SAFETY RELATED (X) YES ( ) NO

INITIAL
PIPING STRESS ANALYSIS
COMMONWEALTH EDISON CO.
BYRON/BRAIDWOOD UNIT 1
4391-00/4683-00
FEEDWATER
1FW-04

Rev.:04 Date: 7-17-80

ACCESSION NO. EMD- 019178

ENGINEERING MECHANICS DIVISION

SIGNATURE PAGE

PREPARED BY: _____ DATE: 7/17/80
J. Pebler

REVIEWED BY: _____ DATE: 7/21/80
R. Prasad

APPROVED BY: _____ DATE: 10/23/80
B. Tatosian

( ) FIRST ISSUE

(X) THIS ANALYSIS SUPERSEDES:

REV.: 03 DATE: 10-22-76 ACC. NO.: EMD- 005821

TABLE OF CONTENTS

Part I - To Be Filmed

Part II - Do Not Film

		Check
1.	Combined Reactions	
	a. Input	☐
	b. Max. Combined Anchor/Valve-End Reactions	☐
	c. Max. Rigid Restraint Loads	☐
	d. Thermal Mvt. At The Nodes	☐
	e. Spring Hanger Data	☐
	f. Hydraulic Snubber Data	☐
2.	Miscellaneous	
	Welded Attachment Calculations	☒

Part III

Computer Output Microfiche (COM)

Includes "Analyses Performed" as listed in Part I/Page 5.
Number of COM cards 2 .

SUBSYSTEM DOCUMENTATION

System: Feedwater Subsystem: 1FW-04

Piping Classification Group: B Seismic (x) Yes ( ) No

(x) Initial ( ) Formal ( ) Certified Analysis

REFERENCES

1. Certified System Design Spec.: No.: _____ Rev.: _____ Date: _____
2. Anal. Drawing: No.: 1FW-04 Rev.: 04 Date: 7-31-80
3. P&ID Drawings: No.: See analytical Rev.: _____ Date: _____
4. Equip. Spec.: No.: _____ Rev.: _____ Date: _____

_____ _____ _____

5. Seismic Information:

Stm. Gen. Feedwater Nozzle-OBE(WO-NS,VR,EW)

Cont. Bldg. El. 399 Stm. Gen. Support(205-OB-NS,EW,204-OB-VS)

Cont. Bldg. El. 394 Outer Wall (201-OB-NS,VW,EW)

6. Other:

ANALYSES PERFORMED

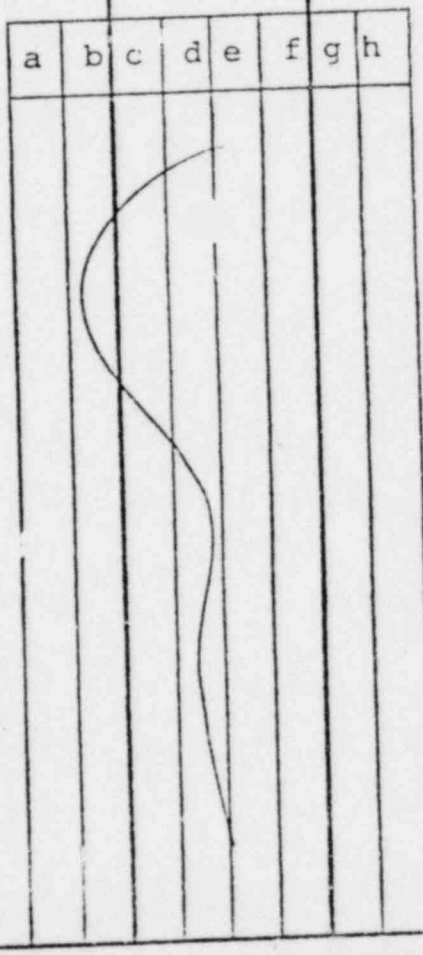
Loadings	Date	Comments	Check-list Item No.	Sec.
DATA 1	7-17-80		1.0	C
THERMAL 1	7-17-80	MAX. OPER. 567°	2.0	D
WEIGHT 1	7-17-80		3.0	E
SEISMIC 1	7-17-80		5.0	F
TRANSIENT1	7-17-80		6.0	I
COMBINED STRESSES	7-17-80		8.0	A
COMBINED REACTIONS	7-17-80		9.0	B

STANDARD EMD CHECKLIST FOR PIPING SYSTEM STRESS ANALYSIS

Validated Programs Used: (X) PIPSYS ( ) NOHEAT ( ) SRVA

Description	Checked	Comments
1.0 Basic Design Data (Output Section C)		
1.1 Are all branch lines per Ref. 3 included where $I_R/I_B \leq 7.0$?	✓	
1.2 Are all material types coded in agreement with Ref. 2?	✓	
1.3 Are all pipe/fitting thicknesses and uniform weights in agreement with Ref. 2?	✓	
1.4 Are all motor or pneumatic operated valves modeled using lumped masses and cg's?	✓	No Valves
1.5 Is the system modeled correctly (length ratios, etc.)?	✓	Some too short elements modeled due to fitting configuration.
1.6 Are all hangers/restraints modeled correctly per Ref. 2?		S_y modeled at 40A instead of 40B.
1.7 Are there any special modeling techniques used in the analyses (equipment flexibility, special restraint configurations, etc.)?	NO	Restraints at 73 & 75 modeled interchanges.
1.8 Are all node types coded correctly?	✓	
1.9 Is the internal pressure (max. op. pressure from Ref. 2) coded in Psig?	✓	

Description	Checked	Comments
2.0 Thermal Analysis (Output Section)		
2.1 Are the analyzed thermal modes in agreement with Ref. 2?	✓	
2.2 Are the anchor movements in agreement with Ref. 2?	✓	
2.3 Are all the deflections reasonable (if over 1.5", specify)?	✓	Deflection of order of 2" at some nodes. Check for interference.
3.0 Weight Analysis (Output Section E)		
3.1 Is the overall support system balanced?	✓	
3.2 Are all pipe deflections within 0.2 inches?	✓	
3.3 For hydro-run, verify that all spring hangers were pinned per the appropriate standard.	N/A	
4.0 Equivalent Static Load Analyses (Output Section D)		
The following analyses are performed using the PIPSYS static analysis routine:		
a-		
b-		
c-		
d-		
e-		
f-		
g-		
h-		
4.1 Are all design parameters in agreement with Ref. ____?		
4.2 Are the forces input correctly in the PIPSYS with respect to magnitude, direction and point of action?		
4.3 Has the effect of seismic differential anchor movements been considered (Reference)?		



Description	Checked						Comments		
	a	b	c	d	e	f	g	h	
5.0 Dynamic Analyses (Output Section F)									
5.1 The following analyses are performed using response spectra method (Seismic in PIPSYS Output):									
a-Seismic		✓							
b-									
c-									
d-									
e-									
f-									
g-									
h-									SSE spectra not used - a more conservative estimate used instead.
5.1.1 Are the latest revisions of response spectra used for the analysis (Reference)?	✓								
5.1.2 Are the length ratios acceptable?		✓							
5.1.3 Does cut-off frequency cover the peak acceleration value?	✓								
5.1.4 Is the square root of the double sum method used to combine the modal responses?		✓							
5.1.5 Are all the deflections reasonable (if over 1.0" OBE, specify)?	✓								
5.1.6 Has the effect of seismic differential anchor movements been considered (Reference)?		✓							
5.2 The following analyses are performed using the forcing function method (Transient in PIPSYS Output):									
a- PUMP TRIP		✓							
b-									
c-									
d-									
e-									
f-									
g-									
h-									

Description	Checked								Comments
	a	b	c	d	e	f	g	h	
5.2.1 Is the force calculation performed per the appropriate documents (Reference)?									See EMD-013046
5.2.2 Are all necessary design parameters specified in this analysis (opening/closing times, flow rates, etc.)?									
5.2.3 If force calculations are not attached to this analysis, reference.									
5 2.4 If a safety/relief valve analysis is performed:									
a. Does the steam stagnation pressure and density reflect the S/RV set point?									
b. Are the pipe ID and segment lengths input correctly in the SRVA program?									
c. Is the pipe submerged length correctly calculated and input?									
d. Is the correct density used in the calculation?									
5.2.5 Are the forces input correctly in the PIPSYS with respect to magnitude, direction and point of action?									
5.2.6 Are the equipment reactions included with the correct load set?									
6.0 Thermal Transient Analysis (ASME Class 1 Piping Only)									N/A
6.1 Are the results of transient analysis attached to this report?									

Description	Checked	Comments
6.2 Are all transient stresses identified and are the NOHEAT RUNS properly documented?		
6.3 Are thermal transient conditions and cycles correct per Ref. 1?		
6.4 Are all discontinuities considered?		
6.5 Check film coefficients, densities and material thermal conductivity.		
6.6 Are correct time steps used in performing the transient analysis?		
7.0 Hand Calculations		
7.1 If hand calculations are not attached to this analysis, reference.		
7.2 Are the calculations reviewed in accordance with GQ-3.08?		
○ A detailed review of original calculation.		
○ A review by an alternate, simplified or approximate method of calculation.		
○ A review of a representative sample of repetitive calculation.		
○ A review of the calculation against a similar calculation previously performed.		
8.0 Combined Stresses (Output Section A)		
8.1 Are the stresses within the allowables?	✓	
8.2 Are the allowable stresses for the materials used in the analysis in agreement with the Code?	✓	
8.3 Is the design pressure in agreement with Ref. 2?	✓	

Description	Checked	Comments
8.4 Are all thermal load combinations specified per Ref. 1?	✓	
8.5 Are all mechanical loads listed, per the design specification, as service level B, C or D?	✓	
8.6 Are the number of earthquake cycles calculated per the design specification or per SRP-3.7.3?	N/A	
8.7 Are all high-stress/usage factor (over .1) points run with the detailed output?	N/A	
9.0 Combined Reactions (Output Section B)		
9.1 Are all applicable forces and moments considered for both upset and emergency conditions?	✓	
9.2 Are all the equipment nozzles identified correctly?	✓	
9.3 Are equipment loads and valve accelerations acceptable? Have they been forwarded to the EMD/CAS?	✓	
9.4 Are the vendor supplied component supports able to carry the imposed loads?	✓	
9.5 Are all Type 3 restraints reviewed to determine if they can be replaced by rigid restraints?		
9.6 Method used to combine the loads: (x) Absolute Sum ( ) SRSS		

GENERAL NOTES

I. The analysis is based on the following Code and S&L Programs:

(x) ASME Code, Sec. III - Class 2 of 1975 issue.

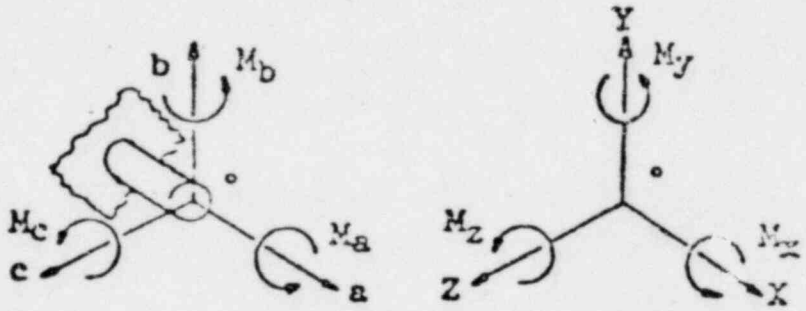
( ) ANSI B31.1 of issue.

(x) "PIPSYS" (Prog. No. 09.5.065-5.0) of 6-13-80 issue.

( ) "SRVA" (Prog. No.) of issue.

( ) "NOHEAT" (Prog. No. 09.5.075.) of issue.

II. Coordinate Systems:



LOCAL GLOBAL

III. Conclusions & Design Requirement.

1. The pipe stresses are within Code allowables.

2. The following support changes were made:

Node 15A & 75 - add S_x skew (horiz. ⊥ to pipe)
Node 15A, 40A, 82 - Add S_y
Node 45 - add S_x
Node 65B - add S_z skew (axial to pipe)

3. The loads on the Steam Generator nozzle are within Westinghouse allowables.

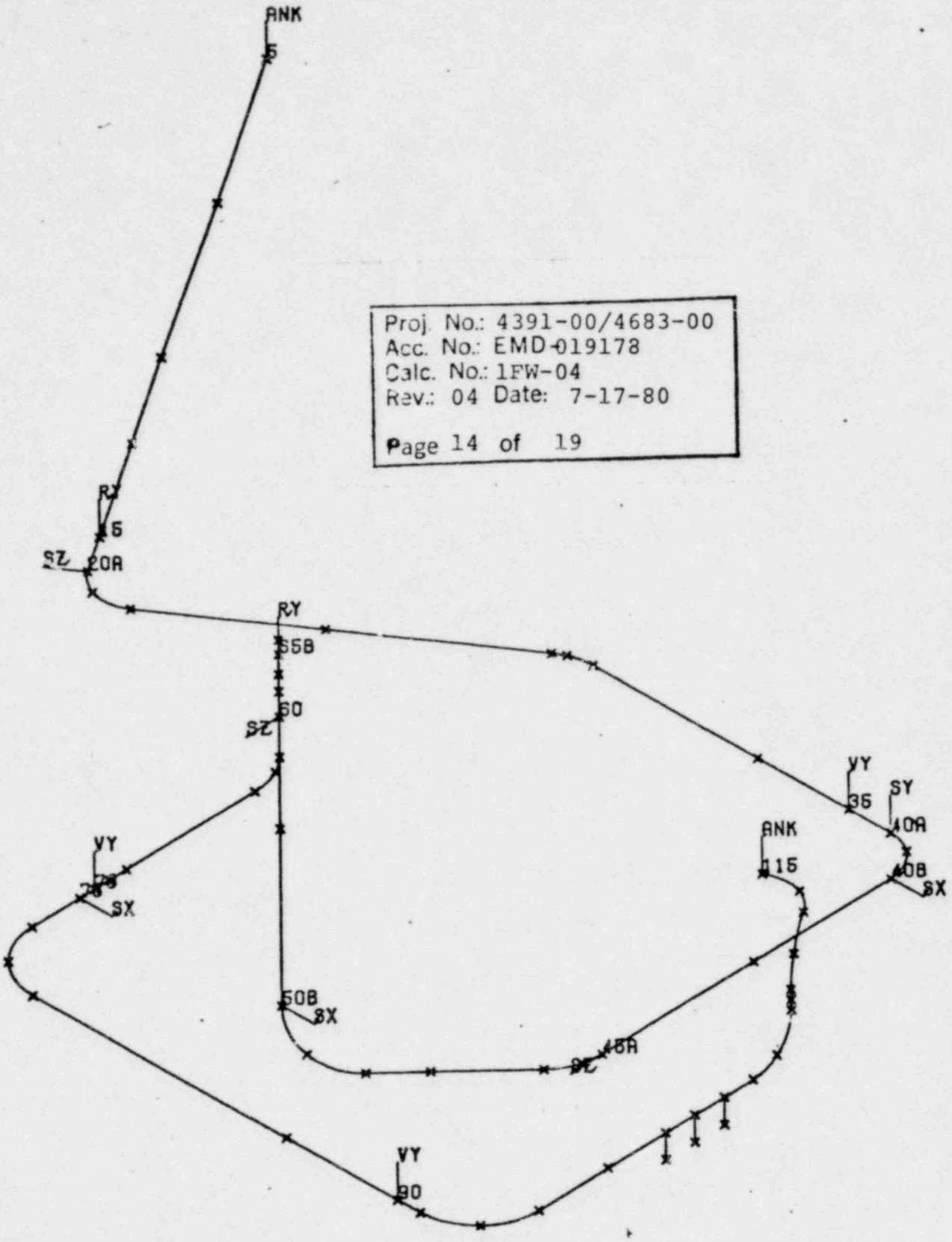
GENERAL NOTES - cont.

4. Tee Information:

   The instrument taps at nodes, IT1, IT2 & IT3 (all 16x16x2-3/4) need no additional reinforcement.

5. Compressive loads occur on the hangers at the following node points: 55B & 75.

6. Loads from FW Pump Trip Hydraulic Transients were considered in this analysis.



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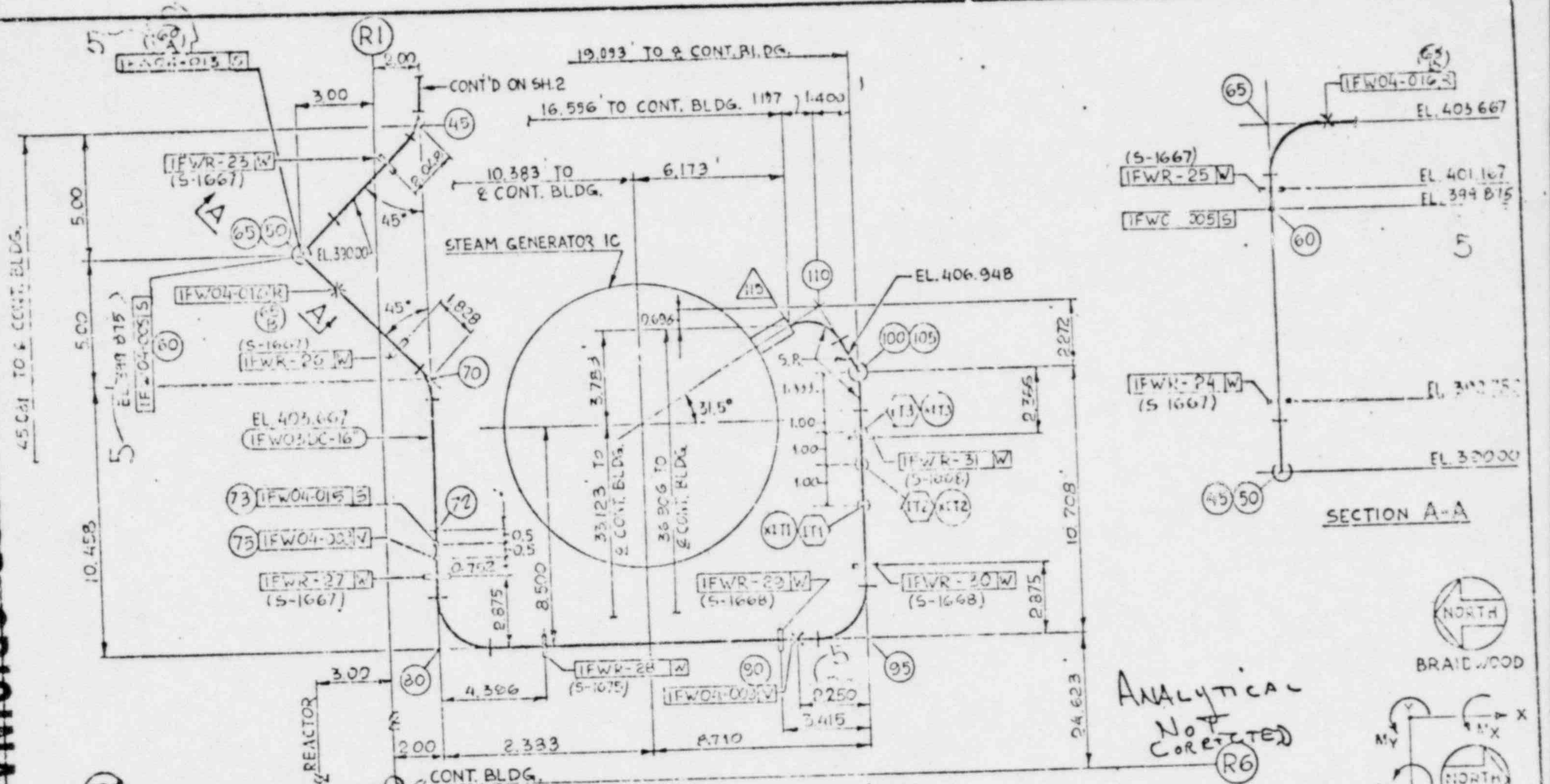


CONT'D ON SH.2
19.093' TO ℄ CONT. BLDG.
16.596' TO CONT. BLDG.
10.383' TO ℄ CONT. BLDG.
6.173'
STEAM GENERATOR 1C
EL. 406.948
EL. 405.667
EL. 390.00
45.681' TO ℄ CONT. BLDG.
1FWR-23 W (S-1667)
1FW04-012 R
1FWR-26 W (S-1667)
1FW04-005 S
1FW04-013 G
1FW04-015 S
1FW04-003 V
1FWR-27 W (S-1667)
1FWR-28 W (S-1675)
1FWR-29 W (S-1668)
1FWR-30 W (S-1668)
1FWR-31 W (S-1668)
1FW04-009 V
REACTOR
℄ CONT. BLDG.
SECTION A-A
1FW04-016 S
EL. 403.667
EL. 401.167
EL. 399.815
EL. 390.00
1FWR-25 W (S-1667)
1FWC 305 S
1FWR-24 W (S 1667)
NORTH
BRAIDWOOD
BYRON
NO SCALE

ANALYTICAL
NOT CORRECTED

NOTE:
PER STRESS REPORT 03-31-80 SUPPORT NO. 1FW04008R & 1FW04010X ARE DELETED FROM ...

REFERENCE DRAWINGS	DWG. NO.	REV.	DWG. NO.	REV.	DWG. NO.	REV.	DWG. NO.	REV.	DWG. NO.	REV.
	M-156-1	H	M-163	J	M-940-5	K	M-197-4	F		
	M-157-1	H	M-36-1	K	M-197-1	G	M-520-2	H		

RELEASE RECORD

NO.	DATE	PREPARED	CHECKED	APPROVED	REV. DESCRIPTION
5	[illegible]	[illegible]	[illegible]	[illegible]	FOR FORMAL ANALYSIS
2	1-26-76	[illegible]	[illegible]	[illegible]	FOR COMMENTS
3	12-21-76	[illegible]	[illegible]	[illegible]	FOR ANALYSIS - SEISMIC
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	PER STRESS REPORT [illegible]

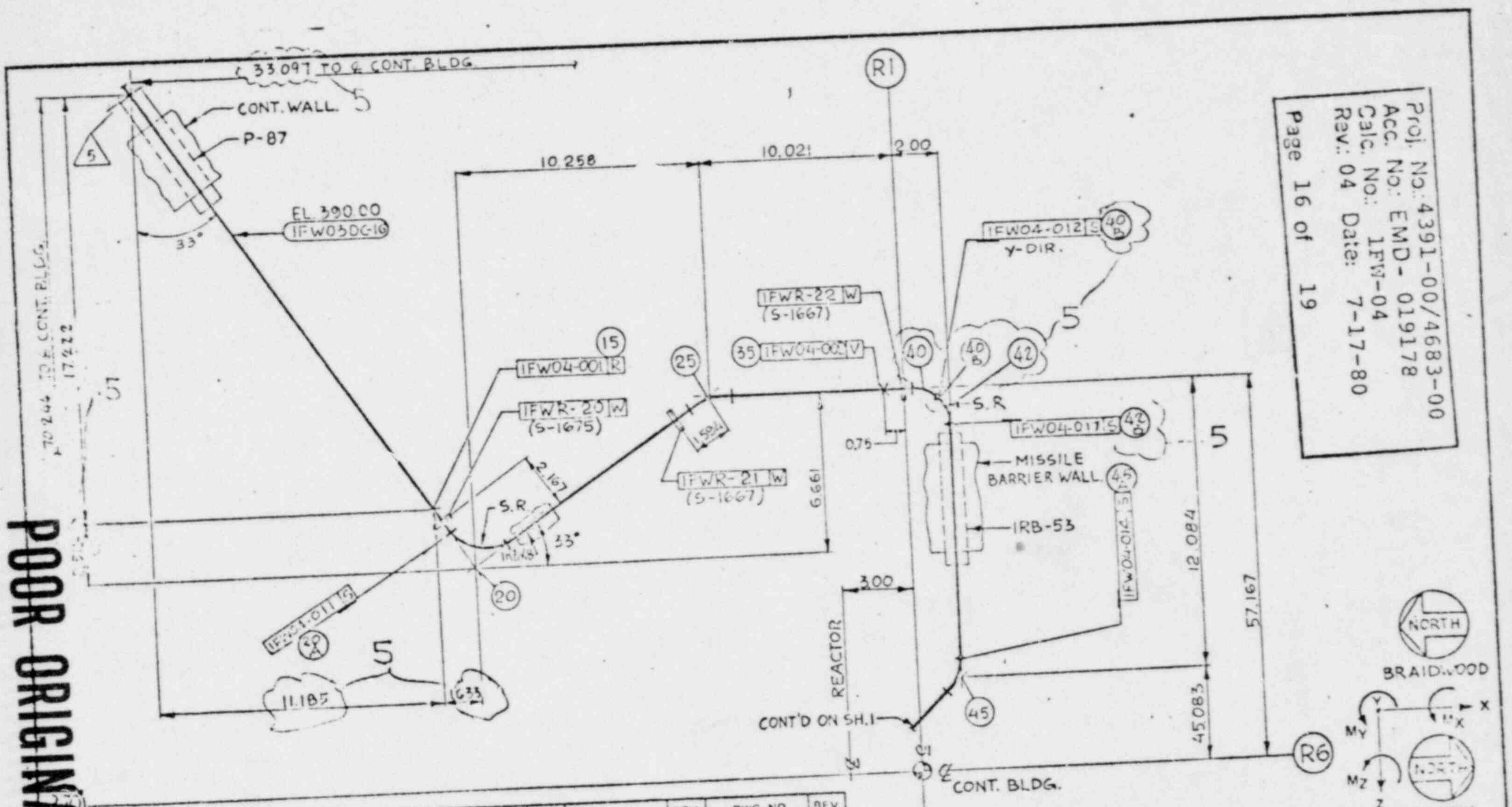
Proj. No.: 4391-00/4683-00
Acc. No.: EMD- 019178
Calc. No.: 1FW-04
Rev.: 04 Date: 7-17-80

SARGENT & LUNDY

1FW04 5

SHEET 1 OF 4

POOR ORIGINAL



Proj. No: 4391-00/4683-00
Acc. No: EMD-019178
Calc. No: 1FW-04
Rev.: 04 Date: 7-17-80
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33.097 TO ℄ CONT. BLDG.
CONT. WALL
P-87
EL. 390.00
1FW03DG-16
33°
10.258
10.021
2.00
R1
1FW04-012 S
40B
Y-DIR.
1FWR-22 W
(S-1667)
35 1FW04-002 V
40
42
15
1FW04-001 R
25
1FWR-20 W
(S-1675)
1FWR-21 W
(S-1667)
S.R
2.167
33°
6.661
0.75
1FW04-011 S
42B
MISSILE BARRIER WALL
1RB-53
1FW04-013 S
12.084
57.167
3.00
REACTOR
20
1FW04-011 G
42A
11.185
6.33
CONT'D ON SH.1
45
45.083
R6
℄ CONT. BLDG.
17.222
NORTH
BRAIDWOOD
BYRON
X
Y
Z
M_X
M_Y
M_Z
NO SCALE
POOR ORIGINAL

REFERENCE DRAWINGS	DWG. NO.	REV.	DWG. NO.	REV.	DWG. NO.	REV.	DWG. NO.	REV.	DWG. NO.	REV
	M-156-1	H	M-163	J	M-940-5	K	M-137-4	F		
	M-157-1	H	M-36-1	K	M-137-1	G	M-520-2	H		

RELEASE RECORD

REV.	DATE	PREPARED	CHECKED	ENG'R APP'L.	REV. DESCRIPTION	FILM
5	[illegible]	[illegible]	[illegible]	[illegible]	FOR FORMAL ANALYSIS	
2	1-13-76	R. Laup	R. [illegible]	[illegible]	FOR COMMENTS	
3	12-21-76	R. Laup	R. [illegible]	[illegible]	FOR ANALYSIS-SEISMIC	
4	12-16-77	J. Azarl	[illegible]	[illegible]	LOC FOR PIPE WHIP CONSTR.	
	07-15-7?	[illegible]	[illegible]	[illegible]	ANALYSIS HYDRAULIC TRANSIENT	
		[illegible]	[illegible]	[illegible]	FOR STRESS REPORT 02-21-80	V

PIPING ANALYTICAL & PHYSICAL DATA

FOR FEED WATER SYSTEM

PROJECT BYRON / BRAIDWOOD-1

CLIENT COMMONWEALTH EDISON CO

PROJECT NO. 4391-00 4683-00

SARGENT & LUNDY

SUBSYSTEM NO. 1FW04 REV 5

SHEET 2 OF 4

PIPE DATA

REV.	NODE POINTS FROM	NODE POINTS TO	LINE NUMBER	PIPE CLASS	PIPING DESIGN TABLE	MATERIAL SPEC.	MATERIAL GR.	DESIGN PRESS.	MAX. OPER. PRESS.	MAX. OPER. TEMP.	O.D.	SCHED.	WALL THICK	INSUL. THICK	WEIGHTS – LBS/LINEAL FT. 1. PIPE	2. OPER FLUID	3. INSUL.	OPER. TOTAL 1+2+3	4. WATER	HYDRO 1+4
	5	115	1FW03DC-16"	B	0905BB	ASTM A-106	B	1185	1185	567	16.0	80	0.843	2.5	136.5	69.7	11.6	217.8		

VALVE & SPECIAL FITTINGS DATA

NODE POINTS FROM	NODE POINTS TO	TYPE	PRESSURE RATING	VAL. STROKING TIME (SEC.) OPEN	VAL. STROKING TIME (SEC.) CLOSE	VAL./FIT. WT. LBS. PRELIM.	VAL./FIT. WT. LBS. ACTUAL	OPERATOR WT. LBS. PRELIM.	OPERATOR WT. LBS. ACTUAL	FLEXIBILITY INFO. O.D.	FLEXIBILITY INFO. THICK	VENDOR	DRAWING NO.	REV.	REMARKS

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POOR ORIGINAL

RELEASE RECORD

REV.	DATE	PREPARED	CHECKED	ENG'R APP'L.	REV. DESCRIPTION	FILM
0	[illegible]	[illegible]	[illegible]	[illegible]	FOR FORMAL ANALYSIS	
2	1-[illegible]-76	[illegible]	[illegible]	[illegible]	FOR [illegible]	
3	11-21-76	[illegible]	[illegible]	[illegible]	FOR ANALYSIS - [illegible]	
4	12-16-77	[illegible]	[illegible]	[illegible]	[illegible] PIPE WHIP [illegible]	
4	07-18-79	[illegible]	[illegible]	[illegible]	[illegible] HYDRAULIC TRANSIENT	
4	03-31-80	[illegible]	[illegible]	[illegible]	PER [illegible] REPORT 03-31-80	

PIPING ANALYTICAL & PHYSICAL DATA

FOR FEED WATER SYSTEM

PROJECT BYRON/BRAIDWOOD-1

CLIENT COMMONWEALTH EDISON CO

PROJECT NO. 4391-00 4683-00

SARGENT & LUNDY ENGINEERS

SUBSYSTEM NO. 1FW04 REV. 5

SHEET 3 OF 4

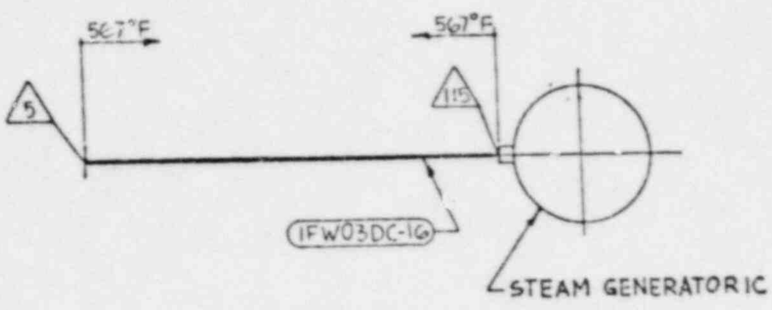
POOR ORIGINAL

SCHEMATIC OF MODES TO BE ANALYZED

TOTAL NO. OF MODES REQUIRED ______

MODE NO. 1 — MODE DESCRIPTION: MAX. OPER.

MODE NO. ______ — MODE DESCRIPTION: ______



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REV.	MODE NO. 1							EQUIPMENT INFORMATION					
	NODE POINT	TEMP.	TERMINAL MOVEMENTS ΔX	ΔY	ΔZ	CALC. BY VDR	S&L	EQUIPMENT NUMBER	EQUIPMENT TITLE	VENDOR	DRAWING NO.	REV.	REMARKS
	5	567	0.000	0.000	0.000				PENET. ANCHOR P-87				
	115	567	1.062	0.443	-2.178	)		IRC01BC	STEAM GEN. 1C	WESTINGHOUSE	1099J30		

REV.	MODE NO. ______						
	NODE POINT	TEMP.	TERMINAL MOVEMENTS ΔX	ΔY	ΔZ	CALC. BY VDR	S&L

RELEASE RECORD

REV.	DATE	PREPARED	CHECKED	ENG. APPR.	REV. DESCRIPTION	FILE
5	08-12-80	[illegible]	[illegible]	[illegible]	FOR FORMAL ANALYSIS	
[illegible]	1-25-75	[illegible] LAUD	R. [illegible]	[illegible]	FOR COMMENTS	
[illegible]	10-21-76	[illegible] LAUD	R. [illegible]	[illegible]	FOR ANALYSIS - [illegible]	
[illegible]	10-16-77	[illegible]	[illegible]	[illegible]	FOR [illegible] PIPE WHIP [illegible]	
[illegible]	07-18-79	[illegible]	[illegible]	[illegible]	FOR ANALYSIS - HYDRAULIC TRANSIENT	
4		[illegible]	[illegible]	[illegible]	PER STRESS REPORT 03-31-80	

PIPING ANALYTICAL & PHYSICAL DATA

FOR FEED WATER SYSTEM

PROJECT BYRON/BRAIDWOOD-1

CLIENT COMMONWEALTH EDISON CO.

PROJECT NO. 4391-00 4683-00

SARGENT & LUNDY ENGINEERS

SUB SYSTEM NO. 1FW04 REV. 5.

SHEET 4 OF 4

SARGENT & LUNDY ENGINEERS CHICAGO

Calc. for Subsystem: FW-04 Node: 1.5

X Safety-Related | Non-Safety-Related

Rev. 04 Date 7/17/80

Client Commonwealth Edison Company	Prepared by [illegible] Date 7/17/80
Project Byron/Braidwood Units 1 & 2	Reviewed by Date
Proj. No. 4391,92/4683,84-00 Equip. No.	Approved by Date

1. Equipment No.: 1RC01B -1C
2. Pipe Line: 1FW03[illegible]-16 Class: 2
3. Pipe Size: 16" Thickness: .843
4. Nozzle Size 16 Thickness: .843
5. Nozzle Connection: FW inlet
6. Max. Op. Temp. 527°F Pressure: 1155 psig

Allowable from memo EMD-020130

POOR ORIGINAL

Forces in lb_f Moments in ft-lb_f

LOAD SOURCE	F_x, F_a	F_y, F_b	F_z, F_c	M_x, M_a	M_y, M_b	M_z, M_c
THERMAL REACTIONS	1027	1375	-4673	-21371	33,177	7154
THERMAL ALLOWABLES	4,000	40,000	8000	100,000	73,000	235,000
WEIGHT REACTIONS	13	-2213	7	3793	-3[illegible]	3[illegible]
WEIGHT ALLOWABLES	2,000	12,000	4000	17,000	7,000	40,000
OBE REACTIONS	3307	9413	2846	20,004	10,5[illegible]	10,526
OBE ALLOWABLES	32,000	20,000	20,000	73,000	83,000	83,000
SSE REACTIONS	6614	4526	5612	40,128	21,143	37,013
SSE ALLOWABLES	40,000	24,000	40,000	97,000	100,000	107,000
FW pump Trip REACTIONS	5334	12,360	7792	25,128	6,34[illegible]	17,640
FW pump Trip ALLOWABLES	None	None	None	None	None	None
% OVER	—	—	—			

Westinghouse Coordinates: X, Y, Z

S/G Piping: a, b, c

Proj. No.: 4391-00/4683-00
Acc. No.: EMD- 019178
Calc. No.: 1FW-04
Rev.: 04 Date: 7-17-80

Form GD 3 (BL) Rev. 2

```
* * * * * * * * * * * * * * * * * * * * * *
*     SARGENT AND LUNDY ENGINEERS           *
* INTEGRATED PIPING ANALYSIS PROGRAM         *
*  PIPSYS  09.5.065-5.0 JUN 13 1980          *
* * * * * * * * * * * * * * * * * * * * * * *

              COMBINED REACTIONS     17 JUL 80
4391-00  B/R 1  1FW-04 REV 4        AJP


 *** CONTENTS OF FILE 13 ON 17 JUL 80 ***
    4391-00  B/R-1  1FW-04 REV 4        AJP
  LOAD    DATE          RUNID      COMMENTS

  DATA    17 JUL 80     247AJP
  SE 1    17 JUL 80     247AJP     OBE  SEISMIC ANALYSIS-INERTIA                    1
  WT 1    17 JUL 80     247AJP     WEIGHT ANALYSIS                                  2
  TH 1    17 JUL 80     247AJP     EXPANSION ANALYSIS AT 567F                       3
  TR 1    17 JUL 80     684AJP     HYDRAULIC TRANSIENT TIME HISTORY ANALYSIS        4

 MAXIMUM NUMBER OF ANALYSES THAT CAN BE SAVED FOR THIS SUBSYSTEM IS 20
```

4391-00 B/B-1 1FW-04 REV 4 AJP

LOADINGS FOR COMBINED REACTIONS 17 JUL 80

WEIGHT LOADING	1
THERMAL LOADING(S)	1
SEISMIC (OBE) LOADING	1
SEISMIC (DBE) LOADING	2.00*(OBE LOADING)
HYDRAULIC TRANSIENT LOADING	
UPSET CONDITION	1
EMERGENCY CONDITION	1
ANCHOR/DISPLACEMENT LOAD(S)	(NOT APPLICABLE)
MECHANICAL LOADS	(NOT APPLICABLE)

4391-00 B/B-1 1FW-04 REV 4 AJP
MAXIMUM OF COMBINED ANCHOR REACTIONS 17 JUL 80
IN LOCAL COORDINATES

(RESULTS ARE IN FT-LB UNITS)

LOCATION	WEIGHT	THERMAL	ANC/ DISP	HYDRAULIC TRANS UPSET	HYDRAULIC TRANS EMERNCY	SEISMIC UPSET	SEISMIC EMERNCY	MECHANICAL 1 UPSET	MECHANICAL 1 EMERNCY	MECHANICAL 2 UPSET	MECHANICAL 2 EMERNCY	COMBINED UPSET	COMBINED EMERNCY
5 FA	-6.	4682.	0.	4176.	4176.	620.	1240.	0.	0.	0.	0.	9471.	10091.
FB	2311.	-657.	0.	86[illegible]	866.	434.	868.	0.	0.	0.	0.	3611.	4045.
FC	-13.	-903.	0.	12570.	12570.	971.	1943.	0.	0.	0.	0.	14458.	15429.
MA	1906.	15964.	0.	1449.	1449.	3187.	6374.	0.	0.	0.	0.	22506.	25692.
MB	513.	-20702.	0.	67590.	67590.	5140.	10281.	0.	0.	0.	0.	92920.	98060.
MC	8148.	-4138.	0.	3782.	3782.	2299.	4599.	0.	0.	0.	0.	14230.	16529.
115 FA	13.	1027.	0.	5384.	5384.	3307.	6614.	0.	0.	0.	0.	9731.	13038.
FB	-2213.	1275.	0.	12260.	122[illegible]0.	2413.	4826.	0.	0.	0.	0.	16887.	19299.
FC	7.	-4673.	0.	7792.	7792.	2846.	5692.	0.	0.	0.	0.	15304.	18150.
MA	3993.	-21391.	0.	28[illegible]28.	28128.	20064.	40128.	0.	0.	0.	0.	65591.	85655.
MB	-328.	38177.	0.	16344.	16344.	10571.	21143.	0.	0.	0.	0.	64764.	75336.
MC	2173.	7154.	0.	17640.	17640.	10506.	21013.	0.	0.	0.	0.	37473.	47980.

4391-00 B/B-1 1FW-04 REV 4 AJP
MAXIMUM OF COMBINED ANCHOR REACTIONS 17 JUL 80

(RESULTS ARE IN FT-LB UNITS)

LOCATION		WEIGHT	THERMAL	ANC/ DISP	HYDRAULIC TRANS UPSET	HYDRAULIC TRANS EMERNCY	SEISMIC UPSET	SEISMIC EMERNCY	MECHANICAL 1 UPSET	MECHANICAL 1 EMERNCY	MECHANICAL 2 UPSET	MECHANICAL 2 EMERNCY	COMBINED UPSET	COMBINED EMERNCY	
5	FX	7.	3335.	0.	11085.	11085.	836.	1672.	0.	0.	0.	0.	15263.	16099.	GLOBAL
	FY	2311.	-657.	0.	866.	866.	434.	868.	0.	0.	0.	0.	3611.	4045.	
	FZ	-12.	3408.	0.	8154.	8154.	793.	1586.	0.	0.	0.	0.	12342.	13135.	
	MX	-5748.	12253.	0.	3369.	3369.	2552.	5105.	0.	0.	0.	0.	12427.	14979.	
	MY	513.	-20702.	0.	67590.	67590.	5140.	10281.	0.	0.	0.	0.	92920.	98060.	
	MZ	6083.	11037.	0.	2250.	2250.	2988.	5976.	0.	0.	0.	0.	22358.	25346.	
115	FX	-7.	-3316.	0.	4698.	4698.	1680.	3360.	0.	0.	0.	0.	9701.	11380.	GLOBAL
	FY	2213.	-1275.	0.	12260.	12260.	2413.	4826.	0.	0.	0.	0.	16887.	19299.	
	FZ	12.	-3449.	0.	9038.	9038.	4026.	8052.	0.	0.	0.	0.	16501.	20527.	
	MX	-2271.	21979.	0.	18741.	18741.	21869.	43737.	0.	0.	0.	0.	60317.	82186.	
	MY	328.	-38177.	0.	16344.	16344.	10571.	21143.	0.	0.	0.	0.	64764.	75336.	
	MZ	3938.	-5066.	0.	25079.	25079.	5892.	11784.	0.	0.	0.	0.	34910.	40802.	

4391-00 B/B-1 1FW-04 REV 4 AJP

EQUIPMENT NOZZLE REACTION SUMMARY (LOCAL) 17 JUL 80

LOCATION : 5 PENETRATION P-87

LOAD CASE		FORCES IN LBS FA	FB	FC	MOMENTS IN FT-LBS MA	MB	MC
WEIGHT		-6.	2311.	-13.	1906.	513.	8148.
THERMAL EXPANSION		4682.	-657.	-903.	15964.	-20702.	-4138.
ANCHOR/DISPLACEMENT		0.	0.	0.	0.	0.	0.
HYDRAULIC TRANSIENT	UPSET	4176.	866.	12570.	1449.	67590.	3782.
	EMERGENCY	4176.	866.	12570.	1449.	67590.	3782.
SEISMIC	UPSET	620.	434.	971.	3187.	5140.	2299.
	EMERGENCY	1240.	868.	1941.	6374.	10281.	4599.
MECHANICAL 1	UPSET	0.	0.	0.	0.	0.	0.
	EMERGENCY	0.	0.	0.	0.	0.	0.
MECHANICAL 2	UPSET	0.	0.	0.	0.	0.	0.
	EMERGENCY	0.	0.	0.	0.	0.	0.
MAXIMUM CONDITION	UPSET	9471.	3611.	14458.	22506.	92920.	14230.
	EMERGENCY	10091.	4045.	15429.	25692.	98060.	16529.
MAXIMUM CONDITION	UPSET	FR =	17657.		MR =	96660.	
	EMERGENCY		18875.			102709.	

I08

4391-00 B/B-1 1FW-04 REV 4 AJP

EQUIPMENT NOZZLE REACTION SUMMARY (LOCAL) 17 JUL 80

LOCATION : 115 STEAM GENERATOR - FW INLET (1C-1RC01BC)

LOAD CASE		FORCES IN LBS FA	FB	FC	MOMENTS IN FT-LBS MA	MB	MC
WEIGHT		13.	-2213.	7.	3993.	-328.	2173.
THERMAL EXPANSION		1027.	1275.	-4673.	-21391.	38177.	7154.
ANCHOR/DISPLACEMENT		0.	0.	0.	0.	0.	0.
HYDRAULIC TRANSIENT	UPSET	5384.	12260.	7792.	28128.	16344.	17640.
	EMERGENCY	5384.	12260.	7792.	28128.	16344.	17640.
SEISMIC	UPSET	3307.	2413.	2846.	20064.	10571.	10506.
	EMERGENCY	6614.	4826.	5692.	40128.	21143.	21013.
MECHANICAL 1	UPSET	0.	0.	0.	0.	0.	0.
	EMERGENCY	0.	0.	0.	0.	0.	0.
MECHANICAL 2	UPSET	0.	0.	0.	0.	0.	0.
	EMERGENCY	0.	0.	0.	0.	0.	0.
MAXIMUM CONDITION	UPSET	9731.	16887.	15304.	65591.	64764.	37473.
	EMERGENCY	11038.	19299.	18150.	85655.	75336.	47980.
MAXIMUM CONDITION	UPSET	FR =	24780.		MR =	99503.	
	EMERGENCY		29528.			123751.	

4391-00 B/B-1 1FW-04 REV 4 AJP

EQUIPMENT NOZZLE REACTION SUMMARY (GLOBAL) 17 JUL 80

LOCATION : 5 PENETRATION P-87

LOAD CASE		FORCES IN LBS FX	FY	FZ	MOMENTS IN FT-LBS MX	MY	MZ
WEIGHT		7.	2311.	-12.	-5748.	513.	6082.
THERMAL EXPANSION		3335.	-657.	3408.	12253.	-20702.	11037.
ANCHOR/DISPLACEMENT		0.	0.	0.	0.	0.	0.
HYDRAULIC TRANSIENT	UPSET	11085.	865.	8154.	3369.	67590.	2250.
	EMERGENCY	11085.	866.	8154.	3369.	67590.	2250.
SEISMIC	UPSET	836.	434.	793.	2552.	5140.	2988.
	EMERGENCY	1672.	868.	1586.	5103.	10281.	5976.
MECHANICAL 1	UPSET	0.	0.	0.	0.	0.	0.
	EMERGENCY	0.	0.	0.	0.	0.	0.
MECHANICAL 2	UPSET	0.	0.	0.	0.	0.	0.
	EMERGENCY	0.	0.	0.	0.	0.	0.
MAXIMUM CONDITION	UPSET	15263.	3611.	12342.	12427.	92920.	22358.
	EMERGENCY	16099.	4045.	13135.	14379.	98060.	25346.
MAXIMUM CONDITION	UPSET	FR =	19958.		MR =	96376.	
	EMERGENCY		21168.			102385.	

4391-00 B/B-1 1FW-04 REV 4 AJP

EQUIPMENT NOZZLE REACTION SUMMARY (GLOBAL) 17 JUL 80

LOCATION : 115 STEAM GENERATOR - FW INLET (1C-1RC01BC)

LOAD CASE		FORCES IN LBS FX	FY	FZ	MOMENTS IN FT-LBS MX	MY	MZ
WEIGHT		-7.	2213.	12.	-2271.	328.	3930.
THERMAL EXPANSION		-3316.	-1275.	-3449.	21979.	-38177.	-5066.
ANCHOR/DISPLACEMENT		0.	0.	0.	0.	0.	0.
HYDRAULIC TRANSIENT	UPSET	4698.	12260.	9038.	18741.	16344.	25079.
	EMERGENCY	4698.	12260.	9038.	18741.	16344.	25079.
SEISMIC	UPSET	1680.	2413.	4026.	21869.	10571.	5892.
	EMERGENCY	3360.	4826.	8052.	43737.	21143.	11784.
MECHANICAL 1	UPSET	0.	0.	0.	0.	0.	0.
	EMERGENCY	0.	0.	0.	0.	0.	0.
MECHANICAL 2	UPSET	0.	0.	0.	0.	0.	0.
	EMERGENCY	0.	0.	0.	0.	0.	0.
MAXIMUM CONDITION	UPSET	9701.	16887.	16501.	60317.	64764.	34910.
	EMERGENCY	11380.	19299.	20527.	82186.	75336.	40802.
MAXIMUM CONDITION	UPSET	FR =	25525.		MR =	95138.	
	EMERGENCY		30387.			118721.	

4391-00 B/B-1 1FW-04 REV 4 AJP

MAX RIGID RESTRAINT LOADS IN LBS 17 JUL 80
(RESTRAINT TYPE 1)

NODE	WEIGHT	THERMAL	ANC/ DISP	HYDRAULIC TRANS UPSET	HYDRAULIC TRANS EMERNCY	SEISMIC UPSET	SEISMIC EMERNCY	MECHANICAL 1 UPSET	MECHANICAL 1 EMERNCY	MECHANICAL 2 UPSET	MECHANICAL 2 EMERNCY	COMBINED UPSET	COMBINED EMERNCY	DIRECTION
15	4543.	2946. 0.	0.	1439.	1439.	1459.	2917.	0.	0.	0.	0.	10387. 1645.	11845. 186.	Y
658	6566.	0. -1008.	0.	8275.	8275.	2558.	5117.	0.	0.	0.	0.	17399. -5275.	19957. -7834.	Y

M08

4391-00 B/B-1 1FW-04 REV 4 AJP

THERMAL MOVEMENTS AT RESTRAINED NODES 17 JUL 80

LOCATION NODE	RANGE OF DISPLACEMENTS IN INCHES X	Y	Z	AXIS
15	.702	.000	.558	
	.000	.000	.000	
658	.518	.000	.000	
	.000	.000	-.798	

4391-00 8/B-1 1FW-04 REV 4 AJP

SPRING HANGER DATA 17 JUL 80
(RESTRAINT TYPE 2)

NODE	WEIGHT LOAD (LBS)	RANGE	THERMAL MOVEMENTS(IN) X	Y	Z	VERTICAL SEISMIC MOVEMENT (IN)
35	5237.	1.235	.000	.000	.010
		.000	-.628	-.958	
73	2904.	.818	.305	.000	.250
		.000	.000	-.403	
90	3634.	1.570	.541	.000	.348
		.000	.000	-1.255	

4391-00 8/8-1 1FW-04 REV 4 AJP

HYDRAULIC SNUBBER DATA 17 JUL 80
(RESTRAINT TYPE 3)

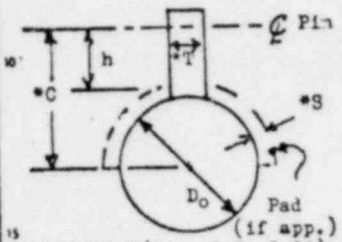
NODE	RANGE OF THERMAL MOVEMENTS (INCHES) X	Y	Z	ANC/ DISP	DYNAMIC LOADS (LBS) HYDRAULIC TRANS UPSET	EMERNCY	MECHANICAL 1 UPSET	EMERNCY	SEISMIC UPSET	EMERNCY	MECHANICAL 2 UPSET	EMERNCY	COMBINED UPSET	EMERNCY	DIRECTION
20A	.911 .000	.000 -.004	.000 -.332	0.	17888.	17888.	0.	0.	2592.	5184.	0.	0.	20480.	23072.	∠ SKEW
40A	1.296 .000	.000 -.654	.000 -1.029	0.	2122.	2122.	0.	0.	1861.	3721.	0.	0.	3982.	5843.	Y
40B	1.383 .000	.000 -.661	.000 -1.018	0.	20148.	20148.	0.	0.	2686.	5372.	0.	0.	22834.	25520.	X
45A	1.361 .000	.000 -.605	.000 -.595	0.	4752.	4752.	0.	0.	2548.	5096.	0.	0.	7300.	9847.	Z
50B	.977 .000	.000 -.589	.000 -.475	0.	3094.	3094.	0.	0.	1633.	3266.	0.	0.	4727.	6360.	X
60	.592 .000	.000 -.230	.000 -.753	0.	8173.	8173.	0.	0.	4325.	8649.	0.	0.	12497.	16822.	Z
75	.830 .000	.315 .000	.000 -.382	0.	15200.	15200.	0.	0.	3763.	7526.	0.	0.	18963.	22726.	X

LONGITUDINAL LUG CALC SHEET

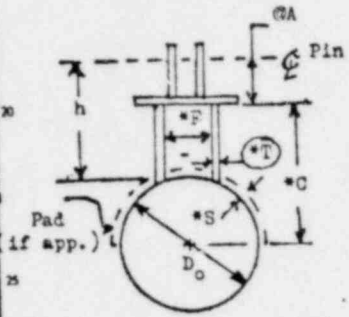
POOR ORIGINAL

RESTRAINT NO.: 1FW040145 REV.:	REF.: M-914 Sheet 25 REV.: B	*WELD TYPE: FE
SUBSYSTEM: 1FW04 REV.	PIPE SIZE: 16 SCHED: 80	*"t"= 3/4
NODE POINT: 45A PIPE CLASS:	D_o= 16 t_n = .844	*"u"=

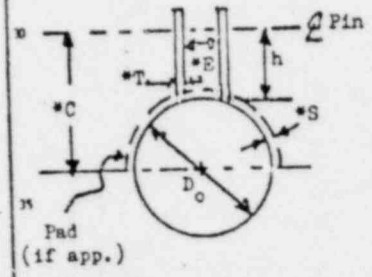
LONGITUDINAL LUGS



SINGLE LUG(Fig. 2,2A,3,3A)



DOUBLE LUGS (Det. A or D)



DOUBLE LUGS (Det. B or E)

☐ SINGLE LUG LF=1.0
(M-914 Fig. 2,2A,3&3A)

☒ SHEAR LUGS LF=0.5
(M-914 Fig. 4)

2.252 → PER EMD 019698

M-914 Fig.	LUG LENGTH
2	*D/cos* =
2A	*L=
3	*D
3A	*D=
4	*H= 9
M-914 Fig.	LUG THICKNESS
All	*T= 2 1/2

W = 3

MOMENT ARM-h

16" CLAMP g = .75

SHEAR LUGS h= .375 IN
(ref. Appx. A, EMD-020697)

SINGLE LUG: *C=_____ *S=_____
h=*C-*S-Do/2

h=_____ IN

☐ DOUBLE LUGS
(M-914, Det. A,B,D&E)

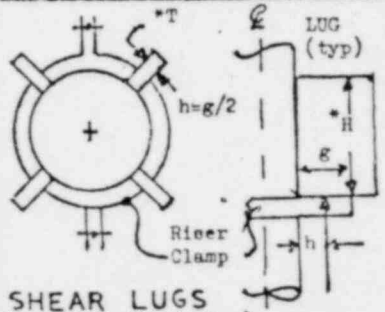
	M-914 Det.	LUG LENGTH	LUG THICKNESS	PAD THICKNESS
	A	*L=	*T=	*S=0.0
	B	*D=	*T=	*S=0.0
	D	*L=	*T=	*S=
	E	*D=	*T=	*S=

MOMENT ARM-h

*C=_____ in
Det. B&E; A = 0.0 in

Det. A&D; @A =_____ in
h = *C+A-S-Do/2

h=_____ IN



SHEAR LUGS
(Model as Single Lug)

LOAD FACTOR - LF

*Ave. Radius: r=_____ in

Separation: *E _____ in

Det. A or B: $\sqrt{rt}$=_____ in

Det. D or E: $\sqrt{r*S}$ =_____ in
is *E ≥ $\sqrt{rt}$ (or) $\sqrt{r*S}$?

☐ YES-LF=0.5
☐ NO -LF=1.0

MODELING

$1/4(D_o+2x*S)$=_____
is E ≤ $1/4(D_o+2x*S)$?

☐ YES- Use Single Lug Model
☐ NO- Use Dobule Lug Model

NOTES:
*Indicates dimension from M-914 dwg.
@Rear End Bracket "A" dimension from Appx. A, EMD-02697.
+ Ave. radius of model from Appx. B, EMD-020697.
g: Clamp thickness

SARGENT & LUNDY ENGINEERS	Client: Commonwealth Edison Company	Prepared by: U.C. Shukla Date: 5/14/81	Calcs. For: Longitudinal Lugs
	Project: Byron/Braidwood Units 1 & 2	Reviewed by: A. Peloton Date: 5/21/81	Calc. No.
	Proj. No. 4391-00 Equip. No.	Approved by: Date:	Rev. Date
			X Safety-Related ☐ Non-Safety-Related
			Page 1 of 2

Form 60432 Rev. 1

SINGLE LUG MODEL

UNIT LOAD & STRESSES

From EMD-020697

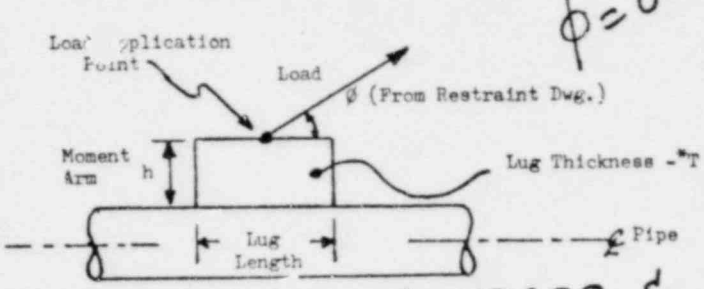
THRUST	JT = 1166
MOMENT	SL = 243
SHEAR	SQ2 = 352
UNIT LOAD	P = 1000

From Sheet 1)

LOAD FACTOR	LF = 2.52
MOMENT ARM	h = 3.5 → (d)

RESTRAINT LOADS (FROM PIPSYS)

WT =	WEIGHT
TH =	THERMAL
SU = 2548	SEIS.-OBE
SE = 5096	SEIS.- SSE
MU = 4752	MECH.- UPSET
ME = 4752	MECH.- EMERG.
AD =	ANCHOR/DISP.



* AS PER EMD 019698 & ATT. CALC. SHEET.

Are full penetration welds used on the lugs?

☐ Yes ☐ No

Are the weld size(s) on Sheet 1 within the criteria below? (If not full penetration)

☐ Yes ☐ No

Mat'l. Thickness of Thicker part Joined	Min. Size for Fillet Weld
to ¾ inc.	1/8
over ¾ to ½	3/16
over ½ to 3/4	1/4
over 3/4 to 1½	5/16
over 1½ to 2¼	3/8

CODE EQN.	(a) COMBINED REACTION 3	(b) (a)xLF / P (Norm. Load)	(c) (b)xSTxSinϕ (Thrust)4	(d) (b)xSLxhcosϕ (Moment)	(e) bxSQ2xcosϕ (Shear)	(f) (c)+(d)+(e) (Lug Stress in Pipe Wall)	(g) From PIPSYS (Pressure & Bending Stress in Pipe Wall)	(h) (f)+(g) (Tot. Stress in Pipe Wall)	(i) Allowable Stress2	Pass	Fail
8	WT								15,000		
9U	WT+SU+MU 7300	16.43	0	1498	5784	7282			18,000	✓	
9E	WT+SE+ME 9848	22.17	0	2021	7804	9825			27,000	✓	
10	TH+AD								22,500		
11₁	WT+TH+AD								37,500		

NOTES:
1. Eqn. 11 is required only if Eqn. 10 fails.
2. Check Allowable Stress if material is not SA-106 Gr. B
3. For loads other than weight, thermal & seismic, consult EMD-TP-2 for proper load combinations.
4. Thrust load is always equal to zero for shear lugs.
5. *Indicates dimension from M-914 (shown also on Sht. 1)

SARGENT & LUNDY ENGINEERS CHICAGO

Client	Commonwealth Edison Company		
Project	Byron/Braidwood Units 1&2		
Proj. No.	4391-00	Equip. No.	

Prepared by	U. Chaghula	Date 5/14/81
Reviewed by		Date 5/21/81
Approved by		Date

Calcs. For Restraint No. 1FW04 0145
Rev.: N·P·45A
X Safety-Related ☐ Non-Safety-Related

Calc. No.
Rev. Date
Page 2 of 2

Form GO 4.3.2 Rev. 1

POOR ORIGINAL