– B&W 177-FA Owners Group –

EFFECTS OF ASYMMETRIC LOCA LOADINGS

– Phase II Analysis –

Supplement 1
Responses to NRC Questions

Document No. 77-1126594-00

BAW-1621, Supp. 1

June 1981

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CONTENTS

INTRODUCTION AND SCOPE

On January 25, 1978, the U. S. Nuclear Regulatory Commission's Division of Operating Reactors requested all PWR licensees to proceed with an evaluation of asymmetric loss-of-coolant accident (LOCA) loadings. In response to this request, The Babcock & Wilcox Company (B&W) and its consultant, EDS Nuclear, Incorporated, performed a detailed Phase II evaluation to determine the effects of these loadings on components, equipment, and structures for the B&W 177-Fuel Assembly Owners Group plants. The results were summarized and reported in BAW-1621 in July 1980 ("Effects of Asymmetric LOCA Loadings — Phase II Analysis").

On January 9, 1981, Robert W. Reid, Chief of Operating Reactors, prepared a letter to all B&W licensees requesting that answers be provided to specific questions related to the Phase II report. Subsequently, on April 2 and 3, 1981, the Owners Group subcommittee, B&W, and EDS representatives met with the NRC staff and the NRC's consultant, EG&G, to review and discuss the questions and to define an acceptable format and scope for responding to each question so that all issues could be resolved with one final response.

This report provides the agreed upon responses and additional information and is submitted for the following member utilities of the B&W 177-FA Owners Group:

Arkansas Power & Light	Arkansas Nuclear One, Unit (ANO-1)
Duke Power Company	Oconee Units 1, 2, and 3
Florida Power Corporation	Crystal River 3 (CR-3)
General Public Utilities	Three Mile Island 1 and 2 (TMI-1, -2)
Sacramento Municipal Utility District	Rancho Seco
Toledo Edison Company	Davis Besse 1 (DB-1)

The questions and responses are numbered to be consistent with the numbering in the January 9, 1981, letter from R. W. Reid. The appendixes are used for the convenience of summarizing technical data.

1.1. How were friction factors obtained? (Section 4.3.2)

Response

Friction factors were calculated internally by the CRAFT2 computer code[1] (reference section 2.2.5) based on flow path input parameters, L/D_h (flow path length/hydraulic diameter) and D_h (hydraulic diameter). As stated in section 4.3.2 of BAW-1621[2], insulation assumptions were made in such a fashion as to produce conservative (maximum resistance) values of L/D_h and D_h. An additional multiplier (greater than one) was then applied to the geometric L/D_h to account for flow over concrete.

The net result of this method is a very conservative calculational procedure for friction factors.

1.2. What L/D_h was used for turns not equal to 90 degrees? (Section 4.3.2)

Response

No flow path turns other than 90° were considered. As stated in the response to Question 1.1, frictional losses were accounted for in a very conservative manner. In addition, turning losses associated with circumferential flow paths (30°) in the reactor vessel cavity were considered negligible when compared to frictional and form losses in reference 3.* Furthermore, most circumferential flow paths undergo some type of "gradual" area change (flow over reactor vessel inlet and outlet piping, core flood line piping and detector thimbles), which was conservatively modeled using the equations in section 4.3.2 of BAW-1621[2] for sudden expansions and contractions.

- - - - -

*See section 6, page 208, of that report.

1.3. Supply sample calculation of a form loss coefficient. (Section 4.3.2)

Response

Consider nodes 1 and 2, whose boundaries respectively are defined by points 12341 and 14561, respectively (shown in Figure 1.3-1). The nodes are connected by flow path ①, which extends from point A to point B (i.e., from the center of node 1 to the center of node 2). Notice that the flow path is impeded by a pipe in node 1 and by the detector thimbles in node 2.

The form loss coefficient for this flow path would be calculated using the equations for sudden expansion and contraction presented in section 4.3.2 of BAW-1621.[2] Letting

ξ_1 - flow area at point A (minimum flow area from $A \rightarrow \alpha$, also minimum flow path area from $A \rightarrow B$),

ξ_2 - flow area from $\alpha \rightarrow \beta$, and

ξ_3 - flow area from $\beta \rightarrow B$,

$$K_F = \left(1 - \frac{\xi_1}{\xi_2}\right)^2 + 0.4\left(1 - \frac{\xi_3}{\xi_2}\right)\left(\frac{\xi_1}{\xi_3}\right)^2$$

and

$$K_R = \left(1 - \frac{\xi_3}{\xi_2}\right)^2 \left(\frac{\xi_1}{\xi_3}\right) + 0.4\left(1 - \frac{\xi_1}{\xi_2}\right)$$

where K_F = forward form loss coefficient,

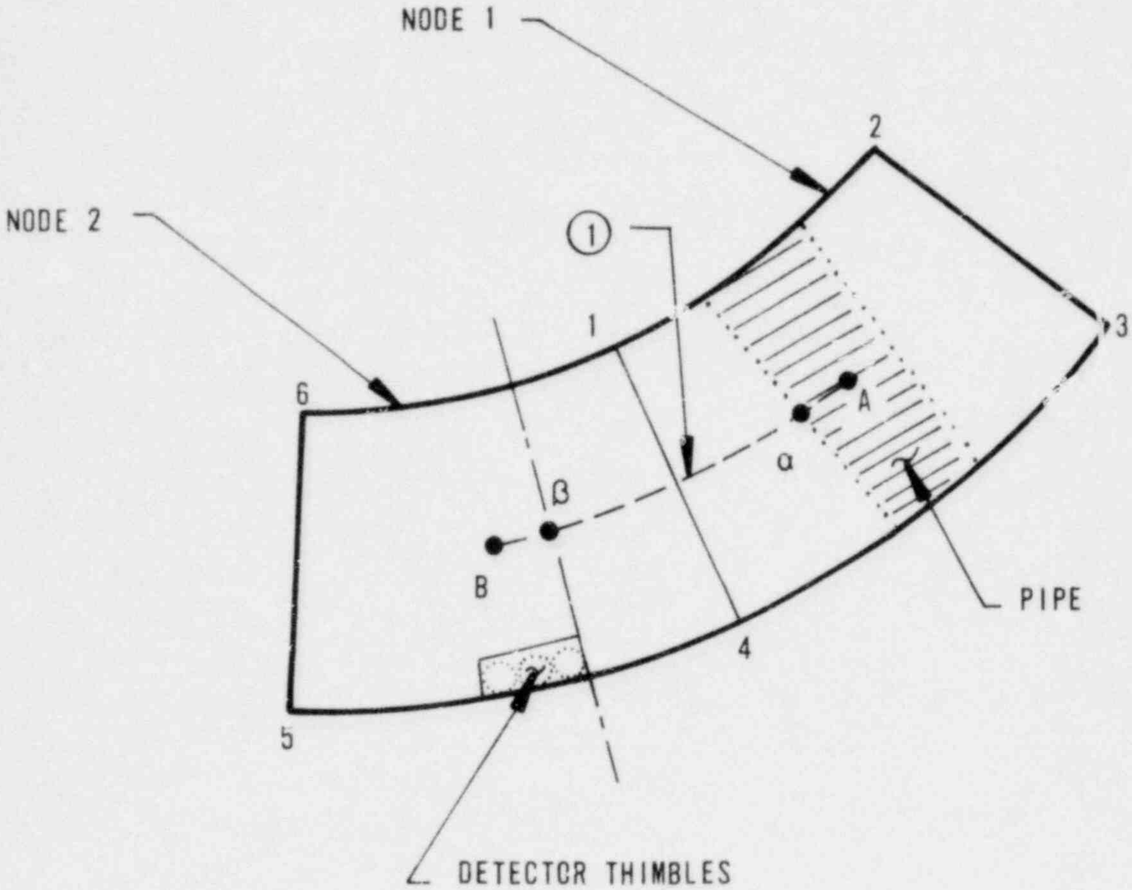
K_R = reverse form loss coefficient for flow path 1 in Figure 1.3-1.

Figure 1.3-1. Form Loss Coefficient Flow Path

A - CENTER OF NODE 1

B - CENTER OF NODE 2

FLOW DIRECTION - A → B



1.4. What, if any, equipment is in the path of motion of venting devices? (Section 4.3.2)

Response

The service support structure and the reactor vessel canal seal plate are the only items in the path of motion of these venting devices. The canal seal plate has been removed on some plants (e.g., Oconee, TMI-1, and ANO-1).

1.5. What uncertainty factors were applied to calculated flow areas? Demonstrate that uncertainty factors were applied in a conservative manner. (Section 4.3.2)

Response

No uncertainty factors were applied to calculated flow path areas. Said areas were determined from utility-supplied, as-built drawings. Physical path areas from the drawings were then reduced by making conservative insulation assumptions and only the minimum area along any given path was used as a computer code input parameter (see section 4.3.2 of BAW-1621[2]).

The result of the procedure above is a conservative calculation of flow path areas.

1.6. Supply the values of any uncertainty factors that may have been applied to other parameters such as volumes, flow lengths, etc. (Section 4.3.2)

Response

No uncertainty factors were applied to such parameters as node volumes, flow path lengths, etc. Such geometric parameters were determined from utility-supplied, as-built drawings. Section 4.3.1 of BAW-1621[2] sets forth the node volume conservatisms employed in the reactor vessel cavity pressure calculations, while section 4.3.2 presents conservatisms introduced in the generation of geometric parameters such as flow path lengths, areas, loss coefficients, etc.

Geometric computer model input parameters were determined in a conservative fashion.

1.7. Supply the initial conditions (pressure and temperature) used in the mass and energy release rate calculations. Demonstrate the generic applicability of these values. (Section 4.3.2)

Response

Table 4.3.8[2] gives the initial conditions for mass and energy release rate calculations. Section 4.3.4.2 gives additional mass and energy inputs. An initial reactor coolant system pressure of 2200 psia in the plenum volume directly above the core was used for the mass and energy release calculations. The reactor coolant system pressure drop is calculated by CRAFT2, and pressure at each node throughout the system is determined.

The loop geometry and fluid conditions of the 177-FA skirt-supported plants are very similar and have been grouped generically in other analyses[4,5]. In order to maximize mass and energy release, 102% of the release from the highest power level plant was used. The response to question 2.10 presents a comparison of plant parameters.

1.8. A drag coefficient of zero does seem unrealistic; however, justification should be provided for the empirical mass multiplier of 2.0. (Section 4.3.2)

Response

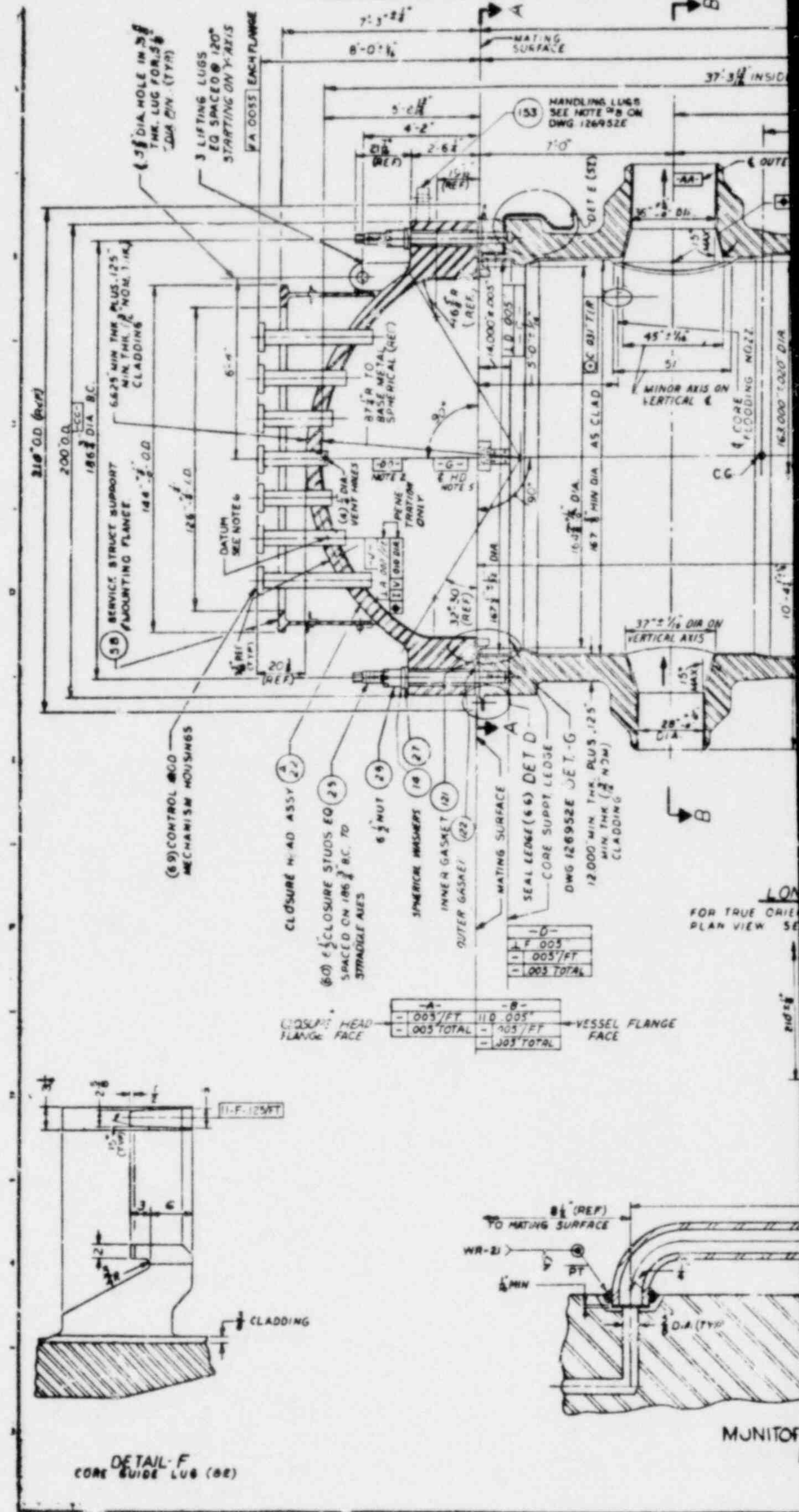
Shield plugs are situated to provide gaps capable of venting flow from the reactor vessel cavity to the service support structure cavity around the circumference of individual plugs. These small vent (gap) paths around the shield plugs were considered in the analysis. As such, form losses and frictional losses associated with flow over the sides of the plugs would be accounted for in the vent flow paths. Hence, drag-type losses due to flow along the height of a shield plug were accounted for. Thus, based on engineering judgement, the shield plug mass multiplier of 2 was introduced as a conservatism which delayed movement of the plugs (and correspondingly, reactor vessel cavity venting was delayed).

1.9. Supply drawings showing the reactor cavity and equipment and piping arrangement for the following plants: Crystal River 3 and Three Mile Island Unit 1. (Section 4.3.2)

Response

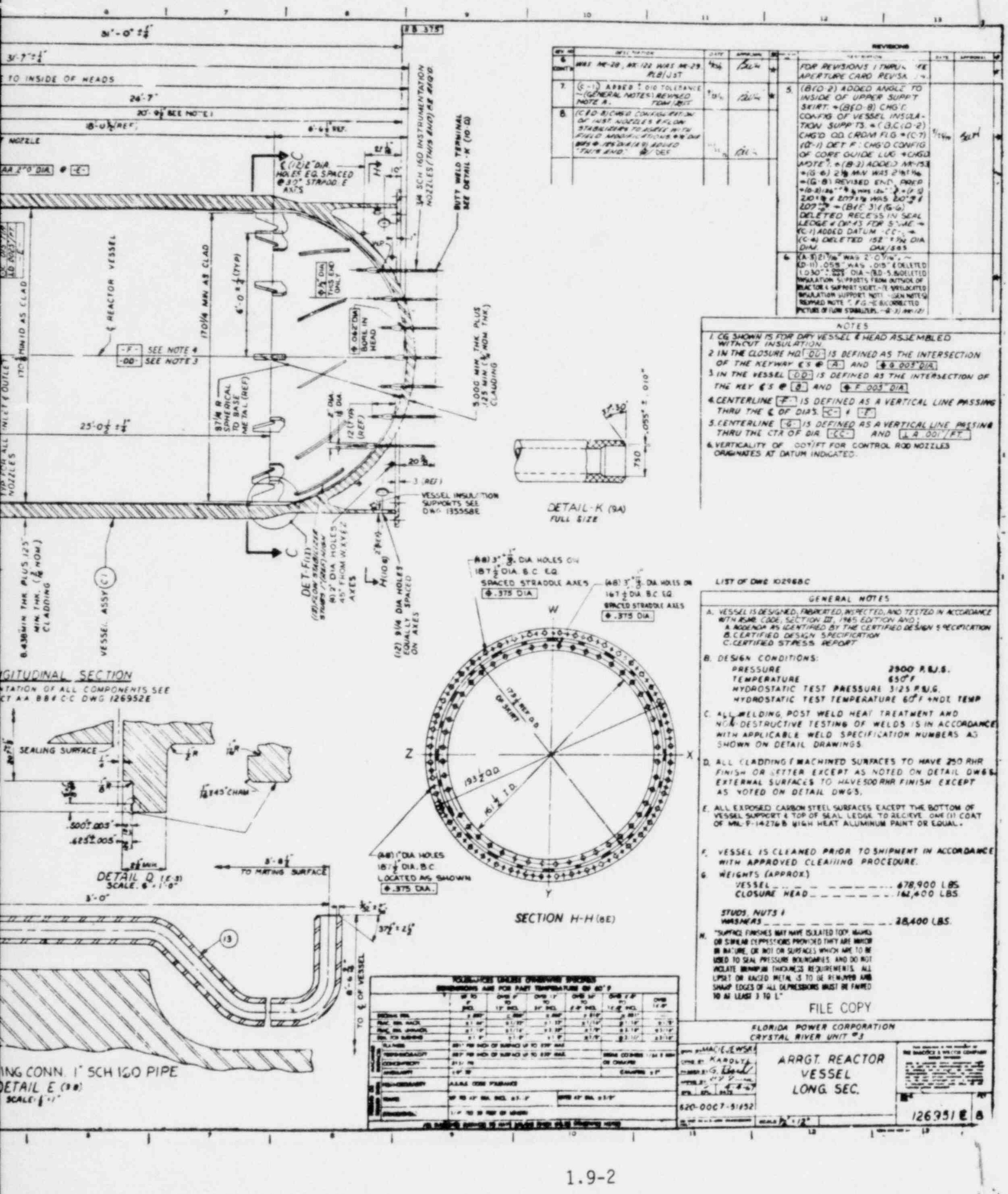
Drawings are provided as follows:

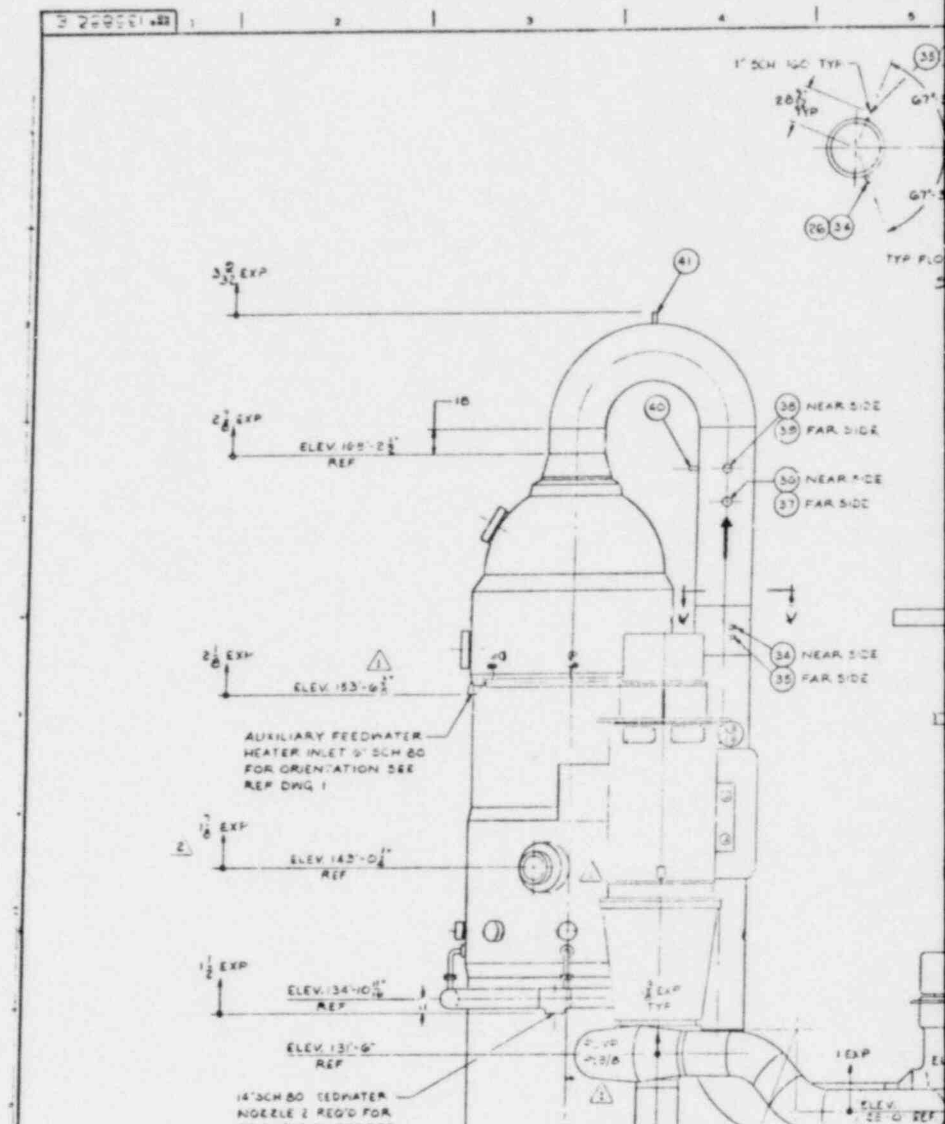
	Figure No.	
	Crystal River 3	TMI Unit 1
Reactor vessel	1.9-1	1.9-5
Reactor coolant piping		
Elevation	1.9-2	1.9-6
Plan	1.9-3	1.9-7
RV primary shield wall	1.9-4	1.9-8



MATING SURFACE
HANDLING LUGS SEE NOTE 8 ON DWG 1269952E
MINOR AXIS ON VERTICAL ℄
CG
VESSEL FLANGE FACE
CLOSURE HEAD FLANGE FACE
TO MATING SURFACE
WR-21
CLADDING
DETAIL-F
CORE GUIDE LUG (8E)

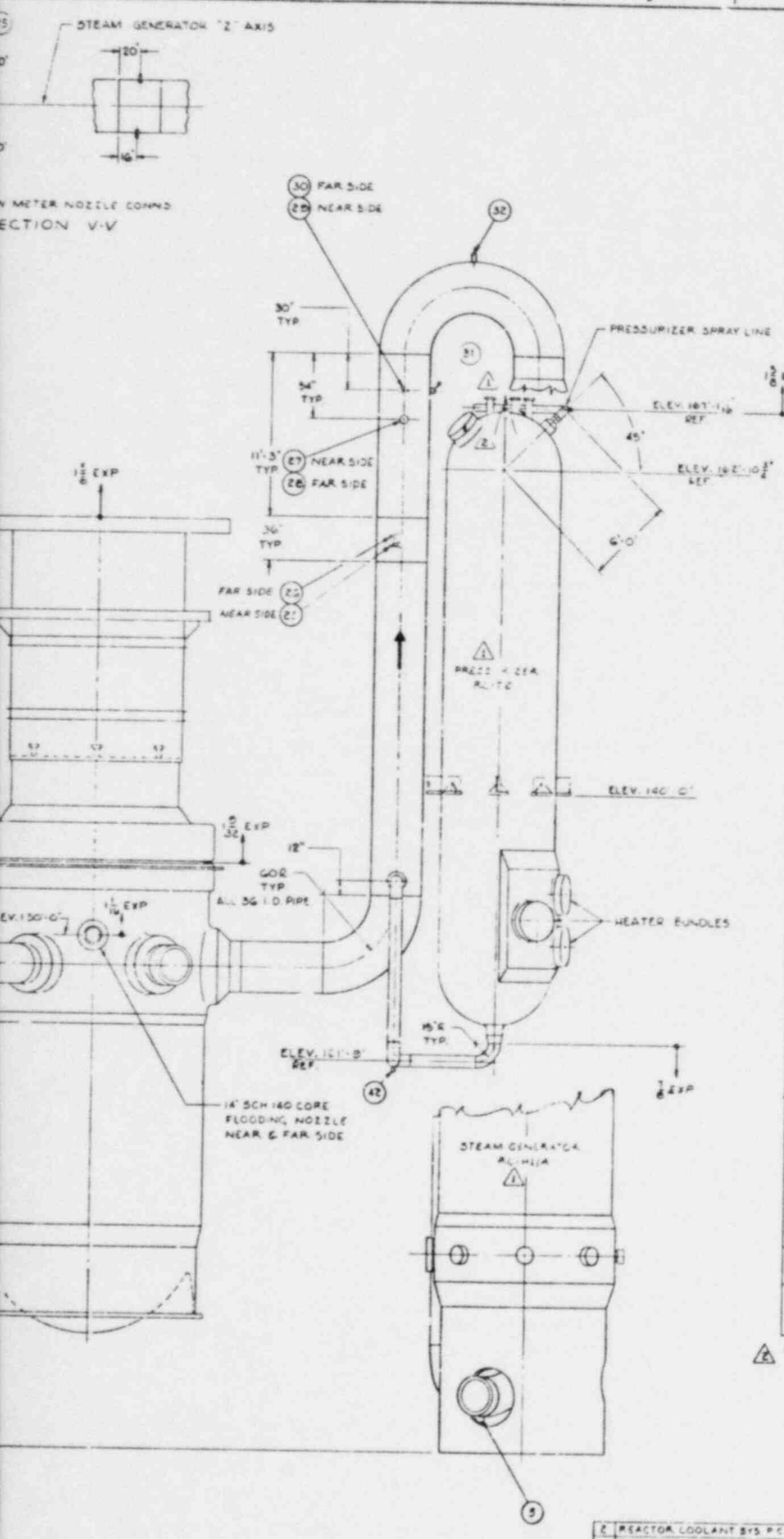
Figure 1.9-1.


NOTES
1. CG SHOWN IS FOR DRY VESSEL & HEAD ASSEMBLED WITHOUT INSULATION.
2. IN THE CLOSURE HD. -DD- IS DEFINED AS THE INTERSECTION OF THE KEYWAY ℄'S -A- AND .003 DIA.
3. IN THE VESSEL -DD- IS DEFINED AS THE INTERSECTION OF THE KEY ℄'S -B- AND .003 DIA.
4. CENTERLINE -F- IS DEFINED AS A VERTICAL LINE PASSING THRU THE ℄ OF DIA'S -C- & -E-
5. CENTERLINE -G- IS DEFINED AS A VERTICAL LINE PASSING THRU THE CTR OF DIA. -CC- AND .001/FT.
6. VERTICALITY OF .001/FT FOR CONTROL ROD NOZZLES ORIGINATES AT DATUM INDICATED.
GENERAL NOTES
A. VESSEL IS DESIGNED, FABRICATED, INSPECTED, AND TESTED IN ACCORDANCE WITH ASME CODE, SECTION III, 1965 EDITION AND: A. ADDENDA AS IDENTIFIED BY THE CERTIFIED DESIGN SPECIFICATION B. CERTIFIED DESIGN SPECIFICATION C. CERTIFIED STRESS REPORT
B. DESIGN CONDITIONS: PRESSURE 2500 P.S.I.G. TEMPERATURE 650°F HYDROSTATIC TEST PRESSURE 3125 P.S.I.G. HYDROSTATIC TEST TEMPERATURE 60°F +NDE TEMP
C. ALL WELDING, POST WELD HEAT TREATMENT AND NON-DESTRUCTIVE TESTING OF WELDS IS IN ACCORDANCE WITH APPLICABLE WELD SPECIFICATION NUMBERS AS SHOWN ON DETAIL DRAWINGS.
D. ALL CLADDING & MACHINED SURFACES TO HAVE 250 RHR FINISH OR BETTER EXCEPT AS NOTED ON DETAIL DWGS. EXTERNAL SURFACES TO HAVE 500 RHR FINISH EXCEPT AS NOTED ON DETAIL DWG'S.
E. ALL EXPOSED CARBON STEEL SURFACES EXCEPT THE BOTTOM OF VESSEL SUPPORT & TOP OF SEAL LEDGE TO RECIEVE ONE (1) COAT OF MIL-P-14276B HIGH HEAT ALUMINUM PAINT OR EQUAL.
F. VESSEL IS CLEANED PRIOR TO SHIPMENT IN ACCORDANCE WITH APPROVED CLEANING PROCEDURE.
G. WEIGHTS (APPROX.) VESSEL 678,900 LBS. CLOSURE HEAD 161,400 LBS. STUDS, NUTS & WASHERS 28,400 LBS.
LONGITUDINAL SECTION
DETAIL-K (9A) FULL SIZE
SECTION H-H (8E)
DETAIL Q (E-3)
DETAIL E (3B)
FILE COPY
FLORIDA POWER CORPORATION
CRYSTAL RIVER UNIT #3
ARRGT. REACTOR VESSEL LONG. SEC.
126951 E



1" SCH 160 TYP
28¾ TYP
67°
(26)(34)
(41)
3 9/32 EXP
2 7/8 EXP
ELEV. 165'-2½" REF
(40)
(38) NEAR SIDE
(39) FAR SIDE
(36) NEAR SIDE
(37) FAR SIDE
(34) NEAR SIDE
(35) FAR SIDE
2 1/8 EXP
ELEV. 153'-6½"
AUXILIARY FEEDWATER HEATER INLET 6" SCH 80 FOR ORIENTATION SEE REF DWG 1
1 7/8 EXP
ELEV. 143'-0¼" REF
1½ EXP
ELEV. 134'-10" REF
ELEV. 131'-6" REF
14"SCH 80 FEEDWATER NOZZLE 2 REQ'D FOR ORIENTATION SEE REF DWG 1
(14)
(15)
1 EXP
STEAM GENERATOR RC-H1/B
ELEV. 104'-0"
ELEV. 85'-0"
(13)

Figure 1.9-2



NOTES

1. FOR GENERAL NOTES AND PLAN VIEW SEE REF DWG. 1.
2. THERMAL EXPANSION INDICATED ON THIS DRAWING ARE FOR CLEARANCE PURPOSES ONLY AND NOT TO BE USED FOR ANY FLEXIBILITY ANALYSIS WORK. REFER TO SPECIFICATION 3002 NSS 7 FOR EXACT DISPLACEMENTS.

LIST OF CUSTOMER CONNECTIONS

PIPING LEG	NOZZLE NO	NOZ. PROJ. FROM PIPING ℄	DESCRIPTION & SIZE	INSTRUMENT NO
STEAM GENERATOR RC-H1 A TO PUMP P1B A	1	26 1 4	DRAIN - 1½" SCH 160	
	2	28 19 32	FAST RESPONSE RTE CONNECTION	TE3-5A TE4-5A
	3	25	STANDARD RTE CONNECTION	TE2-5A
	4	24 3 4	PRESS. TAP - 1" SCH 160	PI
STEAM GENERATOR RC-H1 A TO PUMP P1A A	5	26 1 4	DRAIN - 1½" SCH 160	
	6	28 19 32	FAST RESPONSE RTE CONNECTION	TE1-5A TE2-5A
	7	25	STANDARD RTE CONNECTION	TE1-5A
	8	24 3 4	PRESS. TAP - 1" SCH 160	PI
STEAM GENERATOR RC-H1 B TO PUMP P1A B	*9	30 1/16	DRAIN - 2½" SCH 160	
	10	28 19 32	FAST RESPONSE RTE CONNECTION	TE3-5B TE4-5B
	11	25	STANDARD RTE CONNECTION	TE2-5B
STEAM GENERATOR RC-H1 B TO PUMP P1B B	13	26 1 4	DRAIN - 1½" SCH 160	
	14	28 19 32	FAST RESPONSE RTE CONNECTION	TE1-5B TE2-5B
	15	25	STANDARD RTE CONNECTION	TE1-5B
PUMP P1B A TO REACTOR VESSEL	17	30 1 16	HIGH PRESS. INJECTION - 2½" SCH 160	
	18	24 3 4	PRESS. TAP - 1" SCH 160	PI & LI
PUMP P1A A TO REACTOR VESSEL	19	30 1 16	HIGH PRESS. INJECTION - 2½" SCH 160	
	20	24 3 4	PRESS. TAP - 1" SCH 160	PI
PUMP P1A B TO REACTOR VESSEL	21	30 1 16	HIGH PRESS. INJECTION - 2½" SCH 160	
PUMP P1B B TO REACTOR VESSEL	23	30 1 16	HIGH PRESS. INJECTION - 2½" SCH 160	
REACTOR VESSEL TO STEAM GENERATOR RC-H1 A	25	28 3 32	FLOWMETER CONN. - 1" SCH 160 } FE-14A	dPT1-14A dPT3-14A dP…
	26	28 3 32	FLOWMETER CONN. - 1" SCH 160 } FE-14A	dPT2-14A dPT4-14A
	27	24 19 32	FAST RESPONSE RTE CONNECTION	TE1-4A TE2-4A
	28	24 19 32	FAST RESPONSE RTE CONNECTION	TE3-4A TE4-4A
	29	26 3 8	PRESS. TAP - 1" SCH 160	PT2-3A PT3-3A…
	30	28 1 4	STANDARD RTE CONNECTION	TE-4A
	31	26 3 8	PRESS. TAP - 1" SCH 160	PT1-3A PT3-3A
	32	29 5 8"	VENT CONN. - 1" SCH 160	
REACTOR VESSEL TO STEAM GENERATOR RC-H1 B	33	33 3 4	DECAY HEAT CONN. - 12" SCH 160	
	34	28 3 32	FLOWMETER CONN. - 1" SCH 160 } FE-14B	dPT1-14B dPT2-14B
	35	28 3 32	FLOWMETER CONN. - 1" SCH 160 } FE-14B	dPT, dPT3-14B dPT4-14B
	36	24 19 32	FAST RESPONSE RTE CONNECTION	TE1-4B TE2-4B
	37	24 19 32	FAST RESPONSE RTE CONNECTION	TE3-4B TE-4B
	38	28 1 4"	STANDARD RTE CONNECTION	TE-4B
	39	28 3 8"	PRESS. TAP - 1" SCH 160	PT2-3B RV-10 dPT
	40	28 3 8"	PRESS. TAP - 1" SCH 160	PT1-3B PT3-3B
	41	28 3 8"	VENT CONN. - 1" SCH 160	
SURGE LINE TO PRESSURIZER	42	18 7 8	DRAIN - 1" SCH 160	
SPRAY LINE TO PRESSURIZER	43	2 5 8	FOR SPRAY LINE - 1½" SCH 160	
	44	5 1 4	BY-PASS CONN. - SCH 160	
	45	5 1 4	BY-PASS CONN. - SCH 160	

* NOTE: THE PIPING TO THE LETDOWN COOLERS WILL HAVE TO BE TEED INTO THIS DRAIN LINE

FLORIDA POWER CORPORATION
CRYSTAL RIVER UNIT NO. 3

REACTOR COOLANT PIPING ARRANGEMENT ELEVATION CUSTOMER DRAWINGS

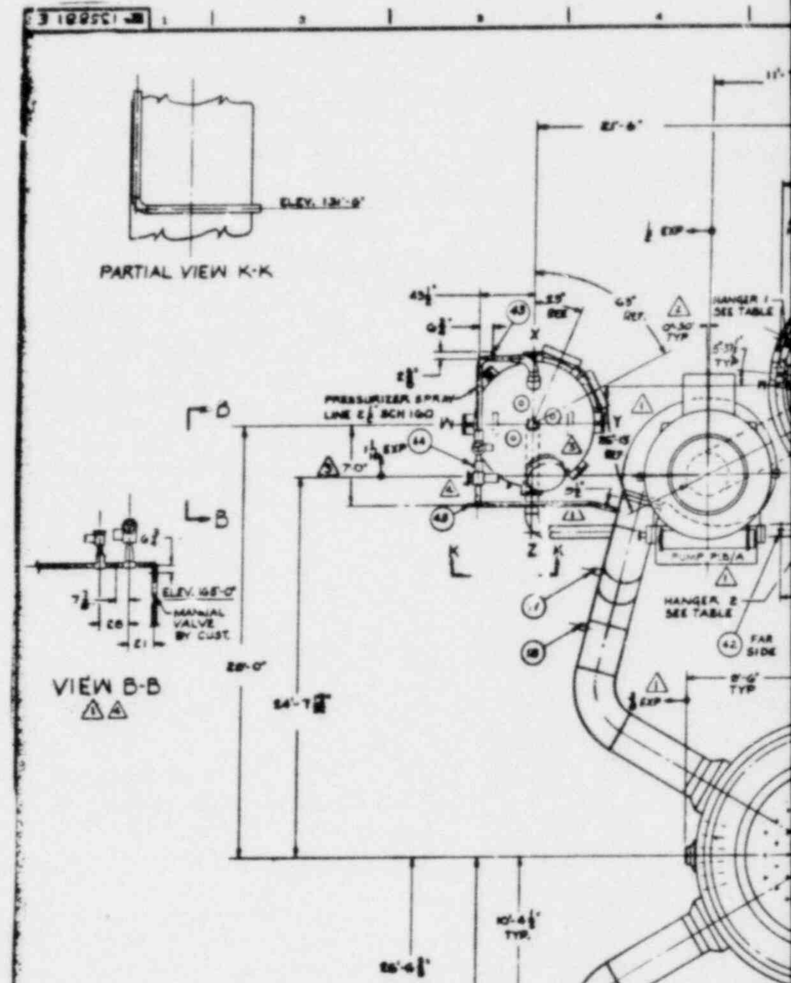
THE BABCOCK & WILCOX COMPANY

NO.	DRAWING TITLE	DWG. NO.
2	REACTOR COOLANT SYS. P.C.L. SCHEMATIC	
1	REACTOR COOLANT PIPING ARRGT. PLAN	135581 E

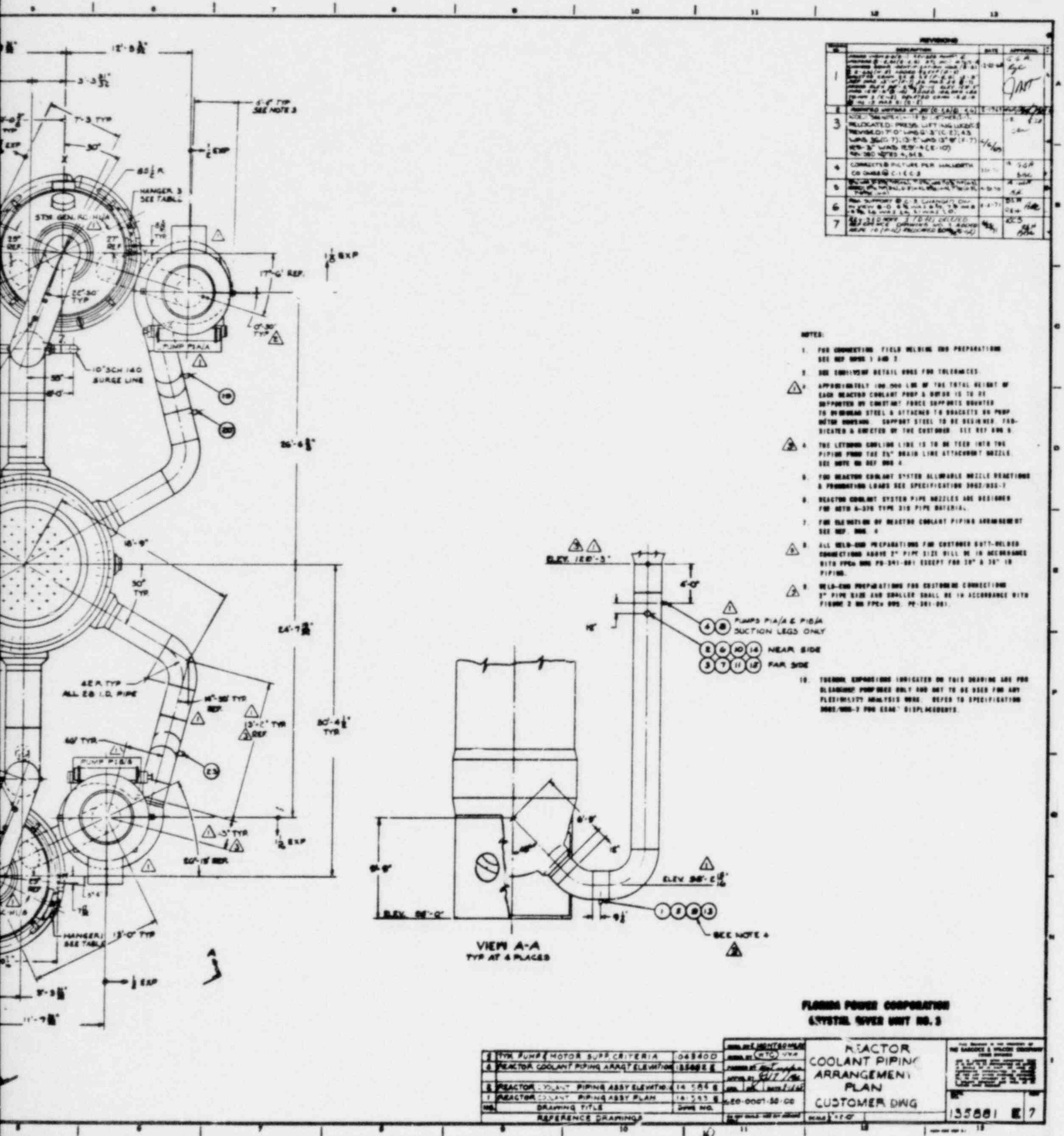
REFERENCE DRAWINGS

620-0007-50 00

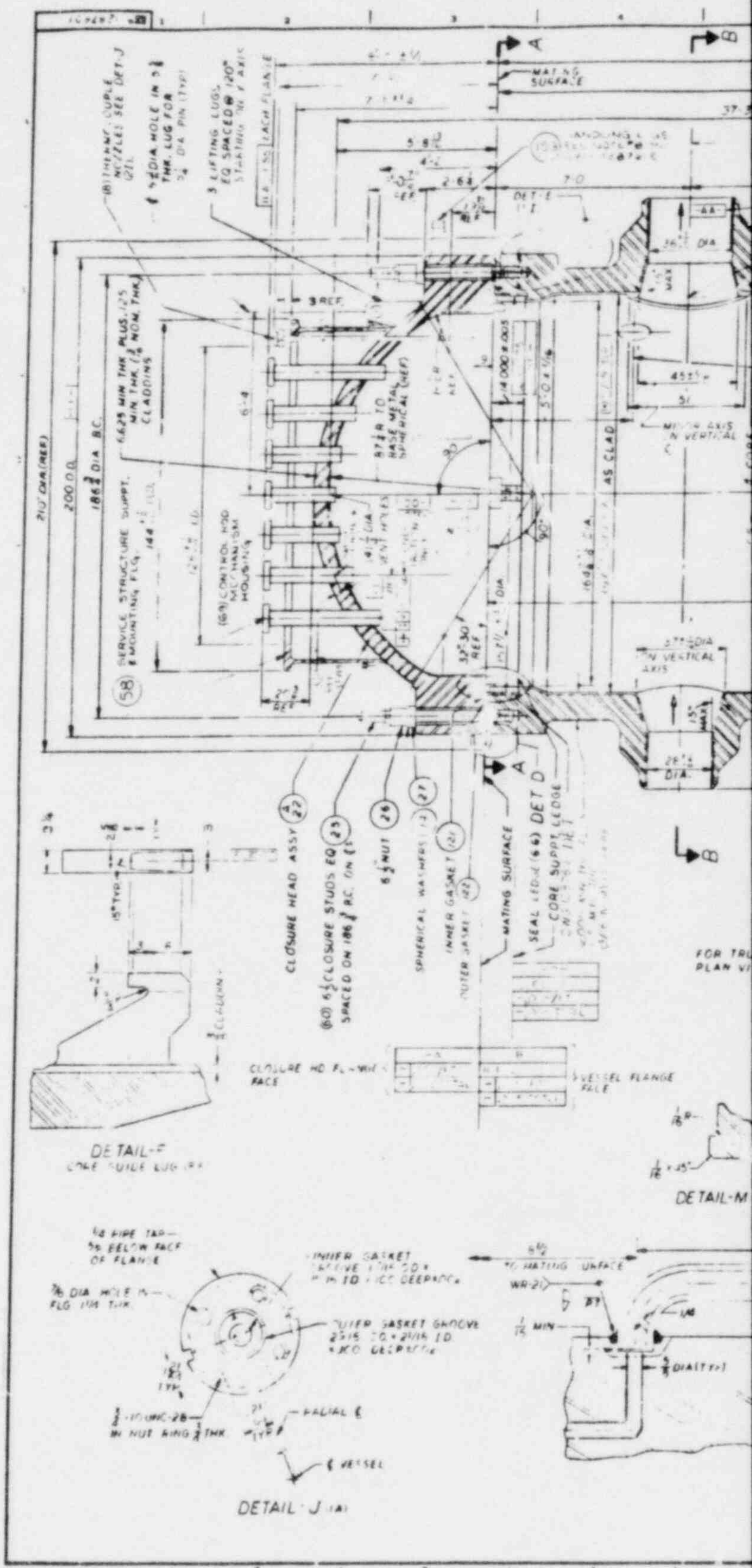
135882 E 6



PARTIAL VIEW K-K
ELEV. 131'-0"
PRESSURIZER SPRAY LINE 2½" SCH 160
VIEW B-B
ELEV. 165'-0"
MANUAL VALVE BY CUST.
HANGER 1 SEE TABLE
HANGER 2 SEE TABLE
HANGER 3 SEE TABLE
FAR SIDE
HANGER DATA
HANGER NO.
TYPE
WORKING RANGE
HOT LOAD
COLD LOAD
330 LBS
GRINNEL CO. SPRING SUPPORT BY CUSTOMER

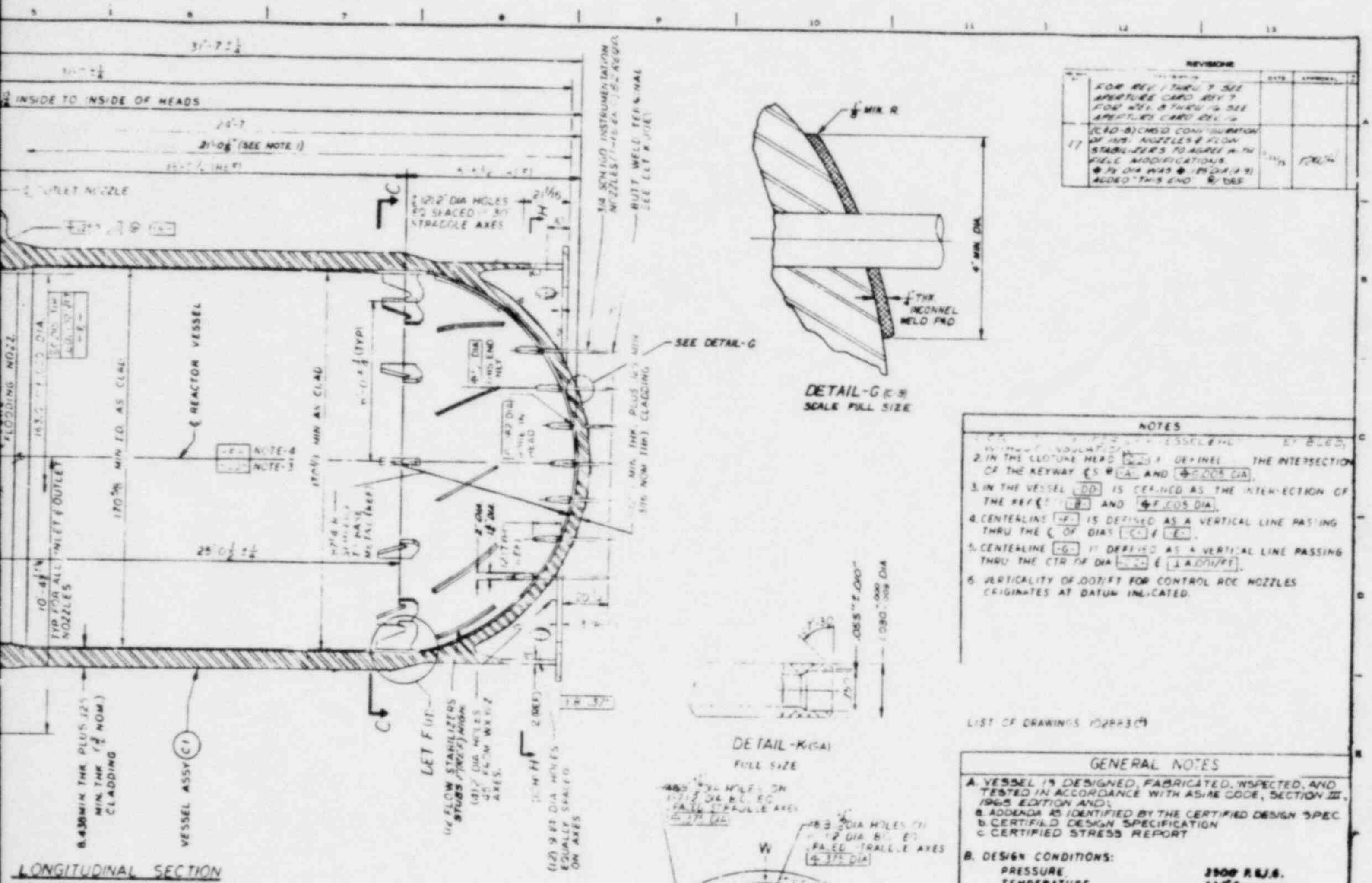

NOTES:
PUMP P1A/A
PUMP P1B/B
10" SCH 140 SURGE LINE
HANGER 3 SEE TABLE
VIEW A-A
TYP AT 4 PLACES
NEAR SIDE
FAR SIDE
SEE NOTE 4
PUMPS P1A/A & P1B/A SUCTION LEGS ONLY
FLORIDA POWER CORPORATION
CRYSTAL RIVER UNIT NO. 3
REACTOR COOLANT PIPING ARRANGEMENT PLAN
CUSTOMER DWG
REFERENCE DRAWINGS
135881

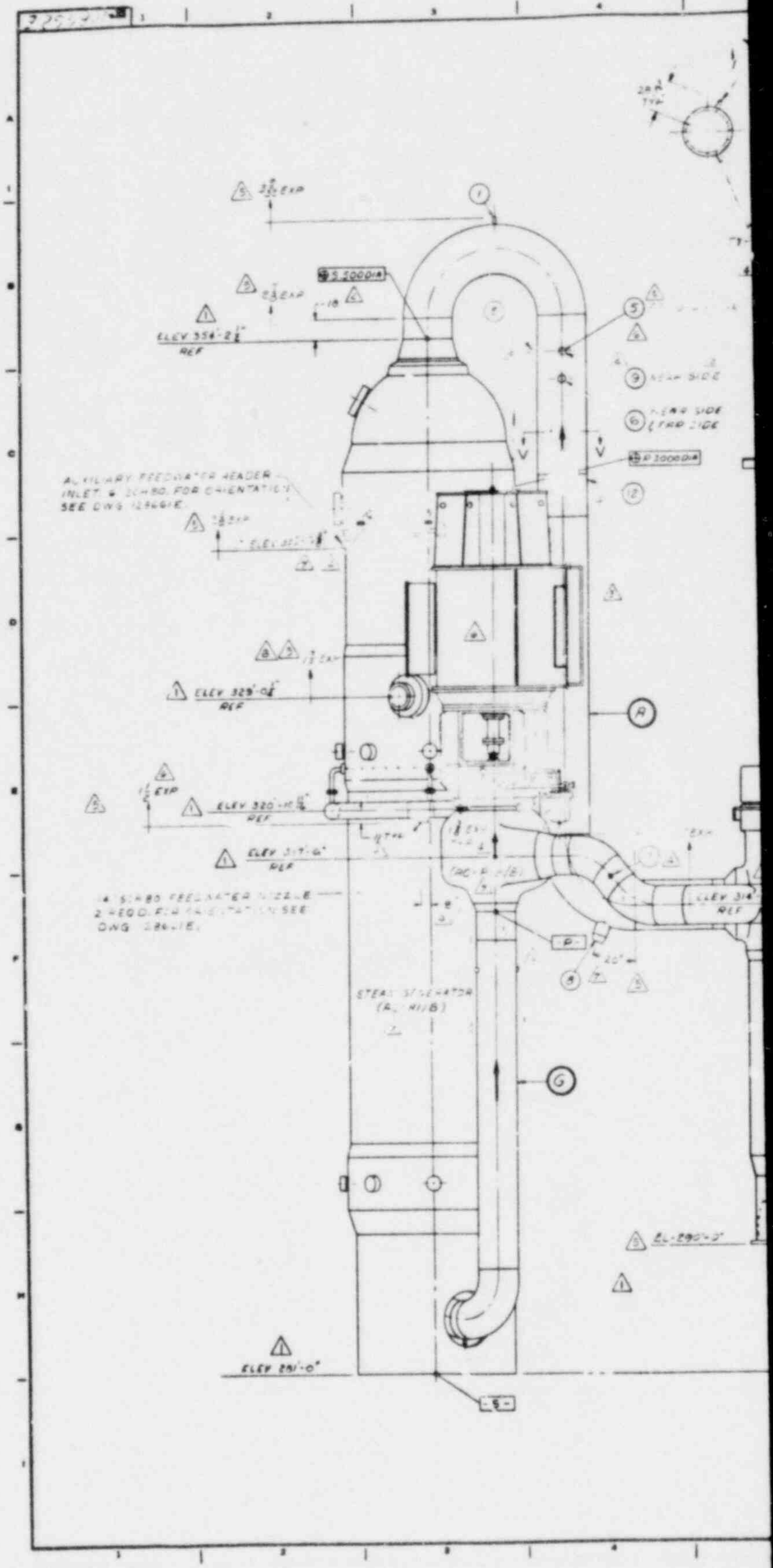
See Appendix A for Figure 1.9-4, Drawing # SC-421-012

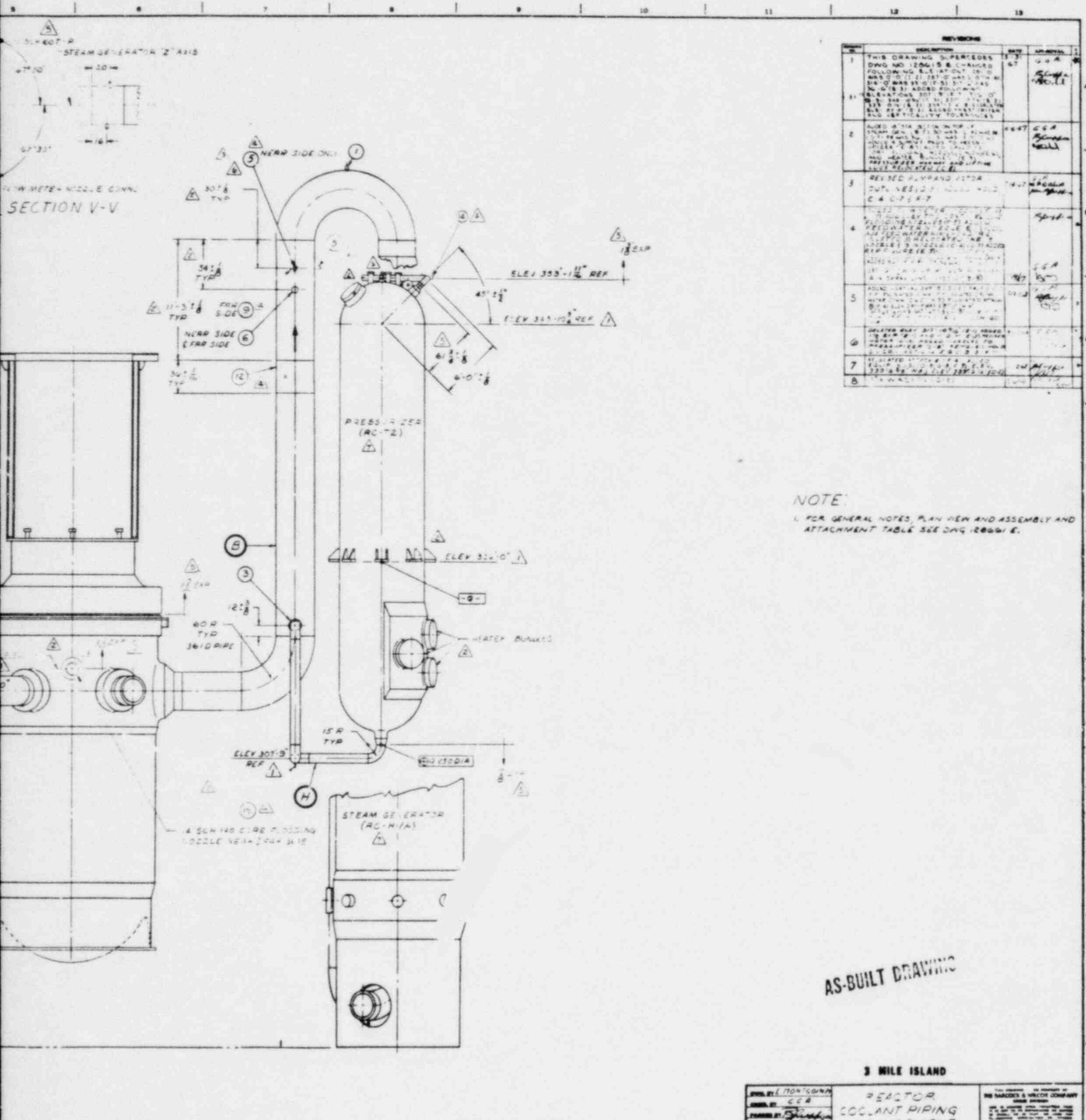


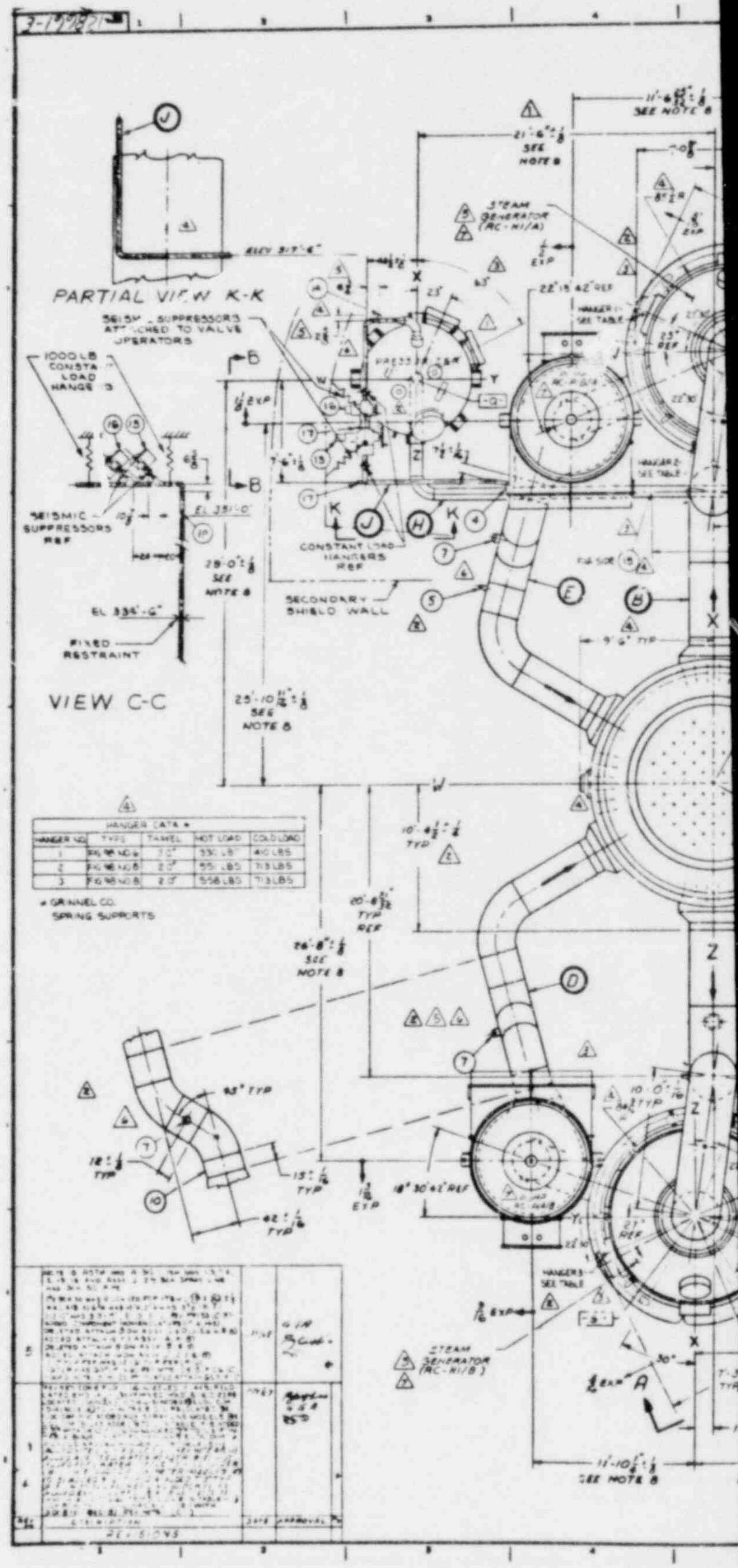
DETAIL-F
CORE GUIDE LUG
DETAIL-J
DETAIL-M
CLOSURE HEAD ASSY
SPHERICAL WASHERS
INNER GASKET
OUTER GASKET
MATING SURFACE
CORE SUPPT LEDGE
VESSEL FLANGE FACE
SERVICE STRUCTURE SUPPT. & MOUNTING FLG.

Figure 1.9-5


LONGITUDINAL SECTION
DETAIL-G
SCALE FULL SIZE
DETAIL-K
FULL SIZE
SECTION H-H
DETAIL-D
DETAIL-E
HALF SIZE
NOTES
LIST OF DRAWINGS
GENERAL NOTES
A. VESSEL IS DESIGNED, FABRICATED, INSPECTED, AND TESTED IN ACCORDANCE WITH ASME CODE, SECTION III, 1965 EDITION AND:
B. DESIGN CONDITIONS:
PRESSURE 2500 P.S.I.G.
TEMPERATURE 650°F
HYDROSTATIC TEST PRESSURE 3125 P.S.I.G.
F. VESSEL IS CLEANED PRIOR TO SHIPMENT IN ACCORDANCE WITH APPROVED CLEANING PROCEDURE
G. WEIGHTS (APPROX)
VESSEL 678,300
CLOSURE HEAD 162,600
WASHERS 40,200
MET ED CO
THREE MILE ISLAND
NUCLEAR STATION
FILE COPY
ARRGT. REACTOR
VESSEL
LONG. SEC.
128760 E 17


ELEV 281'-0"

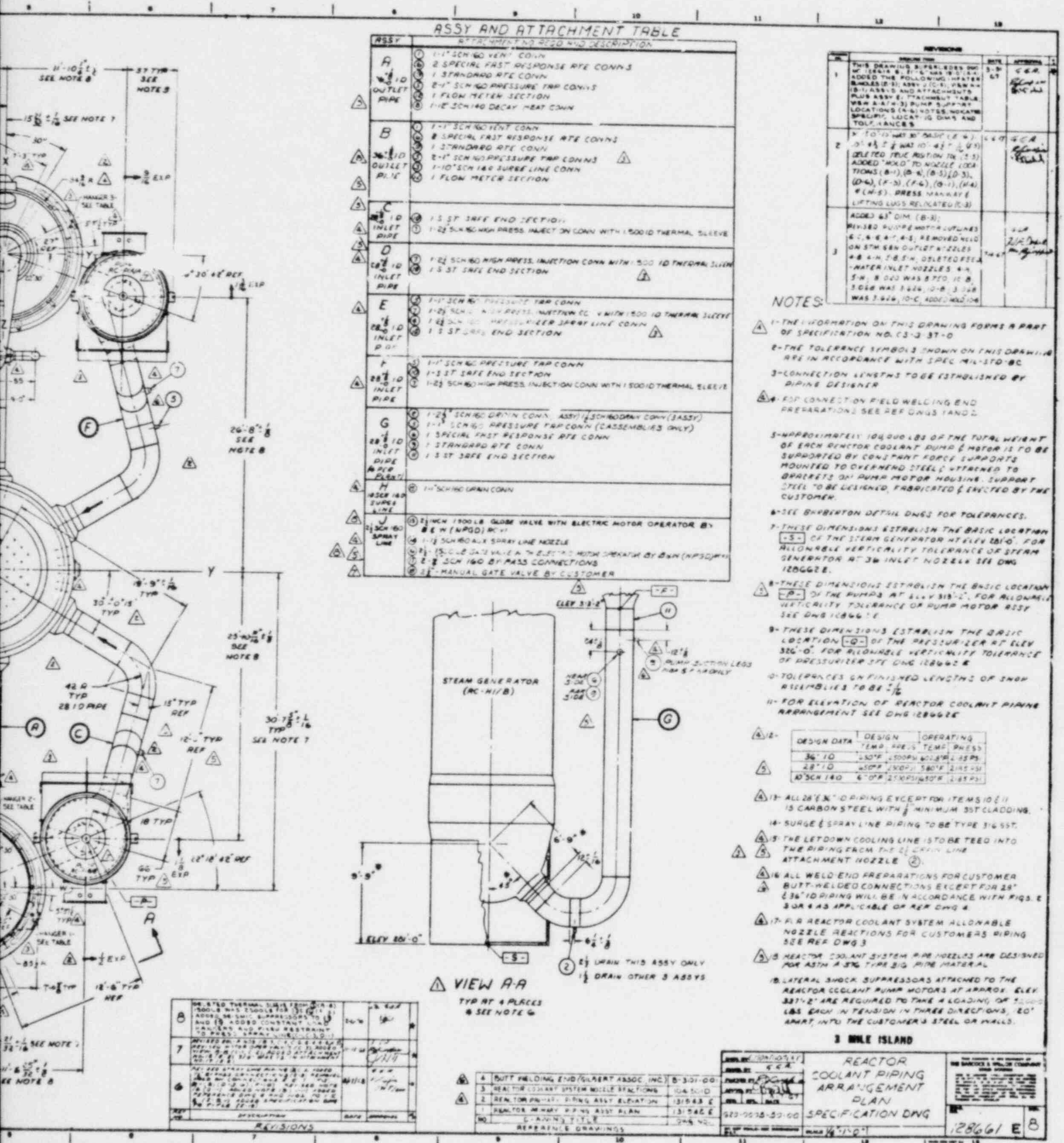

SECTION V-V
PRESSURIZER (RC-T2)
HEATER BUNDLES
STEAM GENERATOR (RC-H1A)
NOTE:
1. FOR GENERAL NOTES, PLAN VIEW AND ASSEMBLY AND ATTACHMENT TABLE SEE DWG 126661 E.
3 MILE ISLAND
REACTOR COOLANT PIPING ARRANGEMENT ELEVATION SPECIFICATION DWG



HANGER DATA *				
HANGER NO.	TYPE	TRAVEL	HOT LOAD	COLD LOAD
1	FIG 98 NO 6	2.0"	531 LBS	410 LBS
2	FIG 98 NO 8	2.0"	551 LBS	713 LBS
3	FIG 98 NO 8	2.0"	558 LBS	713 LBS

* GRINNEL CO. SPRING SUPPORTS

Figure 1.9-7


ASSY AND ATTACHMENT TABLE
NOTES:
STEAM GENERATOR (RC-H1/B)
VIEW A-A
TYP AT 4 PLACES
3 MILE ISLAND
REACTOR COOLANT PIPING ARRANGEMENT PLAN SPECIFICATION DWG
REVISIONS
REFERENCE DRAWINGS
128661 E 8

See Appendix A for Figure 1.9-8, Drawing # E-421-016

1.10. Provide an assessment of the influence of vena contracta effects on the reported results. (Section 4.3.2)

Response

As part of the A-2 program, B&W participated in numerous meetings with the NRC. One topic considered in great detail was the methodology to be used in generating asymmetric reactor cavity pressures. The results of these discussions were that B&W would use the CRAFT2 computer code[1], that all flow paths would be checked for critical flow using the Moody correlation with $C_D = 0.6$, and that minimum geometric flow path areas would be employed.

Consider also that most area changes within the reactor vessel cavity are gradual in nature, so that vena contracta effects should not be significant. Furthermore, the modeling methodology incorporates demonstrated flow path area and loss coefficient conservatisms.

In view of the discussion above, vena contracta effects would not significantly affect the results.

1.11. What is the source document for the ACP and jet impingement loading data? (Section 11.1.3)

This question was revised at the April 2-3 meeting to request a tabulation of peak ACF forces from the available data.

Response

Table 11.1-1 of BAW-1621 provides the forces before multiplication by any factors, and an example of JI loads is given in Table 11.1-2.[2] The attached Table 1.11-1 provides the requested peak forces and moments. When the cold leg is broken in this table, it is in the same leg as the P1A1 pump. Also, all breaks are 1.0A except the upper hot leg breaks for the Midland plant, which are 2.0A.

Table 1.11-1. Peak Forces and Moments

Component	Peak forces/moments, kips/ft-kips											
	Break @ pump discharge			Break @ pump suction			Break @ lower hot leg			Break @ upper hot leg		
	FX	FY	FZ	FX	FY	FZ	FX	FY	FZ	FX	FY	FZ
Midland 1												
P1A1 casing	-120.6[a]	201.5[b]	-167.3[a]	28.4	150.2	24.4				-5.0	114.8	11.1
MS	-6.6	N	11.7	-6.2	N	6.6		NA		18.0	N	23.6
M	-11.1	N	19.7	-10.5	N	11.1				30.4	N	39.8
MT	-4.5	N	7.9	-4.2	N	4.5				12.2	N	16.0
P1A2		NA			NA			NA			NA	
OTSG LO	309.7[c]	N	-206.9[c]	292.3	N	-49.7				26.0	N	-18.9
MID	140.6	N	-145.7	347.1	N	-90.8		NA		-35.8	N	34.2
UP	94.7	N	-113.6	128.0	N	-4.0				160.0	N	-99.0
UH	9.8	N	4.7	9.9	N	2.7				53.4	N	-262.5
DB-2, 3												
P1A1 F	301.0[d]	329.4[e]	601.2[d]	-74.7	445.0	129.2	-171.5	274.0	208.5			
M	6779.0	N	3395.0	1904.0	N	-494.0	2446.0	N	1709.0		NA	
P1A2 F	113.0	26.7	30.9		NA		266.9	257.1	117.8		NA	
M	533.7	NA	1792.0				1280.0	N	3037.0			
OTSG							153.6[f]	N	808.5[f]	19.4	N	246.3
		NA			NA		9599.0	N	1831.0	12220.0	N	1062.0

[a]Figure 11.1-9.

[b]Figure 11.1-10 — figure and peak do not agree because peak is net force, not just upward.

[c]Figure 11.1-11.

[d]Figure 11.1-12.

[e]Figure 11.1-13.

[f]Figure 11.1-14 — error in graph; should be $\times 10^6$.

Legend — NA: not available (same as Table 11.1-1), N: negligible or not applicable, MS: motor stand, M: motor, MT: top of motor, LO: discharge lower head, MID: midsection of OTSG, UP: upper tubesheet, UH: upper head.

1.12. Assess asymmetric cavity pressure loadings for which ACP data were not available, including breaks at the steam generator outlet nozzle. (Section 11.1-3)

Response

Terminal end guillotine breaks were considered at the steam generator inlet and outlet nozzles and at the P1A2 pump suction and discharge nozzles (see Table 1.12-3). Data from available ACP cases were applied to locations where data were not available, e.g., pump suction data were applied at the OTSG outlet. Tables 1.12-1 and 1.12-2 show which data from Table 1.12-3, with appropriate multiplication factors, were considered at all locations for both nozzle- and skirt-supported plants. Davis-Besse 1 does not require the 1.5 factor for steam generator compartment configuration applied in Section 11.1-3[2] since Davis-Besse 2 and 3 would have been identical.

At the April 2-3 meeting with NRC and EG&G, the specific emphasis on this question was consideration of a break at the OTSG discharge nozzle. Based on the following consideration, a pressure buildup inside the OTSG support skirt would have essentially no impact on OTSG loadings and thus would not be the design loading case.

Due to the nozzle/pipe interface location in the 177-FA plants with respect to the OTSG support skirt, discharge into the OTSG support skirt cavity would be minimal for a 2A break (see Figure 1.9-3, view A-A). The steam generator side of the break would discharge out through the piping penetration of the support skirt since the OTSG/support skirt relationship would remain fixed during a LOCA. The pump suction side of the break must physically move away from the OTSG nozzle to create a 2A BOA, and this movement would cause most or all of the discharge from the break to be outside the OTSG support skirt. Therefore, the break inside the OTSG support was judged to be bounded by the breaks analyzed.

Table 1.12-1. ACP Data for Lowered-Loop/Skirt-Supported Plants

	Pump disch	Pump suction	OTSG inlet	OTSG outlet
P1A1 broken piping	3A	3C	1.5E	3C
P1A2 unbroken piping	3A	3C	1.5E	3C
OTSG	3B	3D	1.5F	3D

Note: Cases A-F are from Table 1.12-3.

Table 1.12-2. ACP Data for Raised-Loop/Nozzle-Supported Plant

	Pump disch	Pump suction	OTSG inlet	OTSG outlet
P1A1 broken pump	2G	2I	2J	2I
P1A2 unbroken pump	2H	2I	2K	2I
OTSG	2L	2L	2M	2L

Note: Cases G-M are from Table 1.12-3.

Table 1.12-3. Available ACP Cases From Table 11.1-1[2]

Component	Break @ pump disch	Break @ pump suction	Break @ lower hot leg	Break @ upper hot leg
Midland 1				
P1A1 pump	1A (A)	1A (C)	na	2A (E)
P1A2 pump	na	na	na	na
OTSG	1A (B)	1A (D)	na	2A (F)
Davis-Besse 2, 3				
P1A1 pump	1A (G)	1A (I)	1A (J)	na
P1A2 pump	1A (H)	na	1A (K)	na
OTSG	na	na	1A (L)	1A (M)

Notes: 1. A = cross-sectional flow area of pipe.
1A = 642.5 in.^{2} for pump suction or discharge break.
1A = 1018 in.^{2} for upper or lower hot leg break.

2. na = not available.

2.1. In Figures 8.2-1, 8.2-4, 8.2-7, and 8.2-10, identify the interface across which the RV head differential pressures are determined (refer back to Appendix C Figures C-2 and C-9)

Response

Reactor vessel internal head differential pressure is the pressure difference between the lower and upper heads. Figures 8.2-1 and 8.2-4 are for the skirt-supported plants, and the differential pressure is between nodes 141 and 157 shown in Figure C 2 of Appendix C.[2] Figures 8.2-7 and 8.2-10 are for the nozzle-supported plant, and the differential pressure is between nodes 5 and 10, shown in Figure C-9 of Appendix C.[2]

2.2. Identify and discuss out-of-RV cavity pipe break locations considered or evaluated for RV internals hydraulic transients. Apparently in section 8.2, RV internals loads were calculated for the SG cavity break — what was the reason for not identifying this condition in section 4.4? Confirm that out-of-RV cavity BOAs in Section 11 are not limiting relative to RV internals hydraulic transients.

Response

In section 8.2, two hot leg and two cold leg breaks were considered. The hot and cold leg breaks at the RV nozzle are in the RV cavity. The other two breaks, at the entrance to the lower hot leg elbow and at the cold leg elbow exit, as illustrated in Figure 4.1-1, are located in the steam generator cavity. These breaks in the steam generator cavity are identified in section 4.4, first paragraph, last sentence, as "the next closest (to the reactor vessel) hot leg and cold leg break locations."

For consistent BOA/BOT and break type, breaks at the reactor vessel would be expected to be limiting on the RV internals since neither jet impingement nor cavity pressures is present for breaks outside the RV cavity. Also, pipe whip restraints in the steam generator compartment should reduce BOA, but in the interest of conservatism, they were not considered, and evaluations in section 11 were for 2A BOAs only.[2]

2.3. Were high-pressure injection ECCS piping and core flood line check valves considered or analyzed for hydraulic transients? Discuss load severity relative to RCS break size and location.

Response

The structural evaluation of the unbroken primary piping demonstrated that the integrity of the piping was maintained for the postulated breaks within the reactor subcompartment. The high-pressure injection piping is attached directly to the primary piping and was therefore considered acceptable since no large displacements were imparted to it by the primary piping.

The core flood line analysis considered reactor vessel displacement motion due to asymmetric LOCA loadings and was found acceptable. Table 9.9-1 of reference 2 gives the maximum acceleration and maximum displacement at the core flood nozzle for all plants. It can be seen that, based on resulting core flood nozzle stresses, the hot leg break at the reactor vessel on TMI-1, CR-3 and Davis Besse 1 is controlling.

2.4. Discuss the core flood line load severity relative to RCS break location and size.

Response

The core flood line load severity relative to a cold leg guillotine break at the RV nozzle on the RV internals is very small. A 1A cold leg break is 615.75 inches square, whereas a 1A core flood line nozzle break is only 107.51 inches square, or a factor of 5.7 smaller than the 1A cold leg break. A 2A core flood line break would be equivalent in size to a 0.35A cold leg break but would discharge less energy because the core flood tank side of the break is at a lower temperature and pressure than the primary side. Also a core flood line break would only discharge reactor coolant from one side of the break, thus having even less effect on RV internals than a hot or cold leg break.

Also see the response to question 2.3 concerning controlling cases.

2.5. In Table 8.2-2, discuss why the RV head differential pressure is higher for a 1.5A cold leg break rather than for a 2.0A cold leg break. Would a corresponding relationship (as shown) exist for a 1.5A SG cavity cold leg break?

Response

The results reported in Table 8.2-2 of reference 2 for the RV head differential pressure are attributable to the vent valves. Vent valves provide communication between the hot interior of the RV and its relatively cold downcomer region. As such, the valves are continually responding to fluid changes and quickly propagate any such changes to the RV upper and lower heads. This makes the RV head differential pressure more susceptible to large amplitude oscillations.

Since the RV head differential pressure is clearly designed by hot leg breaks (see Table 8.2-1 in reference 2, "Reactor Head Pressure Differential" data), and since breaks in the steam generator cavity exert no asymmetric loadings on the RV shell, variations in the RV head differential pressures for cold leg breaks in the RV or the steam generator cavities are enveloped by other cases.

2.6. It is not clear which BOAs are used for each specific analysis for the skirt- and nozzle-supported plants. In a table, summarize the break location, size, time, and type for each RV internals, ECCS, RCS, and cavity analysis (refer to Figures 4.2-3 through 4.2-17, as applicable). See questions 7, 8, 9, and 10.

Response

The derivation of generic break opening area (BOA) versus break opening time (BOT) curves and their use in the analysis of the B&W 177-FA Owners Group plants is described below.

Generic BOA versus BOT curves are to be used to generate hydraulic forcing functions in a conservative manner without making ultra-conservative assumptions for the BOTs for specific BOAs. These curves also allowed the hydraulic forcing functions to be generated before actual plant specific BOA versus BOT curves were available. Thus, a catalog of BOA hydraulic data was generated for specific BOAs (i.e., 0.3A, 0.6A, 1.0A, 1.5A, 2.0A), and the generic curves were used to determine the BOT rate up to each of the BOAs in the catalog.

The generic curves are developed to be conservative yet give realistic BOTs. As a general rule the faster the break opens, the worse the asymmetric pressures on the internals. Also, the total integrated mass and energy are greater for the break that opens more quickly. The only place a faster opening rate is not a worse case is on the broken pipe. The force on the broken pipe decays as a function of the system pressure times the inside cross-sectional area of the pipe (P · A), and the faster the break opens the faster this decay in the first elbow away from the break (the force generated in the first elbow controls the major portion of the pipe whip). Thus, in a systematic way, BOA versus BOT curves were generated which opened at a realistic and conservatively rapid rate for use in calculating internal asymmetric pressures and mass and energy.

The following is a description of the nonlinear pipe whip analysis used to generate these conservative BOA versus BOT curves:

There were two basic piping configurations for the plants analyzed. The first configuration applies to the skirt-supported plants. The hot and cold leg piping dimensions are generally the same for these plants, with only minor differences. These minor differences do not impact the generic BOA versus BOT curves since they depend on the overall flexibility of the piping from the RV to the steam generator. The pipe whip restraint configurations on each plant are also different. However, they were considered negligible in generating the generic curves.

The other basic loop piping configuration is that of the nozzle-supported plant. Again, the pipe whip restraints were considered to have negligible impact in generating the generic curves.

The following model types were used to obtain the generic area versus time curves.

1. Hot leg piping geometry for skirt-supported plant (Figures B-1 through 6 in reference 2).

2. Cold leg piping geometry for skirt-supported plant (Figure B-9 in reference 2).

3. Hot leg piping geometry for nozzle-supported plant (Figure B-7 in regerence 2).

4. Cold leg piping geometry for nozzle-supported plant (Figure B-8 in reference 2).

The models used in the ANSYS pipe whip analysis to obtain the generic curves included no restraints to impede pipe motion. The piping runs were modeled from the reactor vessel to the steam generator and the cold leg, including the reactor coolant pump. The reactor vessel and steam generator contribution to the motion of the whipping pipe were considered negligible due to mass of the steam generator and the time domain of interest for the pipe whip and thus were fixed dynamically or left out. Thermal and deadweight displacements for the reactor vessel and the OTSG were obtained from previous analyses of plants with the same configurations and were applied as displacements at the boundary joints. The thermal and deadweight, along with the pressure stresses in the piping runs, were addressed via thermal expansion, weight effects, and system pressure being applied to the piping run in concert with the boundary displacements.

Investigations were conducted as to which break locations resulted in the fastest opening rates for the unrestrained pipe whip. For the break locations addressed in section 4.1 of reference 2 (e.g., hot leg RV nozzle, hot leg lower elbow entrance, cold leg RV nozzle, and cold leg elbow exit closest to the RV), the breaks at the reactor vessel nozzles were found to result in the quickest opening rates. Thus, breaks at the RV nozzles for the hot and cold legs were run for both plant configurations.

For the breaks considered, the major forcing function on the pipe is in the first elbow and basically results in a force at time 0^+ (i.e., after instantaneous pipe severance) of the operating pressure times the flow area of the pipe (P · A). This force decays as the pressure in the elbow decreases (i.e., as the break opens). In order to predict the most rapid opening rates, force decay was neglected and a constant PA was maintained until the broken pipe motion resulted in a 2.0A break.

In summary, the geometric piping was modeled using the ANSYS code, and restraints restricting motion were neglected. The state of stress prior to the pipe break was represented at operating temperatures and pressure and included the effects of deadweight. The break was assumed to occur instantaneously, and the break forces were applied conservatively without allowing them to decay as a function of time. Thus, the thermal hydraulics are not required to provide the initial estimate of pipe whip response. For these conditions the displacements of the broken ends of the pipe were tracked and used to compute BOA versus BOT curves which represent the most rapid opening rates physically possible for the piping configuration being addressed.

Figures 2.6-1 through 2.6-4 represent the generic BOA versus BOT curves for the hot and cold leg skirt-supported configurations and the hot and cold leg nozzle-supported configurations.

These generic curves now represent the initial input for the mass and energy calculations and the RV internals asymmetric pressure calculations. These BOA-BOT curves were input into the CRAFT code up to the break opening area they represented so that they reflected a realistic opening rate up to the final opening area.[1] Table 2.6-1 shows the catalog of mass and energy along with the peak generic time for the assumed opening area. Table 2.6-2 provides the catalog of the RV internals asymmetric pressures along with the peak generic opening time for the assumed opening area. Table 2.6-3 lists the actual opening areas and times as well as the as-analyzed areas and times from the catalog in Tables 2.6-1 and 2.6-2. Each of the three distinct as-analyzed phenomena is tabulated as follows; internals ΔP, cavity ΔP, and core bounce ΔP values. In each case the as-analyzed condition was equal to or worse than the actual condition.

The approach above was necessitated by requiring parallel tasks rather than series tasks. The latter is technically pure, while the former permits overview of the analysis and results in some conservatism in the results.

Table 2.6-1. Spectrum of BOAs/BOTs Used for M&E and Cavity Pressure

Broken leg	Assumed BOA	BOT, s[a]
Skirt-Supported Plant		
Hot leg	0.3A	0.012
	0.6A	0.018
	1.0A	0.022
	1.5A	0.028
	2.0A	0.033
Cold leg	0.3A	0.011
	0.6A	0.016
	1.0A	0.020
	1.5A	0.024
	2.0A	0.027
Nozzle-Supported Plant		
Hot leg	1.02A	0.019
Cold leg	0.25A	0.005

[a]BCT: time to open to ar ..

Table 2.6-2. Internal Differential Pressure Catalog

Broken leg	Assumed BOA	BOT, s[a]
Skirt-Supported Plant		
Hot leg in RV cavity	0.3A	0.012
	0.6A	0.018
	1.0A	0.022
	1.5A	0.028
	2.0A	0.033
Hot leg at elbow	1.0A	0.022
	2.0A	0.033
Cold leg in RV cavity	0.3A	0.011
	0.6A	0.016
	1.0A	0.020
	1.5A	0.024
	2.0A	0.027
Cold leg at elbow	1.0A	0.020
	2.0A	0.027

Broken leg	Actual BOA	BOT, s[a]
Nozzle-Supported Plant		
Hot leg in RV cavity	1.024A	0.064
Hot leg at elbow	1.033A	0.057
Cold leg in RV cavity	0.242A	0.070
Cold leg at elbow	1.167A	0.048

[a]BOT: time to open to area.

Table 2.6-3. Analyzed Opening, Area/Time to Area

	Actual opening, area/time to peak, A/s	Analyzed opening, area/time to area		
		Internals, A/s	Cavity ΔP, A/s	Core bounce ΔP, A/s
Oconee				
Hot leg RV nozzle elbow	0.52/0.027	0.60/0.018	0.60/0.018	2.00/0.033
	0.45/0.020	1.00/0.022	--	2.00/0.033
Cold leg RV nozzle elbow	2.00/0.027	2.00/0.027	2.00/0.027	2.00/0.027
	2.00/0.027	2.00/0.027	--	2.00/0.027
TMI-1				
Hot leg RV nozzle elbow	1.39/0.045	1.50/0.028	1.50/0.028	2.00/0.033
	1.04/0.033	2.00/0.033	--	2.00/0.033
Cold leg RV nozzle elbow	2.00/0.027	2.00/0.027	2.00/0.027	2.00/0.027
	2.00/0.027	2.00/0.027	--	2.00/0.027
CR-3				
Hot leg RV nozzle elbow	1.17/0.046	1.50/0.028	1.50/0.028	2.00/0.033
	0.85/0.033	2.00/0.033	--	2.00/0.033
Cold leg RV nozzle elbow	2.00/0.027	2.00/0.027	2.00/0.027	2.00/0.027
	2.00/0.027	2.00/0.027	--	2.00/0.027
ANO-1				
Hot leg RV nozzle elbow	0.38/0.030	0.60/0.018	0.60/0.018	2.00/0.033
	0.27/0.018	1.00/0.022	--	2.00/0.033
Cold leg RV nozzle elbow	2.00/0.027	2.00/0.027	2.00/0.027	2.00/0.027
	2.00/0.027	2.00/0.027	--	2.00/0.027

Figure 2.6-1. Hot Leg Guillotine Break at Reactor Vessel Outlet - Unrestrained - Generic Skirt-Supported Reactor

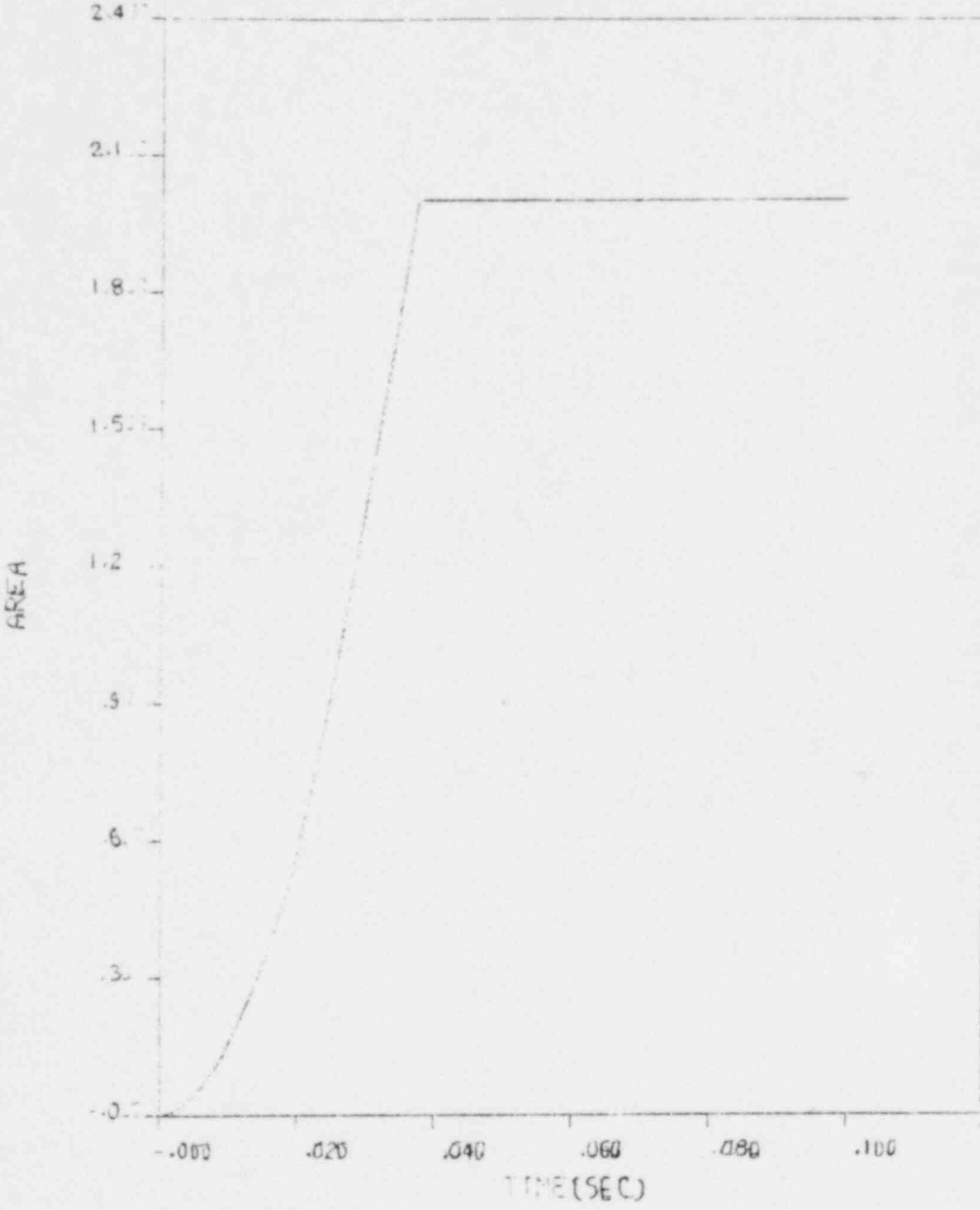


Table 2.6-3. (Cont'd)

	Actual opening, area/time to peak, A/s	Analyzed opening, area/time to area		
		Internals, A/s	Cavity ΔP, A/s	Core bounce ΔP, A/s
Rancho Seco				
Hot leg RV nozzle elbow	0.74/0.041	1.00/0.022	0.75/0.019	2.00/0.033
	0.55/0.026	1.00/0.022	--	2.00/0.033
Cold leg RV nozzle elbow	2.00/0.027	2.00/0.027	2.00/0.027	2.00/0.027
	2.00/0.027	2.00/0.027	--	2.00/0.027
DB-1				
Hot leg RV nozzle elbow	1.02/0.064	1.02/0.064	1.02/0.019	1.02/0.064
	1.03/0.057	1.03/0.057	--	1.03/0.057
Cold leg RV nozzle elbow	0.25/0.100	0.25/0.070	0.25/0.005	0.25/0.070
	1.17/0.049	1.17/0.048	--	1.17/0.048
TMI-2				
Hot leg RV nozzle elbow	--	2.00/0.033	2.00/0.033	2.00/0.033
	--	2.00/0.033	--	2.00/0.033
Cold leg RV nozzle elbow	--	2.00/0.027	2.00/0.027	2.00/0.027
	--	2.00/0.027	--	2.00/0.027

Figure 2.6-2. Cold Leg Guillotine Break at Reactor Vessel — Unrestrained — Generic Skirt-Supported Reactor

Figure 2.6-3. Hot Leg Guillotine Break — Unrestrained — Generic Nozzle-Supported Reactor

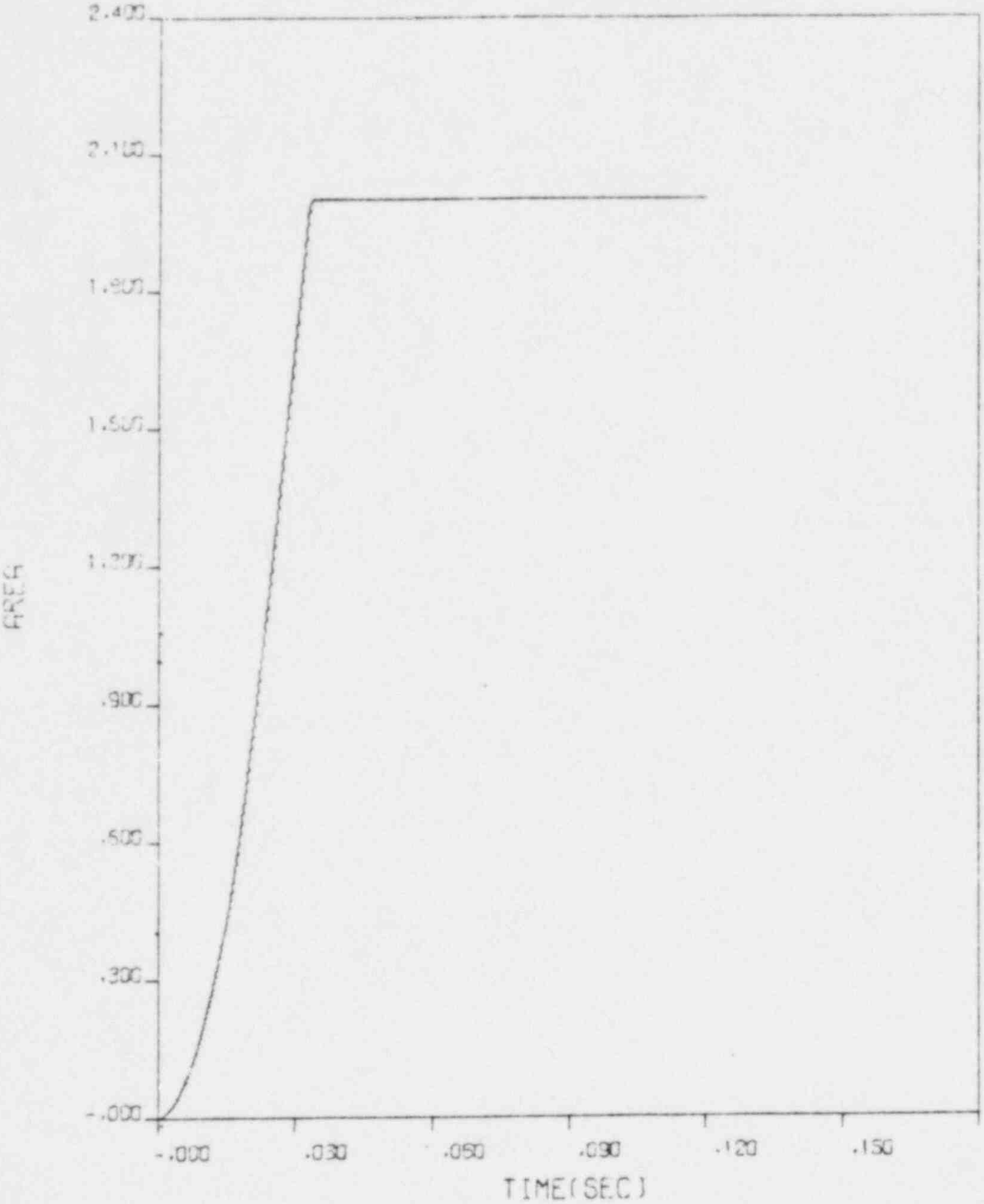
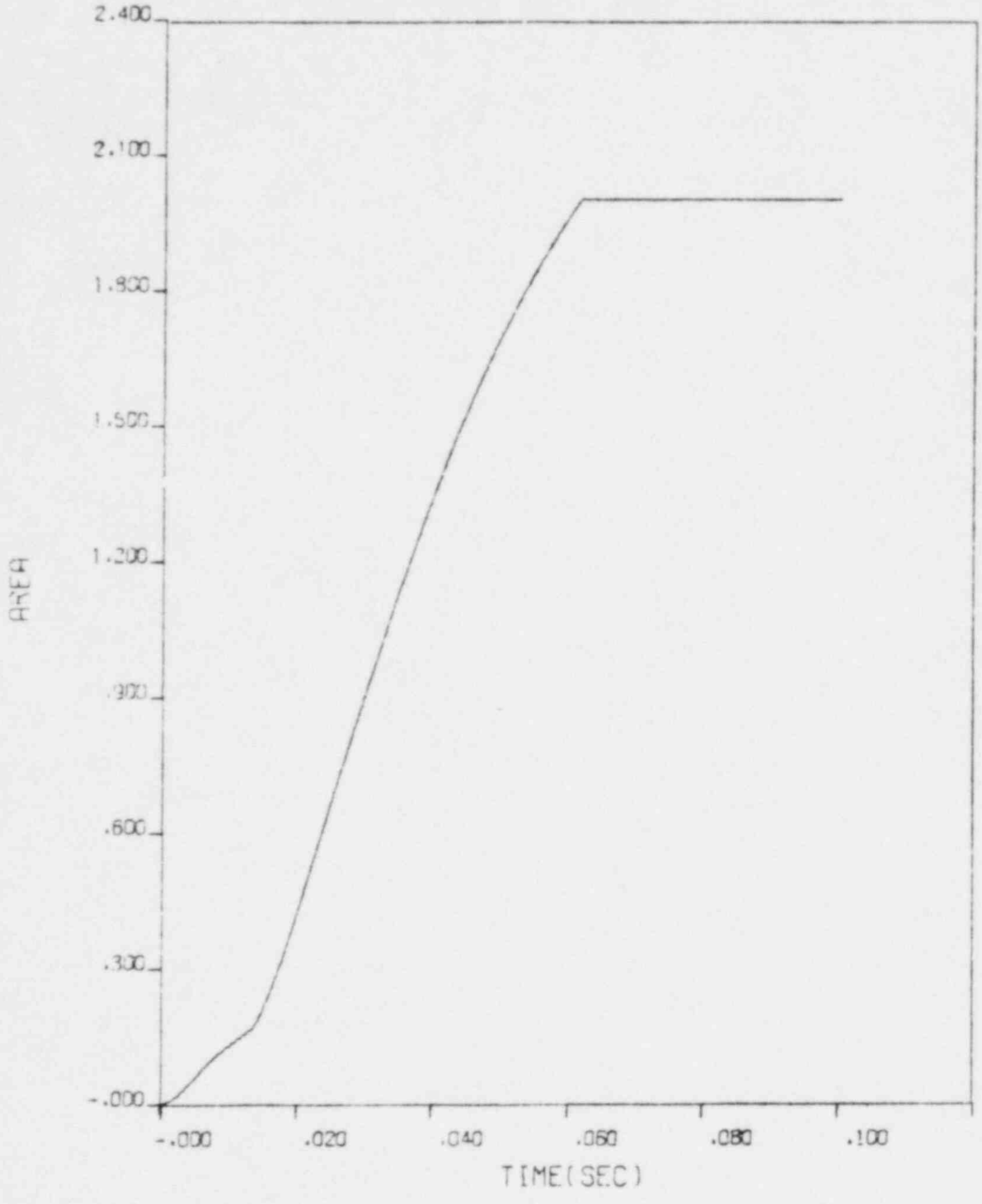


Figure 2.6-4. Upper Cold Leg Guillotine Break — Unrestrained — Generic Nozzle-Supported Reactor



2.7. In section 4.4, are the break locations analyzed depicted in Figure 4.1-1? Clarify the break locations specified in section 4.4 (first paragraph, last sentence).

Response

Break locations analyzed are depicted in Figure 4.1-1.[2] Pipe break locations were selected as specified in section 4.1.[2] Hot and cold leg guillotine pipe breaks were considered at the terminal ends of the reactor vessel nozzles, at the entrance to the lower hot elbow, and at the cold leg elbow exit as illustrated in Figure 4.1-1.

2.8. In section 8.2, what are the assumed break locations, areas, and times?

Response

Break locations are shown in Figure 4.1-1[2] and are either at the reactor vessel nozzle or at the first elbow from the RV, which is inside the steam generator cavity. For the skirt-supported plants a spectrum of break sizes (2.0A, 1.5A, 1.0A, 0.6A, and 0.3A) for guillotine breaks at the reactor vessel inlet and outlet nozzles was analyzed. The skirt-supported plants were also analyzed for a 2.0A and a 1.0A break inside the steam generator cavity. Table 8.2-3[2] presents data for the nozzle-supported plant, Davis-Besse 1, and is for the actual BOA and generic BOT given in Table 2.6-3 of the response to question 2.6. BOTs for the skirt-supported plants are based on a generic break opening schedule, and no pipe restraint effects are included for this analysis. Therefore, the assumed BOT for each BOA is provided in Table 2.6-3.

2.9. In section 4.4, clarify the last sentence in the second paragraph. Identify or provide those BOA curves for each break location considered. Are Figures 4.2-3 through 4.2-17 generic or actual BOA curves? The stated sentence appears to conflict with use of actual BOA codes mentioned in the first paragraph for the nozzle-supported plant (please clarify).

Response

For each of the postulated breaks, the generic BOA versus time data were used and are provided in the response to question 2.6. Davis Besse 1, the nozzle-supported plant, used actual BOAs for each of the postulated breaks but used a generic break opening time based on an unrestrained guillotine break and the time to reach the restrained BOA (generic curve provided in response to question 2.6). Figures 4.2-3 through 4.2-17 of reference 2 are actual BOA curves.

2.10. In Appendix C, paragraph 2, how were the "generic fluid conditions" established?

Response

A generic set of flu d conditions was established so that the most conservative internal loads would be produced. Knowing that the magnitudes of reactor internals loads are directly proportional to the coldest fluid temperatures (lowest T) between inlet and outlet nozzles, the various parameters for the skirt-supported plants given in Table 2.10-1 were compared. The various parameters were taken from heat balance data sheets, and the design total NSS power levels were verified as those being in the SAR. Three cases (Consumers not included) were evaluated to determine which generic fluid conditions tabulated in Appen. C of reference 2 for the skirt-supported plants gave the most conservative (highest) internal loadings.

Table 2.10-1. Comparison of Plant Parameters

Design criteria	Case 1[a]	CR-3	Case 2[a]	Case 3[a]
Core power, MWt	2552	2544	2552	2772
NSS power, MWt	2568	2560	2568	2789
RV inlet temp, F	554	554.4	554	555.7
RV outlet temp, F	604	603.6	604	608.6
Reactor avg temp, F	579	579.0	579	582
Reactor flow, 10^6 lbm/h	131.32	131.4	131.5	131.3
SG outlet temp, F	553.7	554.0	553.7	555.4
Steam outlet temp, F	570	570.2	558	585
Steam outlet pressure	925	925	928	925
FW temp, F	460	459	433	455
FW pressure, psi	1000	1000	1003	1000
FW flow, 10^6 lbm/h	11.2	11.0	10.75	11.76
Steam superheat	35	35.0	22.4	50
RC pump power, MWt	16	16	16	17
RC pump/flow, gpm	88,000	88,000	88,000	88,000

[a]Case 1: Oconee 1, 2, and 3; ANO-1; and TMI-2.
Case 2: Consumers.
Case 3: Davis-Besse 1, TMI-1, and Rancho Seco.

2.11. In Appendix C, for the skirt-supported plant, there are more downcomer nodes than in the "audit model" in BAW-10132P-A. Discuss this and any other differences and how it will impact RV internals pressures and loads.

Response

There are two main differences between the skirt-supported model (Appendix C of reference 2) and the audit model (BAW-10132P-A, Figures 3-25 through 3-30[6]):

- A 12-circumferential node downcomer in the skirt-supported model compared to an 8-node downcomer in the audit model.
- A 10-node upper level plenum annulus in the skirt-supported model compared to a 4-node representation in the audit model.

Noting that the audit model in BAW-10132P-A was shown to provide sufficient noding detail, the increase in noding detail in the skirt-supported model provides for a slightly improved representation of the eight vent valves. In addition, as with all CRAFT2 type codes (RELAP, for example), as modeling detail increases, the average node/flow path properties more closely approximate local conditions.

The impact of added detail in the skirt-supported model is deemed a minor but favorable model improvement in that it more closely approximates the actual fluid system.

2.12. In BAW-10132P-A, Supplement 1, Figure D-1 (design model, 16-node downcomer) shows a peak differential pressure 290 psi less than Figure A-1 (audit model, 40-node downcomer). Based on this indication of lower differential pressures when modeling about 50% fewer downcomer nodes, justify use of the 20-node CRAFT2 downcomer model for the nozzle-supported plant to evaluate RV internals pressures and loads.

Response

Comparing Figures A-1 and D-1 in BAW-10132P-A, Supplement 1[7], is not valid for this application. The legends associated with each of these figures clearly show that different vent valve simulations were employed in the hydraulic modeling. Figure A-1 (40-node downcomer) stems from a model using dynamic vent valves, while Figure D-1 (16-node downcomer) is based on a model with instantaneously opening vent valves.

A proper downcomer noding comparison is presented in Table 3-10 of BAW-10132P-A.[6] This table clearly demonstrates that using a course downcomer nodal representation is conservative and that dynamic vent valves are realistic.

2.13. For the skirt-supported plant for a cold leg RV nozzle break, show a sample calculation for integrating the pressures around the core barrel periphery to get a directional force per unit length. Consider volume nodes 102 through 113 (at one elevation only) in Figures C-2 and C-3.

Response

As agreed at the April 2, 1981, meeting, methods and equations are provided for integrating the pressure around the core barrel periphery.

The equations used for force calculation of resultant horizontal components F_{xj} and F_{zj} (see Figure 2.13-1) are as follows:

$$F_{x_j} = \sum_i A_i P_i \cos \alpha_i = \sum_i F_i \cos \alpha_i$$

$$F_{z_j} = \sum_i A_i P_i \sin \alpha_i = \sum_i F_i \sin \alpha$$

where

A_i = projected area of node i = $\ell_i h_i$,

P_i = absolute pressure of node i, assume uniform in node i,

F_i = resultant force of node i = $A_i P_i$,

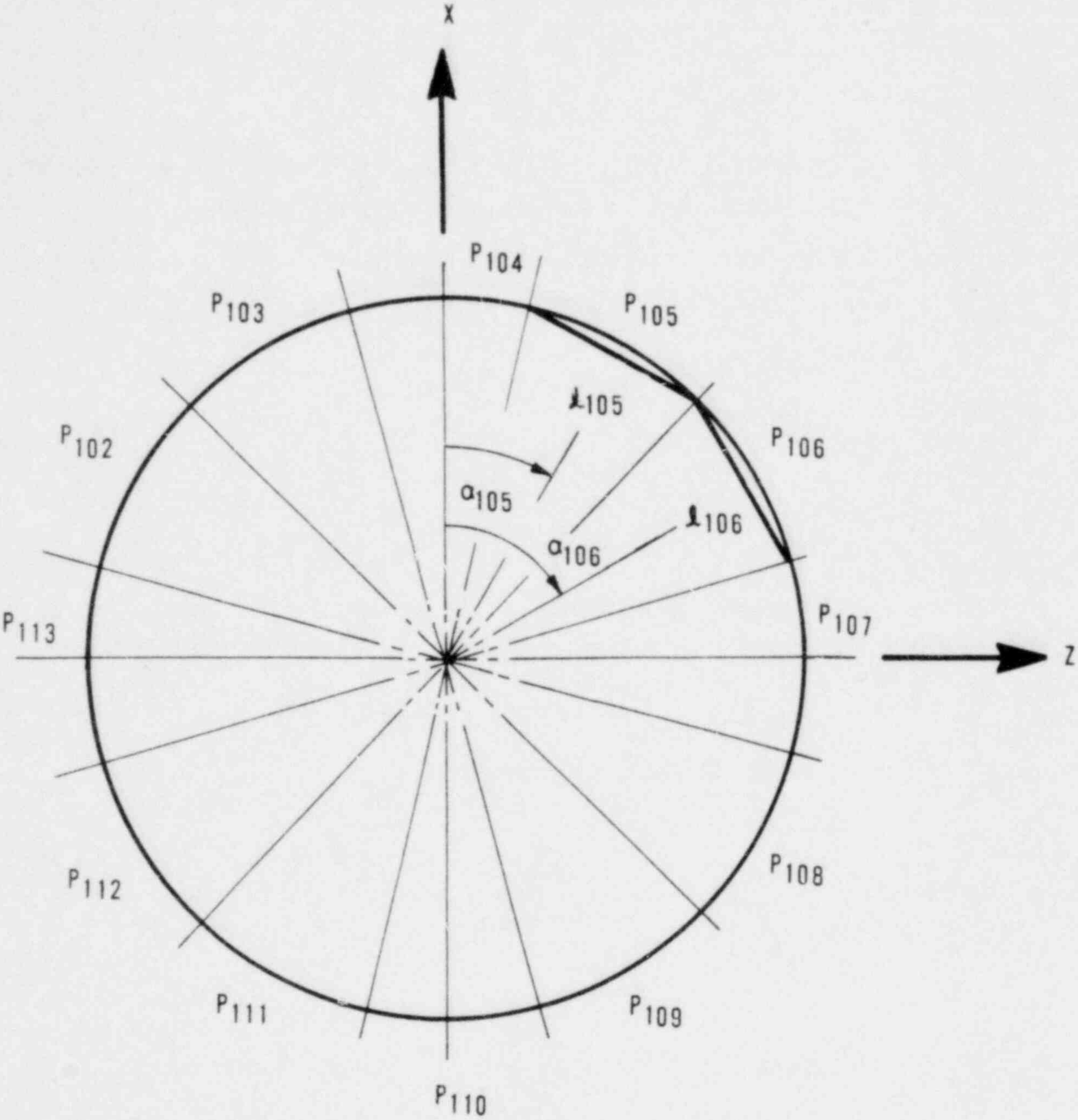
α_i = orientation angle of F_i with respect to X axis,

ℓ_i = projected length of node i,

h_i = projected height of node i.

The resultant horizontal force is applied at the center of the elevation of the projected area.

Figure 2.13-1. Circumferential Pressure/Node Relationship for Skirt-Supported Plant (Figure C-2[2])



2.14. What effect could a sticking vent valve have, i.e., late opening/closing (or) failure to open/close, relative to RV internals differential pressures for hot and cold leg breaks?

Response

Internals vent valves are installed in the core support shield to prevent a pressure buildup that might interfere with core cooling following a postulated inlet pipe rupture. Under all normal operating conditions, the vent valve will be closed. In the event of a pipe rupture in the cold leg of the reactor loop, the valve will open to permit steam generated in the core to flow directly to the leak and will permit the core to be rapidly re-covered and adequately cooled after emergency core coolant has been supplied to the reactor vessel.

The internals vent valves were designed to relieve the pressure generated by steaming in the core following a LOCA so that the core will remain sufficiently cooled. The valves were designed to withstand the forces resulting from rupture of either a reactor coolant inlet or outlet pipe. To verify the structural adequacy of the valves to withstand the pressure forces and perform the venting function, the following tests were performed:

1. A full-size prototype valve assembly (valve disc-retaining mechanism and valve body) was hydrostatically tested to the maximum pressure expected to result during the blowdown.

2. Sufficient tests were conducted at zero pressure to determine the frictional loads in the hinge assembly, the inertia of the valve disc, and the disc rebound resulting from impact of the disc on the seat so that the valve response to cyclic blowdown forces may be determined analytically.

3. A prototype valve assembly was pressurized to determine the pressure differential required to cause the valve disc to begin to open. A determination of the pressure differential required to open the valve disc to its maximum open position was simulated by mechanical means.

4. A prototype valve assembly was successfully installed and removed remotely in a test stand to confirm the adequacy of the vent valve handling tool.

5. A 1/6 scale model valve disc closing force (excluding gravity) test was conducted.

6. The full-size prototype valve's response to vibration was determined experimentally to verify prior analytical results, which indicated that the valve disc would not move relative to the body seal face as a result of vibration caused by transmission of core support shield vibrations. The prototype valve was mounted in a test fixture which duplicated the method of valve mounting in the core support shield. The test fixture with valve installed was attached to a vibration test machine and excited sinusoidally through a range of frequencies which encompassed those that may reasonably be anticipated for the core support shield during reactor operation. The relative motion between the valve disc and seat was monitored and recorded during the test. The results indicated that there was no relative motion of the valve to its seat for conditions simulating operating conditions. After no relative motion was observed or recorded during the test, the valve disc was manually forced open during a test to observe its response. The disc closed with impact on its seat, rebounded open, and reseated with no adverse effects to valve seal surfaces, characteristics, or performance. From this oscillograph record, the natural frequency of the valve disc was conservatively calculated as approximately 1500 Hz, whereas, the range of frequencies for the primary system (including internals components) has been established as 15 to 160 Hz. These frequencies are separated by an ample margin to conclude that no relative motion between the valve disc and its seat will occur during normal reactor operation.

Each production valve is subjected to tests 2 and 3 above except that no additional analysis is performed in conjunction with test 2.

The valve disc, hinge shaft, shaft journals (bushings), disc journal receptacles, and valve body journal receptacles have been designed to withstand, without failure, the internal and external differential pressure loadings resulting from a loss-of-coolant accident. The valve materials are nondestructively tested and accepted in accordance with the ASME Code, Section III, requirements for Class A vessels as a reference quality level.

During scheduled refueling outages after the reactor vessel head and the internals plenum assembly have been removed, the vent valves are accessible for visual and mechanical inspection. A hook tool is provided to engage with the valve disc exercise lug. With the aid of this tool, the valve discs are manually exercised during each refueling outage to evaluate disc freedom. The hinge design incorporates special features to minimize the possibility of impairment of valve disc motion during its service life. With the aid of the hook tool, the valve disc can be raised for remote visual inspection of the valve body and disc sealing faces to evaluate observed surface irregularities.

Vent valve design and evaluations are documented in topical report BAW-10005, Rev. 1.[8] Reference 9 is an NRC review of B&W operating experience with reactor internals vent valves and states that B&W design and safety analyses need not include a vent valve flow penalty.

Based on these design considerations, subsequent testing, years of excellent valve performance, and the valves being manually exercised during each refueling, the probability of a late vent valve opening/closing (or) failure to open/close in combination with a guillotine pipe break is essentially zero. Therefore, a sticking vent valve has not been considered in this analysis.

2.15. In establishing the generic skirt-supported plant model, what sensitivity studies were conducted among the various skirt-supported plants to define wosrt-case internals differential pressures relative to any design or as-built differences in internals geometry, vent areas, flow loss coefficients, and CRAFT2 model volume arrangement and flow inertia terms?

Response

Within manufacturing tolerances, the skirt-supported plants are geometrically the same. Hence, no geometric sensitivity studies were required for the generic, skirt-supported, reactor vessel internals ΔP model.

2.16. How were local fluid acceleration (crossflow drag) forces accounted for in RPV internals loads evaluation (such as lateral forces on the control rod guide tubes and support columns during a hot leg break)?

Response

CRAFT2 is not the vehicle used by B&W to calculate crossflow drag type loadings on the control rod guide tubes.[2] Such loads are generated using an appropriate drag formula in conjunction with the maximum crossflow velocity. The drag load is then combined with the induced structural guide tube loadings in order to perform a stress analysis of the control rod guide tubes. The drag load and the induced load occur at different times: the combination without time-phasing yielded satisfactory stress levels.

2.17. In Appendix C, qualify and justify the statement in paragraph 2: "A generic set of fluid conditions was established to serve as a conservative representation of the fluid conditions present in the 177-FA lowered-loop plants." Were actual or SAR design-quoted fluid-parameters used?

Response

See the response to question 2-10.

2.18. For all skirt-supported plants, provide a table comparing those cognizant geometric, thermal, and hydraulic parameters used to justify generic grouping. What were the main conditions used to establish the similarity between actual plants and the case analyzed for RPV internals and RCS/ECCS hydraulic transients during subcooled blowdown. Include Davis-Besse 1 parameters for comparison with a nozzle supported plant.

Response

Table comparing plant parameters is included in the response to question 2.10. Main conditions considered were geometric, thermal and hydraulic similarity.

2.19. In Figures C-9 and C-11 identify the downcomer volume nodes adjacent to both hot and cold leg breaks and in Figures C-2 and C-7 for a hot leg break.

Response

Figures C-1 through C-7[2] show the CRAFT2 noding model for the 177-FA skirt supported plant. For a hot-leg break, flow would exit the reactor vessel into outlet nozzle control volume 71 shown in Figures C-1 and C-6, via flow path 74 from control volume 95. Figure C-6 shows flow path 250 from control volume 153, flow path 265 from control volume 167, and flow path 264 from control volume 166 flowing into control volume 95. Figure C-2 is an elevation view of the reactor vessel control volumes and does not show broken loop or circumferential volume locations. Figures C-8 through C-11 are the CRAFT2 noding model for the 177-FA nozzle-supported plant. For a hot leg break, refer to Figures C-11a, -11b, and -11c included with the response to question 2.20. Flow to the break must pass through control volume 14, and the following flow paths feed into volume 14: 87, 103, 104, 116, 117, and 131. For a cold leg break, refer to Figures C-8 through C-10; flow must pass through control volume 26. Control volume 82 connects to control volume 26 via flow path 120. Figure C-9 is an elevation view of the reactor vessel control volumes and does not show broken loop or circumferential volume locations.

2.20. Figure C-11 is not interpretable. Provide a description, with legible volume node numbers, like Figures C-6 and C-7.

Response

Figure C-11 has been divided into three parts – Figures 2.20-1, 2.20-2, and 2.20-3 are attached. Description notes have not been provided since the nodes in the outlet annulus are divided into 90° sections.

Figure 2.20-1. CRAFT2 Noding Model for 177-FA Nozzle-Supported Plant — Elevation, Upper Plenum Region

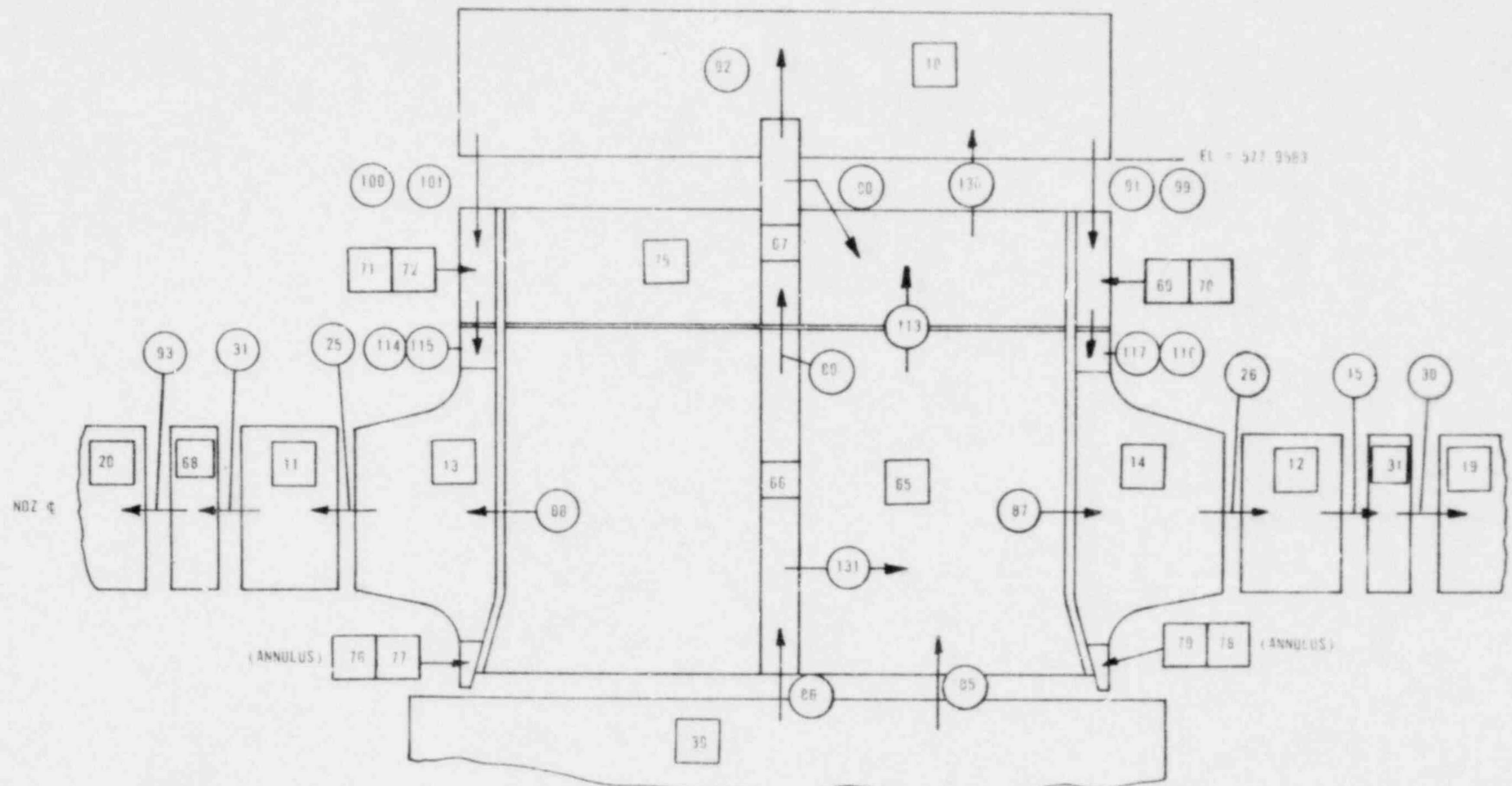


Figure 2.20-2. CRAFT2 Noding Model for 177-FA Nozzle-Supported Plant — Plan, Lower Plenum Region

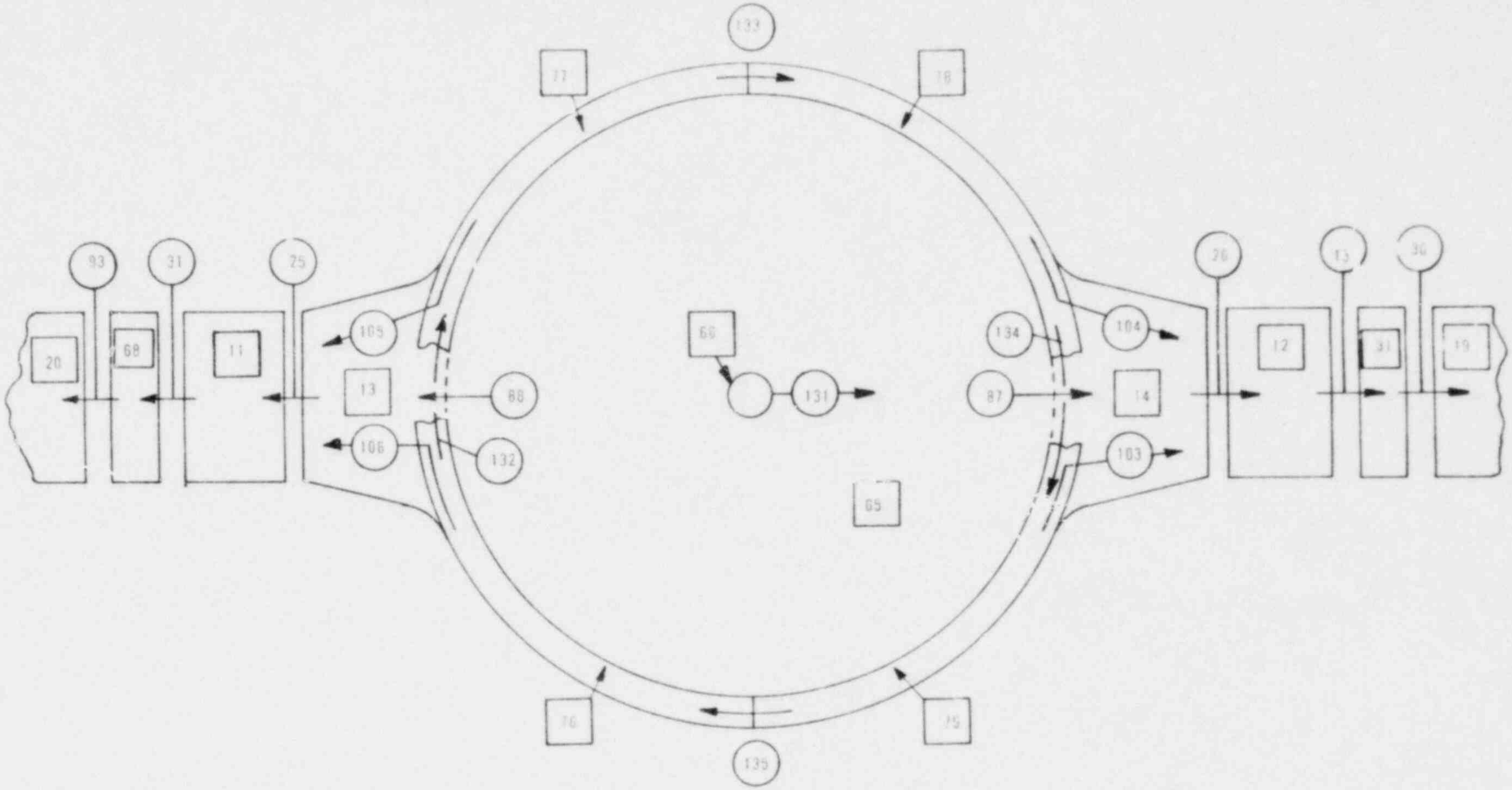
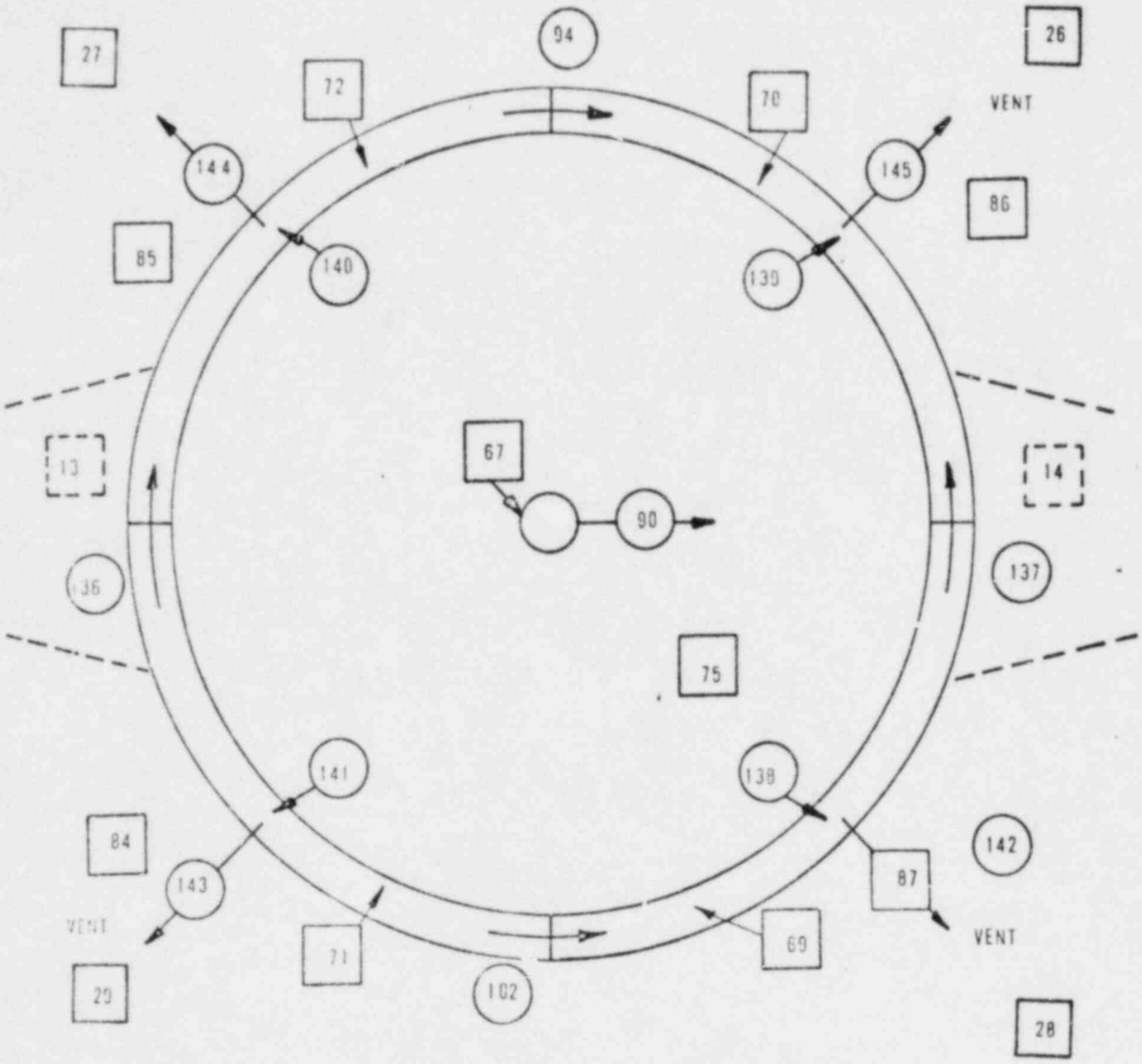


Figure 2.20-3. CRAFT2 Noding Model for 177-FA Nozzle-Supported Plant — Plan, Upper Plenum Region

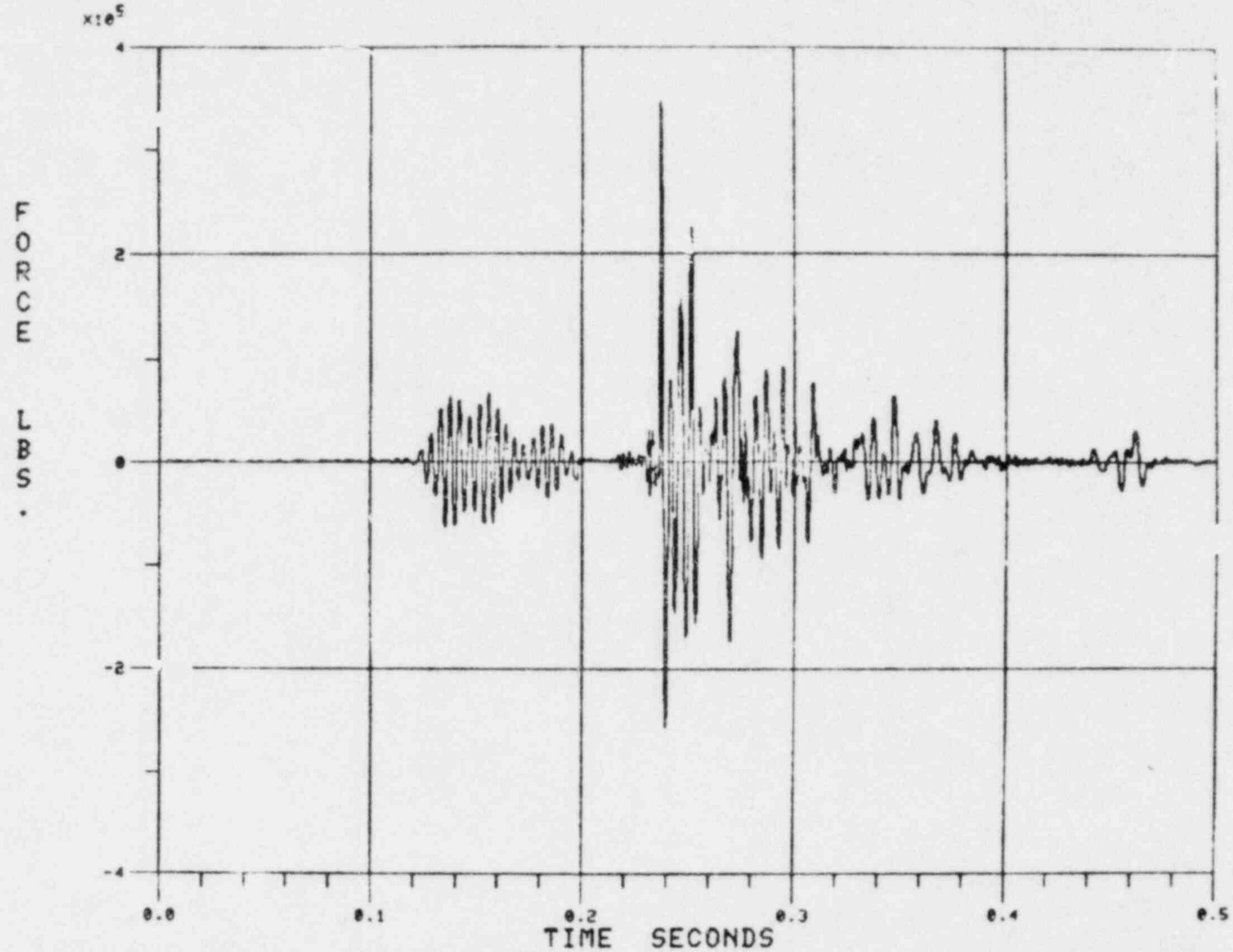


2.21. Provide a table of peak differential pressures and loads for each major RV internals component analyzed for both the skirt- and nozzle-supported plants for each BOA and location evaluated. Indicate time of occurrence.

Response

This question was revised at the April 2-3 meeting to provide peak loads across the core support shield and across the fuel assemblies (top to bottom) for reactor vessel inlet and outlet breaks for both skirt- and nozzle-supported plants. Time history forces across the core support shield for 2A hot and cold leg breaks at the RV nozzle are shown in Figures 2.21-1 and 2.21-2, respectively for a skirt-supported plant. Nozzle-supported plant time history forces are shown in Figures 2.21-3 and 2.21-4 for a 1.024A hot leg break and a 0.242A cold leg break at the RV, respectively. Figures 2.21-5 and 2.21-6 show the total force on the core for a 2A hot and cold leg break at the RV, respectively, for a skirt-supported plant. Forces on the core for a nozzle-supported plant are shown in Figures 2.21-7 and 2.21-8 for a 1.024A hot leg and a 0.242A cold leg break at the RV, respectively. Joint numbers in these figures refer to Figure D-5 of reference 2.

Figure 2.21-1. Force Across Core Support Shield — 2A Hot Leg Break at RV, Skirt Supported Plant



JT 62 FX 31

Figure 2.21-1. (Cont'd)

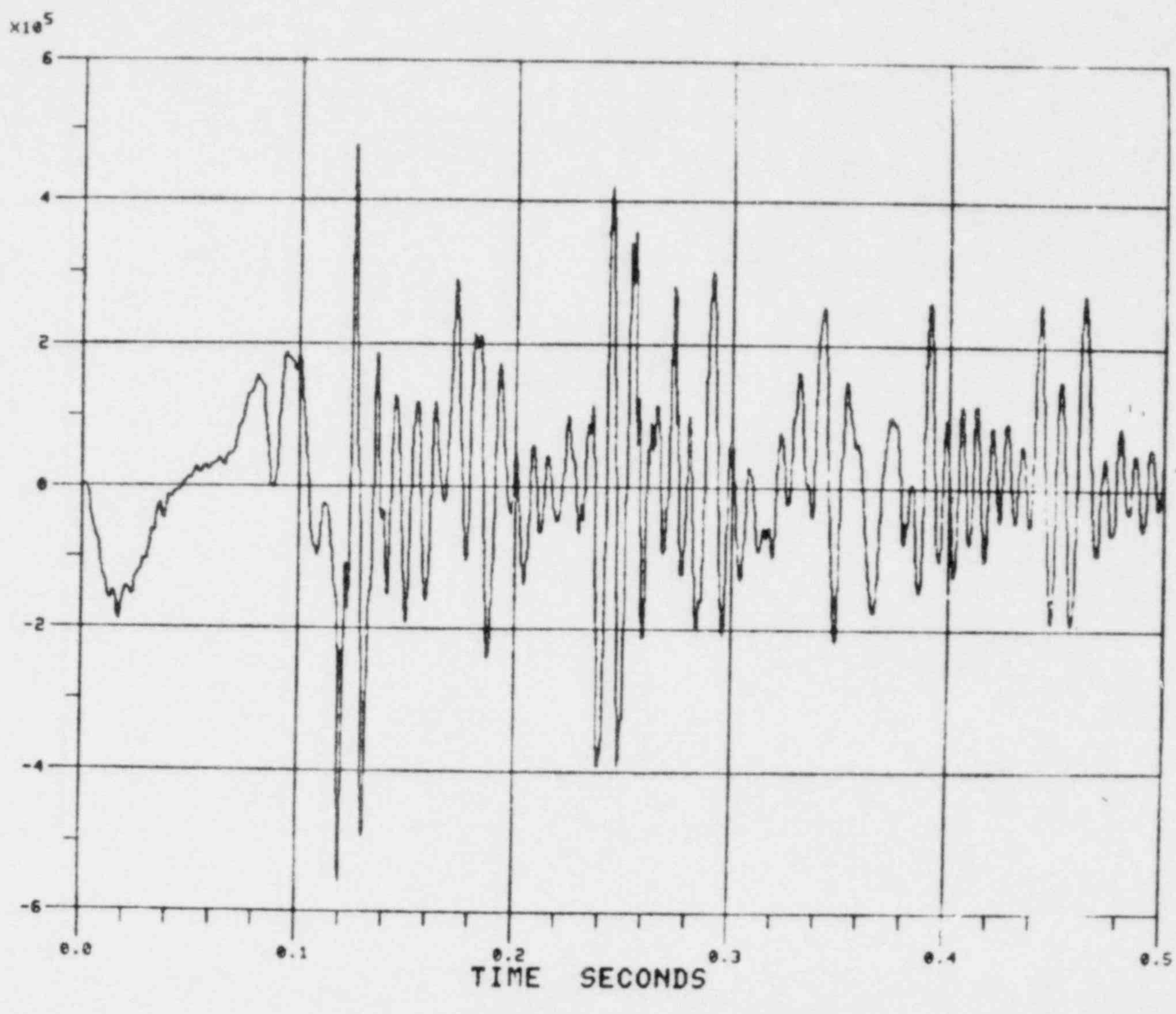
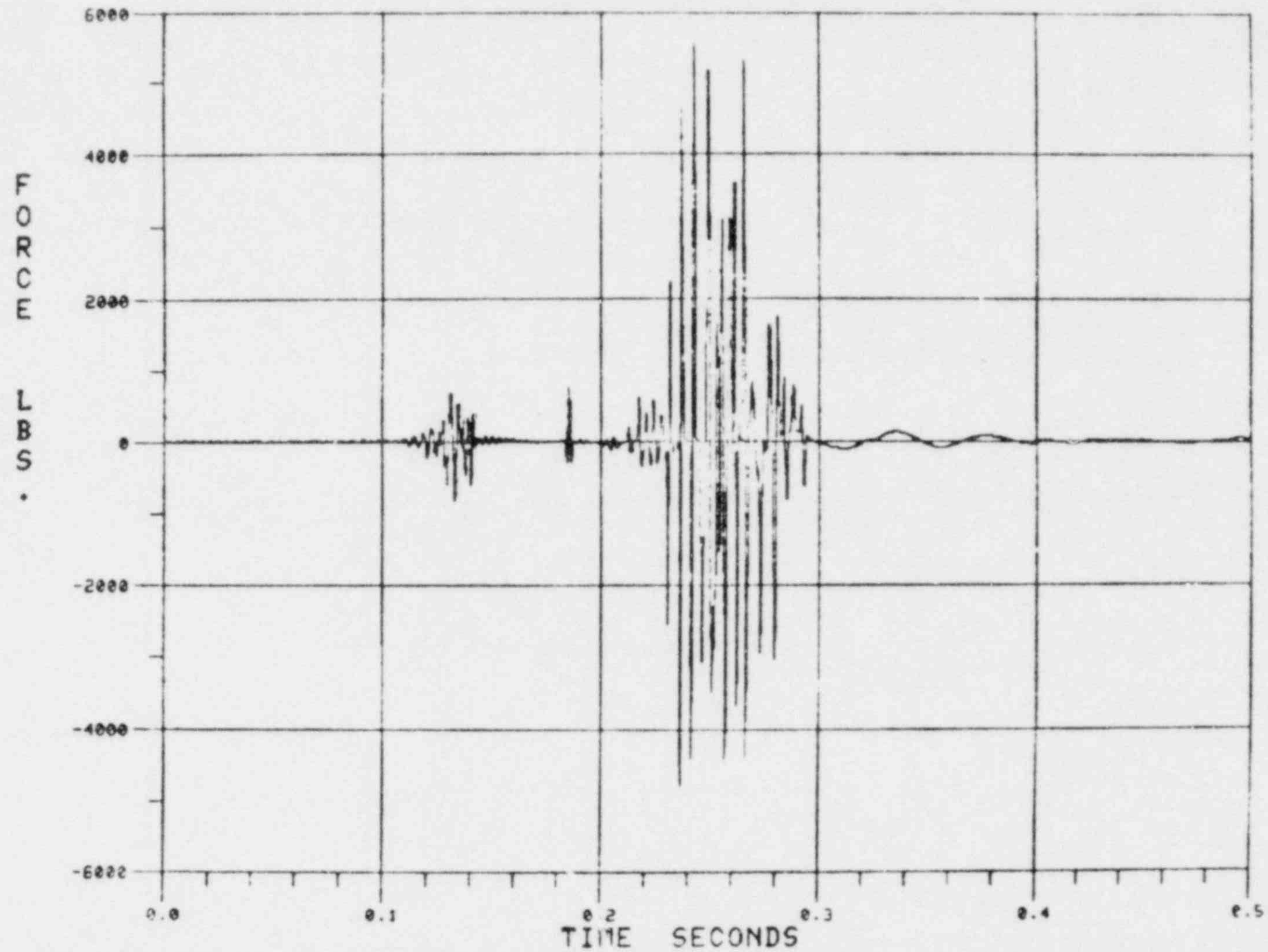
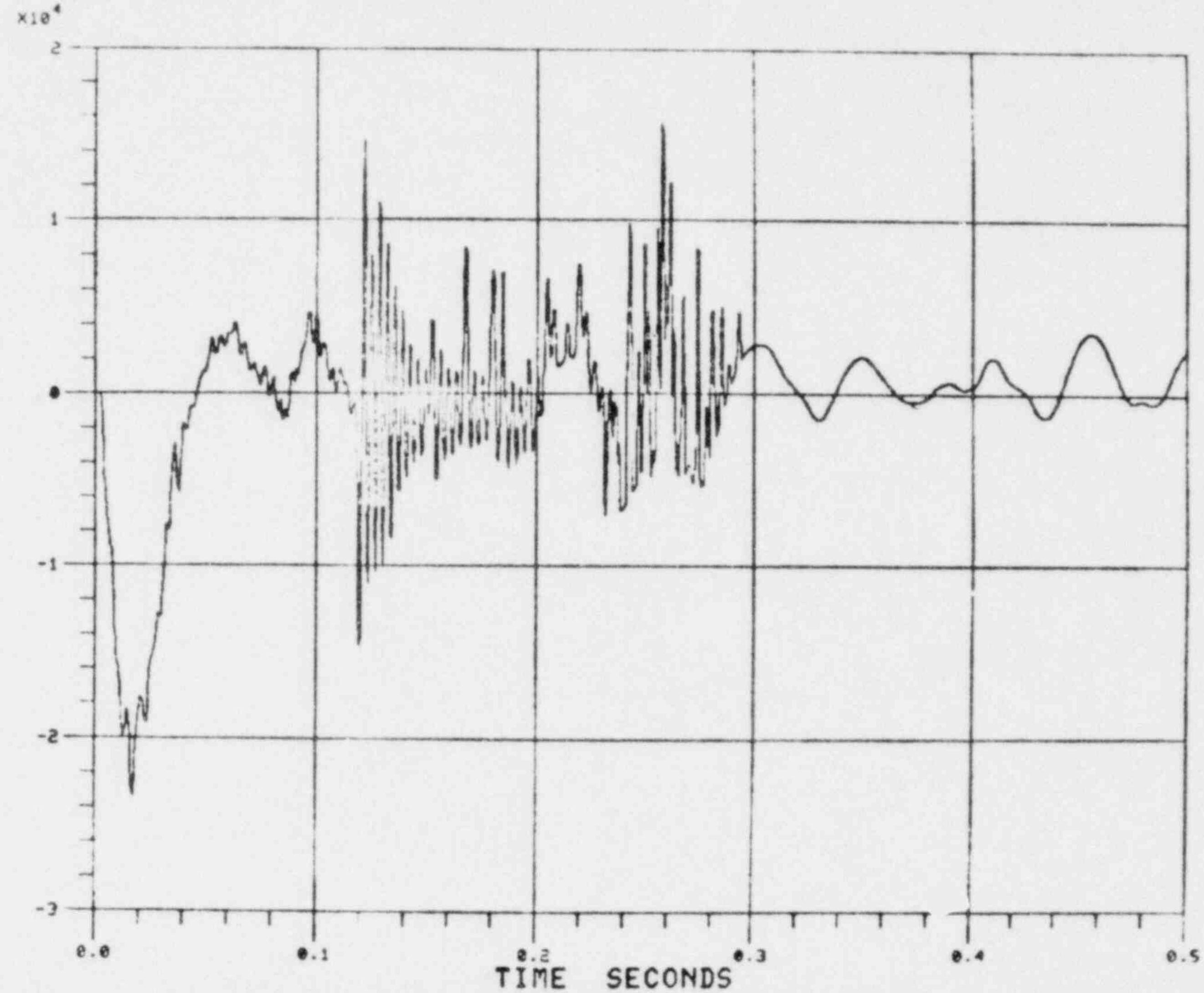


Figure 2.21-1. (Cont'd)



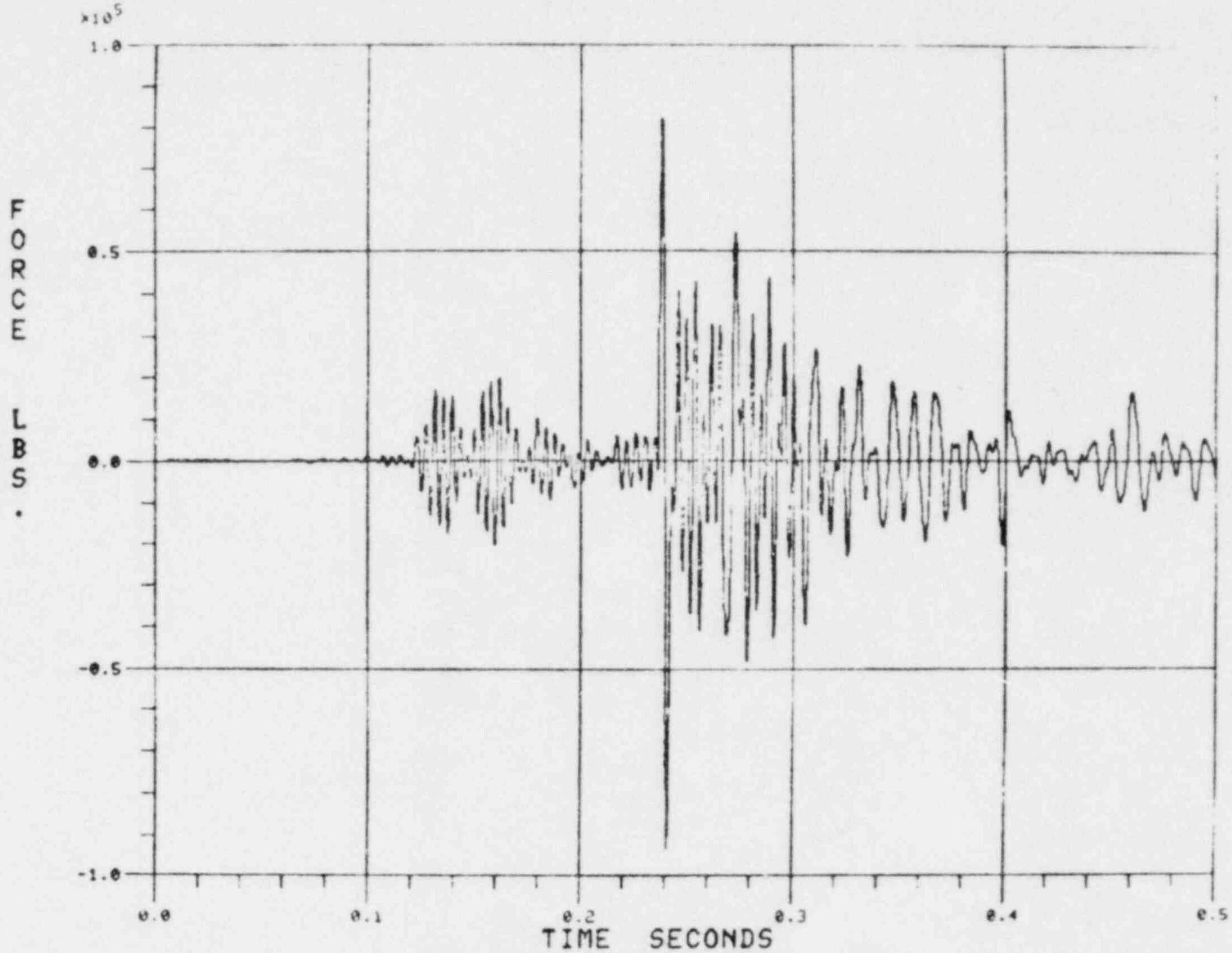
JT 53 FX 37

Figure 2.21-1. (Cont'd)



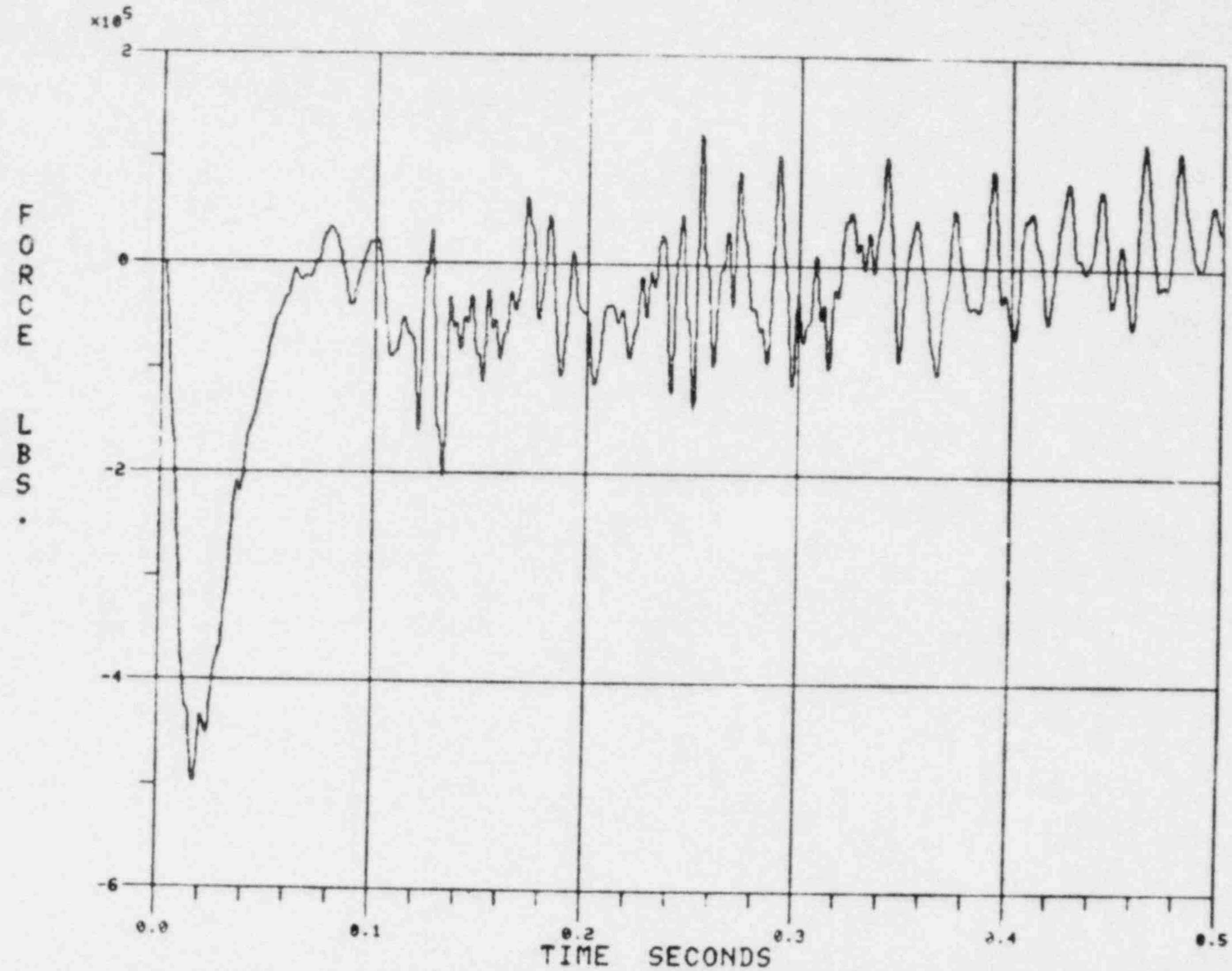
JT 53 FZ 39

Figure 2.21-1. (Cont'd)



JT 44 FX 43

Figure 2.21-1. (Cont'd)



JT 44 FZ 45

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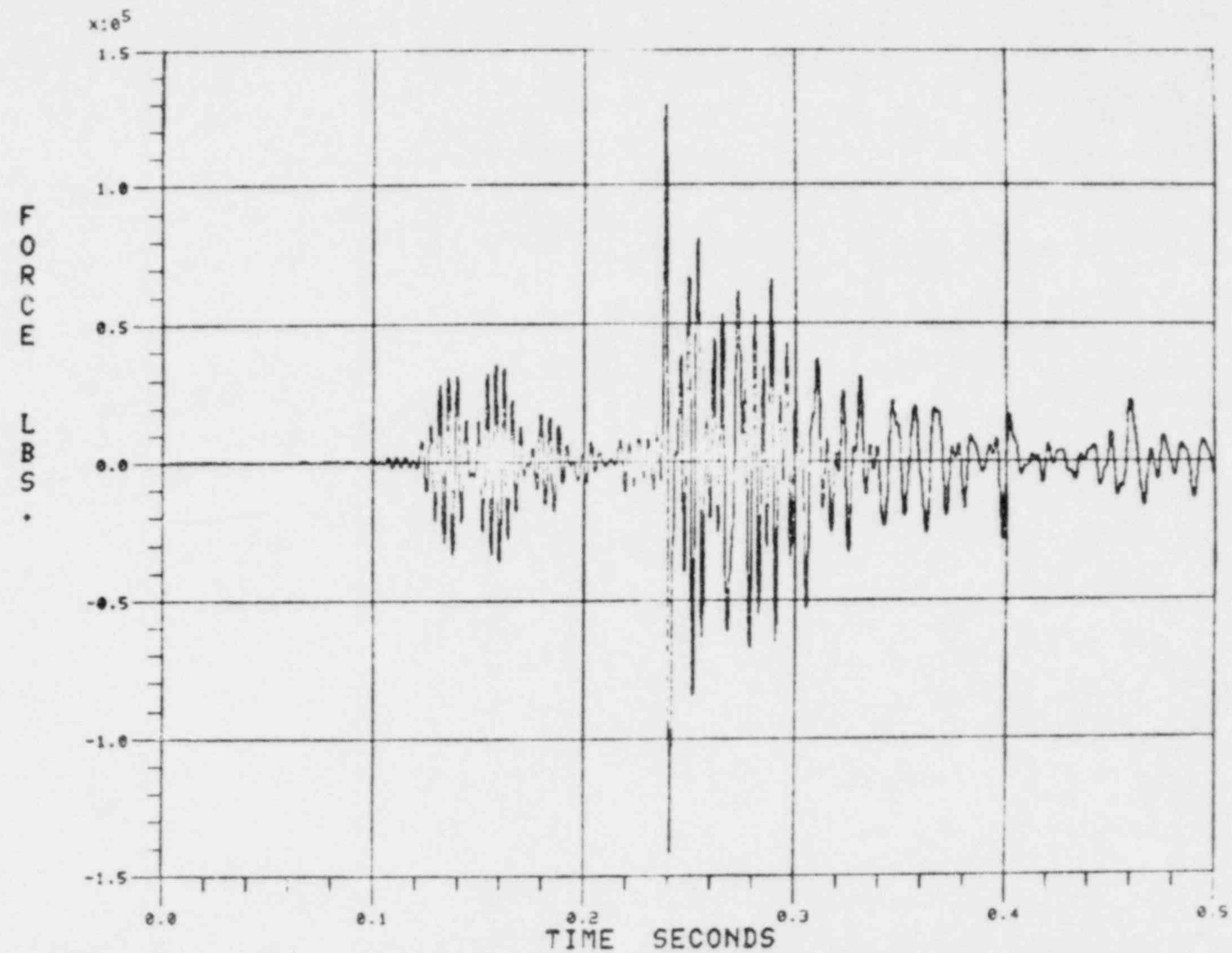


JT 31 FX 49

Figure 2.21-1. (Cont'd)

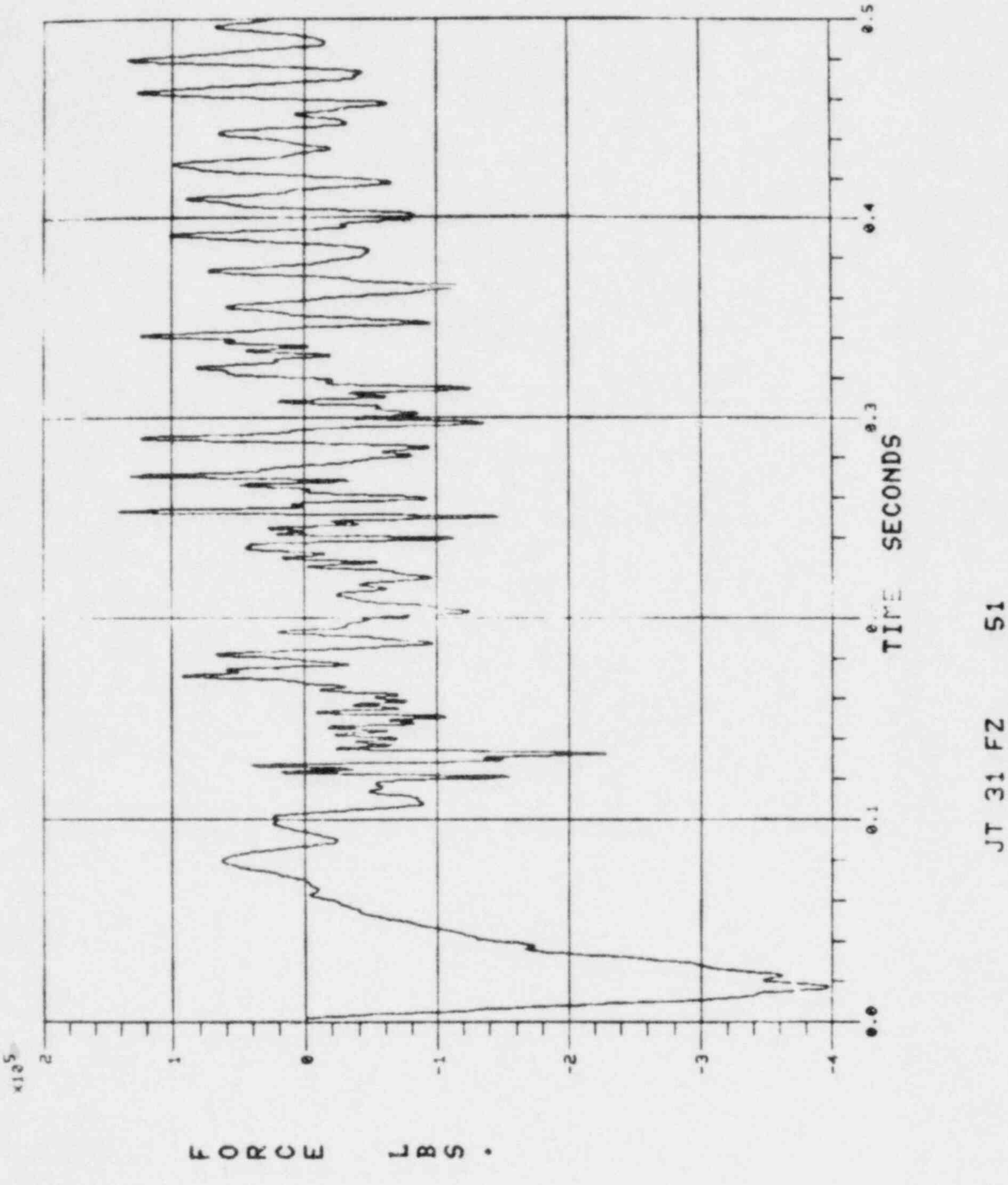
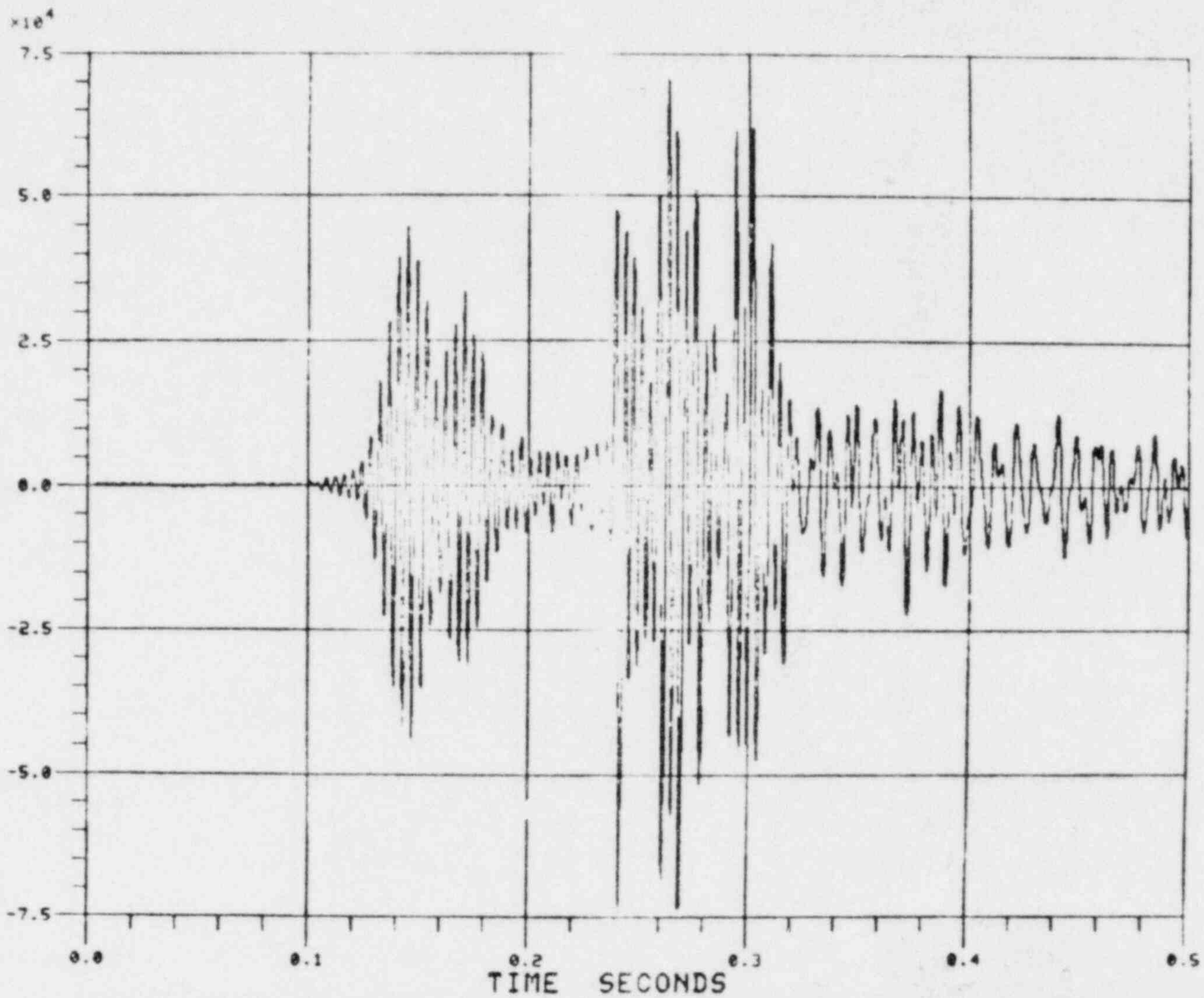


Figure 2.21-1. (Cont'd)



JT 7 FX 85

Figure 2.21-1. (Cont'd)

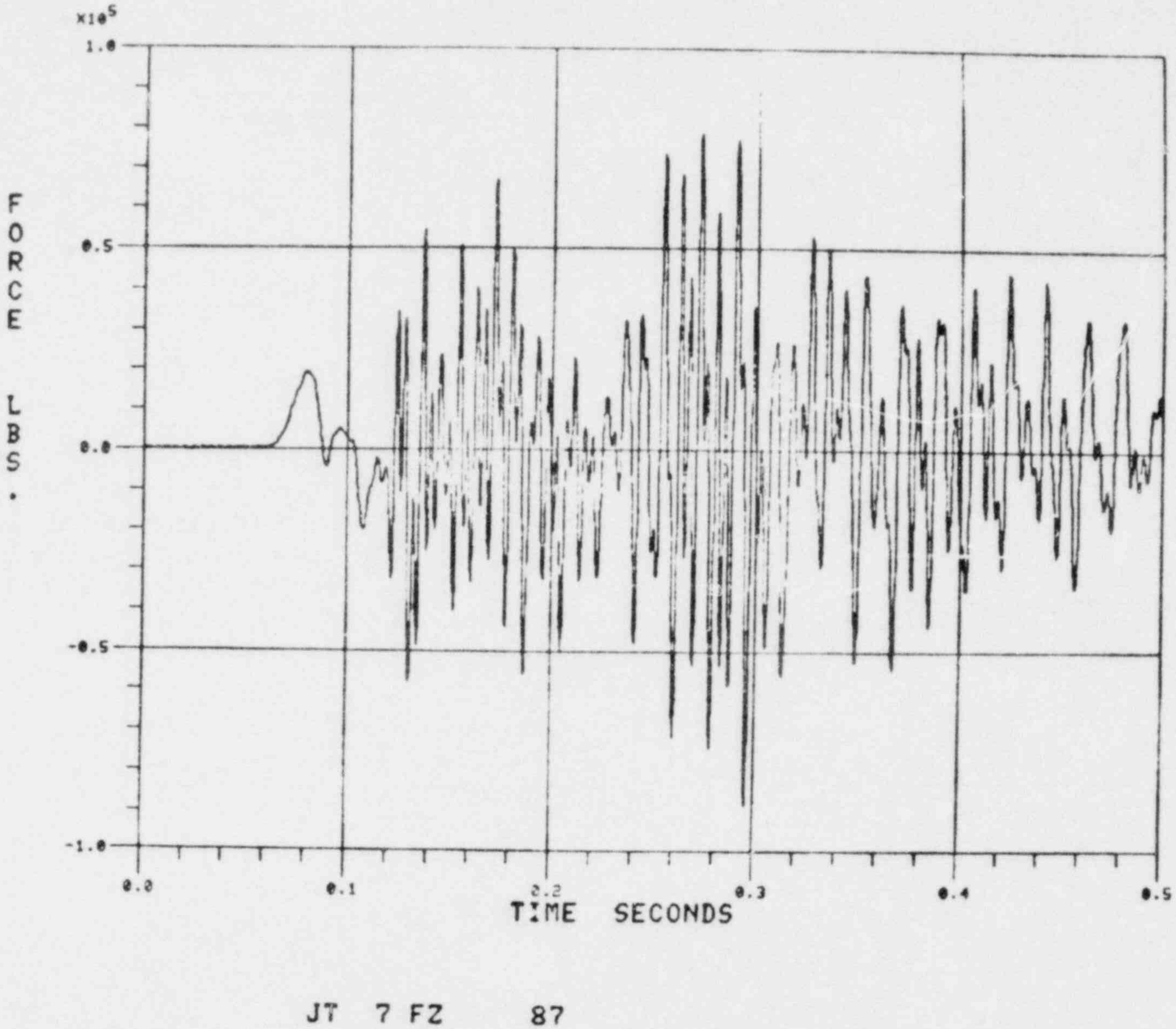


Figure 2.21-1. (Cont'd)

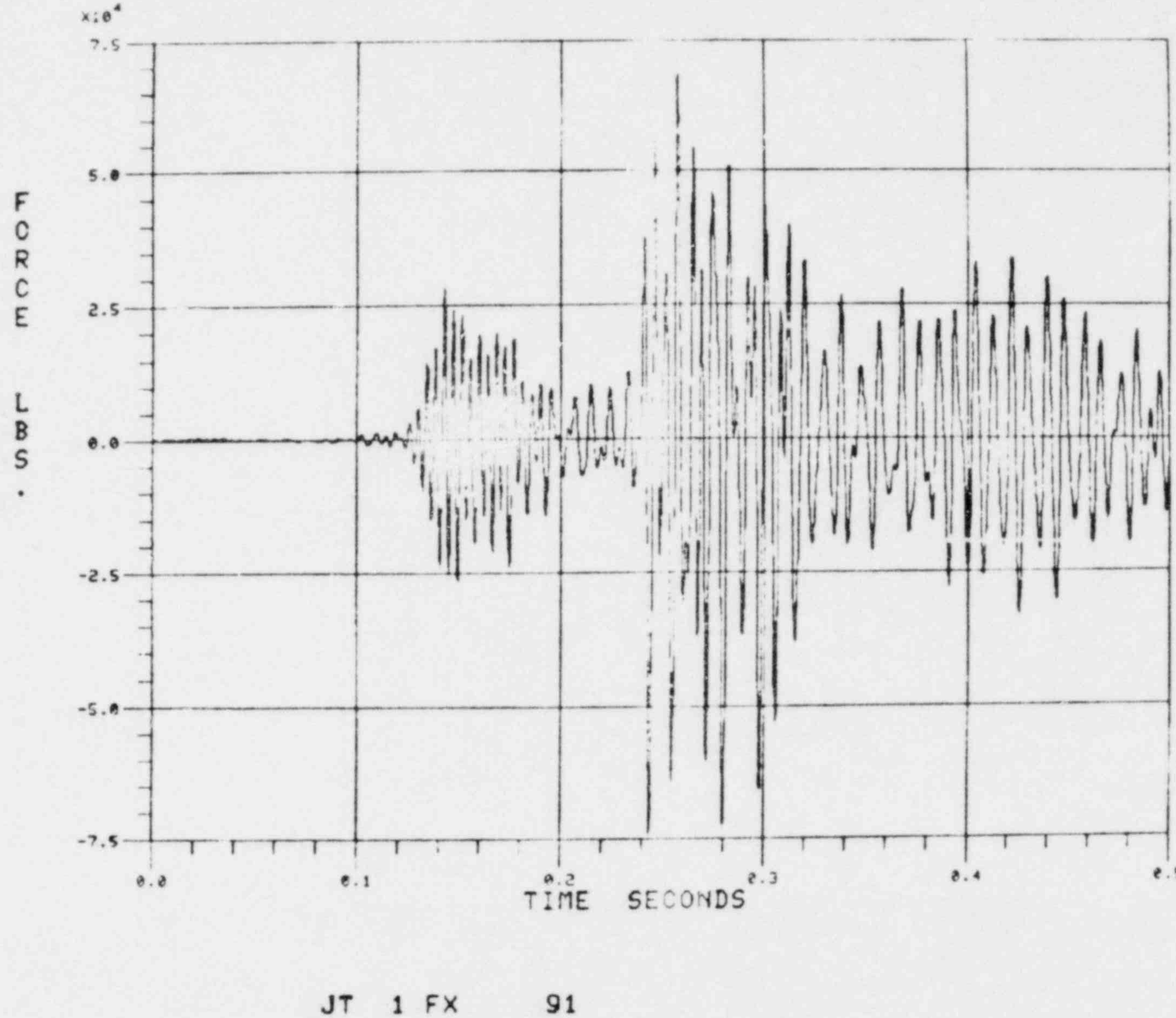
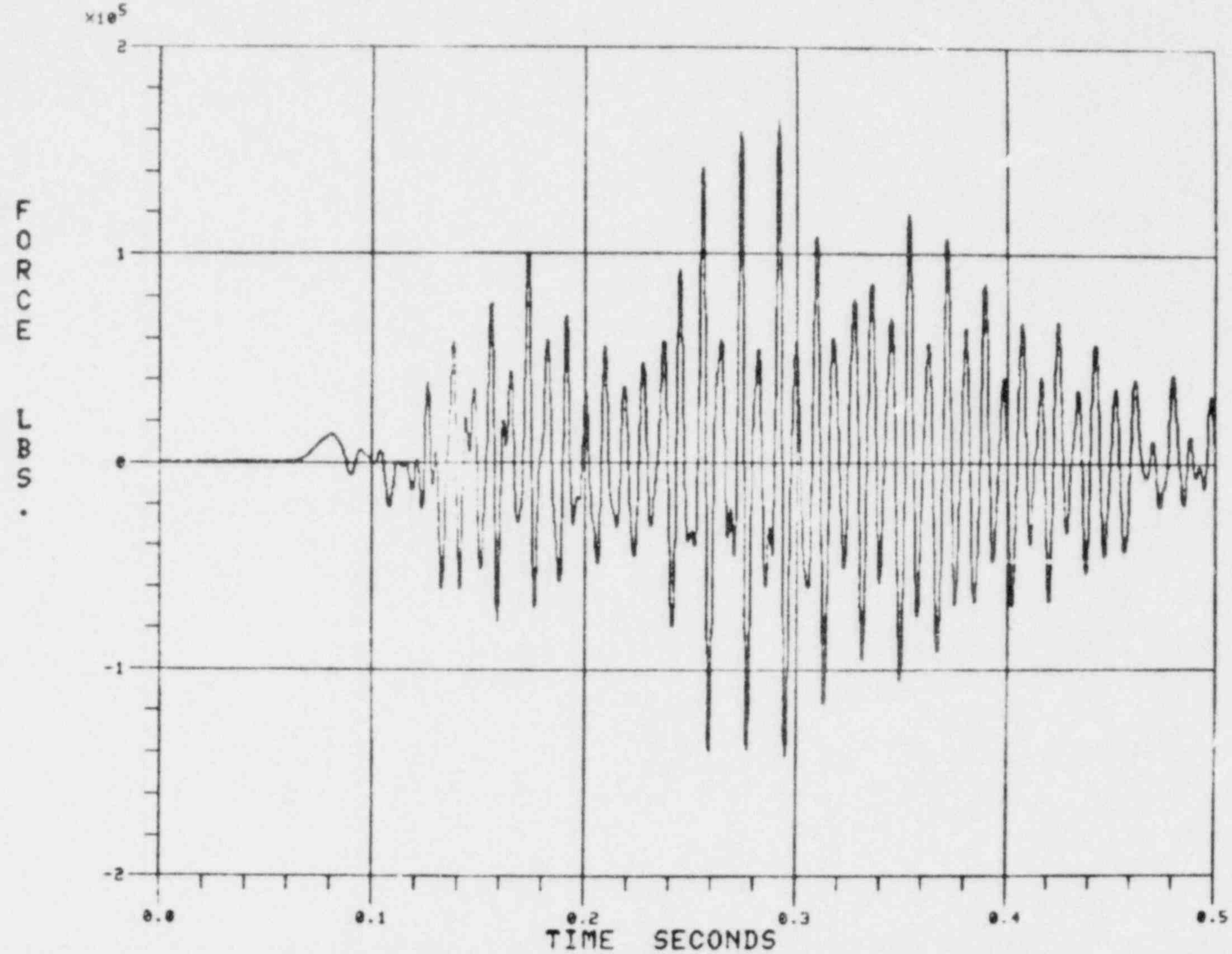


Figure 2.21-1. (Cont'd)



JT 1 FZ 93

Figure 2.21-1. (Cont'd)

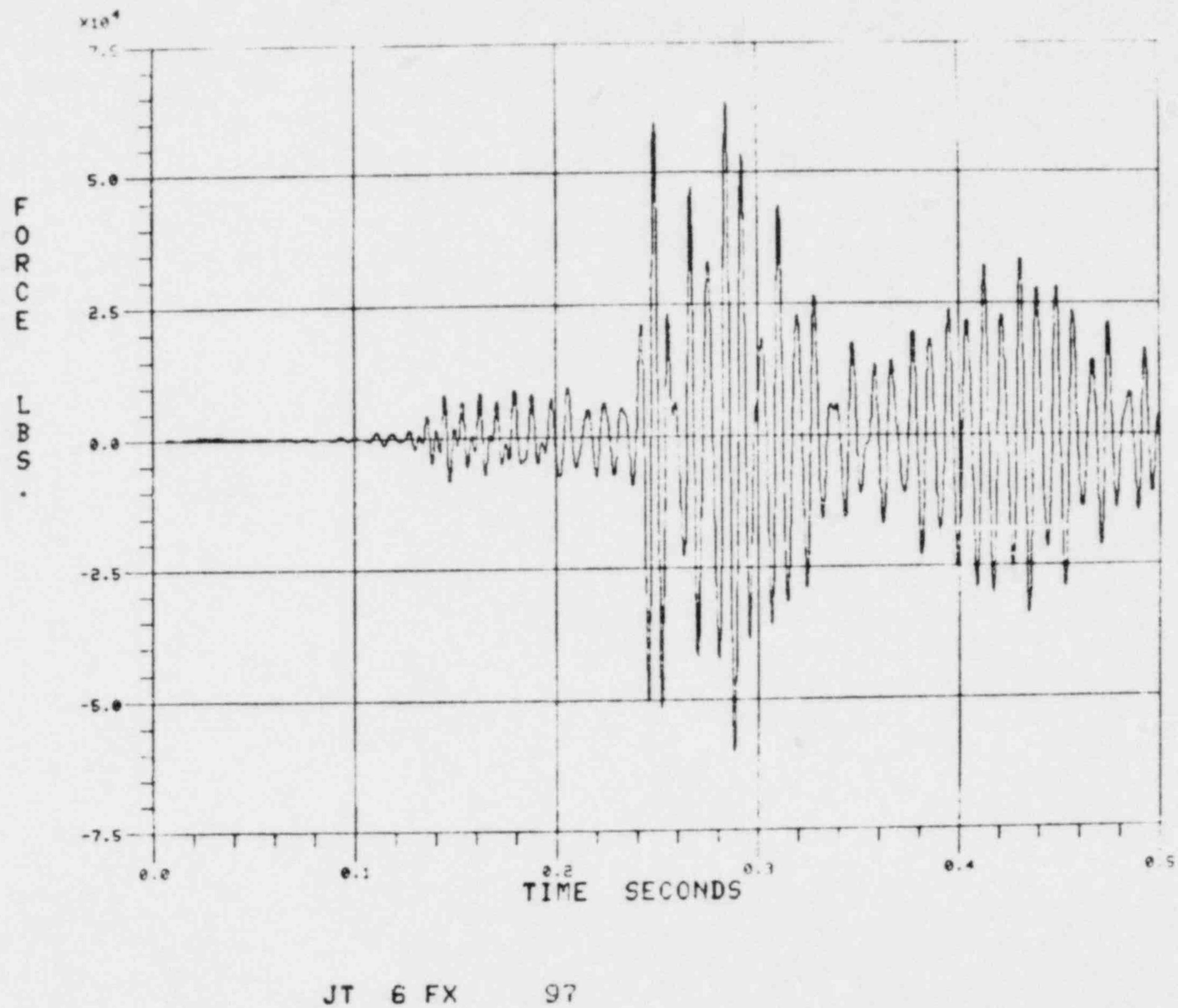
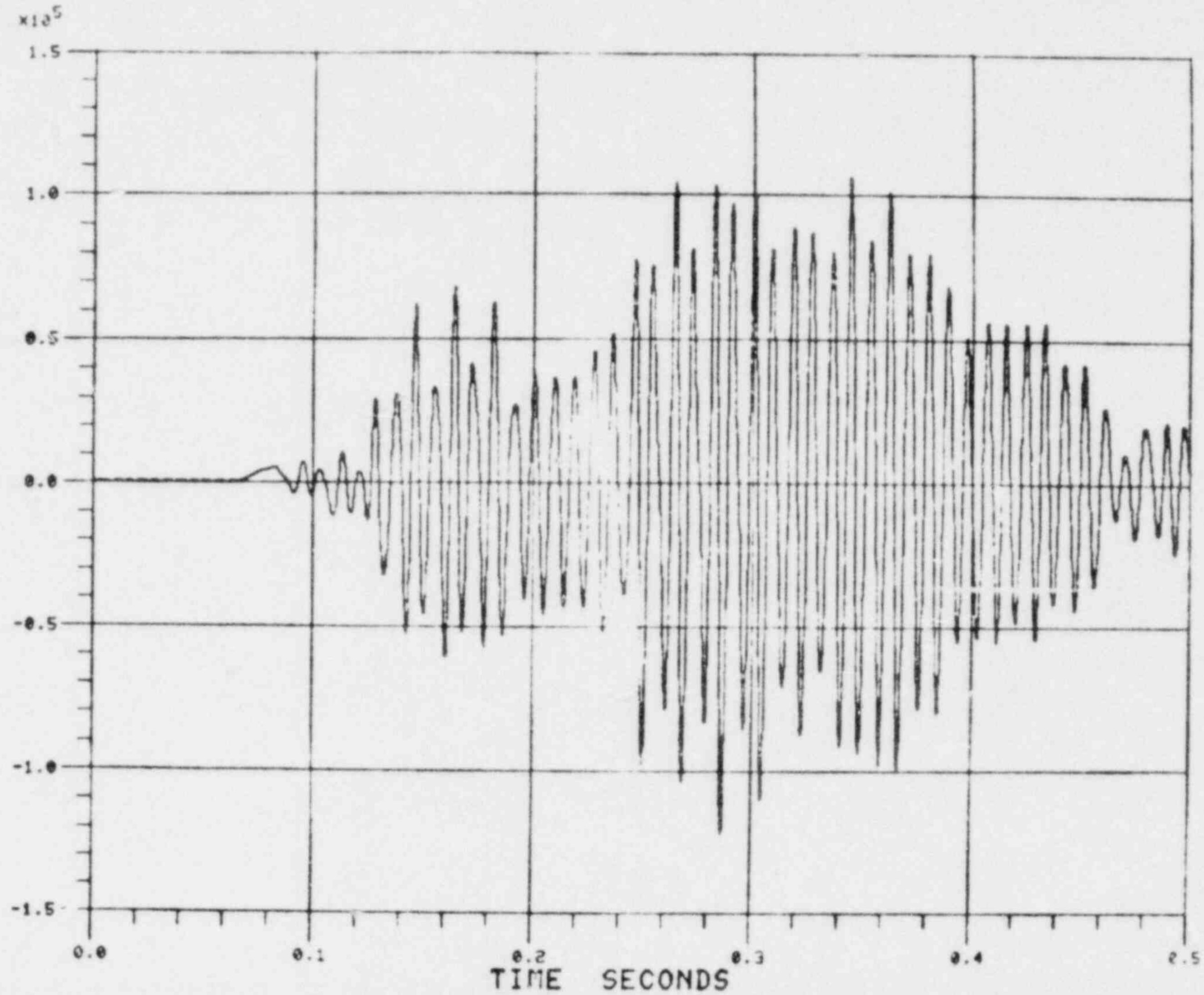
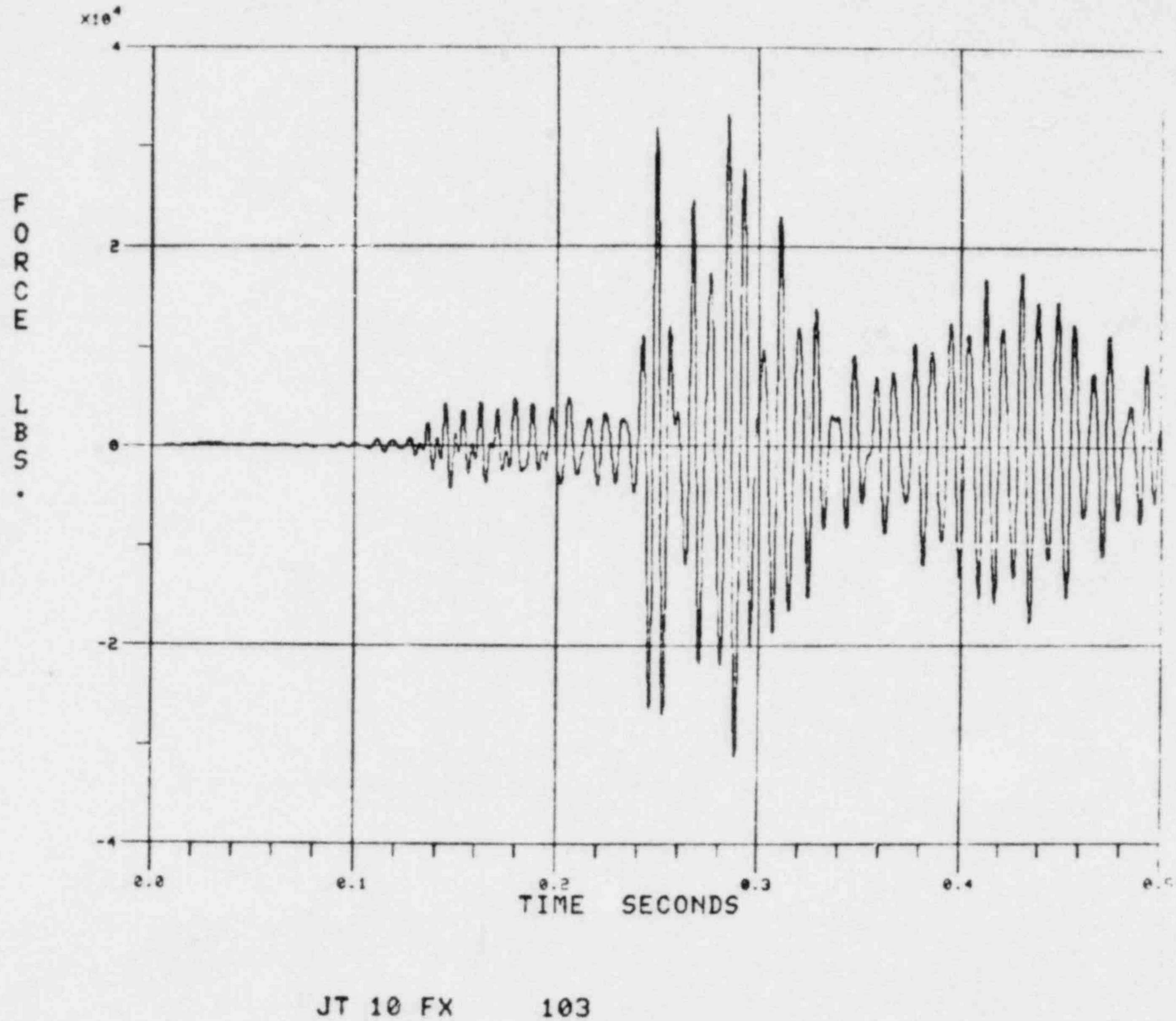


Figure 2.21-1. (Cont'd)



JT 6 FZ 99

Figure 2.21-1. (Cont'd)



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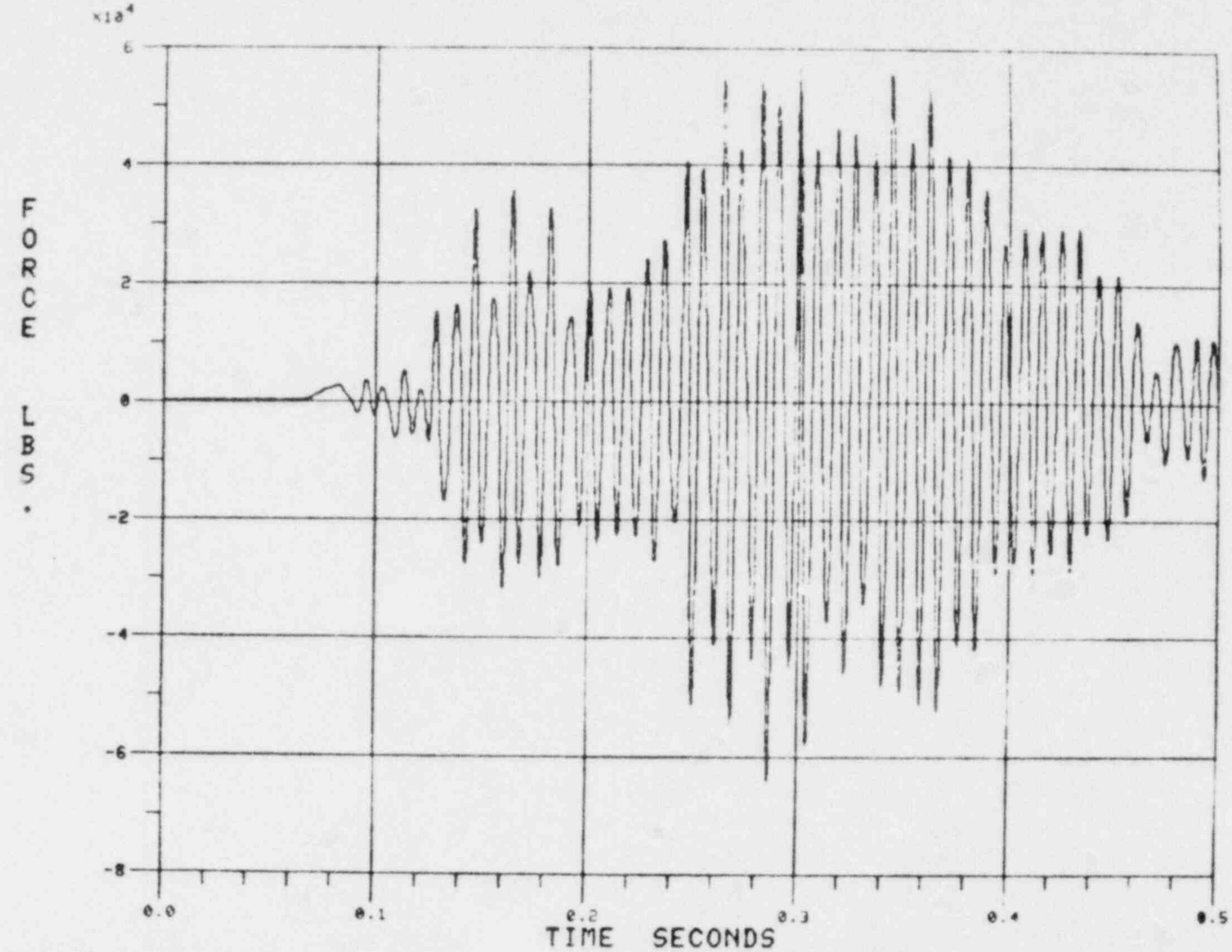
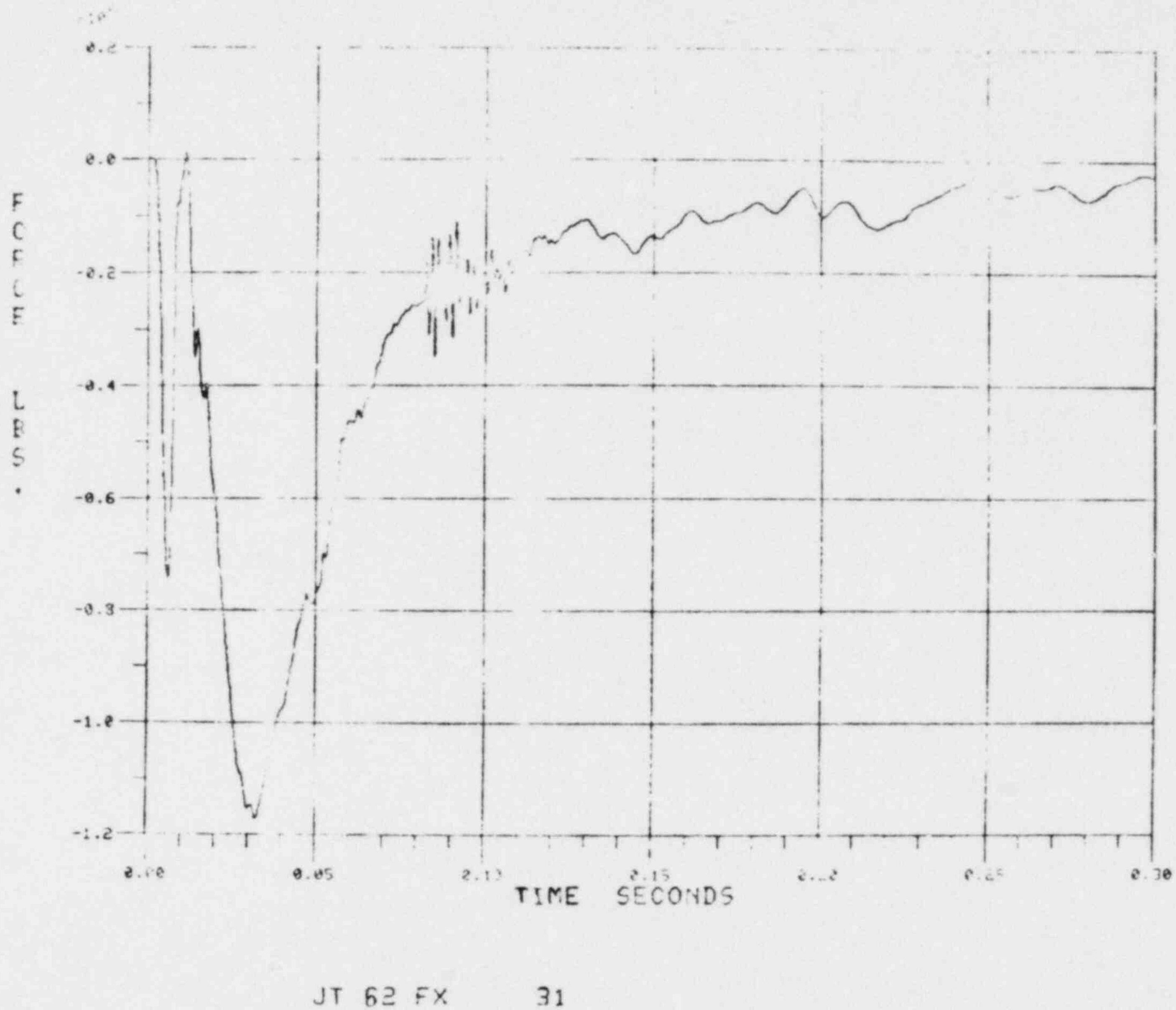


JT 10 FZ 105

Figure 2.21-2. Force Across Core Support Shield 2A Cold Leg Break at RV-Skirt-Supported Plant



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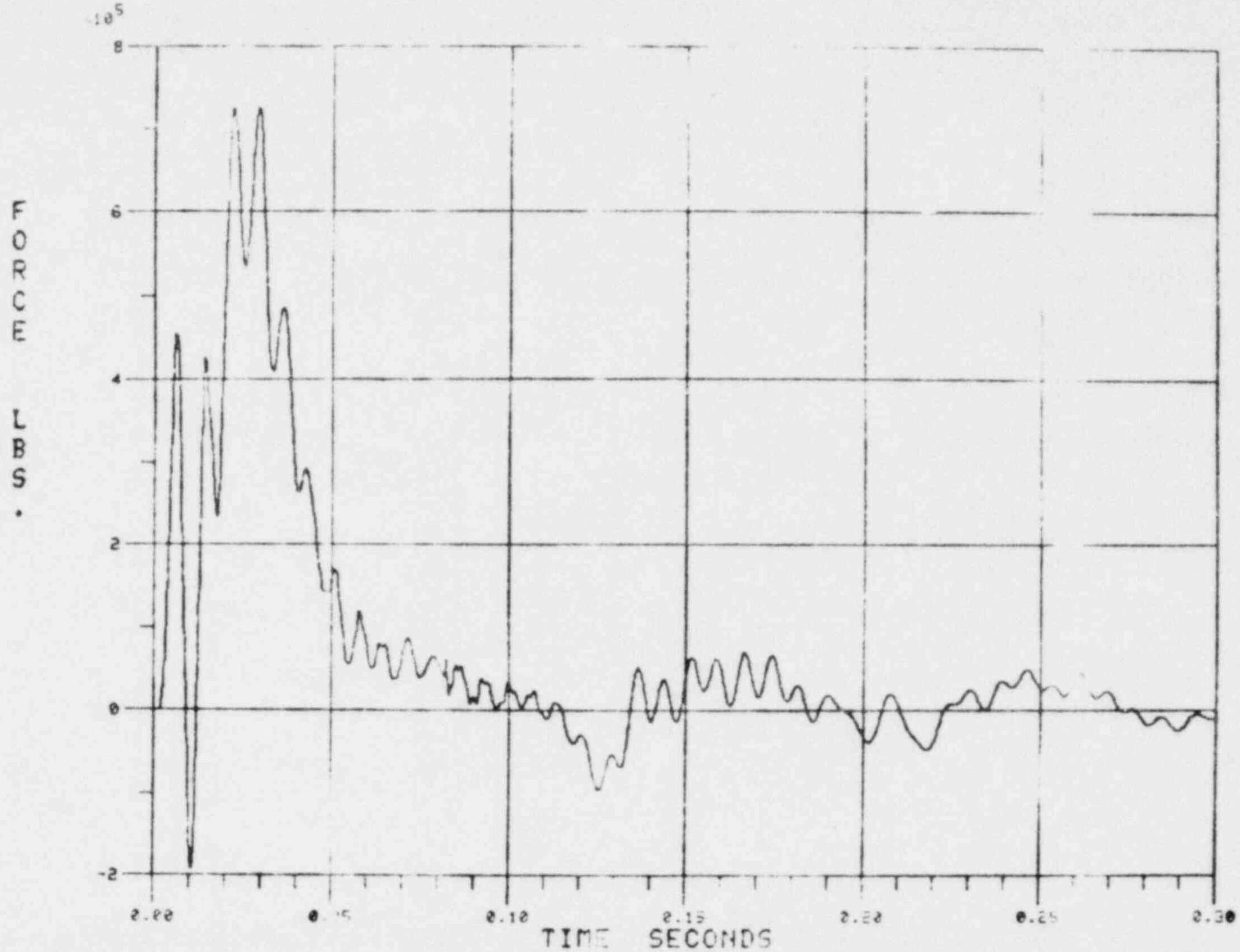

JT 62 FZ 33

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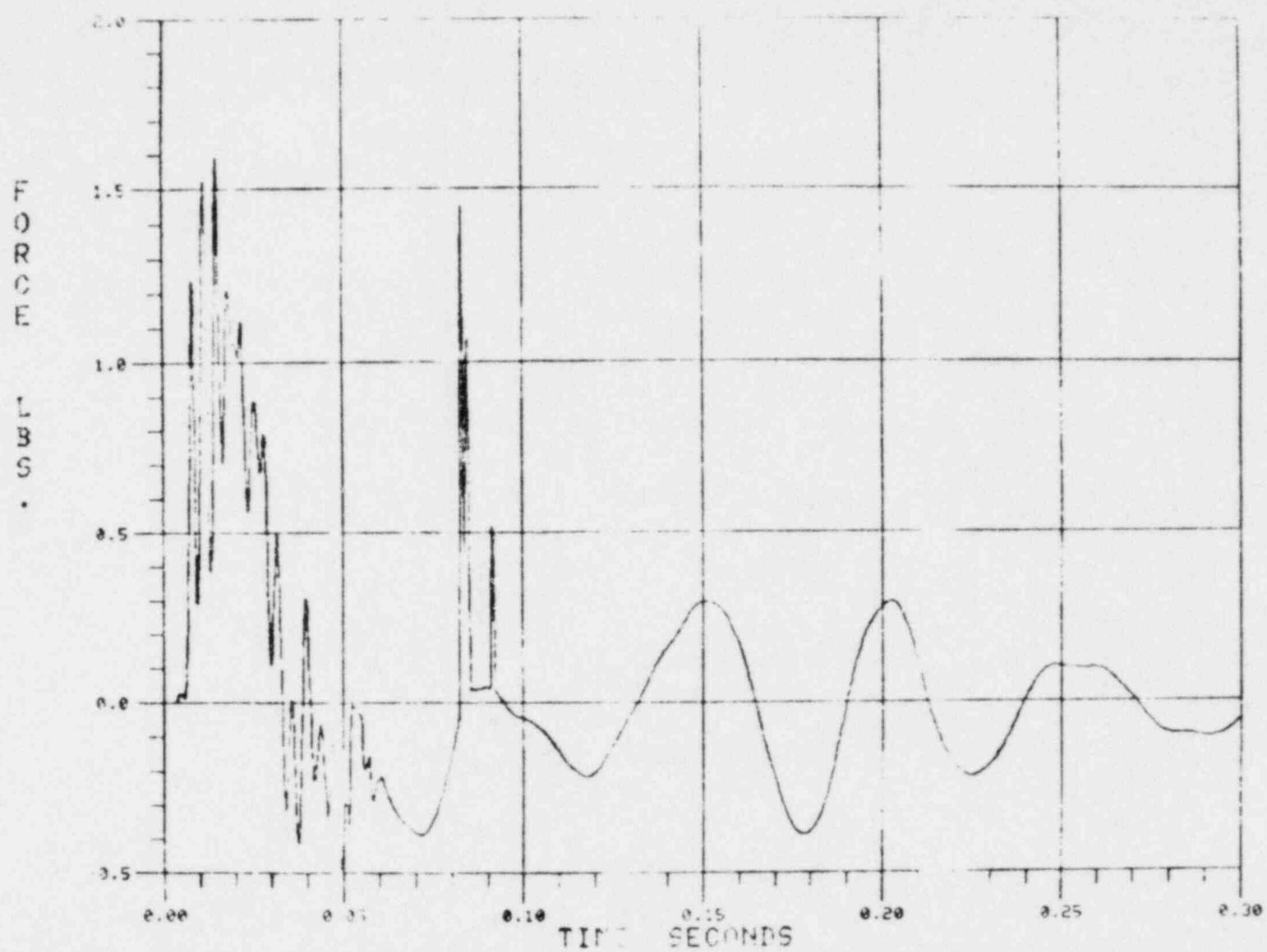
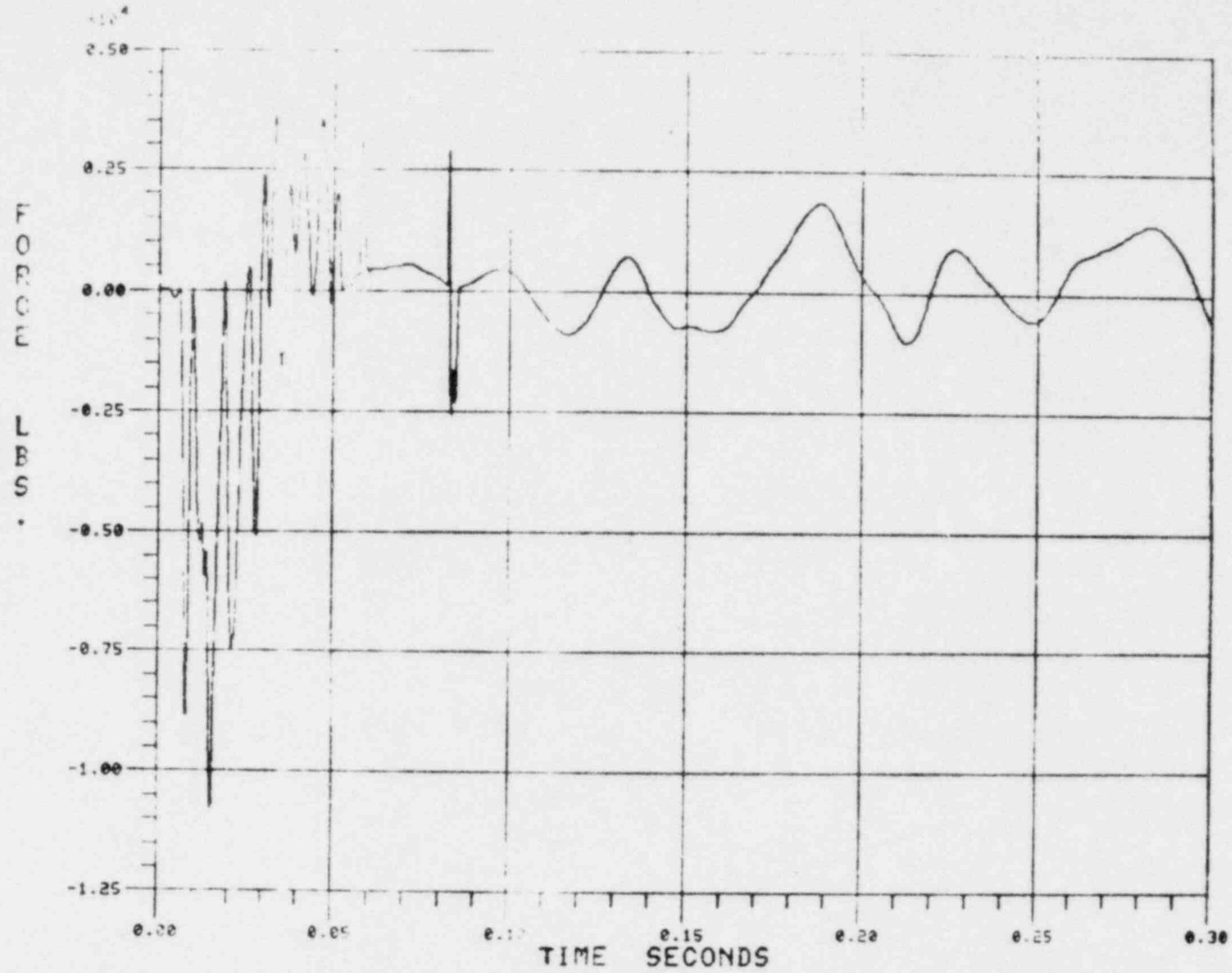


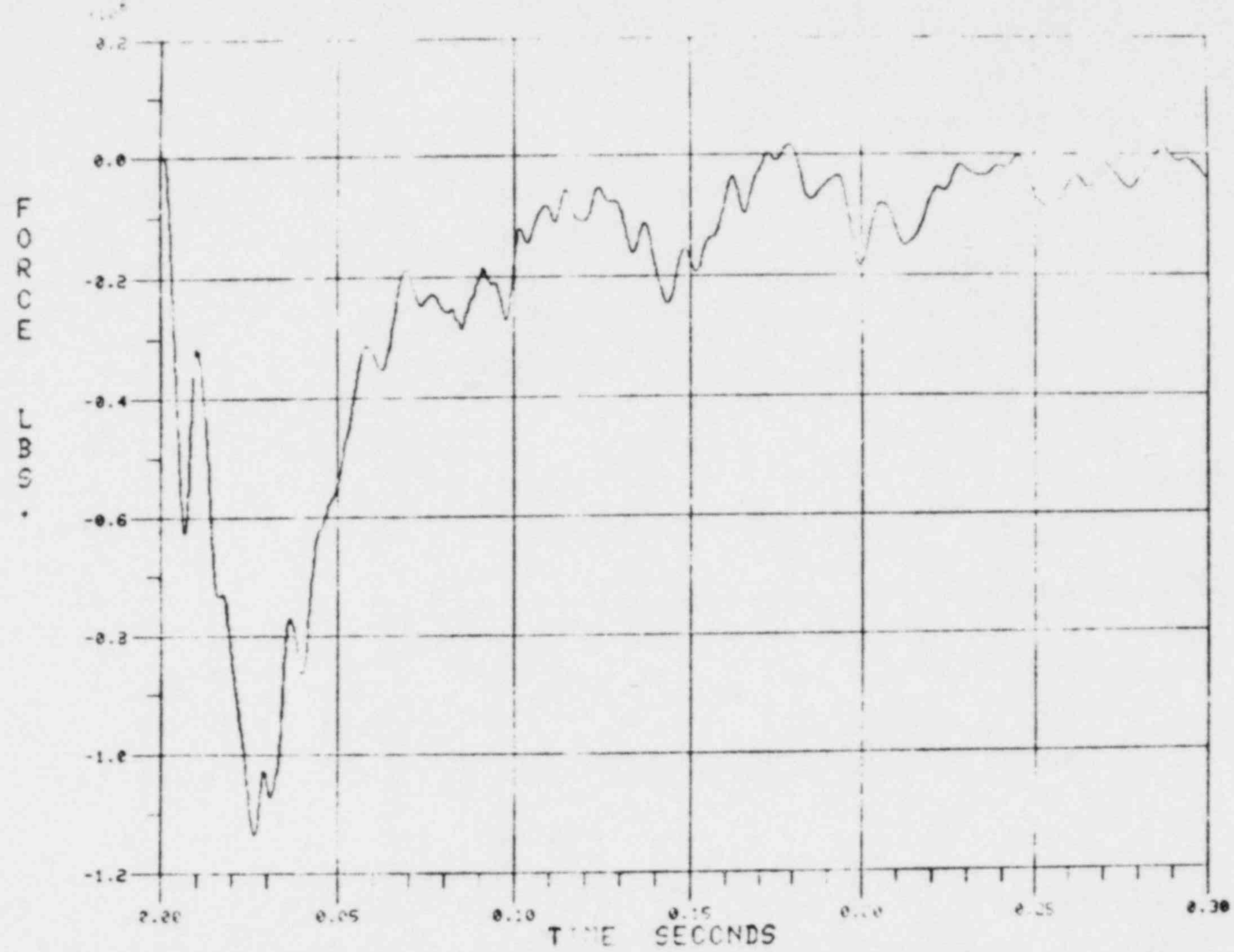
JT 53 FX 37

Figure 2.21-2. (Cont'd)



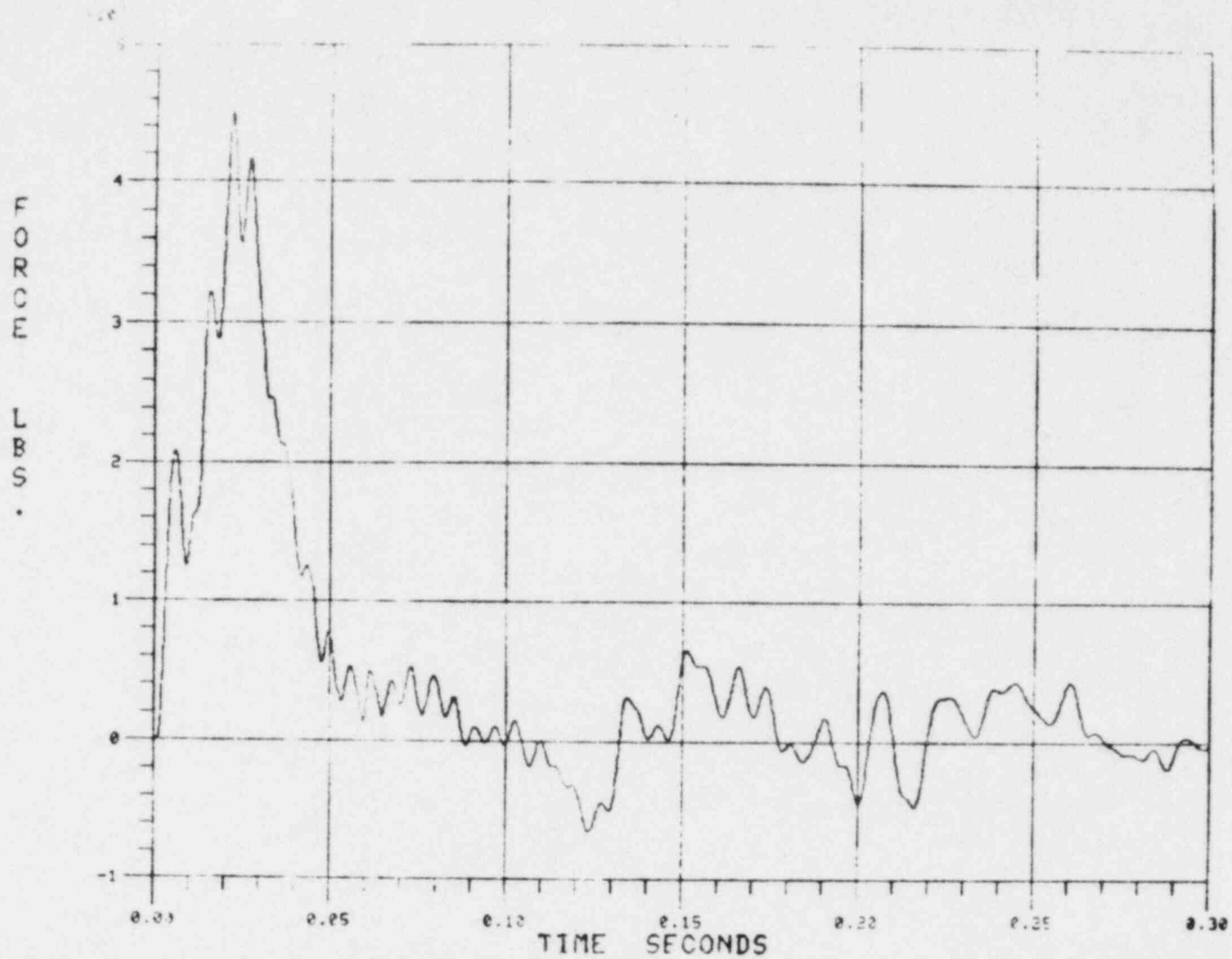
JT 53 FZ 39

Figure 2.21-2. (Cont'd)



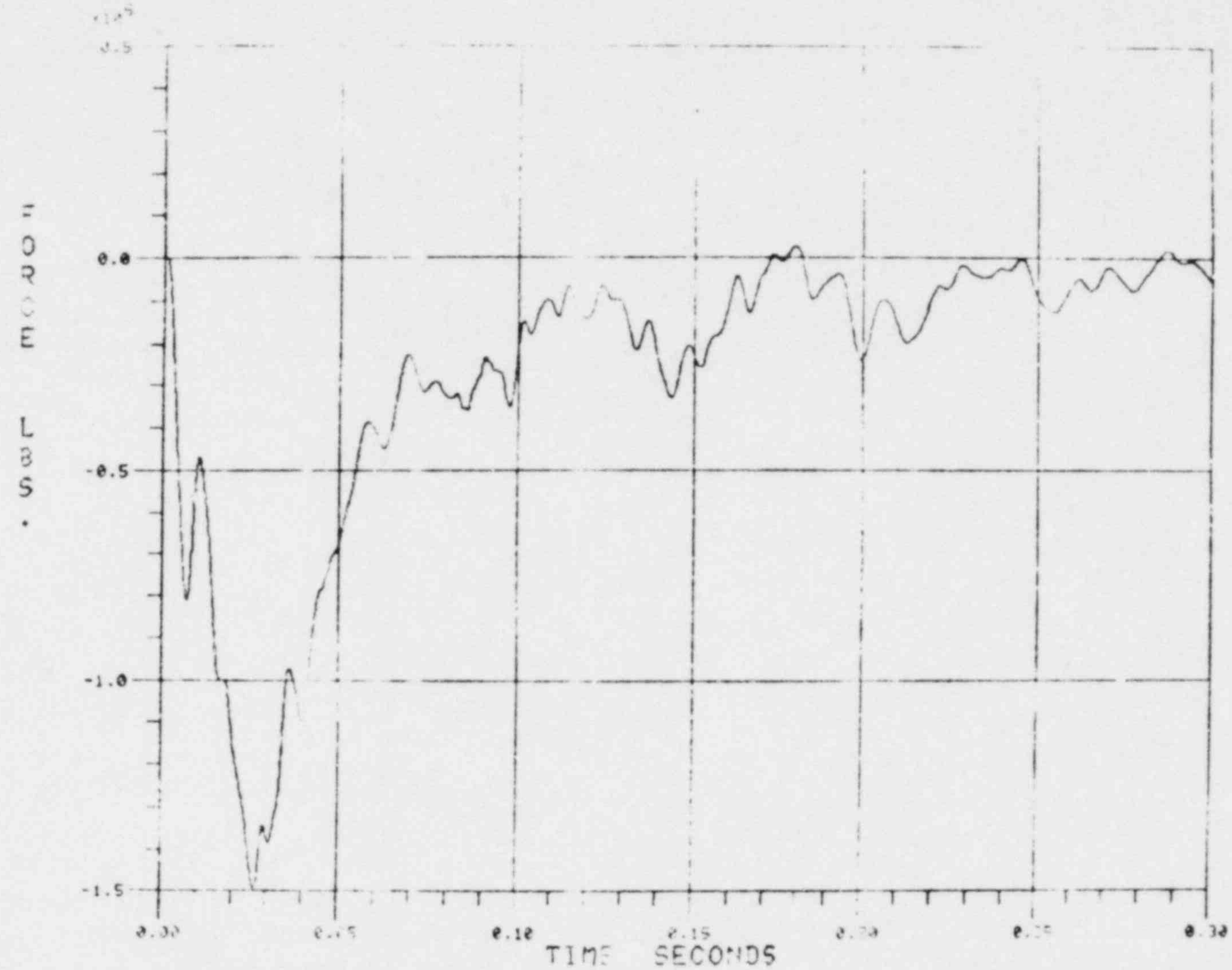
JT 44 FX 43

Figure 2.21-2. (Cont'd)



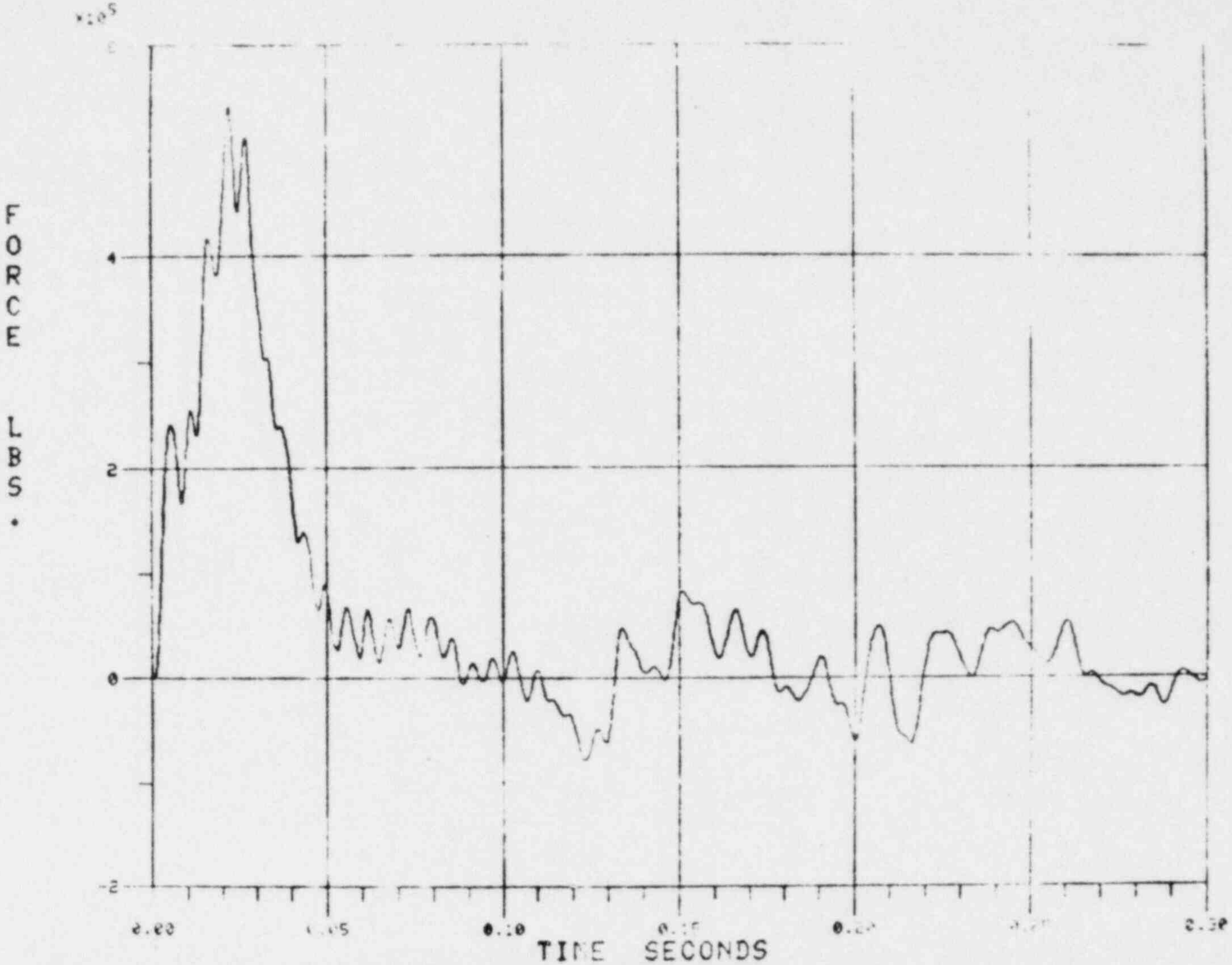
JT 44 FZ 45

Figure 2.21-2. (Cont'd)



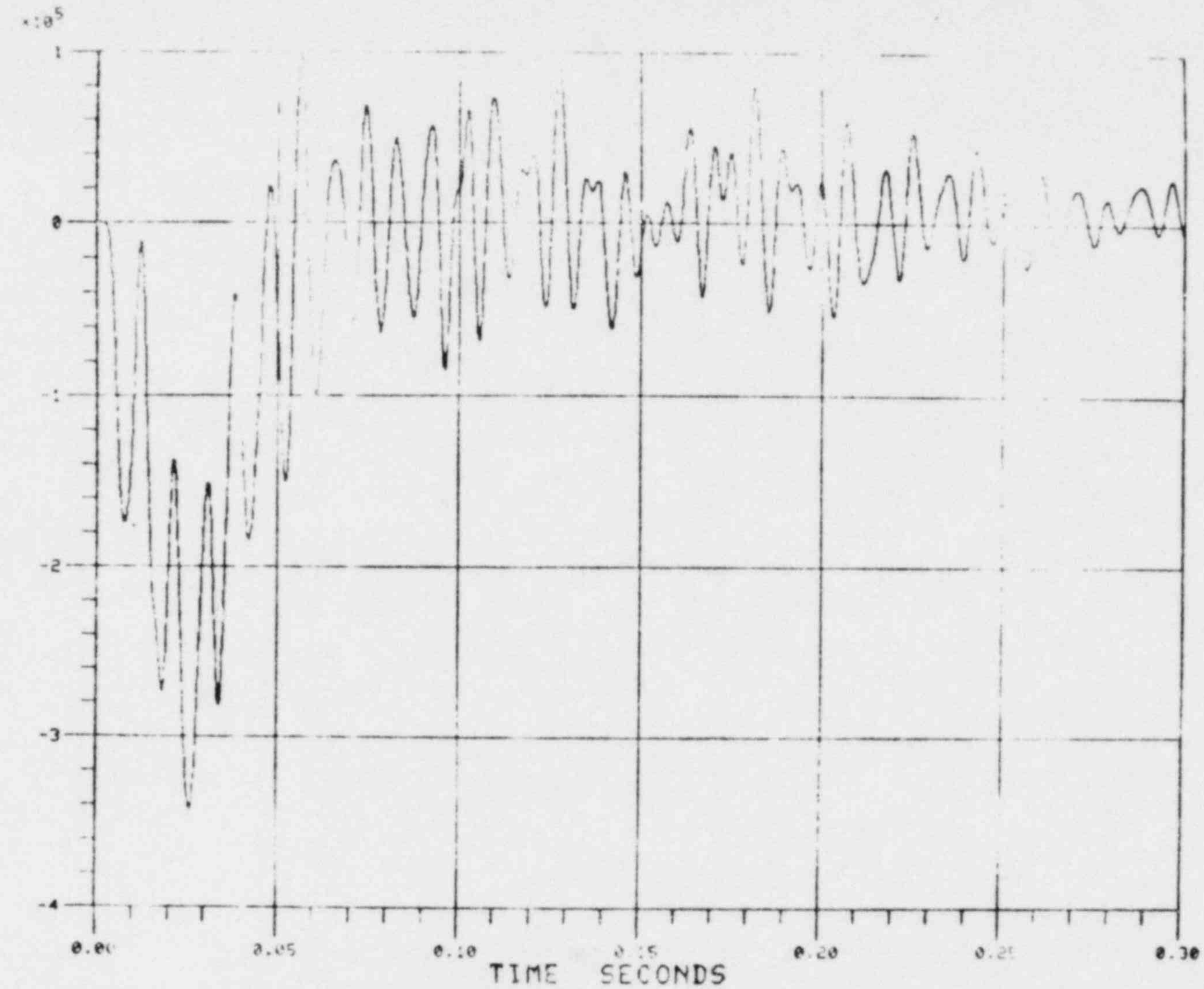
JT 31 FX 49

Figure 2.21-2. (Cont'd)



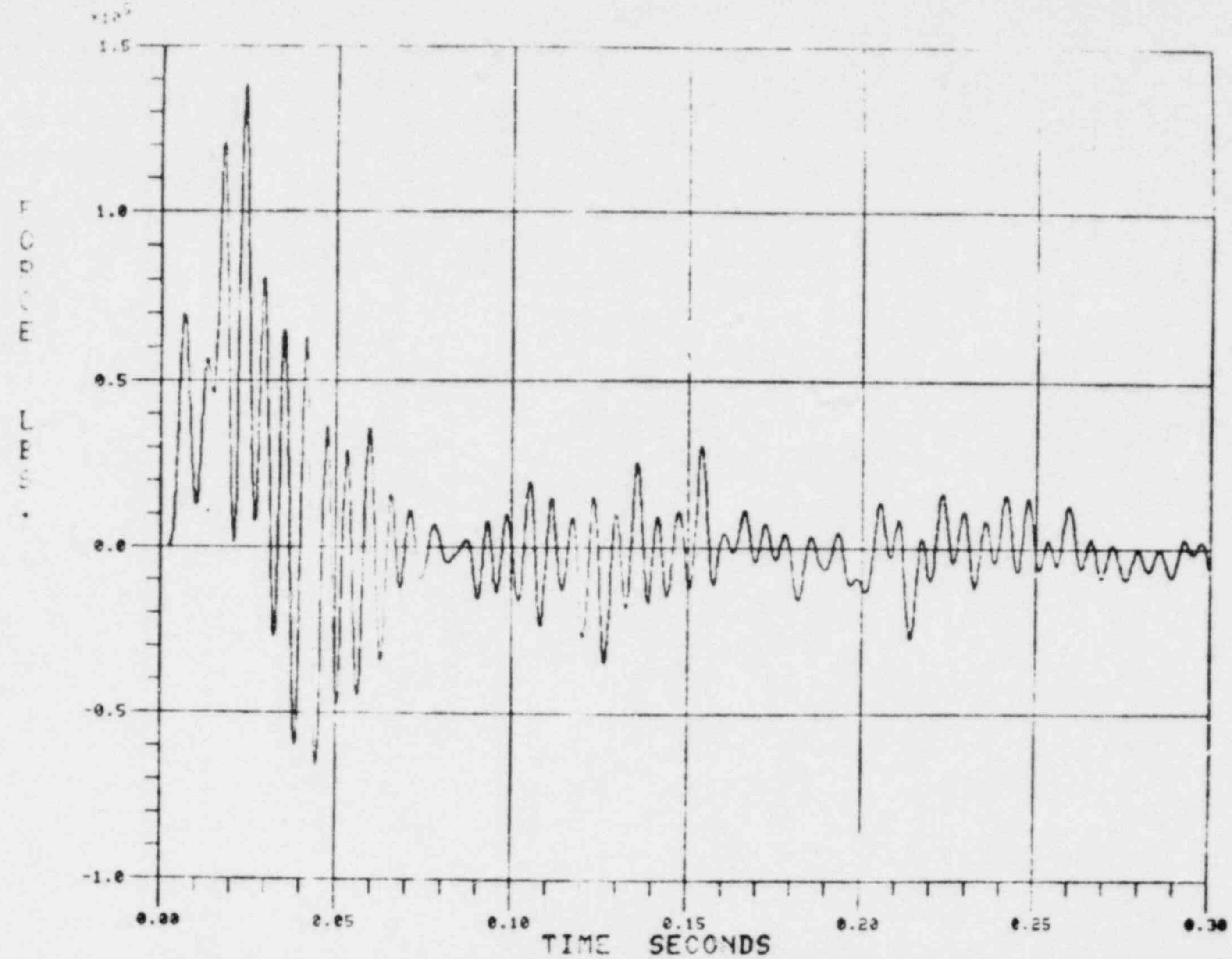
JT 31 FZ 51

Figure 2.21-2. (Cont'd)



JT 1 FX 91

Figure 2.21-2. (Cont'd)



JT 1 FZ 93

Figure 2.21-2. (Cont'd)

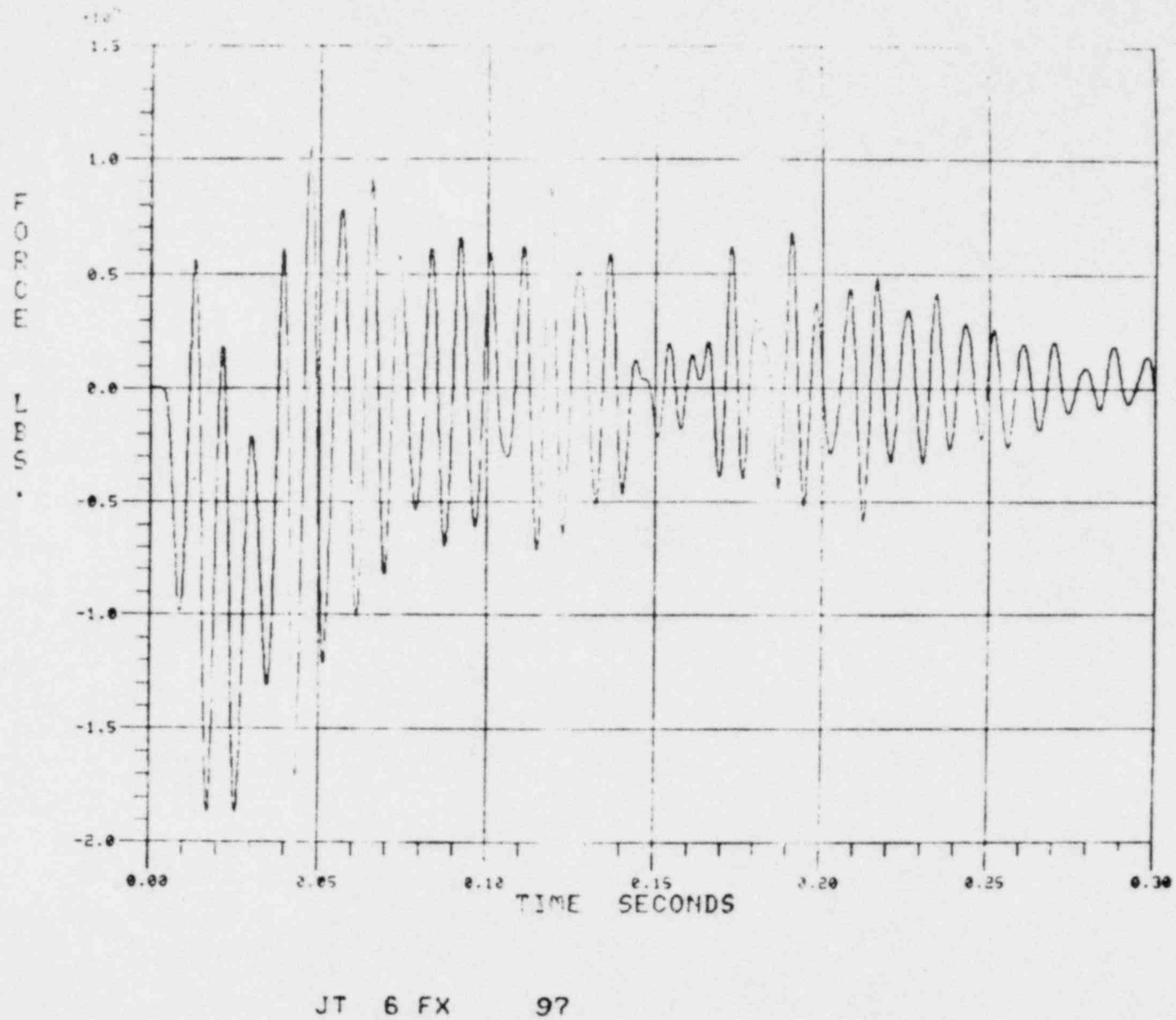
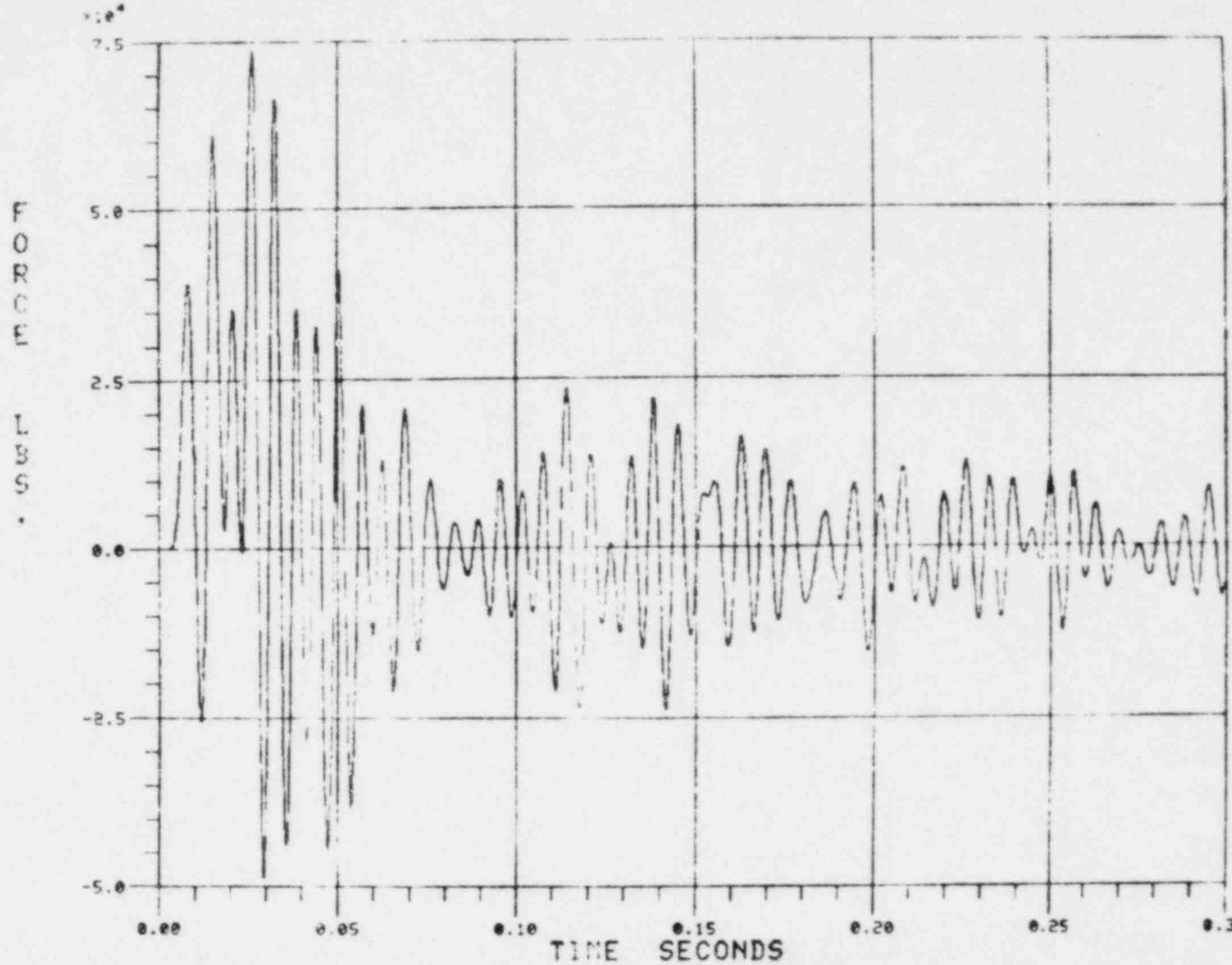
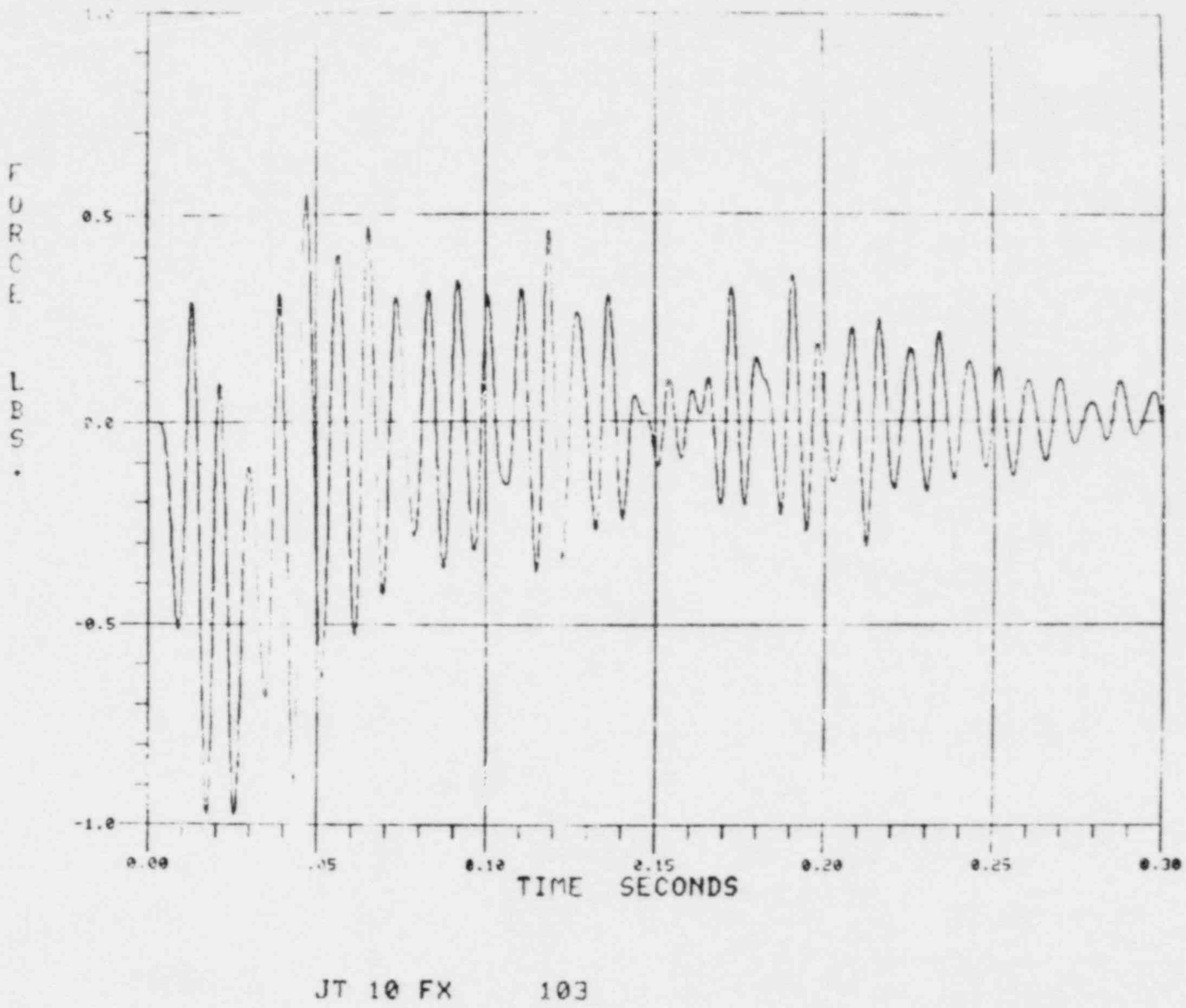


Figure 2.21-2. (Cont'd)



JT 6 FZ 99

Figure 2.21-2. (Cont'd)



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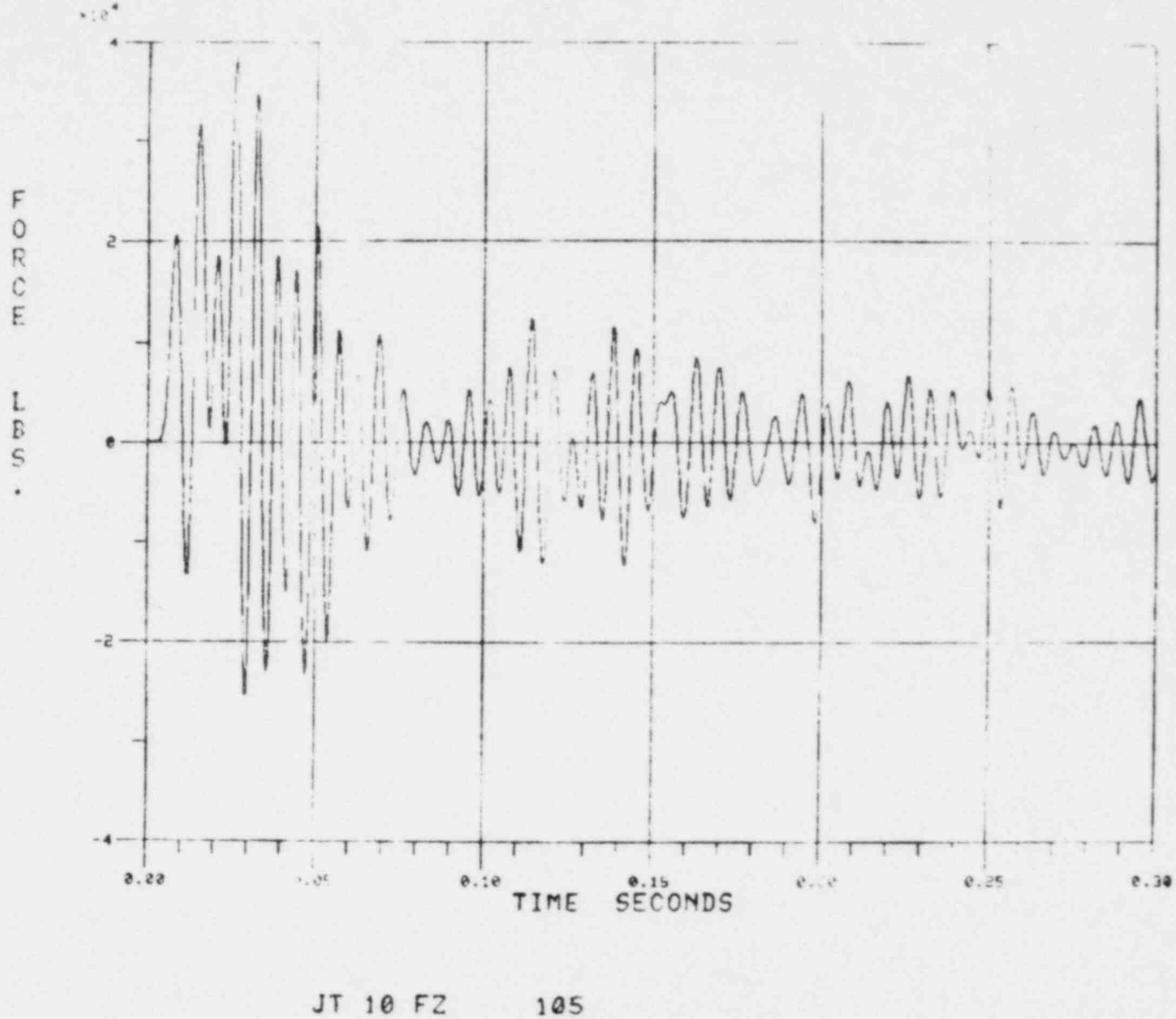


Figure 2.21-3. Force Across Core Support Shield — 1.024A Hot Leg Break at RV, Nozzle-Supported Plant

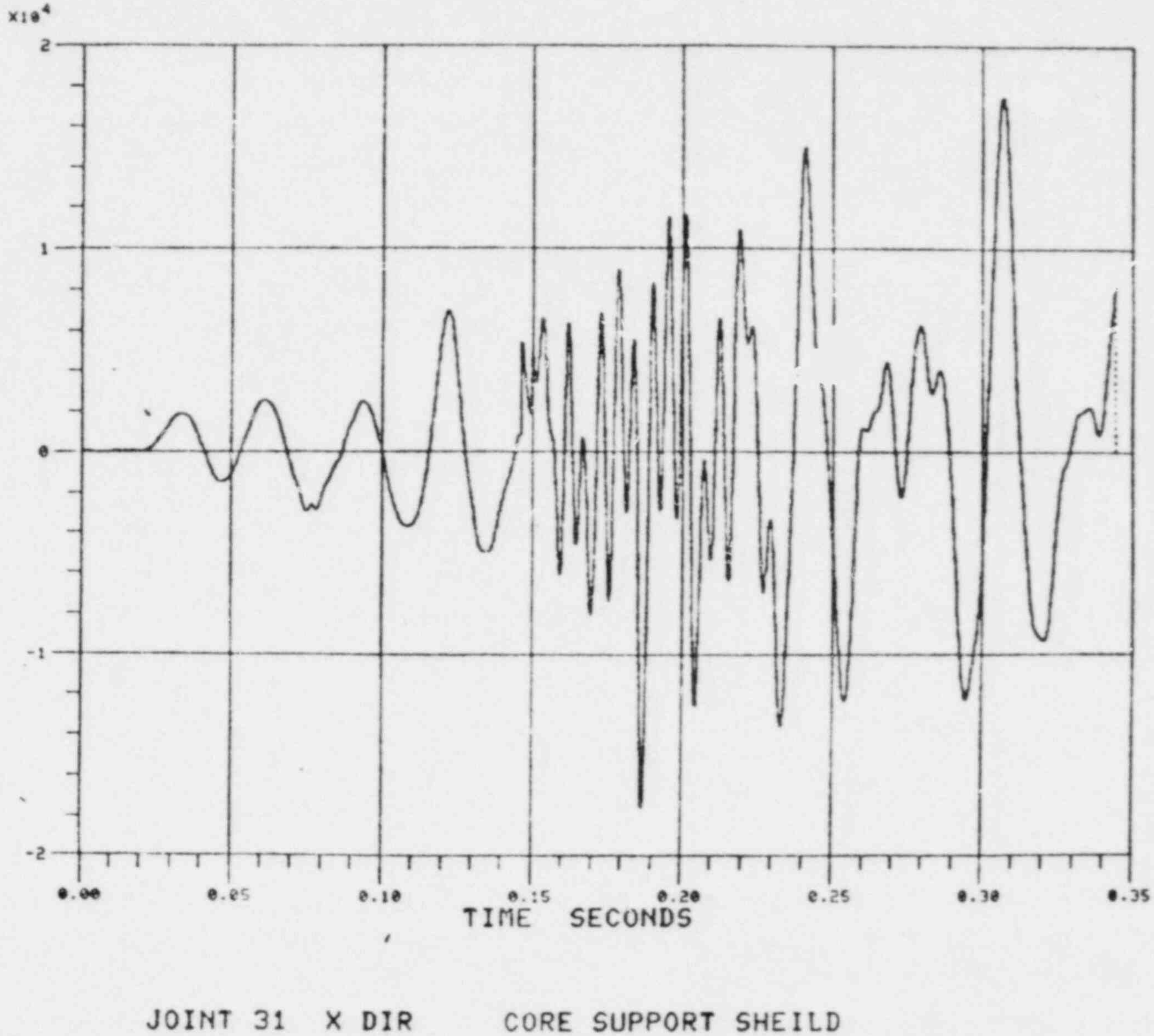
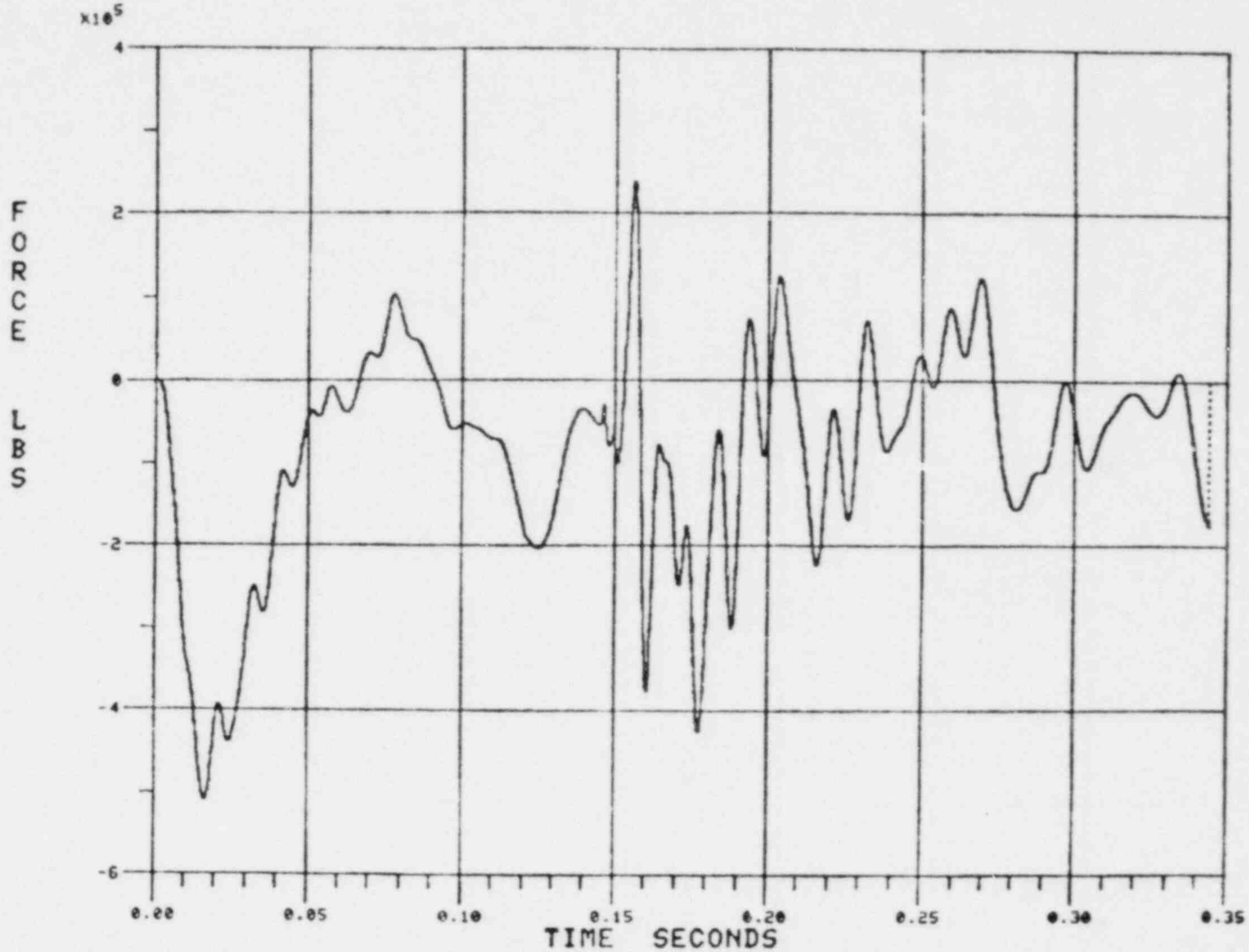
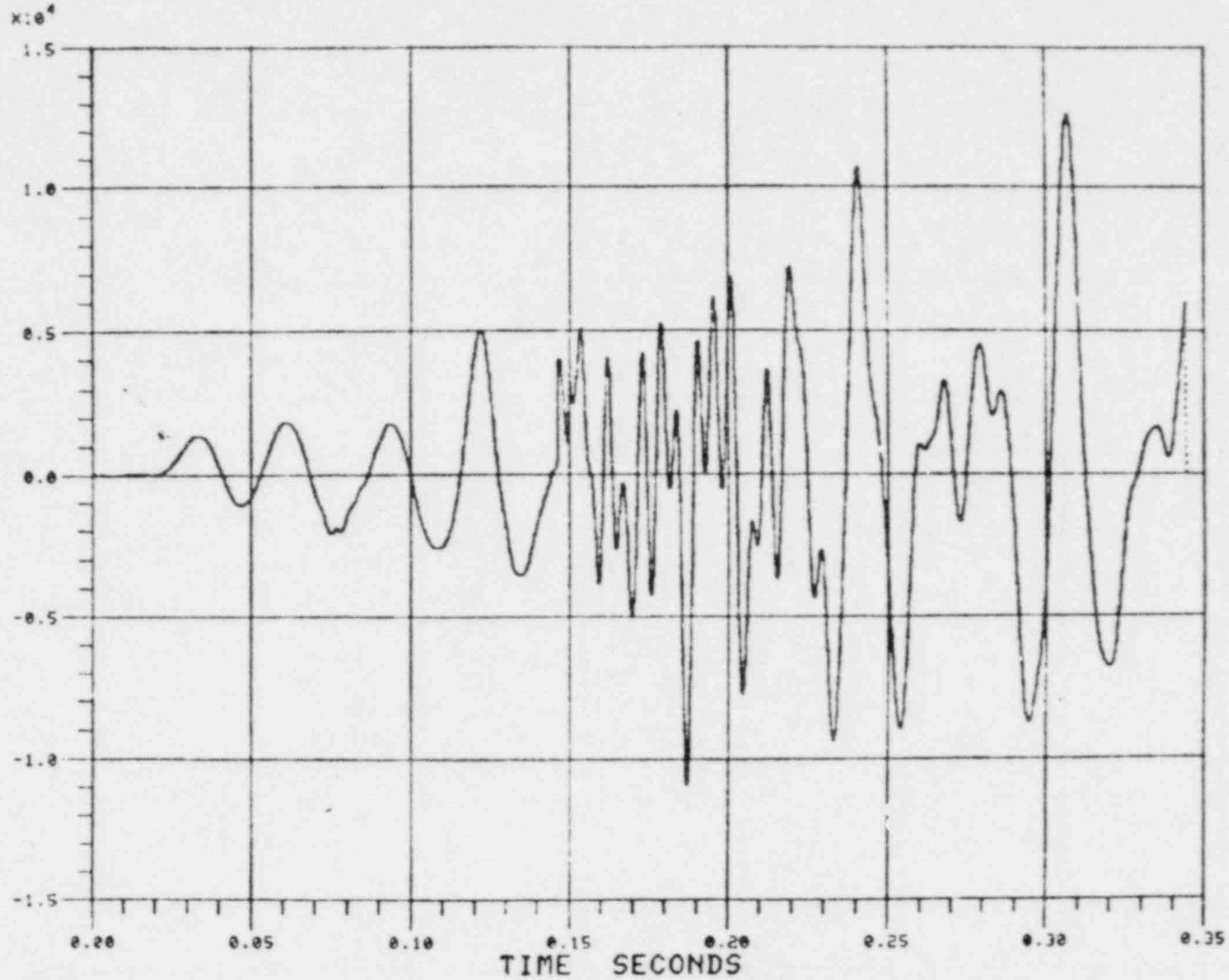


Figure 2.21-3. (Cont'd)



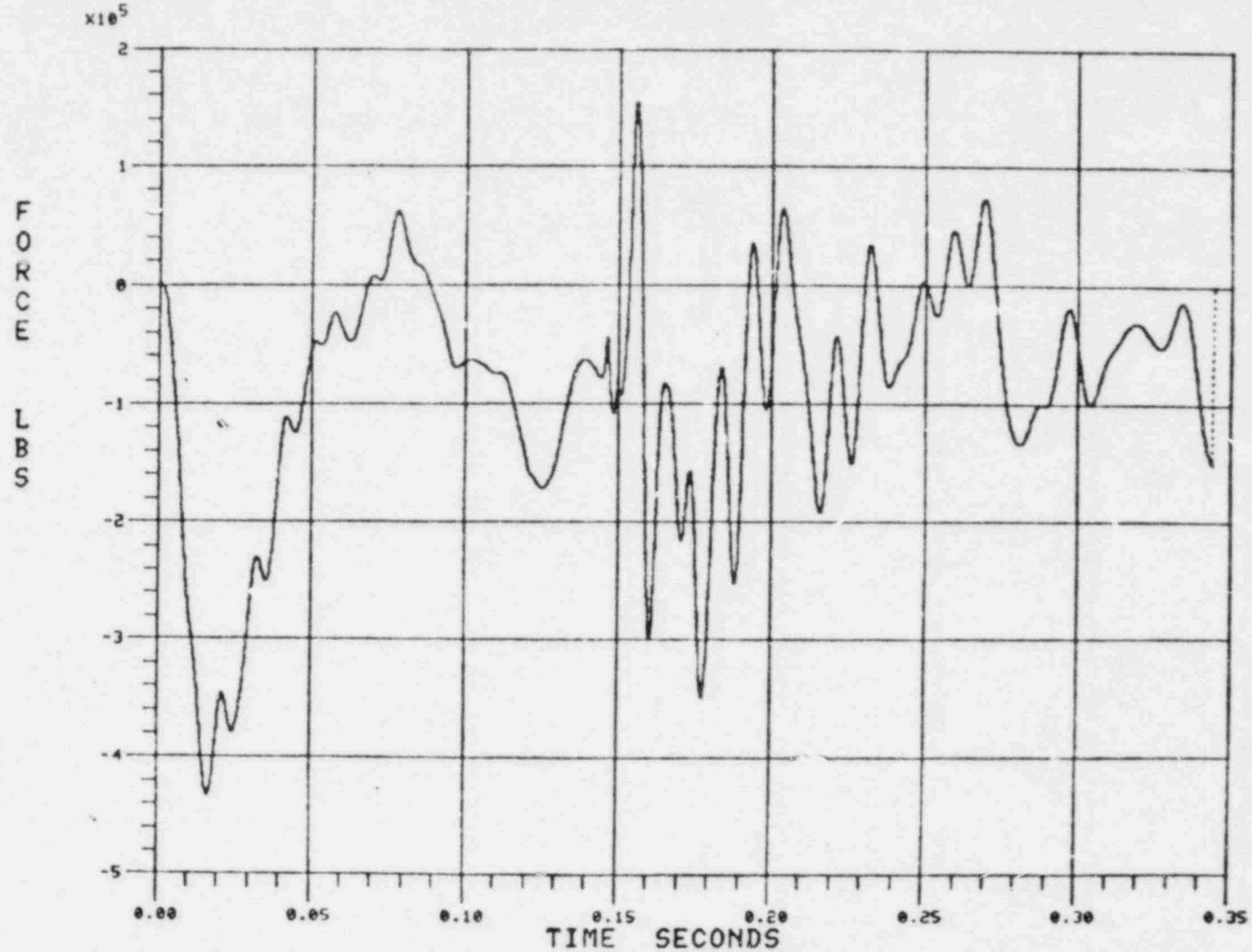
JOINT 31 Z DIR CORE SUPPORT SHEILD

Figure 2.21-3. (Cont'd)



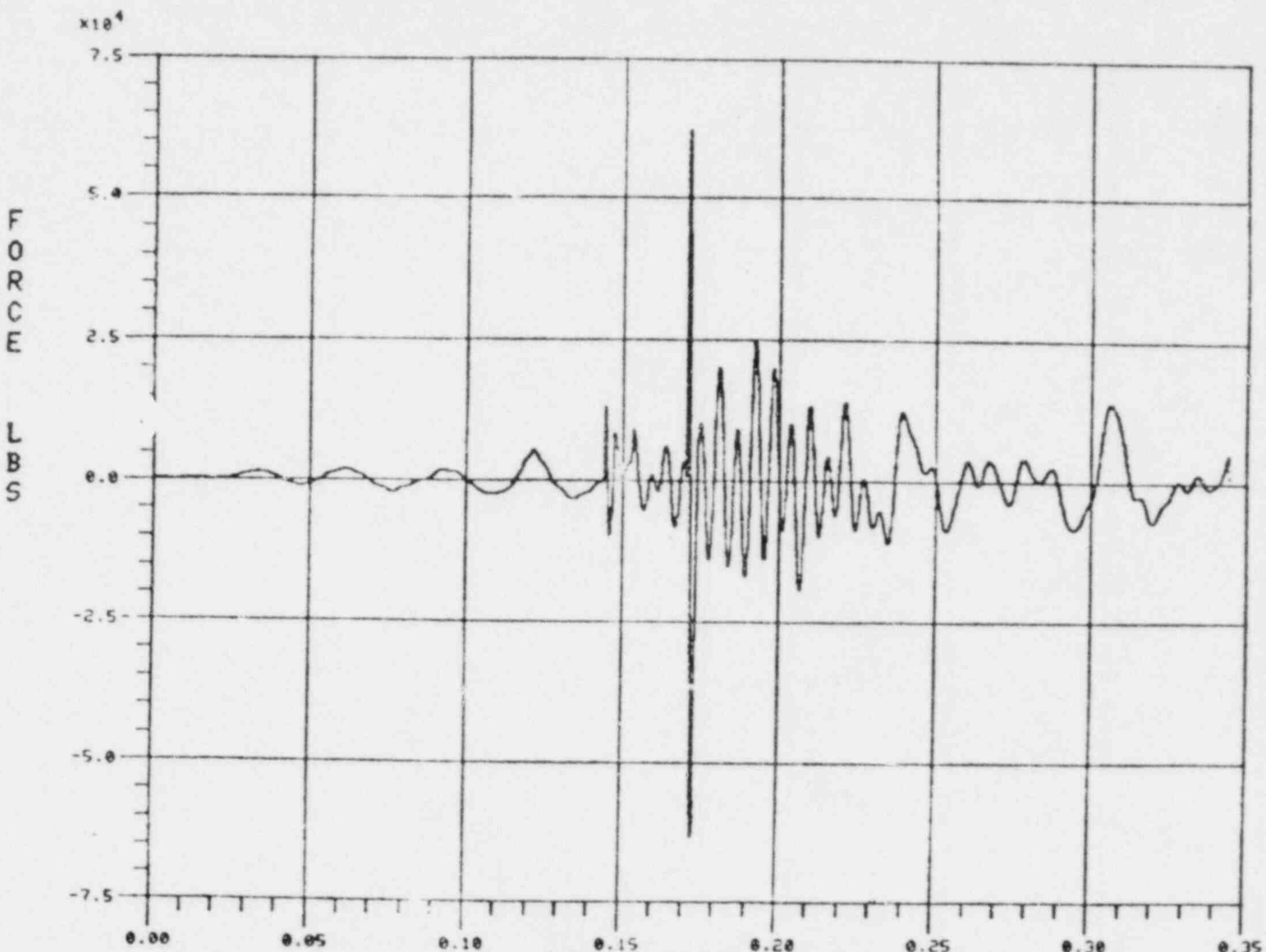
JOINT 44 X DIR CORE SUPPORT SHEILD

Figure 2.21-3. (Cont'd)



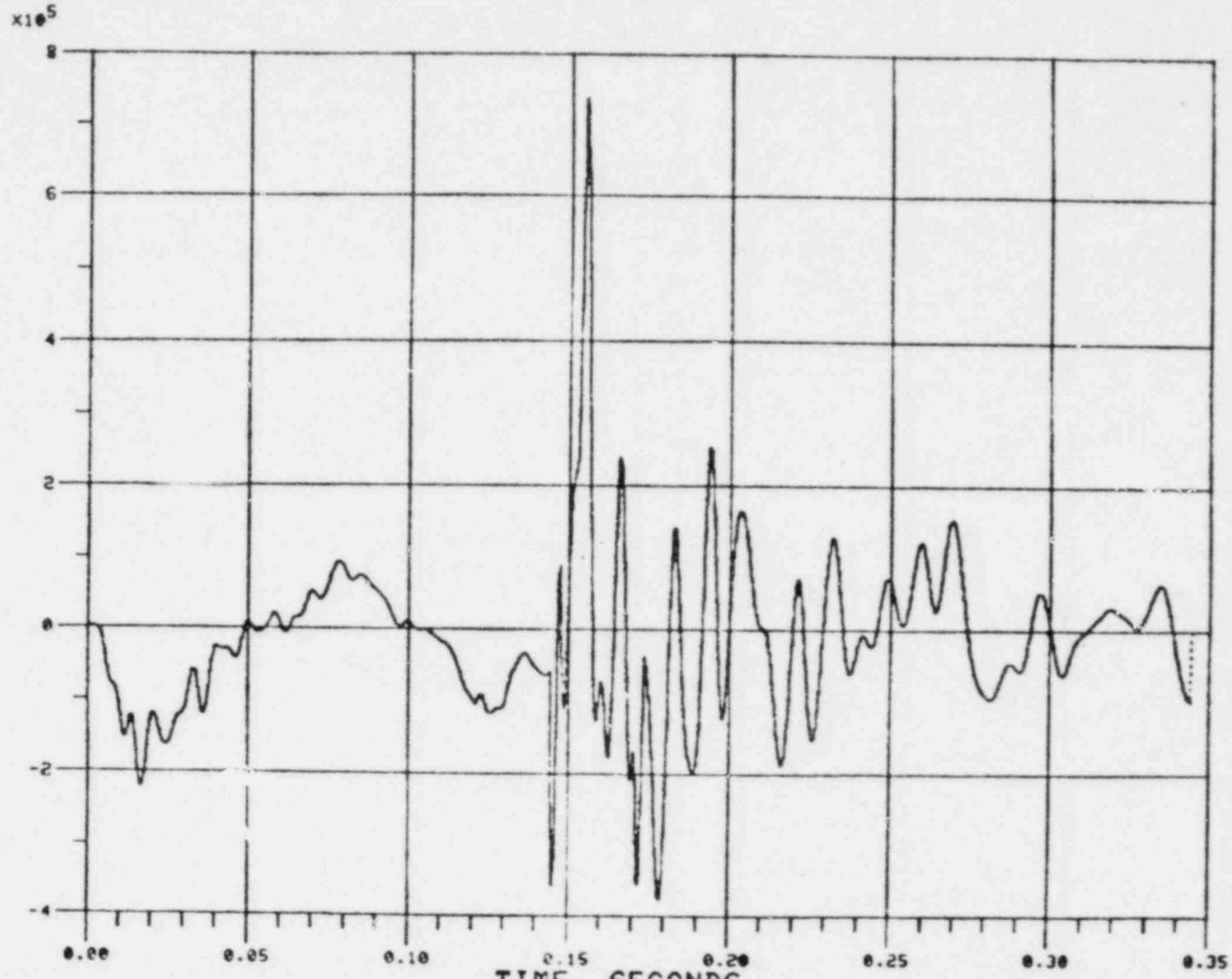
JOINT 44 Z DIR CORE SUPPORT SHEILD

Figure 2.21-3. (Cont'd)



JOINT 62 X DIR CORE SUPPORT SHEILD

Figure 2.21-3. (Cont'd)



JOINT 62 Z DIR CORE SUPPORT SHEILD

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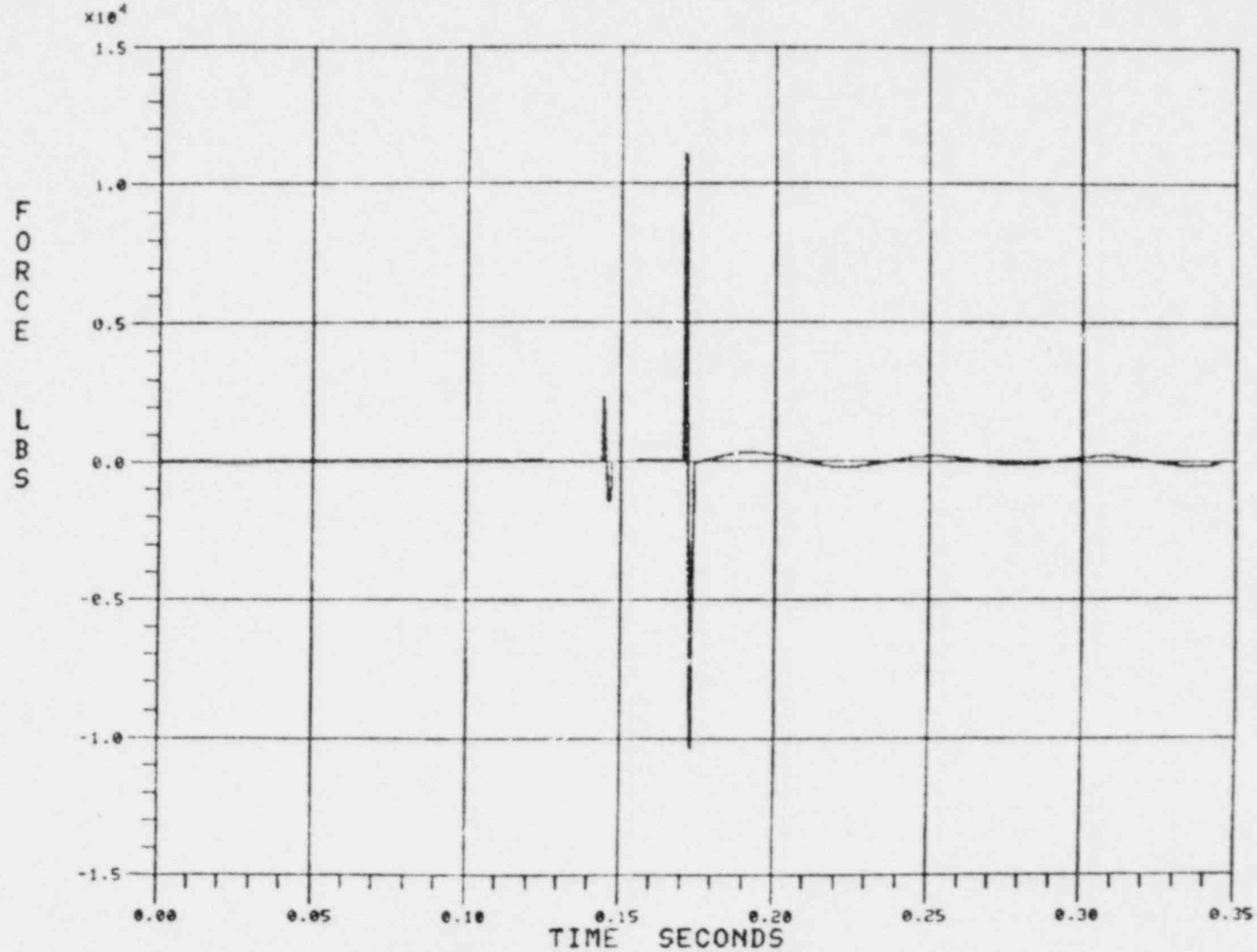


JOINT 53 X DIR CORE SUPPORT SHEILD

Figure 2.21-3. (Cont'd)

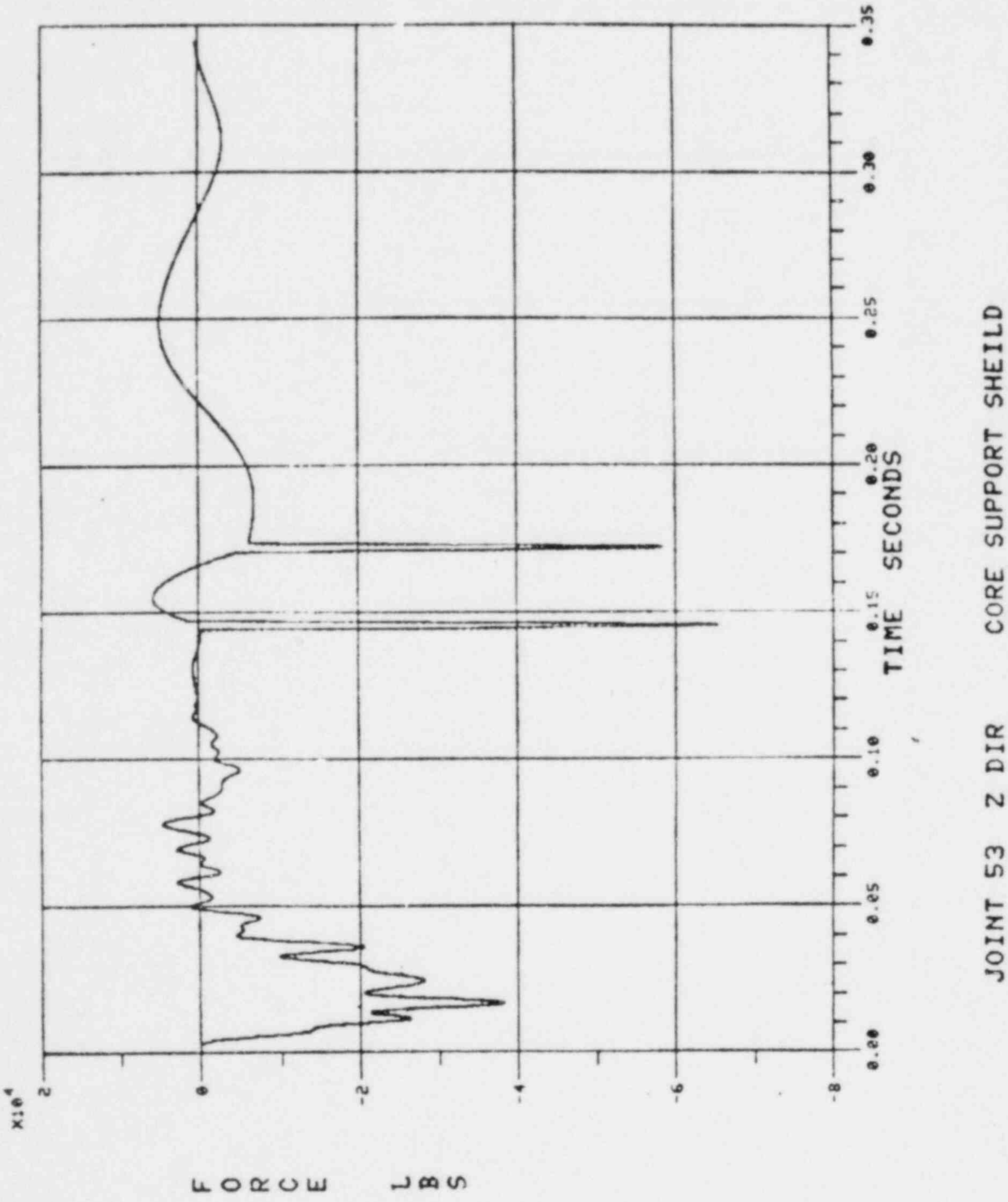


Figure 2.21-3. (Cont'd)

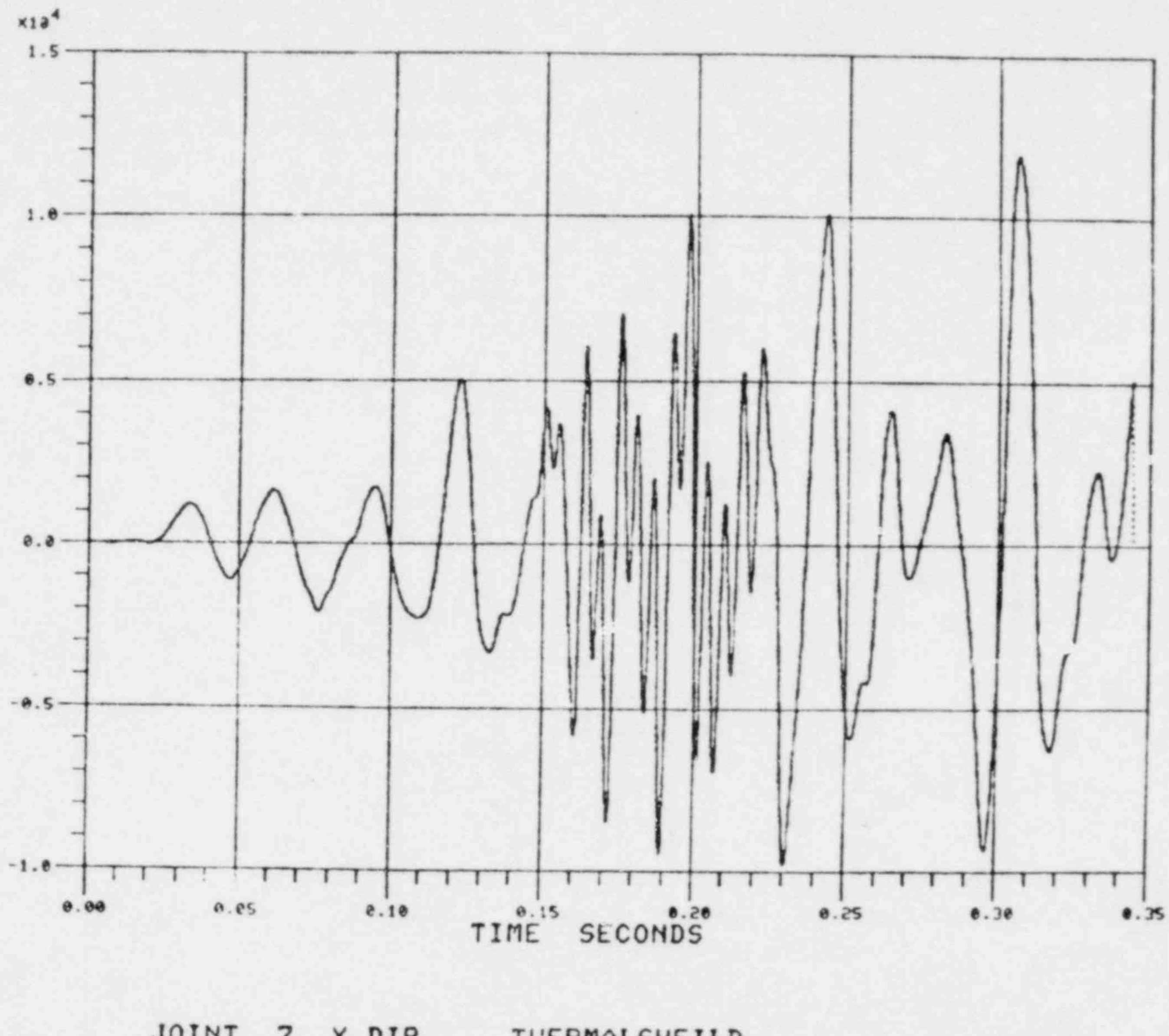
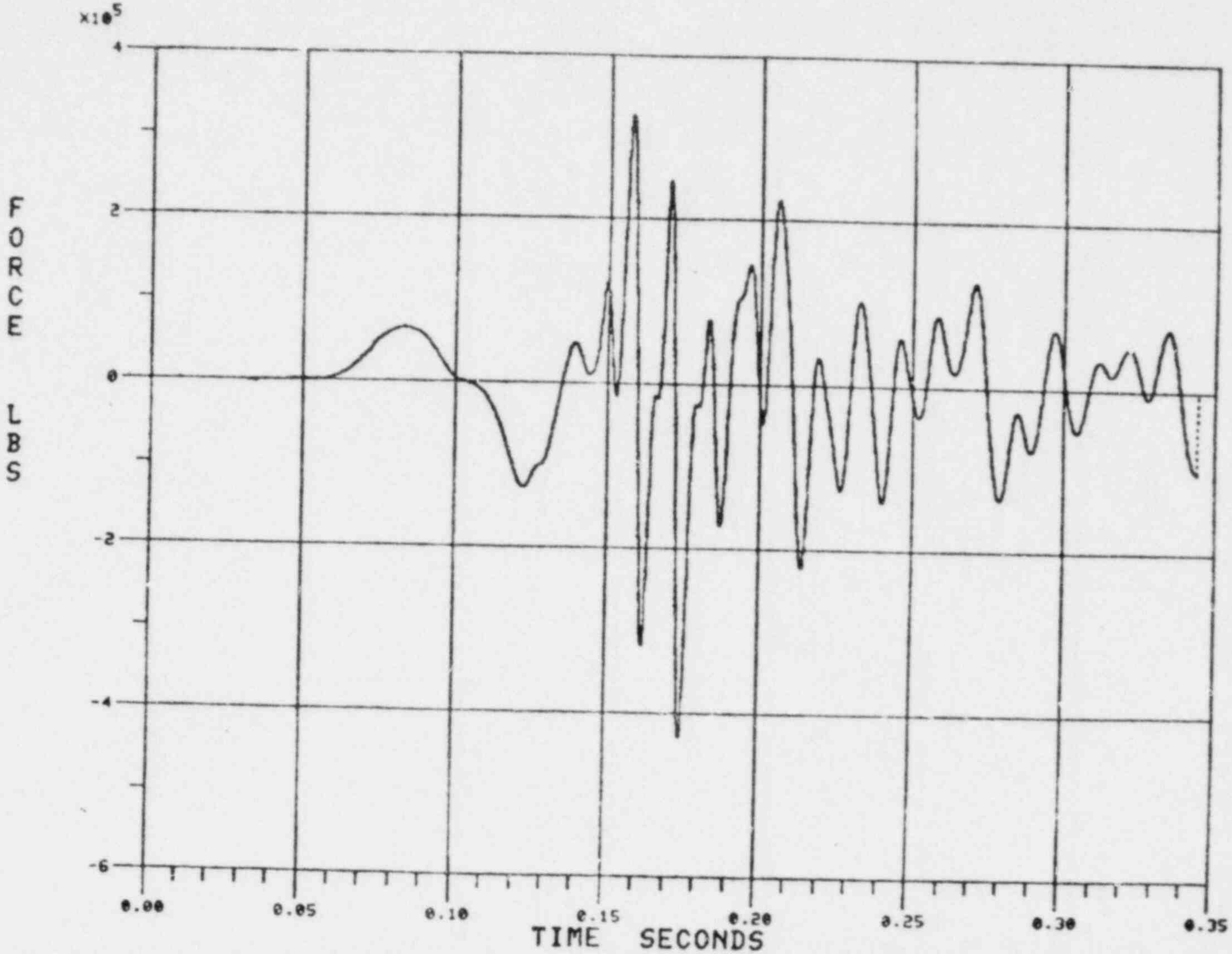
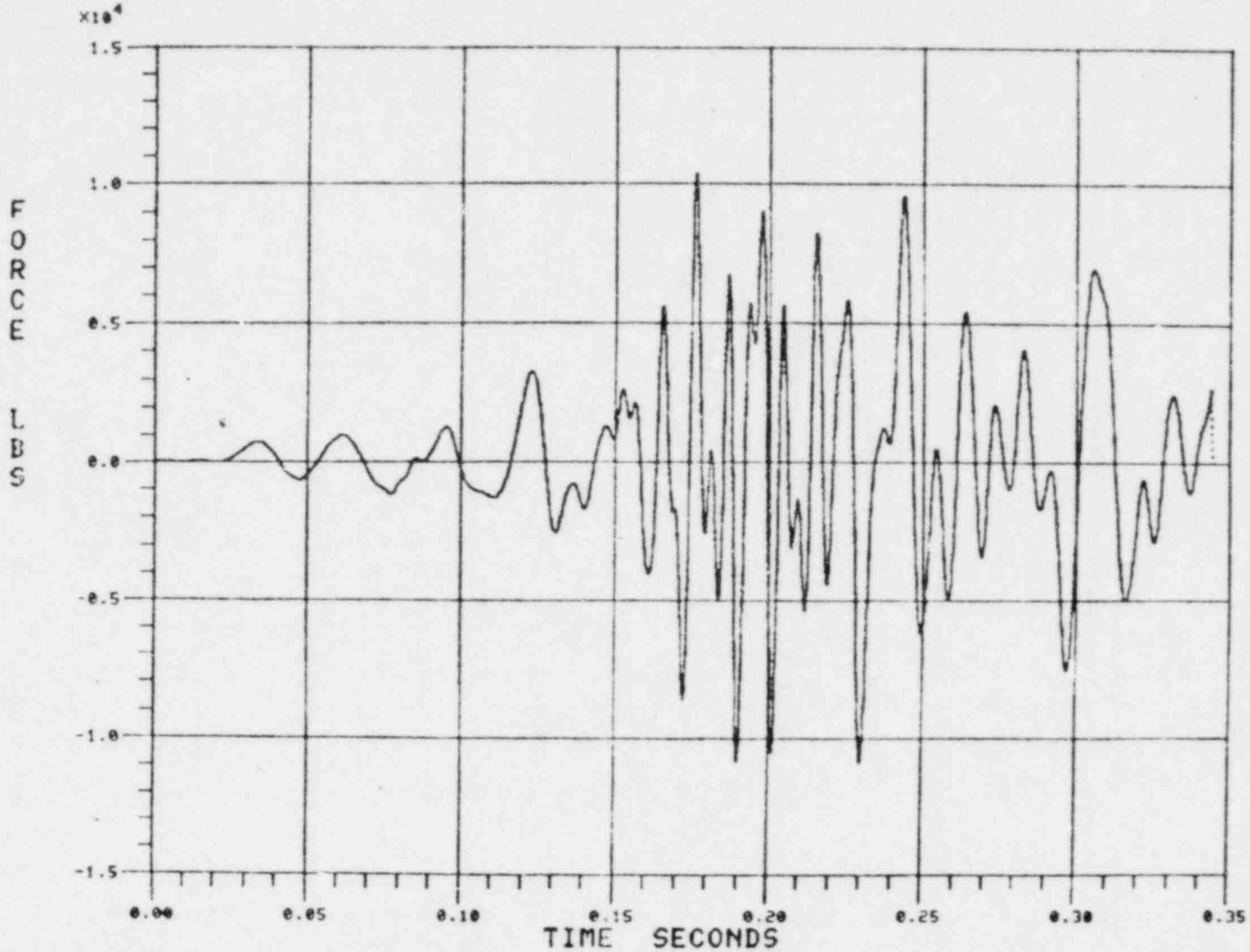


Figure 2.21-3. (Cont'd)



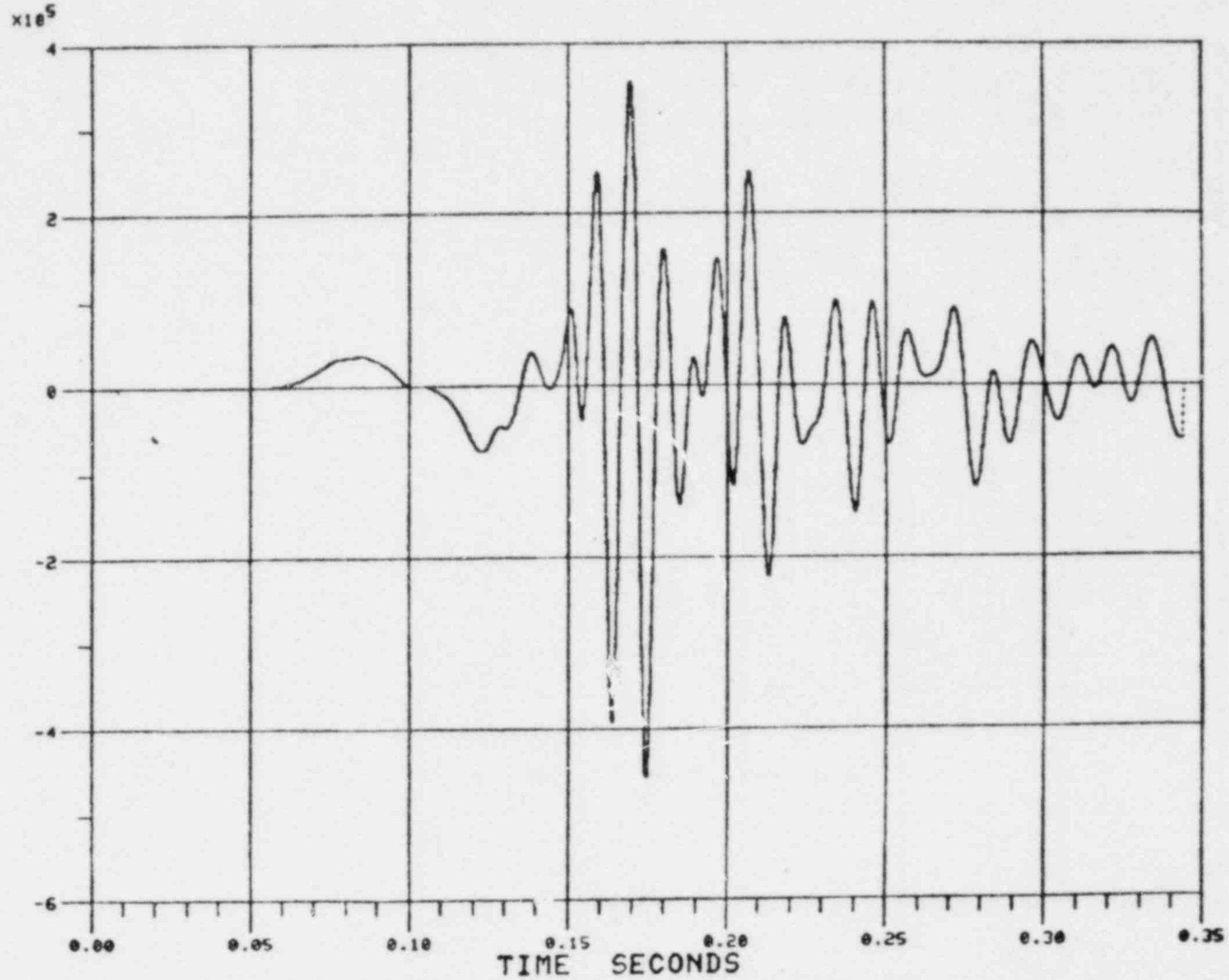
JOINT 7 Z DIR THERMALSHEILD

Figure 2.21-3. (Cont'd)



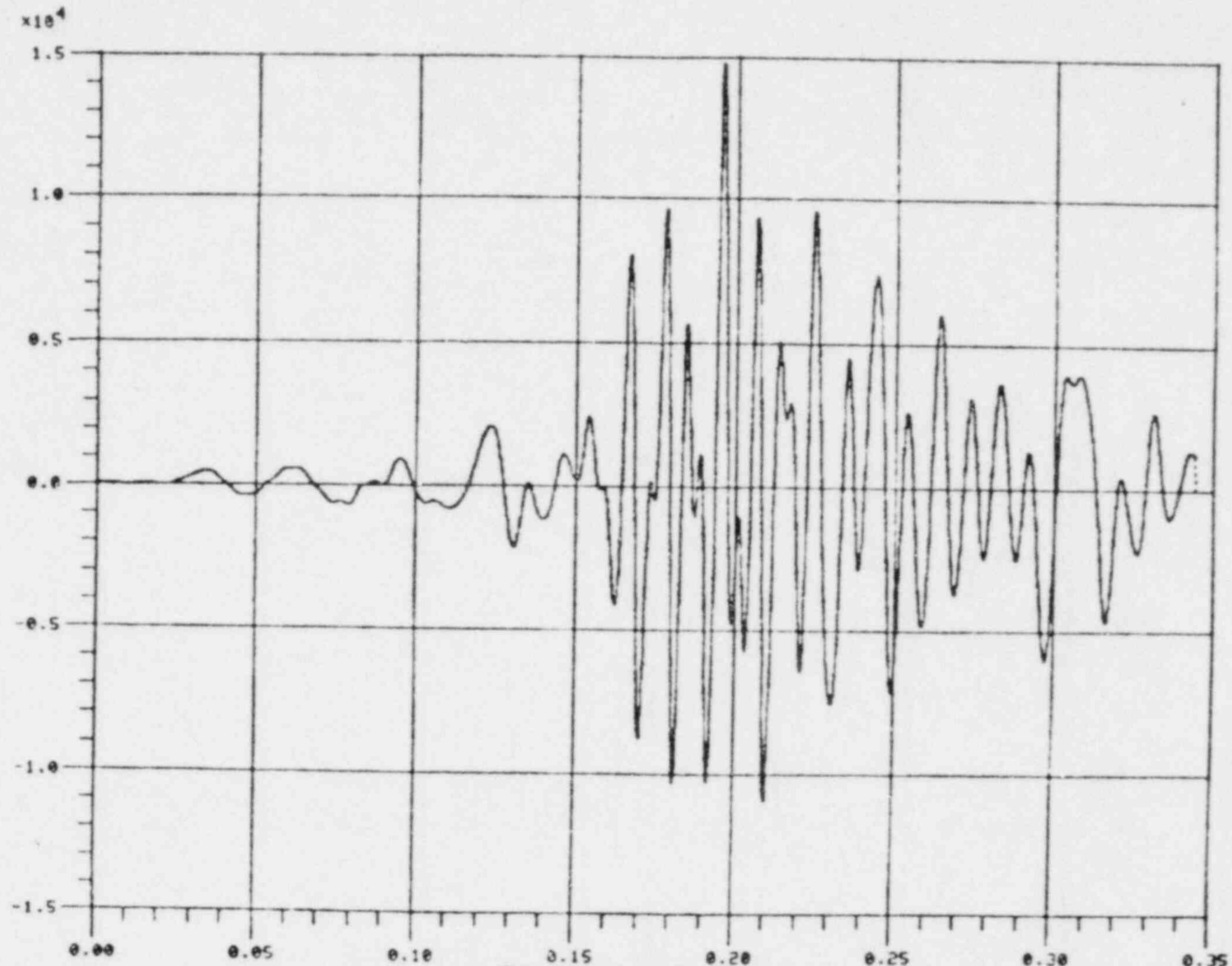
JOINT 1 X DIR THERMALSHEILD

Figure 2.21-3. (Cont'd)



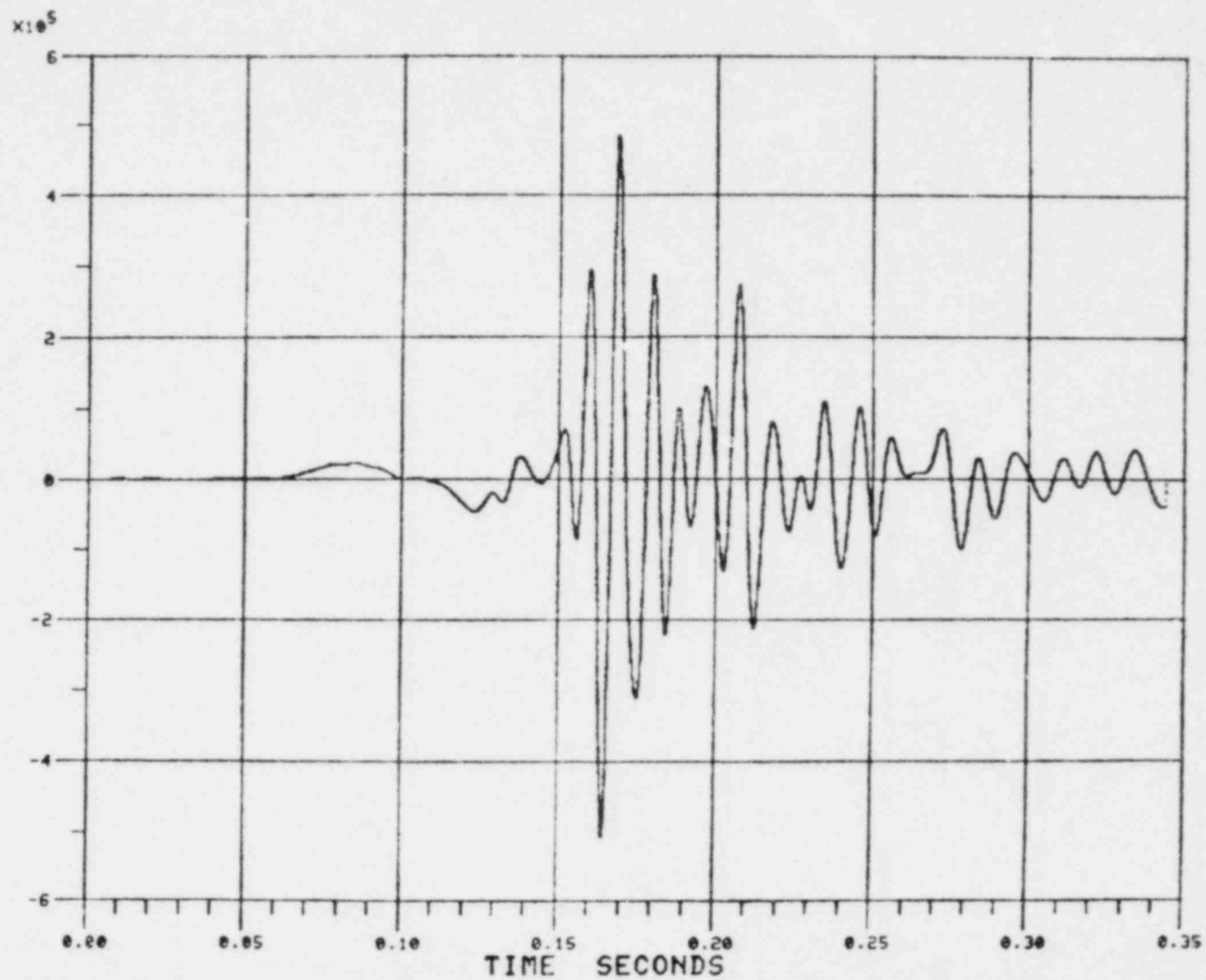
JOINT 1 Z DIR THERMALSHEILD

Figure 2.21-3. (Cont'd)



JOINT 6 X DIR THERMALSHEILD

Figure 2.21-3. (Cont'd)



JOINT 6 Z DIR THERMALSHEILD

Figure 2.21-4. Force Across Core Support Shield — 0.242A Cold Leg Break at RV, Nozzle-Supported Plant

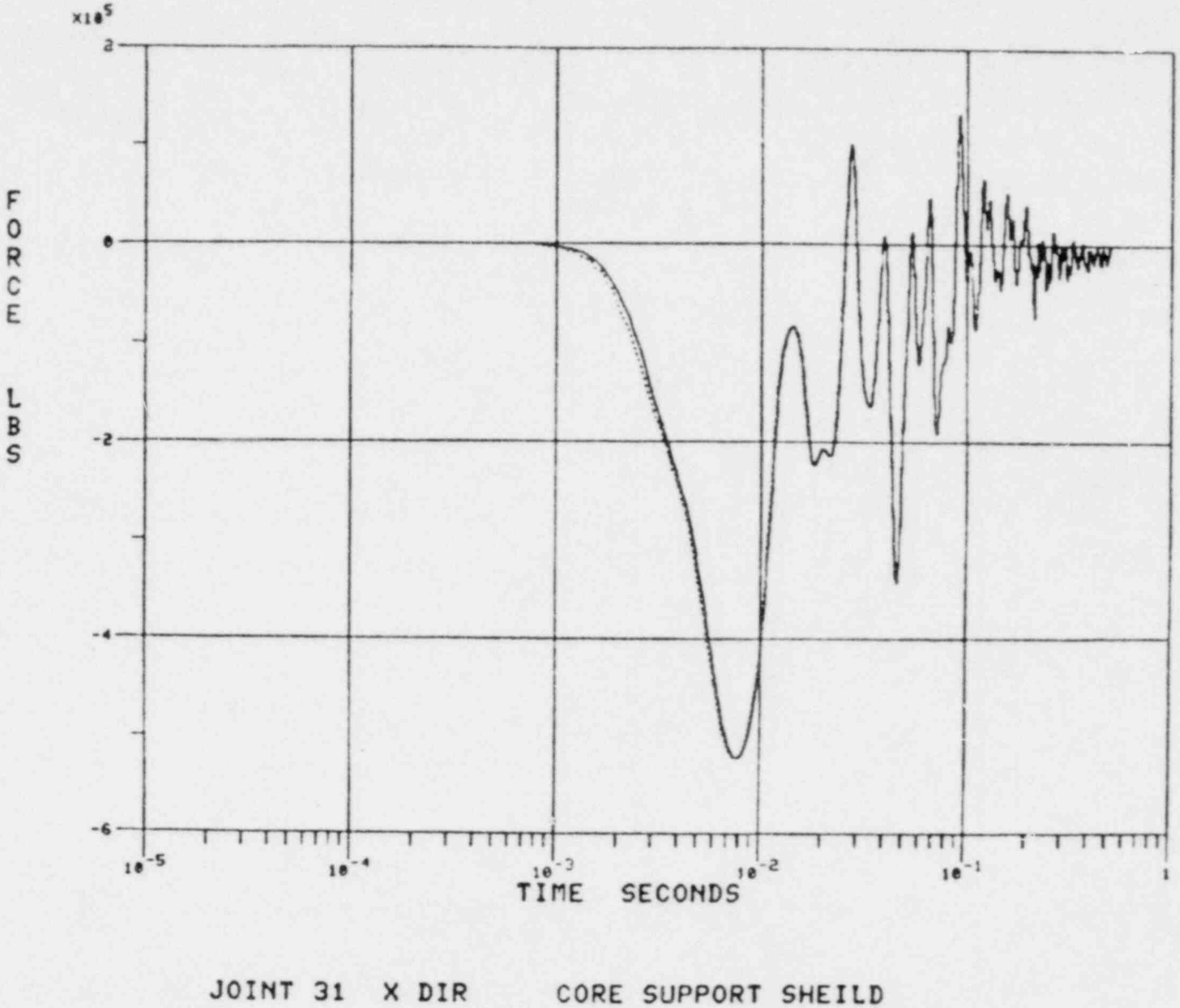


Figure 2.21-4. (Cont'd)

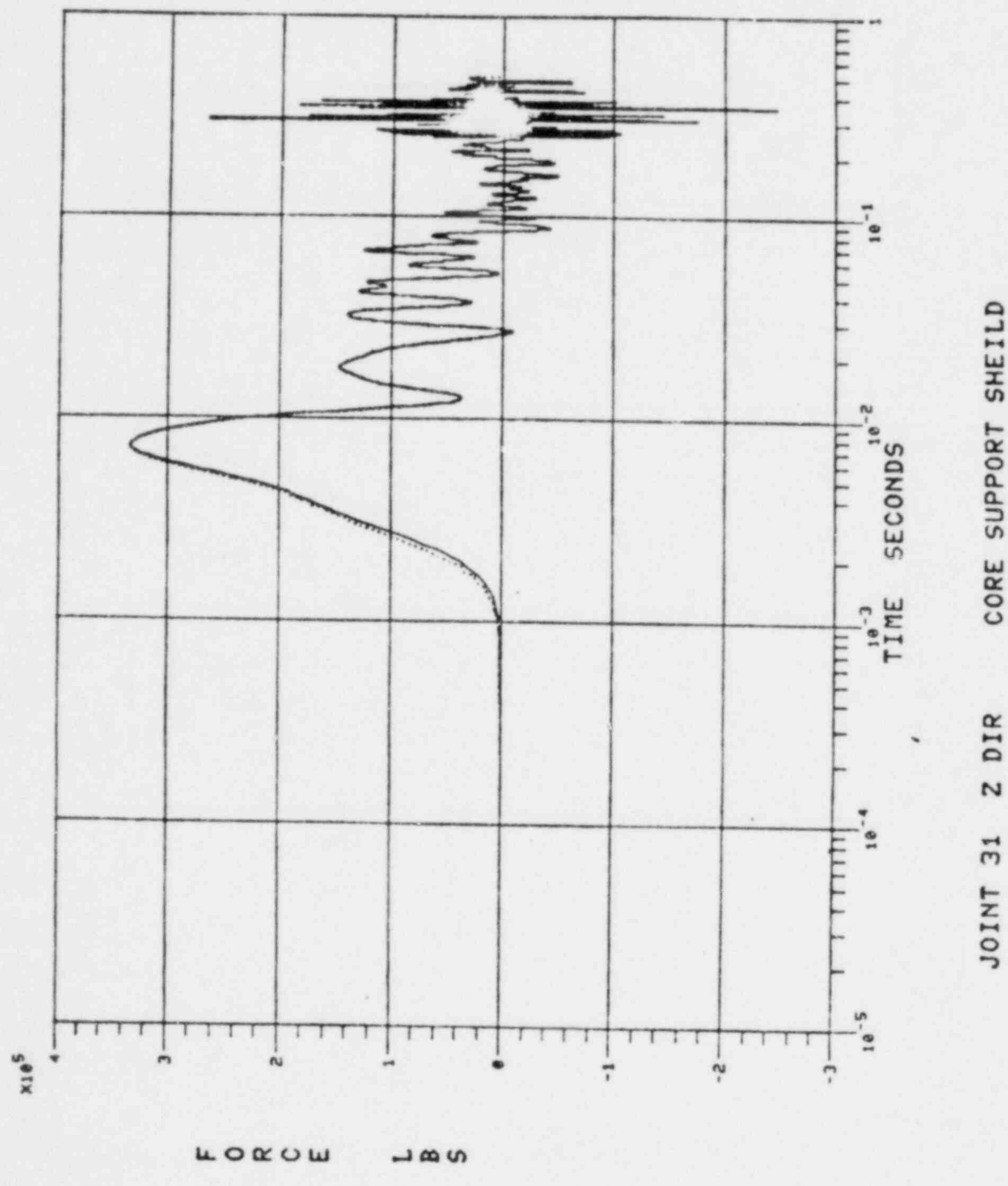
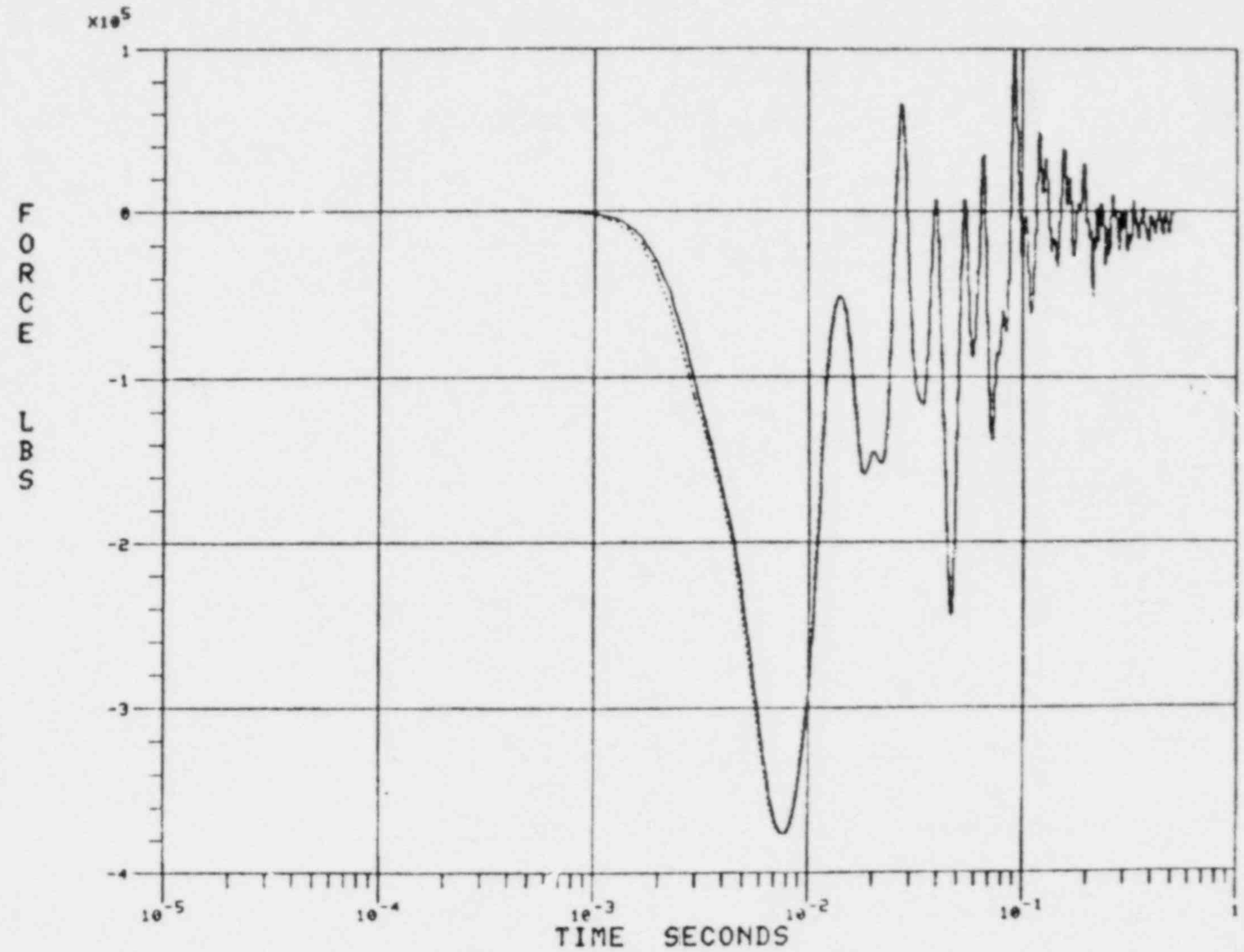
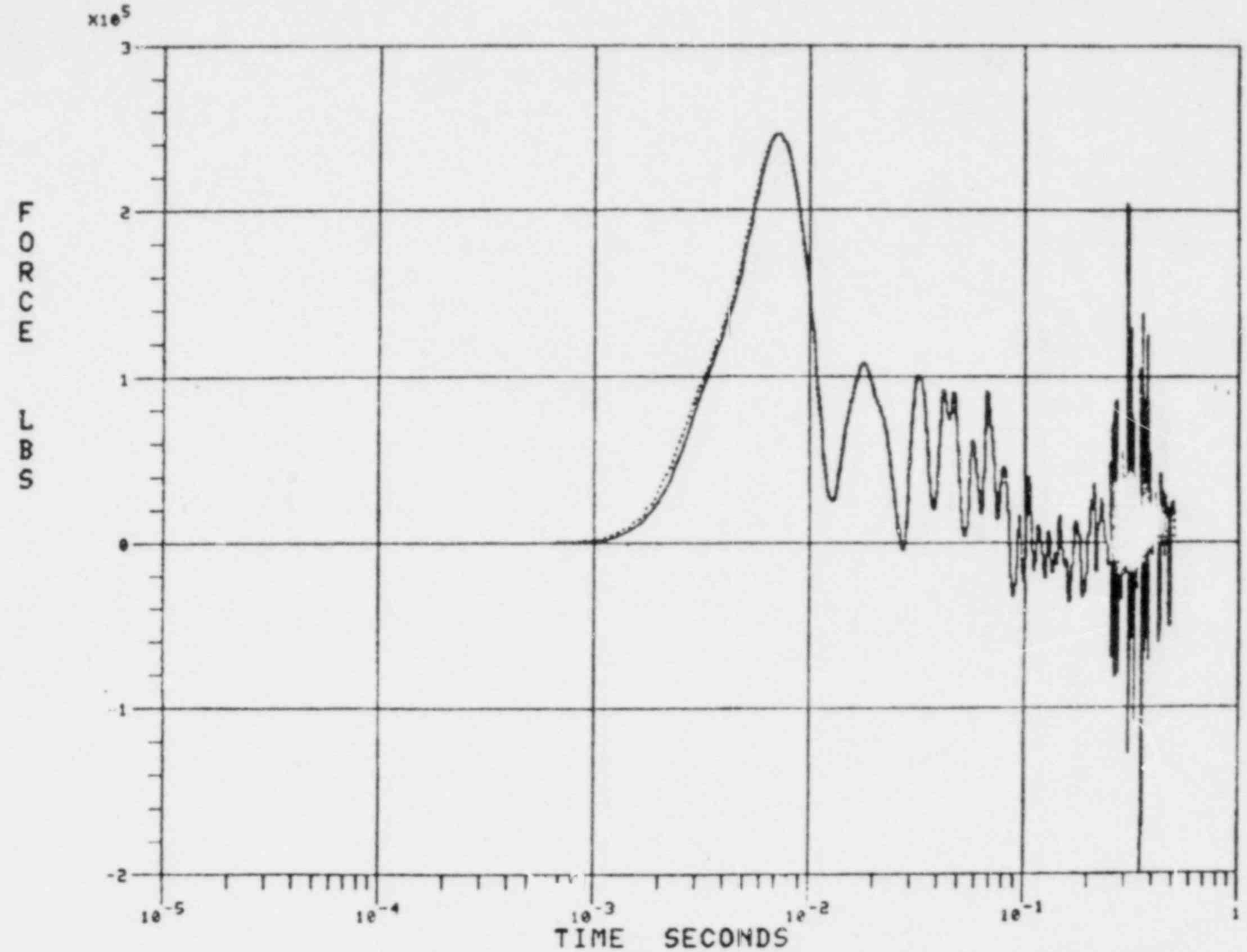


Figure 2.21-4. (Cont'd)



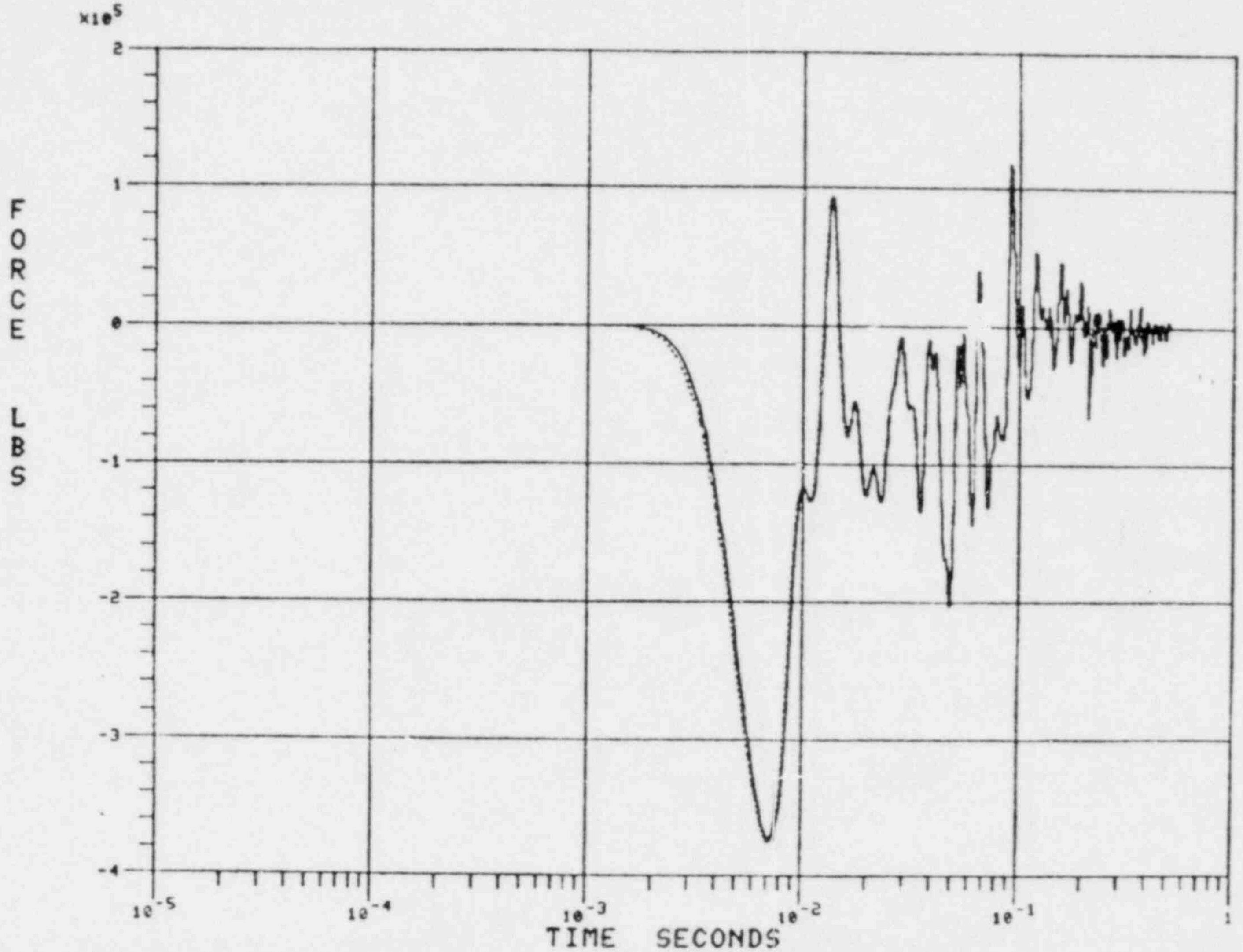
JOINT 44 X DIR CORE SUPPORT SHEILD

Figure 2.21-4. (Cont'd)



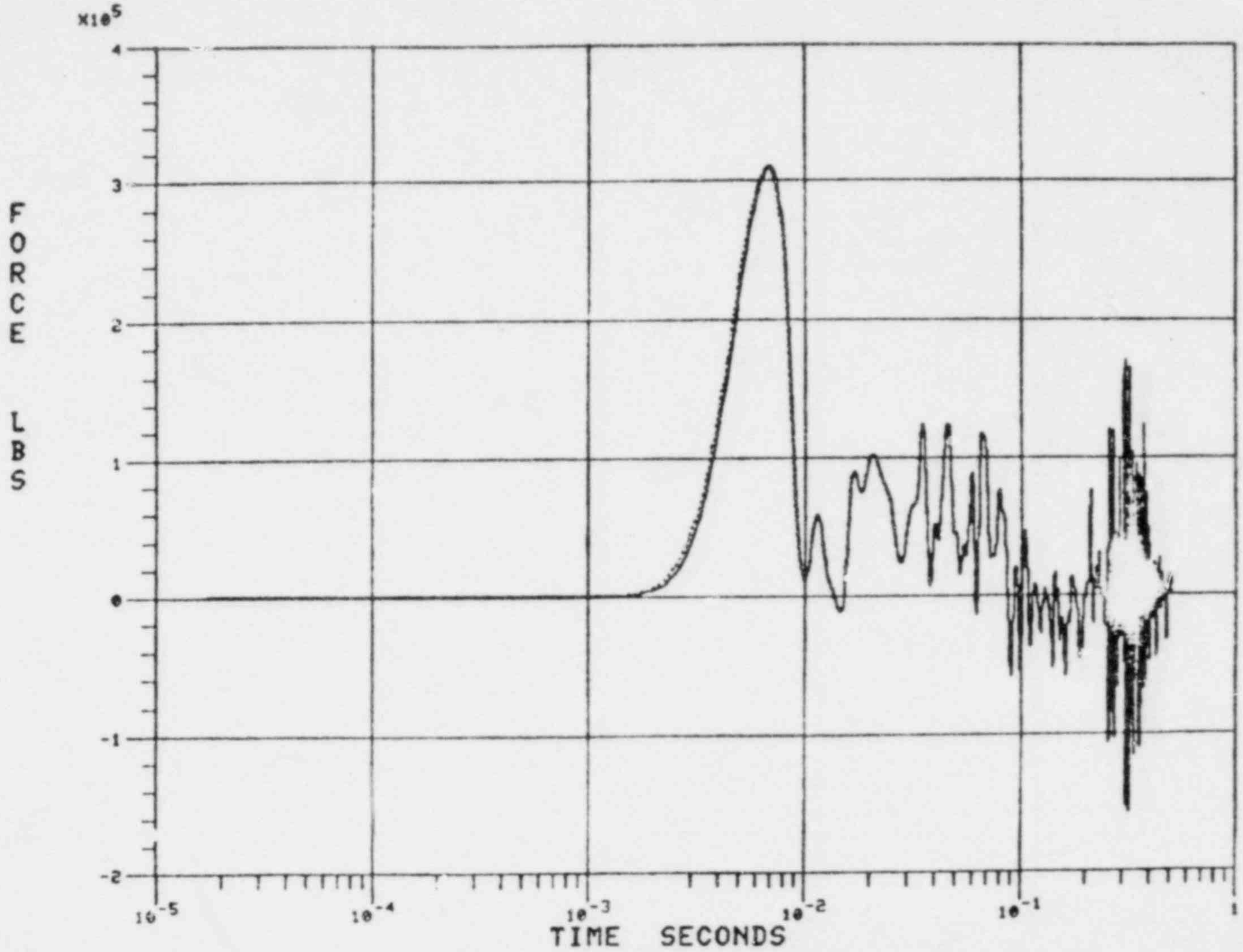
JOINT 44 Z DIR CORE SUPPORT SHEILD

Figure 2.21-4. (Cont'd)



JOINT 62 X DIR CORE SUPPORT SHEILD

Figure 2.21-4. (Cont'd)



JOINT 62 Z DIR CORE SUPPORT SHEILD

Figure 2.21-4. (Cont'd)

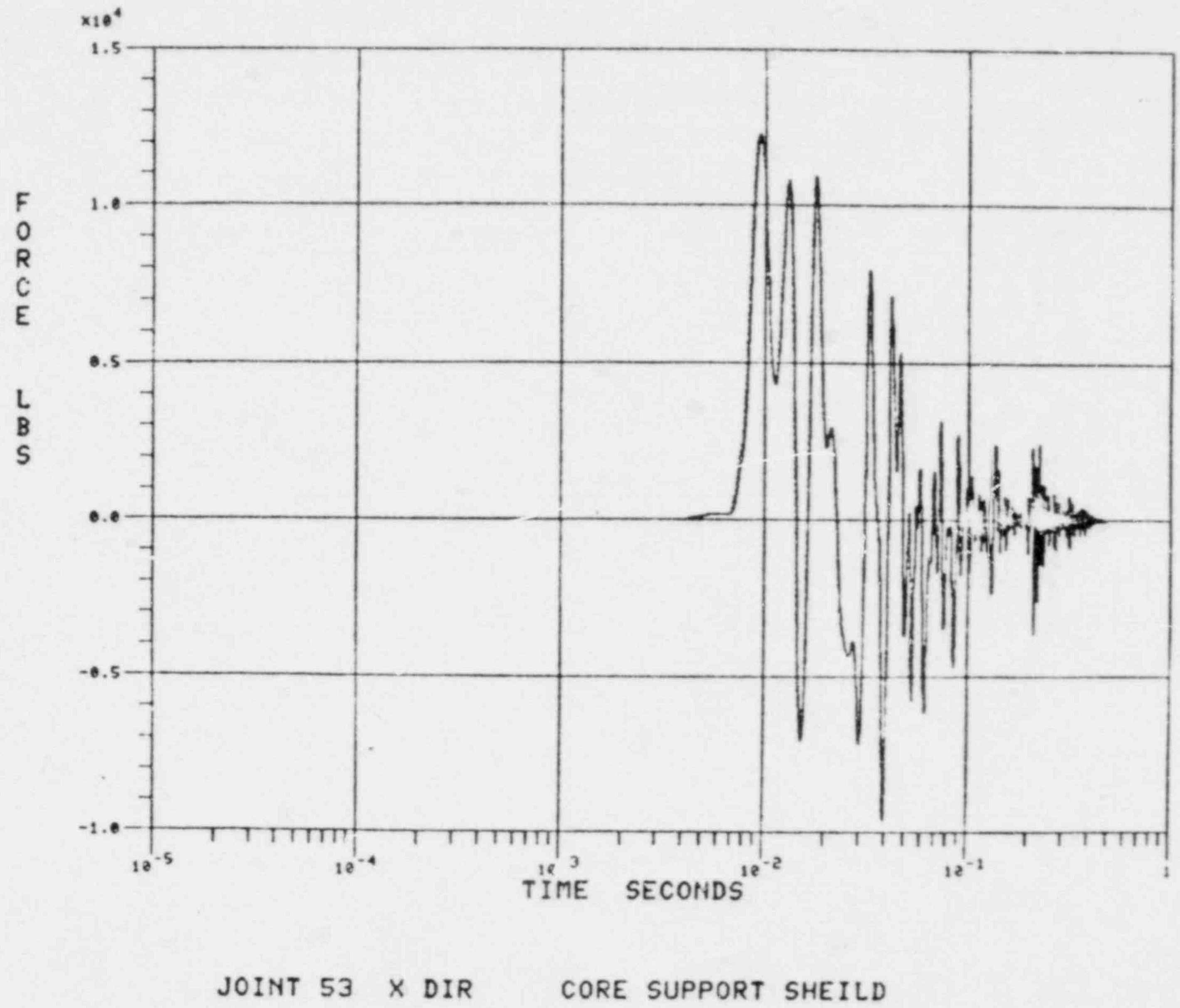
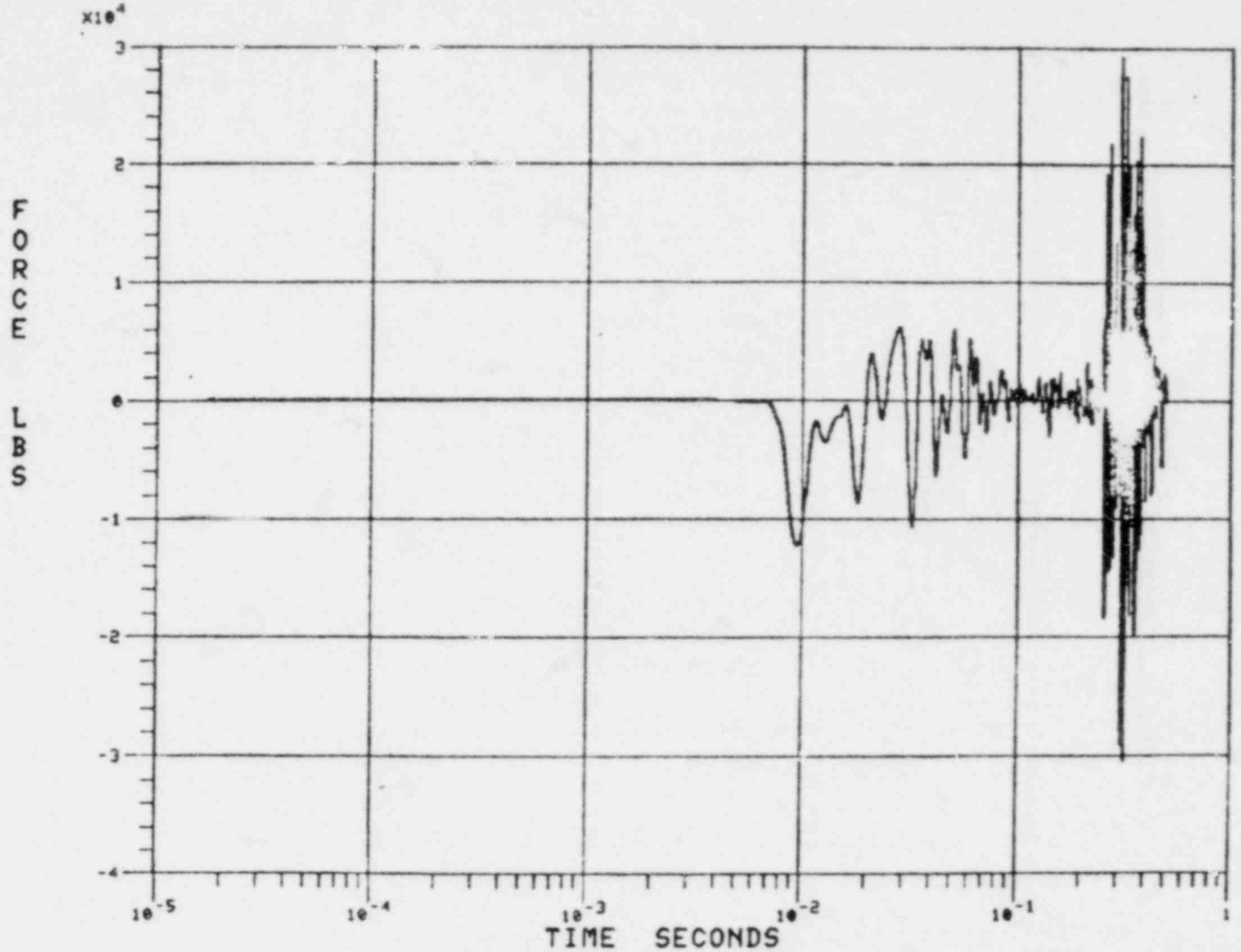
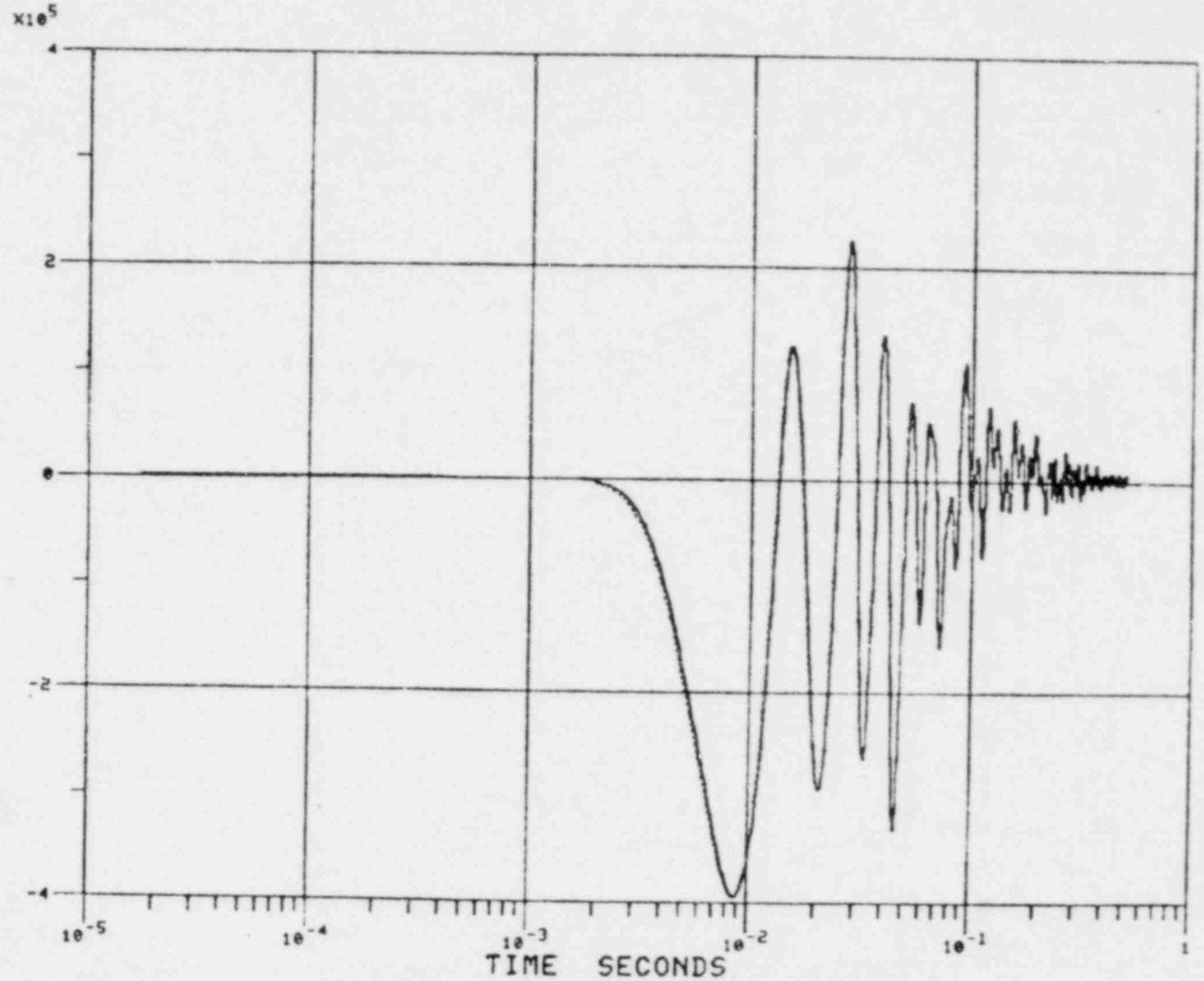


Figure 2.21-4. (Cont'd)



JOINT 53 Z DIR CORE SUPPORT SHEILD

Figure 2.21-4. (Cont'd)



JOINT 7 X DIR THERMALSHEILD

Figure 2.21-4. (Cont'd)

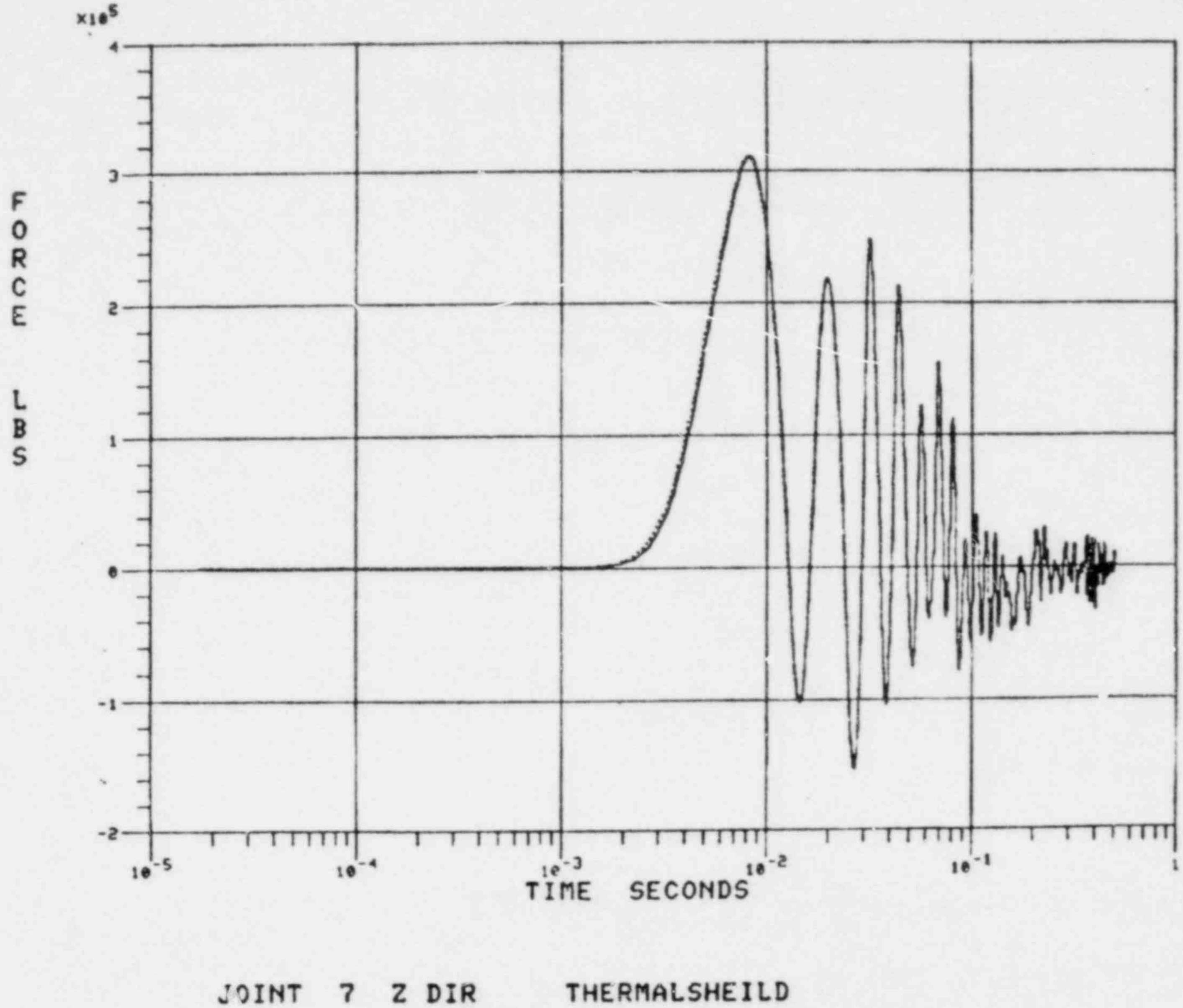
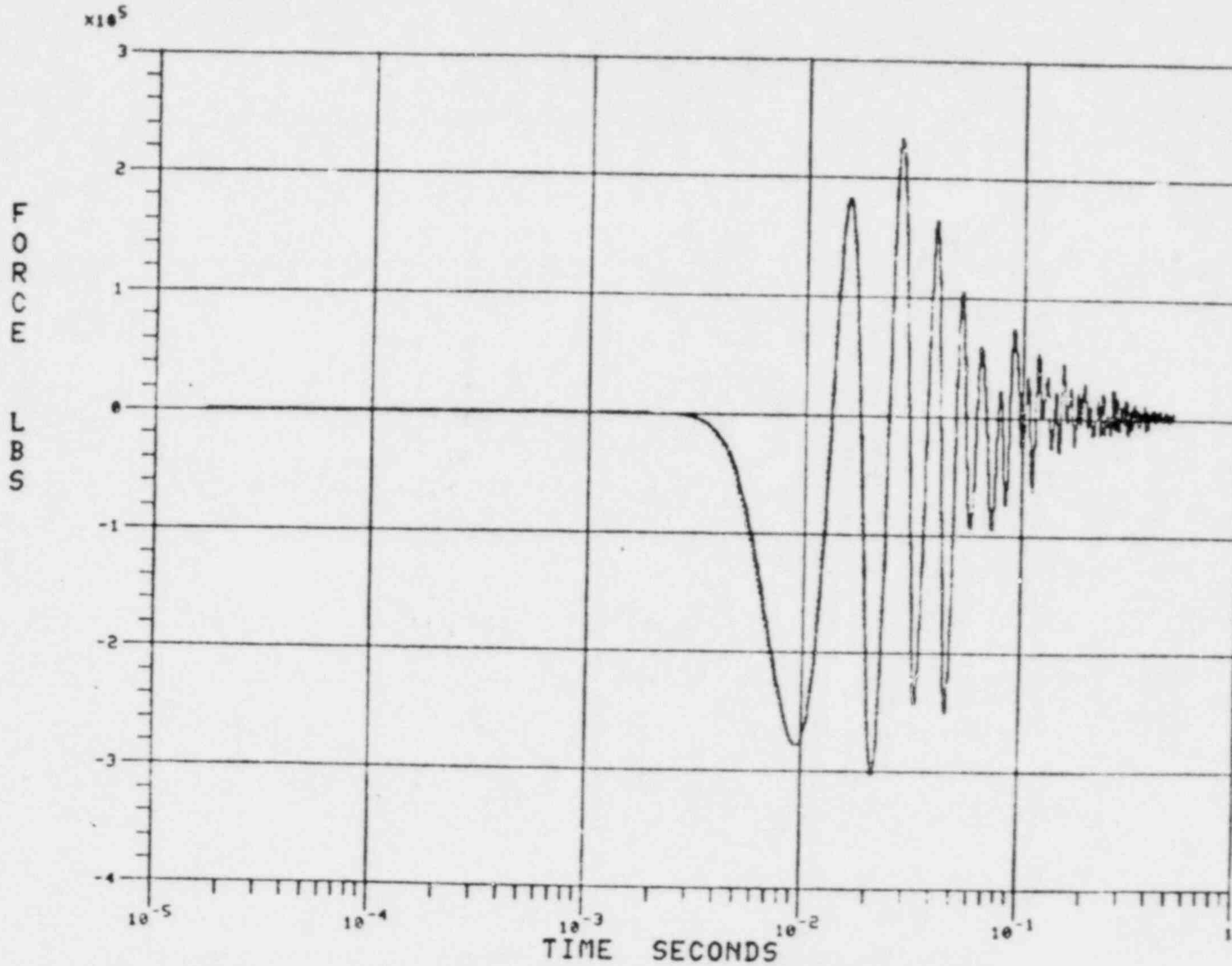
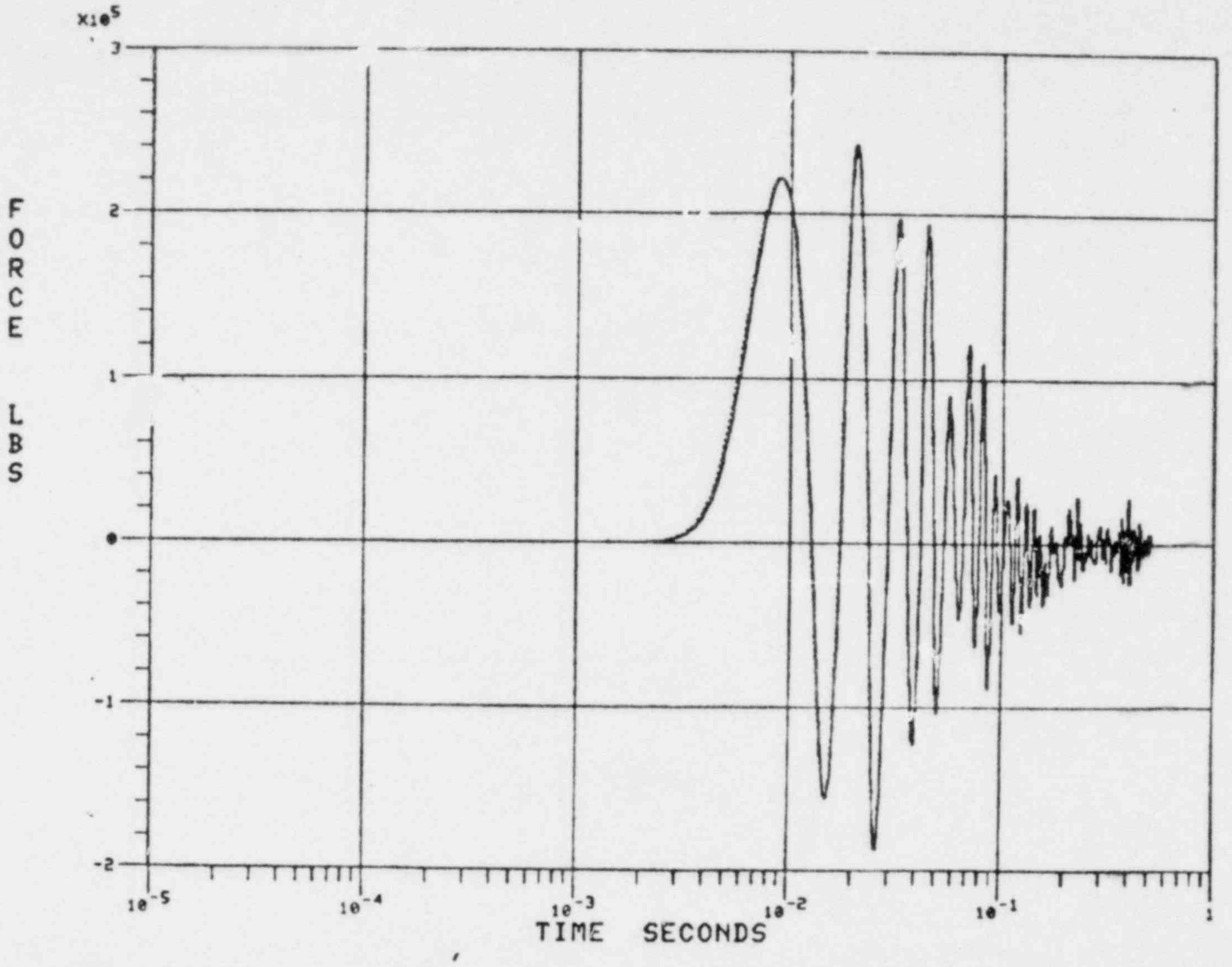


Figure 2.21-4. (Cont'd)



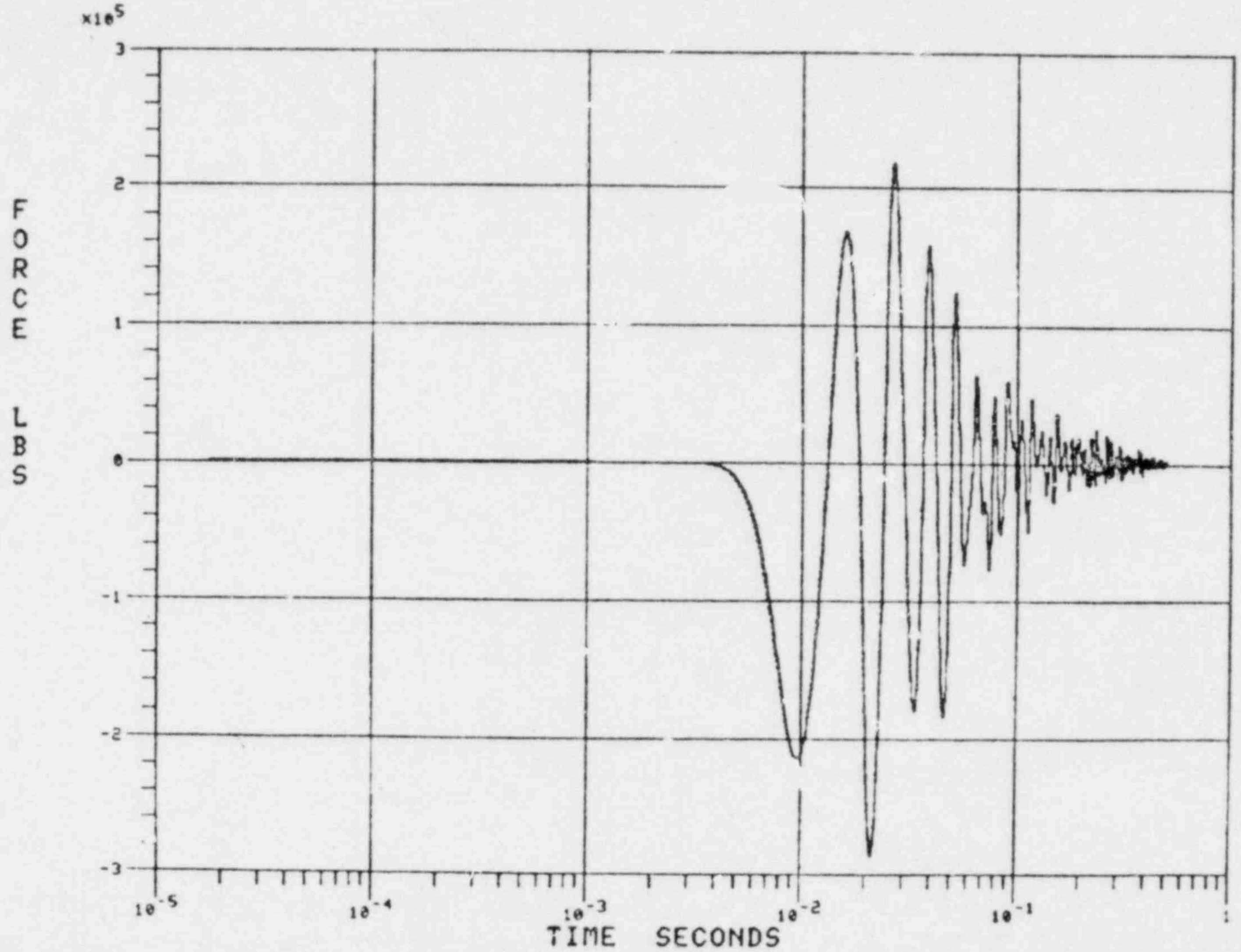
JOINT 1 X DIR THERMALSHEILD

Figure 2.21-4. (Cont'd)



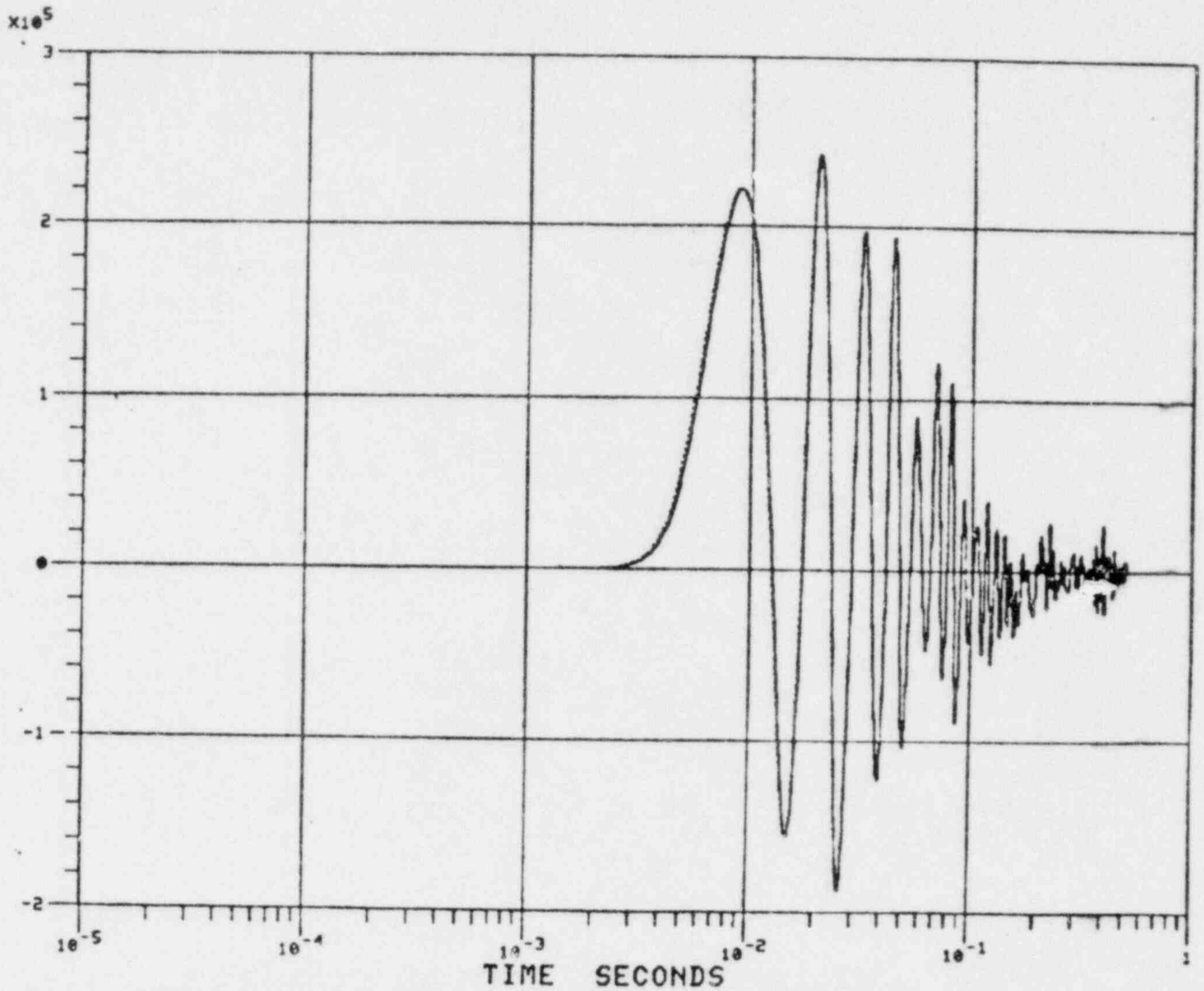
JOINT 1 Z DIR THERMALSHEILD

Figure 2.. 1. (Cont'd)



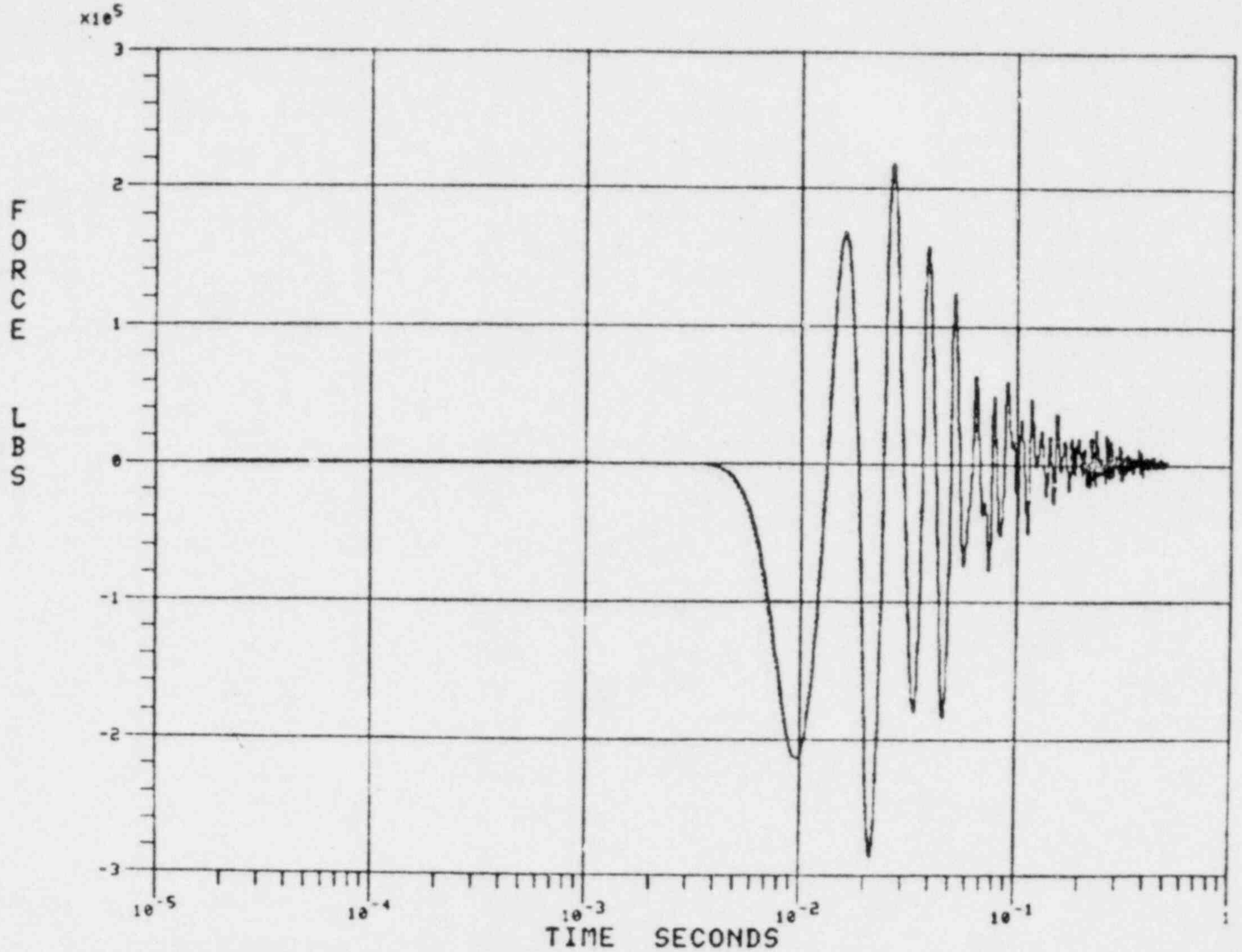
JOINT 6 X DIR THERMALSHEILD

Figure 2.21-4. (Cont'd)



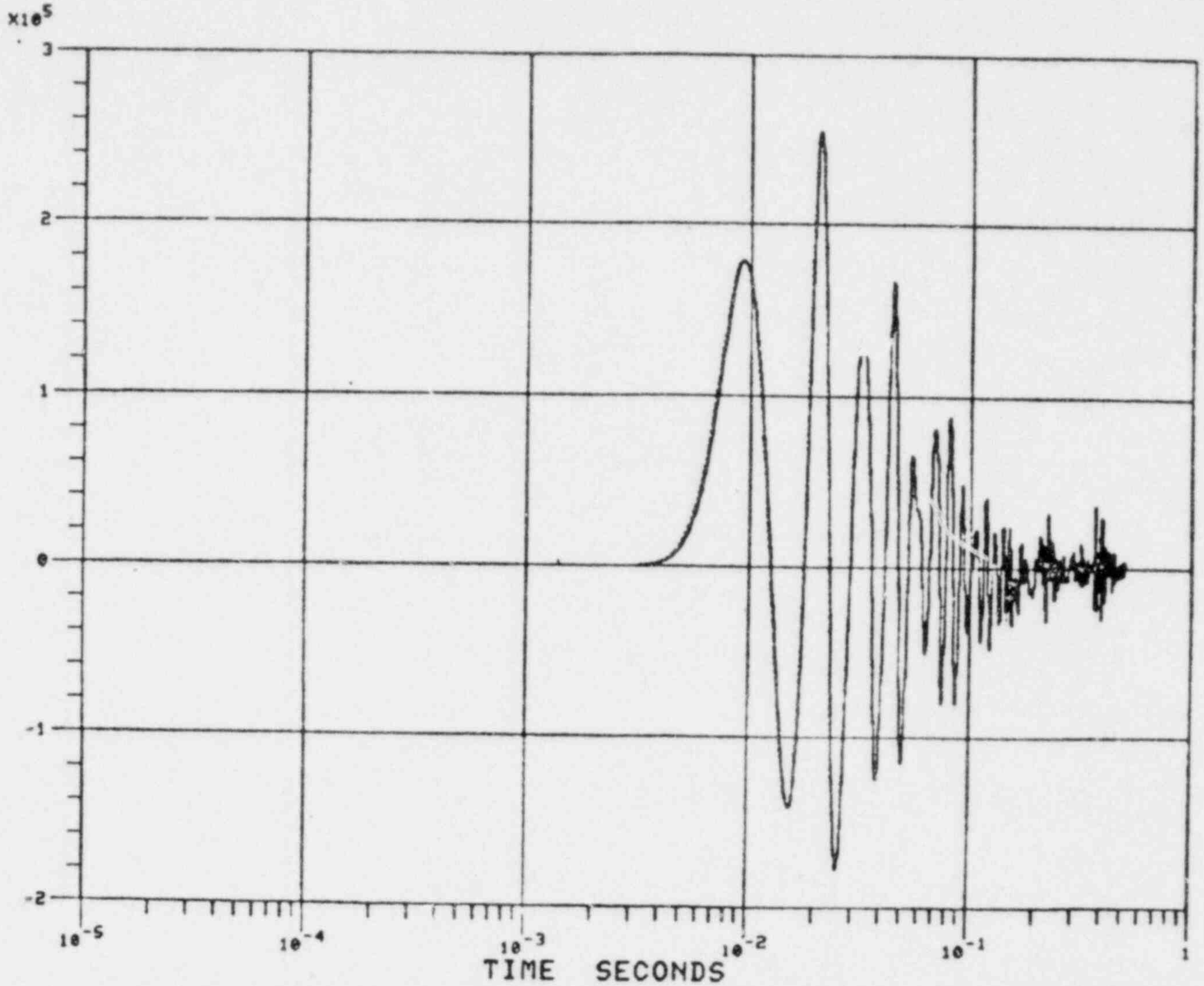
JOINT 1 Z DIR THERMALSHEILD

Figure 2.21-4. (Cont'd)



JOINT 6 X DIR THERMALSHEILD

Figure 2.21-4. (Cont'd)



JOINT 6 Z DIR THERMALSHEILD

Figure 2.21-5. Total Force on Core — 2A Hot Leg Break at RV, Skirt-Supported Plant

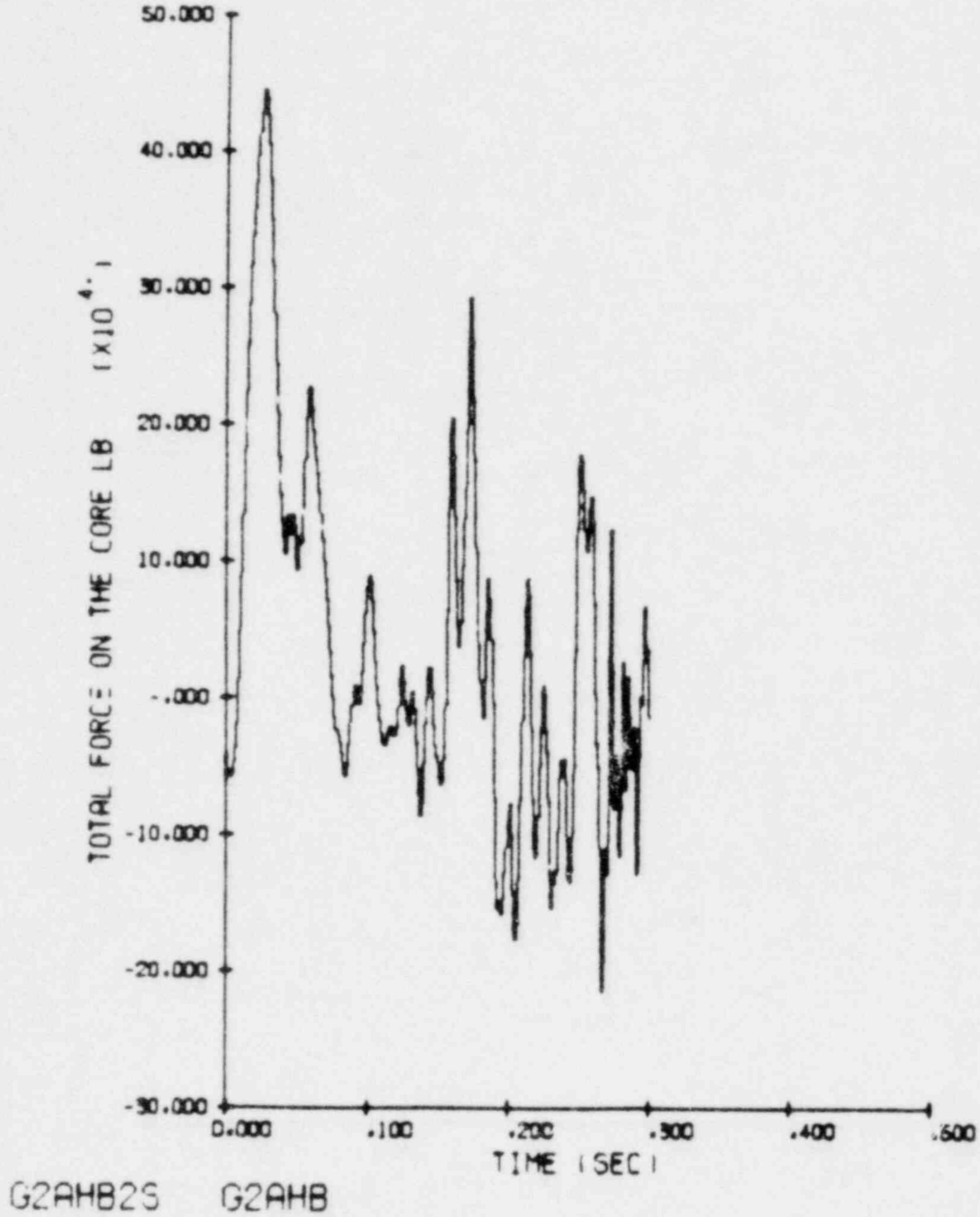


Figure 2.21-6. Total Force on Core — 2A Cold Leg Break at RV, Skirt-Supported Plant

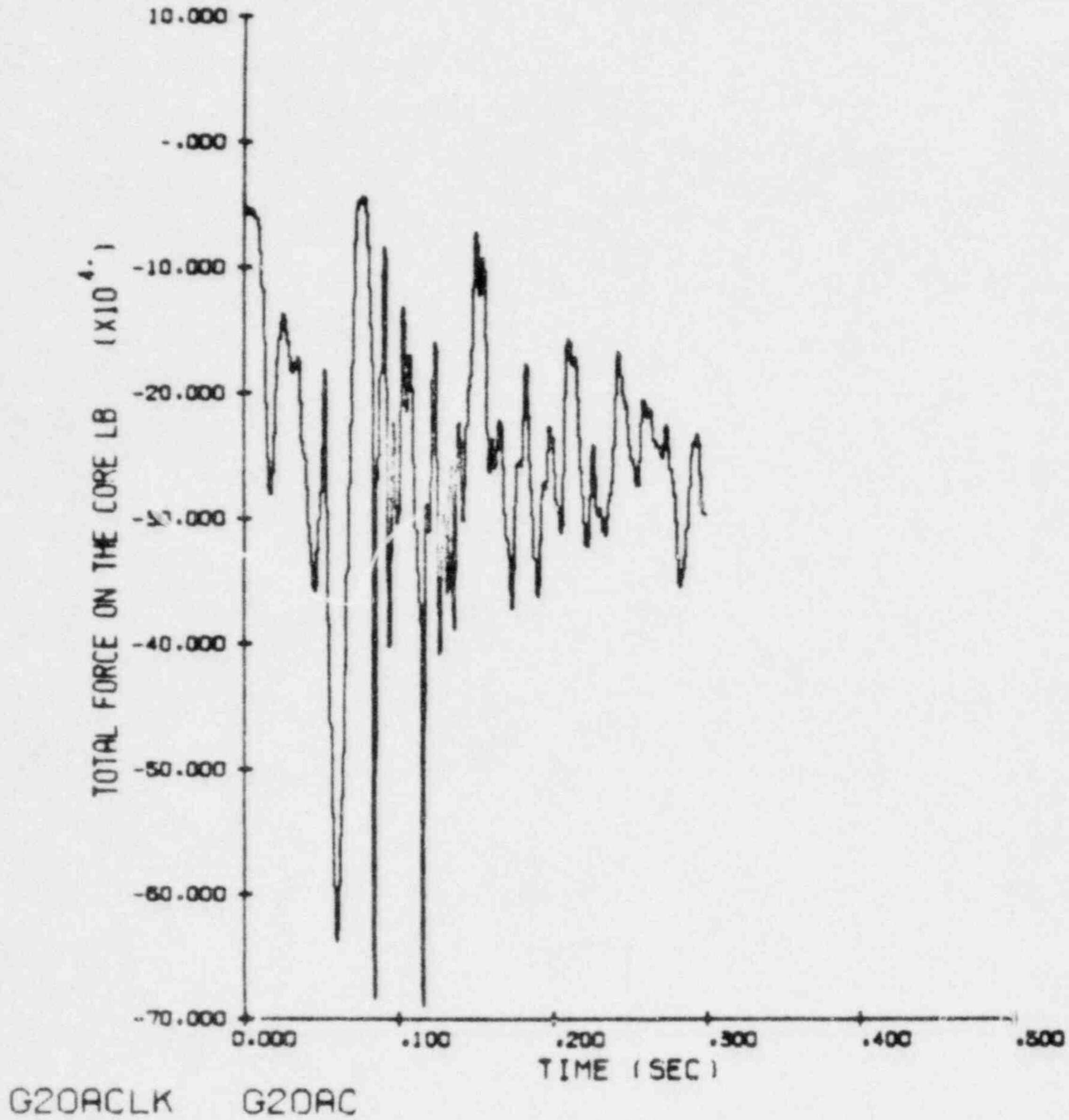


Figure 2.21-7. Total Force on Core — 1.024 Hot Leg Break at RV, Nozzle-Supported Plant

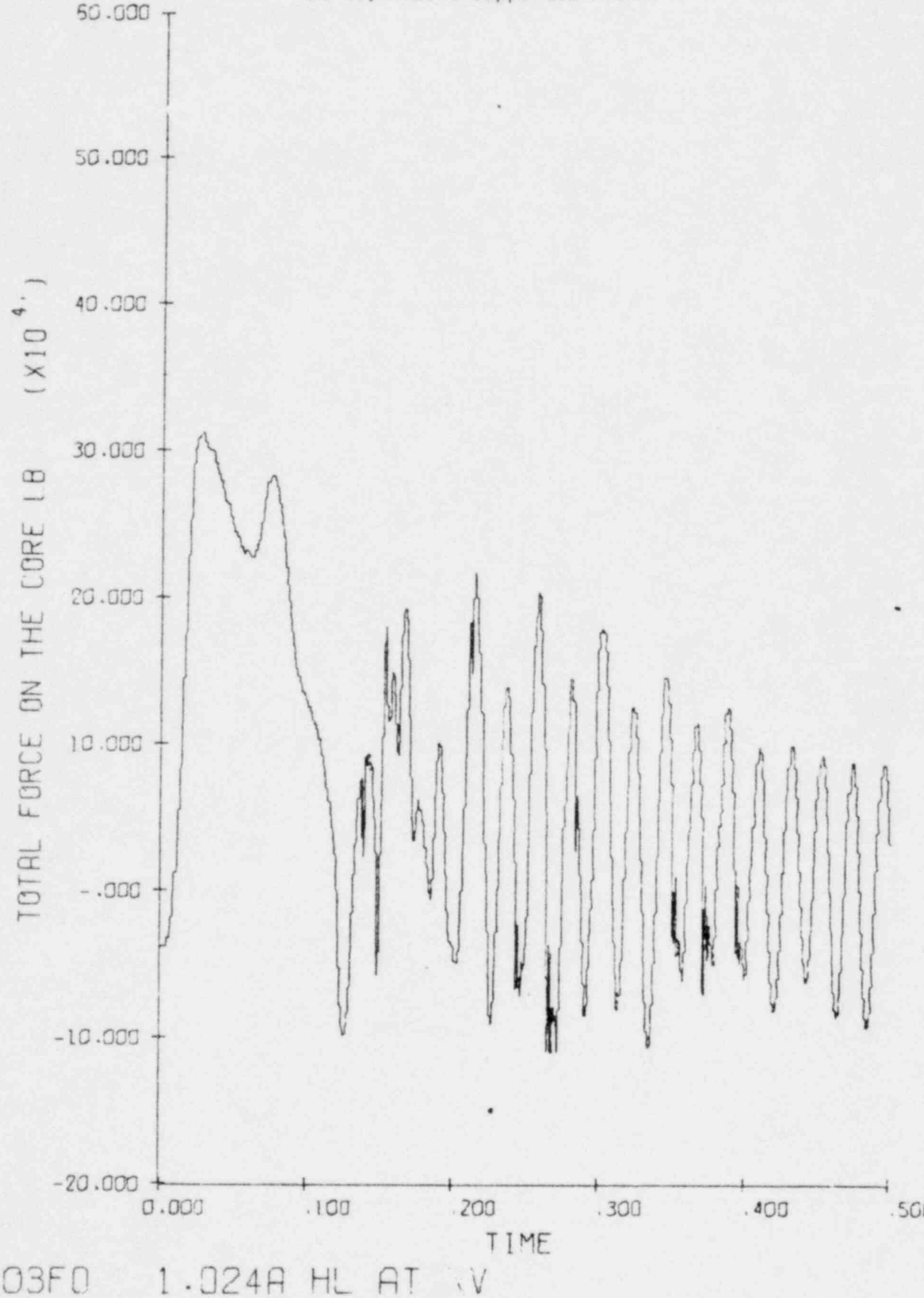
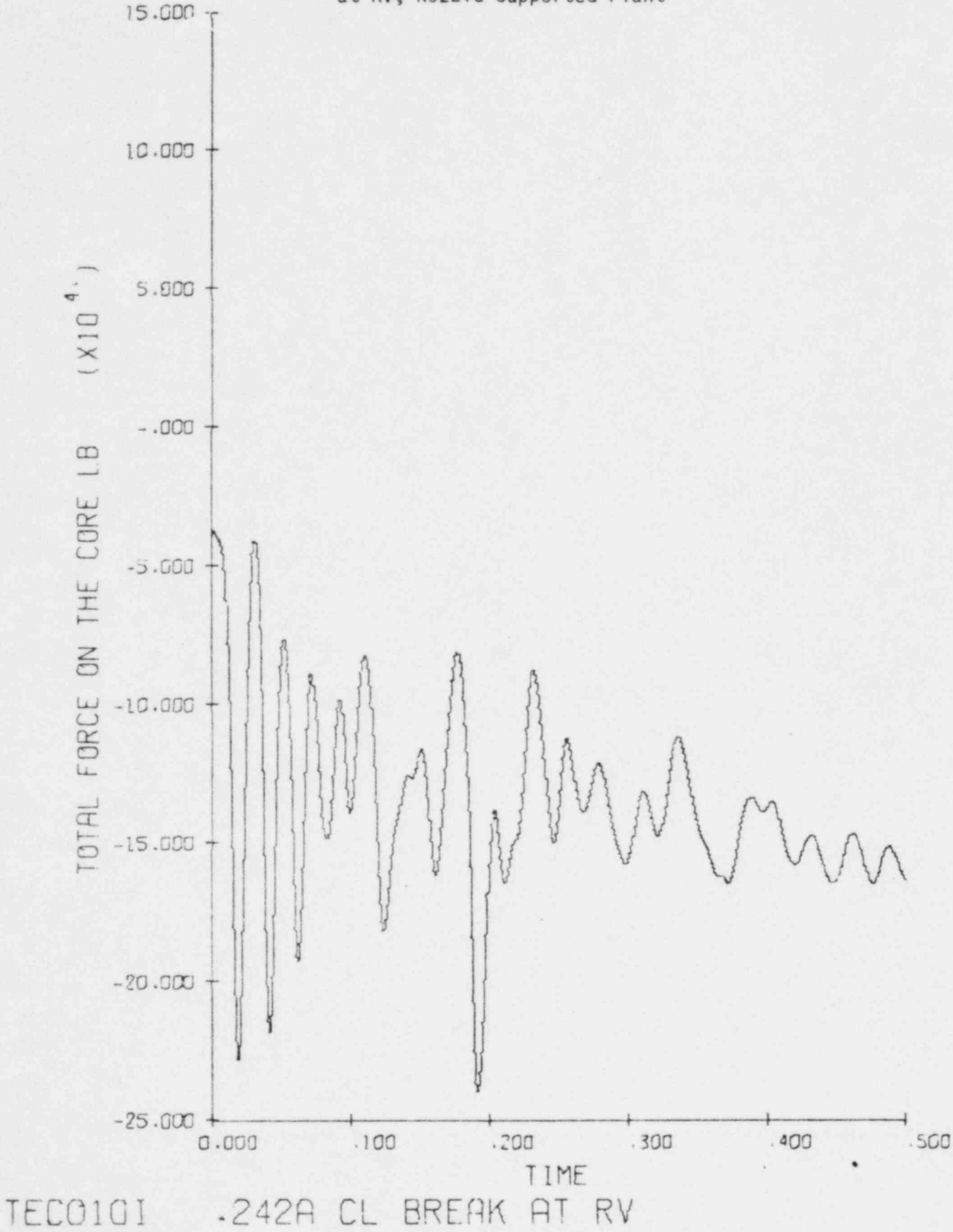


Figure 2.21-8. Total Force on Core — 0.242A Cold Leg Break at RV, Nozzle-Supported Plant



2.22. In Appendix C, what are the differences between skirt- and nozzle-supported plants that require separate CRAFT2 models?

Response

The major differences between the skirt and nozzle supported plants are as follows:

- The loop configuration.
- The number of vent valves.
- Basic thermal-hydraulic parameters, such as flow, power, pressure drop, etc. (see the response to question 2.10).

2.23. In Appendix C, paragraph 3, reference is made to simulation of four vent valves. However, in the Davis-Besse 1 Safety Analysis Report no mention can be found of any vent valves for that plant. Please clarify.

Response

See section 4.2.2.2, item 8, Internals Vent Valves, page 4-20 in the FSAR.[10] Also see section 4.2.2.3, Evaluation of Internal Vent Valves, and Figures 4-3 and 4-3A in the FSAR.[10]

2.24. Identify 177-FA raised- and lowered-loop plants. What is the relationship between these and the skirt- and nozzle-supported-plants? Provide section 4.1 of BAW-10104.

Response

Nozzle-supported is synonymous with raised-loop. Davis Besse 1 is the only B&W 177-FA nozzle-supported plant. All other B&W 177-FA plants listed in section 1 of reference 2 are skirt-supported.

Skirt-supported is synonymous with lowered-loop. For comparison, Figure 11.1-25[2] is an elevation view of a skirt-supported plant, and Figure 11.1-29[2] is an elevation view of the nozzle-supported plant. The basic difference between the 177-FA raised- and lowered-loop plants is the elevation of the steam generator with respect to the reactor vessel inlet and outlet nozzle centerline.

It was agreed at the April 2-3 meeting that section 4.1 of BAW-10104 was not required.

2.25. In Appendix C, what is the significance in nodalizing volumes that appear to cross the physical boundaries of the lower incore support plate, the flow distributor plate, and the lower grid in Figure C-9 for the nozzle-supported plant as compared to Figure C-2 for the skirt-supported plant? To what extent does this influence the direct simulation and proper modeling of the flow inertia terms and the location of minimum area junctions for RV internals differential pressure calculations?

Response

There is no significant difference between the reactor vessel lower internals noding scheme shown in Figure C-2 for the skirt-supported plants and that in Figure C-9 for the nozzle-supported plant.

Recall that a nodal pressure is defined at the center of a node and that a flow path proceeds from the center of one node to the center of the next node. Therefore, to predict the proper pressure responses in adjacent nodes, one is required to model all flow perturbations (area changes, loss coefficients, etc.) occurring over the path length. As such, inertial effects for any given flow path are properly accounted for.

For stress analysis the lower internals are considered as comprising two assemblies, the lower grid assembly (lower grid plus the flow distributor plate) and the flow distributor head assembly [incore support plate plus the flow distributor head (defined by the boundary between nodes 141 and 142 in Figure C-2 and between nodes 5 and 9 in Figure C-9)]. Knowing a nodal pressure at the top and bottom surfaces of each of these assemblies allows one to properly characterize the hydraulic forcing functions on the two lower internals assemblies. It is not important that any given plate or assembly be spanned by a single flow path, but rather that the path or paths (in series) account for all flow perturbations induced by the component (plate, assembly, etc.) under consideration.

Both the skirt- and nozzle-supported reactor vessel internals models allow for the proper characterization of the hydraulic forcing functions on the two assemblies that make up the lower internals.

2.26. For both skirt- and nozzle-supported plants and for both hot and cold leg RV nozzle breaks, and the 2A cold leg SG compartment break (if available), provide (1) computer listing of the CRAFT2 input for RV internals analysis and (2) the following pressure transients:

a. The differential pressure across the RV upper and lower head for volume nodes 141-157 in Figure C-2 and nodes 5-10 in Figure C-9.

b. The differential pressure in the downcomer annulus across volume nodes 97-91, 109-103, and 133-127 for Figure C-2. Provide the same data at the same approximate locations for the nozzle-supported plant.

c. Pressures in the RV for volume nodes 153, 141, 97, 91, and 127 in Figure C-2. Provide the same data at the same approximate locations for the nozzle-supported plant.

d. Differential pressures across the vent valves across volume nodes 169-186 and 162-180 in Figure C-7. Provide the same data at the same approximate locations for the nozzle-supported plant.

Response

Table 2.26-1 lists the production run names associated with the data requested in this question. Table 2.26-2 provides a CRAFT2 reactor vessel internals code input listing for the skirt-supported plants. Table 2.26-3 is the same as Table 2.26-2 except that it is for the nozzle-supported plant.

Copies of microfiche plots for all runs listed in Table 2.26-1 are presented in Table 2.26-4.

Table 2.26-1. Production Run Names

Break location	Production run name/break area	
	Skirt-supported	Nozzle-supported
Reactor vessel outlet	G15AB29/1.5A G10ABNS/1.0A G06ABN7/0.6A	TEC03F0/1.024A
Reactor vessel inlet	G20ACLK/2.0A	TEC010I/0.242A
Cold leg SG compartment	G2ACGXW/2.0A	TEC2BQR/1.167A

Table 2.26-2. Listing of CRAFT2 Code Inputs for Skirt-Supported Reactor Vessel Internals ΔP Model

```
LISTING OF INPUT DATA FOR CASE  1
                 *     177 OWNERS GROUP GENERIC LOCA LOADS MODEL
                 *     2A (8.55 FT2) BREAK IN COLD LEG AT REACTOR VESSEL INLET
                 *     REFERENCE CALCULATION FILE 32-9616-00
                 *     REFERENCE CORE POWER=2560 MW
                 *     TOTAL SYSTEM FLOW=131.5+06 LBM/HR
                 *     BYRON JACKSON REACTOR COOLANT PUMPS
                 *     MOODY DISCHARGE MODEL, DISCHARGE COEFFICIENT CD=1.21
                 ****************************************************************
                 *     TIME INFORMATION
****             101,0.3
****             1001,0.3,0.0,0.0271
****             1002,0.,0.,0.05,.0062,0.15,.0116,0.3,.0159,0.5,.020,0.75,.0242,1.00,.027
                 +1,1.0,1.0+06
****             1004,10.,10.,10.
                 ****************************************************************
                 *     PLOT INFORMATION
****             1500,1
****             1501,1102,1,0.,2.,.4,1,0.,0.,6.,0,0,1104,1,0.,2.,.4,1,0.,0.,6.,0,0,
                 +      1106,1,0.,2.,.4,1,0.,0.,6.,0,0,1108,1,0.,2.,.4,1,0.,0.,6.,0,0
****             1502,1110,1,0.,2.,.4,1,0.,0.,6.,0,0,1112,1,0.,2.,.4,1,0.,0.,6.,0,0,
                 +      1114,1,0.,2.,.4,1,0.,0.,6.,0,0,1116,1,0.,2.,.4,1,0.,0.,6.,0,0
****             1503,1118,1,0.,2.,.4,1,0.,0.,6.,0,0,1120,1,0.,2.,.4,1,0.,0.,6.,0,0,
                 +      1122,1,0.,2.,.4,1,0.,0.,6.,0,0,1124,1,0.,2.,.4,1,0.,0.,6.,0,0
****             1504,1126,1,0.,2.,.4,1,0.,0.,6.,0,0,1130,1,0.,2.,.4,1,0.,0.,6.,0,0,
                 +      1134,1,0.,2.,.4,1,0.,0.,6.,0,0,1138,1,0.,2.,.4,1,0.,0.,6.,0,0
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                 +      1167,1,0.,2.,.4,1,0.,0.,6.,0,0,1168,1,0.,2.,.4,1,0.,0.,6.,0,0
****             1508,1169,1,0.,2.,.4,1,0.,0.,6.,0,0,1170,1,0.,2.,.4,1,0.,0.,6.,0,0,
                 +      1171,1,0.,2.,.4,1,0.,0.,6.,0,0,1172,1,0.,2.,.4,1,0.,0.,6.,0,0
****             1509,1173,1,0.,2.,.4,1,0.,0.,6.,0,0,1174,1,0.,2.,.4,1,0.,0.,6.,0,0,
                 +      1175,1,0.,2.,.4,1,0.,0.,6.,0,0,1176,1,0.,2.,.4,1,0.,0.,6.,0,0
****             1510,1178,1,0.,2.,.4,1,0.,0.,6.,0,0,1179,1,0.,2.,.4,1,0.,0.,6.,0,0,
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          +     11168,1,0.,2.,.4,1,0.,0.,6.,0,0,11169,1,0.,2.,.4,1,0.,0.,6.,0,0
****      1533,11170,1,0.,2.,.4,1,0.,0.,6.,0,0,11171,1,0.,2.,.4,1,0.,0.,6.,0,0,
          +     11172,1,0.,2.,.4,1,0.,0.,6.,0,0,11173,1,0.,2.,.4,1,0.,0.,6.,0,0
****      1534,1801,1,0.,2.,.4,1,0.,0.,6.,141,142,
          +     1802,1,0.,2.,.4,1,0.,0.,6.,142,143
****      1535,1803,1,0.,2.,.4,1,0.,0.,6.,143,144,
          +     1804,1,0.,2.,.4,1,0.,0.,6.,144,145
****      1536,1805,1,0.,2.,.4,1,0.,0.,6.,145,152,
          +     5701,1,0.,2.,.4,1,0.,0.,6.,0,0
****      1537,25219,1,0.,2.,.4,1,0.,0.,6.,0,0,25220,1,0.,2.,.4,1,0.,0.,6.,0,0,
          +     25221,1,0.,2.,.4,1,0.,0.,6.,0,0,25222,1,0.,2.,.4,1,0.,0.,6.,0,0
****      1538,21303,1,0.,2.,.4,1,0.,0.,6.,0,0,21304,1,0.,2.,.4,1,0.,0.,6.,0,0,
          +     22303,1,0.,2.,.4,1,0.,0.,6.,0,0,22304,1,0.,2.,.4,1,0.,0.,6.,0,0
****      1539,62303,1,0.,2.,.4,1,0.,0.,6.,0,0,62304,1,0.,2.,.4,1,0.,0.,6.,0,0,
          +     85303,1,0.,2.,.4,1,0.,0.,6.,0,0,85304,1,0.,2.,.4,1,0.,0.,6.,0,0
****      1540,11174,1,0.,2.,.4,1,0.,0.,6.,0,0,11175,1,0.,2.,.4,1,0.,0.,6.,0,0,
          +     11176,1,0.,2.,.4,1,0.,0.,6.,0,0,25299,1,0.,2.,.4,1,0.,0.,6.,0,0
****      1541,21250,1,0.,2.,.4,1,0.,0.,6.,0,0,21251,1,0.,2.,.4,1,0.,0.,6.,0,0,
          +     21264,1,0.,2.,.4,1,0.,0.,6.,0,0,21265,1,0.,2.,.4,1,0.,0.,6.,0,0
****      1542,21266,1,0.,2.,.4,1,0.,0.,6.,0,0,21267,1,0.,2.,.4,1,0.,0.,6.,0,0,
          +     21229,1,0.,2.,.4,1,0.,0.,6.,0,0,21231,1,0.,2.,.4,1,0.,0.,6.,0,0
****      1543,21252,1,0.,2.,.4,1,0.,0.,6.,0,0,21253,1,0.,2.,.4,1,0.,0.,6.,0,0,
          +     21254,1,0.,2.,.4,1,0.,0.,6.,0,0,21255,1,0.,2.,.4,1,0.,0.,6.,0,0
****      1544,21276,1,0.,2.,.4,1,0.,0.,6.,0,0,21277,1,0.,2.,.4,1,0.,0.,6.,0,0,
          +     21278,1,0.,2.,.4,1,0.,0.,6.,0,0,21279,1,0.,2.,.4,1,0.,0.,6.,0,0
****      1545,21280,1,0.,2.,.4,1,0.,0.,6.,0,0,21281,1,0.,2.,.4,1,0.,0.,6.,0,0,
          +     2172,1,0.,2.,.4,1,0.,0.,6.,0,0,2174,1,0.,2.,.4,1,0.,0.,6.,0,0
****      1601,1801,1802,1803,1804,1805,21303,21304,22303,22304,62303,62304
****      1602,85303,85304,5701
****      1701,10,10,10
          ****************************************************************
          *     TIME STEP INFORMATION
****      2001,1.0-05,0.050,50.,1.0-05,0.1,5.,1.0-05,0.3,4.,
          ****************************************************************
          *     CONTROL VOLUMES
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Table 2.26-3. (Cont'd)

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*     HOT LEG PIPING VOLUMES
3001,16.665,4.025,628.465,627.0,625.5,2175.24,618.726,0.0
3002,16.665,4.025,628.465,627.0,625.5,2175.24,618.726,0.0
3003,6.614,10.396,637.6,628.465,627.404,2169.62,618.726,0.0
3004,6.614,10.396,637.6,628.465,627.404,2169.62,618.726,0.0
3005,7.069,9.623,647.223,638.0,637.8,2166.28,618.726,0.0
3006,7.069,9.623,647.223,638.0,637.8,2166.28,618.726,0.0
3007,7.069,9.623,656.847,647.623,647.427,2162.94,618.726,0.0
3008,7.069,9.623,656.847,647.623,647.423,2162.94,618.726,0.0
3009,7.069,9.623,666.470,657.247,657.047,2159.61,618.726,0.0
3010,7.069,9.623,666.470,657.247,657.047,2159.61,618.726,0.0
3011,8.190,8.538,673.708,666.870,666.670,2156.02,618.726,0.0
3012,8.190,8.538,673.708,666.870,666.670,2156.02,618.726,0.0
3013,8.265,8.0,667.408,673.708,667.208,2153.57,618.726,0.0
3014,8.265,8.0,667.408,673.708,667.208,2153.57,618.726,0.0
****************************************************************
*      STEAM GENERATOR VOLUMES
3015,37.41,7.467,659.941,667.008,659.741,2166.55,618.726,0.0
3016,37.41,7.467,659.941,667.008,659.741,2166.55,618.726,0.0
3017,26.155,11.25,648.691,659.541,648.491,2166.76,605.433,0.0
3018,26.155,11.25,648.691,659.541,648.491,2166.76,605.433,0.0
3019,26.155,11.25,637.441,648.291,637.241,2167.17,592.140,0.0
3020,26.155,11.25,637.441,648.291,637.241,2167.17,592.140,0.0
3021,26.155,11.25,626.191,637.041,625.991,2165.63,578.846,0.0
3022,26.155,11.25,626.191,637.041,625.991,2165.63,578.846,0.0
3023,26.155,11.25,614.941,625.791,614.741,2165.94,565.553,0.0
3024,26.155,11.25,614.941,625.791,614.741,2165.94,565.553,0.0
3025,26.155,11.25,603.691,614.541,603.491,2163.45,552.260,0.0
3026,26.155,11.25,603.691,614.541,603.491,2163.45,552.260,0.0
3027,27.170,4.960,598.905,603.291,598.530,2159.30,552.260,0.0
3028,27.170,4.960,598.905,603.291,598.530,2159.30,552.260,0.0
3029,27.170,4.960,598.905,603.291,598.530,2159.30,552.260,0.0
3030,27.170,4.960,598.905,603.291,598.530,2159.30,552.260,0.0
****************************************************************
*      COLD LEG PIPING VOLUMES
3031,9.868,4.667,600.545,598.905,596.078,2153.30,552.26,0.0
3032,9.868,4.667,600.545,598.905,596.078,2153.30,552.26,0.0
3033,9.868,4.667,600.545,598.905,596.078,2153.30,552.26,0.0
3034,9.868,4.667,600.545,598.905,596.078,2153.30,552.26,0.0
3035,4.276,9.918,610.463,600.945,600.745,2147.99,552.26,0.0
3036,4.276,9.918,610.463,600.945,600.745,2147.99,552.26,0.0
3037,4.276,9.918,610.463,600.945,600.745,2147.99,552.26,0.0
3038,4.276,9.918,610.463,600.945,600.745,2147.99,552.26,0.0
3039,4.276,9.918,620.382,610.863,610.663,2144.39,552.26,0.0
3040,4.276,9.918,620.382,610.863,610.663,2144.39,552.26,0.0
3041,4.276,9.918,620.382,610.863,610.663,2144.39,552.26,0.0
3042,4.276,9.918,620.382,610.863,610.663,2144.39,552.26,0.0
3043,4.545,8.975,629.357,620.782,620.582,2141.12,552.26,0.0
3044,4.545,8.975,629.357,620.782,620.582,2141.12,552.26,0.0
3045,4.545,8.975,629.357,620.782,620.582,2141.12,552.26,0.0
3046,4.545,8.975,629.357,620.782,620.582,2141.12,552.26,0.0
3047,34.43,2.614,630.5,629.756,629.556,2229.39,552.26,0.0
3048,34.43,2.614,630.5,629.756,629.556,2229.39,552.26,0.0
3049,34.43,2.614,630.5,629.756,629.556,2229.39,552.26,0.0
3050,34.43,2.614,630.5,629.756,629.556,2229.39,552.26,0.0
3051,6.859,5.833,627.0,630.5,625.833,2228.23,552.26,0.0
3052,6.859,5.833,627.0,630.5,625.833,2228.23,552.26,0.0
3053,6.859,5.833,627.0,630.5,625.833,2228.23,552.26,0.0
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Table 2.26-2. (Cont'd)

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****      3054,6.859,5.833,627.0,630.5,625.833,2228.23,552.26,0.0
****      3055,12.923,2.333,627.0,627.0,625.833,2227.70,552.26,0.0
****      3056,12.923,2.333,627.0,627.0,625.833,2227.70,552.26,0.0
****      3057,12.923,2.333,627.0,627.0,625.833,2227.70,552.26,0.0
****      3058,12.923,2.333,627.0,627.0,625.833,2227.70,552.26,0.0
****      3059,10.973,2.333,627.0,627.0,625.833,2226.11,552.26,0.0
****      3060,10.973,2.333,627.0,627.0,625.833,2226.11,552.26,0.0
****      3061,10.973,2.333,627.0,627.0,625.833,2226.11,552.26,0.0
****      3062,10.973,2.333,627.0,627.0,625.833,2226.11,552.26,0.0
          ********************************************************************
          *     BROKEN COLD LEG RV INLET NOZZLE VOLUMES
****      3063,1.632,2.33[illegible],627.0,627.0,625.833,2225.92,552.26,0.0
****      3064,1.632,2.333,627.0,627.0,625.833,2225.82,552.26,0.0
****      3065,1.498,2.397,627.0,627.0,625.65,2225.76,552.26,0.0
****      3066,1.711,3.107,627.0,627.0,625.447,2224.83,552.26,0.0
          ********************************************************************
****      3067,5.374,3.107,627.0,627.0,625.447,2225.84,552.26,0.0
****      3068,5.374,3.107,627.0,627.0,625.447,2225.84,552.26,0.0
****      3069,5.374,3.107,627.0,627.0,625.447,2225.84,552.26,0.0
****      3070,8.918,4.183,627.0,627.0,624.908,2175.73,618.726,0.0
          *     BROKEN HOT LEG RV OUTLET NOZZLE VOLUMES
****      3071,2.009,4.183,627.0,627.0,624.908,2186.78,618.726,0.0
****      3072,1.822,3.826,627.0,627.0,625.087,2182.93,618.726,0.0
****      3073,1.636,3.469,627.0,627.0,625.266,2179.04,618.726,0.0
****      3074,1.532,3.112,627.0,627.0,625.444,2175.89,618.726,0.0
****      3075,1.914,3.0,627.0,627.0,625.5,2175.89,618.726,0.0
****      3076,1.914,3.0,627.0,627.0,625.5,2175.89,618.726,0.0
          ********************************************************************
          *     PRESSURIZER CONTROL VOLUME
****      3077,36.35,42.571,623.244,623.244,623.044,2163.69,0.0,22.255
          ********************************************************************
          *     DOWNCOMER VOLUMES
****      3078,1.807,3.362,631.16,631.16,629.474,2230.11,552.26,0.0
****      3079,0.476,3.362,631.16,631.16,629.474,2230.11,552.26,0.0
****      3080,2.484,3.362,631.16,631.16,629.474,2230.11,552.26,0.0
****      3081,0.476,3.362,631.16,631.16,629.474,2230.11,552.26,0.0
****      3082,1.807,3.362,631.16,631.16,629.474,2230.11,552.26,0.0
****      3083,2.723,3.362,631.16,631.16,629.474,2230.11,552.26,0.0
****      3084,1.807,3.362,631.16,631.16,629.474,2230.11,552.26,0.0
****      3085,0.476,3.362,631.16,631.16,629.474,2230.11,552.26,0.0
****      3086,2.484,3.362,631.16,631.16,629.474,2230.11,552.26,0.0
****      3087,0.476,3.362,631.16,631.16,629.474,2230.11,552.26,0.0
****      3088,1.807,3.362,631.16,631.16,629.474,2230.11,552.26,0.0
****      3089,2.723,3.362,631.16,631.16,629.474,2230.11,552.26,0.0
****      3090,2.810,4.948,627.0,627.0,624.526,2231.20,552.26,0.0
****      3091,0.593,4.948,627.0,627.0,624.526,2231.20,552.26,0.0
****      3092,4.211,4.948,627.0,627.0,624.526,2231.20,552.26,0.0
****      3093,0.593,4.948,627.0,627.0,624.526,2231.20,552.26,0.0
****      3094,2.810,4.948,627.0,627.0,624.526,2231.20,552.26,0.0
****      3095,5.586,4.948,627.0,628.884,624.136,2188.75,618.726,0.0
****      3096,2.810,4.948,627.0,627.0,624.526,2231.20,552.26,0.0
****      3097,0.593,4.948,627.0,627.0,624.526,2231.20,552.26,0.0
****      3098,4.211,4.948,627.0,627.0,624.526,2231.20,552.26,0.0
****      3099,0.593,4.948,627.0,627.0,624.526,2231.20,552.26,0.0
****      3100,2.810,4.948,627.0,627.0,624.526,2231.20,552.26,0.0
****      3101,5.586,4.948,627.0,628.884,624.136,2188.75,618.726,0.0
****      3102,3.230,4.948,622.052,622.052,619.578,2226.30,552.26,0.0
****      3103,0.682,4.948,622.052,622.052,619.578,2226.30,552.26,0.0
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Table 2.26-2. (Cont'd)

```
****     3104,4.816,4.948,622.052,622.052,619.578,2226.30,552.26,0.0
****     3105,0.682,4.948,622.052,622.052,619.578,2226.30,552.26,0.0
****     3106,3.206,4.948,622.052,622.052,619.578,2226.30,552.26,0.0
****     3107,3.900,4.948,622.052,622.052,619.573,2226.30,552.26,0.0
****     3108,3.230,4.948,622.052,622.052,619.578,2226.30,552.26,0.0
****     3109,0.682,4.948,622.052,622.052,619.578,2226.30,552.26,0.0
****     3110,4.840,4.948,622.052,622.052,619.578,2226.30,552.26,0.0
****     3111,0.682,4.948,622.052,622.052,619.578,2226.30,552.26,0.0
****     3112,3.206,4.948,622.052,622.052,619.578,2226.30,552.26,0.0
****     3113,3.900,4.948,622.052,622.052,619.578,2226.30,552.26,0.0
****     3114,3.348,4.948,617.104,617.104,614.63,2228.03,552.26,0.0
****     3115,0.707,4.948,617.104,617.104,614.63,2228.03,552.26,0.0
****     3116,4.936,4.948,617.104,617.104,614.63,2228.03,552.26,0.0
****     3117,0.707,4.948,617.104,617.104,614.63,2228.03,552.26,0.0
****     3118,3.266,4.948,617.104,617.104,614.63,2228.03,552.26,0.0
****     3119,4.046,4.948,617.104,617.104,614.63,2228.03,552.26,0.0
****     3120,3.348,4.948,617.104,617.104,614.63,2228.03,552.26,0.0
****     3121,0.707,4.948,617.104,617.104,614.63,2228.03,552.26,0.0
****     3122,5.018,4.948,617.104,617.104,614.63,2228.03,552.26,0.0
****     3123,0.707,4.948,617.104,617.104,614.63,2228.03,552.26,0.0
****     3124,3.266,4.948,617.104,617.104,614.63,2228.03,552.26,0.0
****     3125,4.046,4.948,617.104,617.104,614.63,2228.03,552.26,0.0
****     3126,3.348,7.328,610.966,610.966,607.302,2229.55,552.26,0.0
****     3127,0.707,7.328,610.966,610.966,607.302,2229.55,552.26,0.0
****     3128,5.018,7.328,610.966,610.966,607.302,2229.55,552.26,0.0
****     3129,0.707,7.328,610.966,610.966,607.302,2229.55,552.26,0.0
****     3130,3.348,7.328,610.966,610.966,607.302,2229.55,552.26,0.0
****     3131,4.046,7.328,610.966,610.966,607.302,2229.55,552.26,0.0
****     3132,3.348,7.328,610.966,610.966,607.302,2229.55,552.26,0.0
****     3133,0.707,7.328,610.966,610.966,607.302,2229.55,552.26,0.0
****     3134,5.018,7.328,610.966,610.966,607.302,2229.55,552.26,0.0
****     3135,0.707,7.328,610.966,610.966,607.302,2229.55,552.26,0.0
****     3136,3.348,7.328,610.966,610.966,607.302,2229.55,552.26,0.0
****     3137,4.046,7.328,610.966,610.966,607.302,2229.55,552.26,0.0
         ***************************************************************
         *     THERMAL SHIELD ANNULUS VOLUMES
****     3138,3.186,3.922,619.778,623.30,619.578,2227.30,552.26,0.0
****     3139,3.186,4.948,614.830,619.378,614.63,2228.56,552.26,0.0
****     3140,3.186,5.005,609.825,614.43,609.625,2230.15,552.26,0.0
         ***************************************************************
         *     LOWER HEAD THROUGH LOWER GRID VOLUMES
****     3141,55.756,4.885,605.144,607.102,602.417,2229.65,552.26,0.0
****     3142,47.243,1.792,606.936,605.544,605.344,2225.37,552.26,0.0
****     3143,64.833,1.740,608.676,607.336,607.136,2222.33,552.26,0.0
****     3144,86.102,0.531,609.207,609.076,608.876,2221.06,552.26,0.0
****     3145,55.407,1.130,610.337,609.607,609.407,2219.65,552.26,0.0
         ***************************************************************
         *     CORE VOLUMES
****     3146,59.5,4.0,614.337,610.737,610.537,2215.51,563.338,0.0
****     3147,59.5,4.0,618.337,614.737,614.537,2209.29,585.492,0.0
****     3148,59.5,4.0,622.337,618.737,618.537,2205.32,607.648,0.0
         ***************************************************************
         *     INNER CORE BYPASS VOLUMES
****     3149,14.55,4.535,614.337,610.202,610.002,2213.98,552.26,0.0
****     3150,14.55,4.0,618.337,614.737,614.537,2209.55,552.26,0.0
****     3151,14.55,4.798,622.936,618.737,618.537,2204.98,552.26,0.0
         ***************************************************************
         *     UPPER PLENUM VOLUMES
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****        3152,72.672,2.344,624.681,622.740,622.537,2204.05,618.726,0.0
****        3153,52.972,4.812,629.493,625.081,624.881,2201.45,618.726,0.0
****        3154,52.972,4.282,633.775,629.893,629.693,2200.09,618.726,0.0
****        3155,20.620,4.812,629.493,625.031,624.881,2201.17,618.726,0.0
****        3156,20.620,6.053,635.546,629.893,629.693,2199.04,618.726,0.0
****        3157,67.275,5.734,634.175,635.546,633.975,2197.49,618.726,0.0
****        3158,8.399,3.579,634.175,635.764,633.975,2198.04,618.726,0.0
****        3159,8.399,3.579,634.175,635.764,633.975,2198.04,618.726,0.0
****        3160,8.399,3.579,634.175,635.764,633.975,2198.04,618.726,0.0
****        3161,8.399,3.579,634.175,635.764,633.975,2198.04,618.726,0.0
            ***********************************************************************
            *     OUTLET ANNULUS VOLUMES
****        3162,1.862,4.083,629.284,632.967,629.084,2198.85,618.726,0.0
****        3163,1.862,4.083,629.284,632.967,629.084,2198.85,618.726,0.0
****        3164,1.862,4.083,629.284,632.967,629.084,2198.85,618.726,0.0
****        3165,2.793,4.083,629.284,632.967,629.084,2198.85,618.726,0.0
****        3166,5.586,4.948,627.0,628.884,624.136,2188.75,618.726,0.0
****        3167,5.586,4.948,627.0,628.884,624.136,2188.75,618.726,0.0
****        3168,2.793,4.083,629.284,632.967,629.084,2198.85,618.726,0.0
****        3169,1.862,4.083,629.284,632.967,629.084,2198.85,618.726,0.0
****        3170,1.862,4.083,629.284,632.967,629.084,2198.85,618.726,0.0
****        3171,1.862,4.083,629.284,632.967,629.084,2198.85,618.726,0.0
****        3172,2.793,4.083,629.284,632.967,629.084,2198.85,618.726,0.0
****        3173,2.793,4.083,629.284,632.967,629.084,2198.85,618.726,0.0
            ***********************************************************************
            *     CONTAINMENT NODE
****        3174,2.205+04,100.0,627.0,627.0,577.0,14.7,0.0,0.001
            ***********************************************************************
            *     CONTAINMENT NODE
****        3801,174,303,304
            ***********************************************************************
            *     FLOW PATHS
            *     CORE PATHS
****        4001,1,145,146,3.573+04,0.052,49.64,2.356,0.0,0.0,0.0,1.238,0.048
****        4002,1,146,147,3.573+04,0.079,49.64,0.0,-3.414-09,0.0,0.0,2.425,0.048
****        4003,1,147,148,3.573+04,0.079,49.64,0.0,-4.024-09,0.0,0.0,2.405,0.048
****        4004,1,148,152,3.573+04,0.065,49.64,2.744,0.0,0.0,0.0,1.0-04,0.048
            ***********************************************************************
            *     HOT LEG PIPING PATHS
****        4005,8,5,7,1.826+04,1.361,7.069,0.0,0.0,0.0,0.0,0.0274,3.0
****        4006,8,6,8,1.826+04,1.361,7.069,0.0,0.0,0.0,0.0,0.0274,3.0
****        4007,8,7,9,1.826+04,1.361,7.069,0.0,0.0,0.0,0.0,0.0274,3.0
****        4008,8,8,10,1.826+04,1.361,7.069,0.0,0.0,0.0,0.0,0.0274,3.0
****        4009,8,9,11,1.826+04,1.381,7.069,0.0436,0.0,0.0,0.0,0.0,[illegible],3.0
****        4010,8,10,12,1.826+04,1.381,7.069,0.0436,0.0,0.0,0.0,0.0195,3.0
****        4011,8,11,13,1.826+04,1.361,7.069,0.1442,0.0,0.0,0.0,1.0-04,3.0
****        4012,8,12,14,1.826+04,1.361,7.069,0.1442,0.0,0.0,0.0,1.0-04,3.0
****        4013,8,13,15,1.826+04,1.058,7.069,0.1526,1.705-06,0.0,0.0,0.0086,3.0
****        4014,8,14,16,1.826+04,1.058,7.069,0.1526,1.705-06,0.0,0.0,0.0086,3.0
            ***********************************************************************
            *     STEAM GENERATOR PATHS
****        4015,8,15,17,1.826+04,0.247,26.155,1.242,4.323-07,0.0,0.0,1.7185,0.046
****        4016,8,16,18,1.826+04,0.247,26.155,1.242,4.323-07,0.0,0.0,1.7185,0.046
****        4017,8,17,19,1.826+04,0.430,26.155,0.0,0.0,0.0,0.0,3.437,0.046
****        4018,8,18,20,1.826+04,0.430,26.155,0.0,0.0,0.0,0.0,3.437,0.046
****        4019,8,19,21,1.826+04,0.430,26.155,0.0,0.0,0.0,0.0,3.437,0.046
****        4020,8,20,22,1.826+04,0.430,26.155,0.0,0.0,0.0,0.0,3.437,0.046
****        4021,8,21,23,1.826+04,0.430,26.155,0.0,0.0,0.0,0.0,3.437,0.046
```

Table 2.26-2. (Cont'd)

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****        4022,8,22,24,1.826+04,0.430,26.155,0.0,0.0,0.0,0.0,3.437,0.046
****        4023,8,23,25,1.826+04,0.430,26.155,0.0,0.0,0.0,0.0,3.437,0.046
****        4024,8,24,26,1.826+04,0.430,26.155,0.0,0.0,0.0,0.0,3.437,0.046
****        4025,8,25,27,9132.0,0.5005,13.073,0.5804,-2.9034-06,0.0,0.0,1.7188,0.046
****        4026,8,26,28,9132.0,0.5005,13.078,0.5804,-2.9034-06,0.0,0.0,1.7188,0.046
****        4027,8,25,29,9132.0,0.5005,13.078,0.5804,-2.9034-06,0.0,0.0,1.7188,0.046
****        4028,8,26,30,9132.0,0.5005,13.078,0.5804,-2.9034-06,0.0,0.0,1.7188,0.046
            ********************************************************************
            *     COLD LEG PIPING PATHS
****        4029,8,27,31,9132.0,1.8102,4.276,0.146,-2.9084-06,0.0,0.0,0.0138,2.333
****        4030,8,28,32,9132.0,1.8102,4.276,0.146,-2.9034-06,0.0,0.0,0.0138,2.333
****        4031,8,29,33,9132.0,1.8102,4.276,0.146,-2.9084-06,0.0,0.0,0.0138,2.333
****        4032,8,30,34,9132.0,1.8102,4.276,0.146,-2.9084-06,0.0,0.0,0.0138,2.333
****        4033,8,31,35,9132.0,2.419,4.276,0.1804,0.0,0.0,0.0,0.0188,2.333
****        4034,8,32,36,9132.0,2.419,4.276,0.1804,0.0,0.0,0.0,0.0188,2.333
****        4035,8,33,37,9132.0,2.419,4.276,0.1804,0.0,0.0,0.0,0.0188,2.333
****        4036,8,34,38,9132.0,2.419,4.276,0.1804,0.0,0.0,0.0,0.0188,2.333
****        4037,8,35,39,9132.0,2.320,4.276,0.0,0.0,0.0,0.0,0.0368,2.333
****        4038,8,36,40,9132.0,2.320,4.276,0.0,0.0,0.0,0.0,0.0368,2.333
****        4039,8,37,41,9132.0,2.320,4.276,0.0,0.0,0.0,0.0,0.0368,2.333
****        4040,8,38,42,9132.0,2.320,4.276,0.0,0.0,0.0,0.0,0.0368,2.333
****        4041,8,39,43,9132.0,2.209,4.276,0.0,0.0,0.0,0.0,0.0352,2.333
****        4042,8,40,44,9132.0,2.209,4.276,0.0,0.0,0.0,0.0,0.0352,2.333
****        4043,8,41,45,9132.0,2.209,4.276,0.0,0.0,0.0,0.0,0.0352,2.333
****        4044,8,42,46,9132.0,2.209,4.276,0.0,0.0,0.0,0.0,0.0352,2.333
            ********************************************************************
            *     PUMP PATHS
****        4045,2,43,47,9132.0,0.957,4.276,0.0,0.0,0.0,0.0,0.012,2.333
****        4046,2,44,48,9132.0,0.957,4.276,0.0,0.0,0.0,0.0,0.012,2.333
****        4047,2,45,49,9132.0,0.957,4.276,0.0,0.0,0.0,0.0,0.012,2.333
****        4048,2,46,50,9132.0,0.957,4.276,0.0,0.0,0.0,0.0,0.012,2.333
            ********************************************************************
            *     COLD LEG PIPING PATHS
****        4049,8,47,51,9132.0,1.680,4.276,0.118,0.0,0.0,0.0,7.091-03,2.333
****        4050,8,48,52,9132.0,1.680,4.276,0.118,0.0,0.0,0.0,7.091-03,2.333
****        4051,8,49,53,9132.0,1.680,4.276,0.118,0.0,0.0,0.0,7.091-03,2.333
****        4052,8,50,54,9132.0,1.680,4.276,0.118,0.0,0.0,0.0,7.091-03,2.333
****        4053,8,51,55,9132.0,1.919,4.276,0.1377,0.0,0.0,0.0,0.019,2.333
****        4054,8,52,56,9132.0,1.919,4.276,0.1377,0.0,0.0,0.0,0.019,2.333
****        4055,8,53,57,9132.0,1.919,4.276,0.1377,0.0,0.0,0.0,0.019,2.333
****        4056,8,54,58,9132.0,1.919,4.276,0.1377,0.0,0.0,0.0,0.019,2.333
****        4057,8,55,59,9132.0,1.524,4.276,0.1412,0.0,0.0,0.0,0.0097,2.333
****        4058,8,56,60,9132.0,1.524,4.276,0.1412,0.0,0.0,0.0,0.0097,2.333
****        4059,8,57,61,9132.0,1.524,4.276,0.1412,0.0,0.0,0.0,0.0097,2.333
****        4060,8,58,62,9132.0,1.524,4.276,0.1412,0.0,0.0,0.0,0.0097,2.333
****        4061,10,62,63,9132.0,0.804,4.276,0.0,-2.648-08,0.0,0.0,0.0141,2.333,1.0
****        4062,8,60,68,9132.0,1.093,4.276,0.0,-9.999-08,0.0,0.0,0.0190,2.333
****        4063,8,61,67,9132.0,1.093,4.276,0.0,-9.999-08,0.0,0.0,0.0190,2.333
****        4064,8,59,69,9132.0,1.093,4.276,0.0,-9.999-08,0.0,0.0,0.0190,2.333
****        4065,8,63,64,9132.0,0.202,4.276,0.0,-5.139-08,0.0,0.0,3.473-03,2.333
****        4066,8,68,93,9132.0,0.385,5.102,0.1894,3.947-06,0.0,0.0,1.0-03,2.333
****        4067,8,64,65,9132.0,0.192,4.276,0.0,-3.407-08,0.0,0.0,2.299-03,2.333
****        4068,8,69,91,9132.0,0.385,5.102,0.1894,3.947-06,0.0,0.0,1.0-03,2.333
****        4069,8,65,66,9132.0,0.144,5.695,0.1296,2.186-06,0.0,0.0,1.0-04,2.335
****        4070,8,66,97,9132.0,0.135,7.113,0.164,1.673-06,0.0,0.0,1.0-03,3.009
****        4071,8,67,99,9132.0,0.385,5.102,0.1894,3.947-06,0.0,0.0,1.0-03,2.333
****        4072,8,101,70,1.826+04,0.223,10.845,0.122,-1.557-06,0.0,0.0,1.0-03,3.721
****        4073,8,70,1,1.826+04,0.375,7.07,0.0,-4.442-08,0.0,0.0,0.0212,3.0
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Table 2.26-2. (Cont'd)

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****    4074,8,95,71,1.826+04,0.083,13.183,0.027,-2.351-07,0.0,0.0,1.0-03,4.098
****    4075,8,71,72,1.826+04,0.059,11.523,0.0416,-4.701-07,0.0,0.0,1.0-03,3.834
****    4076,8,72,73,1.826+04,0.070,9.432,0.028,-4.701-07,0.0,0.0,1.0-03,3.480
****    4077,8,73,74,1.826+04,0.088,8.234,0.0178,-3.818-07,0.0,0.0,1.0-03,3.24
****    4078,8,74,75,1.826+04,0.105,7.069,0.0,0.0,0.0,0.0,0.0022,3.0
****    4079,8,75,76,1.826+04,0.115,7.069,0.0,0.0,0.0,0.0,0.0024,3.0
****    4080,8,76,2,1.826+04,0.729,7.069,0.0,0.0,0.0,0.0,0.0147,3.0
****    4081,5,77,4,0.0,142.76,0.4176,0.0,0.0,0.0,0.0,81.45,0.729
        *****************************************************************
        *     DOWNCOMER FLOW PATHS
****    4082,8,78,79,0.00,1.611,1.871,0.0,0.0,0.0,0.0,2.479,1.00
****    4083,8,79,80,0.00,2.485,1.871,0.0,0.0,0.0,0.0,3.500,1.00
****    4084,8,80,81,0.00,2.485,1.871,0.0,0.0,0.0,0.0,3.500,1.00
****    4085,8,81,82,0.00,1.611,1.871,0.0,0.0,0.0,0.0,2.479,1.00
****    4086,8,82,83,0.00,2.702,1.871,0.0,0.0,0.0,0.0,4.521,1.00
****    4087,8,83,84,0.00,2.702,1.871,0.0,0.0,0.0,0.0,4.521,1.00
****    4088,8,84,85,0.00,1.611,1.871,0.0,0.0,0.0,0.0,2.479,1.00
****    4089,8,85,86,0.00,2.485,1.871,0.0,0.0,0.0,0.0,3.500,1.00
****    4090,8,86,87,0.00,2.485,1.871,0.0,0.0,0.0,0.0,3.500,1.00
****    4091,8,87,88,0.00,1.611,1.871,0.0,0.0,0.0,0.0,2.479,1.00
****    4092,8,88,89,0.00,2.702,1.871,0.0,0.0,0.0,0.0,4.521,1.00
****    4093,8,89,78,0.00,2.702,1.871,0.0,0.0,0.0,0.0,4.521,1.00
****    4094,8,91,90,913.20,0.723,3.428,0.0,0.0,0.0,0.0,0.024,1.385
****    4095,8,91,92,913.20,1.021,3.428,0.0,0.0,0.0,0.0,0.035,1.385
****    4096,8,93,92,913.20,1.021,3.428,0.0,0.0,0.0,0.0,0.035,1.385
****    4097,8,93,94,913.20,0.723,3.428,0.0,0.0,0.0,0.0,0.024,1.385
****    4098,8,97,96,913.20,0.723,3.428,0.0,0.0,0.0,0.0,0.024,1.385
****    4099,8,97,98,913.20,1.021,3.428,0.0,0.0,0.0,0.0,0.035,1.385
****    4100,8,99,98,913.20,1.021,3.428,0.0,0.0,0.0,0.0,0.035,1.385
****    4101,8,99,100,913.20,0.723,3.428,0.0,0.0,0.0,0.0,0.024,1.385
****    4102,8,103,102,4794.14,0.634,3.910,0.0,0.0,0.0,0.0,0.021,1.580
****    4103,8,103,104,1750.45,0.895,3.910,0.0,0.0,0.0,0.0,0.030,1.580
****    4104,8,105,104,1750.48,0.910,3.910,0.0,0.0,0.0,0.0,0.030,1.580
****    4105,8,105,106,4794.14,0.634,3.910,0.0,0.0,0.0,0.0,0.021,1.580
****    4106,8,106,107,2148.88,1.172,3.910,0.0,0.0,0.0,0.0,0.039,1.580
****    4107,8,108,107,2148.88,1.156,3.910,0.0,0.0,0.0,0.0,0.039,1.580
****    4108,8,109,108,4794.14,0.634,3.910,0.0,0.0,0.0,0.0,0.021,1.580
****    4109,8,109,110,1750.45,0.895,3.910,0.0,0.0,0.0,0.0,0.030,1.580
****    4110,8,111,110,1750.48,0.895,3.910,0.0,0.0,0.0,0.0,0.030,1.580
****    4111,8,111,112,4794.14,0.634,3.910,0.0,0.0,0.0,0.0,0.021,1.580
****    4112,8,112,113,2148.88,1.172,3.910,0.0,0.0,0.0,0.0,0.039,1.580
****    4113,8,102,113,2148.88,1.156,3.910,0.0,0.0,0.0,0.0,0.039,1.580
****    4114,8,114,115,0.0,0.613,4.046,0.0,0.0,0.0,0.0,1.516,1.635
****    4115,8,115,116,0.0,0.865,4.046,0.0,0.0,0.0,0.0,2.141,1.635
****    4116,8,116,117,0.0,0.987,4.046,0.0,0.0,0.0,0.0,2.141,1.635
****    4117,8,117,118,0.0,0.613,4.046,0.0,0.0,0.0,0.0,1.516,1.635
****    4118,8,118,119,0.0,1.240,4.046,0.0,0.0,0.0,0.0,2.765,1.635
****    4119,8,119,120,0.0,1.117,4.046,0.0,0.0,0.0,0.0,2.765,1.635
****    4120,8,120,121,0.0,0.613,4.046,0.0,0.0,0.0,0.0,1.516,1.635
****    4121,8,121,122,0.0,0.865,4.046,0.0,0.0,0.0,0.0,2.141,1.635
****    4122,8,122,123,0.0,0.865,4.046,0.0,0.0,0.0,0.0,2.141,1.635
****    4123,8,123,124,0.0,0.613,4.046,0.0,0.0,0.0,0.0,1.516,1.635
****    4124,8,124,125,0.0,1.240,4.046,0.0,0.0,0.0,0.0,2.765,1.635
****    4125,8,125,114,0.0,1.117,4.046,0.0,0.0,0.0,0.0,2.765,1.635
****    4126,8,126,127,0.0,0.414,5.992,0.0,0.0,0.0,0.0,1.516,1.635
****    4127,8,127,128,0.0,0.584,5.992,0.0,0.0,0.0,0.0,2.141,1.635
****    4128,8,128,129,0.0,0.584,5.992,0.0,0.0,0.0,0.0,2.141,1.635
****    4129,8,129,130,0.0,0.414,5.992,0.0,0.0,0.0,0.0,1.516,1.635
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****          4130,8,130,131,0.0,0.755,5.992,0.0,0.0,0.0,0.0,2.765,1.635
****          4131,8,131,132,0.0,0.755,5.992,0.0,0.0,0.0,0.0,2.765,1.635
****          4132,8,132,133,0.0,0.414,5.992,0.0,0.0,0.0,0.0,1.516,1.635
****          4133,8,133,134,0.0,0.584,5.992,0.0,0.0,0.0,0.0,2.141,1.635
****          4134,8,134,135,0.0,0.584,5.992,0.0,0.0,0.0,0.0,2.141,1.635
****          4135,8,135,136,0.0,0.414,5.992,0.0,0.0,0.0,0.0,1.516,1.635
****          4136,8,136,137,0.0,0.755,5.992,0.0,0.0,0.0,0.0,2.765,1.635
****          4137,8,137,126,0.0,0.755,5.992,0.0,0.0,0.0,0.0,2.765,1.635
****          4138,8,90,78,0.0,1.465,2.836,0.0,0.0,0.0,0.0,2.999,1.385
****          4139,8,91,79,0.0,6.941,0.599,0.0,0.0,0.0,0.0,2.999,1.385
****          4140,8,92,80,0.0,0.978,4.250,0.0,0.0,0.0,0.0,2.999,1.385
****          4141,8,93,81,0.0,6.941,0.599,0.0,0.0,0.0,0.0,2.999,1.385
****          4142,8,94,82,0.0,1.465,2.836,0.0,0.0,0.0,0.0,2.999,1.385
****          4143,8,96,84,0.0,1.465,2.836,0.0,0.0,0.0,0.0,2.999,1.385
****          4144,8,97,85,0.0,6.941,0.599,0.0,0.0,0.0,0.0,2.999,1.385
****          4145,8,98,86,0.0,0.978,4.250,0.0,0.0,0.0,0.0,2.999,1.385
****          4146,8,99,87,0.0,6.941,0.599,0.0,0.0,0.0,0.0,2.999,1.385
****          4147,8,100,88,0.0,1.465,2.836,0.0,0.0,0.0,0.0,2.999,1.385
****          4148,8,90,102,913.20,1.661,2.979,33.05,3.732-05,0.0,0.0,1.0-03,1.456
****          4149,8,91,103,7305.60,7.868,0.629,0.023,5.831-07,0.0,0.0,1.0-03,1.456
****          4150,8,92,104,1826.40,1.108,4.465,18.56,9.33-06,0.0,0.0,1.0-03,1.456
****          4151,8,93,105,7305.60,7.868,0.629,0.023,5.831-07,0.0,0.0,1.0-03,1.456
****          4152,8,94,106,913.20,1.661,2.979,33.05,3.732-05,0.0,0.0,1.0-03,1.456
****          4153,8,96,108,913.20,1.661,2.979,33.05,3.732-05,0.0,0.0,1.0-03,1.456
****          4154,8,97,109,7305.60,7.868,0.629,0.023,5.831-07,0.0,0.0,1.0-03,1.456
****          4155,8,98,110,1826.40,1.108,4.465,18.56,9.33-06,0.0,0.0,1.0-03,1.456
****          4156,8,99,111,7305.60,7.868,0.629,0.023,5.831-07,0.0,0.0,1.0-03,1.456
****          4157,8,100,112,913.20,1.661,2.979,33.05,3.732-05,0.0,0.0,1.0-03,1.456
****          4158,8,102,114,3546.28,1.478,3.348,0.0,8.028-07,0.0,0.0,0.0296,1.635
****          4159,8,103,115,748.87,7.002,0.707,0.0,1.713-05,0.0,0.0,0.028,1.635
****          4160,8,104,116,5315.19,0.999,5.018,0.029,3.54-07,0.,0.,1.0-03,1.635
****          4161,8,105,117,748.87,7.002,0.707,0.0,1.713-05,0.0,0.0,0.028,1.635
****          4162,8,106,118,3546.28,1.507,3.348,0.029,8.028-07,0.,0.,1.0-03,1.635
****          4163,8,107,119,4285.62,1.223,4.046,0.0,5.518-07,0.0,0.0,0.0297,1.635
****          4164,8,108,120,3546.28,1.478,3.348,0.0,8.028-07,0.0,0.0,0.0296,1.635
****          4165,8,109,121,748.87,7.002,0.707,0.0,1.713-05,0.0,0.0,0.028,1.635
****          4166,8,110,122,5315.19,0.986,5.018,0.0,3.54-07,0.0,0.0,0.029,1.635
****          4167,8,111,123,748.87,7.002,0.707,0.0,1.713-05,0.0,0.0,0.028,1.635
****          4168,8,112,124,3546.28,1.507,3.348,0.029,8.028-07,0.,0.,1.0-03,1.635
****          4169,8,113,125,4285.62,1.223,4.046,0.0,5.518-07,0.0,0.0,0.0297,1.635
****          4170,8,114,126,3546.28,1.833,3.348,0.0,0.0,0.0,0.0,0.0298,1.635
****          4171,8,115,127,748.87,8.682,0.707,0.0,0.0,0.0,0.0,0.029,1.635
****          4172,8,116,128,5315.19,1.232,5.018,0.028,0.0,0.0,0.0,1.0-03,1.635
****          4173,8,117,129,748.87,8.682,0.707,0.0,0.0,0.0,0.0,0.029,1.635
****          4174,8,118,130,3546.28,1.853,3.348,0.030,0.0,0.0,0.0,1.0-03,1.635
****          4175,8,119,131,4285.62,1.517,4.046,0.0,0.0,0.0,0.0,0.030,1.635
****          4176,8,120,132,3546.28,1.833,3.348,0.0,0.0,0.0,0.0,0.0298,1.635
****          4177,8,121,133,748.87,8.682,0.707,0.0,0.0,0.0,0.0,0.029,1.635
****          4178,8,122,134,5315.19,1.223,5.018,0.0,0.0,0.0,0.0,0.030,1.635
****          4179,8,123,135,748.87,8.682,0.707,0.0,0.0,0.0,0.0,0.029,1.635
****          4180,8,124,136,3546.28,1.853,3.348,0.030,0.0,0.0,0.0,1.0-03,1.635
****          4181,8,125,137,4285.62,1.517,4.046,0.0,0.0,0.0,0.0,0.030,1.635
****          4182,8,126,141,3545.55,1.547,3.348,1.807,8.102-06,0.0,0.0,1.0-04,1.0
****          4183,8,127,141,748.87,7.326,0.707,1.753,1.729-04,0.0,0.0,1.0-04,1.0
****          4184,8,128,141,5314.46,1.032,5.018,1.830,3.576-06,0.0,0.0,1.0-04,1.0
****          4185,8,129,141,748.87,7.326,0.707,1.753,1.729-04,0.0,0.0,1.0-04,1.0
****          4186,8,130,141,3545.55,1.547,3.348,1.807,8.102-06,0.0,0.0,1.0-04,1.0
****          4187,8,131,141,4285.62,1.280,4.046,1.826,5.569-06,0.0,0.0,1.0-04,1.0
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Table 2.26-2. (Cont'd)

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****        4188,8,132,141,3545.55,1.547,3.348,1.807,8.102-06,0.0,0.0,1.0-04,1.0
****        4189,8,133,141,748.87,7.326,0.707,1.753,1.729-04,0.0,0.0,1.0-04,1.0
****        4190,8,134,141,5314.46,1.032,5.018,1.830,3.576-06,0.0,0.0,1.0-04,1.0
****        4191,8,135,141,748.87,7.326,0.707,1.753,1.729-04,0.0,0.0,1.0-04,1.0
****        4192,8,136,141,3545.55,1.547,3.348,1.807,8.102-06,0.0,0.0,1.0-04,1.0
****        4193,8,137,141,4285.62,1.280,4.046,1.826,5.569-06,0.0,0.0,1.0-04,1.0
            ************************************************************************
            *     THERMAL SHIELD ANNULUS PATHS
****        4194,8,102,138,12.14,0.616,3.185,88.99,-2.2104-04,0.0,0.0,1.0-04,0.1667
****        4195,8,103,138,12.14,0.616,3.185,88.99,-2.2104-04,0.0,0.0,1.0-04,0.1667
****        4196,8,104,138,12.14,0.616,3.185,88.99,-2.2104-04,0.0,0.0,1.0-04,0.1667
****        4197,8,105,138,12.14,0.616,3.185,88.99,-2.2104-04,0.0,0.0,1.0-04,0.1667
****        4198,8,106,138,12.14,0.616,3.185,88.99,-2.2104-04,0.0,0.0,1.0-04,0.1667
****        4199,8,107,138,12.14,0.616,3.185,88.99,-2.2104-04,0.0,0.0,1.0-04,0.1667
****        4200,8,108,138,12.14,0.616,3.185,88.99,-2.2104-04,0.0,0.0,1.0-04,0.1667
****        4201,8,109,138,12.14,0.616,3.185,88.99,-2.2104-04,0.0,0.0,1.0-04,0.1667
****        4202,8,110,138,12.14,0.616,3.185,88.99,-2.2104-04,0.0,0.0,1.0-04,0.1667
****        4203,8,111,138,12.14,0.616,3.185,88.99,-2.2104-04,0.0,0.0,1.0-04,0.1667
****        4204,8,112,138,12.14,0.616,3.185,88.99,-2.2104-04,0.0,0.0,1.0-04,0.1667
****        4205,8,113,138,12.14,0.616,3.185,88.99,-2.2104-04,0.0,0.0,1.0-04,0.1667
****        4206,8,138,139,145.528,1.392,3.185,0.0,-2.851-06,0.0,0.0,1.031,0.1667
****        4207,8,139,140,145.528,1.554,3.185,0.0,0.0,0.0,0.0,0.824,0.1667
****        4208,8,126,140,0.736,119.07,0.0014,1.2024,0.0,0.0,0.0,1.0-04,0.042
****        4209,8,128,140,0.736,119.07,0.0014,1.2024,0.0,0.0,0.0,1.0-04,0.042
****        4210,8,130,140,0.736,119.07,0.0014,1.2024,0.0,0.0,0.0,1.0-04,0.042
****        4211,8,132,140,0.736,119.07,0.0014,1.2024,0.0,0.0,0.0,1.0-04,0.042
****        4212,8,134,140,0.736,119.07,0.0014,1.2024,0.0,0.0,0.0,1.0-04,0.042
****        4213,8,136,140,0.736,119.07,0.0014,1.2024,0.0,0.0,0.0,1.0-04,0.042
****        4214,8,140,149,149.944,1.812,0.092,0.762,0.0,0.0,0.0,1.856,0.062
            ************************************************************************
            *     LOWER HEAD THROUGH LOWER GRID FLOW PATHS
****        4215,8,141,142,3.633+04,0.043,30.965,1.366,1.020-09,0.0,0.0,1.0-04,1.0
****        4216,8,142,143,3.633+04,0.035,35.46,0.609,-3.543-08,0.0,0.0,1.0-04,1.0
****        4217,8,143,144,3.633+04,0.015,44.88,1.385,3.5740-08,0.0,0.0,1.0-04,1.0
****        4218,8,144,145,3.633+04,0.012,45.650,0.134,-0.30-07,0.0,0.0,1.0-04,1.0
            ************************************************************************
            *     INNER CORE BYPASS FLOW PATHS
****        4219,8,145,149,651.670,0.718,14.55,944.42,1.535-06,0.0,0.0,1.0-04,4.30
****        4220,8,149,150,801.614,0.757,14.55,448.87,1.012-06,0.0,0.0,1.0-04,1.0
****        4221,8,150,151,801.614,0.564,14.55,429.06,0.0,0.0,0.0,1.0-04,1.002
****        4222,8,151,152,801.614,0.271,14.55,460.706,4.336-07,0.0,0.0,1.0-03,4.30
            ************************************************************************
            *     UPPER PLENUM FLOW PATHS
****        4223,8,168,95,2559.52,1.500,3.010,6.586,0.0,0.0,0.0,1.0-04,1.333
****        4224,8,171,167,3383.84,2.252,2.005,1.672,0.0,0.0,0.0,1.0-04,1.333
****        4225,8,170,167,3383.84,2.252,2.005,1.672,0.0,0.0,0.0,1.0-04,1.333
****        4226,8,149,146,0.0,0.076,0.825,2.5,0.0,0.0,0.0,0.544,0.115
****        4227,8,150,147,0.0,0.095,0.66,2.5,0.0,0.0,0.0,0.543,0.115
****        4228,8,151,148,0.0,0.038,1.65,2.5,0.0,0.0,0.0,0.543,0.115
****        4229,8,152,153,3.358+04,0.068,57.68,0.618,0.0,0.0,0.0,1.0-04,1.349
****        4230,8,153,154,2.759+04,0.076,57.68,0.0,0.0,0.0,0.0,0.151,1.349
****        4231,8,152,155,2951.44,0.164,23.01,19.72,0.0,0.0,0.0,1.0-03,0.665
****        4232,8,155,156,2951.44,0.256,21.19,0.0,0.0,0.0,0.0,6.674,0.665
****        4233,8,156,157,2951.44,0.167,21.19,7.674,0.0,0.0,0.0,1.0-03,0.665
****        4234,8,157,158,737.86,0.120,30.107,0.0,0.0,0.0,0.0,1.0-03,1.0
****        4235,8,157,159,737.86,0.120,30.107,0.0,0.0,0.0,0.0,1.0-03,1.0
****        4236,8,157,160,737.86,0.120,30.107,0.0,0.0,0.0,0.0,1.0-03,1.0
****        4237,8,157,161,737.86,0.120,30.107,0.0,0.0,0.0,0.0,1.0-03,1.0
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Table 2.26-2. (Cont'd)

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****      4238,8,158,162,1056.62,2.615,0.584,0.059,0.0,[illegible],0.0,1.0-03,0.230
****      4239,8,158,163,1056.62,2.615,0.584,0.059,0.0,0.0,0.0,1.0-03,0.230
****      4240,8,158,164,1056.62,2.615,0.584,0.059,0.0,0.0,0.0,1.0-03,0.230
****      4241,8,159,165,1584.93,1.743,0.876,0.059,0.0,0.0,0.0,1.0-03,0.230
****      4242,8,154,158,2432.5,2.424,0.860,0.048,0.0,0.0,0.0,1.0-04,1.0
****      4243,8,154,159,2432.5,2.424,0.860,0.048,0.0,0.0,0.0,1.0-04,1.0
****      4244,8,154,160,2432.5,2.424,0.860,0.048,0.0,0.0,0.0,1.0-04,1.0
****      4245,8,154,161,2432.5,2.424,0.860,0.048,0.0,0.0,0.0,1.0-[illegible],1.0
****      4246,8,158,159,0.0,2.758,3.275,0.0,0.0,0.0,0.0,3.542,2.55
****      4247,8,159,160,0.0,2.758,3.275,0.0,0.0,0.0,0.0,3.542,2.55
****      4248,8,160,161,0.0,2.758,3.275,0.0,0.0,0.0,0.0,3.542,2.55
****      4249,8,161,158,0.0,2.758,3.275,0.0,0.0,0.0,0.0,3.542,2.55
****      4250,8,153,95,2991.627,0.654,1.178,0.819,0.0,0.0,0.0,1.0-03,0.25
****      4251,8,153,101,2991.627,0.654,1.178,0.819,0.[illegible]0.0,0.0,1.0-03,0.25
          ****************************************************************
          *     OUTLET ANNULUS FLOW PATHS
****      4252,8,154,162,2327.08,0.501,6.305,3.49,0.0,0.0,0.0,1.0-03,2.833
****      4253,8,154,163,2327.08,0.501,6.305,3.49,0.0,0.0,0.0,1.0-03,2.833
****      4254,8,154,164,2327.08,0.501,6.305,3.49,0.0,0.0,0.0,1.0-03,2.833
****      4255,8,154,165,974.383,0.368,2.640,3.46,0.0,0.0,0.0,1.0-03,1.833
****      4256,8,162,166,3383.84,2.252,2.005,1.672,0.0,0.0,0.0,1.0-04,1.333
****      4257,8,163,166,3383.84,2.252,2.005,1.672,0.0,0.0,0.0,1.0-04,1.333
****      4258,8,164,166,3383.84,2.252,2.005,1.672,0.0,0.0,0.0,1.0-04,1.333
****      4259,8,165,95,2559.52,1.5,3.010,6.586,0.0,0.0,0.0,1.0-04,1.333
****      4260,8,163,162,0.0,1.106,2.722,0.0,0.0,0.0,0.0,2.442,1.233
****      4261,8,163,164,0.0,1.106,2.722,0.0,0.0,0.0,0.0,2.442,1.233
****      4262,8,164,165,0.0,1.383,2.722,0.0,0.0,0.0,0.0,3.052,1.233
****      4263,8,165,168,0.0,1.659,2.722,0.0,0.0,0.0,0.0,3.663,1.233
****      4264,8,166,95,5075.76,2.741,3.295,0.0,0.0,0.0,0.0,1.0-03,1.248
****      4265,8,167,95,5075.76,2.741,3.295,0.0,0.0,0.0,0.0,1.0-03,1.248
****      4266,8,167,101,5075.76,2.741,3.295,0.0,0.0,0.0,0.0,1.0-03,1.248
****      4267,8,166,101,5075.76,2.741,3.295,0.0,0.0,0.0,0.0,1.0-03,1.248
****      4268,8,162,80,0.0,0.233,1.069,0.0,0.0,1.0+16,0.0,1.0-03,1.167
****      4269,8,164,80,0.0,0.233,1.069,0.0,0.0,1.0+16,0.0,1.0-03,1.167
****      4270,8,165,82,0.0,0.233,1.069,0.0,0.0,1.0+16,0.0,1.0-03,1.167
****      4271,8,168,84,0.0,0.233,1.069,0.0,0.0,1.0+16,0.0,1.0-03,1.167
****      4272,8,169,86,0.0,0.233,1.069,0.0,0.0,1.0+16,0.0,1.0-03,1.167
****      4273,8,171,86,0.0,0.233,1.069,0.0,0.0,1.0+16,0.0,1.0-03,1.167
****      4274,8,172,88,0.0,0.233,1.069,0.0,0.0,1.0+16,0.0,1.0-03,1.167
****      4275,8,173,78,0.0,0.233,1.069,0.0,0.0,1.0+16,0.0,1.0-03,1.167
****      4276,8,154,168,974.383,0.368,2.640,3.46,0.0,0.0,0.0,1.0-03,1.833
****      4277,8,154,169,2327.08,0.501,6.305,3.49,0.0,0.0,0.0,1.0-03,2.833
****      4278,8,154,170,2327.08,0.501,6.305,3.49,0.0,0.0,0.0,1.0-03,2.833
****      4279,8,154,171,2327.08,0.501,6.305,3.49,0.0,0.0,0.0,1.0-03,2.833
****      4280,8,154,172,974.383,0.368,2.640,3.46,0.0,0.0,0.0,1.0-03,1.833
****      4281,8,154,173,974.383,0.368,2.640,3.46,0.0,0.0,0.0,1.0-03,1.833
****      4282,8,169,168,0.0,1.383,2.722,0.0,0.0,0.0,0.0,3.052,1.233
****      4283,8,170,169,0.0,1.106,2.722,0.0,0.0,0.0,0.0,2.442,1.233
****      4284,8,170,171,0.0,1.106,2.722,0.0,0.0,0.0,0.0,2.442,1.233
****      4285,8,171,172,0.0,1.383,2.722,0.0,0.0,0.0,0.0,3.052,1.233
****      4286,8,172,173,0.0,1.659,2.722,0.0,0.0,0.0,0.0,3.663,1.233
****      4287,8,162,173,0.0,1.383,2.722,0.0,0.0,0.0,0.0,3.052,1.233
****      4288,8,159,168,1584.93,1.743,0.876,0.059,0.0,0.0,0.0,1.0-03,0.230
****      4289,8,160,171,1056.62,2.615,0.584,0.059,0.0,0.0,0.0,1.0-03,0.230
****      4290,8,160,170,1056.62,2.615,0.584,0.059,0.0,0.0,0.0,1.0-03,0.230
****      4291,8,160,169,1056.62,2.615,0.584,0.059,0.0,0.0,0.0,1.0-03,0.230
****      4292,8,161,173,1584.93,1.743,0.876,0.059,0.0,0.0,0.0,1.0-03,0.230
****      4293,8,161,172,1584.93,1.743,0.876,0.059,0.0,0.0,0.0,1.0-03,0.230
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****        4294,8,169,167,3383.84,2.252,2.005,1.672,0.0,0.0,0.0,1.0-04,1.333
****        4295,8,173,101,2559.52,1.5,3.010,6.586,0.0,0.0,0.0,1.0-04,1.333
****        4296,8,172,101,2559.52,1.5,3.010,6.586,0.0,0.0,0.0,1.0-04,1.333
****        4297,8,27,29,0.0,0.141,38.644,0.0,0.0,0.0,0.0,0.707,7.014
****        4298,8,28,30,0.0,0.141,38.644,0.0,0.0,0.0,0.0,0.707,7.014
****        4299,8,1,3,1.826+04,1.362,7.069,0.1826,0.0,0.0,0.0,5.043-03,3.0
****        4300,8,2,4,1.826+04,1.362,7.069,0.1826,0.0,0.0,0.0,5.043-03,3.0
****        4301,8,3,5,1.826+04,1.369,7.069,0.0,0.0,0.0,0.0,0.0276,3.0
****        4302,8,4,6,1.826+04,1.369,7.069,0.0,0.0,0.0,0.0,0.0276,3.0
            ****************************************************************
            *     LEAK FLOW PATHS
****        4303,7,63,174,-10.,-10.,4.276,1.21,1.0,0.0
****        4304,7,62,174,-10.,-10.,4.276,1.21,1.0,0.0
            ****************************************************************
            *     MODIFIED FLOW PATHS
****        4901,194,622.052,622.052,195,622.052,622.052,196,622.052,622.052
****        4902,197,622.052,622.052,198,622.052,622.052,199,622.052,622.052
****        4903,200,622.052,622.052,201,622.052,622.052,202,622.052,622.052
****        4904,203,622.052,622.052,204,622.052,622.052,205,622.052,622.052
****        4905,208,609.875,609.875,209,609.875,609.875,210,609.875,609.875
****        4906,211,609.875,609.875,212,609.875,609.875,213,609.875,609.875
****        4907,214,610.125,610.125,219,610.037,610.037,222,622.936,622.936
****        4908,226,614.527,614.527,227,617.277,617.277,228,620.443,620.443
****        4909,297,601.011,601.011,298,601.011,601.011,81,623.244,628.465
            ****************************************************************
            *     VARIABLE FLOW AREA VS. TIME TABLE
****        4951,4.276,0.,4.062,.0062,3.635,.0116,2.993,.0159,2.138,.020,1.069,.0242
            +,0.0,0.0271,0.0,1.0+06
            ****************************************************************
            *     VENT VALVE SPECIFICATIONS
****        4820,268,269,270,271,272,273,274,275
****        4821,0.625,0.742,0.167,0.037,0.454,2.558,113.11,0.0,1.0
****        4831,1.0+06,0.,1.0+06,.0373,1.0+04,.105,630.,.124,315.,.129,153.,.140,86
            +.4,.157,62.1,.175,46.8,.192,29.,.227,21.,.262,16.,.297,11.,.332,9.7,.36
            +7,8.6,.401,6.3,.436,5.7,.4537,5.7,1.57
            ****************************************************************
            *     CORE PARAMETERS
****        5001,0.048,2.0,7500.0,3000.0,10.0,1,175583.71,8296.4,0.166,-1.2-03
****        5002,1.0,1.0,0.0,0.0,0
****        5003,0.048,4.0,7500.0,3000.0,10.0,1,175583.71,16592.8,0.33,-1.2-03
****        5004,1.0,1.0,0.0,0.0,0
****        5005,0.048,4.0,7500.0,3000.0,10.0,1,175583.71,16592.8,0.33,-1.2-03
****        5006,1.0,1.0,0.0,0.0,0
****        5007,0.048,2.0,7500.0,3000.0,10.0,1,175583.71,8296.4,0.166,-1.2-03
****        5008,1.0,1.0,0.0,0.0,0
            ****************************************************************
            *     FUEL,PIN,GAP,AND CLADDING PROPERTIES
****        5101,.0152775,0.,0.,1325.,.0004657,-1.,-1.,.0021894
****        5102,.0,.0,.0,.0,1.,1,775.
****        5103,.0152775,0.,0.,1325.,.0004657,-1.,-1.,.0021894
****        5104,.0,.0,.0,.0,1.,1,775.
****        5105,.0152775,0.,0.,1325.,.0004657,-1.,-1.,.0021894
****        5106,.0,.0,.0,.0,1.,1,775.
****        5107,.0152775,0.,0.,1325.,.0004657,-1.,-1.,.0021894
****        5108,.0,.0,.0,.0,1.,1,775.
****        5500,660,25
****        5505,0.35,0.00020307,0.00050972,1.0,.2,.0153,1
****        5510,1,1,4
```

Table 2.26-2. (Cont'd)

```
          ****************************************************************************
          *     FORCE ON CORE
****      5911,4,40.99,49.64,267624.0
          ****************************************************************************
          *     SCRAM PARAMETERS
****      6001,0.0,1.0+04,2064.7,0.5,1.0+04,21,21
****      6011,1.0,0.0,1.0.100.
          ****************************************************************************
          *     STEAM GENERATOR PARAMETERS
****      7001,17,242781.875,525.0
****      7002,18,242781.875,525.0
****      7003,19,242781.875,525.0
****      7004,20,242781.875,525.0
****      7005,21,242781.875,525.0
****      7006,22,242781.875,525.0
****      7007,23,242781.875,525.0
****      7008,24,242781.875,525.0
****      7009,25,242781.875,525.0
****      7010,26,242781.875,525.0
****      7011,1.0-05,1.0+06,14.70,1.0+06,1.0+06,26,26
****      7021,1.0,0.0,1.0,1.0+06
          ****************************************************************************
          *     PUMP CHARACTERISTICS
****      8001,1,2.73,2.37,2.07,1.85,1.69,1.51,1.40,1.25,1.17,1.11,1.
****      8002,2,.71,.47,.29,.14,.05,-.02,-.10,-.42,-.99,-1.64,-2.44
****      8003,3,-2.44,-2.30,-2.16,-1.93,-1.69,-1.45,-1.09,-.51,.10,.48,1.
****      8004,4,.71,.69,.74,.83,.94,1.06,1.21,1.42,1.70,2.15,2.73
****      8005,5,1.96,1.56,1.25,1.13,.93,.77,.74,.79,.90,.96,1.
****      8006,6,.41,.10,-.18,-.38,-.53,-.87,-1.29,-1.98,-2.87,-3.7,-4.73
****      8007,7,-4.73,-4.,-3.31,-2.78,-2.23,-1.64,-1.,-.29,.24,.59,1.
****      8008,8,.41,.60,.78,.91,1.02,1.13,1.21,1.34,1.50,1.66,1.96
          ****************************************************************************
          *     PUMP ELECTRIC TORQUE VS. ACTUAL PUMP SPEED
****      8016,40162.,0.,41344.,120.,42919.,240.,44100.,360.,46069.,480.,48038.,
****      8017,600.,50794.,720.,55125.,840.,62212.,960.,82688.,1080.,88988.,1140.,
****      8018,74025.,1176.,0.,1200.,-74025.,1224.,-88988.,1260.,-82688.,1320.,
****      8019,-62212.,1440.,-55125.,1560.,-50794.,1680.,-48038.,1800.,-46069.,
****      8020,1920.,-44100.,2040.,-42919.,2160.,-41344.,2280.,-40162.,2400.
          ****************************************************************************
          *     PUMP SHUTDOWN PARAMETERS
****      8021,0.,1.+10,0.,0.,0.,0.,0.
****      8022,0.,1.+10,0.,0.,0.,0.,0.
****      8023,0.,1.+10,0.,0.,0.,0.,0.
****      8024,0.,1.+10,0.,0.,0.,0.,0.
          ****************************************************************************
          *     PUMP PARAMETERS
****      8031,45,273.,37300.,1191.,88068.45,4.28,1191.
****      8032,46,273.,37300.,1191.,88068.45,4.28,1191.
****      8033,47,273.,37300.,1191.,88068.45,4.28,1191.
****      8034,48,273.,37300.,1191.,88068.45,4.28,1191.
          ****************************************************************************
          *     PUMP MOTOR CONSTANTS
****      8041,71.111,429.34,40000.,117.34,1.7372,74.048,.4869,390.115
****      8042,.00102,.4332,1925.,71100.
****      8051,-26.6026,50.9643,-33.6919,9.3302
          *

INPUT FILE OCCUPIES 8809 DATA WORDS
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Table 2.26-3. Listing of CRAFT2 Code Inputs for Nozzle-Supported Reactor Vessel Internals ΔP Model

```
LISTING OF INPUT DATA FOR CASE  1
                        *        CASE INFORMATION
                        *        CALC. 32-1102319-01
                        * MODIFIED BREAK OPENING AREA VS. TIME SCHEDULE
                        * TOLEDO NS14
                        * .5 SEC RUN
                        * BREAK OPENING TIME=.070 SEC.
****                    1001,0.50,7.0-05,0.070
****                    1002,0.,0.,.0035,.0025,.042,.009,.0554,.016,.060,.026,.0813,.035,.0936,.
                        +045,.0968,.053,.121,.070,.121,1.0+06
****                    1004,5.,5.,5.
                        *        PLOT INFORMATION
****                    1501,1101,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1102,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1103,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1104,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1105,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1106,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1107,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1108,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1109,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1110,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0
****                    1502,1111,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1112,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1113,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1114,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1115,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1116,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1117,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1118,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1119,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1120,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0
****                    1503,1121,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1122,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1123,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1124,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1125,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1126,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1127,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1128,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1129,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1130,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0
****                    1504,1131,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1132,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1133,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1134,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1135,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1136,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1137,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1138,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1139,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1140,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0
****                    1505,1141,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1142,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1143,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1144,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1145,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
                        +    1146,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
```

Table 2.26-3. (Cont'd)

	47	+	1147,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	48	+	1148,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	49	+	1149,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	50	+	1150,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
****	51	1506,	1151,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	52	+	1152,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	53	+	1153,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	54	+	1154,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	55	+	1155,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	56	+	1156,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	57	+	1157,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	58	+	1158,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	59	+	1159,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	60	+	1160,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0
****	61	1507,	1161,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	62	+	1162,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	63	+	1163,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	64	+	1164,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	65	+	1165,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	66	+	1166,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	67	+	1167,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	68	+	1168,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	69	+	1169,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	70	+	1170,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0
****	71	1508,	1171,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	72	+	1172,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	73	+	1173,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	74	+	1174,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	75	+	1175,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	76	+	1176,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	77	+	1177,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	78	+	1178,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	79	+	1179,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	80	+	1180,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0
****	81	1509,	1181,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	82	+	1182,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	83	+	1183,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	84	+	1184,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	85	+	1185,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	86	+	1186,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	87	+	1187,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	88	+	1188,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	89	+	1189,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	90	+	1190,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0
****	91	1510,	1191,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	92	+	1192,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
	93	+	1193,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0
****	94	1511,	1801,1,0.,0.5,0.1,1,0.,0.,5.0, 5,10,
	95	+	1802,1,0.,0.5,0.1,1,0.,0.,5.0,10,84,
	96	+	1803,1,0.,0.5,0.1,1,0.,0.,5.0,10,69,
	97	+	1804,1,0.,0.5,0.1,1,0.,0.,5.0,10,75,
	98	+	1805,1,0.,0.5,0.1,1,0.,0.,5.0, 6,38,
	99	+	1806,1,0.,0.5,0.1,1,0.,0.,5.0,10,85,
	100	+	1807,1,0.,0.5,0.1,1,0.,0.,5.0,10,70,
	101	+	1808,1,0.,0.5,0.1,1,0.,0.,5.0,10,67,
	102	+	1809,1,0.,0.5,0.1,1,0.,0.,5.0,38,39,
	103	+	1810,1,0.,0.5,0.1,1,0.,0.,5.0,10,86,
	104	+	1811,1,0.,0.5,0.1,1,0.,0.,5.0,10,71,

Table 2.26-3. (Cont'd)

```
        105   +      1812,1,0.,0.5,0.1,1,0.,0.,5.0, 5, 9,
        106   +      1813,1,0.,0.5,0.1,1,0.,0.,5.0,10,87,
        107   +      1814,1,0.,0.5,0.1,1,0.,0.,5.0,10,72,
        108   +      1815,1,0.,0.5,0.1,1,0.,0.,5.0, 9, 6
****    109   1512,2520,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        110   +      2516,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        111   +      2561,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        112   +      2579,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        113   +      2585,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        114   +      2187,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        115   +      2188,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        116   +      2190,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        117   +      2186,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        118   +      2185,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        119   +      2125,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        120   +      2128,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0
****    121   1513,21138,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        122   +      21139,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        123   +      21140,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        124   +      21141,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        125   +      21131,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        126   +      21103,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        127   +      21104,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        128   +      21105,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        129   +      21106,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0
****    130   1514, 5701,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        131   +       5401,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        132   +       5501,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        133   +       6259,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        134   +       6278,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        135   +       2159,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        136   +       2178,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        137   +       8559,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        138   +       8578,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        139   +       2259,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        140   +       2278,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0,
        141   +       1194,1,0.,0.5,0.1,1,0.,0.,5.0, 0, 0
****          1601,1105,1103,1108,1106,1139,1110,1173,1188,1801,1805,5701,1809,1812
****          1701,1,1,1
              *     TIME STEPS
****          2001,.00007,.2,100,.00007,1.,80.
              *     CONTROL VOLUMES
              *CARD AREA  HEIGHT  EXIT   INLET BOTTOM PRESSURE ENTHALPY LEVEL
****          3001,8.8550,4.705  ,563.42,567.42,562.92,2225.278,553.68  ,0.
****          3002,8.8550,4.705  ,563.42,567.42,562.92,2225.278,553.68  ,0.
****          3003,8.5560,4.75   ,553.96,557.71,553.46,2228.458,553.68  ,0.
****          3004,8.5560,4.75   ,553.96,557.71,553.46,2228.458,553.68  ,0.
****          3005,51.684,7.1670,546.79,552.96,546.29,2227.430,553.68  ,0.
****          3006,73.479,1.4790,552.83,552.35,551.85,2221.330,553.68  ,0.
****          3007, 49.925, 3.75, 557.71, 554.96, 554.46,2213.383,559.6 ,0.0
****          3008, 49.925, 4.71, 562.42, 558.71, 558.21,2208.742,590.3 ,0.0
****          3009,55.197,2.4370,551.35,549.92,549.42,2221.124,553.68  ,0.
****          3010,82.092,6.00   ,578.46,578.46,577.96,2190.000,625.74  ,0.
****          3011,4.1230,3.00   ,571.0 ,571.0 ,569.5 ,2163.428,625.74  ,0.
****          3012,4.1230,3.00   ,571.0 ,571.0 ,569.5 ,2163.628,625.74  ,0.
****          3013,6.3390,5.50   ,571.0 ,571.0 ,568.0 ,2177.000,625.74  ,0.
****          3014,6.3390,5.50   ,571.0 ,571.0 ,568.0 ,2177.000,625.74  ,0.
****          3015,15.116,8.0    ,633.48,639.98,637.98,2133.329,625.74  ,0.
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Table 2.26-3. (Cont'd)

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*****           3016,15.116,8.0   ,638.48,639.98,637.98,2133.329,625.74  ,0.
*****           3017,7.0680,31.74 ,607.24,576.5 ,576.0 ,21[illegible].031,625.74  ,0.
*****           3018,7.0680,31.74 ,607.24,576.5 ,576.0 ,21[illegible].031,625.74  ,0.
*****           3019,15.330,6.5   ,575.5 ,571.0 ,569.5 ,2162.009,625.74  ,0.
*****           3020,15.330,6.5   ,575.5 ,571.0 ,569.5 ,2162.009,625.74  ,0.
*****           3021,26.155,11.24,575.0,535.0,574.452,21[illegible].5[illegible],553.6[illegible]6,0.0
*****           3022,26.155,11.24,620.0,630.0,619.412,2144.04,624.573,0.0
*****           3023,26.155,11.24,575.0,535.0,574.452,2139.53,553.686,0.0
*****           3024,26.155,11.24,620.0,630.0,619.412,2144.04,624.573,0.0
*****           3025,10.+5 ,10.+2 ,571.0 ,571.0 ,0.0    ,14.7    ,0.0     ,1.-5
*****           3026,3.34,3.033,571.0,571.0,569.459,2226.125,553.680,0.0
*****   CHIENUPD3027,5.4242,3.0333,571.0,571.,569.4533,2227.161,553.68,0.
*****   CHIENUPD3028,5.4242,3.0333,571.0,571.,569.4533,2227.161,553.68,0.
*****   CHIENUPD3029,5.4242,3.0333,571.0,571.,569.4533,2227.161,553.68,0.
*****           3030,7.0680,31.74 ,638.98,603.24,607.74,2137.973,625.74  ,0.
*****           3031,2.3560,3.00  ,571.0 ,571.0 ,569.5 ,2163.363,625.74  ,0.
*****           3032,12.894,4.75  ,557.71,553.96,553.46,2215.500,559.60  ,0.
*****           3033,14.108,4.71  ,562.42,558.71,558.[illegible],22[illegible]30,590.30  ,0.
*****           3034,11.398,6.92  ,574.0 ,568.08,567.[illegible],2134.350,553.24  ,0.
*****           3035,11.398,6.92  ,574.0 ,568.08,567.58,2134.350,553.24  ,0.
*****           3036,23.276,5.84  ,570.33,575.17,569.83,2224.830,553.68  ,0.
*****           3037,22.18,5.84,570.33,575.2,569.830,2224.830,553.680,0.0
*****           3038,55.653,1.125 ,553.96,553.83,553.33,2219.600,553.68  ,0.
*****           3039,64.106,2.292 ,568.25,566.96,566.46,[illegible].000,625.48  ,0.
*****           3040,11.398,6.92  ,574.0 ,568.08,567.58,2134.350,553.24  ,0.
*****           3041,11.398,6.92  ,574.0 ,568.08,567.58,2134.350,553.24  ,0.
*****           3042,23.276,5.84  ,570.33,575.17,569.83,2224.830,553.68  ,0.
*****           3043,23.276,5.84  ,570.33,575.17,569.83,2224.830,553.68  ,0.
*****           3044,77.526,56.2  ,601.57,601.57,573.47,1000.    ,0.0    ,25.
*****           3045,77.526,56.2  ,601.57,601.57,573.47,1000.    ,0.0    ,25.
*****           3046,24.100,44.0  ,593.0 ,593.0 ,592.0 ,2148.440,0.000   ,8.0
*****           3047,53.939,4.92  ,569.05,572.97,568.55,2141.557,553.24  ,0.
*****           3048,53.969,4.92  ,569.05,572.97,568.55,2141.557,553.24  ,0.
*****           3049,37.645,7.33  ,631.17,637.48,630.65,2145.146,625.74  ,0.
*****           3050,37.645,7.33  ,631.17,637.48,630.65,2145.146,625.74  ,0.
*****           3051,7.0680,31.74 ,638.98,603.24,607.74,2137.973,625.74  ,0.
*****           3052,8.8550,4.705 ,563.42,567.42,562.92,2225.278,553.68  ,0.
*****           3053,8.5560,4.75  ,553.96,557.71,553.46,2228.458,553.68  ,0.
*****           3054,8.8550,4.705 ,563.42,567.42,562.92,2225.278,553.68  ,0.
*****           3055,8.5560,4.75  ,553.96,557.71,553.46,2228.458,553.68  ,0.
*****           3056, 49.925, 3.54, 565.96, 563.42, 562.92,2205.000,620.13,0.0
*****           3057,13.422,4.71  ,567.12,563.42,562.92,2205.400,620.13  ,0.
*****           3058,3.1660,4.75  ,557.71,553.96,553.46,2232.446,553.68  ,0.
*****           3059,2.9920,4.71  ,562.42,558.71,558.21,2231.925,553.68  ,0.
*****           3060,3.4350,4.71  ,567.12,563.42,562.92,2230.404,553.68  ,0.
*****           3061,8.6290,4.71  ,558.71,562.42,558.21,2226.867,553.68  ,0.
*****           3062,8.6290,4.71  ,558.71,562.42,558.21,2226.867,553.68  ,0.
*****           3063,8.6290,4.71  ,558.71,562.42,558.21,2226.867,553.68  ,0.
*****           3064,8.6290,4.71  ,558.71,562.42,558.21,2226.867,553.68  ,0.
*****   CHIENUPD3065,55.8355,4.75,571.0,571.0,568.75,2193.220,625.74,0.
*****           3066,23.348,4.6040,572.85,569.25,568.75,2194.425,625.74  ,0.
*****           3067,23.348,4.6040,577.46,573.85,573.35,2193.223,625.74  ,0.
*****           3068,2.3560,3.00  ,571.0 ,571.0 ,569.5 ,2163.363,625.74  ,0.
*****   CHIENUPD3069,4.486,4.458,575.72 ,575.72 ,573.5,2190.750,625.74,0.
*****   CHIENUPD3070,4.486,4.458,575.729,575.729,573.5,2190.750,625.74,0.
*****   CHIENUPD3071,4.486,4.458,575.729,575.729,573.5,2190.750,625.74,0.
*****   CHIENUPD3072,4.486,4.458,575.729,575.729,573.5,2190.750,625.74,0.
*****           3073,2.75,2.330,571.0,571.0,569.830,2224.490,553.680,0.0
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Table 2.26-3. (Cont'd)

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****         3074,26.155,11.24,609.0,619.0,608.172,2142.94,621.741,0.0
****         3075,55.8355,4.4513,575.7292,575.7292,573.5,2191.800,625.74,0.
**** CHIENUPD3076,4.3110,5.500,570.75,570.75,[illegible].0,2120.521,625.74,0.
**** CHIENUPD3077,4.3110,5.500,570.75,570.75,5[illegible]3.0,2120.521,625.74,0.
**** CHIENUPD3078,4.3110,5.500,570.75,570.75,[illegible].0,2[illegible]0.521,625.74,0.
**** CHIENUPD3079,4.3110,5.500,570.75,570.75,5[illegible].0,2120.521,625.74,0.
**** CHIENUPD3030,6.4332,5.875,571.0,571.0,567.625,2229.702,553.68,0.
**** CHIENUPD3031,6.4332,5.875,571.0,571.0,567.625,2229.702,553.68,0.
**** CHIENUPD3032,6.4332,5.875,571.0,571.0,567.625,2229.702,553.68,0.
**** CHIENUPD3033,6.4332,5.875,571.0,571.0,567.625,2229.702,553.68,0.
**** CHIENUPD3034,6.4332,3.333,575.167,575.167,573.5,222[illegible].635,553.68,0.
**** CHIENUPD3035,6.4332,3.333,575.167,575.167,573.5,2223.635,553.68,0.
**** CHIENUPD3036,6.4332,3.333,575.167,575.167,573.5,2223.635,553.68,0.
**** CHIENUPD3037,6.4332,3.333,575.167,575.167,573.5,222[illegible].635,553.68,0.
****         30[illegible],2.75,2.330,571.0,571.0,569.050,2224.590,553.6[illegible]0,0.0
****         3089,26.155,11.24,597.0,608.0,596.932,2141.[illegible],594.012,0.0
****         3090,26.155,11.24,586.0,596.0,585.6 2,2141.[illegible],567.407,0.0
****         3091,26.155,11.24,609.0,619.0,608.172,2142.94,621.741,0.0
****         3092,26.155,11.24,597.0,608.0,596.932,2141.88,594.012,0.0
****         3093,26.155,11.24,586.0,596.0,585.692,2141.89,567.407,0.0
****         3801,25,59,78
             *BUBBLE RISE VELOCITY
****         3901,1028.0,
****         CARD,TY,FR,TO,FLOW   ,L/A   ,AREA,FWDK ,MOMFFAC,REVK ,HT   ,KFRIC ,HYDIA
****         4001, 1,38, 7,35827.80,0.0475, 49.90,2.529,   0.0  ,0.0,0.0,0.695,0.0478
****         4002, 1, 7, 8,35827.80,0.0840, 49.90,2.372,-3.784-9,0.0,0.0,1.234,0.0478
****         4003, 1, 8,56,35827.80,0.0340, 49.90,2.155,-4.235-9,0.0,0.0,0.761,0.0478
****         4004, 1,56,39,35827.80,0.0526, 49.90,1.708,   0.0  ,0.0,0.0,1.144,0.0478
**** CHIENUPD4005,08,81,52,9083.32,0.7776,7.394,2.056,4.97-7,0.,0.,1.-5,1.42
**** CHIENUPD4006,08,82,54,9083.32,0.7776,7.394,2.056,4.97-7,0.,0.,1.-5,1.42
**** CHIENUPD4007,08,80,01,9083.32,0.7776,7.394,2.056,4.97-7,0.,0.,1.-5,1.42
**** CHIENUPD4008,08,83,02,9083.32,0.7776,7.394,2.056,4.97-7,0.,0.,1.-5,1.42
****         4009,08,61,64,0.0     ,2.73   ,3.85,1.-10,0.0      ,0.0  ,0.  ,7.57  ,1.
****         4010,08,06,33,35327.5,0.0220,101.,6.709,-3.01-8,0.0   ,0.  ,1.-10 ,1.
****         4011,08,74,72,18238.9,0.430,26.2,0.136,0.,0.,0.,3.43,1.
****         4012,08,61,03,9083.3 ,0.547  ,8.61,1.-10,0.0      ,0.0  ,0.  ,.027  ,1.
****         4013,08,01,61,9083.3 ,0.542  ,8.61,1.-10,0.0      ,0.0  ,0.  ,.027  ,1.
****         4014,08,02,64,9083.3 ,0.542  ,8.61,1.-10,0.0      ,0.0  ,0.  ,.027  ,1.
****         4015,08,12,31,18238.9,.191   ,7.07,1.-10,0.0      ,0.0  ,0.  ,.00382,1.
****         4016,08,32,33,650.   ,.240   ,14.8,1463.3,0.0,0.0, 0.0, 1.0-4,1.
****         4017,08,62,53,9083.3 ,0.547  ,8.61,1.-10,0.0      ,0.0  ,0.  ,0.027 ,1.
****         4018,08,63,55,9083.3 ,0.547  ,8.61,1.-10,0.0      ,0.0  ,0.  ,0.027 ,1.
****         4019,08,64,04,9083.3 ,0.547  ,8.61,1.-10,0.0      ,0.0  ,0.  ,0.027 ,1.
****         4020,08,06,32,650.0  ,.240   ,14.8,1.-10,3.076-6,0.0  ,0.  ,859.8 ,1.
****         4021,08,03,05,9083.3 ,1.66   ,8.61,1.83 ,1.22-6  ,0.0  ,0.  ,1.-10 ,1.
****         4022.08,04,05,9083.3 ,1.66   ,8.61,1.83 ,1.22-6  ,0.0  ,0.  ,1.-10 ,1.
****         4023,08,05,09,36333.2,0.0169,53.  ,5.362,-3.44-8,0.0  ,0.  ,1.-10 ,1.
****         4024,08,61,62,0.0     ,2.73   ,3.85,1.-10,0.0      ,0.0  ,0.  ,7.57  ,1.
****         4025,08,13,11,18238.9,.276   ,9.   ,.0841,-1.55-6,0.0  ,0.  ,.00391,1.
****         4026,08,14,12,18238.9,.276   ,9.   ,.0841,-1.55-6,0.0  ,0.  ,.00391,1.
****         4027,08,17,30,18238.9,4.49   ,7.07,1.-10,0.0      ,0.0  ,0.  ,.0905 ,1.
****         CARD,TY,FR,TO,FLOW   ,L/A    ,AREA,FWDK ,MOMFFAC,REVK ,HT   ,KFRIC ,HYDIA
****         4028,08,18,51,18238.9,4.49   ,7.07,1.-10,0.0      ,0.0  ,0.  ,.0905 ,1.
**** CHIENUPD4029,08,82,60,36.120,3.4125,0.7963,471.97,+0.03910,0.0,0.0,1.-5 ,0.167
****         4030,08,31,19,18238.9,.954   ,7.07,1.-10,0.0      ,0.0  ,0.  ,.0192 ,1.
****         4031,08,11,68,18238.9,.191   ,7.07,1.-10,0.0      ,0.0  ,0.  ,.00382,1.
****         4032,08,19,17,18238.9,3.356  ,7.07,.182 ,0.0      ,0.0  ,0.  ,.045  ,1.
****         4033,08,20,18,18238.9,3.356  ,7.07,.182 ,0.0      ,0.0  ,0.  ,.045  ,1.
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Table 2.26-3. (Cont'd)

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*****          4034,08,30,15,18238.9,4.453 ,7.07,.1160,0.0      ,0.0  ,0.  ,.045  ,1.
*****          4035,08,51,16,18238.9,4.453 ,7.07,.1160,0.0      ,0.0  ,0.  ,.045  ,1.
*****          4036,08,22,74,18238.9,0.430,26.2,0.136,0.,0.,0.,3.43,1.
*****          4037,08,24,91,18223.9,0.430,26.2,0.136,0.,0.,0.,3.43,1.
*****          4038,08,21,48,18238.9,0.238,26.2,0.977,0.,0.,0.,1.66,1.
*****          4039,08,23,47,18238.9,0.238,26.2,0.977,0.,0.,0.,1.66,1.
*****          4040,08,48,41,9119.44,1.593 ,4.28,.143 ,-2.90-6,0.0 ,0.  ,.0166 ,1.
*****          4041,08,47,40,9119.44,1.593 ,4.28,.143 ,-2.90-6,0.0 ,0.  ,.0166 ,1.
*****          4042,08,43,35,9119.44,1.593 ,4.28,.143 ,-2.90-6,0.0 ,0.  ,.0166 ,1.
*****          4043,08,47,34,9119.44,1.593 ,4.28,.143 ,-2.90-6,0.0 ,0.  ,.0166 ,1.
*****          4044,02,35,37,9119.44,3.257 ,4.28,.9060,0.0      ,0.0  ,0.  ,.0265 ,1.
*****          4045,02,34,38,9119.44,3.257 ,4.28,.9060,0.0      ,0.0  ,0.  ,.0265 ,1.
*****          4046,02,41,43,9119.44,3.257 ,4.28,.9060,0.0      ,0.0  ,0.  ,.0265 ,1.
*****          4047,02,40,42,9119.44,3.257 ,4.28,.9060,0.0      ,0.0  ,0.  ,.0265 ,1.
*****          4048,08,45,23,9119.44,2.69  ,4.28,.178 ,1.98-6  ,0.0  ,0.  ,.0328 ,1.
*****          4049,08,42,29,9119.44,2.69  ,4.28,.178 ,1.98-6  ,0.0  ,0.  ,.0328 ,1.
*****          4050,8,37,68,9119.44,1.79,4.276,.112.0,.0,.9,.0221,2.33
*****          4051,08,38,27,9119.44,2.69  ,4.28,.178 ,1.98-6  ,0.0  ,0.  ,.0328 ,1.
*****          4052,08,49,24,18238.9,0.238,26.2,0.977,0.,0.,0.,1.66,1.
*****          4053,08,56,57,0.0     ,.031  ,1.65,1.-10,0.0     ,0.0  ,0.  ,0.543 ,0.115
*****  CHIENUPD4054,08,82,83,0.0     ,5.817 ,4.16 ,.381 ,0.0   ,0.  ,5.0,7.37,1.42
*****          4055,08,52,54,0.0     ,2.73  ,3.85,1.-10,0.0     ,0.0  ,0.  ,7.57  ,1.
*****  CHIENUPD4056,08,81,82,0.0     ,2.508 ,4.16 ,.045 ,0.0   ,0.  ,5.0,7.37,1.42
*****  CHIENUPD4057,08,83,80,0.0     ,2.508 ,4.16 ,.045 ,0.0   ,0.  ,5.0,7.37,1.42
*****          4058,08,16,49,18238.9,1.709 ,7.07,.226 ,1.70-6  ,0.0  ,0.  ,.0043 ,1.
*****          4059,7,73,25,-10.,-10.,4.276,1.21,-1.,0.
*****          4060,08,07,05,36333.2,0.0281,40.6,.177 ,3.56-8  ,0.0  ,0.  ,1.-10 ,1.
*****          4061,08,33,57,650.0  ,.24   ,14.8,665.97, 0.0  ,0.0, 0.0 ,1.0-4,1.
*****          4062,08,53,55,0.0     ,2.71  ,3.88,1.-10,0.0     ,0.0  ,0.  ,7.54  ,1.
*****  CHIENUPD4063,08,80,81,0.0     ,5.817 ,4.16 ,.381 ,0.0   ,0.  ,5.0,7.37,1.42
*****          4064,08,62,63,0.0     ,2.73  ,3.85,1.-10,0.0     ,0.0  ,0.  ,7.57  ,1.
*****          4065,08,15,50,18238.9,1.709 ,7.07,0.226,1.70-6  ,0.0  ,0.  ,.0043 ,1.
*****          4066,08,64,63,0.0     ,2.73  ,3.85,1.-10,0.0     ,0.0  ,0.  ,7.57  ,1.
*****          4067,08,50,22,18238.9,0.238,26.2,0.977,0.,0.,0.,1.66,1.
*****          4068,08,59,06,144.5  ,.968  ,3.18,0.0   ,.0039   ,.0000,0.  ,0.0   ,1.
*****          4069,08,46,17,0.0     ,129.5 ,.417,1.-10,0.0     ,0.0  ,0.  ,177.6 ,.73
*****          4070,08,53,05,9083.3 ,1.66  ,8.61,1.83 ,1.22-6  ,0.0  ,0.  ,1.-10 ,1.
*****          4071,08,55,05,9083.3 ,1.66  ,8.61,1.83 ,1.22-6  ,0.0  ,0.  ,1.-10 ,1.
*****          4072,08,52,62,9083.3 ,0.542 ,8.61,1.-10,0.0     ,0.0  ,0.  ,.027  ,1.
*****          4073,08,54,63,9083.3 ,0.542 ,8.61,1.-10,0.0     ,0.0  ,0.  ,.027  ,1.
*****          4074,08,01,52,0.0     ,2.73  ,3.85,1.-10,0.0     ,0.0  ,0.  ,7.57  ,1.
*****          4075,08,03,53,0.0     ,2.71  ,3.88,1.-10,0.0     ,0.0  ,0.  ,7.54  ,1.
*****          4076,08,02,54,0.0     ,2.73  ,3.85,1.-10,0.0     ,0.0  ,0.  ,7.57  ,1.
*****          4077,08,04,55,0.0     ,2.71  ,3.88,1.-10,0.0     ,0.0  ,0.  ,7.54  ,1.
*****          4078,7,88,25,-10.,-10.,4.276,1.21,-1.,0.
*****          4079,08,57,39,650.0  ,.24   ,14.8,890.0,5.98-7  ,0.0  ,0.  ,1.-10 ,1.
*****          4080,08,08,33,0.0     ,.023  ,2.67,1.-10,0.0     ,0.0  ,0.  ,.6767 ,.092
*****          4081,08,01,02,0.0     ,2.73  ,3.85,1.-10,0.0     ,0.0  ,0.  ,7.57  ,1.
*****          CARD,TY,FR,TO,FLOW    ,L/A   ,AREA,FWDK ,HOMFFAC,REVK ,HT  ,KFRIC ,HYDIA
*****          4082,08,03,04,0.0     ,2.71  ,3.88,1.-10,0.0     ,0.0  ,0.  ,7.57  ,1.
*****          4083,08,59,58,144.5  ,1.112 ,9.69,1927.,0.0      ,0.0  ,0.  ,3.53  ,1.
*****          4084,08,60,59,144.5  ,1.0988,9.69,1.-10,0.0      ,0.0  ,0.  ,3.5371,1.
*****          4085, 8,39,65,26867.00,0.0618, 49.90,0.0  ,-1.973-7,0.0,0.0,0.0  ,1.19
*****          4086, 8,39,66, 9610.78,0.0099, 1.0 ,0.015,   0.0  ,0.0,0.0,1.-10,1.0
*****          4087, 5,65,14, 3285.42,1.41  , 1.18 ,0.816,  0.0  ,0.0,.25,1.0-5,0.250
*****          4088, 5,65,13, 3285.42,1.41  , 1.18 ,0.816,  0.0  ,0.0,.25,1.0-5,0.250
*****          4089, 8,66,67, 3906.86,0.197 , 1.0 ,0.009,   0.0  ,0.0,0.0,1.-10,1.0
*****          4090, 8,67,75, 1168.51,0.136 , 23.42,0.0  ,  0.0  ,0.0,.25,0.0  ,0.250
```

Table 2.26-3. (Cont'd)

```
*****          4091, 8,10,69, 1352.51,2.504 ,0.2727,0.015,   0.0  ,0.0,0.0,1.0-5,0.167
*****          4092, 8,67,10, 2739.35,0.050 ,  1.0 ,0.054,   0.0  ,0.0,0.0,1.-10,1.0
*****          4093,03,03,20,18238.9,.9540 ,7.07,1.-10,0.0      ,0.0  ,0.  ,.0192 ,1.
*****  CHIENUPD4094,05,72,70,0.0,3.13,2.88,.045,0.0,0.0,4.0,6.98,1.29
*****          4095,03,91,92,18238.9,0.430,26.2,0.135,0.,0.,0.,3.43,1.
*****          4096,03,89,90,18238.9,0.430,26.2,0.135,0.,0.,0.,3.43,1.
*****          4097,08,92,93,18238.9,0.430,26.2,0.135,0.,0.,0.,3.43,1.
*****          4098,03,90,21,18238.9,0.430,26.2,0.135,0.,0.,0.,3.43,1.
*****          4099, 8,10,70, 1352.51,2.504 ,0.2727,0.015,   0.0  ,0.0,0.0,1.0-5,0.167
*****          4100, 8,10,71, 1352.51,2.504 ,0.2727,0.015,   0.0  ,0.0,0.0,1.0-5,0.167
*****          4101, 8,10,72, 1352.51,2.504 ,0.2727,0.015,   0.0  ,0.0,0.0,1.0-5,0.167
*****  CHIENUPD4102,05,71,69,0.0,3.13,2.88,.045,0.0,0.0,4.0,6.98,1.29
*****          4103, 8,79,14, 7476.74,1.146 , 9.82 ,8.947,   0.0  ,0.0,0.0,1.0-5,1.290
*****          4104, 8,78,14, 7476.74,1.146 , 9.82 ,8.947,   0.0  ,0.0,0.0,1.0-5,1.290
*****          4105, 8,77,13, 7476.74,1.146 , 9.82 ,8.947,   0.0  ,0.0,0.0,1.0-5,1.290
*****          4106, 8,76,13, 7476.74,1.146 , 9.82 ,8.947,   0.0  ,0.0,0.0,1.0-5,1.290
*****          CARD,TY,FR,TO,FLOW   ,L/A   ,AREA,FWFK ,MOMFFAC,REVK ,HT   ,KFRIC ,HYDIA
*****          4107,8,73,26,9119.44,.39,4.276,.042,1.25-6,0.,2.,.005,2.33
*****  CHIENUPD4108,08,81,60,36.120,3.4125,0.7963,471.97,+0.03910,0.0,0.0,1.-5  ,0.167
*****  CHIENUPD4109,08,82,60,36.120,3.4125,0.7963,471.97,+0.03910,0.0,0.0,1.-5  ,0.167
*****  CHIENUPD4110,08,80,60,36.120,3.4125,0.7963,471.97,+0.03910,0.0,0.0,1.-5  ,0.167
*****  DUMYPATH4111,03,25,25,0.0    ,0.158 ,1.00,149.2,0.0     ,0.0  ,0.  ,1.-10 ,1.
*****  DUMYPATH4112,03,25,25,0.0    ,0.158 ,1.00,149.2,0.0     ,0.0  ,0.  ,1.-10 ,1.
*****          4113, 8,65,75,26000.08,0.034 , 55.84,0.193,   0.0  ,0.0,0.0,1.0-5,1.19
*****          4114, 8,71,76, 7476.74,0.855 , 5.823,  0.0,   0.0  ,0.0,0.0, 0.0 ,1.290
*****          4115, 8,72,77, 7476.74,0.855 , 5.823,  0.0,   0.0  ,0.0,0.0, 0.0 ,1.290
*****          4116, 8,70,78, 7476.74,0.855 , 5.823,  0.0,   0.0  ,0.0,0.0, 0.0 ,1.290
*****          4117, 8,69,79, 7476.74,0.855 , 5.823,  0.0,   0.0  ,0.0,0.0, 0.0 ,1.290
*****  CHIENUPD4118,08,29,80,9119.44,0.112,4.276,0.0648,+1.9816-6,0.09,2.0,.00124,2.33
*****  CHIENUPD4119,03,27,81,9119.44,0.112,4.276,0.0643,+1.9816-6,0.09,2.0,.00124,2.33
*****          4120,8,26,82,9119.44,.16,4.276,.090,2.71-6,.09,2.,.001,2.33
*****  CHIENUPD4121,08,28,83,9119.44,0.112,4.276,0.0648,+1.9816-6,0.09,2.0,.00124,2.33
*****  CHIENUPD4122,08,80,84,0.0   ,0.715,6.438,0.0,0.0,0.0,0.0,3.25,0.0
*****  CHIENUPD4123,03,81,85,0.0   ,0.715,6.438,0.0,0.0,0.0,0.0,3.25,0.0
*****  CHIENUPD4124,08,82,86,0.0   ,0.715,6.438,0.0,0.0,0.0,0.0,3.25,0.0
*****  CHIENUPD4125,08,83,87,0.0   ,0.715,6.438,0.0,0.0,0.0,0.0,3.25,0.0
*****  CHIENUPD4126,08,84,85,0.0,4.42,2.36,.045,0.0,0.0,3.0,7.37,1.42
*****  CHIENUPD4127,08,85,86,0.0,4.42,2.36,.045,0.0,0.0,3.0,7.37,1.42
*****  CHIENUPD4128,03,86,87,0.0,4.42,2.36,.045,0.0,0.0,3.0,7.37,1.42
*****  CHIENUPD4129,08,87,84,0.0,4.42,2.36,.045,0.0,0.0,3.0,7.37,1.42
*****          4130, 8,75,10, 2671.69,0.094 ,  4.78,0.0 ,    0.0  ,0.0,0.0,0.0  ,0.167
*****          4131, 8,66,65, 5703.92,0.0412, 70.26,35.37,   0.0  ,0.0,.25,1.0-5,0.250
*****  CHIENUPD4132,05,76,77,0.0,2.54,3.55,.045,0.0,0.0,5.0,6.98,1.29
*****  CHIENUPD4133,05,77,78,0.0,2.54,3.55,.045,0.0,0.0,5.0,6.98,1.29
*****  CHIENUPD4134,05,78,79,0.0,2.54,3.55,.045,0.0,0.0,5.0,6.98,1.29
*****  CHIENUPD4135,05,79,76,0.0,2.54,3.55,.045,0.0,0.0,5.0,6.98,1.29
*****  CHIENUPD4136,05,71,72,0.0,3.13,2.88,.045,0.0,0.0,4.0,6.98,1.29
*****  CHIENUPD4137,05,69,70,0.0,3.13,2.88,.045,0.0,0.0,4.0,6.98,1.29
*****          4138, 8,75,69, 6124.23,0.63   ,12.097,2.933,   0.0  ,0.0,1.8,1.0-5,1.833
*****          4139, 8,75,70, 6124.23,0.63   ,12.097,2.933,   0.0  ,0.0,1.8,1.0-5,1.833
*****          4140, 8,75,72, 6124.23,0.63   ,12.097,2.933,   0.0  ,0.0,1.8,1.0-5,1.833
*****          4141, 8,75,71, 6124.23,0.63   ,12.097,2.933,   0.0  ,0.0,1.8,1.0-5,1.833
*****  CHIENUPD4142,08,69,87,0.0,0.478,1.069,3.9,0.0,1.+14,1.17,1.-5,1.17
*****  CHIENUPD4143,08,71,84,0.0,0.478,1.069,3.9,0.0,1.+14,1.17,1.-5,1.17
*****  CHIENUPD4144,08,72,85,0.0,0.478,1.069,3.9,0.0,1.+14,1.17,1.-5,1.17
*****  CHIENUPD4145,08,70,86,0.0,0.478,1.069,3.9,0.0,1.+14,1.17,1.-5,1.17
*****          4146,08,93,23,18238.9,0.430,26.2,0.136,0.,0.,0.,3.43,1.
*****          4147,10,88,73,9119.44,.351,4.276,1.-5,0.,0.,2.,.006,2.33,1.
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Table 2.26-3. (Cont'd)

```
****            4148,8,53,58,0.0  ,0.1,1.0,  1.0+10 ,0.,0.,0.,1.-5,1.0
****            4149,8,04,53,0.0  ,0.1,1.0,  1.0+10 ,0.,0.,0.,1.-5,1.0
****            4150,8,03,53,0.0  ,0.1,1.0,  1.0+10 ,0.,0.,0.,1.-5,1.0
****            4151,8,53,58,0.0  ,0.1,1.0,  1.0+10 ,0.,0.,0.,1.-5,1.0
****            4601,59,78
****            4671, 59, 0., 1.
****            4672, 78, 0., 1.
****    CHIENUPD4320,142,143,144,145
****    CHIENUPD4321,0.5033,0.617,0.156,.087,.454,1.3524,80.76,0.0,1.0
****    9M 10F3 4831,1.+6,0.,1.+6,.0373,1.+4,.105,630.,.124,315.,.129,153.,.140,86.4,.15
        9M 20F3 +7,62.1,.175,46.8,.192,29.,.227,21.,.262,16.,.297,11.,.332, 9.7,.367,8.6
        9M 30F3 +, .401,6.3,.436,5.7,.4537,5.7,1.57
****            4951,4.276,0.,4.248,.0025,4.096,.009,4.039,.016,4.019,.026,3.928,.033,3.
                +876,.045,3.862,.053,3.759,.070,3.759,1.0+06
                *     REACTOR CORE PARAMETERS
****            5001,.04364,1.875,7500.,3000.,10.,3,191556.2,7771.0,.0395,-1.157-3,.5241
****            5002,1.,.5241,1.,0
****            5003,.04364,4.203,7500.,3000.,10.,3,191556.2,17441.,.4727,-1.216-3,1.210
****            5004,1.,1.210,1.,0
****            5005,.04364,4.167,7500.,3000.,10.,3,191556.2,17269.,.4515,-1.216-3,1.189
****            5006,1.,1.189,1.,0
****            5007,.04364,1.667,7500.,3000.,10.,3,191556.2,6908.0,.0363,-1.157-3,.5328
****            5008,1.,.5328,1.,0
                *     FUEL PIN, GAP, AND CLADDING PROPERTIES
****            5101,.01528  ,0.,0.,970.0,4.5175-4,-1.,-1.,.0022053
****            5102,0.,0.,0.,0.,1.,1,1107.
****            5103,.01533  ,0.,0.,1570.,4.0175-4,-1.,-1.,.0022053
****            5104,0.,0.,0.,0.,1.,1,1107.
****            5105,.01533  ,0.,0.,1570.,4.0175-4,-1.,-1.,.0022053
****            5106,0.,0.,0.,0.,1.,1,1107.
****            5107,.01528  ,0.,0.,970.0,4.5175-4,-1.,-1.,.0022053
****            5108,0.,0.,0.,0.,1.,1,1107.
                *     FUEL PIN FUEL DENSITY
****            5500,660.282
****            5505,.35,1.5527-4,2.8906-4,1.,0.2,.0153,1
****            5510,1,1,4
                *     METAL WATER REACTION CONSTANTS
****            5901,91.22,140.5,6.5,2.0,1.2500-6,1500.0,45500.0,33.3,0.0
****            5911,4,41.70,48.93,274350.
                *     DNB PARAMETERS
****            5921,6.0+6,0.1,0.45,2.75,.5
                *     SCRAM AND KINETICS
                *     SCRAM PARAMETERS
****            6001,0.0,1.0+4,1900.0,0.5,1.0+4,21,21
                *     KINETICS PARAMETERS
****            6002, .283-4,.9675,.002,10000000.
                *     MODERATOR COEFFICIENT=0.0   BOL
****            6003,-  45,0.,-0.273,22.5,-0.174,30.,-0.087,40.,-0.053,50.
****            6004,-0.032,60.,-0.0195,67.,-0.0156,70.,-0.0102,75.
****            6005,-0.0073,80.,-0.0035,85.,-0.0027,90.,-0.0005,95.
****            6006,0.,100.,-0.0005,110.,-0.003,120.,-0.012,140.,-0.012,200.
                *     HEAT GENERATION VERSUS TIME   ( NOT USED )
****            6011,1.0,0.0,1.0,.01,1.14,.75,.213,1.15,.1,2.5,.066,6.,.056,15.
****            6012,.045,50.,.039,100.,.0315,300.,.024,1000.
                *     REACTIVITY VS. TIME
****            6021,0.,0.,0.,14.9,-0.08,15.,-0.08,10000.
                *     DELAYED NEUTRON FRACTIONS
****            6031, .226-3,.1554-2,.1418-2,.2954-2,.816-3, .339-3
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Table 2.26-3. (Cont'd)

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*      PRECURSOR  DECAY CONSTANTS
6041, .125-1, .3080-1, .1140, .307 , .1200+1, .3210+1
*      INITIAL PRECURSOR CONSENTRATIONS
605?, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
*      FISSION PRODUCT POWER FRACTIONS
6061,.0183,.0161,.017,.0185,.06,-.076,.0423,-.048,.057,0.,0.
*      DECAY CONSTANTS OF FISSION PRODUCTS
6071,3.212-5,7.996-4,.0050849,.044887,.31801,.43779
6072,1.2104,5.2543,8.5752,0.,0.
*      NORMALIZED CONCENTRATION OF FISSION PRODUCTS
6081,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.
*STEAM GENERATOR
7001,21,251785.,536.4
7002,22,21422.9,591.
7003,23,251785.,536.4
7004,24,21422.9,591.
7005,74,51970.3,568.4
7006,89,500359.5,536.
7007,90,488230.1,536.2
7008,91,51970.3,568.4
7009,92,500359.5,536.
7010,93,488230.1,536.2
7011,0.0,10000.,1.0,10000.,0.5,44.44
7021,1.0,0.0,1.0,100000.
7100,1,1
*STEAM GENERATOR LOGIC PARAMETERS
7201,1200.0,470.5,36.0
*MAIN FEEDWATER COASTDOWN
7211,2305.55,0.0,0.0,17.0,0.0,600000.0
*AUXILIARY FEEDWATER VERSUS SECONDARY PRESSURE
7231,182.72,0.,182.72,872.87,138.59,1260.,68.95,1527.5
*RELIEF VALVE ACTUATION VERSUS TIME (AFTER SCRAM)
7251,1200.,0.,1200.,1.+5
*RELIEF VALVE FLOW VERSUS SECONDARY PRESSURE
7271,0.,0.,0.,1199.999,650.83,1200.,650.83,1260.,1533.89,1260.001
7272,1533.89,1500.
*SAFETY VALVE FLOW VERSUS SECONDARY PRESSURE
7291,0.,0.,0.,1249.999,1242.5,1250.,1242.5,1270.,2480.,1270.001
7292,2480.,1290.,3757.78,1290.001,3757.78,1300.
*      PUMP CHARACTERISTICS
8001,1,2.73,2.37,2.07,1.85,1.69,1.51,1.40,1.25,1.17,1.11,1.0
8002,2,.77,.50,.29,.14,.05,-.02,-.10,-.42,-.99,-1.64,-2.44
8003,3,-2.44,-2.30,-2.16,-1.93,-1.69,-1.45,-1.09,-0.51,0.0,.51,1.0
8004,4,.71,.69,.74,.83,.94,1.06,1.21,1.42,1.70,2.15,2.73
8005,5,1.96,1.56,1.25,1.13,.93,.77,.74,.79,.90,.96,1.0
8006,6,.49,.16,-.18,-.38,-.53,-.87,-1.29,-1.98,-2.87,-3.70,-4.73
8007,7,-4.73,-4.00,-3.31,-2.78,-2.23,-1.64,-1.0,-.29,.24,.61,1.0
8008,8,.41,.60,.78,.91,1.02,1.13,1.21,1.34,1.50,1.66,1.96
*      PUMP ELECTRIC TORQUE VS. ACTUAL PUMP SPEED
8016,38[illegible].,0.0,39624.,120.,41626.,240.,44427.,360.,48030.,480.
8017,52832.,600.,60437.,720.,70043.,840.,82851.,960.,90456.,1080.
8018,90456.,1128.,40025.,1181.,0.,1200.,-40025.,1219.,-90456.,1272.
8019,-90456.,1320.,-82851.,1440.,-70043.,1560.,-60437.,1680.
8020,-52832.,1800.,-48030.,1920.,-44427.,2040.,-41626.,2160.
+,-39624.,2280.,-38023.,2400.,-39624.,2520.,-41626.,2640.
+,-44427.,2760.,-48030.,2880.,-52832.,3000.,-60437.,3120.
+,-70043.,3240.,-82851.,3360.,-90456.,3480.,-90456.,3528.
+,-40025.,3581.,0.,3600.
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Table 2-26-3. (Cont'd)

```
                   *     PUMP SHUTDOWN PARAMETERS
*****              8021,0.,1.0  ,0.,0.,0.,0.,0.
*****              8022,0.,1.0  ,0.,0.,0.,0.,0.
*****              8023,0.,1.0  ,0.,0.,0.,0.,0.
*****              8024,0.,1.0  ,0.,0.,0.,0.,0.
                   *     PUMP PARAMETERS
*****              8031,44,314.82,36300.,1187.16 ,87763.,4.28,1187.15
*****              8032,45,314.82,36300.,1187.16 ,87763.,4.28,1187.15
*****              8033,46,314.82,36300.,1187.16 ,87763.,4.28,1187.15
*****              8034,47,314.82,36300.,1187.16 ,87763.,4.28,1187.15
                   *     PUMP MOTOR CONSTANTS
*****              8041,71.111,429.34,35870.,117.34,1.732,74.048,0.48690,390.115
*****              8042,0.00102,0.43320,1925.,72700.
*****     M1       8051,-26.6026,50.9645,-33.6919,9.3302
                   *

INPUT FILE OCCUPIES 5606 DATA WORDS

INPUT COMPLETE
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Table 2.26-4. Microfiche Plots for Runs Listed in Table 2.26-1

3.1. In reference to Table 4.2-2, how are the break opening times determined for the 2A cold leg break? (Section 4.4)

Response

Generic BOT versus BOA curves for skirt- and nozzle-supported plants were used to determine the break opening time for each specific break opening area. Please refer to the response to question 2.6, Figures 2.6-1 through 2.6-4.

3.2. The comparison indicated in paragraph 4 between Figures D-6 and D-7 is unclear. Explain. (Section 5.1)

Response

Paragraph 4 of reference 2 should have stated:

> By comparing Figure D-4 with the lumped-mass model shown in Figure D-5, a correlation can be seen between the components and the model elements representing them. The model-component correlation is addressed in more detail in Appendix D.

3.3. Provide the basis for the selection of the composite elements. (Section 5.1.4)

Response

One equivalent element represents all CRDMs. Section properties of one CRDM are used to determine the mass and stiffness of one drive unit. Mass and stiffness are then multiplied by the total number (no shear coupling) of CRDMs to define one equivalent element.

3.4. What method was used to calculate the stiffness values? (Section 5.1.4)

Response

Stiffness values were calculated for one CRDM and then multiplied by the total number of drives. Actual CRDM dimensions were used to calculate the properties of a single CRDM. Each CRDM unit is supported so that no shear connection exists between the drives.

3.5. Was pipe whip also considered for breaks outside the RPV cavity? (Section 5.2)

Response

Yes. Data presented in Tables 9.8-1 through 9.8-7 of reference 2 are summaries of pipe whip restraint loads for the various plants. Hot and cold leg guillotine breaks at the elbow referred to in these tables are for breaks in the steam generator cavity and are shown in Figure 4.1-1 of reference 2.

3.6. Expand the description of the initial conditions used in this analysis. Were the steady-state momentum forces considered in determing these initial conditions? (Section 5.2.1)

Response

The initial conditions for the pipe whip analysis were applied so that the state of stress in the piping to be analyzed reflects the normal operating conditions of the plant.

The thermal conditions were reflected by applying the temperature and coefficient of thermal expansion of the isolated piping model. Displacements were applied to the boundary conditions to reflect the growth of the balance of plant and its effect on the isolated model. Displacements were taken from existing stress reports and associated analyses. Since all skirt-supported plants are dimensionally similar, Rancho Seco displacements were applied to all of these plants. Thermal displacements for Davis Besse 1 were taken from the original Davis Besse 1 analysis.

The weight effects on the piping were applied using techniques similar to those used to apply thermal effects. The deadweight of the isolated pipe was applied while boundary condition displacements were superimposed with the thermals. Original Rancho Seco and Davis Besse 1 analyses were the source of boundary displacements due to deadweight.

The steady-state fluid hydraulics were reflected by applying the operating pressure to the piping. The momentum effects were found to be less than 5% of the steady-state hydraulics, which includes the pressure stress. Therefore, momentum effects were not included.

An investigation was conducted to determine the pipe whip sensitivity to the operating stress since plant-unique operating stresses were not imposed. For this investigation, pipe whip was run with and without operating stresses. The resultant pipe displacements and restraint loads were within 10% of each other. Thus, it was concluded that exact reflection of operating stress was unnecessary.

3.7. Discuss in detail the full loop model used to determine the operating condition loads. (Section 5.2.2.7)

Response

The loop model used for boundary displacemei .. for the skirt-supported plants was the Rancho Seco model, which was used for contract analysis in support of the Rancho Seco FSAR.[11] For the nozzle-supported plant, boundary displacements were taken from the Davis Besse 1 contract analysis, which supports the Davis Besse 1 FSAR.[10] A general description of modeling techniques for these loop models is presented in sections 4, 5, and 12 of topical report BAW-10131.[12]

3.8. Provide more detail on the iteration procedure (include break area and break time) described in Figure 5.2-1. (Section 5.2.2.9)

Response

Initially the plant is operated at steady-state flow, temperature, and pressure with the piping system intact. An instantaneous pipe severance is postulated to occur, which results in an unbalanced force on the piping that had, prior to the break, acted as an axial load (longitudinal pressure stress $Pr_m/2T$) in the continuous piping system. This unbalanced force is equal to the pressure in the first elbow adjacent to the break times the flow area inside the pipe ($P \cdot A_{pipe}$). This primary force in a pipe whip analysis causes the majority of the motion in the broken piping. As the pressure in the adjacent elbow decays, the force driving the broken pipe decays. As the pipe opens faster, the driving force decays faster. To avoid allowing this force to decay too rapidly, a "zero area" break is hydraulically hypothesized (hydraulic analysis No. 1). This is accomplished by assuming that the break causes no decay in the driving force and thus remains at a constant $P \cdot A_{pipe}$. This method results in a pipe whip analysis (pipe whip analysis No. 1) with high restraint loads accompanied by pipe motion at a faster opening rate than normal, which is conservative. If the loads are beyond allowable or the opening area/rate is too conservative for the unbroken loop, so that loading problems appear elsewhere, the hydraulics are iterated again in hydraulic pressure analysis No. 2 using the opening areas and rates predicted by the zero area pipe whip No. 1 analysis.

These iterated forces (hydraulic pressure analysis No. 2) are used as input to pipe whip analysis No. 2 and new restraint loads and opening rates are determined.

Loads from this iteration are lower, and opening rates are slower than those from pipe whip No. 1. Since the hydraulics for this iteration (hydraulics No. 2) have the fastest opening rates (a zero area) possible for the restraint and piping scheme, the pressures decay as rapidly as possible. The new opening rates from this iteration, which are slower than pipe whip No. 1, must then be addressed.

Opening rates from pipe whip No. 2 are the slowest possible for the piping and restraint configuration since the input forces from hydraulics No. 2 decay the fastest as a result of the "zero area" concept. Thus, the hydraulics generated by hydraulics No. 3 are conservative for the driving forces using opening rates from pipe whip No. 2; yet they are converging from the zero area concept.

Next, pipe whip No. 3 is run using the hydraulics transient results (pressure) and opening rates from hydraulics No. 3 and pipe whip No. 2 analyses, respectively. Since the input is conservative, the results from pipe whip No. 3 are conservative. This is usually the last iteration, and these results are reported for restraint and pipe whip. These restraint loads are conservative and opening rates are fast, which is conservative for the component analysis and the unbroken loop analysis. Figure 3.8-1 is a flow chart for this iterative sequence.

Figure 3.8-1. Pipe Reaction Force Iterative Process

Hydraulic No. 1	"Zero area" longitudinal stress release and no pressure decay, i.e., zero area of the break.
↓	
Pipe Whip No. 1	The most conservative case for loads and unbroken loop hydraulics. Fast opening time.
↓	
Hydraulic No. 2	Produces unconservative forcing functions (decayed too fast) on broken loop.
↓	
Pipe Whip No. 2	Produces unconservative loads on restraints and unbroken loop and slow opening time.
↓	
Hydraulic No. 3	Produces conservative forcing function on broken loop (decayed slowly).
↓	
Pipe Whip No. 3	Produces conservative loads on restraints and unbroken loop. Fast opening time.
↓	
etc.	

3.9. Clarify this discussion. (Section 5.3.6.3)

Response

Given the horizontal and vertical pipe reactions H and V on the LOCA ring, the friction force was determined by the formula

$$F = \rho(H^2 + V^2)^{\frac{1}{2}}$$

where the friction coefficient $\rho = 0.42$.

This friction force acts parallel to the pipe axis. A conservative horizontal force was then calculated by the formula

$$R = (H^2 + F^2)^{\frac{1}{2}}.$$

This force R was applied in the horizontal direction in the plane of the LOCA ring with the vertical force V to conservatively determine the concrete stresses around the ring.

3.10. Was a scram time evaluation performed? (Section 6)

Response

A scram time evaluation was not performed as a part of the Phase II analysis, and we know of no licensing requirement for a post-LOCA trip evaluation.

The integrity of the control rod drive pressure boundary was demonstrated in the Phase II analysis; therefore, in our judgement, the drives would be capable of inserting the control rods after LOCA.

3.11. Supply the supporting data for the compressive strength value of embedment concrete used for the Rancho Seco plant. (Section 6.2.1.4)

Response

The compressive strength values for the embedment concrete are based on 90-day strength tests. Where three strength tests were available, the 90-day strength was taken as either the average of the three test strengths or the minimum test strength plus 500 lb/in.^{2}, whichever was the lesser. This is consistent with ACI 214-77[15].

One strength test consists of two cylinder tests. For the Rancho Seco plant, only two series of strength tests (four cylinder tests) were available[16]. The results of these tests are given in Table 3.11-1. The average of the 90-day strength tests, 7275 lb/in.^{2}, was taken as the in situ concrete strength.

Table 3.11-1. Compressive Strength of Embedment Concrete for Rancho Seco

Test No.	Tested strength, lb/in. 7-day	28-day	90-day
28	4492	6512	7340
29	4628	6237	7216
Avg	4560	6575	7275

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Response

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Avg	4560	6575	7275

3.12. Supply a sample calculation demonstrating the procedure outlined for combining seismic and LOCA responses for the embedments. (Section 6.2.1.9)

Response

The following example calculation is provided for the Oconee plant embedment. The methodology used is that described in section 6.2.1.9 of reference 2.

The design seismic overturning moment on the reactor vessel support embedment is[17]

$$M_{eq} = 100 \times 10^3 \text{ kips in.}$$

This overturning moment was calculated using the pre-liftoff embedment condition. Furthermore, this moment is considerably less than that required to initiate liftoff.

The rotational tangent stiffnesses of the Oconee embedment before and after liftoff, K_1 and K_2, are

$$K_1 = 6.875 \times 10^9 \text{ kips in./rad}$$

and

$$K_2 = 0.997 \times 10^9 \text{ kips in./rad.}$$

The rotational secant stiffness at the moment corresponding to the maximum LOCA loading is

$$K_3 = 1.534 \times 10^9 \text{ kips in./rad.}$$

Assume that the seismic overturning moment is governed by the post-liftoff rather than pre-liftoff embedment stiffness. The increase in M_{eq} can be determined as follows from the fixed-shape spectra given in NRC Regulatory Guide 1.60.[18]

The ratio of the post- and pre-liftoff tangent stiffnesses, R_K, is

$$R_K = 0.15.$$

Thus, the ratio of the post- and pre-liftoff fundamental periods of the RV on the embedment, T_K, is

$$T_K = 2.63.$$

Assuming damping equal to 10% of critical (for highly stressed reinforced concrete), the maximum increase in response due to the increase in fundamental period, A_K, is

$$A_K = e^{0.494 \ln T_K}$$
$$= 1.61.$$

Thus, the upper-bound seismic overturning moment is

$$M'_{eq} = 1.61 \times M_{eq}$$
$$= 161 \times 10^3 \text{ kips in.}$$

The energy demand associated with this loading, E_{eq}, is

$$E_{eq} = \frac{(M'_{eq})^2}{2 \times K_3}$$
$$= 8.45 \text{ kips in./rad.}$$

The peak LOCA overturning moment for Oconee is M_L, where

$$M_L = 2496 \times 10^3 \text{ kips in.}$$

This moment produces a rotation of θ_L, where

$$\theta_L = 1.630 \times 10^{-3} \text{ rad.}$$

The increased rotation, θ_{L+eq}, required for the seismic energy demand, E_{eq}, to be met is, from the moment-rotation curve for Oconee,

$$\theta_{L+eq} = 1.633 \times 10^{-3} \text{ rad.}$$

This corresponds to a total seismic-plus-LOCA overturning moment of

$$M_{L+eq} = 2501 \times 10^3 \text{ kips in.}$$

As an alternative, the total seismic-plus-LOCA overturning moment was also calculated using the SRSS (square root sum of the squares) method, i.e.,

$$M_{L+eq} = [(2496 \times 10^3)^2 + (100 \times 10^3)^2]^{\frac{1}{2}}$$
$$= 2498 \times 10^3 \text{ kips in.}$$

Similar calculations were performed for the remaining plants.

3.13. Was a core barrel shell analysis performed: (Section 6.5)

Response

A core barrel analysis was performed. The results of the evaluation are included in the response to question 3.24.

3.14. Essentially four methods of demonstrating acceptability of the core flood line piping are discussed in this section: (Section 6.9.3)

1. Response spectrum.
2. Response spectrum removing failed support.
3. Time history.
4. Time history removing failed supports.

Methods 1 and 3 are acceptable with no further justifications; however, methods 2 and 4 require additional quantitative justification.

Response

The core flood line piping for B&W plants feeds directly into the reactor vessel. After a hot or cold leg guillotine break at the reactor vessel nozzle, the reactor vessel rocks in response to the applied asymmetric loads. From the vessel motion, displacement, velocity, and acceleration, time history motions were calculated at the core flood line nozzle attachment points.

The core flood lines for all B&W plants were analyzed using the response spectrum (methods 1 and 2) or time history (methods 3 and 4) approach. The results of these linear elastic analyses indicate that the following plants have overloaded core flood line supports:

Three Mile Island 1 —	Two snubbers loop A Two snubbers loop B
Crystal River 3 —	One snubber loop A Three snubbers loop B
Arkansas Nuclear One, Unit 1 —	One X-stop loop A One X-stop loop B

Table 3.14-1 summarizes the supports that are overloaded due to the LOCA event.

The function of the core flood lines after the LOCA event is to inject water into the reactor vessel. For this to occur, the piping and valves must remain functional. To show functionality, the pipe stress values were evaluated to service level C, and the valve stresses were evaluated to service level B.

Under methods 1 and 3, (assuming no support failures), all core flood lines have primary stresses below level C limits. All core flood lines have valve stresses below level B limits. All core flood lines have secondary stress limits below the $3S_m$ limit except for TMI-1 loop A, which is only 14% over.

Under methods 2 and 4, (assuming failed supports removed), the secondary stress on TMI-1 loop A is below the $3S_m$ limit. Thi result is reasonable since secondary stresses are due to imposed anchor displacements. With the yielding or fa:,ure of the TMI-1 loop A snubber, the piping becomes more flexible, allowing for easier acceptance of the imposed anchor movement.

Under methods 2 and 4, (assuming failed supports removed), all core flood lines have primary stresses below level C limits, valve stresses below level B limits, and secondary stresses below the $3S_m$ limit. We can firmly conclude that all core flood lines would remain functional during the LOCA event if the identified supports were nonexistent.

The actual phenomena of support failures cause the subject core flood lines to behave in a nonlinear fashion. Engineering judgment based on experience with nonlinear systems indicates that secondary stress values in the piping will decrease due to support yielding. Analyses using methods 2 and 4 show that primary and valve stresses remain acceptable if the subject failed supports were not in place at the start of the event.

Therefore, it is concluded that all core flood lines should remain functional during the LOCA event. Further data are given in Tables 3.14-2 through 3.14-4.

Table 3.14-1. Failed Supports on Core Flood Lines

Loop	Support	Description
TMI-1		
A	CF-6	2.5-in. bore, 5-in. stroke snubber
A	CF-7	
B	PA-9	
B	PB-10	
CR-3		
A	CFH-16	2.5-in. bore, 5-in. stroke snubber
B	CFH-14	
B	CFH-13	
B	CFH-12	
ANO-1		
A	DH-196	WF 4 × 13 x-stop
B	DH-164	

Table 3.14-2. Support Reaction Data

Support	P+G+LOCA reaction, lb	P+G+LOCA ratio to one-time load rating
TMI-1		
CF-6	43,738	1.70
CF-7	30,544	1.19
CF-8	22,600	0.88
CF-9	11,161	0.43
CF-14	25,461	0.99
CF-15	58,993	0.89
PA-9	49,922	1.94
PB-10	55,856	2.17
ANO-1		
D196	52,552	2.43
D198	23,074	0.60
CR-3		
CFH-12	37,698	1.80
CFH-13	31,113	1.48
CFH-14	54,429	2.60
CFH-15	38,859	0.67
CFH-16	33,550	1.60
CFH-17	15,362	0.26
CFH-18	18,139	0.86
CFH-19	31,227	0.54

Table 3.14-3. Core Flood Line Valve Stress Ratios

Valve type & size, in.	Node	Stress ratio to level B limit: With supports	Without supports
TMI-1			
14 check	A-19	0.41	0.62
14 check	A-28	0.66	0.60
14 check	B-39	0.44	0.48
CR-3			
14 check	A-23	0.44	0.54
14 check	B-63	0.54	0.51
ANO-1			
14 check	A-250	0.27	0.30
14 gate	A-345	0.55	0.58

Table 3.14-4. Core Flood Line Peak Pipe Stress Data

		Stress, psi		
Case	Location	Primary	Allowable	Ratio
TMI-1, Loop A				
CL,W	Nozzle	22,050	31,280	0.71
CL,WO	Nozzle	22,239	31,280	0.71
HL,W	Nozzle	14,350	31,280	0.46
HL,WO	Nozzle	26,774	31,280	0.86
HL,W	Elbow	13,014	31,280	0.42
HL,WO	Elbow	23,951	31,280	0.77
CL,W	Branch	49,417	51,750	0.96
CL,WO	Branch	44,443	51,750	0.86
TMI-1, Loop B				
HL,W	Nozzle	18,894	32,327	0.59
HL,WO	Nozzle	25,629	32,327	0.79
CR-3, Loop B				
HL,W	Nozzle	24,207	31,395	0.77
HL,WO	Nozzle	21,224	31,395	0.68
ANO-1, Loop A				
HL,W	Elbow	13,867	32,378	0.43
HL,WO	Elbow	15,784	32,378	0.49

Legend — CL: cold leg break
HL: hot leg break
W: with supports
WO: with failed supports removed

3.15. How was the 7% critical damping incorporated in the dynamic analysis? Specify which modes were critically damped. (Section 6.10.4.5)

Response

Damping for the dynamic analysis was specified through Rayleigh (α, β) damping. The mass and stiffness proportional factors α and β were determined by setting 7% damping at frequencies of 40 and 150 Hz ($\alpha = 27.37$, $\beta = 1.1727 \times 10^{-4}$).

3.16. Demonstrate with a detailed calculation that the dynamic load factor is 1.15. (Section 6.10.4.6)

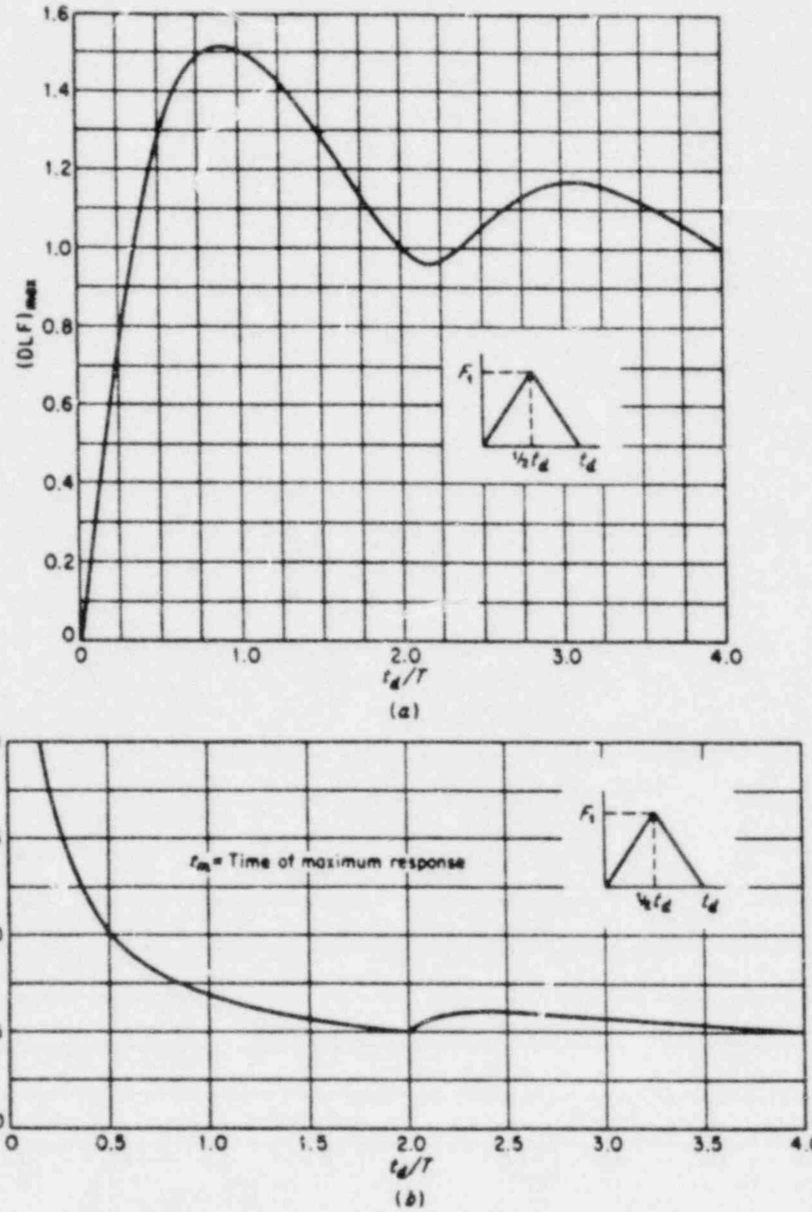
Response

The loads on the cavity walls can be approximated as a triangular pulse with pulse duration from 0.06 to 0.08 s (Figures 9.10-1 through 9.10-6[2]). The range of the first mode frequency of cavity walls is from 30 Hz for ANO-1 (orthotropic analysis) to 50 Hz for Rancho Seco.

Considering the range of pulse durations t_d and the range of frequencies, a range of ratios t_d/T can be derived. In Figure 3.16-1 the dynamic load factor (DLF) for a triangular load pulse is given for values of t_d/T.[19] For the range of interest, $1.82 \leq t_d/T \leq 4.0$, the maximum DLF is about 1.15.

Dynamic and static analyses were run for both the Arkansas and Rancho Seco cavity walls. Stress results from both analyses were compared. Actual peak dynamic stress results were less than those predicted by the DLF curve.

Figure 3.16-1. Maximum Response of One-Degree Elastic Systems (Undamped) Subjected to Isosceles Triangular Load Pulse



3.17. Demonstrate that the strain rates are sufficiently high to justify an increase in yield stress of 10%. (Section 7.1.1.1)

Response

The strain rates for the rupture restraints near yield stress range from 0.26 to 1.97 in./in.-s as given in Table 3.17-1. For these values of strain rate, experimental data show 25% increase in yield stress.[20]

Standard Review Plan 3.6.2 suggests a 10% increase in yield stress for rupture load analyses.[21]

Therefore, using a 10% increase in yield stress is conservative.

Table 3.17-1. Rupture Restraint Strain Rate

Rupture restraint	Strain rate, in./in.-s
Oconee hot leg bumper restraint	Stresses below yield
Oconee hot leg collar restraint	Stresses below yield
TMI-1 U-bar rupture restraint	1.13
TMI-2 U-bar rupture restraint	0.99
CR hot leg U-bar rupture restraint	0.26
ANO-1 hot leg strap rupture restraint	0.61
Rancho Seco hot leg upper rupture restraint	Stresses below yield
Rancho Seco hot leg lower rupture restraint	1.97

3.18. Explain the shear and tension interaction equation development. (Section 7.1.1.4)

Response

From pages 35 and 54 of reference 22, the interaction formulas based on the experimental data for combined tension and shear for steel are

$$\frac{fv^2}{(0.75\ Sy)^2} + \frac{ft^2}{Sy^2} \leq 1 \quad \text{for a rivet}$$

and

$$\frac{fv^2}{(0.6\ Sy)^2} + \frac{ft^2}{Sy^2} \leq 1 \quad \text{for a bolt.}$$

The interaction formula used for rupture restraint qualification was conservatively taken as:

$$\frac{fv^2}{(0.577\ Sy)^2} + \frac{ft^2}{Sy^2} \leq 1$$

for both pins and bolts. Hence, the interaction equation for shear and tension conservatively models experimental data.

3.19. Demonstrate that the strain rates are sufficiently high to justify an increase in concrete strength of 25% in compression and 10% in shear. (Section 7.2.1)

Response

From Appendix C of ACI 349-76[23], impulse loads are defined as including blast pressurization and compartment pressurization. For these loadings, a dynamic increase factor (DIF) may be applied to static material strengths. Appendix C gives DIFs of 1.25 for concrete under axial and flexural compression, and 1.10 for concrete under shear.

For the reactor vessel embedment, the concrete strain rate during the impulsive stage of the loading is approximately 0.067 in./in.-s. This value was determined by analysis. For strain rates of this order, Park and Paulay[24] give the DIF as approximately 1.25, which confirms the applicability of the ACI Code.[23]

3.20. Justify the use of level D stress limits for tees and branch connections. (Section 7.3.2.1)

Response

Appendix A of the proposed revision to Standard Review Plan 3.9.3 (PSRP 3.9.3[25]) states:

2.3.4. Service Limit D

The use of a service limit not greater than Level D for Class 1, 2, and 3 components of Type II safety-related systems and component supports of Type I and II safety-related systems, in lieu of service limit B, when subjected to the loadings described in section 2.3.2(b) (2) may be permitted for designated components and component supports provided that (1) the operability of active pumps and valves is demonstrated at service limit D (see section 3.1); (2) the functional capability requirements of section 3.3 at service limit D are satisfied; and (3) stresses produced by constraint of free-end displacement and anchor point motions satisfy section 3.4 for the above loadings.

3.3.2. Piping Components for Which Functional Capability is Ensured Without Further Demonstration

Functional capability may be considered ensured without further demonstration for Class 1, 2, and 3 piping components with an outside diameter-to-thickness ratio not greater than 50 ($D_o/t \leq 50$) which meet one of the following criteria:

a. Class 1 piping components:

1. All piping components for which Service Limit C is permitted by section 2.3.3, provided the primary stress intensity as calculated by equation 9 of NB-3652[2/] does not exceed 1.5 S_y.

2. Tees and branch connections for which Service Limit D is permitted by section 2.3.4, provided the primary stress intensity as calculated by equation 9 of NB-3652[2/] does not exceed 2.0 S_y.

The D_o/t ratios for all core flood lines was less than 50. The peak check valve stress on the core flood lines was less than service level B limits. Hence, the use of service level D limits for tees and branch connections is justified.

3.21. Specify the BOA time considered in determining the loadings shown in Table 8.1-1. (Section 8.1)

Response

Break opening times considered in determining the loadings shown in Table 8.1-1 of reference 2 are tabulated in the response to question 2.6, Tables 2.6-1 and 2.6-3.

3.22. The vertical load shown in this and subsequent figures does not appear to have reached its maximum value. Please discuss in detail. (Section 8.1)

Response

With reference to the vertical load curves shown in section 8.1 of reference 2, it was determined that these loads peak after the 0.5-second time shown. This can be seen by referring to Figures 8.1-1g, -2g, -3h, and -4h of reference 2. The data in Tables 9.1-2 through 9.1-5[2] were used to analyze the supports. These data show that the moments are very large in comparison to the magnitude of the vertical forces. This is demonstrated by considering the following stress calculation on the reactor vessel support skirt:

Support skirt diameter, in.	179.5
Support skirt thickness, in.	2.0
Number of holes in skirt,	12
Diameter of holes in skirt, in.	9.25
Vertical force on TMI-1/CR-3 from Table 9.1-3, kips	6358.2

$$\text{Stress: } \frac{P}{A} = \frac{6,358,200}{(179.5\pi - 12 \times 9.25)2} = 7,019 \text{ psi}$$

Even if vertical loads in Tables 9.1-3 through 9.1-5[2] were increased by 50%, the stresses from these loads would not approach the stress due to the moment loading.

3.23. Identify the break locations from Figure 4.1-1 associated with each of the loadings tabulated in Table 8.1-1. (Section 8.1)

Response

With reference to Figure 4.1-1 of reference 2, break locations would be at the terminal ends of the reactor vessel nozzles for the specified hot or cold leg break. Data referenced in Table 8.1-1 for Davis Besse 1 (nozzle supported plant) were for the actual inlet and outlet nozzle break areas. A spectrum of break sizes — 2.0A, 1.5A, 1.0A, 0.6A, and 0.3A — was used for all other plants referenced in Table 8.1-1.[2] Additional data are provided in response to question 2.6.

3.24. Supply quantitative results and allowable values. (Section 10.5)

Response

The quantitative results for the reactor internals/core support assembly are found in Tables 3.24-1 through 3.24-5.

Table 3.24-1. Core Support Shield Stress Analysis Results for Faulted Conditions

Location	Stress category	Maximum allow. stress, psi	Max calculated stress, psi	
			Skirt-supported RV	Nozzle-supported RV
Core support shield	Pm	39,800	14,109	14,517
	Buckling	319	145.4	187.9
CSS/CB flanges and joint				
Bolted joint	Pm	91,000	28,460	35,381
CB upper flange	Pm	38,200	4,564	5,675
	Bearing	35,400	8,439	10,492
	Shear	19,080	4,974	6,183
CSS lower flange	Pm	38,200	8,473	9,719
	Pm + Pb	57,300	19,391	22,242
	Bearing	35,400	8,345	9,572
CSS upper flange	Limit load, kips	1.98×10^4	1.82×10^4	1.68×10^4

Table 3.24-2. Lower Grid Assembly Stress Analysis Results for Faulted Conditions

Location	Stress category	Maximum allow. stress, psi	Max calculated stress, psi: Skirt-supported RV	Max calculated stress, psi: Nozzle-supported RV
LGA Shells				
CB/LGA bolts	Pm	86,600	18,712	21,464
	Stripping	19,080	6,374	3,735
	Bearing	35,400	4,321	4,957
CB lower flange	Pm	38,160	4,080	4,680
Lower Grid Assembly				
Grid pad	Bearing	35,400	4,921	3,281
Grid pad/rib sec joint - bolt	Shear	38,160	10,338	7,419
dowel	Pm	19,080	3,465	2,486
Rib section	Pm	38,160	20,669	14,515
	Pm + Pb	57,420	33,900	26,653
Support post/rib sec joint - bolt	Pm	38,160	3,399	2,266
Rib sec/shell forging joint - bolt	Pm	38,160	20,187	13,458
Support posts	Pm	38,160	8,686	6,443
FD plate	Pm	57,240	1,908	1,272
FD plate/shell forging joint - weld	Pm	22,896	2,159	1,439
Support post/FD plate welded joint	Pm	15,264	560	373
Support forging	Pm	38,160	1,712	1,425
	Pm + Pb	57,240	15,194	12,652
Support post/support forging joint - weld	Pm	30,528	16,686	23,758
Shell forging	Pm	38,160	885	779

Table 3.24-3. Flow Distributor Assembly Stress Analysis Results for Faulted Conditions

Location	Stress category	Maximum allow. stress, psi	Max calculated stress, psi	
			Skirt-supported RV	Nozzle-supported RV
Flow distributor head/LGA joint				
FDH/LGA bolts	Pm	91,000	11,340	11,340
	Tear-out	20,256	184	184
	Bearing	37,560	1,456	1,456
FDA shell	Pm	40,512	125.7	125.7
	Pm + Pb	60,768	1,125.4	1,125.4
FDA flange	Pm	40,512	284.6	284.6
	Pm + Pb	60,768	6,240	6,240

Table 3.24-4. Core Basket Assembly Stress Analysis Results for Faulted Conditions

Location	Stress category	Maximum allow. stress, psi	Max calculated stress, psi	
			Skirt-supported RV	Nozzle-supported RV
Core barrel	Pm	38,400	10,521	10,826
	Buckling	20,750	8,572	8,583
Core barrel assembly				
Baffle-former A-A bolts	Pm	38,160	8,082	6,510
Barrel-former A-A bolts	Pm	38,160	22,503	16,135
Thermal shield				
Lower end	Pm	38,160	1,525	1,824
Upper end	Pm	38,160	10,316	10,711
TB/LG shell forging bolts	Pm	91,000	43,969	40,451
TS upper restraint	Bearing	35,400	5,999	6,234
	Shear	19,080	8,145	8,464
Bolts	Pm	91,000	26,849	27,902
Dowels	Shear	51,960	3,988	4,144

Table 3.24-5. Plenum Assembly Stress Analysis Results for Faulted Conditions

Location	Stress category	Maximum allow. stress, psi	Max calculated stress, psi	
			Skirt-supported RV	Nozzle-supported RV
Plenum cover	Bearing	27,300	14,742	17,059
Plenum cylinder	Pm	39,120	27,534	24,613
CRGT	Buckling	21,500	14,175	11,669
Slotted region	Pm	39,190	6,003	8,253
	Buckling	21,250	6,003	8,253
Perforated region	Pm	39,190	4,277	5,909
	Buckling	21,250	4,277	5,909
Lower joint - bolt	Pm	39,190	12,398	11,745
- dowel	Shear	51,960	3,408	4,797
CRGT/plenum cover joint	Pm	13,776	2,340	2,672
Upper grid assembly				
Rib section	Pm	39,245	16,903	10,775
	Pm + Pb	58,867	27,130	16,934
UG pad joint	Dowel	51,960	6,682	4,356
	Bolt	39,187	24,675	16,088

3.25 Provide a calculated load value wh ch yields the spacer grid deflection indicated in Table 10.6-1 (section 10.6).

Response

Table 10.6-1 of reference 2 shows a spacer grid permanent deformation of 0.114 in. This deformation was determined as follows.

The calculated maximum impact load for the worst LOCA load case was 12,576 lb. Another impact of slightly less magnitude occurred before the maximum impact. The rest of the impacts were substantially less. These loads were determined at the hot operating reactor condition. An equivalent maximum impact load at room temperature was obtained by multiplying this load by the ratio of modulus of elasticity at room temperature to that at reactor operating temperature.

A curve of permanent deformation versus impact load was developed from spacer grid impact test data. A permanent deformation of 0.057 in. corresponds to the predicted maximum impact load. This deformation was doubled to 0.114 in. to account for the second pact. This is a conservative treatment of the experimental permanent deformation data to account for the multiple impacts resulting from the use of the nonlinear elastic plastic model of the spacer grid in the dynamic analyses. Spacer grid impact tests show that once the grid has plastically deformed, a second impact at about 90% of the buckling impact velocity results in much lower additional permanent deformation. Substantially lower impact loads (impact velocity = 50 to 80% of the buckling velocity) on the buckled grid do not cause additional permanent deformation.

3.26. Are all Owners Group plants supplied with Inconel grids? If not, explain. (Section 10.6)

Response

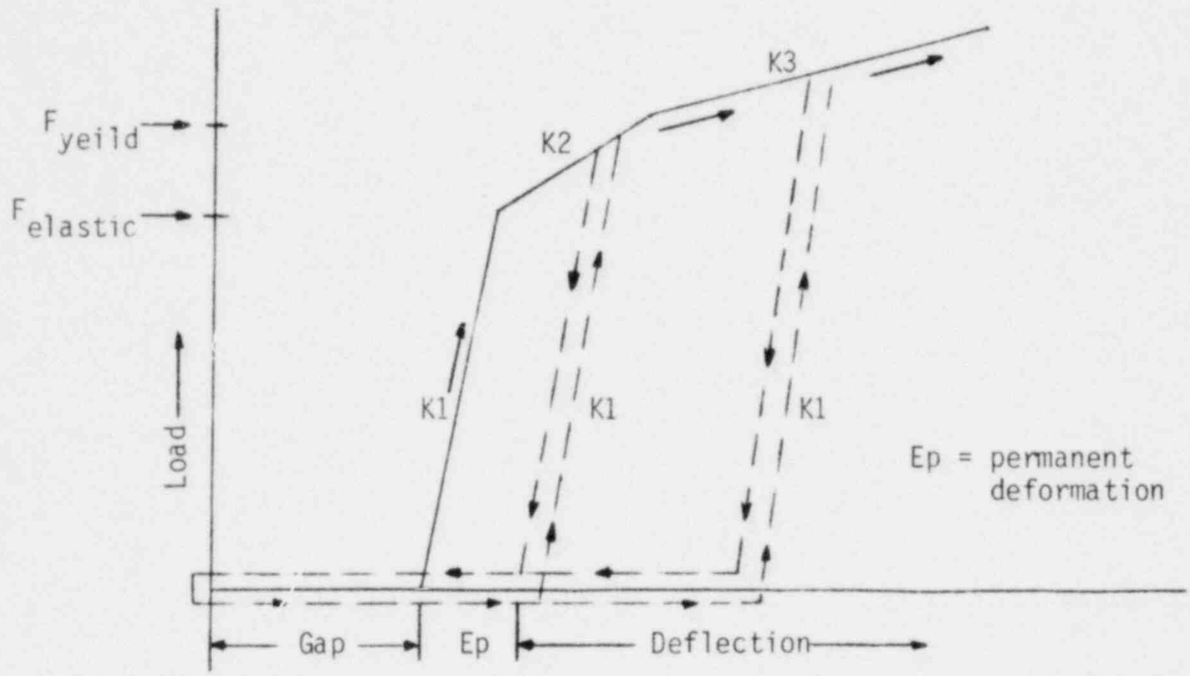
All Owners Group plants are supplied with Inconel grids except for demonstration assemblies that have been or soon will be inserted at Oconee. At present, Oconee 2 has one fuel assembly with Zircaloy intermediate spacer grids. Four demonstration fuel assemblies with Zircaloy grids are scheduled to go into Oconee 1.

The acceptable use of these demonstration assemblies has been documented in BAW-1565, Rev 1, and BAW-1533, Rev 1, for Oconee 2 and in BAW-1660 and BAW-1661 for Oconee 1.

3.27. Were nonlinear imp-:t elements incorporated in the appropriate computer code to yield the spacer grid deflection? If so, were these elements nonlinear elastic or elastic plastic? Provide a discussion. (Section 10.6)

Response

Yes. Nonlinear elastic-plastic elements are incorporated in the STARS computer code. The spacer grid is represented as a trilinear gapped spring as shown below.



The spacer grid spring rates were determined from the room temperature spacer grid impact tests. Impact loads are calculated at hot operating conditions using this trilinear spring model. An equivalent load at room temperature was determined by multiplying this calculated load by a ratio of modulus of elasticity at room temperature to that at reactor operating temperature.

A permanent deformation was determined from a curve of permanent deformation versus impact load developed from the test data.

3.28. Are these results applicable for both broken and unbroken loop piping? (Section 10.7)

Response

The results in section 10.7 of reference 2 are for unbroken loop piping. For example, the moments and stresses given for a point on the A loop hot leg are produced by a postulated hot leg break in the B loop.

3.29. Identify which breaks yield which stresses. (Section 10.7)

Response

Tables 3.29-1 through 3.29-3 provide the following information: the plant having the largest load, the joint location at which the resultant moment acts, the LOCA case (break location) that produces the load, and the maximum resultant moment and actual bending stress at the joint.

Table 3.29-1. Additional Information for Table 10.7-1 of Reference 2, HLG LOCA Case[a]

Pipe location, section	Plant	Joint No.	Moment M_i, ft-kips	Actual stress f_b, psi
Hot leg, straight	TMI-1 CR-3	138	4,726.4	26,040
Cold leg, straight	TMI-2	89	2,150.1	24,622
Hot leg, elbow	TMI-2	158	3,097.3	44,967
Cold leg elbow	TMI-2	97	1,520.3	30,702
Cold leg, safe-end	TMI-2	149	1,338.4	15,349

[a]HLG: hot leg guillotine at reactor vessel outlet nozzle.

Table 3.29-2. Additional Information for Table 10.7-2 of Reference 2, Davis Besse 1 Plant, LOCA Case 1[a]

Pipe location, section	Joint No.	M_i, ft-kips	Actual stress f_b, psi
Hot leg, straight	74	2,673.4	18,822.3
Cold leg, straight	97	5,731.5	54,724.8
Hot leg, elbow	104	1,619.0	25,715.2
Cold leg, elbow	--	--	--
Cold leg, safe-end	142	2,880.9	25,142.8

[a]LOCA case 1: hot leg guillotine at reactor vessel outlet nozzle.

Table 3.29-3. Additional Information for Table 10.7-3 of Reference 2, Davis Besse 1 Plant, LOCA Case 1[a]

Elbow location	Joint No.	M_i, ft-kips	Actual stress f_b, psi
P1A1	110	5,458.95	66,090
	119	5,057.28	60,821
	135	3,239.37	40,469
	143	2,834.41	38,338
P1A2	107	5,511.61	63,066
	117	5,097.78	58,143
	133	3,244.01	38,448
	141	2,831.85	37,140
P1B1	106	5,521.31	65,073
	116	5,127.46	62,919
	132	3,279.88	43,585
	140	2,875.48	39,766
P1B2	108	5,480.16	62,654
	118	5,096.79	59,838
	134	3,279.11	41,144
	142	2,880.93	38,509

[a]LOCA case 1: hot leg guillotine at reactor vessel outlet nozzle.

3.30. Are the results in Tables 10.7-1 and 10.7-2 consistent with the equations in section 6.7? (Section 10.7)

Response

Yes. From section 6.7 of reference 2, the equation is

$$B_1 \frac{PD_o}{2t} + B_2 \frac{D_o}{2I} M_i \leq 3\, S_m.$$

A sample calculation is performed to provide the results for the hot leg straight pipe in Table 10.7-1 of reference 2:

Hot Leg Straight Pipe

$B_1 = 0.5$ $D_o = 42.25$ in.

$B_2 = 1.0$ $t = 2.813$ in.

$P = 2250$ psi $I = 68{,}107$ in.^{4}

$M_i = 4726.4$ ft-kips

$$\text{Actual } f_b = 0.5 \frac{(2250)42.25}{2(2.813)} + 1.0 \frac{42.25}{2(68{,}107)} 4726.4(12)1000$$

$$= 26{,}040.6 \text{ psi}$$

3.31. Explain in detail the calculations performed to reflect the assumed 2A BOA. (Section 11.1.2)

Response

The response to question 3.33 addresses the 2A BOA.

3.32. What was the basis for assuming that all the skirt-supported plants were hydraulically similar to Midland 1 and 2? The same question applies for nozzle-supported plants. Are specific plant analyses planned in the future? (Section 11.1.2)

Response

The piping configurations for the 177-FA skirt-supported plants are very similar. Other plant parameters used to establish generic fluid conditions are tabulated in response to question 2.10 and are similar. Thus, it was concluded that the plants are hydraulically similar. Davis Besse 1 is the only operating 177-FA nozzle-supported plant; however, piping reaction forces were calculated using Davis Besse 2 and 3 plant data. These plants are hydraulically identical to Davis Besse 1. No additional analyses of asymmetric loading effects for pipe breaks in the steam generator compartment are planned.

Breaks in the RV compartment present the most severe challenge to core cooling, and extensive analysis has shown that the core flood line, RV internals, and the RV are qualified for core cooling. Review of available data for the steam generator compartment results in qualifying the remaining primary piping as maintaining the pressure boundary.

3.33. Justify multiplying the 1A break results by 2.0 to obtain 2A results. Why was a factor of 1.5 chosen instead of some other value? (Section 11.1.3)

Response

From previous work done on asymmetric cavity pressure hot leg or cold leg breaks, it has been seen that doubling the break area from 1A to 2A does not double loads on components. Lateral forces, moments, and uplift forces on the RV do not follow a linear behavior with respect to break opening area. Loads actually will be consistently lower than the linear ratio. The same relationship is valid for 0.3A and 0.6A breaks. See Table 3.33-1, i.e., multiplying 1A break loads by 2 to determine 2A break loads is a conservative method. The factor of 1.5 was chosen on the basis of our experience in reviewing ACP data from numerous sources (e.g., subcompartment cavity pressure forces on NSS components for various B&W plants). We noted a large variation in the results even considering the differences in cavity configurations and break opening area. However, it was our engineering judgement that 1.5 was a reasonable factor by which LOCA cavity pressure forces should be multiplied.

Figure 3.33-1 illustrates the Midland 1 and 2 compartment, which is comparable to Figures 11.1-5 through 11.1-20 of reference 2. Given the same break opening areas and cavities, which are not significantly different from Midland, the factor of 1.5 should adequately account for these differences.

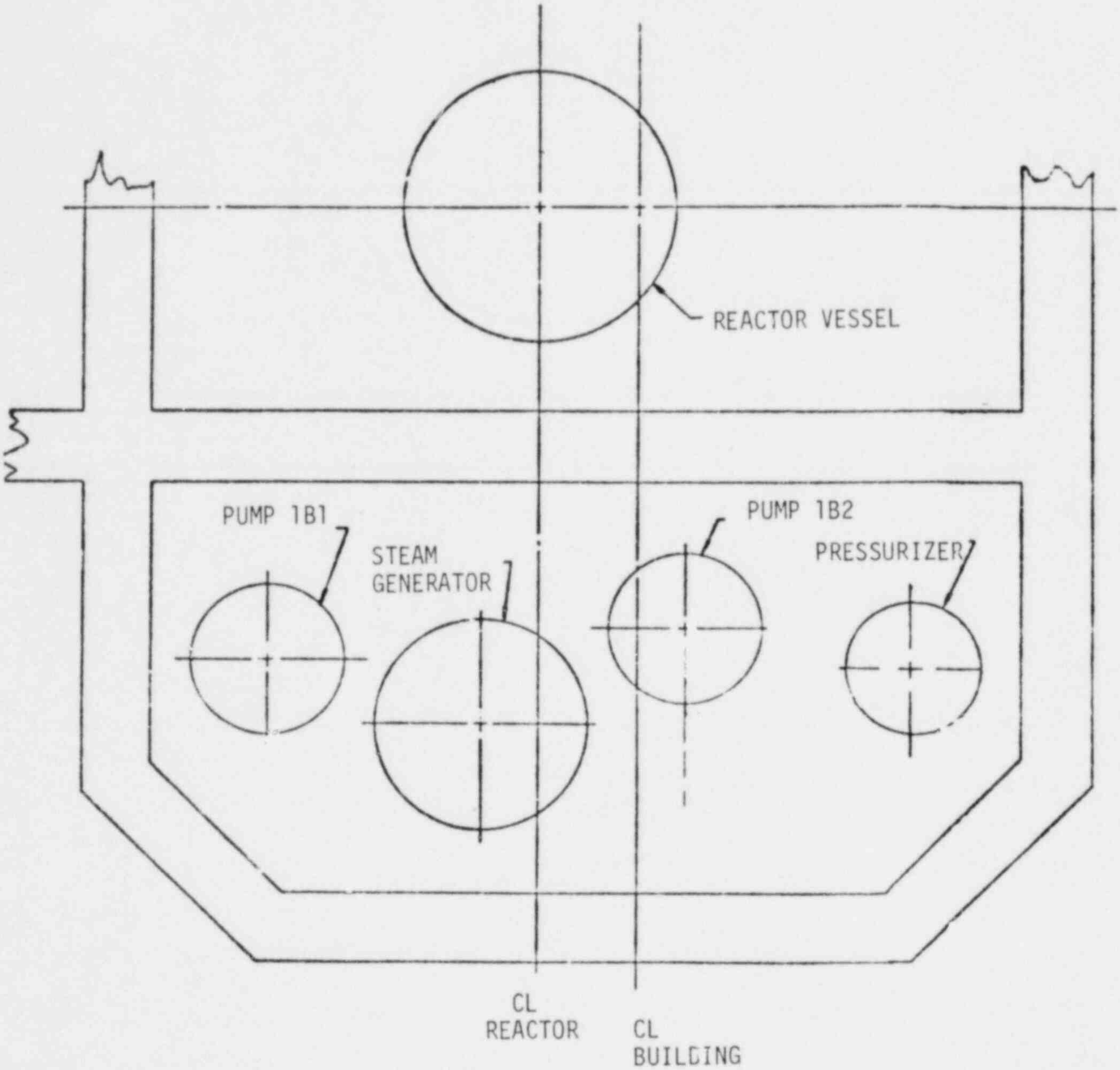
Table 3.33-1. Peak Loads for ANO-1 Reactor Vessel Cavity

		Lateral force, 10^6 lb	Moment at skirt, 10^6 in.-lb	Uplift force, 10^6 lb
Hot leg break	2A	8.94	1973	6.31
	1A	5.41	1178	4.14
	0.6A	3.46	744	2.89
	0.3A	2.10	442	1.75
Cold leg break	2A	3.25	359	3.90
	1A	2.06	260	3.17
	0.6A	1.58	188	2.46
	0.3A	1.04	122	1.34

Notes:

1. For all cases 2 · (1A data) > 2A data, 2 · (0.3A data) > 0.6A data.
2. The ANO data tabulated above are representative of similar data for other plants.

Figure 3.33-1. Midland Unit 2, Loop B —
Plan View at EL. 634 ft
(Ref. Dwg C-676, Rev 0)



Note: Unit 1 is opposite hand.

3.34. Clarify Figures 11.1-9 through 11.1-14 with regard to their generation and application. (Section 11.1.3)

Response

Figures 11.1-9 through 11.1-14 of references 2 were part of the data supplied to B&W by Bechtel from their steam generator compartment ACP analysis for Midland 1 and 2 and Davis Besse 2 and 3. The figures are a sample of the ACP forces applied to the RCS model in determining the structural reaction forces.

As an example of their application, the forces from Figure 11.1-9 for a break at the pump discharge were applied as indicated in response to question 3.39 to a mass on the RC pump. The force from Figure 11.1-10 was simultaneously applied in the vertical direction. The forces from Figure 11.1-11 were likewise applied as indicated in response to question 3.39 on the OTSG. In addition, piping reaction forces and jet impingement forces were applied at appropriate locations as described in response to question 3.39.

The data presented in Figures 11.1-9 through 11.1-14 are the basic data, which were then multiplied by the factors described in section 11.1.3 before application to a component.[2] The entire time history was multiplied, time-for-time, not just the peaks.

3.35. Justify that removing the gapped restraints from the model is conservative. (Section 11.1.4.1)

Response

Performing detailed pipe whip calculations that take credit for the effect of gapped restraints in limiting the BOA can only result in BOAs less than or equal to the 2A breaks that were assumed. If the BOAs are reduced as might be expected by restraints designed to limit pipe whip, the ACP forces will be reduced and so will conservatism.

Regarding the dynamic response of the structure, the gapped pipe whip restraints are assumed to be effective only in the piping runs in which a break is postulated. Thus, if a gapped pump restraint were active for a hot leg break, the model would not represent the structure accurately. However, additional restraints would have the general effect of shifting structural modes to higher frequencies and providing additional load paths for the distribution of applied forces.

There is a possibility that a structural frequency might move into resonance with a forcing function, resulting in higher response loads, but that is not likely to increase the design loads significantly. The redistribution of loads to the added load paths could only reduce loads on the major component supports, which we were attempting to assess for structural adequacy.

3.36. Hydraulic compartment pressure and jet impingement are mentioned as loading conditions for the RCS structural analysis. Were dead weight and thermal loadings also considered in the analysis? (Section 11.1.4.1)

Response

Deadweight loads were considered in the simplified pipe stress analysis as stated in section 11.4 of reference 2. Thermal loads were not included because they do not produce primary stresses.

3.37. Expand the discussion concerned with factoring the forces at the break plane. (Section 11.1.4.1)

Response

Suppose a pump suction break as shown in Figure 3.37-1 produces a thrust force, T, which causes moments at point A that are 1.5 times greater than the pipe can actually transmit without forming a plastic hinge. It is unrealistic to evaluate stresses in the OTSG supports resulting from this applied moment, so T is multiplied by a factor less than 1.0 in a second iteration of this load case. Because the dynamics of the pipe are important and the model representation is linear elastic, the thrust T is reduced until subsequent iterations result in the peak moment at point A being within 10% of the elastic limit of the pipe.

3.38. Was the broken pipe loop considered for determining steam generator support loadings? (Section 11.1.4.3)

Response

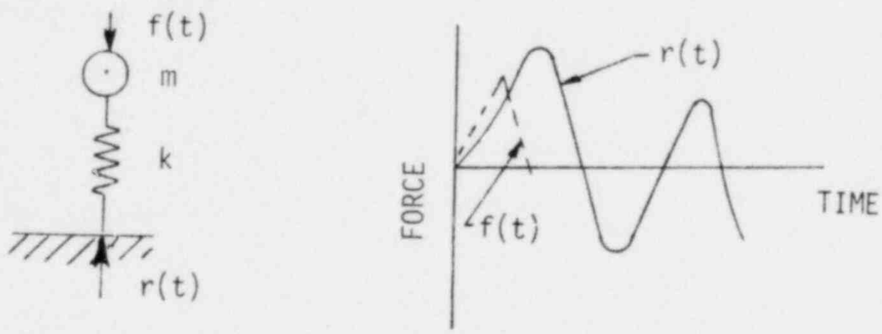
Yes, the broken pipe loop was considered for determining steam generator OTSG support loadings. It is confusing to use the word "loop" to describe portions of the B&W NSS because there are two reactor coolant (RC) pumps associated with each OTSG. "Side" is a less confusing term. Referring to figures in Appendix F of reference 2, it may be seen that only the A side of the RCS has been modeled. The A side consists of the A OTSG and the A1 and A2 cold leg piping. The A side may thus be further subdivided to refer to the A1 and A2 piping.

In determining the OTSG support loads, the entire A side model was active, so whether the question refers to a postulated break in the A hot leg or in the A2 piping, the broken piping was considered. If the break is located so that a plastic hinge would develop in the piping between the break and the next nozzle, then the moments transmitted through that nozzle are equal to the plastic limit, and the adjacent component does experience realistic loading.

3.39. Identify in detail what constitutes the applied forces and what constitutes the response loads. Discuss in detail for a specific plant the mathematical model that includes applied force locations and response locations. (Section 11.0)

Response

The figure below illustrates the distinction between applied forces and response loads. The mass, m, in the single-degree-of-freedom oscillator has an applied force, f(t), which is a function of time as shown. The response load at the supporting structure is a function of the structural properties m and k (stiffness), and of the nature of the applied force.



In the loading analysis, the applied forces are piping reaction forces*, ACP forces, and jet impingement forces (if any). For the P1A2 pump discharge break, Table 3.39-1 summarizes the forces applied to the model illustrated in Figures F-1 through F-3 of reference 2.

An example of a source for response loads is element 61, structural joint 23 for the OTSG base (see Figure 11.1-31,[2] a different LOCA case from the example above). Other locations in Table 11.1-3 are similarly chosen. (Note that F_y for points 25 and 23 in Table 11.1-3 is out of date. The value used in the section 11.2 evaluation of the skirt was 8100 kips compression. This value agrees with Figure 11.1-31.)

- - - - -

*Piping reaction force means reaction to the pressure transient within the RC pressure boundary. It is an applied force and not a response load.

Table 3.39-1. Summary of Applied Forces

Force type	Joint	Direction of application	Comments
Piping reaction	185	X, Y, Z	Summary of multiple fluid from force paths.
	162	Y, Z	See Figure 11.1-6[2]
	24	Y	
	33	Y	
	13	Y	
	25	X, Y, Z	Summary of multiple fluid force paths.
	44,8	X, Y, Z	Some forces on P1A2 upper cold leg omitted because of plastic hinge consideration.
	55, 154	X, Y, Z	
	37	X, Z	
	64	X, Y, Z	
	93	X, Z	
	168	X, Z	
	188	X, Z	
ACP	154, 55	X, Y, Z	See Figures 11.1-9, 11.1-10[2]
	139, 71	X, Z	
	86, 124	X, Z	
	58, 160	X, Z	
	12	X, Z	See Figure 11.1-11[2]
	2	X, Z	
	40	X, Z	
	16	X, Z	
Jet impingement	None	--	Jet impingement targets are in the broken piping run and do not affect intact supports.

3.40. Supply results data and comparisons. (Sections 11.2.1 and 11.2.2)

Response

The requested information is included in calculational packages 3.40-1 and 3.40-2.

BWNP-20210-1 (1-78)

CALCULATION DATA/TRANSMITTAL SHEET

DOCUMENT IDENTIFIER

CALC. 32 - ______ - ______

TRANS. 86 - 1125142 __ - 00

TYPE: ___RESEARCH & DEVELOPMENT ___SAFETY ANALYSIS REPORT ___NUC. SERV. INPUT ___DESIGN RQMT. ___DESIGN VERIF. ___OTHER

TITLE PHASE II - OTSG SUPPORT SKIRT EVALUATION & RESULTS FOR VESSEL SUPPORTED VESSELS

PREPARED BY EDWARD A. MALONE REVIEWED BY LARRY E. WHITE

TITLE ASSOCIATE ENGINEER DATE 3-30-81 TITLE ENGINEER DATE 3-31-81

PURPOSE:

THIS PACKAGE PROVIDES THE 177 FA OTSG SUPPORT SKIRT EVALUATION RESULTS FOR THE SKIRT SUPPORTED VESSELS, WHEN SUBJECTED TO PHASE II LOADS.

SUMMARY OF RESULTS (INCLUDE DOC. ID'S OF PREVIOUS TRANSMITTALS & SOURCE CALCULATIONAL PACKAGES FOR THIS TRANSMITTAL)

SINCE THE SMUD STRESS REPORT RESULTS SHOW THE SUPPORT SKIRT ASSEMBLIES OF ALL THE LOW-LOOP PLANTS TO BE ACCEPTABLE FOR LOADS HIGHER THAN THE ACP LOADS, THE ACP LOADS ARE ACCEPTABLE.

DISTRIBUTION

2) LOWER SUPPORT SKIRT ASSEMBLY

THE PROVIDED ACP LOADS WILL BE COMPARED TO THE LOWER SUPPORT LOADS SHOWN IN THE STRESS REPORT AND CALCULATIONS WILL BE MADE WHEN NECESSARY TO QUANTIFY SIGNIFICANT DIFFERENCES.

A) LOW-LOOP PLANT

ACP LOADS** + DEADWEIGHT△	F_x (KIPS)	F_y (KIPS)	F_z (KIPS)	M_x (FT-K)	M_y (FT-K)	M_z (FT-K)
SKIRT @ BASE	2560	8205	5550	42750	2210	190

THESE VALUES WILL BE RESOLVED INTO A RESULTANT HORIZONTAL FORCE (F_R), A VERTICAL FORCE (F_y), A RESULTANT OVERTURNING MOMENT (M_R), AND A TORSIONAL MOMENT (M_y) FOR DIRECT COMPARISON WITH THE VALUES SHOWN IN MOST OF THE STRESS REPORTS. **REF. 1 △REF. 4C

ACP LOADS** + DEADWEIGHT	F_R (KIPS)	F_Y (KIPS)	M_R (FT-K)	M_Y (FT-K)
SKIRT @ BASE	6112	8205	42,751	2210

** REF. 1

THE COMPARABLE ITEMS FROM THE RESPECTIVE STRESS REPORTS FOR EACH CUSTOMER ARE SHOWN BELOW.

STRESS REPORT LOADS	F_R (KIPS)	F_Y (KIPS)	M_R (FT-K)	M_Y (FT-K)	SEE REF. #
DUKE	5220	1825	17,500	0	4a
FLORIDA	5220	1825	17,500	0	4b
TMI-I	5580	2046	25,500	0	4c
TMI-II	4355	1513	26,397	12,470	4d
ARKANSAS	6404	2155	33863	11641	4e
SMUD	8439	1845	40,833	0	4f

IT CAN BE SEEN FROM THE LOADS FOR THE VARIOUS CONTRACTS THAT THOSE IN THE SMUD ANALYSIS ARE THE MOST SEVERE OVERALL.*

THEREFORE, THE SMUD LOADS WILL BE COMPARED TO THE ACP LOADS.

* IT IS ACKNOWLEDGED HERE THAT THE SKIRT ASSEMBLY MATERIALS AND GEOMETRIES FOR THE VARIOUS CONTRACTS ARE ESSENTIALLY THE SAME.

A REVIEW OF THE CALCULATIONS IN THE SMUD STRESS REPORT (REF. 4A) SHOWS THAT THE LARGE MAJORITY OF EACH SIGNIFICANT STRESS IS GENERATED BY F_R OR M_R. THESE F_R AND M_R VALUES ON SMUD ARE MUCH LARGER THAN THE ACP F_R AND M_R VALUES. THEREFORE, THE ACP LOADS WOULD RESULT IN LOWER STRESSES.

IT IS RECOGNIZED THAT THE ACP VALUES OF F_Y AND M_Y ARE SOMEWHAT LARGER THAN THE SMUD F_Y AND M_Y. HOWEVER, AS WAS IMPLIED ABOVE, THESE ARE ONLY MINOR CONTRIBUTORS TO THE TOTAL SIGNIFICANT STRESSES (I.E. - F_Y GIVES FLANGE BEARING CONTRIBUTION $\simeq$ 0.8 KSI; M_Y GIVES A SHEAR CONTRIBUTION OF $\simeq$ 0.6 KSI, BOTH OF WHICH ARE INSIGNIFICANT).

CONCLUSION:

IT IS CONCLUDED THEN THAT SINCE THE SMUD STRESS REPORT RESULTS SHOW THE SUPPORT SKIRT ASSEMBLIES OF ALL THE LOW-LOOP PLANTS TO BE ACCEPTABLE FOR LOADS HIGHER THAN THE ACP LOADS, THE ACP LOADS ARE ACCEPTABLE.

REFERENCES:

1) B&W DOCUMENT # 86-1106948-02 (ACP LOADS)

2) FOR DUKE - B&W DWG. 112793 D-0
FOR TMI-I - B&W DWG 112794 D-10/20/71
FOR TMI-II - B&W DWG 112795 D-3
FOR FLORIDA - B&W DWG. 112796 D-1
FOR ARKANSAS - B&W DWG. 112797 D-2
FOR SMUD - B&W DWG. 112799 D-3

3) B&W SPECIFICATION 3002/NSS-14/1077 FOR REACTOR COOLANT SYSTEM FOUNDATION AND NOZZLE LOADINGS

4) STRESS REPORT FOR STEAM GENERATOR, REPORT #12, "STRESS ANALYSIS OF STEAM GENERATOR SUPPORT SKIRT" -

a) B&W CONTRACT 620-0003/4/9-55
b) B&W CONTRACT 620-0007-55
c) B&W CONTRACT 620-0005-55
d) B&W CONTRACT 620-0006-55
e) B&W CONTRACT 620-0008-55
f) B&W CONTRACT 620-0011-55

5) STRESS REPORT FOR STEAM GENERATOR, REPORT #12, "STRESS ANALYSIS OF STEAM GENERATOR SUPPORT SKIRT AND ATTACHMENTS FOR MECHANICAL LOADS", B&W CONTRACT 620-0014-55

CALCULATION DATA/TRANSMITTAL SHEET

DOCUMENT IDENTIFIER
CALC. 32 - 1125237 - 00
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TYPE: ___RESEARCH & DEVELOPMENT ___SAFETY ANALYSIS REPORT ___NUC. SERV. INPUT ___DESIGN RQMT. ✓ DESIGN VERIF. ___OTHER

TITLE OTSG SUPPORT SKIRT FILLET WELD STRESS ANALYSIS - ACP PHASE II

PREPARED BY LARRY E. WHITE REVIEWED BY D.E. Thoren
TITLE ENGINEER DATE 4-3-81 TITLE Principal Engr. DATE 4/21/81

PURPOSE:

THE PURPOSE OF THIS CALCULATIONAL PACKAGE IS TO PERFORM THE STRESS ANALYSIS OF THE 1" FILLET WELD (WG-194) THAT JOINS THE OTSG SUPPORT SKIRT GUSSET TO THE TOP + BOTTOM CENTER SUPPORT DISKS.

SUMMARY OF RESULTS (INCLUDE DOC. ID'S OF PREVIOUS TRANSMITTALS & SOURCE CALCULATIONAL PACKAGES FOR THIS TRANSMITTAL)

THE AVERAGE SHEAR STRESS ON THE THROAT OF THE 1" FILLET WELD IS CALCULATED TO BE 25,288 PSI WHICH IS LESS THAN THE SHEAR ALLOWABLE OF 35,280 PSI.

THE PRIMARY SOURCE CALCULATIONAL PACKAGE IS B+W DOCUMENT # 32-1119695-00, "OTSG SUPPORT-WELD STRESS ANALYSIS, PHASE II", BY D.E. THOREN, DATED 6-13-80.

DISTRIBUTION

DISCUSSION:

THE CALCULATIONS CONTAINED HEREIN ARE PERFORMED IN ORDER TO DEMONSTRATE THE STRUCTURAL ADEQUACY OF THE 1" FILLET WELD (TOP/BOTTOM SUPT. DISC-TO-SUPPORT GUSSET WELD) FOR ASYMMETRIC CAVITY PRESSURE LOADS - PHASE II. THE SUBJECT WELD IS DESIGNATED AS WG-194 ON REFERENCE 1.
THE SIGNIFICANT LOAD ON THIS WELD RESULTS FROM THE DOWNWARD COMBINED DEADWEIGHT AND LOCA FORCE OF 10,083 KIPS (PER REF. 1, SHT. 12)

A FINITE ELEMENT ANALYSIS OF THIS WELD HAS DETERMINED THE FORCES ACTING ON THE WELD DUE TO THIS LOAD (REF. 1, PG.'S 19 + 20).

AS WAS DONE IN THE STRESS REPORT (REF. 3), THE AVERAGE SHEAR STRESS ON THE THROAT AREA OF THE WELD WILL BE CALCULATED AND COMPARED TO THE ALLOWABLE STRESS.

WELD SHEAR STRESS ALLOWABLE:

PER REF. 4 TABLE F-1322.2-1, ELASTIC SYSTEM, COMPONENT SUPPORTS, STRESS LIMITS, THE LIMIT FOR THE BASE METAL IS:

$1.5 S_m$ OR $1.2 S_y$, WHICHEVER IS GREATER

BUT NOT TO EXCEED $0.7 S_u$

THE MATERIALS INVOLVED ARE:

TOP + BOTTOM SUPPT. DISC	SA-302 GR B	REF. 6
CENTER SUPPT. FORGING	SA-541 CL 2	
SUPPT. GUSSET	SA-302 GR B	

THESE ARE ALL MAG MOLY MATERIALS WITH THE FOLLOWING PROPERTIES FROM REF. 4:

S_y = 47,100 PSI* S_m = 26,700 PSI* S_u = 80,000 PSI*

$1.2 S_y$ = 56,520 PSI
$1.5 S_m$ = 40,050 PSI
$0.7 S_u$ = 56,000 PSI

∴ 56,000 PSI IS ALLOWABLE; HOWEVER, TAKING INTO ACCOUNT THE 5% INCREASE ON ULTIMATE STRENGTH PERMITTED BY REF. 5, THE TOTAL ALLOWABLE BECOMES 1.05 (56,000) = 58,800 PSI

* PER REF. 3, THE WELD TEMPERATURE WILL BE LESS THAN 200°F, THUS, PROPERTIES ARE TAKEN @ 200°F

THUS, THE SHEAR ALLOWABLE (APPLICABLE TO THE WELD) IS:

$$\tau_{Allow.} = (.6)(58,800) = \underline{\underline{35,280 \text{ PSI}}}$$

FORCES IN THE WELD:

1) AVERAGE FORCE IN WELD PARALLEL TO GUSSET LENTH -

FROM REF. 1, PG. 19, THE RESULTING FORCES ALONG THE LENGTH OF THE WELD ARE SHOWN. THESE FORCES AVERAGED ALONG THE LENGTH YIELD -

(SEGMENT LENGTH ↓)

$$\frac{2.2''(273,160 + 2(87,585) + 2(50,940) + 2(29,920) + 2(16,360) + 10,7\ldots)}{5(2.2'')\ (2)}$$

(TOTAL LENGTH ↑)

$$= P_{X_{AVE}} = \frac{2.2}{(2)11.0}[653,480] = 65,348\ \#/\text{SEGMENT}$$

2) AVERAGE FORCE IN WELD IN UPWARD DIRECTION -

FROM REF. 1, PG. 20, THE RESULTING FORCES IN THE UPWARD DIRECTION ARE SHOWN. THESE FORCES AVERAGED ALONG THE LENGTH OF THE WELD YIELD -

$$\frac{2.2(180,050 + 2(89,790) + 2(58,250) + 2(40,000) + 2(26,760) + 9,690)}{5(2.2)\ (2)}$$

$$= P_{Y_{AVE}} = \frac{2.2}{2(11)}[619,340] = 61,934\ \#/\text{SEGMENT}$$

3) RESULTANT SHEAR LOAD ON WELD THROAT:

LOAD PER INCH OF WELD -

$P_{X_{AVE}}$ / 4.4" = 65,348 / 4.4 = 14,852 #/IN

(4.4": LENGTH OF WELD PER SEGMENT CONSIDERING WELD ON BOTH SIDES OF GUSSET THICKNESS)

$P_{Y_{AVE}}$ / 4.4" = 61,934# / 4.4" = 14,076 #/IN

RESULTANT SHEAR FORCE:

$$\Phi = \left[(14,852)^2 + (14,076)^2\right]^{1/2} = 20,462 \text{ \#/IN}$$

WELD STRESS :

$\tau = Q/A = 20{,}462/(0.707)(1.0")$

$= 28{,}939$ PSI

THIS IS LESS THAN THE ALLOWABLE SHEAR STRESS OF 35,280 PSI (FROM SHEET 4); THEREFORE, THE 1" FILLET WELD (WG-194) IS ACCEPTABLE FOR THE PHASE II ACP LOADS.

REFERENCES

1) B+W CALCULATIONAL DOCUMENT # 32-1119695-00 "OTSG SUPPORT-WELD STRESS ANALYSIS, PHASE II", BY D. E THOREN, DATED 6-13-80.

2) STRESS REPORT FOR STEAM GENERATOR, REPORT #12, "STRESS ANALYSIS OF STEAM GENERATOR SUPPORT SKIRT + ATTACHMENTS FOR MECHANICAL LOADS", B+W CONTRACT 620-0014-55.

3) STRESS REPORT FOR STEAM GENERATOR, REPORT # 3 "STRESS ANALYSIS OF SUPPORT SKIRT", B+W CONTRACT 620-0014-55, PAGE B-6-5.

4) ASME CODE, SECTION III, 1977 EDITION, APPENDICES.

5) ASSUMPTIONS, METHODOLOGY, AND ACCEPTANCE CRITERIA REPORT FOR ASYMMETRIC LOCA LOADS EVALUATION, PHASE II, BAW-1538, REV. 1, APRIL 1979.

6) "LIST OF MATERIAL, STEAM GENERATOR, SHEET # 2", B+W DRAWING # 151925 E, REV. 8.

7) "ASSEMBLY AND DETAIL OF SUPPORT SKIRT", B+W DRAWING # 151930 E, REV. 9.

3.41. Supply justification that all of the 177-FA skirt-supported plants are hydrodynamically equivalent. Also include a list of differences, if any. (Section 2, Appendix C)

Response

The 177-FA skirt-supported plants have internals that are dimensionally identical except for manufacturing tolerances. Historically, the 177-FA skirt-supported plants have been grouped into a single generic category as shown in BAW-10103, Rev 1[4], sections 1.2 and 3; and BAW-10104, Rev 1[5], section 4.1 and Table 1-1. The responses to questions 2.10, 2.18, and 3.32 provide additional qualifications that these plants are hydrodynamically equivalent.

3.42. Is the hydrodynamic mass matrix changed as the annulus changes size during the dynamic analysis? What experimental/analytical correlations exist for using this technique for this type of analysis? Have benchmark cases been completed? Enclose the results of these analyses. (Section 3.3, Appendix D)

Response

The hydrodynamic mass matrix was assumed to be constant as the annulus changes size. The justification to this assumption is that by design, the reactor core will not deflect more than 1/4 inch during a LOCA, in an annular gap width of about 10 inches. The change in nodal volume is therefore negligible, resulting in a hydrodynamic mass matrix that is more or less constant as the core moves.

B&W has conducted extensive analytical and experimental studies to verify the hydrodynamic mass approach to steady-state vibration analysis of coupled fluid-shell systems. The results of these benchmark studies were presented to the NRC and EG&G on March 14, 1979. B. F. Saffell and R. W. Macek from EG&G represented the NRC as consultants at this presentation. Three NRC staff members were also present for all parts of this presentation.

Reference 29, sections 3, 4, 5, and 6 and Appendix A discuss benchmark studies, including experimental tests.

3.43. Describe in detail how the core bounce results are used in the system dynamic analysis. (Section 5.2.2)

Response

The core bounce analysis is a vertical dynamic analysis of the internals for LOCA. The model includes a vertical representation of the core support cylinder, lower grid, fuel assemblies, upper grid, plenum cylinder, column weldments, and plenum cover. The internals are supported vertically from the reactor vessel ledge via the plenum cover, and the core support cylinder and fixed boundary conditions at the RV ledge terminate the core bounce model. This analysis includes the linear internals along with the nonlinear effects of the fuel assemblies and their movement between the upper and lower grids.

For the core bounce analysis the internal pressures during the LOCA transient are integrated over the vertical area of each part of the internals, producing force time histories. These time histories are then applied to the structures and the response recorded. The total resulting force at the reactor vessel ledge is applied to the reactor vessel isolated model.

For the reactor vessel isolated model, the internal pressures are integrated over the vertical area of the reactor vessel to create a force time history. This time history is applied to the reactor vessel in the vertical direction along with core bounce time history at the reactor vessel flange. Thus, the reactor vessel sees the total integrated vertical pressure force from the internals and the force caused by the differential pressure in the upper and lower vessel heads integrated over the vertical surface area of the heads along with the dynamic response of the internals.

The vertical displacement response of the reactor vessel in the isolated model feeds back into the internals (linear components). This feedback loop excites the mass of the internals in the vertical direction causing a time history response. This time history response (caused by vertical vessel displacement) can be time-phased with the linear structural response in core bounce.

The method of analysis described above allows necessary detail in the nonlinear core bounce while permitting the analysis to be performed in reasonable computer time. If the linear and the nonlinear are combined, the computer time is extensive, and study of separate effects is questionable.

3.44. Supply the following (Appendix E):

a. Boundary conditions used in the analyses.
b. Expanded mathematical model description.
c. Detailed discussion of the applied loads.

Response

The finite element skirt model included the lower end of the reactor vessel and was built to determine stiffness values for the skirt and to evaluate the load-carrying capability of the support.

In the stiffness study the base of the skirt was fixed by fixing the flange base at each bolt location for the tension side of the skirt. At the same time the compression side of the skirt was fixed at the base of the flange. The flange was also fixed horizontally to shear.

A force was applied, and the resultant deflection and rotation were used to calculate the flexibility terms. A moment was then applied, and again flexibility terms were calculated. These terms were then combined to form the skirt flexibility matrix, which was used to determine equivalent beam section properties to represent the skirt in the linear model.

The loading capability evaluations were performed using ANO-1 foundation spring rates. The individual bolt stiffness was modeled at the bolt locations, and these became active when their preload was overcome. Prior to this point the foundation stiffness (local concrete) was active for the tensile and compressive loadings. These were distributed evenly at the base of the flange. The shear stiffness of the foundation was input radially to the flange.

The model, including the boundary conditions, represented the flange and skirt geometry including the holes in the support skirt. It should be noted that the minimum skirt thickness of 2 inches was used so that the load carrying capability as well as the skirt flexibility were conservatively low and high, respectively.

The only results actually used in the analysis were the flexibilities, which were used in the beam model. The load-carrying capability evaluations confirmed that ASME Code allowables were reasonable; therefore, the code allowables were used in the final stress analysis of the skirts.

3.45. Specify and justify the value of f'_c used in the analysis. (Appendix I)

Response

The compressive strength f'_c of concrete used for the cavity wall analysis is given in Table 3.45-1. For the linear analysis, the 28-day minimum specified strength was used and is conservative. For the nonlinear analysis of the TMI-1 cavity wall, the 90-day strength was used as a more realistic value of f'_c (see section 6.2.14 of reference 2 for further discussions).

Table 3.45-1. Concrete Compressive Strength for Cavity Walls

Plant	Compressive strength f'_c, psi	Reference
Oconee	5000	Duke Power Co. Dwg O-1069A, Rev 7
TMI-1	5000[a] 6650[b]	Gilbert Assoc. Dwg D-421-019, Rev 1
TMI-2	5000	Burns & Roe Dwg 4157, Rev 8
Crystal River	5000	Gilbert Assoc. Dwg SC-421-012, Rev 5
ANO-1	5500	Bechtel Corp. Dwg C-167, Rev 6
Rancho Seco	5000	Bechtel Corp. Dwg C-309, Rev 2
Davis Besse	5000	Bechtel Corp. Dwg C-154, Rev 5

[a]Linear analysis.
[b]Nonlinear analysis.

3.46. Discuss in detail all boundary conditions. (Appendix I)

Response

Oconee Cavity Wall (Figure I-2 of reference 2)

1. The base of the model is fixed in all three directions at the cavity wall/pedestal intersection because this condition gives the most conservative base reactions. For a cylindrical structure, the edge boundary conditions have limited effects on the primary stresses for pressure loads.

2. The edges of the fuel canal slab and fuel canal walls are fixed in all directions at the interface with the secondary shield walls. The effects of the stiffnesses of the secondary shield walls on the primary cavity shield wall are not significant.

3. The core flood tank walls are modeled with equivalent trusses in three directions. The stiffness of these trusses was taken as the lower bound values, so that more loads were carried by the cavity wall.

4. At the line of structural symmetry (through the hot legs), the displacements normal to the plane of the symmetry are fixed for the symmetric load analysis (symmetric boundary conditions), and the displacements parallel to the plane of symmetry are fixed for the asymmetric load analysis (asymmetric boundary condition).

TMI-1 Axisymmetric Cavity Wall Nonlinear Analysis Model (Figure I-3 of reference 2)

1. At the pedestal/liner plate interface, only the vertical displacements are restrained. At the outside face of the pedestal base, equivalent springs are modeled to account for the base concrete slab extending outward above the liner plate to the edge of the containment building.

2. At the junction of the fuel canal slab, equivalent springs are used to account for the fuel canal slab and walls. These springs are lower bound values and were calculated from detailed finite element models.

TMI-1 Fuel Canal Slab Model (Figure I-4 of reference 2)

1. The fuel canal slab and walls are fixed in all three directions at the interface with the secondary shield walls.

2. A symmetric boundary condition is used at the line of symmetry.

TMI-2 Cavity Wall Model (Figure I-5 of reference 2)

1. The base of the model is fixed in all directions at the cavity wall/pedestal interface.

2. The stiffness of the secondary shield wall is modeled by equivalent truss elements in three directions at the interface with the fuel canal slab and walls.

3. The core flood tank walls are represented by equivalent truss elements in three directions.

4. Appropriate symmetric or asymmetric boundary conditions are used at the line of symmetry.

CR-3 Cavity Wall Model (Figures I-6 and I-7 of reference 2

1. The model base is fixed in all directions at the cavity wall/pedestal interface.

2. The fuel canal slab and walls are fixed in all directions at the secondary shield wall interfaces.

ANO-1 Cavity Wall Model (Figure I-8 of reference 2)

1. The model base is fixed in all three directions at the cavity wall/pedestal interface.

2. There is an elastomer between the fuel canal floor and the top of the cavity wall. The top of the cavity wall was modeled as free to displace in all directions.

3. Appropriate symmetric or asymmetric boundary conditions are used at the line of symmetry.

Rancho Seco Cavity Wall Model (Figure I-9 of reference 2)

1. The model base is fixed in all three directions at the cavity wall/pedestal interface.

2. The edges of the fuel canal slab and walls are fixed at the secondary shield wall interfaces.

3. Appropriate symmetric or asymmetric boundary conditions are used at the line of structural symmetry.

Davis Besse Cavity Wall Model (Figure I-10 of reference 2)

1. The model base is fixed in all three directions at the cavity wall/pedestal interface.

2. The stiffness of the secondary shield wall is modeled with equivalent springs in three directions at the interface with the fuel canal slab.

3. The boundary of the core flood wall is fixed in the strong direction and modeled with equivalent springs in the weak direction of the secondary shield wall.

4. The boundary of the fuel canal wall is fixed in the strong direction and free in the weak direction of the secondary shield wall.

5. Symmetric boundary conditions were used at the model edges for hot leg break analyses.

3.47. Define the applied loadings, including application points. (Appendix I)

Response

The pressure load developed in the cavity was applied to the inner surfaces and penetrations of each cavity wall using the pressure load option of EDS-SNAP. Typical pressure functions and the element surfaces where these functions are applied are shown in Figure 3.47-1. Forty-six pressure functions and 60 pressure element surfaces are used in this example. Detailed descriptions of the actual pressure-time histories used in the analysis are given in Appendix B.

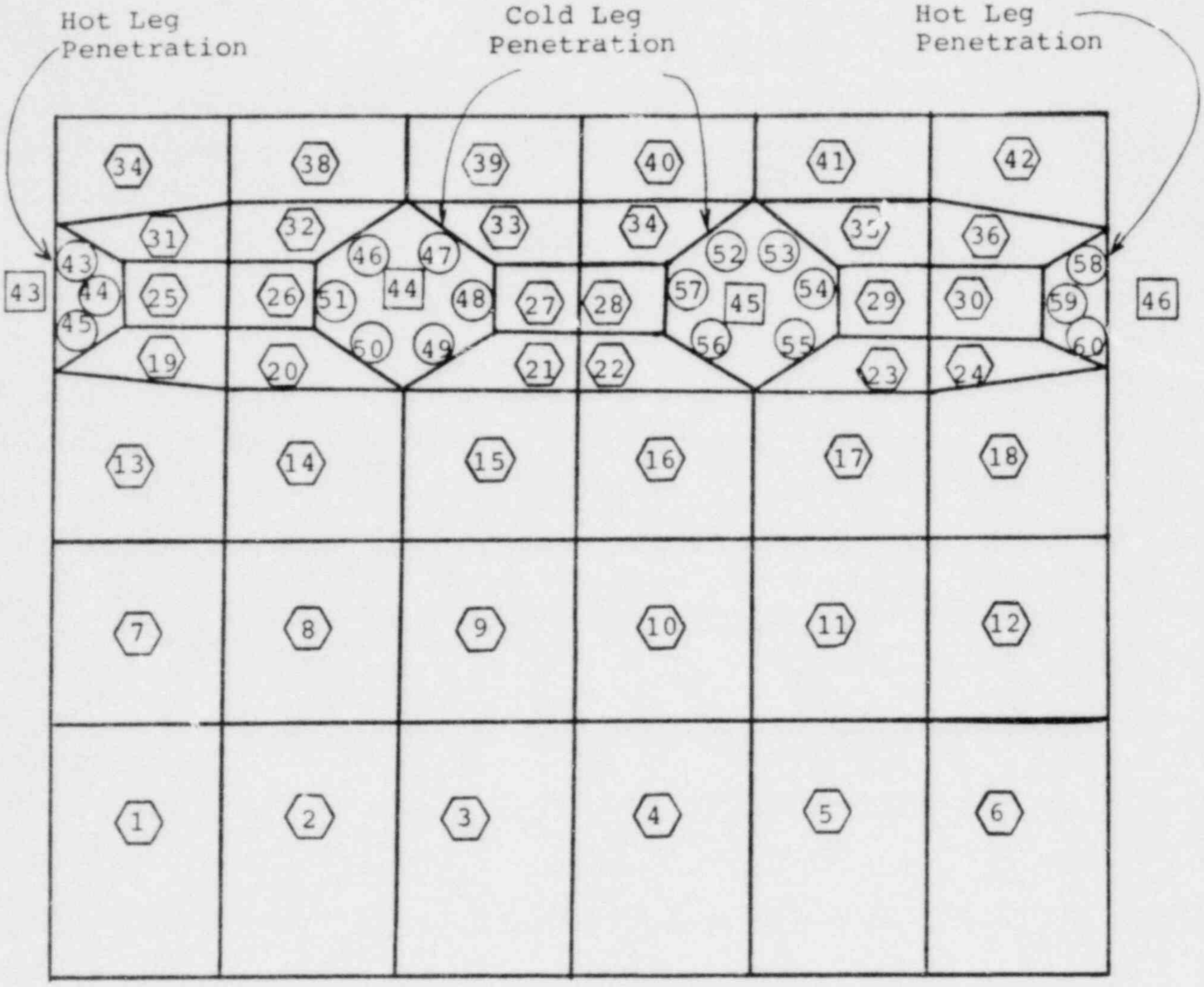
EDS-SNAP element pressures are developed from CRAFT2[1] pressures as follows: the pressures are weighted with respect to the surface areas of the EDS-SNAP elements and CRAFT2 volumes so that the net loads on the cavity walls are maintained. The pressures are taken as constant over the elements since the pressure gradients at a time are small, and also as the EDS-SNAP elements are typically smaller than CRAFT2 elements. Where EDS-SNAP element surfaces are larger than corresponding CRAFT2 volumes, pressures from the CRAFT2 volumes are extended to conservatively apply pressure to the total EDS-SNAP element surface. Figure 3.47-2 shows EDS-SNAP pressure surfaces and the corresponding CRAFT2 pressure volumes.

The data in Appendix B are divided into four sections:

1. Input to program MAP.
2. CRAFT2 volume pressure data.
3. EDS-SNAP element pressure-time histories.
4. Integrated net thrust load on total cavity wall.

For example, in section 3, EDS-SNAP pressure-time history 30 is for the EDS-SNAP element adjacent to the hot leg penetration where a 2.0A break occurs. The time history is given from time 0.0000 to 1.9996 seconds. This pressure-time history is applied over the entire exposed surface area of the EDS-SNAP element.

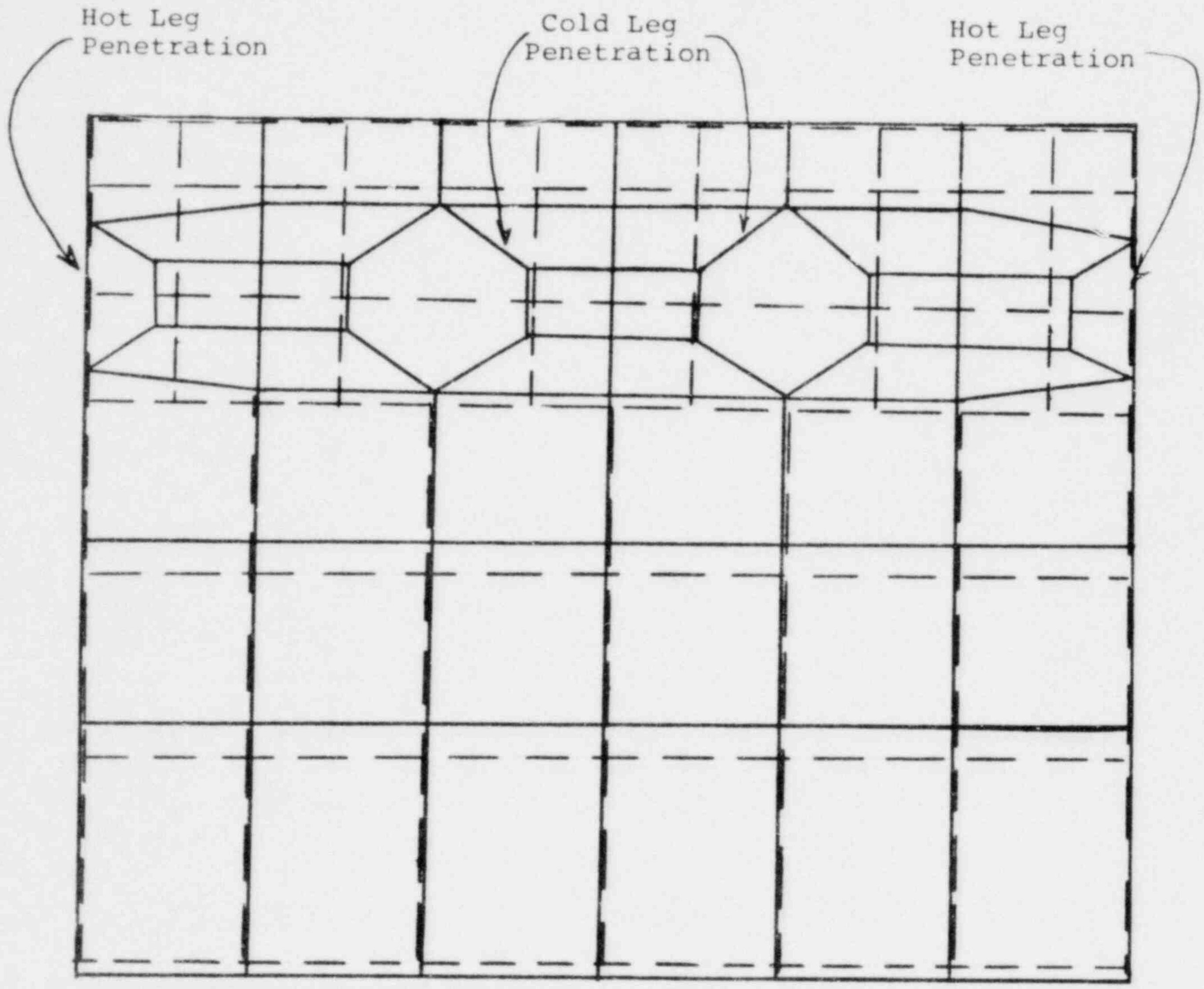
Figure 3.47-1. TMI-2 Pressure Surfaces and Functions



Symbol	Count	Meaning
hexagon, circle	60	Pressure Surfaces
hexagon, square	46	Pressure Functions

Note: This figure is an expanded view of the inside surfaces of the 180° TMI-2 cavity wall model.

Figure 3.47-2. TMI-2 Pressure Surfaces and Volumes



Solid Lines - EDS-SNAP Pressure Surfaces
Dotted Lines - CRAFT2 Pressure Volumes

Note: This figure is an expanded view of the inside surfaces of the 180° TMI-2 cavity wall model.

3.48. Discuss in detail the procedure used for handling asymmetric loadings. (Appendix I)

Response

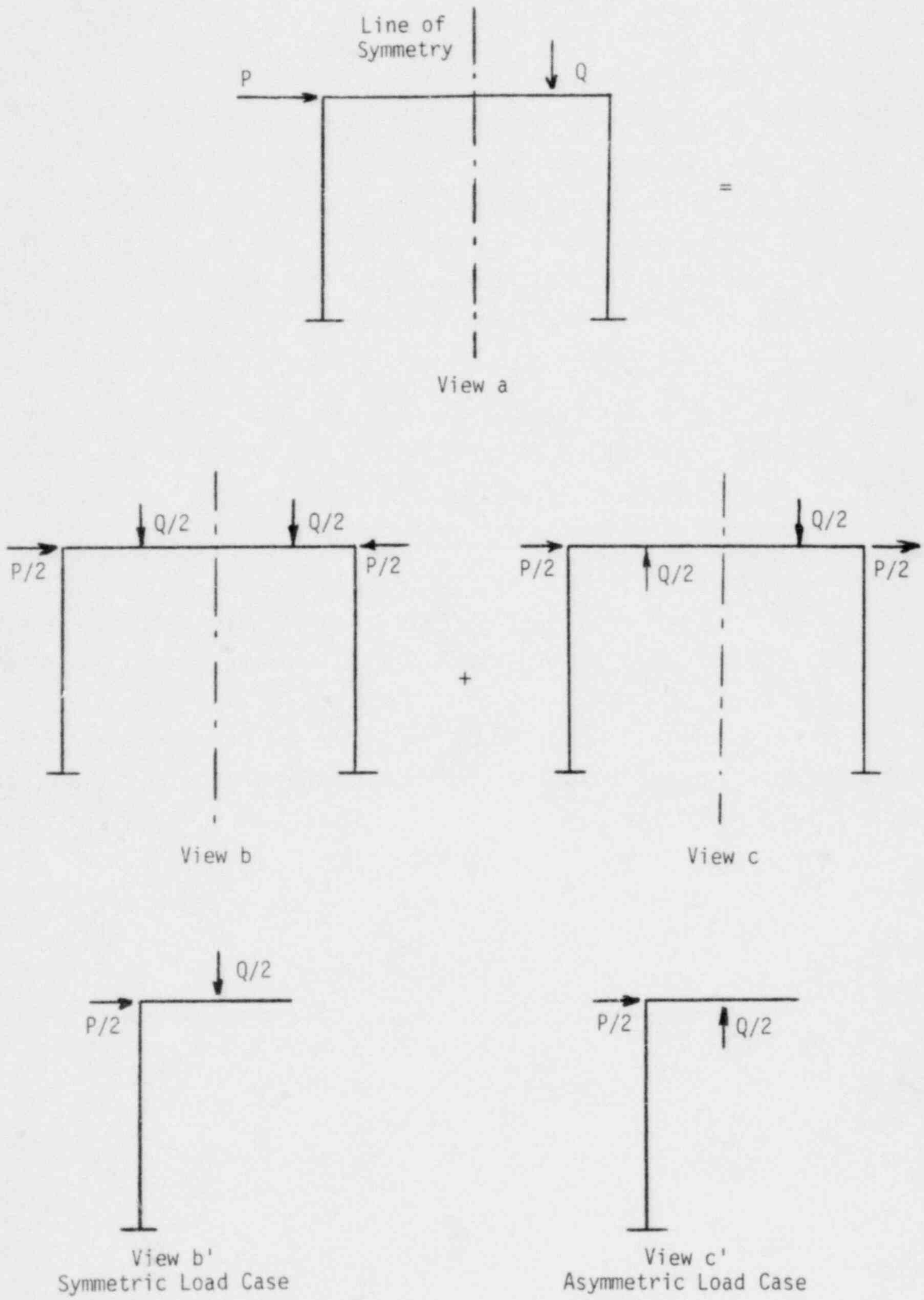
For a structure with structural symmetry, we can decompose any arbitrary loads with symmetric and asymmetric values and analyze only half of the structure.

For example, consider a simple, two-dimensional frame as shown in Figure 3.48-1, View a. The structure has a line of symmetry as indicated by the dashed line. Arbitrary loads P and Q are applied to the structure. The loads are divided into symmetric and asymmetric loads as shown in Views b and c. These load cases can then be analyzed with half of the structure as indicated in Views b' and c'.

In applying this procedure to the cavity wall analysis, the pressure data for a full 360° model was first developed. The analyses were then performed with symmetric and asymmetric loads using one half of the cavity wall. The final results were obtained by combining these separate analyses.

Specifically, for the hot leg break case analyses, the structural and pressure loads are both symmetric. Hence, only one symmetric structure analysis was performed. For the cold leg break case analyses, the structure is symmetric about the hot leg centerline, but the loads are not. Thus, two analyses were performed, one with the symmetric portion of the cold leg pressures and one with the asymmetric portion. The results from these two analyses were then combined to give the exact stress state at all locations in the cavity wall.

Figure 3.48-1. Two-Dimensional Frame



3.49. Is using isotropic properties conservative for loads other than in the hoop direction? (Appendix I, Section 2)

Response

When static analyses of the cavity walls were performed, the orthotropic analysis gave lower hoop stresses and higher bending stresses than the isotropic analysis. Thus, using isotropic properties is not conservative for bending loads at the cavity wall/pedestal interface.

The primary load-carrying mechanism of the cavity walls is hoop tension. Using isotropic properties for the analysis predicts upper bound hoop loads. If the hoop steel can take these loads, without yielding, then the cavity wall is able to withstand the LOCA event. Therefore, we did not perform further analyses using a cracked concrete orthotropic material law.

However, if we found some hoop steel yielding from isotropic analysis results, we reran the analysis using an orthotropic material law to model the cracking of concrete. Bending moments at the cavity wall/pedestal interface in the orthotropic analysis were higher than those in the isotropic analysis. These effects are localized to the base of the cavity wall. Bending moments are carried by vertical steel in the cavity wall.

3.50. In light of the fuel canal slab strength reduction, discuss bending and strength at discontinuities and boundaries. (Section 3.1, Appendix I)

Response

The fuel canal slab reduction assumption for the Oconee cavity wall was adopted in the analysis to conservatively predict hoop stress in the wall.

The primary mode of cavity wall resistance to the pressure load is through hoop tension. The fuel canal slab restrains radial expansion and thereby causes lower hoop stresses than might otherwise occur. Thus, by making the fuel canal slab weak in comparison to the pedestal, a larger portion of the load is carried by hoop steel. As the hoop steel carries this load, below yield stress, this modeling assumption results in a conservative load-carrying capacity analysis of the cavity wall.

As can be seen in Tables 10.10-1 and 10.10-2 of reference 2, the shear and bending stress ratios are low: they are not expected to be excessive if the analysis was performed with the fuel canal slab at full strength. The steady-state isotropic analysis of the cavity wall with reduced slab stiffness, however, gave an upper bound prediction of the hoop stresses. This ensures the functional adequacy of the cavity wall even if there should be local yielding at the boundary interfaces due to excessive moments.

3.51. What effect does the water mass have on impact values? (Appendix J, Section 1)

Response

In developing the STARS model of the fuel assembly, the water mass was added to the fuel assembly node masses. This increase in the fuel assembly mass due to water mass tends to reduce the fuel assembly frequencies and increase the fuel assembly impact loads. This is conservative assumption since it yields higher loads on the fuel assembly components.

3.52. Are grid-to-grid-to-baffle and grid-to-baffle impact stiffnesses verified? Supply the details. (Appendix J, Section 1)

Response

Yes. The grid-to-grid-to-baffle and grid-to-baffle impact stiffnesses are verified by testing.

The single spacer grid testing as shown in Figure 3.52-1 shows the test configuration to determine the spacer grid stiffness, elastic impact load, and damping ratio. This test configuration simulates the grid-to-baffle impact because the spacer grid with loaded rods is impacted against a very stiff impact surface.

Double spacer grid testing was also performed to determine the stiffness for a grid-to-grid-to-baffle impact. Both possible configurations were tested as shown in Figures 3.52-2 and 3.52-3 to simulate such impacts. Test results indicated that the spacer grid properties, such as stiffness, elastic impact load limit, and damping ratio, do not change for both these configurations from those obtained from the single spacer grid testing. Therefore, the spacer grid properties from single spacer grid testing are used for both types of impacts.

Figure 3.52-1. Single Grid Impact

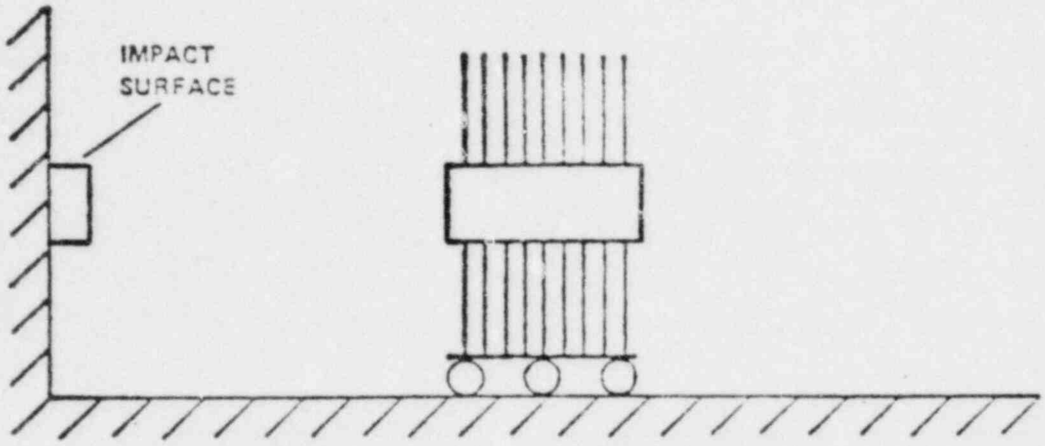


Figure 3.52-2. Double Grid Impact Configuration 1

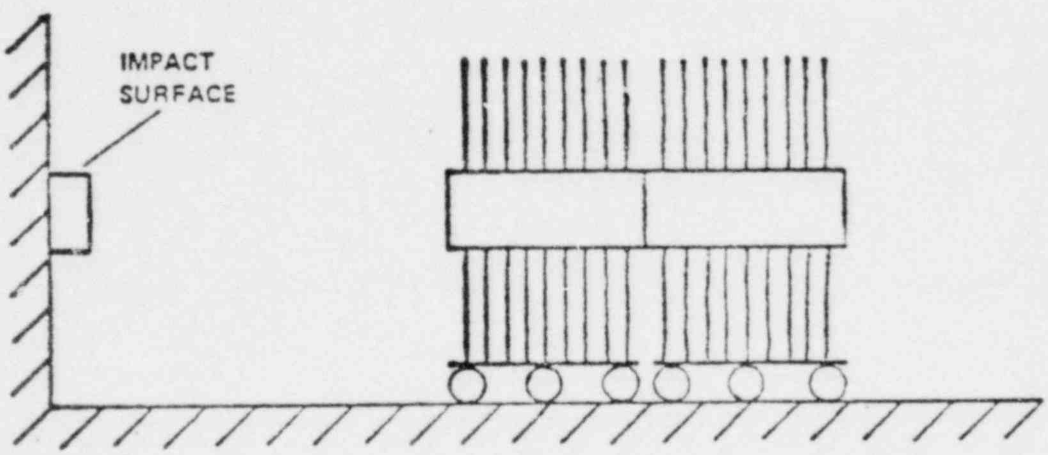
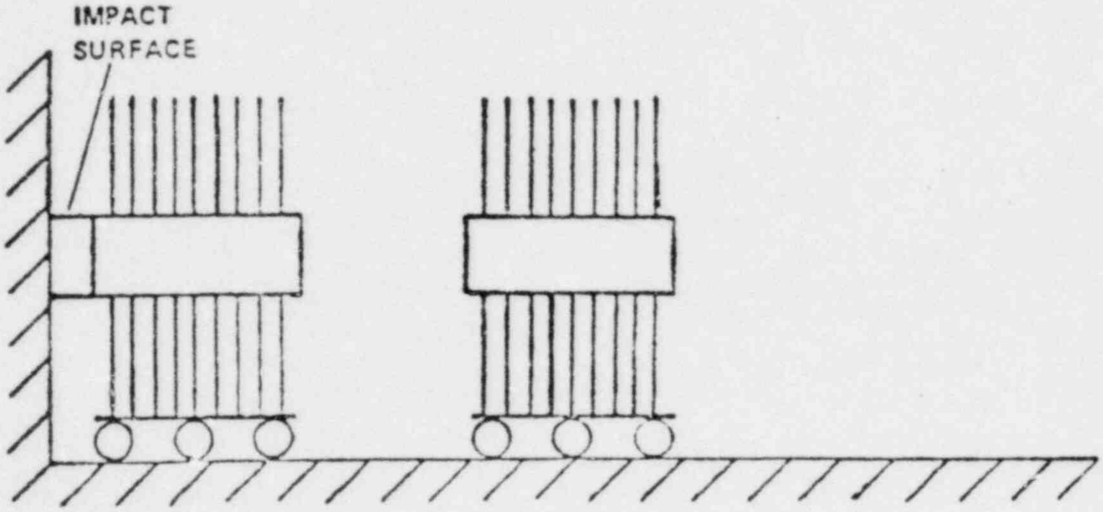


Figure 3.52-3. Double Grid Impact Configuration 2



3.53. Supply the following information: (Appendix K)

a. Detailed math models
   1. Nodalization
   2. Applied Force Locations

b. Model boundary conditions

Response

Four embedment models were used. Clarification on the nodalization, applied force locations, and boundary conditions for three of these models is provided in this response. The fourth, the nonlinear embedment model, is of relatively simple configuration and is fully described in section 2.3, Appendix K, of reference 2.

1. Generic Embedment Model

The generic embedment model is shown in Figures 3.53-1 and 3.53-2. The nodalization shown in Figure 3.53-1 was maintained for all analyses performed using this model, with the dimensions adjusted to match specific embedments.

The overturning moment and vertical force induced by the LOCA were applied at the top of the skirt, which was constrained to remain plane and circular. The lateral force was similarly applied to the top of the skirt. The distribution of the applied lateral force was consistent with the shear distribution that would exist in a cylinder under flexure; it should be noted, however, that the analysis is insensitive to this assumed distribution. The prestress in the anchor bolts was modeled by including a preload in the appropriate truss elements. The reactions from the cavity wall were applied as concentrated nodal forces to the nodes corresponding to the edges of the wall.

Two sets of boundary conditions were applied. As noted, the top of the skirt was constrained to remain plane and circular in recognition of the stiffness of the reactor vessel to which it is fixed. At the basemat level, vertical springs were included to model the flexibility of the mat.

2. Axisymmetric Embedment Model

The axisymmetric embedment model, complete with nodalization, is shown in Figure 3.53-3. For analysis of its response to an overturning moment a point force, V, was applied as shown. This force was prescribed to vary linearly with its normal distance to the reactor vessel centerline, using the harmonic loading option available in ANSYS. For analysis of its response to a lateral force a horizontal force, H, was applied as shown. The distribution of this force about the embedment circumference was approximately that which would correspond to the shear distribution in a cylinder under flexure.

The boundary conditions imposed at the soffit of the basemat are described in full in section 2.2, Appendix K.[2] Boundary conditions appropriate to the axisymmetry of the model were applied to the basemat at the reactor vessel centerline. At the interface between the reactor vessel support skirt and the embedment (corresponding to the point of application of the vertical force in Figure 3.53-3), the rigidity of the skirt was included by prescribing that the interface remain plane. No restraint was imposed in the horizontal plane, however.

3. Embedment Substructure Model

The embedment substructure model is shown in Figures 3.53-4 and 3.53-5. This nodalization was maintained with the dimensions of the model varied to match specific embedments.

The vertical force induced by the overturning moment was applied to node 81 (see Figure 3.53-5). The beam representing the flange and sole plate distributed this load into the underlying concrete. Where shear anchors were present, the radial lateral force induced by the LOCA was included as point forces at the nodes corresponding to the shear anchor elevation. These point forces were in the direction of the applied load. Where shear anchors were not included, the lateral force was input in two parts: as distributed point forces on the concrete nodes beneath the sole plate to account for the friction, and as radial forces at node 125 to account for the load transferred to the vertical bearing plate via the sole plate. The cavity wall reactions were modeled as point forces at the three nodes on the top of the cavity wall stub.

The nodes on the underside of the pedestal were fixed.

Figure 3.53-1. Generic Embedment Model

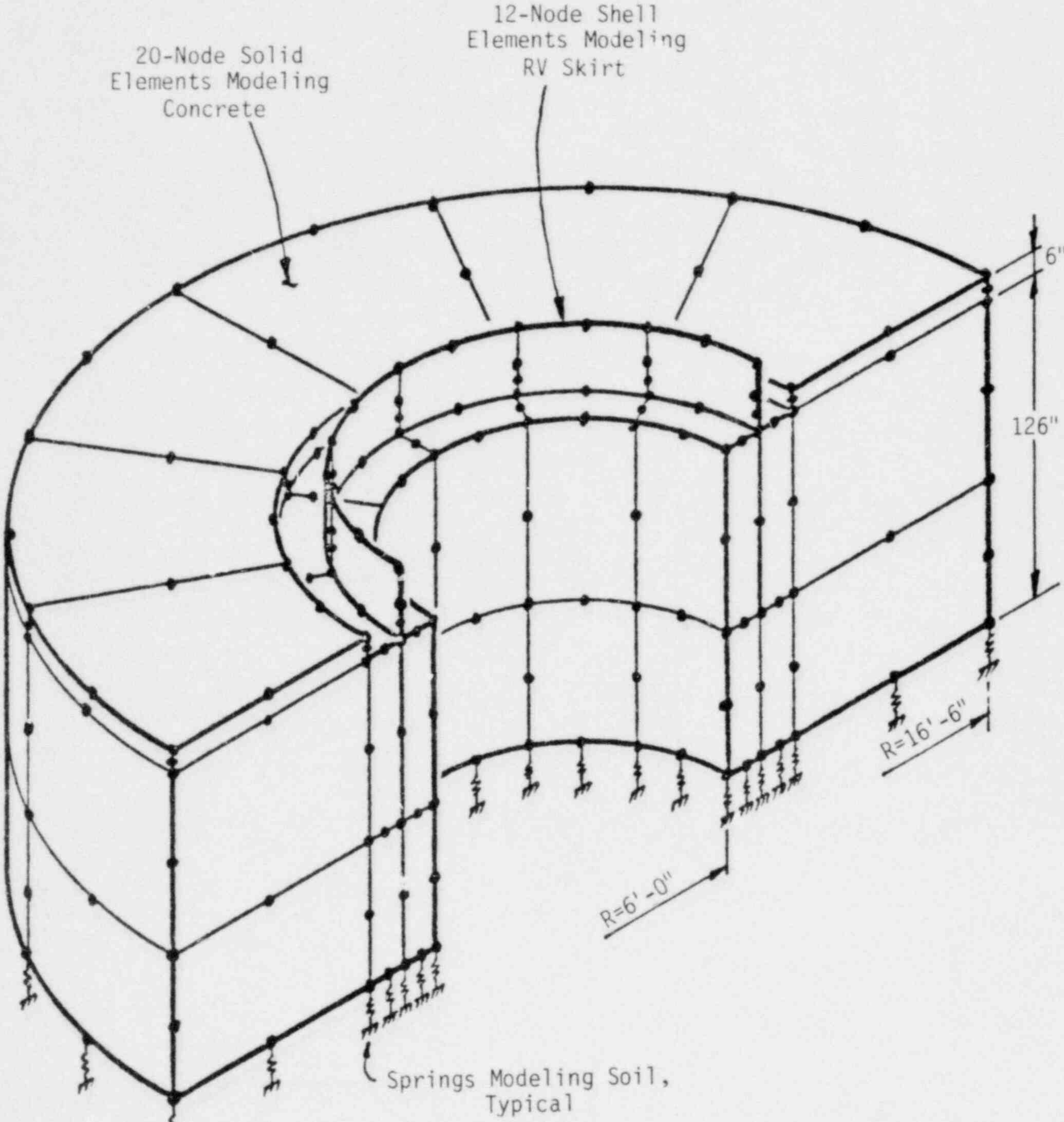
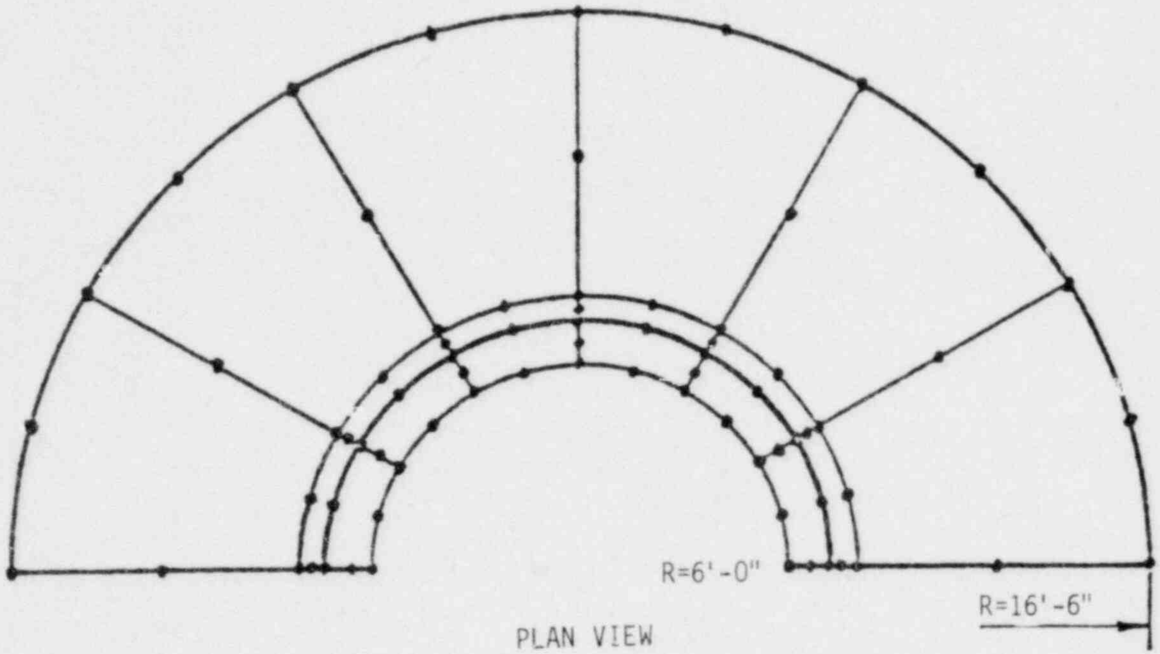


Figure 3.53-2. Generic Embedment Model Sections



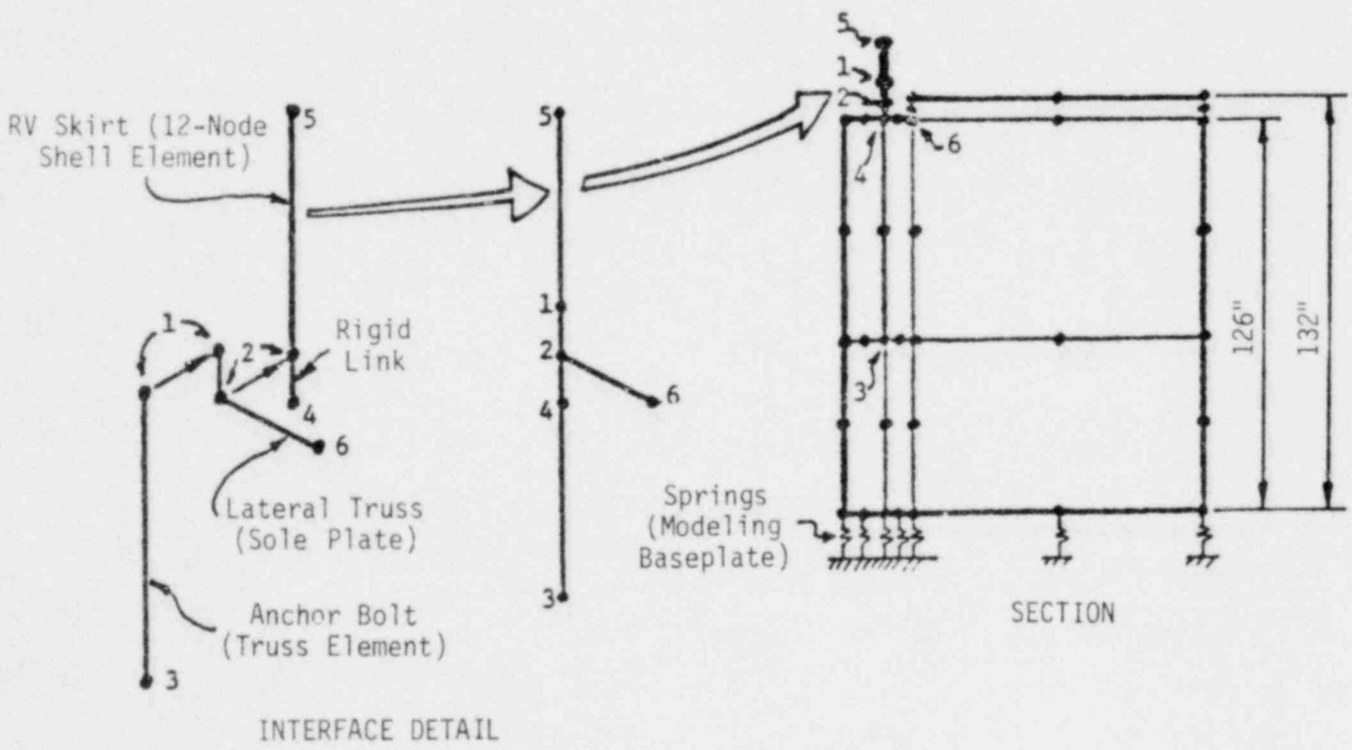


Figure 3.53-3. Axisymmetric Model of Embedment

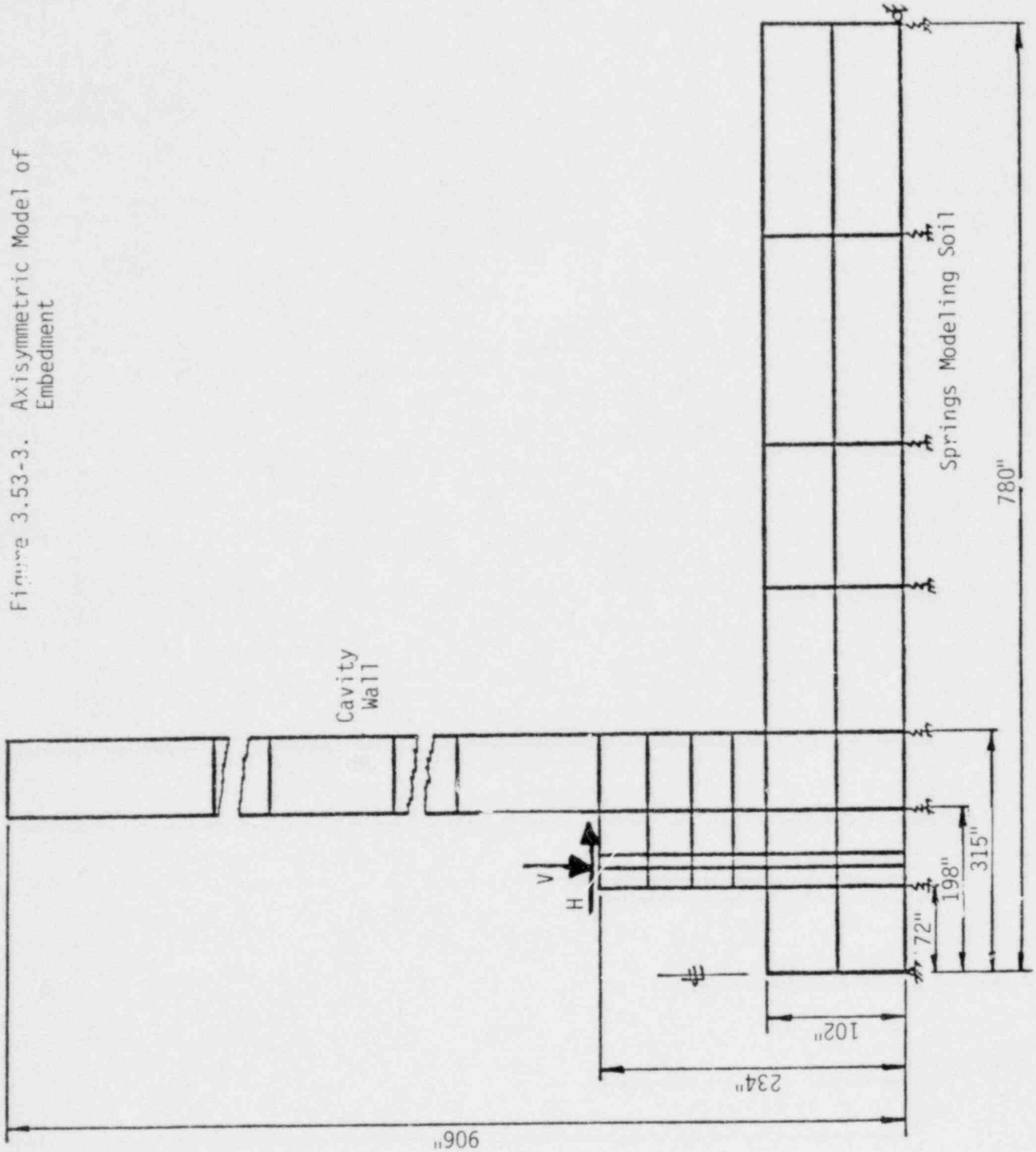
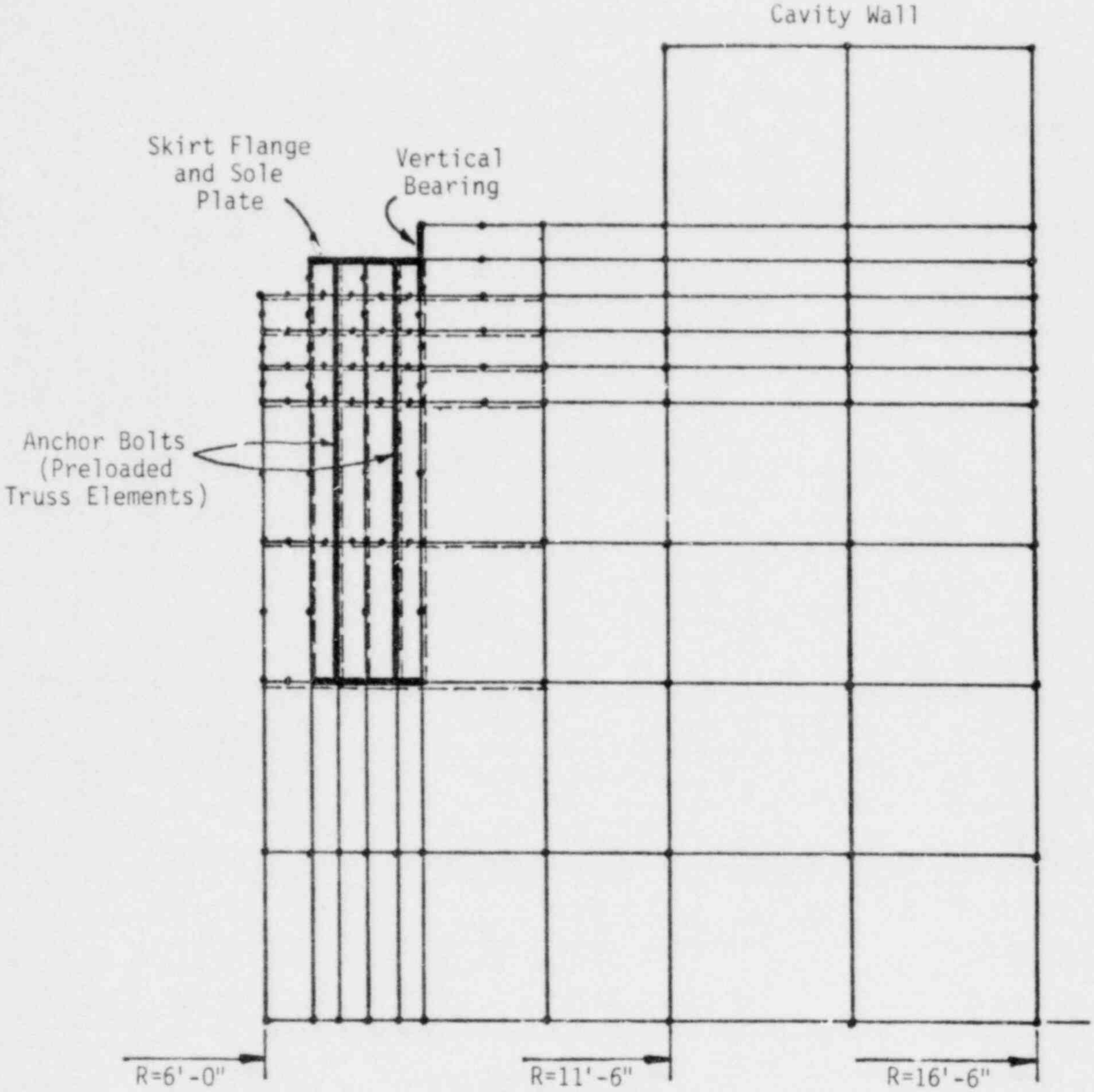
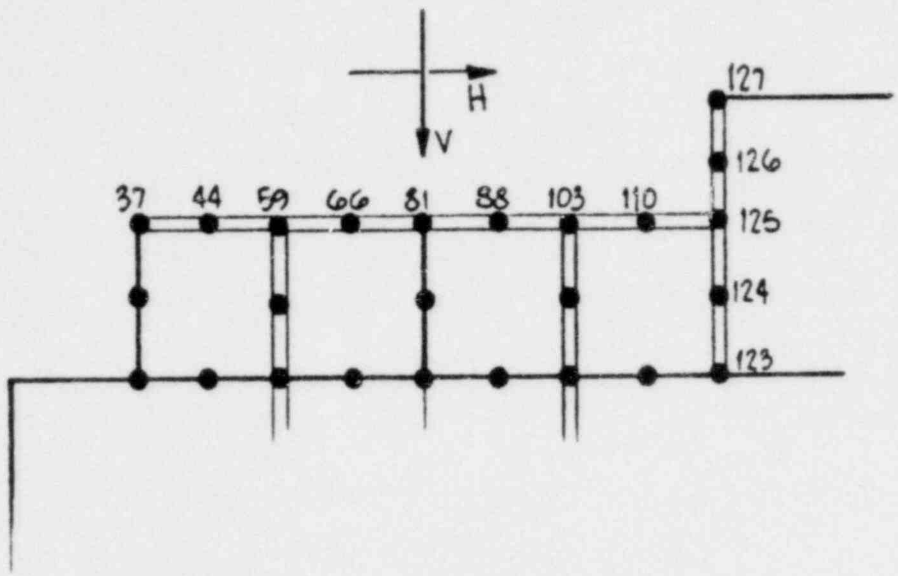


Figure 3.53-4. Embedment Substructure Model



Note: Dashed lines show reinforcing steel that was modeled.

Figure 3.53-5. Embedment Substructure Model Detail



3.54. Describe the differences between various plants. (Section 2.5, Appendix K)

Response

Owing to the standard support skirt and reactor vessel configurations, there are no major differences between the reactor vessel support embedments for the skirt-supported plants. Minor variations in dimensions, details, and material properties are shown in Table 3.54-1. These are summarized below.

1. Overall Dimensions

The depths of the reinforced concrete pedestals vary little, while their internal and external radii are constant. The depths of the basemats beneath the pedestals vary from 96 to 150 inches, but this will have no significant effect on the stiffness or strength of the pedestals.

2. Connection of Skirt to Pedestal

The reactor vessel support skirt flange bears on a steel sole plate and against a circular vertical bearing plate, as shown in Figure K-2 of reference 2.

The dimensions of the skirt flanges do not change from plant to plant. The dimensions of the sole plates and the vertical bearing plates do change by relatively small amounts, and this was reflected in the plant-specific qualification. Details of the connections between the flange and the sole plate, the flange and the bearing plate, and the sole plate and the bearing plate also vary slightly, but this does not lead to significant variation among the responses of the various plants.

Three plants — Crystal River, Three Mile Island 1, and Three Mile Island 2 — have shear anchors beneath the sole plate. This was considered in the analysis of these plants were appropriate.

3. Anchor Bolts

All anchor bolts are of 2-1/2-inch diameter with the exception of those for Oconee, which are of 2-inch diameter. The lengths of the anchor bolts vary from 65 to 109 inches. The prestress in the anchor bolts is (the least) 147 kips/bolt for Rancho Seco and (the most) 232 kips/bolt for the two Three Mile Island plants. The bolt strengths are relatively similar, with the exception of that for Rancho Seco, which is approximately 80% of the others. These variations in anchor bolt properties were considered where appropriate for both analysis and qualification.

4. Pedestal Concrete Strengths

The minimum specified design strength of the pedestal concrete was 5500 psi for Arkansas and 5000 psi for the remaining plants. The 90-day strengths, which were used for qualification, varied from a low of 5500 psi for Arkansas to a high of 7455 psi for Three Mile Island 2. This variation in strengths had a direct impact on the qualification of the embedments.

5. Openings in Pedestal

Variations between the plants in the orientation, size, and detailing of the incore instrumentation tunnels and access hatches are minor.

6. Reinforcement

The pedestals of all the plants have different quantities and layouts of reinforcement. While all are well reinforced, those at Three Mile Island 1 and Crystal River are particularly strong. The Arkansas and Rancho Seco pedestals are the least reinforced, with the latter plant relying less on specific shear reinforcement.

In the Oconee and Arkansas plants, the reinforcement continuity is maintained across the liner plate beneath the pedestals. It is not on the remaining plants.

These variations were all taken into account for qualification. They have no effect on stiffness.

Table 3.54-1. Embedment Properties for Skirt-Supported Plants

	ANO-1	Oconee	CR-3	TMI-1	TMI-2	Rancho Seco
Overall Dimensions, in.						
Pedestal depth	126	126	132	132	132	126
Basemat depth	108	102	150	108	138	96
Skirt/Pedestal Connection						
Sole plate width, in.	21	18	20	20	26	20
Sole plate thickness, in.	4	2.25	3.25	3.25	3.25	4
Vertical plate height, in.	11	12	12	12	12	7
Vertical plate thickness, in.	3	2	2.5	2.5	2	3
Shear anchors	No	No	Yes	Yes	Yes	No
Anchor Bolts						
Diameter, in.	2.5	2	2.5	2.5	2.5	2.5
Length, in.	65	70	92	92	92	109
Post-tension, kips/bolt	226	157	174	232	232	147
Yield strength, kips/bolt	130	130	140	130	130	105
Concrete Strength, psi						
Specified	5500	5000	5000	5000	5000	5000
90-day	5500	6355	7035	6650	7455	7275

3.55. Supply the gap dimensions. (Section 3.1.2, Appendix K)

Response

The gap dimensions for the Davis Besse 1 LOCA rings are given in Table 3.55-1. These gaps, between the pipe and the 12 shims which are located at regular angles on the inner face of each LOCA ring, apply for the hot condition. They are taken from the Bechtel Company's Davis Besse Nuclear Power Station Drawing No. C-196A, Revision 5.[26]

Table 3.55-1. Davis Besse LOCA Ring Gap Dimensions

Shim location[a]	Hot gap, in.	
	Hot leg	Cold leg
0°	0.125	0.125
30°	0.125	0.125
60°	0.125	0.125
90°	0.125	0.125
120°	0.166	0.166
150°	0.208	0.208
180°	0.250	0.250

[a]Shim location is the angle from top dead center of the pipe. Gaps are symmetric about the vertical centerline of the pipe.

3.56. Provide the basis for selecting stiffness values for the embedments from the parametric studies. (Section 4.1.1, Appendix K)

Response

The embedments of three plants were analyzed explicitly using three-dimensional finite element models. The three chosen were Rancho Seco, Oconee, and Crystal River 3. From these analyses, the parameters governing the stiffnesses of the embedments were identified. Using these parameters and the results for the Rancho Seco, Oconee, and Crystal River 3 embedments, stiffnesses (along with applicable elastic and ultimate limits) were calculated for the remaining plants.

For the rotational stiffnesses of the embedments prior to liftoff, the three plants were analyzed using the three-dimensional, generic embedment model. The pedestal depths and the anchor bolt length were identified as the governing parameters. For the rotational stiffnesses after liftoff, analyses were performed using the nonlinear embedment model. Linear response of the concrete was assumed, with the stiffnesses of the simplified concrete elements being chosen to reproduce the pre-liftoff stiffnesses determined earlier. The parameters governing the post-liftoff rotational stiffnesses were identified as the pedestal depth; the anchor bolt prestress, length, and diameter; and the pre-liftoff stiffness. Pre- and post-liftoff rotational stiffnesses for the remaining embedments were calculated accordingly.

The lateral stiffnesses of the three plants were determined from analyses using the generic embedment model. Based on the results of these analyses, pedestal depth was identified as the governing parameter, and stiffnesses for the remaining plants were determined accordingly.

The resultant variation between the rotational and lateral sitffnesses of the various plants was very small. The maximum difference was in the moments at which liftoff first occurred, and this was governed by the prestress in the anchor bolts.

Detailed descriptions of the generic and nonlinear embedment models are included in Appendix K of reference 2.

3.57. Seismic and LOCA evaluations do not exist for some of the components and piping analyzed. Provide these evaluations. (General)

Response

Seismic loadings were combined with LOCA for the evaluation of the reactor vessel supports and support embedments. Loadings and structural response data are found in sections 9 and 10 of reference 2.

As previously discussed with the staff during the Bethesda meeting on October 22, 1979, seismic loadings were not combined with LOCA in the evaluation of the remaining components, which included the fuel assemblies, control rod drives, core flood piping, primary piping, reactor internals, steam generator supports, and primary shield walls.

In combining seismic and LOCA for the vessel restraints and embedments, it was found that the influence of seismic loads on structural response was minimal when compared to LOCA. For this reason, it is judged that if seismic load were combined with LOCA for the remaining components, that no significant change in existing structural margin would result.

This is further substantiated in the application of the SRSS method for combining these loadings. When using this method, the seismic contribution to the total response has historically been very low (normally on the order of 1 to 2%). This further shows that the margins identified in section 10 of reference 2 for all components would not be significantly affected.

3.58. An evaluation of pump and steam generator supports is not provided for breaks occurring in the reactor cavity. Supply these evaluations. (General)

Response

Pump and steam generator supports were not evaluated for breaks within the primary reactor cavity.

For postulated breaks within the primary cavity, the jet impingment and cavity pressure effects on these supports would be essentially negligible because of the shielding effects of the primary cavity wall.

For this reason, postulated breaks external to the primary cavity were judged to be the design case for these supports, thereby eliminating the need to consider the postulated breaks within the primary cavity.

3.59. Some of the major system component evaluations were excluded from the evaluations for steam generator compartment pipe breaks. Provide these evaluations (include reactor internals). (General)

Response

The internals were evaluated only for the postulated breaks within the reactor subcompartment and for breaks at the first elbow outside the RV subcompartment.

For other postulated breaks within the steam generator subcompartment, there would be no significant pressures within the reactor cavity, and no asymmetric loading component could be applied to the internals through their attachment to the reactor vessel.

The same is true for all components having a support function attached directly to the reactor vessel. These include not only the internals but the reactor vessel supports and embedments, fuel assemblies, control rod drives, core flood lines, and the service support structure.

Therefore, these components were excluded from the evaluation of breaks within the steam generator subcompartment since the postulated breaks within the reactor compartment were judged to be the design case.

ANO-1 — 1. Supply reactor vessel cavity wall drawings and include a detailed discussion of the critical loads, load paths, and functional integrity of the cavity wall. Particular attention should be focused on the location of the overstressed condition.

Response

The only area that is overstressed due to a 2.0A cold leg break is that immediately below the cold leg penetration. The model of the elements surrounding the cold leg penetration is illustrated in Figures ANO-1 - 1-1 and ANO-1 — 1.2.

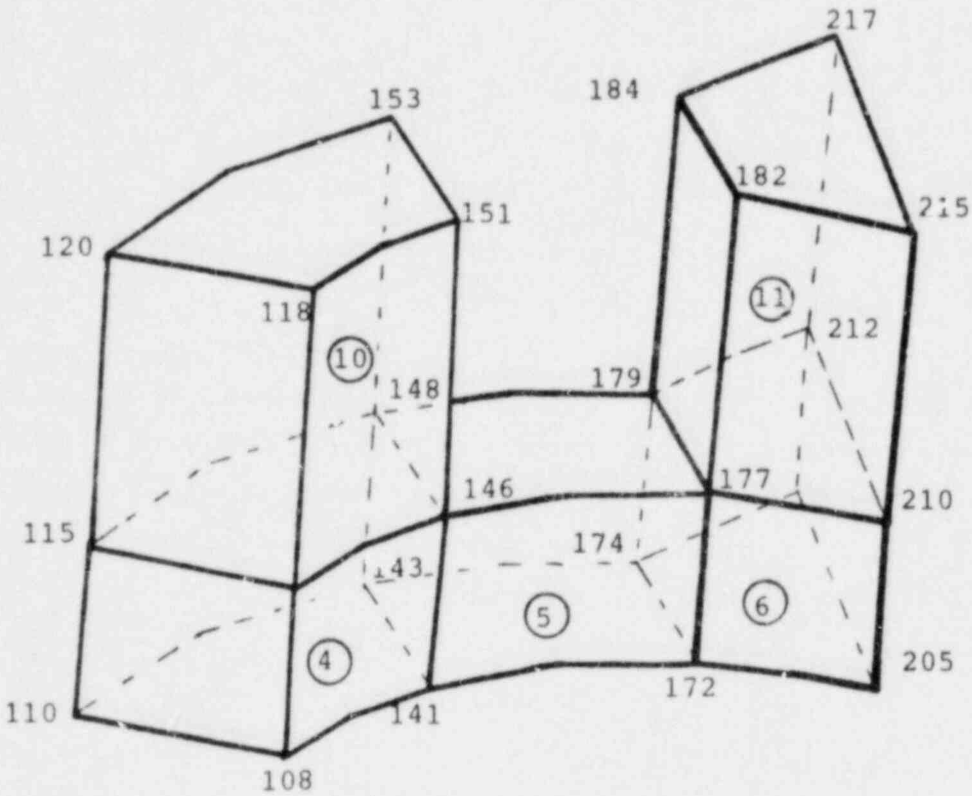
Figure ANO-1 — 1-2 shows the stress distribution on the elements surrounding the cold leg penetration. The overstress is seen to be very localized within the first element (element 5) directly below the cold leg. When the reinforcing steel yields, the load becomes distributed to the other hoop steel rebars surrounding the penetration. When the overstress in element 5 is distributed over the full height of the element, the average steel stress in that element is calculated to be 65.0 ksi. As shown in Figure ANO-1 — 1-2, the stresses on elements 4 and 6 are well below the allowable yield stress of 63 ksi. Thus, the overstress is localized to the area of element 5 and will not affect the functional integrity of the cavity wall.

Drawings of the ANO-1 cavity wall showing reinforcing steel are given as Figures ANO-1 — 1-3 and ANO-1 — 1.4 in Appendix A:

"Reactor Building Primary Shield Developed Elevation," Arkansas Nuclear One, Drawing C-169, Rev 3, Bechtal Corp.

"Reactor Building Primary Shield Reinforcing Plans," Arkansas Nuclear One, Drawing C-167, Rev 6, Bechtel Corp.

Figure ANO-1 — 1-1. Model of Elements Surrounding Cold Leg Penetration

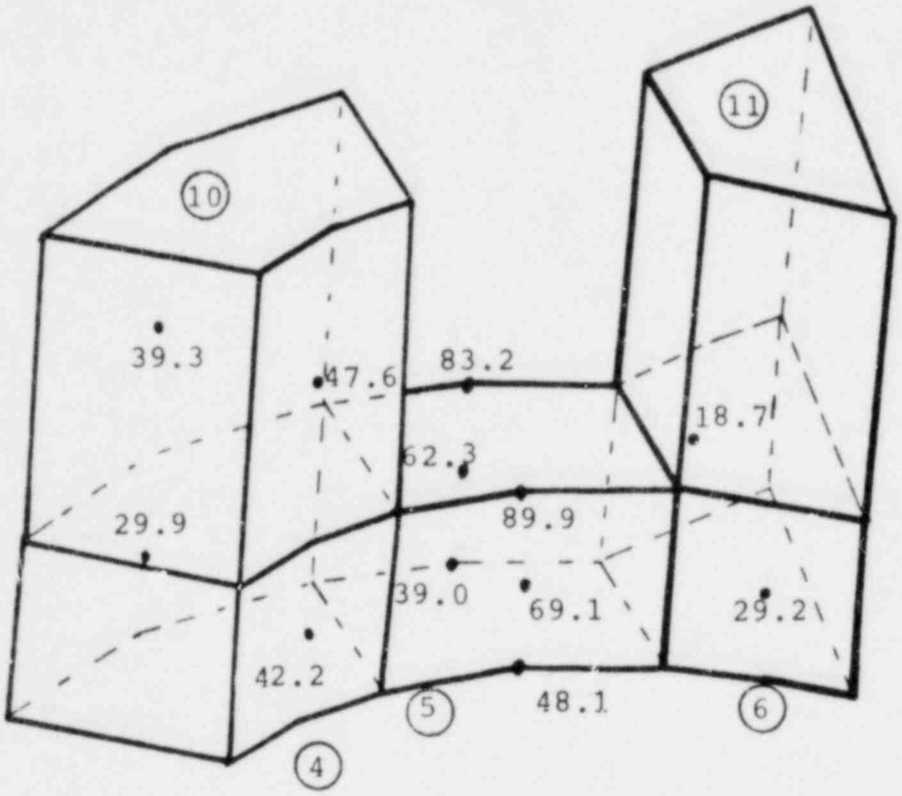


000 Corner node numbers

(00) Three-dimensional element numbers

Note: Midside node numbers not shown.

Figure ANO-1 — 1-2. Stresses on Inner and Outer Element Faces Around Cold Leg Penetration (Combined Tension and Bending Stresses, ksi)



(0) Element number

Note: Stresses on element 11 are lower than those on element 10.

Figures ANO-1 — 1-3 and ANO-1 — 1-4

(In Appendix A of this report)

ANO-1 — 2. Comment briefly on the response of restraints 2, 3, and 4 shown in Figure B-4. (Appendix B)

Response

For a hot leg guillotine break at the reactor vessel or at the first elbow, restraints 2, 3, and 4 shown in Figure B-4[2] are not impacted (also see Figure 4.1-1). That is, these breaks did not cause a hot leg displacement at restraints 2, 3, and 4 large enough to close the gap between the hot leg pipe and restraint. Table 9.8-5[2], "Summary of Pipe Whip Restraint Loads for ANO-1," provides peak loads for restraint No. 1 and demonstrates that restraints 2, 3, and 4 are not impacted.

Figures ANO-1 — 2-1 and ANO-1 — 2-2 provide the location of hot leg restraints 1 through 4 (Mk-24, Mk-33, and Mk-34) and summarize the cold gap clearances.

Figure ANO-1 — 2-1. ANO-1 Hot Leg Restraints 1 and 2
(From Bechtel Dwg. C-183)

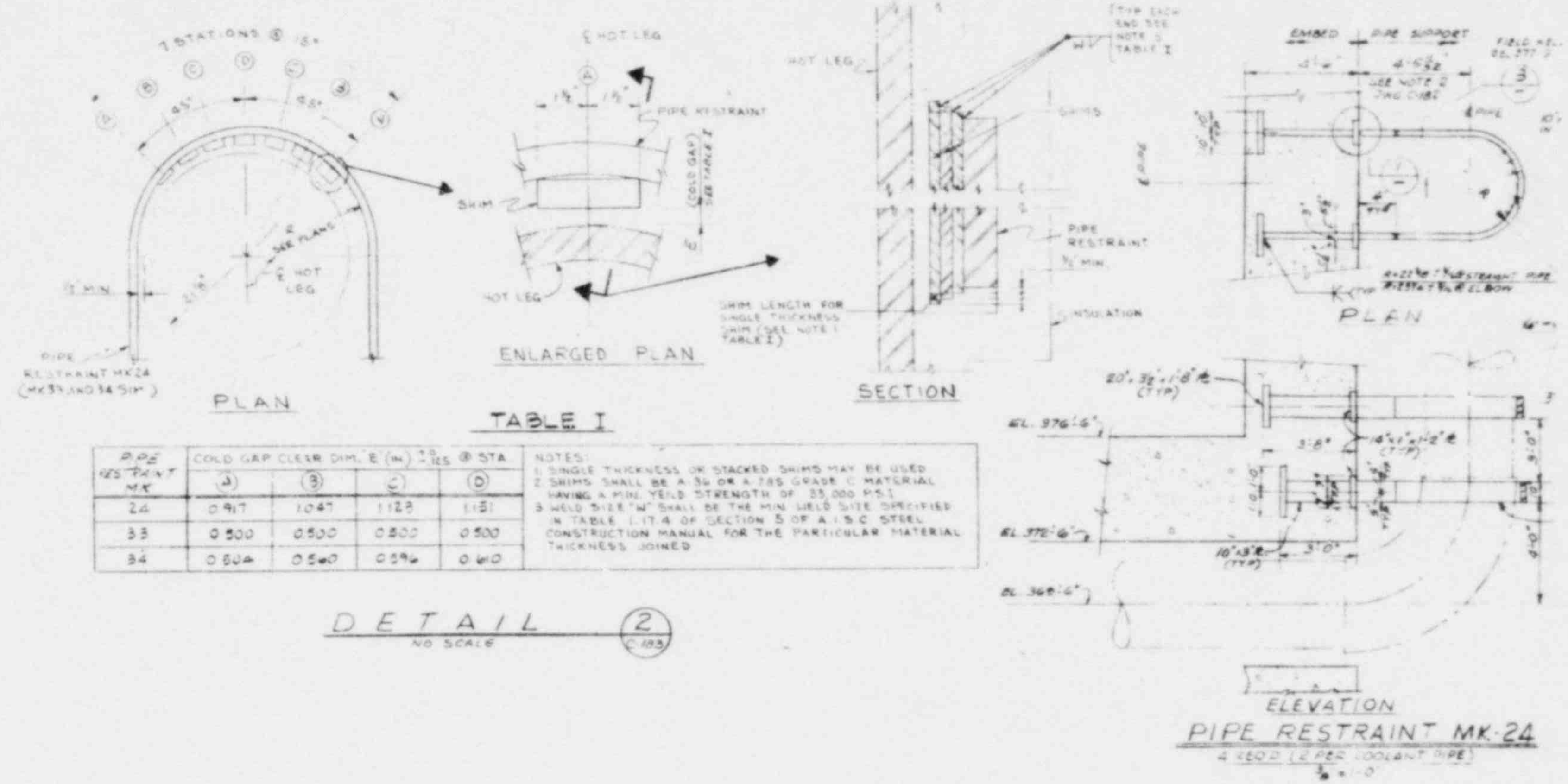
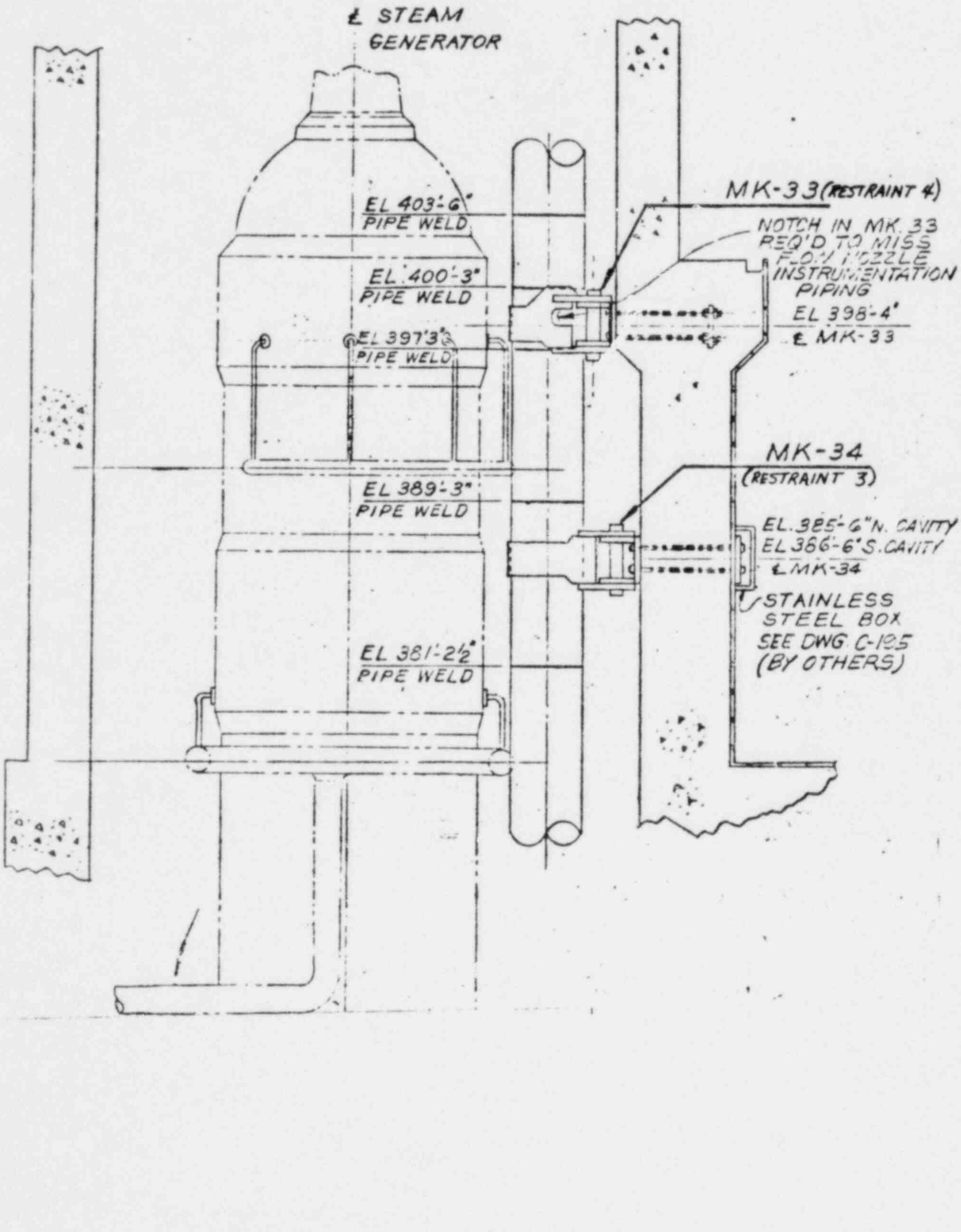


TABLE I

PIPE RESTRAINT MK	COLD GAP CLEAR DIM. E (IN) +0/-.125 @ STA. A	B	C	D
24	0.917	1.047	1.128	1.151
33	0.500	0.500	0.500	0.500
34	0.504	0.560	0.596	0.610

NOTES:
1. SINGLE THICKNESS OR STACKED SHIMS MAY BE USED
2. SHIMS SHALL BE A-36 OR A-285 GRADE C MATERIAL HAVING A MIN. YEILD STRENGTH OF 33,000 P.S.I.
3. WELD SIZE "W" SHALL BE THE MIN. WELD SIZE SPECIFIED IN TABLE 1.17.4 OF SECTION 5 OF A.I.S.C. STEEL CONSTRUCTION MANUAL FOR THE PARTICULAR MATERIAL THICKNESS JOINED

Figure ANO-1 — 2-2. ANO-1 Restraints 3 and 4



CR-3 — 1. Supply reactor vessel support and embedment drawings showing the general configuration. Provide a discussion of the loading and response of the embedment including the linear plate interface. Demonstrate that stability will be maintained and reactor shutdown and coolability will not be impaired.

Response

Only at the linear plate level were the stress limits defined by the acceptance criteria exceeded for the Crystal River embedment. The exceedance was only 4%, with a margin of at least 6% shown against the calculated ultimate strength.

In calculating the overturning load at the liner plate, a conservative interpretation of the load paths that would be induced by an asymmetric LOCA was adopted. The asymmetric LOCA produces moments of opposite direction on the reactor vessel support embedment and the cavity wall. These two structures are both linked to the basemat — the cavity wall through both the pedestal and the extremely strong secondary shield wall. This is most clearly shown in Figure I-1 of reference 2, which is reproduced here as Figure CR-3 — 1-1. If separation began to occur at the liner plate beneath the pedestal, displacement would be induced at the pedestal/cavity wall interface (shown as item 9 in the figure). This displacement would be resisted by the cavity wall, the reaction being transferred back to the basemat through the secondary shield wall. The resistance provided by the cavity wall was not considered in the Crystal River embedment analysis; all the overturning moment was assumed to pass into the basemat.

Thus, given the conservative manner in which the allowable stress at the liner plate was calculated, the small degree of overstress, and the additional resistance of the cavity wall, it is not considered that reactor vessel stability or coolability would be impaired by liner plate separation.

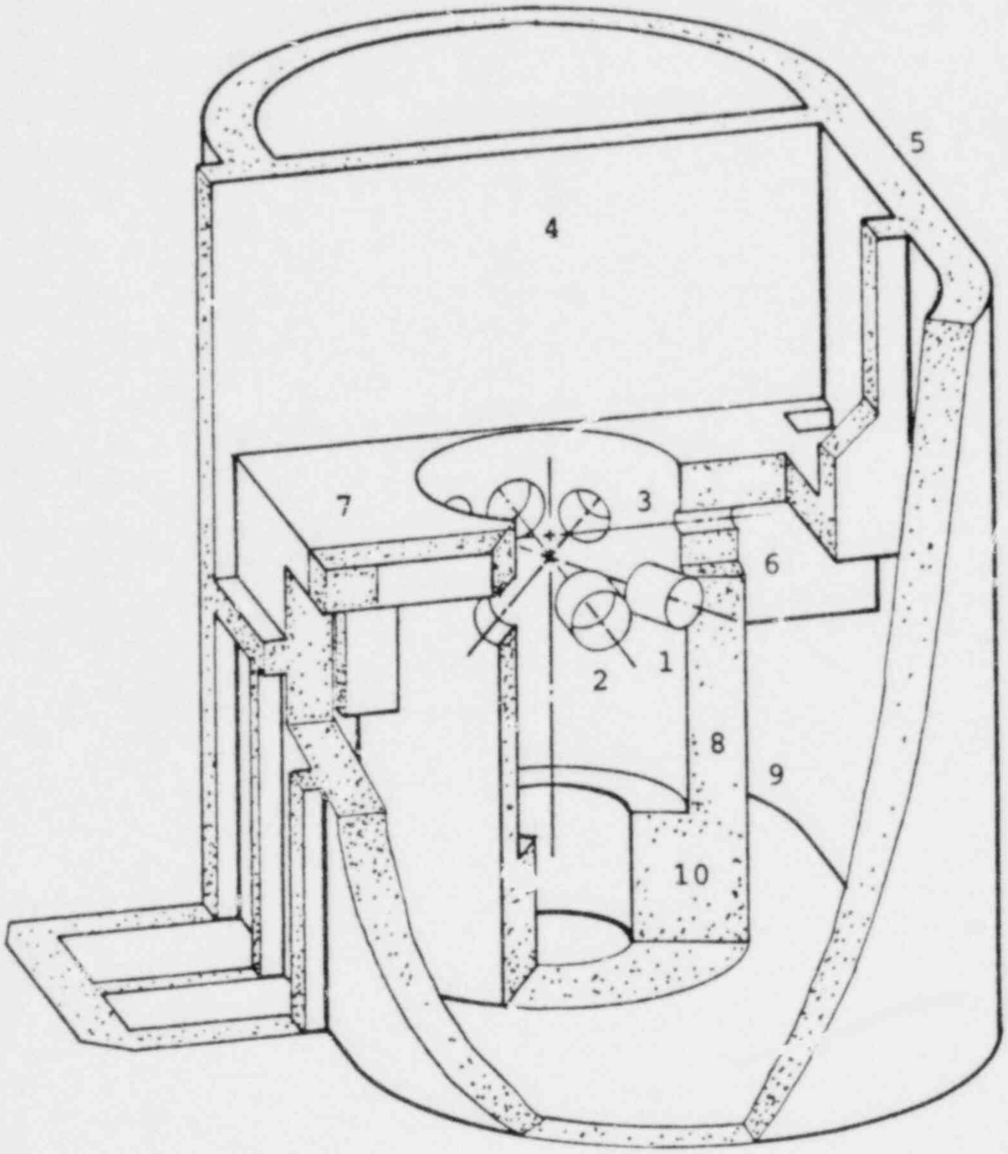
The following reactor vessel support and embedment drawings are provided in Appendix A.

> "Reactor Building — Steel, Reactor Vessel Support Anchor," Crystal River Plant, FPC Drawing S-521-022, Rev 6, Gilbert Associates, Inc.
>
> "Reactor Building — Concrete Outline, Basement Floor, El. 95'," Crystal River Plant, FPC Drawing SC-421-008, Rev 5, Gilbert Associates, Inc.

"Reactor Building — Dowel and Anchor Bolt Plan, Basement Floor El. 95'," Crystal River Plant, FPC Drawing SC-421-009, Rev 1, Gilbert Associates, Inc.

"Reactor Building — Reactor Vessel Foundation, Plan and Sections," Crystal River Plant, FPC Drawing SC-421-015, Rev 4, Gilbert Associates, Inc.

Figure CR-3 — 1-1. Generic Cavity Wall



1 - Cold Leg Penetration
2 - Hot Leg Penetration
3 - Core Flood Line Penetration
4 - Fuel Canal Wall
5 - Secondary Shield Walls
6 - Core Flood Line Shield Wall
7 - Fuel Canal Floor
8 - Cavity Wall
9 - Pedestal - Cavity Wall Interface
10 - Pedestal

CR-3 — 2. Discuss in detail the modifications proposed for limiting the hot leg break area and explain what changes would be anticipated in component response. Supply drawings showing locations of the proposed modifications.

Response

Modification to limit the hot leg break area are not required. Section 9.8 of reference 2, which states that the CR-3 restraints were overstressed, is in error. Table 2-1[2] shows that the hot leg restraints are within acceptance limits; however, section 9.8 has not yet been revised to include these acceptable results obtained in subsequent analyses.

In addition, section 12.4[2] provides information that demonstrates that the reactor vessel support stability is maintained, thereby eliminating the need to modify the hot leg restraints to reduce the break area.

CR-3 — 3. Supply bracket plate and hot leg restraint drawings with a discussion of the applied loads responses and consequences of failure. Discuss in detail the calculation of the allowable loads.

Response

No response needed; see CR-3 — 2.

CR-3 — 4. Comment briefly on restraints 2 and 3 in Figure B-5. (Appendix B)

Response

For a hot leg guillotine break at the reactor vessel or at the first elbow, restraints 2 and 3 in Figure B-5 are not impacted (also see Figure 4.1-1).[2] That is, these breaks do not cause a hot leg displacement at restraints 2 and 3 large enough to close the gap between hot leg pipe and restraint. Table 9.8-4, "Summary of Pipe Whip Loads for Crystal River," provides peak loads for restraints 1, 2, and 3 shown in Figure B-5.

CR-3 — 5. Provide a detailed discussion of the load redistribution predicted to take place in the cavity wall. Supply drawings of the affected area and discuss the overall functional integrity of the wall.

Response

In the elastic analysis, moments at the cavity wall base exceed the allowable. This overstress is very localized around the cavity wall/pedestal interface. The values from the elastic analysis are only approximate, as the actual structure will behave in a nonlinear fashion. A plastic hinge forms around the base where overstress is predicted. The moment at these locations will not exceed the plastic moment for the cross section.

The excess moment is redistributed to the lower third of the cavity wall and causes increased hoop tension. Figures CR-3 — 5-1 and CR-3 — 5-2 show the distribution of hoop stress in the lower part of the cavity wall. Final stresses after the distribution of the excess moment are still below the allowable yield stress of 42 ksi for hoop stress.

The increase in hoop stress reported in Figure CR-3 — 5-2 was calculated for the maximum excess moment on the cavity wall. Actual moment distribution at various azimuths around the base of the wall is lower. The values reported are for the 1.092A hot leg break, which is the critical load case. Results for the 2.0A cold leg break are lower for all stress values.

The cavity wall retains functional integrity for all loading conditions.

Figure CR-3 — 5.3 is a drawing of the Crystal River 3 cavity wall with reinforcing steel. (Figure CR-3 — 5.3 provided in Appendix A)

"Reactor Building – Reactor Vessel Primary Shield Wall Plans and Sections," Crystal River Plant, FPC Drawing SC-421-012, Gilbert Associates, Inc.

Figure CR-3 — 5-1. Hoop Steel Stresses Before Redistribution of Excess Moment — 1.092A Hot Leg Break (0°), Steady-State Condition

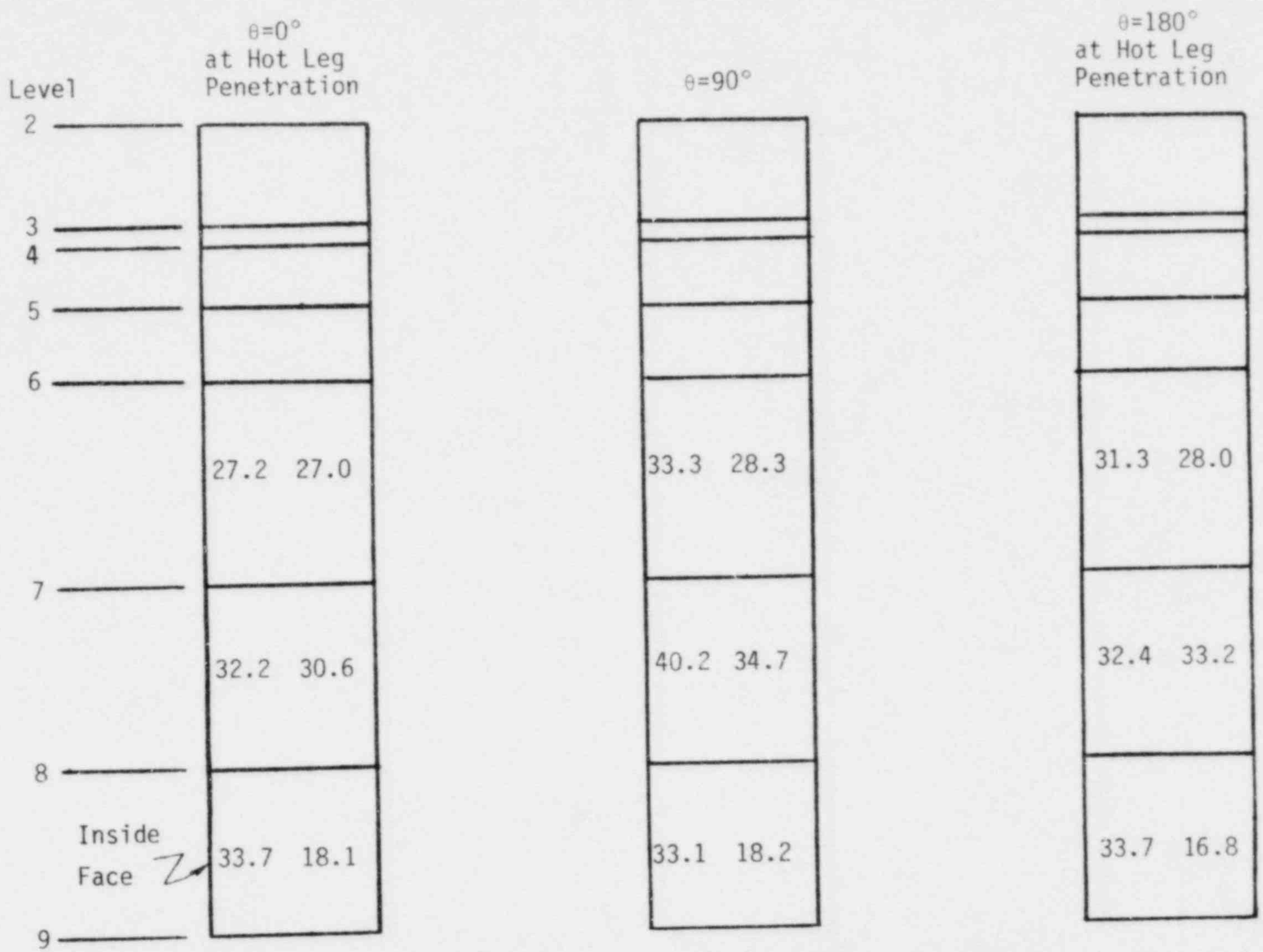
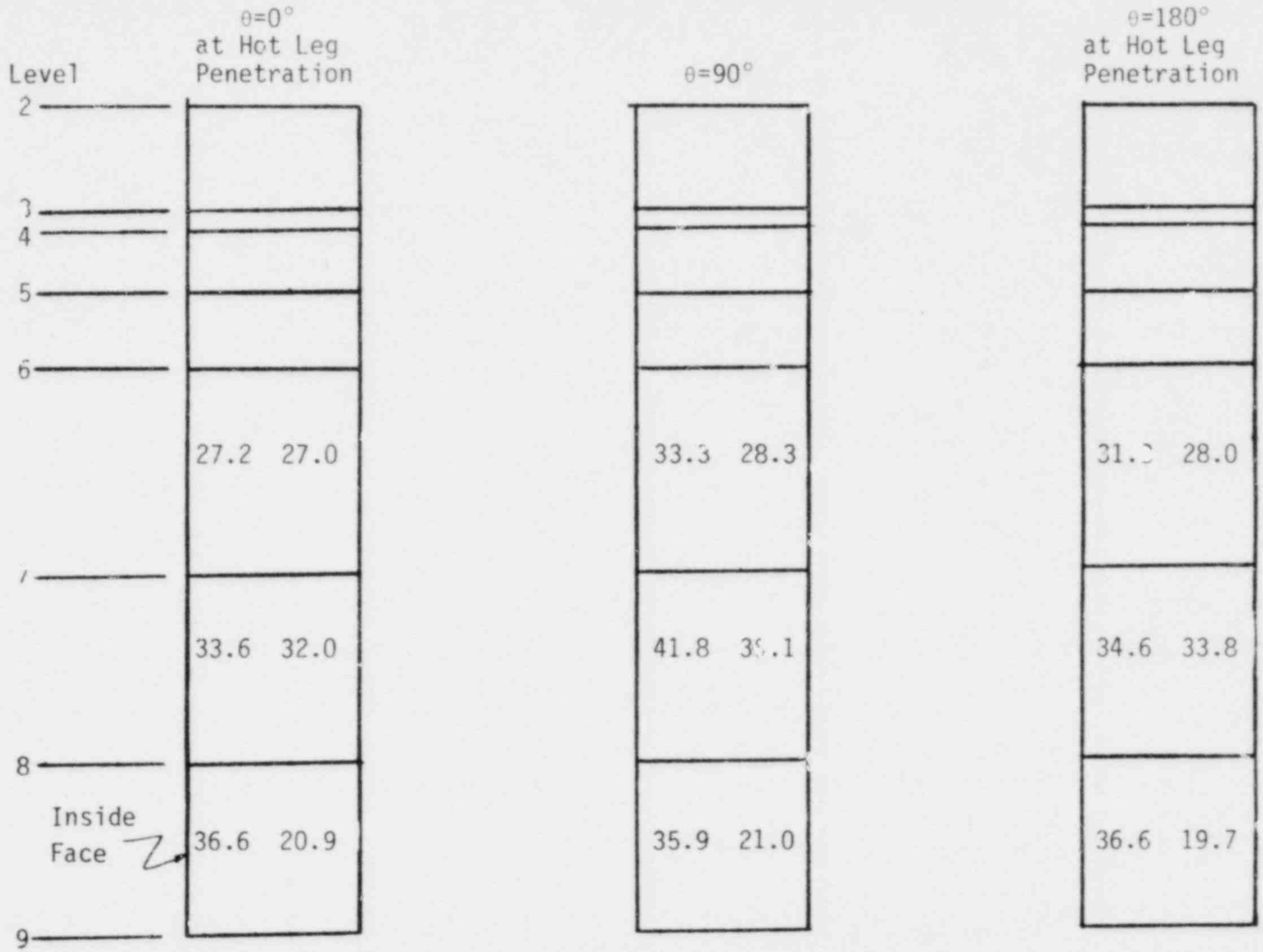


Figure CR-3 — 5-2. Hoop Steel Stresses After Redistribution of Excess Moment — 1.092A Hot Leg Break (0°), Steady-State Condition



DB-1 — 1. Detail the changes made to the skirt-supported models to facilitate the Davis Besse 1 analysis. Provide a detailed discussion of the response loads and the mathematical models, especially in the reactor vessel support regions.

Response

Davis Besse 1 is a nozzle-supported plant. During normal operating conditions, the reactor vessel (RV) is supported by four pairs of support beams, one pair at each cold leg. Each pair of support beams is connected by a support pad upon which the RV nozzle rests. There is also a LOCA ring at each hot and cold leg penetration. Figure K-3 of reference 2 shows a section at a cold leg penetration with the locations of a support beam and a typical LOCA ring. There are finite gaps between the LOCA rings and the pipes they encircle. Thus, the rings are not loaded under normal conditions.

During the LOCA event, the support beams take vertical loads (due to vertical and overturning loads on the RV) and lateral load. The lateral loads the support beams take are limited by the shear strength of the support pad/support beam bolts. After the support pad bolts fail in shear, the lateral load is taken by the LOCA rings. Thus, the LOCA rings at the unbroken hot and cold legs will be subject to horizontal, vertical, and out-of-plane (due to friction) loads.

A support beam model (Figures K-12 and K-13[2]) was developed for the analysis of the support beam and the concrete immediately surrounding it. This model was discussed in detail in section 3.2 of Appendix K.[2] The loadings applied to this model were the maximum vertical load due to RV deadweight plus LOCA and a lateral load, the magnitude of which was equal to the shear strength of the support pad/support beam bolts.

Two- and three-dimensional models of the LOCA rings were developed. These are fully described in Appendix K.[2] These models accounted for the interaction between the pipe and the restraint, the yielding of the LOCA ring, and the stiffness of the concrete in which it is embedded. The loading applied to these models was based on the assumption that all the lateral load was carried by the LOCA rings. An out-of-plane, frictional load equal to 42% of the resulting normal load on the LOCA rings was applied simultaneously. Neither the yielded support pad bolts nor these frictional forces were assumed to act to help resist the lateral force on the RV. Clearly, this is conservative.

Loadings from the boundaries of these support beam and LOCA ring models were included in the analysis and qualification of the Davis Besse 1 cavity wall.

DB-1 — 2. Supply drawings of the reactor pressure vessel support system and the general plant layout.

Response

At the April 2-3, 1981 meeting with NRC and EG&G, this question was revised to state that the main area of interest was the LOCA ring. Figure DB-1 — 2-1 provides details of the hot and cold leg LOCA restraints, and Figure DB-1 — 2-2 is a general layout of the reactor pressure vessel support system including LOCA rings.

Figures DB-1 — 2-1 and DB-1 — 2-2

(In Appendix A of this report)

Oconee 1. Supply reactor vessel support and embedment drawings showing the general configuration along with a detailed discussion of the loading and structural response with particular attention to stability and component functions.

Response

As discussed at the April 2-3 1981, meeting in Bethesda, the question of the Oconee embedment stability is addressed in section 12.4 of reference 2. The following reactor vessel support and embedment drawings are attached:

"Reactor Building — Reactor Foundation Concrete," Oconee Nuclear Station Units 1, 2, 3; Drawing O-68A, Rev 15, Bechtel Corporation.

"Reactor Building — Reactor Foundation Reinforcing," Oconee Nuclear Station Units 1, 2, and 3; Drawing O-68B Rev 4, Bechtel Corporation.

"Reactor Building — Primary and Secondary Shield Walls, Plans at El. 777'-6" and 802'-0, Concrete," Oconee Units 1, 2, and 3; Drawing O-69A, Rev 12, Bechtel Corporation.

"Reactor Building — Primary and Secondary Shield Walls, Sections and Elevations, Concrete," Oconee Units 1, 2, and 3; Drawing O-69D, Rev 15, Bechtel Corporation.

Oconee 2. Supply drawings of the control rod drive mechanism and housing and discuss the applied loads, responses, and modified mechanisms.

Response

Drawings of the control rod drive mechanism and housing are found in Figures Oconee 2-1 through 2-3.

The applied loadings are found in section 9.4 of reference 2 and the structural response information is contained in section 10.4 of reference 2.

For a discussion of the modified mechanism please refer to BAW-10047, Rev 1.[13]

OCONEE 1, 2

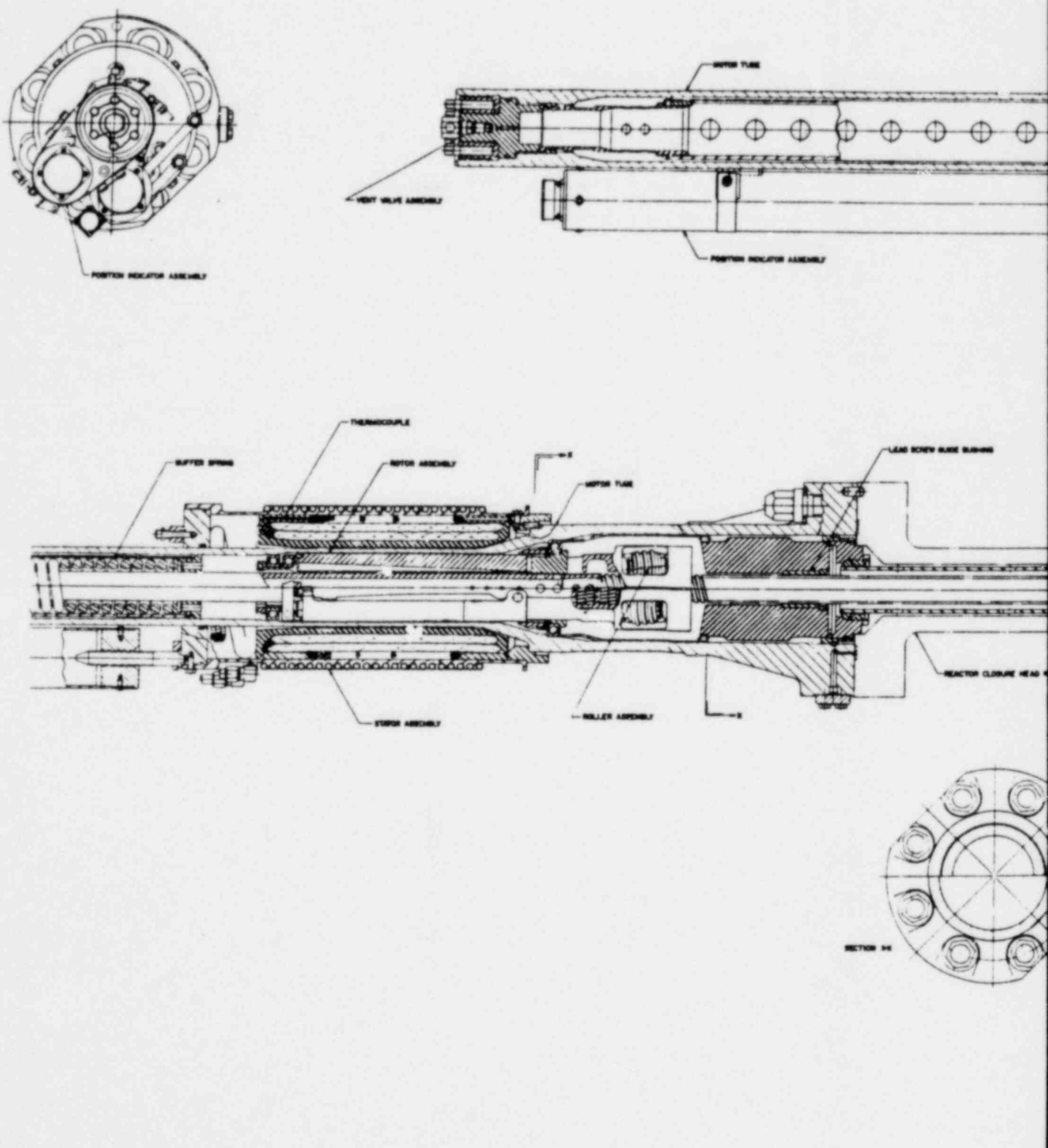
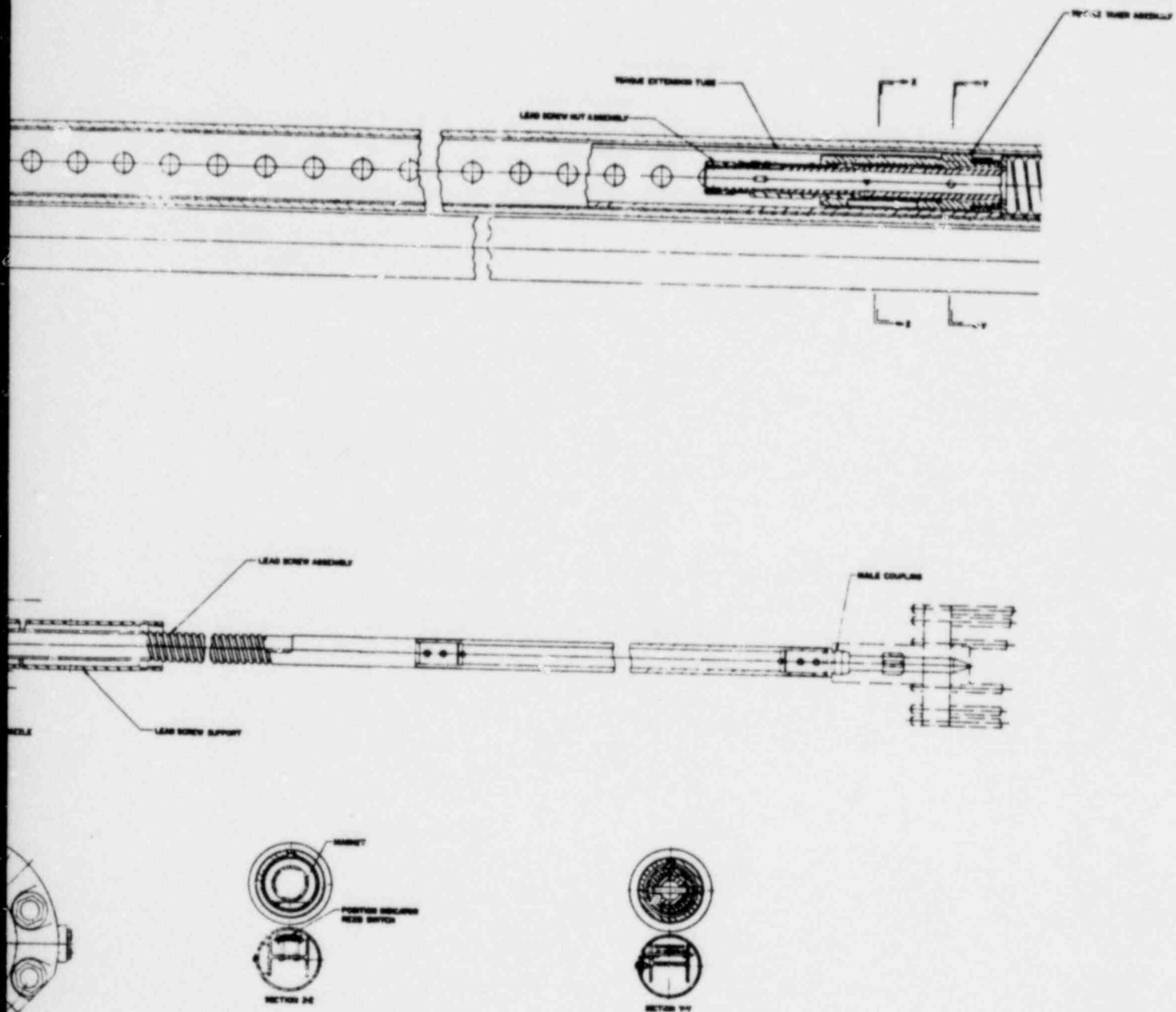

MOTOR TUBE
VENT VALVE ASSEMBLY
POSITION INDICATOR ASSEMBLY
POSITION INDICATOR ASSEMBLY
THERMOCOUPLE
BUFFER SPRING
ROTOR ASSEMBLY
MOTOR TUBE
LEAD SCREW GUIDE BUSHING
REACTOR CLOSURE HEAD
STATOR ASSEMBLY
ROLLER ASSEMBLY
SECTION X-X

Figure Oconee 2-1. Control Rod Drive Mechanism



OCONEE 3

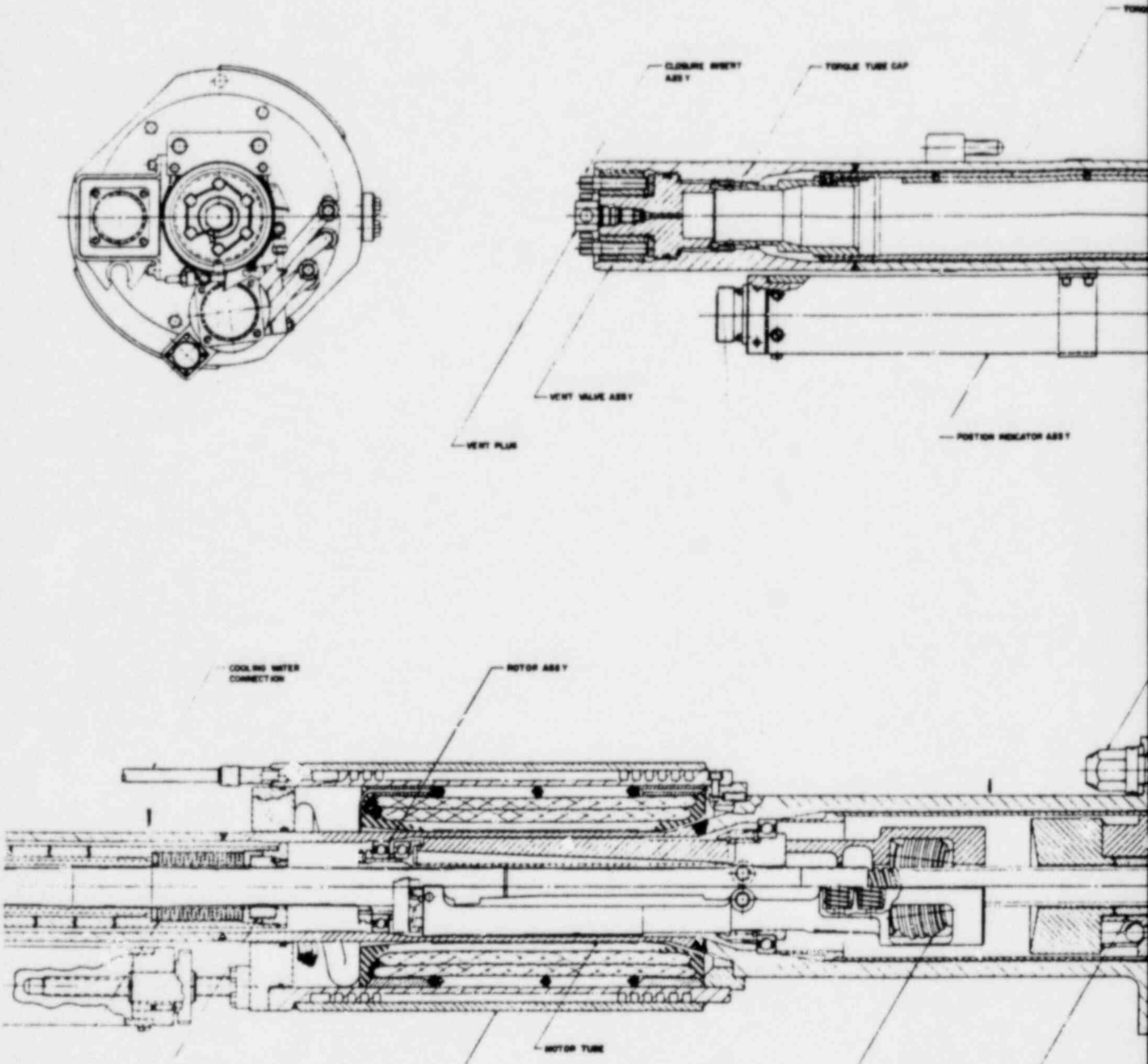

CLOSURE INSERT ASSY
TORQUE TUBE CAP
VENT VALVE ASSY
VENT PLUG
POSITION INDICATOR ASSY
COOLING WATER CONNECTION
ROTOR ASSY
MOTOR TUBE
STATOR-WATER JACKET ASSY
ROLLER ASSY
LEAD SCREW GUIDE BUSHING

Figure Oconee 2-2. Control Rod Drive-
Vertical Section

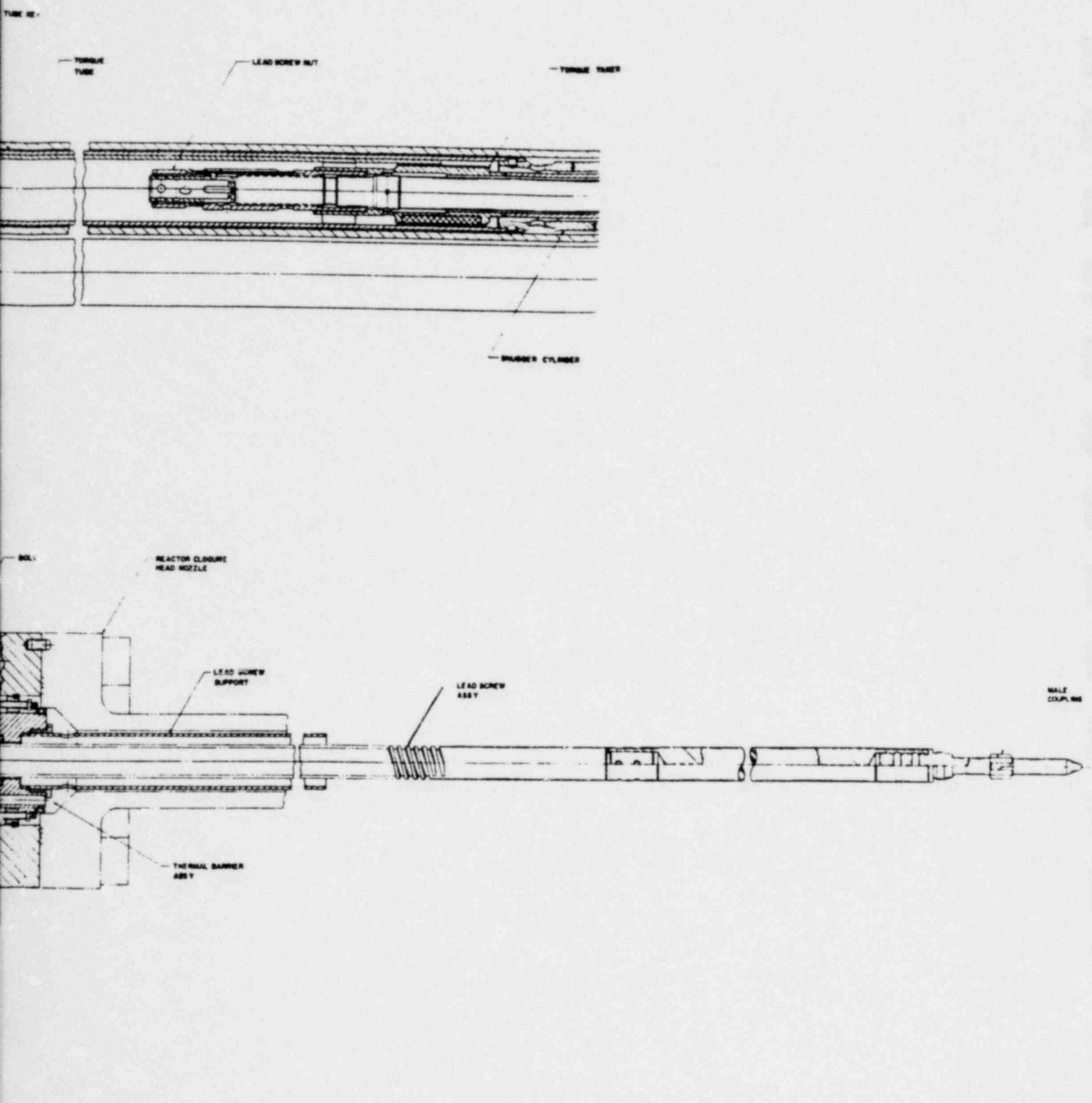
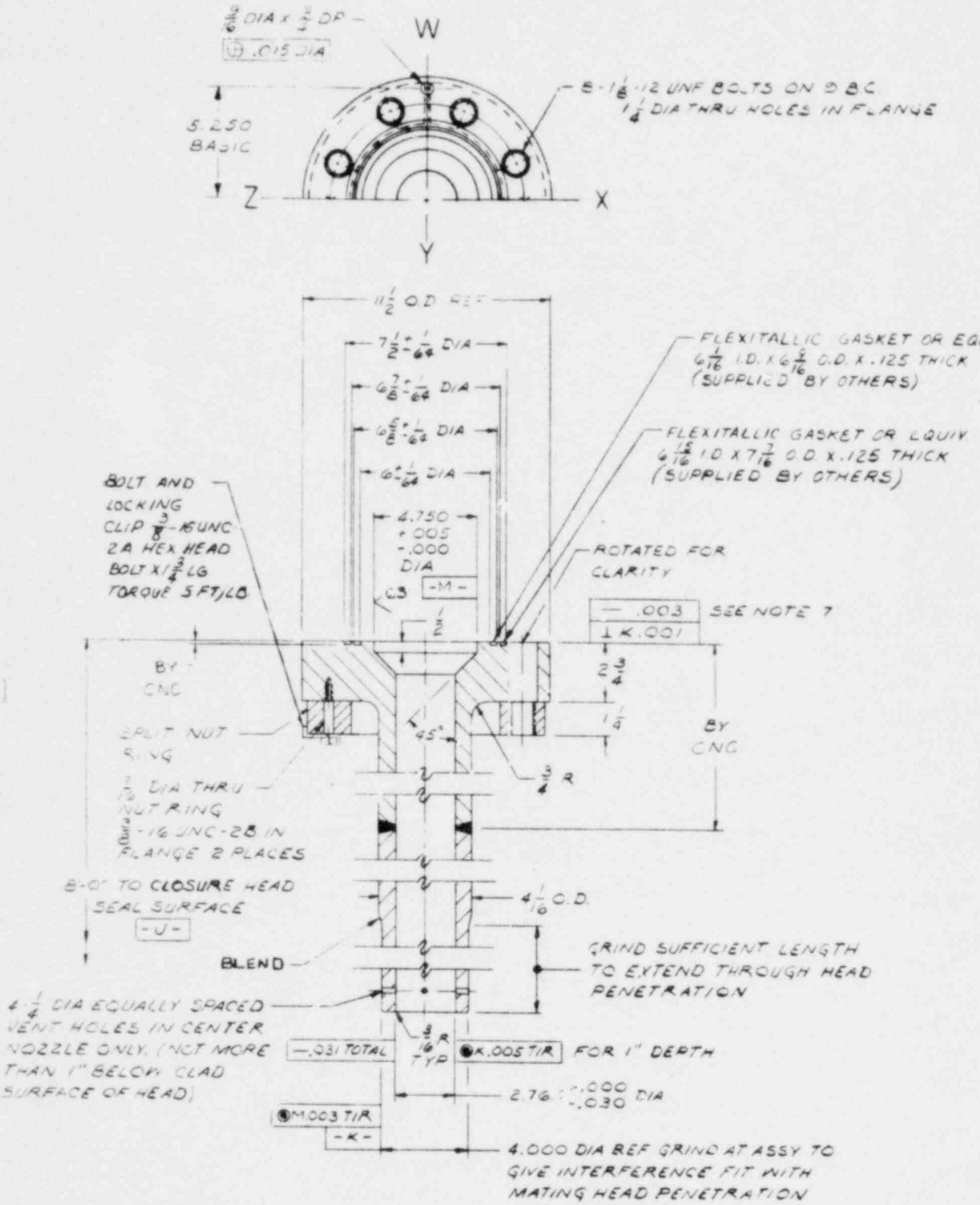


Figure Oconee 2-3. Control Rod Drive RV Head Nozzle



Rancho Seco 1. Supply drawings of the reactor vessel embedments detailing the location where the acceptance criterion is exceeded. Discuss the various responses and the effect on overall stability.

Response

The peak asymmetric LOCA loading leads to exceedance of the acceptance criteria in three locations for the Rancho Seco reactor vessel support embedment.

In two of these locations, above the incore instrumentation hatch and around the vertical hatch, the allowable shear stress is exceeded locally by 8%. The actual shear stress is still only 91% of the calculated ultimate. The allowable shear stress was calculated using the relevant code procedures.[23] Given the intensity of the reinforcement and the depth of the pedestal, this is considered to be a conservative methodology. Furthermore, the reinforcement will ensure that any failure will be relatively ductile, leading to a considerable redistribution of the shear stress to neighboring, less highly stressed locations. This effect was not taken into account.

In the third location, against the vertical bearing plate, the allowable compressive stress on the concrete was exceeded by 7%. The actual stress was, however, only 75% of the calculated ultimate. Again, conservative code procedures were used to calculate this allowable. Given the increases in allowables that were obtained for the concrete under the sole plate when explicit nonlinear analysis was performed, this 7% overstress is not considered significant. Furthermore, no account was taken for redistribution.

In all three locations, the overstress occurs locally at an opening in the pedestal. Only one of the six possible LOCAs would load the pedestal in this manner. Given the local nature of the calculated overstresses, the conservative manner in which the allowables were calculated and the results of analyses described in section 12.4[2], it is concluded that neither reactor vessel stability nor component functionality will be adversely affected.

The following reactor vessel support and embedment drawings are attached as requested:

"Reactor Building – Area 1, Reactor Support," Rancho Seco Nuclear Station – Unit 1, Drawing C-368, Rev 7, Bechtel Corporation.

"Reactor Building – Area 1 Reinforced Concrete Primary Shield – Sheet 1," Rancho Seco Nuclear Station – Unit 1, Drawing C-309, Rev 2, Bechtel Corporation.

"Reactor Building – Area 1 Reinforced Concrete Primary Shield – Sheet 2," Rancho Seco Nuclear Station – Unit 1, Drawing C-310, Rev 1, Bechtel Corporation.

"Reactor Building – Area 1 Reinforced Concrete Primary Shield – Sheet 3," Rancho Seco Nuclear Station – Unit 1, Drawing C-311, Rev 4, Bechtel Corporation.

"Reactor Building – Area 1 Reinforced Concrete Primary Shield – Sheet 4," Rancho Seco Nuclear Station – Unit 1, Drawing C-312, Rev 4, Bechtel Corporation.

Rancho Seco 2. Comment briefly on restraints 1 and 4 in Figure B-6.

Response

For a hot leg guillotine break at the reactor vessel or at the first elbow, restraints 1 and 4 in Figure B-6[2] are not impacted (also see Figure 4.1-1[2]). That is, these breaks do not cause a hot leg displacement at either restraint 1 or 4 large enough to close the gap between hot leg pipe and restraint. Table 9.8.6[2], "Summary of Pipe Whip Loads for Rancho Seco," provides peak loads for restraints 1, 2, 3, and 4 shown in Figure B-6[2].

TMI-1 — 1. Discuss in detail the differences between the TMI-1 and CR-3 power plants in the following areas:

a. Reactor vessel supports.
b. Reactor vessel support embedments.
c. Control rod drive mechanism housings.
d. Proposed modifications for limiting the hot leg break area.

Response

For TMI-1 and CR-3 there are no significant differences in the reactor vessel supports or the control rod drive mechanism housings.

There are no major differences between the reactor vessel support embedments for the CR-3 and TMI-1 power plants. The density and layout of the reinforcements in the two embedments are relatively similar. Major dimensions, together with anchor bolt properties, are summarized in Table TMI-1 — 1. Differences between the plants are the following:

- The 90-day concrete strength was 6% higher for the CR-3 plant.
- A number of small differences in detail do exist, and these affect the relative strength ratios reported for the two embedments:
  - The CR-3 plant has shear anchors beneath the sole plate, whereas TMI-1 does not.
  - More horizontal load is thrust against the vertical bearing plate in the TMI-1 plant than at Crystal River.

A nonlinear vessel stability evaluation was performed for CR-3 (section 12.4, reference 2) which demonstrated that the vessel remained stable for the postulated hot leg LOCA. For this reason CR-3 does not plan to install an additional hot leg restraint in the penetration.

As noted in reference 14, TMI-1 plans to initiate a program to evaluate the probability of leak before break and/or conservatisms in the Phase II analysis to determine whether an additional hot leg restraint is required. Pending the outcome of the program, they will, by the first refueling outage, either install a restraint or provide justification for the adequacy of the existing plant design.

Table TMI-1 — 1-1. TMI-1 and CR-3 Embedment Properties

Property/parameter	CR-3	TMI-1
Pedestal depth, in.	132	132
Basemat depth, in.	150	108
Anchor bolt length, in.	92	92
Anchor bolt diameter, in.	2.5	1.5
Effective post tension, kips/bolt	174	232
Bolt yield stress, psi	140	130
90-day concrete compressive strength, psi	7035	6650

TMI-1 — 2. Supply hot-leg pipe whip restraint drawings and discuss analytical results with respect to these drawings. Detail the consequences of failure of this support.

Response

For Crystal River, the hot leg restraint did not exceed allowable stresses for the postulated hot leg LOCA, and vessel stability was demonstrated. (See response to question CR-3 — 2.)

As noted in reference 14, TMI-1 will evaluate the probability of leak before break and/or analytical conservatisms and will either modify and/or install restraints by the first refueling outage or will provide justification for the adequacy of the existing plant design. (See response to question TMI-1 — 1.)

TMI-1 — 3. Comment briefly on restraint 2 in Figure B-2.

Response

For a hot leg guillotine break at the reactor vessel or at the first elbow, restraint 2 shown in Figure B-2[2] is not impacted (also see Figure 4.1-1[2]). That is, these breaks do not cause a hot leg displacement at restraint 2 large enough to close the gap between hot leg pipe and the restraint. The "Summary of Pipe Whip Loads for TMI-1," Table 9.8-2[2], provides peak loads for restraints 1 and 2 shown in Figure B-2.

TMI-1 — 4. The following information is requested on the reactor vessel cavity wall:

1. Drawings describing the wall and the surrounding structures.
2. Allowable values based on the wall primary functions.
3. A discussion of the load distribution, load path, and magnitude along with a comparison of the results to a functional allowable.
4. A definitive margin of safety for the wall.
5. Definitive ratio of ductility as used in this context.

Response

1. The requested drawings are included as Figures TMI-1 — 4-1, TMI-1 — 4-2, and TMI-1 — 4-3 in Appendix A.

   "Sections A-A and B-B, Reactor Building," Three Mile Island Nuclear Station, Unit 1 Drawing E-002-004, Rev 33, Gilbiert Associates, Inc.

   "Reactor Building — Concrete Reactor Vessel Primary Wall, Elev. 289'-7" to Elev. 317'-0"." Three Mile Island Nuclear Station, Unit 1, Drawing E-421-016, Rev 6, Gilbert Associates, Inc.

   "Reactor Building — Concrete Plan Floor Elev. 346'-0"," Three Mile Island Nuclear Station, Unit 1, Drawing E-421-009, Rev 6, Gilbert Associates, Inc.

2. The functional integrity of the wall is maintained for a given load if the maximum tensile strain in the reinforcement is less than 3.75%. This corresponds to an average maximum pressure of 280 psi over the cavity wall and a maximum radial displacement of 4.6 inches.

3. The analysis was performed for a 1.295A hot leg break. At maximum load, the concrete has cracked over much of the cavity wall and pedestal. At this load, the total load applied to the cavity wall is resisted as follows:

   a. Hoop reinforcement, 57%
   b. Pedestal, 25%
   c. Fuel canal slab and wall system, 18%

   Yielding of the hoop reinforcement extends over the full length of the cavity wall except the hoop steel in vicinity of the fuel canal slab and pedestal. Maximum strain of the hoop reinforcement is 1.27%.

Yielding of the vertical reinforcement primarily extends over three regions:

a. At the outside face of the cavity wall, the reinforcement experiences tensile yielding for a distance of about 12 feet below the nozzle belt region.

b. At the inside face of the cavity wall, at the pedestal/cavity wall interface, yielding extends from 1.5 feet above the pedestal to 5 feet below it.

c. At the inside face of the cavity wall, at midheight, there is localized compressive yielding. The strain of the reinforcement in this area is less than 1.42%.

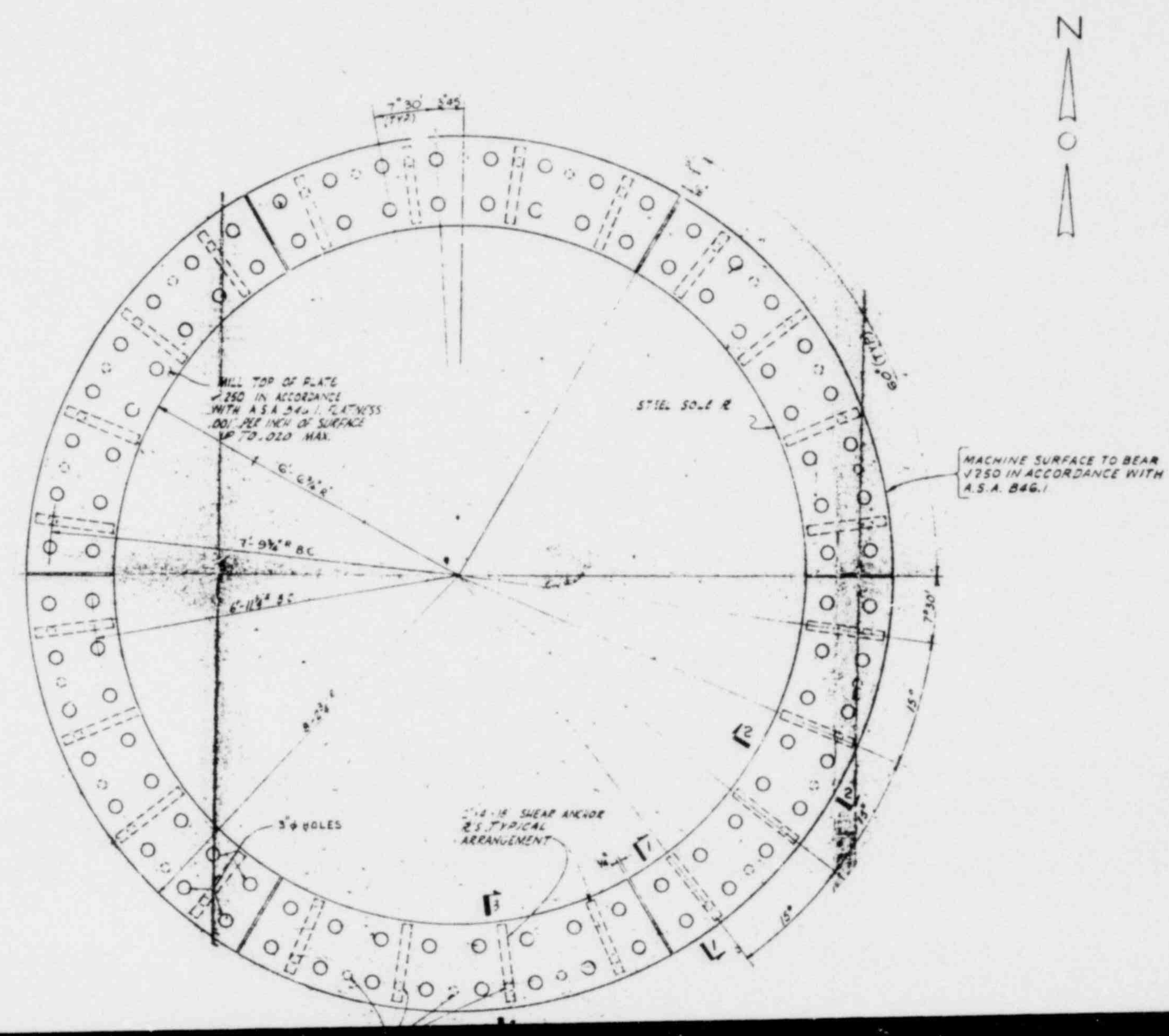
At no point is steel strain over 1.42%, or wall displacement over 2 inches. These values are below the functional allowables.

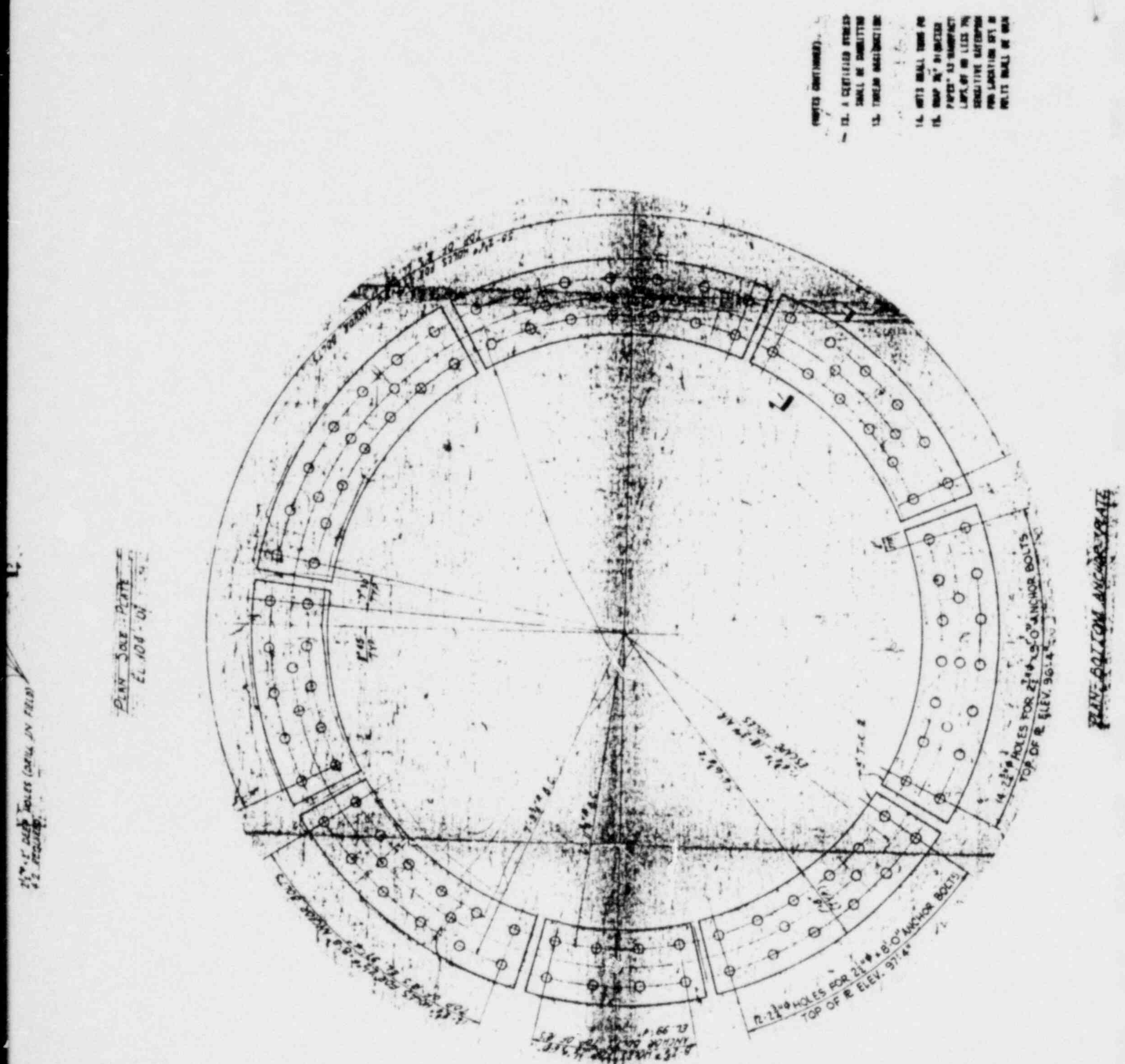
4. The average pressure that produces 3.75% strain is 280 psi. The maximum average pressure for a 1.295A hot leg break is 255 psi. Therefore, the margin of safety for the wall is 1.10.

5. The maximum radial displacement at the start of the yielding of the hoop reinforcement is 0.24 inch. The corresponding displacement at a pressure of 255 psi is 1.91 inches. Therefore, the ratio of ductility is 7.96. Results were extended from the original analysis for actual peak loads (255 psi) to ultimate loads (280 psi) as discussed in reference 27. From these data, the corresponding displacement for a pressure of 280 psi is 4.60 inches, which gives a ratio of ductility of 19.2. Therefore, the ratio of actual ductility to the function level ductility is 0.41.

APPENDIX A

Drawings


N
MILL TOP OF PLATE
√250 IN ACCORDANCE
WITH A.S.A. B46.1. FLATNESS
.001" PER INCH OF SURFACE
UP TO .020 MAX.
STEEL SOLE R
MACHINE SURFACE TO BEAR
√250 IN ACCORDANCE WITH
A.S.A. B46.1
3"φ HOLES
SHEAR ANCHOR
TYPICAL
ARRANGEMENT
7°30'
15°



FLORIDA POWER CORPORATION
ST. PETERSBURG, FLORIDA
CRYSTAL RIVER PLANT
UNIT NO. 3 855,000 KW

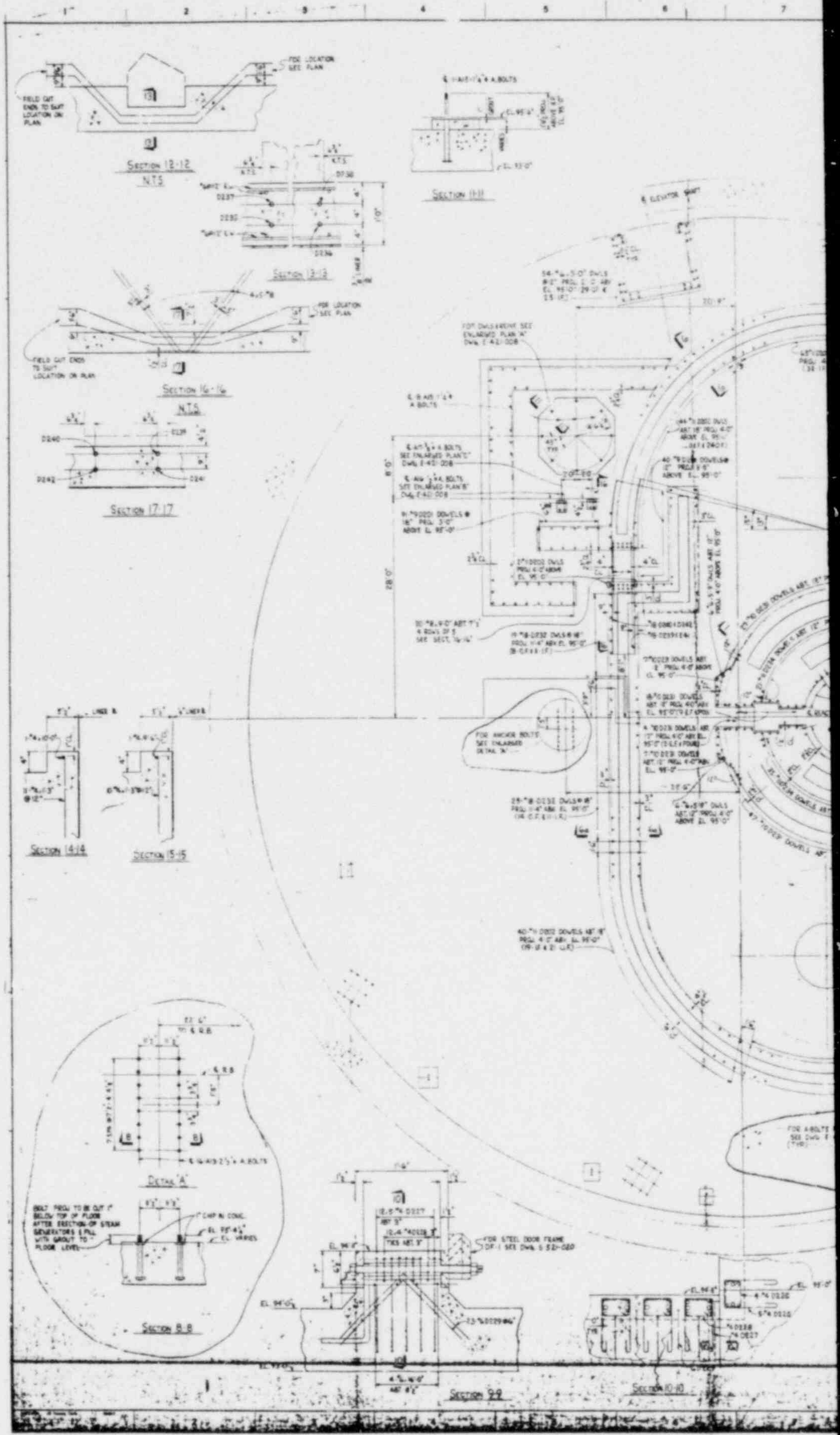
REACTOR BUILDING - STEEL
REACTOR VESSEL SUPPORT ANCHORS

GILBERT ASSOCIATES, INC.

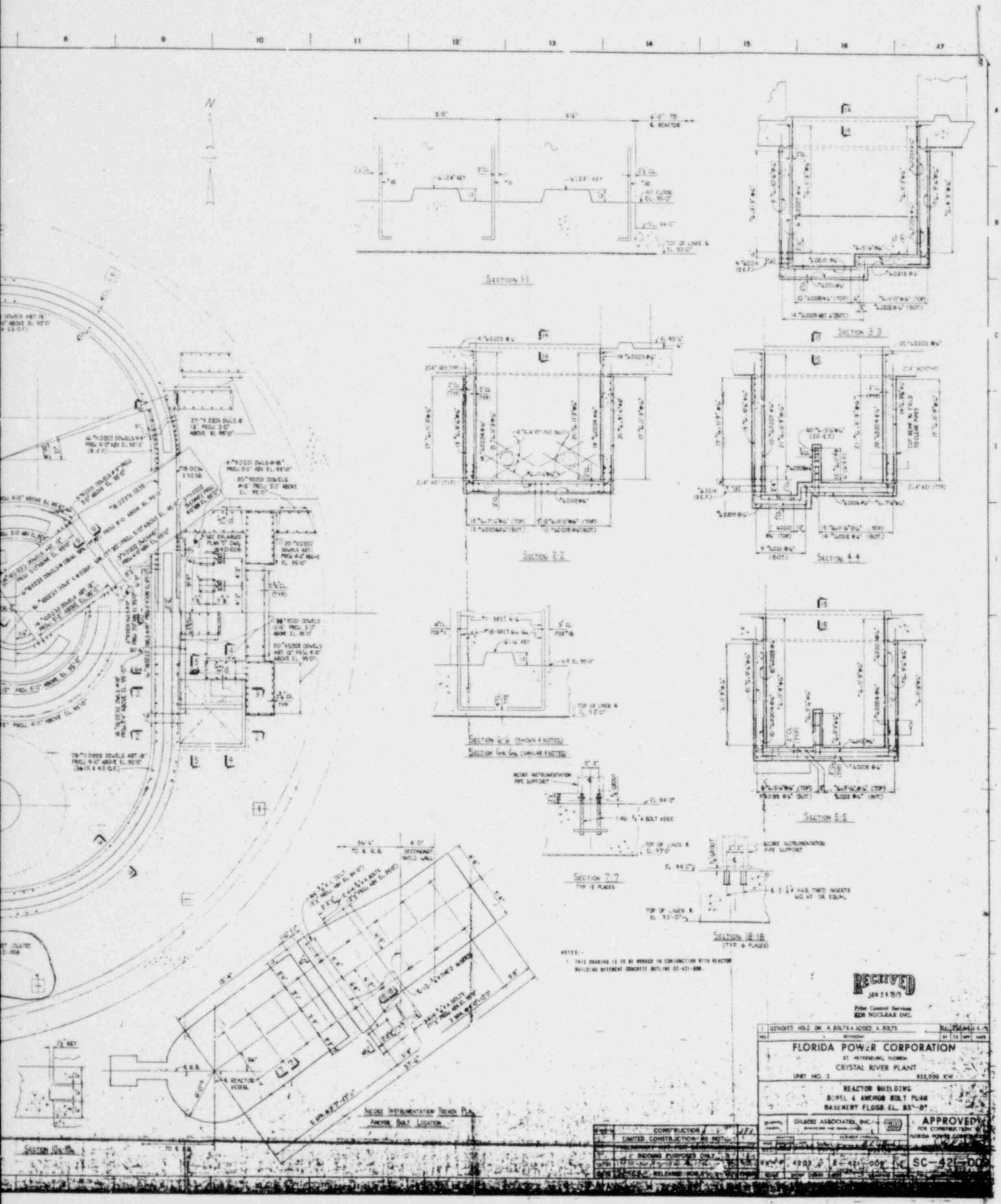
APPROVED

4205 E-3-521-022

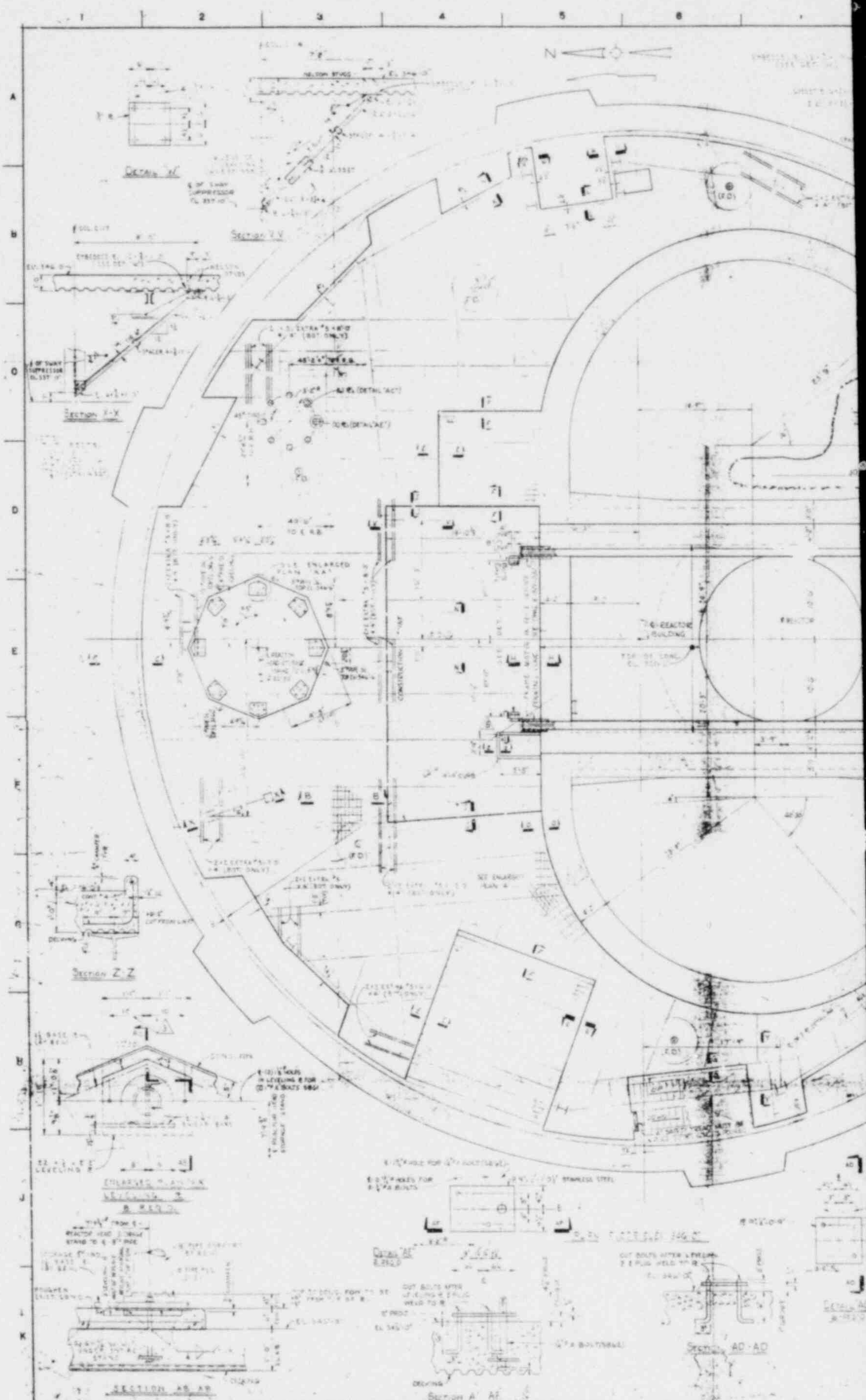
S-521-022, Rev 6



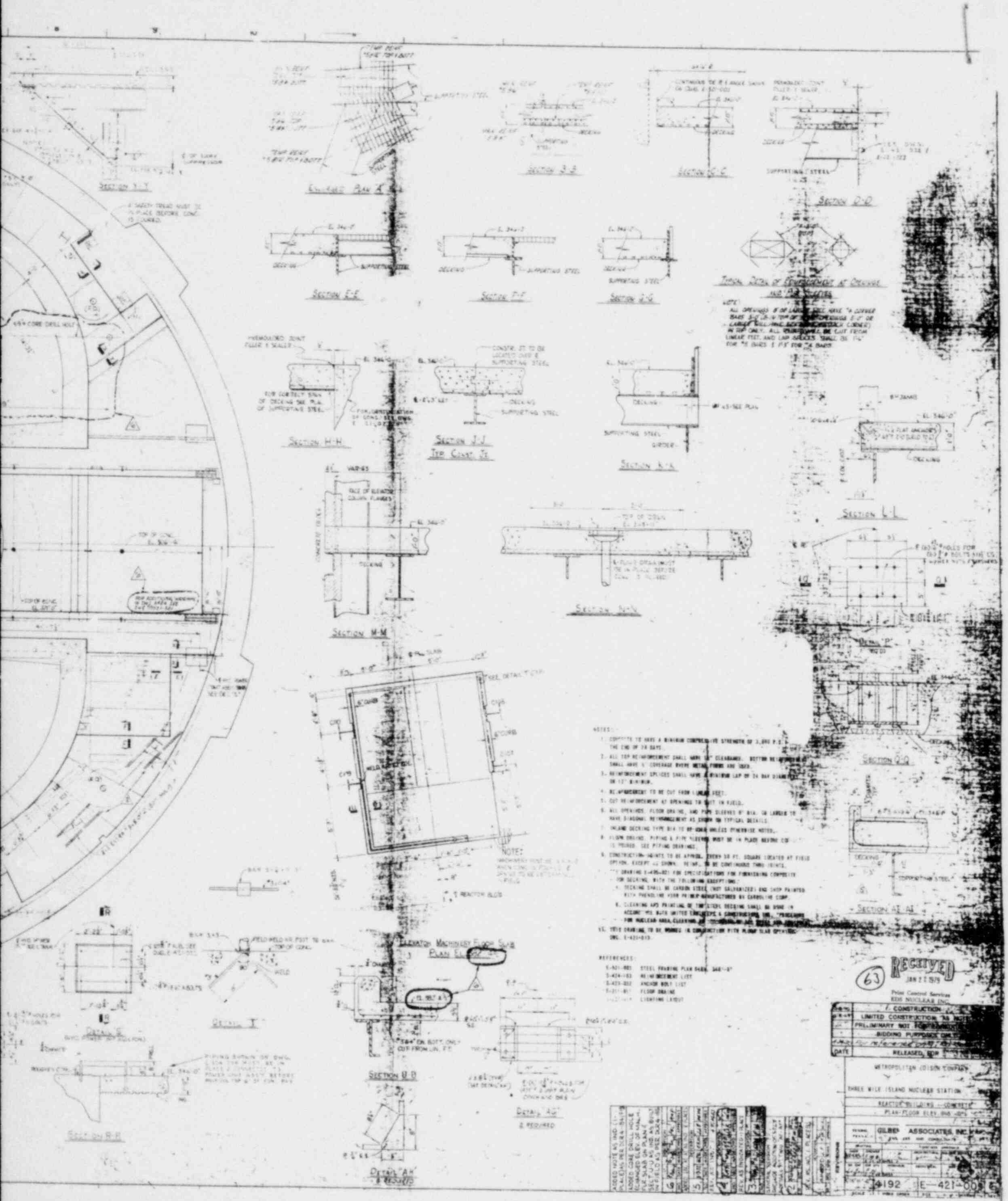
Section 12-12
N.T.S
Section 11-11
Section 13-13
Section 16-16
N.T.S
Section 17-17
Section 14-14
Section 15-15
Detail 'A'
Section 8-8
Section 9-9
Section 10-10



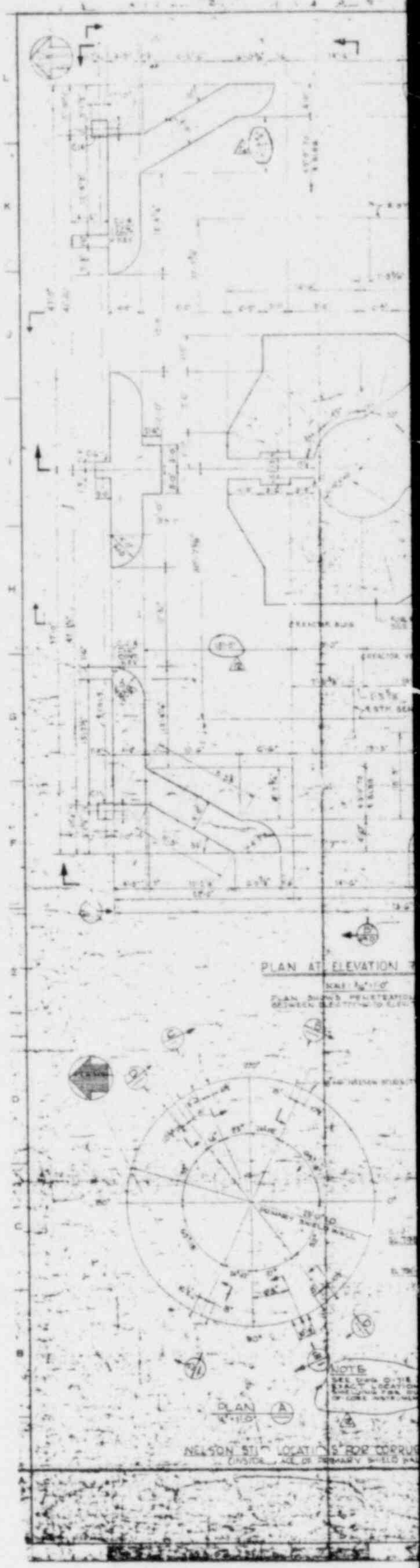
Section 1-1
Section 2-2
Section 3-3
Section 4-4
Section 5-5
Section 6-6 (shown & noted)
Section 6a-6a (similar & noted)
Section 7-7
Typ 16 places
Section 18-18
(Typ 6 places)
Incore Instrumentation Trench Plan
Anchor Bolt Location
NOTES:-
1. THIS DRAWING IS TO BE WORKED IN CONJUNCTION WITH REACTOR BUILDING BASEMENT CONCRETE OUTLINE SC-421-008.
RECEIVED
FLORIDA POWER CORPORATION
ST. PETERSBURG, FLORIDA
CRYSTAL RIVER PLANT
UNIT NO. 3
REACTOR BUILDING
DOWEL & ANCHOR BOLT PLAN
BASEMENT FLOOR EL. 95'-0"
GILBERT ASSOCIATES, INC.
APPROVED
FOR CONSTRUCTION
CONSTRUCTION
LIMITED CONSTRUCTION
SC-421-009

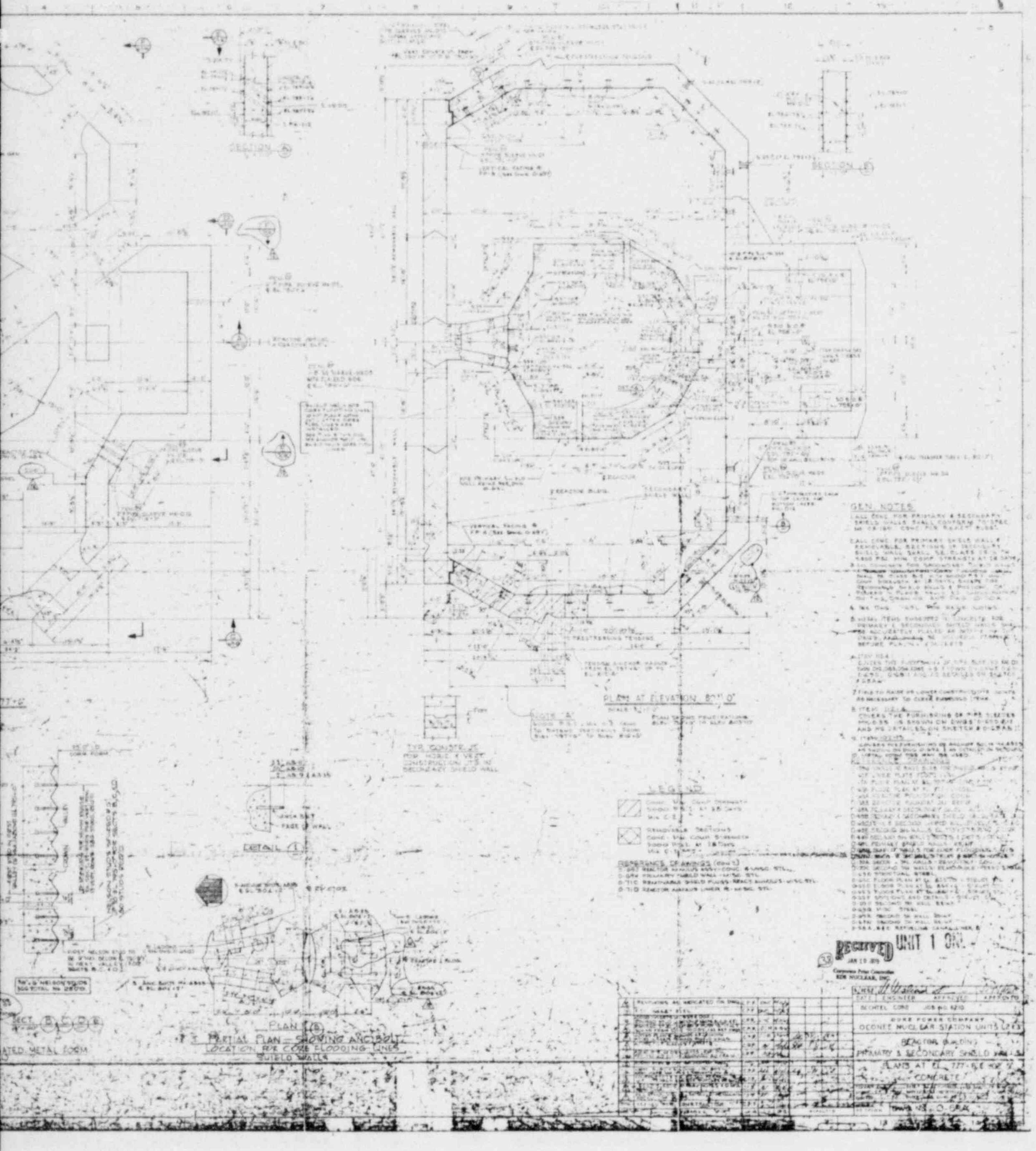


SECTION Y-Y
SECTION X-X
SECTION Z-Z
REACTOR
REACTOR BUILDING
SECTION AD-AD

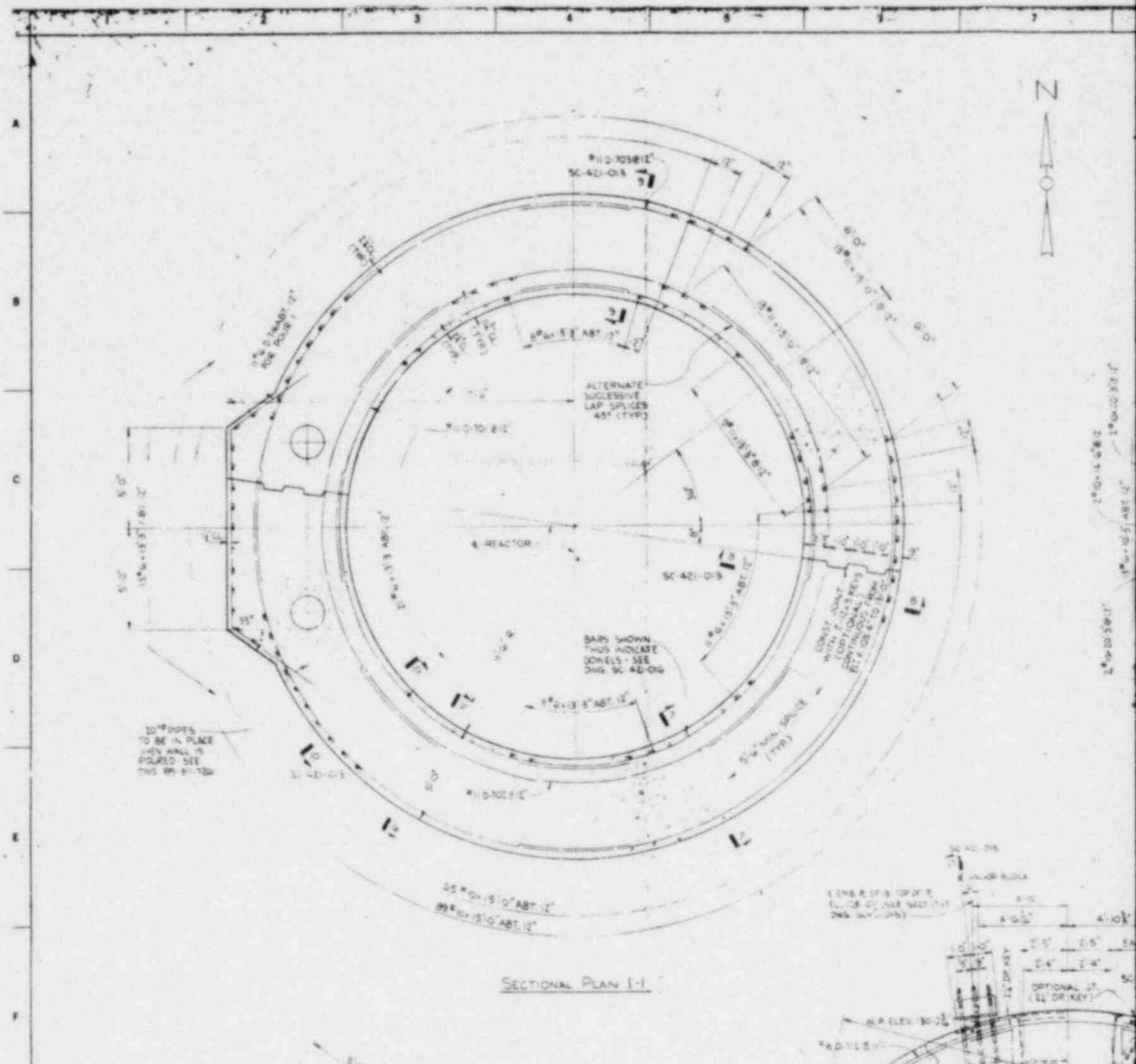


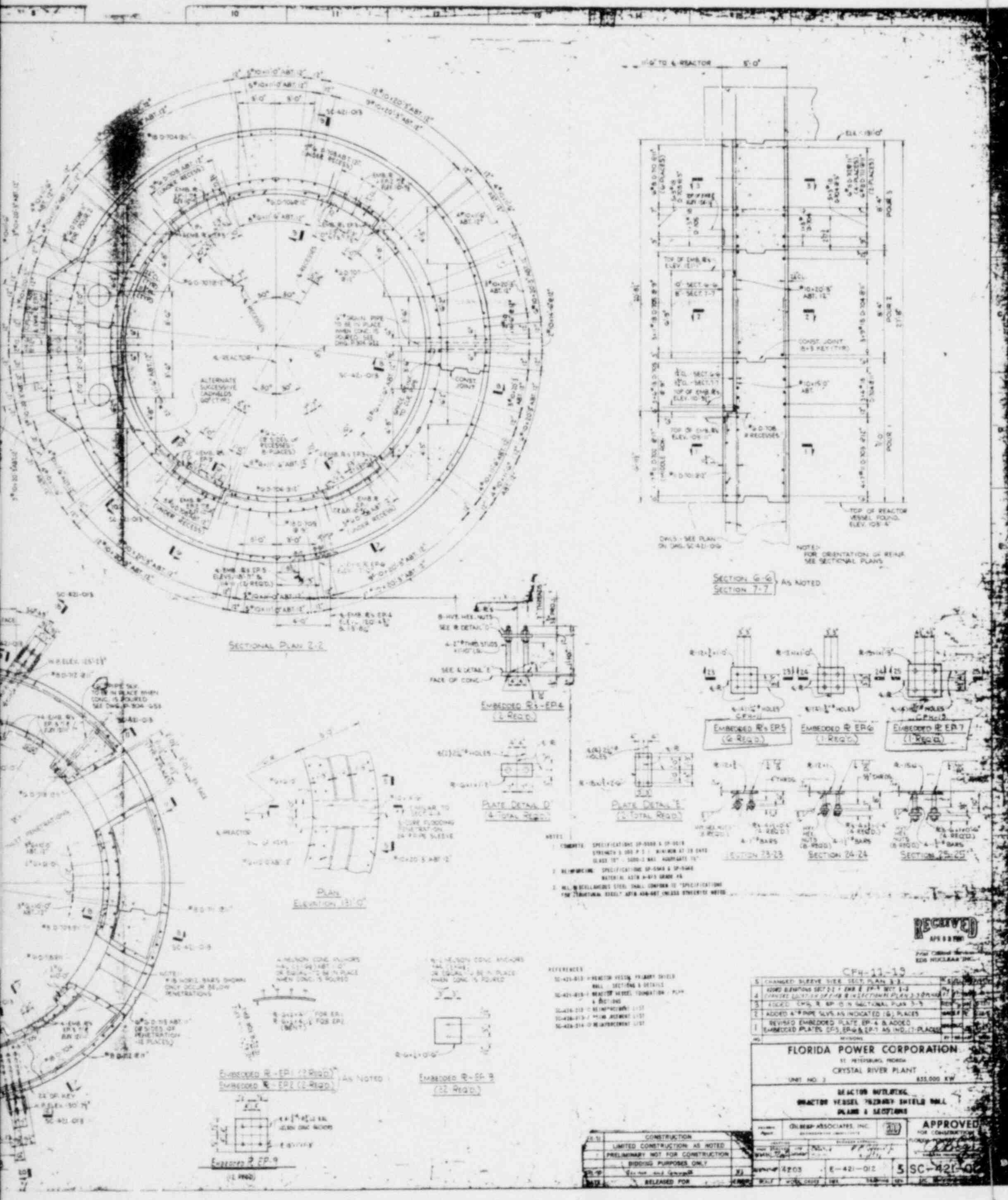
SECTION 3-3
SECTION C-C
SECTION D-D
ENLARGED PLAN "A"
SECTION E-E
SECTION F-F
SECTION G-G
TYPICAL DETAIL OF REINFORCEMENT AT OPENINGS
SECTION H-H
SECTION J-J
SECTION K-K
SECTION L-L
SECTION M-M
SECTION N-N
SECTION Q-Q
SECTION AI-AI
SECTION R-R
SECTION U-U
DETAIL "AG"
DETAIL "AH"
ELEVATOR MACHINERY FLOOR SLAB
NOTES:
1. CONCRETE TO HAVE A MINIMUM COMPRESSIVE STRENGTH OF 3,000 P.S.I. AT THE END OF 28 DAYS.
4. REINFORCEMENT TO BE CUT FROM LINEAR FEET.
5. CUT REINFORCEMENT AT OPENINGS TO SUIT IN FIELD.
REFERENCES:
STEEL FRAMING PLAN
REINFORCEMENT LIST
ANCHOR BOLT LIST
FLOOR DRAINS
LIGHTING LAYOUT
RECEIVED
63
Print Control Services
EDS NUCLEAR INC.
CONSTRUCTION
LIMITED CONSTRUCTION AS NOTED
PRELIMINARY NOT FOR CONSTRUCTION
BIDDING PURPOSES ONLY
DATE
RELEASED FOR
METROPOLITAN EDISON COMPANY
THREE MILE ISLAND NUCLEAR STATION
REACTOR BUILDING - CONCRETE
GILBERT ASSOCIATES, INC.
4192
E-421-009


PLAN AT ELEVATION
NOTE
PLAN



SECTION (A)
SECTION (B)
PLAN AT ELEVATION 807'-0"
LEGEND
DETAIL (1)
TYP. CONSTR. JT.
PLAN (B)
PARTIAL PLAN - SHOWING ANCHOR BOLT LOCATION FOR CORE FLOODING LINES
SHIELD WALL
GEN. NOTES
REFERENCE DRAWINGS (CONT)
RECEIVED
UNIT 1 ORIG.
ENGINEER
BECHTEL CORP. JOB NO. 6210
DUKE POWER COMPANY
OCONEE NUCLEAR STATION UNITS 1, 2 & 3
REACTOR BUILDING
PRIMARY & SECONDARY SHIELD WALLS
PLANS AT EL. 777-6 & 807-0
CONCRETE
O-GRA


N
ALTERNATE SUCCESSIVE LAP SPLICES 45° (TYP)
REACTOR
SC-421-019
BARS SHOWN THUS INDICATE DOWELS - SEE DWG. SC-421-016
SECTIONAL PLAN 1-1
PLAN
ELEVATION 131'-0"
CPN-11
SECTION 4-4
ELEVATION 5-5
(2-PLACES)
SECTIONAL PLAN 3-



SECTIONAL PLAN 2-2
SECTION 6-6
SECTION 7-7
AS NOTED
EMBEDDED PL'S EP-4
(2 REQ'D)
PLATE DETAIL 'D'
(4 TOTAL REQ'D)
PLATE DETAIL 'E'
(2 TOTAL REQ'D)
EMBEDDED PL'S EP-5
(6 REQ'D)
EMBEDDED PL EP-6
(1 REQ'D)
EMBEDDED PL EP-7
(1 REQ'D)
SECTION 23-23
SECTION 24-24
SECTION 25-25
PLAN
ELEVATION 131'-0"
EMBEDDED PL-EP-1 (2 REQ'D)
EMBEDDED PL-EP-2 (2 REQ'D)
AS NOTED
EMBEDDED PL-EP-9
(32 REQ'D)
NOTE: FOR ORIENTATION OF REINF. SEE SECTIONAL PLANS
TOP OF REACTOR VESSEL FOUND. ELEV. 105'-6"
CF4-11-19
RECEIVED
5 CHANGED SLEEVE SIZE SECT. PLAN 3-3
4 ADDED ELEVATIONS SECT 2-2 + EMB PL EP-9 SECT 1-1
3 ADDED EMB PL EP-8 IN SECTIONAL PLAN 3-3
2 ADDED 4" PIPE SLVS. AS INDICATED (6) PLACES
1 REVISED EMBEDDED PLATE EP-4 & ADDED EMBEDDED PLATES EP-5, EP-6 & EP-7 AS IND. (7-PLACES)
REVISIONS
FLORIDA POWER CORPORATION
ST. PETERSBURG, FLORIDA
CRYSTAL RIVER PLANT
UNIT NO. 3
REACTOR BUILDING
REACTOR VESSEL PRIMARY SHIELD WALL
PLANS & SECTIONS
GILBERT ASSOCIATES, INC.
APPROVED
CONSTRUCTION
LIMITED CONSTRUCTION AS NOTED
PRELIMINARY NOT FOR CONSTRUCTION
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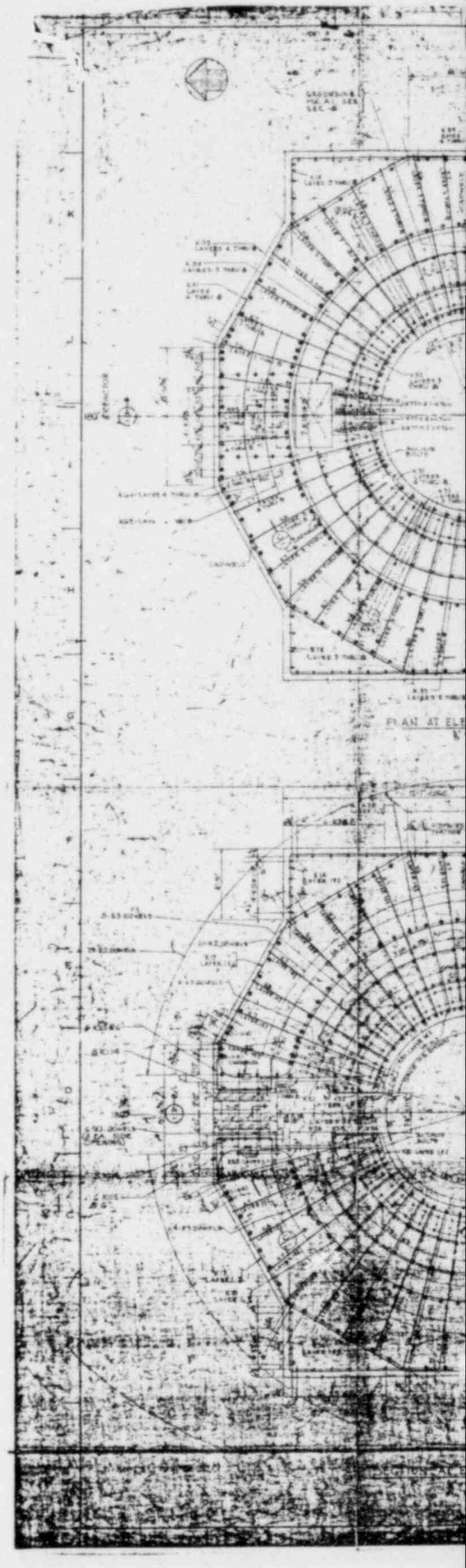
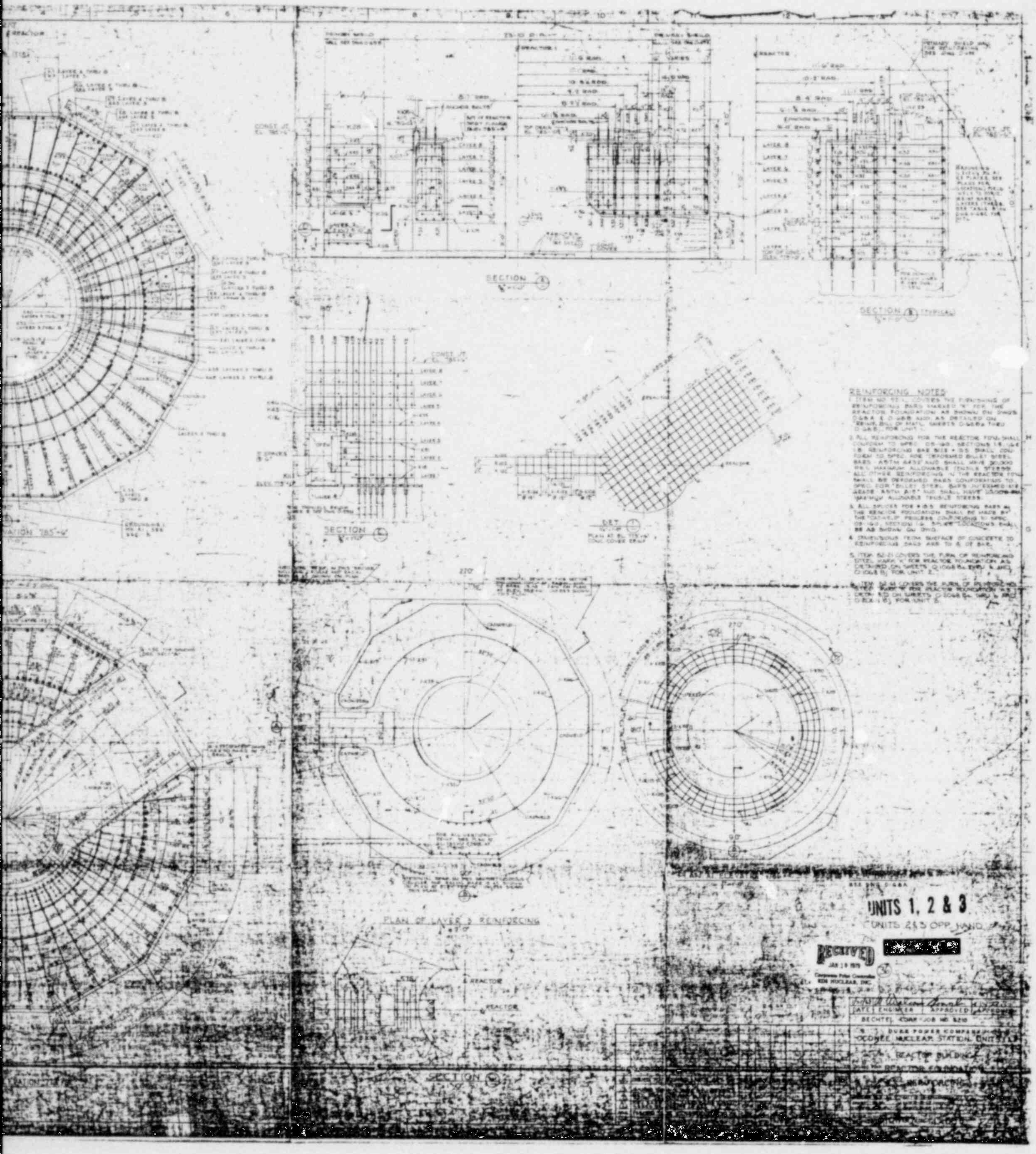
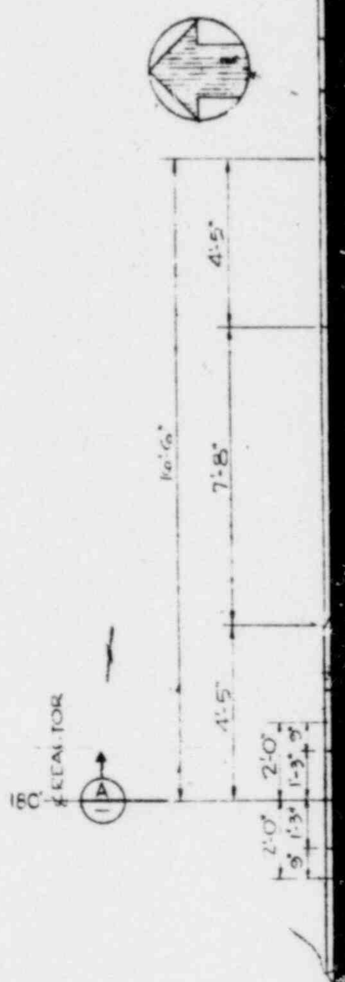
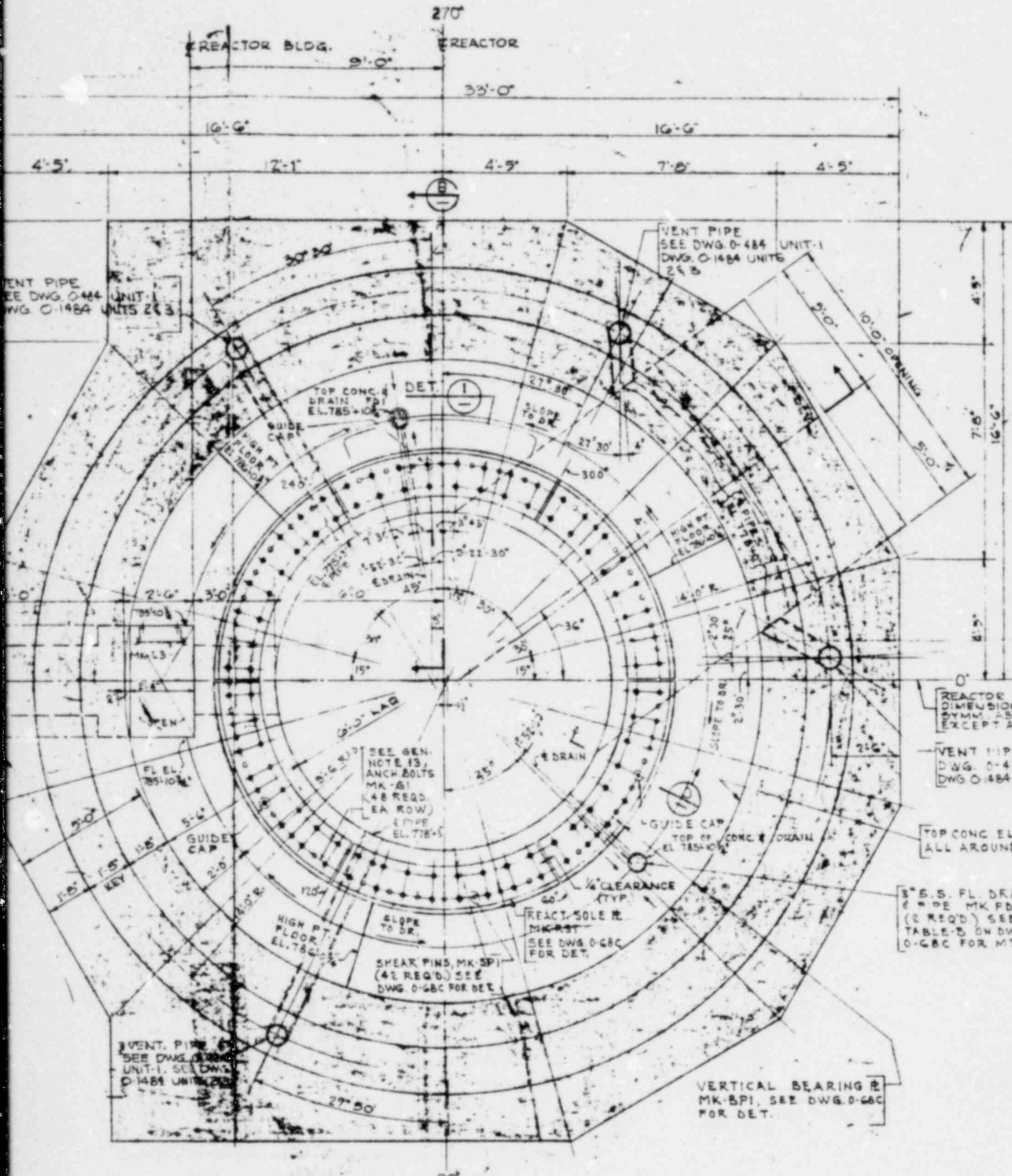
RELEASED FOR
4203
E-421-012
5
SC-421-0





SECTION
PLAN OF LAYER 5 REINFORCING
REINFORCING NOTES
UNITS 1, 2 & 3
UNITS 2&3 OPP. HAND
RECEIVED
DATE
ENGINEER
APPROVED
DUKE POWER COMPANY
OCONEE NUCLEAR STATION
REACTOR BUILDING

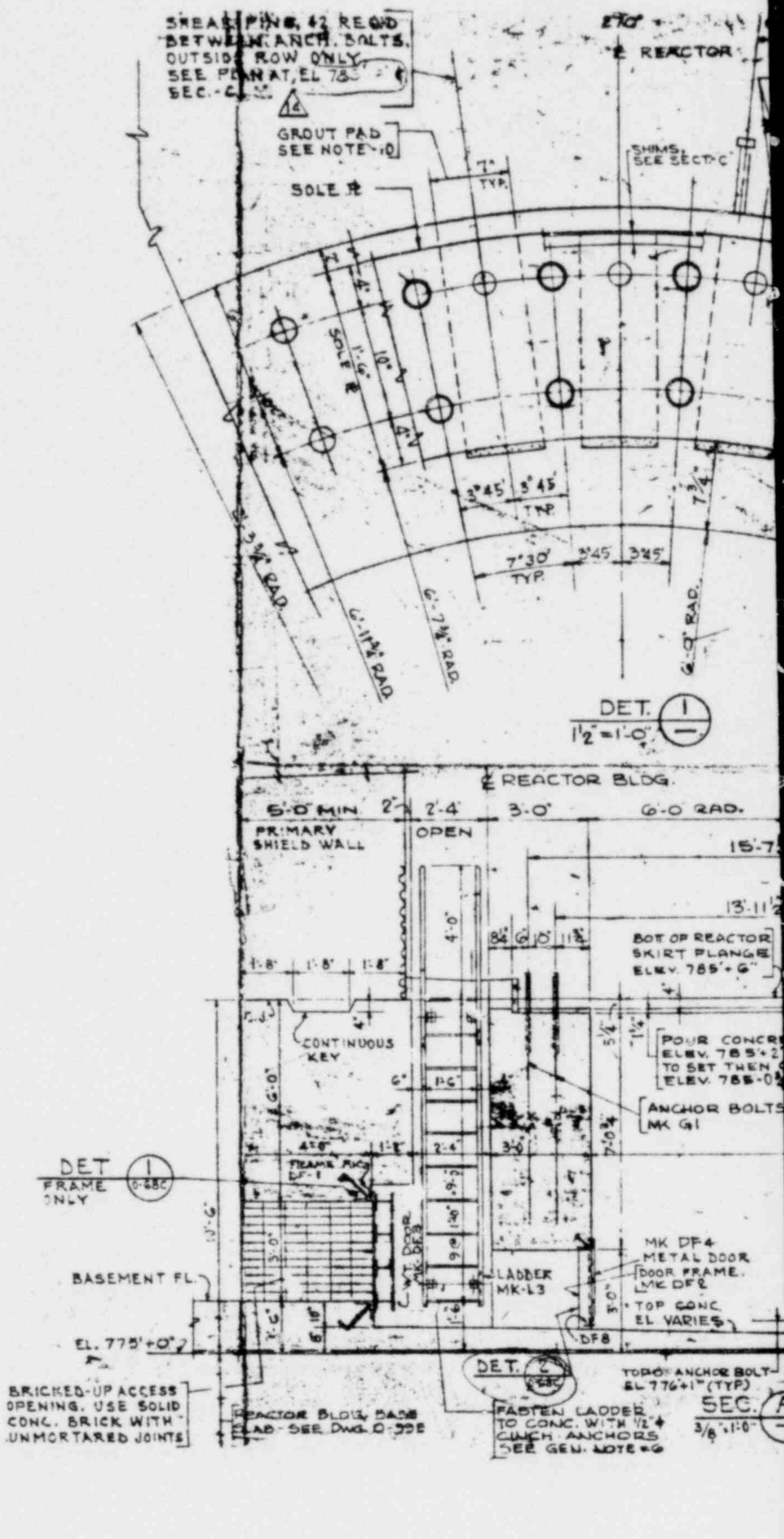

180°
REACTOR
A
16'-6"
4'-5"
7'-8"
4'-5"
2'-0"
2'-0"
1'-3"
1'-3"
9"
9"



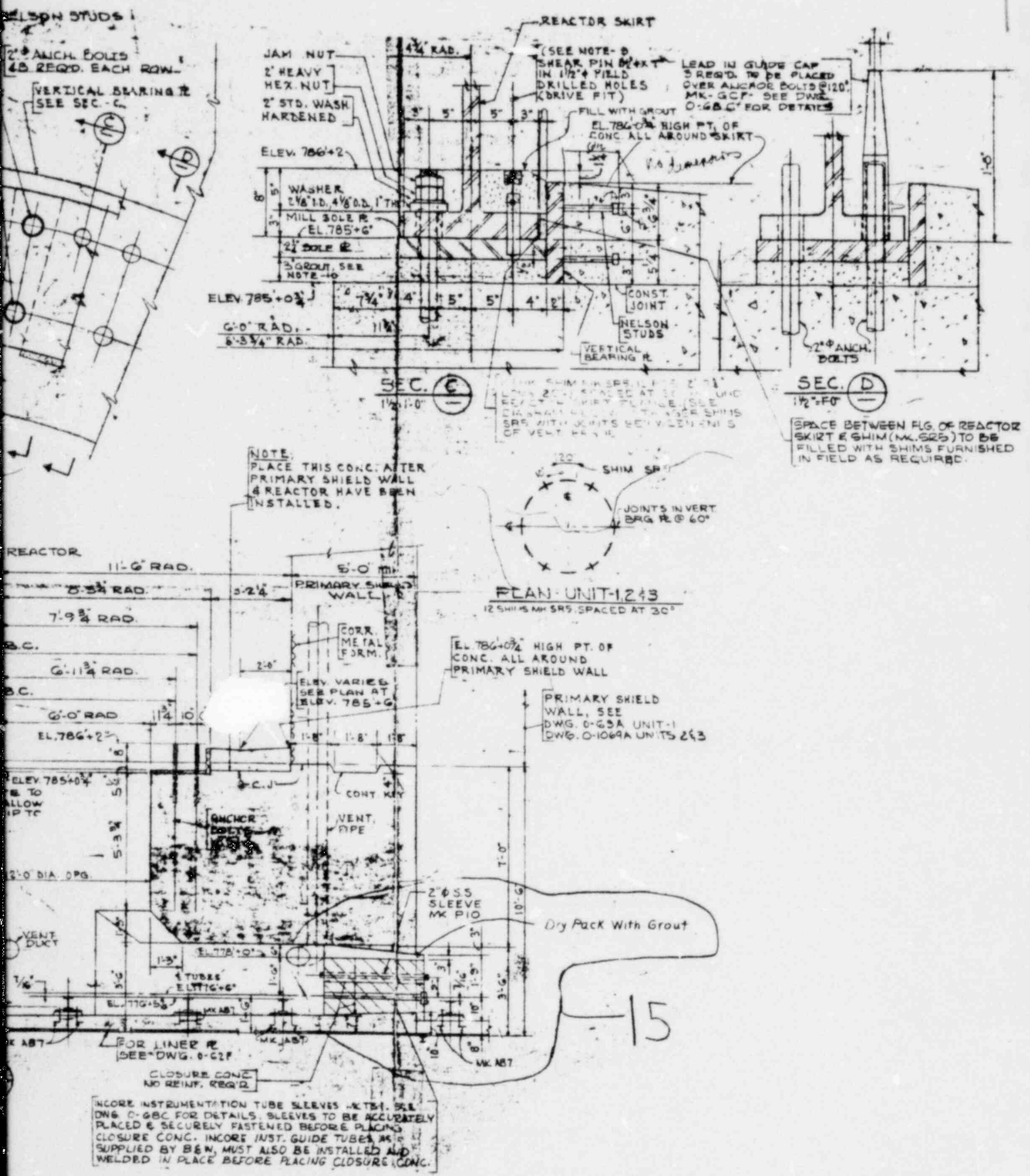
PLAN AT ELEVATION 785'+6"

3/8" = 1'-0"

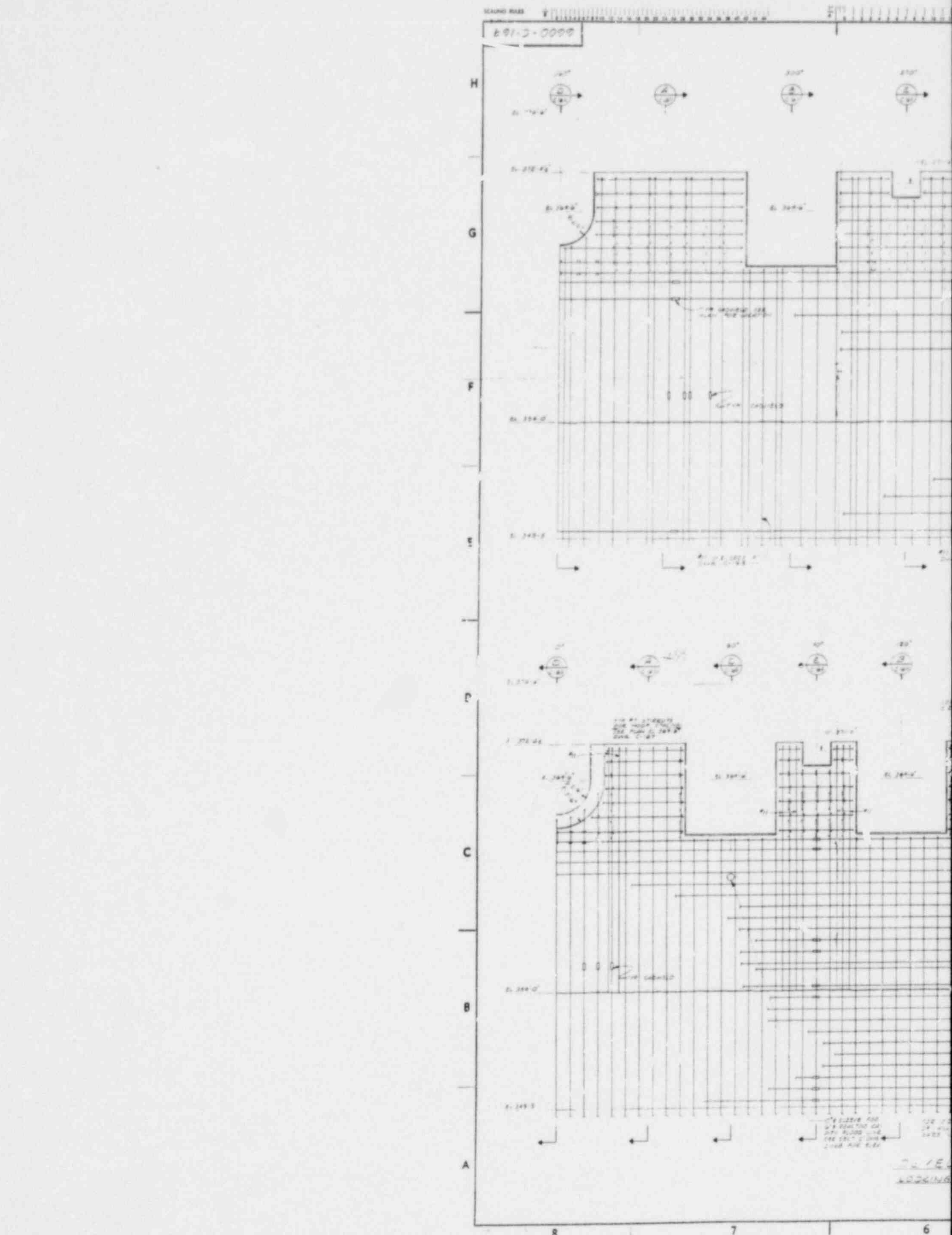
Drawing No. 0-68A



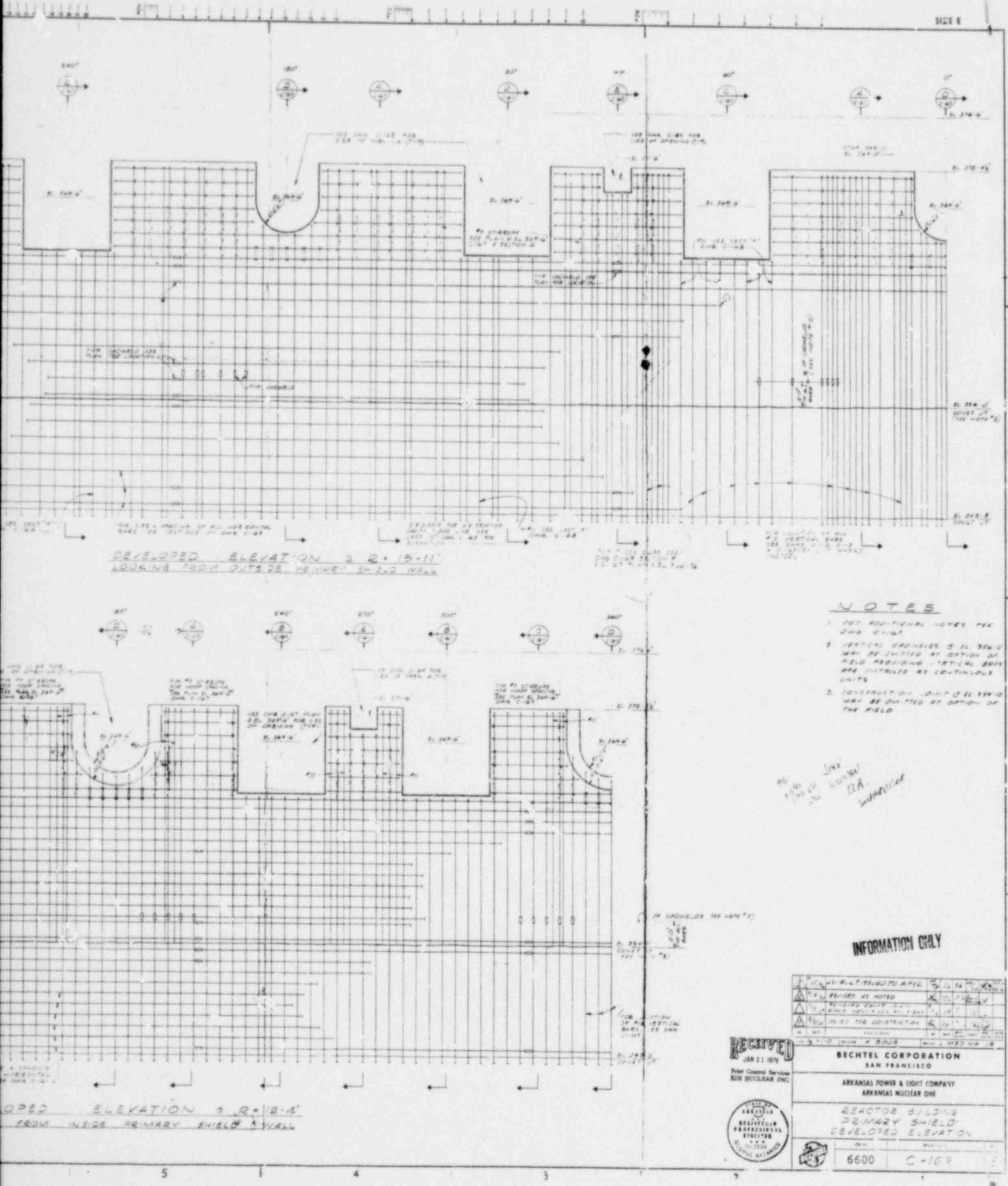
SHEAR PINS, 42 REQ'D BETWEEN ANCH. BOLTS, OUTSIDE ROW ONLY, SEE PLAN AT EL 785 SEC.-C
GROUT PAD SEE NOTE 10
SOLE PL
SHIMS SEE SECT C
REACTOR
TYP.
3°45' 3°45' TYP.
7°30' TYP.
3°45' 3°45'
6'-0" RAD.
6'-7½" RAD.
6'-11½" RAD.
DET. 1
1½"=1'-0"
REACTOR BLDG.
5'-0" MIN
2'-4"
3'-0"
6'-0" RAD.
PRIMARY SHIELD WALL
OPEN
15'-7
13'-11½
BOT OF REACTOR SKIRT FLANGE ELEV. 785'+6"
CONTINUOUS KEY
POUR CONCRE ELEV. 785'+2 TO SET THEN ELEV. 785'-0
ANCHOR BOLTS MK G1
DET 1 FRAME ONLY
BASEMENT FL.
LADDER MK-L3
MK DF4 METAL DOOR DOOR FRAME MK DF8
TOP CONC. EL VARIES
DF8
EL. 775'+0"
DET. 2
TOP OF ANCHOR BOLT EL 776'+1" (TYP)
SEC.
3/8"=1'-0"
BRICKED-UP ACCESS OPENING. USE SOLID CONC. BRICK WITH UNMORTARED JOINTS
REACTOR BLDG. BASE SLAB - SEE DWG. D-39E
FASTEN LADDER TO CONC. WITH ½" Ø CINCH ANCHORS SEE GEN. NOTE 6

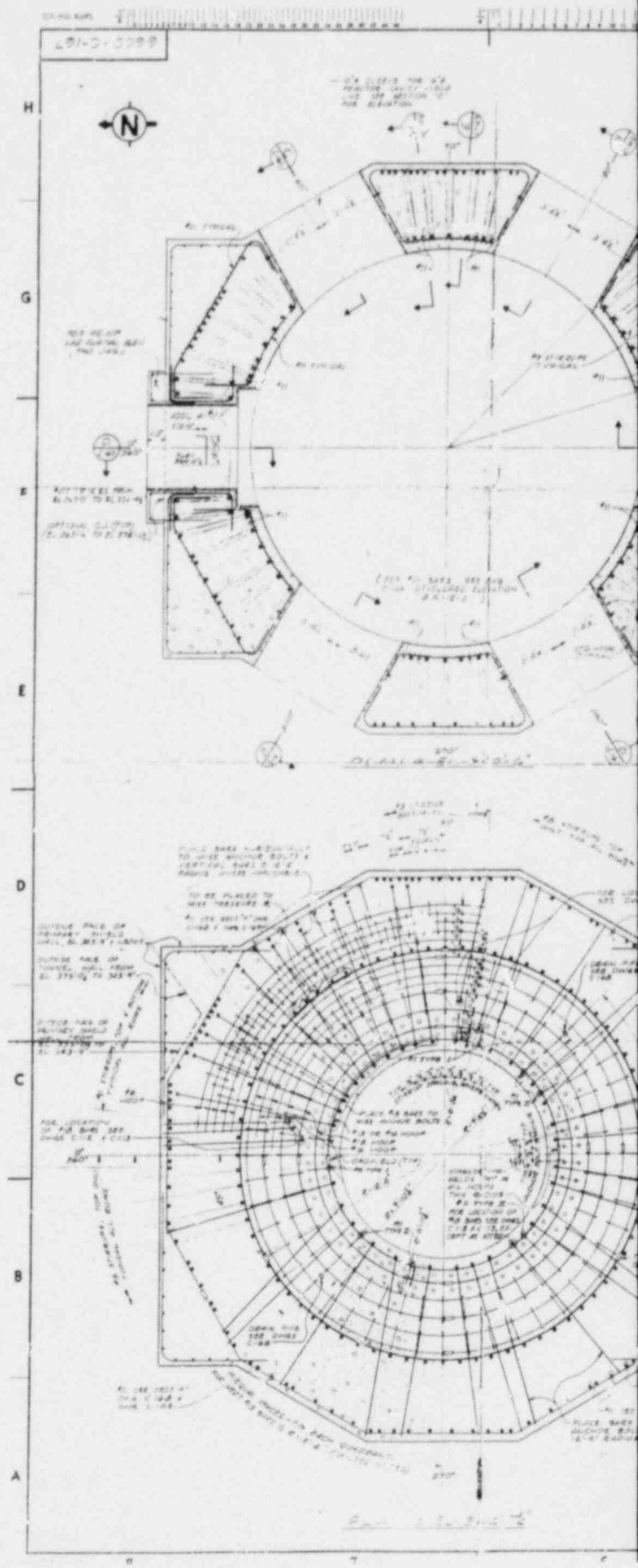


Drawing No. 0-68A

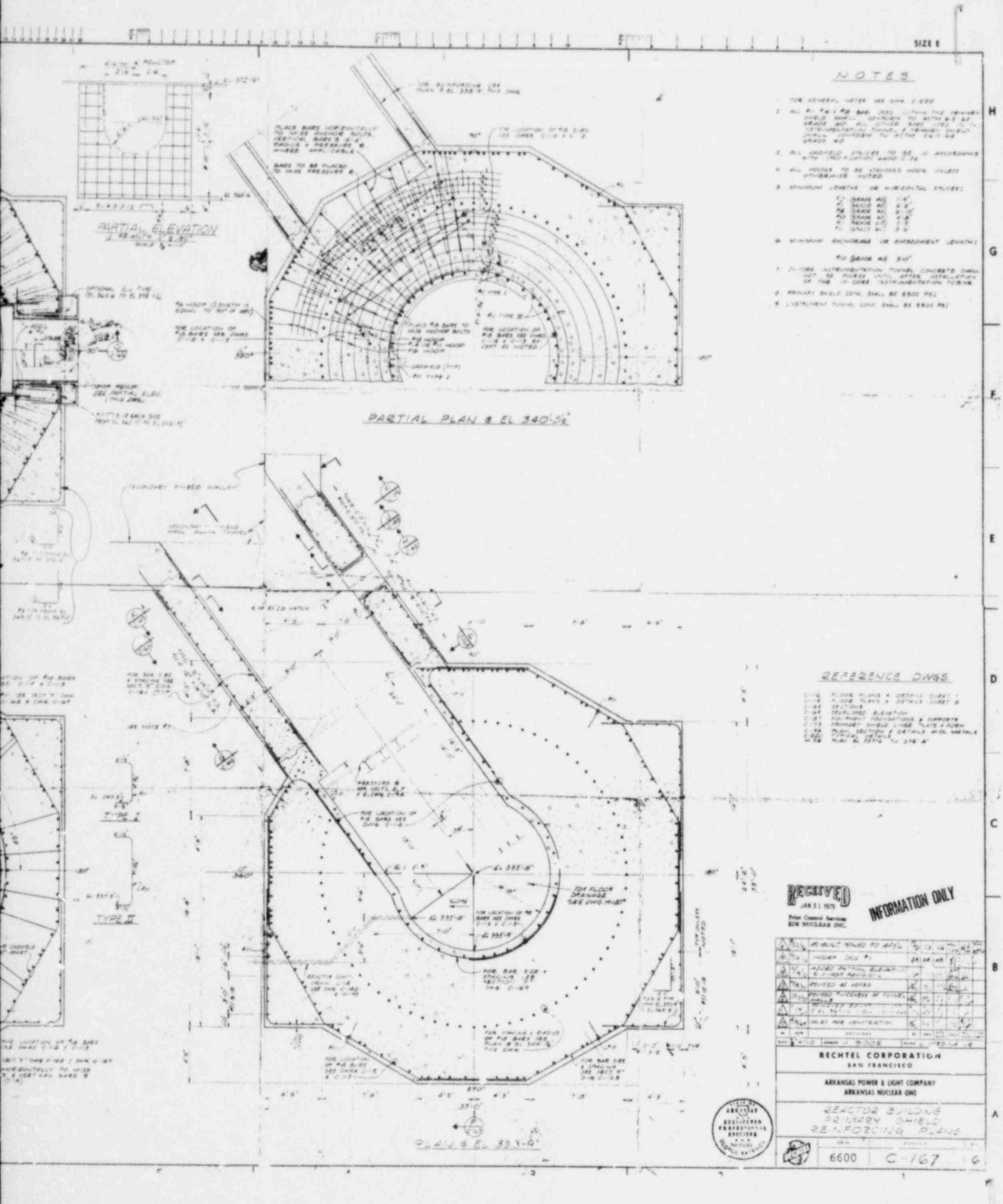


H
G
F
E
D
C
B
A
8
7
6

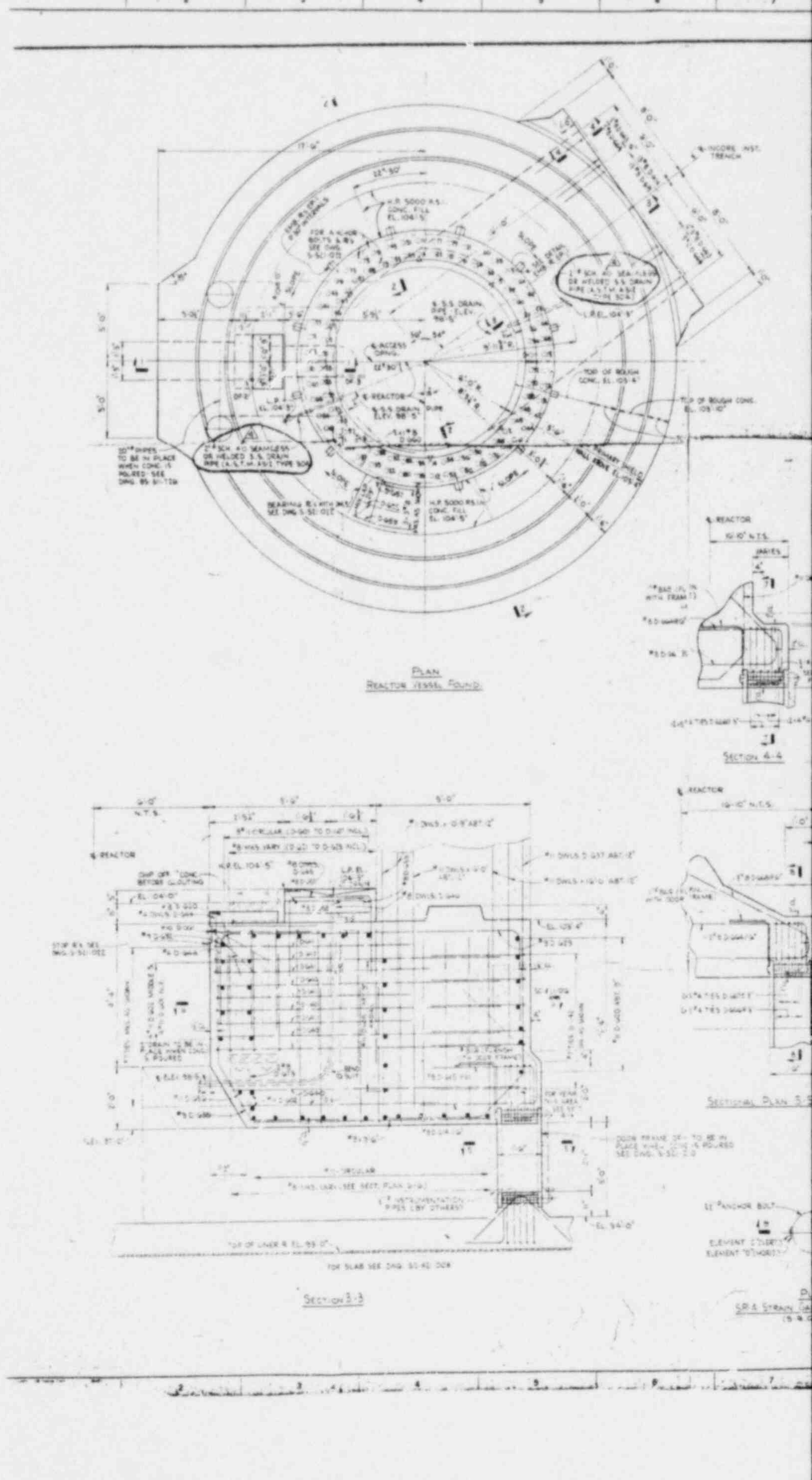

SIZE E
DEVELOPED ELEVATION @ R = 13-11"
LOOKING FROM OUTSIDE PRIMARY SHIELD WALL
NOTES
1. FOR ADDITIONAL NOTES SEE DWG C-167
2. VERTICAL CADWELDS @ EL 356-0 MAY BE OMITTED AT OPTION OF FIELD PROVIDING VERTICAL BARS ARE INSTALLED AS CONTINUOUS UNITS
3. CONSTRUCTION JOINT @ EL 356-0 MAY BE OMITTED AT OPTION OF THE FIELD
INFORMATION ONLY
RECEIVED
JAN 31 1979
Print Control Services
KDB NUCLEAR INC.
BECHTEL CORPORATION
SAN FRANCISCO
ARKANSAS POWER & LIGHT COMPANY
ARKANSAS NUCLEAR ONE
REACTOR BUILDING
PRIMARY SHIELD
DEVELOPED ELEVATION
6600
C-167
ELEVATION @ R = 12-4"
FROM INSIDE PRIMARY SHIELD WALL



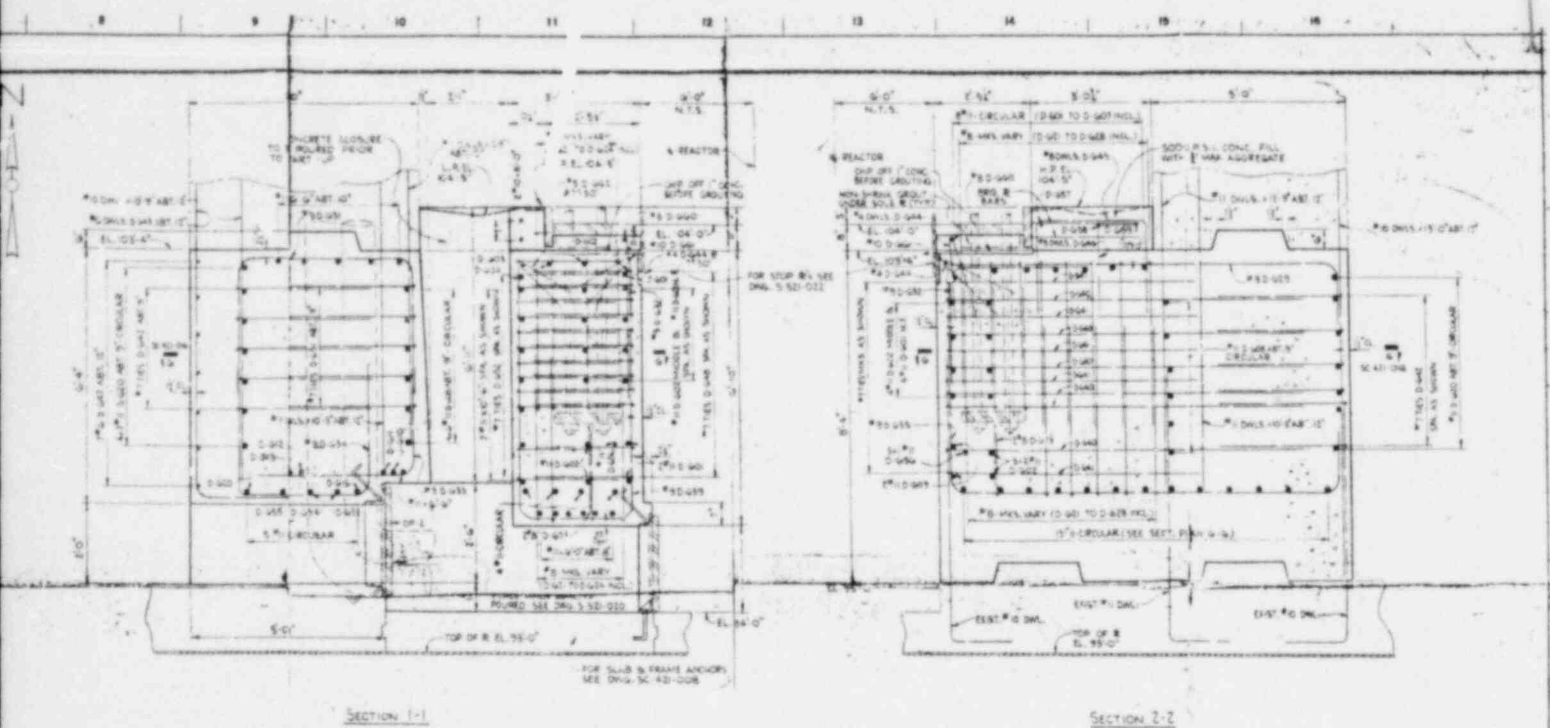
N
H
G
F
E
D
C
B
A

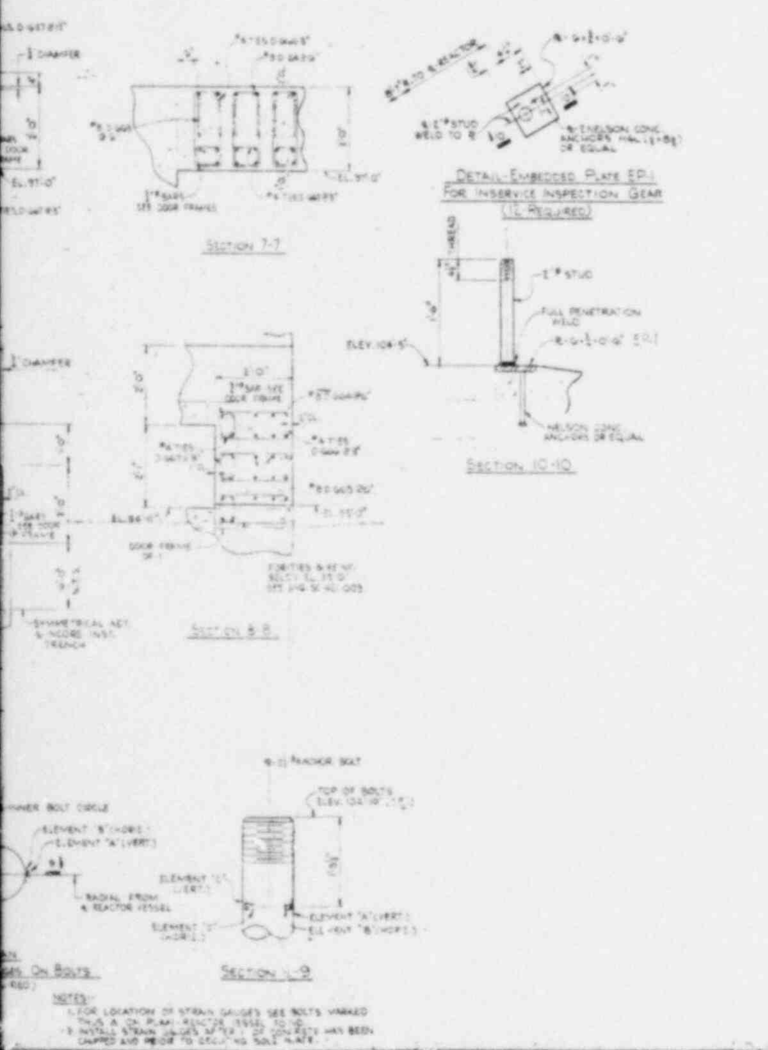


SIZE E
NOTES
PARTIAL ELEVATION
PARTIAL PLAN @ EL 340'-5½"
TYPE I
TYPE II
PLAN @ EL 333'-4"
REFERENCE DWGS
RECEIVED
INFORMATION ONLY
BECHTEL CORPORATION
SAN FRANCISCO
ARKANSAS POWER & LIGHT COMPANY
ARKANSAS NUCLEAR ONE
REACTOR BUILDING
PRIMARY SHIELD
REINFORCING PLANS
6600
C-167
6



PLAN
REACTOR VESSEL FOUND.
SECTION 4-4
SECTIONAL PLAN 5-5
SECTION 3-3
TOP OF ROUGH CONC. EL. 105'-10"
FOR SLAB SEE DWG. 5-S2-008





NOTES

1. CONCRETE: SPECIFICATIONS SP-5569 AND SP-5618. STRENGTH 5,000 P.S.I. MINIMUM AT 28 DAYS. CLASS "D"-5000-I MAX. AGGREGATE 1½".
2. REINFORCING: SPECIFICATIONS SP-5646 & SP-5646. MATERIAL ASTM A615 GRADE 40
3. NONSHRINK GROUT SHALL BE NON-METALLIC, DIMENSIONALLY STABLE, PREMIXED AND INORGANIC "SAUEREISEN LEVEL-FILL GROUT" AS MANUFACTURED BY SAUEREISEN CEMENTS CO. OR APPROVED EQUAL. PERFORM ALL WORK IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS. THE NON-SHRINK GROUT SHALL REACH A MINIMUM COMPRESSIVE STRENGTH OF 5,000 PSI IN 28 DAYS. CURE GROUT IN ACCORDANCE WITH CONCRETE SPECIFICATIONS NOTED ON DRAWING.
4. SIXTEEN (16) EMBEDDED STRAIN GAUGES SHALL BE CEMENTED TO THE EIGHT (8) BOLTS LOCATED ON THE INNER BOLT CIRCLE AS NOTED ON "PLAN-REACTOR VESSEL FOUNDATION". THE STRAIN GAUGES SHALL BE PROTECTED FROM DAMAGE BEFORE AND DURING CONCRETE PLACEMENT, BE WATERPROOF AND ABLE TO FUNCTION PROPERLY FOR ONE YEAR AFTER THE INITIAL TENSILE STRESSING OF THE 2½" DIAMETER ANCHOR BOLTS. THE STRAIN GAUGES SHALL BE "SR-4 TYPE FABT-250-3S53" AS MANUFACTURED BY BALDWIN-LIMA-HAMILTON. THE STRAIN GAUGES AND ASSOCIATED INSTRUMENTATION SHALL HAVE A RESOLUTION OF TWO (2) MICRO INCHES PER INCH AND AN ACCURACY OF THIRTY-FIVE (35) MICRO INCHES PER INCH. STRAIN GAUGES SHALL BE FURNISHED, INSTALLED AND MONITORED BY AN ENGINEERING TESTING LABORATORY QUALIFIED TO ENGAGE IN THIS TYPE OF WORK. THE TESTING LABORATORY SHALL SUBMIT INSTRUMENTATION DETAILS AND DRAWINGS TO THE ENGINEER PRIOR TO INSTALLATION OF THE STRAIN GAUGES. THE WIRING CONNECTION OF THE STRAIN GAUGES TO THE BOLTS SHALL ACCOMMODATE A MINIMUM VERTICAL DISPLACEMENT OF 0.750 INCHES. STRAIN GAUGES SHALL BE WIRED IN A FOUR (4) ACTIVE ARM STRAIN GAUGE WHEATSTONE BRIDGE. INSTRUMENTATION EQUIPMENT SHALL BE CAPABLE OF MONITORING APPROXIMATELY 1200 MICROINCHES PER INCH. THE STRAIN GAUGES SHALL BE MONITORED AT THE TIME OF POST-TENSIONING ... YEAR AFTER POST-TENSIONING, WHICHEVER TIME OCCURS FIRST. ALL CALIBRATION AND STRAIN DATA SHALL BE SUBMITTED TO THE ENGINEER.
5. FOR POST TENSIONING REFER TO "PROPOSED ANCHOR BOLT POST-TENSIONING PROCEDURE." NUMBER SEQUENCE SHOWN ON "PLAN-REACTOR VESSEL FOUNDATION" IS THE ORDER OF TENSIONING OF THE ANCHOR BOLTS.

REFERENCES:

- SC-421-015-1 REACTOR VESSEL FOUND. REINFORCEMENT PLACING
- SC-421-008 CONCRETE OUTLINE-BSMT. FLR. ELEV. 95'-0"
- 1-521-020 DOOR PLATE & EMBEDDED FRAMES
- RE-211-126 ALIGN. SERVICE PLAN AT ELEV. 119'-6"
- SC-424-101 REINFORCEMENT LIST
- SC-424-108 REINFORCEMENT LIST
- SC-424-108 REINFORCEMENT LIST
- SC-424-113 REINFORCEMENT LIST

RECEIVED
JAN 24 1979
Prime Control Services
EDH NUCLEAR INC.

NO.	REVISIONS	BY	CK	APP	DATE
4	CHANGED 2" DRAIN PIPE TO SCH 40 (6 PLACES) TO SUIT AS BUILT CONDITION PER/ ECN-T-21. ALSO UPDATED NOTE #3 AS INDICATED.				
3	ROTATED LOC. OF 18 & EP-1 15° (SEE PLAN). REMOVED GROUT AS INDICATED (3) PLACES				
2	ADDED DRAIN PIPE INFORMATION AS NO. (3) PLACES				
1	ADDED EMBEDDED PLATE EP-1 AS INDICATED				

FLORIDA POWER CORPORATION
ST. PETERSBURG, FLORIDA
CRYSTAL RIVER PLANT
UNIT NO. 3 — 855,000 KW

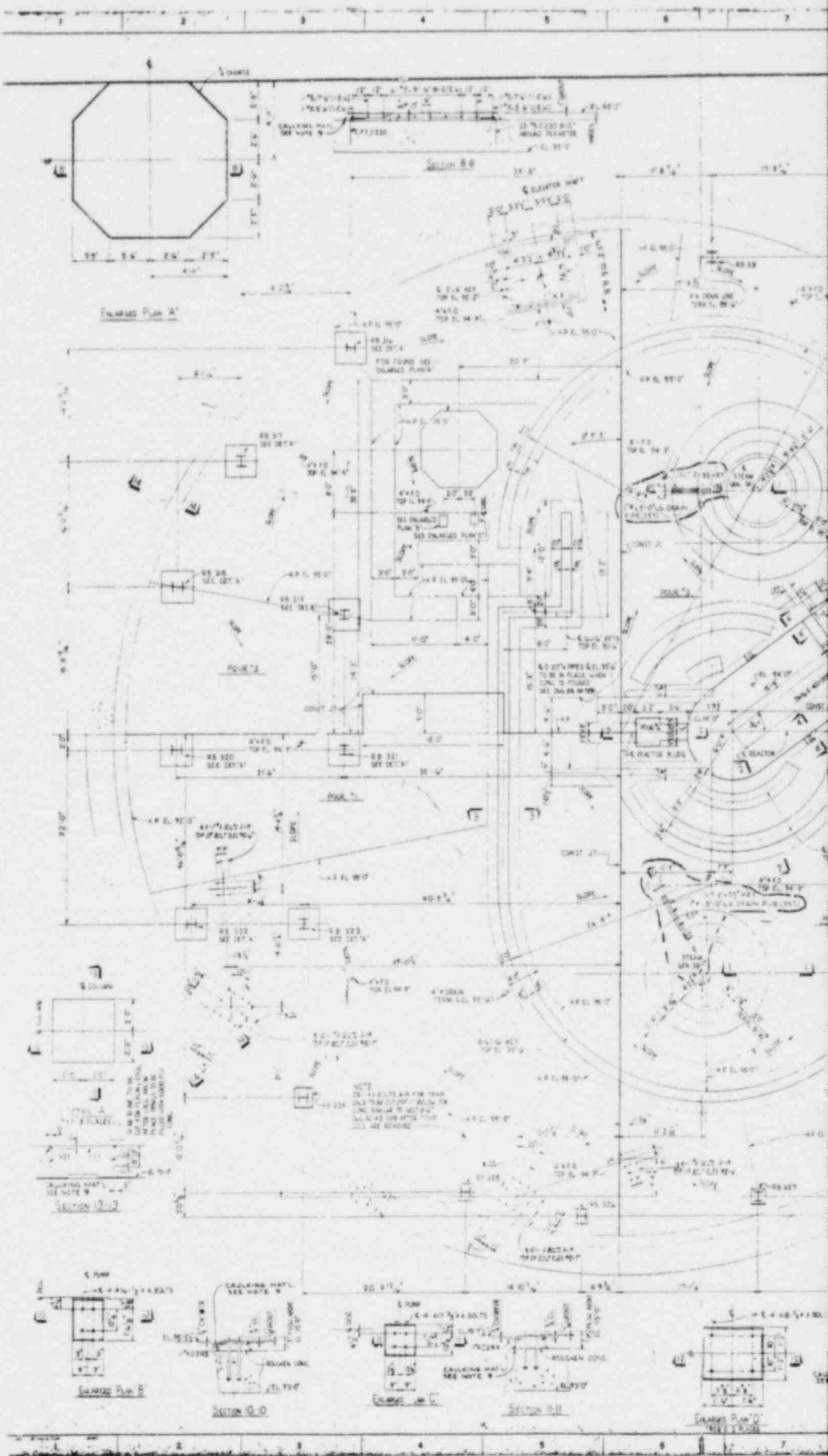
REACTOR BUILDING
REACTOR VESSEL FOUNDATION
PLAN & SECTIONS

GILBERT ASSOCIATES, INC.

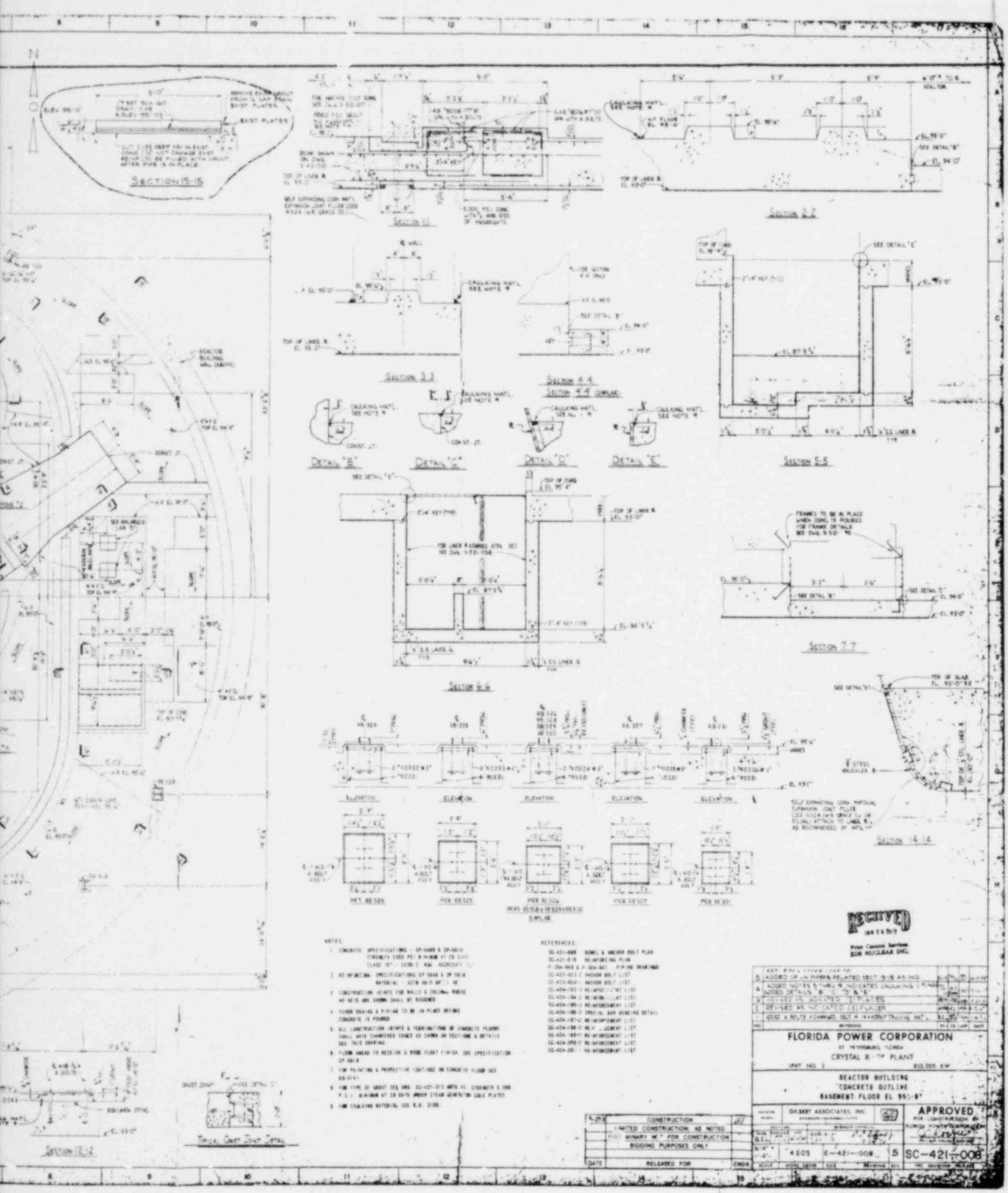
APPROVED FOR CONSTRUCTION BY FLORIDA POWER CORPORATION

ISSUE	
	CONSTRUCTION
	LIMITED CONSTRUCTION AS NOTED
	PRELIMINARY NOT FOR CONSTRUCTION
	BIDDING PURPOSES ONLY
DATE	RELEASED FOR

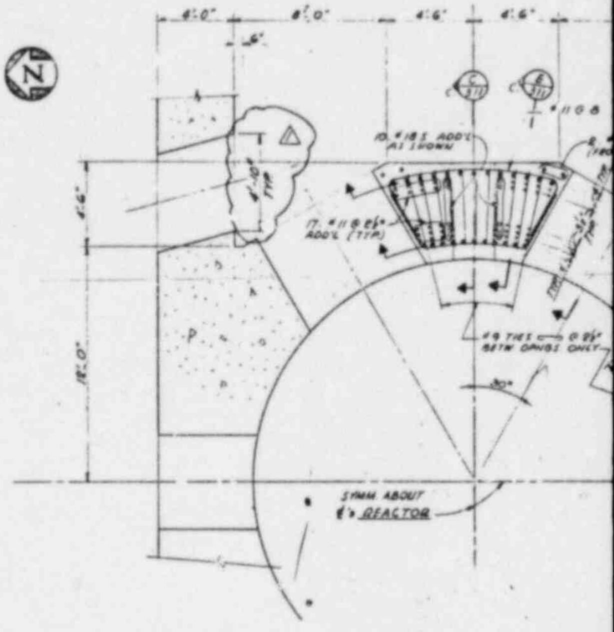
SCALE	WORK ORDER	DRAWING	REV.	FPC DRAWING NUMBER
	4203	S-421-015	4	SC-421-015



Enlarged Plan 'A'
Section B-B
Section 13-13
Enlarged Plan 'B'
Section 10-10
Enlarged Plan 'C'
Section 11-11
Enlarged Plan 'D'
1
2
3
4
5
6
7

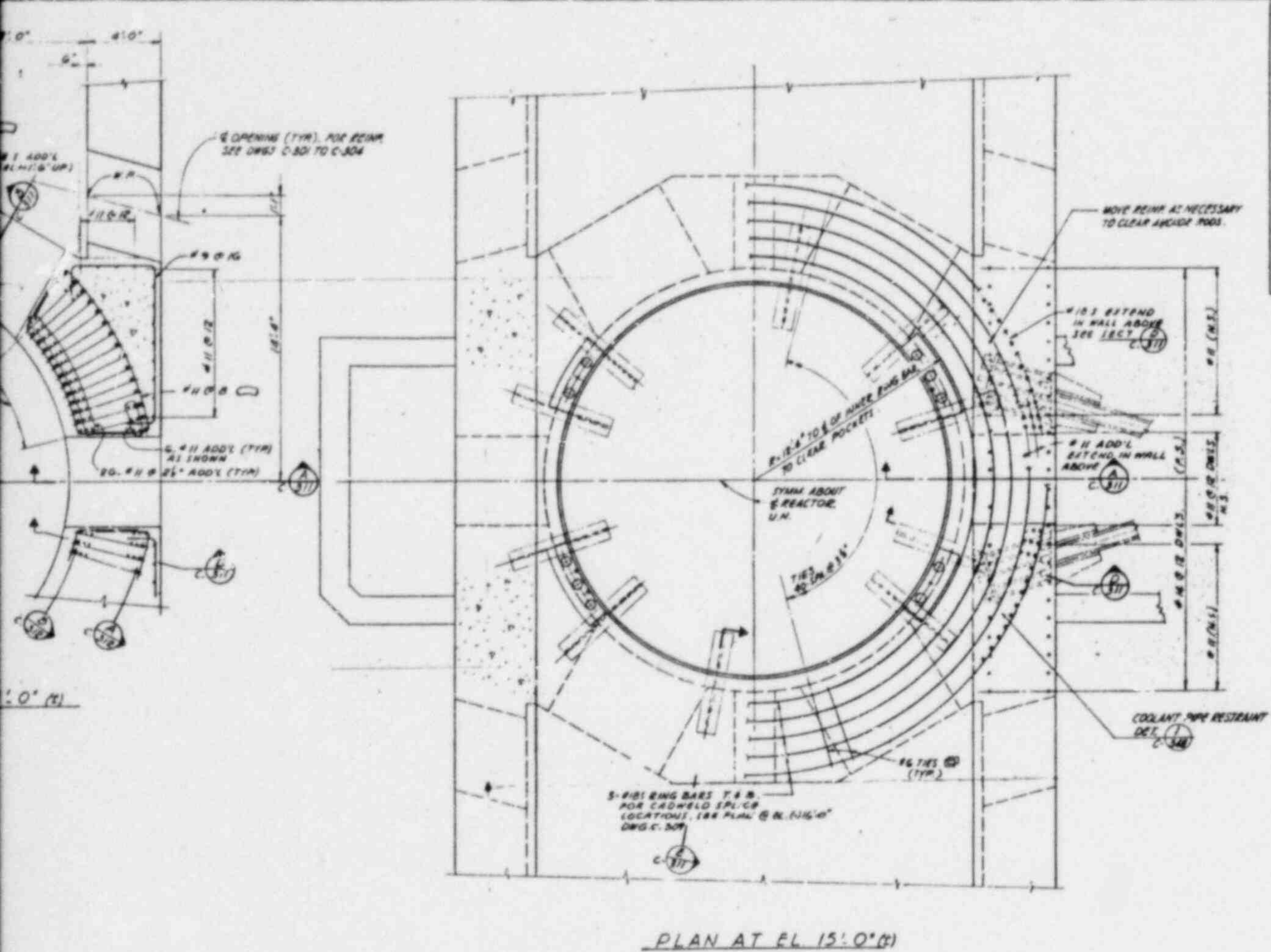


SECTION 15-15
SECTION 1-1
SECTION 2-2
SECTION 3-3
SECTION 4-4
SECTION 4'-4' (SIMILAR)
SECTION 5-5
SECTION 6-6
SECTION 7-7
SECTION 12-12
SECTION 14-14
DETAIL "B"
DETAIL "C"
DETAIL "D"
DETAIL "E"
ELEVATION
TYPICAL CONST JOINT DETAIL
REACTOR BUILDING WALL (ABOVE)
NOTES:
REFERENCES:
RECEIVED
CONSTRUCTION
LIMITED CONSTRUCTION AS NOTED
PRELIMINARY NOT FOR CONSTRUCTION
BIDDING PURPOSES ONLY
RELEASED FOR
DATE
ENGR
5 ADDED OR ... PIPE & RELATED SECT 15-15 AS IND.
4 ADDED NOTES 5 THRU 9, INDICATED CAULKING ... ADDED DETAILS "B" "C" "D" & "E"
3 REVISED AS INDICATED (1) PLACES
2 REVISED AS INDICATED (3) PLACES
NO. REVISIONS
FLORIDA POWER CORPORATION
ST. PETERSBURG, FLORIDA
CRYSTAL RIVER PLANT
UNIT NO. 3
REACTOR BUILDING
CONCRETE OUTLINE
BASEMENT FLOOR EL 95'-0"
GILBERT ASSOCIATES, INC.
APPROVED
4205
E-421-008
5
SC-421-008

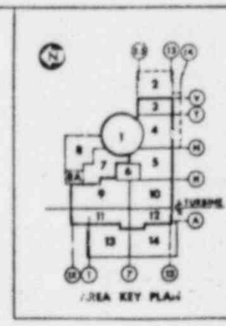


PARTIAL PLAN AT EL.

REVISION B
ISSUED FOR INVITATION
C.I.I (2-7-68)



PLAN AT EL. 15'-0" (±)



NOTES:
1. FOR CONC NOTES SEE DWG. C-276
2. WORK THIS DWG. WITH DWGS. C-309, C-311, C-318, C-400, C-401, C-281 & C-348

RECEIVED
JAN 24 1979
Print Control Services
EDS NUCLEAR INC.

DATUM EL. 0.0' = EL. 165.0' MSL

BECHTEL CORPORATION
LOS ANGELES

SACRAMENTO MUNICIPAL UTILITY DISTRICT
RANCHO SECO NUCLEAR STATION - UNIT 1

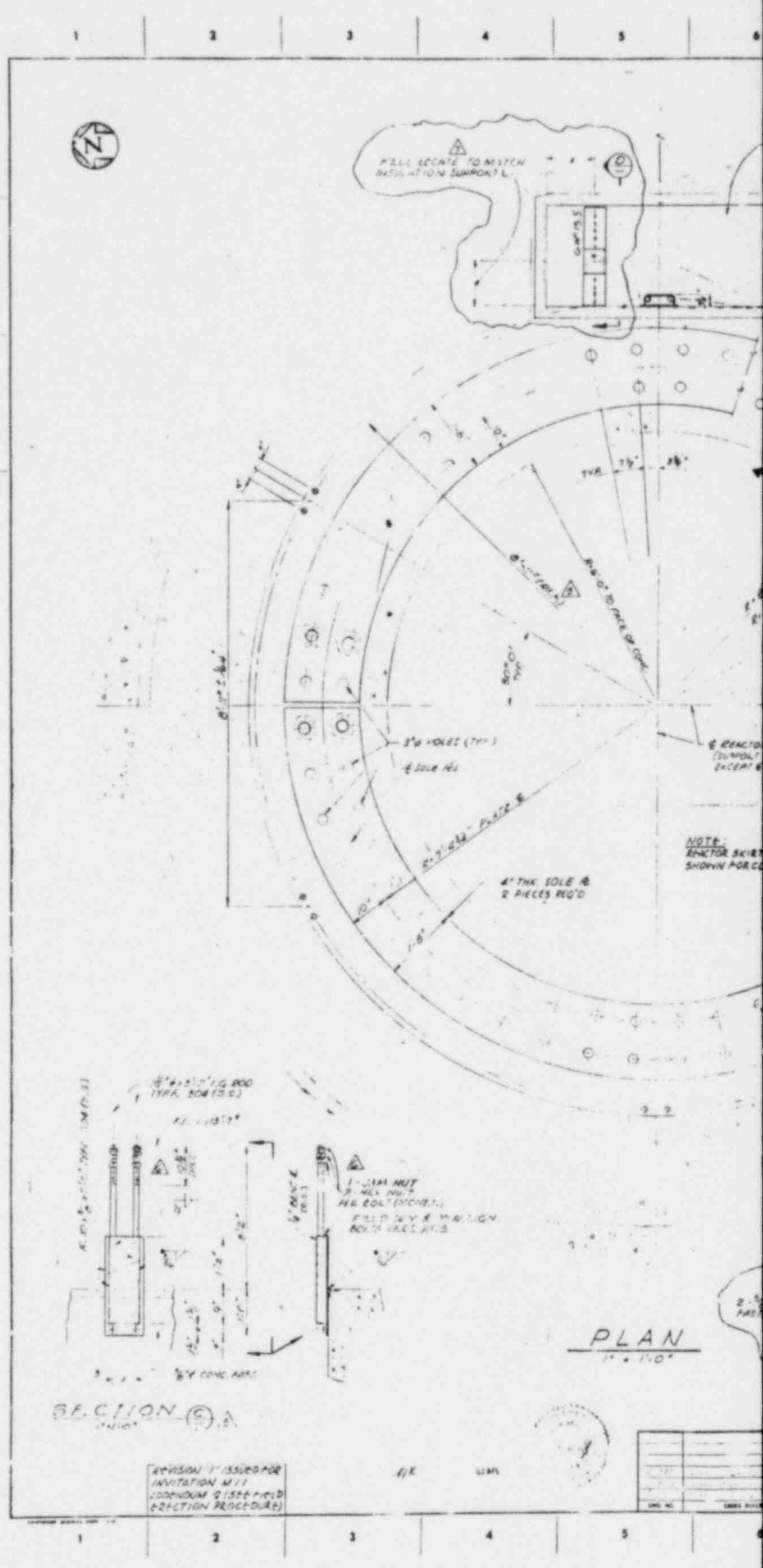
REACTOR BUILDING - AREA 1
REINFORCED CONCRETE
PRIMARY SHIELD - SHEET 2

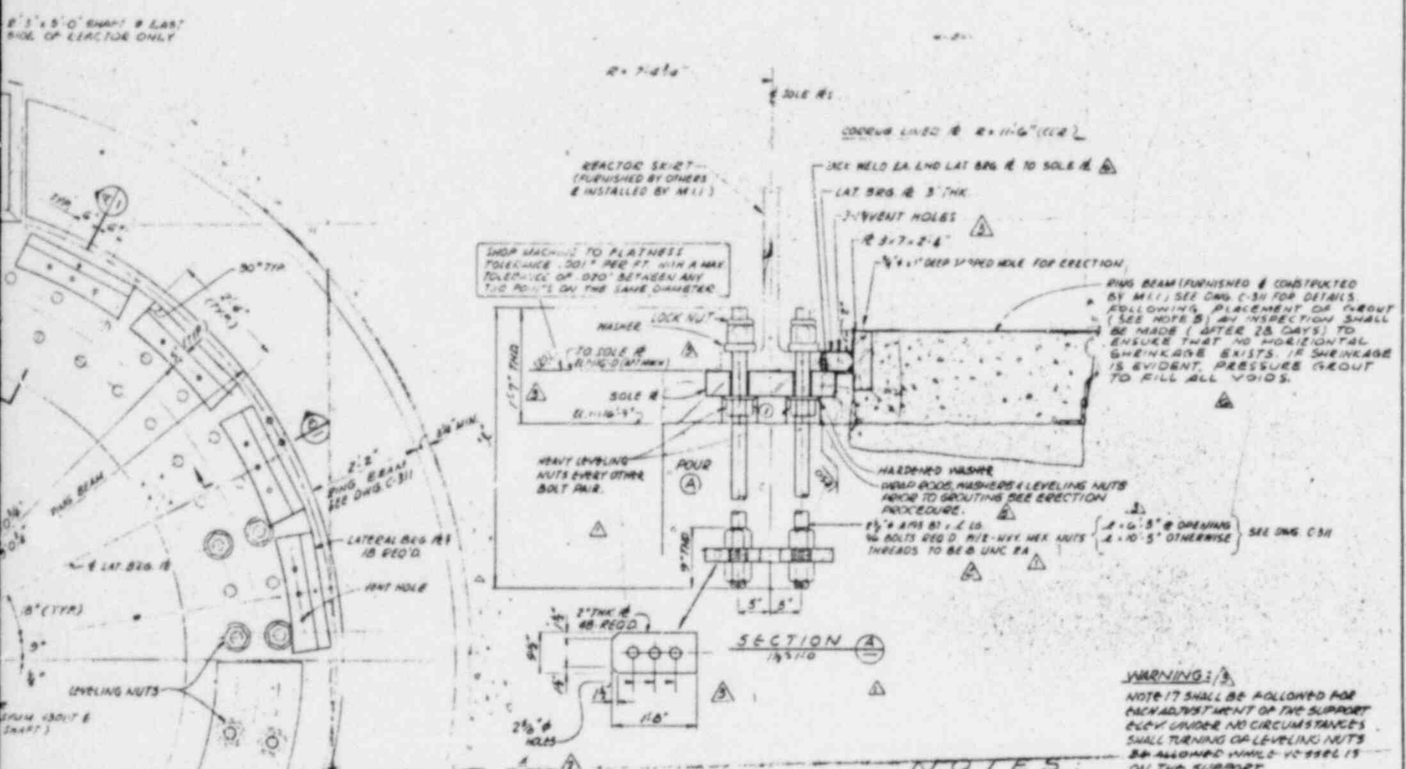
C-310 | 1

ABA474

Ref. Dwg.	
C-400	REACTOR CAVITY LINER
C-311	PRIMARY SHIELD, SHT. 3
C-281	TRANSFER CANAL SLAB
C-104	DESIGN DATA & GEN NOTES

No.	Revision
1	ADDED DIM AT D-9
0	ISSUED FOR CONSTRUCTION


PLAN
SECTION
4" THK. SOLE PL
2 PIECES REQ'D
NOTE:
REVISION 1 ISSUED FOR
INVITATION M11
ADDENDUM 2 (SEE FIELD
ERECTION PROCEDURE)



NOTES:

GENERAL

1. RANDOM SAMPLES OF EACH BOLT SIZE AND MATERIAL WILL BE SUBJECTED TO A BRINNEL HARDNESS TEST, FOR MATERIAL VERIFICATION, BY THE USER.
2. DRILL HOLES IN SOLE ℞'S AND MAKE A TEMPLATE OF THESE HOLES IN ACCORDANCE WITH ENGINEERS INSTRUCTIONS TO BE USED LATER TO SET ANCHOR BOLTS & TO DRILL CORRESPONDING HOLES IN THE REACTOR SKIRT FLG. BY THE REACTOR MANUFACTURER.
3. LATERAL BEARING ℞'S SHALL BE STRESS RELIEVED AFTER WELDING & PRIOR TO MACHINING (1150°F-1250°F)
4. MACHINED SURFACES SHALL BE PROTECTED FROM DAMAGE DURING SHIPMENT.
5. ALL GROUT SHALL BE NON-SHRINK (MINIMUM COMPRESSIVE STRENGTH = 6000 p.s.i.) BRAND SUBJECT TO APPROVAL BY ENGINEER.
6. NORTH ARROW AND UPPER FACE SHALL BE CORRECTLY MARKED ON THE TEMPLATE.
7. ENTIRE ASSEMBLY IS GA-1

FIELD ERECTION PROCEDURE:

WORK TO BE DONE BY C.L.E.

8. PLACE CONCRETE (A) WITH ANCHOR BOLTS POSITIONED USING TEMPLATE.
9. POSITION LEVELING NUTS SO THAT THE TOP OF THE SOLE PLATES WILL BE BELOW ELEV. 116'-0"
10. INSTALL SOLE PLATES OVER ANCHOR BOLTS ONTO LEVELING NUTS
11. ADJUST LEVELING NUTS TO RAISE SOLE PLATES TO REQUIRED SETTING ELEV. WITH MAX TOLERANCE ACROSS ANY DIA. OF THE SUPPORT TOP SURFACE = .02"
12. INSTALL HOLD-DOWN NUTS FINGER TIGHT.
13. SNUG ALL LEVELING NUTS.

WORK TO BE DONE BY MII

16. ADJUST POSITION OF SOLE ℞ SO THAT THE TOP FLANGE OF THE REACTOR WILL BE LEVEL AT ELEVATION 151'-0" PER B & W AS BUILT INFORMATION.
17. ADJUST POSITION OF REACTOR IF REQUIRED BY LIFTING THE VESSEL VERTICALLY OFF THE SUPPORT AND ADJUSTING ALL LEVELING NUTS TO INSURE FULL CONTACT WITH SOLE ℞. REPEAT STEP 16.

17a. REINSTALL HOLD DOWN NUTS SNUG TIGHT.

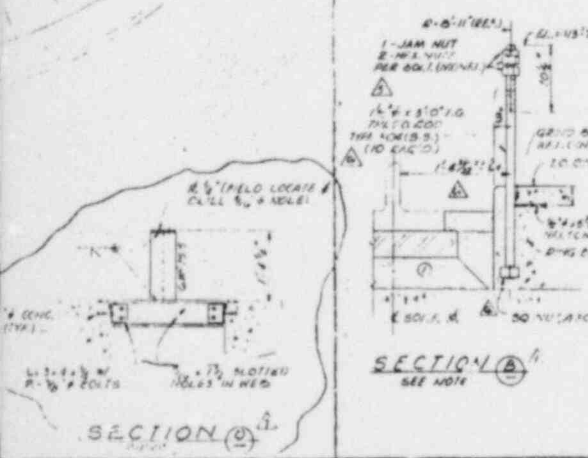
17b. SNUG ALL LEVELING NUTS.

18. PLACE GROUT (1) LEAVING SPACE AROUND LEVELING NUTS FOR WRENCH.

19a. AFTER GROUT (1) HAS CURED, BACK OFF LEVELING NUTS.

19b. WRAP BOLTS, NUTS AND WASHERS TO PREVENT BOND AND BEARING, SEE SECT. (A).

19c. PLACE REMAINING GROUT (1).



DATUM EL. 0.0' = EL. 165.0' MSL

BECHTEL CORPORATION
LOS ANGELES

SACRAMENTO MUNICIPAL UTILITY DISTRICT
RANCHO SECO NUCLEAR STATION - UNIT 1

REACTOR BUILDING - AREA 1
REACTOR SUPPORT

ABA712

C-368 | 7

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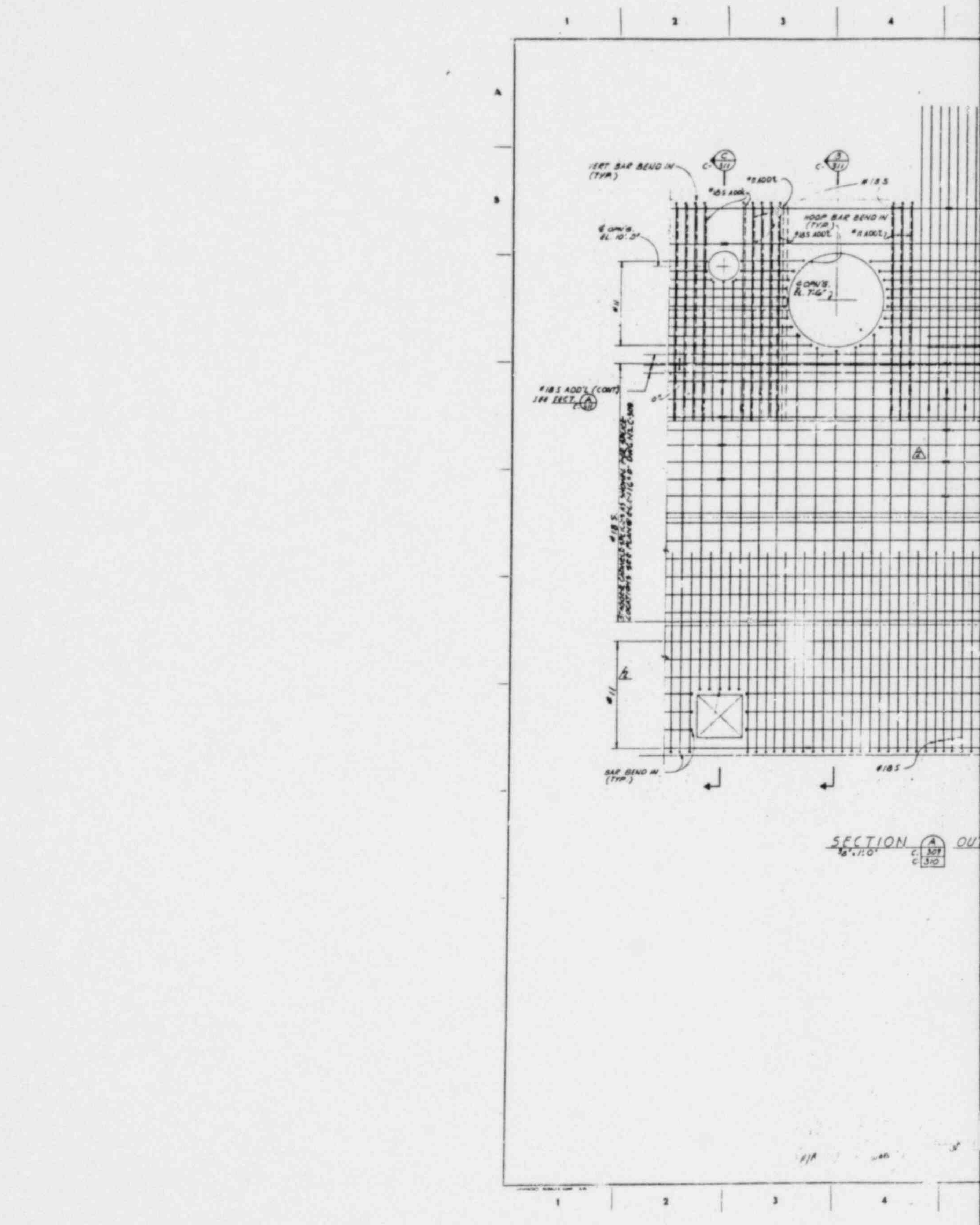
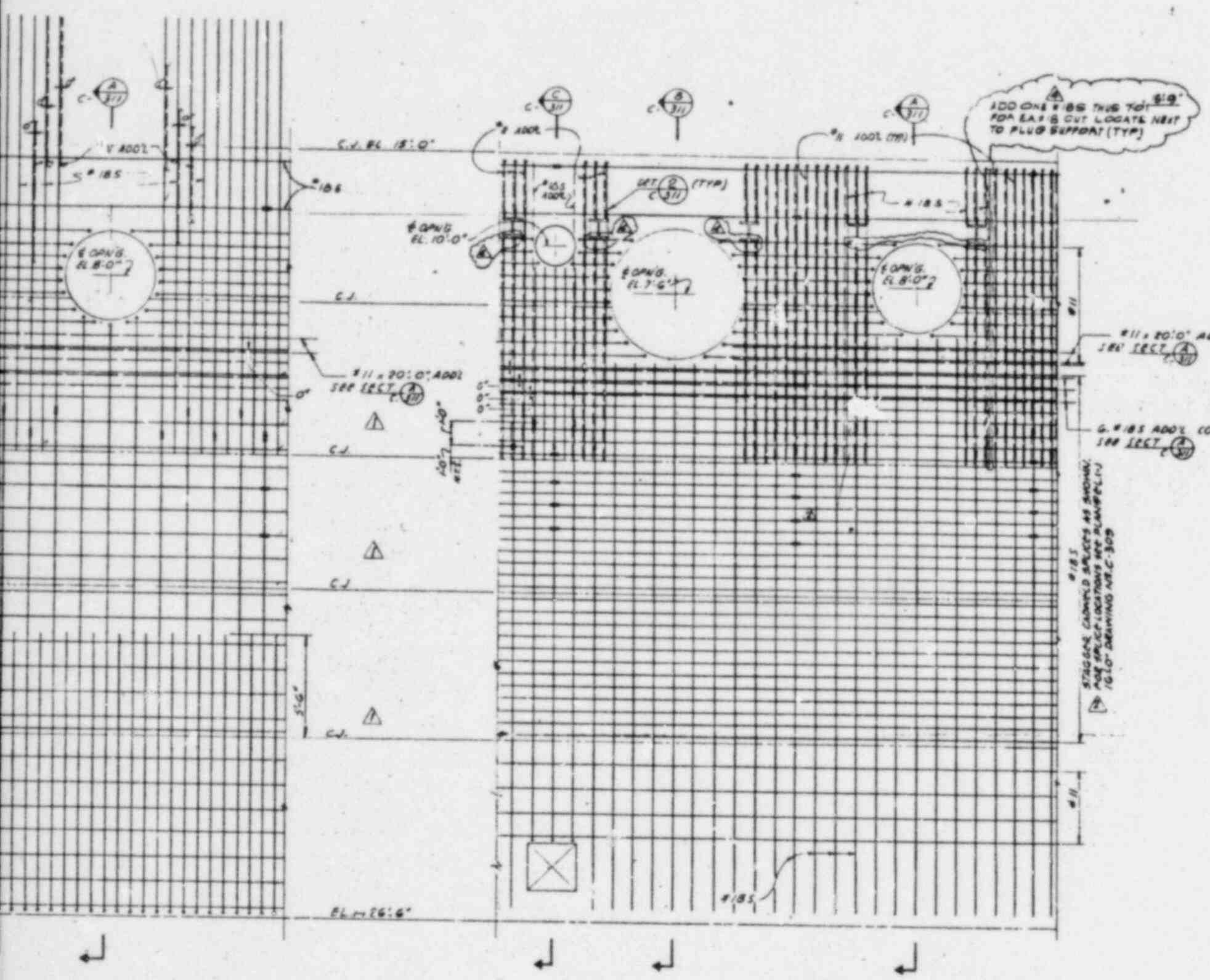

HOOP BAR BEND IN (TYP.)
BAR BEND IN (TYP.)
#18S
SECTION



...SIDE FACE

SECTION B INSIDE FACE
3/8" = 1'-0"
C-309
C-310

RECEIVED
JAN 24 1979
Print Control Services
EDS NUCLEAR INC.

NOTES:
1. WORK THIS DWG WITH DWGS C-309, C-310 & C-311
⚠ 2. FOR CONCRETE NOTES SEE DWG. C-276.

DATUM EL. 0.0' = EL. 165.0' MSL

Ref. Dwg. No.	Title
C-300	REACTOR CAVITY LINER
C-311	PRIMARY SHIELD-SHT 3
C-309	PRIMARY SHIELD-SHT 1
C-2..	DESIGN DATA & GEN NOTES

No.	Revisions
4	REMOVED CADWELDS UNDER PLUG SUPPORTS & ADDED #18S NEXT TO SAME
3	ISSUED FOR CONSTRUCTION
2	[illegible]
1	[illegible] FOR PADDED CADWELDS
0	ISSUED FOR FIRST STAGE CONC.

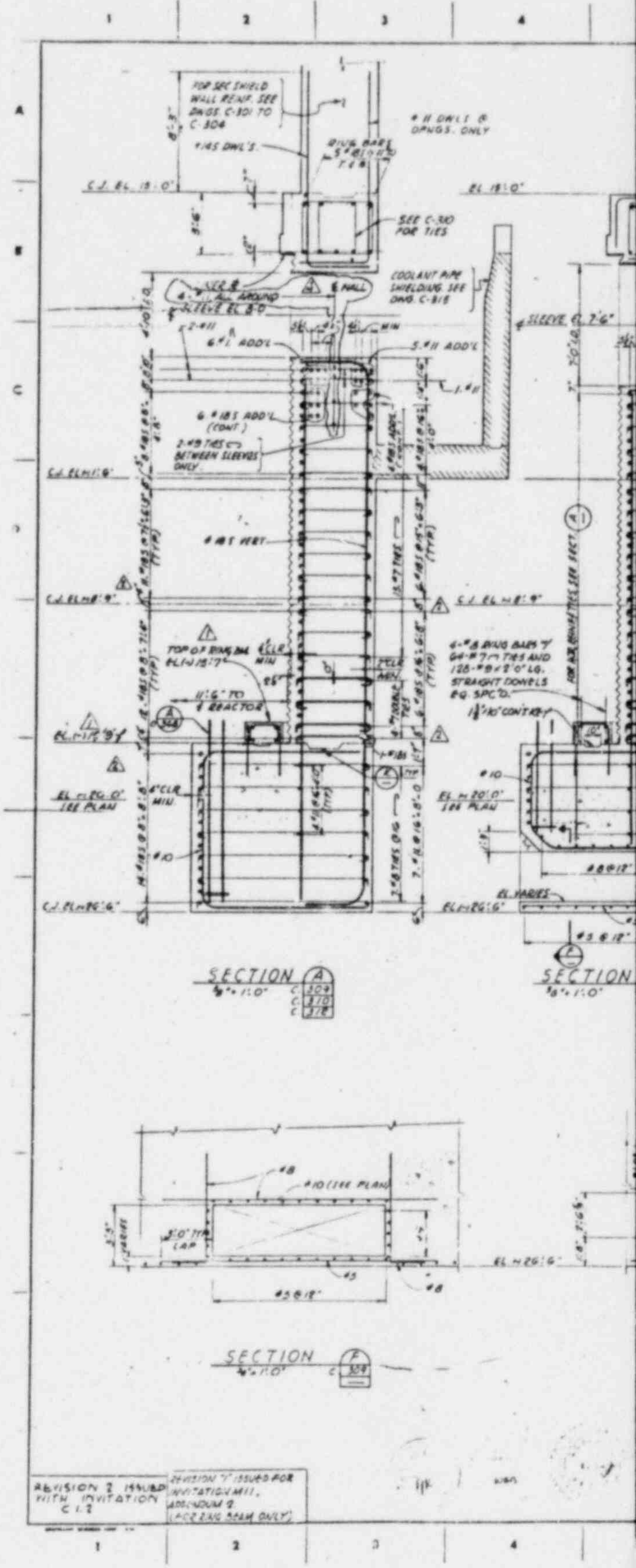
BECHTEL CORPORATION
LOS ANGELES

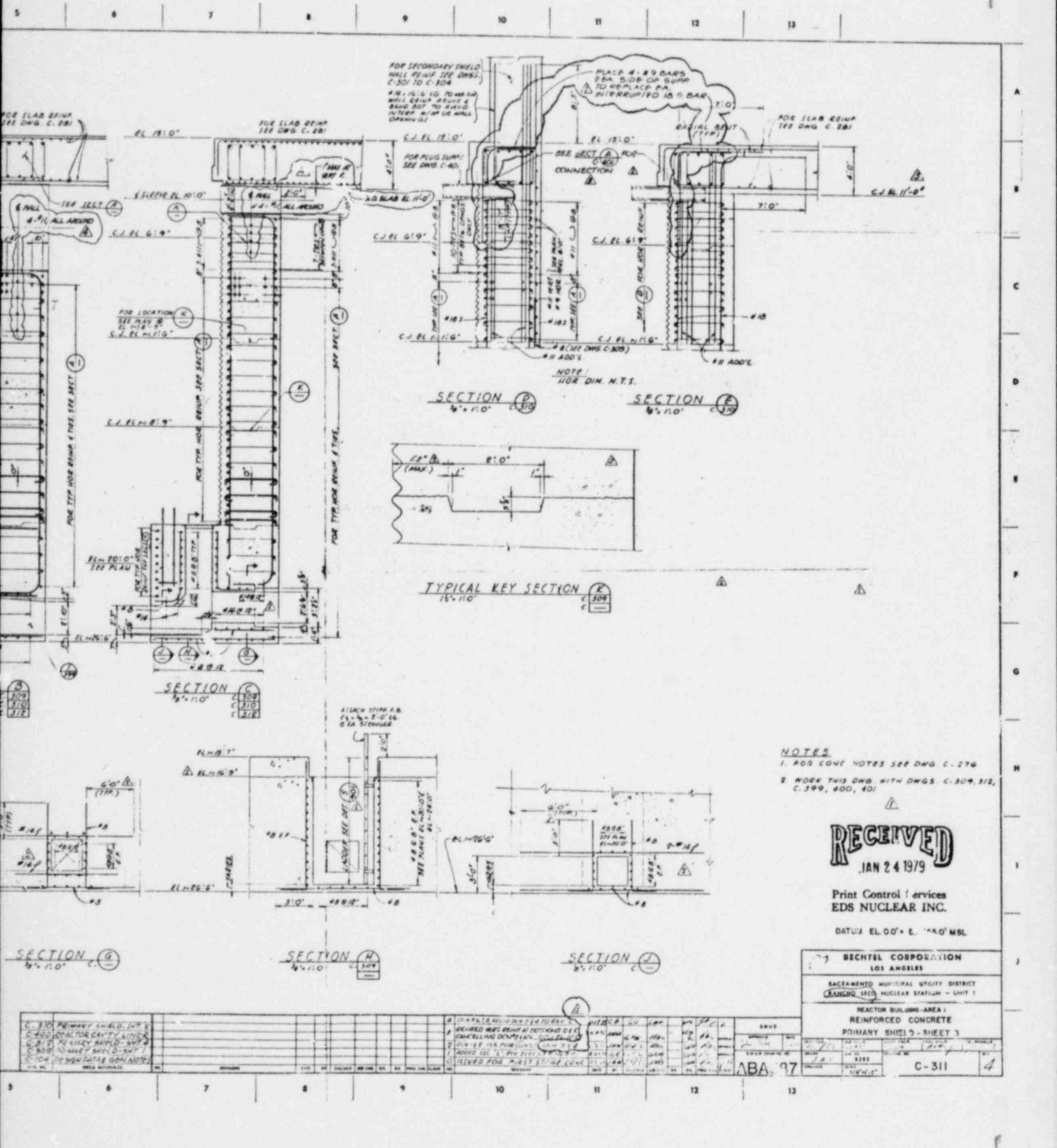
SACRAMENTO MUNICIPAL UTILITY DISTRICT
RANCHO SECO NUCLEAR STATION — UNIT 1

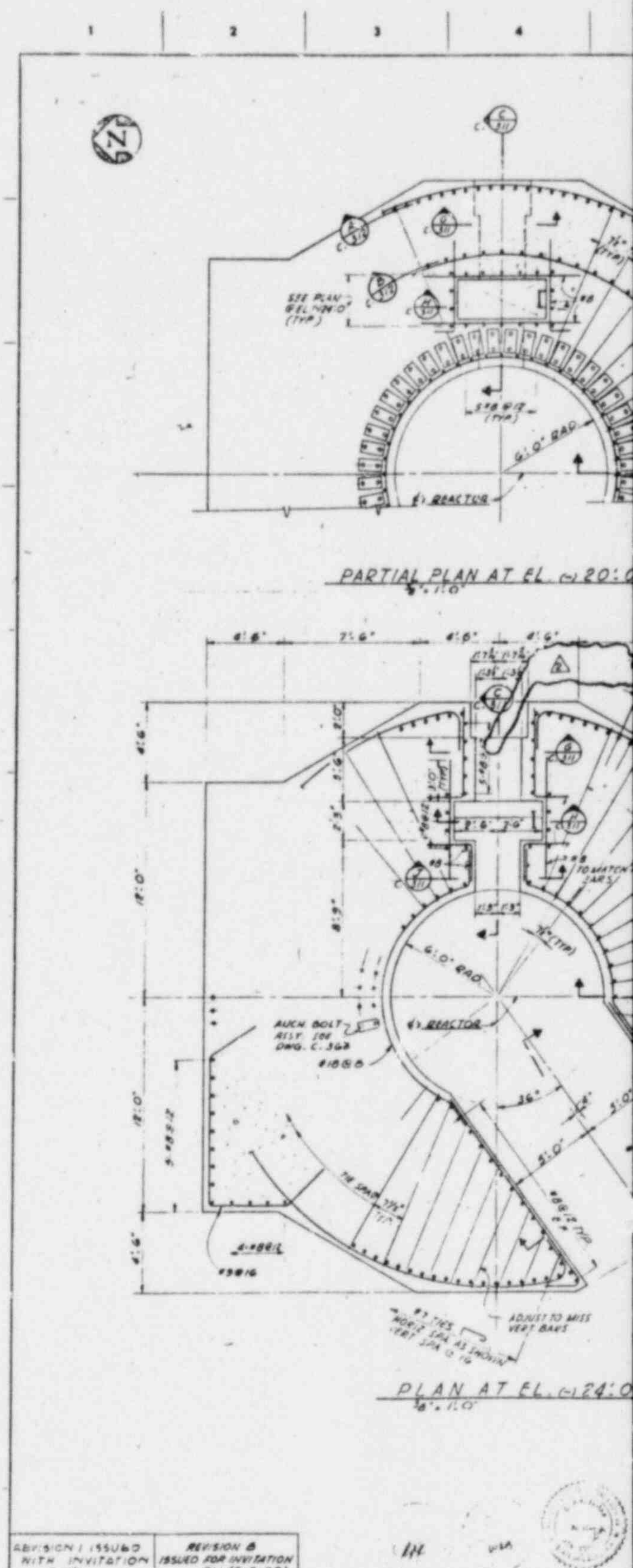
REACTOR BUILDING-AREA I
REINFORCED CONCRETE
PRIMARY SHIELD - SHEET 4

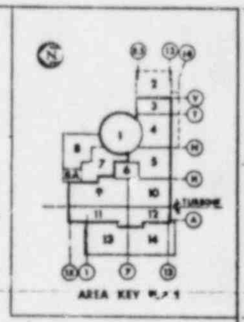
A183

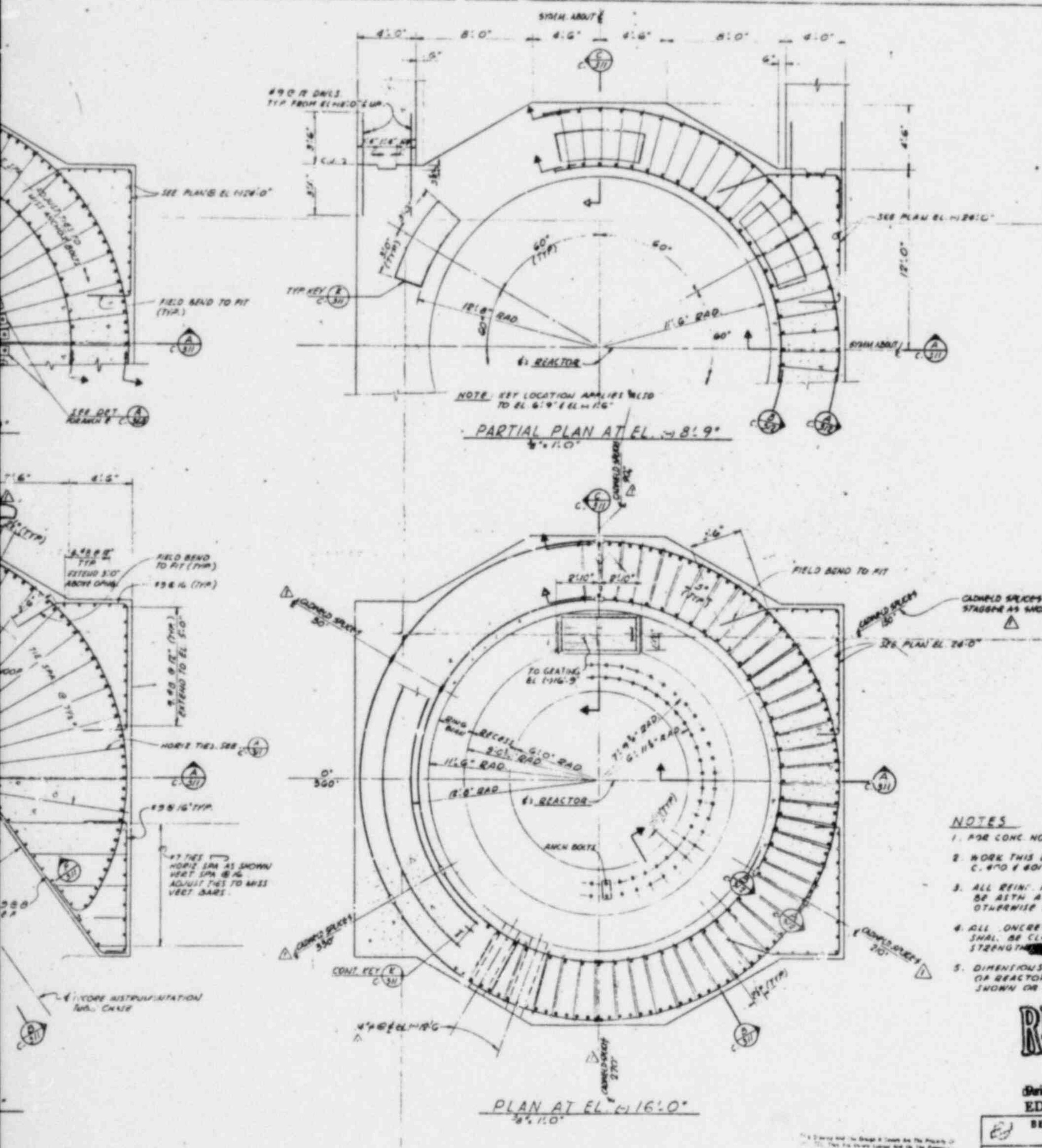
C-312 | Rev. 4


SECTION A
3/8" = 1'-0"
SECTION
SECTION F
REVISION 2 ISSUED WITH INVITATION C 1.2
REVISION "1" ISSUED FOR INVITATION M11, ADDENDUM 2 (FOR RING BEAM ONLY)
COOLANT PIPE SHIELDING SEE DWG. C-315
SEE C-310 FOR TIES


FOR SECONDARY SHIELD WALL REINF SEE DWGS. C-301 TO C-304
PLACE 4-#9 BARS 2 EA. SIDE OF SUPP TO REPLACE EA. INTERRUPTED 18 BAR
FOR SLAB REINF SEE DWG. C. 281
EL 15'-0"
C.J. EL 15'-0"
FOR PLUG SUPP SEE DWG. C-401
SEE SECT FOR CONNECTION
RADIAL BENT (TYP)
C.J. EL 11'-0"
C.J. EL 6'-9"
C.J. EL 1'-6"
#11 ADD'L
NOTE: HOR. DIM. N.T.S.
SECTION D
SECTION E
SECTION C
TYPICAL KEY SECTION K
SECTION G
SECTION H
SECTION J
NOTES
1. FOR CONC NOTES SEE DWG. C-274
2. WORK THIS DWG. WITH DWGS. C-309, 312, C-399, 400, 401
RECEIVED
JAN 24 1979
Print Control Services
EDS NUCLEAR INC.
DATUM EL. 0.0' = EL. [illegible] MSL
BECHTEL CORPORATION
LOS ANGELES
SACRAMENTO MUNICIPAL UTILITY DISTRICT
RANCHO SECO NUCLEAR STATION – UNIT 1
REACTOR BUILDING-AREA 1
REINFORCED CONCRETE
PRIMARY SHIELD - SHEET 3
C-311
4
ABA 87
C-310 PRIMARY SHIELD-SHT 2
C-400 REACTOR CAVITY LINER
C-312 PRIMARY SHIELD-SHT 4
C-309 PRIMARY SHIELD-SHT 1
C-104 DESIGN DATA & GEN NOTES
4 CHANGED RADIUS DIM & REV. TO
3 REVISED VERT. REINF AT SECTIONS D & E CANCELLING DOWELS
2 REVISED ISS FOR CONST
1 ADDED SEC "L"
0 ISSUED FOR FIRST STAGE CONC


PARTIAL PLAN AT EL. (-)20'-0
PLAN AT EL. (-)24'-0
6'-0" RAD
℄ REACTOR
REVISION 1 ISSUED WITH INVITATION C.1.2
REVISION B ISSUED FOR INVITATION C11 (2-7-69)





NOTES

1. FOR CONC. NOTES SEE DWG. C-276
2. WORK THIS DWG. WITH DWGS. C-310, 311, C-470 & 601
3. ALL REINF. FOR PRIMARY SHIELD SHALL BE ASTM A-615 GRADE 60 EXCEPT AS OTHERWISE NOTED.
4. ALL CONCRETE FOR PRIMARY SHIELD SHALL BE CLASS C.1 CONC. (28 DAYS STRENGTH[redacted] REFER TO DWG C-287.
5. DIMENSIONS SYMMETRICAL ABOUT ℄ OF REACTOR UNLESS OTHERWISE SHOWN OR NOTED.

BECHTEL CORPORATION
LOS ANGELES

SACRAMENTO MUNICIPAL UTILITY DISTRICT
RANCHO SECO NUCLEAR STATION - UNIT 1

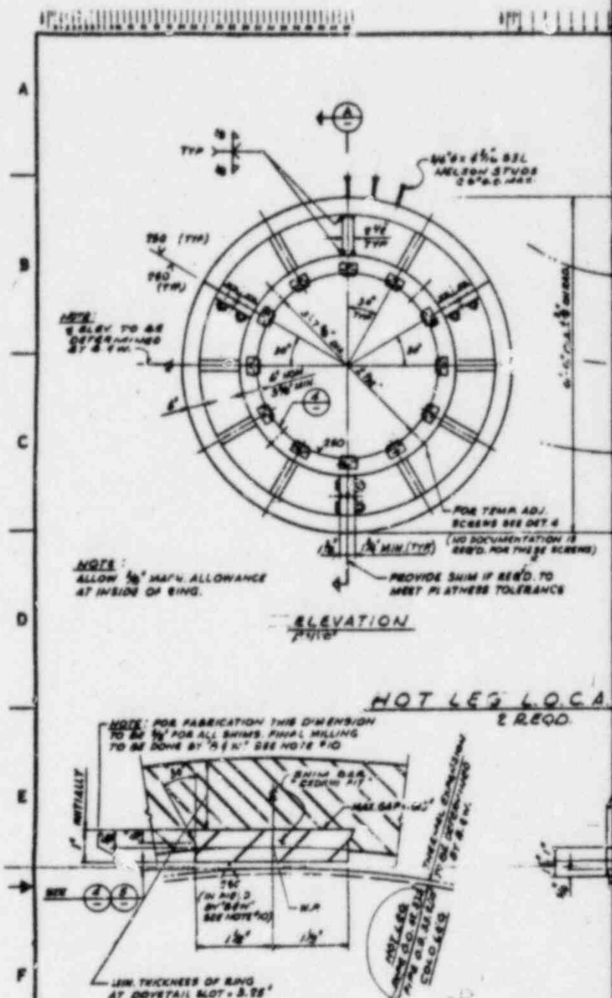
REACTOR BUILDING - AREA 1
REINFORCED CONCRETE
PRIMARY SHIELD - SHEET 1

ABA586

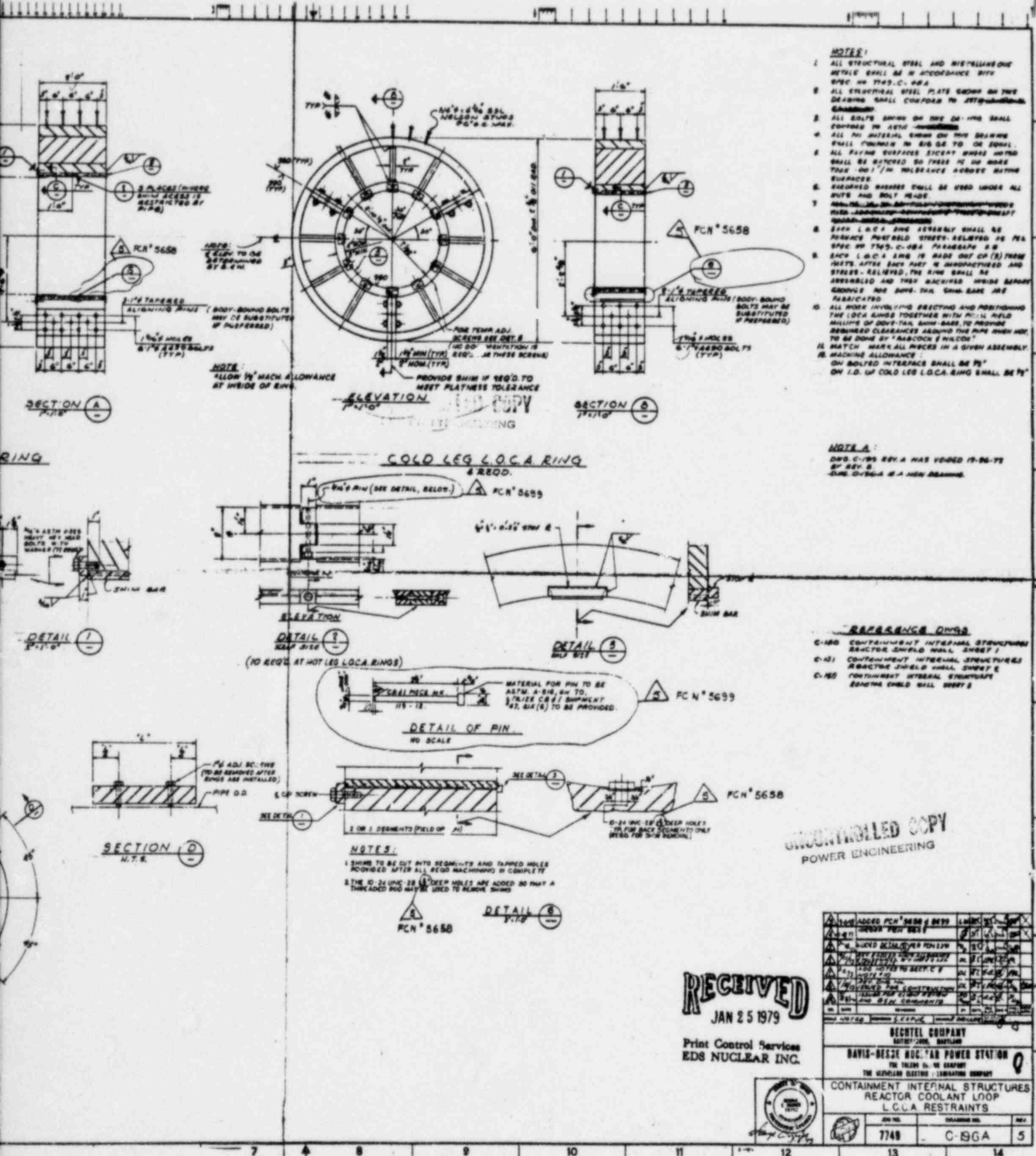
C-309 | Rev. 2

C-310	REACTOR CAVITY LINER
C-311	PRIMARY SHIELD - SHT. 4
C-311	PRIMARY SHIELD - SHT. 3
F-106	DESIGN DATA & GENERAL

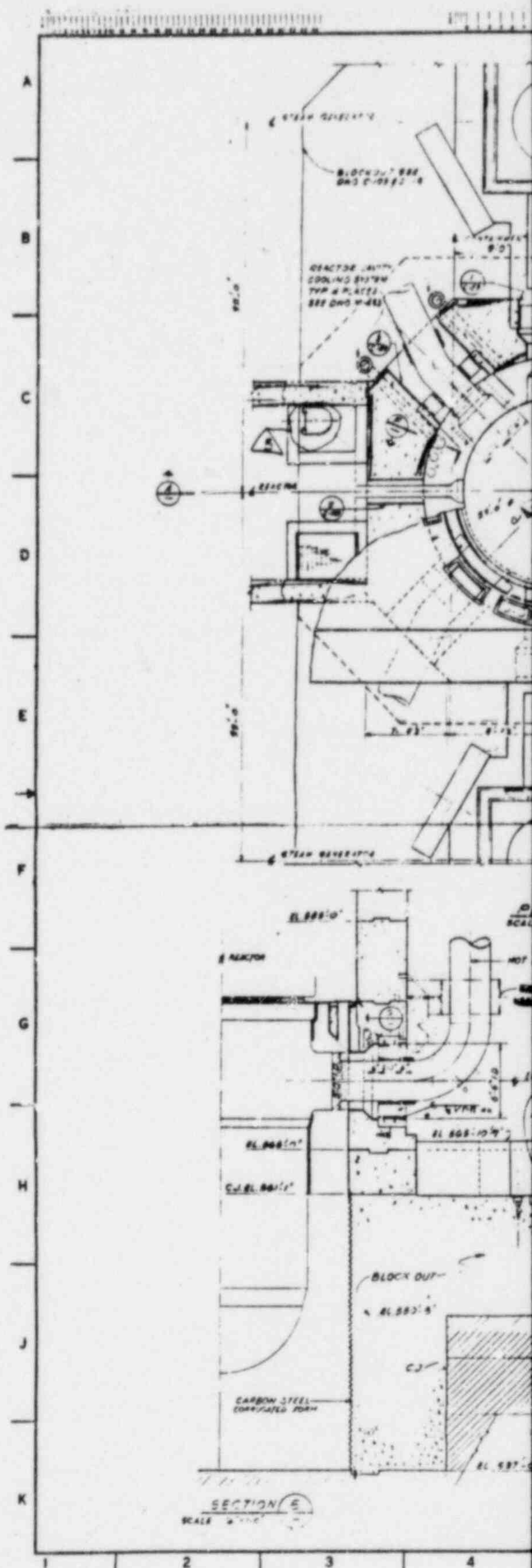
Rev.	Revisions
2	DCN 5, ADDED ... TO SEC. 1
1	ADDED DCN ... 4
0	ISSUED FOR FIRST STAGE CONC.

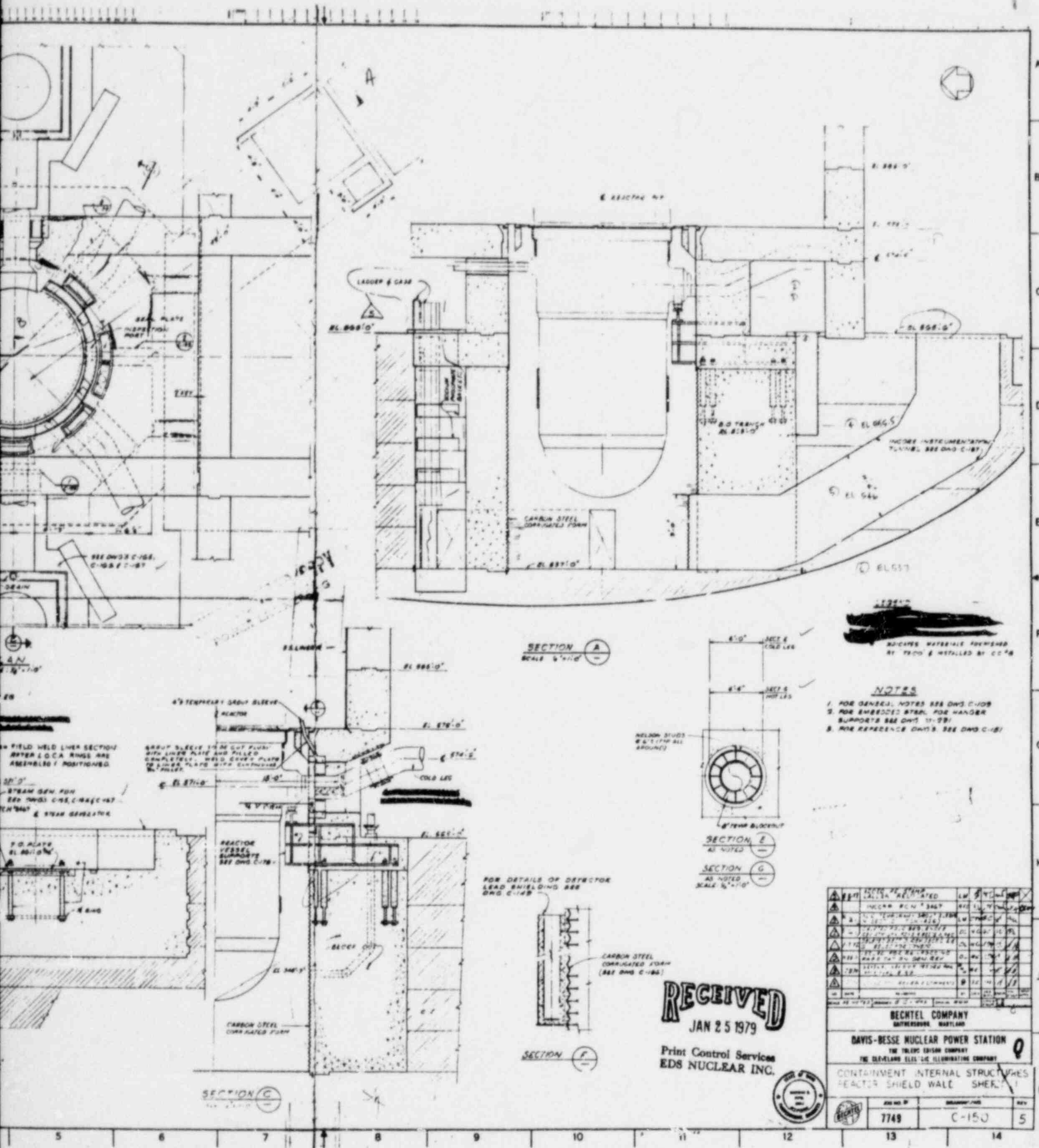


ELEVATION
HOT LEG LOCA
SECTION C
DETAIL 4
DETAIL 5

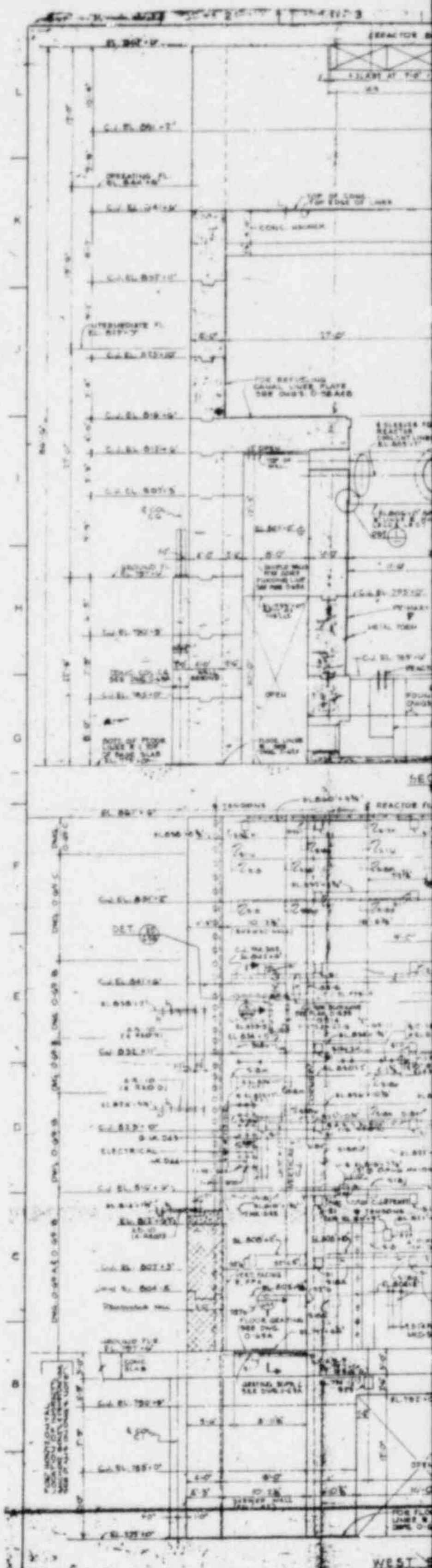


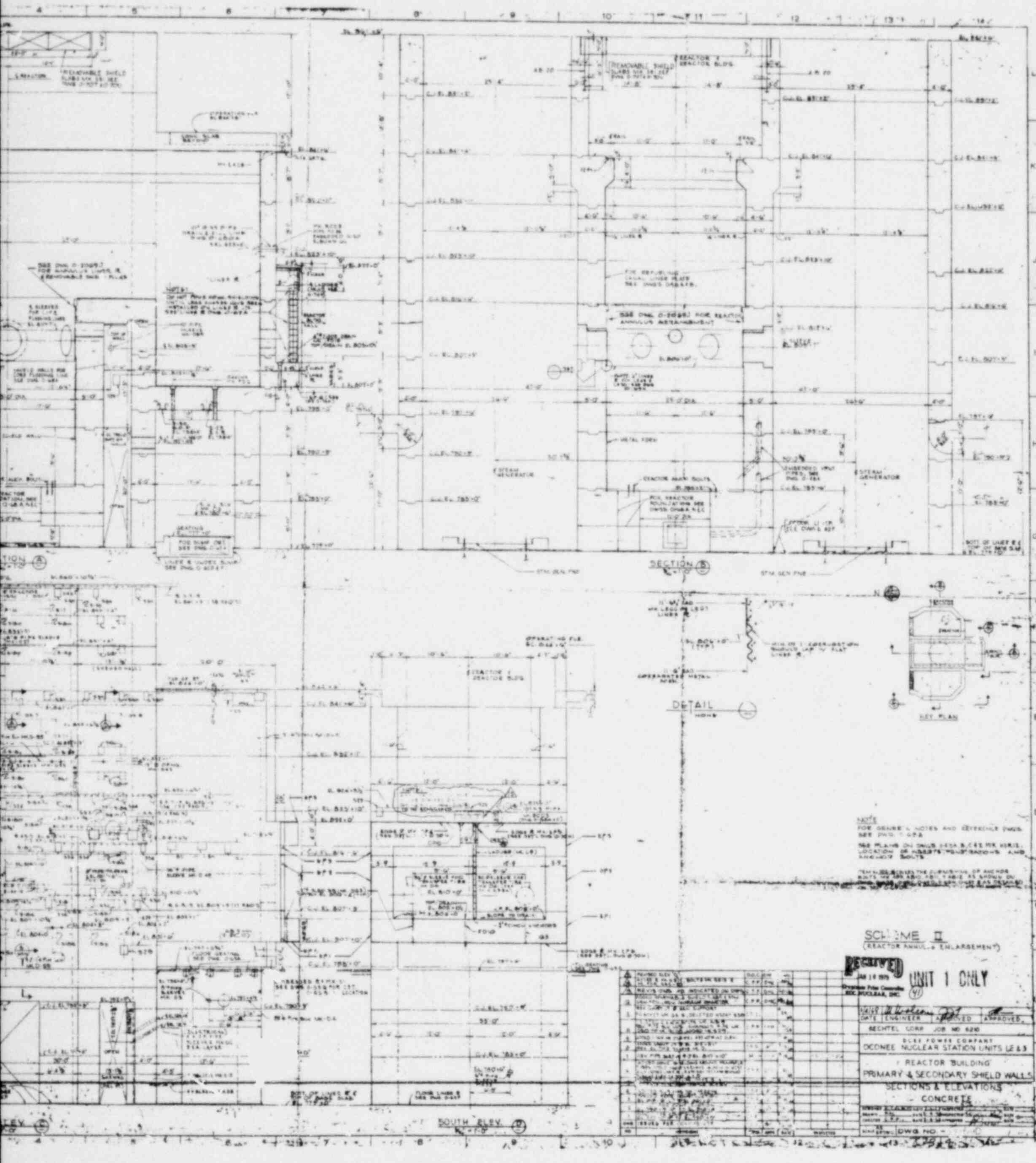
COLD LEG L.O.C.A. RING
ELEVATION
SECTION A
SECTION B
SECTION D
DETAIL 1
DETAIL 2
DETAIL 5
DETAIL 6
DETAIL OF PIN.
NO SCALE
(10 REQ'D. AT HOT LEG L.O.C.A. RINGS)
FCN# 5658
FCN# 5699
SHIM BAR
PROVIDE SHIM IF REQ'D. TO MEET FLATNESS TOLERANCE
NOTES:
NOTE A:
MATCH MARK ALL PIECES IN A GIVEN ASSEMBLY.
MACHINE ALLOWANCE:
REFERENCE DWGS
UNCONTROLLED COPY
POWER ENGINEERING
RECEIVED
JAN 25 1979
Print Control Services
EDS NUCLEAR INC.
BECHTEL COMPANY
DAVIS-BESSE NUCLEAR POWER STATION
CONTAINMENT INTERNAL STRUCTURES
REACTOR COOLANT LOOP
L.O.C.A. RESTRAINTS
7749
C-19GA
5


BLOCK OUT
CARBON STEEL
CORRUGATED FORM
SECTION E

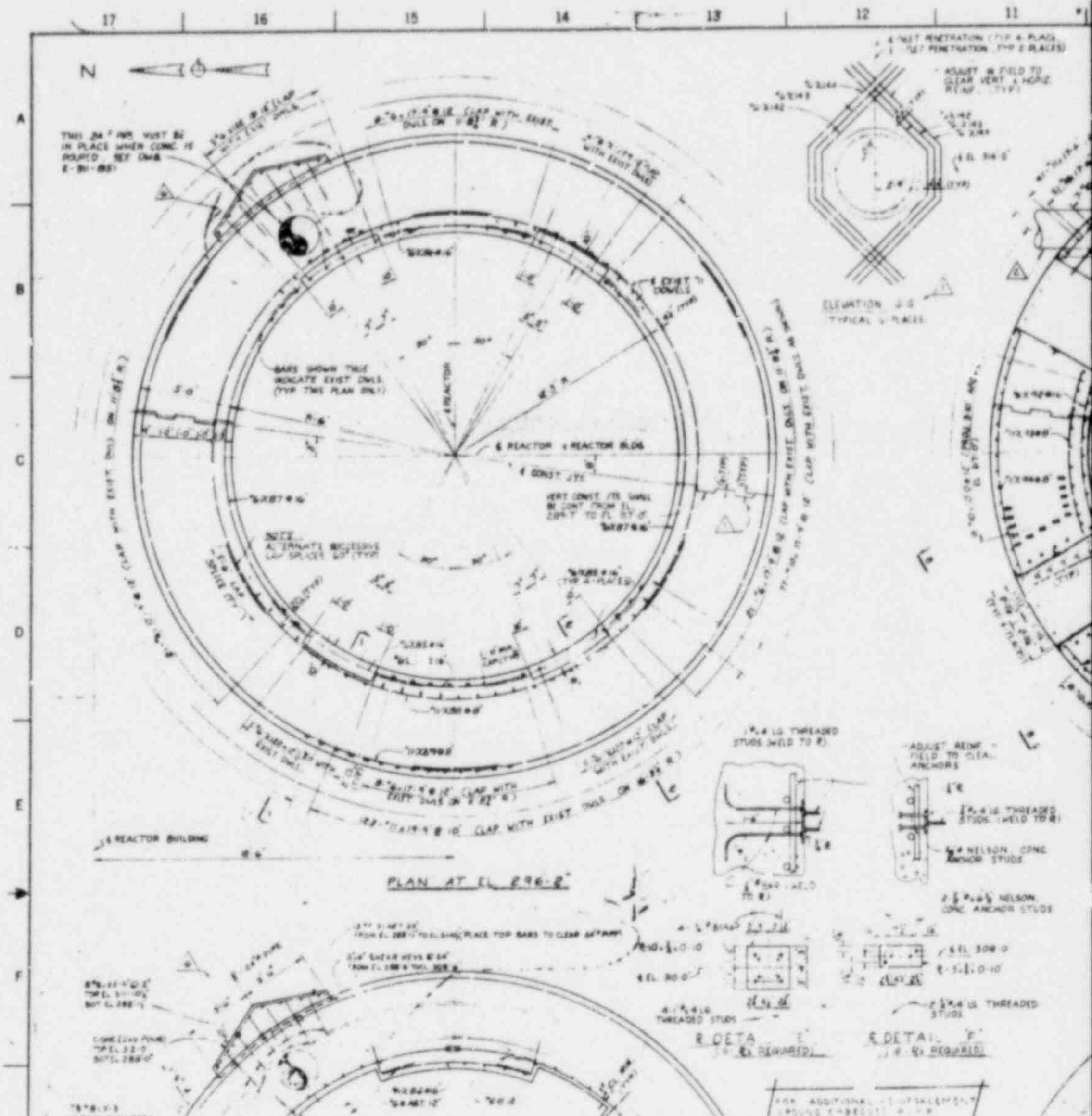


RECEIVED
JAN 25 1979
Print Control Services
EDS NUCLEAR INC.

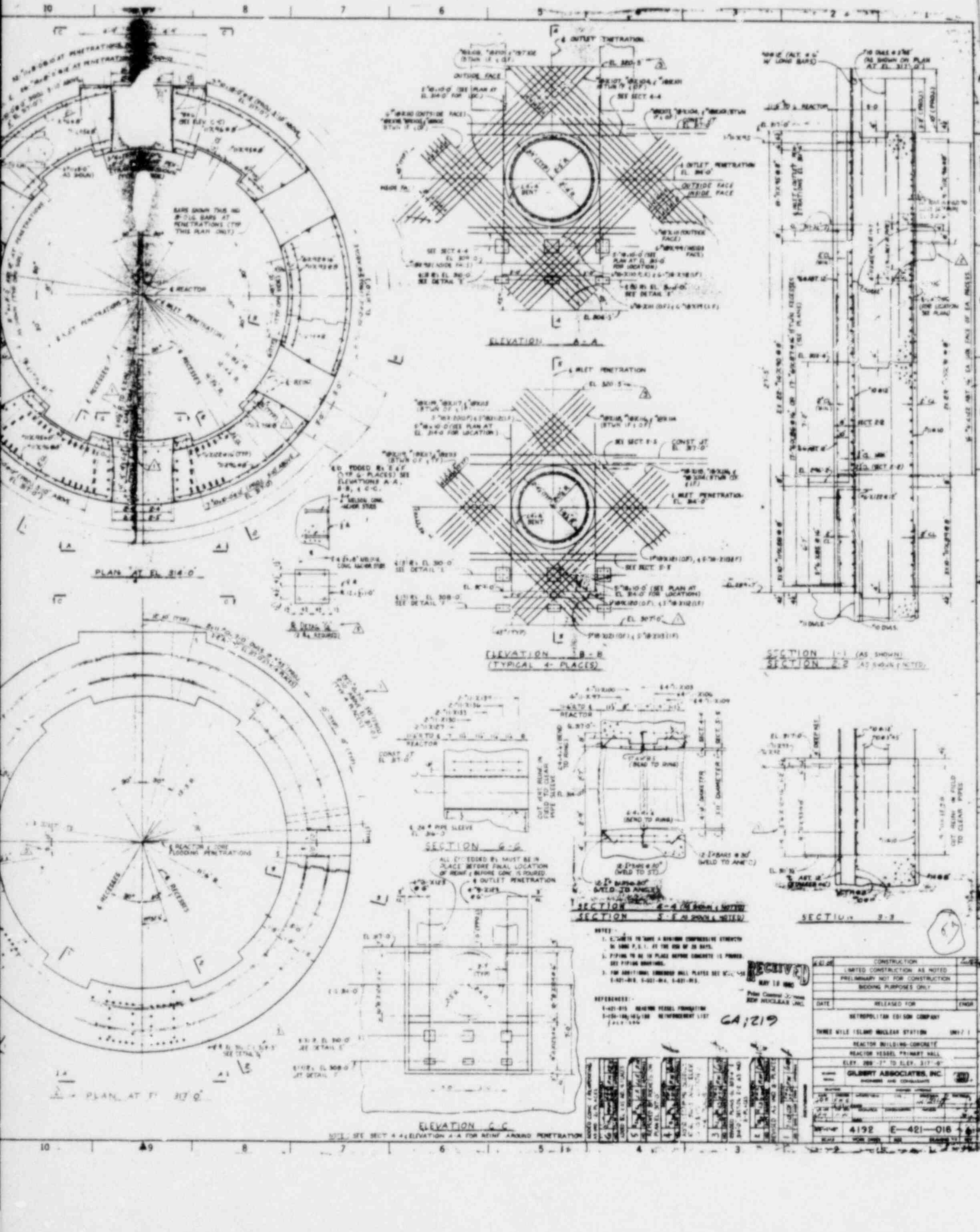




SECTION (B)
DETAIL
KEY PLAN
SOUTH ELEV.
STEAM GENERATOR
SCHEME II
(REACTOR ANNULUS ENLARGEMENT)
RECEIVED
UNIT 1 ONLY
DATE ENGINEER APPROVED APPROVED
BECHTEL CORP JOB NO 6210
DUKE POWER COMPANY
OCONEE NUCLEAR STATION UNITS 1,2 & 3
REACTOR BUILDING
PRIMARY & SECONDARY SHIELD WALLS
SECTIONS & ELEVATIONS
CONCRETE
DWG NO

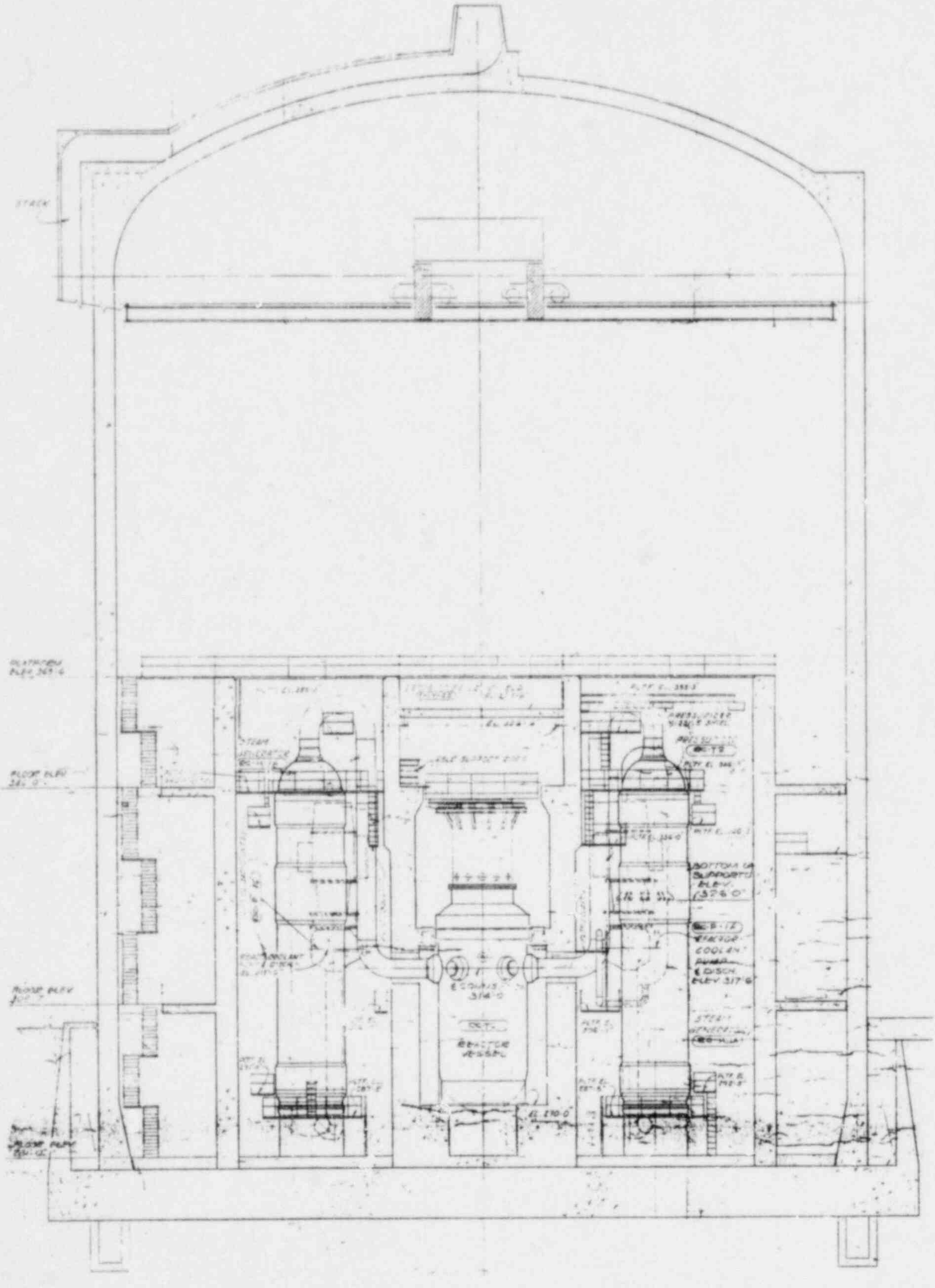


N
PLAN AT EL
ELEVATION D-D
(TYPICAL 2 PLACES)



ELEVATION A-A
ELEVATION B-B
(TYPICAL 4 PLACES)
PLAN AT EL. 314'-0"
SECTION 1-1 (AS SHOWN)
SECTION 2-2 (AS SHOWN & NOTED)
SECTION 6-6
SECTION 4-4
SECTION 5-5
SECTION 3-3
ELEVATION C-C
PLAN AT EL. 317'-0"
NOTE: SEE SECT 4-4 & ELEVATION A-A FOR REINF AROUND PENETRATION
CONSTRUCTION
LIMITED CONSTRUCTION AS NOTED
PRELIMINARY NOT FOR CONSTRUCTION
BIDDING PURPOSES ONLY
RELEASED FOR
METROPOLITAN EDISON COMPANY
THREE MILE ISLAND NUCLEAR STATION UNIT 1
REACTOR BUILDING-CONCRETE
REACTOR VESSEL PRIMARY WALL
ELEV. 289'-7" TO ELEV. 317'-6"
GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
4192
E-421-016
RECEIVED
GA;219

Figure TMI-1. Containment (Dwg E-002-004)



APPENDIX B

Typical Pressure-Time Histories
For Cavity Wall Analysis

SQENDA7

SQENOA7
SQENOA7
SQENOA7
SQENOA7
SQENOA7
SQENOA7
SQENOA7
SQENOA7
SQENOA7
SQENOA7
SQENOA7
SQENOA7

B-2

TMI2-001-002

TMI-2 HL analysis.
MAP RUN to:
Plot net asym. Load
5 load cases: 2.0A
1.5A
1.0A
0.6A
0.3A.

DESIGN VERIFICATION	
CLIENT B&W	
JOB NO. 0110-061-221	
CALC/PROB NO. TMI2-001-002	
BY: Marn	DATE: 11/23/79
CHKD: AK.	DATE: 3 DEC. 79

```
************************
*    PROGRAM MAP       *
*  VERSION 09/20/79    *
************************
```

43	237	1.000
44	239	1.000
45	241	1.000
46	243	1.000

SECTION 1: INPUT DATA

IW= 0 (=0, NO WRITE ONTO TAPE 2, =1, WRITE ALL T/HS, =2, WRITE ONLY MERGED TIME HISTORIES
IP= 0 (=0, NO PUNCHED DECKS, =1, PUNCH ALL T/HS, =2, PUNCH ONLY MERGED TIME HISTORIES)

TOTAL AREAS OF EDS PRESSURE TIME HISTORIES, INCHES SQUARE

7874.1600	7874.1600	7874.1600	7874.1600	7874.1600	7874.1600	5129.0400	5129.0400
5129.0400	5129.0400	5129.0400	5129.0400	5020.6800	4840.0800	4840.0800	4840.0800
4840.0800	5020.6800	1287.1600	1337.7600	1337.7600	1337.7600	1337.7600	1287.1600
1061.7600	941.7600	941.7600	941.7600	941.7600	1061.7600	1287.1600	1337.7600
1337.7600	1337.7600	1337.7600	1287.1600	3589.3800	3408.7800	3408.7800	3408.7800
3408.7800	3589.3800						

} Surface area of EDS-SNAP BRICK ELEMENTS

NUMBER OF SUB AREAS FOR EACH EDS PRESSURE TIME HISTORY

2	2	2	2	2	2	2	2
2	2	2	2	3	3	3	3
3	3	2	2	2	2	2	2
4	4	4	4	4	4	2	2
2	2	2	2	4	4	4	4
4	4						

} NUMBER OF CRAFT2 VOLUMES OVERLAPPING ON EDSSNAP ELEMENTS

APPROXIMATE DIRECTION ANGLE FOR EACH EDS PRESSURE TIME HISTORY

165.0000	135.0000	105.0000	75.0000	45.0000	15.0000	165.0000	135.0000
105.0000	75.0000	45.0000	15.0000	165.0000	135.0000	105.0000	75.0000
45.0000	15.0000	165.0000	135.0000	105.0000	75.0000	45.0000	15.0000
158.6450	141.3550	98.6450	81.3550	38.6450	21.3550	165.0000	135.0000
105.0000	75.0000	45.0000	15.0000	165.0000	135.0000	105.0000	75.0000
45.0000	15.0000						

SUBAREA VALUES FOR EACH EDS PRESSURE TIME HISTORY
WITH CORRESPONDING BW VOLUME

EDS P. T/H. 1 AREA = 7874.16000 . SUM OF ALL SUB AREAS= 7874.16000
6754.4400 1119.7200
BW VOL= 10 22

} BREAK DOWN OF WHICH BW CRAFT VOLUMES ARE ON EACH EDS EDSSNAP ELEMENT WITH SUBAREAS GIVEN IN SQUARE INCHES.

EDS P. T/H. 2 AREA = 7874.16000 . SUM OF ALL SUB AREAS= 7874.16000
6754.4400 1119.7200
BW VOL= 11 23

EDS P. T/H. 3 AREA = 7874.16000 . SUM OF ALL SUB AREAS= 7874.16000
6754.4400 1119.7200
BW VOL= 12 24

EDS P. T/H. 4 AREA = 7874.16000 . SUM OF ALL SUB AREAS= 7874.16000
6754.4400 1119.7200
BW VOL= 1 13

EDS P. T/H. 5 AREA = 7874.16000 . SUM OF ALL SUB AREAS= 7874.16000
6754.4400 1119.7200
BW VOL= 2 14

EDS P. T/H 6 AREA = 7874.16000 . SUM OF ALL SUB AREAS= 7874.16000
6754.4400 1119.7200
BW VOL= 3 15

```
      6754.4400        1119.7200
BW VOL=      3                15

EDS P. T/H.    7 AREA =      5129.04000 . SUM OF ALL SUB AREAS=      5129.04000
      4081.5600        1047.4800
BW VOL=     22                34

EDS P. T/H.    8 AREA =      5129.04000 . SUM OF ALL SUB AREAS=      5129.04000
      4081.5600        1047.4800
BW VOL=     23                35

EDS P. T/H.    9 AREA =      5129.04000 . SUM OF ALL SUB AREAS=      5129.04000
      4081.5600        1047.4800
BW VOL=     24                36

EDS P. T/H.   10 AREA =      5129.04000 . SUM OF ALL SUB AREAS=      5129.04000
      4081.5600        1047.4800
BW VOL=     13                25

EDS P. T/H.   11 AREA =      5129.04000 . SUM OF ALL SUB AREAS=      5129.04000
      4081.5600        1047.4800
BW VOL=     14                26

EDS P. T/H.   12 AREA =      5129.04000 . SUM OF ALL SUB AREAS=      5129.04000
      4081.5600        1047.4800
BW VOL=     15                27

EDS P. T/H.   13 AREA =      5020.68000 . SUM OF ALL SUB AREAS=      5020.68000
      4153.8000         478.5900         388.2900
BW VOL=     34                46               47

EDS P. T/H.   14 AREA =      4840.08000 . SUM OF ALL SUB AREAS=      4840.08000
      4153.8000         343.1400         343.1400
BW VOL=     35                47               40

EDS P. T/H.   15 AREA =      4840.08000 . SUM OF ALL SUB AREAS=      4840.08000
      4153.8000         343.1400         343.1400
BW VOL=     36                48               37

EDS P. T/H.   16 AREA =      4840.08000 . SUM OF ALL SUB AREAS=      4840.08000
      4153.8000         343.1400         343.1400
BW VOL=     25                37               38

EDS P. T/H.   17 AREA =      4840.08000 . SUM OF ALL SUB AREAS=      4840.08000
      4153.8000         343.1400         343.1400
BW VOL=     26                38               39

EDS P. T/H.   18 AREA =      5020.68000 . SUM OF ALL SUB AREAS=      5020.68000
      4153.8000         388.2900         478.5900
BW VOL=     27                39               40

EDS P. T/H.   19 AREA =      1287.16000 . SUM OF ALL SUB AREAS=      1287.16000
       465.4300         821.7300
BW VOL=     46                47
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         865.4300      821.7300
BW VOL=       46            47

EDS P. T/H.   20 AREA =     1337.76000 , SUM OF ALL SUB AREAS=     1337.76000
         866.8800      470.8800
BW VOL=       47            48

EDS P. T/H.   21 AREA =     1337.76000 , SUM OF ALL SUB AREAS=     1337.76000
         866.8800      470.8800
BW VOL=       37            48

EDS P. T/H.   22 AREA =     1337.76000 , SUM OF ALL SUB AREAS=     1337.76000
         866.8800      470.8800
BW VOL=       37            38

EDS P. T/H.   23 AREA =     1337.76000 , SUM OF ALL SUB AREAS=     1337.76000
         470.8800      866.8800
BW VOL=       38            39

EDS P. T/H.   24 AREA =     1287.16000 , SUM OF ALL SUB AREAS=     1287.16000
         821.7300      465.4300
BW VOL=       39            40

EDS P. T/H.   25 AREA =     1061.76000 , SUM OF ALL SUB AREAS=     1061.76000
          97.4400      433.4400       97.4400      433.4400
BW VOL=       58            59            46            47

EDS P. T/H.   26 AREA =      941.76000 , SUM OF ALL SUB AREAS=      941.76000
         433.4400       37.4400      433.4400       37.4400
BW VOL=       59            60            47            48

EDS P. T/H.   27 AREA =      941.76000 , SUM OF ALL SUB AREAS=      941.76000
          37.4400      433.4400       37.4400      433.4400
BW VOL=       60            49            48            37

EDS P. T/H.   28 AREA =      941.76000 , SUM OF ALL SUB AREAS=      941.76000
         433.4400       37.4400      433.4400       37.4400
BW VOL=       49            50            37            38

EDS P. T/H.   29 AREA =      941.76000 , SUM OF ALL SUB AREAS=      941.76000
          37.4400      433.4400       37.4400      433.4400
BW VOL=       50            51            38            39

EDS P. T/H.   30 AREA =     1061.76000 , SUM OF ALL SUB AREAS=     1061.76000
         433.4400       97.4400      433.4400       97.4400
BW VOL=       51            52            39

EDS P. T/H.   31 AREA =     1287.16000 , SUM OF ALL SUB AREAS=     1287.16000
         865.4300      821.7300
BW VOL=       58            59

EDS P. T/H.   32 AREA =     1337.76000 , SUM OF ALL SUB AREAS=     1337.76000
         866.8800      470.8800
BW VOL=       59            60

EDS P. T/H.   33 AREA =     1337.76000 , SUM OF ALL SUB AREAS=     1337.76000
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EDS P. T/H.   33 AREA =      1337.76000 , SUM OF ALL SUB AREAS=      1337.76000
         866.8800        470.8800
BW VOL=       49              60

EDS P. T/H.   34 AREA =      1337.76000 , SUM OF ALL SUB AREAS=      1337.76000
         866.8800        470.8800
BW VOL=       49              50

EDS P. T/H.   35 AREA =      1337.76000 , SUM OF ALL SUB AREAS=      1337.76000
         866.8800        470.8800
BW VOL=       51              50

EDS P. T/H.   36 AREA =      1287.16000 , SUM OF ALL SUB AREAS=      1287.16000
         821.7300        465.4300
BW VOL=       51              52

EDS P. T/H.   37 AREA =      3589.38000 , SUM OF ALL SUB AREAS=      3589.38000
      1270.9500      1270.9500      568.8900      478.5900
BW VOL=       80             81            58            59

EDS P. T/H.   38 AREA =      3408.78000 , SUM OF ALL SUB AREAS=      3408.78000
      1270.9500      1270.9500      433.4400      433.4400
BW VOL=       81             82            59            60

EDS P. T/H.   39 AREA =      3408.78000 , SUM OF ALL SUB AREAS=      3408.78000
      1270.9500      1270.9500      433.4400      433.4400
BW VOL=       82             71            60            49

EDS P. T/H.   40 AREA =      3408.78000 , SUM OF ALL SUB AREAS=      3408.78000
      1270.9500      1270.9500      433.4400      433.4400
BW VOL=       71             72            49            50

EDS P. T/H.   41 AREA =      3408.78000 , SUM OF ALL SUB AREAS=      3408.78000
      1270.9500      1270.9500      433.4400      433.4400
BW VOL=       72             73            50            51

EDS P. T/H.   42 AREA =      3589.38000 , SUM OF ALL SUB AREAS=      3589.38000
      1270.9500      1270.9500      478.5900      568.8900
BW VOL=       73             74            51            52
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EDS PRESSURE FUNCTIONS 43, 44, 45, 46 NOT SHOWN IN THIS RUN, BUT ARE EQUAL TO CORRESPONDING CRAFT2 VOLUMES DATA IN PENETRATIONS (TWO HOTLEG AND TWO COLD LEG PENETRATIONS)

SECTION 2: CRAFT2 VOLUME DATA

PRESSURE (PSIG) OF CRAFT2 VOLUME

ICASE= 1 20A HC

TIME (SECONDS)

LOAD STEP = 1

0.0000

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	[illegible]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000							

LOAD STEP = 51

.0050

.0003	.0002	.0007	.0006	.0002	-.0001	-.0001	.0002	.0002	.0002
.0002	.0003	.0002	.0020	.0419	.0423	.0020	.0001	.0001	.0001
.0001	.0001	.0001	.0001	.0018	.0779	1.3643	1.3697	.0777	.0017
-.0003	-.0003	-.0003	-.0003	-.0004	-.0003	.0013	.0756	1.9468	31.3248
1.9278	.0752	.0013	.0005	.0003	.0007	.0003	.0005	.0008	.07[illegible]
1.8094	27.4918	1.7922	.0701	.0008	.0010	-.0004	.0020	-.0004	.0010
5.2887	.0162	.0192	.0192	.0165	.0165	.0163	.0163	.0007	.0000
-.0014	.0066	.3743	8.3204	.3727	.0066	-.0014	-.0014	-.0016	-.0012
-.0016	-.0014	.0010							

LOAD STEP = 101

.0100

.0021	.0118	.0634	.0629	.0115	.0014	.0006	.0009	.0012	.0012
.0012	.0013	.0263	.2593	1.1782	1.1834	.2557	.0258	.0015	.0003
.0003	.0003	.0003	.0017	.2887	2.1574	7.2083	7.2154	2.1495	.2875
.0183	.0004	-.0002	-.0002	.0004	.0184	.1615	2.2114	11.9357	101.7496
11.8193	2.1959	.1604	.0133	.0012	.0070	.0012	.0130	.1431	1.9672
11.4281	88.0324	11.3126	1.0359	.1423	.0101	-.0000	.0058	-.0000	.0102
33.6267	.0214	.3762	.3739	.0193	.0193	.0313	.0312	.0024	.0003
.0463	.9305	7.6026	4[illegible].6352	7.5500	.9265	.0461	.0011	-.0028	.0014
-.0028	.0011	.0034							

LOAD STEP = 107

.0150

.0602	.2902	.7503	.7443	.2874	.0584	.0090	.0031	.0029	.0031
.0036	.0096	.6533	2.4972	5.2245	5.2191	2.4697	.6467	.0905	.0088
.0019	.0015	.0091	.0917	2.6811	7.3849	15.6292	15.6310	7.3733	2.6702
.4846	.0540	.0059	.0054	.0536	.4871	1.7009	6.5107	27.6883	207.0627
27.4753	6.4861	1.6913	.2512	.0209	.0035	.0208	.2527	1.5116	6.5187
26.7911	165.4998	26.5081	6.4873	1.5032	.1829	.0150	.0062	.0149	.1839
87.0315	.0059	2.9132	2.8974	.0365	.0367	.3861	.3830	.0087	.0011
1.0047	6.0217	28.9142	151.8909	28.6793	5.9893	.9996	.0976	.0072	.0063
.0072	.0980	.0073							

LOAD STEP = 112

.0200

.7657	2.0451	3.3644	3.3399	2.0300	.7392	.1665	.0299	.0090	.0092
.0306	.1725	3.7160	7.4587	10.8123	10.7634	7.4018	3.6876	1.0837	.2011
.0262	.0264	.2004	1.0920	6.8503	12.7284	27.2913	27.4604	12.6079	6.8283
2.7351	.6545	.0945	.0953	.6497	2.7450	4.8512	10.5171	54.0126	351.8965
53.6296	10.4591	4.8325	1.5938	.7618	.0655	.2610	1.5992	4.6680	12.5232
58.0874	295.6503	57.6614	12.4363	4.6478	1.2004	.1913	.0417	.1909	1.2054
166.6983	.0187	5.3198	5.2960	.4204	.4224	2.0163	2.0067	.0327	.0031
3.9544	13.2881	59.0151	281.0268	58.5785	13.2016	3.9393	.9285	.1250	.0219
.1251	.9323	.0426							

LOAD STEP = 117

.0250

3.8499	6.5794	8.3451	8.3202	6.5186	3.6495	1.3830	.3579	.0775	.0760

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EDS P. T/H.   33 AREA =      1337.76000 . SUM OF ALL SUB AREAS=      1337.76000
       866.8800         470.8800
BW VOL=       49               60

EDS P. T/H.   34 AREA =      1337.76000 . SUM OF ALL SUB AREAS=      1337.76000
       866.8800         470.8800
BW VOL=       49               50

EDS P. T/H.   35 AREA =      1337.76000 . SUM OF ALL SUB AREAS=      1337.76000
       866.8800         470.8800
BW VOL=       51               50

EDS P. T/H.   36 AREA =      1287.16000 . SUM OF ALL SUB AREAS=      1287.16000
       821.7300         465.4300
BW VOL=       51               52

EDS P. T/H.   37 AREA =      3589.38000 . SUM OF ALL SUB AREAS=      3589.38000
         1270.9500       1270.9500       568.8900       478.5900
BW VOL=       80               81              58              59

EDS P. T/H.   38 AREA =      3408.78000 . SUM OF ALL SUB AREAS=      3408.78000
         1270.9500       1270.9500       433.4400       433.4400
BW VOL=       81               82              59              60

EDS P. T/H.   39 AREA =      3408.78000 . SUM OF ALL SUB AREAS=      3408.78000
         1270.9500       1270.9500       433.4400       433.4400
BW VOL=       82               71              60              49

EDS P. T/H.   40 AREA =      3408.78000 . SUM OF ALL SUB AREAS=      3408.78000
         1270.9500       1270.9500       433.4400       433.4400
BW VOL=       71               72              49              50

EDS P. T/H.   41 AREA =      3408.78000 . SUM OF ALL SUB AREAS=      3408.78000
         1270.9500       1270.9500       433.4400       433.4400
BW VOL=       72               73              50              51

EDS P. T/H.   42 AREA =      3589.38000 . SUM OF ALL SUB AREAS=      3589.38000
         1270.9500       1270.9500       478.5900       568.8900
BW VOL=       73               74              51              52
```

EDS PRESSURE FUNCTIONS 43, 44, 45, 46 NOT SHOWN IN THIS RUN, BUT ARE EQUAL TO CORRESPONDING CRAFT2 VOLUMES DATA IN PENETRATIONS (TWO HOTLEG AND TWO COLD LEG PENETRATIONS)

SECTION 2: CRAFTZ VOLUME DATA

ICASE= 1 20A HC

TIME (SECONDS)

PRESSURE (PSIG) OF CRAFTZ VOLUME

LOAD STEP = 1									
0.0000									
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000							
LOAD STEP = 91									
.0050									
.0003	.0002	.0007	.0006	.0002	-.0001	-.0001	.0002	.0002	.0002
.0002	.0003	.0002	.0020	.0419	.0423	.0020	.0001	.0001	.0001
.0001	.0001	.0001	.0001	.0018	.0179	1.3643	1.3697	.0777	.0017
-.0003	-.0003	-.0003	-.0003	-.0004	-.0003	.0013	.0758	1.9468	31.3248
1.9278	.0752	.0013	.0005	.0003	.0007	.0003	.0005	.0008	.0704
1.8094	27.4918	1.7922	.0701	.0008	.0010	-.0004	.0020	-.0004	.0010
5.2887	.0162	.0192	.0192	.0165	.0165	.0163	.0163	.0007	.0006
-.0014	.0066	.3743	8.3204	.3727	.0066	-.0014	-.0014	-.0016	-.0012
-.0016	-.0014	.0010							
LOAD STEP = 101									
.0100									
.0021	.0118	.0634	.0629	.0115	.0014	.0006	.0009	.0012	.0012
.0012	.0013	.0263	.2593	1.1782	1.1834	.2557	.0258	.0015	.0003
.0003	.0003	.0003	.0017	.2887	2.1574	7.2083	7.2154	2.1495	.2875
.0163	.0004	-.0002	-.0002	.0004	.0184	.1615	2.2114	11.9357	101.7496
11.8193	2.1959	.1604	.0133	.0012	.0070	.0012	.0134	.1431	1.9672
11.4281	88.0324	11.3126	1.9559	.1423	.0101	-.0000	.0058	-.0000	.0102
33.6267	.0214	.3762	.3739	.0193	.0193	.0313	.0312	.0024	.0003
.0463	.9305	7.6026	49.6352	7.5500	.9265	.0461	.0011	-.0028	.0014
-.0028	.0011	.0034							
LOAD STEP = 107									
.0150									
.0602	.2902	.7503	.7443	.2874	.0584	.0090	.0031	.0029	.0031
.0036	.0096	.6533	2.4972	5.2245	5.2191	2.4697	.6467	.0905	.0088
.0019	.0015	.0091	.0917	2.6811	7.3849	15.6292	15.6310	7.3733	2.6702
.4846	.0540	.0059	.0054	.0536	.4871	1.7009	6.5107	27.6683	207.0627
27.4753	6.4861	1.6913	.2512	.0209	.0035	.0208	.2527	1.5116	6.5187
26.7911	165.4998	26.5881	6.4873	1.5032	.1829	.0150	.0062	.0149	.1839
87.0315	.0059	2.9132	2.8974	.0365	.0367	.3861	.3839	.0087	.0011
1.0047	6.0217	28.9142	151.8909	28.6793	5.9893	.9996	.0976	.0072	.0063
.0072	.0980	.0073							
LOAD STEP = 112									
.0200									
.7657	2.0451	3.3644	3.3399	2.0300	.7392	.1065	.0299	.0090	.0092
.0306	.1725	3.7160	7.4587	10.8123	10.7834	7.4018	3.6876	1.0837	.2011
.0262	.0264	.2003	1.0920	6.8503	12.7284	27.2913	27.4604	12.6079	6.8283
2.7351	.6545	.0545	.0953	.6497	2.7450	4.8512	10.5171	54.0126	351.8965
53.6296	10.4591	4.8325	1.5938	.2616	.0655	.2610	1.5992	4.6680	12.5232
58.0874	295.6503	57.6614	12.4363	4.6478	1.2004	.1913	.0417	.1907	1.2054
166.6983	.0187	5.3198	5.2960	.4204	.4224	2.0163	2.0067	.0327	.0031
3.9544	13.2881	59.0151	281.0268	58.5785	13.2076	3.9393	.9285	.1250	.0219
.1251	.9323	.0426							
LOAD STEP = 117									
.0250									
3.8499	6.5794	8.3451	8.3202	6.5186	3.6495	1.3830	.3579	.0775	.0780

LOAD STEP = 117

.0250

3.8499	5.5794	8.3451	8.3202	6.5186	3.6495	1.3830	.3579	.0775	.0780
.5472	1.4589	8.3716	12.0286	15.4055	15.4078	11.9338	8.3036	4.4133	1.5332
.3397	.3398	1.5312	4.4429	10.6806	18.6739	48.0497	48.2717	18.4335	10.5736
6.1318	2.7694	.8028	.8082	2.7527	6.1562	7.7663	23.6792	98.6014	525.3371
95.9610	23.4792	7.7345	4.1373	1.4161	.6266	1.4110	4.1422	8.0519	27.3403
103.8574	466.4991	103.0980	27.1341	8.0191	3.3975	1.1010	.3673	1.0987	3.4044
277.8953	.1280	9.4311	9.3384	1.6621	1.6664	3.8438	3.8319	.0952	.0071
8.0391	23.8208	98.4748	420.6115	97.7877	23.6377	8.0017	3.1080	.8323	.2609
.8324	3.1183	.3788							

LOAD STEP = 122

.0300

9.7896	12.9486	15.1183	15.0895	12.7225	9.0457	5.3061	2.2414	.7002	.7107
2.3397	5.7554	11.8561	17.0913	23.2800	23.2210	16.8999	11.6709	8.2764	4.9448
2.0722	2.0761	4.9787	8.3799	13.1678	33.7580	73.6091	73.7556	33.2394	13.0667
9.0750	5.7960	3.1947	3.2092	5.7924	9.1296	11.9690	43.4424	153.5343	706.9244
152.5938	43.5614	11.8889	6.6765	3.9075	2.6778	3.8994	6.6915	12.1201	44.7130
154.5384	623.2094	153.5484	44.4065	12.0475	6.0766	3.3625	1.7309	3.3569	6.0895
418.7875	.7029	19.5137	19.3227	3.0801	3.0833	5.2859	5.2594	.2219	.0137
12.6207	45.0852	155.0230	587.1469	154.0405	44.7539	12.5585	6.1208	2.8097	1.4588
2.8065	6.1325	2.0155							

LOAD STEP = 127

.0350

16.4704	20.9035	24.1602	23.9894	20.2052	15.3501	11.4759	7.2605	3.8456	3.9409
7.7620	12.3447	16.9397	26.6693	32.5434	32.4675	26.1512	16.4080	11.1355	8.5226
6.4150	6.4527	8.7364	11.5184	19.7464	56.6185	99.4275	100.3125	55.1327	19.3779
12.2981	8.9134	7.3082	7.3356	8.9768	12.4373	17.8609	63.3905	211.7656	860.0615
210.5939	62.8510	17.[illegible]12	10.3367	7.2579	6.3697	7.2688	10.3958	19.3252	68.4818
210.9968	753.4709	209.8231	68.0463	19.0371	9.4252	6.7250	4.7516	6.7261	9.2646
578.7401	2.3690	35.3397	35.0256	4.5047	4.5192	8.2839	8.2483	.4347	.0238
18.2976	70.3675	214.0485	756.1804	212.8508	69.9212	18.1702	9.3681	6.3042	4.4916
6.2996	9.3902	5.[illegible]500							

LOAD STEP = 132

.0400

24.5244	30.6771	33.6646	33.3294	29.5911	23.3296	17.1594	14.0082	12.0703	12.4449
15.2147	19.0262	27.9273	38.5985	38.5486	38.6289	37.3787	26.8170	17.4931	12.8130
12.0876	12.2456	13.4208	18.5594	31.5209	86.1456	108.0225	109.1477	83.8721	30.4559
19.3180	13.6689	12.1211	12.1885	13.9175	19.9230	26.5262	82.6371	259.8834	900.7467
258.6162	81.9233	26.1279	15.4237	11.5523	10.7029	11.5983	15.6714	30.2006	94.9361
266.5253	807.7471	265.2176	94.3686	29.9767	11.2287	10.6061	9.0271	10.6072	11.3015
735.9983	5.1216	58.2495	57.7167	6.7630	6.1476	14.4163	14.2961	.7456	.0385
29.4150	94.1151	262.0462	886.5742	260.7966	93.5679	29.0845	11.5389	10.6592	9.1133
10.6502	11.4492	11.1331							

LOAD STEP = 138

.0456

36.3119	41.9702	42.9129	42.4480	40.8726	34.3248	27.4386	23.9684	25.3547	26.0006
25.4462	29.1962	41.4942	46.5252	41.4280	40.3232	45.7570	39.6857	31.1158	24.5160
20.8467	21.3000	25.8254	32.7683	43.7063	109.8735	106.3790	104.7942	108.4193	42.6821
32.3419	23.4203	19.2605	19.5105	24.1722	33.7075	47.0164	109.6551	300.0199	889.9567
298.8501	108.1553	46.1364	17.0293	17.1183	16.9663	17.1406	17.5360	42.3707	119.4892
308.8119	863.3084	307.5568	118.7487	41.5021	17.1194	16.1498	14.4676	16.1808	16.9651
852.5682	10.9581	82.9619	82.2535	11.3160	10.2940	23.7368	23.4187	1.2140	.0603
44.2206	120.0918	303.8203	955.8957	302.4904	119.4393	43.7736	15.6305	15.2786	14.4009
15.3086	15.7106	19.7605							

LOAD STEP = 143

.0506

47.5452	48.8848	48.7578	48.2949	47.7302	45.0553	41.2725	38.7361	36.6042	36.8688
39.7651	43.6143	47.5473	46.9484	45.6685	45.0798	45.0318	46.1948	43.7215	39.1133
35.0908	35.5304	40.5836	45.3889	50.4146	118.1194	107.8649	106.5048	116.8964	49.2447
44.4672	35.2215	30.2038	30.6342	36.6055	45.8625	57.6371	131.0987	326.6595	870.4009
325.7070	129.7139	57.0088	29.0661	24.4263	25.6808	24.9099	30.1330	59.2209	136.1924
333.8203	923.6789	332.6707	137.2504	58.1869	24.1635	22.0951	20.6720	22.2122	24.4902
903.4113	18.8079	101.8695	100.8698	16.6836	16.7743	36.2748	35.5336	1.7465	.0829
55.0055	137.4871	338.2477	961.6273	336.8672	136.5817	54.2490	24.1399	21.7336	19.9039
21.7992	24.1362	30.0329							

LOAD STEP = 148

.0556

55.1467	52.8549	53.1406	53.0227	51.1398	52.1761	55.6730	55.8256	51.2871	51.3486

LOAD STEP = 148

.0556

55.1467	52.8549	53.1406	53.0227	51.1398	52.1761	55.6730	55.8256	51.2871	51.3486
56.9555	58.2651	51.1740	49.2071	52.4593	53.2552	48.0880	49.6061	52.1355	52.8335
52.4516	52.4193	53.6451	53.5338	54.9960	120.[illegible]872	114.5212	114.5831	119.5781	53.5993
50.3811	49.2146	47.4412	47.7898	50.3874	51.6922	62.9542	144.1733	347.1575	85[illegible].6259
346.3037	143.0575	62.3943	49.2937	38.0738	39.7076	38.7141	51.0330	69.6850	154.2745
356.2672	963.7189	355.1426	153.2428	68.7824	35.1752	32.[illegible]628	20.7372	32.9866	35.8117
920.00[illegible]	27.2196	118.4098	117.3463	24.8758	25.6427	50.3297	44.5496	2.3829	.1075
71.138	149.3700	361.0265	948.0172	359.8158	148.3162	69.5468	33.9636	30.3980	28.1291
30.7311	34.5386	46.0191							

LOAD STEP = 153

.0606

61.0078	57.2409	57.2407	57.0129	55.3290	58.9192	64.9655	68.[illegible]502	71.6002	72.0476
69.6835	66.8096	58.2877	56.2034	59.7738	59.9042	55.3158	56.4518	59.0846	64.5977
67.1029	67.1077	65.1170	60.5459	56.2326	123.4635	123.2876	123.7347	122.8276	56.9160
57.2428	62.7452	66.7475	66.6371	63.2254	58.6418	67.7654	150.7630	365.6912	851.6224
364.3517	169.8913	66.5117	59.3722	55.3138	58.3257	35.5337	59.7578	70.7945	163.0315
372.1647	970.5131	371.1928	162.0104	70.3435	51.1030	49.8351	43.2663	50.5612	5[illegible].7965
913.9634	38.7055	129.4998	129.0711	36.8450	38.1066	57.2869	56.7118	3.1129	.1340
79.5932	157.9062	373.3507	941.8916	372.3620	156.9677	79.1321	48.4254	45.7515	40.6022
46.9230	50.1901	62.7275							

LOAD STEP = 158

.0656

67.9111	64.4080	62.2905	61.2617	63.2772	68.3630	71.3965	78.5757	88.4057	88.6937
78.9493	70.9323	67.6452	66.1430	65.9609	64.8004	64.7453	86.3748	70.2390	75.5810
62.2392	82.5930	76.5188	71.3767	64.1844	128.1928	131.4776	131.3726	127.9664	62.7405
68.2897	75.3858	80.9990	81.0270	75.5916	69.2840	72.2688	155.3864	382.0281	860.4914
381.2063	154.6971	71.3937	65.3619	69.0317	73.0471	68.9228	65.9889	73.0022	165.2831
379.7768	956.0840	379.0184	164.4572	71.9299	66.6185	66.9184	62.5804	69.5723	67.6967
893.8623	54.6384	135.8814	135.0494	49.9362	50.9665	57.9214	57.4330	3.9256	.1623
70.8426	160.4597	381.3308	948.6859	380.5334	159.6567	70.8417	68.3910	69.8536	62.8565
70.8703	70.2544	77.3017							

LOAD STEP = 163

.0706

75.4374	73.[illegible]315	69.4802	68.8982	74.1562	78.5828	82.4959	89.8304	94.7588	94.2911
88.1856	79.1370	77.4451	76.1576	71.3574	70.4821	73.5403	77.2859	82.[illegible]22	88.8621
95.98[illegible]	96.0488	89.2553	82.5926	76.0556	132.5429	138.1556	137.7941	133.5840	74.4715
80.2033	85.7714	90.5200	90.9048	86.6354	80.5893	77.1209	158.8677	393.1892	877.9146
392.4241	158.3914	76.6079	81.4344	82.1513	82.9857	82.8108	82.2001	74.2125	163.7616
385.6005	943.3737	384.9785	163.[illegible]782	73.5311	79.0596	86.1222	86.2382	86.3622	79.8000
868.4908	71.1141	137.7406	137.1091	60.2255	60.9258	58.4505	57.7832	4.8146	.1922
67.9031	155.9881	386.5642	957.2751	385.9259	155.4479	66.6567	80.3105	89.2795	87.4571
89.3356	80.4834	87.5625							

LOAD STEP = 168

.0756

85.6329	83.3810	79.6078	80.8803	85.2356	90.2754	98.1855	99.[illegible]591	96.6341	95.5983
96.5397	93.1499	91.5485	95.0368	79.3055	78.8802	9[illegible].2922	91.1770	95.5271	101.8326
101.1439	100.6760	100.1040	93.5847	104.7933	104.6185	142.2729	142.7591	111.8357	104.4432
99.9520	98.2177	100.3695	100.4629	98.9203	95.5934	86.2280	156.7896	398.9017	896.7089
398.2286	156.9273	85.5343	92.7551	97.8898	97.1712	98.4021	93.1441	77.7165	159.3204
394.3197	944.0835	393.7348	158.9771	77.0600	88.3435	99.4516	102.6733	99.6618	87.9905
847.6367	86.4409	137.2262	136.8387	70.6402	71.0312	59.2460	58.6881	5.7823	.2240
76.3752	149.3037	390.6112	957.9470	390.0998	149.0062	75.4728	85.0922	97.2645	103.6504
96.9288	84.8280	94.7587							

LOAD STEP = 173

.0806

102.6231	96.4471	94.4375	96.0375	99.9007	106.0611	109.5838	106.9529	102.0900	100.8406
103.4375	106.0812	111.8751	98.5901	104.6115	105.0413	104.2624	114.0951	111.7330	108.2891
103.005[illegible]	102.0921	105.7083	109.6149	113.7176	89.1831	124.0803	126.5965	89.2698	117.7443
115.9727	113.0746	1[illegible]1.1774	110.7821	111.9462	115.0145	107.9902	130.9071	402.5356	910.9657
401.9982	133.7980	106.6766	103.6785	108.4251	110.1156	107.8573	103.8971	94.6973	150.2537
402.7445	953.7620	402.2074	151.1617	93.1119	93.4515	105.2927	107.8850	105.0886	93.2389
840.13[illegible]	99.8089	132.3565	132.5997	78.4522	78.4194	63.7272	63.1813	6.8426	.2578
85.0930	143.1457	[illegible]97.5208	951.6724	397.0543	143.0706	85.0139	91.72[illegible]	103.6487	107.7883
103.9497	91.4611	101.5094							

LOAD STEP = 178

.0856

120.9916	113.1118	11[illegible].3323	117.2429	117.6949	122.5735	117.4555	112.8580	111.1286	110.3849

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(TIMES .09 to 1.60 OMITTED FOR BREVITY)

LOAD STEP # 235
1.6396

199,1990	199,1767	199,3899	199,4138	199,1898	199,2231	199,2731	199,2459	199,3592	199,3408
199,2233	199,2696	199,3992	199,2815	199,5768	199,5366	199,2529	199,3743	199,3160	199,1617
199,0391	199,0262	199,1531	199,3343	199,1157	199,1802	199,7733	199,7768	199,1469	199,0959
199,0837	199,0469	199,1989	199,2063	199,0942	199,1463	187,6353	198,7202	219,4002	628,0044
219,5392	198,7267	187,6305	187,3172	184,9920	187,1432	184,9645	187,3340	182,0260	186,2585
219,3103	660,6964	219,4576	186,3189	182,0350	177,1490	184,8175	183,7141	184,7934	177,1378
603,0007	171,5631	164,0275	164,0527	1?5,1234	155,1226	149,3494	149,4134	202,8709	17,8896
172,6830	180,98?	219,1403	658,1339	219,2917	181,0423	172,6964	172,2332	184,1989	183,6560
184,1616	172,2165	199,3842							

LOAD STEP # 237
1.7396

194,5678	194,5922	194,6994	194,7195	194,6064	194,5741	194,5592	194,6337	194,6859	194,6770
194,6249	194,5498	194,7258	194,6851	194,9145	194,8802	194,6662	194,7167	194,6242	194,5569
194,3868	194,3783	194,5514	194,6263	194,4753	194,5005	195,0882	195,0948	194,5270	194,4434
194,4419	194,4710	194,4824	194,4917	194,5143	194,4849	183,2427	194,1519	214,6607	616,5104
214,7987	194,1517	183,2437	182,9614	180,6381	182,6992	180,6263	182,9738	177,7610	182,0066
214,5493	608,8604	214,6938	182,0654	177,7773	172,9746	180,4659	179,3719	180,4520	172,9612
591,7716	167,4742	160,1097	160,1448	151,3414	151,3302	145,5803	145,5888	197,5430	18,8254
168,6195	176,8416	214,4088	646,2869	214,5563	176,9007	168,6390	168,1589	179,8521	179,3048
179,8153	168,1394	194,7318							

LOAD STEP # 239
1.8396

190,5576	190,6035	190,6605	190,6791	190,6183	190,5641	190,5474	190,6349	190,6759	190,6658
190,6183	190,5327	190,6709	190,6793	190,9157	190,9052	190,6725	190,6518	190,5923	190,5515
190,3902	190,3923	190,5488	190,5981	190,4703	190,5391	191,0455	191,0670	190,5075	190,4239
190,4639	190,4887	190,4356	190,4462	190,5120	190,4944	179,4460	190,1737	210,5070	605,8706
210,6460	190,1671	179,4494	179,1997	176,8834	178,8812	176,8660	179,1968	174,0569	178,2901
210,3826	637,8593	210,5241	178,3471	174,0753	169,3589	176,7122	175,6283	176,7011	169,3460
581,4366	163,9346	156,6997	156,7355	148,0646	148,0590	142,2730	142,2805	192,8776	19,7363
165,0781	173,2187	210,2468	635,3059	210,3865	173,2777	165,0983	164,6283	176,1108	175,5598
176,0018	164,0137	190,7207							

LOAD STEP # 241
1.9396

186,9339	186,9608	187,0152	187,0315	186,9691	186,9530	186,9465	186,9893	187,0825	187,0773
186,9740	186,9207	187,0329	187,0234	187,2946	187,2873	187,0290	187,0276	186,9694	186,8963
186,8029	186,8049	186,9002	186,9816	186,8386	186,8644	187,3672	187,3855	186,8330	186,7919
186,8524	186,8535	186,8249	186,8275	186,8698	186,8876	176,0045	186,5203	206,5566	594,9494
206,6873	186,5093	176,0031	175,7661	173,4910	175,4578	173,4599	175,7639	170,6922	174,8513
206,4285	626,5342	206,5670	174,9073	170,7096	166,0814	173,3204	172,2538	173,3081	166,0698
571,0290	160,7360	153,5769	153,6033	145,0979	145,1009	139,2727	139,2883	188,8115	20,6241
161,8540	169,8637	206,2787	623,9857	206,4218	169,9214	161,8760	161,4295	172,7266	172,1863
172,7121	161,4167	186,0967							

LOAD STEP # 243
1.9996

184,8974	184,9331	184,9447	184,9667	184,9603	184,9134	184,8630	184,8629	184,8179	184,8100
184,8403	184,8408	184,7491	184,8137	185,0916	185,0821	184,8328	184,7836	184,8324	184,8439
184,8143	184,8071	184,8176	184,7911	184,8019	184,8481	185,2920	185,3206	184,8634	184,8275
184,7796	184,7453	184,6249	184,6187	184,7315	184,7543	174,0903	184,3955	204,1715	589,1640
204,3017	184,4143	174,1107	173,8022	171,4478	173,3277	171,4085	173,7802	168,7986	172,9653
204,2022	619,9003	204,3748	172,9983	168,8051	164,1873	171,3057	170,1949	171,2769	164,1793
565,7987	158,7724	151,8686	151,8794	143,3994	143,3972	137,5729	137,5581	186,5523	21,1461
168,0253	168,0396	204,3505	618,3976	204,4558	168,0670	160,0236	159,5997	170,7666	170,1442
170,7252	159,5976	184,8054							

EOS PRESSURE TIME HISTORY NUMBER 1

TIME	P	TIME	P	TIME	P	SEC TIME	PSIG PRESSURE
0,00000	0.0	.00500	.0	.01000	.0	.01500	.0
.02000	.0	.02500	.1	.03000	.9	.03500	4.3
.04000	12.4	.04560	25.3	.05060	36.7	.05560	51.5
.06060	71.3	.06560	87.8	.07060	94.5	.07560	96.3
.08060	101.0	.08560	110.5	.09060	123.3	.09560	138.7
.10960	161.2	.12960	167.6	.14960	196.8	.16960	201.5
.18960	211.2	.21960	215.8	.26460	238.1	.31460	245.7
.36460	244.5	.43960	257.0	.53960	264.4	.63960	265.0
.73960	260.6	.83960	250.8	.93960	243.2	1.03960	235.4
1.13960	228.9	1.23960	223.1	1.33960	217.0	1.43960	210.8
1.53960	204.7	1.63960	199.3	1.73960	194.6	1.83960	190.6

SECTION 3: EOS-SNAP ELEMENT PRESSURE TIME HISTORIES

.73960	260.6	.83960	25	.93960	243.2	1.03960	235.4
1.13960	228.9	1.23960	223.1	1.33960	217.0	1.43960	210.8
1.53960	204.7	1.63960	199.3	1.73960	194.6	1.83960	190.6
1.93960	187.0	1.99960	184.9				

EDS PRESSURE TIME HISTORY NUMBER 2

2 46

0.00000	0.0	.00500	.0	.01000	.0	.01500	.0
.02000	.1	.02500	.5	.03000	2.7	.03500	7.9
.04000	15.0	.04560	25.5	.05060	34.9	.05560	56.5
.06060	69.9	.06560	78.6	.07060	88.3	.07560	97.0
.08060	103.8	.08560	112.0	.09060	125.1	.09560	139.9
.10960	161.0	.12960	162.8	.14960	184.4	.16960	196.2
.18960	210.9	.21460	218.1	.26460	232.8	.31460	245.0
.36460	250.6	.43960	255.5	.53960	266.7	.63960	267.4
.73960	260.1	.83960	251.7	.93960	243.4	1.03960	235.4
1.13960	228.8	1.23960	223.0	1.33960	216.9	1.43960	210.6
1.53960	204.6	1.63960	199.2	1.73960	194.6	1.83960	190.6
1.93960	187.0	1.99960	184.8				

EDS PRESSURE TIME HISTORY NUMBER 3

3 46

0.00000	0.0	.00500	.0	.01000	.0	.01500	.0
.02000	.3	.02500	1.9	.03000	6.1	.03500	12.2
.04000	19.0	.04560	29.7	.05060	43.9	.05560	57.6
.06060	65.9	.06560	71.0	.07060	79.6	.07560	93.2
.08060	106.6	.08560	118.1	.09060	128.3	.09560	135.4
.10960	163.5	.12960	171.4	.14960	190.7	.16960	196.7
.18960	214.6	.21460	218.8	.26460	235.3	.31460	245.7
.36460	247.6	.43960	258.5	.53960	265.4	.63960	264.3
.73960	259.7	.83960	250.9	.93960	243.3	1.03960	235.2
1.13960	229.0	1.23960	223.1	1.33960	217.1	1.43960	210.7
1.53960	204.7	1.63960	199.3	1.73960	194.6	1.83960	190.5
1.93960	186.9	1.99960	184.8				

EDS PRESSURE TIME HISTORY NUMBER 4

4 46

0.00000	0.0	.00500	.0	.01000	.0	.01500	.1
.02000	1.2	.02500	4.5	.03000	10.1	.03500	16.5
.04000	25.0	.04560	37.0	.05060	47.5	.05560	54.6
.06060	60.6	.06560	67.9	.07060	75.7	.07560	86.5
.08060	103.7	.08560	120.5	.09060	129.2	.09560	137.5
.10960	150.8	.12960	172.2	.14960	192.3	.16960	192.9
.18960	210.3	.21460	222.9	.26460	236.1	.31460	241.4
.36460	249.3	.43960	263.5	.53960	266.5	.63960	263.6
.73960	259.3	.83960	251.4	.93960	242.6	1.03960	235.5
1.13960	228.9	1.23960	223.1	1.33960	216.9	1.43960	210.7
1.53960	204.7	1.63960	199.2	1.73960	194.6	1.83960	190.6
1.93960	186.9	1.99960	184.9				

EDS PRESSURE TIME HISTORY NUMBER 5

5 46

0.00000	0.0	.00500	.0	.01000	.0	.01500	.6
.02000	2.8	.02500	7.4	.03000	13.5	.03500	21.7
.04000	31.5	.04560	42	.05060	48.6	.05560	52.3
.06060	57.1	.06560	64.7	.07060	74.0	.07560	85.0
.08060	96.8	.08560	112.2	.09060	134.3	.09560	151.1
.10960	144.9	.12960	176.5	.14960	190.3	.16960	190.2
.18960	206.4	.21460	217.1	.26460	233.0	.31460	242.8
.36460	248.3	.43960	270.6	.53960	269.6	.63960	264.0
.73960	260.7	.83960	251.5	.93960	243.1	1.03960	235.4
1.13960	229.1	1.23960	222.9	1.33960	216.9	1.43960	210.5
1.53960	204.5	1.63960	199.2	1.73960	194.6	1.83960	190.6
1.93960	187.0	1.99960	184.9				

EDS PRESSURE TIME HISTORY NUMBER 6

6 46

0.00000	0.0	.00500	.0	.01000	.2	.01500	1.4
.02000	4.4	.02500	9.3	.03000	16.3	.03500	25.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

6 46

0.00000	0.0	.00500	.0	.01000	.2	.01500	1.4
.02000	4.4	.02500	9.3	.03000	16.3	.03500	25.4
.04000	34.4	.04560	42.7	.05060	48.3	.05560	53.0
.06060	57.6	.06560	62.6	.07060	69.7	.07560	79.6
.08060	95.9	.08560	117.6	.09060	135.3	.09560	146.1
.10960	145.0	.12960	179.6	.14960	166.7	.16960	196.9
.18960	214.0	.21460	222.3	.26460	231.8	.31460	244.6
.36460	251.0	.43960	267.1	.53960	268.8	.63960	263.7
.73960	258.9	.83960	251.0	.93960	242.9	1.03960	235.7
1.13960	229.0	1.23960	223.2	1.33960	217.1	1.43960	210.9
1.53960	204.9	1.63960	197.4	1.73960	194.1	1.83960	190.7
1.93960	187.1	1.99960	185.0				

EDS PRESSURE TIME HISTORY NUMBER 7

7 46

0.00000	0.0	.00500	.0	.01000	.0	.01500	.0
.02000	.0	.02500	.4	.03000	2.3	.03500	6.6
.04000	12.2	.04560	20.9	.05060	34.5	.05560	51.5
.06060	67.0	.06560	82.3	.07060	95.0	.07560	100.6
.08060	103.9	.08560	112.7	.09060	127.1	.09560	139.5
.10960	150.1	.12960	168.7	.14960	190.2	.16960	211.7
.18960	211.3	.21460	215.3	.26460	234.9	.31460	246.1
.36460	245.1	.43960	261.8	.53960	259.8	.63960	260.2
.73960	260.0	.83960	251.0	.93960	243.1	1.03960	235.1
1.13960	228.8	1.23960	222.9	1.33960	216.8	1.43960	210.6
1.53960	204.5	1.63960	199.1	1.73960	194.4	1.83960	190.4
1.93960	186.8	1.99960	184.8				

EDS PRESSURE TIME HISTORY NUMBER 8

8 46

0.00000	0.0	.00500	.0	.01000	.0	.01500	.0
.02000	.3	.02500	1.8	.03000	5.1	.03500	8.8
.04000	13.5	.04560	25.5	.05060	39.8	.05560	53.0
.06060	64.7	.06560	76.3	.07060	88.7	.07560	99.9
.08060	107.0	.08560	116.3	.09060	128.8	.09560	133.8
.10960	157.2	.12960	167.6	.14960	180.2	.16960	201.0
.18960	203.6	.21460	216.4	.26460	230.7	.31460	244.8
.36460	251.1	.43960	261.7	.53960	265.0	.63960	266.3
.73960	260.6	.83960	251.4	.93960	243.0	1.03960	235.6
1.13960	228.5	1.23960	223.0	1.33960	216.8	1.43960	210.5
1.53960	204.5	1.63960	199.1	1.73960	194.5	1.83960	190.5
1.93960	186.9	1.99960	184.8				

EDS PRESSURE TIME HISTORY NUMBER 9

9 46

0.00000	0.0	.00500	.0	.01000	.0	.01500	.2
.02000	1.4	.02500	4.8	.03000	8.5	.03500	11.7
.04000	18.8	.04560	33.0	.05060	45.5	.05560	53.1
.06060	60.2	.06560	70.9	.07060	82.2	.07560	94.0
.08060	110.7	.08560	124.5	.09060	123.7	.09560	121.8
.10960	153.2	.12960	164.5	.14960	182.4	.16960	205.9
.18960	209.6	.21460	217.7	.26460	232.5	.31460	245.3
.36460	248.4	.43960	262.0	.53960	263.9	.63960	265.4
.73960	250.6	.83960	250.5	.93960	243.2	1.03960	235.4
1.13960	229.1	1.23960	223.0	1.33960	217.1	1.43960	210.6
1.53960	204.7	1.63960	199.3	1.73960	194.6	1.83960	190.6
1.93960	187.0	1.99960	184.8				

EDS PRESSURE TIME HISTORY NUMBER 10

10 46

0.00000	0.0	.00500	.0	.01000	.1	.01500	1.1
.02000	4.4	.02500	8.8	.03000	12.1	.03500	17.5
.04000	28.7	.04560	41.9	.05060	48.1	.05560	52.0
.06060	58.3	.06560	66.9	.07060	77.2	.07560	94.3
.08060	112.3	.08560	114.8	.09060	115.9	.09560	128.4
.10960	109.2	.12960	168.4	.14960	189.4	.16960	202.8
.18960	206.0	.21460	222.6	.26460	235.3	.31460	247.0
.36460	248.9	.43960	263.9	.53960	265.6	.63960	263.8

.10960	149.2	.12960	168.4	.14960	189.4	.16960	202.8
.18960	206.0	.21960	222.6	.26460	235.3	.31460	247.0
.36460	248.9	.43960	263.9	.53960	265.6	.63960	263.8
.73960	259.7	.83960	251.3	.93960	242.7	1.03960	235.6
1.13960	229.0	1.23960	223.2	1.33960	217.0	1.43960	210.8
1.53960	20[illegible].8	1.63960	199.3	1.73960	194.7	1.83960	190.6
1.93960	187.0	1.99960	184.8				

EDS PRESSURE TIME HISTORY NUMBER 11

11 46

0.00000	0.0	.00500	.0	.01000	.6	.01500	3.5
.02000	8.5	.02500	13.4	.03000	20.5	.03500	32.8
.04000	48.3	.04560	59.5	.05060	61.5	.05560	63.8
.06060	69.9	.06560	78.8	.07060	87.7	.07560	97.0
.08060	96.7	.08560	105.9	.09060	123.2	.09560	125.1
.10960	160.7	.12960	169.1	.14960	186.9	.16960	196.0
.18960	203.9	.21460	219.6	.26460	233.8	.31460	244.6
.36460	247.4	.43960	266.7	.53960	268.5	.63960	263.9
.73960	261.4	.83960	251.7	.93960	243.4	1.03960	235.3
1.13960	224.1	1.23960	223.0	1.33960	216.9	1.43960	210.7
1.53960	204.6	1.63960	199.3	1.73960	194.7	1.83960	190.7
1.93960	187.0	1.99960	189.8				

EDS PRESSURE TIME HISTORY NUMBER 12

12 46

0.00000	0.0	.00500	.3	.01000	2.4	.01500	7.3
.02000	14.2	.02500	22.1	.03000	33.6	.03500	46.2
.04000	52.7	.04560	34.7	.05060	58.4	.05560	65.1
.06060	72.7	.06560	79.4	.07060	85.0	.07560	92.2
.08060	108.6	.08560	118.1	.09060	110.9	.09560	110.2
.10960	165.8	.12960	169.1	.14960	185.3	.16960	196.7
.18960	209.3	.21460	223.1	.26460	235.8	.31460	245.6
.36460	256.0	.43960	261.0	.53960	271.8	.63960	263.4
.73960	259.8	.83960	251.1	.93960	243.3	1.03960	236.0
1.13960	229.4	1.23960	223.5	1.33960	217.4	1.43960	211.1
1.53960	[illegible]	1.63960	199.6	1.73960	194.9	1.83960	190.9
1.93960	187.3	1.99960	185.1				

EDS PRESSURE TIME HISTORY NUMBER 13

13 46

0.00000	0.0	.00500	-.0	.01000	.0	.01500	.0
.02000	.1	.02500	.8	.03000	3.2	.03500	7.2
.04000	12.0	.04560	[illegible]	.05060	29.7	.05560	46.3
.06060	65.0	.06560	79.3	.07060	89.5	.07560	100.0
.08060	110.5	.08560	118.0	.09060	123.8	.09560	130.6
.10960	143.2	.12960	169.0	.14960	178.8	.16960	196.8
.18960	201.0	.21460	217.1	.26460	235.9	.31460	241.8
.36460	245.2	.43960	258.5	.53960	259.1	.63960	260.7
.73960	258.0	.83960	248.9	.93960	240.4	1.03960	232.7
1.13960	226.3	1.23960	220.5	1.33960	214.5	1.43960	208.3
1.53960	202.4	1.63960	197.0	1.73960	192.3	1.83960	188.3
1.93960	184.7	1.99960	182.5				

EDS PRESSURE TIME HISTORY NUMBER 14

14 46

0.00000	0.0	.00500	-.0	.01000	.0	.01500	.1
.02000	.7	.02500	2.8	.03000	5.7	.03500	9.0
.04000	13.9	.04560	23.2	.05060	35.3	.05560	49.6
.06060	62.4	.06560	74.4	.07060	86.0	.07560	98.5
.08060	111.1	.08560	121.4	.09060	125.2	.09560	125.3
.10960	148.7	.12960	175.0	.14960	181.3	.16960	201.5
.18960	202.5	.21460	211.6	.26460	230.8	.31460	245.3
.36460	245.4	.43960	262.4	.53960	263.4	.63960	262.6
.73960	258.0	.83960	248.7	.93960	241.2	1.03960	233.1
1.13960	226.6	1.23960	220.8	1.33960	214.7	1.43960	208.6
1.53960	202.6	1.63960	197.3	1.73960	192.7	1.83960	188.7
1.93960	185.1	1.99960	183.0				

EDS PRESSURE TIME HISTORY NUMBER 15

1.93960	185.1	1.99960	183.0

EDS PRESSURE TIME HISTORY NUMBER 15

15 46

0.00000	0.0	.00500	-.0	.01000	.0	.01500	.6
.02000	2.8	.02500	6.1	.03000	9.2	.03500	12.7
.04000	20.1	.04560	33.5	.05060	45.6	.05560	52.4
.06060	59.4	.06560	69.3	.07060	80.5	.07560	94.8
.08060	113.7	.08560	122.5	.09060	119.3	.09560	119.6
.10960	146.6	.12960	175.4	.14960	179.7	.16960	199.8
.18960	204.3	.21460	220.3	.26460	234.1	.31460	243.1
.36460	246.5	.43960	263.1	.53960	264.1	.63960	262.2
.73960	258.1	.83960	248.7	.93960	241.2	1.03960	233.3
1.13960	227.0	1.23960	221.1	1.33960	215.1	1.43960	208.8
1.53960	202.8	1.63960	197.5	1.73960	192.9	1.83960	188.9
1.93960	185.3	1.99960	183.2				

EDS PRESSURE TIME HISTORY NUMBER 16

16 46

0.00000	0.0	.00500	.0	.01000	.4	.01500	2.9
.02000	7.0	.02500	11.4	.03000	15.3	.03500	22.7
.04000	34.8	.04560	48.6	.05060	56.6	.05560	61.9
.06060	65.5	.06560	71.2	.07060	82.0	.07560	107.2
.08060	114.5	.08560	105.4	.09060	112.5	.09560	124.2
.10960	144.4	.12960	172.8	.14960	183.2	.16960	196.0
.18960	198.1	.21460	226.0	.26460	236.0	.31460	240.1
.36460	248.6	.43960	264.4	.53960	265.6	.63960	263.0
.73960	258.2	.83960	250.9	.93960	241.6	1.03960	234.4
1.13960	227.8	1.23960	222.1	1.33960	215.9	1.43960	209.7
1.53960	203.7	1.63960	198.3	1.73960	193.7	1.83960	189.7
1.93960	186.0	1.99960	184.0				

EDS PRESSURE TIME HISTORY NUMBER 17

17 46

0.00000	0.0	.00500	.2	.01[illegible]	2.9	.01500	8.8
.02000	15.5	.02500	24.6	[illegible]	43.0	.03500	68.1
.04000	98.2	.04560	123.3	[illegible]	133.8	.05560	138.4
.06060	142.6	.06560	148.1	[illegible]	152.9	.07560	129.2
.08060	114.4	.08560	124.3	[illegible]	126.6	.09560	132.2
.10960	164.6	.12960	187.[illegible]	[illegible]	206.5	.16960	212.0
.18960	217.6	.21460	236.6	[illegible]460	251.7	.31460	255.7
.36460	262.9	.43960	268.7	.53960	273.5	.63960	265.1
.73960	262.0	.83960	253.1	.93960	244.3	1.03960	237.2
1.13960	230.5	1.23960	224.5	1.33960	218.3	1.43960	212.0
1.53960	206.0	1.63960	200.6	1.73960	196.0	1.83960	191.9
1.93960	188.2	1.99960	186.2				

EDS PRESSURE TIME HISTORY NUMBER 18

18 46

0.00000	0.0	.00500	4.3	.01000	16.6	.01500	34.8
.02000	60.3	.02500	97.3	.03000	140.2	.03500	180.6
.04000	195.3	.04560	196.0	.05060	197.5	.05560	203.2
.06060	211.5	.06560	220.3	.07060	228.4	.07560	234.0
.08060	220.6	.08560	194.4	.09060	191.9	.09560	209.0
.10960	248.7	.12960	261.3	.14960	283.5	.16960	282.4
.18960	290.8	.21460	309.8	.26460	316.2	.31460	318.1
.36460	333.3	.43960	332.3	.53960	331.7	.63960	324.4
.73960	315.4	.83960	303.4	.93960	293.0	1.03960	284.3
1.13960	277.2	1.23960	270.1	1.33960	262.8	1.43960	255.3
1.53960	248.3	1.63960	242.1	1.73960	236.8	1.83960	232.1
1.93960	227.7	1.99960	225.3				

EDS PRESSURE TIME HISTORY NUMBER 19

19 46

0.00000	0.0	.00500	.0	.01000	.0	.01500	.0
.02000	.2	.02500	1.1	.03000	3.5	.03500	6.9
.04000	11.3	.04560	17.1	.05060	25.2	.05560	39.1
.06060	56.5	.06560	70.4	.07060	62.9	.07560	98.0
.08060	108.7	.08560	112.9	.09060	117.9	.09560	122.9

.04000	11.3	.04560	17.1	.05060	25.2	.05560	39.1
.06060	56.5	.06560	70.4	.07060	82.9	.07560	98.0
.08060	108.7	.08560	112.9	.09060	117.9	.09560	122.9
.10960	137.6	.12960	150.4	.14960	166.9	.16960	181.9
.18960	191.5	.21460	203.1	.26460	221.5	.31460	227.1
.36460	231.0	.43960	240.1	.53960	246.7	.63960	246.9
.73960	244.1	.83960	235.3	.93960	227.3	1.03960	219.8
1.13960	213.7	1.23960	210.2	1.33960	202.4	1.43960	196.5
1.53960	190.8	1.63960	185.8	1.73960	181.4	1.83960	177.6
1.93960	174.2	1.99960	172.1				

EDS PRESSURE TIME HISTORY NUMBER 20

20 46

0.00000	0.0	.00500	.0	.01000	.0	.01500	.1
.02000	.7	.02500	2.4	.03000	4.9	.03500	8.4
.04000	13.0	.04560	17.3	.05060	26.7	.05560	43.1
.06060	57.0	.06560	67.9	.07060	82.6	.07560	96.6
.08060	106.5	.08560	115.0	.09060	120.0	.09560	120.6
.10960	137.4	.12960	158.3	.14960	166.9	.16960	184.8
.18960	193.0	.21460	202.8	.26460	220.1	.31460	228.4
.36460	230.3	.43960	247.6	.53960	248.1	.63960	247.8
.73960	243.8	.83960	235.2	.93960	227.5	1.03960	219.9
1.13960	213.8	1.23960	208.2	1.33960	202.4	1.43960	196.5
1.53960	190.9	1.63960	185.8	1.73960	181.5	1.83960	177.7
1.93960	174.3	1.99960	172.2				

EDS PRESSURE TIME HISTORY NUMBER 21

21 46

0.00000	0.0	.00500	.0	.01000	.1	.01500	1.2
.02000	3.7	.02500	6.5	.03000	10.1	.03500	15.2
.04000	22.7	.04560	36.6	.05060	48.0	.05560	58.8
.06060	64.9	.06560	70.1	.07060	78.9	.07560	88.7
.08060	106.5	.08560	121.5	.09060	122.1	.09560	118.2
.10960	134.8	.12960	164.3	.14960	167.6	.16960	187.5
.18960	193.8	.21460	209.1	.26460	221.5	.31460	229.2
.36460	233.0	.43960	252.0	.53960	252.4	.63960	249.9
.73960	245.3	.83960	237.1	.93960	229.3	1.03960	221.9
1.13960	215.8	1.23960	210.1	1.33960	204.3	1.43960	198.4
1.53960	192.6	1.63960	187.5	1.73960	183.1	1.83960	179.4
1.93960	175.9	1.99960	174.0				

EDS PRESSURE TIME HISTORY NUMBER 22

22 46

0.00000	0.0	.00500	.0	.01000	.9	.01500	3.4
.02000	6.8	.02500	13.4	.03000	23.2	.03500	33.9
.04000	46.3	.04560	69.1	.05060	83.5	.05560	91.5
.06060	97.0	.06560	101.5	.07060	105.9	.07560	111.1
.08060	116.1	.08560	121.2	.09060	123.8	.09560	123.7
.10960	138.7	.12960	169.6	.14960	172.6	.16960	190.4
.18960	196.3	.21460	215.5	.26460	227.4	.31460	232.4
.36460	242.4	.43960	256.9	.53960	258.9	.63960	254.7
.73960	250.1	.83960	242.1	.93960	233.7	1.03960	226.6
1.13960	220.3	1.23960	214.6	1.33960	208.6	1.43960	202.5
1.53960	196.7	1.63960	191.5	1.73960	187.1	1.83960	183.2
1.93960	179.7	1.99960	177.7				

EDS PRESSURE TIME HISTORY NUMBER 23

23 46

0.00000	0.0	.00500	1.3	.01000	8.5	.01500	20.2
.02000	38.7	.02500	70.9	.03000	165.0	.03500	159.5
.04000	197.6	.04560	233.0	.05060	257.8	.05560	275.7
.06060	290.0	.06560	302.3	.07060	310.7	.07560	313.7
.08060	306.9	.08560	305.5	.09060	311.2	.09560	314.9
.10960	325.2	.12960	337.9	.14960	341.8	.16960	346.4
.18960	350.4	.21460	358.1	.26460	361.8	.31460	356.0
.36460	335.5	.43960	288.3	.53960	289.1	.63960	283.5
.73960	276.6	.83960	266.4	.93960	257.2	1.03960	249.8
1.13960	243.3	1.23960	237.1	1.33960	230.6	1.43960	223.9
1.53960	217.6	1.63960	212.1	1.73960	207.4	1.83960	203.3

.73960	276.6	.83960	266.4	.93960	257.2	1.03960	249.8
1.13960	243.3	1.23960	237.1	1.33960	230.6	1.43960	223.9
1.53960	217.6	1.63960	212.1	1.73960	207.4	1.83960	203.3
1.93960	199.5	1.99960	197.2				

EDS PRESSURE TIME HISTORY NUMBER 24

24 46

0.00000	0.0	.00500	12.6	.01000	44.4	.01500	92.5
.02000	161.7	.02500	251.6	.03000	353.6	.03500	446.2
.04000	491.6	.04560	513.3	.05060	523.3	.05560	531.0
.06060	541.4	.06560	555.0	.07060	568.5	.07560	578.9
.08060	586.4	.08560	591.5	.09060	594.4	.09560	595.8
.10960	600.1	.12960	603.6	.14960	609.0	.16960	608.3
.18960	608.6	.21960	611.2	.26460	606.6	.31460	588.7
.36460	561.2	.43960	534.8	.53960	510.6	.63960	502.2
.73960	482.4	.83960	455.6	.93960	438.9	1.03960	427.2
1.13960	417.6	1.23960	407.4	1.33960	396.5	1.43960	385.3
1.53960	375.5	1.63960	367.1	1.73960	360.0	1.83960	353.5
1.93960	347.0	1.99960	343.4				

EDS PRESSURE TIME HISTORY NUMBER 25

25 46

0.00000	0.0	.00500	.0	.01000	.0	.01500	.0
.02000	.2	.02500	1.1	.03000	3.4	.03500	6.7
.04000	10.9	.04560	16.5	.05060	23.5	.05560	35.6
.06060	52.6	.06560	69.0	.07060	84.6	.07560	99.2
.08060	106.9	.08560	110.3	.09060	115.8	.09560	121.2
.10960	134.2	.12960	153.3	.14960	166.9	.16960	182.5
.18960	192.4	.21460	201.2	.26460	219.7	.31460	226.2
.36460	229.6	.43960	246.4	.53960	245.5	.63960	246.7
.73960	243.0	.83960	234.3	.93960	226.4	1.03960	219.0
1.13960	212.8	1.23960	207.3	1.33960	201.5	1.43960	195.7
1.53960	190.0	1.63960	185.0	1.73960	180.6	1.83960	176.9
1.93960	173.5	1.99960	171.4				

EDS PRESSURE TIME HISTORY NUMBER 26

26 46

0.00000	0.0	.00500	.0	.01000	.0	.01500	.0
.02000	.3	.02500	1.3	.03000	3.8	.03500	7.2
.04000	11.3	.04560	16.7	.05060	23.5	.05560	36.5
.06060	53.3	.06560	69.1	.07060	84.3	.07560	98.4
.08060	105.8	.08560	110.3	.09060	116.4	.09560	121.3
.10960	133.0	.12960	153.5	.14960	166.3	.16960	182.8
.18960	192.1	.21460	201.0	.26460	219.3	.31460	226.1
.36460	229.0	.43960	246.4	.53960	245.7	.63960	246.4
.73960	242.5	.83960	233.9	.93960	226.0	1.03960	218.7
1.13960	212.5	1.23960	207.0	1.33960	201.2	1.43960	195.3
1.53960	189.7	1.63960	184.7	1.73960	180.3	1.83960	176.6
1.93960	173.2	1.99960	171.2				

EDS PRESSURE TIME HISTORY NUMBER 27

27 46

• 0.00000	0.0	.00500	.0	.01000	.1	.01500	1.5
.02000	4.5	.02500	7.6	.03000	11.6	.03500	17.9
.04000	27.2	.04560	42.5	.05060	56.0	.05560	64.5
.06060	68.2	.06560	72.2	.07060	76.1	.07560	82.7
.08060	101.1	.08560	120.9	.09060	121.6	.09560	118.3
.10960	126.5	.12960	159.5	.14960	164.6	.16960	184.4
.18960	190.0	.21460	205.4	.26460	217.6	.31460	224.8
.36460	229.5	.43960	249.6	.53960	249.2	.63960	246.4
.73960	241.7	.83960	233.6	.93960	225.8	1.03960	218.7
1.13960	212.5	1.23960	206.9	1.33960	201.1	1.43960	195.3
1.53960	189.6	1.63960	184.6	1.73960	180.3	1.83960	176.6
1.93960	173.2	1.99960	171.2				

EDS PRESSURE TIME HISTORY NUMBER 28

28 46

0.00000	0.0	.00500	.0	.01000	.3	.01500	2.0
.02000	5.3	.02500	9.3	.03000	14.6	.03500	22.4

28 46

0,00000	0.0	.00500	.0	.01000	.3	.01500	2.0
.02000	5.3	.02500	9.3	.03000	10.6	.03500	22.4
.04000	33.2	.04560	50.2	.05060	64.5	.05560	72.9
.06060	76.2	.06560	79.6	.07060	82.5	.07560	88.0
.08060	104.5	.08560	121.7	.09060	122.1	.09560	119.3
.10960	127.9	.12960	160.8	.14960	165.9	.16960	185.2
.18960	190.7	.21460	206.6	.26460	218.6	.31460	225.5
.36460	230.9	.43960	250.8	.53960	250.6	.63960	247.4
.73960	242.7	.83960	234.6	.93960	226.7	1.03960	219.6
1.13960	213.4	1.23960	207.8	1.33960	202.0	1.43960	196.1
1.53960	190.5	1.63960	185.0	1.73960	181.1	1.83960	177.3
1.93960	173.9	1.99960	172.0				

EDS PRESSURE TIME HISTORY NUMBER 29

29 46

0,00000	0.0	.00500	1.7	.01000	16.9	.01500	25.6
.02000	52.5	.02500	94.3	.03000	145.3	.03500	199.8
.04000	249.3	.04560	289.3	.05060	314.7	.05560	335.6
.06060	352.1	.06560	363.9	.07060	371.3	.07560	377.6
.08060	381.8	.08560	384.6	.09060	388.1	.09560	391.6
.10960	398.3	.12960	404.3	.14960	408.5	.16960	411.3
.18960	411.7	.21460	413.9	.26460	413.3	.31460	404.7
.36460	380.7	.43960	299.4	.53960	296.8	.63960	291.6
.73960	283.5	.83960	272.4	.93960	263.0	1.03960	255.5
1.13960	249.0	1.23960	232.6	1.33960	236.0	1.43960	229.1
1.53960	222.8	1.63960	217.2	1.73960	212.5	1.83960	208.4
1.93960	204.4	1.99960	202.2				

EDS PRESSURE TIME HISTORY NUMBER 30 PTH NEXT TO HOT LEG BREAK

30 46

0,00000	0.0	.00500	6.9	.01000	27.0	.01500	56.4
.02000	105.2	.02500	172.9	.03000	247.8	.03500	320.7
.04000	371.7	.04560	409.4	.05060	434.3	.05560	454.1
.06060	468.4	.06560	477.7	.07060	485.1	.07560	492.7
.08060	499.9	.08560	504.8	.09060	507.6	.09560	509.7
.10960	515.2	.12960	519.0	.14960	523.7	.16960	524.7
.18960	524.5	.21460	526.4	.26460	523.1	.31460	509.6
.36460	486.2	.43960	425.2	.53960	410.5	.63960	403.6
.73960	389.3	.83960	370.[illegible]	.93960	356.8	1.03960	347.1
1.13960	339.0	1.23960	330.6	1.33960	321.7	1.43960	312.6
1.53960	304.4	1.63960	297.4	1.73960	291.3	1.83960	286.0
1.93960	280.7	1.99960	277.7				

EDS PRESSURE TIME HISTORY NUMBER 31

31 46

0,00000	0.0	.00500	.0	.01000	.0	.01500	.0
.02000	.1	.02500	.8	.03000	2.8	.03500	6.0
.04000	10.0	.04560	15.6	.05060	21.7	.05560	31.5
.06060	47.9	.06560	67.0	.07060	86.3	.07560	100.8
.08060	106.1	.08560	108.3	.09060	113.1	.09560	119.1
.10960	131.7	.12960	150.0	.14960	167.8	.16960	182.4
.18960	193.3	.21460	199.4	.26460	218.1	.31460	225.0
.36460	228.6	.43960	246.4	.53960	243.7	.63960	246.5
.73960	242.3	.83960	233.5	.93960	225.8	1.03960	218.5
1.13960	212.2	1.23960	206.7	1.33960	200.9	1.43960	195.1
1.53960	189.4	1.63960	184.4	1.73960	180.[illegible]	1.83960	176.3
1.93960	172.9	1.99960	170.9				

EDS PRESSURE TIME HISTORY NUMBER 32

32 46

0,00000	0.0	.00500	.0	.01000	.0	.01500	.1
.02000	.5	.02500	1.9	.03000	4.3	.03500	7.6
.04000	10.9	.04560	16.5	.05060	23.0	.05560	34.0
.06060	51.3	.06560	68.9	.07060	84.1	.07560	95.6
.08060	100.9	.08560	107.6	.09060	115.5	.09560	120.5
.10960	124.3	.12960	149.3	.14960	164.0	.16960	181.3
.18960	190.1	.21460	198.0	.26460	215.8	.31460	222.3
.36460	225.7	.43960	244.4	.53960	242.3	.63960	243.7

.10960	124.3	.12960	149.3	.14960	164.0	.16960	181.3
.18960	190.1	.21460	198.0	.26460	215.8	.31460	222.3
.36460	225.7	.43960	244.4	.53960	242.3	.63960	243.7
.73960	239.2	.83960	230.7	.93960	222.9	1.03960	215.8
1.13960	209.6	1.23960	[illegible]	1.33960	198.4	1.43960	192.6
1.53960	187.1	1.63960	182.1	1.73960	177.8	1.83960	174.1
1.93960	170.8	1.99960	168.8				

EDS PRESSURE TIME HISTORY NUMBER 33

33 46

0.00000	0.0	.00500	.0	.01000	.1	.01500	1.0
.02000	3.4	.02500	6.4	.03000	10.0	.03500	15.8
.04000	23.5	.04560	33.4	.05060	47.0	.05560	57.8
.06060	64.5	.06560	71.1	.07060	76.2	.07560	81.3
.08060	94.2	.08560	115.9	.09060	120.7	.09560	118.7
.10960	117.8	.12960	151.6	.14960	160.9	.16960	180.9
.18960	186.3	.21460	198.0	.26460	212.0	.31460	219.7
.36460	223.6	.43960	244.4	.53960	243.0	.63960	241.5
.73960	236.5	.83960	228.4	.93960	220.7	1.03960	213.7
1.13960	207.6	1.23960	202.1	1.33960	196.4	1.[illegible]3960	[illegible]90.7
1.53960	185.2	1.63960	180.3	1.73960	176.1	1.83960	172.4
1.93960	[illegible]9.1	1.99960	167.2				

EDS PRESSURE TIME HISTORY NUMBER 34

34 46

0.00000	0.0	.00500	.0	.01000	.8	.01500	3.3
.02000	7.4	.02500	14.8	.03000	23.6	.03500	36.6
.04000	53.0	.04560	69.5	.05060	87.0	.05560	99.5
.06060	103.3	.06560	105.5	.07060	105.7	.07560	106.4
.08060	114.3	.08560	123.9	.09060	123.5	.09560	122.1
.10760	125.8	.12960	157.6	.14960	166.6	.16960	184.8
.18960	190.2	.21460	202.0	.26460	215.0	.31460	222.7
.36460	226.6	.43960	250.9	.53960	249.1	.63960	245.9
.73960	240.5	.83960	232.2	.93960	224.3	1.03960	217.4
1.13960	211.3	1.23960	205.7	1.33960	199.9	1.43960	194.0
1.53960	188.5	1.63960	183.5	1.73960	179.3	1.83960	175.5
1.93960	172.2	1.99960	170.3				

EDS PRESSURE TIME HISTORY NUMBER 35

35 46

0.00000	0.0	.00500	1.2	.01000	8.1	.01500	19.7
.02000	42.[illegible]	.02500	76.9	.03000	115.9	.03500	160.8
.04000	206.[illegible]	.04560	242.2	.05060	265.0	.05560	285.2
.06060	298.6	.06560	304.3	.07060	307.5	.07560	311.6
.08060	313.9	.08560	309.8	.09060	310.5	.09560	314.3
.10960	320.1	.12960	332.2	.14960	339.1	.16960	345.0
.18960	347.3	.21460	351.3	.26460	354.9	.31460	351.3
.36460	344.5	.43960	287.8	.53960	283.9	.63960	279.2
.73960	271.5	.83960	261.1	.93960	252.0	1.03960	244.7
1.13960	238.4	1.23960	232.1	1.33960	225.8	1.43960	219.2
1.53960	213.1	1.63960	207.7	1.73960	203.1	1.83960	199.1
1.93960	195.3	1.99960	193.2				

EDS PRESSURE TIME HISTORY NUMBER 36

36 46

0.00000	0.0	.00500	11.1	.01000	39.1	.01500	76.9
.02000	144.0	.02500	235.0	.03000	324.0	.03500	407.2
.04000	462.2	.04560	509.3	.05060	547.1	.05560	575.9
.06060	588.5	.06560	589.3	.07060	587.3	.07560	593.1
.08060	602.0	.08560	607.5	.09060	606.8	.09560	609.2
.10960	614.4	.12960	617.8	.14960	623.5	.16960	624.6
.18960	623.5	.21460	626.2	.26460	621.5	.31460	605.4
.36460	592.9	.43960	553.5	.53960	525.0	.63960	516.4
.73960	496.2	.83960	468.9	.93960	451.8	1.03960	440.1
1.13960	430.3	1.23960	419.9	1.33960	408.8	1.43960	397.4
1.53960	387.4	1.63960	378.9	1.73960	371.6	1.83960	3[illegible]5.0
1.93960	358.3	1.99960	354.6				

EDS PRESSURE TIME HISTORY NUMBER 37

1.93960	358.3	1.99960	354.6

EDS PRESSURE TIME HISTORY NUMBER 37

37 46

0.00000	π.0	.00500	-.0	.01000	.0	.01500	.0
.02000	.1	.02500	.6	.03000	2.2	.03500	5.5
.04000	9.8	.04560	15.0	.05060	21.0	.05560	29.8
.06060	44.6	.06560	66.5	.07060	87.8	.07560	100.6
.08060	106.1	.08560	107.7	.09060	110.3	.09560	118.5
.10960	132.2	.12960	148.0	.14960	168.1	.16960	183.5
.18960	193.7	.21460	198.6	.26460	217.0	.31460	224.2
.36460	228.0	.43960	245.9	.53960	242.2	.63960	246.3
.73960	241.9	.83960	232.9	.93960	225.4	1.03960	218.1
1.13960	211.7	1.23960	206.2	1.33960	200.5	1.43960	194.7
1.53960	189.0	1.63960	184.0	1.73960	179.6	1.83960	175.9
1.93960	172.5	1.99960	170.5				

EDS PRESSURE TIME HISTORY NUMBER 38

38 46

0.00000	0.0	.00500	-.0	.01000	.0	.01500	.1
.02000	.6	.02500	2.0	.03000	4.5	.03500	7.9
.04000	11.0	.04560	15.8	.05060	23.1	.05560	33.1
.06060	49.8	.06560	70.1	.07060	84.4	.07560	91.6
.08060	98.1	.08560	109.2	.09060	113.0	.09560	121.8
.10960	118.8	.12960	144.8	.14960	161.2	.16960	179.6
.18960	187.0	.21460	194.5	.26460	211.9	.31460	218.0
.36460	221.7	.43960	241.6	.53960	238.1	.63960	239.9
.73960	235.3	.83960	226.7	.93960	219.2	1.03960	212.1
1.13960	206.0	1.23960	200.6	1.33960	194.9	1.43960	189.3
1.53960	183.8	1.63960	178.9	1.73960	174.7	1.83960	171.0
1.93960	167.7	1.99960	165.8				

EDS PRESSURE TIME HISTORY NUMBER 39

39 46

0.00000	0.0	.00500	-.0	.01000	.0	.01500	.6
.02000	2.6	.02500	5.6	.03000	9.3	.03500	14.0
.04000	20.5	.04560	29.9	.05060	40.3	.05560	52.8
.06060	64.1	.06560	70.5	.07060	74.9	.07560	81.2
.08060	89.7	.08560	104.8	.09060	119.5	.09560	120.9
.10960	110.0	.12960	143.6	.14960	156.0	.16960	175.4
.18960	180.2	.21460	189.4	.26460	205.0	.31460	212.5
.36460	216.4	.43960	237.2	.53960	234.7	.63960	234.2
.73960	229.1	.83960	221.1	.93960	213.6	1.03960	206.8
1.13960	200.8	1.23960	194.4	1.33960	189.9	1.43960	184.3
1.53960	179.0	1.63960	174.3	1.73960	170.2	1.83960	166.6
1.93960	163.4	1.99960	161.5				

EDS PRESSURE TIME HISTORY NUMBER 40

40 46

0.00000	0.0	.00500	.0	.01000	.6	.01500	3.6
.02000	8.6	.02500	16.4	.03000	28.7	.03500	44.2
.04000	62.0	.04560	81.8	.05060	97.0	.05560	110.7
.06060	118.3	.06560	116.5	.07060	113.7	.07560	114.3
.08060	116.2	.08560	119.7	.09060	122.9	.09560	121.5
.10960	122.3	.12960	152.3	.14960	164.4	.16960	180.7
.18960	186.2	.21460	195.2	.26460	209.3	.31460	217.2
.36960	220.9	.43960	244.6	.53960	243.3	.63960	240.3
.73960	234.7	.83760	226.3	.93460	218.6	1.03960	211.8
1.13960	205.9	1.23960	200.3	1.33960	194.7	1.43960	188.9
1.53960	183.5	1.63960	178.7	1.73960	174.5	1.83960	170.9
1.93940	167.5	1.99960	165.8				

EDS PRESSURE TIME HISTORY NUMBER 41

41 46

0.00000	0.0	.00500	.4	.01000	4.9	.01500	17.3
.02000	35.9	.02500	62.3	.03000	99.9	.03500	141.6
.04000	178.8	.04560	212.5	.05060	237.4	.05560	255.2
.06060	266.2	.06560	271.3	.07060	272.1	.07560	271.7
.08060	271.9	.08560	269.2	.09060	268.2	.09560	270.8
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

.04000	178.8	.04560	212.5	.0[illegible]60	237.4	.05560	255.2
.06060	266.2	.06560	271.3	.07060	272.1	.07560	271.7
.08060	271.9	.08560	269.2	.09060	268.2	.09560	270.8
.10960	276.1	.12960	291.4	.14960	300.5	.16960	307.4
.18960	310.6	.21460	315.5	.26460	321.1	.3146[illegible]	329.2
.36460	317.0	.43960	276.9	.53960	274.8	.63960	270.0
.73960	263.0	.83960	252.6	.93960	243.9	1.03960	236.9
1.13960	230.6	1.23960	224.5	1.33960	218.3	1.43960	211.9
1.53960	206.0	1.63960	200.8	1.73960	196.3	1.83960	192.4
1.93960	188.7	1.99960	186.8				

EDS PRESSURE TIME HISTORY NUMBER 42

42	46						
0.00000	0.0	.0[illegible]	7.7	.01000	35.7	.01500	93.8
.02000	175.0	.025[illegible]	271.6	.03000	382.2	.03500	491.1
.04000	570.3	.04560	629.1	.05060	651.2	.05560	663.8
.06960	669.2	.06560	673.2	.07060	676.8	.07560	679.7
.08060	682.6	.08560	685.9	.09060	689.1	.09560	691.3
.10960	693.8	.12960	699.3	.14960	704.2	.16960	705.0
.18960	7[illegible]3.1	.21460	706.8	.26460	701.2	.31460	[illegible]01.7
.36460	672.1	.43960	654.3	.53960	619.1	.63960	608.7
.73960	583.9	.83960	549.4	.93960	528.8	1.03960	515.3
1.13960	504.1	1.23760	492.0	1.33960	479.0	1.43960	465.8
1.53960	45[illegible].3	1.63960	444.6	1.73960	436.[illegible]	1.83960	428.5
1.93960	420.8	1.99960	416.8				

NET THRUST ON CAVITY WALL (½ model) in direction of HOTLEG Break (lbs.)

APPROXIMATE NET ASYMMETRIC LOAD AND ASYMMETRIC LOAD + 90 DEGREES, FOR THIS LOAD CASE, BY TIME STEP

NSTEP=	1	TIME=	0.0000	ASYMMETRIC=	0.	ASYM+90DEG=	0.
NSTEP=	2	TIME=	.0050	ASYMMETRIC=	.90547E+05	ASYM+90DEG=	.28889E+05
NSTEP=	3	TIME=	.0100	ASYMMETRIC=	.39801E+06	ASYM+90DEG=	.15057E+06
NSTEP=	4	TIME=	.0150	ASYMMETRIC=	.95961E+06	ASYM+90DEG=	.41667E+06
NSTEP=	5	TIME=	.0200	ASYMMETRIC=	.17991E+07	ASYM+90DEG=	.87118E+06
NSTEP=	6	TIME=	.0250	ASYMMETRIC=	.28935E+07	ASYM+90DEG=	.15465E+07
NSTEP=	7	TIME=	.0300	ASYMMETRIC=	.41641E+07	ASYM+90DEG=	.24437E+07
NSTEP=	8	TIME=	.0350	ASYMMETRIC=	.54243E+07	ASYM+90DEG=	.35200E+07
NSTEP=	9	TIME=	.0400	ASYMMETRIC=	.62628E+07	ASYM+90DEG=	.46[illegible]E+07
NSTEP=	10	TIME=	.0456	ASYMMETRIC=	.66588E+07	ASYM+90DEG=	.60157E+07
NSTEP=	11	TIME=	.0506	ASYMMETRIC=	.66286E+07	ASYM+90DEG=	.71171E+07
NSTEP=	12	TIME=	.0556	ASYMMETRIC=	.63560E+07	ASYM+90DEG=	.80797E+07
NSTEP=	13	TIME=	.0606	ASYMMETRIC=	.59769E+07	ASYM+90DEG=	.89278E+07
NSTEP=	14	TIME=	.0656	ASYMMETRIC=	.56219E+07	ASYM+90DEG=	.97418E+07
NSTEP=	15	TIME=	.0706	ASYMMETRIC=	.53778E+07	ASYM+90DEG=	.10563E+08
NSTEP=	16	TIME=	.0756	ASYMMETRIC=	.52138E+07	ASYM+90DEG=	.11441E+08
NSTEP=	17	TIME=	.0806	ASYMMETRIC=	.50958E+07	ASYM+90DEG=	.12336E+08
NSTEP=	18	TIME=	.0856	ASYMMETRIC=	.49915E+07	ASYM+90DEG=	.13159E+08
NSTEP=	19	TIME=	.0906	ASYMMETRIC=	.49070E+07	ASYM+90DEG=	.13849E+08
NSTEP=	20	TIME=	.0956	ASYMMETRIC=	.48612E+07	ASYM+90DEG=	.14441E+08
NSTEP=	21	TIME=	.1096	ASYMMETRIC=	.48657E+07	ASYM+90DEG=	.16037E+08
NSTEP=	22	TIME=	.1296	ASYMMETRIC=	.49720E+07	ASYM+90DEG=	.17920E+08
NSTEP=	23	TIME=	.1496	ASYMMETRIC=	.479[illegible]+07	ASYM+90DEG=	.19298E+08
NSTEP=	24	TIME=	.1696	ASYMMETRIC=	.428[illegible]+07	ASYM+90DEG=	.20454E+08
NSTEP=	25	TIME=	.1896	ASYMMETRIC=	.43653E+07	ASYM+90DEG=	.21253E+08
NSTEP=	26	TIME=	.2146	ASYMMETRIC=	.45210E+07	ASYM+90DEG=	.22352E+08
NSTEP=	2[illegible]	TIME=	.2646	ASYMMETRIC=	.40756E+07	ASYM+90DEG=	.23675E+08
NSTEP=	28	TIME=	.3146	ASYMMETRIC=	.37783E+07	ASYM+90DEG=	.24430E+08
NSTEP=	29	TIME=	.3646	ASYMMETRIC=	.37966E+07	ASYM+90DEG=	.24764E+08
NSTEP=	30	TIME=	.4396	ASYMMETRIC=	.31174E+07	ASYM+90DEG=	.25789E+08
NSTEP=	31	TIME=	.5396	ASYMMETRIC=	.28788E+07	ASYM+90DEG=	.25923E+08
NSTEP=	32	TIME=	.6396	ASYMMETRIC=	.25099E+07	ASYM+90DEG=	.25717E+08
NSTEP=	33	TIME=	.7396	ASYMMETRIC=	.23929E+07	ASYM+90DEG=	.25221E+08
NSTEP=	34	TIME=	.8396	ASYMMETRIC=	.224[illegible]+07	ASYM+90DEG=	.24334E+08
NSTEP=	35	TIME=	.9396	ASYMMETRIC=	.213[illegible]+07	ASYM+90DEG=	.23527E+08
NSTEP=	36	TIME=	1.0396	ASYMMETRIC=	.21125E+07	ASYM+90DEG=	.22795E+08
NSTEP=	37	TIME=	1.1396	ASYMMETRIC=	.20801E+07	ASYM+90DEG=	.22171E+08
NSTEP=	38	TIME=	1.2396	ASYMMETRIC=	.20292E+07	ASYM+90DEG=	.21599E+08
NSTEP=	39	TIME=	1.3396	ASYMMETRIC=	.19769E+07	ASYM+90DEG=	.21005E+08
NSTEP=	40	TIME=	1.4396	ASYMMETRIC=	.19230E+07	ASYM+90DEG=	.20398E+08
NSTEP=	41	TIME=	1.5396	ASYMMETRIC=	.18824E+07	ASYM+90DEG=	.19817E+08

SECTION 4: INTEGRATED NET THRUST DATA

```
NSTEP=    39 TIME=    1.3396 ASYMMETRIC=     .19769E+07 ASYM+90DEG=     .21005E+08
NSTEP=    40 TIME=    1.4396 ASYMMETRIC=     .19730E+07 ASYM+90DEG=     .20398E+08
NSTEP=    41 TIME=    1.5396 ASYMMETRIC=     .18824E+07 ASYM+90DEG=     .19817E+08
NSTEP=    42 TIME=    1.6396 ASYMMETRIC=     .18495E+07 ASYM+90DEG=     .19299E+08
NSTEP=    43 TIME=    1.7396 ASYMMETRIC=     .18217E+07 ASYM+90DEG=     .18853E+08
NSTEP=    44 TIME=    1.8396 ASYMMETRIC=     .17942E+07 ASYM+90DEG=     .18467E+08
NSTEP=    45 TIME=    1.9396 ASYMMETRIC=     .17623E+07 ASYM+90DEG=     .18115E+08
NSTEP=    46 TIME=    1.9996 ASYMMETRIC=     .17494E+07 ASYM+90DEG=     .17912E+08
```

```
 MCZ   MCC  SCOPE 3.4.3    406G.000  08/07/79  S/N 115
15.30.48.SRENHA7  FROM      /00
15.30.48.ISIP, INPUT  ,00000012 IUDHS, ***/H0, DC= 00.
15.30.48.$SEQUENCE,DEN.
15.30.48.MAP,P4,TP1,T100.                   M MANRIQUE
15.30.49.USER(ED800MC,)
15.30.50.PROJECT,*110*061221.
15.30.51.ACCN, F3275, *110*061221           *
15.30.52.ROUTE,OUTPUT,DC=PR,FC=IP,DEF.
15.30.52.FTN,LOO,A.
15.30.57.        .701 CP SECONDS COMPILATION TIME
15.30.57.MAP,OFF.
15.30.57.LABEL,X,R,VSN=PA4224.
15.31.57.MT24 VOLUME SERIAL NUMBER IS  PA4224
15.31.57.MT24 ASSIGNED TO  X
15.32.00.$VSN= PA4224, RD ACCESS GRANTED
15.32.00. LS   READ HAS       JMEXHMC*007
15.32.00.    EDITION NUMBER    01
15.32.00.    RETENTION CYCLE  000
15.32.00.    CREATION DATE     79242
15.32.00.    REEL NUMBER       0001
15.32.00.COPYSF,X,TAPE1,5.
15.32.22.UNLOAD,X.
15.32.22.REWIND,TAPE1.
15.32.22.LGO,PL=20000.
15.32.39.       END  MAP
15.32.40.ISOP, OUTPUT ,00000431 IODBS, ***/HU, DC= 40.
15.32.40.ISEQ, ENTERED QUEUE 15.30.47  79327
15.32.40.ISS*,          80.747 EXECUTION TIME
15.32.40.MS    60928  WORDS  (  215040 MAX USED)
15.32.40.CPA       12.889 SEC.
15.32.40.IO        67.857 SEC.
15.32.40.CM       986.662 KWS.
15.32.40.ISSN,          44.391 TOTAL SBUS NON-APPLICATION
15.32.40.PP        41.631 SEC.        DATE 11/23/79
15.32.40.EJ  END OF JOB, MO
```

APPENDIX C

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