the new RB* positions: the experimental results will negate the need for gamma heat calculations that were previously scheduled, but never completed, under the neutronic analysis task.

The experimental control room upgrade, which contains the utilities for the new instrumented experiments, was scheduled to be completed this month; however, lack of craft personnel will delay this task. The delay will cause no problem unless the reactor startup is imminent.

A final report covering the completion of Phase 1 and Phase 2 (ORNL/TM-10505) is currently being reviewed and, hopefully, will be distributed in early August 1987.

The HIFI Project was a team effort comprising personnel from several different ORNL divisions including their Associate Directors and Division Directors. Thanks are extended to all those people who contributed their efforts to making this project a success.

B.H. Montgomery

B. H. Montgomery, Project Leader, FEDC, Rm. 146 (4-0258)

BHM:kfr

Distribution

S. J. Ball
L. A. Berry
E. E. Bloom
S. E. Burnette
B. L. Corbett
W. G. Craddick
C. J. Cromwell
T. L. Dahl
M. A. Holtzclaw
S. S. Hurt
A. W. Longest
A. L. Lotts
R. V. McCord
D. M. McGinty
J. R. Merriman
F. R. Mynatt
B. W. Patton
M. W. Rosenthal
J. L. Scott
I. I. Siman-Tov
W. E. Thomas
K. R. Thoms
H. E. Trammell
C. A. Watson
C. D. West
A. Zucker
File-2

THE HFIR IRRADIATION FACILITIES UPGRADE (OR-638-86-ORNL-2, Mod. 1) WAS COMPLETED ON SCHEDULE AND $160,000 UNDER ESTIMATE.

($000)

DISCIPLINE	10/29/85 ESTIMATE	ACTUAL	UNDERUN/ (OVERUN)
DESIGN	233.0	182.8	50.2
PROCUREMENT/FABRICATION *	603.0	424.5	178.5
ASSEMBLY	63.0	83.5	(20.5)
INSPECTION	0	40.2	(40.2)
SURVEILLANCE	144.0	162.9	(18.9)
NEUTRONIC ANALYSIS	69.0	27.1	11.0
GAMMA HEAT EXPERIMENT **		30.9**	
TOTAL	1,112.0	952.0	160.0

* Does not include the cost associated with the scheduled removable beryllium replacement which was, as always, funded by Operations Division operating funds.

** These funds are to be used to design, fabricate, and assemble a proposed experiment to measure gamma heating rates in the new RB* facilities. These experimental results will avoid the need for gamma heat calculations that were previously shown under Neutronic Analysis funding.

B. H. Montgomery
June 30, 1987

APPENDIX C

PROJECT MILESTONES — ACHIEVEMENT REPORTING FORMS

MARTIN MARIETTA ENERGY SYSTEMS, INC.

ACHIEVEMENT REPORTING FORM

ORIGINATOR (NAME)	TELEPHONE NO.	DATE
Colin D. West	4-0370	9/4/86

BRIEF DESCRIPTION:

Achievement

During the August 13-17 refueling shutdown of the High Flux Isotope Reactor (HFIR), Phase I of the HFIR Irradiation Facilities Improvement (HIFI) Project was completed on schedule, and under budget, with the installation of the equipment necessary to operate instrumented irradiation experiments in the target region. At the same time the first capsule to utilize this facility was installed. This capsule, part of the US/Japan Fusion Materials Collaboration Program, simulates the design of eight uninstrumented target capsules of the program and is instrumented to record the specimen temperatures. Additionally, it contained three test sections designed to gather better information on the gamma heating rates in the target region and to determine the variation of heating rate with time through a HFIR fuel cycle.

Significance

The completion of Phase I gives the nation a new research capability by allowing the irradiation of instrumented experiments in the highest continuous neutron flux presently available in the world. The new facility provides accelerated irradiation damage rates for the testing, under controlled conditions, of materials for the construction of fusion and fission reactors. The neutron flux available at the test positions is twice as high as the best instrumented positions previously available at the HFIR, and higher than the flux in the Materials Open Test Assembly at the Fast Flux Test Facility (FFTF). New experiments are already planned by the Magnetic Fusion Energy Program and the Gas-Cooled Reactor Program to take advantage of this additional capability.

C. D. West was the manager of this project; B. H. Montgomery, K. R. Thoms and G. R. Hicks played an essential part in planning and implementing the facilities work. I. I. Siman-Tov and J. E. Wolfe were responsible for the irradiation capsule work.

PLANT
ORNL

DIVISION AND PROGRAM
Engineering Technology/HFIR Irradiation Facilities Improvement (HIFI) Project

TYPE (CHECK)	ACTION (CHECK)	BY WHEN	BY WHOM
☒ Meeting or Betterment of Milestones	☐ Report to ORO		
☒ Significant Technical Achievement	☐ Report to General Staff Meeting		
☐ Important Honor or Award	☐ Report to Site Manager's Meeting		
☐ Completion of Audit Recommendations, etc.	☐ Prepare Press Release		
☐ Significant Technology Transfer*	☐ Report to DOE/HQ		
☐ New Program Developed/Funded*	☐ Report for Award Fee		
☐ Greatly Reduced Costs	☐ Other:		
☐ Outside Liaison with University/Industry*			
☐ Other:			

NOTE: Send to Appropriate Site Vice President

**Send copy to OTA,* ~~FEDC, K-XX~~ 4500N, K251

UCN-15820 (12356 1-86)

MARTIN MARIETTA ENERGY SYSTEMS, INC.

ACHIEVEMENT REPORTING FORM

ORIGINATOR (NAME)	TELEPHONE NO.	DATE
Colin D. West	4-0370	6/22/87

BRIEF DESCRIPTION:

Achievement

Modifications to the High Flux Isotope Reactor (HFIR) for the new removable beryllium (RB*) irradiation positions - Phase 2 of the HFIR Irradiation Facilities Improvement (HIFI) Project - was completed June 19, 1987 on schedule and below the estimated cost. The functional use of each new component was confirmed in the reactor mockup using optical alignment equipment. The completion of Phase 2 has met an ORNL/Energy Systems Award Fee Milestone - "complete HFIR modifications to allow conduct of instrumented experiments in the RB positions, June 1987".

Significance

The modifications increased the number of RB positions from four to eight, each with almost twice the available experimental space of the previous ones. Irradiation tests that were previously carried out in the ORR can now be moved to the HFIR and obtain the same radiation damage in one-half the irradiation time and at lower cost.

C. D. West was manager of this project; K. R. Thoms, S. E. Burnette and G. R. Hicks played an essential part in planning and implementing the facilities work, under the leadership of B. H. Montgomery.

PLANT

ORNL

DIVISION AND PROGRAM

Engineering Technology/HFIR Irradiation Facilities Improvement (HIFI) Project

TYPE (CHECK)	ACTION (CHECK)	BY WHEN	BY WHOM
☒ Meeting or Betterment of Milestones	☐ Report to ORO		
☒ Significant Technical Achievement	☐ Report to General Staff Meeting		
☐ Important Honor or Award	☐ Report to Site Manager's Meeting		
☐ Completion of Audit Recommendations, etc.	☐ Prepare Press Release		
☐ Significant Technology Transfer*	☐ Report to DOE/HQ		
☐ New Program Developed/Funded*	☐ Report for Award Fee		
☒ Greatly Reduced Costs	☐ Other:		
☐ Outside Liaison with University/Industry*			
☐ Other:			

NOTE: Send to Appropriate Site Vice President

**Send copy to OTA,* ~~XXXXXXX~~ 4500N, K251

UCN-15820 (13386 1-86)

APPENDIX D

DOE APPROVAL OR-638-86-ORNL-2-MOD 1

MAR 24 1987

Department of Energy
Oak Ridge Operations
P. O. Box E
Oak Ridge, Tennessee 37831

March 23, 1987

DIST. by R. S. WILTSHIRE
Date
Barker Oliphant
Eads Parzyck
Garrett Swanks
Krieg Travaglini ✓
Kuykendall Whitesides
Melroy Other
Assoc Dir
Com Syst
Handle/Reply
Travaglini Responsible
for further distribution

Dr. Herman Postma, Director
Oak Ridge National Laboratory
Martin Marietta Energy Systems, Inc.
P. O. Box X
Oak Ridge, Tennessee 37831

Dear Dr. Postma:

OR-638 - HFIR IRRADIATION FACILITIES, PROJECT 86-ORNL-2, MOD. 1

Enclosed is the approved original of Form OR-638 for the HFIR Irradiation Facilities Upgrade, Project 86-ORNL-2, Modification 1. This modification increases the total cost by $242,000 (from $710,000 to $952,000) to provide for equipment previously proposed for inclusion in the FY 86 and FY 87 Reactor Improvement and Modification Projects. We agree that these items are appropriately part of 86-ORNL-2.

K8883 K8882

Funds for the increased costs are to be charged to 35-AT-15, 35-KC-01, and 35-KC-02, as shown on the Form OR-638.

If you have questions, please call J. W. Nehls of my staff on extension 6-0743.

K8918

Sincerely,

Joe Lenhard

Joseph A. Lenhard
Assistant Manager for Energy
Research and Development

ER-112:Nehls

Enclosure

cc w/encl:
J. Penry, AD-46
W. A. Hampton, CE-52

Form OR-638
(Rev. 4/76)

REQUEST AND APPROVAL FOR EQUIPMENT, MAINTENANCE, AND EXPERIMENTAL PROJECTS

A. REQUEST (Use reverse side for description and justification.) Date FEB 0 6 1987

Contractor and Installation: Martin Marietta Energy Systems, Inc. (ORNL)

Proposed Item and Location: HFIR Irradiation Facilities Upgrade (Bldg. 7900)

Fiscal Year Authorized & Consecutive Number of Project: 86-ORNL-2

Modification No. 1

B. BREAKDOWN OF ESTIMATED COST

1. Engineering Design & Inspec.		$ 240,000
2. Direct Cost:		
A. Equipment	$ 222,000	
B. Inst. of Equip.	36,000	
C. Maint. & Related Expense	50,000	
D. Other (Specify) (Neutronics calculations)	40,000	348,000
3. Indirect Cost		364,000
4. Contingency		0
Gross Total		$ 952,000
5. Salvage Credits		0
Net Total		$ 952,000

C. NET COST BY ACTIVITY

Activity No.	Net Cost	
35-KC-01	$ 100,000	[initials] 1/27/87
35-AT-15-03	717,000	MAH
35-KC-02	135,000	[initials] 1/27/87
Total	$ 952,000	

D. FINANCIAL PLAN

Change Required: Yes ☐ No ☐

(If "Yes" attach explanation following items and amount involved.)

E. TIMING

1. Estimated Starting Date ______
(If other than when approved.)

2. Estimated Time To Complete 19 Mos.

F. MODIFICATIONS (Complete if applicable and use reverse side for explanation.)

1. This action involves change (increase or decrease) from previous estimated cost:
   - Gross $ 242,000
   - Salvage
   - Net $ 242,000

2. This action involves an Extension ☐ Advancement ☐ of ____ months from previous estimated time to complete.

G. REQUESTING OFFICIAL

Executive Director, ORNL — Title

R. S. Wiltshire — Signature

H. CONCURRENCES (Required only on Contract Administrator file copy.)

I. APPROVAL – Approved by the DEPARTMENT OF ENERGY by

Date: 3-20-87

Title: Assistant Manager for Energy ~~Research and Development~~

J. A. Lenhard — Signature

J. DISTRIBUTION (Check one box)

- x Contractor (After approval by Contract Administrator)
- ___ Contract Administrator (Concurrences required on this copy)
- ___ Budget Division
- ___ Davis-Bacon Committee (6)
- ___ Contractor (Suspense file)

BHM 1/6/87 1-6-87 MAH 1/30/87 MWS 1/30/87 1/9/87 1/12/87 1/14/87 1/20

FORM OR–638 (5-79)

NARRATIVE DESCRIPTION AND JUSTIFICATION FOR PROJECT

(If the proposed item has been fully described and justified in a budget document or correspondence to DOE, a reference to the documents containing the information should be included, in which case a brief narrative description and justification will suffice.)

Reference Documents:

1. Letter to Dr. John F. Clarke from W. M. Rosenthal, March 22, 1985
2. Letter to Dr. M. W. Rosenthal from John F. Clarke, April 5, 1985
3. Letter to Mr. Robert J. Dowling from Lee A. Berry, October 10, 1985
4. Letter to Dr. John F. Clarke from M. W. Rosenthal, October 21, 1985
5. C. W. Alexander, et al, "Report of the Materials Irradiation Facilities Improvements Committee," ORNL/TM-9709, October 19, 1985

Description:

This request includes design, engineering analysis, procurement and/or fabrication and installation of the following reactor components for the HFIR Irradiation Facilities Upgrade (HIFI) Project: hydraulic rod actuator, top plug, beryllium reflector, and grid assembly.

Justification:

The HIFI Project will increase the size and number of the removable beryllium penetrations for materials irradiation studies. It will also add instrumentation capabilities for the target irradiation facilities. A cost saving of $3 million to the DOE-OFE will be realized over the next three fiscal years by utilization of these facilities.

Method of Accomplishment:

Energy Systems Engineering will provide design and analysis under the supervision of ORNL Operations Division HFIR Technical Group. Procurement and/or fabrication will follow established practice involving the ORNL Engineering Technology Division and Energy Systems Purchasing Division. Installation will be provided by ORNL Operations Division personnel and associated crafts.

Direct Costs

	Original	Modified
Outside machinists	$ 5,000	$ 20,000
Riggers	5,000	16,000
Shop fabrication	50,000	50,000
Total	$ 60,000	$ 86,000

Total Estimate

	Original	Modified
Direct labor	$246,000	$366,000
Procurement	193,000	222,000
Overhead	236,000	364,000
Contingency	35,000	0
Total	$710,000	$952,000

Safety Assessment:

The HIFI Project will have no adverse effects on the operational safety of the reactor.

NOTE: The capital equipment funds necessary for the HIFI Project will be in accordance with DOE/CR-0009 Part 6, Paragraph 4.G(4).

JUSTIFICATION FOR JOINT FUNDING

Basic Energy Sciences (BES) is responsible for the monetary support of the HFIR. The general upgrade of the HFIR will provide bigger and more irradiation facilities for an increase in isotope production capabilities, more places to insert experiments (resulting in less effect on beam tubes), and more space available for future sponsors of engineering materials testing; the income from these new facilities by other sponsors will reduce the monetary support required of BES.

The Office of Fusion Energy (OFE-DOE) would conduct irradiation experiments of the type done in the ORR with damage rates two to seven times larger in the upgraded HFIR facilities and realize a cost savings of $3 million over the next three fiscal years.

JUSTIFICATION FOR REVISION

This project to upgrade the HFIR which began in FY 1986 is one of several concurrent tasks to improve the irradiation surface area and quality in HFIR. Related tasks, fabrication of new and improved outer shroud, shroud flange and track assembly for the HFIR, were to have been funded with $250 K of FY 86 and $250 K of FY 87 ARIM funds. Due to program decisions within DOE-ER, those funds were allocated to higher priority tasks within the accelerator/reactor community. A review of the work to have been performed with ARIM funding indicates that it is appropriate to include some of these efforts in the scope of the present OR-638, which is funded with Basic Energy Sciences and magnetic fusion equipment funds. Therefore, a funding and TEC increase is requested for Project 86-ORNL-2 in the amount of $242 K.

APPENDIX E

REPORT ON CORE-LIFE EXPERIMENT: "HAFNIUM SHIELDS IN THE RB POSITIONS ARE OK"

★ ★ ★ ★ ★

HAFNIUM SHIELDS IN THE RB POSITIONS ARE O.K. ★

★ ★ ★ ★ ★

The Materials Irradiation Facilities Improvement Committee recommended, inter alia, certain modifications to the HFIR. The recommendation was accepted by the Executive Committee, and I was instructed to take responsibility for the work.

A major technical reservation concerned the effect that experiments in the new removable beryllium (RB) positions would have on the slow neutron flux in the beam tubes; in particular, there was concern that spectral tailored irradiation capsules, involving a hafnium absorber shield, might unacceptably reduce the beam tube flux.

Preliminary calculations, presented to all concerned at a meeting on May 10, indicated that with the new RB positions shielded capsules need not be placed closer than about 200 mm from the nearest beam tubes, and that the maximum flux depression effect at the beam tubes would be in the range of 4% to 10%. All agreed that a 4% to 10% reduction would be acceptable.

The calculations, although simplistic, were sufficiently convincing for us to justify the expense of some experimental measurements to verify the viability of the proposed modifications, and the first results of some low power experiments in the HFIR are now available; the measured loss of beam tube flux when a hafnium tube, 3.8 mm thick, is placed in RB positions 200-400 mm away is less than 5%. The more distant beam tubes are affected less; in fact, as expected the tubes on the opposite side of the core from the hafnium see a slightly (up to 4%) increased flux due to power tilting in the core. Naturally, at shorter distances - which would not be used in practice - the depression is higher (13% at 100 mm). The results are shown in the attached table and graph, which compare flux levels with a base case in which the usual iridium loadings were placed in all RB positions except RB-3. All combinations of hafnium position and beam tube use except one (RB3 and HB2) are acceptable, as expected, showing a loss of 6% or less. RB3 will be reserved for experiments without hafnium shielding.

Preliminary estimates, based on the extra control plate withdrawal needed to compensate for the hafnium, show that the loss of reactivity is less than twice that caused by the iridium that is usually placed in the RB positions, and should shorten the fuel cycle only a matter of hours; we shall have a better measurement of this after the full power, full cycle run that will begin shortly. We are also making flux and spectrum measurements in the RB positions.

Ken Thoms designed the experimental program; Dave McGinty coordinated the Operations Division effort; Bob Nicklow coordinated the beam tube measurements.

C. D. West/8-8-85

Distribution:

C. W. Alexander
T. D. Anderson
L. A. Berry
E. E. Bloom
B. L. Corbett
F. C. Difilippo
M. B. Farrar
G. R. Hicks
S. S. Hurt
M. J. Kania
W. C. Koehler
R. A. Lillie
R. E. MacPherson
R. V. McCord
D. M. McGinty
B. H. Montgomery
R. M. Moon, Jr.
F. R. Mynatt
E. Newman, Jr.
R. M. Nicklow
R. T. Primm
H. Postma
C. R. Richmond
M. W. Rosenthal
A. F. Rowcliffe
J. L. Scott
R. L. Senn
I. I. Siman-Tov
R. M. Stinnett
J. H. Swanks
W. E. Thomas
K. R. Thoms
H. E. Trammell
M. K. Wilkinson
R. S. Wiltshire
S. Zinkle
A. Zucker

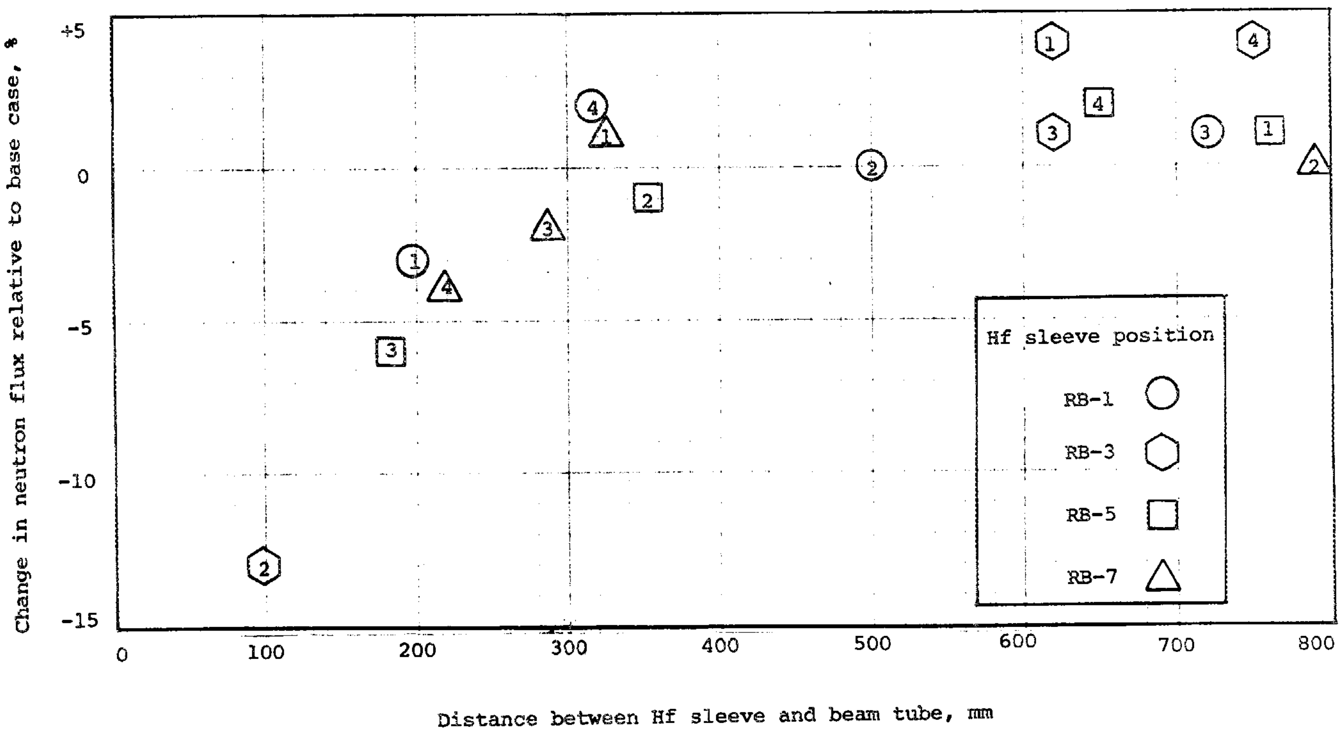
EFFECT OF HAFNIUM ON BEAM TUBE FLUX[1]

	% change in thermal flux at beam tubes[2]			
	HB1	HB2	HB3	HB4
Hafnium position				
RB1[3]	-3	0	+1	+2
RB3	+4	-13%	+1	+4
RB5[3]	+1	-1	-6	+2
RB7[3]	+1	0	+2	-4

[1] Measured at a reactor power of 100 kW

[2] The base case has the usual iridium (isotope production) capsules at all RB positions except RB3

[3] The iridium in these positions was replaced by the hafnium sleeve to make the measurement.



Results of 100 kW runs with a hafnium sleeve in various RB positions. The numbers inside of symbols designate beam tube numbers.

ORNL/TM-10505

Internal Distribution

1. D. L. AuBuchon
2. S. J. Ball
3. L. A. Berry
4. E. E. Bloom
5–7. S. E. Burnette
8. R. D. Cheverton
9. B. L. Corbett
10. W. G. Craddick
11. C. J. Cromwell
12. T. L. Dahl
13. E. C. Fox
14. R. M. Harrington
15. M. A. Holtzclaw
16. S. S. Hurt
17. A. W. Longest
18. A. L. Lotts
19. R. V. McCord
20. D. M. McGinty
21. J. R. Merriman
22–26. B. H. Montgomery
27. F. R. Mynatt
28. R. K. Nanstad
29. B. W. Patton
30. H. B. Piper
31. H. Postma
32. K. H. Poteet
33. C. E. Pugh
34. M. W. Rosenthal
35. A. F. Rowcliffe
36. J. L. Scott
37. R. L. Senn
38. I. I. Siman-Tov
39. W. E. Thomas
40–44. K. R. Thoms
45. H. E. Trammell
46. D. B. Trauger
47. C. A. Watson
48–50. C. D. West
51. R. S. Wiltshire
52. A. Zucker
53. ORNL Patent Office
54. Central Research Library
55. Document Reference Section
56–57. Laboratory Records Department
58. Laboratory Records (RC)

External Distribution

59. Dr. Ekkehrdt Bauer, Institut Laue-Langevin, BP156 Grenoble, Cedex F38042, Grenoble, France
60. Dr. Gunter Bauer, Leiter: Abteilung Neutronenquellen, Zentralabteilung Forchungsreaktoren der, Kernforschungsanlage Julich GmbH, Postfach 1913, D-5170 Julich, West Germany
61. Dr. Klaus Bohning, Fakultat Fur Physik, E21, Technischen Universitat Munchen, James Franck Strasse, 8046 Garching, West Germany
62. Paul Dickson, Idaho National Engineering Laboratory, EG&G Idaho, P.O. Box 1625, Idaho Falls, ID 83415
63. Dr. K. J. Henry, Head, Research Reactors Division, Building 521, AERE Harwell, Oxfordshire, X11 ORA, England
64. Carlo Vitanza, Head, HFR Division, Joint Research Center — Petten Establishment, Postbus 2, 1755 ZG, Petten (NH), The Netherlands
65. Peter von der Hardt, Head, Nuclear Support Division, Joint Research Center — Ispra Establishment, 21020 Ispra (Varese), Italy
66. Office of Assistant Manager for Energy Research and Development, Department of Energy, ORO, Oak Ridge, TN 37831
67–96. Technical Information Center, Department of Energy, Oak Ridge, TN 37831

☆U.S. GOVERNMENT PRINTING OFFICE:1987 -748 -168/ 60085