Docket No. 50-346

License No. NPF-3

Serial No. 1-494

January 18, 1985

TOLEDO EDISON

RICHARD P. CROUSE
Vice President
Nuclear
(419) 259-5221

Mr. James G. Keppler, Regional Administrator
Region III
United States Nuclear Regulatory Commission
7^9 Roosevelt Road
Glen Ellyn, Illinois 60137

Dear Mr. Keppler:

This letter transmits the information that Toledo Edison agreed to provide in the December 21, 1984 meeting at the Nuclear Regulatory Commission (NRC) Glen Ellyn offices, between members of the NRC Region III staff and Toledo Edison representatives, relative to a failed snubber found on the pressurizer surge line at the Davis-Besse Nuclear Power Station, Unit 1.

The listed information was requested prior to return to "full power" operation following the refueling outage.

(a) Calculations to demonstrate postulated failure mechanism.

Calculation number M8, Revision C3, is attached, which models the failure mechanism for the failed snubber. The results of this calculation conclude that a transverse loading of 730 pounds with a deflection of .042 inches (assuming a stress concentration factor of 1.6) would cause failure. The postulated failure mechanism is supported by the calculation.

(b) Calculations to demonstrate the adequacy of the Nuclear Class 1 stanchion to pipe weld.

The requested information is provided in the following attachments:

(1) Calculation number C-PS/PSU-1;
(2) Calculation number M8, Revision C2, in its entirety; and
(3) Calculation number M8, Revision C1, Attachment 1, Sheet 1 of 1; Attachment 2, Sheet 2 of 4; Attachment 3, Sheets 2 of 3 and 3 of 3; and Attachment 4, Sheet 2 of 2.

These calculations show the stanchion to pipe weld to be acceptable for the design conditions.

(c) Review of the pressurizer surge line, restraints and surrounding area to assure adequate clearances.

Field walkdowns and measurements were conducted on two occasions. The first on December 22, 1984 (Plant in Mode 6, Reactor Coolant System (RCS) temperature less than 150°F), and the second on January 11, 1985 (Plant in Mode 3, RCS temperature 535°F). The relative displacements of the pressurizer surge line at the failed snubber support location was: up (+7/8"); east (-1/4"); and north (-1 3/8").

The analyzed thermal movements shown on Attachment No. 7, Sheet 8 of 10, of Calculation number M8, Revision C2 were: up (+.177"); west (+.69"); and north (-1.651"). These movements consider the maximum operating conditions, hot leg at 608°F, and the pressurizer and surge line at 670°F.

Since the temperature of the RCS when the "hot" measurements were taken was less than the analyzed condition, the actual movements will be different. Bechtel performed a thermal analysis of the RCS, considering all the various operating and start-up conditions.

Results of this analysis show the surge line can move in the opposite direction and with magnitudes different from those originally considered. For example, when the hot leg is above 500°F, portions of the surge line can be at significantly lower temperatures due to minimal flow through the surge line and normal heat losses. This can result in line movement slightly east, as observed.

Accounting for the observed thermal movements and evaluating "worst case" combinations of start-up/operations, the range of movements does not invalidate the design of PSU-R1 as presently installed or lessen the interference with the wall that was postulated to cause failure of the snubber.

The field walkdowns also confirmed that adequate clearances are available for the pressurizer surge line, pressurizer spray line, and pressurizer sample line in the area in question.

Based on the above, Toledo Edison is confident of the adequacy of the new support design, which was completed during the refueling outage as corrective action relative to the failed snubber.

Toledo Edison feels the information submitted in this letter fully addresses the concerns expressed by members of the NRC staff in the December 21, 1984 meeting, and, therefore, removes the constraint to proceed to full power operation.

Very truly yours,

RPC:JKW:nlf
cc: DB-1 NRC Resident Inspector

BECHTEL

CALCULATION COVER SHEET

Q

PROJECT Davis Besse Unit-1 JOB NO. 12501009 DISCIPLINE MECH./PROCESS

SUBJECT Pipe Stress Analysis FILE NO

CALC NO M8

ORIGINATOR William Gallagher DATE 7/15/82

CHECKER [signature] DATE 7/15/82 NO OF SHEETS 60 C3

C3 CALC. SHTS. = 23, ATTACHMENT # 1 = 1 DWG, ATTACHMENT # 2 = 4 SHTS

RECORD OF ISSUES ATTACHMENT #3 = 3 SHTS, ATTACHMENT #4 = 2 SHT. ATTACHMENT # 5 = 3 SHTS, ATTACH. #6 = 2 SHTS, ATT. #7 = 10 SHT

NO.	DESCRIPTION	BY	DATE	CHKD	DATE	APPRD	DATE	DATE FILMED
C1	ISSUED For Study	[signature]	7/15/82	[signature]	7/15/82	SPL	7-15-82	
C2	REVISED SHT NO. 3 AND ADDED SHT. NOS. 13, 14, 15, 16 & 17 AND ATTACH. NO. 6 & 7	SPL	12-5-84	DPO	12-5-84	[signature]	12-5-84	
C3	ADDED SHT. NOS. 18 THRU 23 & ATTACHMENTS 8 THRU 13	[signature]	12-27-84	[signature]	12/27/84	MSW	12-28-84	

PRELIMINARY CALC. ☐ COMMITTED PRELIMINARY DESIGN CALC. ☐

SUPERSEDED CALC. ☐ FINAL CALC. ☒

C3 ATTACHMENT #8 = 3 SHTS ATTACHMENT #9, 10, 11 & 12 = 1 SHT ATTACHMENT #13 = 4 SHTS

STUDY For FCR 82-043

C2 ONE OF THE VERTICAL SNUBBERS FOR HANGER NO. PSU-R1 (DATA PT. 40) FAILED (NCR NO. 84-180).
IN ADDITION, THERE IS INTERFERENCE PROBLEM BETWEEN PIPE AND WALL AT THIS HANGER DUE TO THERMAL EXPANSION OF PIPE.
THIS STUDY IS MADE WITH THESE CONDITIONS.

NOTE: 1) REV. C2 IS INDEPENDENT OF REV. C1
2) REV. C2 → NCR NO. 84-180.

C3 THIS REVISION MODELS THE FAILURE MECHANISM FOR THE BROKEN SNUBBER IN NCR 84-180

NOTE: REV. C3 IS INDEPENDENT of REV'S C1 & C2
Rev. C3 adds shts. 18 thru 23 and Attachments 8 thru 13.

GPD-2704 Rev. 9/77 (ED-1)

CALCULATION SHEET

JOB NO. 12501 DAVIS BESSE UNIT 1	CALC. NO. M-8	REV. NO. C3	SHEET NO 18
ORIGINATOR C.H. [illegible]	DATE 12/27/84	CHECKED [illegible]	DATE 12-27-84

THIS CALCULATION IS TO DETERMINE THE MAX APPLIED LOAD THAT CAUSED THE SNUBBER TO BREAK AT THE CRITICAL POINT (PISTON ROD) & THE DEFLECTION NECESSARY TO INDUCE THIS LOAD

DATA FROM STRUDL OUTPUT DATED 12/27/84

CHECK MEM 4 (MODELED FOR PISTON ROD - FAILURE AT JOINT 4)

$$F_b = \frac{M}{S} = \frac{2.625'' \text{ kip}}{.0202 \text{ in}^3} = 111.386 \text{ Ksi}$$

PISTON ROD REF: GRINNELL LCD = MATERIAL ASTM A 434-64 GR BC
1½" FIG. 200

ULTIMATE TENSILE STRENGTH = 130 KSI (REF. ATTACHMENT 13)

$$\text{APPLIED LOAD FOR 130 Ksi} = \frac{130 \text{ KSI}}{111.386 \text{ KSI}}(1.0 \text{ KIP}) = 1.167 \text{ kips}$$

$$\text{FAILURE LOAD} = \frac{1{,}167\#}{\text{STRESS CONC. FACTOR } K} = \frac{1{,}167\#}{1.6} = 730 \#\text{s}$$

(ref sheet 21)

$$\text{MAX. DEF. AT POINT OF LOAD} = \frac{730\# (.0579)}{1000\#}$$

$$\Delta_2 = .042''$$

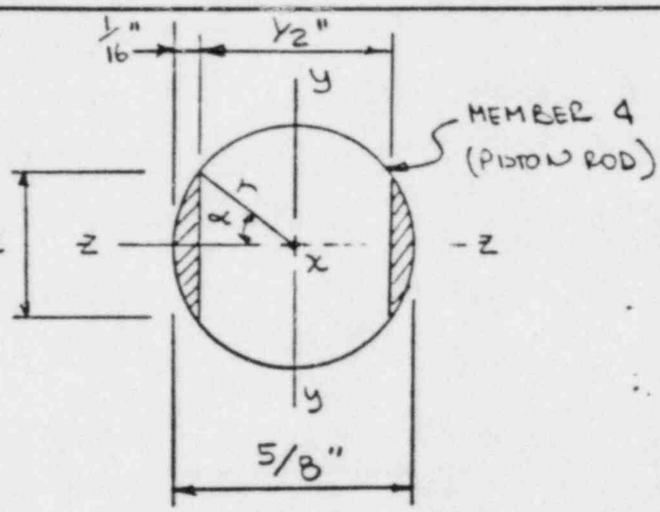
GPD 2708 Rev. 4/82 (ED 09)

CALCULATION SHEET

JOB NO. 12501	CALC. NO.	REV. NO.	SHEET NO.
DAVIS BESSE UNIT 1	M-8	C3	19
ORIGINATOR: C. H. [illegible]	DATE: 12/26/87	CHECKED: [illegible]	DATE: 12-27-87

REF: FORMULAS FOR STRESS & STRAIN BY ROARK

$r = \frac{.625}{2} = .3125''$



$\alpha = 36.87°$

$\text{Arc Length} = \frac{\pi r \; 73.74°}{180°} = .402''$

$c = 2\sqrt{2br - b^2}$

$= 2\sqrt{2(.0625)(.3125) - (.0625)^2}$

$= .375 \text{ in}$

NOTE: REF: FORMULAS FOR STRAIN & STRESS TABLE 1
$\alpha < \frac{\pi}{4}$ USE FORM OF SECTION NO. 18
FORM OF SECTION NO. 17 WAS USE IN CALC. NO SIGNIFICANT DIFFERENCE IN THIS CASE. ∴ OK.

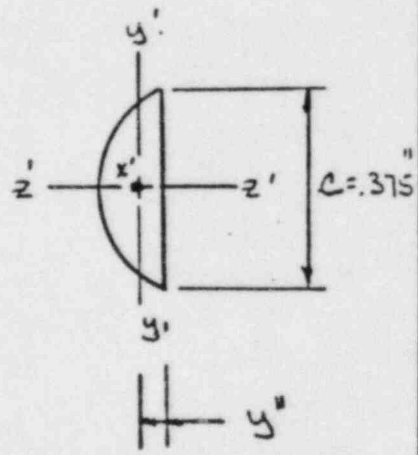
$A_x = A_y = A_z = \pi r^2 - \frac{2[(\text{ARC LENGTH} \times r) - c(r-b)]}{2}$

$= \pi(.3125)^2 - [(.402)(.3125) - .375(.3125 - .0625)]$

$= .307 - [.126 - .09375]$

$= .275 \text{ in}^2$

$I_{circle} = \frac{\pi(.3125)^4}{4} = .0075 \text{ in}^4$



$A' = \frac{.126 - .09375}{2} = .0161 \text{ in}^2$

$y'' = r\left[\frac{2\sin^3\alpha}{3(\alpha - \sin\alpha\cos\alpha)} - \cos\alpha\right]$

$\alpha = \frac{36.87°}{57.28°/\text{RAD}} = .6437 \text{ RAD}$

GPO 2706 Rev 4-82 (ED 69)

CALCULATION SHEET

JOB NO. 12501 DAVIS BESSE UNIT 1	CALC. NO. M-8	REV. NO. C3	SHEET NO. 20
ORIGINATOR C. H. Alverton	DATE 12/26/84	CHECKED Ries	DATE 12.27.84

$$y'' = .3125\left[\frac{2\sin^3 36.87}{3(.6437 - \sin 36.87 \cos 36.87)} - \cos 36.87\right]$$

$$= .3125\left(\frac{.432}{.491} - .80\right)$$

$$= .025''$$

$$I_{y'-y'} = \frac{r^4}{4}\left[\alpha - \sin\alpha\cos\alpha + 2\sin^3\alpha\cos\alpha - \frac{16\sin^6\alpha}{9(\alpha - \sin\alpha\cos\alpha)}\right]$$

$$= \frac{(.3125)^4}{4}\left[.6437 - .48 + .3456 - .507\right]$$

$$= .0024\,(.0023)$$

$$= 5.5\times10^{-6}\ \text{in}^4$$

$$I_{y-y} = .0075 - 2\left[.0000055 + .0161(.025 + .25)^2\right]$$

$$= .00505\ \text{in}^4$$

$$S_{y-y} = \frac{.00505}{.25} = .0202\ \text{in}^3$$

$$I_{z'-z'} = \frac{r^4}{12}\left[3\alpha - 3\sin\alpha\cos\alpha - 2\sin^3\alpha\cos\alpha\right]$$

$$= .0008\left[3\times.6437 - 1.44 - .3456\right]$$

$$= .00012\ \text{in}^4$$

$$I_{zz} = .0075 - 2(.00012) \qquad S_{z-z} = \frac{.00726}{.3125} = .0232\ \text{in}^3$$

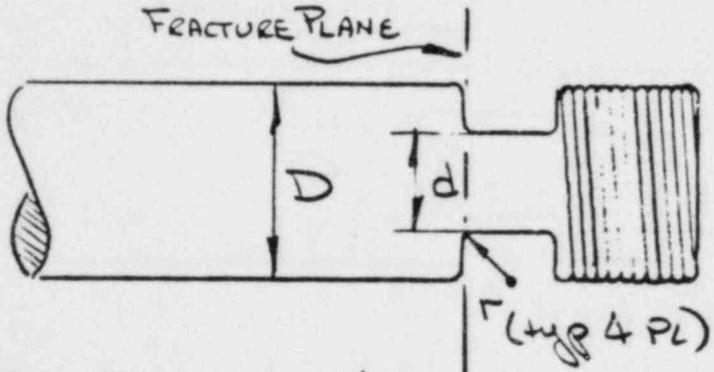
$$= .00726\ \text{in}^4$$

CALCULATION SHEET

JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
12501	M-8	C3	21

ORIGINATOR	DATE	CHECKED	DATE
[illegible]	12-27-84	C.H. [illegible]	12/27/84

PISTON SHAFT - ITT GRINNELL 1½" FIG. 200 HYDRAULIC SNUBBER



STRESS CONCENTRATION FACTOR (K)

$D = 5/8"$ $d = 1/2"$

1) ratio $D/d = .625/.5 = 1.25$

approximate $r = 1/16"$

$r/d = \frac{.0625}{.5} = .125 \longrightarrow K = 1.6$

2) approximate $r = 1/32"$

$r/d = \frac{.03125}{.5} = .0625 \longrightarrow K = 2.1$

(ATTACHMENT 9) Fig. 4.27 pg. 173 Mechanics of Materials - Beer & Johnston

1) $D/d = 1.25$ $r/d = .125 \longrightarrow K = 1.62$

2) $r/d = .0625 \longrightarrow K = 1.98$

(ATTACHMENT 10) FIG. AF9 pg 585

1) $D/d = 1.25$ $r/d = .125 \longrightarrow K = 1.58$

2) $r/d = .0625 \longrightarrow K = 1.88$

(ATTACHMENT 11) FIG. AF 12 pg. 586 Design of Machine Elements - Faires

CALCULATION SHEET

JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
12501	M-8	C3	22

ORIGINATOR	DATE	CHECKED	DATE
Kies	12 27 84	C H D[illegible]	12/27/84

As can be seen, if we model the round shaft w/a flat slot as a flat bar (Attachments 9 & 10) or as a round shaft (Attachment 11) the stress concentration factor only varies from K = 1.6 → 2.1

For purposes of this analysis, a lower K will give a higher load and deflection to cause failure, therefore use K = 1.6.

<u>Conclusion</u> —

From revision C2 it was shown that a thermal interference of .292" would have generated a reaction of 5288#. This revision shows that it would have only taken a reaction of 730# and a thermal interference of .042" to cause failure of the piston rod. From the scale drawing in Attachment 12 and from photographs of the wall it can be seen

CALCULATION SHEET

JOB NO.	CALC. NO.	REV. NO.	SHEET NO.
12501	M-8	C3	23

ORIGINATOR	DATE	CHECKED	DATE
[illegible]	12-27-84	C.H. [illegible]	12/27/8[illegible]

that the upper tube steel contacted the 45° haunch of the wall after approximately 3/8" of movement. The 45° incline then forced the surge line down during continued west thermal movement. When the tube steel finally contacted the vertical portion of the wall just below the haunch there had already been an interference between the two (2) valve body bolts and the wall. The effect of this interference can be seen on the photographs as chipped concrete in a circular arc ≈ 1" long. The magnitude of the interference can be approximated as ≈ 1"/1.6" × .667" ≈ .42" where ≈ 1" is the length of contact with wall in a north direction, 1.6" is the total analyzed north mvt, and .667" is total analyzed west mvt. This interference with a relative east-west piping system stiffness of 5288/.292 = 18109 #/" would generate a force of 7506#, obviously much greater than the necessary 730#

```
*********************************************
*                                           *
*         UNIVAC 1100 SERIES ICES           *
*    DEC 27, 1984             07:57:12      *
*              VERSION  2.9                 *
*                                           *
*********************************************
>@ADD CAR2.
  1. STRUDL 'PSU-R1' '         '
       ****************************************************
       *                                                  *
       *                ICES STRUDL-II                    *
       *.       THE STRUCTURAL DESIGN LANGUAGE            *
       *                                                  *
       *      CIVIL ENGINEERING SYSTEMS LABORATORY        *
       *      MASSACHUSETTS INSTITUTE OF TECHNOLOGY       *
       *            CAMBRIDGE, MASSACHUSETTS              *
       *                                                  *
       *         07.57.46           27 DEC 84             *
       *          SPERRY UNIVAC   1100 SERIES             *
       *          UNIVAC 1100 SERIES   EXEC 8             *
       *                VERSION 2.9.2                     *
       *                                                  *
       ****************************************************
  2. TYPE SPACE FRAME
  3. UNIT IN KIP DEG
  4. CONSTANT E 27100. ALL
  5. BETA 0. ALL
  6. JOINT COORDINATES
  7. 1       0          0         0          SUPPORT
  8. 2       11.0625    0         0          SUPPORT
  9. 3       12.5625    0         0
 10. 4       13.4375    0         0
 11. 5       13.8125    0         0
 12. 6       16.0625    0         0
 13. MEMBER INCIDENCES
 14. 1       1          2
 15. 2       2          3
 16. 3       3          4
 17. 4       4          5
 18. 5       5          6
 19. JOINT RELEASE
 20. 1 MOMENT Y
 21. 2 MOMENT Y
 22. MEM PROP
 23. 1 2 5 PRIS AX 10 AY 10 AZ 10 IX 10 IY 10 IZ 10
 24. 3 PRIS AX .307 AY .307 AZ .307 IX .015 IY .0075 -
 25.    IZ .0075 SY .024 SZ .024
 26. 4 PRIS AX .275 AY .275 AZ .275 IX .01015 IY .00505 -
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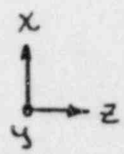
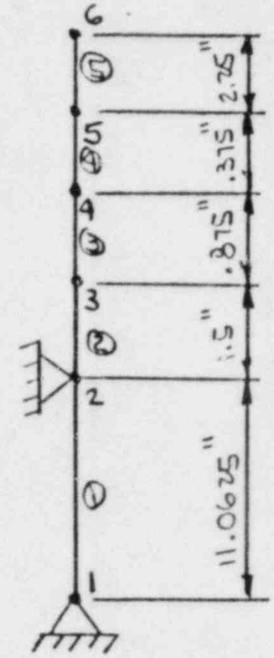
ORIGINATOR: [signature] CHECKED BY: [signature] DATE: 12-27-84





JOB #12501
ATTACHMENT # 8, sht 1/3
CALC. # M-8
REV. C3

28. LOADING 1
29. JOINT LOAD
30. 6 FORCE Z -1.0
31. STIFFN A
32. OUTPUT BY MEMBER
33. OUT DEC 4
34. LIST FORCE REA DISP ALL

SHOULD BE :
* Iz = .00726 } OUT PUT NOT
Sz = .0232 } AFFECTED CMA 12/27/84

****
RESULTS OF LATEST ANALYSIS
****

PROBLEM - PSU-R1 TITLE -

ACTIVE UNITS INCH KIPS DEGREE DEGF SECOND

ACTIVE STRUCTURE TYPE SPACE FRAME

ACTIVE COORDINATE AXES X Y Z

JOB #12501
ATTACHMENT # 8 - Sht 2/3
CALC. # M-8
REV. C3

MEMBER FORCES

MEMBER / LOADING	JOINT	FORCES AXIAL	FORCES SHEAR Y	FORCES SHEAR Z	MOMENTS TORSIONAL	MOMENTS BENDING Y	MOMENTS BENDING Z
1							
1	1	.0000	.0000	-.4520	.0000	.0000	.0000
	2	.0000	.0000	.4520	.0000	5.0000	.0000
2							
1	2	.0000	.0000	1.0000	.0000	-5.0000	.0000
	3	.0000	.0000	-1.0000	.0000	3.5000	.0000
3							
1	3	.0000	.0000	1.0000	.0000	-3.5000	.0000
	4	.0000	.0000	-1.0000	.0000	→ 2.6250	.0000
4							
1	4	.0000	.0000	1.0000	.0000	-2.6250	.0000
	5	.0000	.0000	-1.0000	.0000	2.2500	.0000
5							
1	5	.0000	.0000	1.0000	.0000	-2.2500	.0000
	6	.0000	.0000	-1.0000	.0000	.0000	.0000

JOINT

SUPPORTS

LOADS -

JOINT LOADING		X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
1	GLO						
1		.0000	.0000	-.4520	.0000	.0000	.0000
2	GLO						
1		.0000	.0000	1.4520	.0000	-.0000	.0000

(FORCES: X FORCE, Y FORCE, Z FORCE; MOMENTS: X MOMENT, Y MOMENT, Z MOMENT)

JOINT
SUPPORTS
DISPLACEMENTS -

JOINT LOADING		X DISPL	Y DISPL	Z DISPL	X ROT	Y ROT	Z ROT
1	GLO						
1		.0000	.0000	.0000	.0000	-.0017	.0000
2	GLO						
1		.0000	.0000	.0000	.0000	.0041	.0000

(DISPLACEMENTS: X DISPL, Y DISPL, Z DISPL; ROTATIONS: X ROT, Y ROT, Z ROT)

JOINT
FREE JOINTS
DISPLACEMENTS -

JOINT LOADING		X DISPL	Y DISPL	Z DISPL	X ROT	Y ROT	Z ROT
3	GLO						
1		.0000	.0000	-.0001	.0000	.0055	.0000
4	GLO						
1		.0000	.0000	-.0065	.0000	.7609	.0000
5	GLO						
1		.0000	.0000	-.0129	.0000	1.1436	.0000
6	GLO						
1		.0000	.0000	→ -.0579	.0000	1.1441	.0000

(DISPLACEMENTS: X DISPL, Y DISPL, Z DISPL; ROTATIONS: X ROT, Y ROT, Z ROT)

35. FINISH

CORE REQUESTED 62074 DECIMAL WORDS
THERE WERE 6 REORGANIZATIONS IN THIS JOB
1 DATA COMPACTIONS
1 MODULE COMPACTIONS
0 LOW RELEASED
4 LOW DEAD MODULES
0 HIGH RELEASED
0 HIGH DEAD MODULES
0 LOW UNRELEASED
24 DD4 BLOCKS READ FROM BANKS

JOB #12501
ATTACHMENT # 8 Sht 3/3
CALC. # M-8
REV. C3

4.7. STRESS CONCENTRATIONS

The formula $\sigma_m = Mc/I$ was derived in Sec. 4.4 for a member with a plane of symmetry and a uniform cross section, and we saw in Sec. 4.5 that it was accurate throughout the entire length of the member only if the couples M and M′ were applied through the use of rigid and smooth plates. Under other conditions of application of the loads, stress concentrations will exist near the points where the loads are applied.

Higher stresses will also occur if the cross section of the member undergoes a sudden change. Two particular cases of interest have been studied,† the case of a flat bar with a sudden change in width, and the case of a flat bar with grooves. Since the distribution of stresses in the critical cross sections depends only upon the geometry of the members, stress-concentration factors may be determined for various ratios of the parameters involved and recorded as shown in Figs. 4.27 and 4.28. The value of the

ATTACHMENT 9
CALC M-8 Rev CS
By [signature] 12-27-84
Chk C. H. [signature] 12/27/84

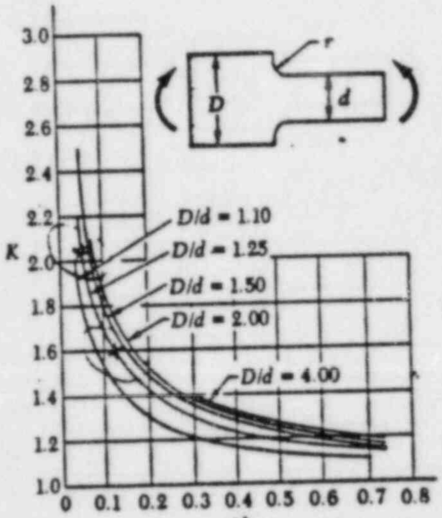


Fig. 4.27 Stress-concentration factors for *flat bars* with fillets under pure bending.†

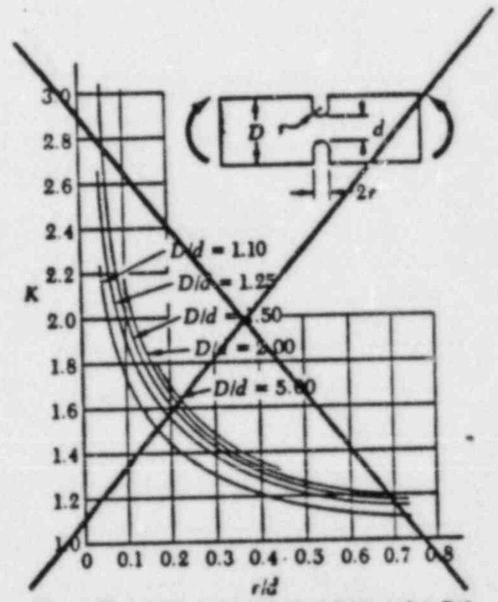
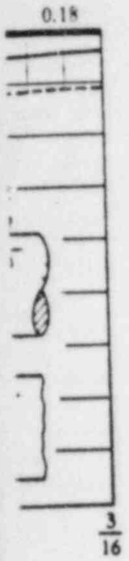


Fig. 4.28 Stress-concentration factors for *flat bars* with grooves under pure bending.†

† M. M. Frocht, "Photoelastic Studies in Stress Concentration," *Mechanical Engineering*, August 1936, pp. 485–489.

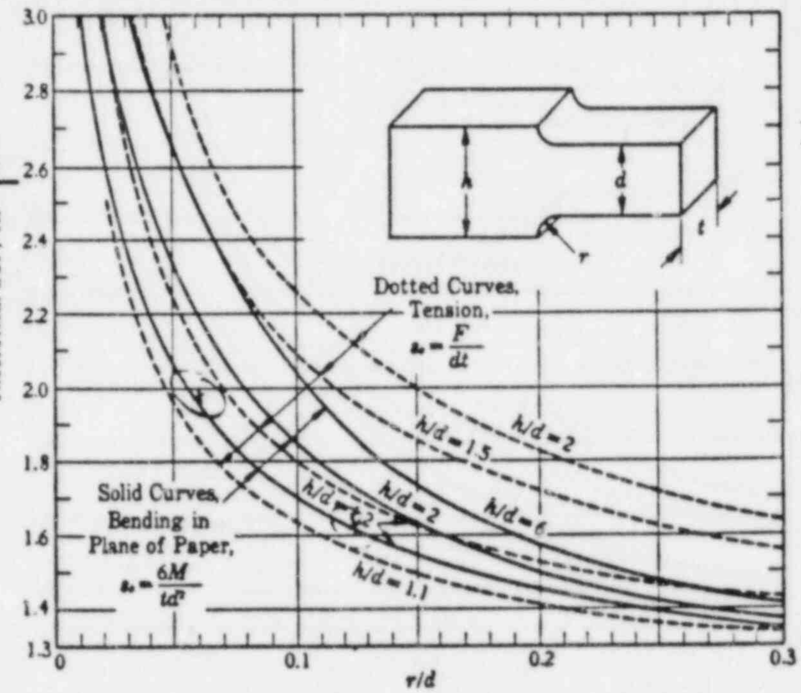


ATTACHMENT 10

CALC M-8 Rev C3

By ___ 12-27-84

Ckd [illegible] 12/27/84

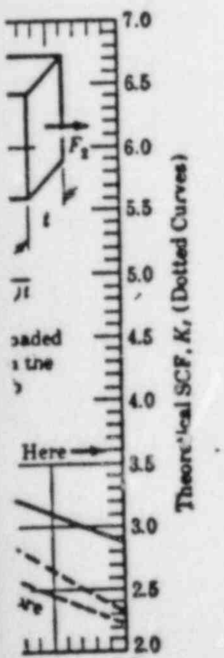


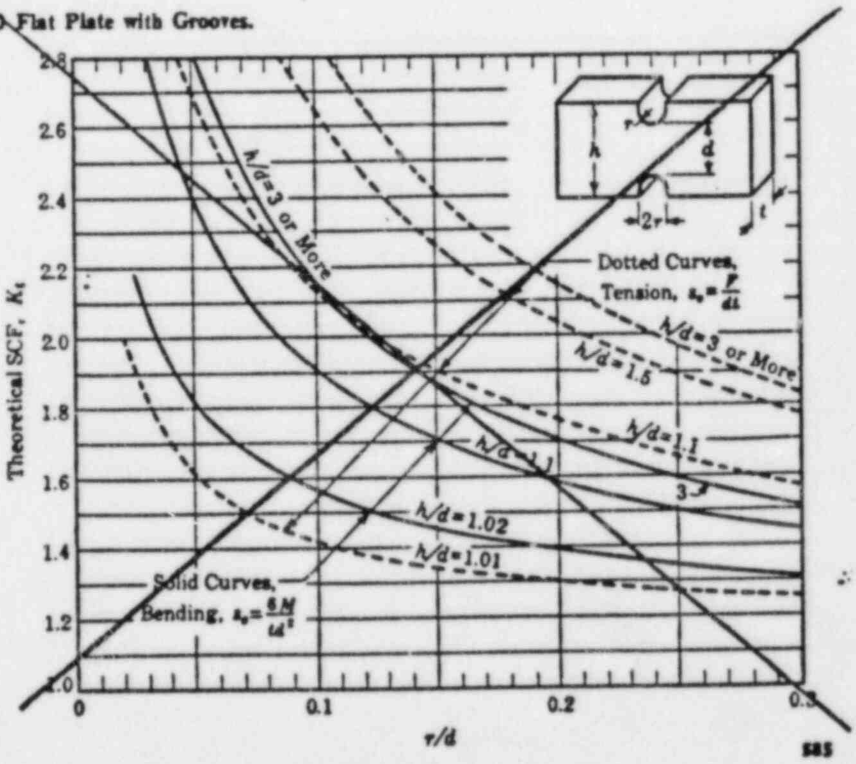
…particularly to normal …[4.37]

FIGURE AF 9 Flat Plate with Fillets. The tensile load is central. For h/d = 1.1, tensile and bending curves are very close together down to r/d = 0.04. (After R. E. Peterson)[4.21]

…and Bending.[4.8, 4.16, 4.21]
…) with a hole (d) in tension.
…ile rectangular body are

FIGURE AF 10 Flat Plate with Grooves.





ATTACHMENT 11

CALC M-8 Rev C3

By [signature] 12-27-84

Ckd C.H. [signature] 12/27/84

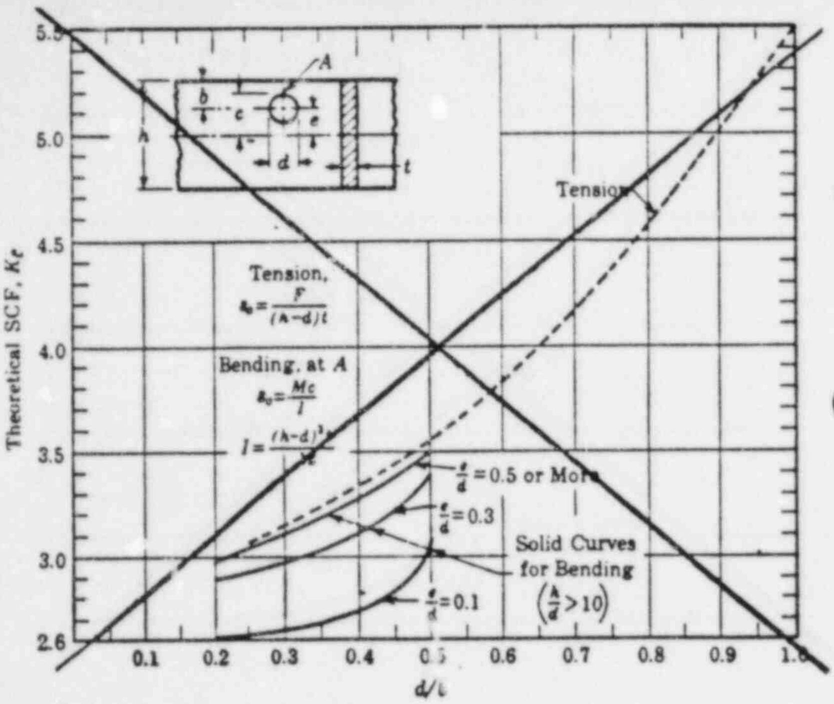
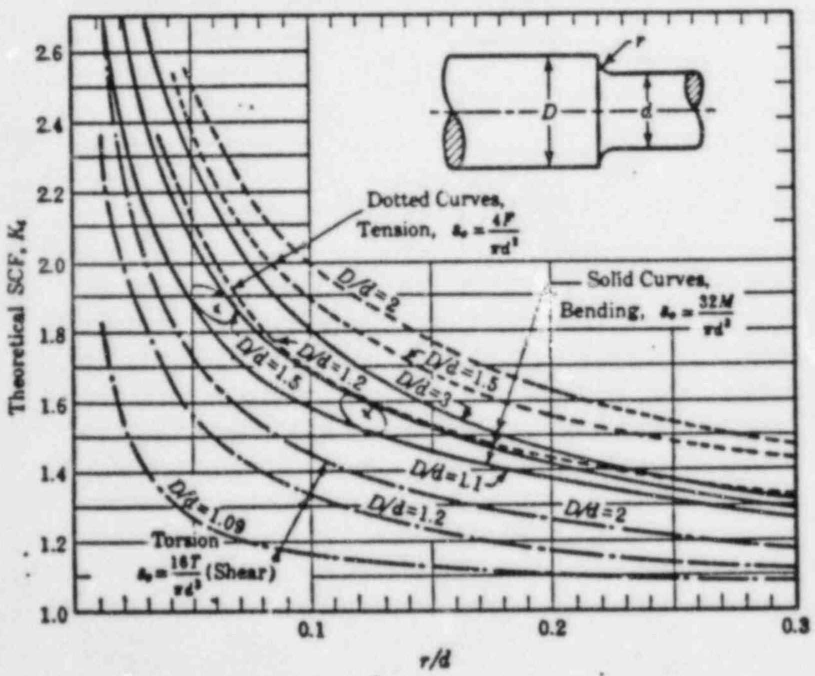


FIGURE AF 11 Flat Plate with Eccentric Hole.[4.2,4.20] For tension, if $h < 20d$, K_t is somewhat smaller than shown. (After R. E. Peterson).[4.21]

FIGURE AF 12 Shaft with Fillet. The tensile load is central. Torsion curve $D/d = 1.2$ approximates the bending curve for $D/d = 1.01$; torsion curve $D/d = 2$, approximates the bending curve for $D/d = 1.02$ (down to $r/d \approx 0.04$). Bending curve $D/d = 1.1$ approximates the tensile curve $D/d = 1.1$. (After R. E. Peterson).[4.21]



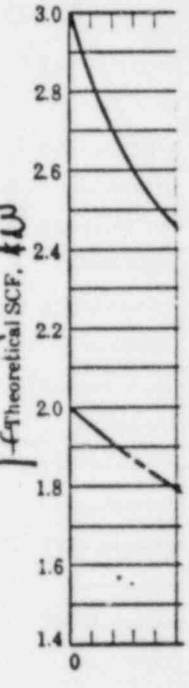
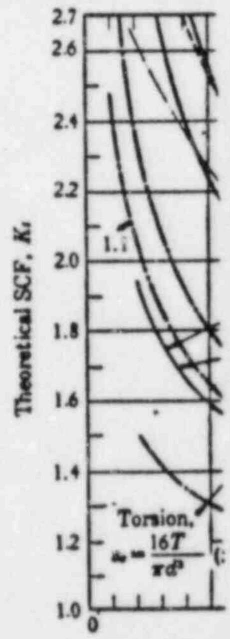


FIGURE AF 13 Shaft with Radial
stress for this case falls slightly inside
some point B. (After R. E. Peterson)

FIGURE AF 14 Shaft with Groove.
as bending (approximate).

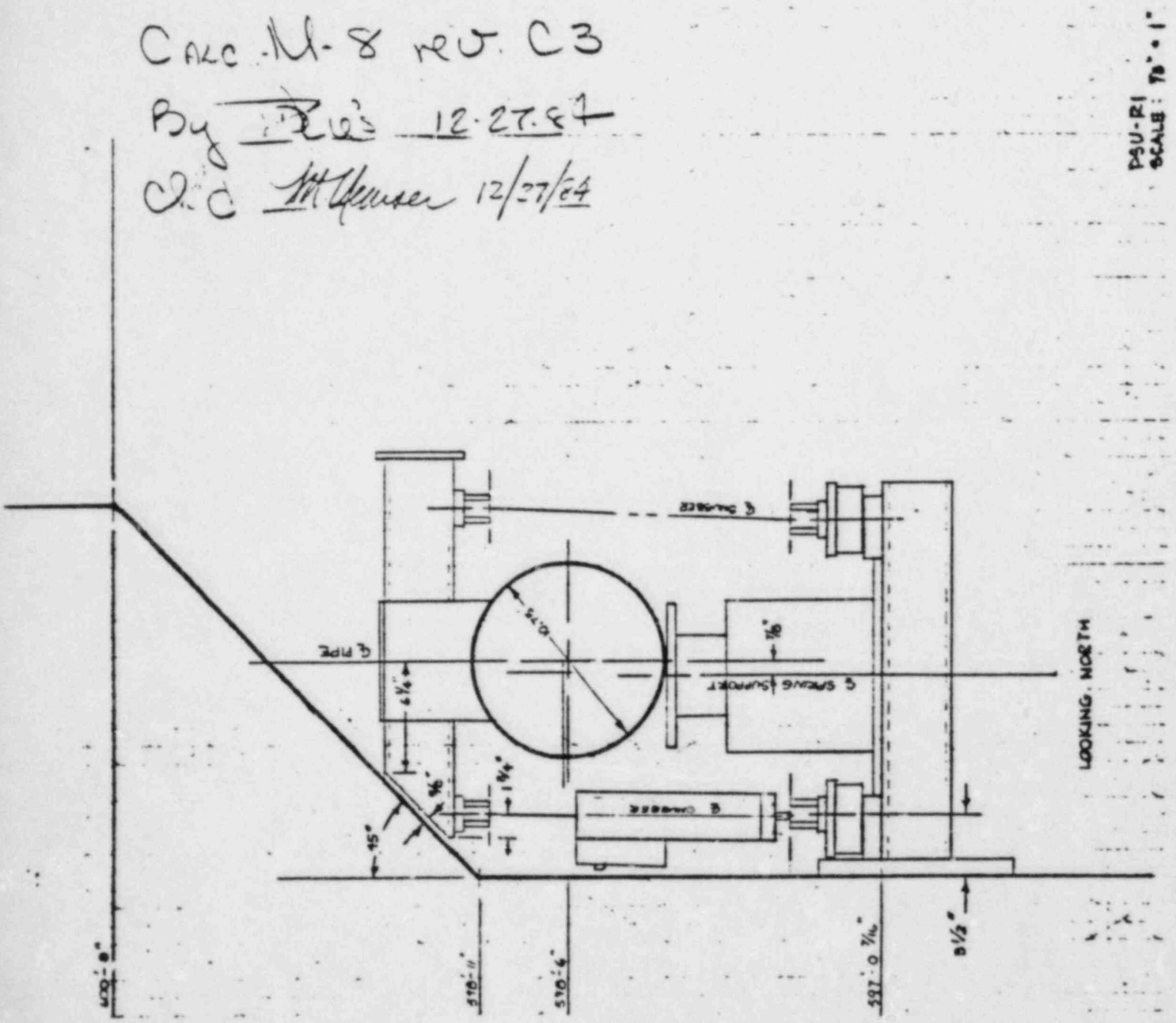


ATTACHMENT 12

CALC. M-8 rev. C3

By [signature] 12.27.84

Q.C [signature] 12/27/84



ATTACHMENT 13 SHT 1 of 4
CALC M-8 rev C3
By [illegible] 12-27-84
Chkd [illegible] 12/27/84

ITT GRINNELL
PIPE HANGER DIVISION
ASME SECTION III SUBSECTION NF
LOAD CAPACITY DATA SHEET

4. COMPONENT SUPPORT INFORMATION		
ITEM	MATERIAL SPECIFICATION	ANALYSIS
REAR BRACKET BASE PLATE	SA-515 GR 65 or SA-36	PLATE & SHELL
REAR BRACKET LUGS	SA-515 GR 65 or SA-36	LINEAR
REAR BRACKET PIN	SA-193 GR B 7	LINEAR
PIVOT LUG	SA-515 GR 65 & SA-36	LINEAR
PIVOT LUG BASE PLATE	SA-515 GR 65 & SA-36	PLATE & SHELL
CYLINDER CAP	ASTM A 108-73 GR 1018*	PLATE & SHELL
CYLINDER BARREL	ASTM A 519-74 GR 1018 CW*	PLATE & SHELL
TIE RODS	ASTM A-193-73 GR B 7	LINEAR
TIE ROD NUTS	ASTM A 194-73 GR 7	LINEAR
PISTON (1 1/2 - 6")	ASTM A 108-73 GR 1018*	LINEAR
PISTON (8")	ASTM A434-64 CLASS BC	LINEAR
→ PISTON ROD	ASTM A 434-64 GR B C*	LINEAR
CYLINDER ROD EYE	SA-515 GR 65, SA-36, SA-182 GR F22	LINEAR
PIPE CLAMP (DESIGN TEMP = 650 F)	SA-515 GR 65, SA-36	LINEAR
CLAMPING BOLTS (DES.TEMP = 650 F)	SA-307 GR B*, or ASTM A-307-74 GR A*	LINEAR
CLAMP LOAD STUD	SA-193 GR B 7	LINEAR
EXTENSION ROD END (FIG. 201 ONLY)	SA-515 GR 65, SA-36, SA-675 GR 50-70	LINEAR [illegible]

TABLE 1 Tensile Properties

NOTE—The mechanical properties of hot-wrought bars ordered for cold finishing, shall be governed by the cold-finished size

Class	Diameter, in. (mm)	Yield Strength, min, ksi (MPa)[a]	Tensile Strength, min, ksi (MPa)	Elongation in 2 in. or 50 mm, min, %	Reduction of Area, min, %	SAE or AISI Representative Grade Types[b]
BB[c]	1½ (38.1) and under	90 (620)	110 (760)	20	50	3100, 4100, 8600, 8700
	Over 1½ to 2½ (38.1 to 63.5), incl	80 (550)	105 (720)	20	50	
	Over 2½ to 4 (63.5 to 114), incl	75 (520)	100 (690)	20	50	
	Over 4 to 7 (114 to 178), incl	75 (520)	95 (660)	20	50	
	Over 7 to 9½ (178 to 241.3), incl	65 (450)	90 (620)	18	40	
BC[c]	1½ (38.1) and under	110 (760)	130 (900)	16	50	3100, 4100, 6100, 8600, 8700
	Over 1½ to 2½ (38.1 to 63.5), incl	105 (720)	125 (860)	16	50	
	Over 2½ to 4 (63.5 to 114), incl	95 (660)	115 (790)	16	45	3100, 4100, 4300, 9800
	Over 4 to 7 (114 to 178), incl	85 (590)	110 (760)	16	45	
	Over 7 to 9½ (178 to 241.3), incl	80 (550)	105 (720)	15	40	
BD[c]	1½ (38.1) and under	130 (900)	155 (1070)	14	35	4100, 4300, 9800
	Over 1½ to 2½ (38.1 to 63.5), incl	120 (830)	150 (1030)	14	35	
	Over 2½ to 4 (63.5 to 114), incl	110 (760)	140 (960)	14	35	
	Over 4 to 7 (114 to 178), incl	105 (720)	135 (930)	14	35	
	Over 7 to 9½ (178 to 241.3), incl	100 (690)	130 (900)	14	35	

[a] Determined by the 0.2% offset method.

[b] The carbon content of all steels listed in this column may vary up to 0.55% max, as agreed upon by the manufacturer and the purchaser.

[c] Class BB, BC, BD hot-wrought; Class BB, BC cold-finished.

The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, Pa. 19103.

ATTACHMENT 13 Sht 2 of 4
CALC M-8 rev. C3
By [signature] 12-27-84
Ck'd [signature] 12/27/84

ASTM Designatio

Standarc
MAGNE
FORGIN

This standard is issued und
original adoption or, in the
A superscript epsilon (ε) in

1. Scope

1.1 This is an acc
magnetic particle i
crankshafts having
crankpins 8 in. (203

1.2 There are thr
standards of increasi

1.2.1 Class 1

1.2.2 Class 2 (ori
standard of Specifica

1.2.3 Class 3 (forr
tary requirement S1
(1970)).

1.3 This specifica
diesel locomotive c
Class 2 or 3 may be
ultimate user agree t

NOTE—Specificatior
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specification which ma

1.4 The values st
to be regarded as the

2. Applicable Docu

2.1 ASTM Stand
A 275 Method fc
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E 165 Recommen
etrant Inspectic

3. Ordering Inform

3.1 The inquiry
shall contain a stat
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this specification. If
Class 2 shall apply.

TABLE 3 (Cont'd)

Yield Strength Values, S_y, for Ferritic Steels and Copper Alloys for Classes 1, 2, 3, and MC Linear Type Component Supports

Nominal Composition	P-No.	Group No.	Product Form	Specification No.	Type or Grade	Class	Notes	Min Yield Strength	Min Ultimate Tensile Strength	Yield Strength, ksi (multiply by 1000 to obtain psi) for metal temperatures, F, not to exceed: 100	200	300	400	500	600	650	700	750	800
AISI 4140, 4145,4340			Bar	A434-64	–	BC	1,2	110	130	110.0	102.9	99.4	96.6	93.6	89.5	86.8	83.6	–	–
			Bar	A434-64	–	BC	1,2	105	125	105.0	98.1	94.8	92.2	89.4	85.5	82.9	79.8	–	–
			Bar	A434-64	–	BC	1,2	95	115	95.0	88.5	85.4	83.0	80.6	77.0	74.6	72.0	–	–
			Bar	A434-64	–	BC	2	85	110	85.0	79.5	76.8	74.6	72.4	69.1	67.0	64.6	–	–
			Bar	A434-64	–	BC	2	80	105	80.0	74.8	72.3	70.3	68.1	65.1	63.1	60.9	–	–
AISI 4140, 4145,4340			Bar	A434-64	–	BD	1,2	130	155	130.0	121.5	117.2	114.1	110.7	105.7	102.5	98.8	–	–
			Bar	A434-64	–	BD	1,2	120	150	120.0	112.1	108.4	105.2	102.1	97.6	94.6	91.1	–	–
			Bar	A434-64	–	BD	1,2	110	140	110.0	102.9	99.4	96.6	93.6	89.5	86.8	83.6	–	–
			Bar	A434-64	–	BD	1,2	105	135	105.0	98.1	94.8	92.2	89.4	88.5	82.9	79.8	–	–
			Bar	A434-64	–	BD	1,2	100	130	100.0	93.5	90.3	87.8	85.1	81.4	78.9	76.0	–	–
			Bar	SA-540	B21,B22, B23,B24	1	1,2	150	165	150.0	140.1	135.3	131.7	127.7	122.6	118.2	114.0	–	–
			Bar	SA-540	B21,B22, B23,B24	2	1,2	140	155	140.0	131.0	126.3	123.0	119.1	114.0	110.4	106.3	–	–
			Bar	SA-540	B21,B22, B23,B24	3	1,2	130	145	130.0	121.5	117.2	114.1	110.7	105.7	102.5	98.8	–	–
			Bar	SA-540	B21,B22, B23,B24	4	1,2	120	135	120.0	112.1	108.4	103.2	102.1	97.6	94.6	91.1	–	–
			Bar	SA-540	B21,B22, B23,B24	5	1,2	100	115	100.0	93.5	90.3	87.8	85.1	81.4	78.9	76.0	–	–
			Bar	SA-540	B21,B22, B23,B24	5	1,2	105	120	105.0	98.1	94.8	92.2	89.4	85.5	82.9	79.8	–	–
			Plate,Bar Shapes	A572-74b		–		42	60	42.0	40.0	38.3	36.8	35.2	33.5	32.7	31.8	–	–
			Plate,Bar Shapes	A572-74b		–		50	65	50.0	47.5	45.6	43.8	41.8	39.9	38.9	37.9	–	–
5Ni-Cr-Mo-V			Forging	A579-70	12a*	–	1,2	140	150	140.0	138.6	134.0	129.5	127.7	126.3	123.5	117.6	–	–
			Plate,Bar Shapes	A588-74a	A,B	–		42	63	42.0	40.0	38.3	36.8	35.2	33.5	32.7	31.8	–	–
			Plate,Bar Shapes	A588-74a	A,B	–		46	67	46.0	43.8	41.9	40.3	38.6	36.7	35.8	34.8	–	–
			Plate,Bar Shapes	A588-74a	A,B	–		50	70	50.0	47.5	45.6	43.0	41.8	39.9	38.9	37.9	–	–
			Tube	A618-74	II	–		50	70	50.0	–	–	–	–	–	–	–	–	–
			Tube	A618-74	III	–		50	65	50.0	–	–	–	–	–	–	–	–	–

*Grade 12 modified

ATTACHMENT 13
SHT 4 of 4
CALC M-8, rev. C3
By [initials] 12-27-84
Ch E [signature] 12/27/84

TABLE I-6.0
MODULI OF ELASTICITY OF MATERIALS FOR GIVEN TEMPERATURES

Material	Modulus of Elasticity, E, = Value Given × 10⁶ (psi) for Temperature (F) of: −325	−200	−100	70	200	300	400	500	600	700	800
Ferrous Materials											
Carbon steels with carbon content 0.30 or less, 3½ Ni	30.0	29.5	29.0	27.9	27.7	27.4	27.0	26.4	25.7	24.8	...
Carbon steels with carbon content above 0.30	31.0	30.6	30.4	29.9	29.5	29.0	28.3	27.4	26.7	25.4	...
Carbon-molybdenum steels, low chrome steels through 3 Cr	31.0	30.6	30.4	29.9	29.5	29.0	28.6	28.0	27.4	26.6	...
Intermediate chrome steels (5 Cr through −9 Cr)	29.4	28.5	28.1	27.4	27.1	26.8	26.4	26.0	25.4	24.9	...
Austenitic steels (304,310,316,321,347)	30.4	29.9	29.4	28.3	27.7	27.1	26.6	26.1	25.4	24.8	24.1
Straight chromium steels (12 Cr, 17 Cr, 27 Cr)	30.8	30.3	29.8	29.2	28.7	28.3	27.7	27.0	26.0	24.8	23.1
Nonferrous Materials											
High Nickel Alloys											
Ni-Cr-Fe, Ni-Fe-Cr, Ni-Cu	...	...	...	31.7	30.9	30.5	30.0	29.6	29.2	28.6	27.9
Ni-Cr-Fe-Mo-Cb	...	...	...	29.0	28.4	27.9	27.5	27.1	26.7	26.3	25.8
Other Nonferrous Materials											
Copper Nickel (70-30)	...	...	...	22.0	...	...	...	...	...	...	...
Aluminum	11.3	11.1	10.9	10.6	10.3	10.2	9.5	8.5	...	...	...
Copper	17.0	16.7	16.5	16.0	15.6	15.4	15.1	14.7	14.2	13.7	...
Unalloyed Titanium	...	...	...	15.5	15.0	...	13.8	13.2	12.5	11.8	11.2

Assume temperature @ snubber = 550°F

$$E = \frac{27.4 + 26.7}{2} = 27.1 \times 10^{6}\ psi$$

CALCULATION COVER SHEET

Q

Discipline Civil/Pipe Support

PROJECT DAVIS-BESSE UNIT 1 JOB NO. 12501 CALC. NO. C-PS/PSU-1

SUBJECT PRESSURIZER SPRAY AND SURGE

Iso. No.

COMPUTER PROGRAM: ☐ NONE ☒ SCP ☐ OTHER

PROGRAM NO(S). see below VERSION/RELEASE NO. see below

TOTAL NO. OF SHEETS 9

☐ PRELIMINARY CALC. ☐ COMMITTED PRELIMINARY CALC.

☐ SUPERSEDES CALC. NO. ____ ☒ FINAL CALC.

STATEMENT OF PROBLEM

Design of Pipe Support for Structural Stability

Support No. PSU-H1, PSU-R1

☐ For Calcs. See Calc. No. ____

☐ No Calcs. Req'd. OK by Inspection

SAR CHECKED ☒ SAR CHANGE REQ'D ☐ SAR CHANGE NOTICE INITIATED ☐

SOURCES OF DATA

☒ Piping Stress Analysis Data - Prob. No. B & W DP.____ Issue No.____

☐ ICES STRUDL II - (CE 901) - Version/Rel. No. ____ Output Attached ____

☐ Anchor Bolt Prog. - (CE 035)-Version/Rel. No. ____ Output Attached ____

☐ Anchor Bolt Prog. - (CE 050)-Version/Rel. No. ____

☒ Local Stress Analysis - (ME 210) - Version/Rel. No. 5

☒ STRESS GROUP MEMO ATTACHMENT A-1

SOURCES OF FORMULAE & REFERENCES

☒ ASME III Subsection NF/Appendix XVII

☐ ANSI B31.1

☒ AISC Manual of Steel Construction - 7th Edition

☐ Pipe Support Design Manual Vol. 1 & 2

☒ Design of Welded Structures by O. W. Blodgett

☐ GPD Pipe Support Group Newsletter No. ____

NO.	DESCRIPTION	BY	DATE	CHKD.	DATE	APPROVED		DATE	
0	OPERABILITY FOR NCR 84-0180	CHA	12/9/84	T. LIN	12/11/84	MF	X	12/17/84	[illegible]

REVISIONS

GPD-2704 Rev. 5/83 (ED-1)

CALCULATION SHEET

BECHTEL

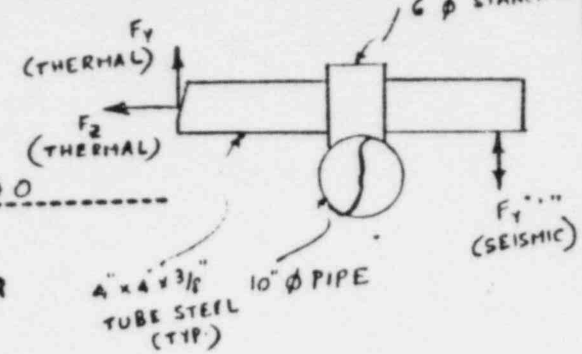
CALC. NO. C-PS/PSU-1 REV. NO. 0

ORIGINATOR Siva P. [illegible] DATE 12.1.84 CHECKED [illegible] DATE 12-5-84

PROJECT DAVIS-BESSE UNIT 1 JOB NO. 12501

SUBJECT DATA SHEET FOR LOCAL STRESS CHECK SHEET NO. 5

FOR OPERABILITY



TO BE FILLED IN BY STRESS GROUP:

STRESS PROBLEM NO. M-8 ISSUE C2 DATA POINT 40

PIPE SUPPORT NO. PSU-R1

TYPE OF SUPPORT:

VERTICAL ☒ (SNUBBER) X ☐ Z ☐ SKEW ☐ ANCHOR ☐

PIPE OUTSIDE DIAMETER 10.75 in PIPE WALL THK 1.0 in

OPERATING PRESSURE 2750 psig DESIGN PRESSURE 2500 psig

PIPING MATERIAL S.S. SA376-TP316 TEMPERATURE 670 °F Sm 16.48 ksi

ME-101 LOAD CASE	SUPPORT LOADS						PIPE STRESS (psi)*
	FORCES (lbs)			MOMENTS (in-lbs)			
	X	Y	Z	X	Y	Z	
WEIGHT		—					825
OBE		2400					4415
SSE		3900					8203
THERMAL		2615	5288				4546
SAM		—					—

NOTE: 1) The stresses are at the center line of pipe * KSI FOR ME 210 INPUT
2) The loads are as shown in figure.

CALCULATION SHEET

BECHTEL

CALC. NO. C-PS/PSU-1 REV. NO. 0

ORIGINATOR C.H. Oluofor DATE 12/4/84 CHECKED T. Lin DATE 12/11/84

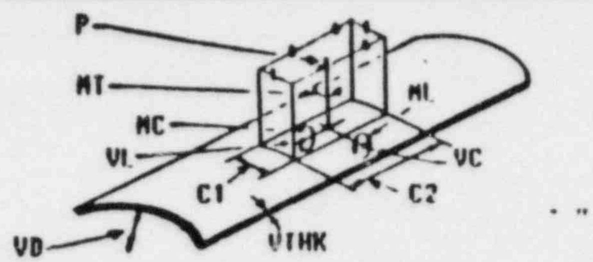
PROJECT DAVIS-BESSE UNIT 1 JOB NO. 12501

SUBJECT ME 210 INPUT DATA SHEET NO. 6

-> TYPE CALL 816566*PROG.210IN

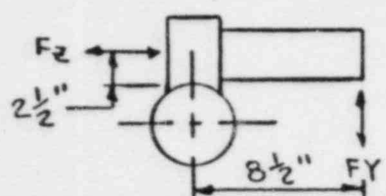
1> TITLE, SUPPORT NUMBER PSU-R1

2> NUMBER OF LOADING CASES ;3



LOADING COMBINATIONS

	CASE NUMBER	TYPE OF COMBINATION	P lbs	ML in-lbs	MC in-lbs	MT in-lbs	VL lbs	VC lbs	COMMENTS
3>	1	WEIGHT+ OBE	2400 ;	0 ;	20400 ;	0 ;	0 ;	0	
4>	2	WEIGHT+ SSE	3900 ;	0 ;	33150 ;	0 ;	0 ;	0	
5>	3	WEIGHT+THRM+ OBE+SAM	5015 ;	0 ;	55848 ;	0 ;	0 ;	5288	



GEOMETRY

	PIPE WALL THICKNESS ACTUAL ☐ EFFECTIVE ☐ in	PIPE DIAMETER ACTUAL MEAN ☐ ADJUSTED ☐ in	ATTACHMENT DIMENSIONS C1 in	ATTACHMENT DIMENSIONS C2 in	SHAPE 0.0 RECTANGULAR 1.0 CIRCULAR 2.0 ELIPTICAL
6> A	1.0 ;	13.25 ;	6.625 ;	6.625 ;	1.0
B	;	;	;	;	

GEOMETRIC PARAMETERS
β AND γ CHECK A B

β =C1/VD= .5

β =C2/VD= .5

$\gamma = \frac{VD}{(2 \times VTHK)}$ = 6.625

$0.01 < \beta < 0.5$ | IF NOT,
$5 < \gamma < 300$ | ADJUST VD.

FOR POINT B:

$VT' = \sqrt{VT^2 + VTU^2}$

= ____ = ____

7> TYPE *CALL 816566*PROG.END

-> TYPE PXQT ADD 816566*210RUN.

-> TYPE CALL 816566*PROG.210SUB ADJUST PAPER, HIT RETURN

ORIGINATOR O.H. [signature] DATE 12/4/84 CHECKER T. Lin DATE 12/11/84 CALC NUM C-PS/PSUA-1
PROJECT DAVIS BESSE UNIT 1 JOB # 12501 STANDARD COMPUTER PROGRAM ME-210 REV NUM 0 SHEET - 7 OF

VERSION : 5
RELEASED : DEC 15, 1982
USER MANUAL VERSION : 1
THEORETICAL MANUAL VERSION : 1
VERIFICATION MANUAL VERSION : 5

B I J L A A R D S T R E S S A N A L Y S I S F O R C Y L I N D E R S

PSU -H1,R1

I N P U T D A T A

	P (LBS)	ML (IN-LBS)	MC (IN-LBS)	MT (IN-LBS)	VL (LBS)	VC (LBS)	MA (FT-LBS)	MB (FT-LBS)
1	2400.	0.	20400.	0.	0.	0.	0.	0.
2	3900.	0.	33150.	0.	0.	0.	0.	0.
3	5015.	0.	55848.	0.	0.	5288.	0.	0.

	VESTHK (IN)	VESDIA (IN)	C1 (IN)	C2 (IN)	SHAPE	PRESSURE (PSI)	SM (KSI)	BEND R (IN)
1	1.0000	13.2500	6.6250	6.6250	CIRCULAR	.0000	.0000	.0000
2	1.0000	13.2500	6.6250	6.6250	CIRCULAR	.0000	.0000	.0000
3	1.0000	13.2500	6.6250	6.6250	CIRCULAR	.0000	.0000	.0000

MAXIMUM PRIMARY PLUS SECONDARY STRESS INTENSITY

1.0000	-1.18	.63	-1.18	.63	-5.06	3.87	2.71	-2.61

MAXIMUM PRIMARY PLUS SECONDARY STRESS INTENSITY

1.0000	-1.91	1.03	-1.91	1.03	-8.21	6.30	4.40	-4.25

MAXIMUM PRIMARY PLUS SECONDARY STRESS INTENSITY

1.0000	-2.78	1.56	-2.78	1.56	-13.98	10.20	8.12	-7.57

ORIGINATOR. C.H. Abula DATE. 12/4/84 CHECKER. T. Lin DATE. 12/11/84 CALC NUM. C-PS/PSU-1
PROJECT. DAVIS-BESSE UNIT 1 JOB # 12501 STANDARD COMPUTER PROGRAM ME-210 REV NUM. 0 SHEET - 8 OF

```
********** ME-210 POST-PROCESSOR  (VERS. B)  12/8/81 ********

DO YOU WANT TO ENTER PRESSURES AND OTHER STRESSES (YES OR NO)? >YES
ENTER ACTUAL PIPE O.D. AND WALL (INCHES) O.D.,W? >10.75,1.0
ENTER OPERATING AND DESIGN PRESSURE (PSIG) P-OP.,P-DES.? >2750.2500
IS ALL DATA O.K. SO FAR (YES OR NO)? >YES
ENTER FOLLOWING STRESSES WT,OBE,SSE,THRM,SAM (KSI)? >.825.4.415.8.203.4.546.0.
ENTER SM STRESS ALLOWABLE (KSI)? >16.48
IS ALL DATA O.K. (YES OR NO)?   >YES


PIPE O.D. =     10.75
PIPE WALL =  1.000
DESIGN PRESSURE =  2500
OPERATING PRESSURE =  2750
WEIGHT STRESS =       .825
OBE STRESS =     4.415
SSE STRESS =     8.203
THERMAL STRESS =      4.546
SAM STRESS =     0.000
ALLOWABLE STRESS (SM) =   16.480
```

CHECK	VALUE		ALLOWABLE	
1A	14.03	<	24.720	OK
1B	14.40	<	49.440	
2A	12.97	<	24.720	
2B	17.39	<	49.440	
3A	13.08 + 14.78 =	<	49.440	
3B	13.08 + 17.18 =	<	49.440	

FOR CHECK 3A AND 3B YOU MUST ADD THE MAX PRI + SEC STRESS INTENSITY
FROM THE ME-210 RUN FOR LOAD CASE #3 AND MUST STILL
BE BELOW THE SPECIFIED ALLOWABLE

BECHTEL

CALCULATION COVER SHEET

Q

PROJECT Davis Besse Unit 1 JOB NO. 12501009 DISCIPLINE MECH./PROCESS

SUBJECT Pipe Stress Analysis FILE NO

CALC NO W8

ORIGINATOR William Gallagher DATE 7/15/82

CHECKER [signature] DATE 7/15/82 NO OF SHEETS 43 C2

C1 CALC SHTS. = 17 ATTACHMENT #1 = 1 DWG, ATTACHMENT #2 = 4 SHTS, ATTACHMENT #3 = 3 SHTS, ATTACHMENT #4 = 2 SHTS, ATTACHMENT #5 = 3 SHTS, ATTACH #6 = 2 SHTS, ATT. #7 = 1 DSHT

RECORD OF ISSUES

NO.	DESCRIPTION	BY	DATE	CHKD	DATE	APPRD	DATE	DATE FILMED
C1	ISSUED For Study	WG	7/15/82	[signature]	7/15/82	SPL	7-15-82	
C2	REVISED SHT NO. 3 AND ADDED SHT. NOS. 13, 14, 15, 16 & 17 AND ATTACH. NO. 6 & 7	SPL	12-5-84	DPO	12-5-84	[signature]	12-5-84	

PRELIMINARY CALC. ☐ COMMITTED PRELIMINARY DESIGN CALC. ☐

SUPERSEDED CALC. ☐ FINAL CALC. ☒

STUDY For FCR 82-043

C2 ONE OF THE VERTICAL SNUBBERS FOR HANGER NO. PSU-R1 (DATA PT. 40) FAILED (NCR NO. 84-180).

IN ADDITION, THERE IS INTERFERENCE PROBLEM BETWEEN PIPE AND WALL AT THIS HANGER DUE TO THERMAL EXPANSION OF PIPE.

THIS STUDY IS MADE WITH THESE CONDITIONS.

NOTE: 1) REV. C2 IS INDEPENDENT OF REV. C1

2) REV. C2 → NCR NO. 84-180.

GPD-2704 Rev. 9/77 (ED-1)

2.0 ISOMETRICS

The following isometrics have been used in the analysis.

Piping Iso. No.	Rev. No.	Piping Iso. No.	Rev. No.
* ISIM-PS/PSU	0		
⋮			

* MADE FROM WALK DOWN OF SURGE LINE.

DESIGN DOCUMENTS

1. Code ☒ ASME Code Section III Subsection NB
   ☐ ANSI B31.1
   ☐
2. System Flow Diagrams N/A Rev. ______
   ______ Rev. ______
   ______ Rev. ______
3. Piping Class SEE 7749-M-509-1-2 Rev. ______
4. Piping Class Summary ⇓ Rev. ______
5. SAR ☒ Checked ☐ Not Checked

6) MATH MODEL: ATTACHMENT 1.

7) B&W Telecopy of 7/2/82 Attachment 2.
   " " " 6/25/82 " 3
   " " " 7/1/82 " 4

COMPUTER OUTPUTS (Snumb No. & Date)

1. WEIGHT Pipe+Insul. (H-1 active) G3752 6/30/82
   WEIGHT Pipe+water+Insul. (H-1 active) G3746 6/30/82
2. Weight Pipe+water+Insul. (H-1 inactive) G3647 6/29/82
3. Seismic ______
4. THERMAL (670°F) G 7377 11-26-84 (NORMAL OPER.)
   G 7455 11-30-84 (WITH APPLIED THERMAL DISPL. AT D.P. 41)
   G 7458 12-01-84 (WITH ZERO THERMAL DISPL. AT D.P. 41)

(C2)

ANALYST [signature] DATE 12-1-84 CHECKER [signature] DATE 12-4-84

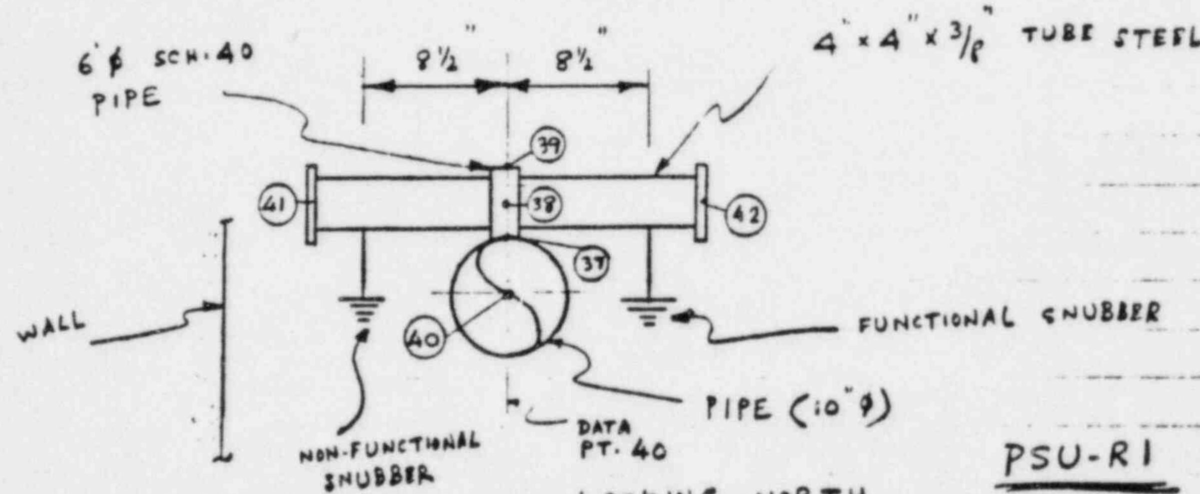
GPO-13584-C 1/80

BECHTEL

CALCULATION SHEET

JOB NO. 12501 NCR 84-180 CALC. NO. M-8 PRESSURIZER SURGE LINE	REV NO. C2	SHEET NO. 13
ORIGINATOR Siva P. Lingam DATE 11-30-84	CHECKED [signature]	DATE 12-4-84

AS PER NCR 84-180, ONE OF THE VERTICAL SNUBBERS (CLOSE TO THE WALL) BECAME NON-FUNCTIONAL AS SHOWN.



PSU-R1

LOOKING NORTH

THIS SNUBBER IS ONLY 4¼" AWAY FROM THE WELD OF THE NEAREST ELBOW (B&W DATA PT. 3).

THE PURPORE OF THIS CALCULATION IS TO CHECK THE PIPE STRESSES FOR OPERABILITY CONDITION.

FROM B&W SPEC. 7749-M-505-22-6, PAGE 8.3, THE LOAD ON THIS SNUBBER IS 3900 LBS. (SSE) & 2400 (OBE).

AS PER ATTACHMENT # 2 OF CALC. NO. M-8, REV. C1, (SHT. NO. 2)

THE MAX. STRESS FOR EQ. 9 OF NB-3652 OCCURS AT B&W DATA PT. 3 WHICH IS VERY CLOSE TO THIS SNUBBER.

MAX. STRESS = 22074.96 psi ($< 1.5 S_m$ = 24,800 psi @ 670°F).

EQ. 9

$$B_1 \frac{P D_o}{2t} + B_2 \frac{D_o}{2I} M_i \leq 1.5 S_m$$

(ASME SEC. III, NB-3652) 1971

GPO-2708 Rev. 4/82 (ED-69)

CALCULATION SHEET

JOB NO. 12501 NCR NO. 84-180 CALC. NO. M-8	REV. NO.	SHEET NO.
PRESSURIZER SURGE LINE	C2	14
ORIGINATOR: Siva P. Lingam — DATE: 11-30-84	CHECKED: [signature]	DATE: 12-4-84

B_1 FOR 10" ELBOW = 1.0 (FROM TABLE NB-3683.2-1)

$$B_2 = 0.75\,C_2 = 0.75 \times \frac{1.95}{\left(\frac{tR}{r^2}\right)^{2/3}}$$

$$= 0.75 \times \frac{1.95}{\left[\frac{(1.0)\times 15}{(4.875)^2}\right]^{2/3}}$$

$$= 0.75 \times 2.65$$

$$= 1.9875$$

$D_o = 10.75"$

$t = 1.0"$

$P = 2500$ psi

$I = 368 \text{ in}^4$

EQ. 9 FOR ELBOW

$$(1.0)\cdot\left(\frac{2500\times 10.75}{2\times 1.0}\right) + (1.9875)\cdot\left(\frac{10.75}{2\times 368}\right)\times M_i = 22074.96$$

$\therefore M_i = 297542$ in-lbs.

THIS IS THE RESULTANT MOMENT DUE TO COMBINED WEIGHT AND SEISMIC LOADS.

FROM BECHTEL COMPUTER RUN G 3746 DATED 6-30-82,

$M_{x_W} = 957$ FT-LBS.
$M_{Y_W} = 319$ "
$M_{Z_W} = 4157$ "

DUE TO WEIGHT LOADS AT DATA PT. 45B. (IGNORING THE SIGN) (EQUIVALENT TO DLW DATA PT. 3)

$$M_i = \sqrt{(M_{xW}+M_{xS})^2 + (M_{YW}+M_{YS})^2 + (M_{ZW}+M_{ZS})^2}$$

$$\frac{297542}{12} = \sqrt{(957+M_{xS})^2 + (319+M_{YS})^2 + (4157+M_{ZS})^2}$$

ASSUME $M_{YS} = M_{ZS} = 0$ (MOMENTS DUE TO SEISMIC LOADS)

$M_{XS} = 23485.1333$ FT.-LBS.

CALCULATION SHEET

JOB NO. 12501 NCR NO. 84-176	CALC. NO. M-8	REV. NO.	SHEET NO.
PRESSURIZER SURGE LINE		C2	15
ORIGINATOR: Siva P. Lingam	DATE: 11-30-84	CHECKED: [illegible signature]	DATE: 12-4-84

SINCE ONLY ONE SNUBBER IS FUNCTIONAL, THE PIPE WILL EXPERIENCE AN ADDITIONAL MOMENT, M_x (N-S) DUE TO 8½" ARM LENGTH.

$$\therefore M_x = 2400 \times 8.5 = 20400 \text{ in-lbs. (OBE)}$$

$$= 3900 \times 8.5 = 33150 \text{ in-lbs. (SSE)}$$

ADDING THIS,

$$M_{xs} = (23485.1333) \times 12 + 20400 = 302222 \text{ in-lbs. (OBE)}$$

$$= (1.875)(23485.1333) \times 12 + 33150 = 561566 \text{ in-lbs. (SSE)}$$

$$M_{ys} = M_{zs} = 0$$

$$M_i = \sqrt{(957 \times 12 + 302222)^2 + (319 \times 12 + 0)^2 + (4157 \times 12 + 0)^2}$$

$$= 317671 \text{ in-lbs. (OBE)}$$

$$= 575230 \text{ in-lbs. (SSE)}$$

EQ. 9 FOR ELBOW WITH NON-FUNCTIONAL SNUBBER (ONE)

$$(1.0) \times \left(\frac{2500 \times 10.75}{2 \times 1.0}\right) + (1.9875) \times \left(\frac{10.75}{2 \times 368}\right) \times 317671 = 22{,}660 \text{ psi}$$

$(< 1.5 S_m = 24{,}800 \text{ psi})$

OBE → UPSET CONDITION

$$(1.0) \times \left(\frac{2500 \times 10.75}{2 \times 1.0}\right) + (1.9875) \times \left(\frac{10.75}{2 \times 368}\right) \times 575230$$

$$= 30{,}137 \text{ psi}$$

$(< 3 S_m = 49{,}600 \text{ psi})$

SSE → FAULTED CONDITION

GPO-2708 Rev. 4/82 (ED-40)

CALCULATION SHEET

BECHTEL

JOB NO. 12501 NCR NO. 84-180 CALC. NO. M-8	REV. NO.	SHEET NO.
PRESSURIZER SURGE LINE	C2	16

ORIGINATOR	DATE	CHECKED	DATE
Siva P. Lingam	11-30-84	[signature]	12-4-84

M_i due to seismic = 302222 in-lbs. (OBE)
561566 in-lbs. (SSE)

$$\sigma_{OBE} = \frac{D_o}{2I} \times M_i = \left(\frac{10.75}{2 \times 368}\right) \times 302222 = 4415 \text{ psi (OBE)}$$

$$\sigma_{SSE} = \left(\frac{10.75}{2 \times 368}\right) \times 561566 = 8203 \text{ psi (SSE)}$$

$\sigma_{WT.}$ = 825 psi (weight) → G 3746 dated 6-30-82

$\sigma_{TH.}$ = 4546 psi (thermal) → G 7377 dated 11-26-84

Also, the cumulative usage factor at B&W data pt. 3 is only 0.045 which is << 1.0.

Conclusions

The stresses are within allowables even if one of the snubbers is non-functional.

Therefore, the operability of the plant is not affected due to pipe stresses.

Since the primary faulted stresses are approximately 60% of the allowable, a slight shift in frequency due to non-functional snubber will not significantly affect the results.

GPO-2708 Rev. 4/82 (ED-88)

BECHTEL

CALCULATION SHEET

JOB NO. 12501 NCR NO. 84-180 CALC. NO. M-8	REV. NO.	SHEET NO.
PRESSURIZER SURGE LINE	C2	17

ORIGINATOR	DATE	CHECKED	DATE
Siva P. Lingam	12-4-84	[signature]	12-4-84

THERMAL EVALUATION DUE TO INSUFFICIENT CLEARANCE AT WALL

AS PER ATTACHMENT NO. 6, THERMAL RUNS ARE MADE WITH AND WITHOUT APPLIED THERMAL DISPLACEMENTS AT DATA PT. 41.

THE PIPE STRESSES ARE WITHIN ALLOWABLES FOR BOTH CLASS-1 AND CLASS-2

$C_2 = 2.65$

CLASS 1 → $C_2 \cdot \frac{D_o}{2I} M_i \le 3 S_m$

CLASS 2 → $i \frac{Mc}{Z} \le S_A$.

HOWEVER, FOR LONG TERM OPERATION, THE PIPE MUST BE EVALUATED FOR FATIGUE (CUMULATIVE USAGE FACTOR ≤ 1.0).

FOR SHORT TERM OPERABILITY, THE PIPE IS SAFE FOR FATIGUE BECAUSE OF UNUSED CYCLES.

BY ENGINEERING JUDGEMENT, THE LOADS AT PRESSURIZER AND HOT LEG ARE REASONABLE FOR OPERABILITY.

GPO 2708 Rev. 4/82 (ED-69)

GPD-9906 1/76 (FORM G-3)

MEMORANDUM

"DON'T SAY IT – WRITE IT"

To: SIVA LINGAM Location:

From: MARC NEMSER Date: 12/3/84

Subject: NCR 84-0180, FAILED SNUBBER PSU-R1

Based on the information I have received from the reanalysis of the Pressurizer Surge line (Thermal movements 1.651" north, 0.177" up, & 0.69" west at data points 40 and 35), I have projected the movements on a scaled drawing to determine interferences. The drawing, copy attached, was prepared for this comparison and uses dimensions from the original Grinnell support design drawing, as well as from the actual dimensions measured in the plant. Because of the possibility of some dimensional inaccuracies, I would suggest that the reanalysis be performed using 3 different interference conditions. The initial run should be calculated considering full restraint (interference) at $\Delta Y = 0.125$" up and $\Delta Z = 0.375$" west. This is conservative, but most accurately reflects the actual interference that occurred. Then, for comparison purposes, run the problem using interference at $\Delta Y = 0.0625$" up and $\Delta Z = 0.25$" west, and finally with no permissible movement, $\Delta Y = 0$, $\Delta Z = 0$. The results of this analysis should help us to determine the operability of this pipe.

[signature]

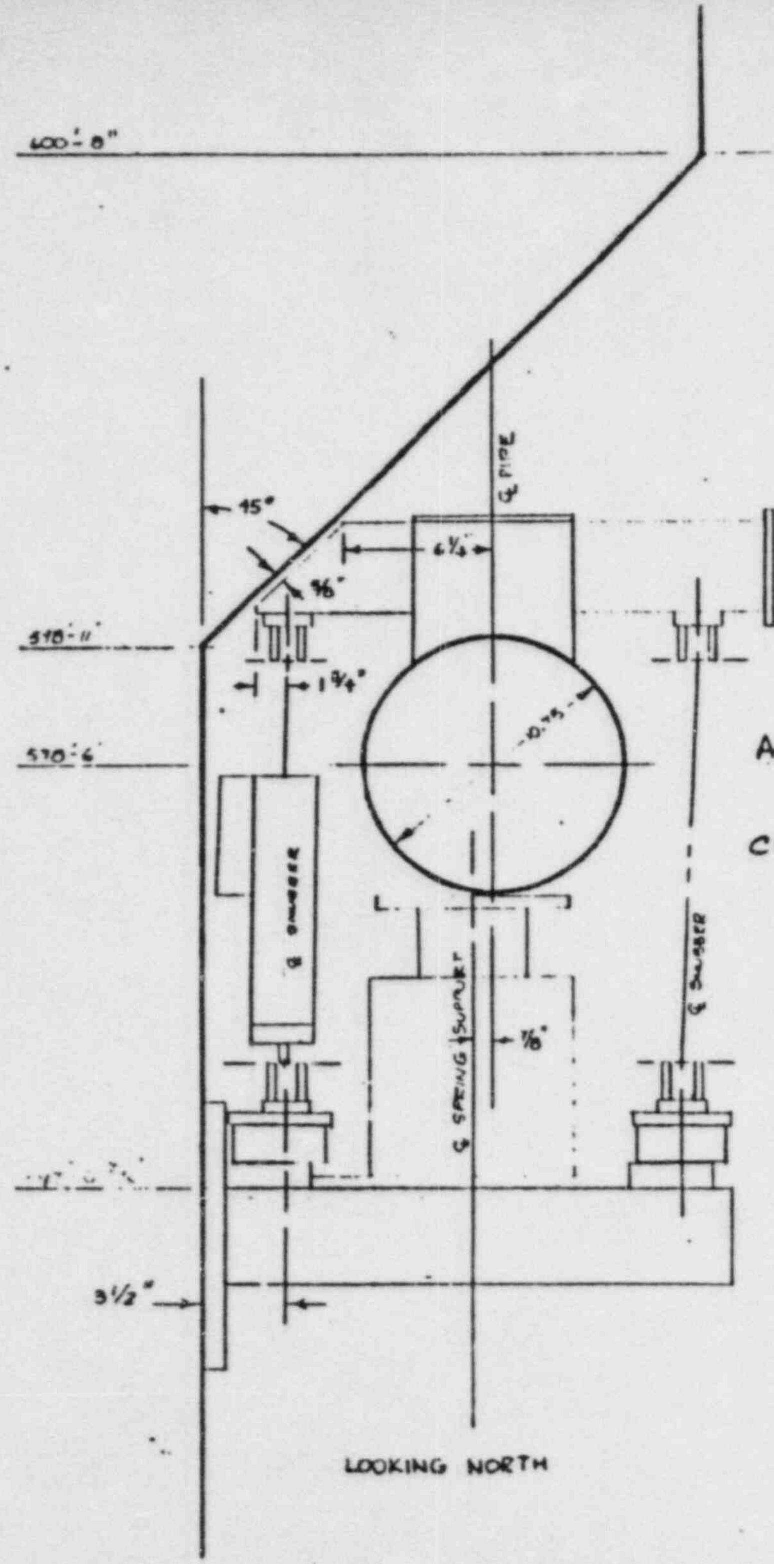
ATTACHMENT NO. 6

SHT. NO. 1 OF 2

PROB. NO. M-8, REV. C2

Added by: Siva P. Lingam date: 12-4-84

ch'kd by: [signature] date: 12-4-84



LOOKING NORTH

ATTACHMENT NO. 6

SHT. NO. 2 OF 2

PROB. NO. M-8, REV. C2

Added by: Siva P. Lingam Date: 12-4-84

Ch'kd by: [signature] Date: 12-4-84

SKETCHED BY: [signature] Date: 12-3-84

PSU-R1
SCALE: 1/8" = 1"

Bechtel Associates
Professional Corporation (Ohio)

15740 Shady Grove Road
Gaithersburg, Maryland 20877-1454
301-258-3000

TELECOPY

DEC 5 1984

Mr. J. K. Wood
General Supervisor
Facility Engineering
The Toledo Edison Company
P. O. Box 929
Toledo, Ohio 43652

Dear Mr. Wood:

The Toledo Edison Company
Davis-Besse Nuclear Power Station
Bechtel Job 12501
TED NCR 84-180
HYDRAULIC SNUBBER PSU-R1
File: 0270, 1523D, 1470, 283293
BT-15086 (A218)

Attached please find our recommended disposition of TED NCR 84-180 telecopied on November 7, 1984. This NCR addresses seismic restraint PSU-R1 on the Pressurizer Surge line, found with one (1) broken hydraulic snubber. Our evaluation and reanalysis of this condition has identified that a thermal interference existed during normal plant operating conditions. This interference resulted from insufficient clearance between the restraint and the secondary shield wall.

All stress levels on the Pressurizer Surge line and supports were found to be within interim criteria for both the condition of the actual thermal interference and a postulated SSE event. However, for long term plant operation the restraint must be modified in accordance with the attached sketch.

In addition, B&W specification 3002/NSS-14/1077 page 8.6 (7749-M-505-22-6) should be revised to show the correct thermal displacements, presently shown reversed between node points 1 and 2. This change has been incorporated in our sketch of the restraint modification. In addition to the revised movements, a new cold spring setting for PSU-H1, and revised hot and cold piston settings for PSU-R1 have also been included.

As discussed during the engineering review meeting held here on November 28, 1984, we will require, in addition to the 115 jobhours already authorized, 130 jobhours to account for our engineering effort to design the restraint modification and complete the operability evaluation.

Also as discussed, it will require 200 jobhours for us to amend B&W's Nuclear Class 1 stress report for this line to reflect the modified support configuration and the effect of the thermal interference.

Added by: Siva P. Lingam 12-5-84
ch'kd by: [signature] 12-5-84

ATTACHMENT NO. 7
SHT. NO. 1 OF 10
PROB. NO. M-8, REV. C2

DEC 5 1984

If you have any questions, please contact us.

Very truly yours,

J. W. Fay, Jr.

J. W. Fay, Jr.
Project Engineer

JWF/RDK/jil
Attachment: As stated above
cc: J. F. Helle w/o
C. T. Daft w/1
R. Rosenthal w/o
Records Management - Mail Stop 3021 w/1

ATTACHMENT NO. 7

SHT. NO. 2 OF 10

PROB. NO. M-8, REV. C2

Added by: Siva P. Lingam Date: 12-5-84

Ch'kd by: [illegible] Date: 12-5-84

Added by: Siva P. Lingam Date: 12-5-84
Ch'cd by: [signature] Date: 12-5-84

NOV 7 1984
ATTACHMENT NO. 7
SHT. NO. 3 OF 10
PROB. NO. M-8, REV. C2

TOLEDO EDISON

DAVIS-BESSE NUCLEAR POWER STATION - UNIT NO. 1
NONCONFORMANCE REPORT
ED 8568-4

NCR NO. (1) 84-0180	PAGE (2) 1 OF	
DATE (3) 5 Nov 1984	ORIGINATOR (4) [signature]	HOLD TAG(S) NO. (5) φ
MWO/FCR NO. (6) 1-84-1089-00	QCS SIGNATURE (9) [signature]	DATE (10) 11/5/84
ITEM IDENTITY NO. (11) 1.2153	PURCHASE ORDER NO. (7) N/A	CONDITIONAL RELEASE (8) N/A

SUBJECT (12)
HYDRAULIC SNUBBER PSU-R1 (D-B No. C-203)

NONCONFORMANCE DESCRIPTION (13)
DURING THE VISUAL INSPECTION PROGRAM FOR 1984 PER SECTION 6.1 OF ST 5044.01, THE ABOVE SUBJECT, LOCATED NEXT TO CONCRETE WALL, PISTON ROD WAS FOUND DISMEMBERED TOTALLY - IE: SNAPPED INTO. A REVIEW OF RECORDS SHOW THAT SUBJECT WAS VISUALLY INSPECTED 7 AUG 1983 TO SATISFY

COMPLETED BY TED QC

GROUP (14)
- [ ] MAINT. ELECT
- [ ] MAINT. I&C
- [ ] MAINT. PIPE
- [ ] MAINT. WELD
- [ ] OTHER

CONTRACTOR'S NAME
- [ ] CONTRACTOR ELECTRICAL
- [ ] CONTRACTOR FITTER
- [ ] CONTRACTOR WELD
- [ ] CONTRACTOR OTHER
- [x] NOT APPLICABLE

CAUSE (15)
- [ ] INADEQUATE PROCEDURE
- [ ] PROCEDURE IMPLEMENTATION
- [ ] WORKMANSHIP
- [ ] PERSONNEL ERROR
- [ ] EQUIPMENT RELATED
- [ ] WRONG MATERIAL
- [ ] DOCUMENTATION
- [x] OTHER PIPE STRESS
- [ ] NOT APPLICABLE

RESPONSIBLE PARTY FOR INDICATING DISPOSITION (16)
- [x] FACILITY ENGINEERING
- [ ] MAINTENANCE ENGINEER
- [ ] FACILITY MODIFICATION
- [ ] PURCHASING
- [ ] OTHER

DISPOSITION (17)
- [ ] USE-AS-IS
- [ ] USE-AS-IS TEMPORARILY UNTIL (Date)
- [ ] REPAIR
- [x] REWORK
- [ ] REJECT

DISPOSITION JUSTIFICATION (17)
Rework seismic restraint PSU-R1: Thermal movement interference between the west hydraulic snubber (part 4) and the secondary shield wall caused the piston shaft to break at the upper end paddle. Also, continuing thermal movement caused interference between the upper (cont on page 5)

SIGNATURE (18) [signature] DATE (19) 12-5-84

COMPLETED BY RESPONSIBLE PARTY FOR INDICATING DISPOSITION

RESPONSIBLE PARTY FOR IMPLEMENTATION OF DISPOSITION (20)
- [ ] FACILITY ENGINEERING
- [ ] MAINTENANCE ENGINEER
- [ ] QC
- [ ] PURCHASING
- [ ] FACILITY MODIFICATION
- [ ] OTHER

ENGINEERING CONCURRENCE OF DISPOSITION (Use As-Is, Use-As-Is Temporarily, Repair Only) (21)

COMPLETED BY FACILITY ENGINEERING

CAN ITEM PERFORM ITS INTENDED SAFETY FUNCTION (22)
- [ ] YES
- [ ] NO If NO, Notify Technical Section

SIGNATURE (Facility Engineering General Supervisor) (23) DATE (24)

IMPLEMENTATION OF DISPOSITION (25)

SIGNATURE (26)	MWO/FCR NO. (26)	SUPP/REV. NO. (26)	DATE (27)

DISTRIBUTION (28)
- [x] QC NCR FILE
- [x] STATION SUPERINTENDENT
- [ ] MAINTENANCE
- [x] NUCLEAR FACILITY ENGINEERING
- [x] CODE INSPECTION/ANI
- [ ] FACILITY MODIFICATION
- [ ] FOR FACILITY ...
- [ ] ...
- [x] Dec. Sainty

FINAL ACCEPTANCE
QC INSPECTOR (29)	DATE (30)
HOLD TAGS REMOVED (Signed) (31)	DATE (32)
AUTHORIZED NUCLEAR INSPECTOR (Code Items Only) (33)	DATE (34)

COMPLETED BY TED QC

TOLEDO EDISON

NONCONFORMANCE REPORT

TO 6758-1

NCR NO. 84-0180

SUBJECT

HYDRAULIC SNUBBER P44-R1

CONTINUATION FROM PAGE 1

THE ST, WITH NO FINDING RECORDED. A REVIEW OF RECORDS FOR INSTALLATION INSPECTION WAS PERFORMED. INSTALLATION OF SNUBBER WAS IN 1982 WITH INSPECTION BEING PERFORMED 12 JULY 1982. PISTON SETTING WAS RECORDED AT 3 7/16" WHICH WAS WITHIN CRITERIA OF DWG M-618. FUNCTIONAL TEST WAS ACCOMPLISHED ON 5 MAY 1982 WITH TENSION LOCK UP 7.86"/MIN. TENSION BLEED RATE 5.1"/MIN. COMPRESSION LOCK UP 8.23"/MIN. COMPRESSION BLEED RATE 5.2"/MIN. THESE WERE WITHIN ACCEPTABLE CRITERIA FOR GROUP III.

NFED IS REQUESTED TO EVALUATE (NCR 80-371 PREVIOUSLY WRITTEN AGAINST THIS OVERALL NCR.) THE ABOVE AND PROVIDE DISPOSITION.

ATTACHMENT NO. 7

SHT. NO. 4 OF 10

PROB. NO. M-8, REV. C2

Added by: Siva P. Lingam Date: 12-5-84

ch'ed by: [signature] Date: 12-5-84

Disposition Justification (17) (cont)

cross member (part 7) and the secondary shield wall at the 45° vertical offset. All stress levels resulting from reanalysis of the pipe and pipe supports on this are within interim criteria. This reanalysis considers the effects of both thermal interference with the wall and one (1) snubber inactive.

The support should be modified in accordance with the attached sketch, 1) deleting the west 1-1/2" snubber; 2) replacing the east 1-1/2" snubber with a 2-1/2"; 3) cutting the upper cross member to eliminate the interference; 4) adding a vertical brace.

ATTACHMENT NO. 7

SHT. NO. 5 OF 10

PROB. NO. M-8, REV. C2

Added by: Siva P. Lingam Date: 12-5-84

ch'kd by: [signature] Date: 12-5-84

CHEC. BY ____ DATE ____

RE DRAWN BY JRS DATE 3-18-76

REV.	1	2	3	4	5
DWG.					
DATE					

5-17-77

CUSTOMER TOLEDO EDISON CO.

ORDER OR CONT. NO. 7763-12 ~~DAVIS-BESSE UNIT #1~~

JOB NAME

ATTACHMENT NO. 7

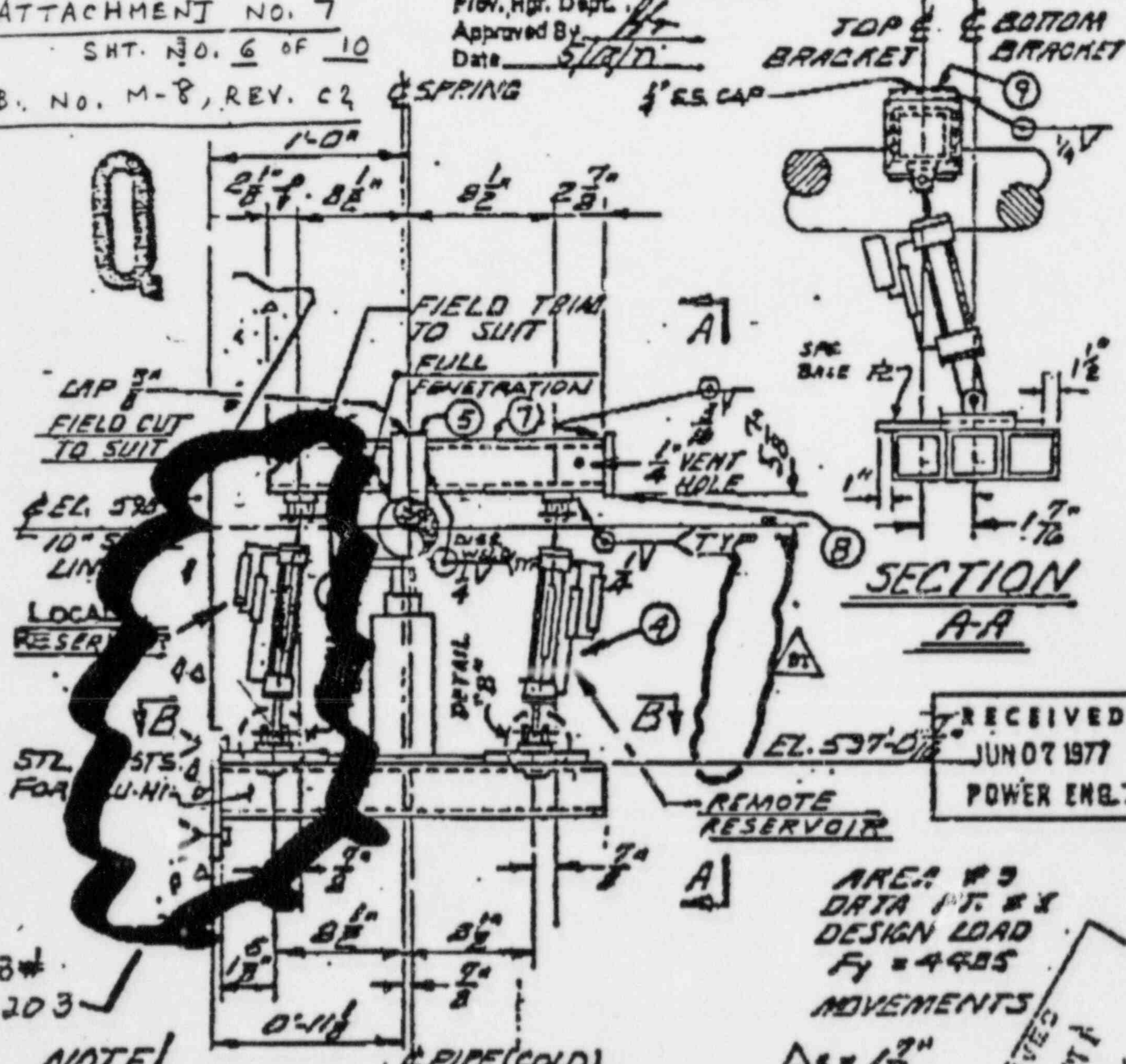
SHT. NO. 6 OF 10

PROB. NO. M-8, REV. C2

Prov. Hgr. Dept.

Approved By

Date 5/17/77



DB# C-203

℄ PIPE (COLD)

NOTE!

WORK THIS SKETCH WITH B&W SKETCH NO. 202 HANGER PSU-H1

7749-M-190-HBW-203-X 4 HBW-203A F2 and O

NOTE!

INSTALLATION BY OTHERS

FOR MATERIALS AND OPERATIONS SEE SKETCH NO. ____ REV. ____

REF. DWG. NO. PIPE M-271-7 STEEL C-124-7 MARK NO. ____ SKETCH NO. BW-203 REV. F2 & O

Added by: Siva P. Lingam Date: 12-5-84

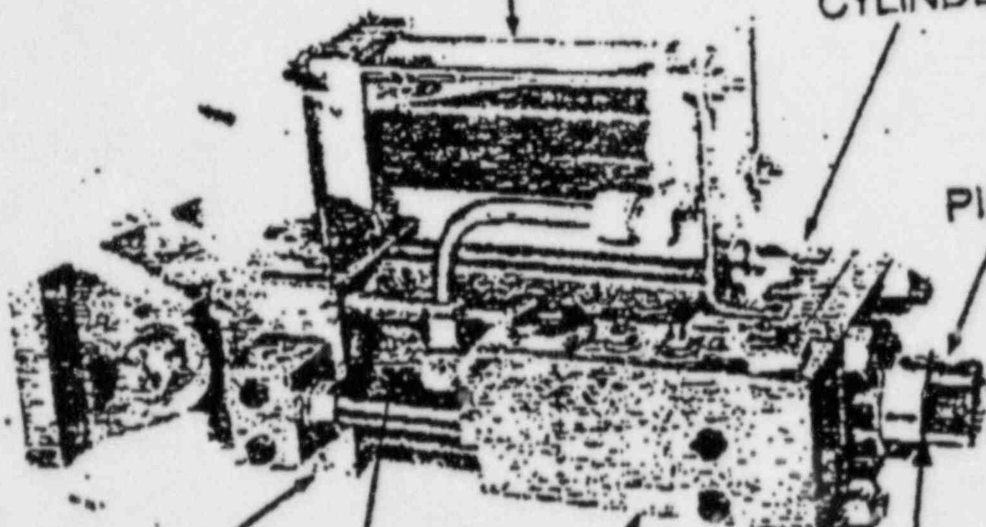
Ch'kd by: [signature] Date: 12-5-84

Quality Control
DOCUMENT ATTACHMENT
NCR 84-0180
PAGE 5 OF ...

ıdraulic Snubber

ɜasic components of all hydraulic snubbers are:

Quality Control
DOCUMENT ATTACHMENT
NCR 84-0180
PAGE 4 OF



ATTACHMENT # 7
SHT. NO. 7 OF 10
PROB. NO. M-8, REV. C2

Added by: Siva P. Lingam date: 12-5-84

ch'ed by: D.L.P.ORG date: 12-5-84

ATTACHMENT NO. 7

SHT. NO. 8 OF 10

PROB. NO. M-8, REV. C2

. rachment to BT-15086

Added by: Siva P. Lingam 12-5-84

ch'kd by: [signature] 12-5-84

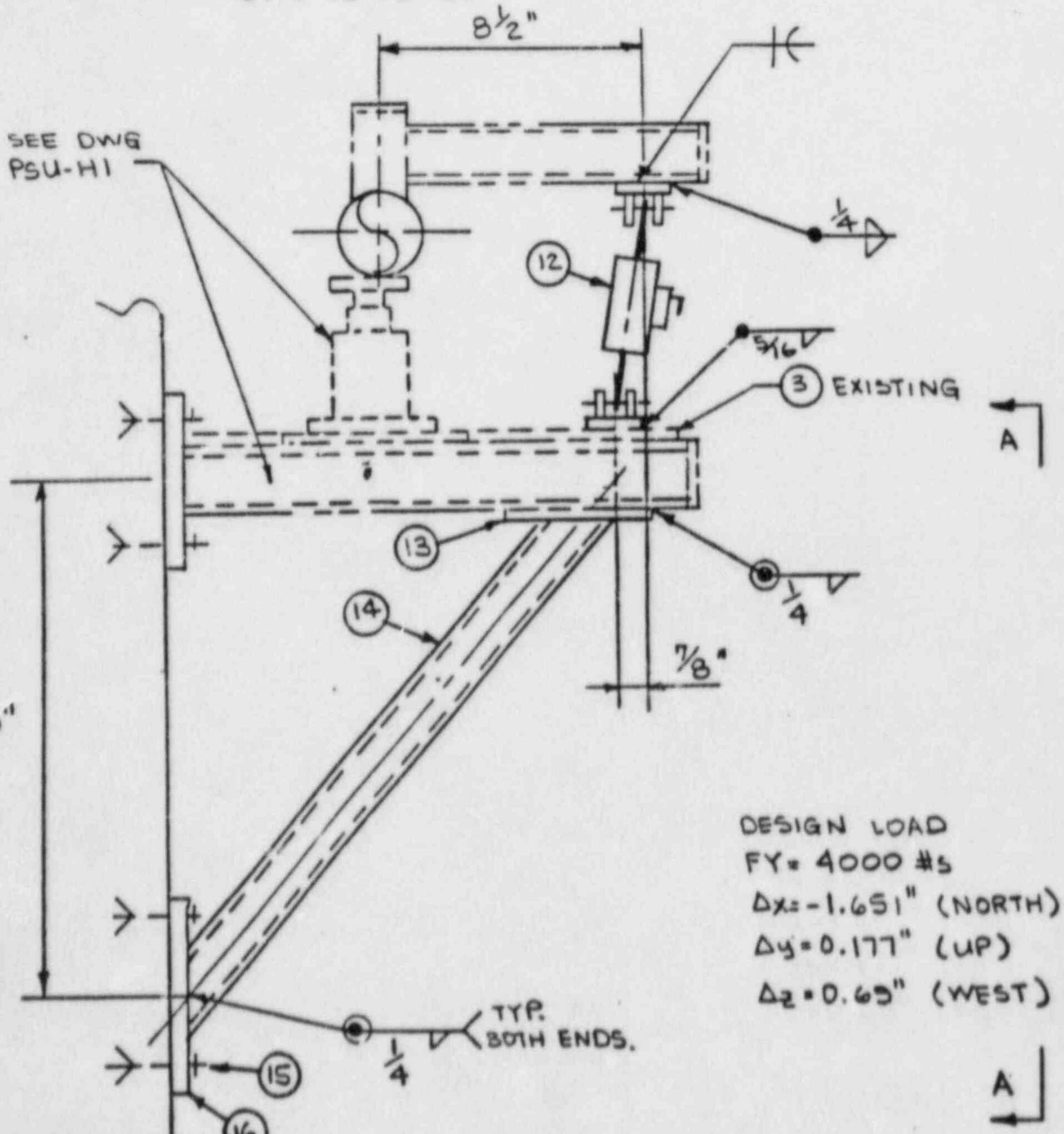
Q

DWG. PSU-R1 REV. B2

SHEET 1 OF 3

DESCRIPTION OF CHANGE:

1. REMOVE EXISTING ITEMS 4, 6, 10 AND 11.
2. MODIFY SUPPORT AS-SHOWN.
3. WORK THIS SUPPORT WITH DWG. PSU-H1.
4. ADD NEW ITEMS 12 TO 16.



ELEVATION LOOKING NORTH

Added by: Siva P. Lingam Date: 12-5-84
ch'kd by: [signature] date: 12-5-84

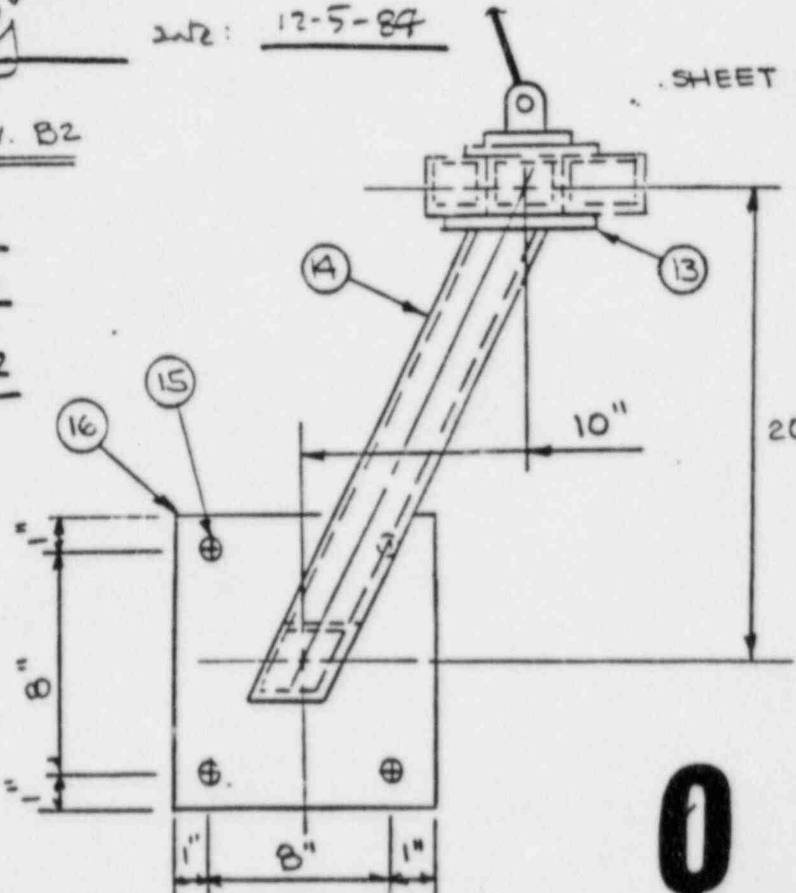
SHEET 2 OF 3

DWG. PSU-R1 REV. B2

ATTACHMENT NO. 7

SHT. NO. 9 OF 10

PROB. NO. M-8, REV. C2



Q

SECTION "A-A"

ITEM	QTY	DESCRIPTION	MATERIAL
12	1	2½" CYLINDER 5" STROKE FIG. 200 OPTION 2	
		HYDRAULIC SHOCK & SWAY SUPPRESSOR	
13	1	½" X 8" X 8" PLATE	ASTM A-36
14	1	TS 4 X 4 X 3/8 X 3'-0" (FIELD COPE TO SUIT)	ASTM A-500 GR. B
15	4	½"φ X 3 3/4" HILTI KWIK BOLT MIN. EMB = 2¼"	ASTM A-108 GR. 1144
16	1	½" X 10" X 10" PLATE W/(4) 9/16" φ HOLES	ASTM A-36

NOTES:

1. FABRICATE & INSTALL PER SPEC. 12501-M-450Q.
2. FOR ACCEPTABLE RANGES OF HOT AND COLD PISTON SETTINGS REFERENCE DWG. 12501-M-618. *
3. PAINT AS REQ'D PER SPEC. 12501-A-24Q.

* REVISED RANGE OF HOT & COLD PISTON SETTINGS
TABLE 1 PAGE 6 OF 6

		CPS (MIN)	CPS (MAX)	HPS (MIN)	HPS (MAX)	LV/BR GROUP
HL-PS-PSU	PSU-R1	1-5/8"	5-½"	1-1/8"	5-3/8"	III

DWG. PSU-H1 REV. B2

Q

RESET SPRING TO:

HL = 4282#

CL = 4565#

REVISE HANGER DWG. TO INCLUDE:

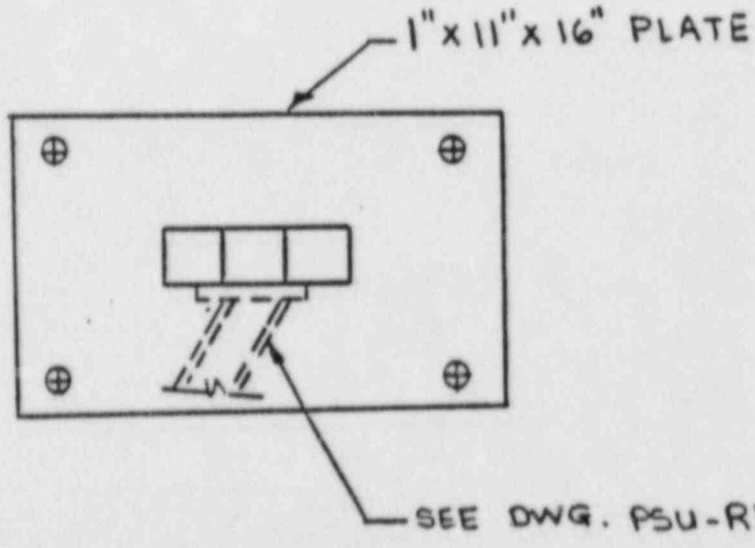
DESIGN LOAD

FY = 4565#

Δ_x = -1.651" (NORTH)

Δ_y = 0.177" (UP)

Δ_z = 0.69" (WEST)



SECTION "A-A"

ATTACHMENT NO. 7

SHT. NO. 10 OF 10

PROB. NO. M-8, REV. C2

added by: Siva P. Lingam date: 12-5-84

ch'kd by: [signature] date: 12-5-84

BECHTEL

CALCULATION COVER SHEET

Q

PROJECT Davis Besse Unit 1 JOB NO 12501009 DISCIPLINE P.D.E.

SUBJECT Pipe Stress Analysis FILE NO

CALC NO M8

ORIGINATOR William Gallagher DATE 7/15/82

CHECKER [signature] DATE 7/15/82 NO OF SHEETS 26

CALC SHTS. = 12, ATTACHMENT # 1 = 1 DWG, ATTACHMENT # 2 = 4 SHTS

ATTACHMENT #3 = 3 SHTS, ATTACHMENT #4 = 2 SHTS, ATTACHMENT # 5 = 3 SHTS.

RECORD OF ISSUES

NO	DESCRIPTION	BY	DATE	CHKD	DATE	APPRD	DATE	DATE FILMED
0	ISSUED For Study	[initials]	7/15/82	[initials]	7/15/82	SPL	7-15-82	

PRELIMINARY CALC. ☐

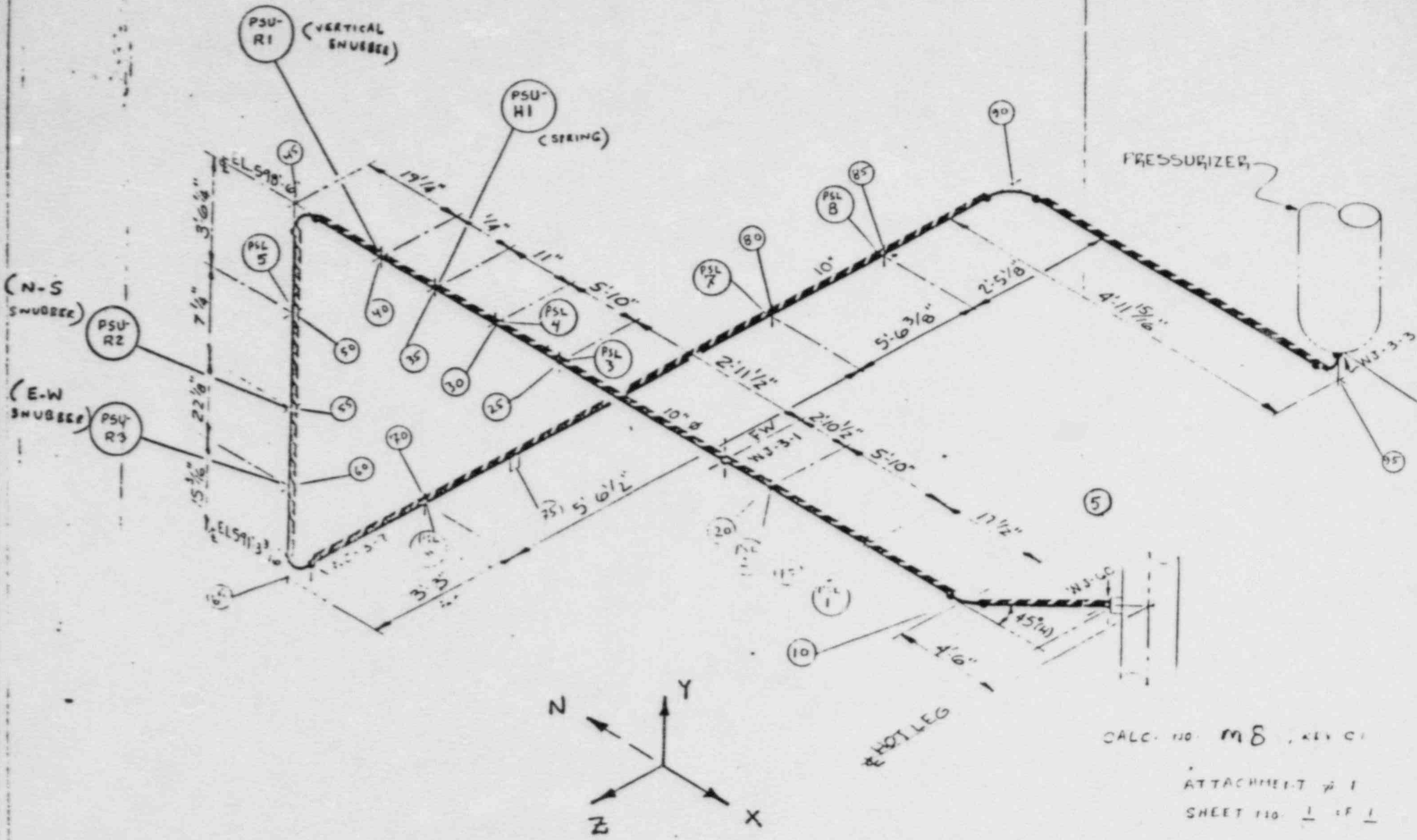
SUPERSEDED CALC. ☐

COMMITTED PRELIMINARY DESIGN CALC. ☐

FINAL CALC. ☒

STUDY For FCR 82-043

GPD-2704 Rev. 9/77 (ED-1)



CALC. NO. M8, REV. C

ATTACHMENT # 1

SHEET NO. 1 OF 1

BY:
CHKD
APPR

pressurizer surge line

Introduction

This report contains the stress analysis of the surge line. All points in the surge line are analyzed including the bimetallic weld at the hot leg surge nozzle. The analysis of the intersection at the pressurizer end is contained in pressurizer Design Report "Surge Nozzle Analysis". The branch intersection analysis is contained in this Design Report under a different section "Surge Nozzle".

Results

All points in the surge line satisfy primary stress limits either in accordance with equation 9 or per Appendix F of the B31.7 code.

Per equation 9 simplified analysis

Maximum Primary Stress = 22074.96 psi < 1.5 S_m = 24800. psi @670°F
Maximum for an elbow (joint 3) = 22074.96 psi < 24800. psi
Maximum for a straight (joint 1) = 10220.54 psi < 24800. psi

All points in the surge line do not satisfy the 3 S_m primary plus secondary stress limit. However, calculations are provided showing that an Elastic-Plastic Analysis is applicable.

Maximum primary plus secondary stress (Bimetallic Weld) (joint 54)
= 75997.62 psi > 3 S_m = 50100. psi @650.°F (PAGE C-11)
Maximum primary plus secondary stress for an elbow (joint 2)
= 67368.71 psi > 50100. psi (PAGE C-13)
Primary plus secondary stress for cycles occurring more than 240 times:
Joint 2 = 36860.4 psi < 3 S_m = 50100. psi
Joint 3 = 33787.9 psi < 3 S_m = 50100. psi
Joint 19 = 36929.7 psi < 3 S_m = 50100. psi

Maximum Usage Factors:

Usage Factor at Bimetallic weld (joint 2) = 0.87 < 1.0 = allowable
Usage Factor for joint 3 = 0.045 < 1.0 = allowable
Usage Factor for joint 19 = 0.036 < 1.0 = allowable

CALC. # M8 , REV. C1

Added by: W. F. S. Date: 7/15/82

Ch'ed by: Al. Nay Date: 7/15/82

Ref: "Stress Analysis of Surge Line, Report #6, for Toledo Edison Company, Davis-Besse," 620-0014-50, Jun 1972 (Rev 1, 5/3/74) RP 7/2/82

1.

ATTACHMENT # 2

SHEET NO. 2 OF 4

Randy Kies Attn: SIVA LINGAM

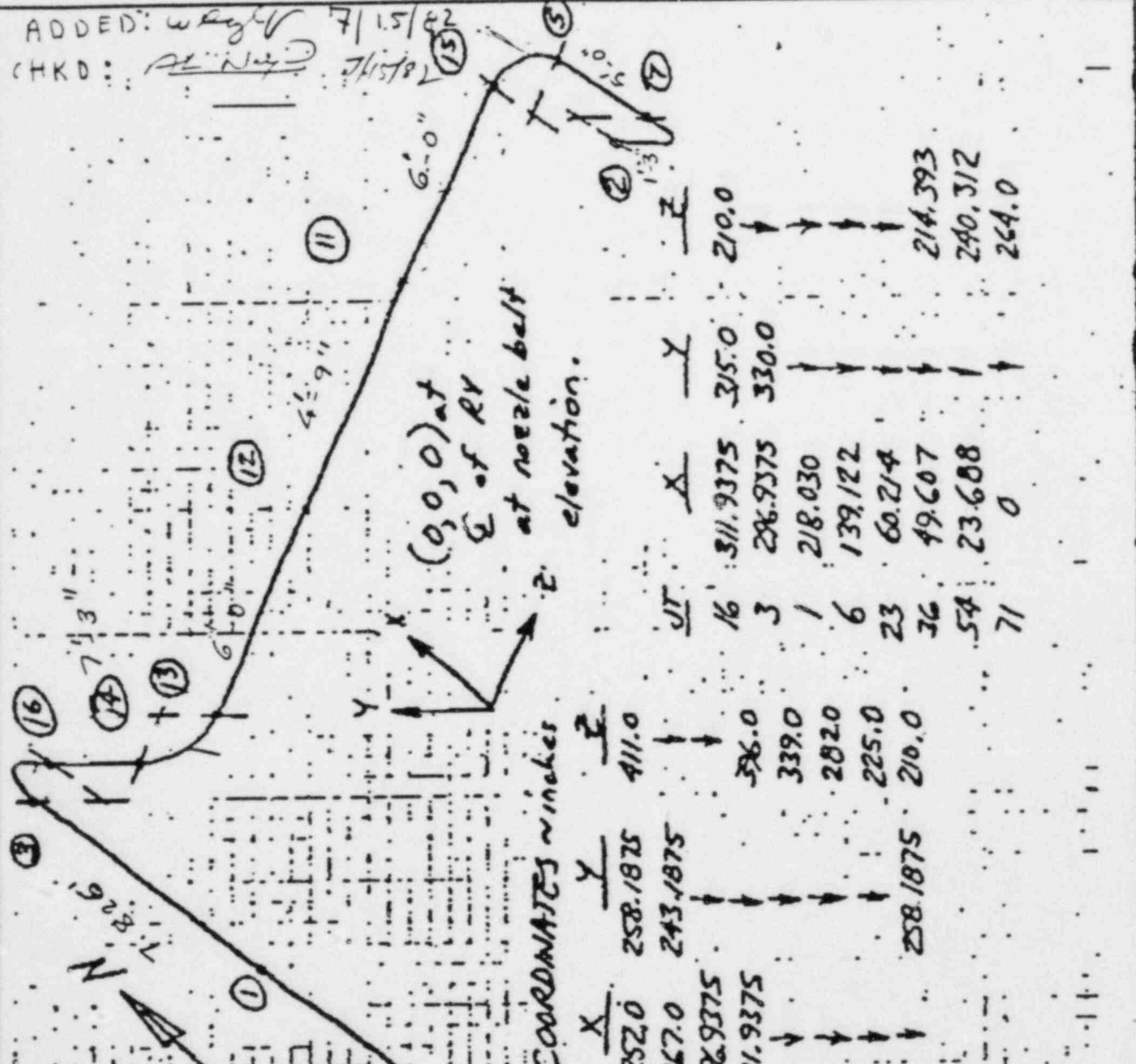
ME(c1)
SH 2 of 3

ATT.# 3

Babcock & Wilcox
a McDermott company
Nuclear Power Generation Division

GENERAL CALCULATIONS

ADDED: [illegible] 7/15/82
CHKD: [illegible] 7/15/82



COORDINATES in inches

JT	X	Y	Z
2	252.0	258.1875	411.0
7	267.0	243.1875	→
5	286.9375	→	→
15	311.9375	→	396.0
11	→	→	339.0
12	→	→	282.0
13	→	→	225.0
14	→	258.1875	210.0

JT	X	Y	Z
16	311.9375	315.0	210.0
3	286.9375	330.0	→
1	218.030	→	→
6	139.122	→	→
23	60.214	→	→
36	49.607	→	214.393
54	23.688	→	240.312
71	0	→	264.0

Ref: "Piping Final Design Document for Toledo Edison Co. & CEI Davis-Besse #1" B&W Contract 620-0014-50, May 75, Vol 1 of 2

PREPARED BY RP Potekhen DATE 6/25/82 DOC. NO. ____

REVIEWED BY ____ DATE ____ PAGE NO. ____

Randy Kies ATTN: SIVALINGAM M8(C1) S-H 3 of 3

Babcock & Wilcox ATTCH. #3

a McDermott company

Nuclear Power Generation Division

GENERAL CALCULATIONS

DAVIS-BESSE SURGE PIPING THERMAL DISPLACEMENTS

JT	8% PWR DX	DY	DZ	15% PWR DX	DY	DZ
2	2.93E-3	-8.67E-1	1.76E-3	2.93E-3	-8.67E-1	1.71E-3
7	8.50E-2	-9.60E-1	1.77E-2	8.50E-2	-9.60E-1	1.74E-2
5	2.56E-1	-9.88E-1	8.95E-2	2.56E-1	-9.88E-1	8.89E-2
15	3.98E-1	-9.84E-1	5.40E-2	3.98E-1	-9.88E-1	5.32E-2
11	6.56E-1	-8.72E-1	-2.72E-1	6.55E-1	-8.67E-1	-2.73E-1
12	9.22E-1	-7.15E-1	-5.98E-1	9.19E-1	-7.03E-1	-5.99E-1
13	1.14E0	-5.27E-1	-9.24E-1	1.14E0	-5.09E-1	-9.25E-1
14	1.26E0	-3.68E-1	-9.54E-1	1.26E0	-3.67E-1	-9.54E-1
16	1.59E0	-6.10E-2	-7.41E-1	1.59E0	-4.17E-2	-7.36E-1
3	1.59E0	1.08E-1	-6.67E-1	1.60E0	1.29E-1	-6.61E-1
1	1.14E0	4.98E-1	-4.31E-1	1.14E0	5.30E-1	-4.21E-1
6	6.89E-1	8.04E-1	-1.23E-1	6.93E-1	8.47E-1	-1.04E-1
23	2.37E-1	1.00E0	1.41E-1	2.41E-1	1.05E0	1.58E-1
36	1.86E-1	1.02E0	1.89E-1	1.90E-1	1.07E0	2.07E-1
54	6.61E-2	1.09E0	3.66E-1	7.04E-2	1.14E0	3.84E-1
71	-8.16E-3	1.14E0	4.57E-1	-8.17E-3	1.20E0	4.80E-1

100% PWR

JT	DX	DY	DZ	JT	DX	DY	DZ
2	2.92E-3	-8.67E-1	1.68E-3	16	1.60E0	-3.92E-2	-7.38E-1
7	8.49E-2	-9.60E-1	1.72E-2	3	1.60E0	1.33E-1	-6.64E-1
5	2.56E-1	-9.69E-1	8.86E-2	1	1.15E0	5.39E-1	-4.25E-1
15	3.98E-1	-9.88E-1	5.29E-2	6	6.97E-1	8.61E-1	-1.15E-1
11	6.55E-1	-8.65E-1	-2.73E-1	23	2.46E-1	1.07E0	1.50E-1
12	9.19E-1	-7.01E-1	-5.99E-1	36	1.94E-1	1.09E0	1.99E-1
13	1.14E0	-5.07E-1	-9.26E-1	54	7.48E-2	1.17E0	3.76E-1
14	1.26E0	-3.64E-1	-9.51E-1	71	-8.17E-3	1.23E0	4.76E-1

ADDED: [illegible] 7/15/82

CHKD: [illegible] 7/15/82

PREPARED BY R P Pottle DATE 6/25/82 DOC. NO.

REVIEWED BY M E Plummer DATE 6/25/82 PAGE NO.

Calc: ME (c1)

SH. 2 of 2

[illegible] Page 2

ATTCH # 4

Babcock & Wilcox
a McDermott company
Nuclear Power Generation Division

POS-21037-1 (8-83)

GENERAL CALCULATIONS

DAVIS-BESSE SURGE PIPING SEISMIC DISPLACEMENTS

~inches

	X-DIR EQ			Y-DIR EQ		
JT	DX	DY	DZ	DX	DY	DZ
2	5.10E-2	1.99E-4	1.12E-2	3.08E-4	3.22E-3	6.01E-4
7	5.50E-2	8.64E-3	1.14E-2	7.95E-4	3.85E-3	9.42E-4
5	5.50E-2	3.53E-2	1.42E-2	7.96E-4	6.27E-3	2.98E-3
15	5.61E-2	5.39E-2	1.87E-2	2.08E-3	8.34E-3	4.52E-3
11	6.81E-2	6.03E-2	1.87E-2	9.01E-3	1.08E-2	4.52E-3
12	8.12E-2	5.96E-2	1.87E-2	1.19E-2	9.48E-3	4.51E-3
13	8.96E-2	5.13E-2	1.87E-2	9.70E-3	5.43E-3	4.49E-3
14	4.70E-2	4.84E-2	1.56E-2	7.15E-3	4.93E-3	4.05E-3
18	5.08E-2	4.84E-2	1.25E-2	3.93E-3	4.92E-3	3.28E-3
16	1.46E-1	4.82E-2	1.60E-2	2.11E-3	4.90E-3	4.73E-3
3	1.89E-1	1.12E-2	2.47E-2	2.44E-3	6.18E-3	7.30E-3
1	1.89E-1	7.68E-2	4.80E-2	2.45E-3	1.43E-2	1.70E-2
6	1.90E-1	5.90E-2	3.82E-2	2.45E-3	1.28E-2	2.06E-2
23	1.91E-1	1.42E-2	1.20E-2	2.44E-3	6.99E-3	2.25E-2
36	1.92E-1	1.20E-2	9.39E-3	2.21E-3	6.38E-3	2.26E-2
54	1.97E-1	9.13E-3	8.26E-3	1.71E-3	5.77E-3	2.25E-2
71	2.00E-1	5.52E-3	8.96E-3	1.89E-3	6.15E-3	2.25E-2

Z-DIR EQ

JT	DX	DY	DZ	JT	DX	DY	DZ
2	1.81E-2	5.50E-4	6.34E-2	16	7.24E-3	1.55E-2	4.66E-2
7	1.50E-2	9.37E-3	6.25E-2	3	1.31E-2	8.36E-3	7.51E-2
5	1.50E-2	3.63E-2	5.81E-2	1	1.30E-2	3.67E-2	1.31E-1
15	2.23E-2	5.57E-2	5.87E-2	6	1.29E-2	5.53E-2	1.59E-1
11	4.99E-2	7.29E-2	5.87E-2	23	1.28E-2	6.06E-2	1.70E-1
12	6.14E-2	6.64E-2	5.86E-2	36	1.11E-2	6.02E-2	1.70E-1
13	5.66E-2	2.87E-2	5.85E-2	54	9.51E-3	5.98E-2	1.69E-1
14	4.21E-2	1.56E-2	4.28E-2	71	8.11E-3	6.19E-2	1.68E-1
18	1.99E-2	1.55E-2	2.04E-2				

ADDED: [illegible] 7/15/82
CHKD. [illegible] 7/15/82

PREPARED BY [illegible] DATE 7-1-82 DOC. NO.
REVIEWED BY [illegible] DATE 7-1-82 PAGE NO.

Docket No. 50-346

License No. NPF-3

Serial No. 1-496

February 1, 1985

TOLEDO EDISON

RICHARD P. CROUSE
Vice President
Nuclear
(419) 259-5221

Mr. James G. Keppler, Regional Administrator
Region III
United States Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, Illinois 60137

Dear Mr. Keppler:

This letter transmits the information that Toledo Edison agreed to provide in the January 28, 1985 meeting at the Nuclear Regulatory Commission (NRC) Glen Ellyn offices, between members of the NRC Region III staff and Toledo Edison representatives, relative to a failed snubber found on the pressurizer surge line at the Davis-Besse Nuclear Power Station, Unit 1.

Information was requested to be submitted by February 1, 1985, to demonstrate the adequacy of the Nuclear Class 1 stanchion to pipe weld.

The requested information is provided in attached Calculation number M8, Revision 01, in its entirety.

These calculations show the stanchion to pipe weld to be acceptable for the design conditions.

Based on the above, Toledo Edison is confident of the adequacy of the new support design, which was completed during the refueling outage as corrective action relative to the failed snubber.

We trust that this fully addresses the concerns expressed by members of the NRC staff in the January 28, 1985 meeting, and thus removes the constraint to proceed to full power operation.

Very truly yours,

R P Crouse

RPC:JKW:lrh
cc: DB-1 NRC Resident Inspector

FEB 4 1985

CALCULATION COVER SHEET

PROJECT DAVIS-BESSE, UNIT-1 JOB NO. 12501 CALC. NO. M-8

SUBJECT PRESSURIZER SURGE LINE – CLASS-I PIPING ANALYSIS

COMPUTER PROGRAM: ☐ NONE ☒ SCP ☐ OTHER

PROGRAM NO(S). ME-101, ME-210 VERSION/RELEASE NO. K1/4.15 P4, 5/12-15-82

TOTAL NO. OF SHEETS 8 (Excluding Attachments)

ATT. NO. 1 = 3 SHTS., ATT. NO. 2 = 14 SHTS., ATT. NO. 3 = 4 SHTS., ATT. NO. 4 = 2 SHTS., ATT. NO. 5 = 1 SHT.

☐ PRELIMINARY CALC. ☐ COMMITTED PRELIMINARY CALC.

☐ SUPERSEDED CALC. ☒ FINAL CALC.

NO.	DESCRIPTION	BY	DATE	CHKD.	DATE	APPROVED	DATE
01	PRESSURIZER SURGE LINE	SPL	1-31-85	[illegible]	1-31-85	MSW —	1-31-85

REVISIONS

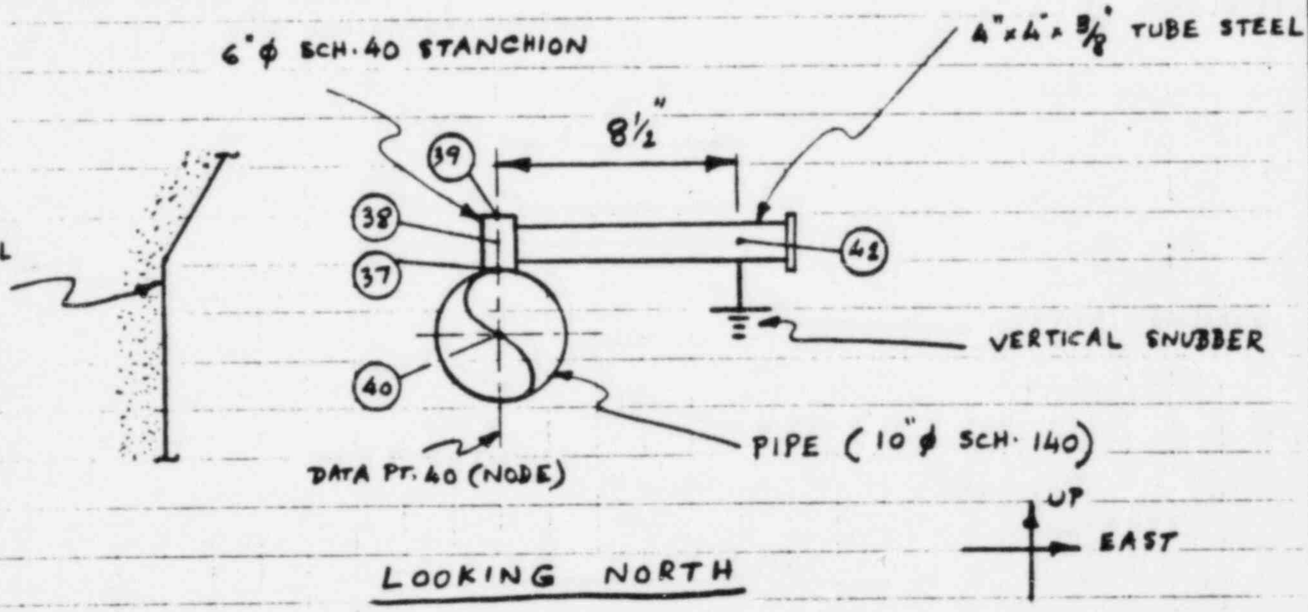
BPD-2704 Rev. 5/83 (ED-1)

BECHTEL

CALCULATION SHEET

JOB NO. 12501 DAVIS-BESSE, UNIT-1 PRESSURIZER SURGE LINE	CALC. NO. M-8	REV. NO. 01	SHEET NO. 1
ORIGINATOR Siva P. Lingam	DATE 1-30-85	CHECKED [signature]	DATE 1-31-85

AS-BUILT CONDITION OF VERTICAL SNUBBER (PSU-R1) ON PRESSURIZER SURGE LINE



LOOKING NORTH

THE PURPOSE OF THIS CALCULATION IS TO CHECK THE PRIMARY PIPE STRESSES (CATASTROPHIC FAILURE) ON THE PRESSURIZER SURGE LINE FOR LONG-TERM OPERATION CRITERIA EXCLUSIVE OF FINAL CLASS-I FATIGUE ANALYSIS.

ORIGINAL ANALYSIS OF THIS LINE WAS DONE BY B&W ON MAY 3, 1974 (STRESS ANALYSIS OF SURGE LINE, REPORT # 6, REV. 1) ALL POINTS WERE ANALYZED BY USING THE SIMPLIFIED METHOD PER USAS B31.7, 1968 (1-705 & TABLE D-201, APPENDIX-D). IN THIS ANALYSIS, VERTICAL SNUBBER PSU-R1 IS CONSIDERED AT THE CENTER LINE OF PIPE.

AS PER NCR 84-180, THE WEST SIDE VERTICAL SNUBBER (CLOSE TO THE WALL) FAILED. THE REASON OF FAILURE IS DETERMINED AS THERMAL INTERFERENCE BETWEEN WALL AND THE FAILED SNUBBER.* AS A RESULT, BECHTEL MODIFIED THIS SNUBBER AS SHOWN ABOVE TO MAKE THE REMAINING SNUBBER ALONE CAPABLE OF CARRYING THE ORIGINAL LOAD. HOWEVER THIS MODIFICATION CAUSES AN UNBALANCED MOMENT (TORSION ON PIPE) AT PIPE AND STANCHION INTERFACE.

* Ref. calc. M-8, REV. C3

CALCULATION SHEET

JOB NO. 12501 DAVIS-BESSE, UNIT-1	CALC. NO. M-8	REV. NO. 01	SHEET NO. 2
PRESSURIZER SURGE LINE			
ORIGINATOR [illegible signature]	DATE 1-30-85	CHECKED [illegible signature]	DATE 1-31-85

BECHTEL MADE TWO SEISMIC RUNS OF PRESSURIZER SURGE LINE (BY DECOUPLING FROM HOT LEG), ONE WITH VERTICAL SNUBBER AT THE CENTER LINE OF PIPE AND OTHER WITH VERTICAL SNUBBER MODELED THROUGH STANCHION & TUBE STEEL TO REFLECT THE MODIFICATION AND AT THE SAME TIME CONSIDER THE EFFECT OF AN UNBALANCED MOMENT ON THE SYSTEM AS A WHOLE. THE DYNAMIC PROPERTIES (EIGEN VALUES & EIGEN VECTORS) WERE THEN COMPARED FOR THE TWO RUNS. THERE IS NO SIGNIFICANT CHANGE IN THE DYNAMIC PROPERTIES LEADING TO THE CONCLUSION THAT THE RESULTS OF THE ORIGINAL ANALYSIS REMAIN UNCHANGED INCLUDING NOZZLE LOADS.

THE COMPARISON OF EIGEN VALUES (NATURAL FREQUENCIES UPTO 33 Hz) IS SHOWN BELOW (SEE ATTACHMENT NO. 1):

WITH SNUBBER AT CENTER LINE OF PIPE	WITH SNUBBER ACTUALLY MODELED	DIFFERENCE IN %	SOURCE
10.031 Hz.	9.805 Hz.	2.253%	BECHTEL
16.265	16.327	0.381	COMPUTER RUNS
19.021	18.914	0.563	G7399 (11-28-84)
21.418	20.054	6.37 (HIGHER MODE)	AND
27.479	26.913	2.06	G7397 (11-28-84)

HOWEVER, THE EFFECT OF ADDITIONAL TORSION MOMENT HAS TO BE CHECKED LOCALLY BY ADDING TO THE ORIGINAL RESULTS. SINCE THE MAXIMUM SEISMIC STRESS AND MAX. PRIMARY STRESS INTENSITY (EQ. 9 OF 1-705.1 OF B 31.7, 1968) OCCUR VERY CLOSE TO THIS SNUBBER (4¼" AWAY) IN THE ORIGINAL ANALYSIS, - THE CORRESPONDING MOMENTS ARE CONSIDERED AT THE SNUBBER AND ARE NOTED BELOW (B&W DATA PT. 3 -# SEE ATTACHMENT #2):

LOAD TYPE	MOMENT IN INCH-POUNDS: M_x #	M_y #	M_z #	TORSIONAL MOMENT (M_x) #
WEIGHT	12615.24	4661.04	51039.12	—
SEISMIC (OBE)	8872.8	22011.6	244343.04	20400 (2400 × 8.5)
SEISMIC (SSE)	15204.6	38394.	451370.28	33150 (3900 × 8.5)
WEIGHT + OBE	21488.04	26672.64	295382.16	20400
WEIGHT + SSE	27819.84	43055.04	502409.4	33150

CALCULATION SHEET

JOB NO. 12501 DAVIS-BESSE, UNIT-1	CALC NO. M-8		REV. NO. 01	SHEET NO. 3
PRESSURIZER SURGE LINE				
ORIGINATOR [illegible signature]	DATE 1-30-85	CHECKED [illegible signature]	DATE 1-31-85	

EQUATION - 9

$$B_1 \frac{PD_o}{2t} + B_2 \frac{D_o}{2I} M_i \le 1.5\, S_m \quad \text{(UPSET)}$$

$$B_1 \frac{PD_o}{2t} + B_2 \frac{D_o}{2I} M_i \le 2.25\, S_m \quad \text{(FAULTED PER B\&W ANALYSIS)}$$

SEE ATTACH. NO. 2, SHT. NO. 13

$B_1 = 1.0$ (elbow) (conservative as stanchion is on straight pipe) → Ref Table D-201 of APPX. D
no hole on the run pipe - this causes only longitudinal pressure stress.

$P = 2500$ psi

$D_o = 10.75''$

$t = 1.0''$

$I = 368\ in^4$

$$M_i = \sqrt{(21488.04 + 20400)^2 + (26672.64)^2 + (295382.16)^2} = 299527.4 \text{ in.-lbs. (upset)}$$

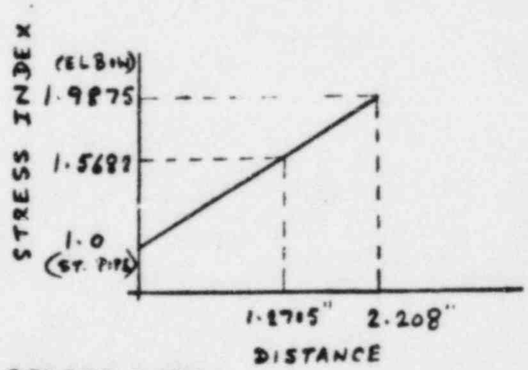
$B_2 = 0.75\, C_2$

$$= 0.75 \cdot \left[\frac{1.95}{\left(\frac{tR}{r^2}\right)^{2/3}} \right]$$

$$M_i = \sqrt{(27819.84 + 33150)^2 + (43055.04)^2 + (502409.4)^2} = 507923.5 \text{ in.-lbs. (Faulted)}$$

$B_2 = 1.9875$ (FOR ELBOW)

$B_2 = 1.5$ (FOR WTEE)



$\sqrt{rt} = \sqrt{4.875 \times 1.0} = 2.208''$

ACTUAL DISTANCE BETWEEN ELBOW WELD & NEAREST STANCHION WELD
$= 0.9875''$

ASSUMING LINEAR DISTRIBUTION OF STRESS INDEX,

$$\frac{0.9875}{B} = \frac{2.208}{1.2705}$$

SEE ATTACHMENT NO. 5 FOR FURTHER DISCUSSION

$B = 0.5682$

$\therefore B = 1.0 + 0.5682 = 1.5682$

$B_2 = 1.5682 \times 1.5 = 2.3523$ (multiplication of overlapping stress index is not required but is implied in note 2 of Table D.201)

If assumed as an unreinforced tee (UTEE), $i = \dfrac{0.9}{h^{2/3}}$ where $h = \dfrac{t_n}{r}$

(from class-2)

$t_n = 1.0$, $r = 4.875$

$i = 2.5877$

$B_2 = 2.5877$ (conservative - no hole on the run pipe)

CALCULATION SHEET

BECHTEL

JOB NO. 12501 DAVIS-BESSE, UNIT-1 CALC. NO. M-8 PRESSURIZER SURGE LINE		REV. NO. 01	SHEET NO. 4
ORIGINATOR: Siva P. Lingam	DATE: 1-30-85	CHECKED: [signature]	DATE: 1-31-85

CONSIDER THE HIGHEST VALUE OF $B_2 = 2.5877$ (UTEE)

$$B_1 \frac{PD_o}{2t} + B_2 \frac{D_o}{2I} M_i \leq 1.5\, S_m$$

$$1.0 \times \frac{2500 \times 10.75}{2 \times 1.0} + 2.5877 \times \frac{10.75}{2 \times 368} \times 299527.4 \leq 24{,}800 \text{ psi}$$

$$24{,}759 \leq 24{,}800 \text{ psi}$$

(UPSET CONDITION)

$$1.0 \times \frac{2500 \times 10.75}{2 \times 1.0} + 2.5877 \cdot \frac{10.75}{2 \times 368} \cdot 507923.5 \leq 37{,}575 \text{ psi}$$

$$32{,}635 \leq 37{,}575 \text{ psi}$$

(Faulted condition).

SEE ATTACH. NO. 2

CALCULATION SHEET

JOB NO. 12501 DAVIS-BESSE, UNIT-1 CALC. NO. M-8 PRESSURIZER SURGE LINE		REV. NO. 01	SHEET NO. 5
ORIGINATOR Siva P. Lingam	DATE 1-30-85	CHECKED [signature]	DATE 1-31-85

BECHTEL PROGRAM ME-210 ALSO CALCULATES THE LOCAL STRESSES AT THE STANCHION & PIPE INTERFACE. Ref.: WRC-107

CHECKS 1A, 1B, 2A & 2B OF ME-210 DEAL WITH UPSET PRIMARY (CIRCUMFERENTIAL), FAULTED PRIMARY (CIRCUMFERENTIAL), UPSET PRIMARY (LONGITUDINAL) & FAULTED PRIMARY (LONGITUDINAL) RESPECTIVELY. (SEE SHT. 4 OF ATTACH. NO. 3)

1A → $\frac{PD_o}{2t}$ + stresses from ME-210 = 14,030 psi

13437.5 + stresses from ME-210 = 14,030

stress from ME-210 = 14030 − 13437.5 = 592.5

Applying stress index of 2.5877,

1A → 13437.5 + (2.5877 × 592.5) = 14,971 psi (< 24,720 psi)

1B → 13437.5 + 2.5877 × (14400 − 13437.5) = 15,929 psi (< 37,575 psi)

B&W → 2.255

2A → $\frac{PD_o}{4t}$ + stresses from ME-210 including ME-101 stress = 12,970

6718.75 + stresses from ME-210 including ME-101 stress = 12,970

stresses from ME-210 including ME-101 stresses = 6251.25

Applying stress index of 2.5877,

2A → 6718.75 + (2.5877 × 6251.25) = 22,896 psi (< 24,720 psi)

2B → 6718.75 + 2.5877 × (17390 − 6718.75) = 34,332 psi (< 37,575 psi)

GPD-2706 Rev 4/82 (ED-69)

CALCULATION SHEET

JOB NO. 12501	CALC. NO.	REV. NO.	SHEET NO.
Davis-Besse Unit One	M-8	01	6

ORIGINATOR	DATE	CHECKED	DATE
[signature]	1-31-85	Siva P. Dungam	1-31-85

REANALYSIS USING CODE CASE N-411 RESULTED IN THE SYSTEM EXPERIENCING THE FOLLOWING REDUCTIONS IN DISPLACEMENTS, LOADINGS AND STRESSES (WHEN COMPARED TO THE ORIGINAL ANALYSIS): (CODE CASE N-411 CALLS OUT FOR 5% DAMPING FOR 0-10cps, A LINEAR DECREASE FROM 5% TO 2% DAMPING FOR 10-20cps, AND 2% DAMPING FOR FREQUENCIES GREATER THAN 20cps – SEE ATTACHMENT #4)

SUPPORTS: @ BECHTEL D.P. (42) : 64% REDUCTION IN LOAD (Y-SNUBBER) – PSU-R1
@ " " (55) : 11% REDUCTION IN LOAD (X-SNUBBER)
@ " " (60) : 70% REDUCTION IN LOAD (Z-SNUBBER)

DISPLACEMENTS : ALL DATA POINTS : 60% TO 75% REDUCTION IN DISPLACEMENT

MOMENTS IN THE PIPE: FOR Mx: 51% TO 70% REDUCTION IN LOADING
FOR MY: 62% TO 70% REDUCTION IN LOADING
FOR Mz: 48% TO 70% REDUCTION IN LOADING

STRESSES IN THE PIPE: AN OVERALL REDUCTION OF 64% TO 69% IN STRESSES.

NOZZLE LOADS: FOR HOT LEG (BECHTEL D.P. (5)): 49% TO 69% REDUCTION IN LOADING
FOR PRESSURIZER (BECHTEL D.P. (100)): 11% TO 70% REDUCTION IN LOADING

THE REDUCTIONS SHOWN ABOVE REFLECT OBE AND SSE CONDITIONS. IN GENERAL, THE MORE SIGNIFICANT LOADINGS EXPERIENCED APPROXIMATELY A 65% REDUCTION IN LOADINGS.

REFER TO: SNUMB N° G0087 DATED 1-30-85 – OBE USING CODE CASE N-411
SNUMB N° G0096 DATED 1-31-85 – SSE USING CODE CASE N-411

CALCULATION SHEET

BECHTEL

JOB NO. 12501 DAVIS-BESSE, UNIT-1 CALC. NO. M-8	REV. NO.	SHEET NO.
PRESSURIZER SURGE LINE	01	7

ORIGINATOR	DATE	CHECKED	DATE
Siva P. Lingam	1-31-85	[signature]	1-31-85

IT IS EVIDENT FROM THE PREVIOUS SHEET THAT AT LEAST 40% REDUCTION IN Y-LOAD, MOMENTS & STRESSES CAN BE ATTAINED FOR CODE CASE N-411 WHICH PERMITS THE USE OF HIGHER DAMPING (5% TO 2% OF CRITICAL DAMPING). APPLYING THIS REDUCTION IN EQUATION-9, WE GET THE FOLLOWING:

$$B_1 \frac{PD_0}{2t} + B_2 \frac{D_0}{2I} M_i \leq 1.5 S_m$$

$$1.0 \times \frac{2500 \times 10.75}{2 \times 1.0} + 2.5877 \times \frac{10.75}{2 \times 368} \cdot (299527.4) \times 0.6 \leq 24,800 \text{ psi}$$

$$20,231 \leq 24,800 \text{ psi}$$

(upset condition)

$$1.0 \times \frac{2500 \times 10.75}{2 \times 1.0} + 2.5877 \times \frac{10.75}{2 \times 368} \cdot (507923.5) \times 0.6 \leq 37,575 \text{ psi}$$

$$24,956 \leq 37,575 \text{ psi}$$

(Faulted condition)

IN A SIMILAR WAY, ME-210 STRESSES (CHECKS 1A, 1B, 2A & 2B) WILL BE MUCH WITHIN THE ALLOWABLES.

CONCLUSIONS

EVEN WITH CONSERVATIVE PRIMARY STRESS INDICES (B_1 FOR AN ELBOW ALTHOUGH STANCHION IS ON A STRAIGHT PIPE AND B_2 FOR AN UNREINFORCED TEE ALTHOUGH THERE IS NO HOLE IN THE PIPE), CONDITION FOR CATASTROPHIC FAILURE IS SATISFIED FOR LONG TERM OPERATION. IN ADDITION, WE HAVE SHOWN THAT SEISMIC ANALYSIS USING 5% DAMPING WOULD REDUCE STRESS LEVELS AN ADDITIONAL 18% (AT LEAST) AND MATERIAL TEST REPORTS SHOW THE ACTUAL YIELD STRENGTH TO BE GREATER THAN THE ALLOWABLE DESIGN VALUES.

TITLE : PRESSR, SURGE LINE
PROJECT NUMBER : 12501
PROBLEM NUMBER : M8
USER : SPL
LOAD CASE : SEIS1

EIGEN SOLVER : DETERMINANT SEARCH

EIGEN VALUES (natural frequencies)

FREQUENCIES FOR THE SEIS1 LOAD CASE (CPS)

10.0313238	16.2646813	19.0205340	21.4183087	27.4791067

SEISMIC

PERIODS FOR THE SEIS1 LOAD CASE (SEC)

.0996877	.0614829	.0525748	.0466890	.0363913

WITHOUT BROKEN SNUBBER

PRESSURIZER SURGE LINE

ATTACHMENT NO. 1

PROB. NO. M-8 (01)

SHT. NO. 1 OF 3

Added by: Siva g. Lingam Date: 1-30-85

ch'kd by: [signature] Date: 1-31-85

TITLE : PRESSR, SURGE LINE
PROJECT NUMBER : 12501
PROBLEM NUMBER : M8
USER : SPL
LOAD CASE : SEIS1

EIGEN SOLVER : DETERMINANT SEARCH

FREQUENCIES FOR THE SEIS1 LOAD CASE (CPS)

9.8041666	16.3267980	18.9134386	20.0543249	26.9129386

PERIODS FOR THE SEIS1 LOAD CASE (SEC)

.1019975	.0612490	.0528719	.0498646	.0371568

EIGEN VALUES (natural frequencies)

SEISMIC

WITH BROKEN SNUBBER

≈ 2.3% – first frequency

PRESSURIZER SURGE LINE

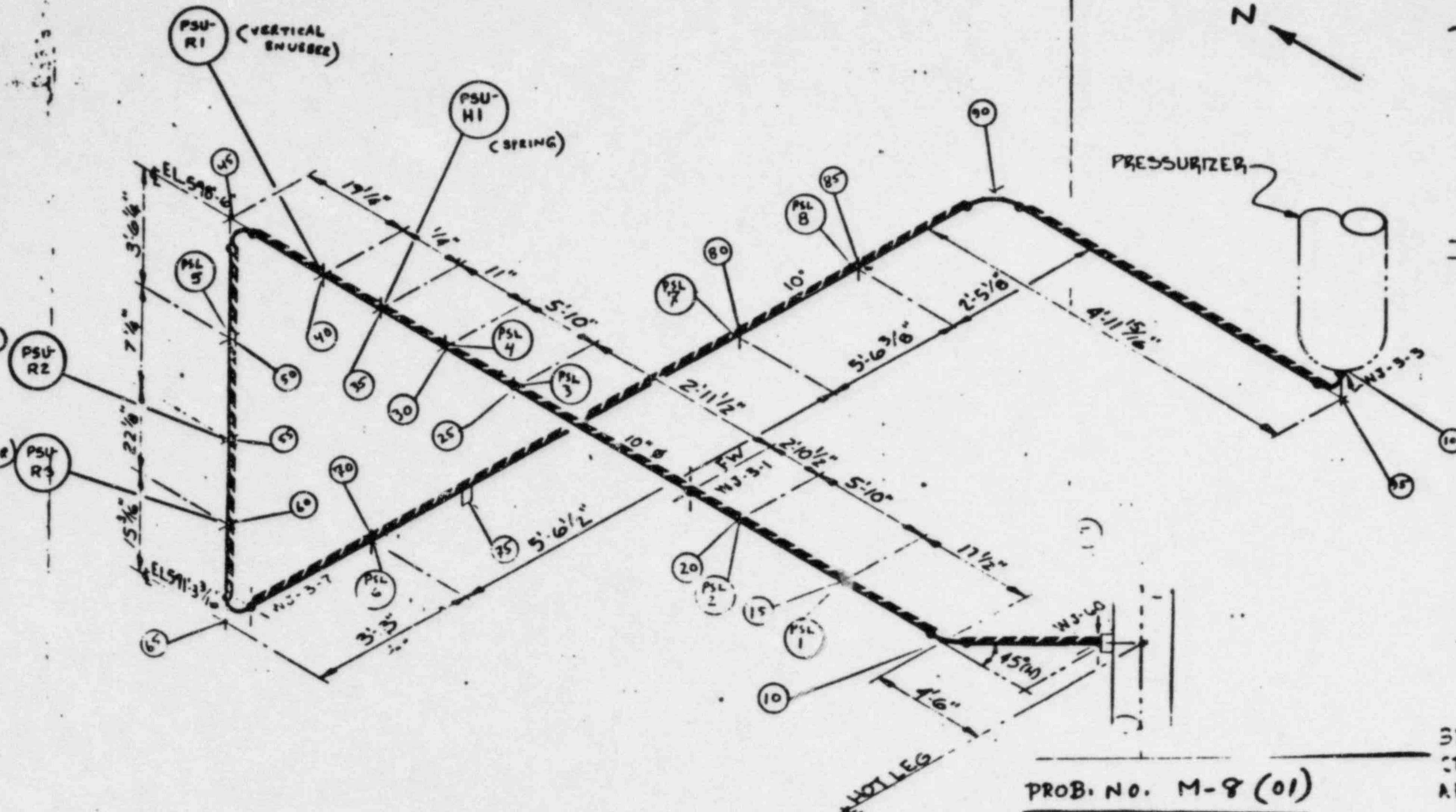
ATTACHMENT NO. 1

PROB. NO. M-8(01)

SHT. NO. 2 OF 3

Added by: Siva P. Lingam Date: 1-30-85

ch'kd by: [signature] Date: 1-31-85



PROB. NO. M-8 (01)

ATTACHMENT # 1

SHT. NO. 3 OF 3

Added by: Sira g. Lingam Date: 1-30-85

ch'cd by: [signature] Date: 1-31-85

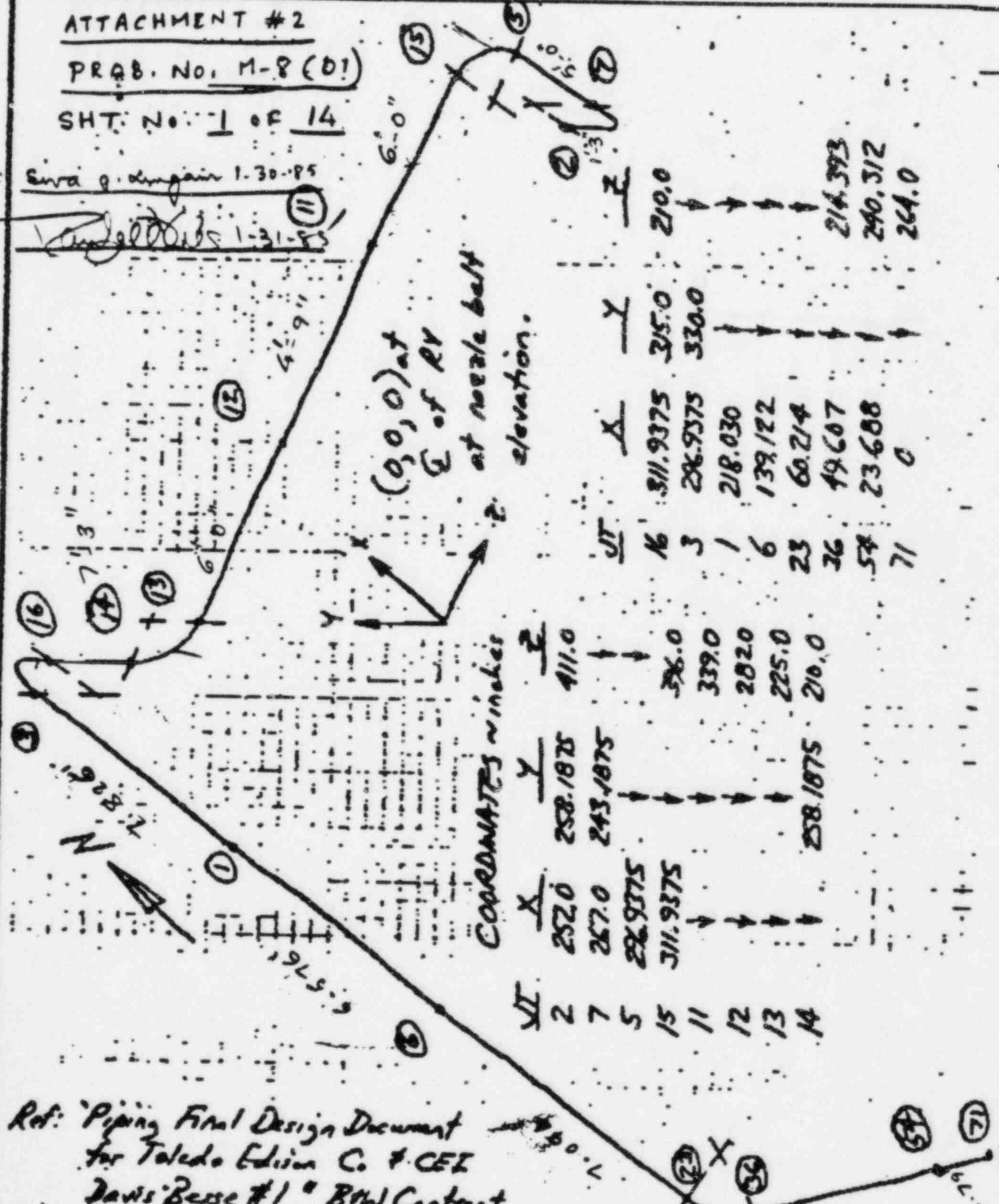
Randy Kies Attn: SIVA LINGAM

Babcock & Wilcox
a McDermott company
Nuclear Power Generation Division

GENERAL CALCULATIONS

ATTACHMENT #2
PROB. No. M-8 (01)
SHT. No. 1 of 14

Added by: Siva g. Lingam 1-30-85
ch'kd by: [signature] 1-31-85



COORDINATES ~ inches

JT	X	Y	Z
2	252.0	258.1875	411.0
7	267.0	243.1875	↓
5	296.9375	↓	↓
15	311.9375	↓	396.0
11	↓	↓	339.0
12	↓	↓	282.0
13	↓	↓	225.0
14	↓	258.1875	210.0

JT	X	Y	Z
16	311.9375	315.0	210.0
3	296.9375	330.0	↓
1	218.030	↓	↓
6	139.122	↓	↓
23	60.214	↓	↓
36	49.607	↓	214.393
54	23.688	↓	240.312
71	0	↓	264.0

Ref: "Piping Final Design Document for Toledo Edison Co. & CEI Davis-Besse #1" B&W Contract 620-0014-50, May 75, Vol 1 of 2

PREPARED BY [signature] DATE 6/25/82 DOC. NO. ____

REVIEWED BY ____ DATE ____ PAGE NO. ____

SURGE LINE SUPPRESSOR/HANGER LOADS

(See Figure 4)

Type of Loading	Forces (Kips)			Moments (Ft-Kips)		
	Fx	Fy	Fz	Mx	My	Mz
Dead Weight	0	-3.8	0	0	0	0
OBE	7.5	2.4	3.2	0	0	0
DBE	13.7	3.9	5.8	0	0	0

PROB. NO. M-8 (01)

ATTACHMENT # 2

SHT. NO. 2 OF 14

Added by: Siva P. Lingam Date: 1-30-85

ch'kd by: Randall Vies Date: 1-31-85

Introduction

This report contains the stress analysis of the surge line. All points in the surge line are analyzed including the bimetallic weld at the hot leg-surge nozzle. The analysis of the intersection at the pressurizer end is contained in pressurizer Design Report "Surge Nozzle Analysis". The branch intersection analysis is contained in this Design Report under a different section "Surge Nozzle".

Results

All points in the surge line satisfy primary stress limits either in accordance with equation 9 or per Appendix F of the B31.7 code.

Per equation 9 simplified analysis

Maximum Primary Stress = 22074.96 psi < 1.5 S_m = 24800. psi @670°F
Maximum for an elbow (joint 3) = 22074.96 psi < 24800. psi
Maximum for a straight (joint 1) = 10220.54 psi < 24800. psi

All points in the surge line do not satisfy the 3 S_m primary plus secondary stress limit. However, calculations are provided showing that an Elastic-Plastic Analysis is applicable.

Maximum primary plus secondary stress (Bimetallic Weld) (joint 54)
= 75997.62 psi > 3 S_m = 50100. psi @650.°F (PAGE C-11)
Maximum primary plus secondary stress for an elbow (joint 2)
= 67368.71 psi > 50100. psi (PAGE C-13)
Primary plus secondary stress for cycles occurring more than 240 times:
Joint 2 = 36860.4 psi < 3 S_m = 50100. psi
Joint 3 = 33777.9 psi < 3 S_m = 50100. psi
Joint 19 = 36929.7 psi < 3 S_m = 50100. psi

Maximum Usage Factors:

Usage Factor at Bimetallic weld (joint 2) = 0.87 < 1.0 = allowable
Usage Factor for joint 3 = 0.046 < 1.0 = allowable
Usage Factor for joint 19 = 0.036 < 1.0 = allowable

PROB. NO. M-8 (01)

ATTACHMENT # 1

SHT. NO. 3 OF 14

Added by: Siva P. Lingam Date: 1-30-85

ch'ked by: [signature] Date: 1-31-85

Ref: "Stress Analysis of Surge Line, Report #6, for Toledo Edison Company, Davis-Besse," 620-0014-50, Jun 1972 (Rev 1, 5/3/74). RP 7/2/82

1.

This section demonstrates that all points in the surge line satisfy primary stress limits according to either Equation 9 or Appendix F of B31.7. A flexibility analysis was run for dead weight, and either (x + y) or (z + y) earthquakes. The moments generated by this analysis are shown on Pages A-4 thru A-7.

These moments are then combined with design pressure of 2500 psi to generate primary stresses in accordance with equation 9 using applicable indicies. The indicies used are listed in the stress output. Two cases were ran: 1) pressure, deadload, (x + y) earthquake; 2) pressure, deadload, (z + y) earthquake.

The results are then compared to 1.5 S_m at 670°F for SA-376-TP-316 (straights) and A-403-WP-316 (bends). Part of the surge line actually has a design temperature of 650°F. S_m = 16,500 psi. for both materials thus the allowable primary stress is 1.5 (16,500.) = 24,800. psi.

The largest primary stress is 22074.96 psi at joint 3 for the x + y earthquake at an elbow juncture. Complete results are tabulated on Page A-8 and 9.

PROB. NO. M-8 (01)

ATTACHMENT # 2

SHT. NO. 4 OF 14

Added by: Siva g. Lingam date: 1-30-85

ch'kd by: [signature] date: 1-31-85

STRESS INDICES

(JOINT CLASSIFICATION)

TYPE	DESCRIPTION
1	STRAIGHT PIPE, REMOTE FROM WELDS OR OTHER DISCONTINUITIES
2	GIRTH BUTT WELD BETWEEN STRAIGHT PIPE OR BETWEEN PIPE AND BUTT-WELDING COMPONENTS. FLUSH
3	GIRTH BUTT WELD BETWEEN STRAIGHT PIPE OR BETWEEN PIPE AND BUTT-WELDING COMPONENTS. AS WELDED
4	GIRTH FILLET WELD TO SOCKET WELD FITTINGS, SLIP-ON FLANGES, OR SOCKET-WELDING FLANGES
5	LONGITUDINAL BUTT WELDS IN STRAIGHT PIPE. FLUSH
6	LONGITUDINAL BUTT WELDS IN STRAIGHT PIPE. AS WELDED
7	TAPERED TRANSITION JOINTS PER SUBPAR. 1-727.4.2(C) AND FIG.1-727.3.1
8	BRANCH CONNECTIONS PER SUBDIV. 1-704.3
9	CURVED PIPE OR BUTT-WELDING ELBOWS PER USAS B16.9, USAS B16.28, OR MSS SP48
10	BUTT-WELDING TEES PER USAS B16.9 OR MSS SP48
11	BUTT-WELDING REDUCERS PER USAS B16.9 OR MSS SP48

PROB. NO. M-8(01)

ATTACHMENT # 2

SHT. NO. 5 OF 14

Added by: Siva P. Lingam Date: 1-30-85

ch'kd by: [signature] date: 1-31-85

TOLEDO SURGE LINE

SECTION PROPERTIES

SECTION	OUTSIDE RADIUS (IN)	OUTSIDE DIAMETER (IN)	THICKNESS (IN)	MOMENT OF INERTIA (IN**4)	BEND RADIUS (IN)	DESCRIPTION
1	5.3750	10.7500	1.0000	367.805		SURGE LINE ST.
2	5.3750	10.7500	1.0000	367.805	15.0000	SURGE LINE CR.

PROB. NO. M-8 (01)

ATTACHMENT #2

SHT. NO. 6 OF 14

Added by: Siva P. Lingam date: 1-30-85

ch'kd by: Randall Vies date: 1-31-85

DEAD LOAD MOM. (FT-LBS)

JOINT	M(X)	M(Y)	M(Z)
1	1051.27	190.21	2956.52
2	48.76	575.73	5475.20
3	1051.27	388.42	4253.26
5	11.08	462.85	162.55
6	1051.27	8.00	4545.22
7	11.08	538.05	3365.43
11	4089.10	120.24	1611.11
12	3647.55	121.16	1611.11
13	352.88	362.57	1611.11
14	870.89	426.09	1674.64
15	1437.53	361.65	1611.11
16	1013.59	426.09	1915.25
18	942.24	426.09	1794.94
23	1051.27	206.20	512.79
36	780.06	251.45	142.01
54	1677.71	426.33	2599.77

PROB. NO. M-8 (01)

ATTACHMENT NO. 2

SHT. NO. 7 of 14

Added by: Siva P. Lingam Date: 1-30-85

Ch'kd by: Randall Davis Date: 1-31-85

A-4

X EARTHQUAKE M[illegible]NTS (FT-LBS)

JOINT	M(X)	M(Y)	M(Z)
1	552.91	5774.54	13644.50
2	1091.14	3150.34	8890.93
3	552.91	1462.31	19615.80
5	803.58	3093.78	5837.96
6	552.91	2393.62	4150.89
7	803.58	2984.70	7184.48
11	2332.90	3832.01	5367.42
12	2374.86	4664.09	5367.42
13	1686.72	2087.29	5367.42
14	1926.39	1927.74	5317.74
15	316.78	2491.91	5367.42
16	762.69	1927.74	10767.60
18	2770.96	1927.74	5636.34
23	552.91	2913.27	5693.95
36	737.77	2680.95	7000.95
54	4052.93	7976.70	10344.10

ATTACHMENT # 2

PROB. No. M-8(01)

SHT. No. 8 of 14

Added by: Siva p. Lingam Date: 1-30-85

ch'kd by: [illegible] date: 1-31-85

A-5

Y EARTHQUAKE M[illegible]NTS (FT-LBS)

JOINT	M(X)	M(Y)	M(Z)
1	186.49	1510.79	1828.76
2	314.57	812.57	1047.93
3	166.49	371.99	746.12
5	403.67	792.55	235.87
6	186.49	613.02	711.74
7	403.67	744.95	767.22
11	1145.29	1185.50	436.78
12	881.24	1481.76	496.78
13	946.49	471.82	496.78
14	1066.14	571.52	301.27
15	117.58	410.45	496.78
16	221.74	571.52	445.15
18	773.30	571.52	711.91
23	186.49	780.29	522.38
36	241.32	811.28	768.08
54	1042.90	1347.92	1561.55

PROB. NO. M-8 (01)

ATTACHMENT # 2

SHT. NO. 9 OF 14

Added by: Siva P. Lingam Date: 1-30-85

Ch'kd by: [illegible] date: 1-31-85

Z EARTHQUAKE MOMENTS (FT-LBS)

JOINT	M(X)	M(Y)	M(Z)
1	2433.64	7961.39	4184.12
2	3388.12	8215.63	10092.10
3	2433.64	2335.07	3456.56
5	3399.79	2767.35	1725.99
6	2433.64	4134.19	2241.79
7	3399.79	5695.74	6636.94
11	6557.96	5244.52	943.78
12	8413.93	5365.99	943.78
13	6341.99	2892.85	943.78
14	4395.61	3892.77	1690.56
15	1445.88	3424.23	943.78
16	1675.18	3892.77	2984.50
18	3877.61	3892.77	4513.19
23	2433.64	3949.75	1820.32
36	2629.71	4271.87	1651.72
54	4643.93	9844.89	3448.70

PROB. NO. M-8 (01)

ATTACHMENT # 2

SHT. NO. 10 OF 14

Added by: Siva P. Lingam Date: 1-30-85

Ch'kd by: [signature] Date: 1-31-85

D-7

TOLEDO SURGE LINE

EQUATION 9 - PRIMARY STRESSES

CONDITION . . . PRESSURE,X+Y EQ , DEAD WT.
EQ 9

MOMENTS IN FT-LBS. STRESSES IN PSI.

JOINT	TYPE	MX	MY	MZ	M(I)	B1	B2	PRIMARY STRESS	RATIO TO ALLOWABLE
1	1	1790.67	7475.54	18429.78	19968.65	.5	1.0	10220.54	.413
2	9	1454.47	4538.64	15454.06	16172.28	1.0	2.0	19074.58	.771
3	9	1790.67	2222.71	24615.18	24780.11	1.0	2.0	22074.96	.892
5	9	1223.34	4256.18	6236.38	7648.80	1.0	2.0	16103.60	.651
6	1	1790.67	3011.64	9467.85	10039.13	.5	1.0	8479.26	.343
7	9	1223.34	4271.70	11317.13	12158.18	1.0	2.0	17675.41	.714
11	1	7487.29	5137.75	7475.31	11761.64	.5	1.0	8781.32	.355
12	1	5902.85	6267.01	7475.31	11950.11	.5	1.0	8814.37	.356
13	9	2988.09	2921.68	7475.31	8564.18	1.0	2.0	16422.67	.664
14	9	3863.42	2925.35	7293.65	8756.77	1.0	2.0	16489.88	.666
15	9	1871.89	3264.00	7475.31	8368.87	1.0	2.0	16354.59	.661
16	9	1998.02	2925.35	13127.99	13597.57	1.0	2.0	18177.13	.734
18	1	4486.50	2925.35	8143.19	9746.68	.5	1.0	8427.97	.341
23	9	1790.67	3609.76	6729.12	7980.96	1.0	2.0	16219.38	.655
36	9	1759.15	3743.67	7911.04	8927.17	1.0	2.0	16549.19	.669
54	3	6773.54	9750.94	14505.42	18744.84	.5	1.0	10005.93	.404

PROB. NO. M-8(01)

ATTACHMENT # 2

SHT. NO. 11 OF 14

Added by: Siva P. Lingam date: 1-30-85

ch'kd by: Randall Ellis date: 1-31-85

8-7

TOLEDO SURGE LINE

EQUATION 9 - PRIMARY STRESSES

CONDITION . . . PRESSURE , Z+Y EQ , DEAD WT.
EQ 9

MOMENTS IN FT-LBS. STRESSES IN PSI.

JOINT	TYPE	MX	MY	MZ	M(I)	B1	B2	PRIMARY STRESS	RATIO TO ALLOWABLE
1	1	3671.40	9662.39	8969.40	13685.44	.5	1.0	9110.69	.368
2	9	3751.45	9603.93	16655.23	19588.40	1.0	2.0	20265.32	.819
3	9	3671.40	3095.47	8455.93	9724.40	1.0	2.0	16827.00	.680
5	9	3819.54	3932.76	2124.41	5879.51	1.0	2.0	15486.89	.626
6	1	3671.40	4752.21	7498.75	9606.98	.5	1.0	8403.47	.340
7	9	3819.54	6978.74	10769.59	13389.39	1.0	2.0	18104.56	.731
11	1	11712.35	6550.26	3051.67	13762.19	.5	1.0	9132.15	.369
12	1	12942.72	6968.91	3051.67	15013.08	.5	1.0	9351.51	.378
13	9	7643.36	3727.24	3051.67	9034.71	1.0	2.0	16586.68	.670
14	9	6332.64	4890.38	3656.47	8797.04	1.0	2.0	16503.83	.667
15	9	3000.99	4196.32	3051.67	5993.98	1.0	2.0	15526.79	.627
16	9	2910.51	4890.38	5344.89	7807.36	1.0	2.0	16158.87	.653
18	1	5593.15	4890.38	7020.04	10221.55	.5	1.0	8511.25	.344
23	9	3671.40	4936.24	2855.49	6782.30	1.0	2.0	15801.57	.638
36	9	3651.09	5334.59	2561.81	6953.50	1.0	2.0	15861.24	.641
54	3	7364.54	11619.13	7610.02	15721.11	.5	1.0	9475.67	.383

PROB. NO. M-8(01)

ATTACHMENT NO. 2

SHT. NO. 12 OF 14

Added by: Siva P. Lingam Date: 1-30-85

Ch'kd by: Randall [illegible] Date: 1-31-85

TOLEDO SURGE LINE

EQUATION 9 - PRIMARY STRESSES

CONDITION . . . X+Y OBE, DEAD WT. ,PRESSURE

EQ 9

MOMENTS IN FT-LBS. STRESSES IN PSI.

JOINT	TYPE	MX	MY	MZ	M(I)	B1	B2	PRIMARY STRESS	RATIO TO ALLOWABLE	ALLOWABLE 2.25 Sm
1	1	2318.32	12877.89	33757.68	33424.98	.5	1.0	12580.30	.297	< 37.575 KSI
2	9	2482.40	7482.58	23461.15	24750.29	1.0	2.0	22064.57	.521	< 37.575 KSI
3	9	2318.32	3587.92	41867.45	42084.81	1.0	2.0	28106.76	.664	< " "
5	9	2024.62	7120.80	11374.37	13571.34	1.0	2.0	18167.98	.429	< " "
6	1	2318.32	5246.59	23197.06	14389.71	.5	1.0	9242.19	.218	< " "
7	9	2024.62	7058.11	17759.43	19217.53	1.0	2.0	20136.04	.475	< " "
11	1	9803.24	8767.98	12269.16	17986.47	.5	1.0	9872.94	.233	< " "
12	1	9188.59	10695.21	12269.16	18690.91	.5	1.0	9996.47	.236	< " "
13	9	4692.66	4855.58	12269.16	14004.64	1.0	2.0	18319.02	.433	< " "
14	9	5805.91	4745.36	11995.40	14146.26	1.0	2.0	18368.38	.434	< " "
15	9	2176.89	5534.58	12269.16	13634.61	1.0	2.0	18190.04	.429	< " "
16	9	2717.08	4745.36	22607.09	23259.00	1.0	2.0	21544.76	.509	< " "
18	1	7090.56	4745.36	13224.78	15738.15	.5	1.0	9478.66	.224	< " "
23	9	2318.32	6629.38	11813.46	13743.40	1.0	2.0	18227.96	.430	< " "
26	9	2461.35	6278.92	14193.89	15714.63	1.0	2.0	18915.06	.447	< " "
[illegible]	3	10560.31	17027.65	23895.17	31183.98	.5	1.0	12187.31	.288	< " "

PROB. NO. M-8(01)

ATTACHMENT NO. 2

SHT. NO. 13 OF 14

Added by: Siva P. Lingam Date: 1-30-85

Ch'kd by: [signature] Date: 1-31-85

A-10

TOLEDO SURGE LINE

EQUATION 9 - PRIMARY STRESSES

CONDITION . . . 2*Y DBE, DEAD WT. ,PRESSURE
EQ 9

MOMENTS IN FT-LBS. STRESSES IN PSI.

JOINT	TYPE	MX	MY	MZ	M(I)	B1	B2	PRIMARY STRESS	RATIO TO ALLOWABLE	ALLOWABLE 2.25 Sm
1	1	5835.29	16966.50	13066.77	22195.79	.5	1.0	10611.10	.251	< 37.575 KSI
2	9	6777.76	15954.67	25707.34	31531.99	1.0	2.0	24428.42	.577	< " "
3	9	5835.29	5219.98	11649.67	14036.16	1.0	2.0	18330.00	.433	< " "
5	9	6879.53	6516.00	3684.99	10166.87	1.0	2.0	16981.31	.401	< " "
6	1	5835.29	8501.46	9627.05	14100.93	.5	1.0	9192.61	.217	< " "
7	9	6879.53	12120.27	15735.53	21778.59	1.0	2.0	21028.74	.496	< " "
11	1	17704.10	11469.37	3996.96	21437.92	.5	1.0	10478.20	.247	< " "
12	1	20483.15	12007.76	3996.96	24077.41	.5	1.0	10941.07	.258	< " "
13	9	13398.91	6361.97	3996.96	15360.90	1.0	2.0	18791.76	.444	< " "
14	9	10423.35	8419.97	5193.87	14370.75	1.0	2.0	18446.63	.436	< " "
15	9	4288.30	7278.01	3996.96	9345.30	1.0	2.0	16694.94	.394	< " "
16	9	4423.35	8419.97	8052.70	12462.26	1.0	2.0	17781.40	.420	< " "
18	1	9159.99	8419.97	11124.49	16585.99	.5	1.0	9645.58	.228	< " "
23	9	5835.29	8567.60	4569.77	11326.60	1.0	2.0	17386.25	.410	< " "
36	9	5999.27	9253.94	4190.83	11797.87	1.0	2.0	17549.82	.414	< " "
54	3	11665.48	20521.17	11000.78	20042.64	.5	1.0	11285.70	.266	< " "

PROB. NO. M-8(01)

ATTACHMENT # 2

SHT. NO. 14 OF 14

Added by: siva p. lingam date: 1-30-85

ch'kd by: [signature] date: 1-31-85

A-11

CALCULATION SHEET

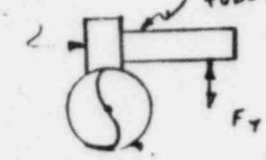
ORIGINATOR: Siva g. Lingam [illegible] DATE: 11-30-84 CALC. NO. PS/PSU-1 REV. NO. 1

CHECKED: [illegible] DATE: 12-5-84

PROJECT: DAVIS-BESSE UNIT 1 JOB NO. 12501

SUBJECT: DATA SHEET FOR LOCAL STRESS CHECK SHEET NO. 11

FOR LONG TERM



TO BE FILLED IN BY STRESS GROUP:

STRESS PROBLEM NO. M-8 ISSUE: C2 DATA POINT 40

PIPE SUPPORT NO. PSU-R1

TYPE OF SUPPORT:

VERTICAL ☒ (SNUBBER LOAD) X ☐ Z ☐ SKEW ☐ ANCHOR ☐

ATTACH. NO. 3
SHT. NO. 1 OF 4
PROB. NO. M-8 (01)
Added by: Siva g. Lingam 1-30-85
ch'kd by: [illegible] 1-31-85

PIPE OUTSIDE DIAMETER 10.75 in PIPE WALL THK 1.0 in

OPERATING PRESSURE 2750 psig DESIGN PRESSURE 2500 psig

PIPING MATERIAL S.S. SA376-TP316 TEMPERATURE 670 °F S_m 16.48 ksi

ME-101 LOAD CASE	SUPPORT LOADS						PIPE STRESS (psi)*
	FORCES (lbs)			MOMENTS (in-lbs)			
	X	Y	Z	X	Y	Z	
WEIGHT		—					825
OBE		2400					4415
SSE		3900					8203
THERMAL		—					4546
SAM		—					—

* KSI FOR ME 210 INPUT

Note: 1) The stresses are at the center line of pipe

2) The loads are as shown in figure.

CALCULATION SHEET

CALC. NO. PS/PSU-1 REV. NO. 1

ORIGINATOR S H [illegible] DATE 11/30/84 CHECKED T. Lin DATE 12/11/84

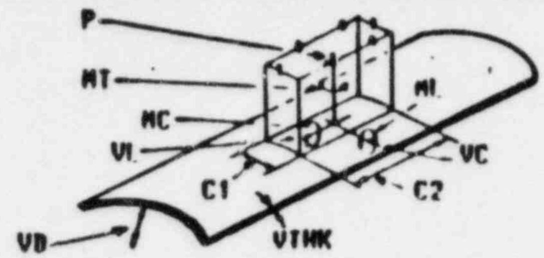
PROJECT DAVIS-BESSE UNIT 1 JOB NO. 12501

SUBJECT ME 210 INPUT DATA SHEET NO. 12

-> TYPE CALL 816566*PROG.210IN

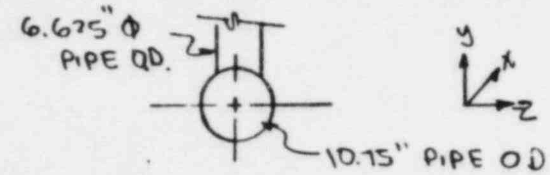
1> TITLE, SUPPORT NUMBER PSU-R1

2> NUMBER OF LOADING CASES ;3



LOADING COMBINATIONS

	CASE NUMBER	TYPE OF COMBINATION	P lbs	ML in-lbs	MC in-lbs	MT in-lbs	VL lbs	VC lbs	COMMENTS
3>	1	WEIGHT+ OBE	2400 ;	0 ;	20400 ;	0 ;	0 ;	0	
4>	2	WEIGHT+ SSE	3900 ;	0 ;	33150 ;	0 ;	0 ;	0	
5>	3	WEIGHT+THRM+ OBE+SAM	2400 ;	0 ;	20400 ;	0 ;	0 ;	0	



GEOMETRY

		PIPE WALL THICKNESS ACTUAL ☒ EFFECTIVE ☐ in	PIPE DIAMETER ACTUAL MEAN ☐ ADJUSTED ☒ in	ATTACHMENT DIMENSIONS C1 in	ATTACHMENT DIMENSIONS C2 in	SHAPE 0.0 RECTANGULAR 1.0 CIRCULAR 2.0 ELIPTICAL
6>	A	1.0 ;	13.25 ;	6.625 ;	6.625 ;	1.0
	B	;	;	;	;	

GEOMETRIC PARAMETERS β AND γ CHECK

	A	B
β = C1/VD =	.5	
β = C2/VD =	.5	
$\gamma = \frac{VD}{(2 \times VTHK)}$ =	6.625	

0.01 < β < 0.5 | IF NOT,
5 < γ < 300 | ADJUST VD.

FOR POINT B:

$VT' = \sqrt{VT^2 + VTU^2}$

= ________ = ____

7> TYPE *CALL 816566*PROG.END

-> TYPE PXQT ADD 816566*210RUN.

-> TYPE CALL 816566*PROG.210SUB ADJUST PAPER, HIT RETURN

ATTACH. NO. 3

SHT. NO. 2 OF 4

PROB. NO. M-8(01)

Added by: Siva P. Lingam 1-31-85

ch'kd by: [illegible] 1-31-85

ORIGINATOR C.H. [illegible] DATE 11/30/84 CHECKER T. Lin DATE 12/11/84 CALC NUM PS/PSU-1
PROJECT DAVIS BESSE UNIT 1 JOB # 12501 STANDARD COMPUTER PROGRAM ME-210 REV NUM 1 SHEET -13 OF

VERSION : 5
RELEASED : DEC 15, 1982
USER MANUAL VERSION : 1
THEORETICAL MANUAL VERSION : 1
VERIFICATION MANUAL VERSION : 5

B I J L A A R D   S T R E S S   A N A L Y S I S   F O R   C Y L I N D E R S

PSU-R1

ATTACH. NO. 3

SHT. NO. 3 OF 4

PROB. NO. M-8 (01)

Added by: Siva p. [illegible] 1-30-85

ch'kd by: [illegible] 1-31-85

I N P U T   D A T A

	P (LBS)	ML (IN-LBS)	MC (IN-LBS)	MT (IN-LBS)	VL (LBS)	VC (LBS)	MA (FT-LBS)	MB (FT-LBS)
1	2400.	0.	20400.	0.	0.	0.	0.	0.
2	3900.	0.	33150.	0.	0.	0.	0.	0.
3	2400.	0.	20400.	0.	0.	0.	0.	0.

	VESTHK (IN)	VESDIA (IN)	C1 (IN)	C2 (IN)	SHAPE	PRESSURE (PSI)	SM (KSI)	BEND R (IN)
1	1.0000	13.2500	6.6250	6.6250	CIRCULAR	.0000	.0000	.0000
2	1.0000	13.2500	6.6250	6.6250	CIRCULAR	.0000	.0000	.0000
3	1.0000	13.2500	6.6250	6.6250	CIRCULAR	.0000	.0000	.0000

MAXIMUM PRIMARY PLUS SECONDARY STRESS INTENSITY

1.0000	-1.18	.63	-1.18	.63	-5.06	3.87	2.71	-2.61

MAXIMUM PRIMARY PLUS SECONDARY STRESS INTENSITY

1.0000	-1.91	1.03	-1.91	1.03	-8.21	6.30	4.40	-4.25

MAXIMUM PRIMARY PLUS SECONDARY STRESS INTENSITY

1.0000	-1.18	.63	-1.18	.63	-5.06	3.87	2.71	-2.61

ORIGINATOR C.H. [illegible] DATE 11/30/84 CHECKER T. [illegible] DATE 12/11/84 CALC NUM. PS/PSU-1
PROJECT DAVIS-BESSE UNIT 1 JOB # 12501 STANDARD COMPUTER PROGRAM ME-210 REV NUM. 1 SHEET - 14 OF

PROB. NO. M-8 (01)

ATTACH. NO. 3

SHT. NO. 4 OF 4

********* ME-210 POST-PROCESSOR (VERS. B) 12/8/81 ********

DO YOU WANT TO ENTER PRESSURES AND OTHER STRESSES (YES OR NO)? >YES
ENTER ACTUAL PIPE O.D. AND WALL (INCHES) O.D.,W? >10.75,1.0
ENTER OPERATING AND DESIGN PRESSURE (PSIG) P-OP.,P-DES.? >2750,2500
IS ALL DATA O.K. SO FAR (YES OR NO)? >YES
ENTER FOLLOWING STRESSES WT,OBE,SSE,THRM,SAM (KSI)? >.825,4.415,8.203,4.546,0.0
ENTER SM STRESS ALLOWABLE (KSI)? >16.48
IS ALL DATA O.K. (YES OR NO)? >YES
PIPE O.D. = 10.75
PIPE WALL = 1.000
DESIGN PRESSURE = 2500
OPERATING PRESSURE = 2750
WEIGHT STRESS = .825
OBE STRESS = 4.415
SSE STRESS = 8.203
THERMAL STRESS = 4.546
SAM STRESS = 0.000
ALLOWABLE STRESS (SM) = 16.480

Added by: Siva P. [illegible] 1-30-85

ch'kd by: [illegible] 1-30-85

CHECK		VALUE	ALLOWABLE	
1A		14.03	24.720	→ upset primary in circumferential direction
1B		14.40	49.440	→ Faulted primary "
2A		12.97	24.720	→ upset primary in longitudinal direction
2B		17.39	49.440	Faulted primary "
3A	5.06 +	14.78 = <	49.440	OK
3B	5.06 +	17.18 = <	49.440	

FOR CHECK 3A AND 3B YOU MUST ADD THE MAX PRI + SEC STRESS INTENSITY
FROM THE ME-210 RUN FOR LOAD CASE #3 AND MUST STILL
BE BELOW THE SPECIFIED ALLOWABLE

TIME [illegible] .044
FURPUR 28R3A-U1 S74T11 11/30/84 10:47:25
END PACK. TEXT=7.TOC=1.SYM=?

Annex #4-371

Code Case N-411 Alternative Damping Values for Seismic Analysis of Piping Section III, Division 1 Class 1, 2, and 3.

Question:

What alternatives to the damping values given in Table N-1230-1, Appendix N, Section III Division 1 are acceptable for use in seismic analysis of Class 1, 2 and 3 piping?

Reply:

It is the opinion of the Committee that for Section III, Division 1, Class 1, 2, and 3, construction, the damping value for seismic analysis of piping shown in Figure 1 may be used as an alternative to those given in Table N-1230-1, Appendix N.

The damping value in Figure 1 is applicable to both OBE and SSE, and is independent of pipe diameter.

This Code Case number shall be shown in the documentation for this analysis and on the Code Data Report.

PROB. NO. M-8 (01)

ATTACH. NO. 4

SHT. NO. 1 OF 2

Added by: Siva P. Lingam date: 1-30-85

ch'kd by: [signature] date: 1-31-85

PROB. NO. M-8 (01)

ATTACH. NO. 4

SHT. NO. 2 OF 2

Added by: [illegible signature] 1-30-85

Ch'kd by: [illegible signature] 1-31-85

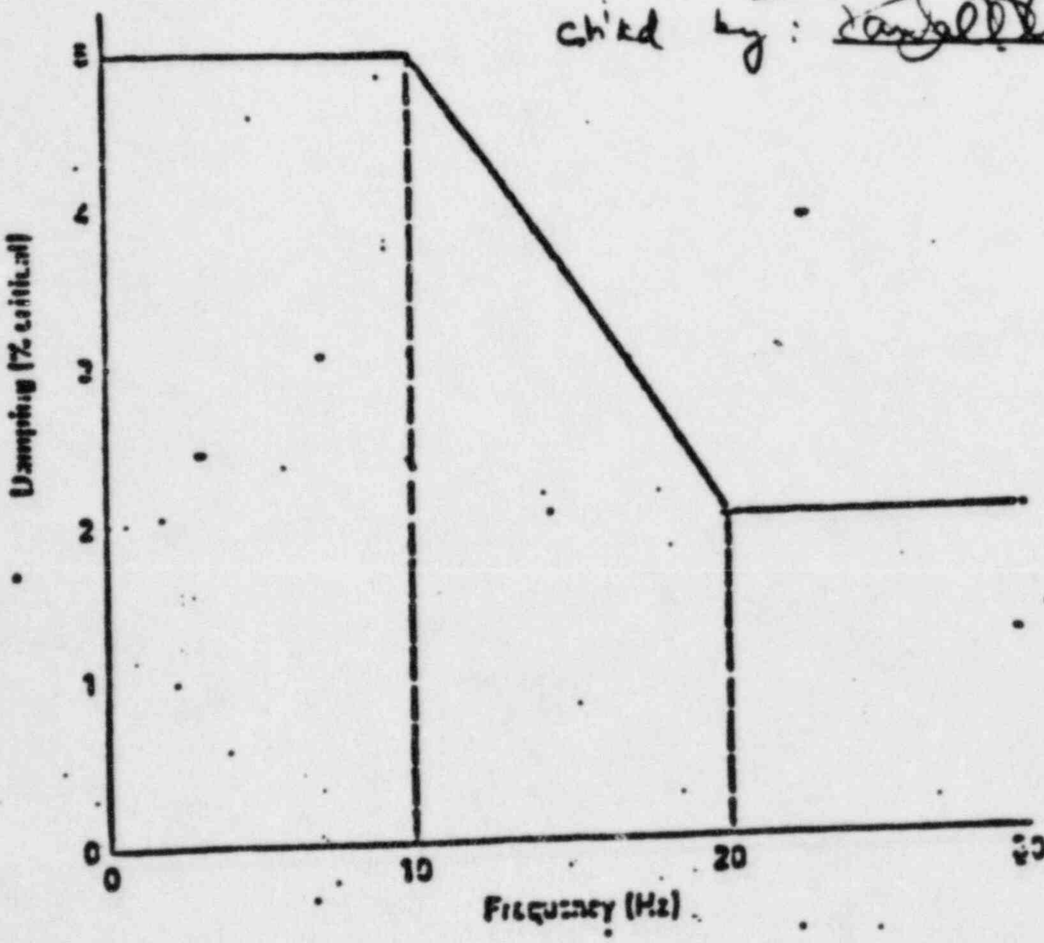


Figure 1

Damping Value for Seismic Analysis of Piping

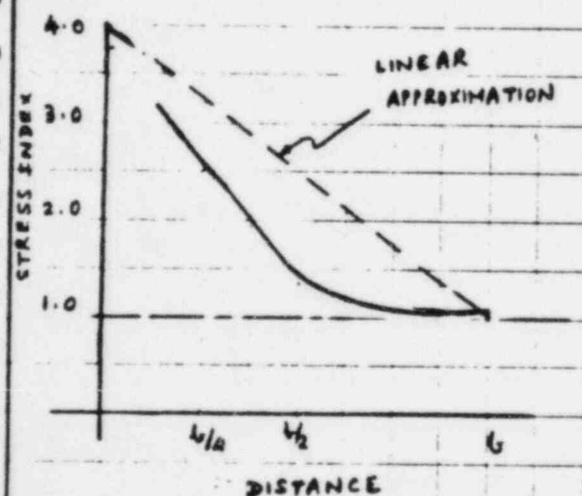
(Applicable to both OBE & SSE, Independent of Pipe Diameter)

ATTACHMENT # 5

CALCULATION SHEET

JOB NO. 12501 DAVIS-BESSE, UNIT-1 PRESSURIZER SURGE LINE	CALC. NO. M-8	REV. NO. 01	SHEET NO. 1 OF 1
ORIGINATOR: Siva P. Lingam	DATE: 1-20-85	CHECKED: [signature]	DATE: 1-31-85

1) ST. VENANT'S PRINCIPLE STATES THAT AT A DISTANCE EQUAL TO OR GREATER THAN THE MEMBER WIDTH (WALL THICKNESS IN THE CASE OF A PIPE) THE MEMBER STRESSES ARE UNAFFECTED BY LOAD APPLICATION OR GEOMETRIC DISCONTINUITY. REFERENCING WELDING RESEARCH COUNCIL (WRC) BULLETIN 198, THE INTERFERENCE DISTANCE TO "ANY OTHER WELD OR DISCONTINUITY" IS DEFINED AS $\sqrt{rt}$. SINCE $\sqrt{rt} = 2.208"$ IS GREATER THAN $t = 1.0$, WE EVALUATED THE EFFECT OF ADJACENT DISCONTINUITY OUT TO A DISTANCE OF 2.208"



PLOT OF STRESS INDEX VS. DISTANCE FROM SOURCE

(REF.: BEER & JOHNSON - "MECHANICS OF MATERIALS", PAGE 79)

AT b, $\dfrac{\sigma_{max}}{\sigma_{av}} = 1.027$

AT $\dfrac{b}{2}$, $\dfrac{\sigma_{max}}{\sigma_{av}} = 1.387$

AT $\dfrac{b}{4}$, $\dfrac{\sigma_{max}}{\sigma_{av}} = 2.575$ WHERE b = MEMBER WIDTH

AS CAN BE SEEN, A LINEAR DISTRIBUTION OF STRESS INDEX AWAY FROM THE POINT OF STRESS CONCENTRATION IS VERY CONSERVATIVE.

2) USE OF CLASS-II FORMULA IN CLASS-I ANALYSIS CAN BE JUSTIFIED BY THE FOLLOWING FORMULA:

$$B, C, K \text{ or } i = \frac{\sigma}{S} = \frac{\text{Elastic stress}}{\text{nominal stress}}$$

(Ref: D-101 of Appendix-D)

GPD 2706 Rev 4/82 (ED 69)