Consumers Power Company

General Offices: 1945 West Parnall Road, Jackson, MI 49201 • (517) 788-0550

October 13, 1982

Dennis M Crutchfield, Chief
Operating Reactors Branch No 5
Nuclear Reactor Regulation
US Nuclear Regulatory Commission
Washington, DC 20555

DOCKET 50-255 - LICENSE DPR-20 -
PALISADES PLANT - SEP TOPIC III-6, SEISMIC DESIGN CONSIDERATIONS

The attached enclosure provides a summary of the actions taken to date by Consumers Power Company to address specific NRC concerns as documented in the April 12, 1982 draft of NUREG-0820 regarding eccentric loads and valve functionability in small bore piping. Also summarized are Consumers Power Company plans to perform additional analysis on control valve CV-3003 piping to more accurately assess pipe stress. It is the opinion of Consumers Power Company that this enclosure adequately responds to the above stated NRC concerns.

Kerry A Toner

Kerry A Toner
Senior Licensing Engineer

CC Administrator, Region III, USNRC
NRC Resident Inspector - Palisades

Enclosure

A 028

ENCLOSURE

CONSUMERS POWER COMPANY

PALISADES SEP TOPIC III-6

Evaluation Of Valve Operator Eccentric Loads And
Functionability In Small Bore Piping

This is a summary of the actions taken by Consumers Power Company to resolve NRC concerns about valve operator eccentric loads and valve functionability during seismic conditions in piping 2-inch and smaller.

A list of all Q-listed, 2-inch and smaller air operated control valves and motor operated valves was made up from the Palisades equipment data base. This list was then reduced by eliminating valves in non-critical services and valves without significant operator weight. Critical services were defined to be: 1) valves forming part of the primary coolant system boundary, 2) valves affecting the ability to maintain a stable shutdown condition (i.e., decay heat removal, reactivity control, primary coolant system inventory control), 3) valves required for emergency core cooling system function and 4) valves required for containment isolation. The result was a total of 62 valves to be considered for evaluation of eccentric loads.

The majority of these valves are 1-inch and 2-inch control valves and 2-inch motor operated valves. There are also two 3/4-inch control valves and five 1/2-inch control valves on the list. The five 1/2-inch control valves are primary coolant sample system valves.

The pipe stresses resulting from valve operator eccentric loads were evaluated on a sample basis and by review of some of the work done under IE Bulletin 79-14. The piping systems associated with three 2-inch control valves and one 1-inch control valve were analyzed as part of the 79-14 work. In these analyses the operators were modeled as eccentric masses and deadweight thermal and seismic loadings were included. One of the three 2-inch control valves (PCV-2164) is installed with its operator in the horizontal position and with a support on the operator itself. This is not typical of other control valves at Palisades so no conclusions were drawn from the analysis of this valve. The other two 2-inch control valves (CV-2130 and CV-2136) are installed with their operators in the vertical position and with no supports attached to the operators. Pipe span lengths from these valves to the nearest supports are typical of other 2-inch control valves in the Palisades Plant. The 79-14 analysis showed the piping to be acceptable without addition of supports to the valve operators or any other modifications due to valve operator eccentric loads. Similarly, the analysis of the piping to 1-inch control valve CV-2153 showed the piping stresses to be within FSAR limits without the addition of any supports to the piping or the valve.

Analyses of three additional valves were performed to confirm that 2-inch motor operated valves are adequately supported and to obtain more data on the piping to air operated control valves. Calculation summaries are attached (see Attachment #1). The analyses were done in accordance with FSAR requirements considering pressure, deadweight and seismic loadings. The valves to be analyzed were chosen based on piping spans between the valve and the nearest supports. Maximum span lengths were chosen since this would likely result in the highest pipe stresses. The results show that valve MO-3072 and CV-0438B are supported adequately.

Since MO-3072 is of the same design as the other 2-inch motor operated valves, all of these valves can be considered to be adequately supported. The analysis of CV-0438B along, with the 79-14 analyses of the 2-inch control valves as discussed above, demonstrates adequate support for the 2-inch air operated control valves. The third analysis, on 1-inch control valve CV-3003, was not completed because of lack of information on piping support locations. A section of the piping was modeled as unsupported because support locations were not known. As a result the piping was overstressed. It is expected that the actual support arrangement would result in stresses within allowable limits at the valve. This piping is inaccessible during plant operation, so the actual support locations have not been determined. During the next refueling outage, the supports will be located and CV-3003 pipe stress will be determined. Any overstress will be reported to the NRC.

In summary, analysis of seven Palisades piping systems containing 2-inch motor operated valves and 1-inch and 2-inch control valves has shown no overstresses resulting from valve operator eccentric loads except in one case where there was insufficient information on support locations. These analyses included limiting cases in terms of operator weights and piping span lengths. Based on these results, we believe that there is no pipe stress problem at Palisades associated with valve operator eccentric loads in small bore piping.

The second NRC concern relative to eccentric loads in small bore piping is valve functionability. In this regard, we are enclosing two analysis reports (see Attachments 2 and 3) on stresses in 1-inch and 2-inch control valves due to seismic loadings. In both reports the seismic stresses are quite low, indicating that valve function would not be impaired by accelerations up to 3.0 g's. Based on these reports, we believe that air operated control valves will function during and after a seismic event.

Although functionability of the 2-inch motor operated valves has not been analyzed specifically for this SEP Topic, Consumers Power Company does not expect that such valves will fail to function during a seismic event. This expectation primarily results from the analyses performed on the 1-inch and 2-inch control valves. The results of such analyses provide an indication of procurement and design practices which were generally employed during initial construction and subsequent modification of the Plant. Any further functionability evaluation at this time is unwarranted since functionability as an issue is being evaluated generically by the NRC as part of Unresolved Safety Issue No. A-46, Seismic Qualification of Equipment In Operating Plants. The results of the NRC evaluation will be to establish an explicit set of guidelines that could be used to judge the adequacy of the seismic qualification of mechanical and electrical equipment at all operating plants (ie, equipment required to safely shutdown the plant and equipment whose function is not required for safe shutdown but whose failure could result in adverse conditions which might impair shutdown functions) and to requalify equipment whose seismic qualification is found to be inadequate.

ATTACHMENT #1

Consumers Power Company

PALISADES SEP TOPIC III-6

October 13, 1982

22 Pages

Bechtel Associates Professional Corporation

777 East Eisenhower Parkway
Ann Arbor, Michigan

Mail Address: P.O. Box 1000, Ann Arbor, Michigan 48106

September 16, 1982

Mr. A. K. Smith
Consumers Power Company
1945 West Parnall Road
Jackson, Michigan 49201

Consumers Power Company
Palisades Plant
CPCO-GWO-9561
Bechtel Job 12447-060
ECCENTRIC PIPE LOADS IN
SMALL BORE (2" &
SMALLER) PIPING
File: 0275
82-12447/060-07

Reference: AKR 11-82, dated July 29, 1982

Dear Mr. Smith:

Consumers Power Company requested Bechtel to perform a computer pipe stress analysis on three small bore (2" & smaller) piping systems as part of their SEP program with regard to eccentric loads.

Bechtel's analysis of stress packages (S/N) 318, (S/N) 337 & (S/N) 320 included pressure, dead weight, and seismic effects only, in accordance with Appendix A of the FSAR. Computer program number ME101 was used in the performance of this request and the results are as follows:

1. S/N 318 Valve MO-3072 is determined to be supported adequately to meet acceleration limits and stress allowables in Appendix A of the FSAR. Valve acceleration does not exceed 3g's. Pipe stresses in the vicinity of the valve are acceptable based on assumptions and valve data listed in the calculation summary (attached) and walkdown information related to piping configuration per drawings 12447-033-SP-FSK-CC-7-2, 3, 4, 5, 6, & 7.

2. S/N 337 Valve CV-0438B is adequately supported and stresses meet FSAR allowables. Valve acceleration is less than 3g's. Stresses in the vicinity of the valve are acceptable based on assumptions and valve data listed in the calculation summary (attached) and walkdown information related to piping configuration per drawings 12447-033-SP-HCC-102-1 & SP-HBC-31-1.

3. S/N 320 Valve CV-3003 is located in a piping system which involves ten isometrics. Additionally, a portion of the pipe was not verified during walkdown because it was deemed inaccessible. The model for this analysis includes only a portion of the ten isometrics (piping beyond the model limits would not have a significant effect on pipe stresses near CV-3003), however, the model does include the piping which was not verified. The piping not verified was assumed to be unsupported which is a conservative assumption. The resulting analysis shows calculated stresses in the immediate area of the valve do not meet the FSAR allowable stresses. We note that if the inaccessible portion of the piping is found to be adequately supported, the stress levels are expected to drop sufficiently in the area of valve CV-3003 and associated piping to permit an acceptable condition without the need for any modifications.

If you have any questions, please advise.

Very truly yours,

P. K. Smith
Project Engineer

TP/PKS/lah

Enclosure

CALCULATION SUMMARY COVER SHEET
12447

PROJECT PALISADES JOB NO. 12447-060 DISCIPLINE

SUBJECT CHEMICAL AND VOLUME CONTROL CHARGING PUMP HEADER; ECCENTRIC LOADS VALVE MO3072 FILE NO.

CALC NO. [illegible]

ORIGINATOR M. A. Valente DATE 8-25-82

CHECKER C.E. HERRON DATE 8/31/82 NO. OF SHEETS

RECORD OF ISSUES

NO.	DESCRIPTION	BY	DATE	CHKD	DATE	APPD	DATE
0	INITIAL REVIEW	MAV	8-25-82	CEH	8/31/82	[illegible]	[illegible]
1							
2							
3							
4							
5							

FINAL CALC ☒ COMMITTED PRELIMINARY DESIGN CALC ☐

CALCULATION SUMMARY PREPARATION INSTRUCTIONS

1. ORIGINATOR RESPONSIBILITIES

a. Complete all title blocks with the following information: project, job number (include subjob), discipline, calculation number, revision, originator (include full name of all originators), date originated, total number of sheets comprising the summary (enter on cover sheet only), and pagination of all sheets excluding cover sheet.

b. Complete all summary sheets appropriately to include all assumptions, methods used (e.g., computer program and revision, etc), design input, results, and conclusions.

c. Complete cover sheet revision block with revision, description, and originator's initials and date.

2. CHECKER RESPONSIBILITIES

a. Check the summary against the calculation to verify completeness and adequacy. (Checker cannot be the originator.)

b. Initial and date all pages including the cover sheet.

c. Initial and date cover sheet revision block.

3. REVIEW AND APPROVAL

a. The discipline group supervisor or designee reviews for completeness and initials and dates the cover sheet revision block to indicate concurrence.

BECHTEL

CALCULATION SUMMARY SHEET

12447-060 CALC NO. CI-03'80 REV NO. 0

ORIGINATOR Heidi Valenta DATE 8/25/82 CHECKED CEH DATE 8/31/82

PROJECT PALISADES JOB NO. 12447-060

SUBJECT CHEMICAL AND VOLUME CONTROL CHARGING PUMP HEADER; ECCENTRIC LOADS VALVE M07072 SHEET NO. 1/4

DESIGN INPUT AND ASSUMPTIONS

INPUT

1.	PIPING CLASS	CC HC
2.	MATERIAL SPEC.	SA376-TP316
3.	PIPE NOM. WALL THICKNESS.	*
4.	OPER. TEMP	120
5.	OPER. PRESS.	2200
6.	DESIGN TEMP	250
7.	DESIGN PRESS.	2735
8.	PIPE WEIGHT	*
9.	CONTENT WEIGHT	*
10.	INSULATION WEIGHT	—
11.	TOTAL WEIGHT	*
12.	Sc	12700
13.	Sh	15500
14.	Sy	30,000
15.	PIPING CODE	PER FSAR APPENDIX A
16.		

* SEE ATTACHED SHEET 2

ASSUMPTIONS

SEE ATTACHMENTS I, II & III

PROJECT: PALISADES NUCL[illegible] PLANT — SHEET 2 OF 4

JOB NO. 12447-010 — PLANT DESIGN GROUP

SYSTEM: CHEMICAL + VOLUME CONTROL EXCESS LETDOWN PIPING

CALC. NO. M-CVCP-6 — ISO NO. SP-FSK-CC7-2345 — REV NO. 5,2,2,0,2,5

A. PIPING STRESS ANALYSIS DATA

a. Safety-Related ☐ Non Safety Related ☐ — Preliminary ☐ Final ☐

1) Pipe Program – Revision: ME101 - J2

2) Thermal Condition Analysed: N/A

3) Other Conditions: Weight ☒ Seismic Inertia ☒ Seismic Anchor Movement ☐ Dynamic/Transients ☐

b. Piping Data

	2"	1½"	1"	¾"	½"	2"	1½"	CHECK
1) Piping Classification	CC	CC	CC	CC	CC	HC		✓
2) Material Specification	SA376-TP316	SA376-TP316	SA376-TP316	SA376-TP316	SA376-TP316	SA376-TP304		✓
3) Mod. of Elasticity (x 10^6 psi)	29.2	29.2	29.2	29.2	29.2	29.2		✓
4) Expansion Coef. (in/100 ft)	—	—	—	—	—	—		✓
5) Expansion Coef. (mil. in/in)	—	—	—	—	—	—		✓
6) Pipe OD (in)	2.375	1.9	1.315	1.05	.84	2.375	1.315	✓
7) Pipe Nom. Wall Thickness (in)	.343	.281	.25	.218	.187	.154	.133	✓
8) Operating Temp (°F)	120	120	120	120	120	120	120	✓
9) Operating Pressure (PSI)	2200	2200	2200	2200	2200	2200	2200	✓
10) Design Temperature (°F)	250	250	250	250	250	250	250	✓
11) Design Pressure (PSI)	2735	2735	2735	2735	2735	2735	2735	✓
12) Pipe Weight (lbs/ft)	7.444	4.859	2.844	1.937	1.304	3.653	1.679	✓
13) Content Weight (lbs/ft)	.971	.608	.226	.1284	.074	1.455	.374	✓
14) Insulation Weight (lbs/ft	—	—	—	—	—	—	—	✓
15) Total Weight (lbs/ft)	8.415	5.467	3.07	2.065	1.378	5.109	2.053	✓
16) Sc (PSI)	18700	18700	18700	18700	18700	18700		✓
17) Sh (PSI)	14800	14800	14800	14800	14800	15350		✓
18) Sy (PSI)	30000	30000	30000	30000	30000	30000		

c. INPUT SOURCE DOCUMENTS:

1) Piping specifications: CC ✓
2) Response Spectra Curve Identification: ENVELOPE ME909PCH318. ✓
3) Piping Class Summary: 5935-M-259 Rev 9
4) Piping Class Sheets: 5935-M-260 Rev 7
5) Piping Code: USAS B31.1-67, USAS B31.7-69 & FSAR
6) P & ID:
7) Piping Drawing:
8) Modal Damping Factor: 0.5 % of critical damping
9) Reference Calculation: No. 03310

ACTION	NAME	SIGNATURE	DATE
CALCULATION BY	HEIDI VALENTA	Heidi Valenta	8-25-82
CHECKED BY	CURT HERRON	Curt Herron	8/31/82
APPROVED BY	P.C. GUPTA	Prem C. Gupta	9/2/82

P-254 9/12/74 EVS/GKW/RFD

CALCULATION SUMMARY SHEET

12447

ORIGINATOR H. O. Valentin DATE 8/25/82 CALC NO. 06032-D REV NO. 0

CHECKED CEH DATE 8/31/82

PROJECT PALISADES JOB NO. 12447-001

SUBJECT CHEMICAL AND VOLUME CONTROL SHEET NO. 3/4

CHARGING PUMP HEADER; ECCENTRIC LOADS VALVE MO3072

RESULTS AND CONCLUSIONS

RESULTS

ALL STRESSES MEET CODE ALLOWABLES AS DEFINED IN B31.1 69' CODE.

VALVE ACCELERATION IS $< 3g$ IN ALL DIRECTIONS FOR SSE.

NODE POINT	STRESS COMBINATION (PSI)		ALLOWABLE STRESS (PSI)
178	PRESS + WT.	9158	15350
181	PRESS + WT + OBE	15603	18420
—	THERMAL		—
181	PRESS + WT + SSE	23158	33000

CONCLUSIONS

VALVE MO3072 IS SUPPORTED ADEQUATELY TO TO MEET ACCELERATION LIMITS AND STRESS ALLOWABLES FSAR, APPENDIX A

IT IS SUGGESTED THAT SUPPORT H4.7, LINE HC-26-Y2, ISO. SP-FSK-CCT-4 IS VERIFIED BY THE FIELD TO ACT IN THE NORTH-SOUTH DIRECTION. IF NOT, PLEASE PROVIDE A SHIM TO DECREASE CLEARANCE TO 3/16" OR LESS. HOWEVER, IT DOES NOT AFFECT THE STRESS IN THE VICINITY OF THE VALVE MO-3072

CALCULATION SUMMARY SHEET

12447

ORIGINATOR Neil D. Valentin DATE 8/25/82 CHECKED CEH DATE 8/31/82

PROJECT DIABLO CANYON JOB NO. 12447-01.A

SUBJECT CHEMICAL AND VOLUME CONTROL SHEET NO. 4/4

CHARGING PUMP HEADER; ECCENTRIC LOADS VALVE M03072

METHODS USED

PROGRAM ME101 VERSION J2 WAS IMPLEMENTED FOR THE ANALYSIS. DEADWEIGHT AND SEISMIC ANALYSIS WERE PERFORMED USING AN ENVELOPE OF AUXILIARY BUILDING ELEVATIONS 829+0, 601+0, 610+0 AND CONTAINMENT SHELL AT 608+9 FOR THE SEISMIC SPECTRA.

VALVE INFORMATION WAS PROVIDED BY VELAN ENGINEERING. FOR VALVE M0-3072.

SUPPORTS WERE MODELED AS PER FIELD WALK-DOWN INFORMATION.

(ATTACHMENT I)

Telephone call

ROUTE _____

BY HEIDI VALENTA OF BECHTEL

TO KUBIS CIT RAYMOND OF VELAN ENGR.

DATE 8-6 19 82 TIME _____

SUBJECT VALVE M0-307Z S/N 318 JOB NO. 12447-060

CALC. # 060120

#514-748-7743 X311

THE FOLLOWING INFORMATION WAS RECEIVED FROM MR. KUBIS CIT RAYMOND REGARDING VALVE

- BODY WT. 75#
- OPER. WT. 195#

COMBINED C.G. 12.125" ON VERTICAL ℄ OF OPERATOR FROM ℄ OF VALVE.

- VALVE BODY C.G. 4.25" FROM ℄ OF VALVE.

AA0-522

BECHTEL

CALCULATION SHEET
(ATTACHMENT II)

CALC. NO. [illegible] REV. NO. 0

ORIGINATOR HEIDI VALENTA DATE 8-25-82 CHECKED CEA DATE 9/1/82

PROJECT PALISADES JOB NO. 12447-060

SUBJECT VALVES MO-3072 SHEET NO. 31/31

S/N 318, VALVE MO-3072

ISOMETRIC:

THE FOLLOWING DRAWINGS WERE SUPPLIED:

VELAN ENGINEERING COMPANIES
BODY: P-3345-6
OPERATOR: PHILADELPHIA GEAR CORP. - LIMITORQUE VALVE CONTROL
02-405-0085-4
9504173*MI-N(A) SH.794-1

THE FOLLOWING INFORMATION WAS OBTAINED FROM MR. KUBIS CIT RAYMOND, VELAN ENGINEERING LTD, MONTREAL ON 8-6-82.

VALVE BODY WT. 75#
OPERATOR WT. 195#

COMBINED C.G. (BODY + OPERATOR) 12.125" ON ℄ OF OPERATOR FROM ℄ OF VALVE.

C.G. VALVE 4.25" FROM ℄ OF VALVE

BECHTEL

CALCULATION SHEET
(ATTACHMENT III)

CALC. NO. 2-03-20 REV. NO. 0

ORIGINATOR H. A. Vogt DATE 9/25/82 CHECKED _____ DATE _____

PROJECT PALISADES JOB NO. 12447-040

SUBJECT _____ SHEET NO. 29/31

ACCUMETRICS: FOR SUPPORTS

SP-FSK-CC7-2 ALL SUPPORTS ACTING AS INSTALLED

SP-FSK-CC7-3

D.P. 89 H3.13 NOT A RESTRAINT

D.P. 94 H3.11 NOT AN AXIAL — GAP > 3/16" IF LIGHTWT. U-BOLT USED.

D.P. 196 H3.8 NOT A RESTRAINT

SP-FSK-CC7-4

D.P. 178 H4.7 INSURE LATERAL CLEARANCE < 3/16"

SP-FSK-CC7-5

D.P. 42/234 H5.2 NOT A RESTRAINT

SP-FSK-CC7-6 ALL SUPPORTS ACTING AS INSTALLED

SP-FSK-CC7-7 ALL SUPPORTS ACTING AS INSTALLED

CALCULATION SUMMARY COVER SHEET

12447

PROJECT PALISADES JOB NO. 12447-060 DISCIPLINE STAFF STRESS

SUBJECT ECCENTRIC PIPE LOADS IN SMALL BORE PIPING — VALVE CV04323 FILE NO.

CALC NO. 0602370

ORIGINATOR Heidi Valentas DATE 8-19-82

CHECKER CURT HERRON DATE 9/1/82 NO. OF SHEETS 4

RECORD OF ISSUES

NO.	DESCRIPTION	BY	DATE	CHKD	DATE	APPD	DATE
0	INITIAL REVIEW	[illegible]	8-19-82	CEH	9/1/82	PC	9/2/82
△							
△							
△							
△							
△							

FINAL CALC ☒ COMMITTED PRELIMINARY DESIGN CALC ☐

CALCULATION SUMMARY PREPARATION INSTRUCTIONS

1. ORIGINATOR RESPONSIBILITIES

a. Complete all title blocks with the following information: project, job number (include subjob), discipline. calculation number, revision, originator (include full name of all originators), date originated, total number of sheets comprising the summary (enter on cover sheet only), and pagination of all sheets excluding cover sheet.

b. Complete all summary sheets appropriately to include all assumptions, methods used (e.g., computer program and revision, etc), design input, results, and conclusions.

c. Complete cover sheet revision block with revision, description, and originator's initials and date.

2. CHECKER RESPONSIBILITIES

a. Check the summary against the calculation to verify completeness and adequacy. (Checker cannot be the originator.)

b. Initial and date all pages including the cover sheet.

c. Initial and date cover sheet revision block.

3. REVIEW AND APPROVAL

a. The discipline group supervisor or designee reviews for completeness and initials and dates the cover sheet revision block to indicate concurrence.

CALCULATION SUMMARY SHEET

12447

ORIGINATOR Heidi Valentin DATE 2-19-92 CALC NO. 06-0227-D REV NO. 0

CHECKED CEH DATE 9/11/92

PROJECT PALISADES JOB NO. 12447-060

SUBJECT ECCENTRIC PIPE LOADS IN SMALL BORE PIPING - VALVE CV0432B SHEET NO. 1 of 4

DESIGN INPUT AND ASSUMPTIONS

INPUT

1.	PIPING CLASS	HCC / HBC
2.	MATERIAL SPEC.	SA312 TP304L / SA106-B
3.	PIPE NOM. WALL THICKNESS	.154 / .218
4.	OPER. TEMP	90 / 90
5.	OPER. PRESS.	10 / 10
6.	DESIGN TEMP	110 / 110
7.	DESIGN PRESS.	16 / 16
8.	PIPE WEIGHT	3.653 / 5.022
9.	CONTENT WEIGHT	1.455 / 1.28
10.	INSULATION WEIGHT	N/A
11.	TOTAL WEIGHT	5.108 / 6.302
12.	Sc	13300 / 15000
13.	Sh	13.100 / 15000
14.	Sy	25,000 / 35,000
15.	PIPING CODE	PER FSAR APPENDIX A
16.		

ASSUMPTIONS

SEE ATTACHMENTS I & II

CALCULATION SUMMARY SHEET

12447

ORIGINATOR H. N. Vaidya DATE 2-1982 CALC NO. D6003370 REV NO. 0

PROJECT PALISADES JOB NO. 12447-060 CHECKED CEH DATE 9/1/82

SUBJECT ECCENTRIC PIPE LOADS IN SMALL BORE PIPING — VALVE CV0432B SHEET NO. 2 OF 4

RESULTS AND CONCLUSIONS

D.P. 5-245A

RESULTS

THIS ANALYSIS REFLECTS ACCEPTABLE STRESSES UNDER THE WEIGHT AND SEISMIC LOADCASE UPSET AND FAULTED. SEE SHEET 3 FOR MORE INFORMATION REGARDING INACCESSIBLE PIPING. THE SYSTEM MAX. STRESS VALUES AND LOCATIONS ARE AS FOLLOWS:

NODE POINT	STRESS COMBINATION (PSI)		ALLOWABLE STRESS (PSI)
245A	PRESS + WT.	5039	15,000
195 THRU 195 TERM	PRESS + WT + OBE	14220	18,000
—	THERMAL	—	—
195 TERM	PRESS + WT + SSE	27352	32,500

CONCLUSIONS

THE PIPING AT AND AROUND VALVE CV0432B IS ADEQUATELY SUPPORTED AND STRESSES MEET CODE ALLOWABLES AND ACCELERATION LIMITS AS SPECIFIED IN FSAR APPENDIX A SEE SHEETS 3 + 4 FOR MORE INFORMATION REGARDING INACCESSIBLE PIPING.

CALCULATION SUMMARY SHEET

12447

ORIGINATOR H. S. Valencia DATE 2/19/82 CALC NO. [illegible] REV NO. 0

PROJECT PALISADES CHECKED CEH DATE 9/1/82

SUBJECT ECCENTRIC PIPE LOADS IN SMALL BORE PIPING — VALVE CV0438B JOB NO. 12447-[illegible] SHEET NO. 3 OF 4

RESULTS AND CONCLUSIONS

D.P. 250-309

RESULTS

THE PIPING IN THIS INACESSIBLE REGION IS HIGHLY OVER-STRESSED DUE TO THE FACT THAT THERE EXIST NO SUPPORT INFORMATION FOR THIS AREA. AND WAS MODELED AS IF NO SUPPORTS EXISTED. THIS IS A HIGHLY CONSERVATIVE ASSUMPTION CONSIDERING THE FACT THAT THE PIPING WAS FIELD SUPPORTED

RESULTS SHOW, THOUGH, THAT THE PIPING AT THE VALVE CV0438B AND CONNECTING MEET CODE STRESS ALLOWABLES AND IS THEREFORE PROPERLY SUPPORTED IN THE AREA OF CONCLUSION — SEE SHEET 4.

NODE POINT	STRESS COMBINATION (PSI)		ALLOWABLE STRESS (PSI)
295	PRESS + WT.	63,988	15,000
30A	PRESS+WT+OBE	109,712	18,000
—	THERMAL	—	—
30A	PRESS+WT+SSE	155,663	32.500

CONCLUSIONS

SEE METHODS USED PAGE 4

CALCULATION SUMMARY SHEET

12447

ORIGINATOR H. D. Walter DATE 8/19/82 CALC NO. 01-0438-D REV NO. 0

CHECKED CEH DATE 9/1/82

PROJECT PRICE-ANDERSON JOB NO. 12447-01-9

SUBJECT SEISMIC PIPE LOADS IN SMALL BORE PIPING - VALVE CV0438B SHEET NO. 4 OF 4

METHODS USED

DUE TO INSUFFICIENT FIELD INFORMATION BETWEEN SUPPORT H1.17 AT ELEVATION 624'-10" AND TANK T-103 AT ELEVATION 620'-1½", AN ASSUMPTION WAS MADE AS TO THE FIELD PIPE ROUTING BETWEEN THESE TWO POINTS. THE RESULT WAS APPROXIMATELY 90'-0" OF UNSUPPORTED PIPING IN THE Y, V, AND Z DIRECTIONS, WHICH IN TURN IMPOSED CONSIDERABLE MOMENT AND LOADING ON SUPPORTS H1.17, H1.14 AND H1.13 LOCATED JUST BELOW THE INACCESSIBLE REGION. THEREFORE STRESS RESULTS WERE SEGREGATED INTO TWO SECTIONS 1) PIPING FROM TANK T-103 TO THE LAST 3 SUPPORTS OF THE ACCESSIBLE REGION AND 2) ACCESSIBLE PIPING UP TO THE 3 SUPPORTS PRIOR TO THE INACCESSIBLE AREA. VALVE CV-0438B IS SUFFICIENTLY INSULATED FROM THE EFFECTS OF THE UNSUPPORTED, INACCESSIBLE PIPING. ACCELERATION OF VALVE CV-0438B IS LESS THAN 3g. IN EACH DIRECTION AND SEISMIC STRESSES ARE BELOW THE ALLOWABLE AS SPECIFIED BY B31.1 '69.

MULTIPLE RESPONSE SPECTRA ANALYSIS WAS USED RATHER THAN ENVELOPED SEISMIC SPECTRA. THIS LESS CONSERVATIVE METHOD WAS USED IN AN EFFORT TO LACE THE SEISMIC EFFECT FROM THE 90' OF UNSUPPORTED PIPING ON THE REST OF THE SYSTEM.

BECHTEL

CALCULATION SHEET (ATTACHMENT I)

CALC. NO. 0603370 REV. NO.

ORIGINATOR HEDI VALENTA DATE 8-11-82 CHECKED CEH DATE 9/1/82

PROJECT PALISADES JOB NO. 12447-060

SUBJECT VALVES CV-0438B SHEET NO. 17 of 17

S/N 337, VALVE CV-0438B

ISOMETRIC: SP-HBC-31-1 REV. 6

THE FOLLOWING DRAWINGS WERE SUPPLIED:

HENRY VOGT MACHINE CO.
BODY: M-48500
OPERATOR: FISHER GOUERNOR DWG. AK5819
VOGT CRO # 157907

THE FOLLOWING INFORMATION WAS OBTAINED FROM MR. SAM RADERER, ENGINEERING MANAGER, HENRY VOGT CO. ON 8-6-82.

VALVE BODY WT. 21.9#
OPERATOR WT. 149.6#

COMBINED C.G. (BODY + OPERATOR) 20.69" ON VERTICAL ℄ OF OPERATOR FROM ℄ OF VALVE.

C.G. VALVE 4.315" FROM ℄ OF VALVE

(ATTACHMENT II)

Telephone call

ROUTE

BY HEIDI VALENTA OF BECHTEL

TO SAM RADERER OF HENRY VOGT CO.

DATE 8-6 19 82 TIME

SUBJECT VALVE C.W.0438B S/N 337 JOB NO. 12447-060

CALC # 060237Q

502-634-1511

THE FOLLOWING INFORMATION WAS RECEIVED FROM MR. SAM RADERER REGARDING VALVE MO-3072.

- BODY WT. 21.9#
- OPER. WT. 149.6#
- COMBINED C.G. 20.69" ON VERTICAL ℄ OF OPERATOR FROM ℄ OF VALVE.
- VALVE BODY C.G. 4.315" FROM ℄ OF VALVE.

CALCULATION SUMMARY COVER SHEET

12447

PROJECT PALISADES JOB NO. 12447-060 DISCIPLINE STPD

SUBJECT SAFETY INJECTION FILL & DRAIN ECCENTRIC LOAD VALVE CV3003 FILE NO.

CALC NO. 0603209

ORIGINATOR Heidi Valenta DATE 9-14-82

CHECKER CURT HERRON DATE 9/15/82 NO. OF SHEETS 3

RECORD OF ISSUES

NO.	DESCRIPTION	BY	DATE	CHKD	DATE	APPD	DATE
0	PRELIMINARY AS-BUILT ANALYSIS	HMV	9/14/82	CEH	9/15/82	PCG	9/15/82
1							
2							
3							
4							
5							

FINAL CALC ☒ COMMITTED PRELIMINARY DESIGN CALC ☐

CALCULATION SUMMARY PREPARATION INSTRUCTIONS

1. ORIGINATOR RESPONSIBILITIES

a. Complete all title blocks with the following information: project, job number (include subjob), discipline, calculation number, revision, originator (include full name of all originators), date originated, total number of sheets comprising the summary (enter on cover sheet only), and pagination of all sheets excluding cover sheet.

b. Complete all summary sheets appropriately to include all assumptions, methods used (e.g., computer program and revision, etc), design input, results, and conclusions.

c. Complete cover sheet revision block with revision, description, and originator's initials and date.

2. CHECKER RESPONSIBILITIES

a. Check the summary against the calculation to verify completeness and adequacy. (Checker cannot be the originator.)

b. Initial and date all pages including the cover sheet.

c. Initial and date cover sheet revision block.

3. REVIEW AND APPROVAL

a. The discipline group supervisor or designee reviews for completeness and initials and dates the cover sheet revision block to indicate concurrence.

CALCULATION SUMMARY SHEET

12447

ORIGINATOR Heidi Valente DATE 9/14/82 CALC NO. 0603209 REV NO. 0

CHECKED CEH DATE 9/15/82

PROJECT PALISADES JOB NO. 12447-060

SUBJECT SAFETY INJECTION FILL + DRAIN SHEET NO. 1 OF 3

ECCENTRIC LOADS VALVE CV3003

DESIGN INPUT AND ASSUMPTIONS

INPUT

1.	PIPING CLASS	GC
2.	MATERIAL SPEC.	SA376-TP304
3.	PIPE NOM. WALL THICKNESS	2" 1" 154, 133
4.	OPER. TEMP	—
5.	OPER. PRESS.	200 (PEAK)
6.	DESIGN TEMP	÷
7.	DESIGN PRESS.	250
8.	PIPE WEIGHT	3.653, 1.679
9.	CONTENT WEIGHT	1.455, .374
10.	INSULATION WEIGHT	—
11.	TOTAL WEIGHT	5.108, 2.053
12.	Sc	18700
13.	Sh	15600
14.	Sy	25000
15.	PIPING CODE B31.1 '73	PER FSAR APPENDIX A
16.		

ASSUMPTIONS

SEE ATTACHMENT I

CALCULATION SUMMARY SHEET

12447

ORIGINATOR H. A. Valenta DATE 9/14/82 CALC NO. 0603209 REV NO. 0

CHECKED CEH DATE 9/15/82

PROJECT PALISADES JOB NO. 12447-060

SUBJECT SAFETY INJECTION FILL + DRAIN, ECCENTRIC LOADS VALVE CV3003 SHEET NO. 2 OF 3

RESULTS AND CONCLUSIONS

RESULTS

AS INDICATED BELOW THIS SYSTEM IS HIGHLY OVERSTRESSED IN WEIGHT AND SEISMIC. THE HIGH STRESS IS DUE IN PART TO THE LACK OF FIELD INFORMATION ON PIPING BETWEEN FLOOR PENETRATION @ 649+0 AND TANK 82-D.

NODE POINT	STRESS COMBINATION (PSI)		ALLOWABLE STRESS (PSI)	
391	P(22) + WT.	30,371	15,600	✓
391	P(32) + WT + OBE	49,426	18,720	✓
—	THERMAL	—	—	
391	PRESS + WT + SSE	68,481	27,500	✓

CONCLUSIONS

IF THE INACCESSIBLE PORTION OF THE PIPING BETWEEN THE TANK AND VALVE CV-3003 IS FOUND TO BE ADEQUATELY SUPPORTED, THE STRESS LEVELS AND SUPPORT LOADS ARE EXPECTED TO DROP.

AS A RESULT THE CONTROL VALVE CV-3003 AS WELL AS PIPING AROUND IT MAY BE SEISMICALLY ACCEPTABLE WITHOUT THE NEED FOR ANY NEW SUPPORTS.

CALCULATION SUMMARY SHEET

12447

ORIGINATOR Heidi Hulett DATE 9-14-82 CALC NO. 6605J04 REV NO. 0

CHECKED CEH DATE 9/15/82

PROJECT PALISADES JOB NO. 12447-060

SUBJECT CAFETY INJECTION FLOW DIAGRAM SHEET NO. 3 OF 7

ECCENTRIC LOADS VALVE CV3003

METHODS USED

ASSUMING PIPE TO BE UNSUPPORTED BETWEEN FLOOR @649+0 AND TANK 82-D GIVES VERY UNREALISTIC LOADS AND STRESSES IN THIS AREA. ALTHOUGH, ACTUAL LOCATION OF SUPPORT IN THIS AREA IS UNKNOWN.

THE ORIGINAL STRESS MODEL CONSISTED OF 10 ISOMETRICS. THE MODEL USED FOR THIS ANALYSIS IS ONLY A PORTION OF THE ORIGINAL. PIPING BEYOND THE LIMITS OF THIS MODEL WAS NOT INCLUDED DUE TO THE FACT THAT THE EFFECT BEYOND THIS POINT UPON THE VALVE CV3003 IN QUESTION WOULD NOT BE SIGNIFICANT ENOUGH TO WARRANT THE MODELING OF THE 10 ENTIRE ISOMETRICS.

AN ENVELOPE SPECTRA FOR ELEVATIONS 616'-4 5/8" TO 718'-10" WAS USED FOR THE ENTIRE PIPING (THE MAJORITY OF THE PIPING IS AT ELEV. 616'-0)

(ATTACHMENT I)

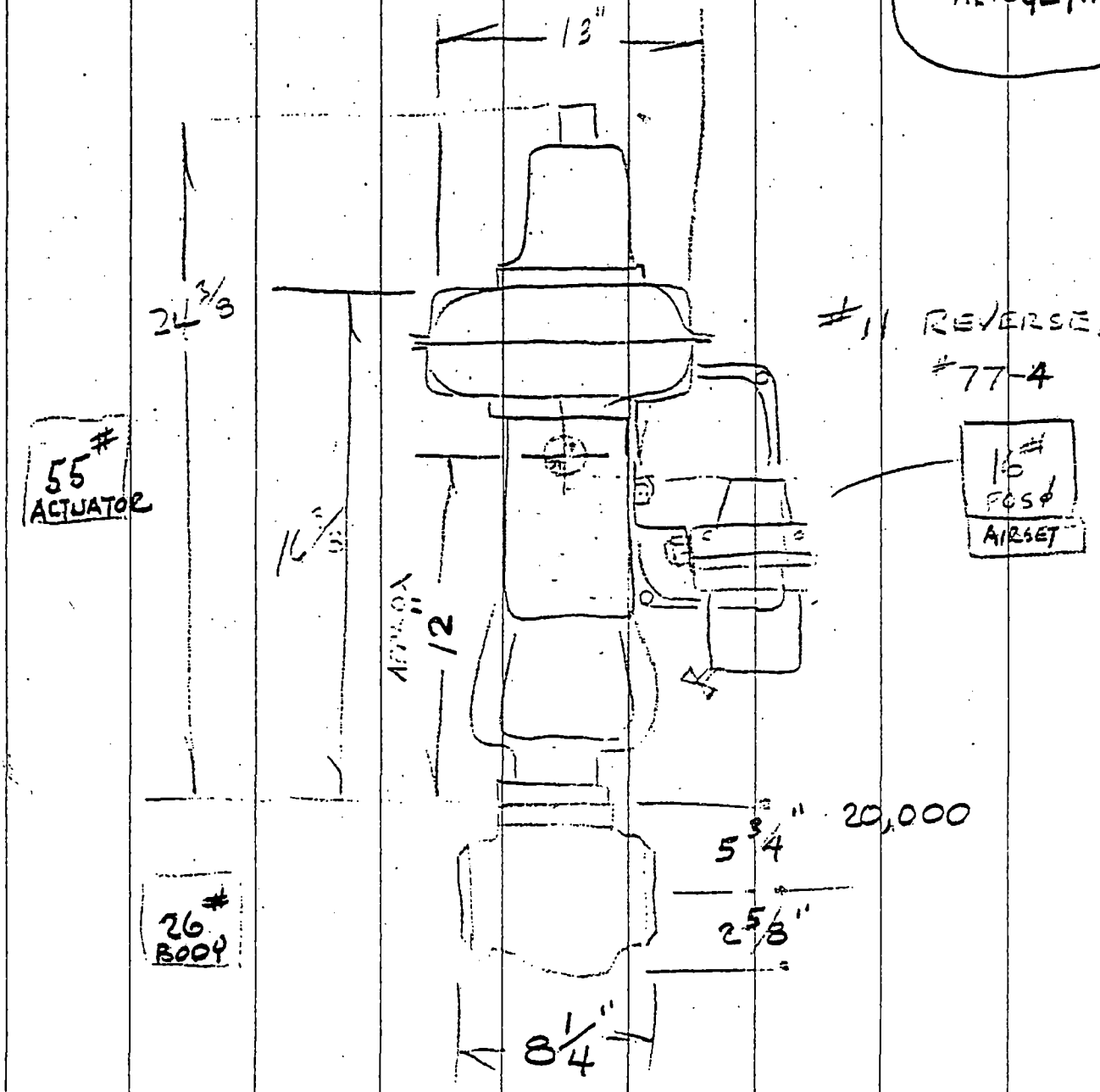
S/N

8-19-82

CV-3003

PALISADES
12447

19 AUGUST 81
16
55
26
~97#
ALTOGETHER



ATTACHMENT #2

Consumers Power Company

PALISADES SEP TOPIC III-6

October 13, 1982

16 Pages

FORM 4-R-1 - 2M - 2-70 - VOGT

HENRY Vogt MACHINE CO.
P.O. Box 1918 Louisville, Ky. 40201
502-634-9411
ENGINEERING DEPARTMENT

CRO 157907

COMPANY Bechtel Corporation JOB NO. 5935-M336-AC

ADDRESS P. O. Box 3965, San Francisco, California

SUBJECT Seismic Analysis - Bechtel Item 15.1

BY G. A. Jolly DATE Oct. 4, 1973 CHECKED BY E.P. Becker DATE 10-8-73

Valve per Vogt Dwg. M-48500
Bechtel Item 15.1
Job No. 5935-M336-AC

EQUIPMENT DESCRIPTION

Vogt valve per Dwg. M-48500 is a 2" - 600# gate valve made from carbon steel (A181-Gr.2) which utilizes a Fisher Control Type 473-1-5 spring return, size 40 side mounted cylinder handwheel and associated equipment for operation. The total weight of the Fisher cylinder operator is 79#. The approximate weight of the valve/operator combination is 110#.

ASSUMPTIONS AND PROCEDURES

1. Two seismic considerations are covered by the calculations as follows:

   A. A complete seismic analysis of the valve operator when operating at a 3g horizontal and vertical acceleration. (Fisher analysis is attached - See Dave Howell's analysis.)

   B. An analysis of the valve bonnet as a result of the increased load due to 3g acceleration forces of the valve actuator. (See Vogt calculation attached - G. A. Jolly)

2. A Natural Frequency Calculation was conducted on valve.

3. Calculations are based on valve installed in horizontal pipe run with valve stem vertical.

CONCLUSIONS

Calculations indicate that valve and operator should operate satisfactorily during and after a 3g seismic load.

FISHER CONTROLS COMPANY

MARSHALLTOWN, IOWA 50158

AUTOMATIC CONTROL EQUIPMENT
SINCE 1880

September 27, 1973

M3360 SN107

Seismic Certification for:
Agent Order: 50-2088
Customer Order: C-40934

Serial No.	Tag No.
5655387	CV-0437A
5655388	CV-0437B
5655389	CV-0438A
5655390	CV-0438B

Enclosed is the seismic calculations for a Size 40 Type 473-1-5 piston actuator. The equipment is considered to be able to withstand the specific seismic disturbance if the calculated stress does not exceed 50% of the tensile stress of cast iron and does not exceed the stress at room temperature of the yoke locknut.

Yoke - Cast Iron, ASTM A48-Class 30
50% of the Tensile Stress = 15000 PSI

Yoke Locknut - Steel, ASTM A235 - Class A
Approximate Yield in Shear = 20000 PSI

Also enclosed is a seismic test of an Asco solenoid performed by the Research Department. This is in compliance with the specifications levied on accessories.

Dave Howells
Project Engineer

DH:dn

encl.

11052705

HENRY VOGT MACHINE CO.

SEISMIC ANALYSIS DAVE HOWELLS

AGENT ORDER: 50-2088
CUSTOMER ORDER: C-40934
SERIAL NUMBER: 5655387-390

SIZE 40 TYPE 473-1-5 PISTON ACTUATOR

I. DETERMINATION OF RESULTANT STRESSES

VALVE INSTALLED IN A HORIZONTAL PIPE RUN WITH THE VALVE STEM VERTICAL

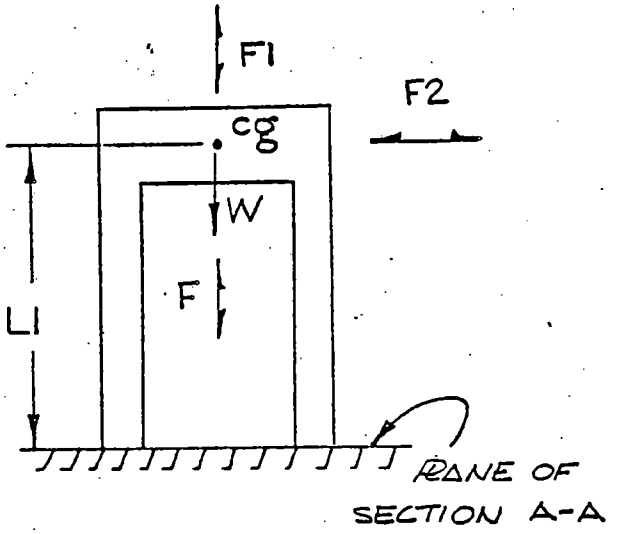
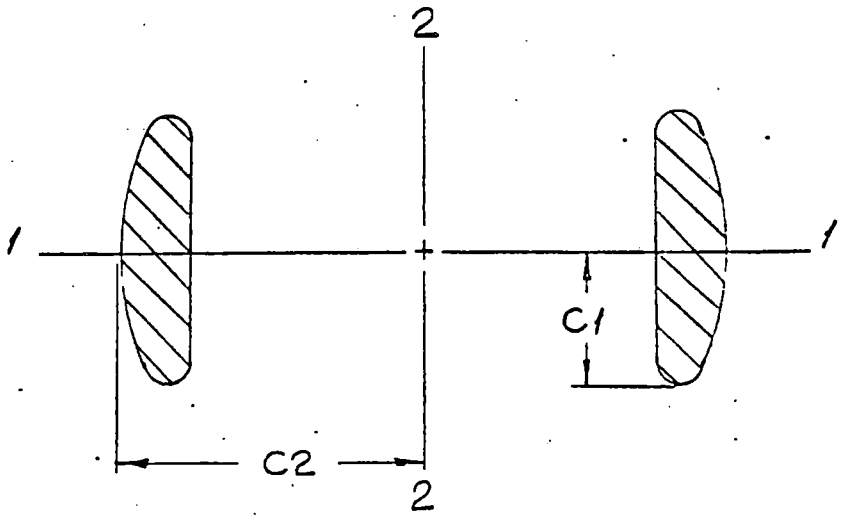


FIG 1



SECTION A-A

FIG 2

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M2360-4M107

- TERMS

C1 - DISTANCE FROM NEUTRAL AXIS 1-1 TO OUTERMOST FIBER (in)
C2 - DISTANCE FROM NEUTRAL AXIS 2-2 TO OUTERMOST FIBER (in)
F - ACTUATOR OUTPUT FORCE (lbs)
F1 - FORCE DUE TO VERTICAL SEISMIC ACCELERATION (lbs)
F2 - FORCE DUE TO HORIZONTAL SEISMIC ACCELERATION (lbs)
G1 - VERTICAL SEISMIC ACCELERATION (g's)
G2 - HORIZONTAL SEISMIC ACCELERATION (g's)
I1 - MOMENT OF INERTIA ABOUT AXIS 1-1 (in^4)
I2 - MOMENT OF INERTIA ABOUT AXIS 22 (in^4)
L1 - DISTANCE FROM SECTION A-A TO CG OF ACTUATOR (in)
M - MOMENT ABOUT SECTION A-A DUE TO LATERIAL LOAD ON ACTUATOR (in
S1 - YOKE LEG STRESS DUE TO VERTICAL LOADS (psi)
S2 - TOTAL YOKE LEG STRESS

$F1 = (G1)W = 3 \times 79 = 237^{\#}$
$F2 = (G2)W = 3 \times 79 = 237^{\#}$

W → wgt of actuator

STRESS DUE TO VERTICAL LOADS, the greater of:

1)* $S1 = \dfrac{F + F1 - W}{A}$ → stress when valve plug is seated

OR

2)* $S1 = \dfrac{F1 + W}{A}$ → stress when valve plug is open

where A is the cross sectional area of yoke legs

$F = (\text{AIR to CYL})(\text{PISTON AREA}) = 100 \times 28.25 = 2825^{\#}$

1) $S1 = \dfrac{2825 + 237 - 79}{2.4} = 1245$ PSI

2) $S1 = \dfrac{2825 + 79}{2.4} = 1210$ PSI

∴ STRESS DUE TO VERTICAL LOADS = 1245 PSI

BENDING STRESS DUE HORIZONTAL SEISMIC LOAD:

$S = \dfrac{MC}{I}$

1052707

HENRY VOGT MACHINE CO

SEISMIC ANALYSIS DAVE HOWELLS

M3310 M1017

$M = (F2)(L1) = 237 \times 12.875 = 3055$ in-lbs

$\frac{c}{I}$ the greater of $*\frac{C1}{I1}$ OR $\frac{C2}{I2}$

$\frac{1.125}{1.19}$ OR $\frac{2.9375}{3.4}$

$*.95$ OR $.86$

$S = \frac{M\,c}{I} = (3055)(.95) = \underline{2910}$ PSI BENDING STRESS DUE TO HORIZONTAL SEISMIC LOAD

TOTAL YOKE LEG STRESS:

$S2 = S1 + \frac{(F2)(L1)C1}{I1} = 1245 + \frac{(237)(12.875)(1.125)}{1.19} = \underline{4155}$ PSI

SUMMARY OF STRESSES

- ✓ STRESS DUE TO VERTICAL LOADS ... 1245 PSI
- ✓ BENDING STRESSES DUE TO HORIZONTAL SEISMIC LOADS ..... 2910 PSI
- ✓ TOTAL YOKE LEG STRESS ..... 4155 PSI

CALCULATIONS PERFORMED BY: Dave Howells PROJ. ENGR.

DATE: 27 Sept 73

1105708

FISHER CONTROLS COMPANY
MARSHALLTOWN, IOWA

Project 73AR23

PROB. 1529
REPORT 14
PAGE 1
DATE 5-9-73

LABORATORY REPORT

VIBRATION TEST OF ASCO SOLENOID VALVE

ITEM Solenoid Valve TYPE 3-Way Universal
MANUFACTURER Automatic Switch Company DESIGN
SIZE 1/4" NPT DWG
SPECIAL IDENTIFICATION Catalog No. HT 8320A107 - SN 95872S
an HTX 8320 is the same as the unit tested, the X designates an explosion proof housing and does not change the seismic parameters

PURPOSE: Vibration tests were conducted to generate data for customers who require seismic information.

TEST PROCEDURE: See attached copy of Test Procedure.

TYPE OF MOUNTING: The assembly was nipple mounted thru a bracket mounted to the shaker table.

ACCELEROMETER LOCATION: The accelerometer was mounted on the shaker table.

RESULTS: DIRECTION 1 - No Malfunction

DIRECTION 2 - No Malfunction

DIRECTION 3 - No Malfunction

1105209

NOTE: See Data Sheets 1 and 2 for illustration of directions.

CONCLUSIONS AND RECOMMENDATIONS: The ASCO Solenoid Valve performed satisfactorily and meets or exceeds the specification outlined in the Test Procedure.

J. M. Wilkinson

James M. Wilkinson
Research Department

M336 5107

HENRY VOGT MACHINE CO. 1 OF
GUY A JOLLY

VOGT CRO 157907
RECHTEL ORDER 5935-M336-AC

DETERMINATION OF RESULTANT STRESSES IN VALVE BONNET BOLTING AS A RESULT OF 3G SEISMIC ACCELERATION.

OPERATING PRESS. (MAX) = 1,440 psig
FLANGE MATERIAL - A181 GR 2.
BOLTING MATERIAL - A193 B7

ALLOWABLE BOLT STRESS - 25,000 PSIG

GASKET DETAILS - 2 3/16" I.D. x 2 15/16" O.D
SPIRAL WOUND

FACING DETAILS - GASKET RECESSED AND BOLTED UP METAL TO METAL WITH A CONTROLLED COMPRESSION OF .030 INCHES.

*GASKET FACTORS
N = .3125 (CONTACT)
b = .15625
Y = 4500
m = 3.00

1052710

(*TAYLOR FORGE BULLETIN #502, MODERN FLANGE D
MIN BOLT LOAD FOR GASKET SEAT - H_{GY}
$H_{GY} = b\pi GY = .15625 \times \pi \times 2.5625 \times 4,500 = 5,660\#$
TOTAL JOINT-CONTACT SURFACE COMPRESSION LOAD = H_{GP}
$H_{GP} = 2b\pi GmP = 2 \times .15625 \times \pi \times 2.5625 \times 3 \times 1,440 = 108$
TOTAL HYDRO LOAD = H
$H = \frac{G^2 \pi P}{2} = \frac{2.5625 \times \pi \times 1,440}{2} = 7426\#$

M336 Ph107

$H_{GP} + H = 18{,}294\#$ REQ. BOLT LOAD (TOTAL)

$A_B = 4 \times .202 = .808$ sq inches A_B = AREA BOLTING

BONNET BOLTING STRESS DUE TO PRESSURE LOADING THE GREATER OF:

$$S_P = \frac{H_{GP} + H}{A_B} \quad \text{OR} \quad S_P = \frac{H_{GY}}{A_B}$$

$$S_P = \frac{18294\#}{.808} = 22{,}641 \text{ psi}$$

SEISMIC LOADS ON BOLTING

A. F_V = VERTICLE LOAD ON BOLTS DUE TO 3g SEISMIC (VERTICLE) ACCELERATION.

$$F_V = (G_1)\, W_V = 3 \times (90) = 270\#$$

W_V = WT OF CYLINDER & BONNET OF VALVE PER M-48500

STRESS ON BOLTS DUE TO THIS LOAD (VERTICLE SEISMIC)

$$S_V = \frac{270\#}{.808} = 334 \text{ psi}$$

1052711

B. F_H = HORIZONTAL LOAD ON CYLINDER & BONNET DUE TO 3g SEISMIC (HORIZONTAL) ACCELERATION. THIS FORCE ACTS THROUGH CENTER OF GRAVITY OF CYLINDER & BONNET

$F_H = (G_s) W_v = 3 \times (90) = 270\#$

THIS FORCE (F_H) ACTS AS A MOMENT ON THE BONNET BOLTING. A MOMENT BALANCE EQUATION HAS TO BE SET UP TO DETERMINE THE ACTUAL FORCES IN THE BOLTING TO RESIST THIS MOMENT.

ASSUMPTIONS:

a. THE PIVOT POINT IS CONSIDERED TO BE THE OUTER EDGE OF THE BOLTED BONNET FLANGE. (SEE SKETCH #2)

b. THE BOLTING LOADS ARE PROPORTIONAL TO THE DISTANCES FROM THE PIVOT POINT. (SEE SKETCH #2) THE PIVOT PT IS AT OUTSIDE EDGE OF BONNET FLANGE (ASSUMED)

$\therefore \frac{F_1}{F_2} = \frac{d_1}{d_2}$ WHERE F_1 & F_2 ARE THE RESISTANT FORCES OF THE BOLTS TO ROTATION.

F_1 ACTS AT DISTANCE OF d_1 FROM PIVOT POINT

F_2 ACTS AT DISTANCE OF d_2 FROM PIVOT POINT

SUMMING MOMENTS ABOUT THE PIVOT POINT

$\Sigma M = 0$ (THERE ARE 4 BOLTS RESISTING ROTATION.)

$L \times F_H = 2F_1 d_1 + 2F_2 d_2$ $\quad \frac{F_1}{F_2} = \frac{d_1}{d_2}$

$L \times F_H = \frac{2F_2}{d_2}(d_1^2 + d_2^2)$

L = DISTANCE FROM PIVOT PT TO [illegible]

M336 Sh 10

$L = 16.375$ INCHES

$d_1 = 1.094$

$d_2 = 3.718$

$$16.375 \times 270 = \frac{2F_2}{3.718}\left(\overline{3.718^2} + \overline{1.094^2}\right)$$

$$\therefore F_2 = 547\#$$

$$\therefore F_1 = 547 \times \frac{1.094}{3.718} = 160.9\#$$

STRESS ON BOLTS DUE TO THIS LOAD (HORIZONTAL SEISMIC)

MAXIMUM STRESS OCCURS ON 2 BOLTS THE GREATEST DISTANCE FROM THE PIVOT POINT.

$$S_H = \frac{F_2}{\frac{A_B}{2}} = \frac{547}{.404} = 1{,}354 \text{ PSI}$$

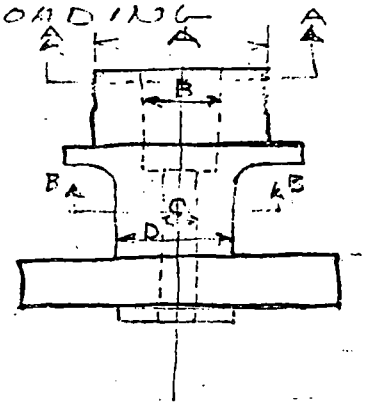
SUMMARY OF BONNET JOINT STRESSES

STRESS DUE TO PRESSURE LOAD = 22,641 PSI
STRESS DUE TO VERTICLE SEISMIC LOAD = 334 PSI
STRESS DUE TO HORIZONTAL SEISMIC LOAD = 1354 PSI
MAXIMUM TOTAL BOLTING STRESS = 24,379 PSI

1.05 x 23,213

M330 Sh 10

STRESS IN BONNET* DUE TO SEISMIC & PRESSURE LOADING



SEE SKETCH #1

DETERMINE MIN. AREA RESISTING PRESS & SEISMIC LOAD.

AREA AT RETAINING NUT THREAD = A_{AA} (SECT AA)

THD: (2 3/4 - 12NC - 2A) ⇒ OD ROOT THD = 2.750

.083

2.667

PACKING CHAMBER DIM. = 1.125

$$\text{AREA} = A_{AA} = \pi/4 \left(\overline{2.667}^2 - \overline{1.125}^2\right) - 2 \times \left(\frac{\pi}{4} \overline{.375}^2\right)$$

PACKING STUDS AREA

$$A_{AA} = 4.59 - .221$$

$$A_{AA} = 4.37$$

(SECT BB) AREA = $\frac{\pi}{4}\left(D^2 - C^2\right) = \frac{\pi}{4}\left(\overline{2}^2 - \overline{.75}^2\right) = A_{BB}$

SEE SKETCH #1

$$A_{BB} = 2.7 \text{ sq in}$$

SINCE THE AREA IS SIGNIFICANTLY LESS AT SECT BB CALCULATE THE STRESS AT THIS POINT DUE TO PRESS & SEISMIC. SECT BB IS THE WEAKEST PT.

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M336 Sh 107

FORCE AT SECT BB DUE TO PRESSURE

$F_{BB} = (A_{AEN\ PACKING} - A_{REA\ STEM}) \times PRESS\ (MAX)$

$= \frac{\pi}{4}\left[1.125^2 - .625^2\right] \times 1440\ PSIG$

$F_{BB} = 989.6\#$ HOWEVER THIS FORCE IS NOT AS GREAT AS THE OPERATOR OUTPUT LOAD (F) – USE F = 2825#

$S_{BBP} = \frac{F}{A_{BB}}$

$S_{BBP} = \frac{2825\#}{2.7\ IN^2} = 1046\ PSI$

STRESS AT SECT BB DUE TO SEISMIC (VERT) CONDITION

$S_{BBV} = \frac{(G_1)\,W_V}{A_{BB}} = \frac{3 \times 90}{2.7}$

$S_{BBV} = 100$

STRESS AT SECT BB DUE TO SEISMIC (HORIZONTAL) CONDITION.

$S_{BBH} = \frac{MC}{I}$

$M = G_2 W \times L_{CC}$ Where L_{CC} = Dist from Sect CC TO CG of Operator/Bonnet.

(SECT BB) $\frac{I_{AA}}{C} = \frac{\pi}{32}\left[\frac{D^4 - C^4}{D}\right]$

Where T... [illegible] $L_{CC} = 12.875 + 3\frac{1}{8}$

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M336 4410

$$\frac{I}{C} = \frac{\pi}{32}\left[\frac{(2)^4 - (.75)^4}{2}\right]$$

$$\frac{I}{C} = .77$$

$$S_{BHH} = \frac{MC}{I_{AA}}$$

$$S_{BBH} = \frac{3 \times 90 \times 16}{.77}$$

$$S_{BBH} = 5{,}610 \text{ psi}$$

SUMMARY OF STRESSES IN BONNET

S_{BBP} = STRESS AT SECT BB DUE TO PRESS LOAD = 1,046 psi
S_{BBV} = STRESS AT SECT BB DUE TO VERT SEISMIC = 100 psi
S_{BBH} = STRESS AT SECT BB DUE TO HORIZ SEISMIC = 5,610 psi
TOTAL STRESS AT SECT BB = 6,756 psi

M336 SM10 (

NATURAL FREQUENCY CALCULATION

$$F_n = 5.42\sqrt{\frac{E\,I}{W(L_{cc})^3}}$$

ASSUME THE OPERATOR & BONNET IS A CANTILEVER BEAM FIXED AT SECT "BB".

$E = 28 \times 10^6$
$I = .77$
$W = 90\#$
$L_{cc} = 16$

$$F_n = 5.42\sqrt{\frac{28\times10^6 \times .77}{90 \times (16)^3}}$$

$F_n = 41.4$ cps ✓

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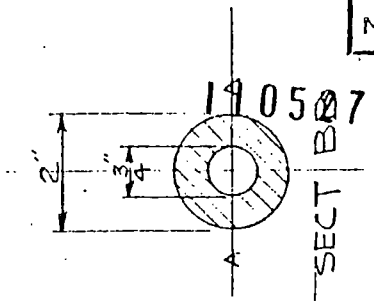
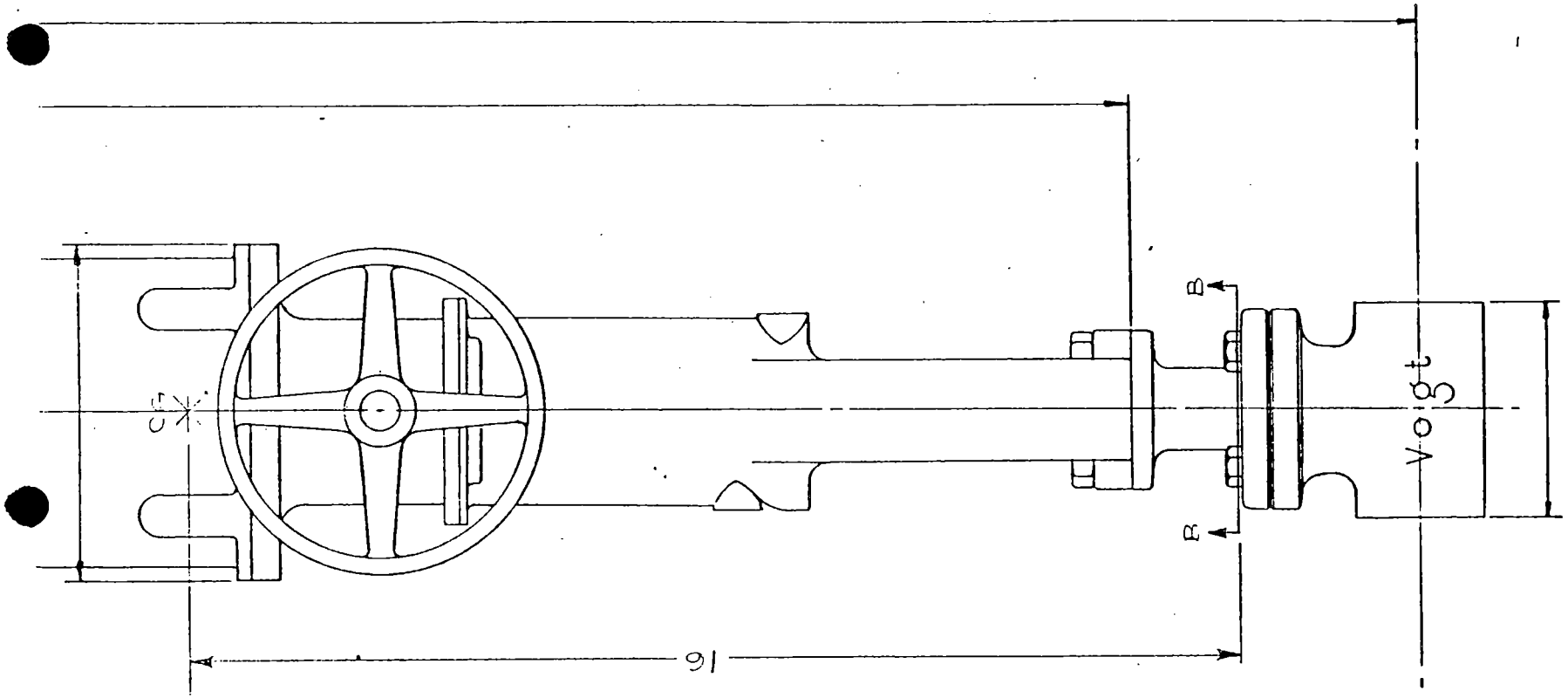
M336 dn 167

REVISION RECORD					
No.		DATE	FROM	TO	BY



1105718



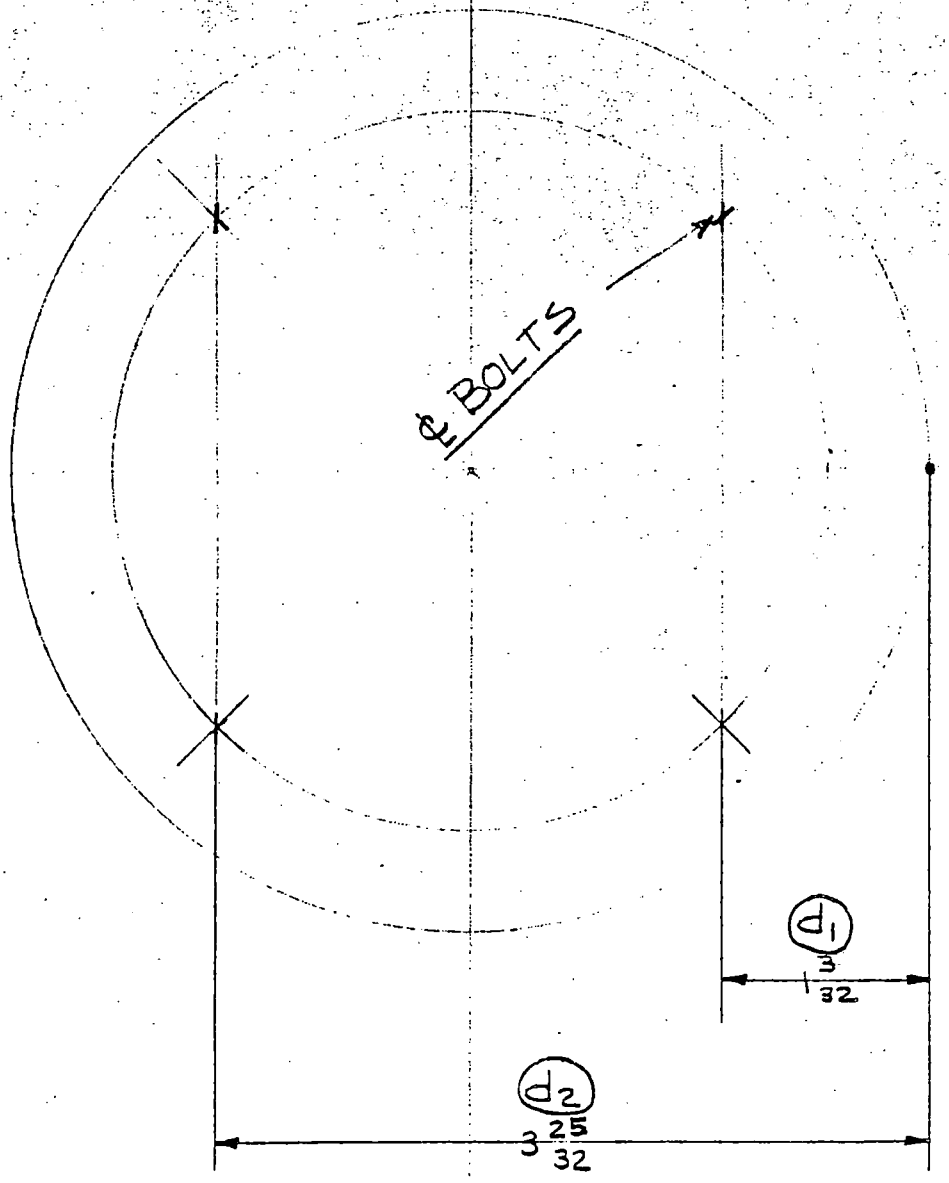
SKETCH 1

Customer Order No. 5935-M336-AC

Vogt Order No. SRO 157907

Fisher Operator No. S12E40-4 on

M336 plug



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BOLTING ARRANGEMENT FOR B48499

SKETCH #2

ATTACHMENT #3
Consumers Power Company
PALISADES SEP TOPIC III-6
October 13, 1982

7 Pages

RBD

D. Control

CONTROLLED COPY

M-233-212

7500W22*M233 SH.2

ENGINEERING RECORDS CENTER
INFORMATION COPY
OCT 1 1982
CONSUMERS POWER CO.
JACKSON, MICH.

VENDOR DRAWING REVIEW

X Approved - Manufacturing may proceed.

Approved except as noted - Make changes and submit final drawing - Manufacturing may proceed.

Review not required - Work may proceed.

Date 11/20/74

HW for H.T.

JOB

MIDLAND PLANT

CONSUMERS POWER CO.

DISTRIBUTION

	NO.	DAT.
VENDOR	1	
CLIENT	RH	
FIELD		
QUAL.		
START UP		
A.A.	1	3C
	1	
	RH	

BECHTEL CO.

P-18536182

5935-004-M348B-2-1 JUL 15 1974
950Y281

MASCHEFF AM INTERNATIONAL
SEISMIC CALCULATIONS PER ASME SECTION III
CLASS 2

WORK ORDER NO. SAMPLE-001
SIZE 1.000INCH TYPE 20561 RATING 600 LBS. ACTUATOR 9.0K DESIGN PRESSURE 1250. PSIG

INPUT DATA

BODY GSKT O.D.	2.380	IN.	BONNET			ACTUATOR WGT.	45.000	LBS.	
I.D.	1.940	IN.	&			WIDTH DIM.	2.500	IN.	
M FACTOR	3.750		ACTUATOR WGT.	50.000	LBS.	OUTSIDE DIM.	4.600	IN.	
Y FACTOR	7600.000		PRESS.	3.000	PSI	INSIDE DIM.	3.600	IN.	
SEAT GSKT O.D.	0.0	IN.	DIAPHRAGM AREA	92.300	SQ.IN.	C.G. HEIGHT	10.200	IN.	
I.D.	0.0	IN.	C.G. HEIGHT	11.500	IN.				
M FACTOR	0.0		HUB O.D.	2.000	IN.	DESIGN STRESS INTENSITY			
Y FACTOR	7600.000					BONNET @ 60F	17500. PSI	@ TEMP	17500. PSI
FLANGE O.D.	4.310	IN.	ACCELERATION			YOKE @ 60F	4000. PSI		
I.D.	1.190	IN.	VERTICAL	1.000	G.	BOLT @ 60F	25000. PSI	@ TEMP	25000. PSI
B.C.	3.250	IN.	HORIZONTAL	1.500	G.	NUT @ 60F	20000. PSI		
THICKNESS	0.625	IN.							
BOLT SIZE	0.500	IN.	NUT SHR AREA/IN.	4.966	SQ.IN./IN.	EXTERNAL MOMENT	0.0	IN-LBS	
QUANTITY	4.000		ENGAGEMENT	0.440	IN.	FORCE	0.0	LBS.	
VALVE BODY ID.	1.000	IN.	DIAMETER	2.250	IN.	PRESSURE RD	1250.000	PSIG	
HAND WHEEL NO.	000		HANDWHEEL DIST.	0.0	IN.	TEMPERATURE	500.	DEG. F	

OUTPUT DATA

WM1 11576. LBS. W 12666. LBS WM2 5573. LBS. MINIMUM REQ'D THICKNESS 0.250 IN.
M01 7475. IN.-LBS M02 6904. IN.-LBS

NORMAL FLANGE STRESSES			ALLOWABLE STRESSES			TOTAL FLANGE STRESSES			ALLOWABLE STRESSES			
OPERATING	SH	12034. PSI		26250.	PSI		SHT	13566. PSI		52500.	PSI	
	ST	8834. PSI		17500.	PSI		STT	10055. PSI		52500.	PSI	
	SR	14146. PSI		17500.	PSI		SRT	16101. PSI		52500.	PSI	
SHR AVG		13091. PSI		17500.	PSI	SHPT AVG		14833. PSI		52500.	PSI	
SHT AVG		10435. PSI		17500.	PSI	SHTT AVG		11810. PSI		52500.	PSI	
NORMAL FLANGE STRESSES			ALLOWABLE STRESSES			TOTAL FLANGE STRESSES			ALLOWABLE STRESSES			
GASKET	SH	11117. PSI		26250.	PSI		SHT	12647. PSI		52500.	PSI	
	ST	8159. PSI		17500.	PSI		STT	9360. PSI		52500.	PSI	
	SR	13066. PSI		17500.	PSI		SRT	15021. PSI		52500.	PSI	
SHR AVG		12091. PSI		17500.	PSI	SHLT AVG		13834. PSI		52500.	PSI	
SHT AVG		9638. PSI		17500.	PSI	SHTT AVG		11013. PSI		52500.	PSI	

NORMAL BOLT STRESS	SB	21032. PSI	ALLOWABLE STRESS	25000.	PSI	TOTAL BOLT STRESS	SBT	22692. PSI	ALLOWABLE STRESS	75000.	PSI	
						TOTAL YOKE STRESS	SYT	741. PSI	ALLOWABLE STRESS	4000.	PSI	
						TOTAL NUT STRESS	NUTT	161. PSI	ALLOWABLE STRESS	20000.	PSI	

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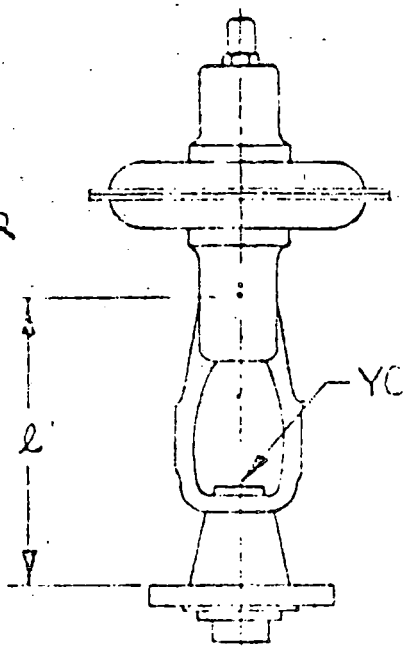
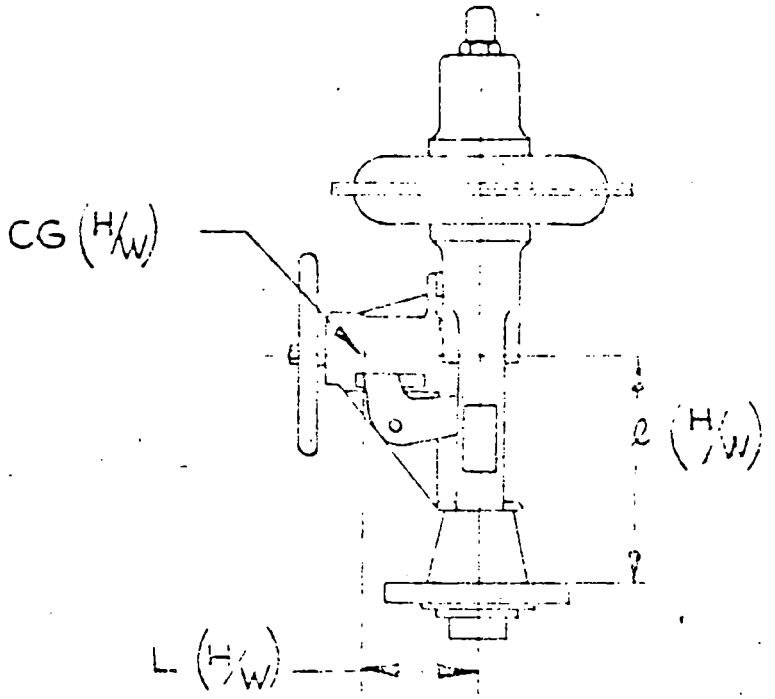
950Y281* M348B Sh. 2-1 (B)



A. BONNET AND ACTUATOR ASSY ARE CONSIDERED AS A CANTILEVER BEAM RIGIDLY ATTACHED WHEN COMPUTING BONNET STRESSES.

B. YOKE AND YOKE BONNET CONNECTIONS ARE ANALYZED SEPARATELY.



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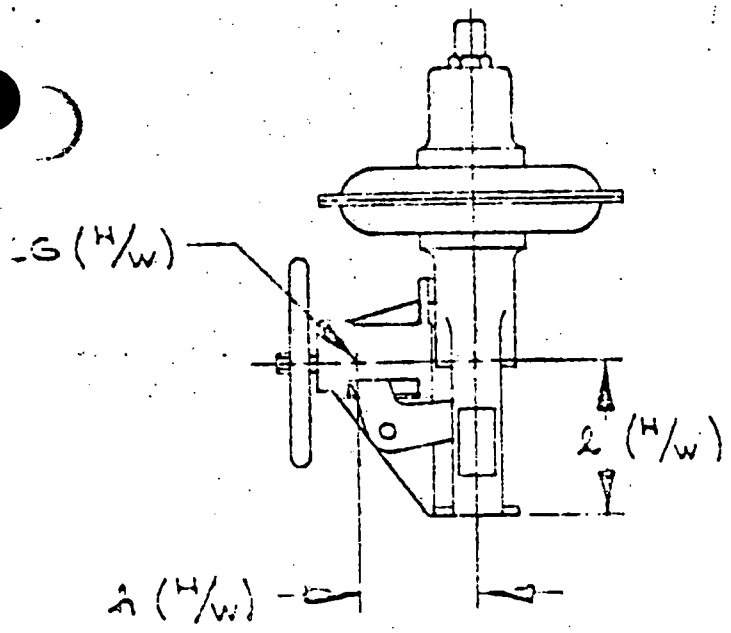
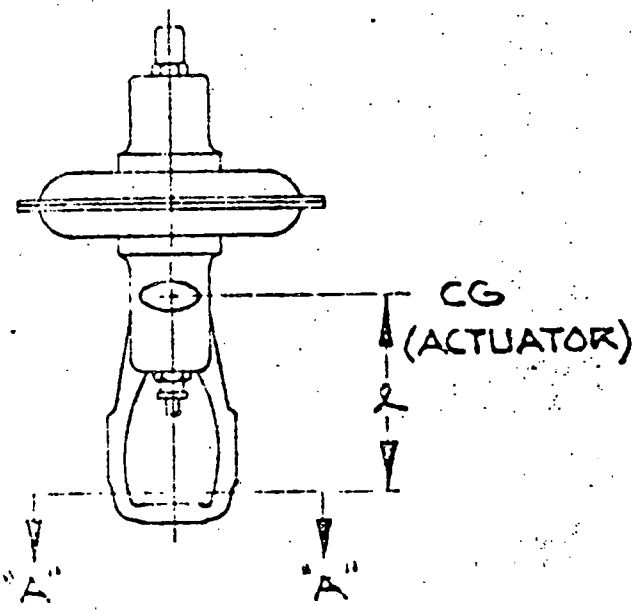
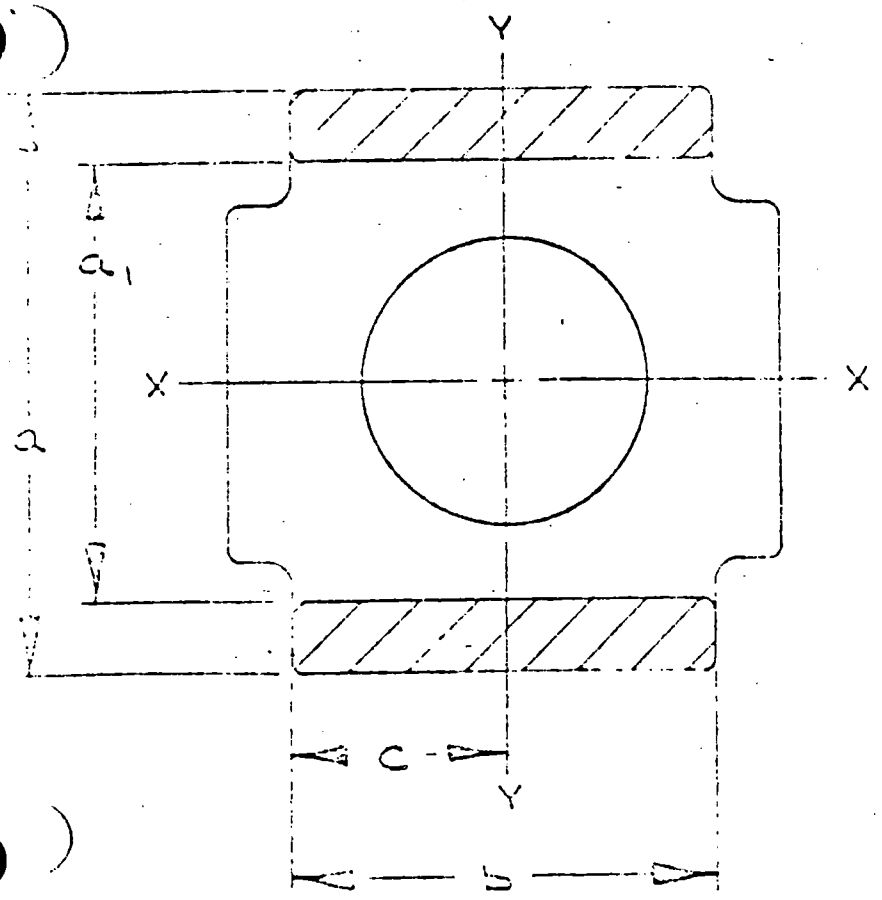
WHEN HANDWHEEL IS SUPPLIED ADDITIONAL STRESSES ARE ADDED SEPARATELY





YOKE CROSS SECTION "A"-"A"
(PLANE OF HIGHEST STRESS INTENSITY)



MOMENT OF INERTIA:

$$I_{yy} = \frac{(a - a_1)\, b^3}{12}$$

SECTION MODULUS:
I/c ABOUT YY AXIS IS SMALLER AND W.I.L. BE USED FOR STRESS CALCULATION

YOKE SIZE	a	a_1	b	c
9	4.0	3.0	2.5	1.25
11	4.6	3.0	2 5/8	1.25
13	5.12	4	2 3/4	1.37
15 / 18	7.16	5.75	4.5	2.25
18L	7.87	6.12	4.5	2.25
24	9.0	7.5	5.0	2.5

MASONEILAN INTERNATIONAL
SEISMIC CALCULATIONS

WORK ORDER NO. H88068-002
SIZE 1.00INCH TYPE 20761 RATING 600 LBS. ACTUATOR 11.0R DESIGN PRESSURE 750. PSIG

INPUT DATA

BODY GSKT O.D.	2.380	IN.	BONNET				ACTUATOR WGT.	55.000	LBS.
I.D.	1.940	IN.	&				WIDTH DIM.	2.500	IN.
M FACTOR	3.000		ACTUATOR WGT.	63.000	LBS.		OUTSIDE DIM.	4.600	IN.
Y FACTOR	4500.000		PRESS.	11.000	PSI		INSIDE DIM.	3.600	IN.
SEAT GSKT O.D.	1.780	IN.	DIAPHRAGM AREA	86.000	SQ.IN.		C.G. HEIGHT	10.500	IN.
I.D.	1.410	IN.	C.G. HEIGHT	11.120	IN.				
M FACTOR	3.000		HUB O.D.	2.000	IN.	DESIGN STRESS INTENSITY			
Y FACTOR	4500.000					BONNET @ 60F	17500. PSI @ TEMP	17500.	PSI
FLANGE O.D.	5.250	IN.	ACCELERATION			YOKE @ 60F	17500. PSI		
I.D.	0.940	IN.	VERTICAL	3.000	G.	BOLT @ 60F	25000. PSI @ TEMP	25000.	PSI
B.C.	3.750	IN.	HORIZONTAL	3.000	G.	NUT @ 60F	20000. PSI		
THICKNESS	0.811	IN.							
BOLT SIZE	0.750	IN.	NUT SHR AREA/IN.	4.985	SQ.IN./IN.	EXTERNAL MOMENT	0.0	IN-LBS	
QUANTITY	4.000		ENGAGEMENT	0.440	IN.	FORCE	0.0	LBS.	
VALVE BODY ID.	1.000	IN.	DIAMETER	2.250	IN.	PRESSURE FD	750.000	PSIG	
HAND-WHEEL NO.	000		HANDWHEEL DIST.	0.0	IN.	TEMPERATURE	550.	DEG. F	

OUTPUT DATA

WM1 6106. LBS. M 19383. LBS WM2 5445. LBS. MINIMUM WALL THICKNESS 0.250 IN.
MO1 5713. IN.-LBS MO2 15409. IN.-LBS

NORMAL FLANGE STRESSES OPERATING	SH	3703.	PSI	ALLOWABLE STRESSES	26250.	PSI	TOTAL FLANGE STRESSES	SHT	7355.	PSI	ALLOWABLE STRESSES	52500. PSI
	ST	3939.	PSI		17500.	PSI		STT	6280.	PSI		52500. PSI
	SR	5908.	PSI		17500.	PSI		SRT	9420.	PSI		52500. PSI
	SHR AVG	4806.	PSI		17500.	PSI		SHRT AVG	8388.	PSI		52500. PSI
	SHT AVG	3821.	PSI		17500.	PSI		SHTT AVG	6817.	PSI		52500. PSI
NORMAL FLANGE STRESSES GASKET	SH	9989.	PSI	ALLOWABLE STRESSES	26250.	PSI	TOTAL FLANGE STRESSES	SHT	13641.	PSI	ALLOWABLE STRESSES	52500. PSI
	ST	10624.	PSI		17500.	PSI		STT	12965.	PSI		52500. PSI
	SR	15937.	PSI		17500.	PSI		SRT	19449.	PSI		52500. PSI
	SHR AVG	12963.	PSI		17500.	PSI		SHRT AVG	16545.	PSI		52500. PSI
	SHT AVG	10306.	PSI		17500.	PSI		SHTT AVG	13303.	PSI		52500. PSI
NORMAL BOLT STRESS	SB	4676.	PSI	ALLOWABLE STRESS	25000.	PSI	TOTAL BOLT STRESS	SBT	6687.	PSI	ALLOWABLE STRESS	75000. PSI
							TOTAL YOKE STRESS	SYT	2107.	PSI	ALLOWABLE STRESS	17500. PSI
							TOTAL NUT STRESS	NUTT	682.	PSI	ALLOWABLE STRESS	20000. PSI

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M348B
sh2

MASONEILAN INTERNATIONAL
SEISMIC CALCULATIONS

WORK ORDER NO. H88068-003
SIZE 3.00INCH TYPE 20761 RATING 600 LBS. ACTUATOR 15.0R DESIGN PRESSURE 750. PSIG

INPUT DATA

BODY GSKT O.D.	4.440	IN.	BONNET & ACTUATOR	WGT.	165.000	LBS.	ACTUATOR	WGT.	140.000	LBS.
I.D.	3.750	IN.						WIDTH DIM.	4.500	IN.
M FACTOR	3.000			PRESS.	15.000	PSI		OUTSIDE DIM.	7.180	IN.
Y FACTOR	4500.000			DIAPHRAGM AREA	178.000	SQ.IN.		INSIDE DIM.	5.750	IN.
SEAT GSKT O.D.	3.620	IN.		C.G. HEIGHT	18.620	IN.		C.G. HEIGHT	19.000	IN.
I.D.	3.193	IN.		HUB O.D.	3.500	IN.				
M FACTOR	3.000						DESIGN STRESS INTENSITY			
Y FACTOR	4500.000						BONNET @ 60F	17500. PSI @ TEMP	17500.	PSI
FLANGE O.D.	7.750	IN.	ACCELERATION				YOKE @ 60F	17500. PSI		
I.D.	1.750	IN.		VERTICAL	3.000	G.	BOLT @ 60F	25000. PSI @ TEMP	25000.	PSI
B.C.	6.000	IN.		HORIZONTAL	3.000	G.	NUT @ 60F	20000. PSI		
THICKNESS	1.281	IN.								
BOLT SIZE	0.875	IN.	NUT SHR AREA/IN.		4.985	SQ.IN./IN.	EXTERNAL MOMENT		0.0	IN-LBS
QUANTITY	8.000		ENGAGEMENT		0.440	IN.		FORCE	0.0	LBS.
VALVE BODY ID.	3.000	IN.	DIAMETER		2.250	IN.		PRESSURE FD	750.000	PSIG
HAND WHEEL NO.	000		HANDWHEEL DIST.		0.0	IN.		TEMPERATURE	550.	DEG. F

OUTPUT DATA

WM1 19859. LBS. W 55110. LBS WM2 15161. LBS. MINIMUM WALL THICKNESS 0.313 IN.
MO1 24972. IN.-LBS MO2 52492. IN.-LBS

NORMAL FLANGE STRESSES OPERATING	SH	4302.	PSI	ALLOWABLE STRESSES	26250.	PSI	TOTAL FLANGE STRESSES	SHT	7558.	PSI	ALLOWABLE STRESSES	52500.	PSI
	ST	4062.	PSI		17500.	PSI		STT	6430.	PSI		52500.	PSI
	SR	6779.	PSI		17500.	PSI		SFT	10731.	PSI		52500.	PSI
	SHR AVG	5541.	PSI		17500.	PSI		SHRT AVG	9145.	PSI		52500.	PSI
	SHT AVG	4182.	PSI		17500.	PSI		SHTT AVG	6994.	PSI		52500.	PSI
NORMAL FLANGE GASKET STRESSES	SH	9044.	PSI	ALLOWABLE STRESSES	26250.	PSI	TOTAL FLANGE STRESSES	SHT	12300.	PSI	ALLOWABLE STRESSES	52500.	PSI
	ST	8539.	PSI		17500.	PSI		STT	10907.	PSI		52500.	PSI
	SR	14250.	PSI		17500.	PSI		SRT	18202.	PSI		52500.	PSI
	SHR AVG	11647.	PSI		17500.	PSI		SHRT AVG	15251.	PSI		52500.	PSI
	SHT AVG	8791.	PSI		17500.	PSI		SHTT AVG	11603.	PSI		52500.	PSI

NORMAL BOLT STRESS	SB	5494.	PSI	ALLOWABLE STRESS	25000.	PSI	TOTAL BOLT STRESS	SBT	7503.	PSI	ALLOWABLE STRESS	75000.	PSI
							TOTAL YOKE STRESS	SYT	2134.	PSI	ALLOWABLE STRESS	17500.	PSI
							TOTAL NUT STRESS	NUTT	2217.	PSI	ALLOWABLE STRESS	20000.	PSI

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Sh2

MASONEILAN INTERNATIONAL
SEISMIC CALCULATIONS

WORK ORDER NO. F88368-001
SIZE 4.00INCH TYPE 40311 RATING 600 LBS. ACTUATOR 18.5P DESIGN PRESSURE 750. PSIG

INPUT DATA

BODY GSKT O.D.	6.440	IN.	BONNET				ACTUATOR	WGT.	260.000	LBS.	
I.D.	5.650	IN.	&					WIDTH DIM.	4.500	IN.	
M FACTOR	3.000		ACTUATOR	WGT.	305.000	LBS.		OUTSIDE DIM.	7.870	IN.	
Y FACTOR	4500.000			PRESS.	13.000	PSI		INSIDE DIM.	6.120	IN.	
SEAT GSKT O.D.	5.620	IN.		DIAPHRAGM AREA	276.000	SQ.IN.		C.G. HEIGHT	16.000	IN.	
I.D.	4.620	IN.		C.G. HEIGHT	17.380	IN.					
M FACTOR	3.000			HUB O.D.	3.000	IN.	DESIGN STRESS INTENSITY				
Y FACTOR	4500.000						BONNET @ 60F	17500. PSI	@ TEMP	17500.	PSI
FLANGE O.D.	9.620	IN.	ACCELERATION				YOKE @ 60F	17500. PSI			
I.D.	1.250	IN.		VERTICAL	3.000	G.	BOLT @ 60F	25000. PSI	@ TEMP	25000.	PSI
B.C.	7.880	IN.		HORIZONTAL	3.000	G.	NUT @ 60F	20000. PSI			
THICKNESS	1.593	IN.									
BOLT SIZE	0.875	IN.	NUT SHR AREA/IN.		7.302	SQ.IN./IN.	EXTERNAL MOMENT		0.0	IN-LBS	
QUANTITY	8.000			ENGAGEMENT	0.625	IN.		FORCE	0.0	LBS.	
VALVE BODY ID.	4.000	IN.		DIAMETER	3.312	IN.		PRESSURE FD	750.000	PSIG	
HAND WHEEL NO.	000			HANDWHEEL DIST.	0.0	IN.		TEMPERATURE	555.	DEG. F	

OUTPUT DATA

WM1 38392. LBS. W 64376. LBS WM2 34574. LBS. MINIMUM WALL THICKNESS 0.375 IN.
MO1 61715. IN.-LBS MO2 59065. IN.-LBS

NORMAL FLANGE STRESSES OPERATING	SH	5777.	PSI	ALLOWABLE STRESSES	26250.	PSI	TOTAL FLANGE STRESSES	SHT	13183.	PSI	ALLOWABLE STRESSES	52500.	PSI
	ST	8208.	PSI		17500.	PSI		STT	12056.	PSI		52500.	PSI
	SR	8420.	PSI		17500.	PSI		SRT	12367.	PSI		52500.	PSI
SHR AVG		7098.	PSI		17500.	PSI	SHRT AVG		12775.	PSI		52500.	PSI
SHT AVG		6993.	PSI		17500.	PSI	SHTT AVG		12620.	PSI		52500.	PSI
NORMAL FLANGE STRESSES GASKET	SH	5529.	PSI	ALLOWABLE STRESSES	26250.	PSI	TOTAL FLANGE STRESSES	SHT	12935.	PSI	ALLOWABLE STRESSES	52500.	PSI
	ST	7856.	PSI		17500.	PSI		STT	11704.	PSI		52500.	PSI
	SR	8058.	PSI		17500.	PSI		SRT	12005.	PSI		52500.	PSI
SHR AVG		6794.	PSI		17500.	PSI	SHRT AVG		12470.	PSI		52500.	PSI
SHT AVG		6692.	PSI		17500.	PSI	SHTT AVG		12320.	PSI		52500.	PSI

NORMAL BOLT STRESS	SB	10622.	PSI	ALLOWABLE STRESS	25000.	PSI	TOTAL BOLT STRESS	SBT	13364.	PSI	ALLOWABLE STRESS	75000.	PSI
							TOTAL YOKE STRESS	SYT	2671.	PSI	ALLOWABLE STRESS	17500.	PSI
							TOTAL NUT STRESS	NUTT	1376.	PSI	ALLOWABLE STRESS	20000.	PSI

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