MPR ASSOCIATES, INC.

OYSTER CREEK
NUCLEAR GENERATING STATION

SEISMIC REANALYSIS OF MAIN STEAM AND FEEDWATER PIPING SUPPORTS INSIDE CONTAINMENT

MPR-802, Rev. 1

Prepared for:

GPU Nuclear
Parsippany, New Jersey

September 1984

1050 CONNECTICUT AVENUE, N.W. WASHINGTON, D.C. 20036 202-659-2320

TABLE OF CONTENTS

1. INTRODUCTION

1.1 PURPOSE

This report presents the results of a seismic reanalysis of Oyster Creek main steam and feedwater piping supports inside containment. The reanalysis of the piping supports was performed in response to Section 4.11(1) of NUREG-0822 (Integrated Plant Safety Assessment - Systematic Evaluation Program - Oyster Creek Nuclear Generating Station) which requested in part that licensee (GPU Nuclear/JCP&L) verify the design adequacy of piping supports for the two large diameter piping systems analyzed by the NRC (i.e., the main steam and feedwater lines).

In this report, the seismic reanalysis of main steam and feedwater piping supports inside containment was performed in accordance with the requirements of the 1980 Edition (including Winter 1982 Addenda) of the ASME Code, Section III, Division 1, Subsection NF for Component Supports. Showing that the piping supports meet the applicable requirements of the 1980 Edition (including Winter 1982 Addenda) of the ASME Code is considered confirmation of the adequacy of the original piping support design.

1.2 SCOPE

The main steam and feedwater lines were initially analyzed by the NRC through their contractor EG&G Idaho, Inc. The results of these analyses are presented in EG&G Report EGG-EA-5211, "Summary of the Oyster Creek Unit 1 Piping

Calculations Performed for the Systematic Evaluation Program" (Reference a). The South piping loops of the main steam and feedwater systems were chosen by EG&G for analysis. This report presents the results of analyses of the piping supports on the South piping loops. Loads for these analyses were generated using the EG&G finite element piping models of the main steam and feedwater lines. The EG&G models were modified slightly to explicitly model the drywell penetration support and the snubber supports. The load paths of the piping supports were analyzed to the point where the loads are transmitted to main structural members of the containment or the biological shield. The analyses are applicable to the piping supports on the North loops of each piping system, which are mirror images of the South loops.

2. SUMMARY

The main steam and feedwater piping dynamic supports inside containment were evaluated for the safe shutdown earthquake (SSE) seismic loads. Allowable stresses were based on Level D Service Limits in accordance with Subsection NF of Section III of the ASME Code.

Dynamic loads on the main steam and feedwater piping seismic supports are tabulated in Tables 2-1 and 2-2, respectively, along with the Level D allowable load for the snubbers. As shown in Tables 2-1 and 2-2, all dynamic loads are below the Level D allowable load for the snubbers. Results of detail evaluations of the structural components of the main steam and feedwater piping supports are summarized in Tables 2-3 and 2-4, respectively. As shown in Tables 2-3 and 2-4, all main steam and feedwater piping supports are judged to be acceptable for seismic loading conditions, (i.e., calculated stresses are below ASME Code allowables for Level D Service Limits).

TABLE 2-1

SUMMARY OF SNUBBER LOADS
MAIN STEAM PIPING SUPPORTS

SUPPORT MARK NO.	FINITE ELEMENT MODEL NODE NO.	SNUBBER LOAD (kips) (Note 1)	ALLOWABLE LEVEL D SNUBBER LOAD (kips) (Note 2)
X-2A-SS-1	620 (Note 3)	3.44	24.2
	625 (Note 4)	1.20	22.9
MS-R1A	50	5.17	24.1
MS-R2A	195	12.33	21.7
MS-R3A	70	7.71	24.1
MS-R4A	285	9.95	23.6
MS-R5A	510	8.33	24.1

NOTES:

1. Loads taken from Appendix E.
2. Allowable Level D snubber load is the minimum of the buckling load of the extension pipe or turnbuckle. See Appendix E.
3. Vertical Snubber.
4. Inclined Snubber.

TABLE 2-2

SUMMARY OF SNUBBER LOADS
FEEDWATER PIPING SUPPORTS

SUPPORT MARK NO.	FINITE ELEMENT MODEL NODE NO.	SNUBBER LOAD (kips) (Note 1)	ALLOWABLE LEVEL D SNUBBER LOAD (kips) (Note 2)
X-4B-SS-1	345 (Note 3)	1.34	14.0
	350 (Note 4)	2.34	23.6
RF-R1A	160	1.30	24.2
RF-R2A	180	1.60	24.1
RF-R3A	180	2.20	24.5
RF-R4A	140	4.19	24.3
RF-R5A	115	4.72	23.3
RF-R6A	115	2.84	24.5

NOTES:

1. Loads taken from Appendix E.
2. Allowable Level D snubber load is the minimum of the buckling load of the extension pipe or turnbuckle. See Appendix E.
3. Inclined Snubber.
4. Vertical Snubber.

TABLE 2-3

SUMMARY OF EVALUATIONS

MAIN STEAM PIPING SUPPORTS

SUPPORT MARK NO.	BERGEN-PATERSON DRAWING NO.	ASME CODE SUBSECTION NF RESULTS
X-2A-SS-1	111	Acceptable
MS-R1A	716A	Acceptable
MS-R2A	717A	Acceptable
MS-R3A	718A	Acceptable
MS-R4A	719A	Acceptable
MS-R5A	720A	Acceptable

TABLE 2-4

SUMMARY OF EVALUATIONS

FEEDWATER PIPING SUPPORTS

SUPPORT MARK NO.	BERGEN-PATERSON DRAWING NO.	ASME CODE SUBSECTION NF RESULTS
X-4B-SS-1	116	Acceptable
RF-R1A	1849	Acceptable
RF-R2A	1850	Acceptable
RF-R3A	1851	Acceptable
RF-R4A	1852	Acceptable
RF-R5A	1853	Acceptable
RF-R6A	1854	Acceptable

3. DETAIL EVALUATIONS

3.1 DESCRIPTION

The piping supports analyzed in this report are shown in Figures 3-1 and 3-2 for the main steam and feedwater pipes, respectively. The main steam piping supports consist of six support locations utilizing seven snubbers. The feedwater piping supports consist of seven support locations utilizing eight snubbers. Analyses were performed for the piping supports on the South loop of each piping system. The analyses are applicable to the piping supports on the North loop of each piping system, which are a mirror image of the South loop.

3.2 REFERENCE DRAWINGS

The main steam and feedwater piping supports are shown on the following drawings.

Company	Drawing No.	Rev.	Description
General Physics	19442 Sh. 2	2	Main Steam Piping
	19443 Sh. 2	2	Feedwater Piping
Bergen-Paterson	716A	2	Support MS-R1A
	717A	1	Support MS-R2A
	718A	3	Support MS-R3A
	719A	3	Support MS-R4A
	720A	2	Support MS-R5A
	111	1	Support X-2A-SS-1
	1849	2	Support RF-R1A
	1850	2	Support RF-R2A
	1851	1	Support RF-R3A
	1852	2	Support RF-R4A
	1853	4	Support RF-R5A
	1854	1	Support RF-R6A
	116	1	Support X-4B-SS-1

Company	Drawing No.	Rev.	Description
Bergen-Paterson	64101	5	EA1 - Attachment
	64108	6	EA2 - Attachment
	E602	0	Supplementary Hanger Supporting Steel
Burns & Roe	4069	4	Reactor Building Radial Beam Framing

3.3 APPLICABLE CODE

The main steam and feedwater piping supports were evaluated in accordance with the 1980 Edition (including Winter 1982 Addenda) of the ASME Code, Section III, Division 1, Subsection NF for Component Supports.

3.4 MATERIALS

All structural steel was assumed to have the material properties of SA-36 carbon steel:

Yield strength - 36 ksi (min.)
Ultimate strength - 58 ksi (min.)

3.5 LOADS

The loads used in the analyses of the main steam and feedwater piping supports were generated using the finite element models in EG&G Report EGG-EA-5211, "Summary of the Oyster Creek Unit 1 Piping Calculations Performed for the Systematic Evaluation Program," dated July 1980 (Reference a). A review of the original EG&G analysis indicated the following:

- The drywell penetrations were not modeled as support locations, and
- Main steam support X-2A-SS-1 and feedwater support X-4B-SS-1 were not modeled explicitly.

The finite element models were reconstructed and modified to account for the support at the drywell penetrations and explicitly model the main steam and feedwater supports. The drywell penetrations were modeled as vertical and horizontal (transverse) supports. No horizontal (axial) support for the pipe is provided by the drywell penetration design. Main steam support X-2A-SS-1 and feedwater support X-4B-SS-1 are truss supports. These supports were modeled explicitly by using additional piping elements to represent the truss arrangement. New loads were then generated. Results of these analyses are contained in Appendix A. The loads consist of safe shutdown earthquake (SSE) seismic loads for both the main steam and feedwater systems with additional relief and safety valve discharge (RV and SV) loads for the main steam system. No deadweight or thermal loads are considered in the seismic analysis of the piping supports.

The piping analyses documented in Reference a were performed using seismic response spectra generated by Lawrence Livermore Laboratories in revised Appendix B of NUREG/CR-1981, "Seismic Review of the Oyster Creek Nuclear Power Plant as Part of the Systematic Evaluation Program," dated April, 1981 (Reference b). A damping value of 3% was used. Piping models were developed for the main steam and feedwater South loop piping inside containment. The North loop piping inside containment are mirror images of the South loop piping and therefore were not analyzed. The same analysis methods were used in the generation of the new loads mentioned above.

The piping support loads calculated using the finite element models of Reference a were then multiplied by 0.165/0.220 = 0.75 to adjust for the site specific zero period acceleration (ZPA) of 0.165 g's for the Oyster Creek site versus the ZPA

at the ground of 0.22 g's used in References a and b. Calculations of the revised piping support loads are also given in Appendix A.

3.6 ACCEPTANCE CRITERIA

The stresses in the piping supports due to SSE seismic loading conditions were evaluated to the requirements of Level D Service Limits of the ASME Code, Section III, Division 1, Subsection NF. The allowable Level D stress limits are calculated in Appendix B and summarized below.

3.6.1 Tension (Net Area)

$f_t \leq F_t$

where $F_t = 40.6$ ksi

3.6.2 Tension (Net Area at Pin Holes)

$f_t \leq F_t$

where $F_t = 32.4$ ksi

3.6.3 Shear

$f_v \leq F_v$

where $F_v = 24.4$ ksi

3.6.4 Shear (Coped Beam)

$f_v \leq F_v$

where $F_v = 21.6$ ksi

3.6.5 Bending

$f_b \leq F_b$

where $F_b = 40.6$ ksi

3.6.6 Compression

Limited to 2/3 Critical Buckling

$f_a < F_a$

where:

For $Kl/r < C_c$, $F_a = 2/3 \left(1 - \left(\frac{Kl}{r}\right)^2 / 2\, C_c^2\right) S_y$

For $Kl/r > C_c$, $F_a = 2/3 \left(\pi^2 E / (Kl/r)^2\right)$

3.6.7 Axial Compression and Bending

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} < 1.0$$

Note: Due to the geometry of the supports, equation (20) of Article NF-3322.1(e) is not used, and equations (21) and (22) reduce to the above interaction equation for Level D Service Limits.

3.6.8 Axial Tension and Bending

$$\frac{f_t}{F_t} + \frac{f_b}{F_b} < 1.0$$

Note: Because the reaction loads can act in both directions, the compressive interaction equation will always be controlling in this analysis.

3.6.9 Weld Shear

$f_v < F_v$

where $F_v = 24.4$ ksi

3.6.10 Nomenclature

C_c = slenderness ratio of compression elements

$= \sqrt{2\pi^2 E/S_y}$

E = modulus of elasticity

$= 29.2 \times 10^3$ ksi @ 135°F.

F_a = allowable stress in axial compression, ksi.

F_b = allowable stress in bending, ksi.

F_t = allowable stress in tension, ksi.

F_v = allowable stress in shear, ksi.

K = effective length factor.

f_y = yield strength, ksi.

f_a = calculated axial compression stress, ksi.

f_b = calculated bending stress, ksi.

f_t = calculated tensile stress, ksi.

f_v = calculated shear stress, ksi.

l = actual unbraced length of member, in.

r = governing radius of gyration, in.

3.7 SPECIFIC EVALUATIONS

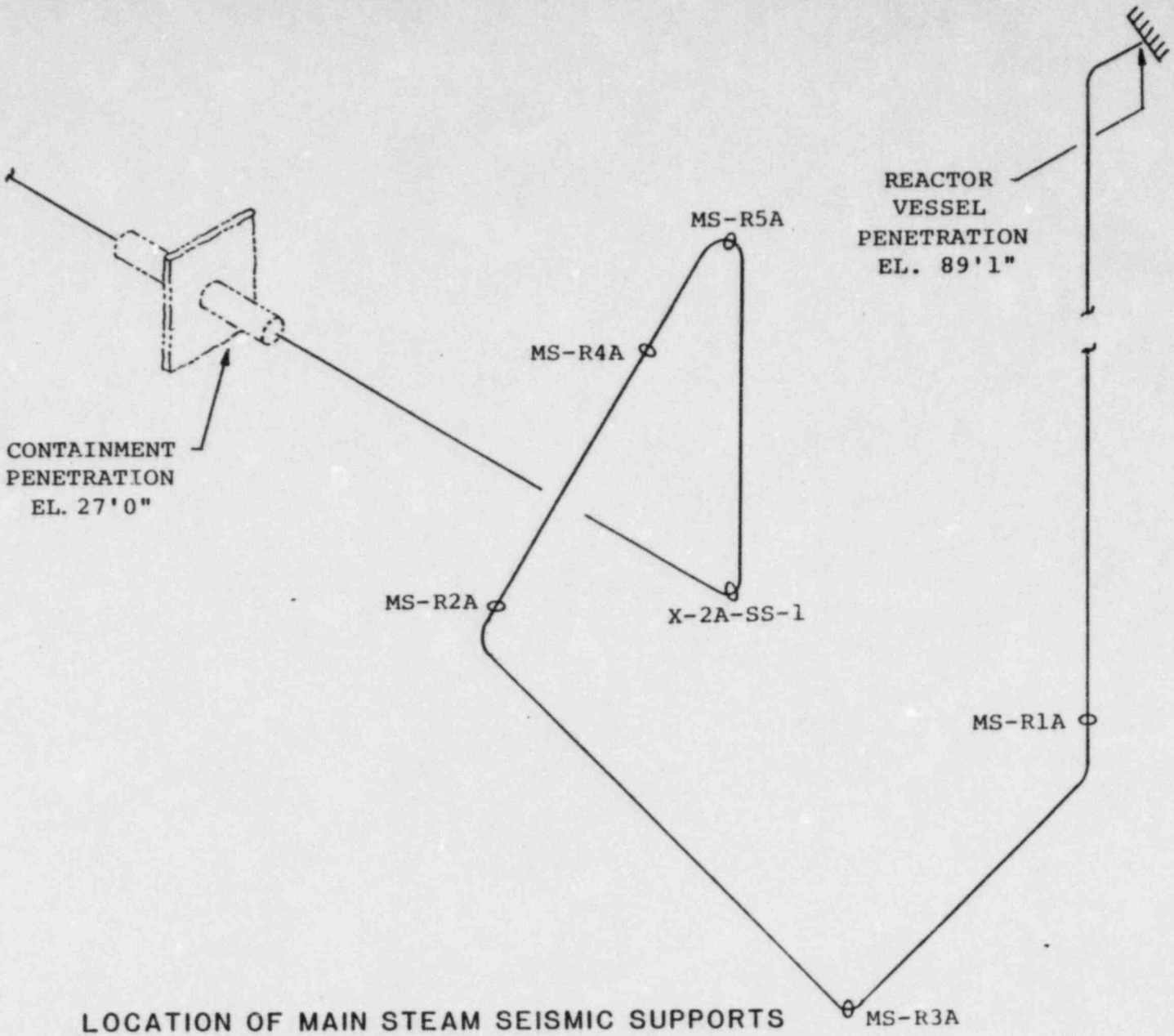
The detail calculations for the main steam and feedwater piping supports are given in Appendices C, D, and E of this report. A summary of the calculations is given in Tables 2-1 through 2-4 and discussed below.

3.7.1 Main Steam Piping Supports

Based on the calculations given in Appendices C and E, all structural components of the main steam system piping seismic supports are considered acceptable.

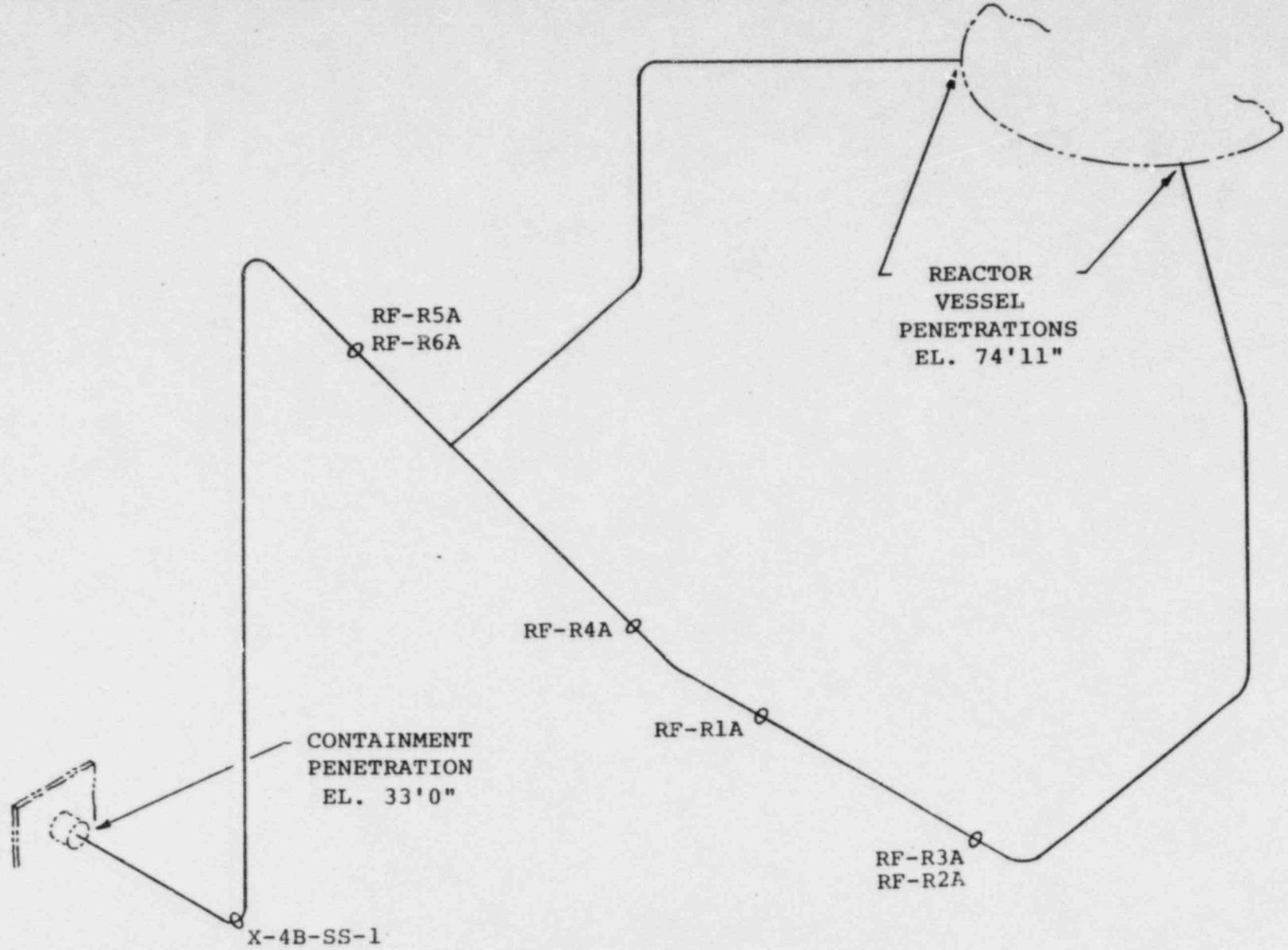
3.7.2 Feedwater Seismic Supports

Based on the calculations given in Appendices D and E, all structural components of the feedwater system piping seismic supports are considered acceptable.



LOCATION OF MAIN STEAM SEISMIC SUPPORTS

FIGURE 3-1



LOCATION OF FEEDWATER SEISMIC SUPPORTS

FIGURE 3-2

4. REFERENCES

a. M. E. Nitzel, "Summary of the Oyster Creek Unit 1 Piping Calculations Performed for the Systematic Evaluation Program," EGG-EA-5211, EG&G Idaho, Inc., July 1980.

b. NUREG/CR-1981, "Seismic Review of the Oyster Creek Nuclear Power Plant as Part of the Systematic Evaluation Program," April 1981.

5. APPENDICES

A. Seismic Support Loads

B. ASME Code, Section III, Division 1, Subsection NF Allowable Level D Stresses

C. Main Steam Seismic Supports

D. Feedwater Seismic Supports

E. Main Steam and Feedwater Snubber Evaluation

MPR ASSOCIATES, INC.
1050 Connecticut Ave., NW – Washington, DC 20036

Title: Seismic Support Loads. Calculated by: MJKennedy Date: 8/1/84
Checked by: BA Imbro Date: 8/9/84
Reviewed by: [illegible] Date: 8-22-84

Project: SEP Piping Supports 83-03

Purpose The purpose of the following calculation is to determine the seismic support loads for the main steam and feedwater piping at Oyster Creek.

Background This piping was originally analyzed by EG&G Idaho in "Summary of the Oyster Creek Unit 1 Piping Calculations performed for the Systematic Evaluation Program," EGG-EA-5211, dated July, 1980. A review of this report indicates that:

a) the drywell penetration was not considered a seismic support location,
b) certain snubber supports were not explicitly modelled, and
c) the response spectra was not Oyster Creek specific.

As a result, new seismic support loads were generated using the EG&G piping models, loads, and spectra with minor modifications to correct for the above items.

References

(1) "Summary of the Oyster Creek Unit 1 Piping Calculations performed for the Systematic Evaluation Program," EGG-EA-5211, July 1980.

(2) General Physics Corporation Dwgs. JCP-19442, sheet 2, JCP-19443, sheet 2.

(3) NUREG/CR-1981, "Seismic Review of the Oyster Creek Nuclear Power Plant as Part of the Systematic Evaluation Program, Revised Appendix B. (Revised Appendix B forwarded to MPR (W. Schmidt) by LLNL (T. Nelson) in letter dated June 23, 1981.

(4) USNRC Letter LS05-81-06-068 dated 6/17/81

Description A summary of changes made to EG&G finite element piping models are given in Table 1. Plots of the EG&G main steam model are given in figures 1-6. Plots of the MPR modifications are given in figures 7-8. Plots of the EG&G feedwater model are given in figures 9-11. Plots of the MPR modifications are given in figures 12-13. Tables 2 and 3 summarize the Dynamic Support loads calculated for main steam and feedwater piping using the finite element code.

The analyses which developed the loads in Ref (1) and in Tables 2 and 3 used a seismic response spectra (Ref. 3) with a ZPA of .22 g's. The currently accepted ZPA is 0.165 g's. The resulting SSE loads are reduced by $\frac{0.165}{0.22}$ or

0.75 Ref (4). Tables 4 and 5 show the calculated Main steam and feedwater support loads revised using the 0.75 reductions. These loads are the loads used in the Analyses in Appendices C, D and E.

Table 1 E G & G finite Element Models
Main Steam and Feedwater Piping

Summary of MPR Review & Changes

Type of Review	Conclusion	Modification to Model for New Seismic Load Generation
Geometry	Geometry used in model is Acceptable	No changes
Hanger Supports	Locations of supports Acceptable. Preloads Not checked by MPR. (Assumed Acceptible – Not within scope of this analysis)	No changes
Seismic supports (snubbers)	Locations and directions of seismic supports checked. All found Acceptable except main steam support X-2A-SS-1 and feedwater support X-4B-SS-1.	Supports X-2A-SS-1 and X-4B-SS-1 were explicitly modeled in order to obtain correct snubber loads. 1

Notes:

1. See Attachments 1 & 2 for the detailed documentation of this modification.

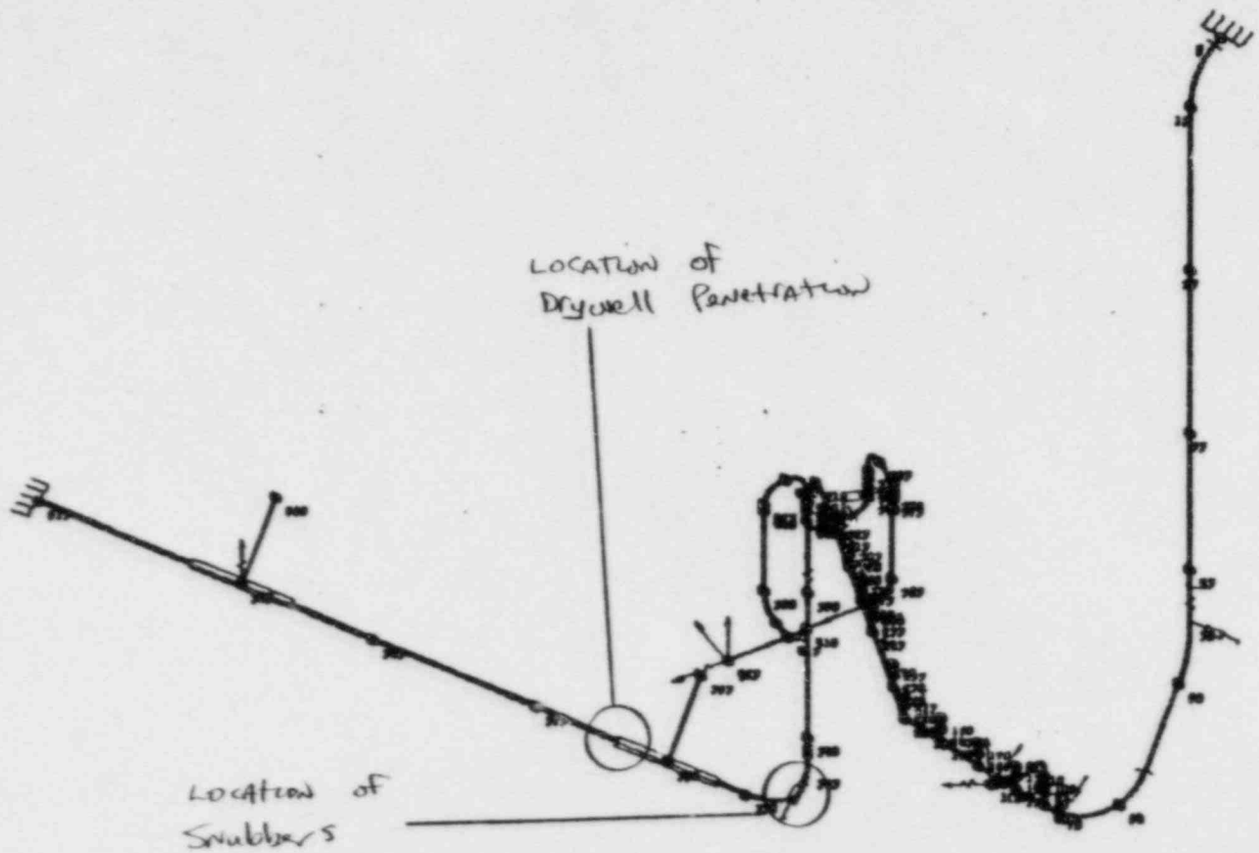
Table 1 (cont.)

TYPE of Review	Conclusion	Modification to Model for New Seismic LOAD Generation
Anchors AND Penetrations	Locations of Anchors Acceptable. No Modeling of the drywell penetrations as supports.	The drywell penetration does not support the pipe along its longitudinal axis but provides support in the vertical AND horizontal (transverse) direction. This support was included in the models.[2]
Response Spectra LOADing AND SV & RV LOADS	Response Spectra checked Not site specific to Oyster Creek SV & RV LOADS not checked. (ASSUMED Acceptable - NOT within scope of this ANALysis	RATIO Seismic LOADS By 0.165/0.22 for Reduction to Oyster Creek Specific LOADing (Note 3)

Notes:

2. See ATTACHment 3 for the detailed documentation of this modification.
3. See Reference 4.

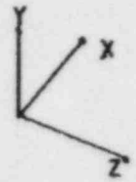
Figure 1. EG&G Piping Model of Main Steam Piping



B.C. SEP - MAIN STEAM S. HEADER - NEW
NUPIPE MATHEMATICAL MODEL (V 1.6)

LEGEND

- / - NODE LOCATION
- ⊕ - MASSPOINT LOCATION
- SPRING HANGER
- SNUBBER
- RIGID SUPPORT
- ANCHOR
- ELASTO JOINT
- FLEXIBLE ANCHOR
- VALVE



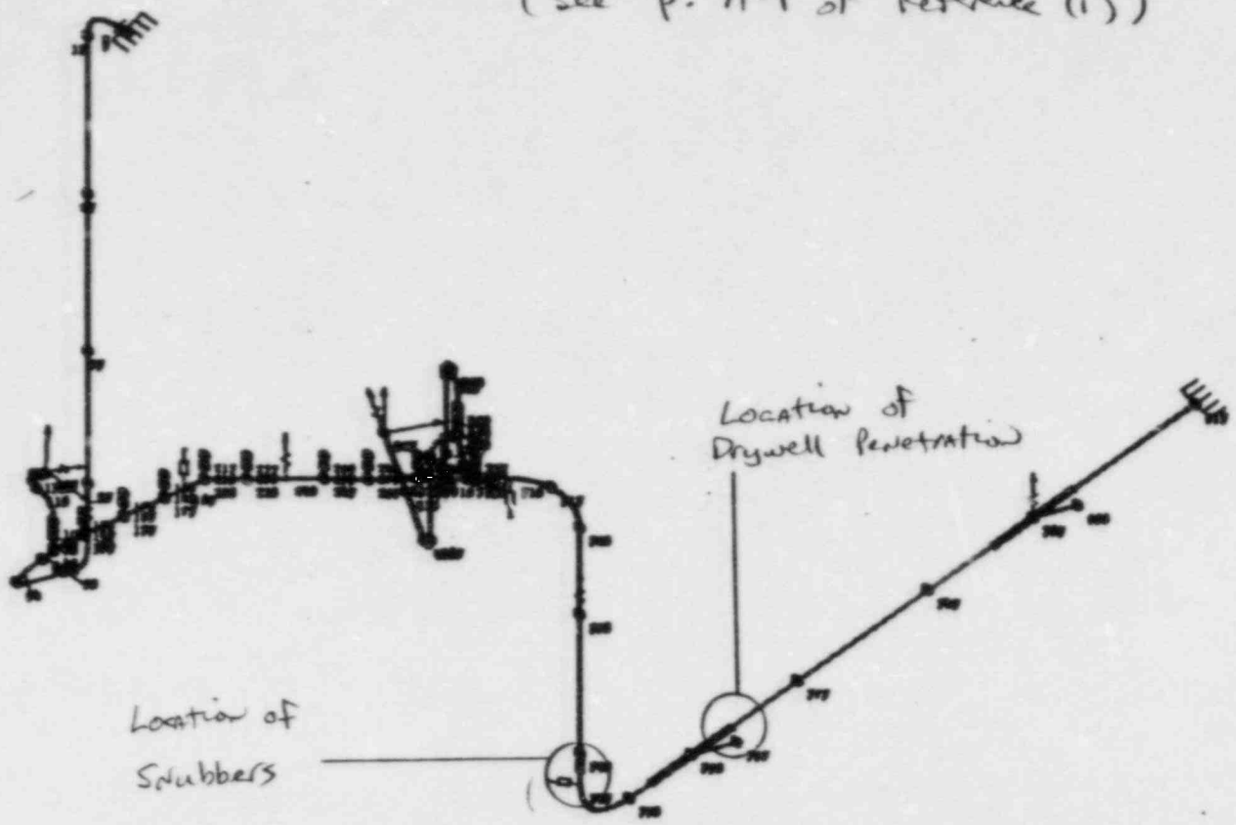
ROTATION ABOUT Y-AXIS = -60 DEG.
X-Z PLANE TILT = 45 DEG.

FRAME NO. 1.00 84/07/18.

Attachment 8/1/84
B Lambert 8/9/04

P.7 of 23

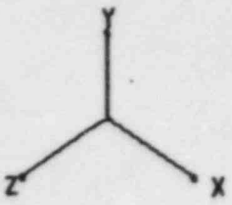
figure 2. EG&G Piping Model of Main Steam Piping (see p. A-1 of Reference (1))



O.C. SEP - MAIN STEAM S, HEADER - NEW
NUPIPE MATHEMATICAL MODEL (V 1.6)

LEGEND

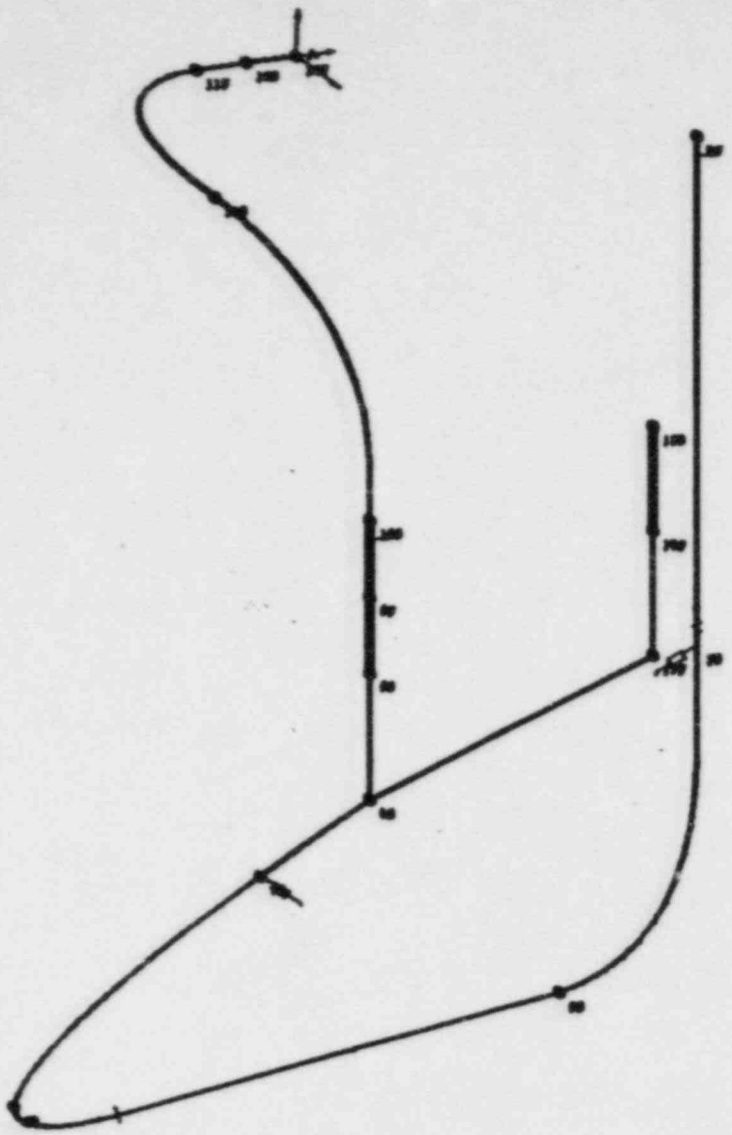
/ - NODE LOCATION
@ - MASSPOINT LOCATION
- SPRING HANGER
- SNUBBER
- RIGID SUPPORT
- ANCHOR
- ELASTO JOINT
- FLEXIBLE ANCHOR
- VALVE



ROTATION ABOUT Y-AXIS = 45 DEG.
X-Z PLANE TILT = 45 DEG.

FRAME NO. 1.00 84/07/18.

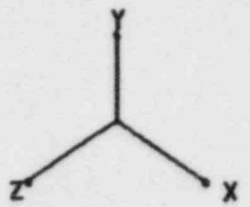
24 Kennedy 5/1/84 p. 8 of 23
B Lindsey 8/9/2021



O.C. SEP - MAIN STEAM S. HEADER - NEW
NUPIPE MATHEMATICAL MODEL (V 1.6)

LEGEND

- / - NODE LOCATION
- ⊕ - MASSPOINT LOCATION
- SPRING HANGER
- SNUBBER
- RIGID SUPPORT
- ANCHOR
- ELASTO JOINT
- FLEXIBLE ANCHOR
- VALVE



ROTATION ABOUT Y-AXIS = 45 DEG.
X-Z PLANE TILT = 45 DEG.

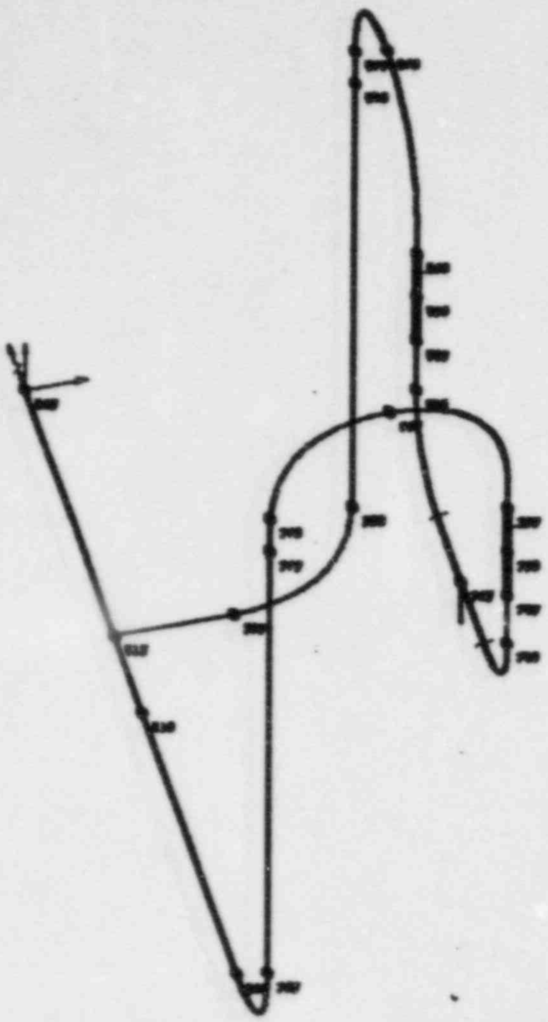
FRAME NO. 1.00 86/07/18.

Figure 3. Detail of EG&G Piping Model (See p. A-2 of Reference (1))

Implemented 6/1/84
B Engineering 8/9/84

[illegible signature] 8/1/84
[illegible signature] 8/9/84

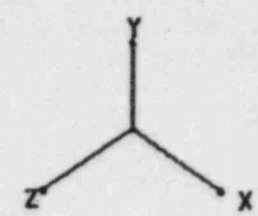
O.C. SEP - MAIN STEAM 3, HEADER - NEW
NUPIPE MATHEMATICAL MODEL (V 1.6)



LEGEND

- / - NODE LOCATION
- ⊕ - MASSPOINT LOCATION
- SPRING HANGER
- SNUBBER
- RIGID SUPPORT
- ANCHOR
- ✱ - ELASTO JOINT
- FLEXIBLE ANCHOR
- VALVE

Figure 4. Detail of EG&G Piping Model (see p. A-3 of Reference (1))



ROTATION ABOUT Y-AXIS = 45 DEG.
X-Z PLANE TILT = 45 DEG.

FRAME NO. 1.00 84/07/18.

Figure 5 Detail of Snubber Location
Main Steam - EG&G Model

B.C. 3EP - MAIN STEAM S. HEADER - NEW
NUPIPE MATHEMATICAL MODEL (V 1.6)

LEGEND

/ - NODE LOCATION
@ - MASSPOINT LOCATION
SPRING HANGER
SNUBBER
RIGID SUPPORT
ANCHOR
ELASTO JOINT
FLEXIBLE ANCHOR
VALVE

Y
Z
X

ROTATION ABOUT Y-AXIS = 0 DEG.
X-Z PLANE TILT = 0 DEG.

FRAME NO. 1.00 84/07/18.

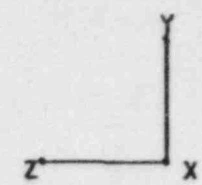
8/1/84
@ Triplett
8/7/84

P. 11 of 23

B.C. SEP - MAIN STEAM S, HEADER - NEW
NUPIPE MATHEMATICAL MODEL (V 1.6)

LEGEND

- / - NODE LOCATION
- ⊕ - MASSPOINT LOCATION
- SPRING HANGER
- SNUBBER
- RIGID SUPPORT
- ANCHOR
- ELASTO JOINT
- FLEXIBLE ANCHOR
- VALVE



ROTATION ABOUT Y-AXIS = 90 DEG.
X-Z PLANE TILT = 0 DEG.

Kennedy 8/1/84
B [illegible] 8/9/84

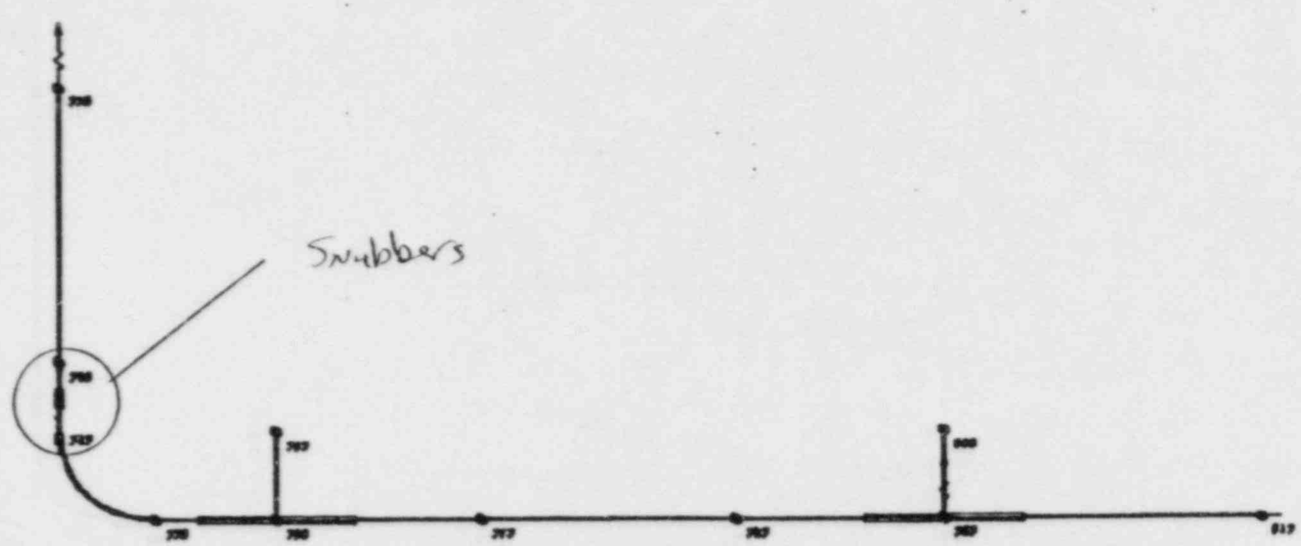


Figure 6 Detail of Snubber Location
Main Steam - EG & G Model

.... FRAME NO. 1.00 84/07/18.

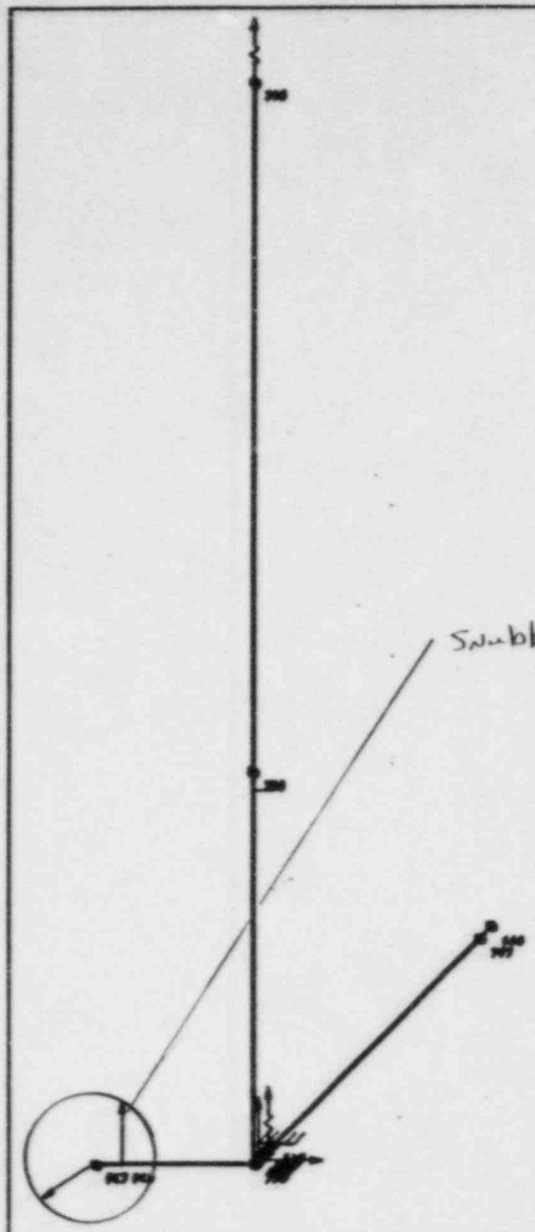
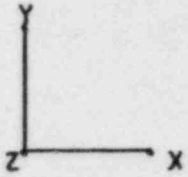


Figure 7. Detail of Snubber Location - Main Steam - MPR Model

O.C. SEP - MAIN STEAM SOUTH SIDE, KERNAL
NUPIPE MATHEMATICAL MODEL (V 1.6)

LEGEND

/ - NODE LOCATION
@ - MASSPOINT LOCATION
SPRING HANGER
SNUBBER
RIGID SUPPORT
ANCHOR
ELASTO JOINT
FLEXIBLE ANCHOR
VALVE



ROTATION ABOUT Y-AXIS = 0 DEG.
X-Z PLANE TILT = 0 DEG.

FRAME NO. 1.00 84/07/18.

24 Remarks 8/1/84
O Engineering 8/2/84

P. 13 of 23

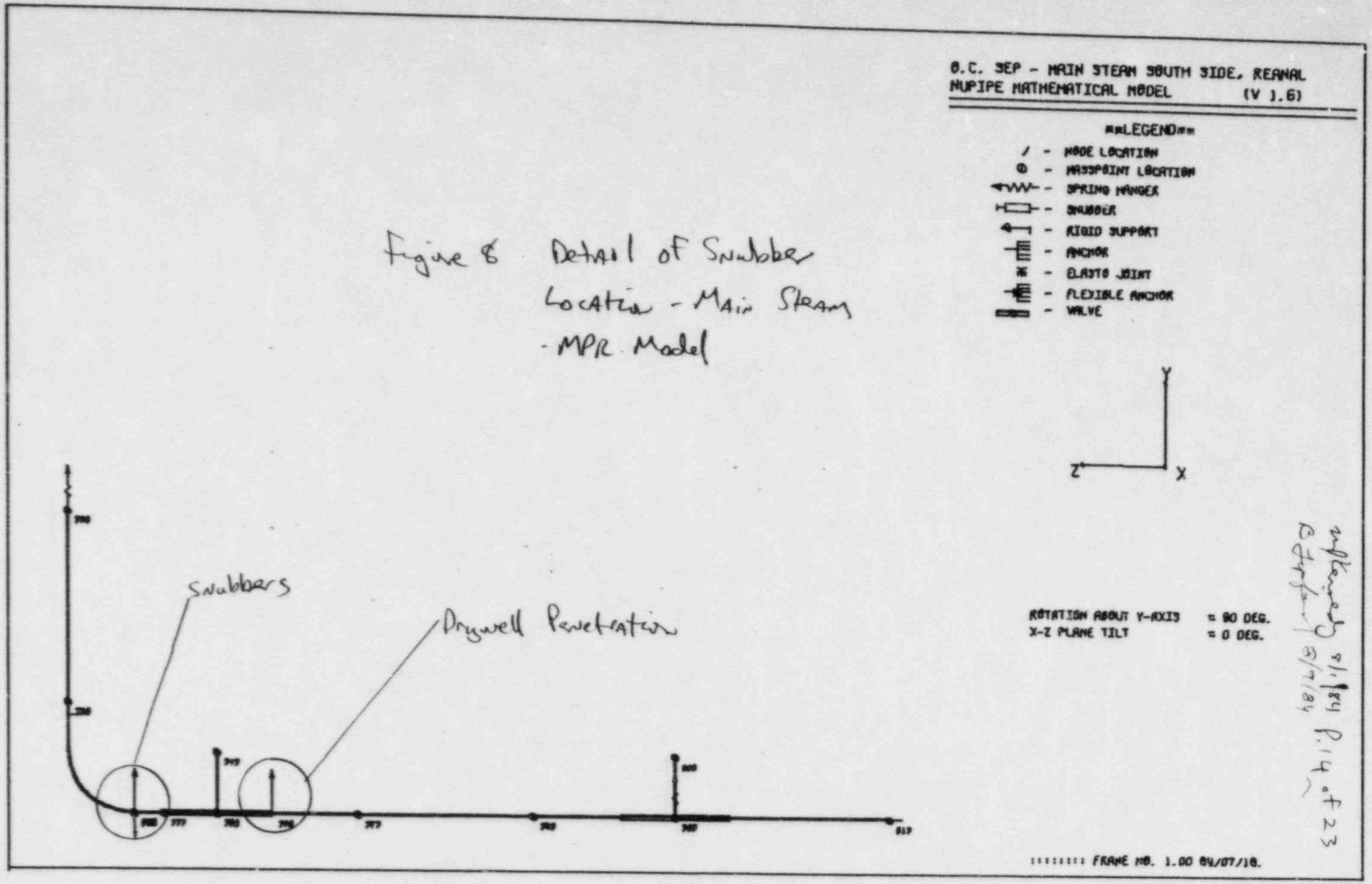
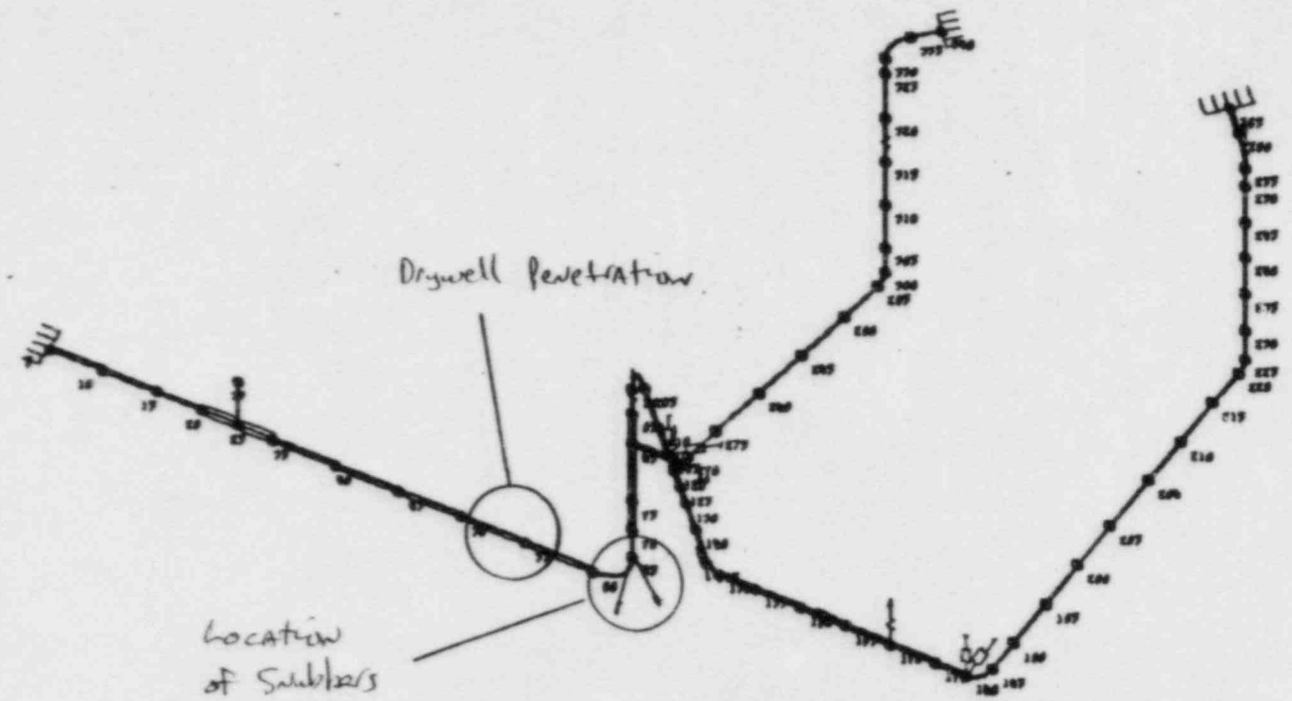


Figure 8 Detail of Snubber Location - Main Steam - MPR Model

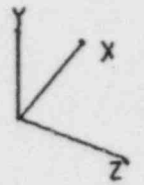
Figure 9. EG&G Piping Model of Feedwater Piping



B.C. SEP - FEEDWATER S. SIDE - NEW
NUPIPE MATHEMATICAL MODEL (V 1.6)

LEGEND

/ - NODE LOCATION
@ - MASSPOINT LOCATION
SPRING HANGER
SNUBBER
RIGID SUPPORT
ANCHOR
ELASTO JOINT
FLEXIBLE ANCHOR
VALVE



ROTATION ABOUT Y-AXIS = -60 DEG.
X-Z PLANE TILT = 45 DEG.

FRAME NO. 1.00 84/07/19.

M Kennedy 5/1/84
B Stevenson 8/9/84

P.15 of 23

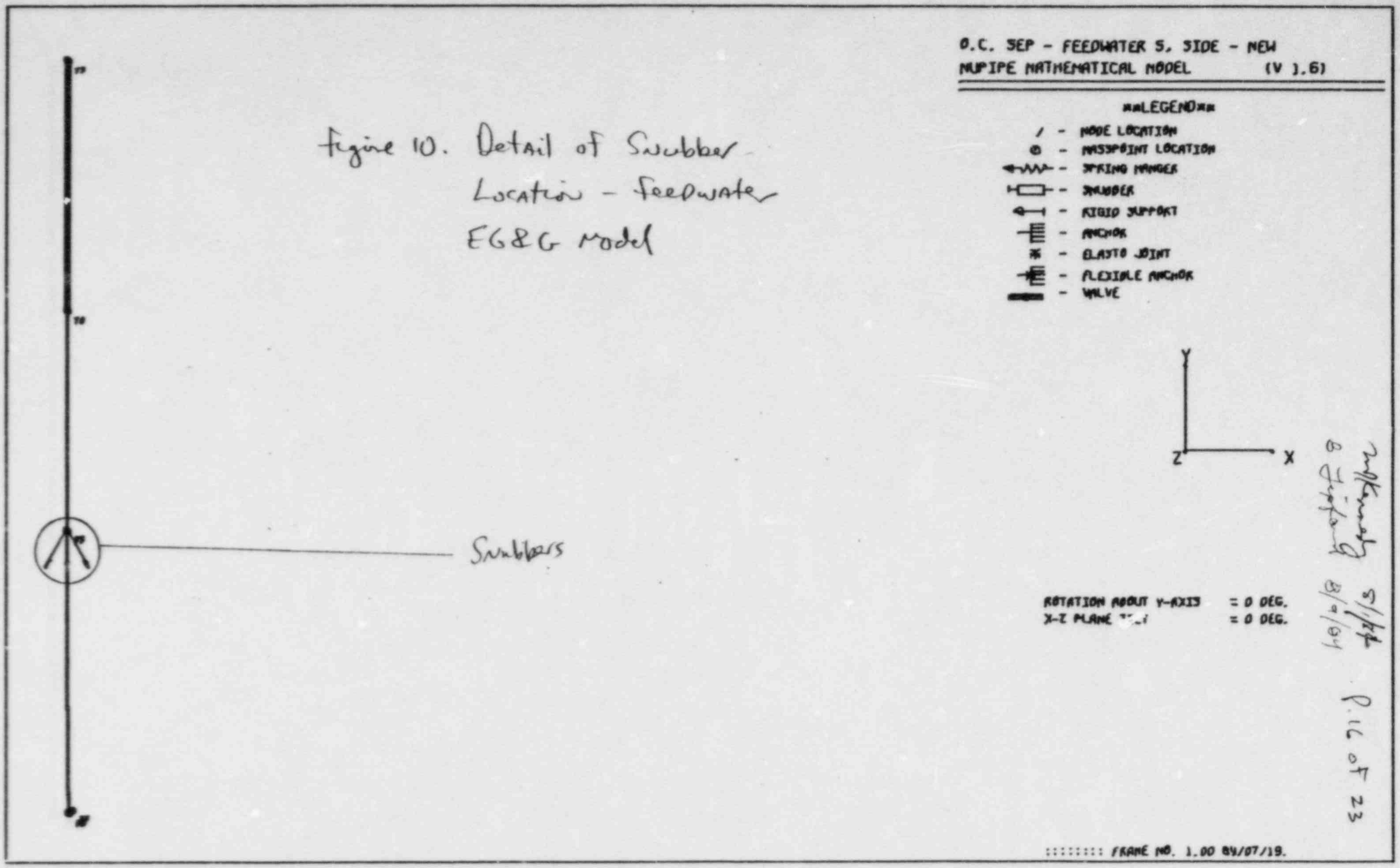


Figure 10. Detail of Snubber Location - Feedwater EG&G Model

[signature] 8/1/84
[signature] 8/9/84

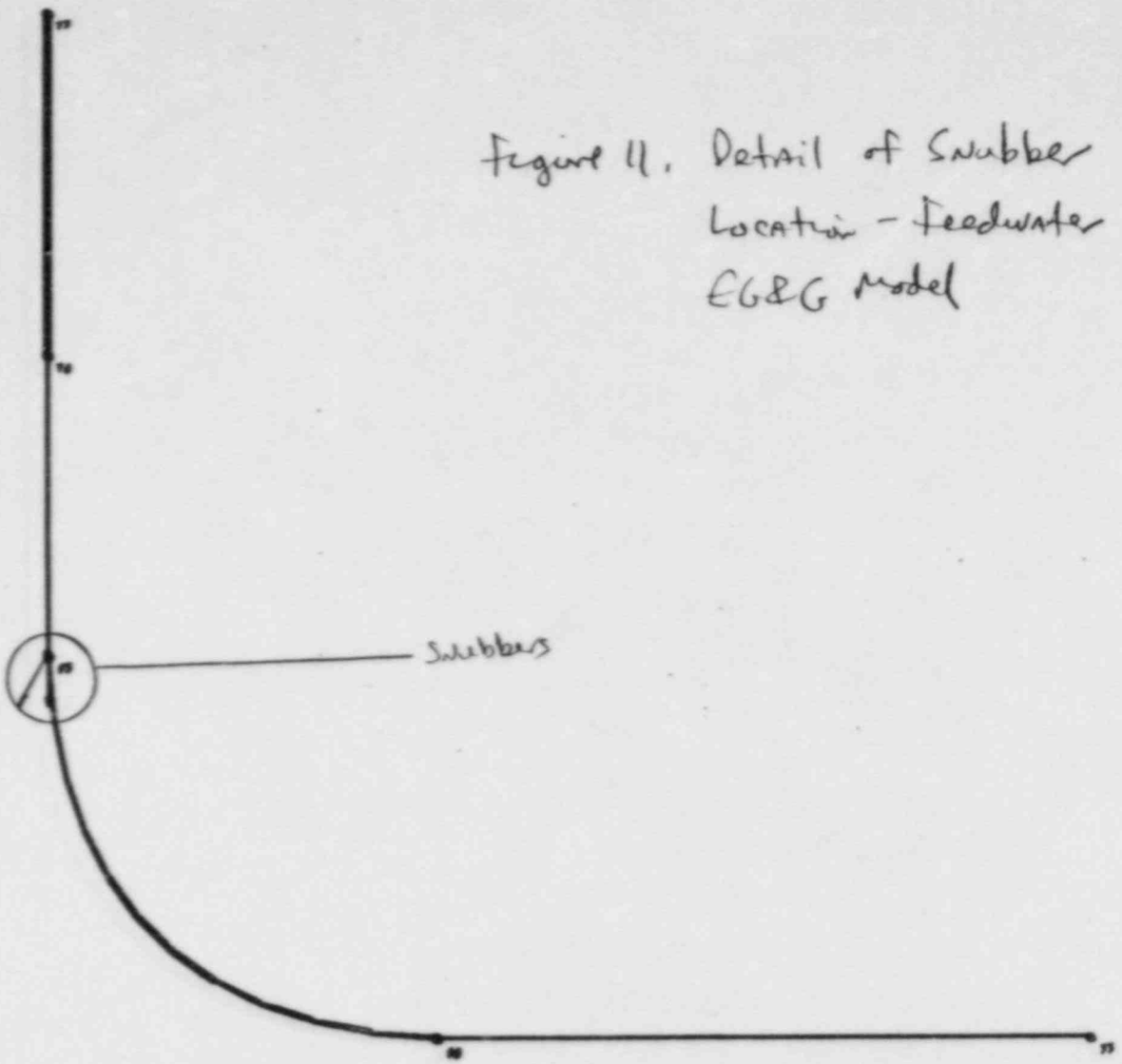


Figure 11. Detail of Snubber Location - Feedwater EG&G Model

O.C. SEP - FEEDWATER S. SIDE - NEW
NUPIPE MATHEMATICAL MODEL (V 1.6)

LEGEND

/ - NODE LOCATION
⊙ - MASSPOINT LOCATION
SPRING HANGER
SNUBBER
RIGID SUPPORT
ANCHOR
ELASTO JOINT
FLEXIBLE ANCHOR
VALVE

Y
Z
X

ROTATION ABOUT Y-AXIS = 90 DEG.
X-Z PLANE TILT = 0 DEG.

FRAME NO. 1.00 84/07/19.

Initial/Comments 4/1/84 B Tapping 8/7/84

P 17 of 23

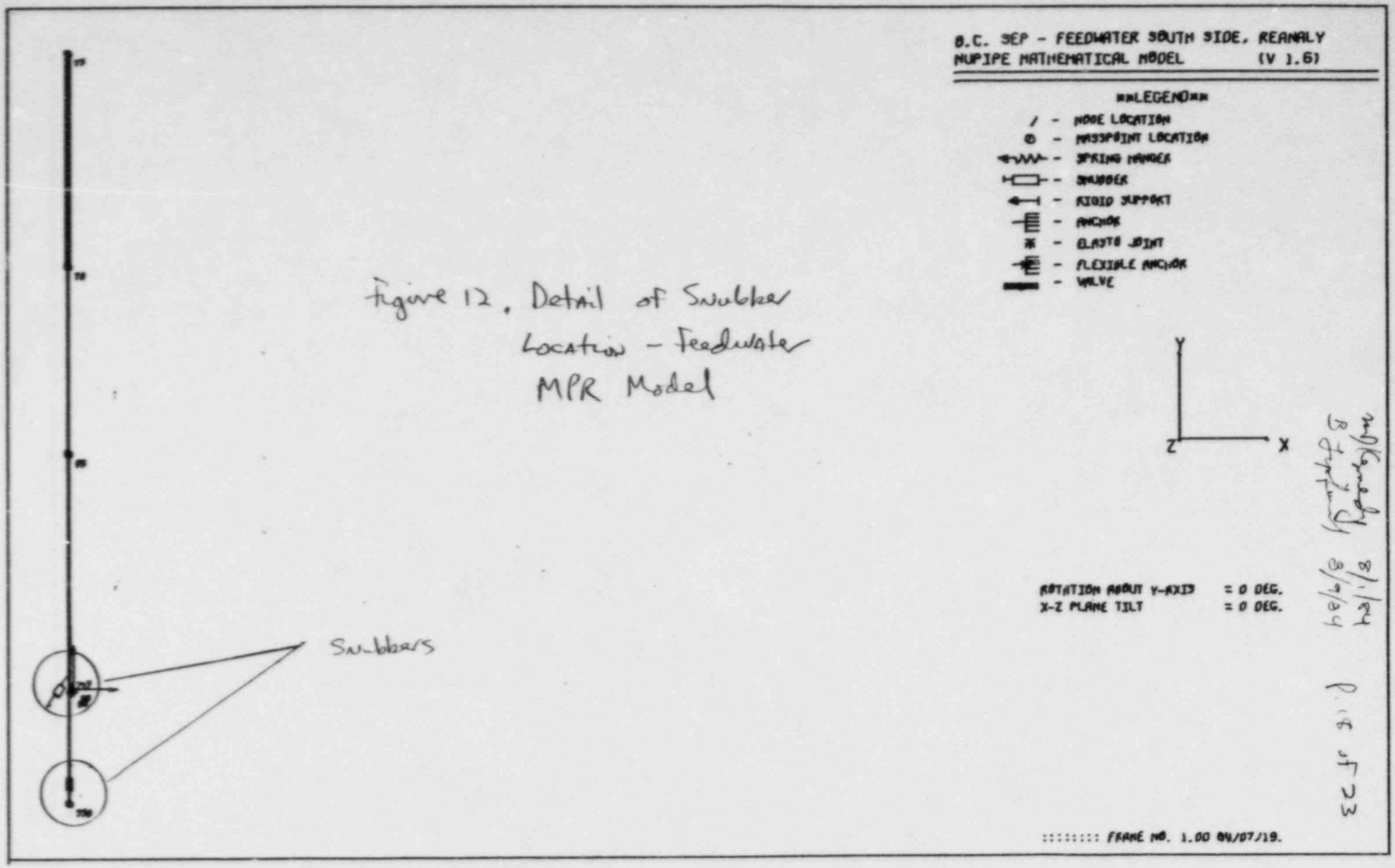


Figure 12, Detail of Snubber Location - Feedwater MPR Model

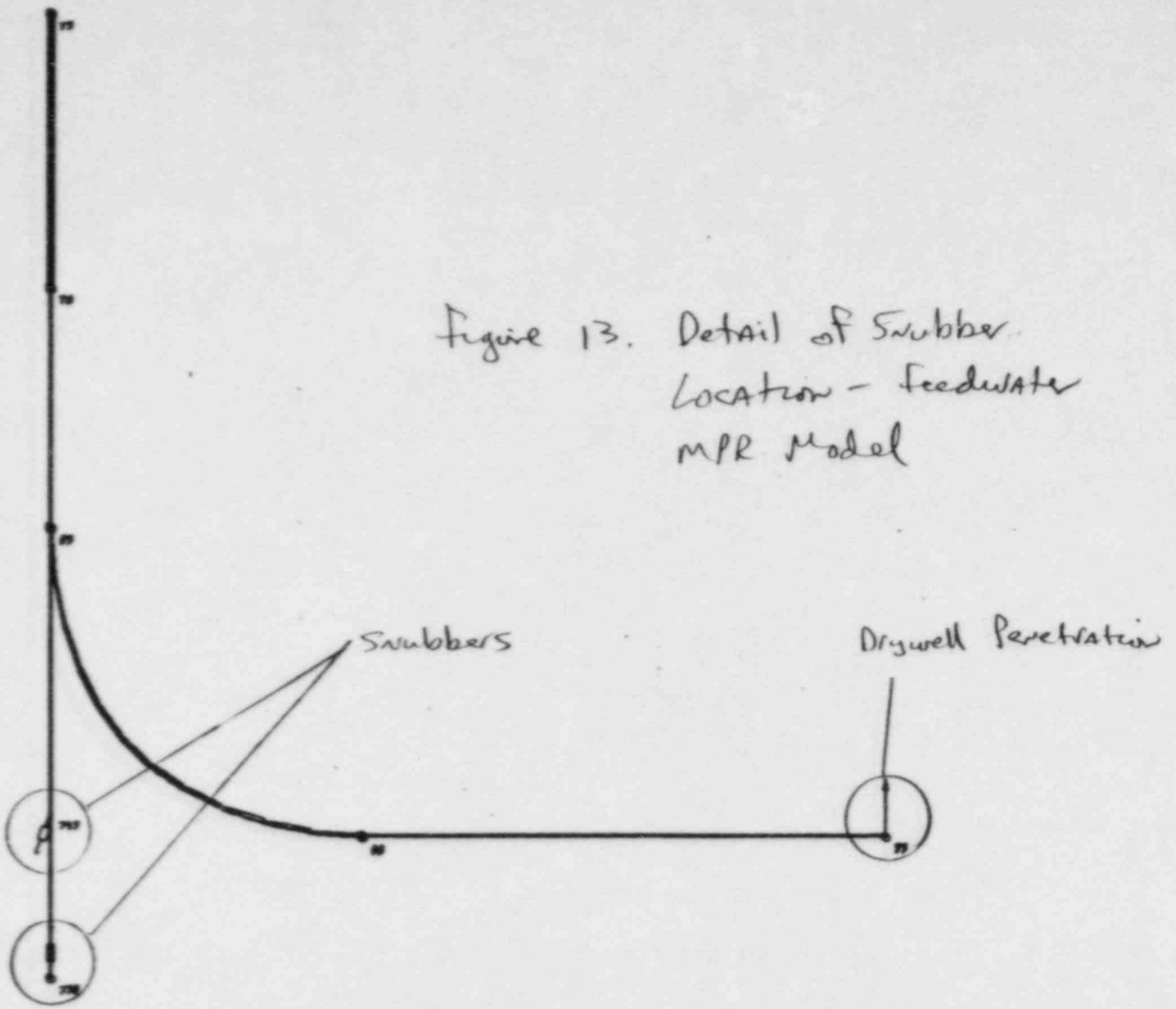


Figure 13. Detail of Snubber Location - Feedwater MPR Model

O.C. SEP - FEEDWATER SOUTH SIDE, REANALY
NUPIPE MATHEMATICAL MODEL (V 1.6)

LEGEND

- / - NODE LOCATION
- ⊙ - MASSPOINT LOCATION
- SPRING HANGER
- SNUBBER
- RIGID SUPPORT
- ANCHOR
- ELASTO JOINT
- FLEXIBLE ANCHOR
- VALVE

Y
Z X

ROTATION ABOUT Y-AXIS = 90 DEG.
X-Z PLANE TILT = 0 DEG.

8/1/84
8/9/84

P. 19 of 23

::::::::: FRAME NO. 1.00 84/07/19.

TABLE 2 Support LOAD Summary - MAIN STEAM Piping Model - Dynamic LOADS Only MPR Model [1]

NODE	DIRECTION	SSE (KIPS)	RV & SV (KIPS)	SSE Plus RV & SV* (KIPS)
50	Z	4.69	-1.65	6.34
70	X	9.56	-0.54	10.10
195	Y	4.33	-9.08	13.41
285	INCL	12.73	-0.40	13.13
510	INCL	8.06	-2.28	10.34
620	Y	201	-1.93	3.94
625	INCL	1.46	0.10	1.56
570	Y	6.89	-5.76	12.65
570	X	3.29	1.04	4.33

* Absolute Sum

1. Taken from computer Run BBCYTUT, Pgs. 33, 282, 302, (see Attachment 4).

TABLE 3 Support Load Summary - Feedwater Piping Model - Dynamic Loads Only MPR Model[1]

NODE	Direction	SSE (KIPS)
55	Y	3.68
55	X	3.85
350	Y	3.12
345	INCL	1.78
115	Y	3.78
115	INCL	6.26
140	INCL	5.54
160	Z	2.96
180	X	2.13
180	Y	1.73

1. Taken from Computer Run BBCYTVF, P. 189, (See Attachment 4).

Table 4 Main Steam Support Loads for Use in Analyses

HANGER / Support DWG # / NODE	Support LOAD SSE (K.IPS)	Support LOAD RV & SV (K.IPS)	Revised Support LOAD SSE + RV & SV (Note 1)	Notes
MS-R1A/50	4.69	1.65	5.17	
MS-R2A/195	4.33	9.08	12.33	
MS-R3A/70	9.56	0.54	7.71	
MS-R4A/285	12.73	0.40	9.95	
MS-R5A/510	8.06	2.28	8.33	
X-2A-SS-1/570 P_H	2.01	1.93	3.44	Y direction
X-2A-SS-1/570 P_I	1.46	0.10	1.20	INCLINED

Notes:

1. Revised $[SSE + RV\&SV]_{LOAD} = .75 * [SSE]_{LOAD} + [RV\&SV]_{LOAD}$

Table 5 Feedwater Support LOADS for Use in Analyses

HANGER/ SUPPORT DWG # /NODE	Support LOAD SSE (KIPS)	Revised Support LOAD SSE (KIPS) (Note 1)	Notes
RF-R1A /160	2.96	2.22	
RF-R2A /180	2.13	1.60	X
RF-R3A /180	1.73	1.30	Y
RF-R4A /140	5.54	4.16	
RF-R5A /115	6.26	4.70	LAT
RF-R6A /115	3.78	2.84	Y
X-4B-SS-1	3.12	2.34	Y DIRECTION
	1.78	1.34	INCLINED

Notes:

1. Revised $[SSE]_{LOAD} = .75 * [SSE]_{LOAD}$

MPR ASSOCIATES, INC.
1050 Connecticut Ave., NW – Washington, DC 20036

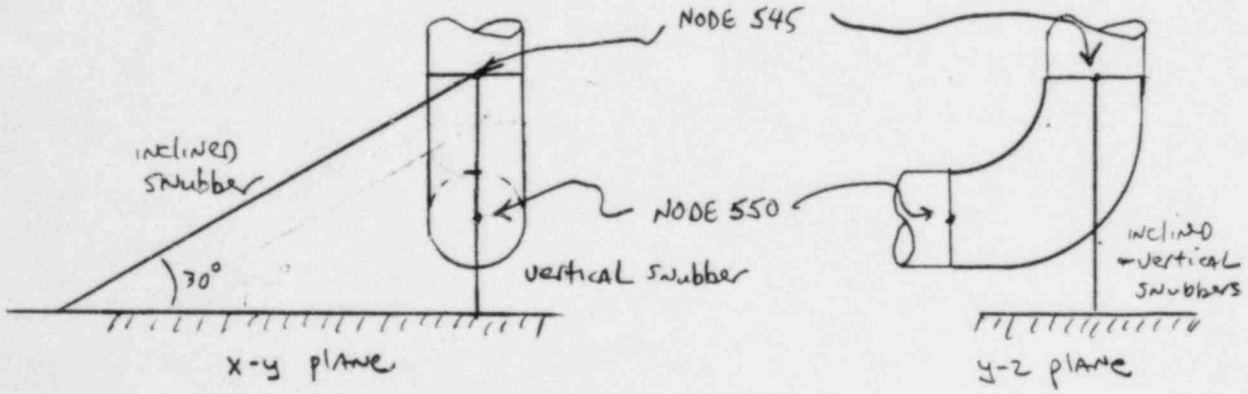
Title: MAIN STEAM Support Modification
Calculated by: M Kennedy Date: 7/19/84
Checked by: B Jagannath Date: 7-18-84
Reviewed by: T Johnson Date: 8-22-84

Project: SEP Piping Supports #3-03

Purpose The purpose of the following calculation is to determine the geometry and element constants used in the explicit modeling of support MARK NO X-2A-SS-1.

EG&G Model In the EG&G pipe finite element model contained in EG&G report EGG-EA-5211, the pipe was constrained at the location of support X-2A-SS1 in the following manner:

EG&G PIPE CONSTRAINT



In actuality, the snubbers are mounted to an eccentric pipe which transmits the load.

Title: Main Steam Support Modification

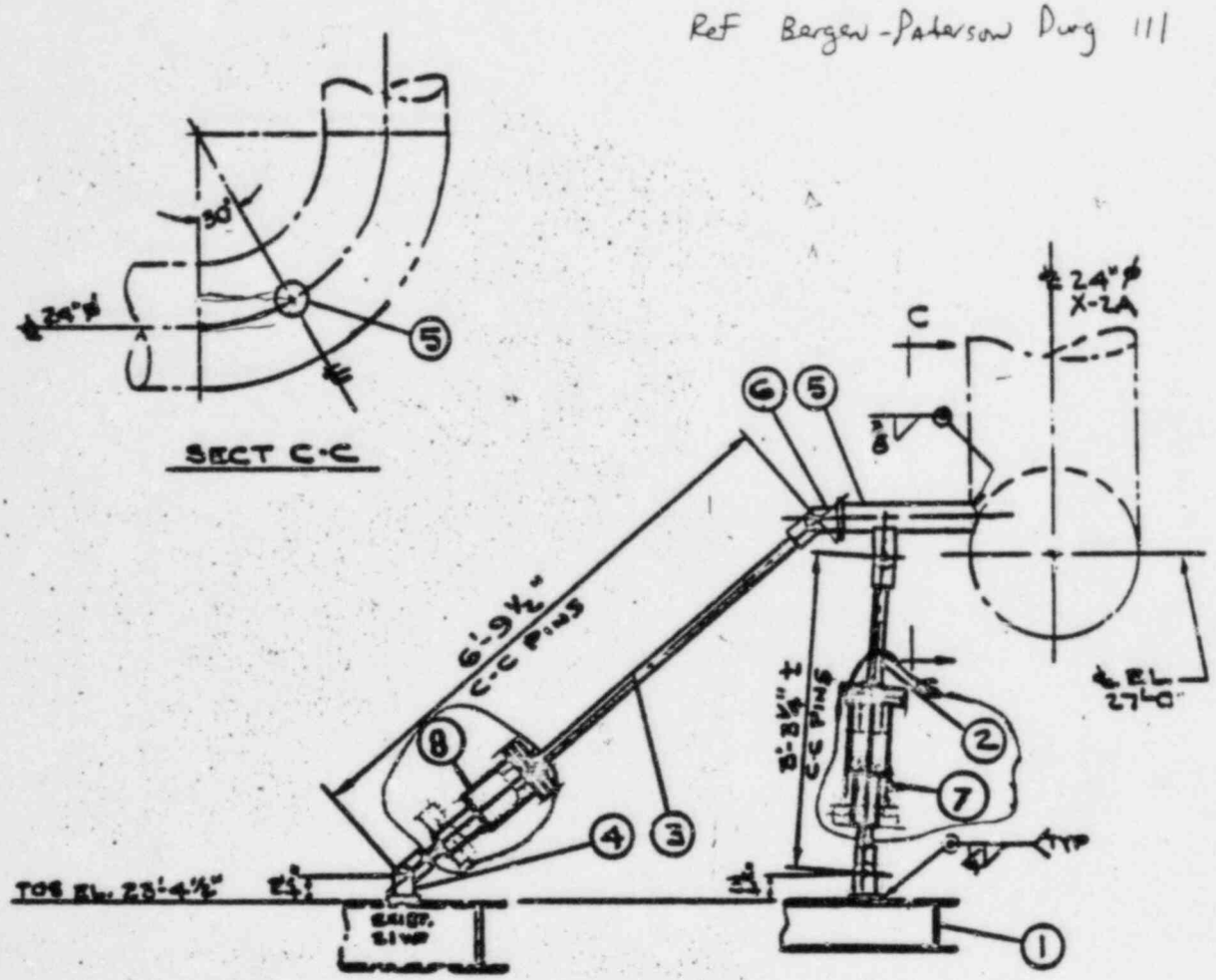
Calculated by: [illegible] Date: 7/17/84
Checked by: [illegible] Date: 7-18-84
Reviewed by: [illegible] Date: 8-22-84

Project: 83-03

Revised MODEL

Actual Geometry

Ref Bergen-Paterson Dwg 111

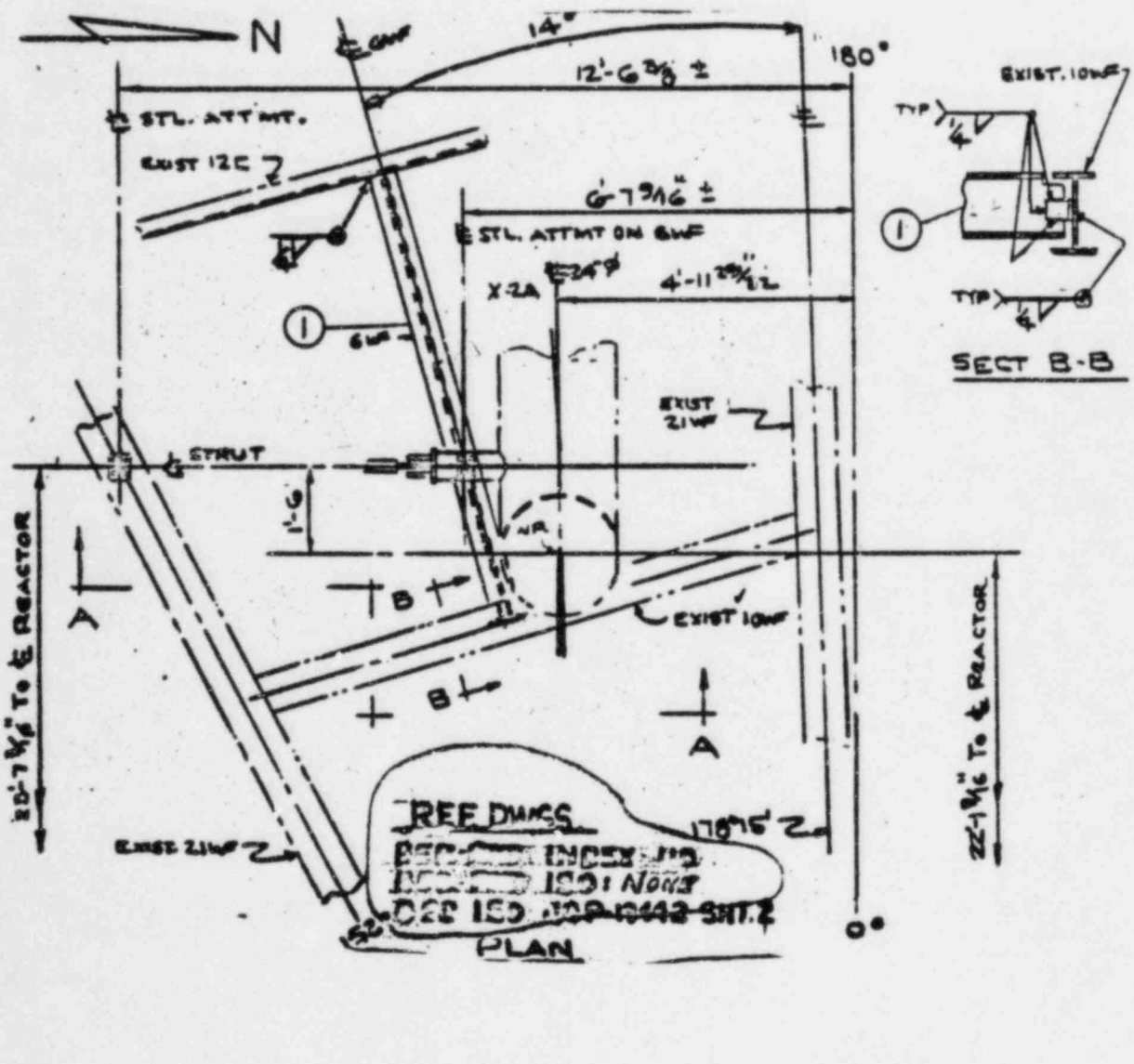


MPR ASSOCIATES, INC.
1050 Connecticut Ave., NW – Washington, DC 20036

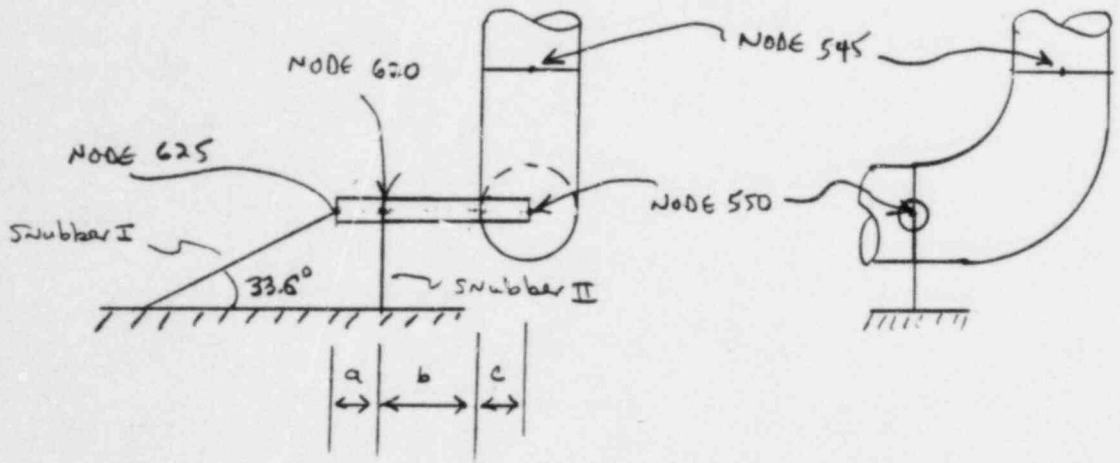
Title: Main Steam Support Modification

Calculated by: [illegible] Date: 7/17/84
Checked by: BJ Date: 7/19/84
Reviewed by: [illegible] Date: 8-22-84

Project: 83-03



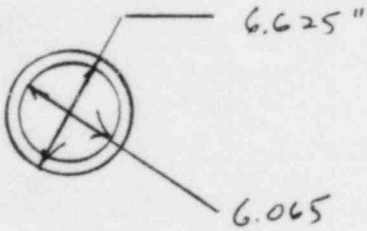
Revised Pipe Constraint



a = 4.0"
b = 7.75"
c = 12.0"

} Dimensions Ref: MPR calculation

The elements which run from NODES 550 to 620 AND 620 to 625 have the following pipe properties:



OD = 6.625"
t = 0.280"

6"ϕ sch 40 weight = 19.0 lb/ft
modulus of elasticity = 27.9×10^6 psi *
design pressure = 0.0 psi

Ref: Crane tech. paper No. 410
* USED IN the original EG&G ANALYSES.

Element coordinates

	x (ft)	y (ft)	z (ft)
545	4.814	-58.748	-23.018
550	4.814	-60.784	-23.018
620	3.168	-60.784	-23.018
625	2.835	-60.784	-23.018

Snubber I

using coordinate offsets from node 625

$\Delta x = \cos 33.6 = -0.833$

$\Delta y = \sin 33.6 = -0.553$

$\Delta z = 0.0$

$K = 2.5 \times 10^3$ lb/in

Snubber II

at node 620, y direction $K = 2.5 \times 10^3$ lb/in

Attachment 2

MPR ASSOCIATES, INC.
1050 Connecticut Ave., NW – Washington, DC 20036

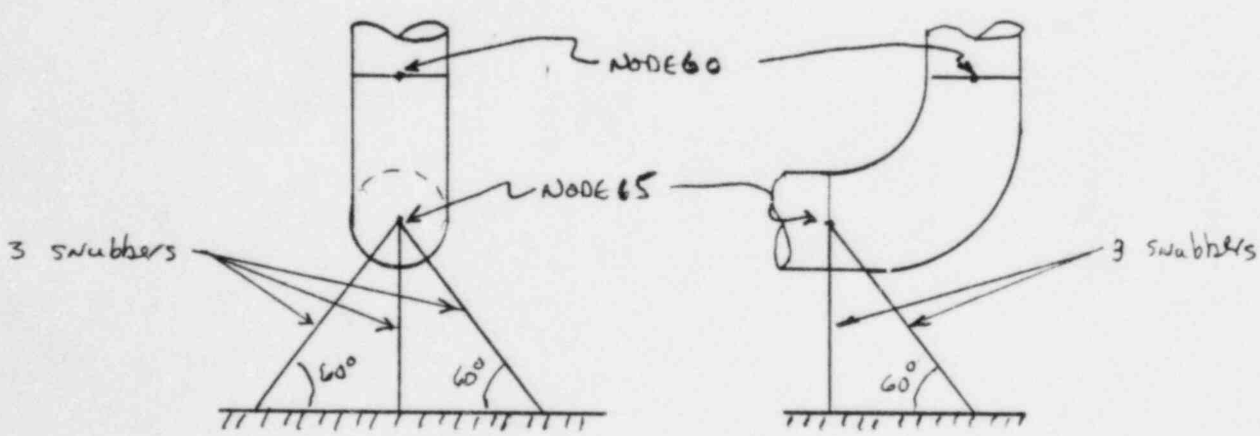
Title: Feedwater Support MODIFICATION
Calculated by: [signature] Date: 7/17/84
Checked by: [signature] Date: 7-19-84
Reviewed by: [signature] Date: 8-22-84

Project: SEP Piping Supports 83-03

Purpose The purpose of the following calculation is to determine the geometry AND element constants used in the explicit modeling of support MARK No. X-4B-SS-1

EG&G Model In the EG&G pipe Finite element model contained in EG&G report EGG-EA-5211, the pipe WAS constrained at the location of support X-4B-SS-1 in the following manner:

EG&G pipe constraint



IN actuality, the snubbers are mounted to an eccentric pipe which transmits the load. There are only two snubbers.

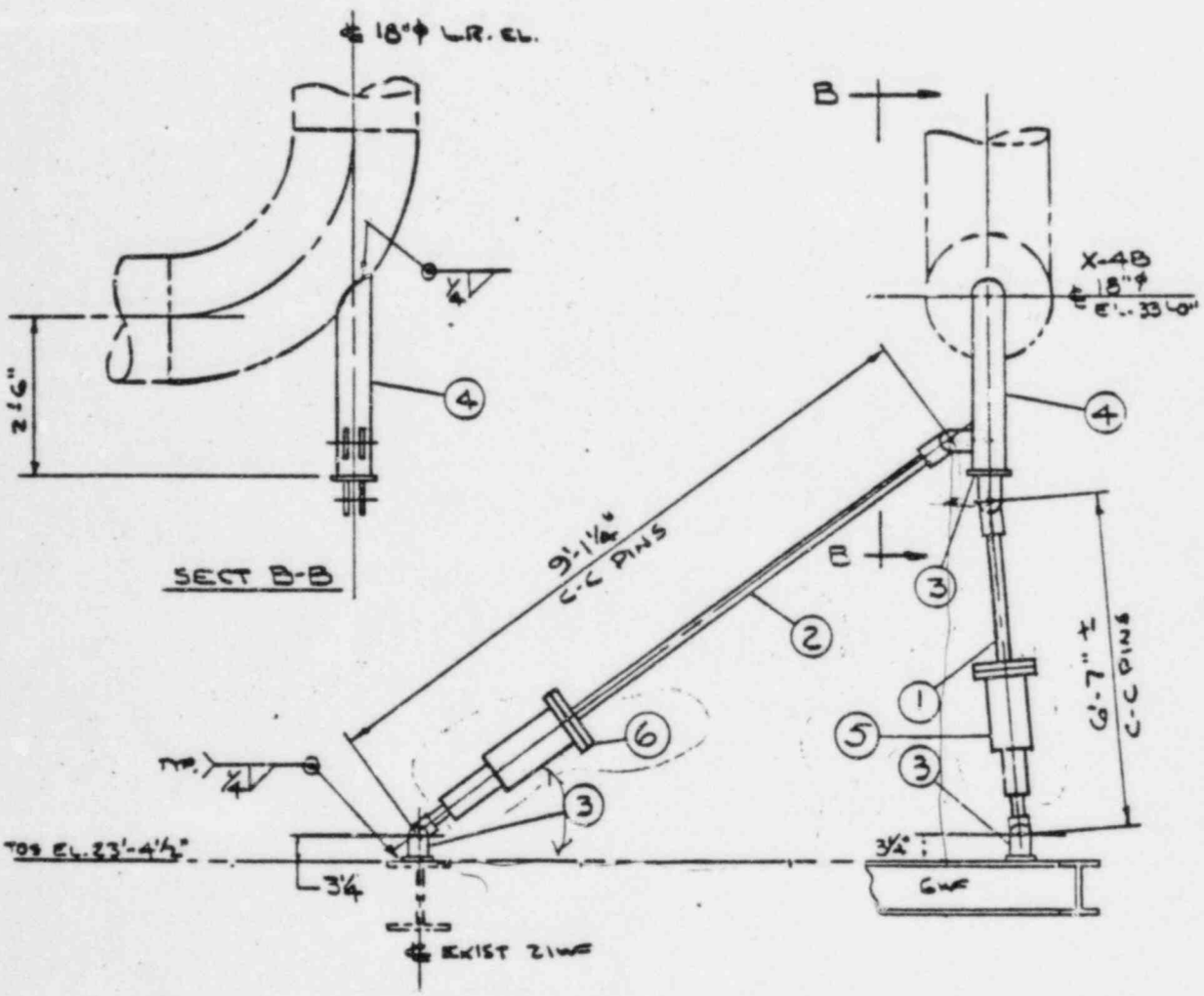
Title: Feedwater support Modification
Calculated by: MJKennedy Date: 7/17/84
Checked by: BJ Date: 7-18-84
Reviewed by: [illegible] Date: 8-22-84

Project: 83-03

Revised Model

Actual Geometry

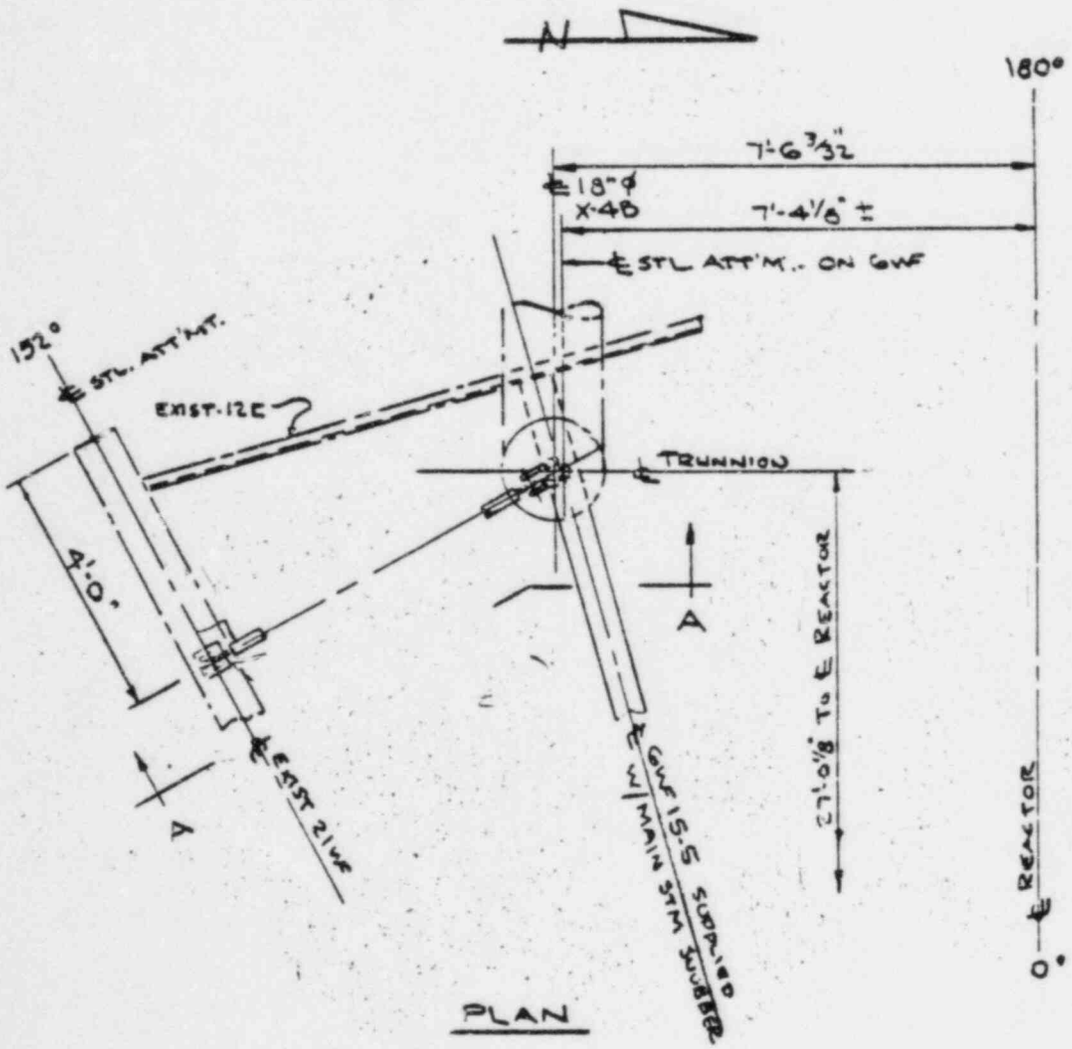
Ref: Bergen-Paterson Dwg 116



Title: Feedwater Support Modification

Calculated by: [illegible] Date: 7/17/84
Checked by: BJ Date: 7-18-84
Reviewed by: JJ Date: 8-22-84

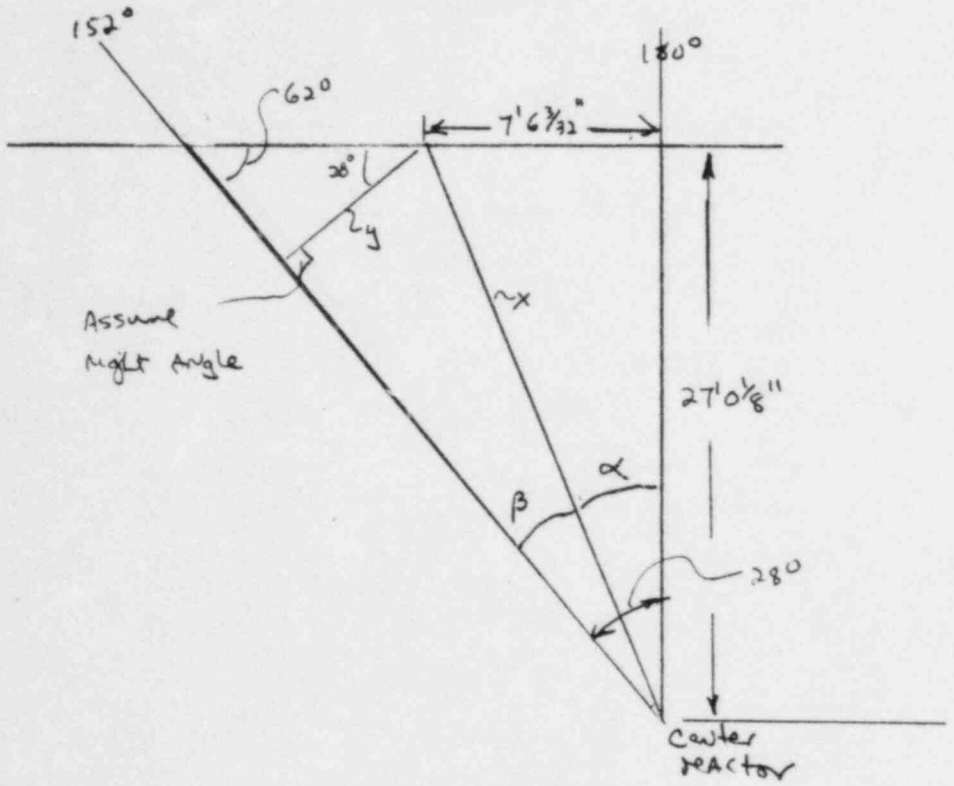
Project: 83-03



Title: Feedwater Support Modification

Calculated by: M Kennedy Date: 7/17/84
Checked by: B J Date: 7-19-84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

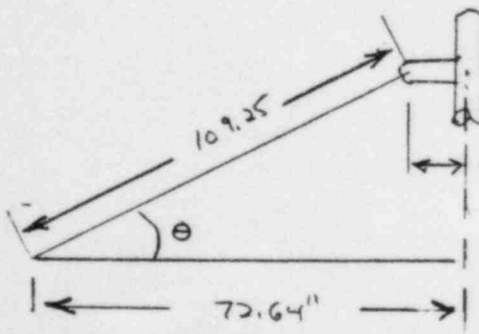


$$\alpha = \tan^{-1} \frac{90.09375}{324.125} = 15.53^\circ$$

$$\beta = 28^\circ - \alpha = 28 - 15.53 = 12.47^\circ$$

$$x = \sqrt{(90.09375)^2 + (324.125)^2} = 336.413$$

$$y = x \sin \beta = 336.413 \sin 12.47 = 72.64''$$



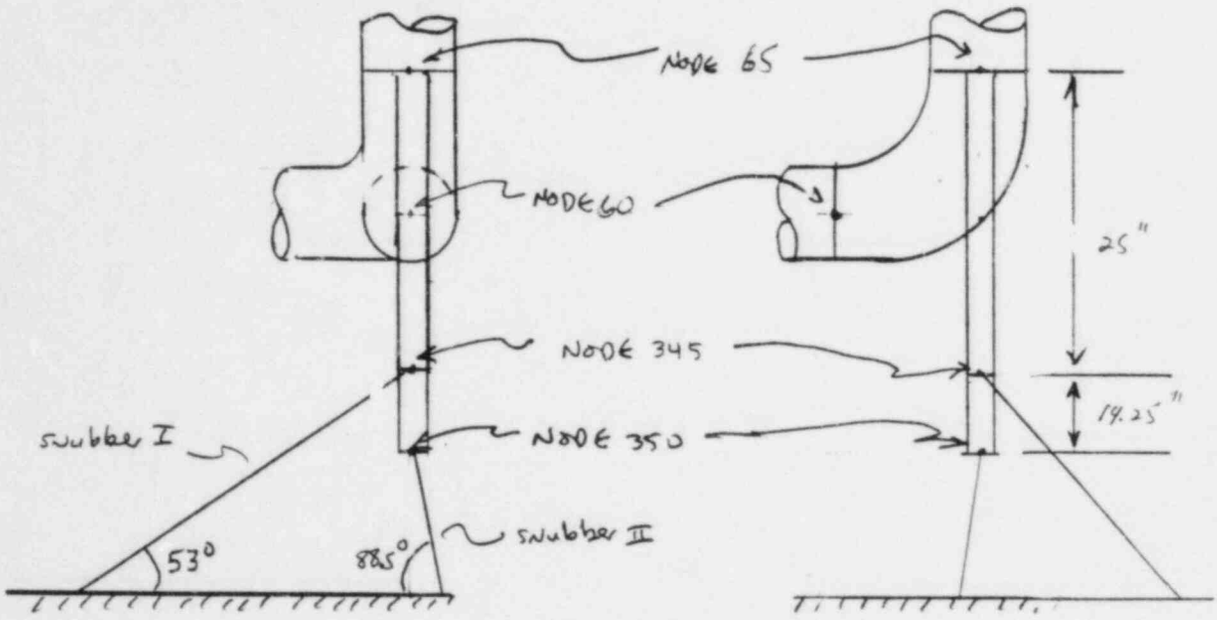
$$\theta = \cos^{-1} \frac{65.5}{109.25} = 53^\circ$$

Bergen-Paterson Part EA2-4

Title: Feedwater Support Modification
Calculated by: [signature] Date: 7/17/84
Checked by: [signature] Date: 7-18-84
Reviewed by: [signature] Date: 8-22-84

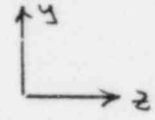
Project: 83-03

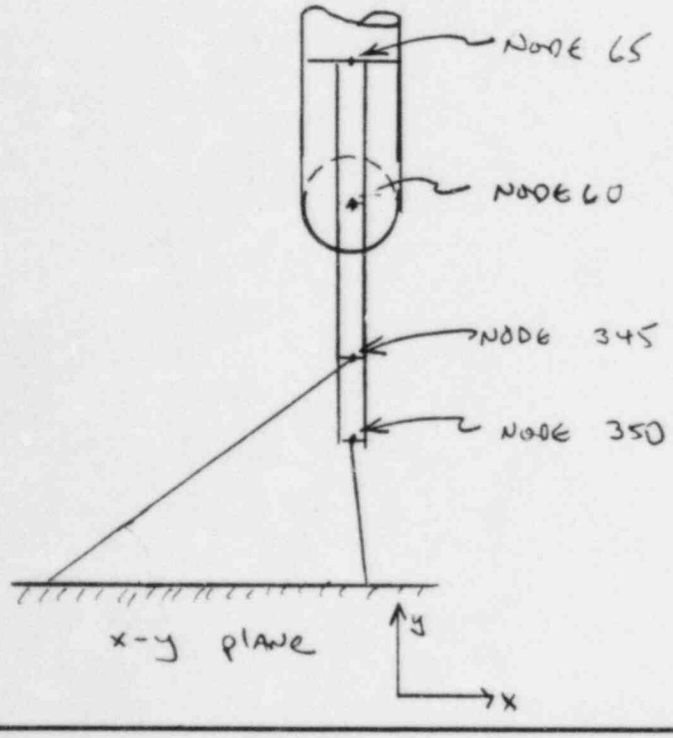
Revised pipe constraint



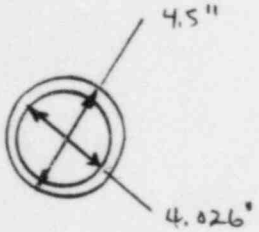
in the plane of the snubber

y-z plane





The elements which run from NODES 65 to 345 AND 345 to 350 have the following pipe properties:



4" ø sch 40

OD = 4.5"
t = .237"

weight = 10.79 lb/ft.
modulus of elasticity = 27.9 x 10^6 PSI *
design pressure = 0.0 psi

Ref: Crane tech paper No. 410
* used in the original EG&G Analyses

Element COORDINATES

	x (ft)	y (ft)	z (ft)
60	0.0	0.0	30.25
65	0.0	2.25	32.5
345	0.0	0.167	32.5
350	0.0	-1.021	32.5

Snubber I

using coordinate offsets from NODE 345

$\Delta x = -\cos 53^\circ \cos 28^\circ = -0.531$
$\Delta y = -\sin 53^\circ = -0.799$
$\Delta z = \cos 53 \sin 28 = 0.283$

$K = 2.5 \times 10^5$ lb/in

Snubber II

at NODE 350, y-direction $K = 2.5 \times 10^5$ lb/in

Attachment 3

MPR ASSOCIATES, INC.
1050 Connecticut Ave., NW – Washington, DC 20036

Title: Drywell Penetrations
Calculated by: M Kennedy Date: 8/1/84
Checked by: B Siegel Date: 8/7/84
Reviewed by: Hamm Date: 8-22-84

Project: SEP P.P.N.S Supports 87-03

Page 1 of 2

Purpose: The purpose of the following calculation is to document the drywell penetration support

Drywell Penetrations: In the initial analyses by EG&G, the drywell penetrations of the main steam and feedwater piping at Oyster Creek were not considered to act as supports. The original models were rerun using NuPIPE II M Version 1.6.1 with radial pipe restraints at the location of the drywell penetration. These restraints are:

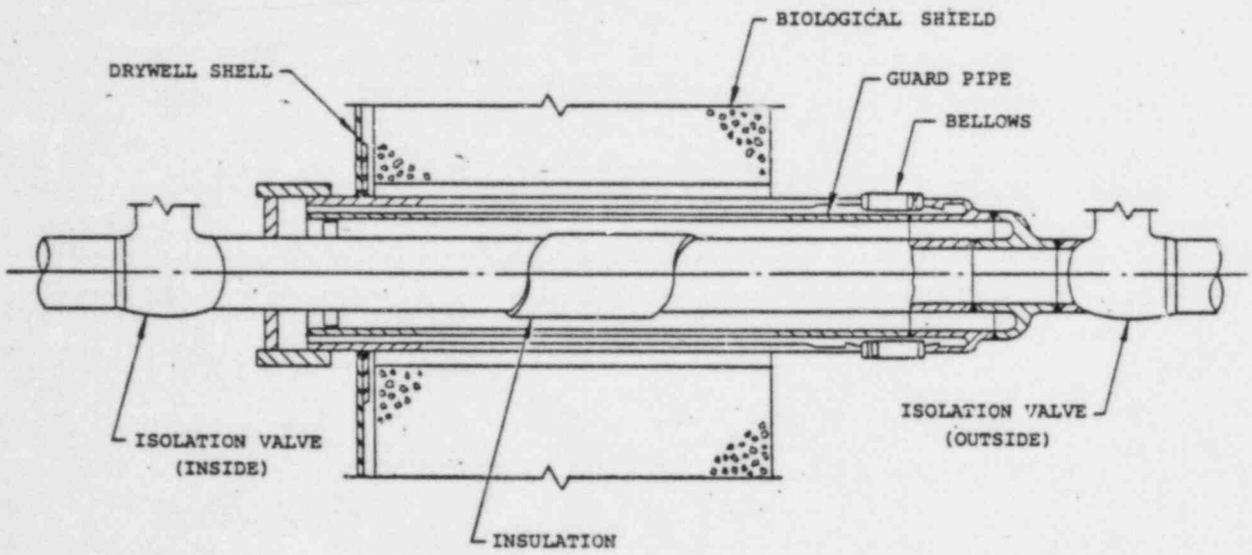
MAIN STEAM

NODE	translation (lb/in)			rotation (in-lb/rad)		
	x	y	z	x	y	z
570	1×10^8	1×10^8	0	0	0	0

feedwater

NODE	translation (lb/in)			rotation (in-lb/rad)		
	x	y	z	x	y	z
55	1×10^8	1×10^8	0	0	0	0

The following figure illustrates the MAIN STEAM AND Feedwater penetration configurations:



Ref: GE Dwg: 112C2866
Oyster Creek FDSAR Figure V-1-1.

The penetration was assumed to be a rigid support $K = 1 \times 10^8$ lb/in

Attachment 4

MPR ASSOCIATES, INC.
1050 Connecticut Ave., NW – Washington, DC 20036

Title: COMPUTER PROGRAM DOCUMENTATION SHEET

Calculated by: _____ Date: _____
Checked by: _____ Date: _____
Reviewed by: _____ Date: _____

Project: 83-03

Page 1 of 1

PROGRAM: Nupipe IIM REVISION: 1.6.1

RUN BANNER: BBCYTUT DATE: 7/18/84

INPUT PREPARED BY: MJ Kennedy DATE: 7/18/84

INPUT CHECKED BY: B Jupfam DATE: 7/19/84

OUTPUT REVIEWED BY: J Johnson DATE: 7/19/84

PROGRAM: Nupipe IIM REVISION: 1.6.1

RUN BANNER: BBCYTVF DATE: 7/18/84

INPUT PREPARED BY: MJ. Kennedy DATE: 7/18/84

INPUT CHECKED BY: B Jupfam DATE: 7/19/84

OUTPUT REVIEWED BY: J Johnson DATE: 7/19/84

PROGRAM: _____ REVISION: _____

RUN BANNER: _____ DATE: _____

INPUT PREPARED BY: _____ DATE: _____

INPUT CHECKED BY: _____ DATE: _____

OUTPUT REVIEWED BY: _____ DATE: _____

APPENDIX B

MPR ASSOCIATES, INC.
1050 Connecticut Ave., NW – Washington, DC 20036

Title: Section III, Div 1, Subsection NF, Allowable Level D stresses
Calculated by: MJKennedy Date: 12/5/83
Checked by: E.C. Ortiz Date: 12/27/83
Reviewed by: J. Johnson Date: 1-3-84
Project: PIPING SUPPORTS 83-03
Page 1 of 8

Purpose The purpose of the following calculation is to document the Allowable Level D stresses for the MAIN STEAM AND feedwater supports.

Reference

(1) ASME Boiler AND Pressure Vessel Code, Section III, Subsection NF - Component Supports, 1980 Edition.
(2) ASME Boiler AND Pressure Vessel Code, Section III Appendicies, 1980 Edition.
(3) AISC Steel Construction MANUAL, 6th Ed.

Approach All structural steel is Assumed to have the material properties of SA-36 carbon steel

S_y = 36.0 KSI yield strength
S_u = 58.0 KSI ultimate strength
$E = 29.2 \times 10^3$ KSI @ 135°F modulus of elasticity

Ref. (2) Table I-7.1
Table I-6.0

Level A Allowables are calculated first to determine the proper Level D allowable.

Nomenclature

C_c = slenderness ratio of compression elements as defined in NF-3322.2
F_a = allowable compressive stress, KSI.
F_b = allowable bending stress, KSI.
F_t = allowable tensile stress, KSI.
F_v = allowable shear stress, KSI.
f_e = Euler stress divided by factor of safety.
K = effective length factor.
S_y = material yield strength
S_u = ultimate strength, KSI.
f_a = computed axial stress, KSI.
f_b = computed bending stress, KSI.
f_v = computed shear stress, KSI.
l = actual unbraced length of member, in.
r = governing radius of gyration, in.

Level A Allowable stresses

TENSION (Net AREA) NF-3322.1 (a) (1)

$$f_t < \begin{cases} 0.60\, S_y = 21.6 \text{ KSI} \\ 0.5\, S_u = 29.0 \text{ KSI} \end{cases}$$

$$f_t = 21.6 \text{ KSI}$$

TENSION (Net AREA w/ PIN Holes) NF-3322.1(a)(2)

$$f_t = 0.45\, S_y = 16.2 \text{ KSI}$$

SHEAR NF-3322.1 (b)(1)

$$f_v = 0.40\, S_y = 14.4 \text{ KSI}$$

SLEAR (coped BEAM) NF-3322.1(b)(2)

$$f_v = 0.30\, S_y = 10.8 \text{ KSI}$$

Compression NF-3322.1 (c) (1), (2)

$$C_c = \sqrt{2\pi^2 E / S_y} = 126.5$$

$$\text{If } \frac{K\ell}{r} < C_c \quad f_a = \frac{\left[1 - (K\ell/r)^2/2C_c^2\right] S_y}{5/3 + \left[3(K\ell/r)/8C_c\right] - \left[(K\ell/r)^3/8C_c^3\right]}$$

$$\text{If } \frac{K\ell}{r} > C_c \quad f_a = \frac{12\pi^2 E}{23(K\ell/r)^2}$$

BENDING NF-3322.1 (d)

$F_b = 0.6 S_y = 24.0$ KSI

Combined Stresses NF-3322.1 (e)

(1) AXIAL COMPRESSION AND BENDING

$$(20)\quad \frac{f_a}{F_a} + \frac{C_{mx} f_{bx}}{(1 - f_a/F'_{ex}) F_{bx}} + \frac{C_{my} f_{by}}{(1 - f_a/F'_{ey}) F_{by}} \leq 1.0$$

$$(21)\quad \frac{f_a}{0.60 S_y} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} \leq 1.0$$

when $f_a/F_a \leq 0.15$

$$(22)\quad \frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} \leq 1.0$$

where $F'_e = \dfrac{12 \pi^2 E}{23 (K l_b / r_b)}$

(2) AXIAL TENSION AND BENDING

Eq (21) above applies

Linear Support TYPE Welds Table - 3324.5(a)-1

allowable shear stress = 21.0 KSI

Level D Allowable Stresses

Tension (Net Area)

$$f_t' = \min \begin{cases} K_s F_t = 2.0\,(21.6) = 43.2 \text{ KSI} \\ 0.7\,S_u = 0.7\,(58.0) = 40.6 \text{ KSI} \end{cases} \rightarrow 40.6 \text{ KSI}$$

Tension (Net Area w/ Pinholes)

$$f_t' = K_s F_t = 2.0\,(16.2) = 32.4 \text{ KSI}$$

Shear

$$f_v' = \min \begin{cases} K_v F_v = 2.0\,(14.4) = 28.8 \text{ KSI} \\ 0.42\,S_u = 0.42\,(58.0) = 24.4 \text{ KSI} \end{cases} \rightarrow 24.4 \text{ KSI}$$

Shear (Coped Beam)

$$f_v' = K_v F_v = 2.0\,(10.8) = 21.6 \text{ KSI}$$

Compression

2/3 Critical Buckling

$$C_c > Kl/r \qquad F_a' = \tfrac{2}{3}\left(1 - \left(\frac{Kl}{r}\right)^2 / 2C_c^2\right) S_y$$

$$C_c < Kl/r \qquad F_a' = \tfrac{2}{3}\,\frac{\pi^2 E}{\left(\frac{Kl}{r}\right)^2}$$

Bending

$$f_b' = \min \begin{cases} K_s F_b = 2.0\,(24.0) = 48.0 \text{ KSI} \\ 0.7\,S_u = 0.7\,(58.0) = 40.6 \text{ KSI} \end{cases} \rightarrow 40.6 \text{ KSI}$$

AXIAL COMPRESSION AND BENDING

USE LEVEL D ALLOWABLES in the denominator of equations (20) (21) AND (22). The compression allowable is limited to 2/3 of the critical buckling stress.

AXIAL TENSION AND BENDING

USE Eq (21) w/ Level D ALLOWABLES

Linear Support Type weld TABLE NF-3623.2-1

$$\text{allowable shear stress} = \min \begin{cases} 2.0\ (21.0) = 42.0\ \text{KSI} \\ 0.42(S_u) = 0.42(58.0) = 24.4\ \text{KSI} \end{cases}$$

$\rightarrow$ 24.4 KSI

MPR ASSOCIATES, INC.
1050 Connecticut Ave., NW – Washington, DC 20036

Title: MAIN STEAM SEISMIC SUPPORTS
Calculated by: M Kennedy Date: 8/1/84
Checked by: R Ferguson Date: 8/9/84
Reviewed by: T Johnson Date: 8-22-84

Project: SEP PIPING SUPPORTS 83-03

PURPOSE: The purpose of the following calculation is to ANALYZE the MAIN STEAM seismic supports for LEVEL D service conditions.[1] LOADS used are from revised EG&G piping model loads documented in Appendix A.

References:

(1) MPR calculation by M. KENNEDY dated 8/2/84 "Seismic Support Loads" – Appendix A.

(2) Bergen-Paterson Pipe Support CATALOG #66 P.46.

(3) CRANE Technical Paper # 10; 1981

(4) AISC Steel Const MANUAL, 6th Ed.

(5) ROARK AND YOUNG, Formulas FOR STRESS AND STRAIN, 5th Ed.

(6) Griffen, HANDBOOK OF FORMULAS FOR STRESS AND STRAIN, 2nd Ed.

(7) AISC Steel Const MANUAL, 8th Ed

(1) The SNUBBER is ANALYZED SEPARATELY in Appendix E. This CALCULATION ANALYZES CLEVISES, WELDS AND structural members supplied with the SNUBBER.

Reference Drawings

Bergen - Paterson

Support	Dwg #
MS - R1A	716A
MS - R2A	717A
MS - R3A	718A
MS - R4A	719A
MS - R5A	720A
X - 2A - SS - 1	111

STANDARD Drawings 64101
64108
602

Burns & Roe Dwg 4069

General Physics Dwg 19442 Sht. 2 of 4

Summary

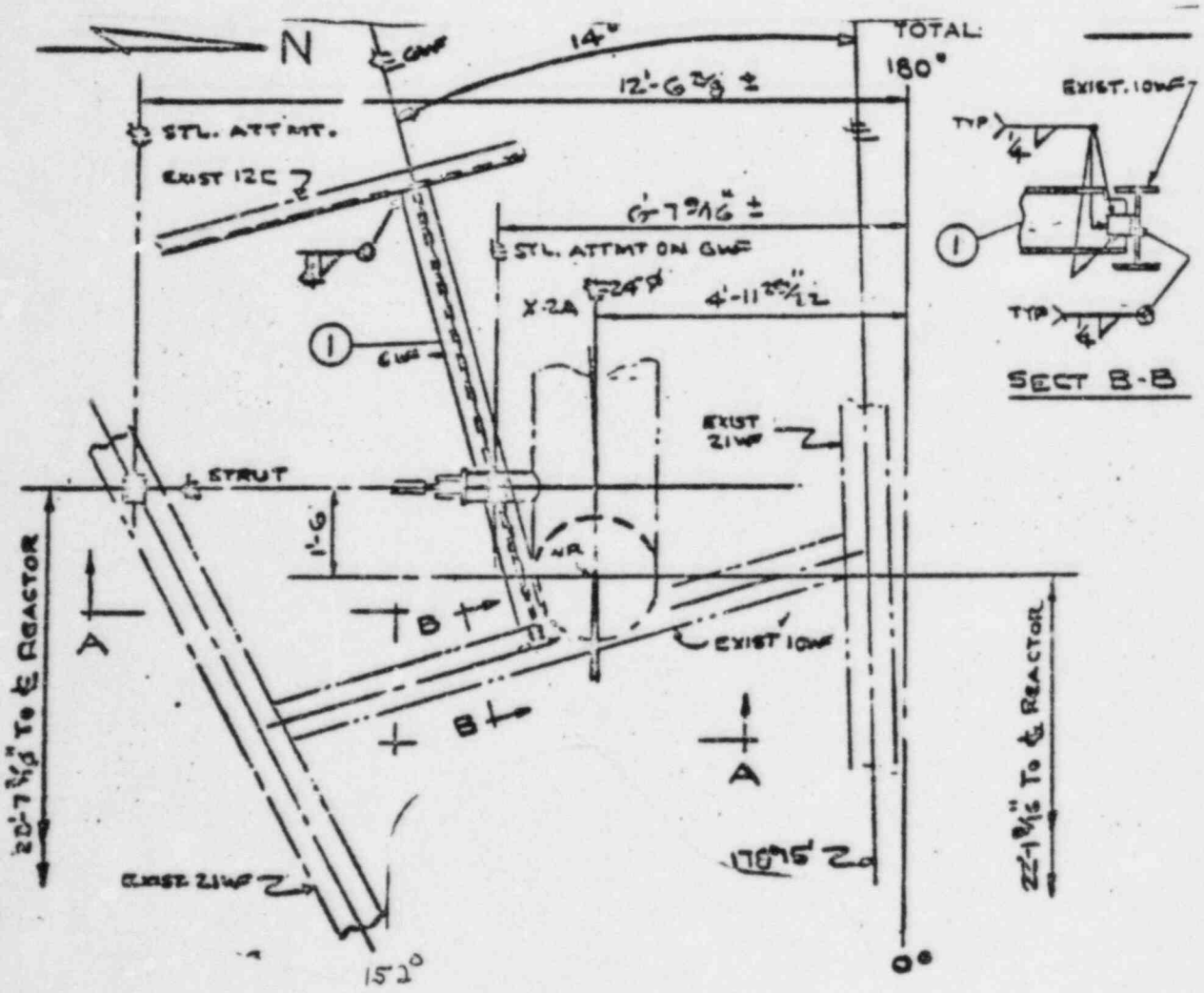
BASED ON the following calculations, ALL MAIN steam supports meet the stress requirements of the 1980 ASME Code, Section III, Subsection NF, A summary table follows each support calculation.

Title: MAIN STEAM Seismic Supports
Calculated by: MJ Kennedy Date: 8/1/84
Checked by: RC Thomas Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

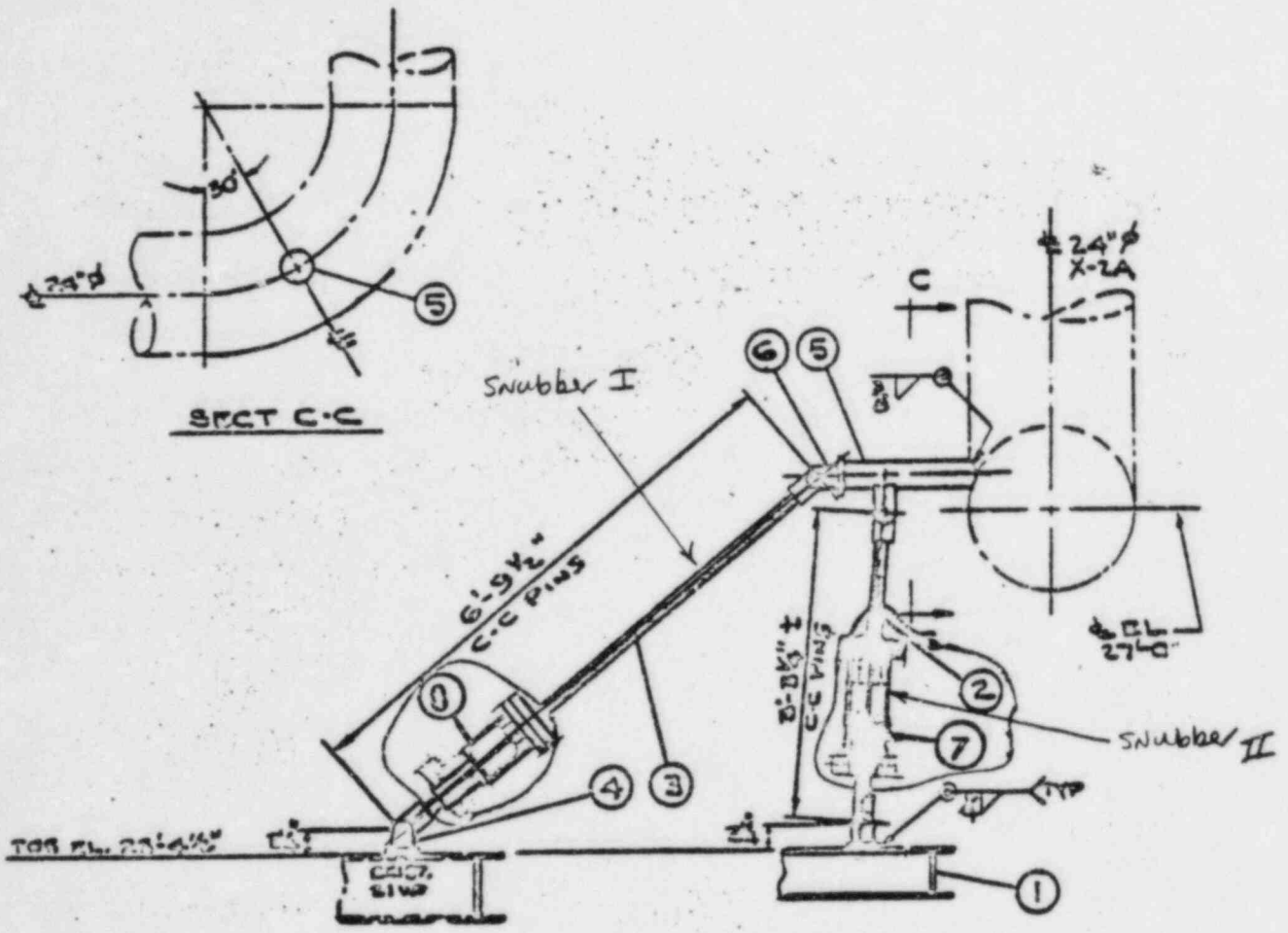
Support MARK No X-2A-55-1

DESCRIPTION



Title: Main Steam Seismic Supports
Calculated by: MJ Kennedy Date: 8/1/84
Checked by: RC Trach Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03



SECT. A-A

P_I = 1200 lb

P_{II} = 3440 lb

Item 5 & 6 Clevis Pipe Assembly

6" Sch 40 Pipe

$I = \pi/64 (d_o^4 - d_i^4) = \pi/64 (6.625^4 - 6.065^4) = 28.142 \text{ in}^4$

$c = 6.625/2 = 3.313 \text{ in}$

$A = \frac{\pi}{4} (d_o^4 - d_i^2) = \pi/4 (6.625^2 - 6.065^2) = 5.581 \text{ in}^2$

AXIAL LOAD = 1,298 lb.
TRANSVERSE LOAD = 4,258 lb
moment LOAD = 86,403 in.lb

} Ref. Computer Run BBC4T4UT P. 310 member 550/620

Tension / compression

$\sigma = AL/A = 1298/5.581 = 233 \text{ PSI} < 40{,}600 \text{ PSI}$ (tension)

$\ell \simeq 7.75"$ $C_c = 126.5$

$r = \frac{\sqrt{d_o^2 + d_i^2}}{4} = \frac{\sqrt{6.625^2 + 6.065^2}}{4} = 2.25"$

$K = 2.0$; $S_y = 36.0$ KSI

} See Section 2 of this Appendix

$F_a' = 2/3 \left(1 - \left(\frac{K\ell}{r}\right)^2 / 2C_c^2\right) S_y$

$= 2/3 \left(1 - \left(\frac{(2.0)(7.75)}{2.25}\right)^2 / 2(126.5)^2\right) 36.0 = 24.0 \text{ KSI}$

$233 \text{ PSI} < 24000 \text{ PSI}$

SHEAR

$f = TL/A = 4258/5.581 = 763$ PSI $<$ 24,400 PSI

BENDING

$b = Mc/I = \frac{86403\ (3.313)}{28.142} = 10,172$ psi

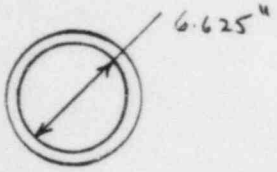
$= 763 + 10,172 = 10,935$ psi $<$ 40,600 psi

AXIAL COMPRESSION AND BENDING

$$\frac{f_a}{F_a'} + \frac{f_b}{F_b'} \leq 1.0$$

$$\frac{233}{24000} + \frac{10,172}{40600} = 0.26 < 1.0$$

Item 5 weld to Main Steam Pipe



Treat weld as line

$A = \pi d \, 5/2$ leg length
$= \pi (6.625) \, 5/2 \, (.375)$
$= 5.519 \text{ in}^2$

$Z = \frac{\pi d^2}{4} \, 5/2$ leg length
$= \pi \frac{(6.625)^2}{4} \, 5/2 \, (.375)$
$= 9.141 \text{ in}^3$

Tension/compression

$\tau_1 = {}^{AL}/_{A} = {}^{1,298}/_{5.519} = 235 \text{ PSI}$

BENDING

$\tau_2 = {}^{M}/_{Z} = {}^{86,403}/_{9,141} = 9,452 \text{ PSI}$

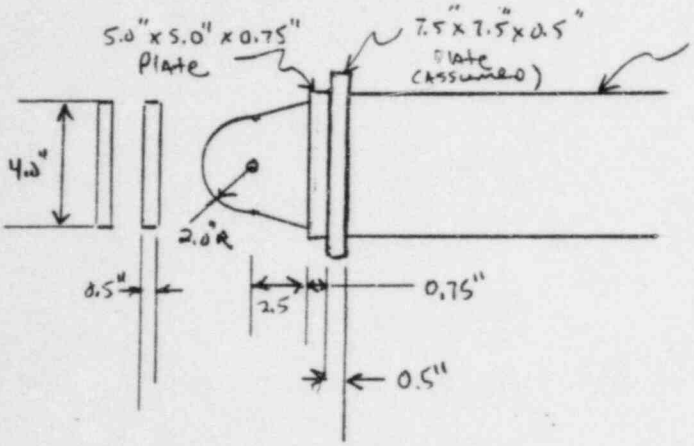
SHEAR

$\tau_3 = {}^{TL}/_{A} = {}^{4,258}/_{5,519} = 772 \text{ PSI}$

$\tau_{net} = \sqrt{(\tau_1 + \tau_2)^2 + \tau_3^2} = \sqrt{(235 + 9452)^2 + (772)^2}$

$= \underline{9,718. \text{ PSI} < 24,400 \text{ PSI}}$

INCLINED SNUBBER CLEVIS ASSEMBLIES (Snubber I)



Item 6 clevis

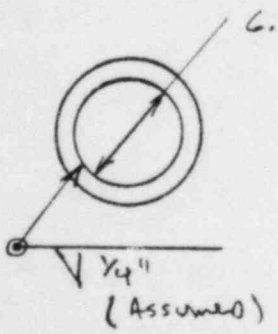
Assume EA 1-A clevis at end of pipe

P_I = 1,200 lb

AXIAL LOAD = 1200 cos 33.6° = 1,000 lb

TRANSVERSE LOAD = 1200 sin 33.6° = 664 lb

6" ϕ Sch 40 Pipe Weld to 7.5" x 7.5" x 0.5" Plate



Weld treated as line

Area = $\pi d \sqrt{2}/2$ leg length

$= \pi (6.625) \sqrt{2}/2 (.25)$

$= 3.679\ in^2$

$Z = \frac{\pi d^2}{4} \sqrt{2}/2$ leg length

$= \frac{\pi (6.625)^2}{4} \sqrt{2}/2 (.25)$

$= 6.094\ in^3$

tension/compression

$\tau_1 = AL/A = 1000/3.679 = 272$ psi

BENDING

$\tau_2 = M/Z = TL \cdot \ell / Z = \frac{664\ (3.75)}{6.094} = 409$ psi

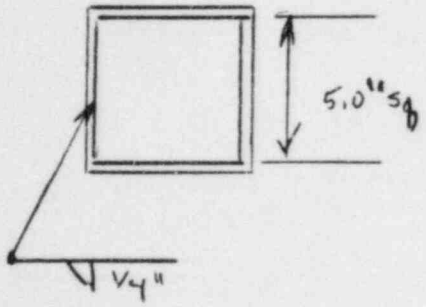
SHEAR

$\tau_3 = TL/A = 664/3.679 = 180$ psi.

$\tau_{net} = \sqrt{(\tau_1 + \tau_2)^2 + \tau_3^2} = \sqrt{(272 + 409)^2 + (180)^2} = 704$ psi

< 24400 psi

clevis base plate weld to 7.5" x 7.5" x 0.5" plate



weld treated as line

Area = 4 s $\sqrt{2}/2$ leg length
= $4(5.0)\sqrt{2}/2\ (.25) = 3.536$ in^2

$Z = \left(s^2 + s^2/3\right)\sqrt{2}/2$ leg length
= $\left(5.0^2 + 5.0^2/3\right)\sqrt{2}/2\ (.25)$
= 5.893 in^3

tension/compression

$\tau_1 = AL/A = 1{,}000/3.536 = 283$ psi

BENDING

$\tau_2 = M/Z = TL \cdot \ell / Z = \frac{664 \cdot (3.25)}{5.893} = 366$ psi

SHEAR

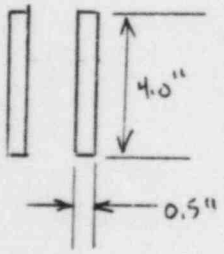
$$\tau_3 = T_L/A = 664/3.536 = 188 \text{ psi}$$

$$\tau_{Net} = \sqrt{(\tau_1+\tau_2)^2 - \tau_3^2} = \sqrt{(283+366)^2+(188)^2}$$

$$= \underline{676 \text{ psi} < 24{,}400 \text{ psi}}$$

Clevis Plate

BENDING AT BASE



$$I = 2\frac{bh^3}{12} = 2\frac{(.5)(4.0)^3}{12} = 5.333 \text{ in}^4$$

$c = 2.0$ in

$A = 2(\ell w) = 2(.5 \cdot 4.0) = 4.0 \text{ in}^2$

$$\sigma = \frac{Mc}{I} = \frac{T_L \ell c}{I} = \frac{664(2.50)2.0}{5.333} = \underline{623 \text{ psi}}$$

$$< 40{,}600 \text{ psi}$$

Pullout SHEAR

$A_{REA} = 2(2rt) = 2(2(2.0)(.5)) = 4.0\ in^2$

$P_I = 1{,}200\ lb$

$f = P_I/A = 1{,}200 / 4.0 =$ **300 PSI < 24,400 PSI**

Bolthole tension

$A_{REA} = 2t(2r - hole\ d) = 2(.5)(2(2.0) - (1 + 1/16)) = 2.938\ in^2$

$f = P_I/A = 1200 / 2.938 =$ **408 PSI < 32 400 PSI**

AXIAL compression

$A_{REA} = min\ A_{REA} = 2t(2r) = 2(.5)(2(2.0)) = 4.0\ in^2$

$f = A_I/A = 1000/4 = 250$ PSI

$l = 2.5"$, $C_c = 126.5$

$r = t/\sqrt{12} = 0.144"$

$K = 2.0$, $S_y = 36$ KSI

} see section 2 of this Appendix

$F_a = 2/3\left(1 - (Kl/r)^2/2C_c^2\right) S_y$

$= 2/3\left(1 - \left(\frac{2(2.5)}{.144}\right)^2 / 2(126.5)^2\right) 36.0 = 23.1$ KSI

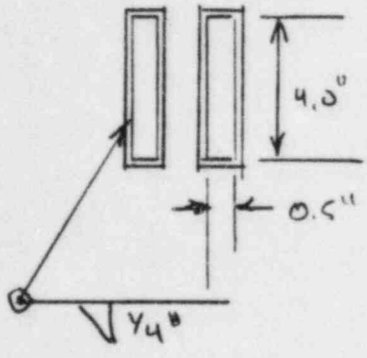
250 PSI < 23100 PSI

AXIAL COMPRESSION + BENDING

$$\frac{f_a}{F_a'} + \frac{f_b}{F_b'} \leq 1.0$$

$$\frac{250}{23100} + \frac{623}{40{,}600} = 0.03 < 1.0$$

CLEVIS PLATE WELD TO BASE PLATE



$$\text{Area} = 2(2R+2W)\,5/16 \text{ leg length}$$
$$= 2(2(4.0)+2(.5))\,5/16\,(.25)$$
$$= 3.182 \text{ in}^2$$

$$Z = 2\left(bd + d^2/3\right)5/16 \text{ leg length}$$
$$= 2(.5(4) + 4^2/3)\,5/16\,(.25)$$
$$= 2.593 \text{ in}^3$$

TENSION / COMPRESSION

$$f_1 = A_L/A = 1000/3.182 = 314 \text{ PSI}$$

BENDING

$$f_2 = \frac{T_L \cdot R}{Z} = \frac{664\ (7.5)}{2.593} = 640 \text{ PSI}$$

SHEAR

$$f_3 = T_L/A = 664/3.182 = 209 \text{ PSI}$$

$$f_{net} = \sqrt{(f_1+f_2)^2 + f_3^2} = \sqrt{(314+640)^2 + (209)^2} = 977 \text{ PSI}$$

$< 24{,}400$ PSI

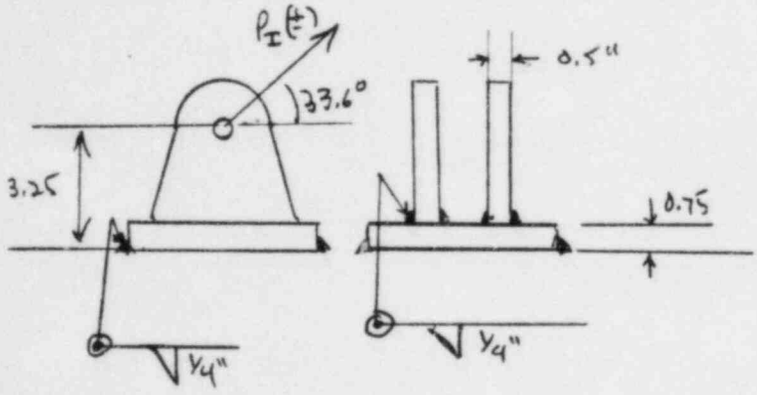
Bolt Shear

$$\text{AREA} = 2\pi\frac{d^2}{4} = 2\pi\frac{(1)^2}{4} = 1.571 \text{ in}^2$$

$$\tau = P_I / A = 1200 / 1.571 = \underline{764 \text{ PSI} < 24,400 \text{ PSI}}$$

Item 4 Clevis AND Bolt STANDARD PART EA 1-A
(SNUBBER I)

Bolt stress same As above



AL = 664 lb
TL = 1,000 lb

Clevis Plate

BENDING AT BASE

$I = 5.333 \text{ in}^4$, $c = 2.0$ in, $A = 4.0 \text{ in}^2$
(see P. 16 of this calculation)

$$\sigma = \frac{Mc}{I} = \frac{T_L \ell c}{I} = \frac{1000 \cdot (2.5)(2.0)}{5.333}$$

$$= \underline{938 \text{ PSI} < 40,600 \text{ PSI}}$$

Pullout Shear & Bolthole tension are same as that calculated for snubber I clevis (item 6)

$\gamma =$ 300 PSI < 24,400 PSI

$\delta =$ 408 PSI < 32,400 PSI

AXIAL compression

$A = 4 in^2$

$\delta = AL/A = \frac{664}{4} =$ 166 PSI < 23,100 PSI

AXIAL compression + bending

$$\frac{Fa}{Fa'} + \frac{Fb}{Fb'} \leq 1.0$$

$$\frac{166}{23,100} + \frac{938}{40,600} = 0.03 < 1.0$$

clevis plate to base plate weld

$A = 3.182 in^2$, $Z = 2.593 in^3$

tension / compression

$\gamma_1 = AL/A = 664/3.182 =$ 209 PSI

BENDING

$\gamma_2 = \frac{TL}{Z} = \frac{1000\ (2.5)}{2.593} =$ 964 PSI

SHEAR

$\tau_3 = T_L/A = 1000/3.182 = 314$ PSI

$\tau_{net} = \sqrt{(\tau_1 + \tau_2)^2 + \tau_3^2} = \sqrt{(209 + 964)^2 + (314)^2}$

$= \underline{1{,}214 \text{ PSI} < 24{,}400 \text{ PSI}}$

BASE PLATE weld to existing 21 WF I-BEAM

$A = 3.536 \text{ in}^2 \qquad Z = 5.893 \text{ in}^3$

tension/compression

$\tau_1 = A_L/A = 664/3.536 = 188$ PSI

BENDING

$\tau_2 = M/Z = \frac{T_L \ell}{2} = \frac{1000\ (3.25)}{5.893} = 552$ PSI

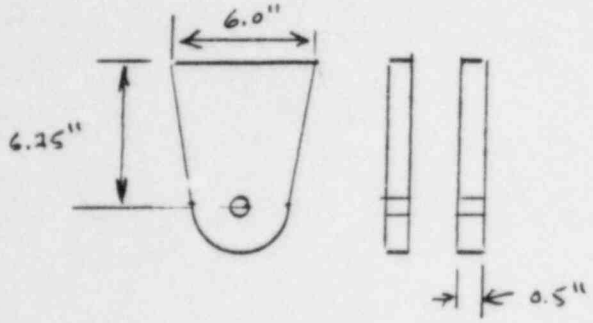
SHEAR

$\tau_3 = T_L/A = \frac{1000}{3.536} = 283$ PSI

$\tau_{net} = \sqrt{(\tau_1 + \tau_3)^2 + \tau_3^2} = \sqrt{(188 + 552)^2 + (283)^2}$

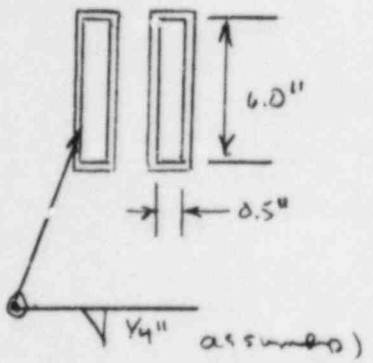
$= \underline{792 \text{ PSI} < 24{,}400 \text{ PSI}}$

Vertical snubber clevis assembles (Snubber II)



Assume STANDARD
EA 2-A clevis attachment

6"ø S/40 PIPE TO clevis PLATE weld



AREA = $2(2R+2W)\sqrt{3}/2$ leg length
$= 2(2(6.0)+2(.5))\sqrt{3}/2\ (.25)$
$= 4.596\ in^2$

tension / compression

$\tau_{net} = \tau_1 = P_{II}/A = 3440/4.596 = 748\ PSI < 24400\ PSI$

clevis plate

Pullout shear

$AREA = 2(2rt) = 2(2(2.0)(.5)) = 4.0 in^2$

$P_{II} = 3,440$ lb.

$f = P_{II}/A = 3440/4 = \underline{860 \text{ PSI} < 24,400 \text{ PSI}}$

Bolthole tension

$AREA = 2t(2r - \text{hole } d) = 2(.5)(2(2.0) - (1 + 1/16)) = 2.938 in^2$

$\sigma = P_{II}/A = 3440/2.938 = \underline{1171 \text{ PSI} < 32,400 \text{ PSI}}$

Axial compression or tension

$AREA = \text{min } AREA = 2t(2r) = 2(.5)(2(2.0)) = 4 in^2$

$\sigma = P_{II}/A = 3440/4 = \underline{860 \text{ PSI} < 40,600 \text{ PSI}}$ (TENSION)

$l = 6.25"$, $C_c = 126.5$
$r = t/\sqrt{12} = 0.144"$
$K = 2.0$, $S_y = 36 \text{ KSI}$

See Appendix B

$F_a = 2/3\left(1 - \left(\frac{Kl}{r}\right)^2 / 2C_c^2\right) S_y$

$= 2/3\left(1 - \left(\frac{2(6.25)}{.144}\right)^2 / 2(126.5)^2\right) 36 = 18.4 \text{ KSI}$

$\underline{860 \text{ PSI} < 18400 \text{ PSI}}$

Bolt shear

$$A = 2\frac{\pi d^2}{4} = \frac{\pi (1)^2}{2} = 1.571 \text{ in}^2$$

$$\tau = P_{II}/A = 3440/1.571 = \underline{2,190 \text{ PSI} < 24,400 \text{ PSI}}$$

Item 4 Clevis and Bolt Standard Part EA1-A

(Snubber II)

Bolt shear, pullout shear, and bolthole tension are same as above for the EA2-A part.

Axial compression

$$\text{Area} = 4.0 \text{ in}^2 \quad \sigma = P_{II}/A = 3440/4 = 860 \text{ PSI}$$

$$\underline{860 \text{ PSI} < 23,100 \text{ PSI}}$$

clevis plate to base plate weld

$$A = 3.182 \text{ in}^2$$

tension / compression

$$\tau_{Net} = \tau_1 = P_{II}/A = 3,440/3.182 = \underline{1,081 \text{ PSI} < 24,400 \text{ PSI}}$$

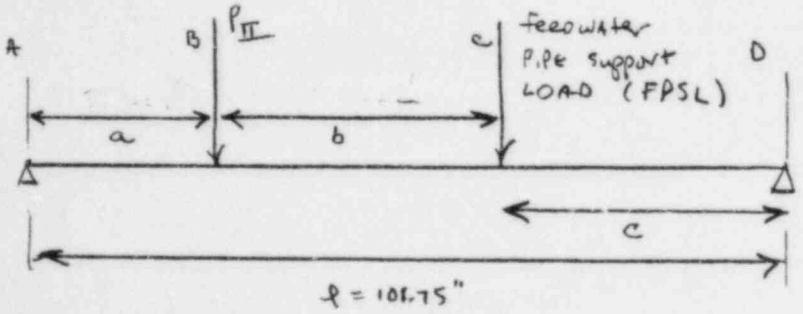
base plate weld to 6 WF 15.5 I-BEAM

$$A = 3.536 \text{ in}^2$$

tension / compression

$$\tau_{Net} = \tau_1 = P_{II}/A = 3,440/3.536 = \underline{973 \text{ PSI} < 24,400 \text{ PSI}}$$

Item 1 6WF 15.5 I-BEAM



P_{II} = 3,440 lb

FPSL = 2,340 lb

a = 33.2"
b = 41.8"
c = 26.75"
a+b = 75.0"
b+c = 68.55"

MOMENT

LOCATION A

M_A = 0

LOCATION D

M_D = 0

LOCATION B

$$M_B = \frac{P_{II}\, a(b+c)}{\ell} + \frac{FPSL\, c(\ell-(b+c))}{\ell}$$

$$= \frac{3440\,(33.2)(68.55)}{101.75} + \frac{2340\,(26.75)(33.2)}{101.75}$$

= 97,367 in. lb.

Location C

$$M_C = \frac{F_{PSL}\, c(b+a)}{\ell} + \frac{P_{II}\, a(\ell-(b+a))}{\ell}$$

$$= \frac{2340(26.75)(75.0)}{101.75} + \frac{3440(33.2)(26.75)}{101.75}$$

$$= 76,164 \text{ in.lb.}$$

$$R_A = \frac{P_{II}(\ell-a)}{\ell} + \frac{F_{PSL}\, c}{\ell} =$$

$$= \frac{3440(68.55)}{101.75} + \frac{2,340(26.75)}{101.75} = 2,933 \text{ lb}$$

$$R_D = \frac{P_{II}\, a}{\ell} + \frac{F_{PSL}(\ell-c)}{\ell} =$$

$$\frac{3440(33.2)}{101.75} + \frac{2340(75.0)}{101.75} = 2,847 \text{ lb}$$

BEAM Stress

$I = 30.3 \text{ in}^4$, $c = 3.0$ in

$A = 4.62 \text{ in}^2$

Shear Area $= 6.0(.25) = 1.5 \text{ in}^2$

BENDING

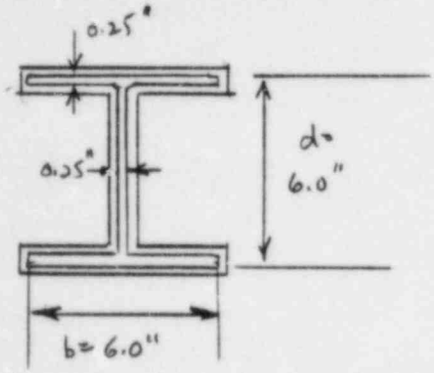
$$\sigma = \frac{Mc}{I} = \frac{97,367\ (3.0)}{30.3}$$

$$= 9,640 \text{ PSI} < 40,600 \text{ PSI}$$

SHEAR

$$\tau = \frac{V}{A} = \frac{2,933}{1.5} = 1,955 \text{ PSI} < 21,600 \text{ PSI}$$

Item 1 weld to Existing 12 C



TREAT WELD AS A LINE

AREA = Perimeter $\sqrt{2}/2$ Reg length

$= \{4(6.0) + 2(5.75)\}\sqrt{2}/2\,(.25)$

$= 6.276\ in^2$

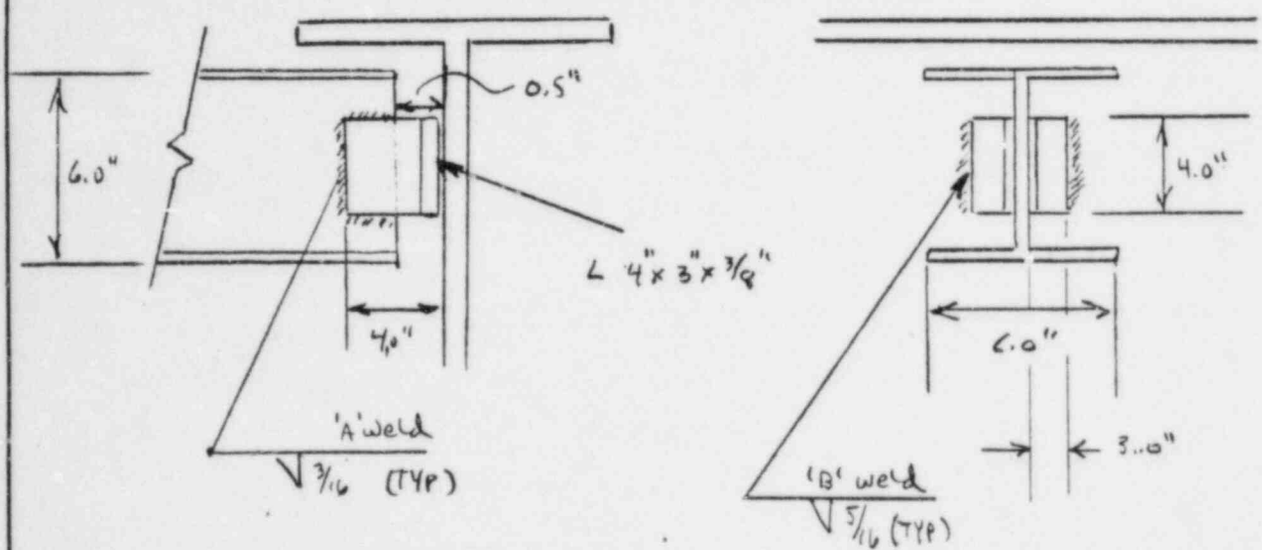
SHEAR

$$\tau_3 = \frac{R_D}{A} = \frac{2847}{6.276} = 454\ psi < 24{,}400\ psi$$

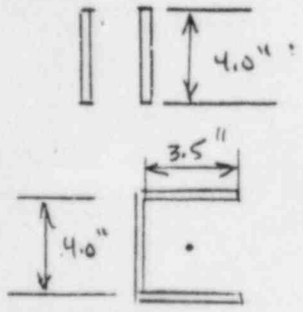
Title: MAIN STEAM SEISMIC SUPPORTS
Calculated by: MJ Kennedy Date: 8/1/84
Checked by: RC Tauch Date: 8/7/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

Item 1 weld to Existing 10 WF



'A' weld



TREAT weld AS LINE

for TOP & Bottom welds

$A = \not{2}\, l\, t\, \sqrt{2}/\not{2}$

$= 3.5\,(3/16)\,\sqrt{2} = 0.928\ in^2$

for side weld

$A = l\, t\, \sqrt{2}/2$

$= 4(3/16)\,\sqrt{2}/2 = 0.53\ in^2$

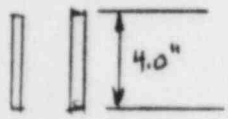
$\Sigma A = 2(0.53 + 0.928) = 2.916\ in^2$

SHEAR

$\tau_{Net} = \tau_3 = R_A / A = 2933 / 2.916 =$ **1,005 PSI**

< **24400 PSI**

'B' Weld



$A = 2\ell \sqrt{3}/2\, t$
$= 2(4.0)\sqrt{3}/2\ 5/16$
$= 1.768\ in^2$

SHEAR

$\tau_{Net} = \tau_3 = R_A / A = 2933 / 1.768 =$ **1,659 PSI**

< **24,400 PSI**

Support X-2A-55-1 Summary Table

Item	TYPE OF STRESS	Calculated Stress (PSI)	Allowable Stress (PSI)
Item 5 & 6	Axial Compression	233	24,000
	SHEAR	763	24,400
	BENDING	10,935	40,600
	Axial comp. & BENDING	0.26 (Note 1)	1.0 (Note 1)
Item 5 weld to MS PIPE	SHEAR	9,718	24,400
PIPE weld to PIPE Plate	SHEAR	704	24,400
BASE PLATE Weld to PIPE Plate	SHEAR	676	24,400
Snubber I clevis	BENDING	623	40,600
	Pullout SHEAR	300	24,400
	Bolthole tension	408	32,400
	Axial compression	250	23,100
	Axial comp. & BENDING	0.03 (Note 1)	1.0 (Note 1)
Clevis Plate Weld to BASE Plate	SHEAR	977	24,400

Summary Table (Cont.)

Item	TYPE OF STRESS	CALCULATED STRESS (PSI)	ALLOWABLE STRESS (PSI)
Snubber I Bolts	SHEAR	764	24,400
Item 4 for Snubber I	BENDING	938	40,600
	AXIAL COMPRESSION	766	23,100
	AXIAL COMP & BENDING	0.03 (NOTE 1)	1.0 (NOTE 1)
clevis Plate weld to BASE Plate	SHEAR	1,214	24,400
BASE Plate weld to I-BEAM	SHEAR	792	24,400
PIPE TO clevis Plate weld	SHEAR	748	24,400
Bolt	SHEAR	2,190	24,400
clevis Plate	Pullout SHEAR	860	24,400
	Bolt Lolp TENSION	1,171	32,400
	AXIAL compression	860	18,400

Summary Table (cont.)

Item	TYPE OF STRESS	Calculated stress (PSI)	Allowable stress (PSI
Item 4 for Snubber II	AXIAL COMPRESSION	860	23,100
clevis plate to base plate weld	SHEAR	1,081	24,400
BASE PLATE to 6WF I-BEAM weld	SHEAR	973	24,400
Item 1 I-BEAM 6WF15.5	BENDING	9,640	40,600
	SHEAR	1,955	21,600
Item 1 weld to channel	SHEAR	454	24,400
Item 1 weld to I-BEAM (COPED END)	SHEAR	1,654	24,400

Notes

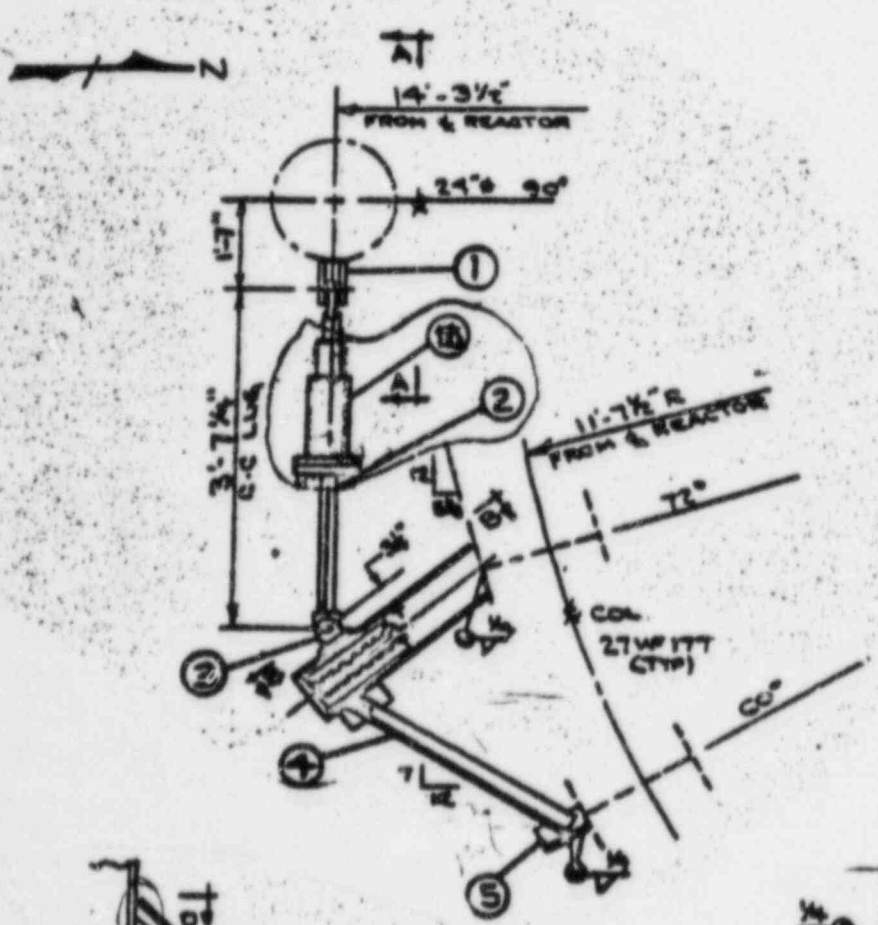
(1) Value is not stress in PSI but stress ratio (NON-DIMENTIONAL).

Title: MAIN STEAM Seismic Supports
Calculated by: MK Date: 8/1/84
Checked by: RC Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

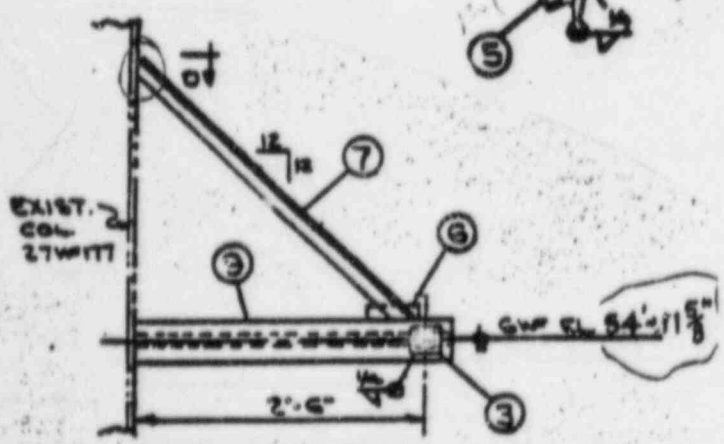
Project: 83-03

Support MS R1A

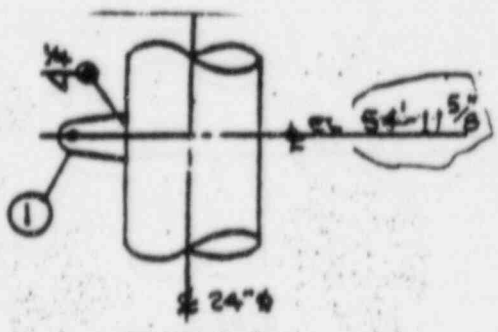
DESCRIPTION



Snubber load
P = 5,170 lb.
Ref (1)



SECT. B-B



SECT. A-A

Item 1 Clevis & Bolt STANDARD PART EA2-A

make 'A' dim = 8.0"
make 'B' dim = 9.0"

Bolt rated to 10,000 lb Ref (2)

Actual LOAD 5,170 lb Ref (1)

No bending moments on the clevis

Axial compression

let AREA = minimum AREA = $2tw = 2(1.5)(4.0) = 4.0\ in^2$

$$\sigma = \frac{P}{A} = \frac{5170}{4} = 1293\ psi$$

$\ell \cong 8.0$ in ; $C_c = 126.5$

$r = t/\sqrt{12} = 0.5/\sqrt{12} = 0.144$

$K = 1.0$; $S_y = 36.0$ KSI

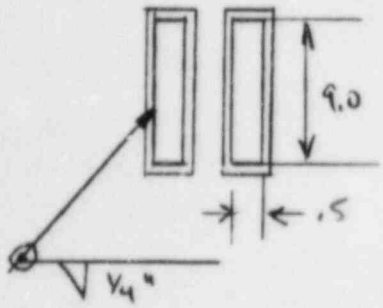
} see Appendix B

$$F_a = \frac{2}{3}\left(1 - \left(\frac{K\ell}{r}\right)^2 / 2C_c^2\right) S_y$$

$$= \frac{2}{3}\left(1 - \left(\frac{1.0(80)}{.144}\right)^2 / 2(126.5)^2\right) 36.0 = 14.7\ KSI$$

1,293 psi < 14,700 psi

Item 1 weld to MAIN steam Pipe



TREAT weld AS LINE

$$\text{AREA} = 2(2l + 2w)\tfrac{\sqrt{2}}{2}\,\text{leg length}$$

$$= 2(2(9.0) + 2(.5))\tfrac{\sqrt{2}}{2}(.25)$$

$$= 6.718\ in^2$$

SHEAR

$$\tilde{\tau}_{wet} = \tau_3 = P/A = \frac{5170}{6.718} = \underline{770\ PSI}$$

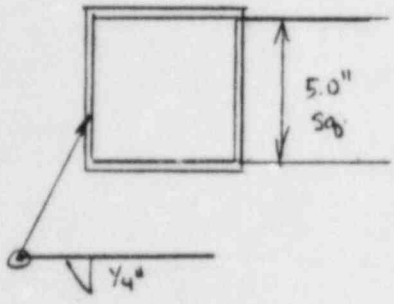
$< 24\,400$ PSI

Item 3 Clevis & Bolt STANDARD PART EA1-A

Rated to 10,000 lb Ref: (2)

Actual load 5170 lb

Item 3 weld to Item 9



TREAT WELD AS LINE

AREA = 4 s $\sqrt{2}/2$ leg length

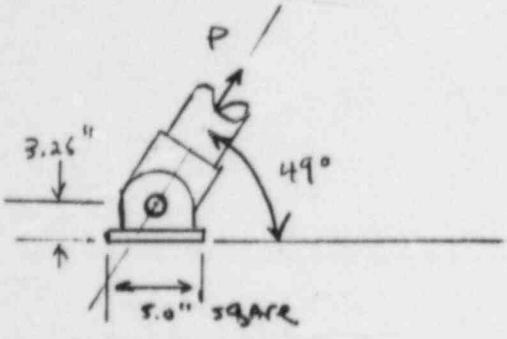
$= 4(5.0)\sqrt{2}/2\,(.25)$

$= 3.535\ in^2$

$Z = (s^2 + \frac{s^2}{3})\frac{\sqrt{2}}{2}$ leg length

$= (5^2 + 5^2/3)\sqrt{2}/2\,(.25)$

$= 5.893\ in^3$



tension / compression

$$\tau_1 = \frac{P\cos 41}{A} = \frac{5170(\cos 41)}{3.535} = 1104\ PSI$$

bending

$$\tau_2 = \frac{LP\sin 41}{Z} = \frac{(3.25)(5170)\sin 41}{5.893}$$

$= 1871\ PSI$

SHEAR

$$\tau_3 = \frac{P\sin 41}{A} = \frac{5170\sin 41}{3.535} = 959\ PSI$$

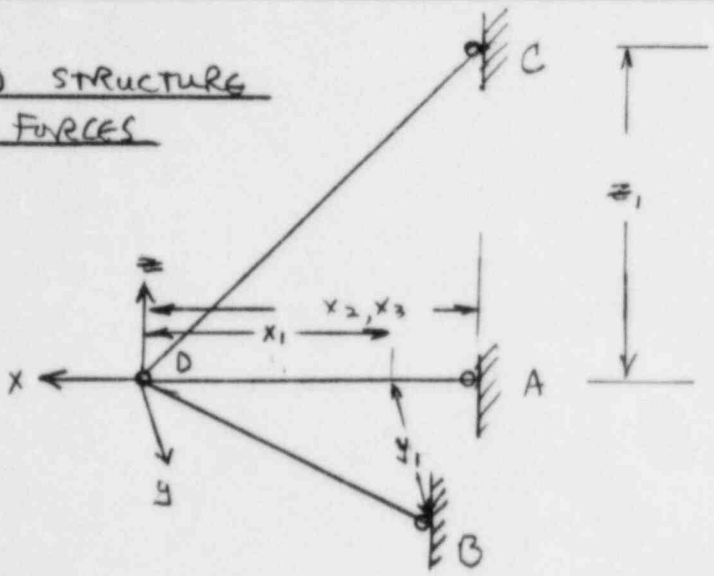
$$\tau_{net} = \sqrt{(\tau_1+\tau_2)^2 + \tau_3^2} = \sqrt{(1104+1871)^2 + (959)^2} = 3{,}126\ PSI$$

< 24,400 PSI

Title: MAIN Steam Seismic Supports
Calculated by: JWKennedy Date: 8/1/84
Checked by: RCTaylor Date: 8/9/84
Reviewed by: JJ Date: 8/22/84

Project: 83-03

TRIPOD STRUCTURE
BEAM FORCES



BEAMS SEE LOAD IN TENSION/COMPRESSION ONLY

Method of tension coefficients

$W_x = 33921b$; $W_y = 3902 lb$; $W_z = 0.0$

$$x_1 t_{BD} + x_2 t_{AD} + x_3 t_{CD} + W_x = 0$$

$$y_1 t_{BD} + W_y = 0$$

$$z_g t_{CD} + W_z = 0 \longrightarrow t_{CD} = 0$$

$x_1 = -33.0 \cos 60 = -16.5$ "

$x_2 = -30.0$ "

$x_3 = -30.0$ "

$y_1 = 33.0 \sin 60 = 28.579$ "

$z_g = 38.0 \sin 45 = 26.870$ "

$W_z = 0 \quad \therefore t_{CD} = 0$

$$t_{BD} = -\frac{W_y}{y_1} = \frac{-3,902}{28.579} = -137 \text{ lb/in}$$

$$y_1 \, t_{BD} \quad x_2 \, t_{AD} + W_x = 0$$

$$-16.5 \, (-137) + -30.0 \, t_{AD} + 3392 = 0$$

$$t_{AD} = 188 \text{ lb/in}$$

$$F_{BD} = \overline{BD} \, t_{BD} = 33.0 \, (-137) = -4,521 \text{ lb.}$$

$$F_{AD} = \overline{AD} \, t_{AD} = 30.0 \, (188) = 5,640 \text{ lb}$$

BEAM AD – Item 9 6WF 15.5 I-BEAM

$I = 30.3 \text{ in}^4$, $c = 3.0''$, $A = 4.62 \text{ in}^2$

pp. 1-21, Ref (4).

tension / compression

$$\sigma = \frac{F_{AD}}{A} = \frac{5640}{4.62} = 1,221 \text{ PSI} < 40,600 \text{ PSI}$$

(tension)

$\ell = 30.0$ in ; $C_c = 126.5$

$r = 1.45$"

Ref (4) p 1-21

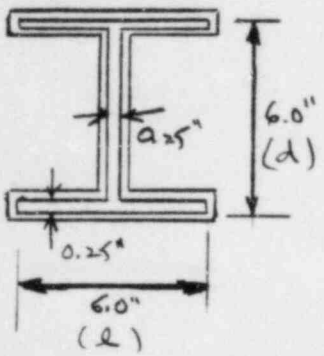
} see Appendix B

$K = 1.0$, $S_y = 36.0$ KSI

$$F_a = \frac{2}{3}\left(1 - \left(\frac{K\ell}{r}\right)^2 / 2C_c^2\right) S_y = 23.7 \text{ KSI}$$

1,221 psi < 23,700 psi

Item 9 weld to existing Col 27 WF 177



TREAT weld AS LINE

$A_{WELD} = (2d + 2l + 2(l-.25))\frac{\sqrt{2}}{2}$ leg length

$= (2(6.0) + 2(6.0) + 2(5.75))\frac{\sqrt{2}}{2}(.25)$

$= 6.276\ in^2$

tension / compression

$f_{net} = f_1 = P/A = \frac{5,640}{6.276} = 899\ PSI < 24,400\ PSI$

Item 4 (BEAM BD) 2 - L 3" x 3" x 0.25"

$Area = 2(l_1 w_1 + l_2 w_2)$

$= 2((2)(.25) + (3.0-.25)(.25)) = 2.375\ in^2$

tension / Compression

$f = \frac{F_{BD}}{A} = \frac{4,521}{2.375} = 1,904\ PSI < 40,600\ PSI$ (tension)

$l = 28.5"$ $\quad C_c = 126.5$

$r = 0.43"$

Ref (4) p 1-33 (Axis z-z)

$K = 1.0$, $S_y = 36.0$

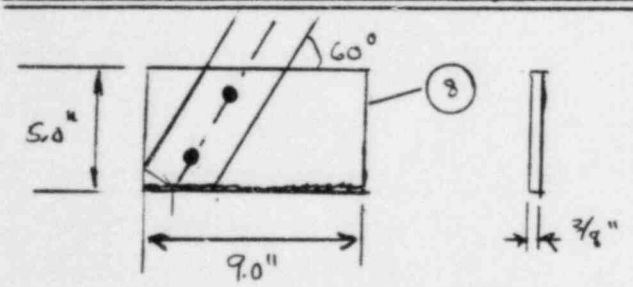
} See Appendix B

$$f_a = \frac{2}{3}\left(1 - \frac{(Kl/r)^2}{2C_c^2}\right) S_y$$

$$= \frac{2}{3}\left(1 - \frac{\left(\frac{1.0(28.5)}{.43}\right)^2}{2(126.5)^2}\right) 36.0 = 20.7 \text{ KSI}$$

1,904 psi < 20,700 PSI

Item 8 Plate 9" x 3/8" x 5" w/ (2) 3/4" ϕ x 3" Lg B&N



Item 8 weld to 6 WF 15.5 I-BEAM (assume 1/4" fillet)

AREA = Perimeter $\frac{\sqrt{2}}{2}$ leg length

$$= 2(l+w)\frac{\sqrt{2}}{2}(1/4) = 2(9+3/8)\frac{\sqrt{2}}{2}(1/4) = 3.315 \text{ in}^2$$

τ_1 = compression / tension = $\frac{F_{BD}\ 5.060}{A} = \frac{+4521\ 5.060}{3.315} = 1181$ PSI

τ_3 = shear = $\frac{F_{BD}\cos 60}{A} = \frac{4521 \cos 60}{3.315} = 682$ PSI

$\tau_{net} = \sqrt{\tau_1^2 + \tau_3^2} = \sqrt{(1181)^2 + (682)^2} = 1364$ PSI < 24,400 PSI

Item 8 PLATE stresses

Net Area = $(\ell - \text{hole } d)\, w = (9 - (3/4 + 1/16))\ 3/8 = 3.070\ in^2$

tension/compression

$$\sigma = \frac{f_{BD} \sin 60}{A} = \frac{4521 \sin 60}{3.070} = \underline{1275\ PSI < 32,400}$$

SLEAR

$$\tau = \frac{f_{BD} \cos 60}{A} = \frac{4521 \cos 60}{3.070} = \underline{736\ PSI < 24,400\ PSI}$$

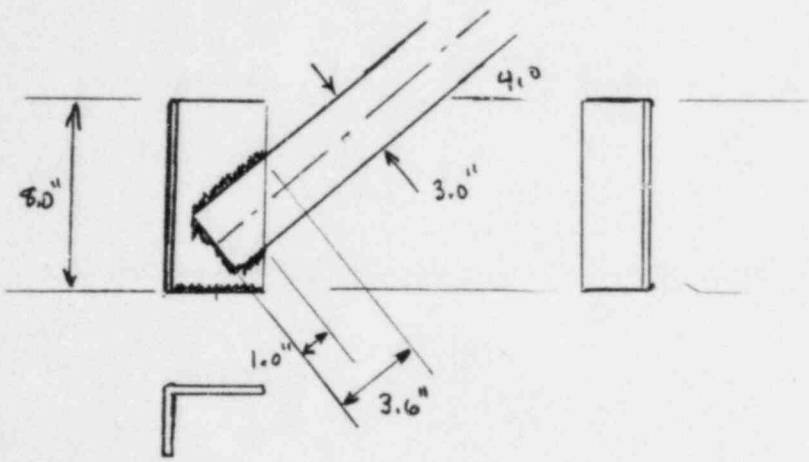
Bolts

Double SLEAR

$$A = 4\left(\frac{\pi}{4} d^2\right) = \pi (3/4)^2 = 1.767\ in^2$$

$$\tau = \frac{f_{BD}}{A} = \frac{4521}{1.767} = \underline{2,559\ PSI < 24,400\ PSI}$$

Item 5 L 4" x 3" x 3/8" x 8" LG



Item 4 weld to Item 5 PLATE

Est. Area = Perimeter $\frac{\sqrt{2}}{2}$ leg length

$= 2(3.0 + 1.0 + 3.6)\frac{\sqrt{2}}{2}(.25) = 2.687\ in^2$

$\tau_{net} = \frac{F_{BD}}{A} = \frac{4521}{2.687} =$ **1,683 PSI < 24,400 PSI**

Item 5 PLATE stress

$Area = \ell w + \ell' w' = 4 \times 3/8 + (3 - 3/8) \times 3/8 = 2.484\ in^2$

tension / compression

$\sigma = \frac{F_{BD}\ \sin 41}{A} = \frac{4,521\ \sin 41}{2.484} =$ **1,194 PSI < 32,400 PSI**

Shear

$\tau = \frac{F_{BD}\ \cos 41}{A} = \frac{4,521\ \cos 41}{2.484} =$ **1,314 PSI < 24,400 PSI**

Item 5 plate weld to existing 21 WF 277 I-BEAM

Area = Perimeter $\frac{\sqrt{2}}{2}$ leg length

$= \left(\ell + w + 2t + (\ell - t) + (w - t)\right) \frac{\sqrt{2}}{2}$ leg length

$= \left(4 + 3 + 2(3/8) + (4 - 3/8) + (3 - 3/8)\right) \frac{\sqrt{2}}{2} (.25)$

$= 2.475 \text{ in}^2$

τ_1 = tension / compression = $\frac{F_{BD}}{A} 5.241 = \frac{4521}{2.475} 5.241 = 11981$ PSI

τ_2 = shear = $\frac{F_{BD}}{A} \cos 41 = \frac{4521 \cos 41}{2.475} = 1379$ PSI

$\tau_{Net} = \sqrt{\tau_1^2 + \tau_2^2} = \sqrt{(1198)^2 + (1379)^2} = 1827$ PSI $<$ 24,400 PSI

Support MSRIA Summary Table

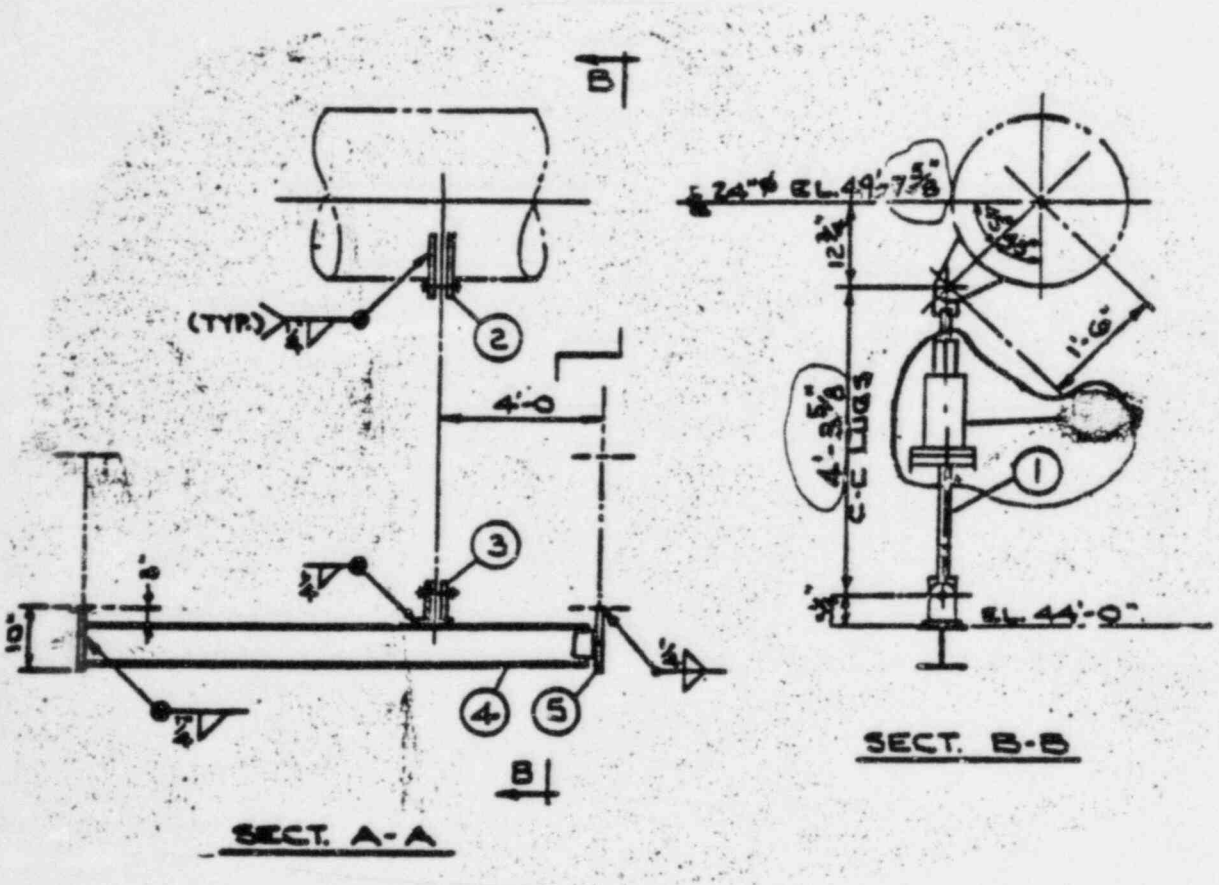
Item	TYPE OF STRESS	Calculated stress (PSI)	Allowable stress (PSI)
Item 1 weld to MS PIPE	SHEAR	770	24,400
Item 1 clevis	AXIAL compression	1,293	14,700
Item 3 weld to Item 9	SHEAR	3,126	24,400
Item 9 BEAM	tension/ compression	1,221	23,700
Item 9 weld to 27WF	SHEAR	899	24,400
Item 4 BEAM	tension/ compression	1,904	20,700
Item 8 weld to 6 WF	SHEAR	1,364	24,400
Item 8 Plate	tension/ compression	1,275	32,400
	SHEAR	736	24,400
Bolts	SHEAR	2,559	24,400
Item 4 weld to Item 5	SHEAR	1,683	24,400
Item 5 Plate	tension/ compression	1,194	32,400
	SHEAR	1,314	24,400
Item 5 weld to 21 WF	SHEAR	1,827	24,400

SUMMARY table (cont.)

Item	Calculated LOAD (lb)	Allowable LOAD (lb)
1	5,170	10,000
3	5,170	10,000

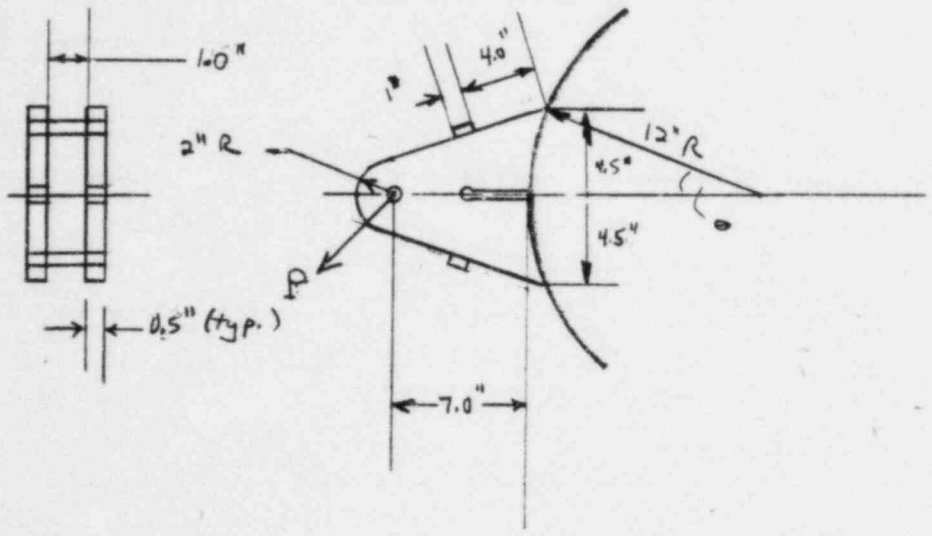
Support MS-R2A

DESCRIPTION



P = 12,330 lb
Ref (1)

Item 2 PIPE ATTACHMENT Clevis & Bolt



Pullout shear

$A = 2(2rt) = 2(2(2.0).5) = 4.0\ in^2$

$\tau = P/A = \frac{12330}{4} = 3083\ PSI < 24,400\ PSI$

Bolt hole tension

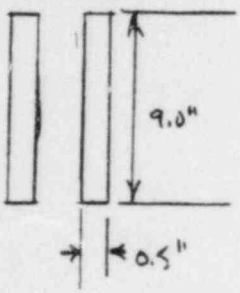
$A = 2t(2r - hole\ d) = 2(.5)\left(2(2.0) - (1.0 + 1/16)\right) = 2.938\ in^2$

$\sigma = P\sin 45/A = \frac{12,330\ \sin 45}{2.938} = 2968\ PSI < 32,400\ PSI$

SHEAR

$\tau = P\sin 45/A = \frac{12,330\ \sin 45}{2.938} = 2968\ PSI < 24,400\ PSI$

BENDING AT BASE



$$I = 2\frac{bh^3}{12} = 2\frac{(.5)(9.0)^3}{12} = 60.75\ in^4$$

$$c = 4.5"$$

$$\sigma = \frac{Mc}{I} = \frac{\ell P \sin 45\, c}{I} = \frac{7.0\,(12330)\sin 45\,(4.5)}{60.75}$$

$$= 4521\ PSI$$

$$< 40{,}600\ PSI$$

AXIAL Compression

let Area = minimum Area = $2tw = 2(.5)(4.0) = 4.0\ in^2$

$$\sigma = \frac{P \sin 45}{A} = \frac{12330 \sin 45}{4.0} = 2180\ PSI$$

$\ell \simeq 7.0$ in, $C_c = 126.5$
$r = t/\sqrt{12} = .5/\sqrt{12} = .144$
$K = 2.0$; $S_y = 36.0$ KSI

} See Appendix B

$$F_a = 2/3\left(1 - \left(\frac{K\ell}{r}\right)^2 / 2C_c^2\right) S_y$$

$$= 2/3\left(1 - \left(\frac{2.0(7.0)}{.144}\right)^2 / 2(126.5)^2\right) 36.0 = 16.9\ KSI$$

$$2{,}180\ PSI < 16{,}900\ PSI$$

AXIAL COMPRESSION AND BENDING

$$\frac{f_a}{F_a} \leq 0.15$$

$$\therefore \quad \frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1.0$$

(Note: bending in this plane gives a larger radius of gyration $\therefore F_a = 24.0$ KSI)

$$\frac{2180}{16,900} + \frac{4521}{40,600} = 0.24 < 1.0$$

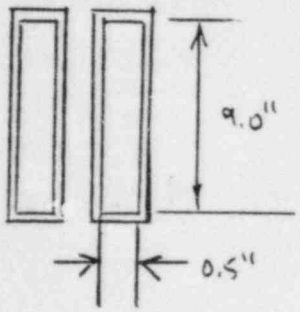
Bolt – 1" ϕ x 3 3/4" LG B & N

$$\text{AREA} = 2\frac{\pi d^2}{4} = (2)\frac{3.14\,(1)^2}{4} = 1.570 \text{ in}^2$$

double shear

$$f_v = \frac{P}{A} = \frac{12,330}{1.570} = 7,854 \text{ PSI} < 24,400 \text{ PSI}$$

Item 2 Weld to Main Steam Pipe



TREAT weld AS LINE

$A = 2(2\ell + 2w)\sqrt{2}/2$ leg length

$= 2(2(9.0) + 2(.5))\sqrt{2}/2(.25)$

$= 6.718\ in^2$

$Z = 2\left(bd + \frac{d^2}{3}\right)\frac{\sqrt{2}}{2}$ leg length

$= 2\left(.5(9.0) + \frac{9.0^2}{3}\right)\sqrt{2}/2\ (.25)$

$= 11.137\ in^3$

tension / compression

$$\gamma_1 = \sqrt{2}/2\ P/A = \frac{\sqrt{2}/2\ (12{,}330)}{6.718} = 1{,}298\ PSI$$

moment

$$\gamma_2 = \frac{\sqrt{2}}{2} P\ell/Z = \frac{\sqrt{2}/2\ (12{,}330)(7.0)}{11.137} = 5{,}480\ PSI$$

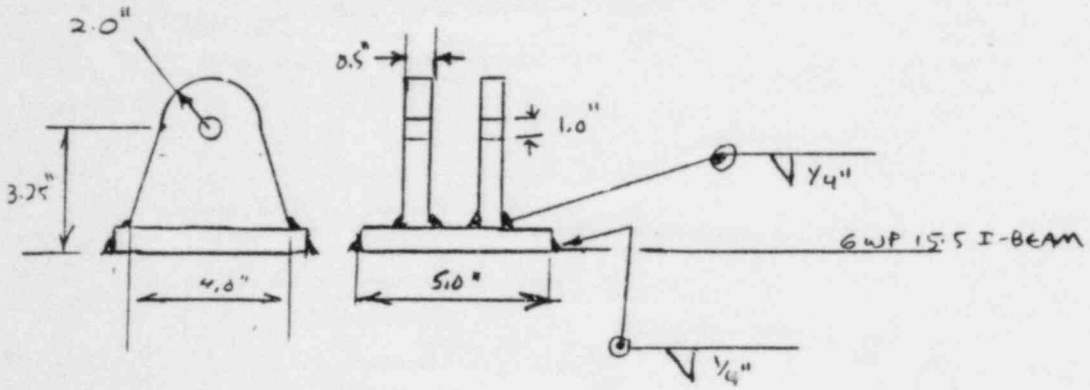
shear

$$\gamma_3 = \sqrt{2}/2\ P/A = \frac{\sqrt{2}/2\ (12{,}330)}{6.718} = 1{,}298\ PSI$$

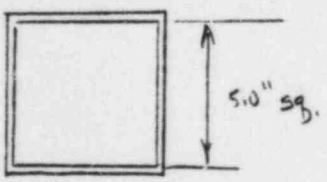
$$\gamma_{Net} = \sqrt{(\gamma_1 + \gamma_2)^2 + \gamma_3^2} = \sqrt{(1298 + 5480)^2 + 1298^2}$$

$$= 6{,}901\ PSI < 24{,}400\ PSI$$

Item 3 clevis & Bolt STANDARD PART FA1-A



Item 3 weld to Item 4 (I-BEAM)



TREAT WELD AS LINE

$A = 4 \text{ s } \sqrt{2} \text{ leg length}$

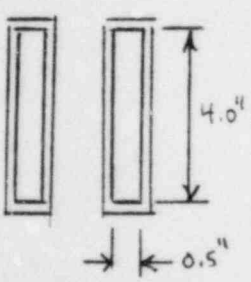
$= 4(5.0)\sqrt{2}(.25)$

$= 3.536 \text{ in}^2$

tension / compression

$\tau_{wet} = \tau_1 = P/A = 12{,}330 / 3.536 = \underline{3{,}487 \text{ PSI} < 24{,}400 \text{ PSI}}$

Clevis Plate Weld to Base Plate



Area $= 4(l+w)\sqrt{2} \text{ leg length}$

$= 4(.5+4)\sqrt{2}(.25) = 3.182 \text{ in}^2$

tension / compression

$\tau_{wet} = \tau_1 = P/A = \frac{12330}{3.182} = \underline{3875 \text{ PSI} < 24{,}400 \text{ PSI}}$

clevis plate

Pullout shear

$A = 2(2Rt) = 2(2(2.0)(.5)) = 4.0\ in^2$

$f = P/A = \frac{12,330}{4.0} = 3083\ PSI < 24400\ PSI$

Bolthole tension

$A = 2(2R - hole\ dia)\ t = 2(4 - (1\frac{1}{16}))(.5) = 2.938$

$f = P/A = 12,330/2.938 = 4197\ PSI < 32400\ PSI$

Axial compression

$A = min\ Area = 2(2rt) = 2(2(2.0)(.5)) = 4.0\ in^2$

$f = P/A = \frac{12330}{4.0} = 3083\ PSI$

$l = 2.75"$, $C_c = 126.5$

$r = t/\sqrt{12} = 0.144\ in$

$K = 2.0$, $S_y = 36.0\ KSI$

} see Appendix B

$f_a = 2/3\ (1 - (Kl/r)^2/2C_c^2)\ S_y = 22.9\ KSI$

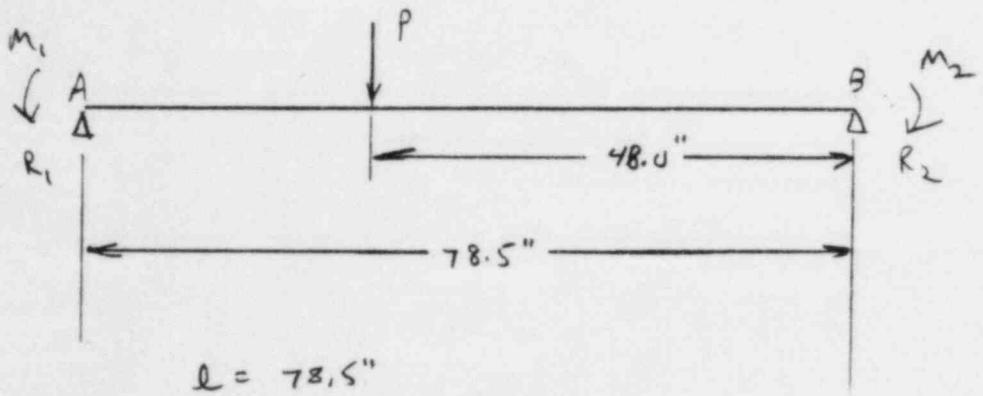
$3,083\ PSI < 22,900\ PSI$

Item 4 I-BEAM

6 WF 15.5 × 6' 6½" LG

$A = 4.62\ in^2$ Ref (4) P. 3-24

$I = 30.3\ in^4$ Ref. (4) P. 1-21



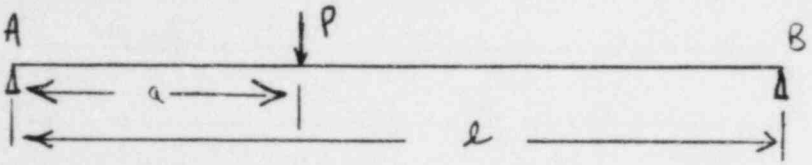
$\ell = 78.5"$

$b = 48.0"$

$a = 30.5"$

the beam is partially restrained at R_1 AND R_2 by the 8" × 10" × ½" plate. Reactions & Moment in the plates AND beams are calculated as follows:

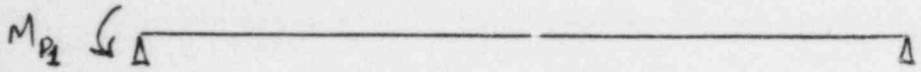
Superposition of Loadings



$$\theta_A = \frac{P a (2\ell - a)(\ell - a)}{6EI\ell} \quad ; \quad \theta_B = -\frac{P a (\ell^2 - a^2)}{6EI\ell}$$

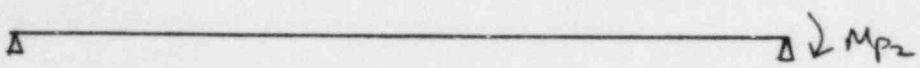
Ref. 5 case 1e P 97

clockwise rotation positive



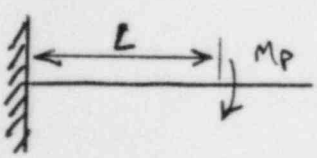
Ref. 6 case 7 P 22

$$\theta_A = -\frac{1/3\, M_{P1}\ell}{EI} \qquad \theta_B = 1/6\, \frac{M_{P1}\ell}{EI}$$



$$\theta_A = -\frac{1}{6}\frac{M_{P2}\ell}{EI} \qquad \theta_B = \frac{1}{3}\frac{M_{P2}\ell}{EI}$$

Plate



$$\theta = \frac{M_p L}{E_p I_p}$$

Ref. 6 case 21

$$\theta_{totalA} = \frac{M_{p_1} L}{E_p I_p} = \frac{P_a a (2l-a)(l-a)}{6EIl}$$

$$- \frac{1}{3} \frac{M_{p1} l}{EI} - \frac{1}{6} \frac{M_{p2} l}{EI}$$

$$\theta_{totalB} = - \frac{M_{p2} L}{E_p I_p} = - \frac{P_a a (l^2-a^2)}{6EIl}$$

$$+ \frac{1}{6} \frac{M_{p1} l}{EI} + \frac{1}{3} \frac{M_{p2} l}{EI}$$

$E_p = E = 29 \times 10^6$ psi (modulus of elasticity)

$I_p = 0.083$ in^4 from p 65 of this calculation

$I = 30.3$ in^4

$L = 6.0$ in

$l = 78.5$ in

$a = 30.5$ in

(1) $$M_{p_1} = \left(\frac{L}{E_p I_p} + \frac{1}{3}\frac{\ell}{EI} \right)^{-1} \left\{ P_a \frac{(2\ell - a)(\ell - a)a}{6EI\ell} - M_{p_2}\left(\frac{\ell}{6EI}\right) \right\}$$

(2) $$M_{p_2}\left(\frac{\frac{L}{E_p I_p} + \frac{1}{3}\frac{\ell}{EI}}{\left(\frac{\ell}{EI6}\right)} \right) = \frac{P_a\left(\frac{a(\ell^2 - a^2)}{6EI\ell}\right)}{\left(\frac{\ell}{EI6}\right)} - M_{p_1}$$

$$\frac{P_a\left(\frac{a(\ell^2-a^2)}{6EI\ell^2}\right)}{\left(\frac{\ell}{EI6}\right)} = \left\{ \frac{P_a\left(\frac{(2\ell-a)(\ell-a)}{6EI\ell}\right) - M_{p_2}\left(\frac{\ell}{6EI}\right)}{\left(\frac{L}{E_p I_p} + \frac{1}{3}\frac{\ell}{EI}\right)} \right\}$$

$$+ \frac{M_{p_2}\left(\frac{L}{E_p I_p} + \frac{1}{3}\frac{\ell}{EI}\right)}{\left(\frac{\ell}{EI6}\right)}$$

$$P_a\left(\frac{a(l^2-a^2)}{2l^2}\right) - \frac{P_a\left(\frac{(2l-a)(l-a)a}{6Il}\right)}{\left(\frac{L}{I_p} + \frac{1}{3}\frac{l}{I}\right)} =$$

$$M_{p_2}\left\{\frac{\frac{L}{I_p} + \frac{1}{3}\frac{l}{I}}{\frac{l}{6I}} - \frac{\frac{l}{6I}}{\frac{L}{I_p} + \frac{1}{3}\frac{l}{I}}\right\}$$

$$12330\left(\frac{30.5(78.5^2-30.5^2)}{(78.5)^2}\right) - \frac{12330\left(\frac{(2(78.5)-30.5)(78.5-30.5)30.5}{6(30.3)(78.5)}\right)}{\left(\frac{6}{0.083} + \frac{1}{3}\frac{78.5}{30.3}\right)}$$

$$= M_{p_2}\left\{\frac{\left(\frac{6}{0.083} + \frac{1}{3}\frac{78.5}{30.3}\right)}{\frac{78.5}{6(30.3)}} - \frac{\frac{78.5}{6(30.3)}}{\left(\frac{6}{0.083} + \frac{1}{3}\frac{78.5}{30.3}\right)}\right\}$$

$M_{p_2} = 1872$ in. lb.

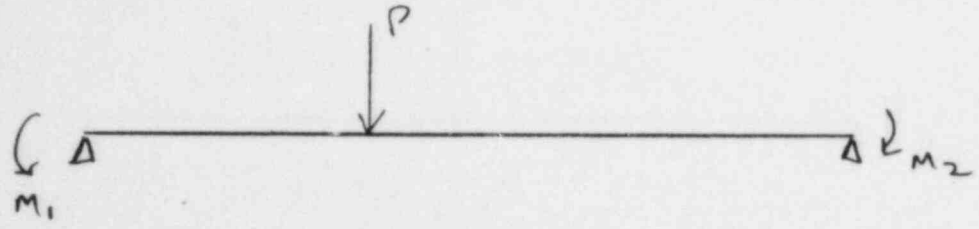
Plugging into Eq (1)

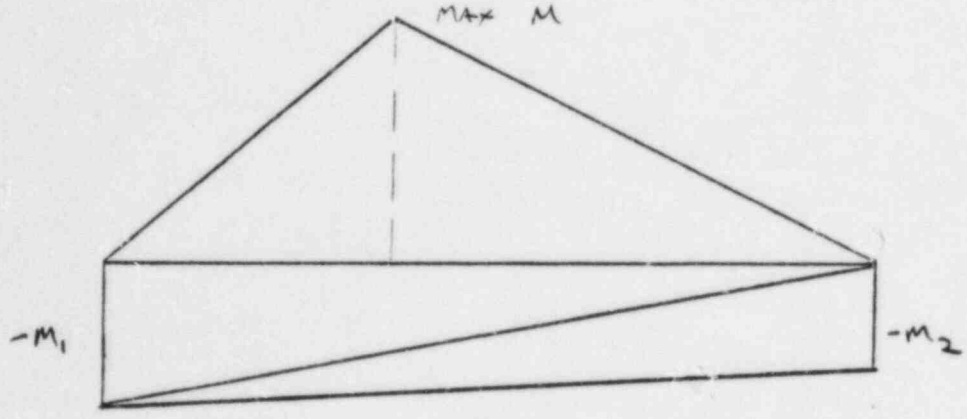
$M_{p_1} = 2176$ in. lb.

Simply supported beam moment

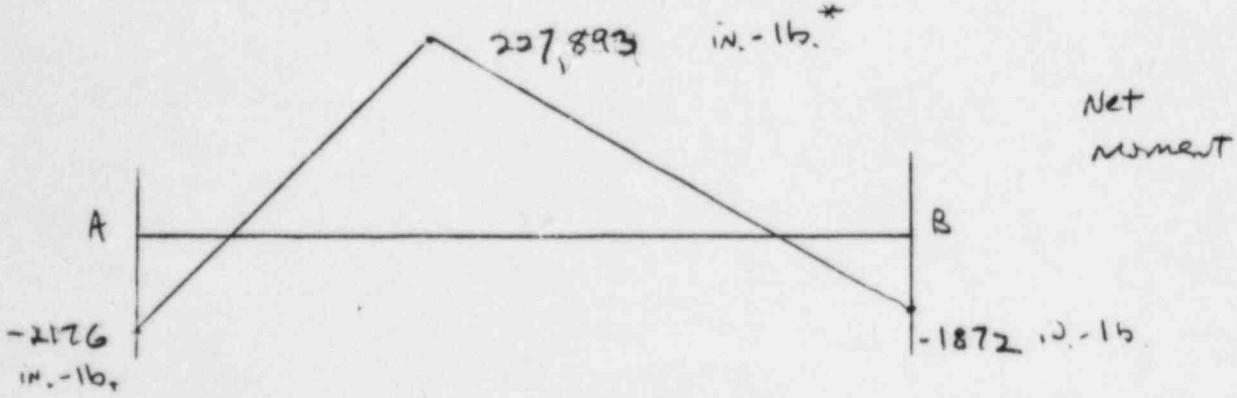
$$\text{MAX } M \text{ at } P = \frac{P\,a\,b}{\ell} = \frac{12330\,(48.0)(30.5)}{(78.5)}$$

$$= 229{,}951 \text{ in-lb}$$





Separate Moments



Net Moment

* This is calculated assuming linear drop in end moments.

ΣM at A = $P_a + M_{P_2} - R_B \ell - M_{P_1}$

$0 = 12330\,(30.5) + 1872 - R_B\,(78.5) - 2176$

$\therefore R_B = 4{,}787$ lb

ΣM at B = $P_b + M_{P_1} - M_{P_2} - R_A \ell$

$0 = 12330\,(48.0) + 2176 - 1872 - R_1\,(78.5)$

$\therefore R_A = 7{,}543$ lb.

SHEAR STRESS IN I-BEAM

R_A to P $V = R_A = 7543$ lb (controlling load)

$\tau = \frac{R_1}{A} = \frac{7543}{4.62} =$ 1633 PSI < 24,400 PSI

BENDING IN I-BEAM

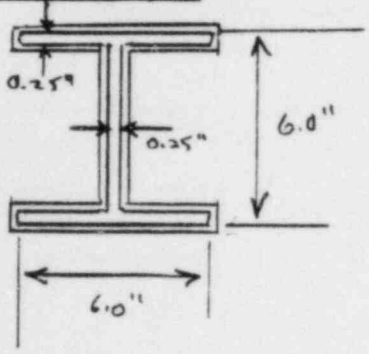
$\delta = \pm \frac{Mc}{I} = \frac{227{,}893\,(3.0)}{30.3} =$ 22,564 PSI < 40,600 PSI

Note: $M = M_{MAX} + \frac{M_1\,(\ell - a)}{\ell} + \frac{M_2\,a}{\ell}$

$= 229{,}951 - \frac{2176\,(48)}{78.5} - \frac{1672\,(30.5)}{78.5} = 227{,}893$ in-lb

Item 4 Weld to Item 5 Plate.

(LOCATION A)



TREAT WELD AS LINE

AREA = Perimeter $\sqrt{2}/2$ leg length

$= \{4(6.0) + 2(5.75)\} \sqrt{2}/2 (.25)$

$= 6.276\ in^2$

$Z = \left\{bd + \frac{d^2}{3} + (b-t)(d-2t)\right\}$ $\sqrt{2}/2$ leg length

$= \left\{6.0^2 + 6.0^2/3 + (6.0-.25)(6.0-2(.25))\right\}$ $\sqrt{2}/2\ (.25)$

$= 14.076\ in^3$

BENDING

$$\tau_2 = \frac{M}{Z} = \frac{2176}{14.076} = 155\ PSI$$

SHEAR

$$\tau_3 = \frac{R_A}{A} = \frac{7543}{6.276} = 1202\ PSI$$

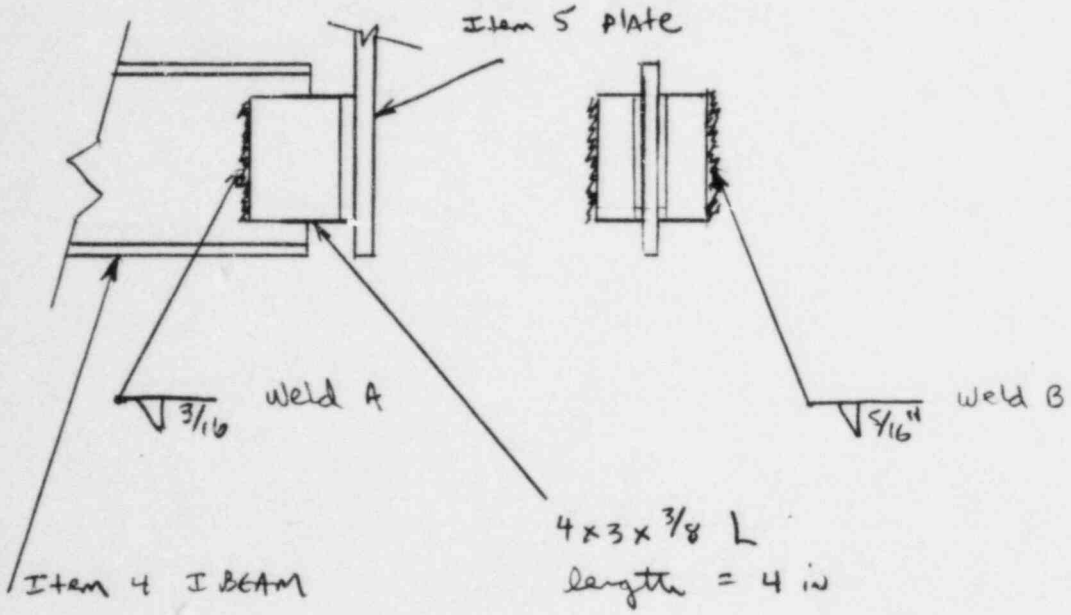
$$\tau_{net} = \sqrt{\tau_2^2 + \tau_3^2} = \sqrt{(155)^2 + (1202)^2} = 1212\ PSI$$

$< 24,400\ PSI$

Title: MAIN STEAM Seismic Supports
Calculated by: MKennedy Date: 8/1/84
Checked by: RC Talarico Date: 8-1-84
Reviewed by: JJ Date: 8-22-84

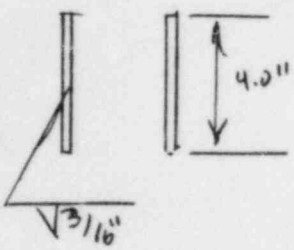
Project: 83-03

MITRED END OF I-BEAM (LOCATION B)



ASSUME CLIP ANGLE AND WELDS PER BP STANDARD E 602

Weld A + B (simplified)



TREAT weld AS LINE

$A_{WA} = 2l \sqrt{3}/2$ leg length
$= 2(4.0) \sqrt{3}/2 (5/16)$
$= 1.061 \text{ in}^2$

$Z = \frac{l^2}{3} \sqrt{3}/2$ leg length
$= 4^2/3 \sqrt{3}/2 (3/16) = 0.707 \text{ in}^3$

BENDING

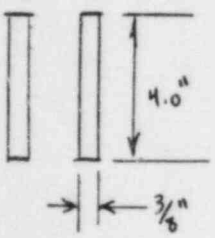
$$\tau_{L2} = M/Z = \frac{1872}{0.707} = 2648 \text{ PSI}$$

SHEAR

$$\tau_{L3} = R_B/A = \frac{4787}{1.061} = 4512 \text{ PSI}$$

$$\tau_{net} = \sqrt{\tau_{L2}^2 + \tau_{L3}^2} = \sqrt{(2648)^2 + (4512)^2} = \underline{5232 \text{ PSI} < 24,400 \text{ PSI}}$$

4 x 3 x 3/8 L clip Angle



$$\text{AREA} = 2(\ell \times w) = 2(4.0 \times 3/8) = 3.0 \text{ in}^2$$

$$Z = \frac{2bh^3}{c\,12} = \frac{\pi(3/8)(4)^3}{\pi(12)} = 2.0 \text{ in}^3$$

SHEAR

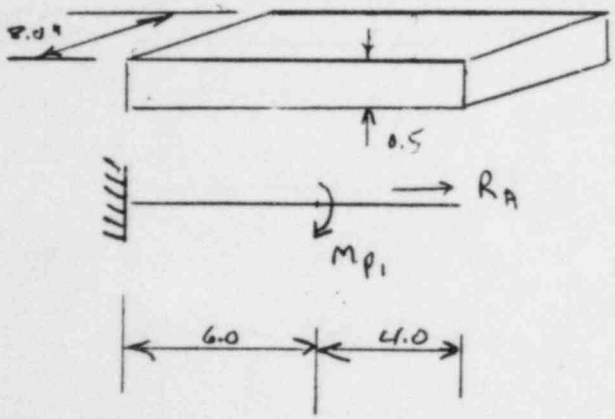
$$\tau = R_B/A = \frac{4787}{3.0} = \underline{1596 \text{ PSI} < 21,600 \text{ PSI}}$$

BENDING

$$\sigma = \frac{M}{Z} = \frac{1872}{2.0} = \underline{936 \text{ PSI} < 40,600 \text{ PSI}}$$

Item 5 plate

Location A Plate controlling



SHEAR = 0 , AXIAL LOAD = R_A = 4282 lb

$M = M_{P1}$ = 2176 in.lb.

$I_p = \frac{bh^3}{12} = \frac{8.0(.5)^3}{12} = 0.083\ in^4$

Axial tension / compression

$\delta = R_A/A = \frac{7543}{4} =$ 1886 PSI < 40,600 PSI (tension)

$\ell = 6.0''$, $C_c = 126.5$
$r = t/\sqrt{12} = .5/\sqrt{12} = 0.144$
} see Appendix B
$K = 1.0$, $S_y = 36.0$ KSI

$$f_a = \tfrac{2}{3}\left(1 - \left(\frac{Kl}{r}\right)^2 / 2C_c^2\right) S_y$$

$$= \tfrac{2}{3}\left(1 - \left[\frac{(1.0)(6.0)}{.144}\right]^2 / 2(126.5^2)\right)(36.0) = 22.7 \text{ KSI}$$

1886 PSI < 22,700 PSI

BENDING

$I = 0.083 \text{ in}^4$, $C = .25$ in

$$\sigma = \frac{MC}{I} = \frac{2176(.25)}{0.083} = 6554 \text{ PSI} \leq 40{,}600 \text{ PSI}$$

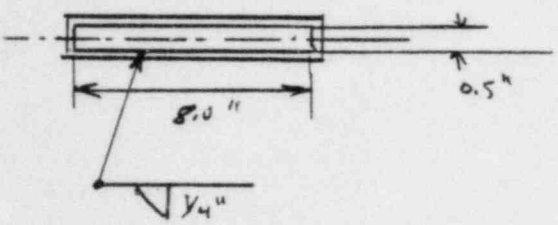
AXIAL COMPRESSION AND BENDING

$$\frac{F_a}{f_a} \leq 0.15$$

$$\therefore \frac{F_a}{f_a} + \frac{F_b}{f_b} \leq 1.0$$

$$\frac{1886}{22700} + \frac{6554}{40600} = 0.24 < 1.0$$

Item 5 Plate Weld to Existing 21 wf 96 I-BEAM



TREAT WELD AS LINE

$$\text{Area} = 2(b+d)\tfrac{\sqrt{2}}{2} \text{ leg length}$$
$$= 2(8.0+.5)\tfrac{\sqrt{2}}{2}(.25)$$
$$= 3.005 \text{ in}^2$$

$$Z = \left(bd + \frac{d^2}{3}\right)\tfrac{\sqrt{2}}{2} \text{ leg length}$$
$$= \left(8(.5) + \left(\frac{.5^2}{3}\right)\right)\tfrac{\sqrt{2}}{2}(.25)$$
$$= 0.722 \text{ in}^3$$

tension / compression

$$\tau_1 = \frac{R_A}{A} = \frac{7543}{3.005} = 2510 \text{ PSI}$$

BENDING

$$\tau_2 = M/Z = \frac{2176}{0.722} = 3014 \text{ PSI}$$

$$\tau_{net} = \tau_1 + \tau_2 = 2510 + 3014 = \underline{5524 \text{ PSI} < 24{,}400 \text{ PSI}}$$

Support MS-R2A Summary Table

Item	TYPE of STRESS	Calculated stress (PSI)	Allowable stress (PSI)
Item 2 clevis	Pullout SHEAR	3,083	24,400
	Bolthole tension	2,968	32,400
	SHEAR	2,968	24,400
	BENDING	4,521	40,600
	AXIAL compression	2,180	16,900
	AXIAL compression AND BENDING	0.24 (NOTE 1)	1.0 (NOTE 1)
Bolt	SHEAR	7,854	24,400
Item 2 weld to MS PIPE	SHEAR	6901	24,400
Item 3 clevis	Pullout SHEAR	3083	24,400
	Bolthole tension	4,197	32,400
	Axial compression	3,083	22,900
Item 3 clevis to Base plate weld	SHEAR	3,875	24,400

Summary Table (cont.)

Item	TYPE of STRESS	Calculated Stress (PSI)	Allowable Stress (PSI)
Item 3 weld to Item 4	SHEAR	3,487	24,400
Item 4	SHEAR	1,633	24,400
	BENDING	22,564	40,600
Item 4 weld to Item 5	SHEAR	1,212	24,400
	SHEAR	5,232	24,400
Clip Angle	SHEAR	1,596	21,600
	BENDING	936	40,600
Item 5 PLATE	Axial compression	1,886	22,700
	BENDING	6,554	40,600
	AXIAL COMPRESSION AND BENDING	0.24 (Note 1)	1.0 (Note 1)
Item 5 weld to 21 WF	SHEAR	5,524	24,400

Notes

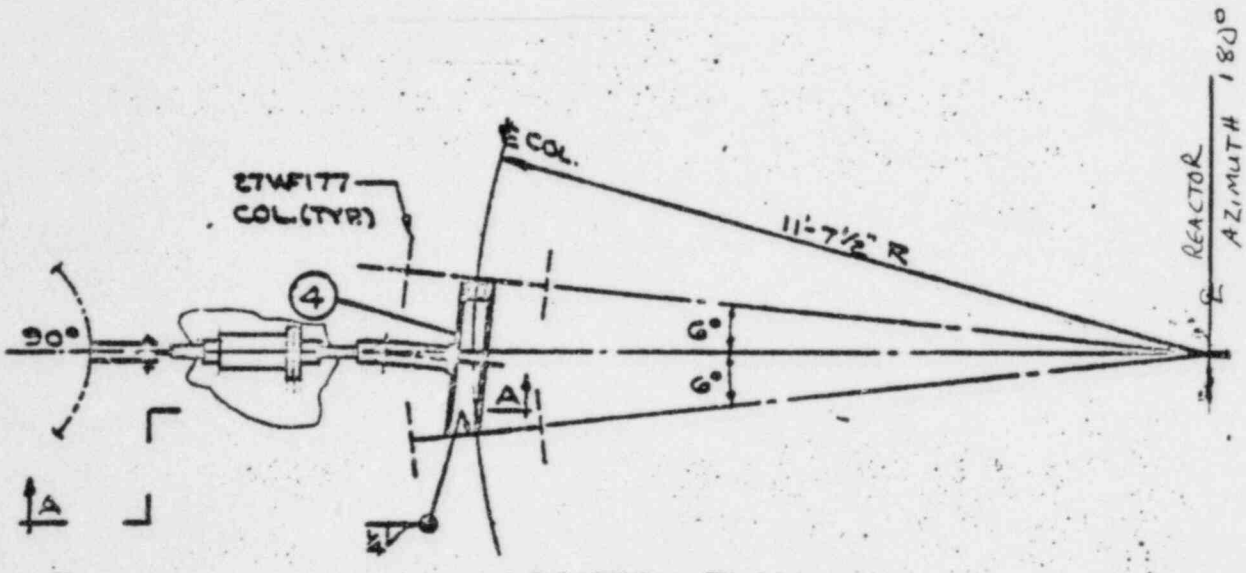
(1) Value is not stress in psi but stress ratio (NON DIMENSIONAL).

Title: MAIN STEAM SEISMIC SUPPORTS
Calculated by: MJ Kennedy Date: 8/1/84
Checked by: RC Gluck Date: 8/4/84
Reviewed by: JJ Date: 8-30-84

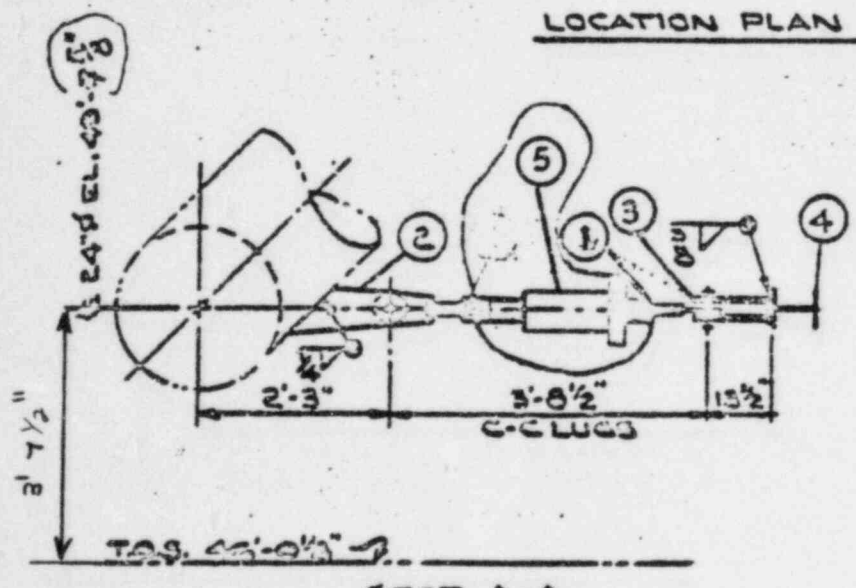
Project: 83-03

Support MS-R3A

DESCRIPTION



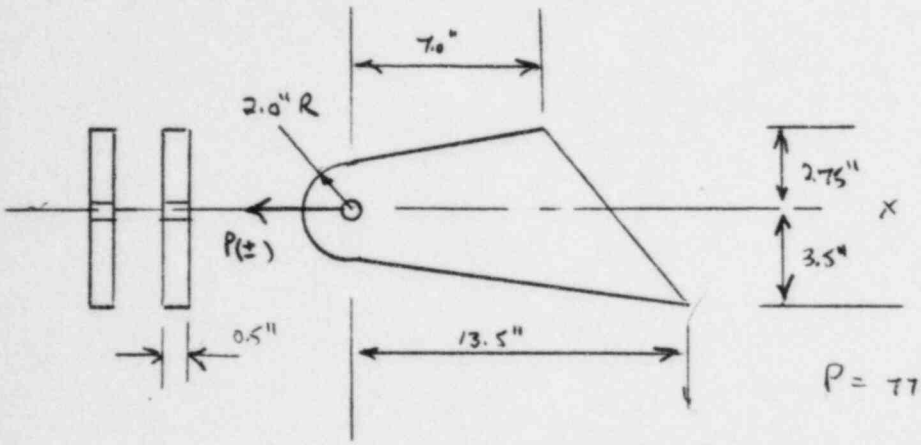
LOCATION PLAN



SECT. A-A

P = 77016
Ref (1)

Item 2 Clevis & Bolt



P = 7700 lb Ref. (1)

Clevis Plate

Pullout shear

$$\text{Area} = 2(2(Rt)) = 2(2(2\times.5)) = 4.0\ in^2$$

$$f = P/A = 7710/4 = \underline{1928\ PSI < 24400\ PSI}$$

Bolthole tension

$$\text{Area} = 2t(2r - \text{hole } d)$$
$$= 2(.5)(2(2.0) - (1+1/16)) = 2.938\ in^2$$

$$\sigma = P/A = 7710/2.938 = \underline{2624\ PSI < 32400\ PSI}$$

AXIAL COMPRESSION

$$\text{Area} = 2t(2r) = 2(.5)(2(2.0)) = 4.0\ in^2$$

$$\sigma = P/A = 7710/4.0 = 1928\ PSI$$

$l = 10.0$, $C_c = 126.5$

$r = t/\sqrt{12} = 0.144$

$K = 2.0$, $E = 29.2 \times 10^3\ KSI$

} see Appendix B

$$f_a = \tfrac{2}{3}\frac{\pi^2 E}{\left(\frac{Kl}{r}\right)^2} = 10.0\ KSI$$

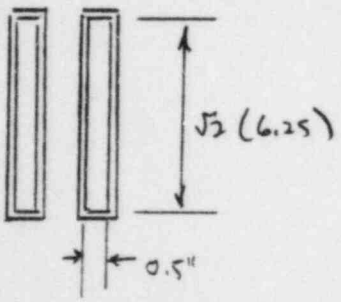
1928 PSI < 10,000 PSI

Bolt Shear

$$\text{Area} = 2\,\frac{\pi}{4}\,d^2 = 2\,\frac{\pi}{4}\,(1)^2 = 1.571\ in^2$$

$$\tau = P/A = 7,710/1.571 = 4908\ PSI < 24,400\ PSI$$

Clevis Plate weld to Main Steam Pipe



TREAT weld AS LINE

$$\text{AREA} = 2\,(2l+2w)\,\sqrt{2}/2 \text{ leg length}$$
$$= 2\,(2(\sqrt{2}(6.25)) + 2(5))\,\sqrt{2}/2\,(.25)$$
$$= 6.604 \text{ in}^2$$

tension / compression

$$f_1 = \frac{\sqrt{2}/2\,P}{A} = \frac{\sqrt{2}/2\,(7710)}{6.604} = 826 \text{ PSI}$$

SHEAR

$$f_3 = \frac{\sqrt{2}/2\,P}{A} = \frac{\sqrt{2}/2\,(7710)}{6.604} = 826 \text{ PSI}$$

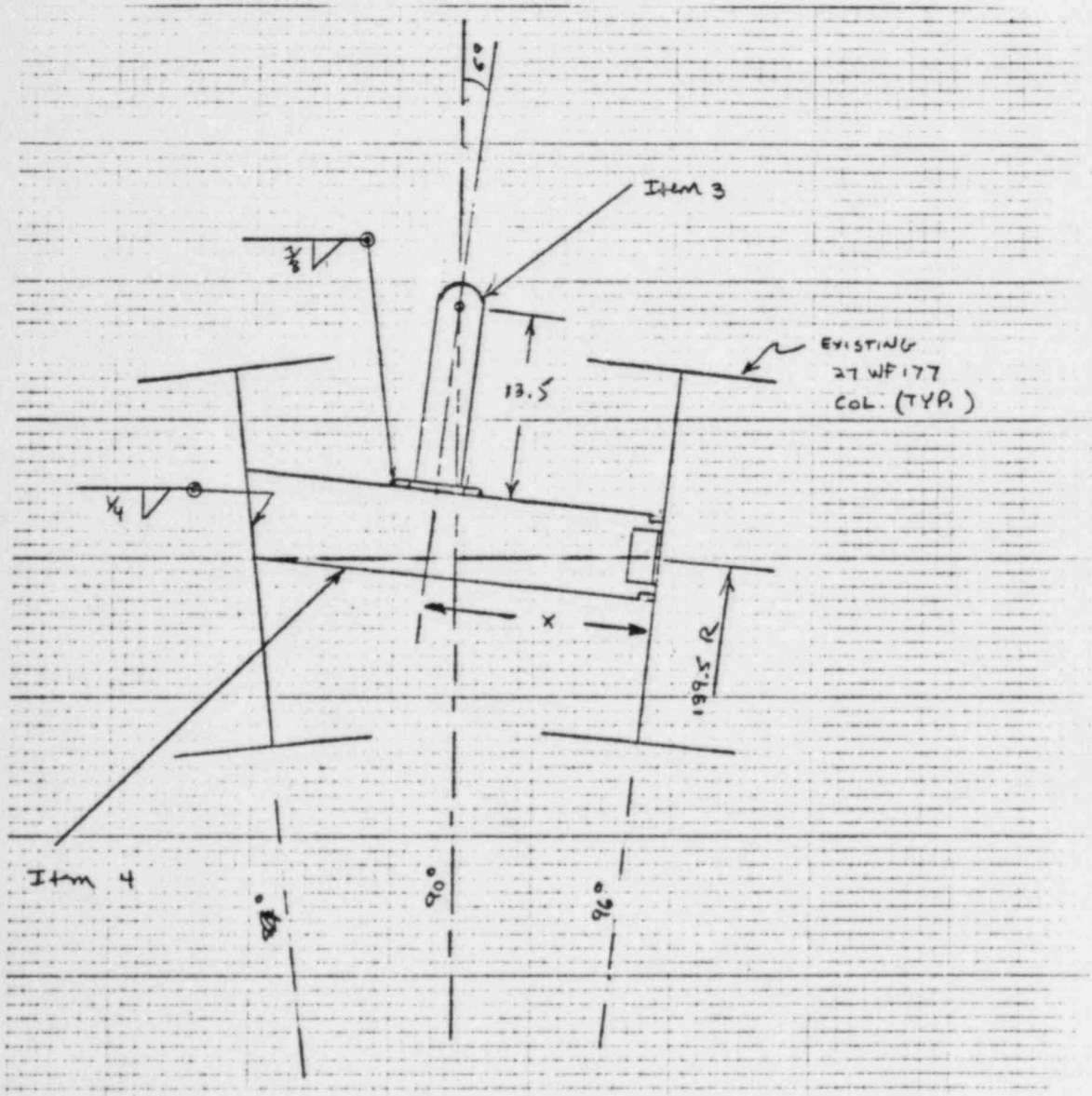
$$f_{NET} = \sqrt{f_1^2 + f_3^2} = \sqrt{(826)^2 + (826)^2} = \underline{1168 \text{ PSI} < 24400 \text{ PSI}}$$

Title: MAIN STEAM Seismic Supports
Calculated by: MKennedy Date: 3/1/84
Checked by: RCTrench Date: 3/6/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

Item 3 long clevis w/bolt

bolt stress same as above

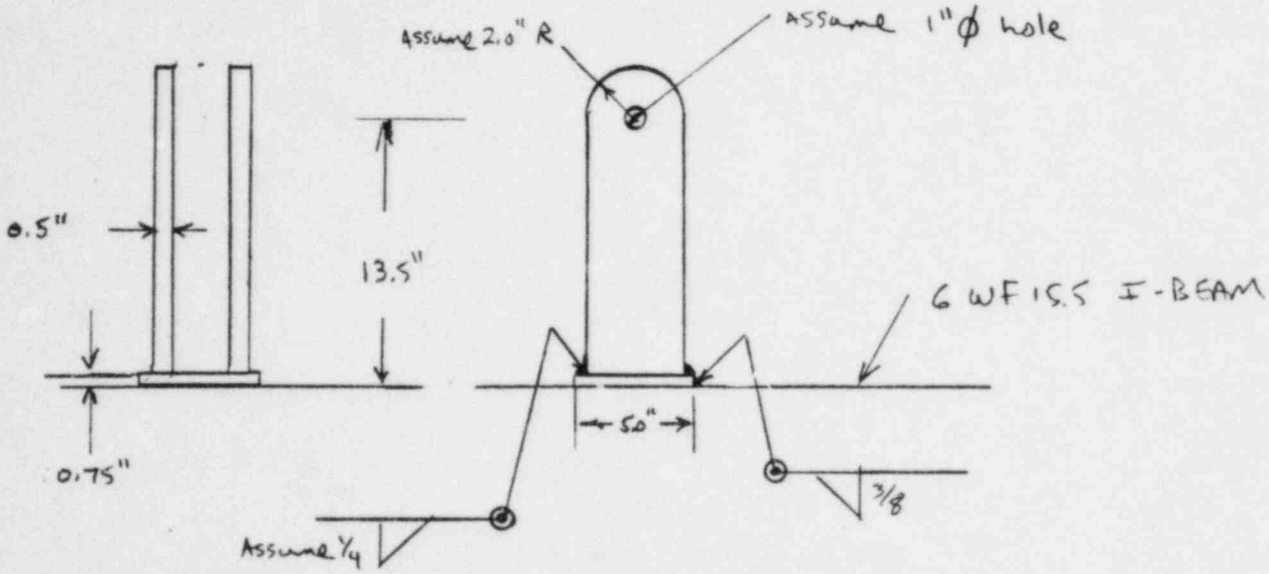


$X = 139.5 \tan 6 + 16.5 \tan 6$

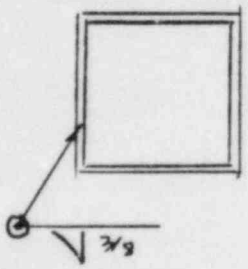
$= 16.40''$

Title: Main Steam Seismic Supports
Calculated by: MK Kennedy Date: 8/1/84
Checked by: R C Date: 8/6/84
Reviewed by: JJ Date: 8-30-84

Project: 83-03



BASE PLATE TO I BEAM WELD



TREAT weld AS LINE

Area = 4 S $\sqrt{3}/2$ leg length
= 4(5.0) $\sqrt{3}/2$ (.375) = 5.303 in^2

Z = $(S^2 + S^2/3)\sqrt{3}/2$ leg length
= $(5.0^2 + 5.0^2/3)\sqrt{3}/2$ (.375) = 8.839 in^3

TENSION / COMPRESSION

$$\gamma_1 = \frac{P\cos\theta}{A} = \frac{7710\cos 6}{5.303} = 1446 \text{ PSI}$$

BENDING

$$\gamma_2 = \frac{P\sin\theta\, \ell}{Z} = \frac{7710\sin 6\,(13.5)}{8.839} = 1231 \text{ PSI}$$

SHEAR

$$\gamma_3 = \frac{P\sin\theta}{A} = \frac{7710\sin 6}{5.303} = 152 \text{ PSI}$$

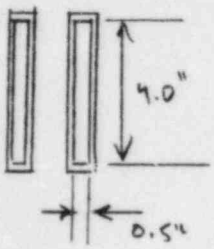
$$\gamma_{net} = \sqrt{(\gamma_1+\gamma_2)^2 + \gamma_3^2} = \sqrt{(1446+1231)^2 + (152)^2} = 2681 \text{ PSI}$$

< 24400 PSI

Title: MAIN STEAM Seismic Supports
Calculated by: MKennedy Date: 8/1/84
Checked by: R Francis Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

clevis to PLATE weld



$A = 2(2\ell + 2w)\ \sqrt{3}/2$ leg length
$= 2(2(4.0) + 2(.5))\ \sqrt{3}/2\ (.25)$
$= 3.182\ in^2$

$z = 2\left(bd + \frac{d^2}{3}\right)\sqrt{3}/2$ leg length
$= 2\left((.5)(4.0) + \frac{4.0^2}{3}\right)\sqrt{3}/2\ (.25)$
$= 2.593\ in^3$

tension / compression

$$\gamma_1 = \frac{P\cos\theta}{A} = \frac{7710\cos 6}{3.182} = 2{,}410\ PSI$$

BENDING

$$\gamma_2 = \frac{P\sin\theta\, \ell}{z} = \frac{7710\sin 6\,(13.5)}{2.593} = 4{,}196\ PSI$$

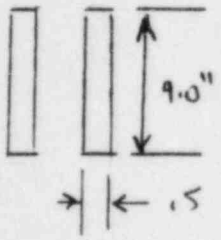
SHEAR

$$\gamma_3 = \frac{P\sin\theta}{A} = \frac{7710\sin 6}{3.182} = 253\ PSI$$

$$\gamma_{Net} = \sqrt{(\gamma_1 + \gamma_2)^2 + \gamma_3^2} = \sqrt{(2410 + 4196)^2 + (253)^2}$$
$$= \underline{6{,}611\ PSI < 24{,}400\ PSI}$$

Clevis Plate

Pullout shear & Bolt hole tension are the same as Item 2



$A = 2lw = 2(4)(.5)) = 4.0\ in^2$

$I = 2\frac{wl^3}{12} = \frac{2(.5)(4)^3}{12} = 5.333\ in^4$

$C = 2.0\ in$

BENDING

$$\sigma = \frac{MC}{I} = \frac{P \sin\theta\ l\ C}{5.333} = \frac{7710 \sin 6 (13.5)^2}{5.333} = \underline{4080\ PSI}$$

$< 40{,}600\ PSI$

AXIAL COMPRESSION

$$\sigma = \frac{P\cos\theta}{A} = \frac{7710 \cos 6}{4} = 1917\ PSI$$

$l = 13.5"$, $C_c = 126.5$

$r = t/\sqrt{12} = 0.144"$

$K = 2.0$, $E = 29.2 \times 10^3\ KSI$

} See Appendix B

$$F_A = \frac{2}{3}\frac{\pi^2 E}{\left(\frac{Kl}{r}\right)^2} = \frac{2}{3}\frac{\pi^2 (29.2 \times 10^3)}{\left(\frac{2 \times 13.5}{.144}\right)^2} = 5.5\ KSI$$

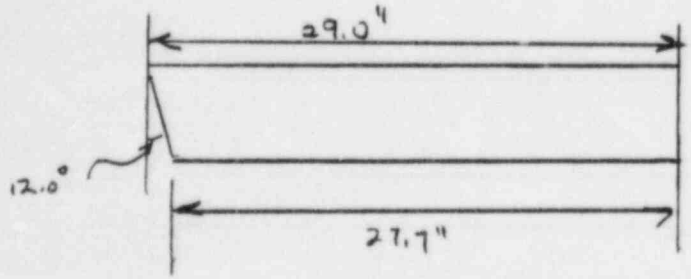
$1917\ PSI < 5{,}500\ PSI$

AXIAL COMPRESSION AND BENDING

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1.0$$

$$\frac{1917}{5500} + \frac{4080}{40,600} = 0.45 < 1.0$$

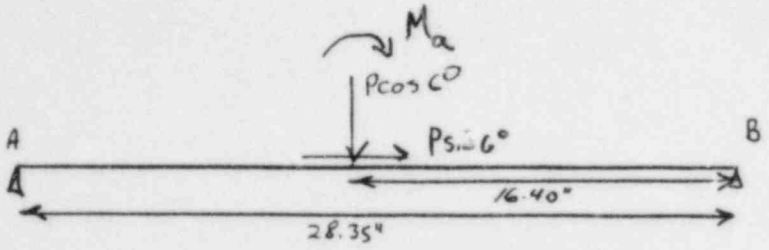
Item 4 I-BEAM 6 WF 15.5



$I = 30.3\ in^4$ P 1-21 Ref (4)

$A = 4.62\ in^2$ P 3-24 Ref (4)

Shear Area = web t x depth = .25 (6.0) = $1.5\ in^2$



TREAT BEAM AS SIMPLY SUPPORTED

$M_a = P \sin 6^\circ \ell$ where $\ell = 13.5"$

$= 7710 \sin 6 \ (13.5) = 10,880$ in-lb

From Moment Load

$$R_A = -R_B = \frac{M_a}{\ell} = \frac{10,880}{28.35} = 384 \text{ lb}$$

From Point Load

$a = 11.95$ $\ell = 28.35$ Ref (5) case 1-e P. 97

$$R_A = \frac{P \cos 6}{\ell}(\ell - a) = \frac{7710 \cos 6 \ (28.35 - 11.95)}{28.35} = 4436 \text{ lb}$$

$$R_B = \frac{P \cos 6}{\ell} a = \frac{7710 \cos 6 \ (11.95)}{28.35} = 3232 \text{ lb}$$

$$M_{MAX} = \frac{P \cos 6 (\ell - a)}{\ell} a = \frac{7710 \cos 6 \ (28.35 - 11.95) 11.95}{28.35}$$

$= 53,007$ in.lb.

Net LOADS

$R_A = 4436 + 384 = 4{,}820$ lb.

$R_B = 3232 + 384 = 3{,}616$ lb.

$M = M_a + M_{MAX} = 10880 + 53{,}007 = 63{,}887$ in. lb.

BEAM STRESSES

SHEAR STRESS

$\tau = R_A / A_s = \frac{4820}{1.5} = 3213$ PSI $< 24{,}400$ PSI

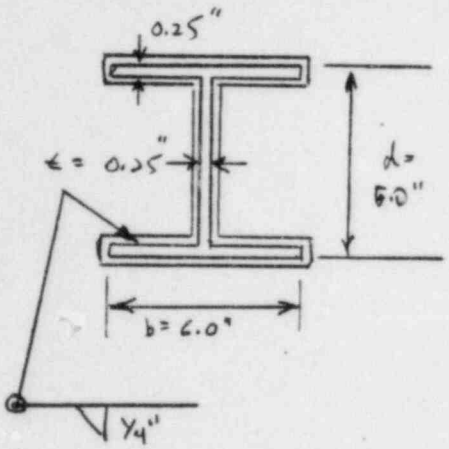
BENDING STRESS

$\sigma = \pm \frac{Mc}{I} = \frac{63{,}887\ (3.0)}{30.3} = 6325$ PSI $< 40{,}600$ PSI

Title: MAIN STEAM Seismic Supports
Calculated by: MJ Kennedy Date: 8/1/84
Checked by: RC Iranda Date: 8/9/84
Reviewed by: JJ Date: 8/22-84

Project: 83-03

Item 4 weld to 84° 27 WF 177 I-BEAM



TREAT WELD AS LINE

$$\text{Area} = (2d + 2b + 2(b-t)) \sqrt{2}/2 \text{ leg length}$$
$$= (2(6.0) + 2(6.0) + 2(6.0-.25)) \sqrt{2}/2 (.25)$$
$$= 6.276 \text{ in}^2$$

tension / compression

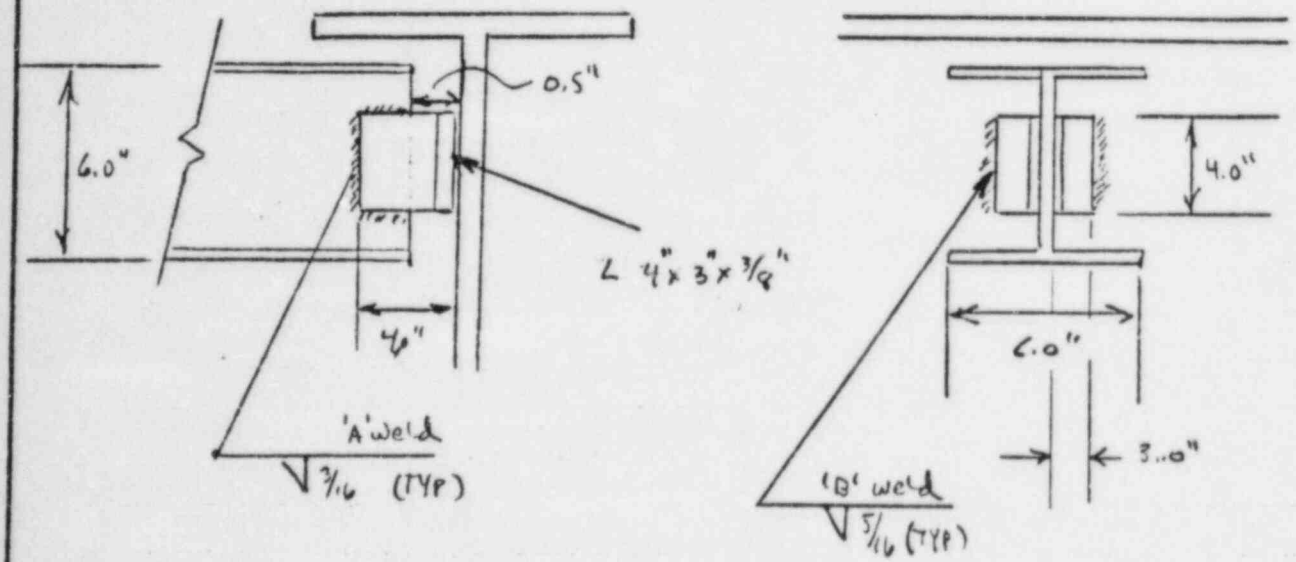
$$\gamma_1 = \frac{AL}{A} = \frac{7710 \sin 6}{6.276} = 128 \text{ PSI}$$

SHEAR

$$\gamma_3 = T_L/A = \frac{4820}{6.276} = 768 \text{ PSI}$$

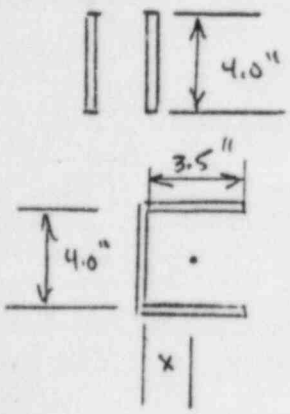
$$\gamma_{wet} = \sqrt{\gamma_1^2 + \gamma_3^2} = \sqrt{(128)^2 + (768)^2} = \underline{779 \text{ PSI} < 24,400 \text{ PSI}}$$

Item 4 weld to 96° 27 WF 177 I-BEAM



'A' weld

TREAT weld AS LINE



For TOP & BOTTOM welds

$A = x\,l\,t\,\sqrt{2}/2$

$= 3.5\,(3/16)\,\sqrt{2} = 0.928\ in^2$

$\Sigma \bar{x} = 2 \times 3.5 \times 1.75$

$\bar{x} = 1.114"$

For side welds

$A = l\,t\,\sqrt{2}/2$

$= 4\,(\frac{3}{16})\,\sqrt{2}/2 = 0.53\ in^2$

$\Sigma A = 0.53 + 0.928 = 1.458\ in^2$

compression / tension

$$\tau_1 = \frac{AL}{A} = \frac{7710 \sin 6}{1.458} = 553 \text{ PSI}$$

SHEAR

$$\tau_3 = \frac{T_L}{A} = \frac{3616}{1.458} = 2480 \text{ PSI}$$

$$\tau_{Net} = \sqrt{\tau_1^2 + \tau_3^2} = \sqrt{(553)^2 + (2480)^2} = 2541 \text{ PSI}$$

< 24400 PSI

'B' weld

$A = 2\ell \, 5^{1}/_{2}$ leg length
$= 2(4.0)\, 5^{1}/_{2}\, (5/16)$
$= 1.768 \text{ in}^2$

tension / compression

$$\tau_1 = A_y/A = \frac{7710 \sin 6}{1.768} = 456 \text{ PSI}$$

SHEAR

$$\tau_3 = \frac{T_L}{A} = 3616/1.768 = 2095 \text{ PSI}$$

$$\tau_{Net} = \sqrt{\tau_1^2 + \tau_3^2} = \sqrt{456^2 + 2045^2}$$

$= 2095$ PSI $< 24,400$ PSI

Support MS-R3A Summary Table

Item	TYPE of Stress	Calculated Stress (PSI)	Allowable Stress (PSI
2	Pullout SHEAR	1,928	24,400
	Bolthole tension	2,624	32,400
	AXIAL COMPRESSION	1,928	10,000
	Bolt SHEAR	4,908	24,400
clevis Plate weld to MS. PIPE	SHEAR	1,168	24,400
Item 3 weld to I-BEAM	SHEAR	2,681	24,400
clevis Plate to BASE Plate weld	SHEAR	6,611	24,400
3	BENDING	4,080	40,600
	AXIAL COMPRESSION	1,917	5,500
	AXIAL COMP. & BENDING	0.45 (Note 1)	1.0 (Note 1)

Summary Table (cont.)

Item	TYPE of STRESS	Calculated stress (PSI	Allowable Stress
4	SHEAR	3,213	24,400
	BENDING	6,325	40,600
Item 4 weld to 27 WF I-BEAM	SHEAR	779	24,400
Item 4 weld to 21 WF I-BEAM	SHEAR	2,541	24,400

Notes

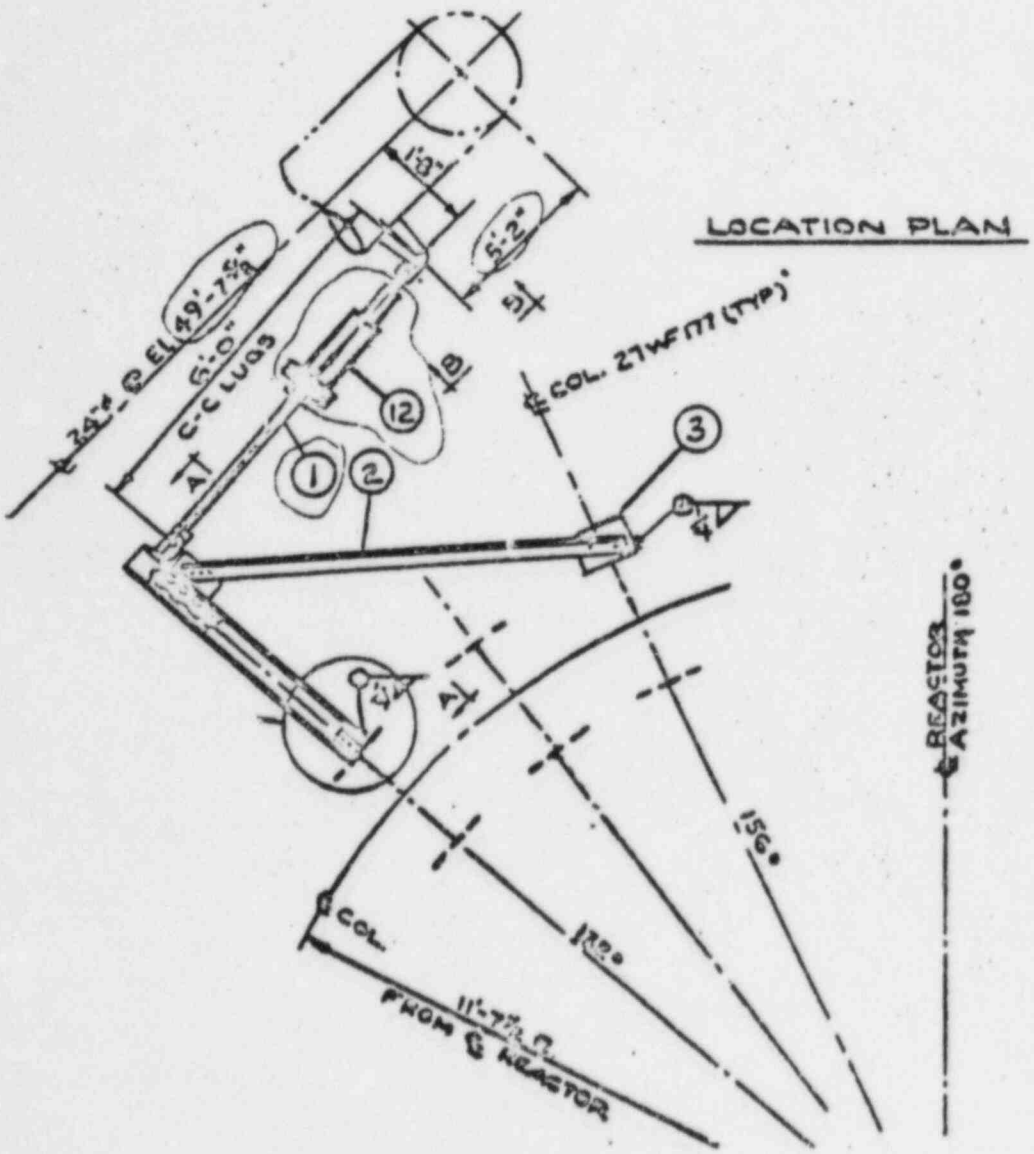
(1) Value is not stress in psi but stress ratio (NON-DIMENSIONAL).

Title: MAIN STEAM SEISMIC SUPPORTS
Calculated by: MJ Kennedy Date: 8/1/84
Checked by: RC Tauscher Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

Support MS-R4A

DESCRIPTION

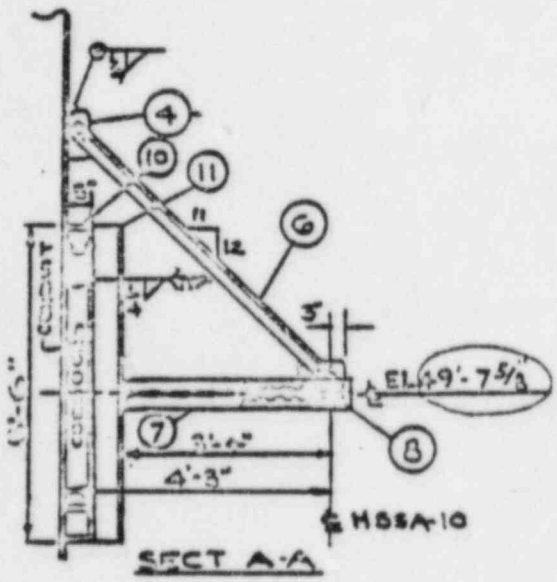


P = 9,950 lb
Ref (1).

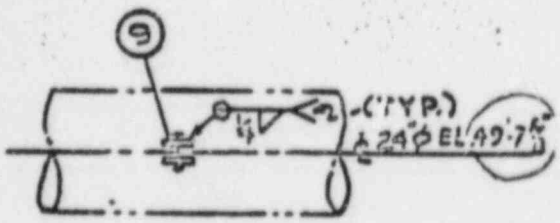
Title: MAIN STEAM SEISMIC SUPPORTS

Calculated by: M Kennedy Date: 8/1/84
Checked by: R C Tennedy Date: 8/1/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03



SECT A-A

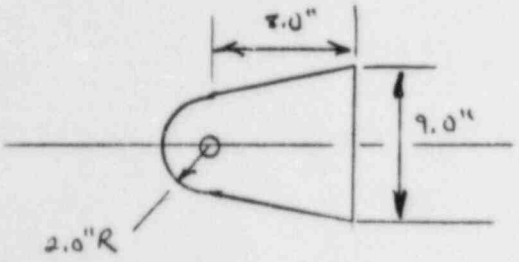


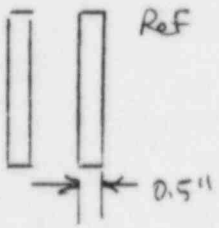
SECT. B-B

Title: MAIN STEAM SEISMIC SUPPORTS
Calculated by: MJ Kennedy Date: 8/1/84
Checked by: R Chuck Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

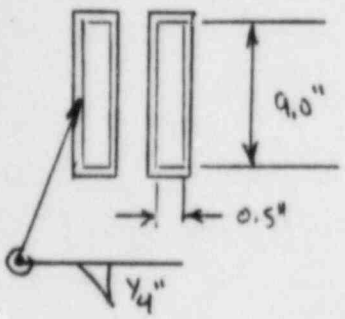
Item 9 Clevis





Ref B.P. DWG 64108-6

clevis plate weld to M.S. PIPE



$A = 2(2\ell + 2w)\ 5/2$ leg length
$= 2(2(9.0) + 2(.5))\ 5/2\ (.25)$
$= 6.718\ in^2$

$Z = 2(\ell w + d^2/3)\ 5/2$ leg length
$= 2(.5(9.0) + 9.0^2/3)\ 5/2\ (.25)$
$= 11.137\ in^3$

BENDING

$\gamma_2 = M/Z = P \cdot d/Z = \frac{9,950\ (80)}{11.137} = 7147\ PSI$

SHEAR

$\gamma_3 = P/A = \frac{9950}{6.718} = 1481\ PSI$

$\tilde{\gamma}_{net} = \sqrt{\gamma_2^2 + \gamma_3^2} = \sqrt{(7147)^2 + (1481)^2}$

$= \underline{7299\ PSI < 24,400\ PSI}$

Elevis Stress

$$I = 2\,\frac{wl^3}{12} = 2\frac{(.5)(9)^3}{12} = 60.75\ in^4$$

$C = 2.0\ in$

$A = 2(wl) = 2(.5 \cdot 9.0) = 9.0\ in^2$

BENDING

$$\delta = \frac{Mc}{I} = \frac{P \cdot d \cdot c}{I} = \frac{(9{,}950)\cdot(8.0)(2.0)}{60.75} = \underline{2{,}620\ PSI}$$

$< 40{,}600\ PSI$

SHEAR

$$\tau = P/A = 9{,}950/9 = \underline{1106\ PSI < 24{,}400\ PSI}$$

Pullout Shear

$A = 2(2Rt) = 2(2(2.0)(.5)) = 4.0\ in^2$

$$\tau = P/A = 9{,}950/4 = \underline{2488\ PSI < 24{,}400\ PSI}$$

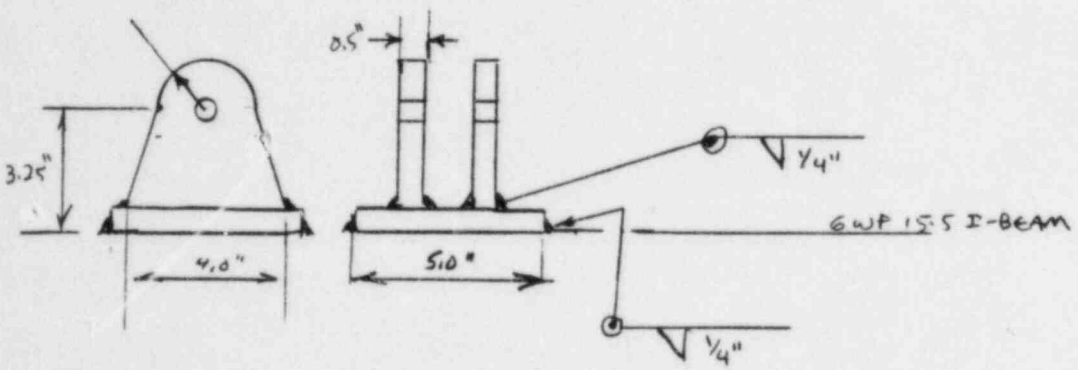
(Bolthole tension same as for Item 8 Below)

Bolt

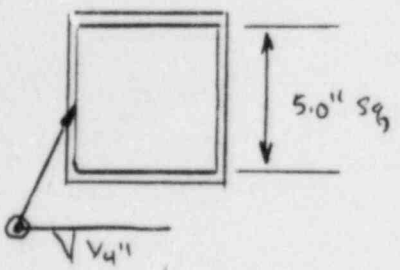
$$\text{Area} = 2\,\frac{\pi}{4}(1.0)^2 = 1.571\ in^2$$

$$\sigma = P/A = 9{,}950/1.571 = \underline{6333\ PSI < 24{,}400\ PSI}$$

Item 8 clevis & Bolt STANDARD PART EA1-A



BASE PLATE WELD TO 6WF 15.5 I-BEAM



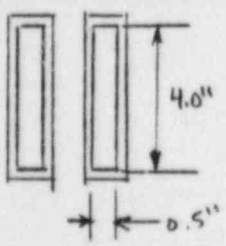
TREAT WELD AS LINE

$A = 4S\sqrt{2}/2$ leg length
$= 4(5.0)\sqrt{2}/2\,(.25)$
$= 3.536\ in.^2$

TENSION / COMPRESSION

$\gamma_{net} = P/A = \frac{9,950}{3.536} = 2,814\ PSI < 24,400\ PSI$

Clevis PLATE weld to BASE PLATE



Area $= 4(l+w)\sqrt{2}/2$ leg length
$= 4(.5+4)\sqrt{2}/2\,(.25) = 3.182\ in^2$

TENSION / COMPRESSION

$\gamma_{net} = \tau_1 = P/A = \frac{9,950}{3.182} = 3127\ PSI <$ 24,400 PSI

clevis plate

Pullout shear

$A = 2(2Rt) = 2(2(2.0)(.5)) = 4.0\ in^2$

$\tau = P/A = \frac{9950}{4.0} = 2488\ PSI < 24{,}400\ PSI$

Bolthole Tension

$A = 2(2R - \text{hole dia})t = 2(4 - (1+1/16)).5 = 2.938\ in^2$

$\sigma = P/A = 9950/2.938 = 3387\ PSI < 32{,}400\ PSI$

Axial compression

$A = \text{min Area} = 2(2rt) = 2(2(2.0).5) = 4.0\ in^2$

$\sigma = P/A = \frac{9950}{4.0} = 2488\ PSI$

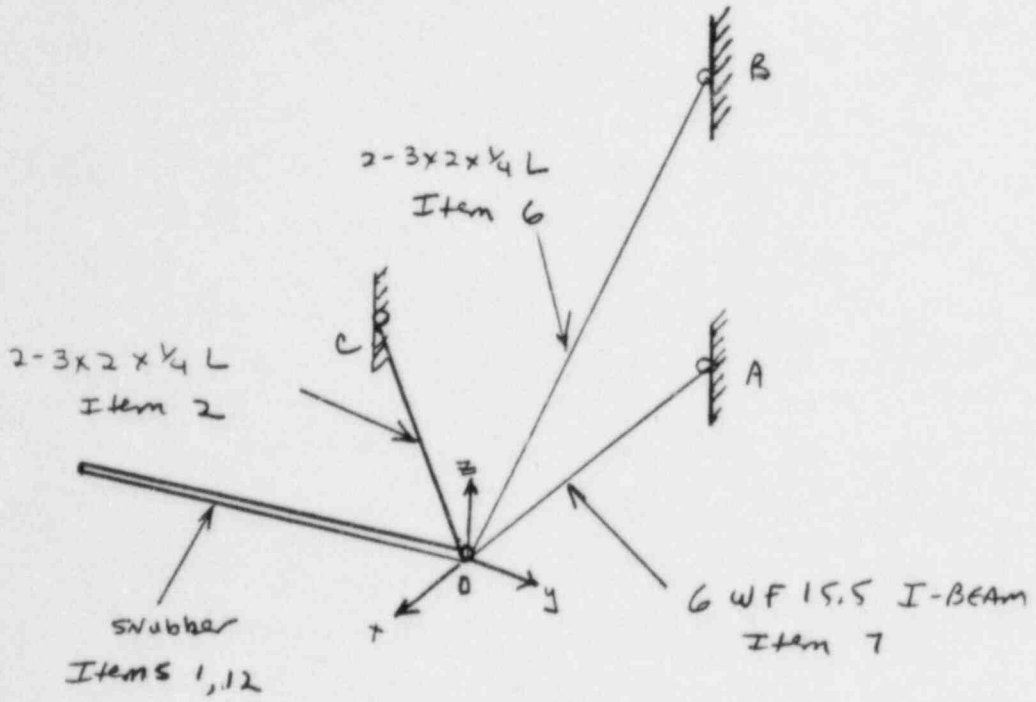
$l = 2.75"$, $C_c = 126.5$
$r = t/\sqrt{12} = 0.144\ in$
$K = 2.0$, $S_y = 36.0\ KSI$

} see Appendix B

$f_a = 2/3\left(1 - \left(\frac{Kl}{r}\right)^2 / 2C_c^2\right) S_y = 22.9\ KSI$

$2488\ PSI < 22{,}900\ PSI$

TRIPOD STRUCTURE
BEAM FORCES



BEAMS SEE LOAD IN TENSION/COMPRESSION ONLY

Method of tension coefficients

$W_X = 0.0$; $W_Y = 9{,}950$ lb; $W_Z = 0.0$

$$X_1 t_{AO} + X_2 t_{BO} + X_3 T_{CO} + W_X = 0.0$$

$$Y_3 t_{CO} + W_Y = 0$$

$$Z_2 t_{BO} + W_Z = 0 \rightarrow t_{BO} = 0 \quad \& \; T_{BO} = 0$$

X_N, Y_N, Z_N are the projected lengths onto the respective axes of Beams $\overline{AO}$ (N=1) $\overline{BO}$ (N=2) AND $\overline{CO}$ (N=3).

$$t_{CD} = -\frac{w_y}{y_1} \qquad y_1 = -\overline{CD} \sin 47.49,$$

$$= 86.0 \sin 47.490 = -63.396 \text{ in}$$

$$t_{CD} = \frac{-9950}{-63.396} = +156.9 \text{ lb/in}$$

$$x_1 = -\overline{AD} = -54.0 \text{ in.}$$

$$x_3 = -\overline{CD} \cos 47.49 = -.96 \cos 47.49 = -58.112 \text{ in}$$

$$x_1 t_{AD} + x_3 t_{CD} + w_x = 0$$

$$-54.0\ t_{AD} + (-58.112)(+156.9) = 0$$

$$t_{AD} = +\frac{58.112\ (156.9)}{-54.0} = -168.8 \text{ lb/in}$$

$$f_{CD} = \overline{CD}\ t_{CD} = 86.0\,(+156.9) = +13{,}493 \text{ lb}$$

$$f_{AD} = \overline{AD}\ t_{AD} = 54.0\,(-168.8) = -9{,}115 \text{ lb}$$

Item 7 6WF 15.5 I-BEAM

$A = 4.62\ in^2$ Ref (4) p 1-21

AXIAL compression

$$\sigma = F_A/A = \frac{9115}{4.62} = 1973\ PSI$$

$\ell = 54.0"$, $C_c = 126.5$

$r = 1.45"$

Ref (4) P 1-21

$K = 1.0$ $S_y = 36.0$ KSI

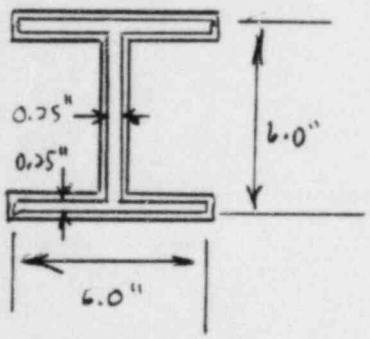
} see Appendix B

$$f_a = \tfrac{2}{3}\left(1 - \frac{\left(\frac{K\ell}{r}\right)^2}{2C_c^2}\right) S_y$$

$$= \tfrac{2}{3}\left(1 - \frac{\left(\frac{(1.0)(54.0)}{1.45}\right)^2}{2(126.5)^2}\right) 36.0 = 23.0\ KSI$$

1973 PSI < 23,000 PSI

Item 7 weld to Existing 27 WF 177 I-BEAM



TREAT weld AS LINE

$$\text{AREA} = (2d + 2w + 2(w-t))\sqrt{3}/2 \text{ leg length}$$
$$= (2(6.0) + 2(6.0) + 2(5.75))\sqrt{3}/2\,(.25)$$
$$= 6.276 \text{ in}^2$$

tension/compression

$$f_{net} = f_1 = F_{AD}/A = \frac{9115}{6.276} = \underline{1452 \text{ PSI} < 24400 \text{ PSI}}$$

Item 2 – 3" x 2" x ¼" L (2)

$$\text{AREA} = 2(l_1 w_1 + l_2 w_2) = 2(3(.25) + 1.75(.25)) = 2.375 \text{ in}^2$$

AXIAL compression

$$f = F_{CD}/A = \frac{13493}{2.375} = 5{,}681 \text{ PSI}$$

$l^* = 77.0"$ $C_c = 126.5$

$r = .43"$
Ref (4) P 1-33 (AXIS 2-2)

$K = 1.0$ $S_y = 36.0$ KSI

$E = 29.2 \times 10^3$ KSI

} See Appendix B

* $86.0" - 9.0" = 77.0"$ (INNER bolt to INNER bolt length)

Title: MAIN STEAM Seismic Supports
Calculated by: MJKennedy Date: 8.1.84
Checked by: RCTaylor Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

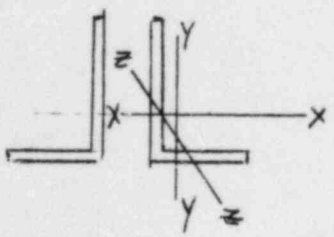
Project: 83-03

$$F_a = 2/3 \frac{\pi^2 E}{\left(\frac{Kl}{r}\right)^2}$$

$$= 2/3 \frac{\pi^2 \ 29.2 \times 10^3}{\left(\frac{(1.0)(77.01)}{1.43}\right)^2} = 6.0 \text{ KSI}$$

5,681 PSI < 6,000 PSI

This Assumes Buckling About the z-z Axis



Direction of buckling

Title: MAIN STEAM SEISMIC SUPPORTS
Calculated by: MJ Kennedy Date: 8/1/84
Checked by: R Chuck Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

Item 3 PLATE w / (2) 3/4" ϕ x 2" LG. B & N

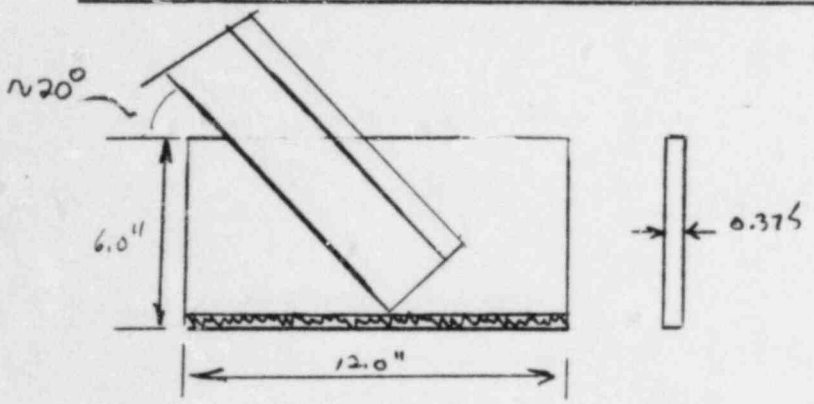


PLATE STRESS

$$\text{AREA} = w(\ell - \text{bolt } d) = (.375)(12.0 - (0.75 + 1/16)) = 4.195 \text{ in}^2$$

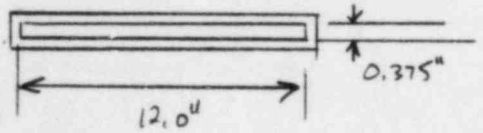
TENSION / COMPRESSION

$$\sigma = \frac{F_{CD} \sin 21.8}{A} = \frac{13{,}493 \sin 20}{4.195} = 1{,}100 \text{ PSI} < 32{,}400 \text{ PSI}$$

SHEAR

$$\tau = \frac{F_{CD} \cos 21.8}{A} = \frac{13{,}493 \cos 20}{4.195} = 3{,}022 < 24{,}400 \text{ PSI}$$

Item 3 Plate weld to 27 WF 177



TREAT weld AS LINE

$A = 2(\ell + w)\sqrt{3}/2$ leg length

$= 2(12.0 + .375)\sqrt{3}/2\ (.25)$

$= 4.375\ in^2$

tension / compression

$$\tau_1 = \frac{f_{CD}\ \sin 20.0}{A} = \frac{13,493\ \sin 20.0}{4.375} = 1,055\ PSI$$

SHEAR

$$\tau_3 = \frac{f_{CD}\ \cos 20.0}{A} = \frac{13,493\ \cos 20.0}{4.375} = 2,898\ PSI$$

$$\tau_{net} = \sqrt{\tau_1^2 + \tau_3^2} = \sqrt{(1055)^2 + (2,898)^2} = 3084\ PSI$$

$< 24400\ PSI$

Bolts (Items 4 & 3)

$$Area = 4\left(\frac{\pi}{4} D^2\right) = \pi (.75)^2 = 1.767\ in^2$$

$$\tau = \frac{f_{CD}}{A} = \frac{13493}{1.767} = 7636\ PSI < 24400\ PSI$$

Item 4 Plate w/(2) 3/4" ϕ x 2" LG B & N

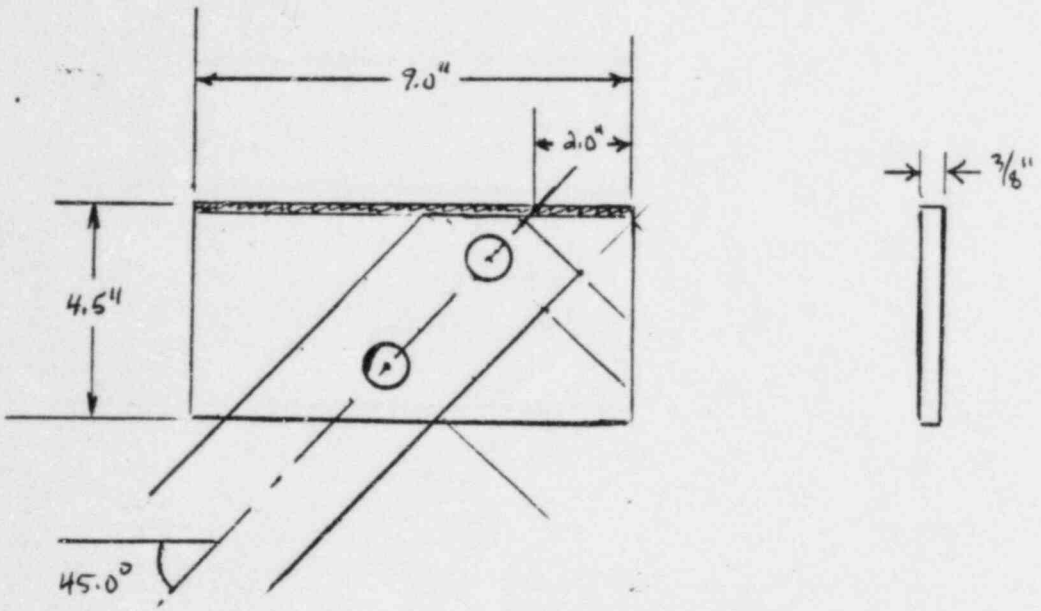


Plate stress

$$\text{AREA} = w\,(\ell - \text{bolt } d) = (.375)(9.0-(.75+1/16)) = 3.070\ \text{in}^2$$

Tension / compression

$$f = \frac{F_{CD}\sin 45.0}{A} = \frac{13{,}493\ \sin 45.0}{3.070} = 3{,}108\ \text{PSI}$$

$< 32{,}400$ PSI

SHEAR

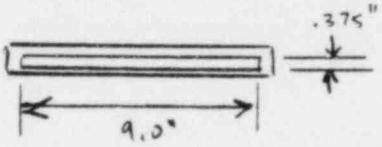
$$\tau = \frac{F_{CD}\cos 45.0}{A} = \frac{13{,}493\ \cos 45.0}{3.070} = 3{,}108\ \text{PSI}$$

$< 24{,}400$ PSI

Item 4 Plate weld to Item 7

Area = $2(\ell + w)\frac{\sqrt{3}}{2}$ leg length

$= 2(9.0 + .375)\frac{\sqrt{3}}{2}(.25) = 3.315$



tension / compression

$$\tau_1 = \frac{f_{CD} \sin 45}{A} = \frac{13,493 \sin 45}{3.315} = 2878 \text{ PSI}$$

SHEAR

$$\tau_3 = \frac{f_{CD} \cos 45}{A} = \frac{13,493 \cos 45}{3.315} = 2878 \text{ PSI}$$

$$\tau_{net} = \sqrt{(\tau_1)^2 + (\tau_3)^2} = \sqrt{(2878)^2 + (2878)^2}$$

$$= 4070 \text{ PSI} < 24,400 \text{ PSI}$$

Support MS-R4A Summary Table

Item	Type of Stress	Calculated Stress (PSI)	Allowable Stress (PSI)
Item 9 weld to M.S. Pipe	SHEAR	7,299	24,400
Item 9	BENDING	2,620	40,600
	SHEAR	2,488	24,400
Item 8 weld to 6WF	SHEAR	2,814	24,400
Item 8 weld	SHEAR	3,127	24,400
Item 8	SHEAR	2,488	24,400
	Bolthole TENSION	3,387	32,400
	AXIAL compression	2,488	22,900
Item 7	AXIAL compression	1,973	23,000
Item 7 weld to 27WF	SHEAR	1,452	24,400
Item 2	AXIAL compression	5,681	6,000
Item 3	TENSION/ compression	1,100	32,400
	SHEAR	3,022	24,400

Summary Table (cont.)

Item	TYPE OF STRESS	Calculated stress (PSI)	Allowable stress PSI
Item 3 weld to 27WF	SHEAR	3,084	24,400
Bolts	SHEAR	7,636	24,400
Item 4	Tension/ compression	3,108	32,400
	SHEAR	3,108	24,400
Item 4 weld to Item 7	SHEAR	4,070	24,400
clevis Bolt	SHEAR	6,333	24,400

MPR ASSOCIATES, INC.
1050 Connecticut Ave., NW – Washington, DC 20036

Title: MAIN STEAM SEISMIC Supports
Calculated by: M J Kennedy Date: 8/1/84
Checked by: K L Thenisch Date: 8/7/84
Reviewed by: JJ Date: 8-22-84

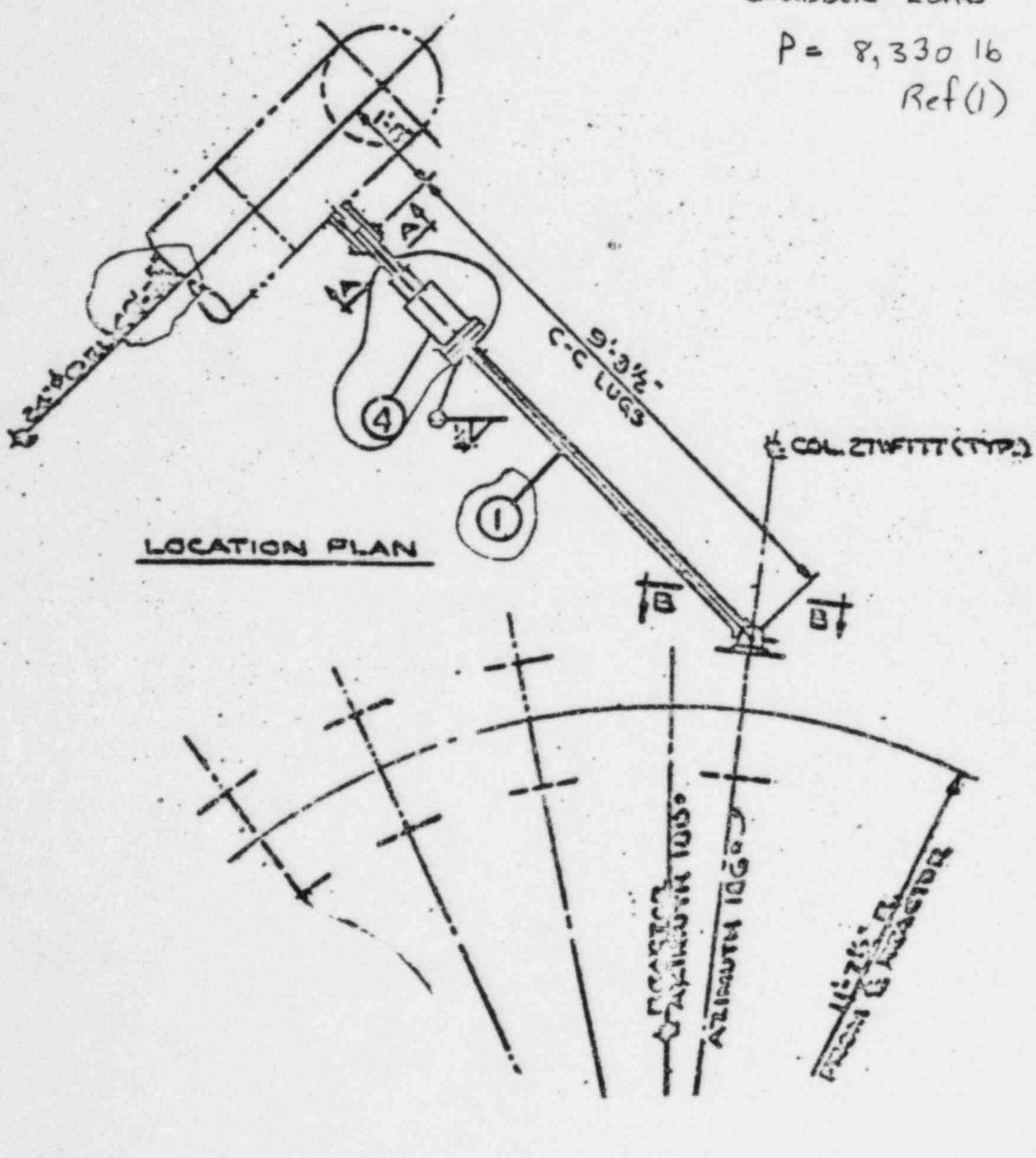
Project: 83-03

Support MARK No. MS-R5A

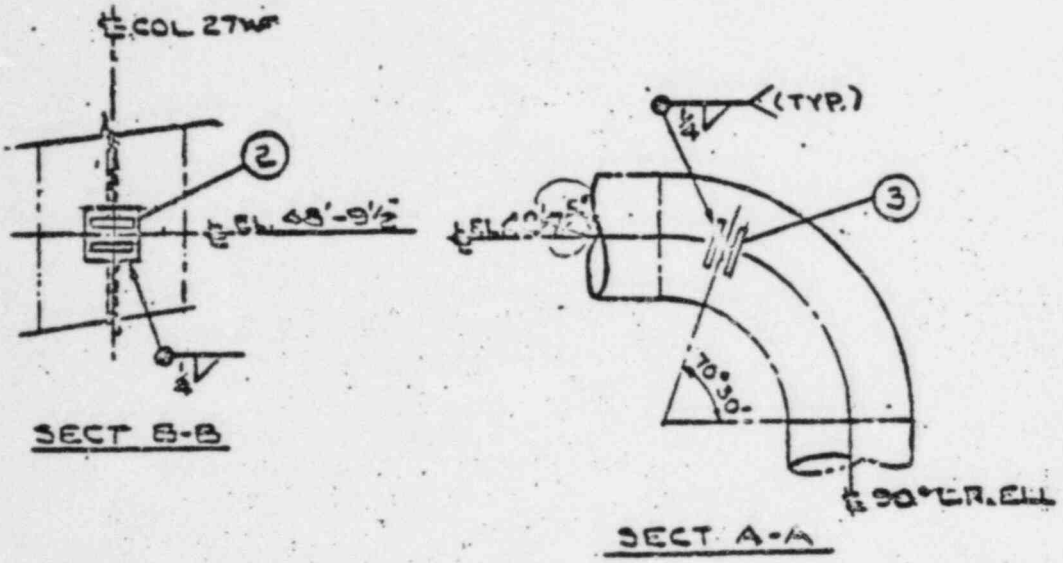
DESCRIPTION

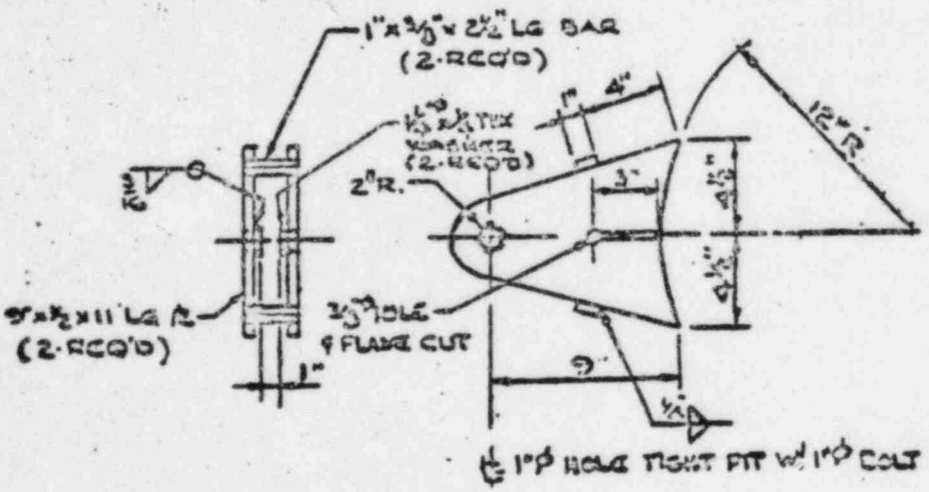
SNUBBER LOAD

P = 8,330 lb
Ref(1)



LOCATION PLAN



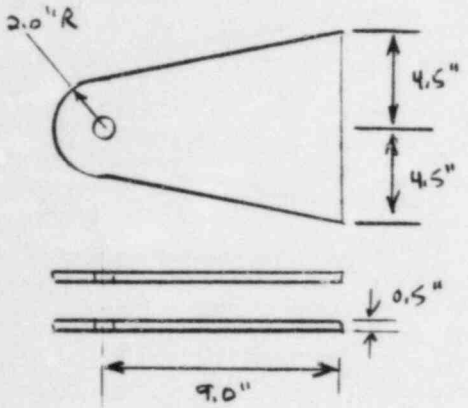


DET. "C"

Item 3 clevis

Item 3 PIPE Attachment w/ (1) 1"ϕ x 3¾" LG B.& N.

Bolt rated to 10,000 lb
Ref (2)



Pullout shear

$AREA = 2(2rt) = 2(2(2.0).5) = 4.0\ in^2$

$\tau = P/A = \frac{8330}{4.0} = 2083\ PSI$

$< 24{,}400$

clevis Bolthole Tension Stress

$AREA = 2(2R - hole\ d)t = 2(2(2.0) - (1 + 1/16))(.5) = 2.938\ in^2$

$\sigma = \frac{P}{A} = \frac{8330}{2.938} = 2835\ PSI < 32{,}400\ PSI$

AXIAL COMPRESSION

let AREA = minimum AREA = $2tw = 2(.5)(4.0) = 4.0\ in^2$

$\sigma = P/A = \frac{8330}{4.0} = 2083\ PSI$

$l \simeq 9.0$; $C_c = 126.5$
$r = t/\sqrt{12} = \frac{.5}{\sqrt{12}} = .144$
$K = 2.0$; $S_y = 36.0\ KSI$

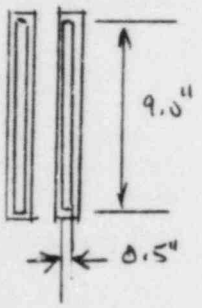
} See Appendix B

$$F_a' = \tfrac{2}{3}\left(1-\left(\frac{Kl}{r}\right)^2/2C_c^2\right) S_y$$

$$= \tfrac{2}{3}\left(1-\frac{\left[(1.0)(9.0)\right]^2}{.144}/2(126.5)^2\right) 36.0 = 12.3 \text{ KSI}$$

2083 PSI < 12,300 PSI

Item 3 weld to 24" ∅ PIPE



TREAT weld AS line

$$\text{AREA} = 2(2l+2w)\frac{\sqrt{2}}{2}\text{ leg length}$$

$$= 2[2(9.0)+2(.5)]\sqrt{2}/2\,(.25)$$

$$= 6.718 \text{ in}^2$$

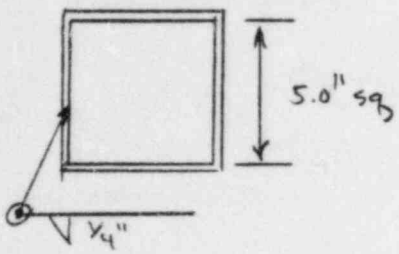
$$\gamma_{jet} = \gamma_3 = \frac{8330}{6.718} = 1240 \text{ PSI} < 24{,}400 \text{ PSI}$$

Item 2 Clevis & Bolt STANDARD PART EA1-A

RATED to 10000 lb

ACTUAL LOAD 8330 lb

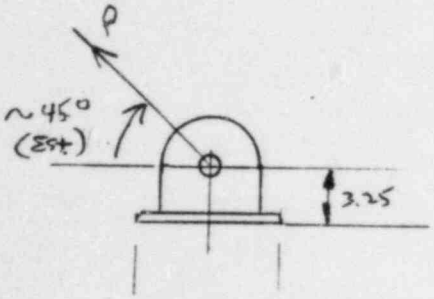
Item 2 Weld to existing 27 WF 177 I-BEAM



TREAT weld as LINE

$A = 4\ s\ \sqrt{2}/2$ leg length
$= 4(5.0)\ \sqrt{2}/2\ (.25)$
$= 3.536\ in^2$

$Z = \left(s^2 + \frac{s^2}{3}\right)^{\sqrt{2}/2}$ leg length
$= \left(5^2 + \frac{5^2}{3}\right)^{\sqrt{2}/2}\ (.25)$
$= 5.893\ in^2$



tension compression

$$\gamma_1 = \frac{P \sin 45}{A} = \frac{8330 \sin 45}{3.536} = 1666\ PSI$$

bending

$$\gamma_2 = \frac{P \cos 45\ \ell}{Z} = \frac{8330 \cos 45\ (3.25)}{5.893} = 3248\ PSI$$

SHEAR

$$\gamma_3 = \frac{P \cos 45}{A} = \frac{8330 \cos 45}{3.536} = 1666\ PSI$$

$$\gamma_{net} = \sqrt{(\gamma_1 + \gamma_2)^2 + \gamma_3^2} = \sqrt{(1666 + 3248)^2 + (1666)^2} = \underline{5189\ PSI}$$

$< 24400\ PSI$

Support MS-R5A Summary Table

Item	TYPE OF STRESS	Calculated Stress (PSI)	Allowable Stress (PSI)
Item 3	SHEAR	2,083	24,400
	Bolthole tension	2,835	32,400
	AXIAL compression	2,083	12,300
Item 3 weld to M.S. Pipe	SHEAR	1,240	24,400
Item 2 weld to 27WF	SHEAR	5,189	24,400

Item	Calculated LOAD (lb)	Allowable LOAD (lb)
2	8,330	10,000

Appendix D

MPR ASSOCIATES, INC.
1050 Connecticut Ave., NW – Washington, DC 20036

Title: Feedwater Seismic Supports
Calculated by: MKennedy Date: 8/1/84
Checked by: RCTalwich Date: 8/1/84
Reviewed by: [illegible] Date: 8-22-84

Project: SEP Piping Supports
83-03

Page 1 of 69

PURPOSE: The purpose of the following calculation is to analyze the feedwater seismic supports for Level D service conditions[1]. Loads used are from revised EG&G piping model loads documented in Appendix A.

References:

(1) MPR calculation by M. Kennedy dated 8/2/84 "Seismic Support Loads", Appendix A.

(2) Bergen Paterson Pipe Support Catalog #66 p. 46.

(3) Crane Technical Paper #410, 1981.

(4) AISC Steel Const. Manual, 6th Ed.

(5) Roark and Young, Formulas for Stress and Strain, 5th Ed.

---

(1) The snubber is analyzed separately in Appendix E. This calculation analyzes clevises, welds and structural members supplied with the snubber

Reference Drawings

Bergen - Paterson.

Support	Dwg #
RF - R1A	1849
RF - R2A	1850
RF - R3A	1851
RF - R4A	1852
RF - R5A	1853
RF - R6A	1854
X-4B-55-1	116

STANDARD Drawings 64101
64108

Burns & Roe Dwg 4069.

General Physics Dwg 19443, Sht. 2 of 3.

Summary

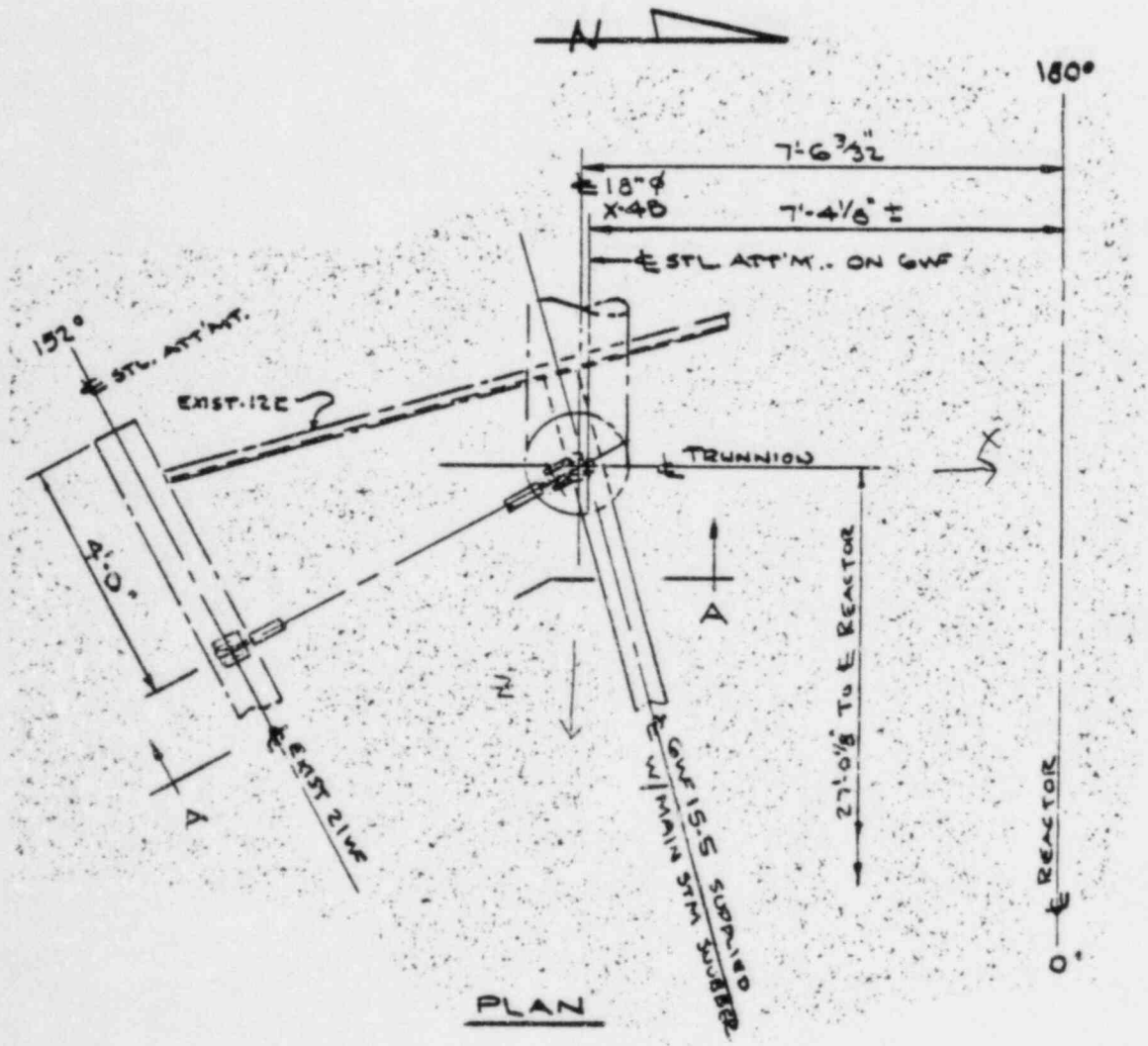
Based on the following calculations, the feedwater seismic supports meet the stress requirements of the 1980 ASME Code, Section III, Subsection NF. The supports are considered acceptable. A summary table follows each support evaluation.

Title: Feedwater Seismic Supports
Calculated by: MJKennedy Date: 9/1/84
Checked by: RCTrench Date: 9/9/84
Reviewed by: JA Date: 9-22-84

Project: 83-03

Support X-4B-SS-1

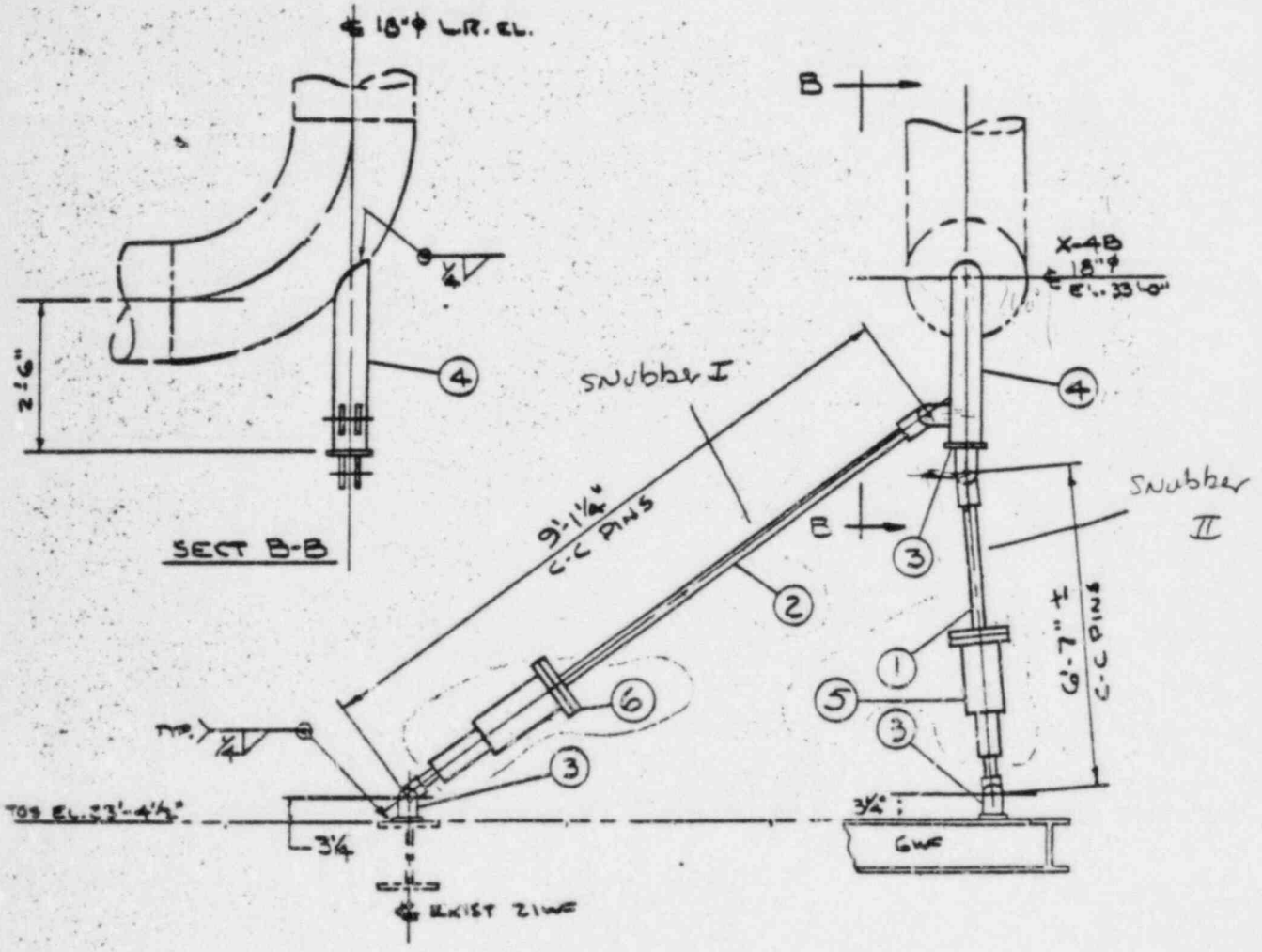
Description



PLAN

Title: Feedwater Seismic Supports
Calculated by: MKeough Date: 8/1/84
Checked by: RChrenka Date: 8/9/84
Reviewed by: JT Date: 8-22-84

Project: 8303



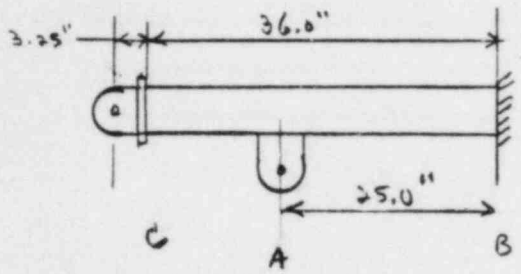
P_I = 1340 lb

P_{II} = 2340 lb

Title: Feedwater Seismic Supports
Calculated by: mf Kennedy Date: 2/1/84
Checked by: RC Trench Date: 2/6/84
Reviewed by: JJ Date: 2-22-84

Project: 8303

Item 4 PIPE / Clevis Assembly



Pipe

AXIAL LOAD = AL = 4276 lb

TRANSVERSE LOAD = $\sqrt{(948)^2 + (510)^2}$ = 1076 lb

MOMENT LOAD = $\sqrt{(12{,}821)^2 + (23{,}733)^2}$

= 26,975 in. lb.

Ref Computer Run BBCYTVF P. 190 member 65/345

$I = \frac{\pi}{64}(d_o^4 - d_i^4) = \frac{\pi}{64}(4.5^4 - 4.026^4) = 7.232\ in^2$

$c = \frac{4.5}{2} = 2.25\ in$

4" ϕ Sch. 40

$A = \frac{\pi}{4}(d_o^2 - d_i^2) = \frac{\pi}{4}(4.5^2 - 4.026^2) = 3.174\ in^2$

SHEAR

$\tau = P_H / A = 1076 / 3.174 =$ 339 PSI < 24,400 PSI

AXIAL TENSION AND COMPRESSION

Between Location A & B

L = Axial Load = 4,276 lb

$\sigma = L/A = 4,276/3.174 =$ 1347 PSI < 40,600 PSI

$\ell = 27.5''$, $C_c = 126.5$
$r = 1.51''$
$K = 2.0$, $S_y = 36.0$ KSI
} See Appendix B

$$F_a = \frac{2}{3}\left(1 - (K\ell/r)^2/2C_c^2\right) S_y$$

$$= \frac{2}{3}\left(1 - \left(\frac{(2.0)27.5}{1.51}\right)^2/2(126.5)^2\right) 36.0 = 23.0 \text{ KSI}$$

1347 PSI < 23,000 PSI

BENDING AT Feedwater Pipe

$$\sigma = \frac{Mc}{I} = \frac{26,975\ (2.25)}{7.232} = 8,392 \text{ PSI}$$

1,347 + 8,392 = 9739 PSI < 40,600 PSI

Title: Feedwater Seismic Supports
Calculated by: MJKamal Date: 8/1/84
Checked by: RCTaylor Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

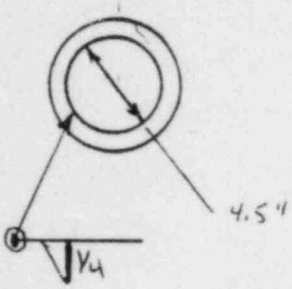
Project: 83-03

Axial Compression and Bending

$$\frac{f_a}{F_a'} + \frac{f_b}{F_b'} \leq 1.0$$

$$\frac{1,347}{23,000} + \frac{8,392}{40,600} = .27 < 1.0$$

Item 4 Weld to Feedwater Pipe



TREAT weld AS LINE

$A = \pi d \, 5/16$ leg length
$= \pi (4.5) \, 5/16 (.25) = 2.499 \text{ in}^2$

$Z = \frac{\pi d^2}{4} \, 5/16$ leg length
$= \pi \frac{(4.5)^2}{4} \, 5/16 \, (.25) = 2.812 \text{ in}^3$

tension / compression

$\tau_1 = AL/A = 4{,}276/2.499 = 1{,}711$ PSI

BENDING

$\tau_2 = \frac{M}{Z} = 26{,}975/2.812 = 9{,}593$ PSI

SHEAR

$\tau_3 = TL/A = 1{,}076/2.499 = 431$ PSI

$\tau_{Net} = \sqrt{(\tau_1 + \tau_2)^2 + \tau_3^2} = \sqrt{(1711 + 9593)^2 + (431)^2}$

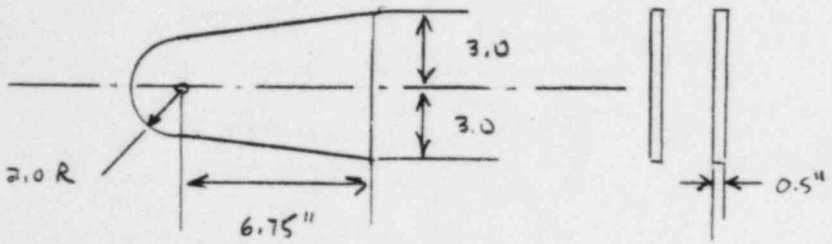
$= \underline{71{,}312 \text{ PSI} < 24{,}400 \text{ PSI}}$

Title: Feedwater Seismic Supports
Calculated by: M Kennedy Date: 3/1/84
Checked by: RC Thurston Date: 3/9/84
Reviewed by: JL Date: 3-20-84

Project: 8303

SNubber I clevis & Bolt

Assume Bergen Paterson STANDARD Part EAI-4



Pullout SHEAR

Area = $2(2rt) = 2(2(2.0)(.5)) = 4.0\ in^2$

$P_I = 1340$ lb., $TL = 1070$ lb., $AL = 806$ lb.

$\tau = P_I/A = 1340/4.0 =$ **335 PSI < 24,400 PSI**

SHEAR AT BASE

Area = $2lw = 2(6.0)(.5) = 6.0\ in^2$

$\tau = TL/A = 1070/6.0 =$ **178 PSI < 24,400 PSI**

BoltHole tension

Area = $2t(2r - \text{hole } d) = 2(.5)(2(2.0) - (1 + 1/16)) = 2.938\ in^2$

$\sigma = P_I/A = 1340/2.938 =$ **456 PSI < 32,400 PSI**

AXIAL COMPRESSION

$$\text{AREA} = \text{min. AREA} = 2t(2r) = 2(.5)(2.(2.0)) = 4.0 \text{ in}^2$$

$$\delta = \frac{AL}{A} = 806/4.0 = 202 \text{ PSI}$$

$l = \simeq 6.75"$; $C_c = 126.5$

$r = t/\sqrt{12} = 0.144"$

$K = 2.0$; $S_y = 36.0$ KSI

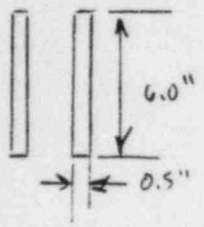
} see section 2 of this Appendix

$$F_a = \tfrac{2}{3}\left(1 - \left(\frac{Kl}{r}\right)^2 / 2C_c^2\right) S_y$$

$$= \tfrac{2}{3}\left(1 - \left(\frac{(2.0)(6.75)}{0.144}\right)^2 / 2(126.5)^2\right) 36.0 = 17.4 \text{ KSI}$$

202 PSI < 17,400 PSI

BENDING AT BASE



$$I = 2\frac{bh^3}{12} = \frac{.5(6.0)^3}{6} = 18.0 \text{ in}^4$$

$C = 3.0$ in

$$\delta = \frac{MC}{I} = \frac{TLd \cdot c}{I} = \frac{1070(6.75)(3.0)}{18.0} = 1204 \text{ PSI}$$

$1204 + 202 = 1406 \text{ PSI} < 40,600 \text{ PSI}$

AXIAL COMPRESSION AND BENDING

$$\frac{f_a}{F_a'} + \frac{f_b}{F_b'} \leq 1.0$$

$$\frac{202}{17400} + \frac{1204}{40,600} = 0.04 < 1.0$$

Bolt Shear

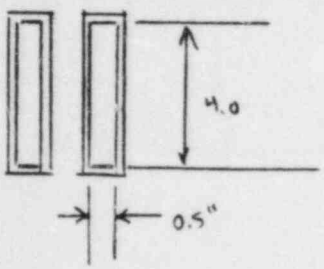
$$\text{Area} = 2\,\frac{\pi d^2}{4} = 2\,\frac{\pi (1.6)^2}{4} = 1.571 \text{ in}^2$$

$$\tau = P/A = 1340/1.571 = \underline{853 \text{ PSI} < 24,400 \text{ PSI}}$$

Title: Feedwater seismic supports
Calculated by: MJKennedy Date: 8/1/84
Checked by: RLTrevigh Date: 5/6/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

Item 4 weld to Snubber I clevis



TREAT weld AS LINE

$A = 2(2\ell + 2w)\ \sqrt{3}/2$ leg length
$= 2(2(4.0) + 2(.5))\ \sqrt{3}/2\ (.25)$
$= 3.182\ in^2$

$Z = 2\left(bd + d^2/3\right)\sqrt{3}/2$ leg length
$= 2(.5(4.0) + 4.0^2/3)\ \sqrt{3}/2\ (.25)$
$= 2.593\ in^3$

Tension / compression

$\tau_1 = AL/A = 806/3.182 = 253$ PSI

BENDING

$\tau_2 = M/Z = \frac{(1070)(1.75)}{2.593} = 2785$ PSI

SHEAR

$\tau_3 = TL/A = 1070/3.182 = 336$ PSI

$\tau_{Net} = \sqrt{(\tau_1 + \tau_2)^2 + \tau_3^2} = \sqrt{(253 + 2785)^2 + (336)^2}$

$= \underline{3057\ \text{PSI} < 24{,}400\ \text{PSI}}$

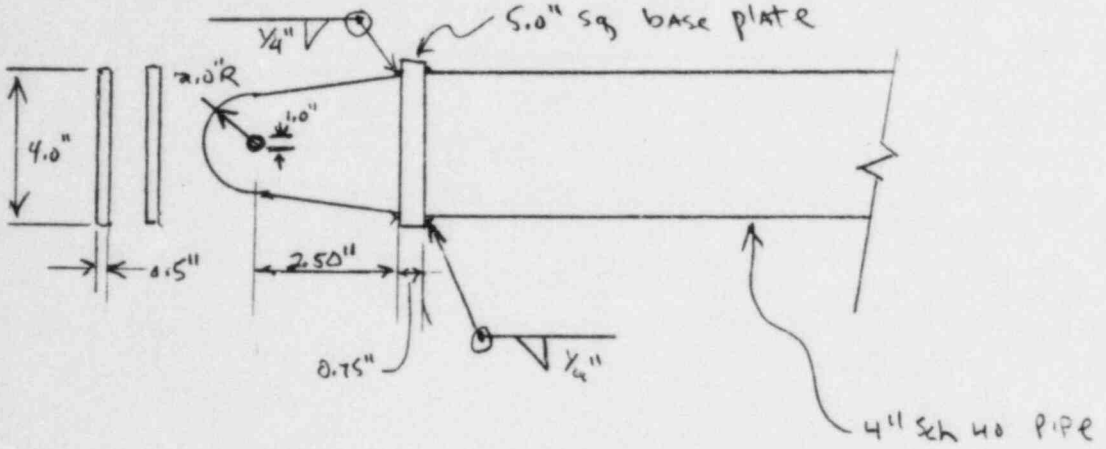
Title: Feedwater Seismic Supports
Calculated by: MKennedy Date: 8/1/84
Checked by: RCTiernay Date: 8/4/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

Snubber II clevis & Bolt

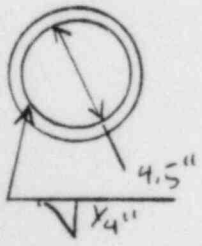
Assume Bergen-Paterson STANDARD Part EA1-A

P_{II} = 2,340 lb
AXIAL LOAD = 2,339 lb
TRANSVERSE LOAD = 61 lb



4" sch 40 PIPE weld to base plate

TREAT weld AS LINE



Area = $\pi d \frac{\sqrt{2}}{2}$ leg length
= $\pi (4.5) \sqrt{2}/2 (.25)$ = 2.499 in^2

$Z = \frac{\pi d^2}{4} \frac{\sqrt{2}}{2}$ leg length
= $\pi \frac{(4.5)^2}{4} \sqrt{2}/2 (.25)$ = 2.812 in^3

tension / compression

$\gamma = A_L/A = 2339/2.499 = 936$ PSI

BENDING

$$\tau_2 = M/Z = TL \cdot e/Z = \frac{61\,(3.25)}{2.812} = 71 \text{ PSI}$$

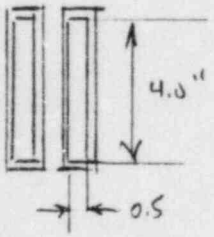
SHEAR

$$\tau_3 = \frac{TL}{A} = \frac{61}{2.499} = 24 \text{ PSI}$$

$$\tau_{Net} = \sqrt{(\tau_1 + \tau_2)^2 + \tau_3^2} = \sqrt{(936 + 71)^2 + (24)^2} = \underline{1007 \text{ PSI}}$$

$$< 24{,}400 \text{ PSI}$$

Clevis Plate to Base Plate Weld



TREAT Weld As Line

$$\text{AREA} = 2\,(2\ell + 2w)\ \sqrt{2}/2 \text{ leg length}$$
$$= 2(2(4.0) + 2(.5))\ \sqrt{2}/2\ (.25) = 3.182 \text{ in}^2$$

$$Z = 2\left(bd + d^2/3\right)\ \sqrt{2}/2 \text{ leg length}$$
$$= 2\left(.5(4.0) + (4.0)^2/3\right)\ \sqrt{2}/2\ (.25)$$
$$= 2.593 \text{ in}^3$$

TENSION / COMPRESSION

$$\tau_1 = AL/A = 2339/3.182 = 735 \text{ PSI}$$

BENDING

$$\tau_2 = M/Z = \frac{TL \cdot \ell}{Z} = \frac{(2.75)(61)}{2.593} = 65 \text{ PSI}$$

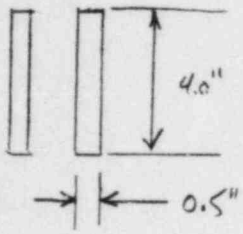
SHEAR

$$\tau_3 = TL/A = 61/3.182 = 19 \text{ PSI}$$

$$\tau_{Net} = \sqrt{(\tau_1 + \tau_2)^2 + \tau_3^2} = \sqrt{(735 + 65)^2 + (19)^2} = \underline{800 \text{ PSI}}$$

$$< 24{,}400 \text{ PSI}$$

clevis plate



$$\text{Area} = 2(\ell w) = 2(.5(4.0)) = 4.0 \text{ in}^2$$

$$I = 2\frac{bh^3}{12} = \frac{2(.5)(4.0)^3}{12} = 5.333 \text{ in}^4$$

$$c = 2.0 \text{ in}$$

SHEAR AT BASE

$$f = TL/A = 61/4 = 15 \text{ PSI} < 24{,}400 \text{ PSI}$$

AXIAL COMPRESSION

$$\sigma = AL/A = 2339/4 = 585 \text{ PSI}$$

$\ell = 2.75"$; $C_c = 126.5$

$r = t/\sqrt{12} = 0.144"$

$K = 2.0$, $S_y = 36.0$ KSI

} See Appendix B

$$f_a = 2/3\left(1 - \left(\frac{(2.0)(2.75)}{0.144}\right)^2 / 2(126.5)^2\right) 36.0 = 22.9 \text{ KSI}$$

585 PSI < 22,900 PSI

Pullout Shear

$A = 4.0\ in^2$ $P_{II} = 13876\ lb$

$\tau = P/A = 2340/4.0 =$ 585 PSI < 24400 PSI

Bolthole tension

$A = 2.938\ in^2$

$\sigma = P/A = 2340/2.938 =$ 796 PSI < 32,400 PSI

Bending at BASE

$\sigma = \frac{MC}{I} = \frac{TL \cdot 2 \cdot C}{I} = \frac{61 \cdot 2.75 \cdot 2}{5.333} =$ 63 PSI

$63 + 585 =$ 648 PSI < 40,600 PSI

Axial compression and Bending

$$\frac{f_a}{F_a'} + \frac{f_b}{F_b'} \leq 1.0$$

$$\frac{585}{22900} + \frac{63}{40,600} = 0.03 < 1.0$$

Bolt

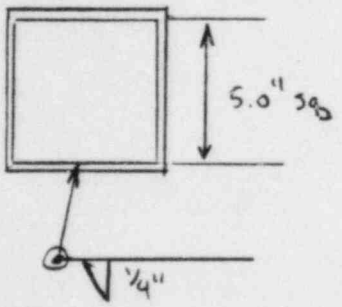
$$\text{Area} = 2\,\frac{\pi d^2}{4} = 2\,\frac{\pi (1.0)^2}{4} = 1.571\ in^2$$

$$f_v = P_v / A = 2339 / 1.571 = \underline{1489\ psi < 24400\ psi}$$

Snubber II Item 3 Clevis & Bolt STANDARD PART EA1-A

the stresses for this part are identical to the stresses for the Snubber II clevis ¾ bolt of the clevis / pipe Assembly by symmetry.

Snubber II Item 3 weld to 6WF 15.5 I-BEAM



TREAT weld AS LINE

Area = $4s\sqrt{3}/2$ leg length
$= 4(5)\sqrt{3}/2\,(.25) = 3.536\ in^2$

$Z = (s^2 + s^2/3)\sqrt{2}/2$ leg length
$= (5^2 + 5^2/3)\sqrt{3}/2\,(.25) = 5.893\ in^2$

Tension / Compression

$\tau_1 = A_L/A = 2339/3.536 = 661$ psi

BENDING

$\tau_2 = M/Z = \frac{TL \cdot \ell}{Z} = \frac{(2.75)(61)}{5.893} = 28$ psi

SHEAR

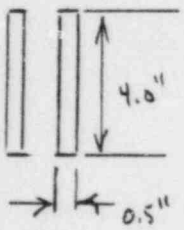
$\tau_3 = TL/A = (61)/3.536 = 17$ psi

$\tau_{net} = \sqrt{(\tau_1 + \tau_2)^2 + \tau_3^2} = \sqrt{(661 + 28)^2 + (17)^2} = 689$ psi

< 24400 psi

Snubber I Item 3 Clevis & Bolt STANDARD PART EA1-A

Clevis Plate



$P_I = 1340$ lb

$\text{Area} = 2(l \cdot w) = 2(.5(4.0)) = 4.0 \text{ in}^2$

$I = \frac{2bh^3}{12} = \frac{2(.5)(4.0)^3}{12} = 5.333 \text{ in}^4$

$c = 2.0$

SHEAR AT BASE

$f = T_L/A = 806/4 = \underline{202 \text{ PSI} < 24400 \text{ PSI}}$

AXIAL compression

$\text{Area} = \text{min area} = 2t(2r) = 2(.5)(2(2.0)) = 4.0 \text{ in}^2$

$b = A_L/A = 1070/4.0 = 268 \text{ PSI}$

$l = 2.50"$; $C_c = 126.5$

$r = t/\sqrt{12} = 0.5/\sqrt{12} = 0.144"$

$K = 2.0$; $S_y = 36.0$ KSI

See Appendix B

$F_a = 2/3\left(1 - \left(\frac{Kl}{r}\right)^2 / 2C_c^2\right) S_y = 2/3\left(1 - \left(\frac{2.0(2.5)}{0.144}\right)^2\right) 36.0 = 23.1 \text{ KSI}$

$\underline{268 \text{ PSI} < 23{,}100 \text{ PSI}}$

Pullout Shear

$$\text{Area} = 2(2rt) = 2(2(2.0)(.5) = 4.0 \text{ in}^2$$

$$P = 1340 \text{ lb}$$

$$\tau = P/A = 1340/4.0 = \underline{335 \text{ PSI} < 24400 \text{ PSI}}$$

Bolthole Tension

$$\text{Area} = 2t(2r - \text{hole } d) = 2(.5)\left(2(2.0) - (1+1/16)\right) = 2.938 \text{ in}^2$$

$$\sigma = P/A = 1340/2.938 = \underline{456 \text{ PSI} < 32,400 \text{ PSI}}$$

BENDING AT BASE

$$\sigma = \frac{Mc}{I} = \frac{Th \cdot l \cdot c}{I} = \frac{806(2.5)(2.0)}{5.333} = 756 \text{ PSI}$$

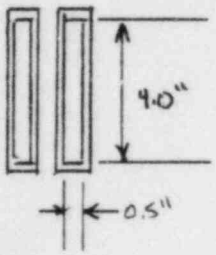
$$268 + 756 = \underline{1,024 \text{ PSI} < 40,600 \text{ PSI}}$$

AXIAL COMPRESSION AND BENDING

$$\frac{F_a}{f_a} + \frac{f_b}{F_b} \leq 1.0$$

$$\frac{268}{23,100} + \frac{756}{40,600} = 0.03 < 1.0$$

clevis plate weld to base plate



TREAT weld AS LINE

$$\text{AreA} = 2(2d + 2w)\ \sqrt{3}/2 \text{ leg length}$$
$$= 2(2(4.0) + 2(1.5))\ \sqrt{3}/2\ (.25) = 3.182\ in^2$$

$$Z = 2(bd + d^2/3)\ \sqrt{3}/2 \text{ leg length}$$
$$= 2(.5(4.0) + (4.0)^2/3)\ \sqrt{3}/2\ (.25)$$
$$= 2.593\ in^3$$

tension / compression

$$\tau_1 = A_L/A = 1070/3.182 = 336 \text{ PSI}$$

BENDING

$$\tau_2 = M/Z = \frac{T_L \cdot \ell}{Z} = \frac{806\ (2.5)}{2.593} = 777 \text{ PSI}$$

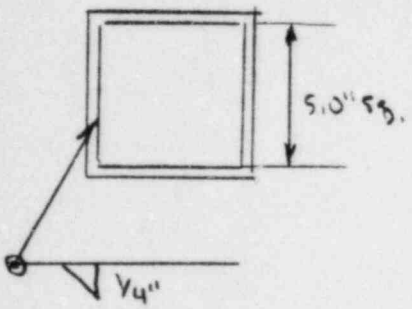
SHEAR

$$\tau_3 = T_L/A = 806/3.182 = 253 \text{ psi}$$

$$\tau_{net} = \sqrt{(\tau_1 + \tau_2)^2 + \tau_3^2} = \sqrt{(336 + 777)^2 + (253)^2} = \underline{1141 \text{ psi}}$$

$< 24{,}400 \text{ PSI}$

BASE PLATE Weld to 21WF I-BEAM



TREAT Weld As LINE

$$\text{AREA} = 4 \times 5 \sqrt{2}/2 \text{ leg length}$$
$$= 4(5)\sqrt{2}/2\,(.25) = 3.536 \text{ in}^2$$

$$Z = (5^2 + 5^2/3)\sqrt{2}/2 \text{ leg length}$$
$$= (5^2 + 5^2/3)\sqrt{2}/2\,(.25) = 5.893 \text{ in}^3$$

Tension compression

$$\tau_1 = AL/A = \frac{1070}{3.536} = 303 \text{ PSI}$$

BENDING

$$\tau_2 = M/Z = \frac{TL \cdot d}{Z} = \frac{806\,(3.25)}{5.893} = 445 \text{ PSI}$$

SHEAR

$$\tau_3 = T4/A = 806/3.536 = 228 \text{ PSI}$$

$$\tau_{net} = \sqrt{(\tau_1 + \tau_2)^2 + \tau_3^2} = \sqrt{(303 + 445)^2 - (228)^2}$$

$$= \underline{782 \text{ PSI} < 24,400 \text{ PSI}}$$

Title: Feedwater Seismic Supports
Calculated by: [illegible] Date: 8/1/84
Checked by: R.C. Arnold Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

Support X-4B-55-1 Summary Table

Item	TYPE of STRESS	Calculated stress (PSI)	Allowable stress (PSI)
4	SHEAR	339	24,400
	Compression	1347	23,000
	BENDING	9,739	40,600
	AXIAL compression AND BENDING	0.27 (Note 1)	1.0 (Note 1)
Snubber I clevis	Pullout SHEAR	335	24,400
	Bolthole tension	456	32,400
	AXIAL compression	202	17,400
	BENDING	1,406	40,600
	AXIAL compression AND BENDING	0.04 (Note 1)	1.0 (Note 1)
Bolt	SHEAR	853	24,400
Item 4 weld to Feed P.pe	SHEAR	11,312	24,400
Item 4 weld to clevis Base Plate	SHEAR	1,007	24,400
Item 4 weld to snubber I clevis	SHEAR	3057	24,400

Summary Table (cont.)

Item	TYPE of STRESS	Calculated Stress (PSI)	Allowable Stress (PSI)
Snubber II clevis plate weld to BASE PLATE	SHEAR	800	24,400
Snubber II clevis Plate	SHEAR	15	24,400
	AXIAL COMPRESSION	585	24,400
	Pullout SHEAR	585	24,400
	Bolthole TENSION	796	32,400
	BENDING	648	40,600
	AXIAL COMPRESSION AND BENDING	0.03 (Note 1)	1.0 (Note 1)
Bolt	SHEAR	1,489	24,400
Item 3 weld to 6 WF 15.5 I-BEAM	SHEAR	689	24,400
Item 3 weld to 21 WF I-BEAM	SHEAR	782	24,400

Summary table (cont.)

Item	TYPE OF STRESS	CALCULATED STRESS (PSI)	ALLOWABLE STRESS (PSI
Snubber I Item 3	SHEAR	202	24,400
	AXIAL COMPRESSION	268	23,100
	Pullout SHEAR	335	24,400
	Bolthole TENSION	456	32,400
	BENDING	1,024	40,600
	AXIAL COMPRESSION AND BENDING	0.03 (Note 1)	1.0 (Note 1)
Clevis Plate weld to BASE Plate	SHEAR	1,141	24,400

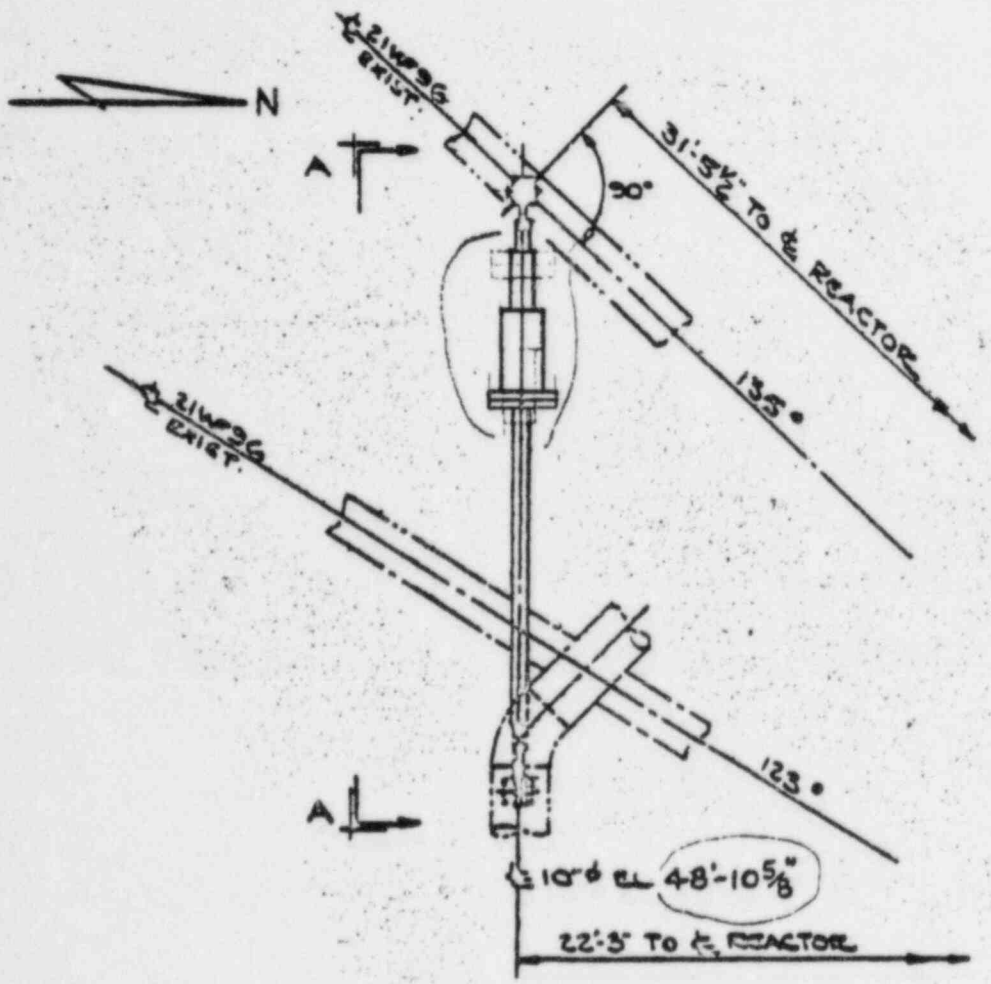
Notes

(1) Value is not stress in psi but stress ratio (non-dimensional)

Title: Feedwater Seismic Supports
Calculated by: [illegible] Date: 8/1/84
Checked by: RCT-Reinch Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

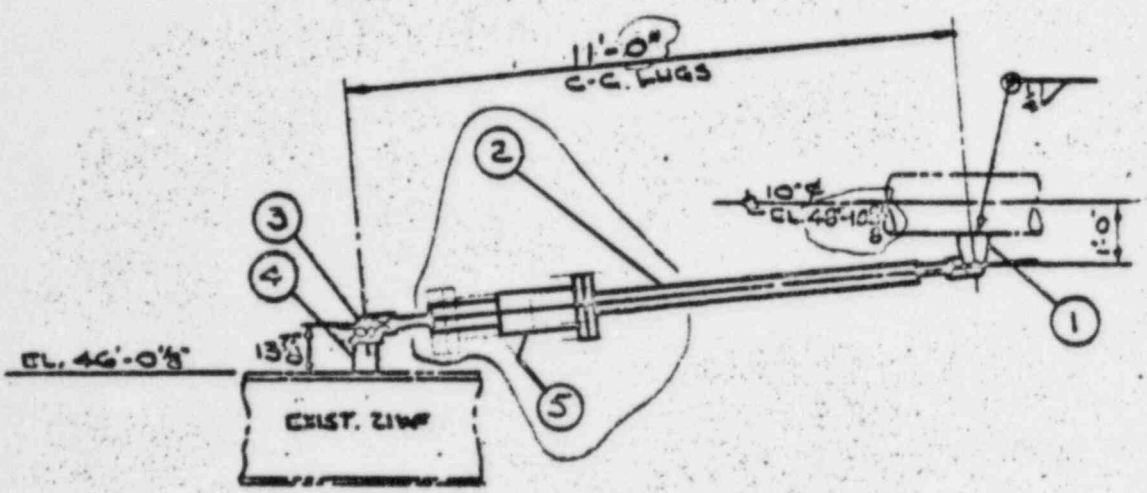
Support RF-R1A



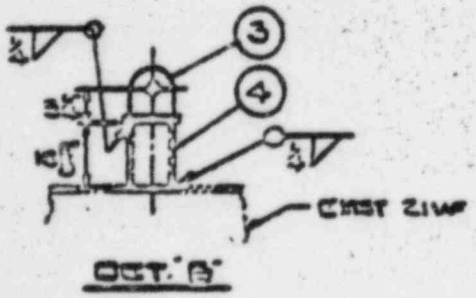
LOCATION PLAN

Title: Feedwater Seismic Supports
Calculated by: MJ Kanetsky Date: 8/1/84
Checked by: RL Tolson Date: 8/9/84
Reviewed by: [illegible] Date: 8-22-84

Project: 83-03

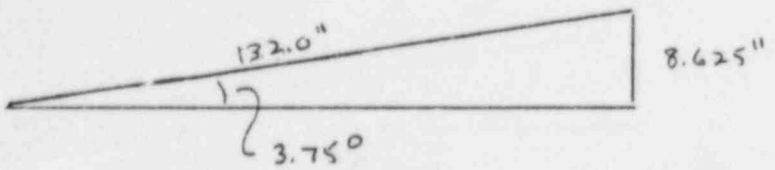


SECT. A-A



DET. B

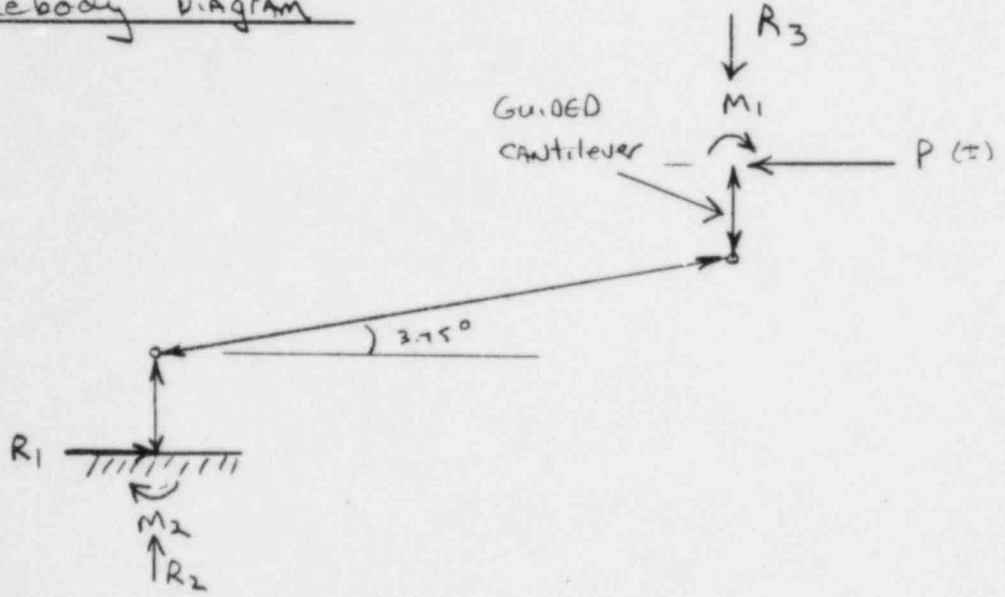
Snubber tilt to horizontal



Title: Feedwater Seismic Supports
Calculated by: [illegible] Date: 8/1/84
Checked by: RC Thevenot Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

Freebody Diagram



P = 2220 lbs Ref. (1)

Snubber load = $\frac{P}{\cos 3.75}$ = 2225 lbs

tension/compression load in clevises = snubber load sin 3.75
= 145 lb. = R_2
ignored in analyses – minimal effect by inspection

$R_3 = R_2$
$R_1 = P$

Item 1 Clevis & Bolt STANDARD PART EA2-4

RATED to 10,000 lb Ref.(2)

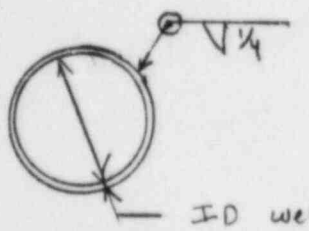
ACTUAL LOAD 2225 lb

Item 3 Clevis & Bolt STANDARD PART EA1-4

RATED to 10,000 lb Ref.(2)

ACTUAL LOAD 2225 lb

Item 3 Weld to Item 4



ID weld = OD 4" Sch 80 pipe = 4.5"

TREAT weld as line

$Z = \frac{\pi d^2}{4} \frac{\sqrt{2}}{2}$ leg length

$= \pi \frac{(4.5)^2}{4} \frac{\sqrt{2}}{2} (.25)$

$= 2.812 \text{ in}^3$

$A = \pi d \frac{\sqrt{2}}{2}$ leg length

$= \pi (4.5) \frac{\sqrt{2}}{2} (.25) = 2.499 \text{ in}^2$

moment

$\tau_2 = P\ell/Z = \frac{2225\ (3.25)}{2.812} = 2572 \text{ psi}$

SHEAR

$\tau_3 = P/A = 2225/2.499 = 890 \text{ psi}$

$\tau_{net} = \sqrt{\tau_2^2 + \tau_3^2} = \sqrt{(2572)^2 + (890)^2} = 2722 \text{ psi} < 24{,}400 \text{ psi}$

Item 4 4" Sch 80 pipe Stress

OD = 4.5", ID = 3.826" (Ref. 3 p.B-17)

$I = 9.610\ in^4$, $A = 4.407\ in^2$

SHEAR

$\tau = P/A = 2225/4.407 =$ 505 PSI < 24,400 PSI

BENDING

$\sigma = \frac{Mc}{I} = \frac{2225(13\ 7/8)(2.25)}{9.610} =$ 7228 PSI < 40,600 PSI

Item 4 Weld to Existing 21 WF I-BEAM

$A = 2.499\ in^2$ $Z = 2.812\ in^3$

(Same as Item 3 weld to Item 4)

Moment

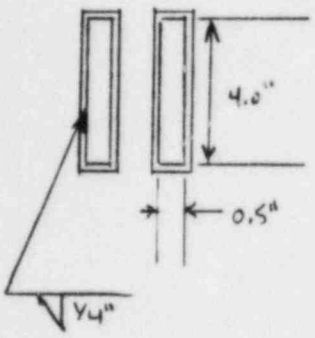
$\tau_2 = \frac{Pl}{Z} = \frac{2225(13\ 7/8)}{2.812} = 10,979$ PSI

SHEAR

$\tau_3 = P/A = 2225/2.499 = 890$ PSI

$\tau_{Net} = \sqrt{\tau_2^2 + \tau_3^2} = \sqrt{(10,979)^2 + (890)^2} =$ 11,015 PSI < 24,400 PSI

Item 1 weld to feedwater pipe



TREAT WELD AS LINE

$A = 2(2\ell + 2w)$ $5/32$ leg length
$= 2(2(4.0) + 2(.5))$ $5/32$ $(.25)$
$= 3.182\ in^2$

$Z = 2\left(bd + \frac{d^2}{3}\right)$ $5/32$ leg length
$= 2\left((4.0)(.5) + \frac{(4.0)^2}{3}\right)$ $5/32$ $(.25)$
$= 2.593\ in^3$

BENDING

$$\tau_2 = M/Z = \frac{TL \cdot \ell}{Z} = \frac{(2225)(6.75)}{2.593} = 5792\ PSI$$

SHEAR

$$\tau_3 = P/A = 2225/3.182 = 699\ PSI$$

$$\tau_{Net} = \sqrt{\tau_2^2 + \tau_3^2} = \sqrt{(5792)^2 - (699)^2} = 5834\ PSI$$

$< 24,400\ PSI$

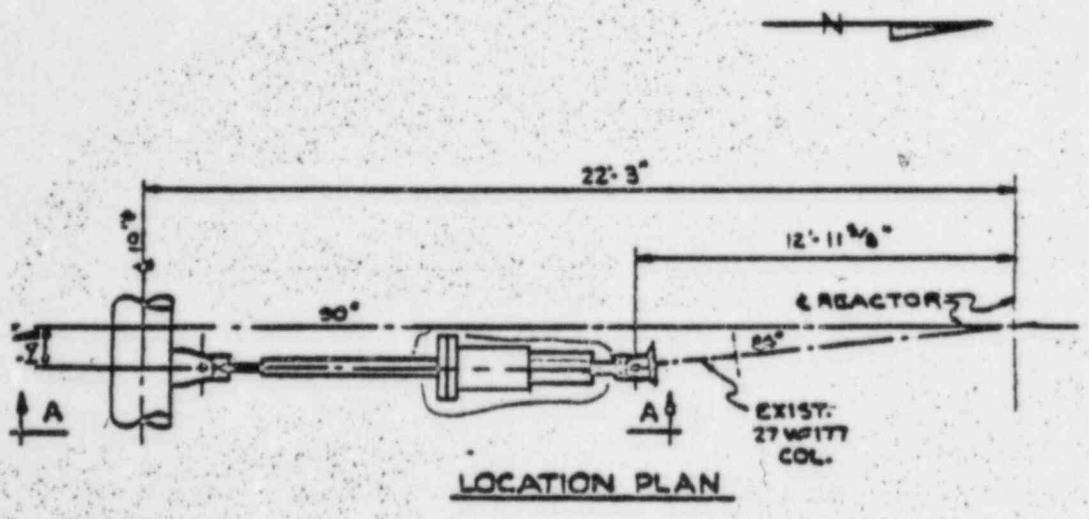
Support RF-R1A Summary Table

Item	TYPE of STRESS	calculated stress (PSI)	Allowable stress (PSI)
Item 3 weld to Item 4	SHEAR	2,722	24,400
4	SHEAR	505	24,400
	BENDING	7,228	40,600
Item 4 weld to I-Beam	SHEAR	11,015	24,400
Item 1 weld to feed P.P.C	SHEAR	5,834	24,400

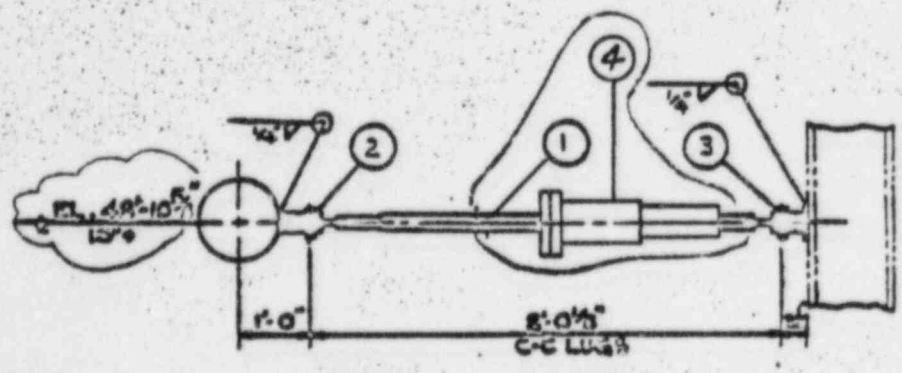
Item	calculated LOAD (lb)	Allowable LOAD (lb)
2	2,225	10,000
3	2,225	10,000

Support RF-R2A

DESCRIPTION



LOCATION PLAN



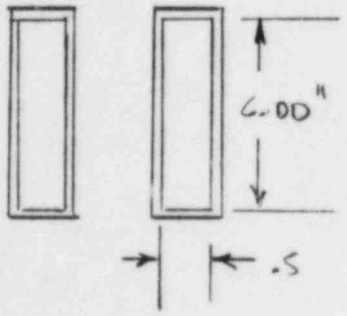
SECT. "A-A"

Item 2 Clevis & Bolt STANDARD Part EA2-A

RATED TO 10,000 lb Ref. (2)

ACTUAL LOAD 1,600 lb

Item 2 Weld to FEEDWATER PIPE



TREAT weld AS LINE

$A_{net} = 2(2b + 2d)\frac{\sqrt{2}}{2}$ leg length

$= 2(2(1.5) + 2(6.00))\frac{\sqrt{2}}{2}(.25)$

$= 4.596\ in^2$

Tension / compression

$\tau_1 = P/A = 1600/4.596 = 348$ PSI

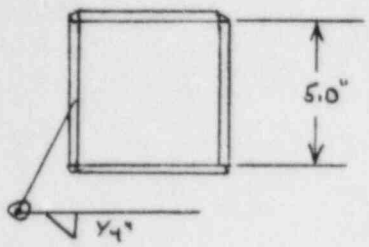
$\tau_{net} = \tau_1 = 348$ PSI $<$ 24,400 PSI

Item 3 Clevis & Bolt STANDARD Part EA1-A

Rated TO 10,000 lb Ref (2)

ACTUAL LOAD 1,600 lb

Item 3 weld to Existing 27 WF 177 col.



TREAT weld AS LINE

AREA = 4 S $\frac{\sqrt{2}}{2}$ leg length

$= 4(5.0)\frac{\sqrt{2}}{2}(.25)$

$= 3.536\ in^2$

$Z = \left(5^2 + \frac{5^2}{3}\right)\frac{\sqrt{2}}{2}$ leg length

$= \left(5^2 + \frac{5^2}{3}\right)\frac{\sqrt{2}}{2}(.25)$

$= 5.893\ in^3$

tension / compression

$\gamma_1 = \frac{P\cos 6}{A} = \frac{(1{,}600)\cos 6}{3.536} = 450$ PSI

bending

$\gamma_2 = \frac{P \sin 6\, \ell}{Z} = \frac{(1{,}600)\sin 6\,(3.25)}{5.893} = 92$ PSI

SHEAR

$\gamma_3 = \frac{P \sin 6}{A} = \frac{(1{,}600)\sin 6}{3.536} = 46$ PSI

$\gamma_{net} = \sqrt{(\gamma_1 + \gamma_2)^2 + \gamma_3^2} = \sqrt{(450+92)^2 + (46)^2} = 544$ PSI

$< 24{,}400$ PSI

Support RF-R2A SUMMARY TABLE

Item	TYPE OF STRESS	CALCULATED Stress (PSI)	Allowable Stress (PSI)
Item 2 weld to Feed. PIPE	SHEAR	348	24,400
Item 3 weld to COL.	SHEAR	544	24,400

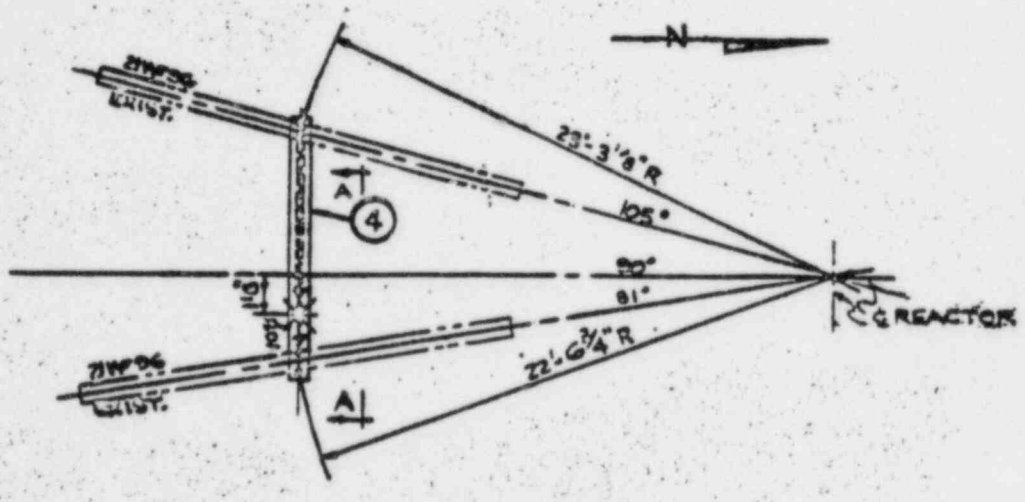
Item	CALCULATED LOAD (lb)	Allowable LOAD (lb)
2	1,600	10,000
3	1,600	10,000

Title: Feedwater Seismic Supports
Calculated by: MKennedy Date: 8/1/84
Checked by: RLTaylor Date: 8/4/84
Reviewed by: JL Date: 8-22-84

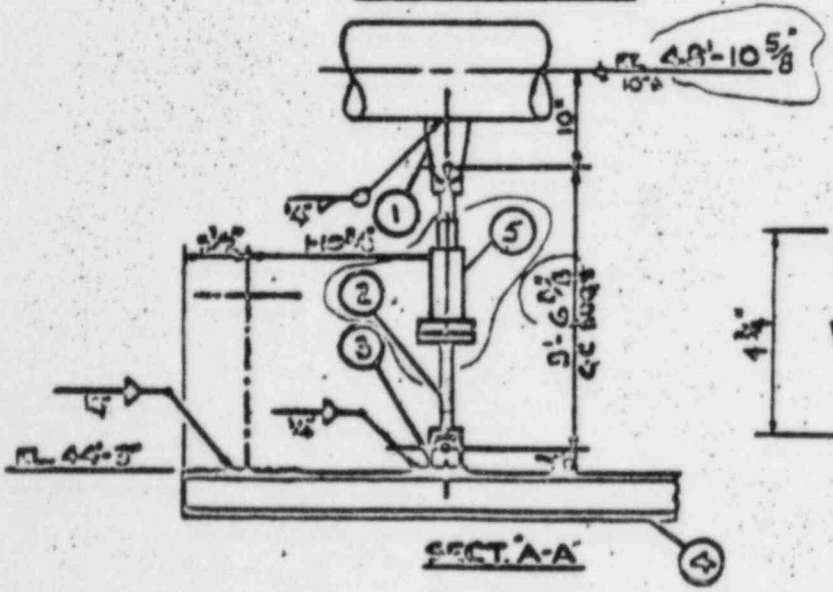
Project: 83-03

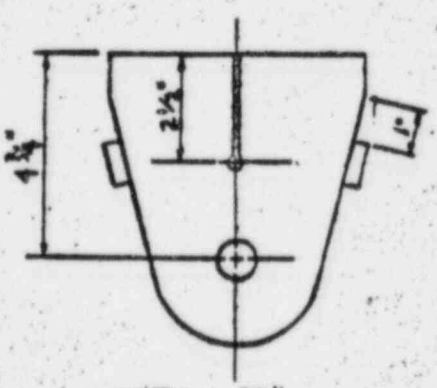
Support RF-R3A

DESCRIPTION



LOCATION PLAN





DETAIL "B"

SP. PART EA2-A
REV. ONLY DIMS SHOWN
ALL OTHER DIMS REMAIN
THE SAME.

Item 1 Clevis & Bolt STANDARD PART EA2-A

Rated to 10,000 lb Ref. (2)
(shortened dimension B on BP Dwg 64102 makes moment arm shorter so load rating not affected)

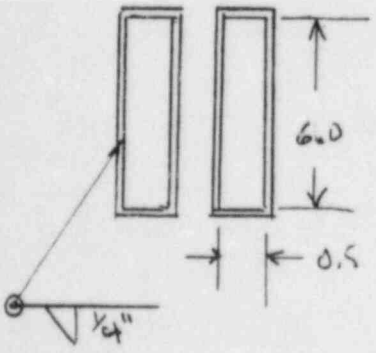
Actual load 1,300 lb

Item 3 Clevis & Bolt STANDARD PART EA1-A

Rated to 10,000 lb Ref. (2)

Actual load 1,300 lb

Item 1 weld to feedwater Pipe



Treat weld as line

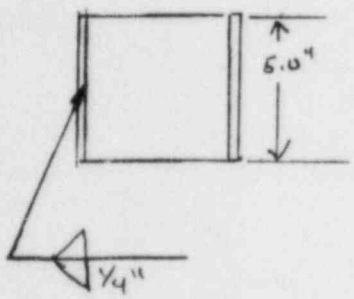
Area = $2(2w + 2l)\ \frac{\sqrt{2}}{2}$ leg length
= $2(2(.5) + 2(6.0))\ \frac{\sqrt{2}}{2}(.25)$
= 4.596 in^2

tension / compression

$\sigma_1 = P/A = 1{,}300/4.596 = 283$ psi

$\sigma_{net} = \sigma_1 =$ 283 psi < 24,400 psi

Item 3 weld to Item 4 I-BEAM



Treat weld as line

Area = 2 (l) $\frac{\sqrt{2}}{2}$ leg length

= 2 (5.) $\frac{\sqrt{2}}{2}$ (.25)

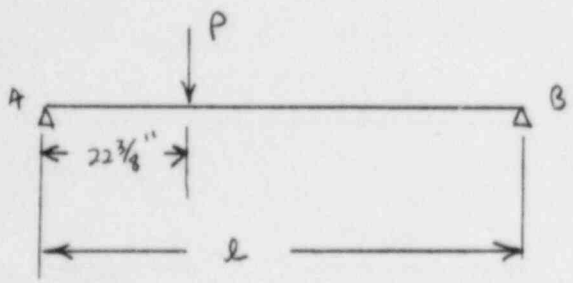
= 1.768 in^2

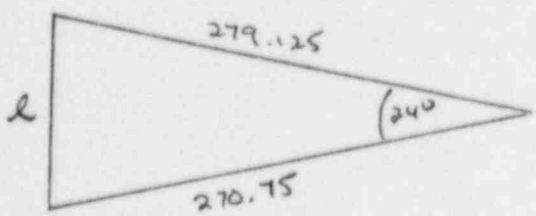
tension / compression

$\tau_i = P/A = 1300/1.768 = 735$ psi

$\tau_{net} = \tau_i = \underline{735 \text{ psi}} < \underline{24{,}400 \text{ psi}}$

Item 4 BEAM





$l^2 = a^2 + b^2 - 2ab \cos\theta = (279.125)^2 + (270.75)^2 - 2(279.125)(270.75)\cos 24$

$l = 114.619$"

$$R_B = P \frac{x}{\ell} = 1{,}300 \left(\frac{22\,3/8}{114.619}\right) = 254 \text{ lb}$$

$$R_A = P \frac{\ell - x}{\ell} = 1{,}300 \left(\frac{114.619 - 22.375}{114.619}\right) = 1{,}046 \text{ lb}$$

$$M_{max} \text{ at } P = P \frac{(\ell - x)\,x}{\ell} = 1{,}300 \left(\frac{114.619 - 22.375)\,22.375}{114.619}\right) = 23{,}409 \text{ in lb}$$

I-BEAM 5 WF 16

$I = 21.3 \text{ in}^4$, $c = 2.5 \text{ in}$, $A = 4.7 \text{ in}^2$ Ref. (4), P 1-21

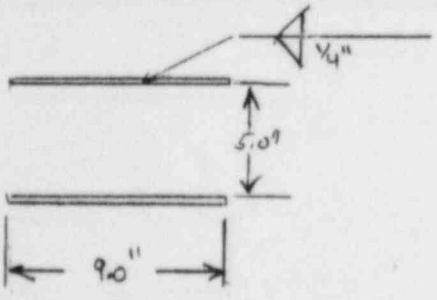
SHEAR

$$\tau = \frac{R_A}{(\text{Web long} \times t_w)} = \frac{1046}{(5 \times .25)} = 837 \text{ PSI} < 24{,}400 \text{ PSI}$$

BENDING

$$\sigma = \pm \frac{Mc}{I} = \frac{23{,}409\,(2.5)}{21.3} = 2748 \text{ PSI} < 40{,}600 \text{ PSI}$$

Item 4 weld to existing 21 WF 96 I-BEAM



treat weld as line

Area = 2 (ℓ) $\sqrt{2}/2$ leg length
= 2 (9) $\sqrt{2}/2$ (.25)
= 3.182 in^2

tension / compression

$$\tau_1 = R_A / A = 1{,}300 / 3.182 = 409 \text{ PSI}$$

$$\tau_{Net} = \tau_1 = 409 \text{ PSI} < 24{,}400 \text{ PSI}$$

Support Rf-R3A Summary Table

Item	TYPE of stress	Calculated stress (PSI)	Allowable stress (PSI
Item 1 weld to feed. PIPE	SHEAR	283	24,400
Item 3 weld to Item 4 I-BEAM	SHEAR	735	24,400
4	SHEAR	837	24,400
	BENDING	2,748	40,600
Item 4 weld to I-BEAM	SHEAR	409	24,400

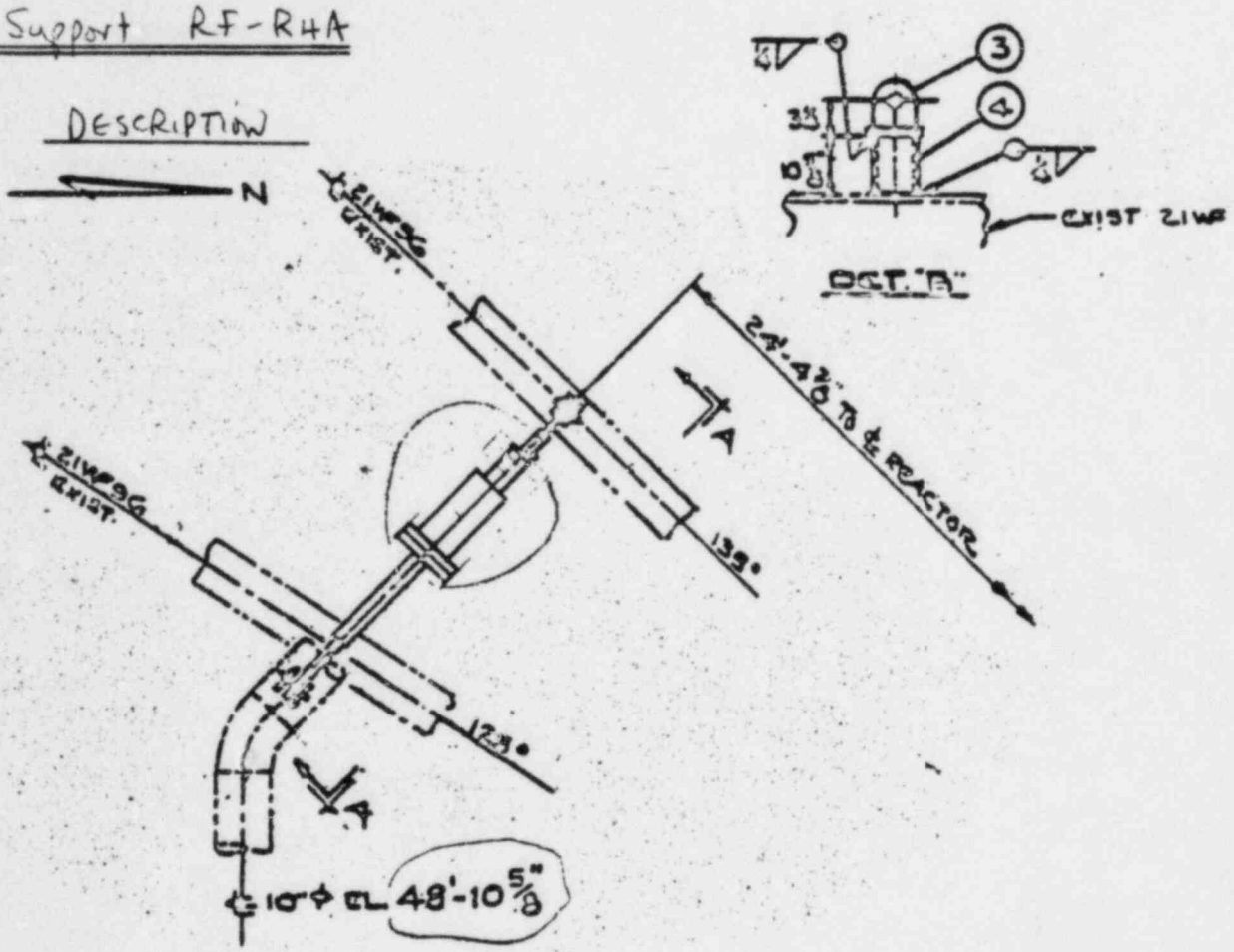
Item	Calculated LOAD (lb)	Allowable LOAD (lb)
1	1,300	10,000
3	1,300	10,000

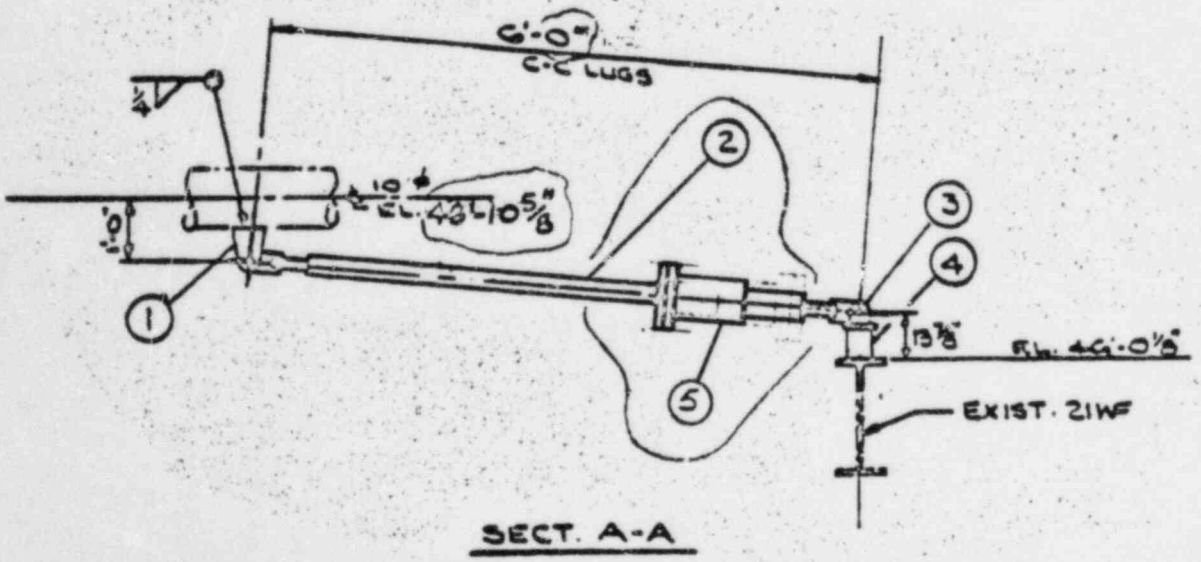
Title: Feedwater Seismic Supports
Calculated by: MJKennedy Date: 8/1/84
Checked by: RCTrundle Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

Project: 8303

Support RF-R4A

DESCRIPTION



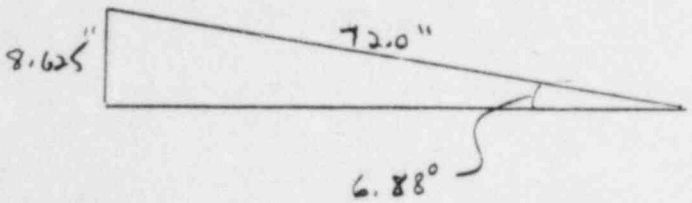


SECT. A-A

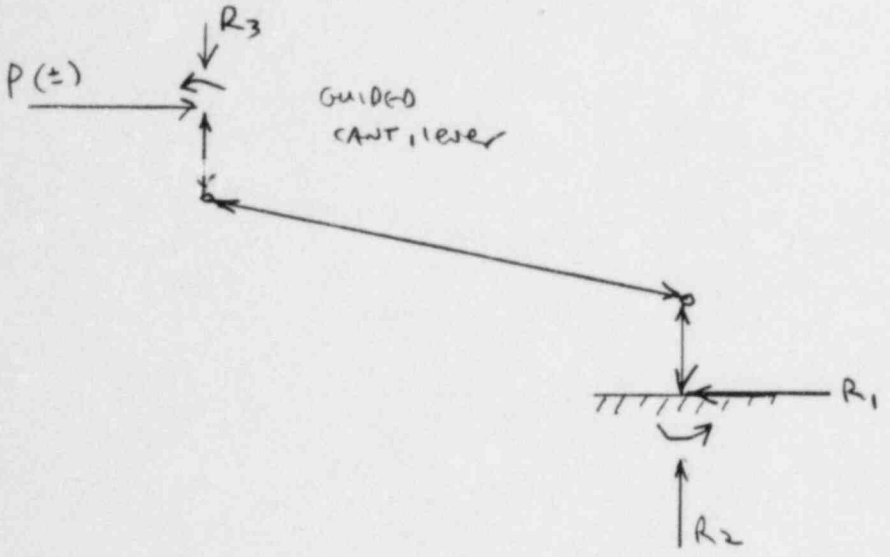
Title: Seawater Seismic Supports
Calculated by: MK Kenyon Date: 8/1/84
Checked by: RC Tuveson Date: 8/9/84
Reviewed by: — Date: 8-22-84

Project: 83-03

Snubber tilt to horizontal



Freebody Diagram



$R_3 = R_2$

$P = R_1$

P = 4160 lbs Ref. (1)

Snubber load = $P / \cos 6.98$ = 4191 lb

tension/compression load in clevises = snubber load sin 6.98
= 4191 sin 6.98
= 509 lb. = R_2

ignored in analyses
minimal effect by
inspection.

Item 1 Clevis & Bolt STANDARD PART EA2-A

Rated to 10,000 lb Ref. (2)

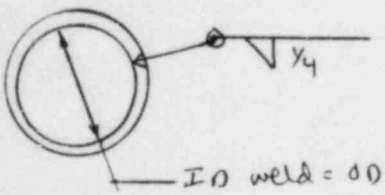
Actual load 4,191 lb

Item 3 Clevis & Bolt STANDARD PART EA1-A

Rated to 10,000 lb Ref (2)

Actual load 4,191 lb

Item 3 Weld to Item 4



TREAT weld as line

$Z = \frac{\pi d^2}{4}\frac{\sqrt{2}}{2}$ leg length

$= \frac{\pi(4.5)^2}{4}\frac{\sqrt{2}}{2}(.25)$

$= 2.812\ in^3$

$A = \pi d \sqrt{2}/2$ leg length

$= \pi(4.5)\sqrt{2}/2\,(.25)$

$= 2.499\ in^2$

Moment

$\tau_2 = \frac{PL}{Z} = \frac{4160(3.25)}{2.812} = 4808$ PSI

SHEAR

$\tau_3 = P/A = 4160/2.499 = 1665$ PSI

$\tau_{net} = \sqrt{\tau_2^2 + \tau_3^2} = \sqrt{(4808)^2 + (1665)^2} = 5088$ PSI $<$ 24400 PSI

Item 4 4" Sch 80 pipe Stress

OD = 4.5" ID = 3.826"

Ref. (3), p B-17

$I = 9.610\ in^4$, $A = 4.407\ in^2$

SHEAR

$$\tau = P/A = 4160/4.407 = 944\ PSI < 24,400\ PSI$$

BENDING

$$\sigma = \frac{Mc}{I} = \frac{4160\ (13\ 7/8)\ (2.25)}{9.610} = 13,614\ PSI < 40,600\ PSI$$

Item 4 Weld to Existing 21 WF I-BEAM

$A = 2.499\ in^2$ $Z = 2.812\ in^3$

(same as Item 3 weld to Item 4)

moment

$$\tau_2 = \frac{Pl}{Z} = \frac{4160\ (13\ 7/8)}{2.812} = 20,526\ PSI$$

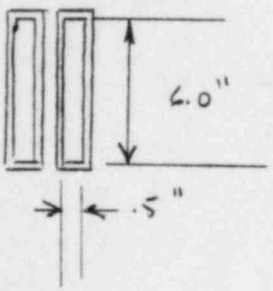
SHEAR

$$\tau_3 = P/A = 4160/2.499 = 1665\ PSI$$

$$\tau_{net} = \sqrt{\tau_2^2 + \tau_3^2} = \sqrt{(20,526)^2 + (1665)^2} = 20,593\ PSI$$

$< 24,400$

Item 1 weld to feedwater pipe



TREAT weld AS LINE

$$\text{Area} = 2(2t+2w)\sqrt{2}/2 \text{ leg length}$$
$$= 2(2(6.0)+2(.5))\sqrt{2}/2\ (.25) = 4.596\ in^2$$

$$Z = 2(bd + d^2/3)\sqrt{2}/2 \text{ leg length}$$
$$= 2(.5(6.0) + 6.0^2/3)\sqrt{2}/2\ (.25)$$
$$= 5.303\ in^3$$

BENDING

$$\tau_2 = M/Z = Pd/Z = \frac{4160\,(7.5)}{5.303} = 5883\ PSI$$ (7.5 ASSUMED)

SHEAR

$$\tau_3 = P/A = 4160/4.596 = 905\ PSI$$

$$\tau_{wet} = \sqrt{\tau_2^2 + \tau_3^2} = \sqrt{(5883)^2 + (905)^2} = \underline{5953\ PSI < 24,400\ PSI}$$

Support RF-R4A Summary Table

Item	TYPE of Stress	Calculated stress (PSI)	Allowable Stress (PSI)
Item 3 weld to Item 4	SHEAR	5,088	24,400
Item 1 weld to feed P.PE	SHEAR	5,953	24,400
4	SHEAR	944	24400
	BENDING	13,514	40,600
Item 4 weld to I-BEAM	SHEAR	20,593	24,400

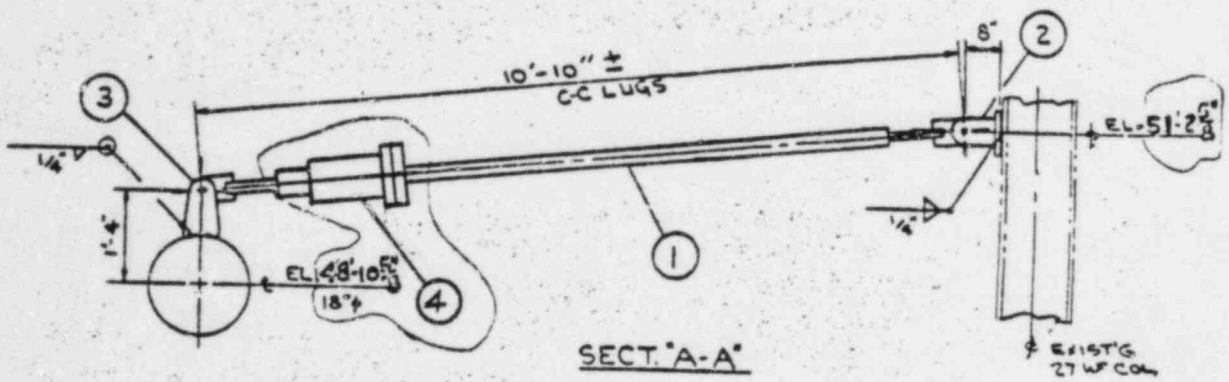
Item	Calculated LOAD (lb)	Allowable LOAD (lb)
1	4,191	10,000
3	4,191	10,000

Title: Feedwater Seismic Supports
Calculated by: MK Kennedy Date: 8/1/84
Checked by: RC Talcott Date: 8/9/84
Reviewed by: D Date: 8-22-84

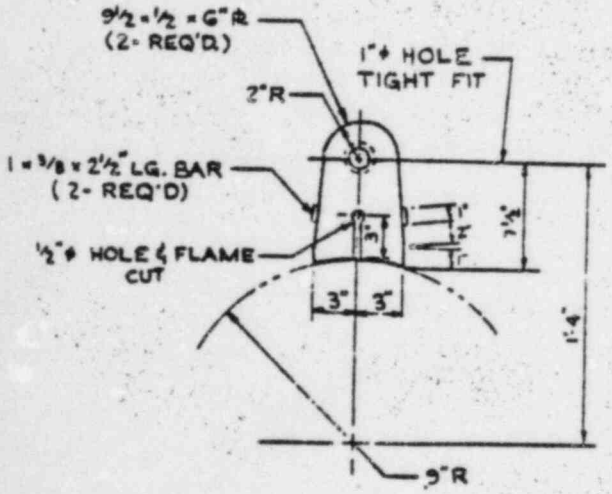
Project: 83-03

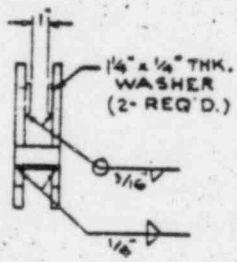
Support RF - R5A

DESCRIPTION



SECT. "A-A"



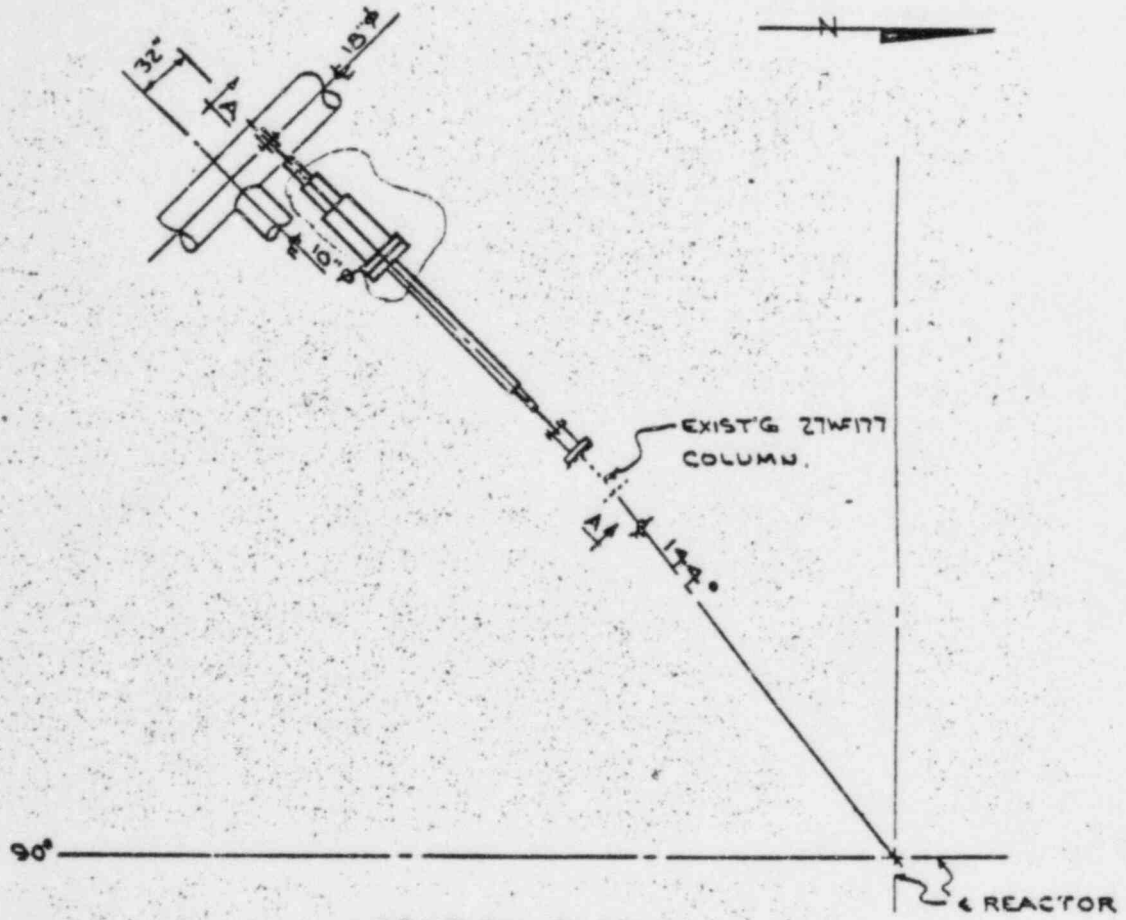


DETAIL "B"

Title: Feedwater Seismic Supports

Calculated by: MKenedy Date: 8/1/84
Checked by: RCLundo Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

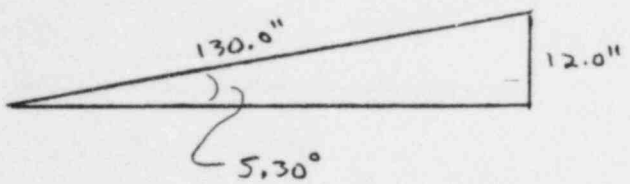


LOCATION PLAN

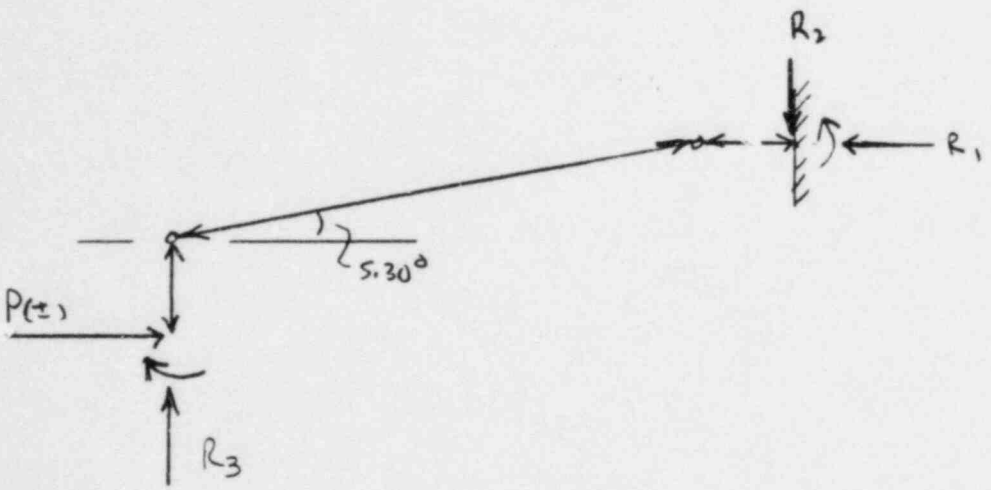
Title: Feedwater Seismic Supports
Calculated by: MJKennedy Date: 8.1.84
Checked by: RCTaylor Date: 8/9/84
Reviewed by: JH Date: 8-22-84

Project: 83-03

Snubber tilt to horizontal



Freebody Diagram



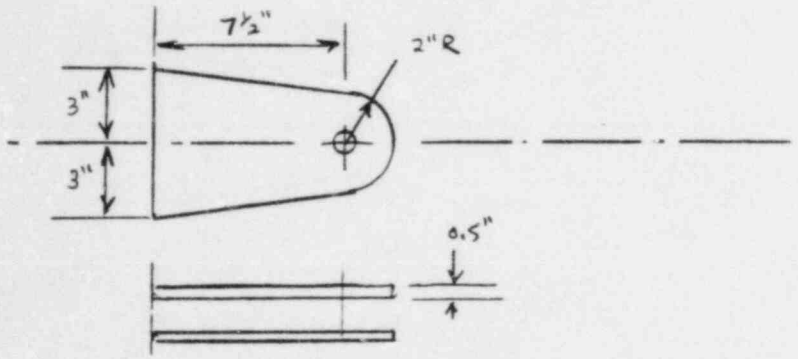
P = 4700 lb Ref (1)

Snubber load = P/cos 5.30 = 4720 lbf

tension/compression load in pipe clevis = snubber load sin 5.30
= 436 lb = R_2
ignored in analyses
minimal effect
by inspection

$R_2 = R_3$; $P = R_1$

Item 3 PIPE ATTMT Clevis w/(1) 1"ϕ x 3¾" LG HEX HEAD CAP SCR & NUT.



Pullout Shear

$$\text{Area} = 2(2\pi t) = 2(2(2.0).5) = 4.0\ in^2$$

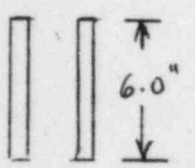
$$\tau = P/A = \frac{4720}{4.0} = \underline{1180\ PSI < 24,400\ PSI}$$

SHEAR AT BASE

$$\text{Area} = 2lw = 2(6.0)(.5) = 6\ in^2$$

$$\tau = P/A = \frac{4700}{6.0} = \underline{783\ PSI < 24,400\ PSI}$$

Bending At BASE

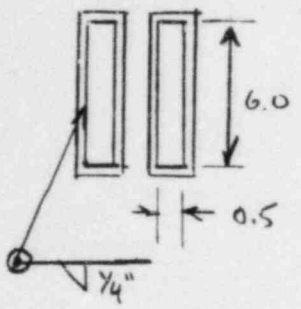


$$I = 2\frac{bh^3}{12} = \frac{.5(6.0)^3}{6} = 18.0\ in^4$$

$$c = 3.0\ in.$$

$$\sigma = \frac{Mc}{I} = \frac{P \cdot d \cdot c}{I} = \frac{4700(7.5)(3)}{18} = \underline{5875\ PSI < 40,600\ PSI}$$

Item 3 Weld to Feedwater Pipe



TREAT weld AS LINE

$$\text{AREA} = 2(2L + 2W)\,\frac{\sqrt{2}}{2}\,\text{leg length}$$

$$= 2(2(6.0) + 2(.5))\,\frac{\sqrt{2}}{2}\,(.25)$$

$$= 4.596\ in^2$$

$$Z = 2\left(bd + \frac{d^2}{3}\right)\frac{\sqrt{2}}{2}\,\text{leg length}$$

$$= 2\left(.5(6.0) + \frac{6.0^2}{3}\right)\frac{\sqrt{2}}{2}\,(.25)$$

$$= 5.303\ in^3$$

BENDING

$$\tau_2 = \frac{M}{Z} = \frac{P \cdot d}{Z} = \frac{4100\,(7.5)}{5.303} = 6{,}647\ \text{PSI}$$

SHEAR

$$\tau_3 = \frac{P}{A} = \frac{4100}{4.596} = 1023\ \text{PSI}$$

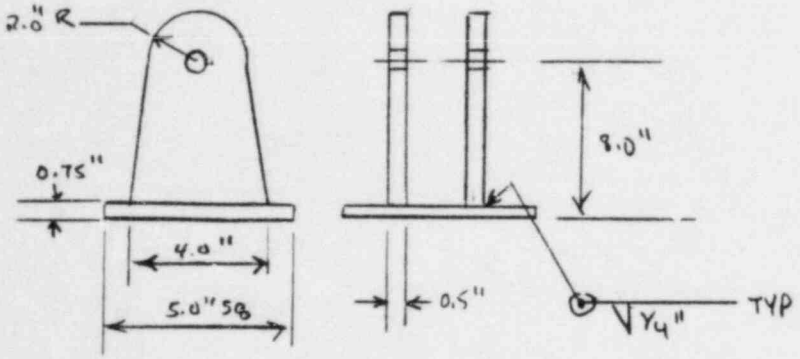
$$\tau_{Net} = \sqrt{\tau_2^2 + \tau_3^2} = \sqrt{(6647)^2 + (1023)^2} = 6725\ \text{PSI} < 24{,}400\ \text{PSI}$$

Item 2 Clevis & Bolt STANDARD Part EA 1-A

Bolt rated to 10,000 lb Ref. (2)

Actual load 4700 lb

the clevis plate length is longer than the STANDARD length so this clevis is analyzed



Pullout shear & clevis bolthole tension are the same as for the STANDARD clevis which is rated to 10,000 lb, so they are not calculated

Axial compression

let Area = minimum Area = $2tw = 2(.5)(4.0) = 4.0 in^2$

$$\sigma = P/A = \frac{4700}{4.0} = 1175 \text{ PSI}$$

$L \simeq 7.25$ in ; $C_c = 126.5$

$r = t/\sqrt{12} = .5/\sqrt{12} = .144$

$K = 2.0$; $S_y = 36.0$ KSI

} see Appendix B

$$F_a = 2/3 \left(1 - \left(\frac{Ke}{r}\right)^2 / 2C_c^2\right) S_y$$

$$= 2/3 \left(1 - \left(\frac{2.0\,(7.25)}{.144}\right)^2 / 2(126.5)^2\right) 36.0 = 16.4 \text{ KSI}$$

1,175 PSI < 16,400 PSI

BENDING (AT BASE)

$$I = 2\,\frac{bh^3}{12} = 2\,\frac{(.5)(4)^3}{12} = 5.333 \text{ in}^4$$

$c = 2.0"$

$$M = R_2 \ell = 436\,(7.25) = 3161 \text{ in-lb}$$

$$f = \pm \frac{Mc}{I} = \frac{3161\,(2.0)}{5.333} = 1185 \text{ PSI} < 40{,}600 \text{ PSI}$$

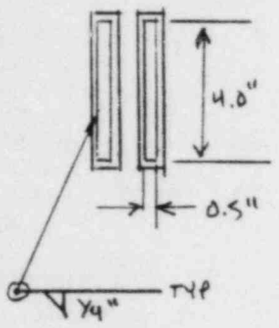
AXIAL COMPRESSION AND BENDING

$$\frac{f_a}{F_a} \leq 0.15$$

$$\therefore \quad \frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1.0$$

$$\frac{1175}{16400} + \frac{1185}{40600} = 0.10 < 1.0$$

clevis plate to base plate weld



TREAT weld AS line

$$\text{AREA} = 2(2L+2W)\,\tfrac{\sqrt{2}}{2}\,\text{leg length}$$
$$= 2(2(4.0)+2(.5))\,\tfrac{\sqrt{2}}{2}\,(.25)$$
$$= 3.182\ \text{in}^2$$

$$Z = 2\left(bd + \frac{d^2}{3}\right)\frac{\sqrt{2}}{2}\,\text{leg length}$$
$$= 2\left(.5(4) + \frac{4^2}{3}\right)\frac{\sqrt{2}}{2}\,(.25) = 2.593\ \text{in}^3$$

tension / compression

$$\tau_1 = P/A = \frac{4700}{3.182} = 1477\ \text{PSI}$$

BENDING

$$\tau_2 = \frac{M}{Z} = \frac{R_2 L}{Z} = \frac{436(7.25)}{2.593} = 1219\ \text{PSI}$$

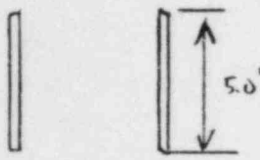
SHEAR

$$\tau_3 = R_2/A = 436/3.182 = 137\ \text{PSI}$$

$$\tau_{net} = \sqrt{(\tau_1+\tau_2)^2+\tau_3} = \sqrt{(1477+1219)^2+(137)^2} = 2699\ \text{PSI}$$

$< 24{,}400$ PSI

Item 2 Weld to Existing 21WF177 Column



TREAT WELD AS LINE

AREA = 2 d $\sqrt{2}/2$ leg length
= 2(5) $\sqrt{2}/2$ (.25)
= 1.768 in^2

$Z = \frac{d^2}{3} \sqrt{2}/2$ leg length
$= \frac{5^2}{3} \sqrt{2}/2$ (.25)
= 1.473 in^3

tension / compression

$\tau_1 = P/A = \frac{4140}{1.768} =$ 2658 psi

BENDING

$\tau_2 = \frac{M}{Z} = \frac{R_2 l}{Z} = \frac{436(8.0)}{1.473} =$ 2368 psi

SHEAR

$\tau_3 = R_2/A = 436/1.768 =$ 247 psi

$\tau_{Net} = \sqrt{(\tau_1 + \tau_2)^2 + \tau_3^2} = \sqrt{(2658 + 2368)^2 + (247)^2} =$ **5032 psi**

< 14,400 psi

Support RF-R5A Summary Table

Item	TYPE OF STRESS	CALCULATED STRESS (PSI)	Allowable Stress (PSI
3	Pullout SHEAR	1,180	24,400
	SHEAR	783	24,400
	BENDING	5,875	40,600
Item 3 weld to feed. P.PE	SHEAR	6,725	24,400
2	COMPRESSION	1,175	16,400
	BENDING	1,185	40,600
	COMPRESSION + BENDING	0.10 (Note 1)	1.0
	Weld SHEAR	2,699	24,400
Item 2 weld to col.	SHEAR	5,032	24,400

Notes

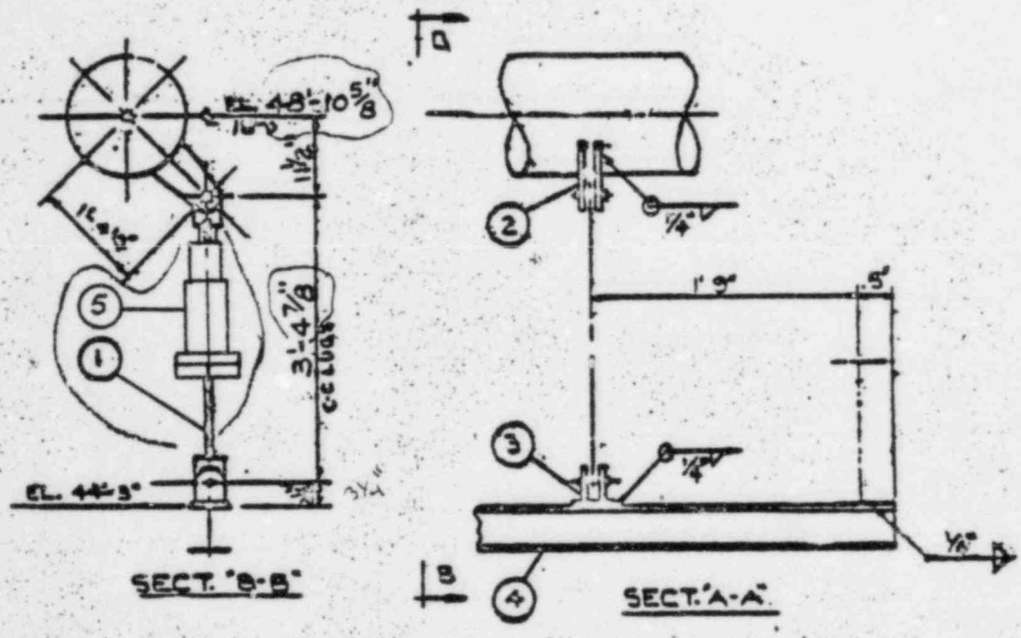
(1) This is a stress RATIO (NONDIMENSIONAL) NOT a stress in PSI.

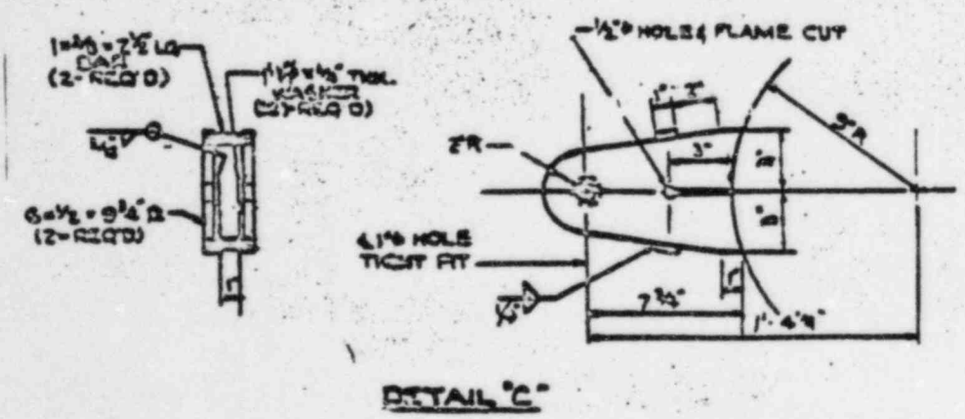
Title: Feedwater Seismic Supports
Calculated by: [illegible] Date: 8/1/84
Checked by: R Arenz Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

Support RF-R6A

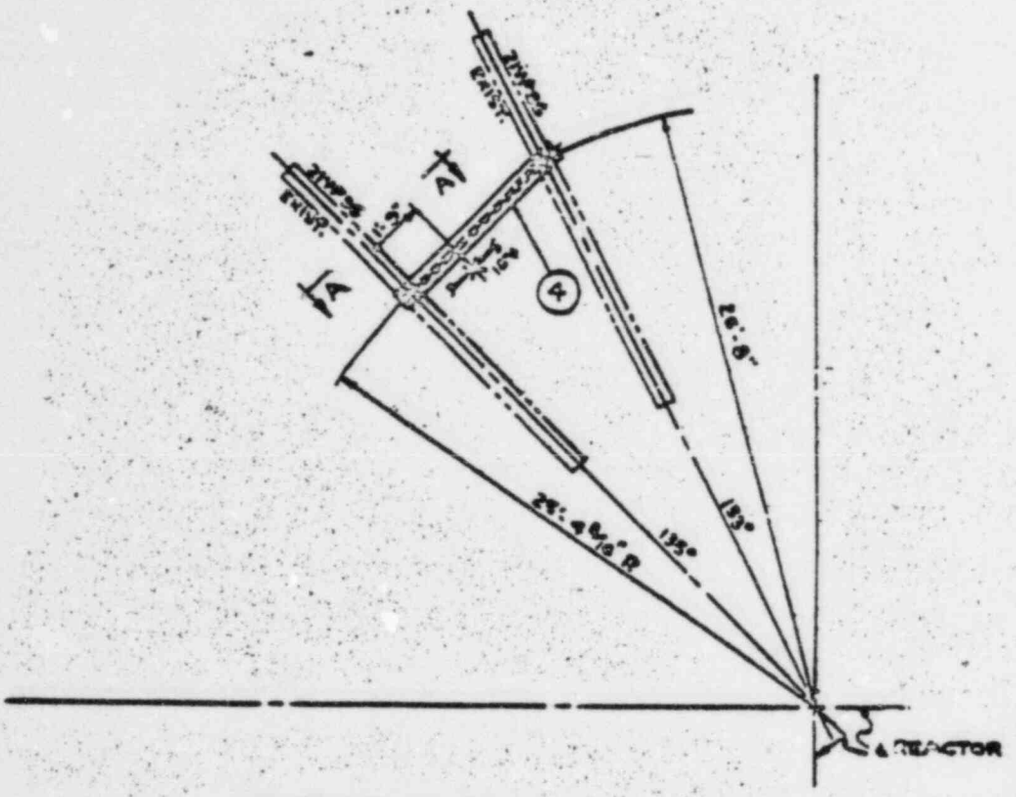
DESCRIPTION





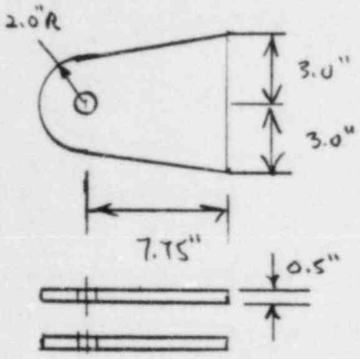
Title: Seawater Seismic Supports
Calculated by: MJKennedy Date: 8/1/84
Checked by: RCTaylor Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03



LOCATION PLAN

Item 2 PIPE ATTACHMENT W/(1) 1"ϕ x 3¼" LG HEX HEAD CAP. SCREW & NUT



P = 2840 lb Ref (1)

AXIAL LOAD = $\frac{\sqrt{2}}{2} P = \frac{\sqrt{2}}{2} 2840 = 2008$ lb

MOMENT LOAD = $\frac{\sqrt{2}}{2} P \ell =$

$= \frac{\sqrt{2}}{2} 2840 (7.75) = 15,563$ in.lb

SHEAR LOAD = AXIAL LOAD = 2008 lb.

Pullout Shear

Area = $2(2rt) = 2(2(2.0).5) = 4.0$ in^2

$\tau = P/A = 2840/4 = 710$ PSI < 24,400 PSI

Clevis Bolthole tension stress

Area = $2t$ (2r - hole d) = $2(.5)\left(2(2.0)-(1.0+1/16)\right) = 2.938$ in^2

$\sigma = \frac{\text{AXIAL LOAD}}{A} = \frac{2008}{2.938} = 683$ PSI < 32,400 PSI

Shear at Base

Area = $2\ell w = 2(6.0)(.5) = 6.0$ in^2

$\tau = \frac{\text{SHEAR LOAD}}{A} = \frac{2008}{6} = 335$ PSI < 24,400 PSI

AXIAL COMPRESSION

let AREA = MINIMUM AREA = $2 t w = 2(.5)(4.0) = 4.0 in^2$

$\sigma = \frac{\text{AXIAL LOAD}}{A} = \frac{2008}{4} = 502$ PSI

$l \approx 7.75$ in ; $C_c = 126.5$
$r = \frac{t}{\sqrt{12}} = \frac{.5}{\sqrt{12}} = .144$ in
$K = 2.0$; $S_y = 36.0$ KSI

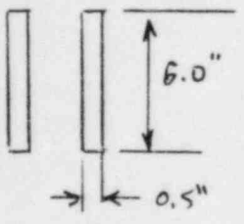
} See Appendix B

$$F_a = \frac{2}{3}\left(1 - \left(\frac{Kl}{r}\right)^2 / 2C_c^2\right) S_y$$

$$= \frac{2}{3}\left(1 - \left(\frac{(2.0)(7.75)}{.144}\right)^2 / 2(126.5)^2\right) 36.0 = 15.3 \text{ KSI}$$

502 PSI < 15,300 PSI

BENDING AT BASE



$I = 2\frac{bh^3}{12} = \frac{2(.5)(6.0)^3}{12}$

$= 18.0 \text{ in}^4$
$C = 3.0$ in

$\sigma = \frac{Mc}{I} = \frac{15,563\ (3.0)}{18.0} = 2594$ PSI

2594 + 502 = 3096 PSI < 40,600 PSI

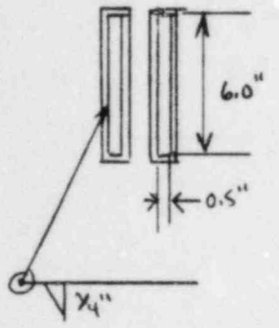
AXIAL COMPRESSION AND BENDING

$$\frac{f_a}{F_a} \leq 0.15$$ Eq (2a) controls

$$\therefore \frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1.0$$

$$\frac{502}{15,300} + \frac{2,594}{40,600} = 0.10 < 1.0$$

Item 2 Weld to Feedwater P.P.P



TREAT weld as LINE

$A = 4(l+w)\,\sqrt{2}/2$ leg length
$= 4(.5+6.0)\,\sqrt{2}/2\,(.25)$
$= 4.596\ in^2$

$Z = 2\left(bd + \frac{d^2}{3}\right)\sqrt{2}/2$ leg length
$= 2\left(.5(6.0) + \frac{6.0^2}{3}\right)\sqrt{2}/2\,(.25)$
$= 5.303\ in^3$

tension / compression

$$\gamma_1 = \frac{P\sqrt{2}/2}{A} = \frac{2840\,\sqrt{2}/2}{4.596} = 437\ PSI$$

BENDING

$$\gamma_2 = \frac{P\sqrt{2}/2\ l}{Z} = \frac{2840\frac{\sqrt{2}}{2}(7.75)}{5.303} = 2935\ PSI$$

SHEAR

$$\gamma_3 = \frac{P\sqrt{2}/2}{A} = \frac{2840\,\sqrt{2}/2}{4.596} = 437\ PSI$$

$$\gamma_{net} = \sqrt{(\gamma_1+\gamma_2)^2 + \gamma_3^2} = \sqrt{(437+2935)^2 + 437^2} = \underline{3400\ PSI}$$

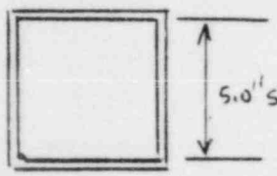
$< 24{,}400\ PSI$

Item 3 Clevis ⅝ Bolt STANDARD PART EA1-A

Rated to 10,000 lb Ref. (2)

Actual LOAD 2840 lb.

Item 3 Weld to Item 4



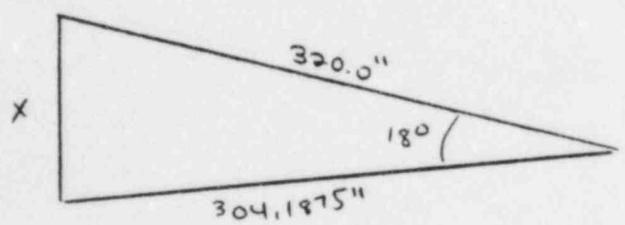
TREAT weld AS LINE

AREA = 4 s $\frac{\sqrt{2}}{2}$ leg length
= 4(5) $\sqrt{2}/2$ (.25)
= 3.536 in²

tension/compression

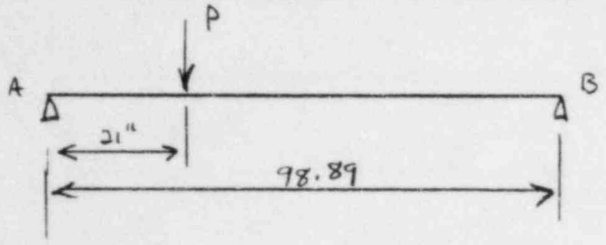
$\gamma_{net} = \gamma_t = P/A = 2840/3.536 =$ **803 PSI < 24,400 PSI**

Item 4 6WF 15.5 I-BEAM



$x^2 = a^2 + b^2 - 2ab\cos\theta = 320.0^2 + 304.1875^2 - 2(320.0)(304.1875)\cos 18$

$x = 98.89$ in



$$R_A = \frac{P(\ell - a)}{\ell} = \frac{2340\,(98.89 - 21.0)}{98.89} = 2237 \text{ lb.}$$

$$R_B = \frac{Pa}{\ell} = \frac{2840\,(21.0)}{98.89} = 603 \text{ lb.}$$

$$M = \frac{Pa(\ell - a)}{\ell} = \frac{2840\,(21.0)(98.89 - 21.0)}{98.89} = 46,975 \text{ in.lb}$$

6 WF 15.5 I-BEAM

$I = 30.3 \text{ in}^4$; $c = 3.0$ in

Ref (4) P. 1-21

$A = 4.62 \text{ in}^2$

BENDING

$$\sigma = \pm \frac{Mc}{I} = \pm \frac{46,975\,(3.0)}{30.3} = \pm 4651 \text{ psi} < 40,600 \text{ psi}$$

SHEAR

$$\tau = R_A / \text{web, long } t_w = \frac{2237}{6\,(.24)} = 1553 \text{ psi} < 24,400 \text{ psi}$$

Item 4 weld to existing 21 WF 96 BEAM

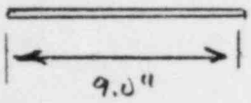
LOCATION 'A' controlling

TREAT weld AS LINE

AREA = 2ℓ $\sqrt{3}/2$ leg length

= 2(9) $\sqrt{3}/2$ (.25)

= 3.182 in^2



Ref p 1-8

tension/compression

$\gamma_{net} = \gamma_1 = R_A/A = 2237/3.182 =$ 703 PSI < 24,400 PSI

Support Rf-R6A Summary Table

Item	Type of Stress	Calculated Stress (PSI)	Allowable Stress (PSI)
2	Pullout Shear	710	24,400
	tension	683	32,400
	Shear	335	24,400
	Bending	3,096	40,600
	Compression	502	15,300
	Compression & Bending	0.10 (Note 1)	1.0 (Note 1)
Item 2 weld to Lead Pipe	Shear	3,400	24,400
Item 3 weld to Item 4	Shear	803	24,400
4	Bending	4,651	40,600
	Shear	1,553	24,400
Item 4 weld to I-Beam	Shear	703	24,400

(1) This is a stress ratio not a stress in PSI

Title: Feedwater Seismic Supports
Calculated by: MKennedy Date: 8/1/84
Checked by: RLFrench Date: 8/9/84
Reviewed by: JJ Date: 8-22-84

Project: 83-03

Item	Calculated Load (lb)	Allowable Load (lb)
3	2,840	10,000

MPR ASSOCIATES, INC.
1050 Connecticut Ave., NW – Washington, DC 20036

Title: MAIN STEAM & FEEDWATER SNUBBER EVALUATION

Calculated by: JPKennedy Date: 9/24/84
Checked by: RGTalarico Date: 9/27/84
Reviewed by: JThomson Date: 9-27-84

Project: SEP PIPING SUPPORTS 83-03

Purpose The purpose of the following calculation is to evaluate the installed Oyster Creek snubbers for loads. Loads resulting from loads reported in EGG-EA-5211, "Summary of the Oyster Creek Piping Calculations performed for the systematic evaluation program."

References

(1) EGG-EA-5211, "Summary of the Oyster Creek Unit 1 Piping Calculations performed for the Systematic Evaluation Program," M. E. Nitzel, July, 1980.

(2) Nutech PAC-03-001, "ASME Section III Class 1 Stress Analysis of 10,000 Pound Mechanical Shock Arrestor 1801103-01," R. F Petrokas, August, 1975.

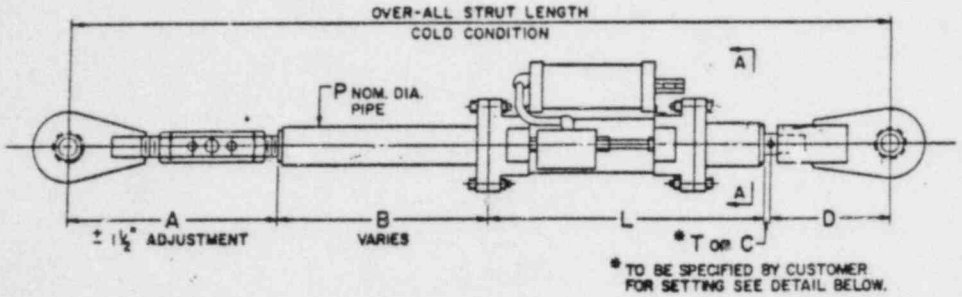
(3) Pacific Scientific Test Report 802, Qualification tests, Mechanical Shock Arrestors P/N 1801107-01, -03, -05 and 1801117-01.

(4) Roark & Young, Formulas for Stress and Strain, McGraw-Hill, 5th Ed.

Title: MAIN STEAM & FEEDWATER Snubber Evaluation
Calculated by: mf Kennedy Date: 9/24/84
Checked by: RC Evans Date: 9/27/84
Reviewed by: JJ Date: 9-27-84

Project: 87-03

DESCRIPTION



MAIN STEAM

SNUBBER		OVERALL length (in.)	L (IN)	D (IN)	T or C (IN.)	B (IN)	A (IN)
X-2A-SS-1	I	81.5	16.0	7.25	3.75	42.0	12.5
	II	39.25	13.5	7.25	3.75	2.75*	12.00
MS-R1A		43.25	16.0	7.25	4.625	2.875	12.50
MS-R2A		51.625	16.0	7.25	3.5625	4.6875	20.125
MS-R3A		44.5	16.0	7.25	3.25	5.5	12.5
MS-R4A		72.0	16.0	7.25	4.25	30.0	14.5
MS-R5A		111.5	16.0	7.25	3.75	72.0	12.5

* MIN

Ref: Bergen-Paterson catalog 66 AND pipe support drawings

FEEDWATER

SNUBBER		OVERALL LENGTH (IN)	L (IN)	D (IN)	T or C (IN)	B (IN)	A (IN)
X-4B-SS-1	I	109.25	16.0	7.25	3.75	69.75	12.5
	II	79.0	16.0	7.25	3.75	39.5	12.5
RF-R1A		132.0	16.0	7.25	3.9375	92.6875	12.125
RF-R2A		96.125	16.0	7.25	3.3125	57.0625	12.5
RF-R3A		42.375	16.0	7.25	3.1875	4.8125	11.125
RF-R4A		72.0	16.0	7.25	3.5625	33.375	11.8125
RF-R5A		130.0	16.0	7.25	3.5	87.5	15.75
RF-R6A		40.875	16.0	7.25	3.25	3.25	11.125

Ref: Bergen-Paterson catalog 66 AND pipe support drawings

Note: In the mid seventies, the hydraulic snubbers originally provided by Bergen-Paterson were replaced by mechanical snubbers provided by Pacific-Scientific. The replacements were designed to replace the parts shown in the figure which span dimension L AND (T or C). The end clevises, turnbuckle AND extension pipe provided by Bergen-Paterson were retained. (see drawings)

EVALUATION

Snubber extension pipe

The main steam and feedwater snubbers have extension pipes which vary in length and axial stress area. They are evaluated in the following calculation for tension/compression loads in accordance with the requirements of the 1980 ASME Code, Division 1, Subsection NF, and are found acceptable.

Snubber turnbuckle

The main steam and feedwater snubbers have turnbuckle adjustment mechanisms which vary in length. They are evaluated in the following calculation for tension/compression loads in accordance with the requirements of the 1980 ASME Code, Division 1, Subsection NF, and are found acceptable.

Snubber

The maximum snubber load is 12,330 lbs and occurs in main steam support MS-R2A. The snubber is rated for 11,000 lb and has been tested for an ultimate structural load of 22,000 lb with no yielding of parts (Ref. 3). An ASME Code analysis of the snubber was completed in Reference 2. In this analysis, the limiting component (based on manufacturer's rated load – not failure) is the ball nut and balls in the screw assembly which are rated at 22,000 lb. Because the mechanism is fuctional at loads of 22,000 lb, the Level D failure load for this component is much higher. The next most limiting component is the ball screw shaft which has a load rating of 26,000 lb for Level D service conditions.

Allowable Calculation

From Appendix B

Level D Compression Allowable

2/3 critical Buckling

$C_c = 126.5$, $S_y = 36.0$ KSI, $E = 29.2 \times 10^3$ KSI

$C_c > Kl/r$ $\quad f_a' = 2/3 \left(1 - \left(\frac{Kl}{r}\right)^2 / 2C_c^2\right) S_y$

$C_c < Kl/r$ $\quad f_a' = 2/3 \dfrac{\pi^2 E}{\left(\frac{Kl}{r}\right)^2}$

Level D TENSION Allowable

$F_t' = 40{,}600$ PSI

SUPPORT EXTENSION PIPES

MAIN STEAM & FEEDWATER support extension PIPES are evaluated for buckling in tables 1-4. In tables 1 & 2, the allowable stress is calculated. In tables 3 & 4, the actual stress is calculated.

Title: MAIN STEAM & FEEDWATER SNUBBER EVALUATION

Calculated by: J. Kennedy Date: 9/24/84
Checked by: R. Church Date: 9/27/84
Reviewed by: [illegible] Date: 9-27-84

Project: 82-03

TABLE 1 MAIN STEAM SUPPORT EXTENSION PIPES

SNUBBER	OVERALL SNUBBER LENGTH (IN.)	ℓ (IN)	r (IN)	$\frac{K\ell}{r}$ **	F_a' (KSI)
X-2A-SS-1 (I_I)	81.5	81.5	0.767	106.3	15.5
X-2A-SS-1 (I_{II})	39.25	39.25	0.767	51.2	22.0
MS-R1A	43.25	43.25	0.767	56.4	21.6
MS-R2A	51.625	51.625	0.767	67.3	20.6
MS-R3A	44.5	44.5	0.767	58.0	21.5
MS-R4A	72.0	72.0	0.767	93.9	17.4
MS-R5A*	111.5	111.5	1.136	98.2	16.8

* uses 3" sch 80 PIPE. All other SNUBBERS use 2" sch 80 PIPE

** $K = 1$

Title: MAIN STEAM & FEEDWATER SNUBBER EVALUATION

Calculated by: M Kennedy Date: 1/8/84
Checked by: R C French Date: 5/9/84
Reviewed by: JJ Date: 9-27-84

Project: 83-03

TABLE 2 FEEDWATER SUPPORT EXTENSION PIPES

SNUBBER	OVERALL SNUBBER LENGTH (in.)	ℓ (in)	r (in.)	$\frac{K\ell}{r}$ **	f'_a (KSI)
RF-R1A *	132.0	132.0	1.136	116.2	13.9
RF-R2A *	96.125	96.125	1.136	84.6	18.6
RF-R3A	42.375	42.375	0.767	55.2	21.7
RF-R4A	72.0	72.0	0.767	93.9	17.4
RF-R5A *	130.0	130.0	1.136	114.4	14.2
RF-R6A	40.875	40.875	0.767	53.3	21.9
XMB-SS-1 (PI)	109.25	109.25	0.767	142.4	9.5
XMB-SS-1 (PE)	79.0	79.0	0.767	103.0	16.0

* uses 3" sch 80 PIPE, All other snubbers use 2" sch 80 PIPE

** K = 1

TABLE 3 MAIN STEAM SUPPORT EXTENSION PIPES

Support MARK #	Area (in^2)	REVISED LOAD (lb)[1]	ACTUAL LOAD (lb)[2]	calculated stress (PSI)	Allowable stress (PSI)
X-2A-SS-1 (P_{II})	1.477	3,440	3,440	2,329	22,000
X-2A-SS-1 (P_I)	1.477	1,200	1,200	812	15,500
MS-R1A	1.477	5,170	5,170	3,500	21,600
MS-R2A	1.477	12,330	12,330	8,348	20,600
MS-R3A	1.477	7,710	7,710	5,220	21,500
MS-R4A	1.477	9,950	9,950	6,737	17,400
MS-R5A	3.016	8,330	8,330	2,762	16,800

Notes

(1) Taken from Appendix A, Table 2

(2) Taken from Appendix C.

(3) $\sigma = F/A$ = Actual load / Area

TABLE 4 FEEDWATER SUPPORT EXTENSION PIPES

SUPPORT MARK #	AREA (in^2)	REVISED LOAD (lb) [1]	ACTUAL LOAD (lb) [2]	CALCULATED STRESS (PSI) [3]	ALLOWABLE STRESS (PSI)
X-4B-SS-1 (P_I)	1.477	1,340	1,340	907	9,500
X-4B-SS-1 (P_{II})	1.477	2,340	2,340	1,584	16,000
RF-R1A	3.016	2,200	2,225	738	13,900
RF-R2A	3.016	1,600	1,600	531	19,600
RF-R3A	1.477	1,300	1,300	880	21,700
RF-R4A	1.477	4,160	4,191	2,838	17,400
RF-R5A	3.016	4,700	4,720	1,565	14,200
RF-R6A	1.477	2,840	2,840	1,923	21,900

Notes

(1) TAKEN FROM APPENDIX A, TABLE 3

(2) TAKEN FROM APPENDIX D.

(3) $\sigma = F/A =$ ACTUAL LOAD / AREA.

turnbuckle

Assuming the clevis / turnbuckle / threaded rod member has the properties of the threaded rod in buckling

Stress Area = 1.0721 in^2
minor diameter = 1.1478 in
} 1¼ 12 N.F. MARK'S HANDBOOK 8th Ed.

$$I = \frac{\pi}{64} d^4 = \frac{\pi}{64} (1.1478)^4 = 8.52 \times 10^{-2}\ in^4$$

$$r = \sqrt{\frac{I}{A}} = \sqrt{\frac{8.52 \times 10^{-2}}{1.0721}} = 0.282\ in$$

Because the section modulus of this member is significantly less than that of the extension pipe this section is evaluated for buckling as an isolated member and not as a stepped column. (see Ref. (4) p 534, Table 34, case 1b.) The "A" dimension listed on pp 2 & 3 is used as the buckling length.

TABLE 5 MAIN STEAM TURNBUCKLES

SNUBBER	"A" (IN)	$\frac{KL}{r}$*	F_a' (KSI)	ALLOWABLE LOAD ** (K.PS)	CALCULATED LOAD (K.PS)	CALCULATED STRESS (PSI)
X-2A-SS-1 I	12.5	44.3	22.5	24.1	1.20	1,119
X-2A-SS-1 II	12.0	42.6	22.6	24.2	3.44	3,209
MS-R1A	12.5	44.3	22.5	24.1	5.17	4,822
MS-R2A	20.125	71.4	20.2	21.7	12.33	11,501
MS-R3A	12.5	44.3	22.5	24.1	7.71	7,191
MS-R4A	14.5	51.4	22.0	23.6	9.95	9,281
MS-R5A	12.5	44.3	22.5	24.1	8.33	7,770

* $K=1$; $r=0.282$ IN. ; $L=A$

** ALLOWABLE LOAD = F_a' * AREA ; AREA = $1.0721\ in^2$

TABLE 6 FEEDWATER TURNBUCKLES

SNUBBER	"A" (IN)	$\frac{Kl}{r}$ *	F_a' (KSI)	ALLOWABLE LOAD ** (KIPS)	CALCULATED LOAD (KIPS)	CALCULATED STRESS (P.S.I)
X-4B-SS-1 I	12.5	44.3	22.5	24.1	1.34	1,250
X-4B-SS-1 II	12.5	44.3	22.5	24.1	2.34	2,183
RF-R1A	12.125	43.0	22.6	24.2	2.23	2,080
RF-R2A	12.5	44.3	22.5	24.1	1.60	1,492
RF-R3A	11.125	39.5	22.8	24.5	1.30	1,213
RF-R4A	11.8125	41.9	22.7	24.3	4.19	3,908
RF-R5A	15.75	55.9	21.7	23.3	4.72	4,403
RF-R6A	11.125	39.5	22.8	24.5	2.84	3,649

* $K = 1$; $r = 0.282$ in. ; $l = A$

** Allowable load = F_a' * Area ; Area = 1.0721 in^2