CYGNA

Final Qualification Report

PROJECT: Equipment Seismic/Hydrodynamic Requalification

JOB NO: 82044

CALC NO: OT.01.F

CLIENT: Washington Public Power Supply System

QID NO: 361106

TITLE: Equipment Seismic and Hydrodynamic Requalification of 24" Cylinder Operated Butterfly Valves for:

CSP-V-3,4,5,6, and 9

CEP-V-3A, and 4A

⚠ D. Searle 11/12/83
TBG Maerun 11-11-83

PREPARED BY: [signature] Mark Scott 6/9/83 DATE

REVIEWED BY: L.C. Fernandez Lourdes Fernandez 6/9/83 DATE

APPROVED BY: [signature] Fawaz Khanachet 6/9/83 DATE

[signature] 11-11-83

REVISION: 4

SUPPLY SYSTEM REVIEW.

RW Hickman R. W. HICKMAN 6/10/83

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

SUPPLIER TRANSMITTAL FORM

(AREA WITHIN HEAVY BORDER TO BE COMPLETED BY SUPPLIER)

TO THE ATTENTION OF: Dennis Armstrong
(COGNIZANT PURCHASE AGENT/BUYER/CONTRACT ADMIN.)
ADDRESS: WNP-2 Mail Drop 9670
SUBJECT: Equip. Seismic/Hydrodynamic Requal.
FROM: Cygna Energy Services
ADDRESS: 1200 Jadwin, Suite 565, Richland, WA

THE FOLLOWING PUBLICATIONS/DRAWINGS ARE SUBMITTED FOR:
[X] APPROVAL [ ] REVIEW [ ] INFORMATION [ ] DISTRIBUTION

NO. OF PRINTS ____ OF EACH NO. OF REPRODUCIBLES ____ OF EACH
SUBMITTED BY: Fawaz Khanachet
TITLE: Project Manager
SUBVENDOR: ____ CONT./P.O. NO.: ____

PAGE 1 OF 1
TRANSMITTAL NO. ____
[ ] NEW [X] RE-SUBMITTAL
DATE SUBMITTED: 11/11/83
REQUESTED DATE OF RETURN: ____
CONTRACT NO: C-0892
P.O. NO: ____
WORK ORDER NO: ____
SPEC. NO: ____
SPEC. SECT. NO: ____

ITEM NO.	PUBLICATION OR DRAWING NO.	REV. NO.	PUBLICATION OR DRAWING TITLE	MANUFACTURER	WPPSS ACTION
1	018011	1	Revised pgs. for 018011		
2	361106	4	Revised pgs. for 361106		A
3			Cygna Transmittal 716RB		

COMMENTS: (USE ADDITIONAL SHEET, IF REQUIRED)

- TO BE REVIEWED BY -

RECEIVED BY: (PURCHASING ONLY) NAME ____ DATE ____

TRANSMITTED BY: (PURCHASING ONLY) NAME ____ DATE ____

APPROVED BY: [signature] TITLE Program Lead DATE 12/2/83

ACTION LEGEND:
A = APPROVED FOR PUBLICATION
AN = APPROVED AS NOTED FOR FABRICATION
I = INFORMATION ONLY
NA = NOT APPROVED

WP-770 R1

QID # 361106

REVISION STATUS REPORT

REV	DATE	PRE'D BY / REV'D BY	APPROVED BY	DESCRIPTION
0	8/6th/82	R. Hsieh / H. Abouhoda	W. Schlofer	ORIGINAL ISSUE
1	10/27/82	R. Hsieh / H. Abouhoda	W. Schlofer	INCLUSION OF SUMMARY & REVISE CALC. TABLE OF CONTENTS
2	12/6/82	J.M Foley / B.J.Bak	[illegible]	Revised entire calc to reflect new cylinder CG and correct spring preloads and to include dynamic torque effects.
	5/12/83	D E Kabrowski / D. E. Searle	[illegible]	Revise entire calc for S2SS method using actual piping loads. Address [illegible] operability.
3	6/9/83	[illegible] / L.C. Fernandez	[illegible]	REVISE EAR WELD STRESS CONCLUSION INCORPORATE COMMENTS
4	11/8/83	D. Searle / TBG Marvin	M. Meyer	1) REVISE EAR WELD STRESS & SHEAR PL CALC 4.3-49-66 2) LOAD (FINAL) COMPARISON

1.0 REQUALIFICATION CERTIFICATION

REVISION 4 1.1

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

REQUALIFICATION CERTIFICATE

WNP- 2

QID# 361106 △3

COMPONENT NO: CSP-V-3, CSP-V-4, CSP-V-5, CSP-V-6, CSP-V-9, CEP-V-3A & CEP-V-4A

COMPONENT DESCRIPTION: 24" Cylinder Operated Butterfly Valves

MANUFACTURER: BIF MODEL NO: A-206765

EQUIPMENT CLASSIFICATION: [X] ACTIVE [ ] PASSIVE

SEISMIC QUALIFICATION REPORT REFERENCE:

Cygna Report 0t.01/F, QID 361106
"24" Cylinder-Operated Butterfly Valve"

[redacted]

Required action: 1) Remove A-307 Ear Bolts and replace with A-325.
2) Reinforce valve ear group with ½" shear plates to qualify air operators for required fatigue cycles. △3

THE ABOVE SEISMIC AND [redacted] QUALIFICATION REPORTS HAVE BEEN REEVALUATED IN ACCORDANCE WITH THE CURRENT NRC SEISMIC AND [redacted] CRITERIA:

1. IEEE STANDARDS 344 (1975)
2. USNRC REGULATORY GUIDES 1.92, 1.100
3. STANDARD REVIEW PLANS 3.9.2, 3.10, [redacted]

△4 A. Searle 11/4/83
TDG [illegible] 11-11-83

THE ABOVE COMPONENT HAS BEEN FOUND ACCEPTABLE FOR PERFORMING ITS INTENDED SAFETY RELATED FUNCTION WHEN SUBJECTED TO THE PLANT SPECIFIC VIBRATORY [redacted] LOADS.

PREPARED BY J.E. Rakowski [signature] △3 [signature] 6/9/83		DATE 5/12/83
REVIEWED BY A.E. Searle	L.C. Fernandez 6/9/83	DATE 5/12/83
APPROVED BY		DATE

968-12576

2.0 SQRT FORM(S) AND REFERENCES

CYGNA

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

Qualification Summary of Equipment

QID# 361106

Ref. No.

I. PLANT NAME: WNP-2 TYPE

PWR

1. NSSS: GE 2. A/E: Burns & Roe BWR 5, Mark II

II. COMPONENT NAME: 24" Cyl.Oper. Butterfly Valve COMPONENT NO. CSP-V-3,4,5,6,&9 CEP-V-3A & 4A (3)

1. SCOPE: [ ] NSSS [X] BOP

2. MODEL NUMBER: A-206765 QUANTITY: 7

3. VENDOR: BIF

4. IF THE COMPONENT IS A CABINET OR PANEL, NAME AND MODEL NO. OF THE DEVICES INCLUDED:

N/A

5. PHYSICAL DESCRIPTION: a. APPEARANCE: Butterfly Valve with 8" Cyl Operator

b. DIMENSIONS: 24" nominal diameters

c. WEIGHT: 847# - Valve Assy; 676# - Operator & bracket

6. LOCATION: BUILDING: Reactor

ELEVATION: Maximum elevation: 495' (CSP-V-3A & 4A) (3)

7. FIELD MOUNTING CONDITIONS: [X] BOLT (NO. ____ SIZE ____)

[ ] WELD (LENGTH ____)

[ ] ____

8. a. SYSTEM IN WHICH LOCATED: Containment Supply Purge Systems

b. FUNCTIONAL DESCRIPTION: Primary Containment isolation, prevention of the release of radioactive material to the environment.

c. IS THE EQUIPMENT REQUIRED FOR: [ ] HOT STANDBY [ ] COLD SHUTDOWN

[X] BOTH [ ] NEITHER

9. PERTINENT REFERENCE DESIGN SPECIFICATION: WPPSS Spec. 2808-68

III. IS EQUIPMENT AVAILABLE FOR INSPECTION IN THE PLANT: [X] YES [ ] NO

Qualification Summary of Equipment (Continued)

QID# 361106

Ref. No.

IV. EQUIPMENT QUALIFICATION METHOD:

☐ TEST ☒ ANALYSIS ☐ COMBINATION OF TEST & ANALYSIS

QUALIFICATION REPORT: 24" Cylinder-Operated Butterfly Valve*

(NO., TITLE & DATE): OT.01.F, Revision 3, June, 1983 △3 15

COMPANY THAT PREPARED REPORT: Cygna Energy Services

COMPANY THAT REVIEWED REPORT: Washington Public Power Supply Systems
*Plus original valve analysis 3;4

V. VIBRATION INPUT:

1. LOADS CONSIDERED: a. ☐ SEISMIC ONLY
b. ☐ HYDRODYNAMIC ONLY
c. ☒ COMBINATON OF (a) AND (b)

2. METHOD OF COMBINING RRS: ☐ ABSOLUTE SUM ☒ SRSS ☐ OTHER (SPECIFY) ______

3. REQUIRED RESPONSE SPECTRA (ATTACH THE GRAPHS): Section 5.1 of QID 361106

4. DAMPING CORRESPONDING TO RSS: ☐ OBE ______ ☐ SSE ______

5. REQUIRED ACCELERATION IN EACH DIRECTION: ☐ ZPA ☒ OTHER (SPECIFY) Section 5.5 △3 15

OBE S/S = Attached F/B = ______ V = ______

SSE S/S = Attached F/B = ______ V = ______

6. WERE FATIGUE EFFECTS OR OTHER VIBRATION LOADS CONSIDERED?

☒ YES ☐ NO

IF YES, DESCRIBE LOADS CONSIDERED AND HOW THEY WERE TREATED IN OVERALL QUALIFICATION PROGRAM:

The calculated stress ranges were compared to the AISC allowables, as the structures analyzed were not part of the pressure boundary.

NOTE: IF MORE THAN ONE REPORT, COMPLETE ITEMS IV THROUGH VII FOR EACH REPORT

Qualification Summary of Equipment (Continued)

QID# 361106

Ref. No.

VI. IF QUALIFICATION BY TEST, THEN COMPLETE*: N/A

1. ☐ SINGLE FREQUENCY ☐ MULTI-FREQUENCY ☐ RANDOM

2. ☐ SINGLE AXIS ☐ MULTI-AXIS ☐ SINE BEAT ☐ ____________

3. NO. OF QUALIFICATION TESTS: OBE ________ SSE ________ OTHER (SPECIFY) ________

4. FREQUENCY RANGE: ____________________

5. NATURAL FREQUENCIES IN EACH DIRECTION (SIDE/SIDE, FRONT/BACK, VERTICAL):

   S/S = ____________ F/B = ____________ V = ____________

6. METHOD OF DETERMINING NATURAL FREQUENCIES:

   ☐ LAB TEST ☐ IN SITU TEST ☐ ANALYSIS

7. TRS ENVELOPING RRS USING MULTI-FREQUENCY TEST: ☐ YES (ATTACH TRS & RRS GRAPHS) ☐ NO

8. INPUT g-LEVEL TEST: OBE S/S = ________ F/B = ________ V = ________

   SSE S/S = ________ F/B = ________ V = ________

9. LABORATORY MOUNTING:

   ☐ BOLT (NO. ________, SIZE ________) ☐ WELD (LENGTH ________) ☐ ________

10. FUNCTIONAL OPERABILITY VERIFIED: ☐ YES ☐ NO ☐ NOT APPLICABLE

11. TEST REULTS INCLUDING MODIFICATIONS MADE:

____

____

____

12. OTHER TEST PERFORMED (SUCH AS AGING OR FRAGILITY TEST, INCLUDING RESULTS):

____

____

____

____

*NOTE: IF QUALIFICATION BY A COMBINTATION OF TEST AND ANALYSIS, ALSO COMPLETE ITEM VII.

Qualification Summary of Equipment (Continued)

QID# 361106

Ref. No.

VII. IF QUALIFICATION BY ANALYSIS, THEN COMPLETE:

1. METHOD OF ANALYSIS:

☐ STATIC ANALYSIS ☒ EQUIVALENT STATIC ANALYSIS

☐ DYNAMIC ANALYSIS ☐ TIME-HISTORY ☐ RESPONSE SPECTRUM

2. NATURAL FREQUENCIES IN EACH DIRECTION (SIDE/SIDE, FRONT/BACK, VERTICAL):

S/S = 10.81 Hz F/B = 26.1 Hz V = >100

3. MODEL TYPE:

☐ 3D ☐ 2D ☐ 1D ☐ FINITE ELEMENT ☒ BEAM ☐ CLOSED FORM SOLUTION

4. ☐ COMPUTER CODES: ________

FREQUENCY RANGE AND NO. OF MODES CONSIDERED: ________

☒ HAND CALCULATIONS

5. METHOD OF COMBINING DYNAMIC RESPONSES: ☐ ABSOULTE SUM ☒ SRSS ☐ OTHER (SPECIFY) ______

6. DAMPING: OBE ______ SSE ______ BASIS FOR THE DAMPING USED: N/A*

7. SUPPORT CONSIDERATIONS IN THE MODEL: pipe-mounted

8. CRITICAL STRUCTURAL ELEMENTS:

A.

IDENTIFICATION	LOCATION	GOVERNING LOAD OR RESPONSE COMBINATION	SEISMIC STRESS	TOTAL STRESS	STRESS ALLOWABLE
Valve Ears	CSP-V-3&4	pipe-axial	15743	19538	26880 (PSI)
Ear Bolts	CSP-V-3&4	pipe-normal	15777	18382	66000 (PSI)
Drive Rod	CSP-V-4	rod-normal	8543	33019	86400 (PSI)
Ear Bolts	CSP-V-6	pipe-normal	57543	58884	66000 (PSI)

3 4

B.

MAX. CRITICAL DEFLECTION	LOCATION	MAXIMUM ALLOWABLE DEFLECTION TO ASSURE FUNCTIONAL OPERABILITY
<0.01"	Valve disk: radial deflection	approx 1/8" radial clearance

4 * COMPUTED STRESSES ARE BASED ON ACCELERATIONS THAT DIFFER SLIGHTLY FOR THE REQUIRED (SECTION 5.5) VALUES. SEE CALCULATION FOR DISCUSSION

Qualification Summary of Equipment (Continued)

#QID 361106

VIII. REFERENCES

1. BIF Drawings:

D-207110-H, D-207110-G,(Valve Data Sheets)

A-206767,18", 24" & 30" Butterfly Valve - General

C-26096,"Certified Dimension for Model A-83-B Cylinder"

2. WPPSS Unit 2 Drawings:

CSP-807-81.08	Containment Purge Air Supply
CSP-809-1.2	Suppression Pool Vacuum Breaker
CEP-625-3.4	From Reactor Nozzle X-67 to SGT-Fu-1A, 1B
CEP-625-1.2	From Reactor Nozzle X-67 to SGT-Fu-1A, 1B
D.220-0310	Support and Erection Isometric-IR64 (Johnson Controls)

3. BIF Report TR-27234 and TR-27235, "Dynamic Torque Calculation of Butterfly Valve; Sizes 24 and 30 inch", dated November 10, 1982.

4. Report #TR-74-7 by McPherson Assoc., Inc., "Design & Seismic Analysis 24" Cylinder operated Butterfly Valve." (Rev. 1) 1/5/76.

5. WPPSS letter to Cygna Energy Services, GE-02-RWH-018, 12/17/82.

11/3/83

4 TBG MARWIN 11-11-83

REFERENCES CONTINUED ON PAGE 2.6

Completed By	J E RAKOWSKI 3 6/9/83	Date	3/25/83
Reviewed By	A. E. Searle 6/9/83	Date	5/12/83

CYGNA

Calculation Sheet

Project: Washington Public Power Supply System	Prepared By: L.C. Fernandez	Date: 5/27/83	
Subject: Equipment Seismic/Hydrodynamic Requal.	Checked By: [signature]	Date: 5/27/83	
System: CSP & CEP	Job No. 82044	File No. OT.01.F	
~~Analysis No.~~ QID 361106	Rev. No. 2	Sheet No. 2.6	3

3 [signature] 6/8/83 L.C. Fernandez 6/9/83

SECTION 4.4

REFERENCES (CONTINUED):

6. Cygna Energy Services Communications Report, R. Ricappito, BIF Valve, and J. Rakowski, CES, "BIF Valve Dimensions", 2/11/83.

7. Cygna Energy Services, Project Manual Design Criteria, DC-1, Rev. 1, November, 1982.

8. Cygna Energy Services, Equipment Qualification Walkdown Verification Forms, Revision 1, dated 1/5/83.

9. WPPSS, WNP-2, Safety Related Mechanical Equipment List Summary Sheets, dated 2/10/83.

10. "AISC Manual of Steel Construction", American Institute of Steel Construction, 8th Edition, 1980.

11. Preliminary Transfer of Final Burns & Roe Piping Loads for CSP-V-1,2,3,4,5,6 and CEP-V-3A&4A, received 4/13/83.

12. Cygna Energy Services, "Equipment Seismic and Hydrodynamic Requalification of 30" Cylinder Operated Butterfly Valves for CSP-V-1, & 2, and CEP-V-1A, & 2A," File No. OS.01.F, QID No. 361104, Revision 1, June, 1983.

13. Cygna Energy Services, "Equipment Seismic and Hydrodynamic Requalification for 8", 10" and 12" Bore Air Cylinder Operators," File No. 1P.01.F, QID No. 018001, Revision 0, May, 1983. 3

14. USNRC, "Standard Review Plan, NUREG-0800"

15. Cygna Energy Services, "Equipment Seismic and Hydrodynamic Requalification of 24" Cylinder Operated Butterfly Valves for CSP-V-3,4,5,6, & 9 and CEP-V-3A & 4A," File No. OT.01.F, QID No. 361106, Revision 3, June, 1983.

Calculation Sheet

CYGNA

Project	WPPSS - EQUIPMENT QUALIFICATION	Prepared By:	(signature)	Date	4/29/83
Subject	24" BUTTERFLY VALVES	Checked By:	(signature)	Date	5/19/83
System	CSP & CEP	Job No.	82044	File No.	1P.01.F
Analysis No.	361106	Rev. No.	2	Sheet No.	361106-2.7

△3 (signature) 6/3/83
J.C. Fernandez 6/9/83
△4 D. Searle 11/10/83
TBG Harvin 11-11-83

SUMMARY TABLE 1.1

24" VALVE REQUIRED G-LEVELS (FAULTED CONDITION)

EPN	H_2O	FN	EL. REAC.	ACCELERATIONS (G's) X	Y	Z	EQUIPMENT CLASSIFICATION △3
CSP-V-3	Y	F/C	481	2.66	2.99	3.76	A
CSP-V-4	Y	F/C	478'	2.46	3.17	4.19	A
CSP-V-5	Y	F/O	475'	2.96	3.44	5.42	A
CSP-V-6	Y	F/O	480'	11.39	3.33	5.65	A
CSP-V-9	Y	F/O	490'	2.57	1.73	2.67	A ***
CEP-V-3A	Y	F/C	495'	4.57	1.26	0.90	A
CEP-V-4A	Y	F/C	495'	3.35	1.34	0.89	A

	EMERGENCY X	Y	Z	UPSET X	Y	Z
CSP-V-3	2.48	2.09	3.62	1.73	1.60	0.96
CSP-V-4	2.80	1.97	1.71	1.14	1.40	1.50
CSP-V-5	2.80	2.69	5.32	0.97	1.40	1.71
CSP-V-6	11.37	3.18	5.63	2.69	3.09	1.48
CEP-V-3A	4.54	0.81	0.74	1.20	0.74	0.51
CEP-V-4A	3.66	0.93	0.73	1.05	0.69	0.51

NOTE: ABOVE ACCELERATIONS WERE OBTAINED FROM TRANSMITTAL (SCHUENZEL TO ARMSTRONG) OF LATEST BURNS & ROE PIPING RESPONSE ANALYSIS SECTION 5.5, INCORPORATING CSP MODEL [illegible]

*** CSP-V-9, HOWEVER, AND PREVIOUS ACCELERATIONS ARE STILL APPLICABLE.

△4 REQUIRED ACCELERATIONS (SECTION 5.5) MAY VARY SLIGHTLY FOR THE VALUES PRESENTED IN THIS TABLE. REFER TO SHEETS 43.63-67 FOR DISCUSSION

*006 CC

3.0 TABLE OF CONTENTS

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QID# 361106

Revision 4

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CON'T

QID# 361106

4.0 CALCULATIONS - CYGNA REQUALIFICATION ANALYSIS

SECTION 4.0

REQUALIFICATION ANALYSIS

CYGNA

Calculation Cover Sheet

Project

Equipment Seismic & Hydrodynamic Requalification

Job No. 82044

File No. OT.01/F

Client

Washington Public Power Supply System

Calc. Set No. 1

No. of Sheets 68

Subject

Seismic Qualification of 24" Cylinder Operated Butterfly Valves
QID 361106, EPN #CSP-V-3,4,5,6 & 9, and CEP-V-3A & 4A

Statement of Problem

The equipment qualification was performed based on calculations using valve and operator response g-levels transmitted by the A/E, (Final piping loads dated 3/31/83 & 4/13/83

Sources of Data

See sheets 4.3.67 and 4.3.68

Sources of Formulae & References

See sheets 4.3.67 and 4.3.68

Remarks

None

Originators	Checkers	Distribution	Revision No. 4
J. Rakowski	D. Searle	WPPSS-2 Project File-1	Supersedes Calculation Set No. Revision 3
M. Kuntz	L. Kaner		
M. Scott	LC Fernandez		Approved By: [signature] Date: 6/9/83
D. SEARLE	TBG MARVIN		[signature] 11-11-83

1005.00

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Calculation Sheet

Project		Prepared By:	Date
Subject		Checked By:	Date
System		Job No.	File No.
Analysis No.	Rev. No.	Sheet No.	

CONTENTS

CYGNA

Calculation Sheet

Project		Prepared By:	Date
Subject		Checked By:	Date
System		Job No.	File No.
Analysis No.	Rev. No.	Sheet No.	

SECTION 4.1

CONCLUSIONS

CYGNA

Calculation Sheet

Project: WPPSS Equipment Seismic Hydrodynamic Requalification		Prepared By: [signature]	Date: 6/9/83
Subject: BIF Valves/Miller Operators		Checked By: L.C. Fernandez	Date: 6/9/83
System: CEP & CSP		Job No.: 82044	File No.: 1T.01.F
Analysis No.: 361106	Rev. No.: 3	Sheet No.: 4.1.1	

CONCLUSIONS

Seven 24-inch BIF Butterfly valves with Miller Air Products cylinder operators have been analyzed for structural integrity and operability for the plant specific seismic and hydrodynamic piping loads transmitted from Burns and Roe. These piping loads are in the form of air operator response G-levels (Section 5.5, dated March 31, 1983).

The valves will be qualified after incorporating the following modifications:

1) Remove the existing operator bracket attachment bolts (A-307) and replace with an A-325 or A-490 bolt.

2) Reinforce the operator support ears with the addition of shear plates as shown on page 4.3-48 or 4.3-54 of 361106, Rev. 3 (this report).

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Calculation Sheet

Project		Prepared By:	Date
Subject		Checked By:	Date
System		Job No.	File No.
Analysis No.	Rev. No.	Sheet No.	

SECTION 4.2

SUMMARY OF RESULTS

CYGNA

Calculation Sheet

Project: WPPSS MECHANICAL EQ		Prepared By: E. R[illegible]	Date 3/20/83
Subject: 24" Butterfly Valves		Checked By: A. E. Searle	Date 3/30/83
System: CSP & CEP		Job No. 82044	File No. OT.01.F
Analysis No. 361106	Rev. No. 2	Sheet No. 361106-42-1	

SUMMARY OF RESULTS

Parametric data for the seven subject valves in this report is given in Table 1.1. Results of the requalification analyses, which include a comparison of calculated stresses to the allowables are given in Table 1.2. Allowable stresses for the various material types are given in Table 1.3.

CYGNA

Calculation Sheet

Project: WPPSS - EQUIPMENT QUALIFICATION	Prepared By: [signature]	Date: 4/29/83	
Subject: 24" BUTTERFLY VALVES	Checked By: [signature]	Date: 5/15/83	
System: CSP & CEP	Job No. 82044	File No. 1P.01.F	
Analysis No. 361106	Rev. No. 2	Sheet No. 361106-4.2-2	

△3 [signature] 6/3/83
[signature] 6/9/83
△4 D. Searle 11/10/83
TBG HAWIN 11-11-83

SUMMARY TABLE 1.1

24" VALVE REQUIRED G-LEVELS (FAULTED CONDITION)

EPN	Hydro	FN	EL. REAC.	ACCELERATIONS (G'S) X	Y	Z	EQUIPMENT CLASSIFICATION △3
CSP-V-3	Y	F/C	481	2.66	2.99	3.76	A
CSP-V-4	Y	F/C	478'	2.16	3.17	4.19	A
CSP-V-5	Y	F/O	475'	2.96	3.44	5.42	A
CSP-V-6	Y	F/O	480'	11.39	3.33	5.65	A
CSP-V-9	Y	F/O	490'	2.57	1.73	2.67	A ***
CEP-V-3A	Y	F/C	495'	4.57	1.26	0.90	A
CEP-V-4A	Y	F/C	495'	3.55	1.34	0.89	A

	EMERGENCY X	Y	Z	UPSET X	Y	Z
CSP-V-3	2.48	2.09	3.62	1.73	1.60	0.96
CSP-V-4	2.80	1.97	1.71	1.14	1.40	1.50
CSP-V-5	2.80	2.69	5.32	0.97	1.40	1.71
CSP-V-6	11.37	3.18	5.63	2.69	3.09	1.48
CEP-V-3A	4.54	0.81	0.74	1.20	0.74	0.51
CEP-V-4A	3.66	0.93	0.73	1.05	0.69	0.51

NOTE: ABOVE ACCELERATIONS WERE OBTAINED FROM TRANSMITTAL (SCHUENZEL TO ARMSTRONG) OF LATEST BURNS & ROE PIPING RESPONSE ANALYSIS SECTION 5.5, INCORPORATING SAP MODEL APPENDIX B. THE PIPING FOR
*** CSP-V-9, HOWEVER, AND PREVIOUS ACCELERATIONS ARE STILL APPLICABLE.

△4 REQUIRED ACCELERATIONS (SECTION 5.5) MAY VARY SLIGHTLY FOR THE VALUES PRESENTED IN THIS TABLE. REFER TO SHEETS 4.3.63-67 FOR DISUSSION

1006 00

SUMMARY TABLE 1.2. FAULTED CONDITION
(STRESS IN PSI)

MEMBER	MAT'L TYPE	TYPE STRESS	VALVE EPN'S CSP-V-3	CSP-V-4*	CSP-V-5	CSP-V-6	CEP-V-3A	CEP-V-4A	MATERIAL ALLOWABLE
TRUNNION PINS	SA-276	S			4108 MAX				11840
TAPERED PINS	SA-276	S			8710 MAX				11840
DRIVE LEVER	A-395	T			10420 MAX				43200
LEVER KEYWAY	A-395	T			27381 MAX				43200
MAIN SHAFT	SA-479	S			9127 MAX				14500
DRIVE ROD	4140	T	31629	33019	40634	33433	7462	7462	86400
EAR BOLTS	A-325**	T	16845	18392	20848	58884	23525	18018	66000
		S	14670	15475	19482	17564	4538	6136	26250
SHEAR PL WELD	E60	S	—	—	8761 △	—	—	—	28800
VALVE EAR WELD	E60	S	—	—	9626 △	—	—	—	28800
FATIGUE RESULTS - STRESS RANGE IN PSI									**ALLOWABLE STRESS RANGE**
TAPER PINS	SA276	S***							90000
DRIVE ROD	4140	T	63258	66038	81268	66866			90000
TRUNNION PINS	SA-276	S***			16432 MAX				90000
SHEAR PL WELD	E60				17522 △				22500
VALVE EAR WELD	E60				19252 △				22500

* EPN- CSP-V-9 ENVELOPED BY CSP-V-4 BY WIDE MARGIN

** AS INSTALLED BOLTS ARE CURRENTLY A-307 — REQUIRE CHANGING TO A-325

*** FATIGUE EVALUATION OF A SHEAR LOAD RESOLVES INTO A TENSILE STRESS RANGE AS FOLLOWS: $\sigma_{MAX} = 2\tau_{MAX}$ $SR = 2\sigma_{MAX} = 4\tau_{MAX}$

△ ACTUAL STRESSES DUE TO FINAL PIPING ACCELERATIONS MAY VARY SLIGHTLY REFER TO SHEETS 4.3.63 → 67 FOR DISCUSSION

Calculation Sheet

△ D. Searle 11/8/83 TSK Hawn 11-11-83

Project: WPPSS EQUIPMENT REQUAL
Subject: 24" B/F BUTTERFLY VALVES
System: CSP & CEP
Analysis No. 361106 Rev. No. 3
Prepared By: [signature] Date 6/8/83
Checked By: Y.C. Fernandez Date 6/9/83
Job No. 8204 File No. 1P.01F
Sheet No. 361106-4.2-3

CYGNA

Calculation Sheet

Project	WPPSS EQ	Prepared By: J E Rokowski	Date 3/25/83
Subject	24" Butterfly Valves	Checked By: A E Sieank	Date 3/30/83
System	CSP & CEP	Job No. 82044	File No. OT.01/F
Analysis No. 361106	Rev. No. 2	Sheet No.	361106-4.2-4

△3 [signature] 6/9/83
J C Fernandez 6/9/83

SUMMARY TABLE 1.3

ALLOWABLE STRESSES

Since operability is required, the stresses for the faulted condition will be kept below yield*. The table below is based on AISC criteria and the yield stresses at temperature (340°F) from PG. 9 of REF. 4 for conservatism.

		LEVEL A & B		LEVEL D **	
MATERIAL	YIELD STRS (PSI)	.6 Fy BENDING ALLOW.	.4 Fy SHEAR ALLOW.	1.6×.6 Fy = 0.96 Fy BENDING ALLOW.	1.6×.4·Fy 0.64 Fy SHEAR ALLOW.
AISI-4140 HEAT TREATED	90,000	54,000	36,000	86,400	57,600
SA-276, GR 304	18,500	11,100	7,400	17,760	11,840
ASTM A-395-60-45-15	45,000	27,000	18,000	43,200	28,800
SA-307	23,300	13,980	9,320	22,370	14,900
AISI-1018 (MIN YIELD)	35,000	21,000	14,000	33,600	22,400
SA-193, GR B3, 304SS	31,000	18,600	12,400	29,760	19,840
SA-479, 304SS	22,650	13,590	9,060	21,744	14,500
SA-516, GR 60	28,000	16,800	11,200	26,880	17,920

** 1.6 FACTOR REFERENCE DESIGN CRITERIA DC-1, REF 14 △3

* BRACKET BOLT ALLOWABLES TAKEN FROM AISC, 8TH ED., SEC. 1.5.2.2

SECTION 4.3

ANALYSIS

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification	Prepared By: E R [signature]	Date: 1/10/83	
Subject: 24" Butterfly Valves	Checked By: A E Searle [signature]	Date: 3/30/83	
System: CSP & CEP	Job No: 82044	File No. OT.01/F	
Analysis No. 361106	Rev. No. 2	Sheet No. 361106-4.3-1	

EQUIPMENT REQUALIFICATION FOR QID 36110
BIF 24" CYLINDER OPERATOR BUTTERFLY VALVES

4.3.1 Introduction

The seven valves in this file are classified according to the parametric data given in Summary Table 1.1.

Since hydrodynamic loads apply in certain cases, fatigue analyses were provided for components with the highest stress ranges.

The calculated stresses are based on valve and operator G-levels calculated from the piping analysis and received from Burns & Roe. Since these loads were initially too high to qualify all EPN's the response G-levels were subsequently recalculated with some of the conservatisms removed from the piping analysis. In addition, an SRSS analysis was set up in a computer program for each valve EPN in its specific orientation in the piping system (see Section 5.4). Each computer program (Appendix A) is compiled and hence not subject to subsequent change unless recompiled (and documented).

The method calculates stress from the north, vertical, and east component of operator response g-levels. The SRSS is taken at the stress level and operating loads due to seating torque force and dead weight are later combined by an absolute sum. Valve ear bending stress components due to any one response g-level component are combined by an absolute sum.

The computer analysis addresses only the more highly stressed components in the valve operator assembly. Separate analysis is given for the remaining components using a simpler approach with upper bound loads. This applies to all valve operator EPN's in QID 361106 (24" Valve/8" cylinders) and QID 361104 (30" valves/10" operators). Hand calculations which check selected portions of computer output are shown in Appendix C.

Appendix B of this section describes the air operator mass/stiffness model which was incorporated in the final piping analysis for calculation of operator response g-levels. The computer program includes an option for using the valve ear forces and moments which are directly output from the piping analysis with the valve/operator model included. This was not finally utilized, however, to qualify the subject equipment.

The equipment locations and elevations were taken from the P&ID's in section 6.0. Natural frequency calculations are given for the air operator assemblies in Section 4.3.2.1.

Preliminary analyses were performed which showed that, for operator response g-levels greater than approximately 3 g's, the air cylinder spring preload force would be exceeded and hence some disk flutter would occur when the valve is in the open position. The calculation in section 4.3.2.2 shows that the magnitude of the valve disk flutter vibration angle due to upper bound g-levels which occur in the hydrodynamic frequency range is approximately 6 degrees. This flutter was evaluated to have no detrimental effect on system safety function as noted in Reference 5.

Valve operability was addressed in the following manner. For the valves with Use Code 2, operability after the event can be assured by demonstrating that faulted condition stresses remain below elastic limits (see Summary of Results.

For valves CSP-V-3 and 4, which must operate from open to fail closed during an event, the following additional evaluations were made:

1) Dynamic flow torques were assessed per Ref. 3 and found to be less than the seating torque which controlled the equipment stresses. Furthermore these flow torques tend to move the valve disk toward the fail-closed position, as noted in the above report.

2) The details of BIF drawing 206 767, parts of which are shown in figures 1.1 and 1.2, allow the following conclusions to be made for valve operability:

   A) Figure 1.1 shows that thrust bearings are part of the shaft bearing design. This design prevents lateral movement of the disk in the direction of the shaft to eliminate interference with the valve body when closing. Further, it is noted on Page 26 of Ref. 3 that frictional torques in the shaft bearing system are negligible.

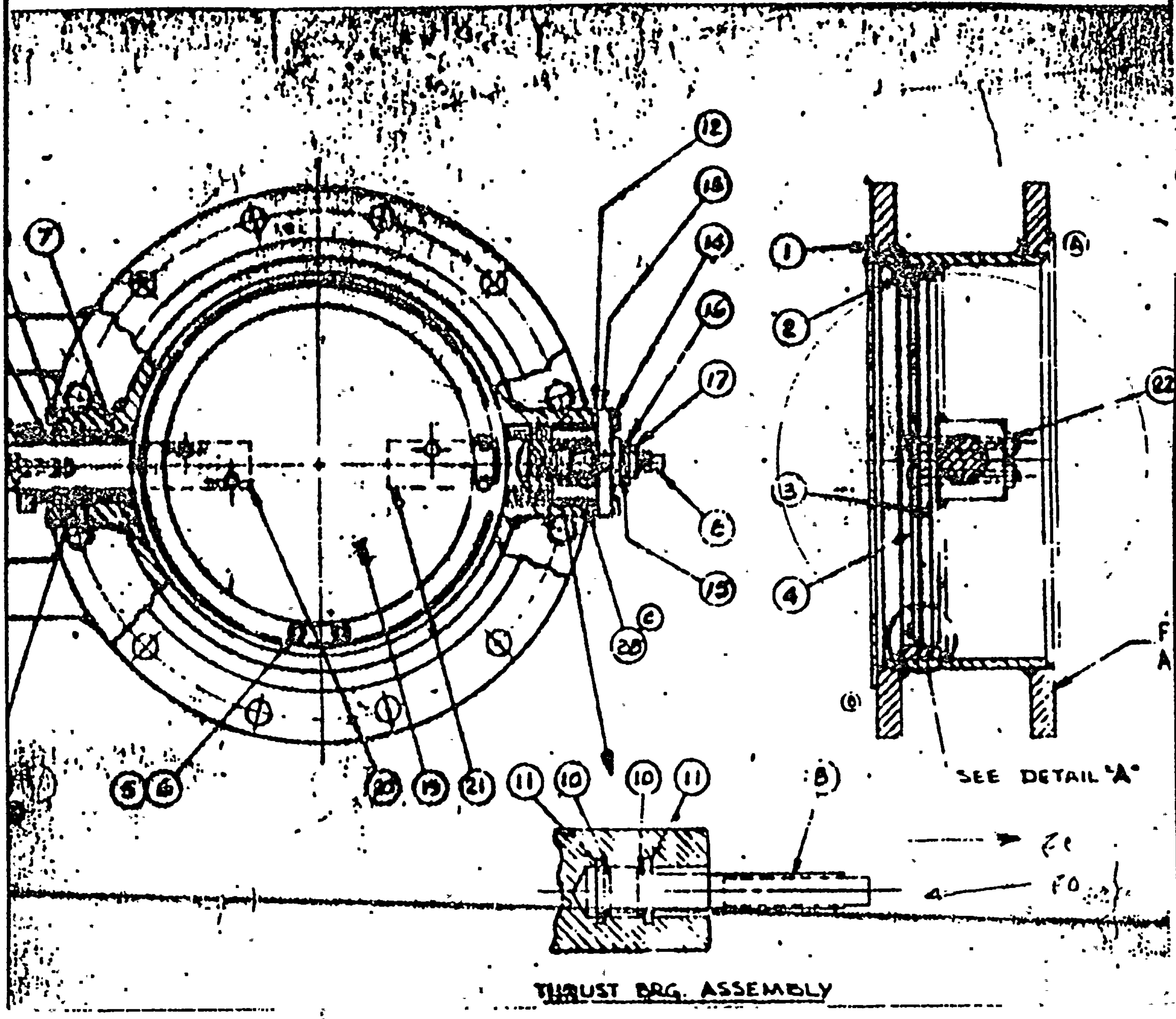
   B) Figures 1.1 and 1.2 show a circular valve cross section having an internal rim within which the valve seats in the closed position. The only mechanism remaining to affect valve closing which can be postulated is out-of-round distortion of the section due to DBE piping loads and dynamic loads on the valve.

These loads were accounted for in Ref. 4 in the overall valve sizing calculations, where analysis showed that the stress intensity in the 0.5 inch thick valve body remained below 1.2 Sm, or approximately 0.8 of yield. Stress contribution from dynamic loads on the valve and operator were relatively small. Further, as shown in the figures:

Calculation Sheet

Project: WPPSS Equipment Qualification
Subject: 24" Butterfly Valves
System: CSP and CEP
Analysis No.: 361106
Rev. No.: 2
Prepared By: JE Rakowski Date: 3/25/83
Checked By: [signature] Date: 3/30/83
Job No.: 82044
File No.: OT.01
Sheet No.: 361106-4.3.4 3A

FIGURE 1.1 BIF DRAWING 206767



Calculation Sheet

Project: WPPSS-EQUIPMENT QUALIFICATION		Prepared By: J E RAKOWSKI	Date 3/25/83
Subject: 24" BUTTERFLY VALVES		Checked By: D E Leark	Date 3/30/83
System: CEP & CSP		Job No. 82044	File No. OT.01/E
Analysis No. 361106	Rev. No. 2	Sheet No. 361106-4.3-5	

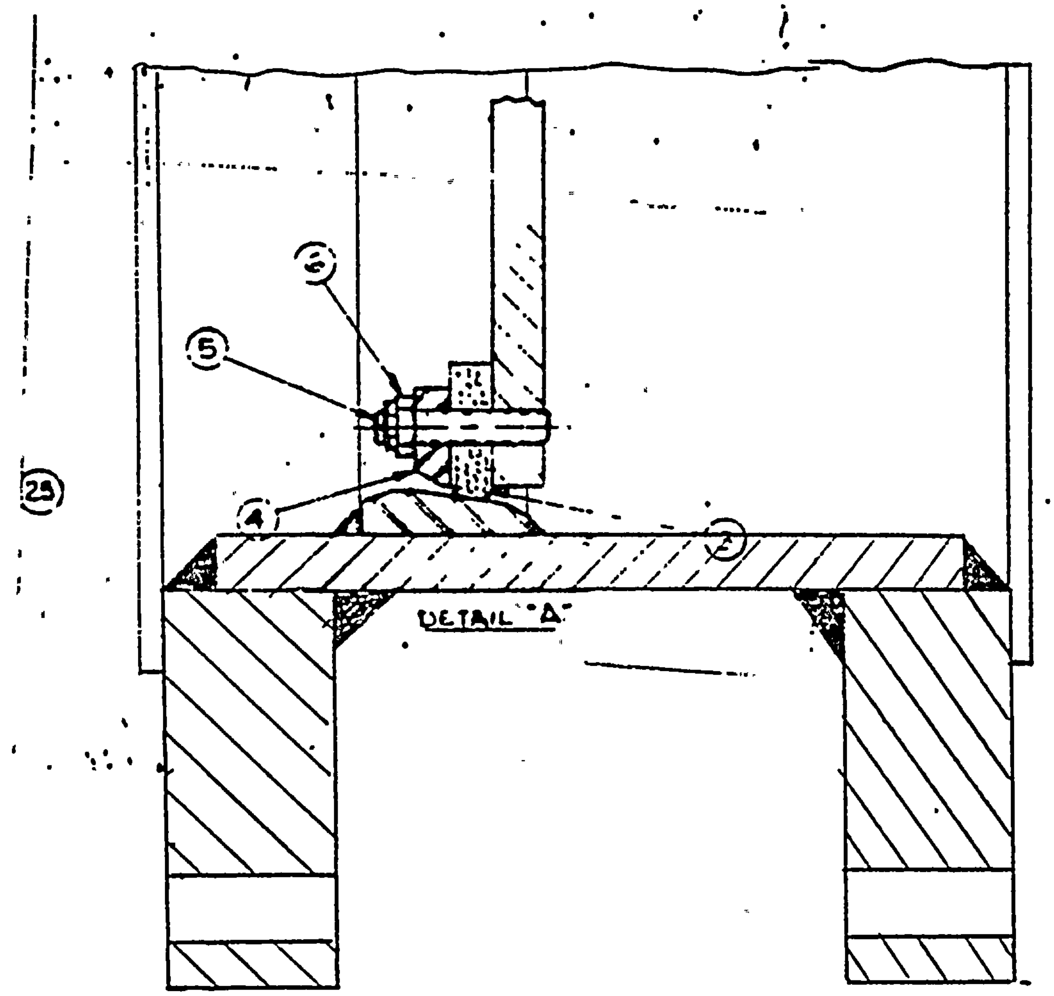


FIGURE 1.2 BIF DRAWING 206767, DETAIL A

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification	Prepared By: [signature]	Date: 1/10/83	
Subject: 24" Butterfly Valves.	Checked By: [signature]	Date: 3/30/83	
System: CSP and CEP	Job No.: 82044	File No.: OT.01/F	
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-43-6	

1. The valve seat forms a heavily reinforced section made up of the valve body, internal hub and external flanges (including the mating flange of the piping). Hence the stress levels in this section are much lower than in the valve body and hence no distortion of the section could occur to affect seating of the valve. Valve flange dimensions are given below. Note the relatively large internal radial clearance of 1/8 inch.

2. Stress analysis of the valve extended structures are given in this report. Air operator operability is addressed in QID 018001.

The design data used in the analyses are given in Summary Table 1.1 (pipe-orientations and elevations are taken from the appropriate P&ID's in Section 6.0). Other pertinant data is given below.

1) Spring preload per communication report in Section 7.0 of QID 018001 are:

Fail Open Preload = 350#
Final = 1850#

Fail Closed Preload = 1500#
Final = 3000#

2) Cylinder C.G.'s shown on the following sketches represent data received from BIF in the communication report of Section 7.0 of QID 018001.

3) Closing torque values are taken from Ref. 3.

4) Valve component dimensions: (Ref. Feb. 10, 11/83 communication report - Section 7)/

Flange: width = 3.5", thickness = 1.78"
Radial Clearance Disk/Seat 1/8"

CYGNA

Calculation Sheet

Project: Supply System - EQ	Prepared By: [signature]	Date: 3/25/83	
Subject: 24" Butterfly Valve	Checked By: [signature]	Date: 3/30/83	
System: CSP & CEP	Job No. 82044	File No. OT.01/F	
Analysis No. 361106	Rev. No. 2	Sheet No. 361106-9.3-7	

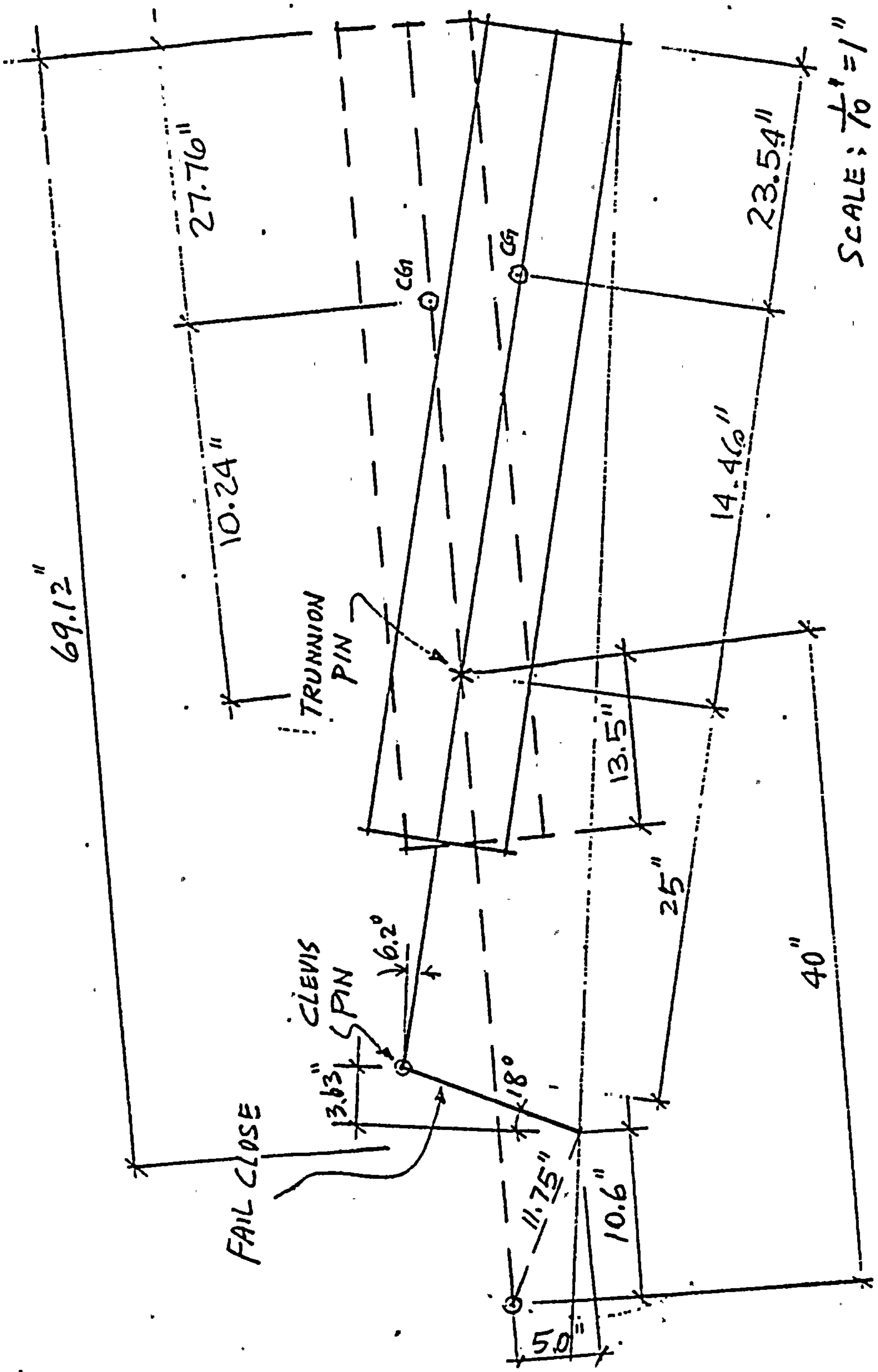


FIGURE 1.3 GEOMETRY OF THE VALVES

24" Cylinder Operated Butterfly Valves QID# 361106

Group II; Cylinder Operator Fail Close

(Valves: CSP-V-3, 4 & CEP-V-3A & 4A)

(Info. taken from Ref. (1) & (4))

CYGNA

Calculation Sheet

Project: Supply System - EQ		Prepared By: J E [signature]	Date 3/25/83
Subject: 24" Butterfly Valve		Checked By: D. E. Searle	Date 3/30/83
System: CSP & CEP		Job No. 82044	File No. OT.01/F
Analysis No. 361106	Rev. No. 2	Sheet No. 361106- 43-8	

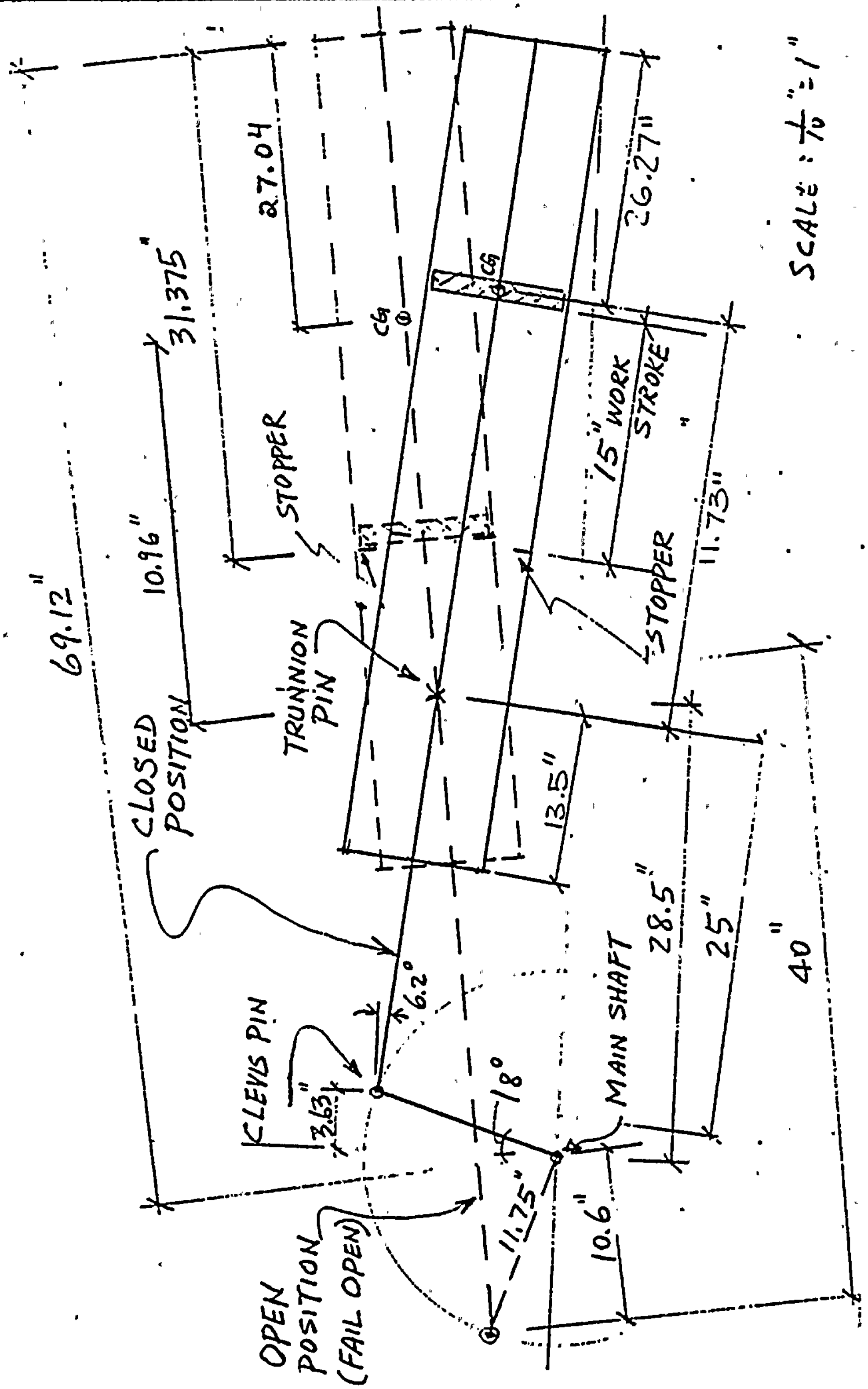


FIGURE 1.4 GEOMETRY OF THE VALVES

24" Cylinder Operated Butterfly Valves QID# 361106

Group I; Cylinder Operator Fail Open

(Valves: CSP-V-5, 6, 9)

(Info. taken from Ref. (1) & (4))

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: J. E. Rolowski	Date: 1/10/83
Subject: 24" Butterfly Valves		Checked By: W. E. Clark	Date: 3/30/83
System: CSP and CEP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-4.3-9	

4.3.2 CALCULATIONS

4.3.2.1 NATURAL FREQUENCY CALCULATIONS

Perform natural frequency calculations for the following four operator configurations:

Group I - Fail Open

EPN's CSP-V-5 6, and 9

Case I Valve Open

Case II Valve Closed

Group II - Fail Closed

EPN's CSP-V- 3 and 4 and CEP-V-3A and 4A

Case I Valve Open

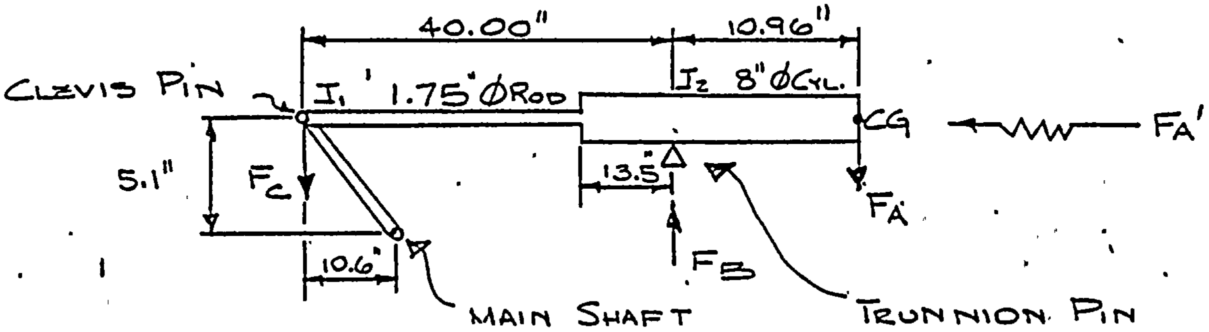
Case II Valve Closed

Calculation Sheet	Prepared By: M. Kunda	Date 11/9/82
	Checked By: L Kaner	Date 11/19/82
Project SUPPLY SYSTEM	Job No. 82044	File No. OT.01/F
Subject 24" BUTTERFLY VALVE		
System CSP & CEP	Sheet No. 361106-4.3-10	
Analysis No. 361106 Rev. No. 2		

GROUP I CYLINDER OPERATOR "FAIL OPEN"

CALCULATE THE NATURAL FREQUENCY OF THE CYLINDER OPERATOR DUE TO THE BENDING STIFFNESS OF THE DRIVE ROD AND THE CYLINDER OPERATOR. THESE CALCULATIONS ASSUME THAT OPERATOR PISTON REMAINS SEATED AGAINST THE OPEN OR CLOSED POSITION STOP BY ACTION OF THE SPRING.

CASE I VALVE OPEN

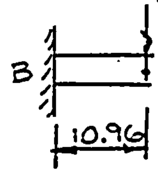


$$I_1 = 0.46 \text{ in}^4$$
$$I_2 = \frac{\pi}{64}(8.45^4 - 7.97^4) = 52.2 \text{ in}^4$$

CALCULATION OF F_N:

$$\delta_A = \frac{Pl^3}{3EI} = \frac{500(10.96)^3}{3(29\times10^6)(52.2)} = .000145 \text{ IN}$$

WITH END B FIXED



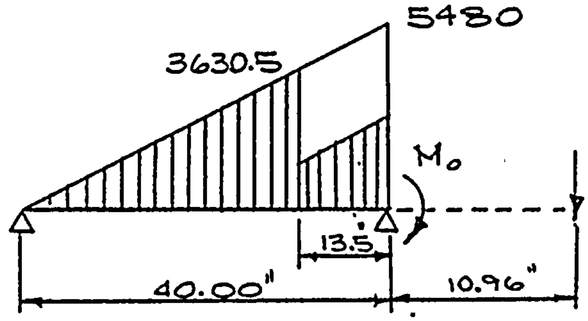
1006 00

CYGNA

Calculation Sheet

Project: SUPPLY SYSTEM	Prepared By: M. Kundz	Date: 11/9/82
Subject: 24" BUTTERFLY VALVE	Checked By: L. Kaur	Date: 11/19/82
System: CSP & CEP	Job No.: 82044	File No.: OT.01/F
Analysis No.: 361106 Rev. No.: 2	Sheet No.: 361106-4.3-11	

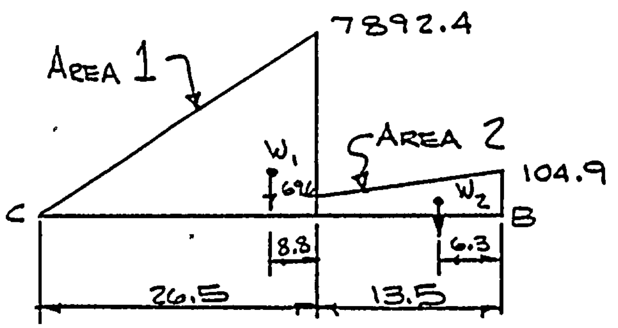
ROTATION AT "B" DUE TO M_o OF M/I DIAGRAM



$M_o = 500(10.96)$
$= 5480$ in#

$\frac{5480}{52.2} = 104.9$ $\quad \frac{3630.5}{52.2} = 69.55$ $\quad \frac{3630.5}{0.46} = 7892.4$

$W_1 = 7892.4\left(\frac{26.5}{2}\right) = 104574.2$ $\quad W_2 = \left(\frac{104.9 + 69.55}{2}\right)(13.5) = 1177.5$



AREA 1

$CG_{AREA\,1} = \frac{1}{3}(26.5) = 8.83$ IN

AREA 2

RECTANGLE:

$CG_R = \frac{1}{2}(13.5) = 6.75$

$A_R = (13.5)(69.6) = 939.6$

TRIANGLE:

$CG_T = \frac{2}{3}(13.5) = 9.0$

$A_T = \frac{1}{2}(13.5)(35.3) = 238.3$

$CG_{AREA\,2} = \frac{(CG_{RECT})(A_{RECT}) + (CG_{TRI})(A_{TRI})}{(A_{RECT}) + (A_{TRI})}$

$= \frac{(6.75)(939.6) + (9)(238.3)}{939.6 + 238.3}$

$= 7.21$ IN

$\therefore 13.5 - 7.21 = 6.3$ IN

$R_B = 104574.2\left(\frac{17.67}{40}\right) + 1177.5\left(\frac{33.7}{40}\right) = 46195.7 + 99.21$

$= 47187.8$

$\theta_B = \frac{47187.8}{29 \times 10^6} = .00163$ rad.

1006 00

Calculation Sheet	Prepared By: M. Kuntz	Date 11/11/82
Project SUPPLY SYSTEM	Checked By: L. Kom	Date 11/19/82
Subject 24" BUTTERFLY VALVE	Job No. 82044	File No. OT.01/F
System CSP & CEP	Sheet No.	
Analysis No. 361106 Rev. No. 2	361106-4.3-12	

DEFLECTION OF POINT A

$\delta_{A'}$ due to θ_B

$= .00163\,(10.96)$

$= .0179$

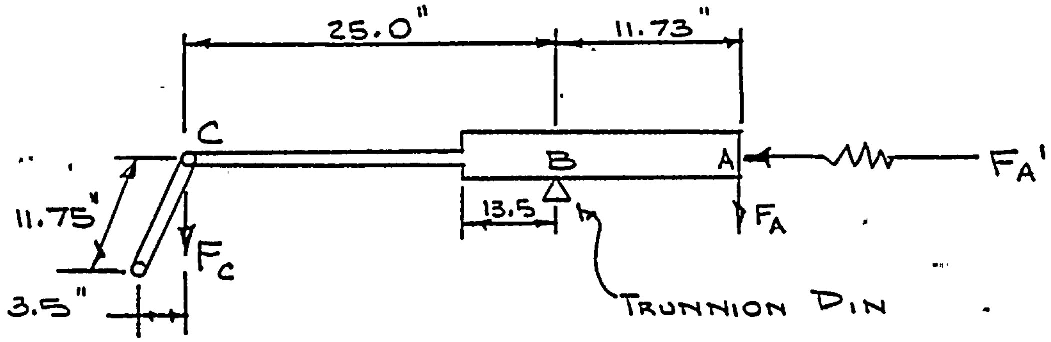
$\therefore$ TOTAL $\delta_A = .000145 + .0179 = .0181$

$K = \frac{500}{.0181} = 27700.8\ \#/in$

$f_N = \frac{1}{2\pi}\sqrt{\frac{27700.8\,(386.4)}{399^{\#}}} = 26.07\ Hz.$

(DEAD WT. OF CYL. OPERATOR = 399#)

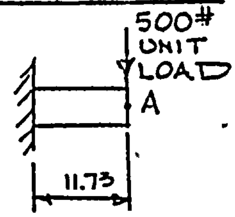
CASE II VALVE CLOSED



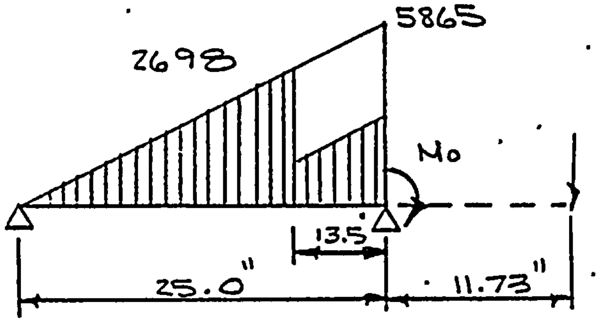
CYGNA	Calculation Sheet	Prepared By: M. Kunde	Date 11/11/82
	Project: Supply System	Checked By: L Kam	Date 11/19/82
	Subject: 24" Butterfly Valve	Job No. 82044	File No. OT.01./F
	System: CSP & CEP	Sheet No.	
	Analysis No. 361106 Rev. No. 2	361106-4.3-13	

Calculation of f_n:

$$\delta_A = \frac{Pl^3}{3EI} = \frac{500^{\#}(11.73^3)}{3(29\times10^6)(52.2)} = .000178$$



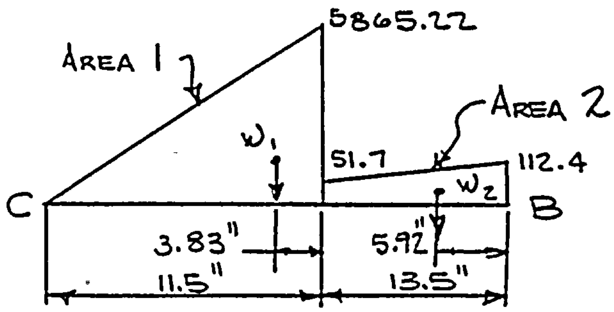
Rotation At "B" Due To Mo of M/I Diagram



$M_o = 500(11.73)$
$= 5865 \text{ in}^{\#}$

$$\frac{5865}{52.2} = 112.36 \qquad \frac{2698}{52.2} = 51.69 \qquad \frac{2698}{0.46} = 5865.22$$

$$W_1 = 5865.22\left(\frac{11.5}{2}\right) = 33725 \qquad W_2 = \left(\frac{112.36+51.69}{2}\right)(13.5) = 1107.3$$



Area 1

$CG_{AREA_1} = \frac{1}{3}(11.5) = 3.83 \text{ in}$

Area 2

Rectangle:

$CG_R = \frac{1}{2}(13.5) = 6.75$

$A_R = (13.5)(51.7) = 697.95$

Triangle:

$CG_T = \frac{2}{3}(13.5) = 9.0$

$A_T = \frac{1}{2}(13.5)(112.4-51.7) = 409.73$

$$CG_{AREA_2} = \frac{(CG_R)(A_R)+(CG_T)(A_T)}{A_R + A_T}$$

$$= \frac{(6.75)(697.95)+(9)(409.73)}{697.95+409.73}$$

$= 7.58 \text{ in}$

$\therefore 13.5 - 7.58 = 5.92 \text{ in}$

1006 00

CYGNA	**Calculation Sheet**	Prepared By: M. Kuntz	Date 11/11/82
		Checked By: [signature]	Date 11/19/82
	Project SUPPLY SYSTEM	Job No. 82044	File No. OT.01/F
	Subject 24" BUTTERFLY VALVE		
	System CSP & CEP	Sheet No. 361106-4.3-14	
	Analysis No. 361106 Rev. No. 2		

$$R_B = 33725\left(\frac{7.67}{25}\right) + 1107.3\left(\frac{19.1}{25}\right) = 10346.8 + 845.2$$
$$= 11191.99$$
$$\theta_B = \frac{11191.99}{29 \times 10^6} = .00039 \text{ rad}$$

DEFLECTION AT POINT "A"

δ_A' due to θ_B
$$= .00039(11.73)$$
$$= .0046$$
TOTAL $\delta_A = .000178 + .0046 = .00478$

$$K = \frac{500^{\#}}{.00478} = 104603^{\#}/\text{IN}$$

$$f_N = \frac{1}{2\pi}\sqrt{\frac{104603(386.4)}{399}} = 50.66 \text{ Hz}$$

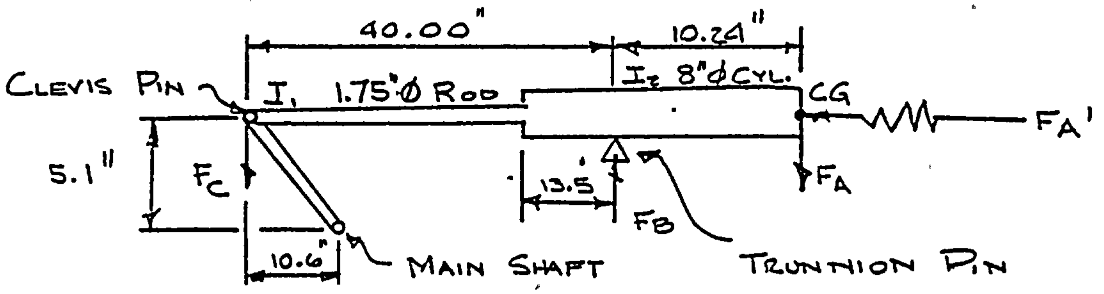
1006 00

Calculation Sheet	Prepared By: M. Kuntz	Date 11/11/82
	Checked By:	Date 11/19/82
Project: SUPPLY SYSTEM	Job No. 82044	File No. OT.01/F
Subject: 24" BUTTERFLY VALVE		
System: CSP & CEP	Sheet No.	
Analysis No. 361106 Rev. No. 2	361106-4.3-15	

GROUP II CYLINDER OPERATOR "FAIL CLOSE"

CALCULATE THE NATURAL FREQUENCY OF THE CYLINDER OPERATOR DUE TO THE BENDING STIFFNESS OF THE DRIVE ROD AND THE CYLINDER OPERATOR.

CASE I VALVE OPEN



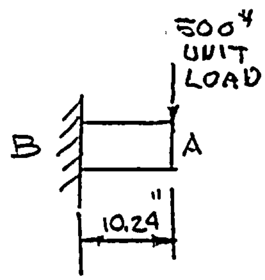
$I_1 = .46 \text{ IN}^4$

$I_2 = \frac{\pi}{64}(8.45^4 - 7.97^4) = 52.2 \text{ IN}^4$

CALCULATION OF f_N:

$$\delta_A = \frac{P\ell^3}{3EI} = \frac{500^{\#}(10.24^3)}{3(29)(10)^6(52.2)} = .000118 \text{ IN}$$

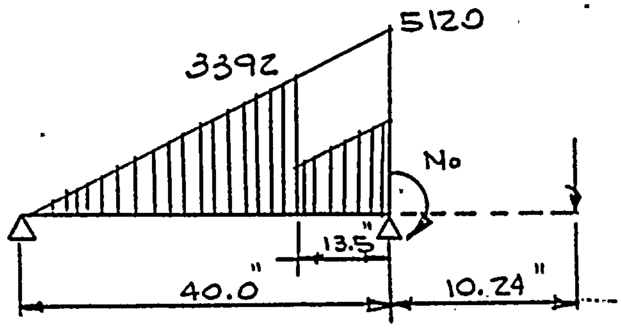
WITH END 'B' FIXED.



1006 00

Calculation Sheet		Prepared By: M. Kuntz	Date: 11/11/82
		Checked By: L. Fosner	Date: 11/19/82
Project: SUPPLY SYSTEM		Job No.: 82044	File No.: OT.01/F
Subject: 24" BUTTERFLY VALVE		Sheet No.: 361106-4.3-16	
System: CSP & CEP			
Analysis No.: 361106	Rev. No.: 2		

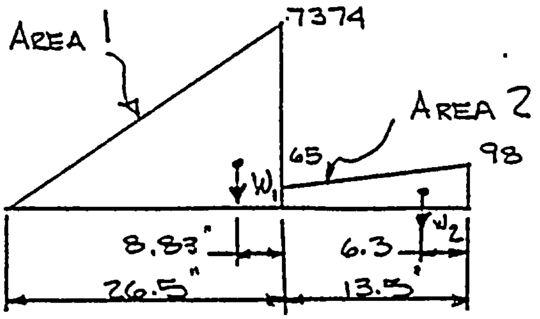
ROTATION AT "B" DUE TO Mo OF M/I DIAGRAM



$M_o = 500(10.24)$
$= 5120 \text{ in}\#$

$\frac{5120}{52.2} = 98.1 \qquad \frac{3392}{52.2} = 64.98 \qquad \frac{3392}{.46} = 7373.9$

$W_1 = (7373.9)\left(\frac{26.5}{2}\right) = 97704.35 \qquad W_2 = \left(\frac{98.1 + 64.98}{2}\right)(13.5) \doteq 1100.8$



AREA 1

$CG_{AREA\,1} = \frac{1}{3}(26.5) = 8.83 \text{ IN}$

AREA 2

RECTANGLE:

$CG_R = \frac{1}{2}(13.5) = 6.75$

$A_R = (13.5)(65) = 877.5$

TRIANGLE:

$CG_T = \frac{2}{3}(13.5) = 9.0$

$A_T = \frac{1}{2}(13.5)(98-65) = 222.75$

$CG_{AREA\,2} = \frac{(CG_R)(A_R) + (CG_T)(A_T)}{A_R + A_T}$

$= \frac{(6.75)(877.5) + (9)(222.75)}{877.5 + 222.75}$

$= 7.21 \text{ IN}$

$\therefore 13.5 - 7.21 = 6.3 \text{ IN}$

$R_B = 97704.35\left(\frac{17.67}{40}\right) + 1100.8\left(\frac{33.7}{40}\right) = 43160.9 + 927.42$

$= 44088.32$

$\theta_B = \frac{44088.32}{29 \times 10^6} = .00152 \text{ rad}$

Calculation Sheet	Prepared By: M. Kuntz	Date 11/11/82
Project SUPPLY SYSTEM	Checked By: L. Kosmer	Date 11/19/82
Subject 24' BUTTERFLY VALVE	Job No. 82044	File No. OT.01 / F
System CSP & CEP	Sheet No.	
Analysis No. 361106 Rev. No. 2	361106-4.3-17	

DEFLECTION OF POINT A.

δ_{A}' due to θ_B

$= .00152(10.24)$

$= .0156$

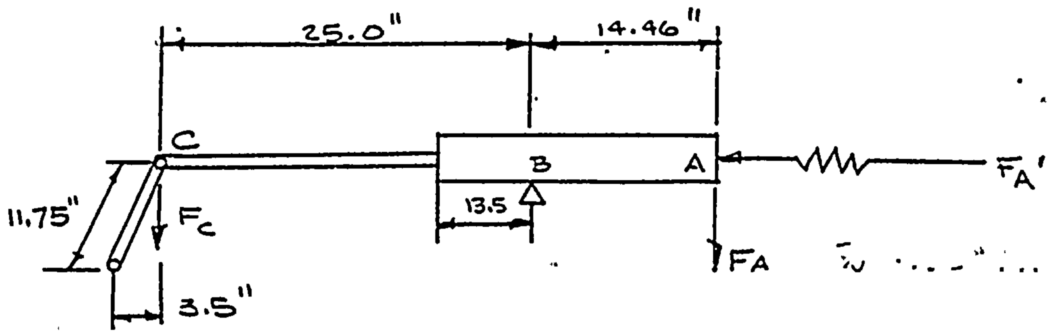
$\therefore$ TOTAL $\delta_A = .000118 + .0156 = .0157$

$k = \frac{500}{.0157} = 31810.7 \frac{\#}{in}$

$f_N = \frac{1}{2\pi}\sqrt{\frac{31810.7(386.4)}{399\#}} = 27.93\ Hz$

(DEAD WEIGHT OF CYL. OPERATOR = 399#)

CASE II VALVE CLOSED



1006.00

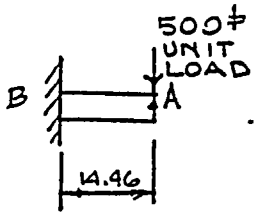
CYGNA

Calculation Sheet

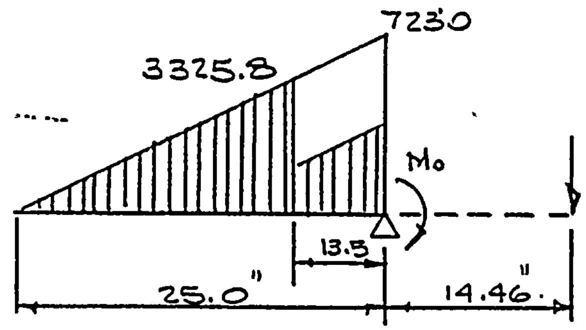
Project: Supply System		Prepared By: M. Kuntz	Date: 11/11/82
Subject: 24" Butterfly Valve		Checked By: L Kemn	Date: 11/17/82
System: CSP & CEP		Job No. 82044	File No. 07.01/F
Analysis No. 361106	Rev. No. 2	Sheet No. 361106-4.3-18	

CALCULATION OF f_N:

$$\delta_A = \frac{Pl^3}{3EI} = \frac{500^{\#}(14.46^3)}{3(29\times10^6)(52.2)} = .000032$$



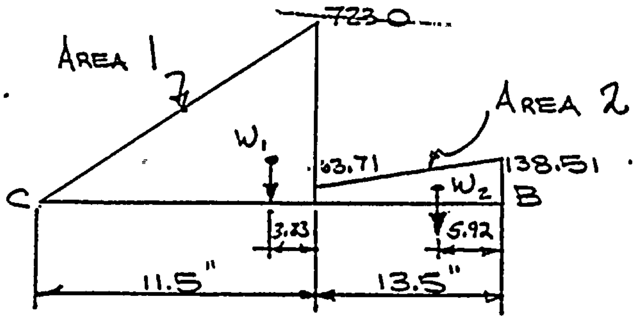
ROTATION AT 'B' DUE TO M_o OF M/I DIAGRAM



$M_o = 500(14.46)$
$= 7230$

$$\frac{7230}{52.2} = 138.51 \qquad \frac{3325.8}{52.2} = 63.71 \qquad \frac{3325.8}{0.46} = 7230$$

$$W_1 = 7230\left(\frac{11.5}{2}\right) = 41572.5 \qquad W_2 = \left(\frac{138.51+63.71}{2}\right)(13.5) = 1364.99$$



AREA 1

$CG_{AREA\,1} = \frac{1}{3}(11.5) = 3.83$ IN

AREA 2

RECTANGLE:

$CG_R = \frac{1}{2}(13.5) = 6.75$

$A_R = (13.5)(63.71) = 860.09$

TRIANGLE:

$CG_T = \frac{2}{3}(13.5) = 9.0$

$A_T = \frac{1}{2}(13.5)(138.51-63.71) = 504.9$

$$CG_{AREA\,2} = \frac{(CG_R)(A_R)+(CG_T)(A_T)}{A_R+A_T}$$

$$= \frac{(6.75)(860.1)+(504.9)(9.)}{860.09+504.9}$$

$= 7.58$ IN

$\therefore 13.5 - 7.58 = 5.92$ IN

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: [signature]	Date: 1/10/83
Subject: 24" Butterfly Valves		Checked By: [signature]	Date: 3/30/83
System: CSP and CEP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-4.3-19	

$R_B = 41572.5(\frac{7.67}{25}) + 1364.99(\frac{19.1}{25}) = 12754.44 + 1042.85 = 13797.29$

$\theta_B = \frac{13797.29}{29x10^6} = .000476$ rad

Deflection at Point "A"

$\delta A'$ due to θ_B

$= .000476(14.46)$

$= .0069$

Total $\delta A = .0069 + .000032 = .0069$

$K = \frac{500\#}{.0069} = 72306.99\#/IN$

$fn = \frac{1}{2\pi}\sqrt{\frac{(72307)\ (386.4)}{399}} = 42.12$ Hz

CALCULATION OF f_N PARALLEL TO THE DRIVE ROD AND TRUNNION PINS ;

(CONTINUED)

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: E Polowski	Date: 3/25/83
Subject: 24" Butterfly Valves		Checked By: E Searle	Date: 3/30/83
System: CSP and CEP		Job No.: 82044	File No.: 0T.01/F
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-4.3-20	

CALCULATION OF fN PARALLEL TO THE DRIVE ROD AND TRUNNION PINS:

APP. B PG. 7/13

BRACKET STIFFNESS IS : (CANTILEVER BEAM OF EFFECTIVE I_{zz})

$$K = \frac{P}{\delta} = \frac{3EI}{l^3} = \frac{3 \times 2.9(10)^7 * 2.16}{(28.5)^3}$$

(2.16 IN^4 FOR 8" CYL)
(4.22 IN^4 FOR 10" CYL)

$$= .00081 \times 10^{-7} = 8100 \text{ lb/in}$$

$$M = \frac{(\bar{W}_{AO} + \bar{W}_{BR})}{g} = \frac{(399+277)}{384.6} = 1.76 \frac{\text{lb sec}^2}{\text{in}}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{K}{M}} = \frac{1}{6.28}\sqrt{\frac{8100}{1.76}} = 10.81 \text{ hz}$$

B) PARALLEL TO DRIVE ROD

APP. B, PG 2/13

SAME MASS, STIFFNESS = EAR BENDING STIFFNESS

EAR STIFFNESS = K_{yy} = 48×10^6 lb/in (10"), = $7.5(10)^6$ lb/in (8")

$$f_n|_{10"} = \frac{10^3}{2\pi}\sqrt{\frac{48}{2.38}} = 715 \text{ Hz}$$

$$f_n|_{8"} = \frac{10^3}{2\pi}\sqrt{\frac{7.5}{1.76}} = 328 \text{ Hz}$$

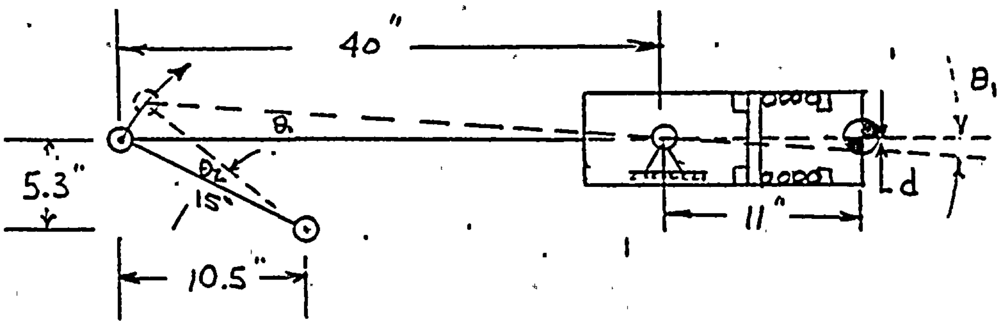
CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: [signature]	Date 3/25/83
Subject: 24" Butterfly Valves		Checked By: [signature]	Date 3/30/83
System: CSP and CEP		Job No. 82044	File No. 0T.01/F
Analysis No. 361106	Rev. No. 2	Sheet No. 361106-4-3-21	

4.3.2.2 APPROXIMATE VALVE FLUTTER MAGNITUDE

USING DIMENSIONS FROM FIGURE 1.3 :



CONSERVATIVELY ASSUME THAT THE MAX ACCELERATION COMPONENT OUTPUT FROM THE PIPING ANALYSIS FOR CSP-V-5 (OPEN / FAIL-OPEN) PRODUCES DISPLACEMENTS OF THE AIR OPERATOR RELATIVE TO THE PIPE IN THE FORM OF

$$d_{max} = \frac{A}{\omega_n^2} \quad \text{WHERE } A = 9.35 g\text{'s} * 386.4 \text{ "/s}^2 \text{ (TABLE 1.1)}$$

FROM THE SPECTRA IN SECTION 5.1, FOR HYDRODYNAMIC LOADS:

$$\omega_n\Big|_{MIN} = 2\pi\ (15\ Hz)\ (R/s)$$

$$\theta_1 = \tan^{-1}\frac{d}{11.0} = \tan^{-1}\left(\frac{1}{11}*\frac{9.35*386.4}{(94.2)^2}\right) = \left(\frac{.41}{11}\right) = \tan^{-1}(.04)$$

$$\theta_1 = 2.13^\circ$$

$$\therefore\ \theta_2 \sim 3*\theta_1 \sim 6^\circ \quad \text{(SMALL)}$$

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: E. Rakowski	Date: 1/10/83
Subject: 24" Butterfly Valves		Checked By: A. Exleake	Date: 3/30/83
System: CSP and CEP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-4.3-22	

4.3.2.3 STRESS ANALYSIS

The procedures for the analysis of the subject valves are outlined below:

1. Recalculate the valve appurtenance stresses addressed in Ref. 4 using response g-levels from the final piping analysis. Incorporate the current seating torque given in Ref. 3. Compare stresses to the appropriate percentage(s) of yield strength as indicated in Summary Table 1.3.

2. Perform a fatigue analysis on significantly stressed components. Determine allowable alternating stress ranges from AISC 8th Edition, Appendix B, noting commentary.

The fatigue analysis is to be performed only for those EPN's subject to hydrodynamic loads. The number of respective load cycles is given below.

LOAD COMBINATIONS & STRESS CYCLES

The following table lists the load combinations and the number of expected stress cycles for each combination. (From the design criteria)

	Combination	Cycles
1.	SRV Alone	13500-200=13300 cycles
2.	OBE+SRV	50
3.	SRV+AP+CHUG	140
4.	SSE+SRV+AP+CHUG	10

Note: Load combination #4 with 150 cycles can be used to conservatively bound combinations 3 and 4.

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: [signature]	Date: 1/10/83
Subject: 24" Butterfly Valves		Checked By: [signature]	Date: 3/30/83
System: CSP and CEP		Job No. 82044	File No. OT.01/F
Analysis No. 361106	Rev. No. 2	Sheet No. 361106-~~4.3-23~~ M	

STRESS ANALYSIS OF VALVE AND AIR OPERATOR COMPONENTS NOT COVERED IN QID 018001

1) TRUNNION PINS

TRUNNION PINS WERE ANALYZED AND THE SHEAR STRESS WAS FOUND TO BE PRIMARILY DEPENDENT ON OVERTURNING IN THE 3-AXIS DIRECTION. WHEN ANALYZED WITH AN ACCELERATION IN THIS DIRECTION OF 13.9 g's, THE SHEAR STRESS WAS ONLY 35 PERCENT OF THE ALLOWABLE. THEREFORE THE PINS ARE SUFFICIENT FOR ALL EPN'S.

THIS CALCULATION FOLLOWS:

(CEP-V-3A)

	8"	10"
L_{CG}	14.46	21.50"
X	12.75"	13.38"
A_{TP}	2.41 IN²	2.41 IN²

$L_{ROD} = 25''$ (CLOSED) $L_{CG} = 14.46''$

$$M_1 = \bar{W}_{AO}\, g_3 L_{CG} = (399)(13.9)(14.46) = 80{,}139 \text{ IN\#}$$

$$F_{23} = \frac{M_1}{X} = \frac{80139}{12.75} = 6285\ \#$$

$$F_{11} = \frac{(L_{ROD}+L_{CG})}{L_{ROD}}\,\frac{\bar{W}_{AO}}{2}\, g_1 = \frac{39.46}{25*2}(399)(1.04) = 327\ \#$$

$$F_{22} = \frac{\bar{W}_{AO}}{2}\, g_2 = \frac{399(1.66)}{2} = 332\#$$

$$F_{ST2} = \frac{1201\#}{2} = 601\ \#$$

$$F_{WEIGHT(2)} = \frac{399}{2} = 200\#$$

} 801# FIXED

$F'_{ST2} = \frac{\text{SEAT-TRQUE}}{11.75''} * \cos 11.82°$

FOR 8" $= \frac{13808''\#}{} * .86 = 1150\#$

FOR 10" $= \frac{22{,}174''\#}{} * .86 = 1847\#$

SEE BIF RPT & McPHERSON RPT

CONSERVATIVE COMBINATION

$$\tau = \frac{1}{.75(2.41)}\left\{\left[\left(F_{23}+F_{22}\right)^2 + F_{11}^2\right]^{\frac{1}{2}} + F_{FIXED}\right\} = 4108 \text{ PSI} < 11{,}840 \text{ PSI}$$

(OK)

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: [signature]	Date: 1/10/83
Subject: 24" Butterfly Valves		Checked By: [signature]	Date: 3/30/83
System: CSP and CEP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-4.3-24	

CLEVIS

4, 32 THE TOTAL LOAD ON THE CLEVIS IS THE VECTOR SUM OF $F_C \rightarrow$ AND $F_{ST} \downarrow$.

	8"	10"
F_{ST2}	1201# (MAX)	1847#
CLEVIS AREA	2.44 in^2	2.44 in^2

$$F_{CLEVIS} = \left[F_C^2 + F_{ST2}^2 \right]^{\frac{1}{2}}$$

ASSUME UPPER LIMIT OF $g_1 = 15g$'s JUST FOR

4, 33 THIS MEMBER, $F_{ST2} = 1847$#, $W_{AO} = 539$ # (10"), $L_{CG} = 21.5$"

$$F_{CLEVIS} = [1847^2 + 6953^2]^{\frac{1}{2}} = 7194 \text{ \#}$$

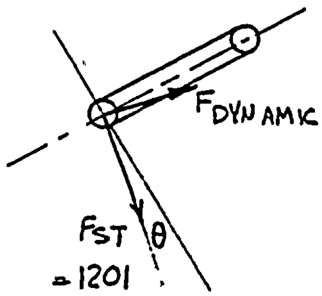
$$\tau_{CLEVIS} = 7194\# / 2.44'' = 2949 \text{ PSI} < 28{,}800 \text{ (OK)}$$

CLEVIS PIN $\tau = 7194\# / 3.53 \text{ IN}^2 * \frac{4}{3} = 2717 \text{ PSI} < 11{,}840$ (OK)

4, 32 ∴ CLEVIS & PIN ARE GOOD FOR ALL 8" & 10" A/O EPN'S.

DRIVE LEVER

IMPOSE THE SEATING TORQUE LOAD AND DYNAMIC REACTION FORCE ON THE DRIVE LEVER IN THEIR RESPECTIVE DIRECTIONS:



$\theta = 6.5°$ MAX

$F_{DYNAMIC} = F_C = 178$ LB

LOAD F_C WILL INCREASE THE AXIAL FORCE IN THE

REF 4, PG 35 DRIVE LEVER, HOWEVER, THE MAXIMUM TORQUE ON THE LEVER IS THE SEATING TORQUE. THE AIR OPERATOR TRUNNIONS AND INTERNAL SPRING HOLD THE VALVE STABLE IN THE CLOSED POSITION.

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: [signature]	Date: 1/10/83
Subject: 24" Butterfly Valves		Checked By: [signature]	Date: 3/30/83
System: CSP and CEP		Job No. 82044	File No. OT.01/F
Analysis No. 361106	Rev. No. 2	Sheet No. 361106-4.3-25	

MAX NORMAL FORCE ON DRIVE LEVER:

$F_{ST} \cos\theta + F_C \sin\theta = 2524$ LB (ENVELOPE)

$1847 * .99 + 6953 * .10 =$

MAX AXIAL FORCE ON DRIVE LEVER:

$F_{ST} \sin\theta + F_C \cos\theta = 7068$ LB (ENVELOPE)

1847 .10 6953 .99

REF 4, Pg. 34: MINIMUM DRIVE LEVER AREA = 1.875 IN^2, CONSIDERING FAILURE MODES.

AXIAL STRESS:

MAX BENDING MOMENT = 13,808 IN-LB (CONSERVATIVE FOR USE ON MIN. AREA OUT NEAR CLEVIS PIN)

$$\sigma_{AXIAL} = \frac{Mc}{I} + \frac{F_{AX}}{A}$$

REF 4, PG 35

$$\sigma_{AXIAL} = 13,808 * \frac{1.44}{2.99} + \frac{7068}{1.875} = 10,420 \text{ PSI}$$

10,420 < 43,200 PSI OK

SHEAR STRESS:

$$\tau = \frac{2524}{1.875} = 1346 \text{ PSI} < 28,800 \text{ PSI OK}$$

DRIVE LEVER SUFFICIENT ON BOTH 8" & 10" A/O's.

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification	Prepared By: [signature]	Date: 1/10/83	
Subject: 24" Butterfly Valves	Checked By: [signature]	Date: 3/30/83	
System: CSP and CEP	Job No. 82044	File No. OT.01/F	
Analysis No. 361106	Rev. No. 2	Sheet No. 361106-4.3-26	

KEY WAY BEARING STRESS - DUE TO SEATING TORQUE

REF 4, PG 36

$A_B = 0.448 \text{ IN}^2$

$M = 13,800 \text{ IN-LB}$

$\frac{D_{MIN}}{2} = 1.125 \text{ IN}$

$F_{BRG} = \frac{M * 2}{D_{MIN}} = 12,267 \text{ LB}$

$\sigma_{BRG} = \frac{F_{BRG}}{A_B} = 27,381 \text{ PSI}$

27,381 < 43,200 PSI

OK MARGIN = 58%

REF 4, PG 37

SHEAR AREA OF KEY = 1.33 IN^2.

THEREFORE - BEARING STRESS CONTROLS.

MAIN SHAFT:

PRELIMINARY ANALYSIS SHOWS THIS IS NOT A HIGHLY STRESSED COMPONENT, ∴ ANALYZE FOR ENVELOPE LOADS.

STRESS = STRESS DUE TO SEATING TORQUE +
STRESS DUE TO SHEAR OF F_{STZ} +
STRESS DUE TO BENDING OF F_{STZ}.

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification	Prepared By: E Rutkowski	Date	1/10/83
Subject: 24" Butterfly Valves	Checked By: E E Searle	Date	3/30/83
System: CSP and CEP	Job No. 82044	File No.	OT.01/F
Analysis No. 361106	Rev. No. 2	Sheet No.	361106-4.3-27

	8"	10"
r =	1.1248"	1.25"
$J = 2I$ =	2.514 IN^4	3.83 IN^4
l_5 =	6.005"	6.32"
l_6 =	10.31"	11.18"
I_s =	1.257	1.916
T_s =	13808"#	22174"#

REF4, PG 49

① $\tau_T = \frac{T\rho}{J} = \frac{22{,}174\,(1.25)}{3.83} = 7237$ PSI

② $\tau_{AVE} = \frac{F_{COMB.}}{A}$ FROM FIG. ON PAGE O, & PG. P

$F_{COMB} = [2524^2 + 7068^2]^{\frac{1}{2}} = 7505$ LB

$\tau_{AVE} = \frac{7505}{3.97} = 1890$ PSI

③ $M = 18.47 \frac{(6.32)(11.18)}{16.315 = (l_6 + l_5)} = 7999$ IN-LB

$\sigma = \frac{Mc}{I} = 7999 \times \frac{(1.1248)}{1.257} = 7158$ PSI

CONSERVATIVELY ADDING SHEAR STRESSES

τ : 7237 + 1890 = 9127 PSI < 14,500 OK	
&	σ = 7158 PSI < 21744 OK

RESULT GOOD FOR BOTH 24" & 30" VALVES

1006.00

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification	Prepared By: E Rakowski	Date: 1/10/83	
Subject: 24" Butterfly Valves	Checked By: D E Stark	Date: 3/30/83	
System: CSP and CEP	Job No.: 82044	File No.: OT.01/F	
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-4.3-28	

Disc

The stresses in the disc were shown on page 51 of Ref. 4 to be due almost entirely to the pressure load. Since the stress found in Ref. 4 of 3871 PSI will not change significantly for the new accelerations, the disc is acceptable.

Taper Pins

The stress in these pins is due only to the seating torque. The stress in Ref. 4, page 53, is 10,753 PSI and is therefore acceptable. For the new, lower seating torque, the stress becomes 8710 PSI.

Analysis for: Drive Rod, cylinder bushing pressure, valve ears and valve ear bolts.

Method I: Use element forces and moments output from the piping analysis (Summary Table 1.1) and the absolute sum of stresses. The conservatism of SRSS summing of the component stresses cannot be assured because the independence of the six element forces (/moments) cannot be determined without analysis of modal participation.

Method II: Use the north, east and vertical operator accelerations output from the piping analysis. Absolute sum for stresses with each component then SRSS over results for N,E and V.

Note 1: Analysis of the distribution of stress on 4 valve ears to predict the maximum tensile stress cannot confirm a maximum value lower than the absolute sum of the elemental tensil stresses due to the six forces (from one acceleration direction, N,E or V). Therefore the absolute sum will be used at this level.

Note 2: Add stress due to the vector sum of deadweight plus seating torque force after above SRSS combinations are performed. (ABS)

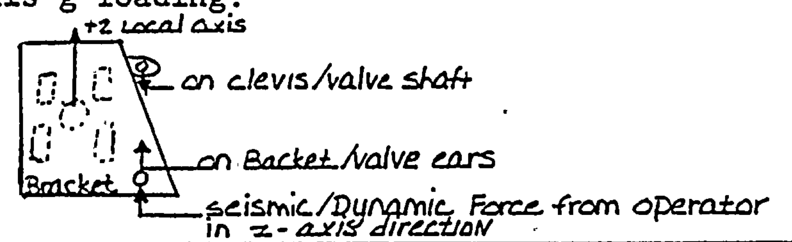
Note 3: 10" A/O parameters are shown for use in QID 361104.

Analysis of Seating Torque Forces

1) Seating Torque loads control the stress in the valve lever arm, keyway, shaft and taper pins. These stresses were less than allowables for the valves of seating torque given in Ref. 3, for all valves.

2) For valve EPN's which are Fail-Open with Use-Code 2, no seating torque forces are applied during the faulted and upset conditions (CSP-V-5,6).

3) For the Fail-Closed valves, the forces at the trunnion pins are shown below, along the cylinder axis, for +2-axis g-loading:



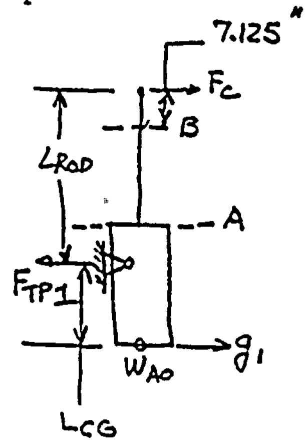
Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification	Prepared By: E R [signature]	Date: 1/10/83	
Subject: 24" Butterfly Valves	Checked By: A. E Searle	Date: 3/30/83	
System: CSP and CEP	Job No.: 82044	File No.: OT.01/F	
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-4.3-30	

As the bracket deflects in +2, under dynamic loads, the seating torque force is releived. The extent of relief depends on the relative stiffness of the bracket and valve ears relative to the valve seat. Since the steel backets and ears are very stiff in this direction, little relief can be expected. Hence seating torque forces will be added as an ABS sum to the valve ears. However, seating torque force will oppose operator weight when the brackets hangs downward from horizontal pipes.

Operator Drive Rod

Drive rod dynamic stress is due only to g_1 because g_3 and g_2 forces are taken out by trunnion pins. Add seating torque stresses.



$$F_c = \frac{L_{CG}}{L_{ROD}} \bar{W}_{AO} g_1$$

TWO POINTS ARE CRITICAL, PT A AT THE BUSHING AND PT B AT THE REDUCED THREAD DIAMETER

$$M_A = F_c (L_{ROD} - 13.5")$$

$$\boxed{\sigma_A = \frac{M_A C_A}{I_A}}$$

$$M_B = 7.125 \; F_c$$

$$\boxed{\sigma_B = \frac{M_B C_B}{I_B}}$$

	8"	10"
I_A	.4604 IN^4	↑
C_A	.875 IN	Same —
I_B	.1383 IN^4	Same
C_B	.6478 IN	Same
A_B	1.405 IN^2	↓
A_A	2.41 IN^2	2.41 IN^2

FINALLY:

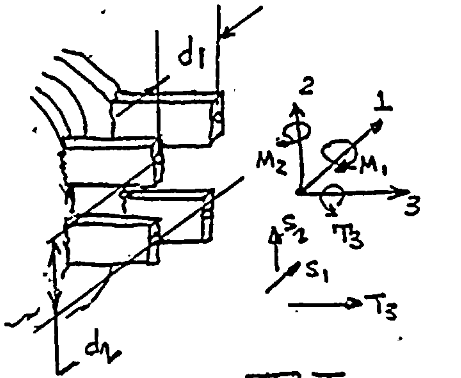
$$\sigma_A)_{OPERATING} = \left.\frac{F_{STZ}}{A_A} + \frac{M_A c}{I_A}\right)_{DW}$$

$$\sigma_B)_{OPERATING} = \left.\frac{F_{STZ}}{A_B} + \frac{M_B c}{I_B}\right)_{DW}$$

} ADD AS ABS SUM AFTER SRSS OF DYNAMIC COMPONENTS

SEISMIC / DYNAMIC FORCES ON VALVE EARS

A SAP-TYPE MASS / STIFFNESS MODEL WAS PREPARED FOR THE PIPING MODEL TO CALCULATE A/O RESPONSE G-LEVELS (SEE ATTACHMENT). THE VALVE-EAR SYSTEM BENDING AND TORSIONAL FLEXIBILITY WAS INCLUDED IN THE MODEL AND SRSS FORCES AND MOMENTS WILL ALSO BE OUTPUT FOR CONVERSION INTO VALVE EAR STRESSES. THE EQUATIONS ARE:

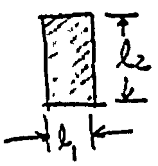


Tension due to M_1 & T_3:
(SEE LOCAL COORD. DEF'N – NEXT PG)

$$2Pd_1 = M_1$$

$$\sigma_{M_1} = \frac{P}{A} = \frac{M_1}{2d_2 A} \qquad A = l_1 l_2$$

	8"	10"
l_2 =	2.5"	3"
l_1 =	1.5	1.75
d_1 =	7.5"	9.5"
d_2 =	10.0"	10.5"

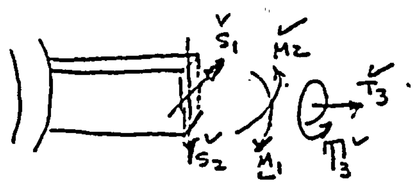


① $\sigma_{T_3} = \frac{P}{4A} = \frac{T_3}{4 l_1 l_2}$ (tension due to T_3) + WHEN T_3 = +

② $\sigma_{3\,tension}$ due to M_1 $= \frac{M_1}{2 d_2 l_1 l_2}$

TOP IN TENSION (+) WHEN M_1 IS +

SAP-MODEL:
(SEE ATTCHMNT)
(APPENDIX B)

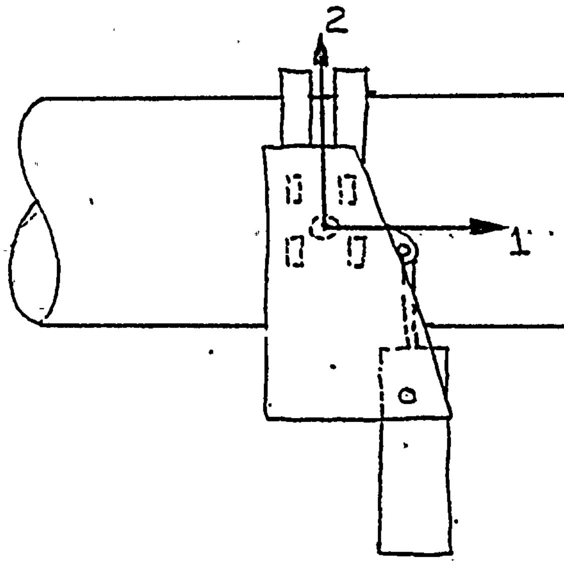


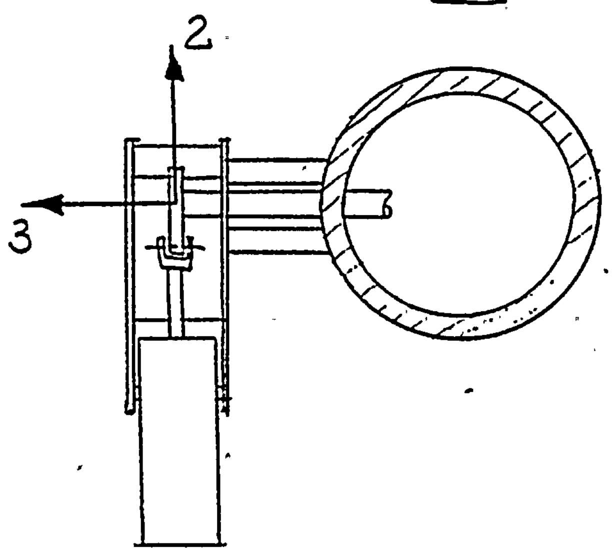
CYGNA

Calculation Sheet

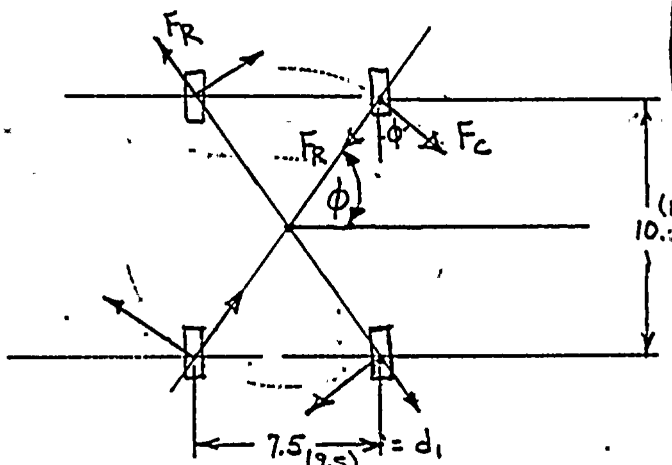
Project: WPPSS Mechanical Equipment Qualification		Prepared By: E Rolowski	Date: 1/10/83
Subject: 24" Butterfly Valves		Checked By: A. E Searle	Date: 3/30/83
System: CSP and CEP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-4.3-32	D

COORDINATE SYSTEM (LOCAL)





FORCES DUE TO TORQUE



$\phi_{8"} = 53°$
$\phi_{10"} = 48°$

F_R & F_c CONSTRAIN EAR DEFLECTION TO BE TANGENT TO CIRCLE.

F_c IS DETERMINED FROM TORQUE DUE TO g_I * W_{AO+B} .. ETC.

OPERATOR STIFFNESS MODEL, APPENDIX B), DETERMINES THAT

$F_R = 0.531 F_c$ for 8" A/O
$= 0.488 F_c$ for 10" A/O

$F_c = \frac{\Sigma M_{SHAFT}}{2D}$

$D = \frac{1}{2}\left[d_1^2 + d_2^2\right]^{\frac{1}{2}}$

	8"	10"
d_1	7.5"	9.5"
d_2	10.0"	10.5"

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: E R Nyunski	Date: 1/10/83
Subject: 24" Butterfly Valves		Checked By: D. E. Searle	Date: 3/30/83
System: CSP and CEP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-4.3-34	

TENSILE STRESS DUE TO M_Z:

$$2P d_f = M_z, \quad \sigma_{M_z} = \frac{P}{A} = \frac{M_z}{2d_f A} = \frac{M_z}{2d_f \ell_1 \ell_2}$$

③ $$\sigma_{M_z\,tension} = \frac{M_z}{2d_f \ell_1 \ell_2}$$

(i.e. LEFT EARS TENSION (+) WHEN $M_z = +$)

Bending due to S_1; S_2 & T_3:

Shear due to T_3:

$$F_c = \frac{T_3}{2D} \qquad D = \text{bolt-circle (dia.)} = \left[(d_1)^2 + (d_2)^2\right]^{\frac{1}{2}} \text{ in}$$

From derivation of stiffness model: (SEE APPENDIX B)

$$F_R = X F_c \qquad X = .531 \text{ for } 8'' \text{ Ao}$$
$$= .488 \text{ '' } 10'' \text{ Ao}$$

Net force in 1-direction per ear: (any ear)

Due to T_3 only:

$$F_{11} = -(F_c \sin\phi - F_R \cos\phi) \qquad \phi_{8''} = 53^\circ$$
$$\phi_{10''} = 48^\circ$$

$$= -(F_c \sin\phi - X F_c \cos\phi)$$

$$F_{11} = -F_c(\sin\phi - X\cos\phi)$$

$$F_{11}\begin{cases} = -F_c * AF_{X8} \\ = -F_c * AF_{X10} \end{cases} \qquad \begin{matrix} 8'' & AF_{X8''} = +.48 \\ 10'' & AF_{X10''} = +.42 \end{matrix}$$

1006.00

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: E. R. [illegible]	Date: 1/10/83
Subject: 24" Butterfly Valves		Checked By: D. E. Searle	Date: 3/30/83
System: CSP and CEP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-4.3-35	

△3 [illegible] 6/2/83 T.C. Fernandez 6/9/83

SHEAR FORCE DUE TO T_3 ON EACH EAR IN THE Z-AXIS DIRECTION.

$$F_{22} : (F_c \cos\phi + F_R \sin\phi)$$
$$= -(F_c \cos\phi + XF_c \sin\phi)$$

$$F_{22} = F_c(\cos\phi + X\sin\phi) = AF_y * F_c$$

$$F_{22} \begin{cases} AF_y)_{8''} = 1.03 \\ AF_y)_{10''} = 1.03 \end{cases}$$ SAME ϕ-fn for 8" & 10".

F_{11} & F_{22} ARE SHEAR FORCES DUE TO T_3 IN THE 1 AND 2-AXIS DIRECTIONS RESPECTIVELY. S_1 & S_2 ARE SIMILAR SHEAR FORCES OUTPUT FROM THE FINAL PIPING ANALYSIS USING THE MODEL IN APPENDIX B.

FOR THE FOLLOWING BENDING EQ, SEE ⟶ ROARK, PG.96, #1b ($a=0$)

BENDING MOMENT AT EITHER END OF THE EAR (SEE REF. FOR GEOMETRY)

$$M = \frac{-W l^2}{2l} = -\frac{Wl}{2}$$

NOTE: SEE PAGE 4.3-53 OF REVISION 3 △3

BENDING STRESS AT EAR CORNER:

$$\sigma_B)_{\text{due to } F_{11}} + \sigma_B)_{\text{due to } F_{22}} = \sigma_B \text{ DUE TO } T_3$$

(4) $$\sigma_{B_{\text{ult}}} \text{ due to } T_3\text{-shears} = \left|\left[(F_{11}\ .\ )\frac{l_{ave}}{2}\right]\frac{c_1}{I_2}\right| + \left|\left[(F_{22}\ .\ .\ )\frac{l_{ave}}{2}\right]\frac{c_2}{I_1}\right|$$

	8"	10"
l_{ave} =	7.125	4.85"
c_1 =	.75	.88
c_2 =	1.25	1.50

(over)

1006.00

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: E Rabowski	Date: 1/10/83
Subject: 24" Butterfly Valves		Checked By: D. E. Searle	Date: 3/30/83
System: CSP and CEP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-4.3-36	

and:

σ Bending due to S_1 & S_2:

(5) $\sigma_{BS1} = \frac{S_1 c_1}{4 I_2}$ love $\ell = 8I_2$)

(6) $\sigma_{BS2} = \frac{S_2 c_2}{4 I_1}$ love $\ell = 8I_1$)

		8"	10"
$I_1 = \frac{1}{12} b h^3 = \frac{1}{12} \ell_1 \ell_2^3 =$		$\frac{1.5}{12} 2.5^3 = 1.95\ IN^4$	$\frac{1.75}{12} 3^3 = 3.94\ IN^4$
$I_2 = \frac{1}{12} b h^3$	$\frac{1}{12} \ell_2 \ell_1^3 =$	$\frac{2.5}{12} 1.5^3 = 0.70\ IN^4$	$\frac{3}{12} 1.75^3 = 1.34\ IN^4$

EAR TENSILE STRESS IS THE ABSOLUTE SUM OF THE ABOVE EXPRESSIONS (1) ⟶ (6). [USE 10" A/O PARAMETERS FOR QID 361104]

SHEAR STRESS ON EARS

$$\tau = \frac{P}{A}$$

DUE TO $S_1 + F_{11}$ $= \frac{S_1}{4 \ell_1 \ell_2} + \frac{F_{11}}{\ell_1 \ell_2} = \tau_{11}$ (→)

AND

DUE TO $S_2 + F_{22}$ $= \frac{S_2}{4 \ell_1 \ell_2} + \frac{F_{22}}{\ell_1 \ell_2} = \tau_{22}$ (↓)

EAR SHEAR STRESS RESULTANT = $[\tau_{11}^2 + \tau_{22}^2]^{1/2}$ (VECTOR SUM)

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification	Prepared By: E R [signature]	Date: 1/10/83	
Subject: 24" Butterfly Valves	Checked By: D. E. Searle	Date: 3/30/83	
System: CSP and CEP	Job No.: 82044	File No.: OT.01/F	
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-43-37	

BOLTS HOLDING BRACKETS TO EARS:

BOLT TENSION IS DUE TO M_1, M_2, T_3

BOLT SHEAR IS DUE TO S_1, S_2, T_3

	8"	10"
$A_B = \frac{\pi D^2}{4}$	$0.31\ IN^2$	$.43\ IN^2$
D	.6273"	.7387"

Tension (ABS SUM):

$$\sigma_{T3} = \frac{T_3}{4 A_B}$$

$$\sigma_T)_{M1} = \frac{M_1}{2 d_2 A_B}$$

$$\sigma_T)_{M2} = \frac{M_2}{2 d_1 A_B}$$

Shear:

$F_{11}/bolt = F_c * AF_x$ (PREVIOUS PAGES ___)

$F_{22}/bolt = F_c * AF_y$

$$\tau_1 = \frac{F_{11}}{A_B} = \frac{F_c * AF_x}{A_B} \rightarrow \quad ①$$

$$\tau_2 = \frac{F_{22}}{A_B} = \frac{F_c * AF_y}{A_B} \downarrow \quad ②$$

Similarly: $\tau_{S1} = \frac{S_1}{4 A_B} \rightarrow \quad ③$

$$\tau_{S2} = \frac{S_2}{4 A_B} \downarrow \quad ④$$

COMBINE IN SAME MANNER AS ON PREVIOUS PAGE. FOR EARS BUT SUBSTITUTE A_B FOR $l_1 * l_2$

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification
Prepared By: E. Rakowski — Date: 1/10/83
Subject: 24" Butterfly Valves
Checked By: D. E. Searle — Date: 3/30/83
System: CSP and CEP
Job No.: 82044 — File No.: OT.01/F
Analysis No.: 361106 — Rev. No.: 2 — Sheet No.: 361106-4.3-38

METHOD II — THE PREVIOUS EQUATIONS FOR STRESS BY METHOD I ARE APPLICABLE. HOWEVER,

1) EXPRESSIONS FOR THE SIX FORCES/MOMENTS ARE DERIVED BELOW IN TERMS OF g-level COMPONENTS IN THE LOCAL AXIS SYSTEM. (SUBSEQUENTLY DIRECTION COSINES WILL BE USED TO CONVERT THE N, E & V ACCELERATION VECTORS, IN TURN, IN TO LOCAL AXES). (SEE SECTION 5.4).

2) THESE EQUATIONS ARE TO BE USED TO FIND THE FORCES AND MOMENTS ON THE EARS DUE TO THE DEADWEIGHT AND SEATING TORQUE FORCES, FOR CALCULATION OF OPERATING STRESSES, FOR USE IN EITHER METHOD 1 & 2.

SEE FORCES & BRACKET ORIENTATION IN LOCAL COORDINATES, NEXT PAGE.

1: T_3 = TORSION ABOUT LOCAL AXIS # 3

$$T_3 = \Sigma M_{SHAFT}\ (+) = F_{TR1}e_3 + F_{BR1}e_4 + F_{AO2}e_2 + F_{BR2}e_1$$

$$= F_{TR1}e_3 + \bar{W}_{BR}g_1e_4 + \bar{W}_{AO}g_2e_2 + \bar{W}_{BR}g_2e_1$$

$T_3 = (+)$	$= F_{TR1}e_3 + \bar{W}_{BR}g_1e_4 + g_2(\bar{W}_{AO}e_2 + \bar{W}_{BR}e_1)$
$T_{3\ FIXED} = (+)$	$= W_{ATR1}e_3 + (W_{AO2} + F_{ST2})e_2 + W_{BR1}e_4 + W_{BR2}e_1$

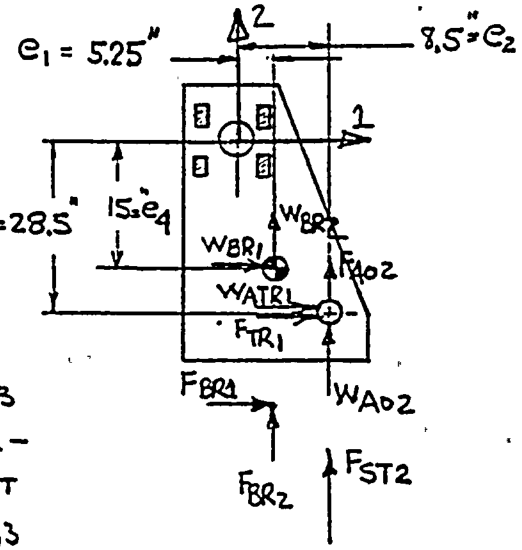
CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: E. Kolwowski (signature)	Date: 1/10/83
Subject: 24" Butterfly Valves		Checked By: D. E. Searle (signature)	Date: 3/30/83
System: CSP and CEP		Job No.: 82044	File No.: OT 01/F
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-4.3-39	

FORCES ON SUPPORT EARS DUE TO LOCAL-AXIS ACCELERATIONS g_1, g_2, g_3

FORCES IN THE LOCAL COORDINATE SYSTEM:



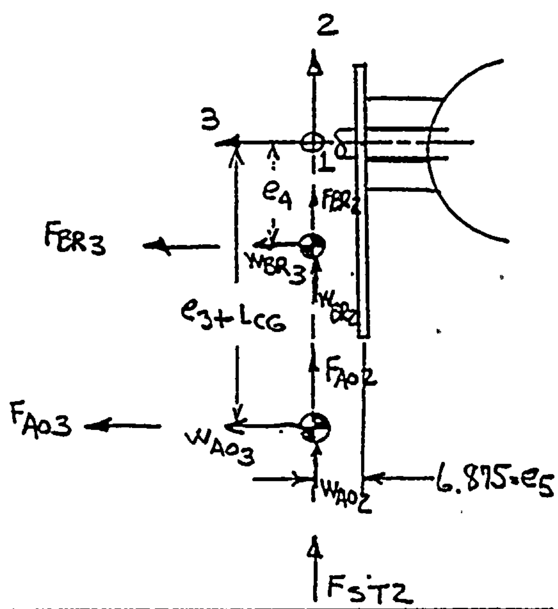
ELEVEN FORCES ACT IN THE LOCAL 1,2,3 . A/O AXIS SYSTEM:

DYNAMIC:

- $F_{AO\,2,3}$ = $\bar{W}_{AO} * g_{2,3}$
- $F_{TR\,1}$ = 1-AXIS COMPONENT OF DYNAMIC FORCE AT TRUNNION
- $F_{BR\,1,2,3}$ = 1,2,3-AXIS COMPONENTS OF BRACKET INERTIA = $\bar{W}_{BR} * g_{1,2,3}$

STATIC:

- W_{ATR1} = FORCE AT TRUNNION IN 1-AXIS DUE TO A/O WEIGHT
- $W_{AO\,1,2,3}$ = WEIGHT OF A/O IN AXES 1,2,3
- $W_{BR\,1,2,3}$ = WEIGHT OF BRACKET IN THE 1,2 & 3-AXIS DIRECTIONS
- $F_{ST\,2}$ = SEATING TORQUE FORCE, IS ALWAYS ALONG 2-AXIS.



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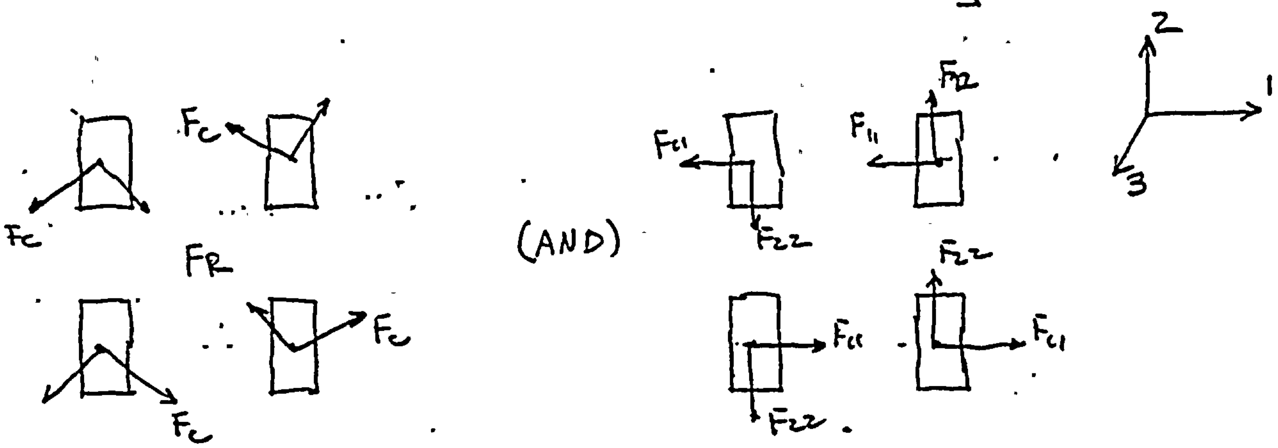
CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: E Robowski	Date: 1/10/83
Subject: 24" Butterfly Valves		Checked By: D. E. Searle	Date: 3/30/83
System: CSP and CEP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-4.3-40	

FORCE ORIENTATIONS ON EARS: IF (+ T_3)



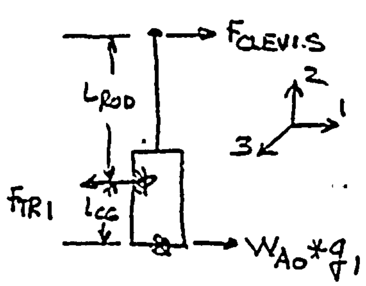
$$S_1 = F_{TR1} + F_{BR1} = F_{TR1} + \bar{W}_{BR}\, g_1$$

$$S_{1\,FIXED} = \quad = W_{BR_1} + W_{ATR1}$$

FROM A FORCE BALANCE OF THE OPERATOR:

$$F_{TR1} = + \frac{(L_{ROD} + L_{CG})}{L_{ROD}} * \bar{W}_{AO} * g_1 \quad (+\text{ FORCE ON BRKT})$$

$$W_{ATR1} = + \frac{(L_{ROD} + L_{CG})}{L_{ROD}} W_{AO1}$$



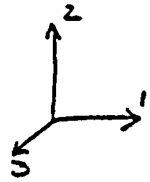
	8"		10"	
	OPEN	CLOSED	OPEN	CLOSED
LROD	40"	25"	40"	25"
LCG	10.96"	14.46	16.25"	21.5"

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification	Prepared By: [signature]	Date: 1/10/83	
Subject: 24" Butterfly Valves	Checked By: D.E. Searle	Date: 3/30/83	
System: CSP and CEP	Job No. 82044	File No. OT.01/F	
Analysis No. 361106	Rev. No. 2	Sheet No. 361106-4.3-41	

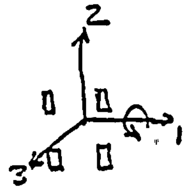
$$S_2 = F_{AO2} + F_{BR2} = (\bar{w}_{AO} + \bar{w}_{BR}) g_2 \quad +\uparrow$$

$$S_{2\,FIXED} = \; = w_{BR2} + w_{AO2} + F_{ST2} \quad +\uparrow$$



FOR OUT OF PLANE BENDING:

$$M_1 = (+) = -F_{AO2}\, e_5 - F_{BR2}\, e_5 - F_{AO3}(e_3^{+LCG}) + F_{BR3}\, e_4$$

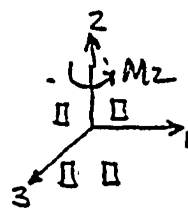


$$M_1 = -(\bar{w}_{AO} + \bar{w}_{BR}) g_2\, e_5 - \bar{w}_{AO} g_3 (e_3^{+LCG}) + \bar{w}_{BR} g_3\, e_4$$

$$M_{1\,FIXED} = (w_{AO2} + w_{BR2} + F_{ST2}) e_5 - w_{AO3}(e_3^{+LCG}) - w_{BR3}\, e_4$$

+ = TOP EARS IN TENSION

$$M_2 = (+) = +F_{TR1}\, e_5 + F_{BR1}\, e_5 + F_{AO3}\, e_2 - F_{BR3}\, e_1$$



$$M_2 = +(F_{TR1} + \bar{w}_{BR} g_1) e_5 - (\bar{w}_{AO}\, e_2 + \bar{w}_{BR}\, e_1) g_3$$

$$M_{2\,FIXED} = +(w_{ATR1} + w_{BR1}) e_5 - w_{AO3}\, e_2 - w_{BR3}\, e_1$$

+ = LEFT EARS IN TENSION

$T_3 = +\swarrow$ (+3 AXIS) $= (\bar{w}_{AO} + \bar{w}_{BR}) g_3$	$T_{3\,FIXED} = w_{AO3} + w_{BR3}$

T_3, M_1, M_2, S_1, S_2, & T_3 COMPLETE

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: E. R. [signature]	Date: 1/10/83
Subject: 24" Butterfly Valves		Checked By: [signature]	Date: 3/22/83
System: CSP and CEP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361106	Rev. No.: 2	Sheet No.: 361106-4.3-42	

4.3.4 Upset Condition Stresses

The cylinder drive rod and valve ears were separately analyzed for upset condition loads for the EPN's and associated response g-levels noted below. All other component faulted stresses are less than the upset allowables except for taper pins and keyway bearing stress. No additional analysis was performed for these components because the stress is controlled by the seating torque only. The allowable stress for the bracket bolts also holds for upset conditions per the AISC manual, 8th Edition. Bolt fatigue is considered as presented in Section 4.3.5.

Upset g-levels (per revised B&R piping analysis, Sec. 5.5)

EPN	N	V	E
CSP-V-3	1.73	1.60	0.96
CSP-V-4	1.14	1.40	1.50
CSP-V-5	0.97	1.40	1.71
CSP-V-6	1.64	1.44	0.59

Component stresses are given in Table 1.2.

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification		Prepared By: E R Dowski	Date: 1/10/83
Subject: 24" Butterfly Valves		Checked By: W. E. Searle	Date: 3/30/83
System: CSP and CEP		Job No. 82044	File No. OT.01/F
Analysis No. 361106	Rev. No. 2	Sheet No. 361106-4.3-43	

Section 4.3.5 - Fatigue Analysis

Discussion

The operator and bracket assembly are not part of the pressure boundary, therefore, the fatigue analysis will be performed in accordance with Appendix B of the AISC Manual for Steel Construction. The following assumptions apply to the fatigue analysis.

1) Faulted stresses (based on piping-analysis accelerations) will be used. This is necessary to insure operability after a design basis event.

2) The actual stresses used will be the ones calculated in Section 4.3.

3) If the alternating portion of the stress has been calculated separately only this part will be used. If the operating loads (i.e. seating torque effects) are already included in the stress analysis it will be conservative to use the calculated stress value. As long as no failures occur, the operating stress does not need to be extracted.

4) The allowable stress will be based on Table B3 of Appendix B in the AISC Manual of Steel Construction.

5) A factor of 1.5 will be applied to the allowable because of the low number of cycles. (Per Section 1.7 of the Commentary on the AISC Manual).

6) The actual stress range is taken as 2 times the maximum stress for components subject to alternating tension and compression.

7) Bracket bolting is assumed to be properly tightened and will not be considered for fatigue per Section B3.1 of the AISC Manual.

The table on the following page gives the calculated stress range, stress category, and allowable for the critical components. The following page gives excerpts from Appendix B of the AISC Manual showing the descriptions of the relevent stress categories.

CYGNA

Calculation Sheet

Project: WPPSS Mechanical Equipment Qualification | Prepared By: [signature] | Date 1/10/83
Subject: 24" Butterfly Valves | Checked By: D.E. Searle | Date 3/30/83
System: CSP and CEP | Job No. 82044 | File No. OT.01/F
Analysis No. 361106 | Rev. No. 2 | Sheet No. 361106-43-45

Fatigue Analysis (cont.)

ITEM	STRESS TYPE	STRESS (PSI)	STRESS RANGE (PSI)	STRESS CATEGORY	1.5 x ALLOW (FROM AISC)
TRUNNION PIN	τ	4108	8216	F (1)	22500
DRIVE ROD (MAX)	σ	- SEE TABLE 1.2 -		A	90000
SUPPORT EARS	σ	- SEE TABLE 1.2 -		A	90000
MAIN SHAFT	σ τ	9127 8064	18,254 16,128	A A	90000 90000

NOTES:

(1) Assume shear stress on nominal area of a stud type shear connection.

Note that this comparison includes all of the load combinations in one conservative comparison using the maximum stress and the total number of cycles ([3 x 4478] + 60 = 13494 cycles).

Calculation Sheet	Prepared By: JM Fr	Date 11/19/82
	Checked By: L Komer	Date 11/19/82
Project SUPPLY SYSTEM	Job No. 82044	File No. OT.01/F
Subject 24" BUTTERFLY VALVE		
System CSP & CEP	Sheet No. 361106-4.3-46	
Analysis No. 361106 Rev. No. 2		

CYGNA

FATIGUE ANALYSIS (CONT.)

THE TABLE BELOW HAS BEEN CONDENSED FROM APPENDIX B OF THE AISC MANUAL OF STEEL CONSTRUCTION. THE CASES USED ARE MARKED WITH AN ARROW.

General Condition	Situation	Kind of Stress[a]	Stress Category. (See Table B3)	
Plain material	Base metal with rolled or cleaned surfaces.	T or Rev.	A	⟵ (90,000)
Built-up members	Base metal and weld metal in members, without attachments, built-up of plates or shapes connected by continuous full- or partial-penetration groove welds or continuous fillet welds parallel to the direction of applied stress.	T or Rev.	B	
	Calculated flexural stress, f_b, in base metal at toe of welds on girder webs or flanges adjacent to welded transverse stiffeners.	T or Rev.	C	
	Base metal at end of partial-length welded cover plates having square or tapered ends, with or without welds across the ends.	T or Rev.	E	
Mechanically fastened connections	Base metal at gross section of high-strength-bolted friction-type connections, except connections subject to stress reversal and axially loaded joints which induce out-of-plane bending in connected material.	T or Rev.	B	
	Base metal at net section of other mechanically fastened joints.	T or Rev.	D	
	Base metal at net section of high-strength bolted bearing connections.	T or Rev.	B	
Attachments	Shear stress on nominal area of stud-type shear connectors.	S	F	⟸ (22,500)

CYGNA

Calculation Sheet

Project: WPPSS- EQUIPMENT QUALIFICATION	Prepared By: [signature]	Date: 4/29/83	
Subject: 24" BUTTERFLY VALVES	Checked By: [signature]	Date: 5/16/83	
System: CSP & CEP	Job No. 82044	File No. 17.01.F	
Analysis No. 361106	Rev. No. 2	Sheet No. 361106-43.47	

8" " MILLER AIR CYLINDER

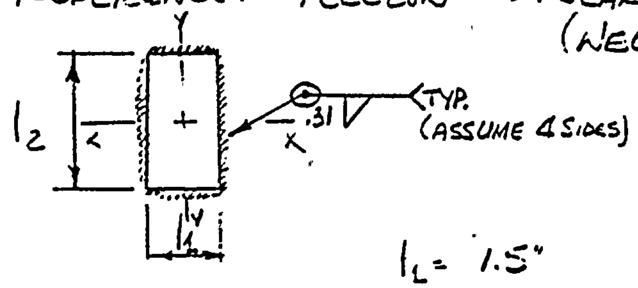
WELD STRESS COMPUTATION - (VALVE FLANGE/"EAR" CONNECTION)

COMPILED PROGRAMS - APPENDIX A - SECTION 4 WILL BE MODIFIED IN THE FOLLOWING MANNER

1.) "EAR" PROPERTIES (CROSS SECTION, MOMENT OF INERTIA, ETC) PREVIOUSLY HAVE BEEN USED IN THE DISTRIBUTION OF THE TOTAL LOAD ABOUT THE "EAR" GROUP, TO COMPUTE THE STRESSES DUE TO THIS LOADING (ABSOLUTE SUM/WORST CASE) ON AN INDIVIDUAL EAR. THESE PROPERTIES WILL BE CHANGED TO REFLECT A WELD GROUP VS "EAR" CROSS SECTION.

2.) PROGRAMS WILL BE RERUN YIELDING STRESSES ON AN INDIVIDUAL WELD GROUP ONLY.

REFERENCE: TELECON D. SEARLE (CES)/R. RICAPPITO (BIF) 4/28/83 (WELD SIZE)



$S_W = bd + \frac{d^2}{3}$

REF: BLODGETT TABLE 5/7.4-7

$l_1 = 1.5"$

$l_2 = 2.5"$

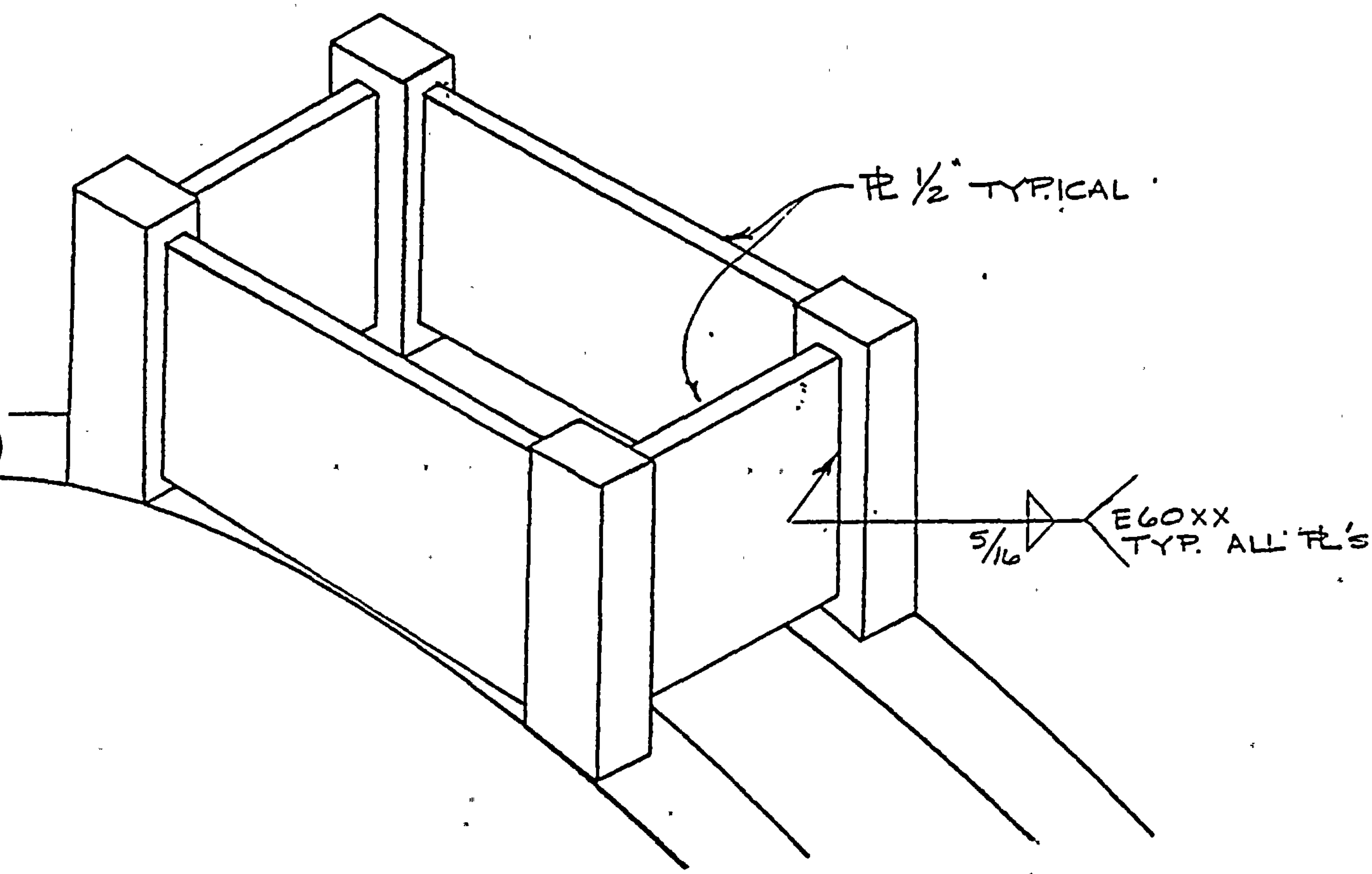
$I_{W_x} = (.707)(.31)(1.25)\left[(2.5)(1.5) + \frac{(2.5)^2}{3}\right] = 1.60 \text{ in}^4$

$I_{W_y} = (.707)(.31)(.75)\left[(2.5)(1.5) + \frac{(1.5)^2}{3}\right] = 0.74 \text{ in}^4$

TENSILE/SHEAR AREA $= (2)(2.5 + 1.5)(.707)(.31) = 1.77 \text{ in}^2$

Calculation Sheet

Project: WPPSS-EQUIPMENT QUALIFICATION	Prepared By: Don Searle	Date: 5/5/83	
Subject: BIF VALVES / MILLER OPERATORS	Checked By: [signature]	Date: 5/16/83	
System: CEP & CSP	Job No: 82044	File No: CT.01.F	
Analysis No: QID 361106	Rev. No: 2	Sheet No: 361106-4.3.48	



PROPOSED

BRACKET EARS AND SHEAR PLATE ARRANGEMENT

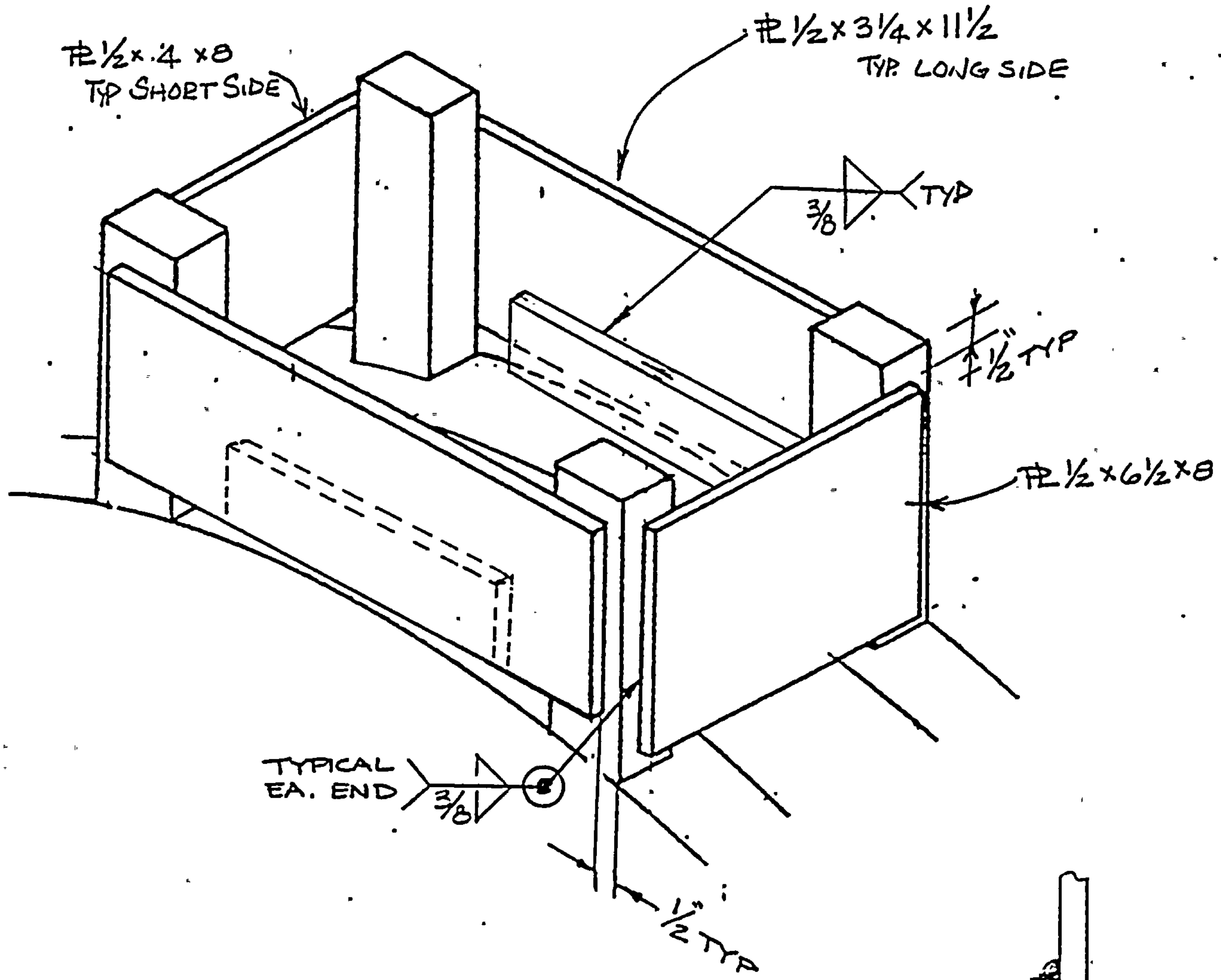
1/2" PLATES TYP.

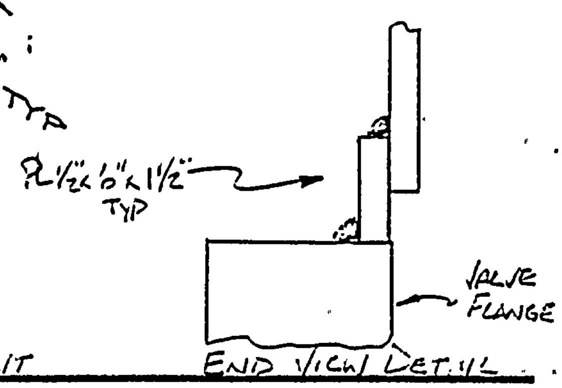
CYGNA

Calculation Sheet

Project	WPPSS Equipment Qualification	Prepared By: [signature]	Date 6/8/83
Subject	24" Butterfly Valves with 8" Miller Operator	Checked By: J C Fernandez	Date 6/9/83
System	CEP & CSP	Job No. 82044	File No. 1T.01.F
Analysis No.	361106 Rev. No. 3	Sheet No.	361106-4.3-49

4 D. Searle 11/5/83
TDG Marvin 11-11-83





AS-BUILT CONDITION
OF EAR-SHEAR PLATE
ARRANGEMENT

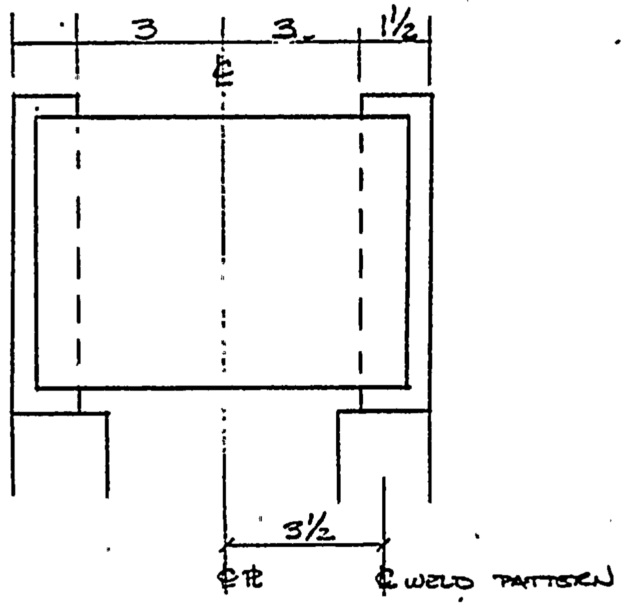
Calculation Sheet

Project WPPSS Equipment Qualification		Prepared By: [signature]	Date 6/8/83
Subject 24" BIF Butterfly Valves with 8" Miller Operator		Checked By: LC Fernandez	Date 6/9/83
System CEP & CSP		Job No. 82044	File No. 1T.01.F
Analysis No. 361106	Rev. No. 3	Sheet No. 361106-4.3-50	

REINFORCMENT PLATES FOR 24 IN. VALVES

	CSPV-5	(WORST CASE)
V_1	4772	SHEAR
V_2	3021	SHEAR
T_3	2325	TENSILE
M_1	76145	MOMENT
M_2	37604	MOMENT
T	106643	TORQUE

DESIGN THE PLATE TO LAP THE SIDE OF THE EAR. FROM PAGE 4.3-62 THE 7½ SIDE IS WORST CASE LOADING.



CYGNA

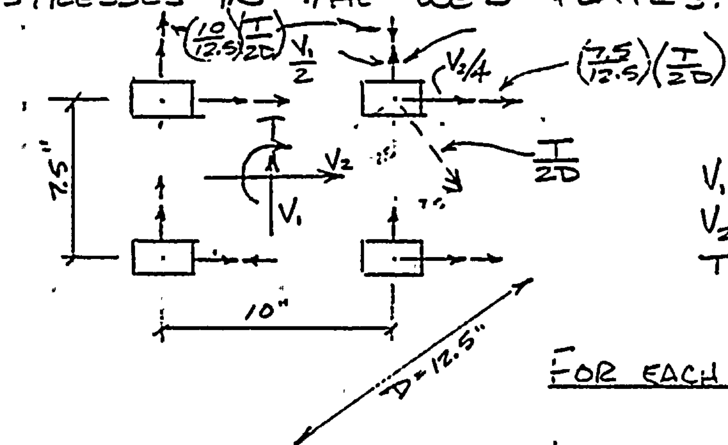
Calculation Sheet

Project: WPPSS Equipment Qualification	Prepared By: [signature]	Date 5/15/83	
Subject: 24" B/F Butterfly Valves/N8" Nillex Oper	Checked By: [signature]	Date 5/16/83	
System: CEP & CSP	Job No. 82044	File No. 17.01.F	
Analysis No. 361106	Rev. No. 2	Sheet No. 361106 - 4.3 - 51	⚠3

⚠3 [signature] 6/9/83
[signature] 6/9/83
⚠4 [signature] 11/4/83
TBG MARVIN 11-11-83

WEB PLATE DESIGN

THE WEB PLATE RESISTS ONLY THE SHEAR LOADS APPLIED TO THE TOP OF THE SUPPORT EAR CONFIGURATION. THE WORST CASE RESULTS FROM CSP-V-5 WILL BE USED FOR DESIGN. THE MOMENTS ARE RESOLVED BY PURE AXIAL LOADS IN THE EARS. AS IS THE TENSILE LOAD. THE SHEAR AND TORSIONAL LOADS PRODUCE STRESSES IN THE WEB PLATES.



$V_1 = 4772^{\#}$
$V_2 = 3021^{\#}$
$T = 106643''^{\#}$

FOR EACH EAR

$$\frac{l_2}{2} = V_2' = \frac{S_2}{4} + \left(\frac{7.5}{12.5}\right)\left(\frac{T}{25}\right)$$

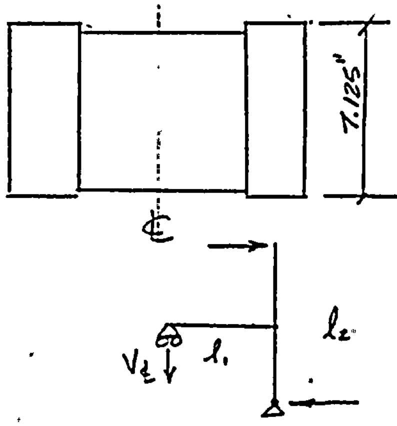
$$= 755 + 2560 = 3315^{\#}$$

$$\frac{V_1}{2} = V_1' = \frac{S_1}{4} + \left(\frac{10.5}{12.5}\right)\left(\frac{T}{25}\right)$$

$$= 1193 + 3583 = 4776^{\#}$$

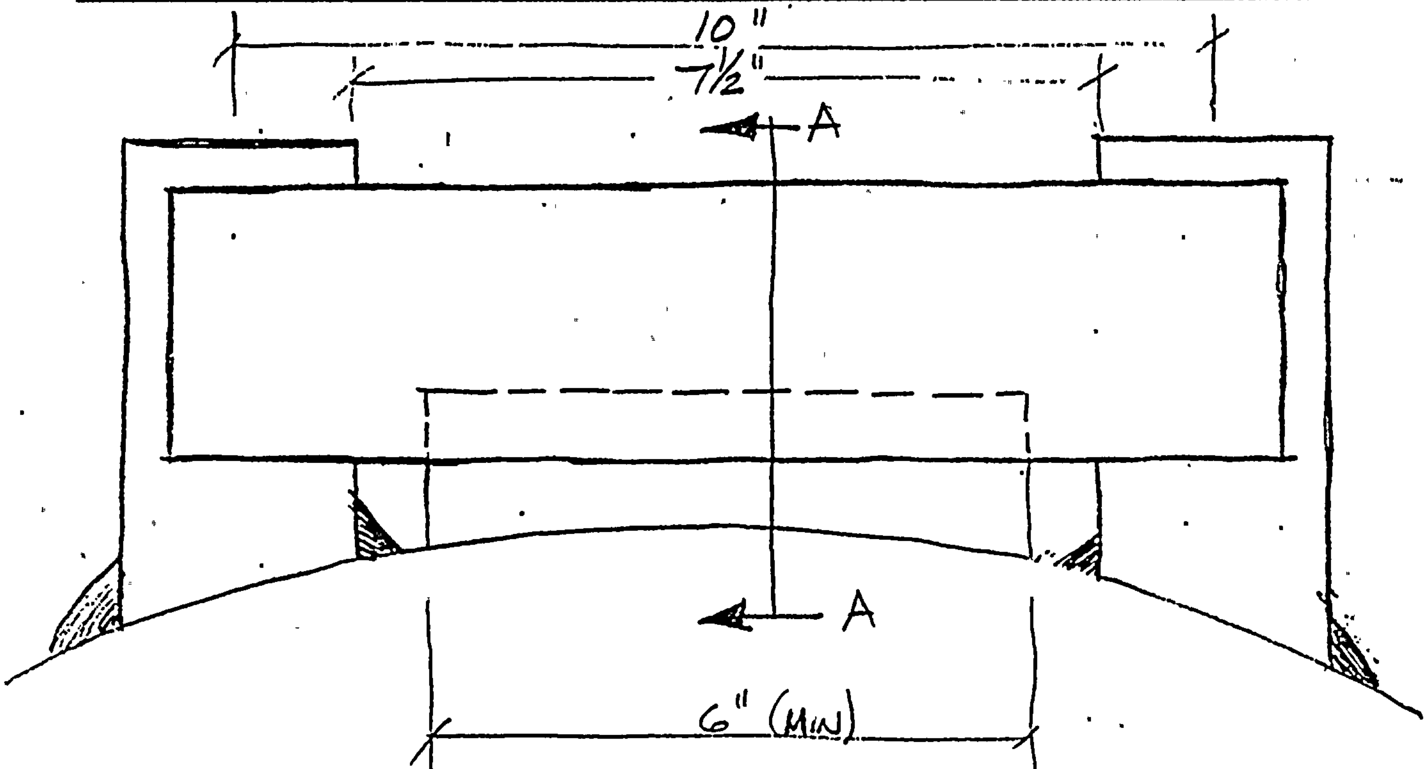
(COMBINED SHEAR LOAD/EAR)

⚠4



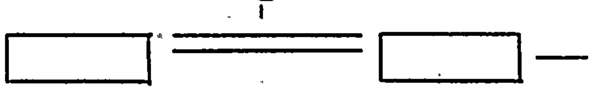
Calculation Sheet

Project WPPSS-WNP #2		Prepared By: [signature]	Date 11/5/83
Subject EQUIPMENT SEISMIC/HYDRO REQUALIFICATION		Checked By: TBG MARVIN	Date 11-11-83
System CSP & CEP		Job No. 82044	File No. 17.01.F
Analysis No. 01D361106	Rev. No. 4	Sheet No. 43.52	



WELD PROPERTIES @ FLANGE (LONG SIDE)

(FOR EACH SIDE)

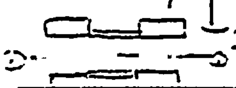


$$A = (2(2.5+1.5)2) + 6)t_w =$$

$$= (16 + 6) = 22 t_w \quad in^2$$

$$I_{2_{HALF}} = \left[\left(\frac{6^3}{12}\right) + 2\left[2\left(\frac{2.5^3}{12}\right) + 2(1.50)\left(\frac{3}{2}\right)^2\right] + 2\left[8(5)^2\right]\right] t_w = 436.71 t_w \, in^3$$

SIMILARLY,



$$I_{1_{GROSS}} = 4\left[2.5(.75)^2 + \frac{(2)(1.5)^3}{(12)} + (6)(3.75)^2\right] + \left[2(6)(3)^2\right] = 565.88 t_w \, in^3$$

CYGNA

Calculation Sheet

Project WPPSS-WNP#2		Prepared By:	Date 11/5/83
Subject EQUIPMENT SEISMIC/HYDRO REQUALIFICATION		Checked By: TBG MARVIN	Date 11-11-83
System CSP/LEP →		Job No. 82044	File No. IT.01.F
Analysis No. 361106	Rev. No. 4	Sheet No. 4.3-53	

THE RESULTING SECTION MODULUS IS THEN

$$S = \frac{I}{c} = \frac{436.71}{(5)+(1.25)} = 69.87\ in^2(t_w) \text{ (PER SIDE)}$$

THE SECTION PROPERTIES OF THE WELDMENT OF THE EARS ABOUT THE 1-1 AXIS WILL IGNORE THE CONTRIBUTION OF THE SHEAR PLATE WELDMENT. SINCE THE STRESS CALCULATIONS WILL ONLY USE THE INDIVIDUAL EAR THE PROPERTIES WILL BE CALCULATED AS FOLLOWS

$$A_{EAR} = t_w(1\tfrac{1}{2}+3\tfrac{1}{2})(2) = 8\,t_w\ in^2$$
$$S_{EAR} = \left[(2.5)(1.5)+\frac{(1.5)^2}{3}\right]t_w = 4.50\,t_w\ in^3$$

THE STRESSES ON THE WELDMENT ABOUT THE 1-1 AXIS ARE DUE TO THE FOLLOWING LOADS

(ASSUME $\frac{M}{2}$ PER SIDE) MOMENT @ WELDMENT {l_{w} = 7.125"}

SHORT SIDE — WELD LOAD TENSILE (M1d, M2d)

$$\text{DUE TO } \frac{M_{22}}{7.5 A_{(1/2)}} = \frac{37604}{(7.5)\,16} = 313\,t_w\ \#/in \quad ④$$

$$\text{DUE TO } \frac{M_{11}}{A_{(1/2)}(7.5)} = \frac{76145}{(10.5)(16)} = 453\,t_w\ \#/in \quad ⑤$$

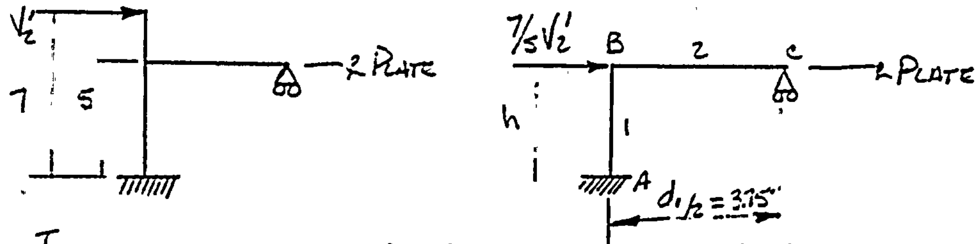
ASSUME MOMENTS (@ EAR CENTROID) ARE REACTED OUT AS AXIAL LOADS IN THE EARS

CYGNA

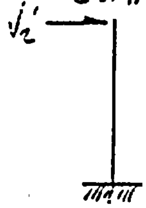
Calculation Sheet

Project: WPPSS-WNP#2		Prepared By: [signature]	Date: 11/5/83
Subject: Equipment Seismic/Hydro Requalification		Checked By: TBG Marwin	Date: 11-11-83
System: CSP & CEP		Job No. 82044	File No. OT.01.F
Analysis No. QID 361106	Rev. No. 4	Sheet No. 4.3.54	

THE V_2 SHEAR AND THE M_2 MOMENT APPLICATION TO THE EAR GROUP IS TREATED AS FOLLOWS



IN REVIEWING THE PROPORTIONS OF THE MEMBERS, THE BENDING DEFLECTIONS WILL BE NEGLIGIBLE IN COMPARISON TO SHEAR. THE RESULTING RESPONSE OF BENDING OF THE EAR IN COMPARISON TO THE HORIZONTAL SHEAR DEFLECTION OF THE PLATE



$$\delta_B = \frac{P\ell^3}{3EI} = \frac{4776(7.125)^3}{(3)(30E^6)\left(\frac{2.5(1.5)^3}{12}\right)} = .0273''$$

ASSUMING THE 1/2" ℄ AND THE EARS ARE EFFECTIVE IN SHEAR

$$A_s = 2(1.5)(2.5) + (6)(.5) = 10.5 \text{ in}^2$$

$$\delta_s = \frac{PL}{AE_s} = \frac{(2)(4776)(6.00)}{(10.5)(12E^6)} = .00045''$$

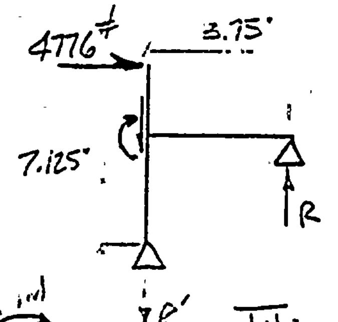
$$\frac{\delta_B}{\delta_s} = 60.02 \Rightarrow$$ SHEAR STIFFNESS IS ABOUT 60 TIMES AS STIFF AS BENDING

∴ ASSUME THAT THE RESULTING LOAD GOES PRIMARILY TO AXIAL AND SHEAR ON THE WELDMENT.

Calculation Sheet

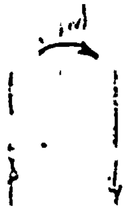
CYGNA

Project WPPSS-WNP#2		Prepared By:	Date 11/4/83
Subject Equipment Seismic/Hydro Requalification		Checked By:	Date 11-11-83
System		Job No. 82044	File No. OT.01.F
Analysis No. 361104	Rev. No. 4	Sheet No. 4.3.55	



$$R_1 = \frac{(4776)(7.125)}{3.75} = 9074^{\#}/\text{EAR}$$

WELD LOAD, EAR $\frac{9074}{8} = 1134^{\#}/\text{in}$



THE VERTICAL LOAD IN THE WELD DUE TO SHEAR (IN LOCAL 1-1 AXIS)

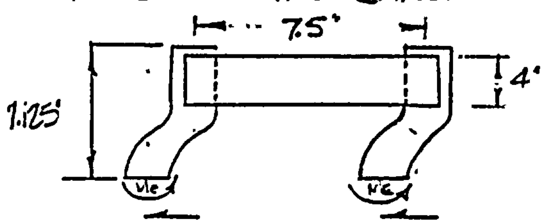
$f_{AXIAL} = \frac{P}{A} = 1134^{\#}/\text{in.}$ where $A = 2(1.5+2.5)$ {DOES NOT INCLUDE CONTRIBUTION (SHEAR ℞ ATTACHED TO FLANGE}

WELD SHEAR LOADS (DUE TO S1f, S2f)

$$f_{v_1} = \frac{V_1'(4)}{2A} = \frac{3315(2)}{(22)} = 301^{\#}/\text{in} (\uparrow)$$

$$f_{v_2} = \frac{V_2'(4)}{2(A)} = \frac{4776(2)}{(16)} = 597^{\#}/\text{in} (\rightarrow)$$ (SHEAR ℞'S ATTACHED TO FLANGE)

SINCE THE AS-BUILT WALKDOWN REVEALED THE SHEAR PLATES (SHORT SIDE) DID NOT EXTEND TOP TO BOTTOM ON THE EARS, THE UNBRACED LENGTH DEVELOPS A MOMENT AT THE BASE OF THE EARS.



MOMENT AT BASE OF EAR (EACH EAR)

$M_E = \frac{1}{2}(3.125)(4776) = 7463 \text{ in.}$

$\sigma_{EAR} = \frac{M}{Z} = \frac{7463}{2.5(.5)^2} =$

$\sigma_{EAR} = 7761$ psi (< .9(36 ksi))

WELD LOAD $f_b = \frac{M}{S} = \frac{7463}{...}$

$f_b = 1658^{\#}/\text{in}$

CYGNA

Calculation Sheet

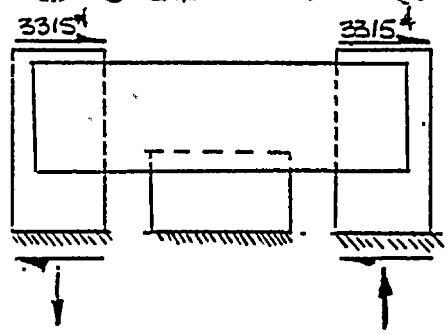
Project: WPPSS-WNP #2		Prepared By: [signature]	Date: 11/3/83
Subject: Equipment Seismic/Hydro Requalification		Checked By: TBG Marvin	Date: 11-11-83
System: 24" B/F Butterfly Valves / CSP & CIP		Job No. 82044	File No. OT.01.F
Analysis No. OD 361106	Rev. No. 4	Sheet No. 43.56	

TOTAL COMBINED WELD LOAD - (EARS)

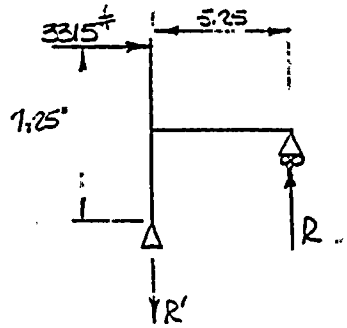
THE REMAINING REACTION TO BE ACCOUNTED FOR ARE DUE TO THE EAR TENSILE REACTION, $t_3 \Rightarrow 2325^{\#}$

$$f_a = \frac{t_3}{2A} = \frac{2325^{\#}}{32} = 73\ ^{\#}/_{IN}$$ ③

③ SHEAR REACTION (INTERNAL COUPLE LONG SIDE)



(CONSERVATIVELY, ASSUME SHEAR NOT ATTACHED TO FLANGE)
AS ANALYZED ON SHORT SIDE
DETERMINE VERTICAL REACTION
(DO NOT INCLUDE CENTER PIECE)



$$R_2 = \frac{3315(7.125)}{5.25} = 4499^{\#}_{EAR}$$

WELD LOAD DUE TO R_1 & R_2 (CONSIDER AS AN AXIAL LOAD)

$$f_{b_1} = \frac{P_{VERTICAL}}{A} = \frac{9074}{8} = 1134\ ^{\#}/_{IN} \qquad f_{b_2} = \frac{4499}{8} = 562\ ^{\#}/_{IN}$$

CYGNA

Calculation Sheet

Project WPPSS-WNP#2		Prepared By: [signature]	Date 11/6/83
Subject Equipment Seismic/Hydro Requalification		Checked By: TBG Marwin	Date 11-11-83
System B/F Butterfly Valves		Job No. 82044	File No. 0T.01.F
Analysis No. VID 361106	Rev. No. 4	Sheet No. 43.57	

TOTAL COMBINED WELD LOAD (EARS)

SUMMARY OF COMPONENT LOADS

$$f_{TOT} = \left[(1134+562+73+658+313+453)^2+(301+597)^2\right]^{1/2}$$

$f_{TOT} = 4288$ lb/in

THE CORRESPONDING WELD STRESS

$$\tau_{WELD_{EAR}} = \frac{4288}{(.707)(.325)} = 19408\,PSI \geq 14000$$

OVERSTRESSED CONDITION

NOTE THIS CONDITION APPLIES FOR WORST CASE LOADING CSP-V-5.

WELD LOAD (TENSILE) DUE TO BENDING MOMENT CAN BE MODIFIED BASED UPON INFORMATION OBTAINED DURING A WALKDOWN. (i.e. $l_{ave} = 5\frac{1}{2}''$).

SEE ATTACHMENT

SINCE IT HAS PREVIOUSLY BEEN DETERMINED THAT SHEAR STIFFNESS PREDOMINATES OVER BENDING STIFFNESS $\left\{\frac{C_B}{C_S} = 27;\right.$ CORRECTED USING $\left.l_{ave} = 5.5\right\}$

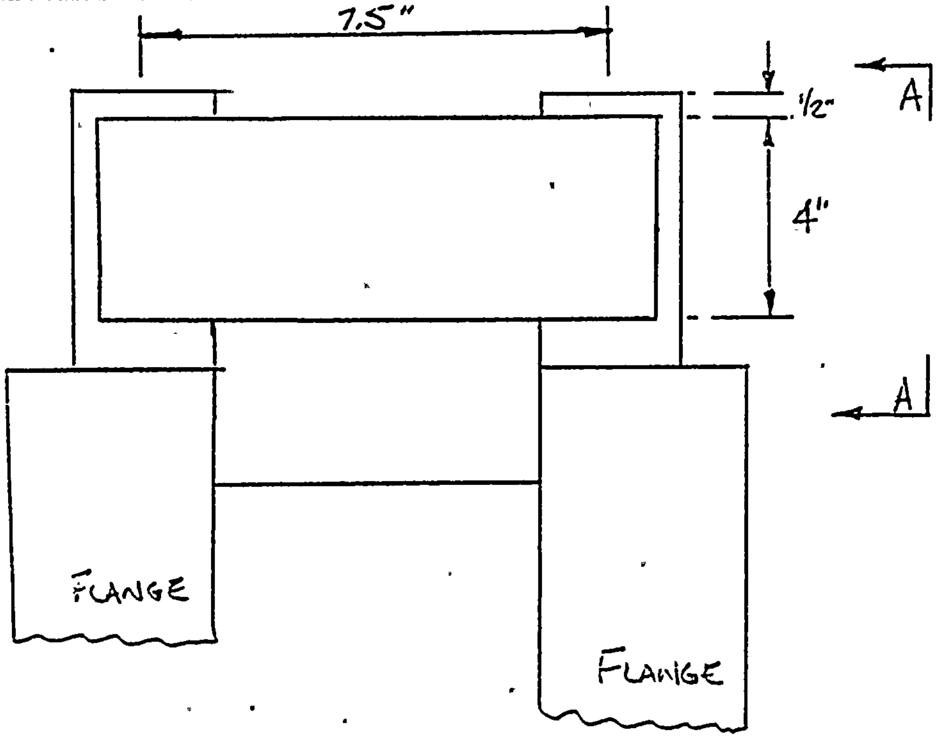
THEREFORE, THE MOMENT AT EAR BASE DUE TO SHEAR LOAD APPLIED AT TOP OF EAR CAN REALISTICALLY BE OMITTED.

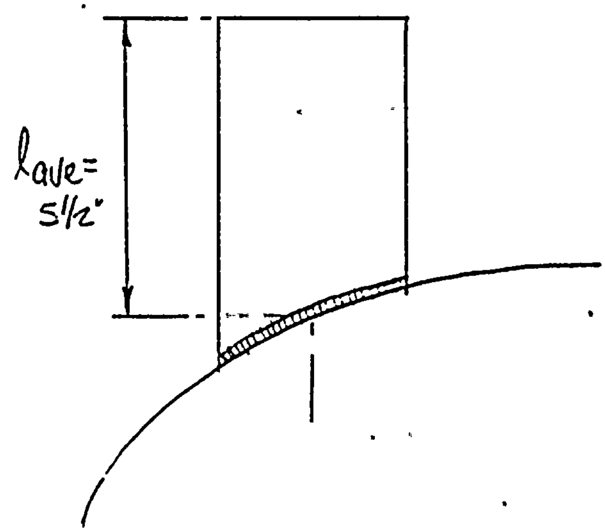
1006.00

Calculation Sheet

CYGNA

Project: WPPSS-WNP#2		Prepared By: [signature]	Date: 11/7/83
Subject: Equipment Seismic/Hydro Requalification		Checked By: [signature]	Date: 11/7/83
System: BIF Butterfly Valves / CSP-CEP		Job No. 82044	File No. 0T.01.F
Analysis No. 361106	Rev. No. 4	Sheet No. 4.3.58	





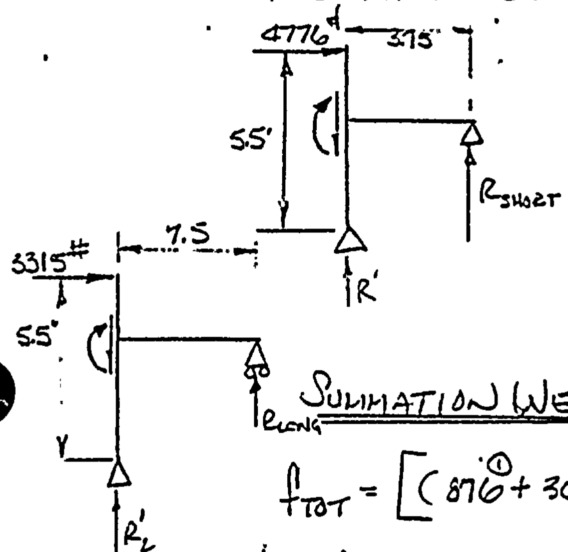
FIELD SKETCH

VERIFICATION OF "EAR" LENGTH

Calculation Sheet

Project: [illegible]		Prepared By: [illegible]	Date 11/7/83
Subject: EQUIPMENT & SUPP. [illegible]		Checked By: TBG MARVIN	Date 11-11-83
System: B/F BUTTERFLY VALVES CEP-CSP		Job No. 82044	File No. 07.01.F
Analysis No. [illegible]	Rev. No. 4	Sheet No.	43.59

THE AXIAL EAR LOAD, DUE TO SHEAR REACTION



$$R_1' = \frac{(4776)(5.5)}{3.75} = 7005\#$$

$$\text{WELD LOAD/EAR} = \frac{7005}{8} = 876^{①} \text{ lb/in}$$

$$R_2' = \frac{3315(5.5)}{(7.5)} = 2431\#$$

$$\text{WELD LOAD/EAR} = \frac{2431}{8} = 304\#^{②}$$

SUMMATION WELD LOADS

$$f_{TOT} = \left[(876^{①} + 304^{②} + 73^{③} + 0 + 313^{④} + 453^{⑤})^2 + (301)^{2⑥} + (597)^{2⑦}\right]^{1/2}$$

$$f_{TOT} = 2127 \text{ lb/in}$$

WELD STRESS @ EAR CONNECTION

$$\sigma_{WELD} = \frac{2127}{(.707)(.3125)} = 9626\text{PSI} \leq 14000\text{PSI}$$

WELD STRESS IN FATIGUE CAN BE TREATED, BY CONSERVATIVELY DOUBLING THE ABOVE FAULTED SEISMIC & OPERATING AND COMPARING TO FATIGUE ALLOWABLE:

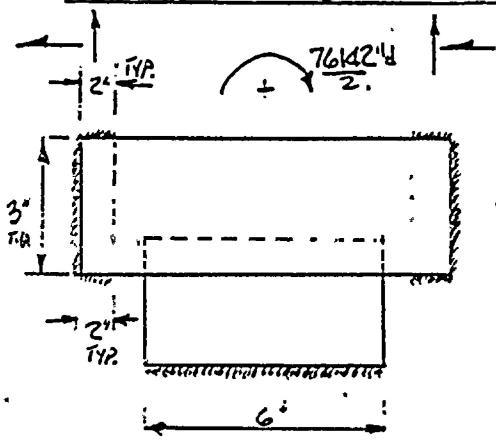
$$\sigma_{WELD_{FATIGUE}} = 2\sigma_{WELD} = 19252\text{PSI} \leq 22500\text{ PSI}$$

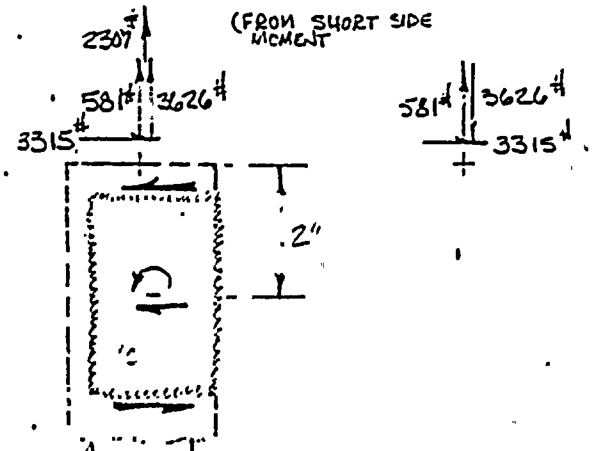
CYGNA

Calculation Sheet

Project: WPPSS-WNP#2	Prepared By: [illegible]	Date: [illegible]/83	
Subject: Equipment Requal. Hidro Requalification	Checked By: TBG Marvin	Date: 11-11-83	
System: [illegible] Butterfly Valves/CSP&CED	Job No. 82044	File No. OT.01.F	
Analysis No. O.D 361136	Rev. No. 4	Sheet No. 43.60	

SHEAR PLATE – WELD FORCES (LONG SIDE)





ASSUME TENSILE LOADS APPLIED AT TOP OF EAR ARE RESISTED BY EAR WELDS (∴ NO LOAD TO SHEAR PL WELDS)

AT THE CENTROID OF THE WELD GROUP THERE IS A SHEAR FORCE AND A MOMENT

$$\begin{cases} S_W = 3315 \text{ lb} \\ M_W = (2)(3315) = 6630 \text{ in lb} \end{cases}$$

WELD LOAD (SHEAR PL TO EAR)

$$f_J = \frac{S_W}{A_W} + \frac{M_W \cdot c)}{J_W} = \frac{3315}{(2)(2)} + \frac{6630(1.30)}{\frac{(2+3)^3}{6}} =$$

$f_J = 1402$ lb/in

THE CORRESPONDING WELD STRESS IS:

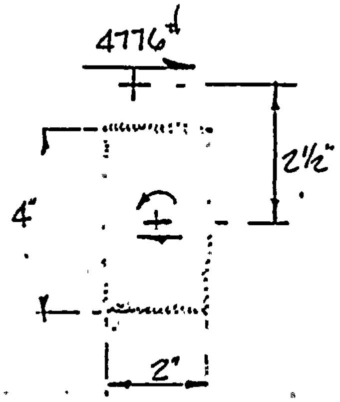
$$\tau_{weld} = \frac{1402}{(.707)(.3125)} = 6344 \text{ psi} \leq 11250 \text{ psi}$$

Calculation Sheet

Project: WPPSS-WNP #2		Prepared By: [illegible]	Date: 11/8/83
Subject: EQUIPMENT SEISMIC/HYDRO REQUALIFICATION		Checked By: TBG MARWIN	Date: 11-11-83
System: BIF BUTTERFLY VALVE CSP-PED		Job No. 82044	File No. 0T.01.F
Analysis No. 361106	Rev. No. 4	Sheet No. 43.61	

SHEAR PLATE - WELD FORCES (SHORT SIDE)

$$\tau_R = \frac{F}{A} = \frac{5.5(4776)}{(3.75)}\left(\frac{1}{(.5)(4)}\right) = 3504\,psi < 11250\,psi$$



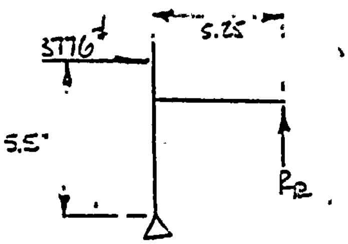
$S_W = 4776\,lb$, $M_W = (2½)(4776) = 11940\,in\,lb$

$$f_V = \frac{S_W}{A_W} + \frac{M_W(c)}{J_W} = \frac{4776}{4} + \frac{11940(\sqrt{5})}{\frac{(4+2)^3}{6}}$$

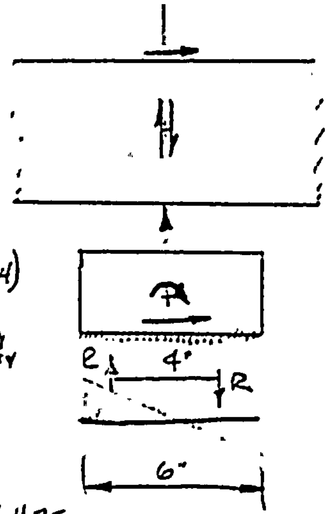
$f_V = 1936\,lb/in$

$$\tau_{WELD} = \frac{1936}{(.707)(.3125)} = 8761\,psi < 11250\,psi$$

SHEAR PLATE - R. CONNECTED TO FLANGE



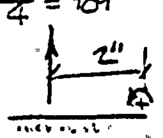
$$R_R = \frac{3776(5.5)}{5.25} = 3956\,lb$$



$$\tau_R = \frac{F}{A} = \frac{3956}{(.5)(3)} = 2637\,psi < 21600\,psi$$

PLATE STRESS LOW

$R = \frac{3956}{4} = 989\#$



- ASSUME R TENDS TO BE "PRYED UP" (FOR ½ LENGTH)

WELD LOAD - $\frac{989}{3} + \frac{(989)(2)}{A_n\,3} = f_r$

$= ((989)^2 + (\frac{3776}{6})^2)^{1/2}$

$= 1172\,lb/in$

$$\tau_{WELD} = \frac{1172}{(.707)(.3125)} = 5306\,psi < 11.25\,ksi$$

$$S_n = \frac{\frac{(3)^3}{12} + (1.5)^2(3)}{3} = tw^3\ \lambda^2$$

CYGNA

Calculation Sheet

Project: WPPSS Equipment Qualification		Prepared By: [signature]	Date: 6/9/83
Subject: 24" BIF Butterfly Valves with 8" Miller Operator		Checked By: J.C. Fernandez	Date: 6/9/83
System: CEP & CSP		Job No.: 82044	File No.: 1T.01.F
Analysis No.: 361106	Rev. No.: 3	Sheet No.: 361106-4.3-62	

THE LOADS ON CSP-V-6 HAVE LOWER SHEAR LOADS BUT HIGHER BENDING MOMENTS. REVIEW OF THE BURNS AND ROE LOADS SHOWS THE BRACKET ACCELERATION @ 11.4 g AND THE OPERATING CYLINDER ACCELERATION IN THE SAME DIRECTION AS 2.55 g. THE WEIGHT OF THE BRACKET WAS 277 POUNDS AND THE WEIGHT OF THE CYLINDER WAS: 399 LBS. THE TOTAL ASSEMBLY WAS ACCELERATED @ 11.4g WHEN IN ACTUALITY THE INDIVIDUAL COMPONENTS SHOULD HAVE BEEN ACCELERATED AT THEIR RESPECTIVE "g" LEVELS. UTILIZING THE PROPER GEOMETRY AND ACCELERATIONS THE LOADS APPLIED TO THE SUPPORT EARS IS COMPARABLE TO CSP-V-5. THE BALANCE OF THE COMPONENTS WILL HAVE CONSERVATIVE FINAL STRESSES DUE TO THE HIGH ACCELERATIONS.

NOTE: ALL WELD STRESSES WERE COMPARED TO 11.25KSI ALLOWABLE. FAULTED ALLOWABLE IS ACTUALLY 14.500KSI BUT THE WELD FATIGUE ALLOWABLE IS 22.500KSI WHICH IS 2 (11.25). COMBINED OPERATING AND DYNAMIC WERE DOUBLED AND ESSENTIALLY COMPARED TO THIS VALUE. THEREFORE BY INSURING σ_{WELD} < 11.25KSI QUALIFIES ELEMENT FOR FATIGUE LOADING △4

△4 [signature] 11/10/83
TBG MARVIN 11-11-83

Calculation Sheet

Project: WPPSS-WNP#2		Prepared By: [signature]	Date: 11/2/83
Subject: Equipment Seismic/Hydro Requalification		Checked By: TBG Marvin	Date: 11-11-83
System: 24" B/F Butterfly Valves / CSP		Job No. 82044	File No. 1P.01.F
Analysis No. 361106	Rev. No. 4	Sheet No. 361106-4.3.63	

COMPARISON OF PRELIMINARY ACCELERATIONS (THOSE USED IN ANALYSIS) VS. FINAL ACCELERATIONS

VALVE EPN		OPERATOR BRACKET			OPERATOR CYLINDER		
		X	Y	Z	X	Y	Z
CSP-V-3	PRELIMINARY	2.66*	2.75	1.53	2.04	2.99*	3.76*
	FINAL	2.66	2.81	1.53	2.04	3.17	3.76
CSP-V-4	PRELIMINARY	2.96*	2.91	1.99	1.87	3.17*	4.19*
	FINAL	3.25	2.94	1.99	1.87	2.87	4.19
CSP-V-5	PRELIMINARY	2.96*	2.81	5.42*	1.62	3.44*	2.55
	FINAL	2.96	2.84	5.42	1.62	3.52	2.55
CSP-V-6	PRELIMINARY VALUES WERE NOT CHANGED IN THE FINAL ANALYSIS	11.39*	1.78	0.75	2.55	3.33*	5.85*
CEP-V-3A		3.10	1.25	0.90	4.57	1.26	0.86
CEP-V-4A		3.71	1.33	0.89	3.35	1.34	0.86

* DENOTES VALUES USED IN QUALIFYING ANALYSIS

ONLY THREE OF THE SIX VALVES ASSIGNED TO THIS QID HAVE HAD THE PREVIOUSLY COMPUTED ("PRELIMINARY") PIPING ACCELERATIONS INCREASED PER THE "AS-BUILT" ANALYSIS

CYGNA

Calculation Sheet

Project: WPPSS-WNP #2 | Prepared By: [signature] | Date: 11/2/83
Subject: Equipment Seismic/Hydrodynamic Requal | Checked By: TJG Marvin | Date: 11-4-83
System: 24" BTF Butterfly Valves / CEP & CSP | Job No. 82044 | File No. P.01.F
Analysis No. 361106 | Rev. No. 4 | Sheet No. 361106-C.3.64

REVIEW OF TABULATED RESULTS ON PREVIOUS PAGE, REVEALS THE FOLLOWING:

1.) IN ONE AXIS ONLY HAVE THE REQUIRED ACCELERATIONS INCREASED IN COMPARISON TO THE ANALYZED ACCELERATIONS.

2.) MOST OF THE "AS-BUILT" RESULTS ARE IDENTICAL TO PREVIOUS ANALYSIS.

THOSE VALVES AND THE DIRECTION(S) OF INCREASED ACCELERATION ARE REPORTED BELOW.

		X	Y	Z
CSP-V-3	ANALYZED	2.66	2.99	3.76
	FINAL	2.66	3.17	3.76
	% DIFFERENCE	0	+6%	0
CSP-V-4	ANALYZED	2.96	3.17	4.19
	FINAL	3.25	2.94	4.19
	% DIFFERENCE	+10%	-7%	0
CSP-V-5	ANALYZED	2.96	3.44	5.42
	FINAL	2.96	3.52	5.42
	% DIFFERENCE	0	+3%	0
CEP-V-4A	ANALYZED	3.35	1.34	0.86
	"REQUIRED	3.71	1.33	0.89
	% DIFFERENCE	+10%	-1%	+3%

CYGNA

Calculation Sheet

Project: WPPSS-WNP#2		Prepared By: [signature]	Date: 11/3/83
Subject: EQUIPMENT SEISMIC/HYDRO REQUALIFICATION		Checked By: TDG MARVIN	Date: 11-11-83
System: 24" BIF BUTTERFLY VALVES/CEP & CSP		Job No. 82044	File No. IP.01.F
Analysis No. 361106	Rev. No. 4	Sheet No. 361106-4.3.65	

BECAUSE OF THE COMPLEXITY OF THE ANALYSIS, THE EXACT STRESS LEVEL FOR EACH COMPONENT WILL NOT BE COMPUTED. INSTEAD, A SIMPLIFIED APPROACH CAN BE UTILIZED WHEREBY THE STRESS LEVELS FOR THE VARIOUS COMPONENTS CAN BE FACTORED BY THE PERCENTAGES OF INCREASE REPORTED ON THE PREVIOUS PAGE.

REVISION TO STRESS SUMMARY TABLE 1.2

FAULTED STRESSES (PSI)

	MEMBER	MAT'L TYPE	TYPE STRESS	VALVE EPN's				MATERIAL ALLOWABLE
				CSP-V-3	CSP-V-4	CSP-V-5	CEP-V-4A **	
*	TRUNN PINS	SA-276	S	4519 MAX			4642	11840
*	TAPER'D PINS	SA-276	S	9581 MAX			9842	11040
*	DRIVE LEVER	A-395	T	11462 MAX			11775	43200
*	MAIN SHAFT	SA-479	S	10040 MAX			10314	14500
	DRIVE ROD	4140	T	33527	36321	41853	8432	86400
	EAR BOLTS	A-325	T	17856	20231	21473	20360	66000
			S	15550	17023	20066	6934	26250
*	LEVER KEY	A-395	T	30119	→	→	30941	43200
*	SHEAR P WELD	E-60	S	→	9637 8761 △	←	←	28800
*	VALVE EAR WELD	E-60	S	→	10589 9626 △	←	←	28800

* 10% INCREASE FOR ALL VALVES
** 13% (10%+3%) FOR CEP-V-4A

	MEMBER	MAT'L TYPE	TYPE STRESS	FATIGUE RESULTS - STRESS RANGE (PSI)				ALLOWABLE RANGE
*	TAPER'D PINS	SA-276	S	38324 MAX			39369	90000
	DRIVE ROD	4140	T	67054	72642	83706	16864	90000
*	TRUNN PINS	SA-276	S	18075 MAX			18568	90000
	SHEAR P WELD	E-60	S	19274 17522			19800	22500
*	VALVE EAR WELD	E-60	S	21177 19252 MAX △			21755	22500

△ STRESS VALUES INDICATED HAVE BEEN COMPUTED FOR THIS REVISION. DOES NOT INCLUDE RESPONSE DUE TO FINAL AS-BUILT ANALYSIS.

CYGNA

Calculation Sheet

Project: WPPSS-WNP#2		Prepared By: Wm Searle	Date: 11/3/83
Subject: Equipment Seismic/Hydro Requalification		Checked By: TBG Marwin	Date: 11-11-83
System: 24" BIF Butterfly Valves / CEP & CSP		Job No. 82044	File No. 1P.01.F
Analysis No. 361106	Rev. No. 1	Sheet No. 361106-4.3.66	

FROM THE PREVIOUS PAGE, ALL MEMBERS SUBJECTED TO INCREASED ACCELERATIONS HAD RESULTING STRESS LEVELS THAT REMAINED WITHIN ALLOWABLE LIMITS. IN CASES, WHERE MEMBER-STRESS WAS CALCULATED FOR ONE VALVE ONLY (WORST CASE), THE GREATEST PERCENT INCREASE OF ACCELERATION WAS APPLIED AND STRESS LEVELS RECOMPUTED. HERE, ALL STRESS REMAINED WITHIN ALLOWABLE LIMITS. IN CASES, WHERE THERE WAS A SIMULTANEOUS DECREASE IN APPLIED GLOBAL ACCELERATION A CORRESPONDING DECREASE IS STRESS, WAS NOT ACCOUNTED FOR.

COMPARISON COMPLETE

CYGNA

Calculation Sheet

Project: Washington Public Power Supply System	Prepared By: [signature]	Date: 3/25/83	
Subject: Equipment Seismic/Hydrodynamic Requal.	Checked By: [signature]	Date: 3/30/83	
System: CSP & CEP	Job No. 82044	File No. OT.01/F	
Analysis No. 361106	Rev. No. 2	Sheet No. 361106 - 4.3.67	△3

SECTION 4.4 △3 [signature] 6/3/83 J C Fernández 6/9/83

REFERENCES:

1. BIF Drawings:

   D-207110-H, D-207110-G, (Valve Data Sheets)

   A-206767, 18", 24" & 30" Butterfly Valve - General

   C-26096, "Certified Dimension for Model A-83-B Cylinder"

2. WPPSS Unit 2 Drawings:

CSP-807-81.08	Containment Purge Air Supply
CSP-809-1.2	Suppression Pool Vacuum Breaker
CEP-625-3.4	From Reactor Nozzle X-67 to SGT-Fu-1A, 1B
CEP-625-1.2	From Reactor Nozzle X-67 to SGT-Fu-1A, 1B
D.220-0310	Support and Erection Isometric-IR64 (Johnson Controls)

3. BIF Report TR-27234 and TR-27235, "Dynamic Torque Calculation of Butterfly Valve; Sizes 24 and 30 inch", dated November 10, 1982.

4. Report #TR-74-7 by McPherson Assoc., Inc., "Design & Seismic Analysis 24" Cylinder operated Butterfly Valve." (Rev. 1) 1/5/76.

5. WPPSS letter to Cygna Energy Services, GE-02-RWH-018, 12/17/82.

CYGNA

Calculation Sheet

Project: Washington Public Power Supply System	Prepared By: L.C. Fernandez	Date: 5/27/83	
Subject: Equipment Seismic/Hydrodynamic Requal.	Checked By: [signature]	Date: 5/27/83	
System: CSP & CEP	Job No. 82044	File No. OT.01.F	
~~Analysis No.~~ QID 361106	Rev. No. 2	Sheet No. 4.3.68	

3 [signature] 6/8/83 L.C. Fernandez 6/9/83

SECTION 4.4

REFERENCES (CONTINUED):

6. Cygna Energy Services Communications Report, R. Ricappito, BIF Valve, and J. Rakowski, CES, "BIF Valve Dimensions", 2/11/83.

7. Cygna Energy Services, Project Manual Design Criteria, DC-1, Rev. 1, November, 1982.

8. Cygna Energy Services, Equipment Qualification Walkdown Verification Forms, Revision 1, dated 1/5/83.

9. WPPSS, WNP-2, Safety Related Mechanical Equipment List Summary Sheets, dated 2/10/83.

10. "AISC Manual of Steel Construction", American Institute of Steel Construction, 8th Edition, 1980.

11. Preliminary Transfer of Final Burns & Roe Piping Loads for CSP-V-1,2,3,4,5,6 and CEP-V-3A&4A, received 4/13/83.

12. Cygna Energy Services, "Equipment Seismic and Hydrodynamic Requalification of 30" Cylinder Operated Butterfly Valves for CSP-V-1, & 2, and CEP-V-1A, & 2A," File No. OS.01.F, QID No. 361104, Revision 1, June, 1983.

13. Cygna Energy Services, "Equipment Seismic and Hydrodynamic Requalification for 8", 10" and 12" Bore Air Cylinder Operators," File No. 1P.01.F, QID No. 018001, Revision 0, May, 1983.

14. USNRC, "Standard Review Plan, NUREG-0800"

APPENDIX A

COMPILED PROGRAMS AND RESULTS FOR

CSP-V-3

CSP-V-4

CSP-V-5

CSP-V-6

CEP-V-3A

CEP-V-4A

```
sbasic csp34
      tm
-BASIC Compiler Version 5.4b

REM***** BIF VALVE AND AIR OPERATOR SEISMIC STRESS *****
REM************** CSP-V/AO-3/4 *************************
REM**SAME ORIENTATION FOR EPN 3&4,SAME PARAMTERS, VARY G'S
REM
var i,j,k = integer
var lrod,lcg,x,phi,lave,ablt,l1,l2,e1,e2,e3,e4,e5 = real
var fst2, ca,ia,cb,ib,aa,ab,d1,d2,c1,i1,c2,i2=real
var lrodo,lcgo,ldr,d, abush, pbush=real
var fcof, fco, ma,mb, siga, sigb, fcdr, fcdrf,maf, mbf=real
var dear, fcear,fr, f11,f22,la, ci12,ci21,stt3,sem1=real
var sem2,set3,ses1,ses2,sr,tau11,tau22,tauear,aear=real
var btens, taublt, set3f,sem1f,sem2f,fcearf, frf,f11f=real
var f22f,stt3f,ses1f,ses2f,srf,tau1f,tau2f,taurf=real
var taubf,btf, dsr,dtaur,dtaub,dbten,dsa,dsb,dpb=real
var sdraf,sdrbf,pbushf,tau11f,tau22f=real
var wao,wbr,ftr1,watr1,s1,s1f,s2,s2f,m1,m1f,m2=real
var m2f,t3,t3f,tt3,tt3f,lbr,wtot=real
var bs1,bs2,bt3,bm1,bm2,btt3=real
dim real av(3)
dim real wa(3)
dim real wb(3)
REM
REM *** BURNS 7 ROE EAR FORCES ARE bs1 etc TURN ON WITH K=1***
REM
REM
dim real a(3,3)
dim real b(3)
dim real glc(3,3)
1  - data 7.5, 10, .75, 1.95, 1.25, .7
2    data 25,14.46,.531,53.,7.125,.31,1.5,2.5
3    data 1150.,.875,.46,.648,.138,2.41,1.4
4    data 399,277,5.25,8.5,28.5,15.,6.875
5.   data 40.,10.96,26.5,30.5,2.075
6    data 90.,90.,180.,0.,90.,90.
7    data 90.,180.,90.,180.,90.,90.
REM DATA 6&7 FOR VALVE/GLOBAL-G ORIENTATIONS AND WEIGHT VECTOR
restore
read d1,d2,c1,i1,c2,i2
restore 2
read lrod,lcg,x,phi,lave,abl/t,l1,l2
restore 3
read fst2,ca,ia,cb,ib,aa,ab
restore 4
read wao,wbr,e1,e2,e3,e4,e5
restore 5
read lrodo,lcgo,ldr,d,abush
restore 6
read  a(1,1),a(2,1),a(3,1),a(1,2),a(2,2),a(3,2)
restore 7
read  a(1,3),a(2,3),a(3,3),av(1),av(2),av(3)
text 0,& INPUT GLOBAL ACCELERATIONS &
input b(1),b(2),b(3)
print
text 0,& INPUT DATA &
print
print "GLOBAL G-LEVELS        = ";b(1),b(2),b(3)
                        LES   = ";a(1,1),a(2,1),a(3,1)
```

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. A-1

34

UT GLOBAL ACCELERATIONS
.66,2.99,3.76

INPUT DATA

GLOBAL G-LEVELS	=	2.66	2.99	3.76
NORTH VECTOR ANGLES	=	90	90	180
VERTICAL VECTOR ANGLES	=	0 90	90	
EAST VECTOR ANGLES	=	90	180	90
WEIGHT VECTOR ANGLES	=	180	90	90

LOCAL G-LEVELS

-1.01471E-5	2.99	-1.43433E-5
-1.01471E-5	-1.14059E-5	-3.76
-2.66	-1.14059E-5	-1.43433E-5

OPERATING DRIVE ROD STRESS AT A	5525.52
OPERATING DRIVE ROD STRESS AT B	8542.57
OPERATING CYLINDER BRG PRESSURE	-98.4646
OPERATING VALVE EAR TENSILE STR	3795.21
OPERATING VALVE EAR SHEAR STRES	244.962
OPERATING EAR BOLT SHEAR STRESS	2963.25
OPERATING EAR BOLT TENSILE STR	2615.86

AMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A	15094.5
DRIVE ROD TENSILE STRESS AT B	23086.2
BUSHING PRESSURE	294.409
VALVE EAR TENSILE STRESS	14765.9
VALVE EAR SHEAR STRESS	967.76
EAR BOLT SHEAR STRESS	11706.8
EAR BOLT TENSILE STRESS	14229.2

FIXED PLUS DYNAMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A	20620.1
DRIVE ROD TENSILE STRESS AT B	31628.7
BUSHING PRESSURE	392.874
VALVE EAR TENSILE STRESS	18561.1
VALVE EAR SHEAR STRESS	1212.72
EAR BOLT SHEAR STRESS	14670
EAR BOLT TENSILE STRESS	16845.1

3:31 55

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. A-2

34

'UT GLOBAL ACCELERATIONS   FAULTED (WELD)
›6,2.99,3.76

INPUT DATA

3LOBAL G-LEVELS	=	2.66	2.99	3.76
NORTH VECTOR ANGLES	=	90	90	180
VERTICAL VECTOR ANGLES=	0	90	90	
EAST VECTOR ANGLES	=	90	180	90
WEIGHT VECTOR ANGLES	=	180	90	90

LOCAL G-LEVELS

-1.01471E-5	2.99	-1.43433E-5
-1.01471E-5	-1.14059E-5	-3.76
-2.66	-1.14059E-5	-1.43433E-5

OPERATING DRIVE ROD STRESS AT A	5525.52
OPERATING DRIVE ROD STRESS AT B	8542.57
OPERATING CYLINDER BRG PRESSURE	-98.4646
OPERATING EAR WELD TENSILE STR	4338.59
OPERATING EAR WELD SHEAR STRES	519.72
OPERATING EAR BOLT SHEAR STRESS	2963.24
OPERATING EAR BOLT TENSILE STR	2615.86

..AMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A	15094.5
DRIVE ROD TENSILE STRESS AT B	23086.2
BUSHING PRESSURE	294.409
EAR WELD TENSILE STRESS	16435.2
EAR WELD SHEAR STRESS	2053.24
EAR BOLT SHEAR STRESS	11706.8
EAR BOLT TENSILE STRESS	14229.2

FIXED PLUS DYNAMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A	20620.1
DRIVE ROD TENSILE STRESS AT B	31628.7
BUSHING PRESSURE	392.874
EAR WELD TENSILE STRESS	20773.8
EAR WELD SHEAR STRESS	2572.96
EAR BOLT SHEAR STRESS	14670
EAR BOLT TENSILE STRESS	16845.1

cs=34
[illegible]UT GLOBAL ACCELERATIONS
[illegible]6,2.99,3.76

INPUT DATA

GLOBAL G-LEVELS	=	2.66	2.99	3.76
NORTH VECTOR ANGLES	=	90	90	180
VERTICAL VECTOR ANGLES	=	0 90	90	
EAST VECTOR ANGLES	=	90	180	90
WEIGHT VECTOR ANGLES	=	180	90	90

LOCAL G-LEVELS

-1.01471E-5	2.99	-1.43433E-5
-1.01471E-5	-1.14059E-5	-3.76
-2.66	-1.14059E-5	-1.43433E-5

OPERATING DRIVE ROD STRESS AT A	5525.52
OPERATING DRIVE ROD STRESS AT B	8542.57
OPERATING CYLINDER BRG PRESSURE	-98.4646
OPERATING VALVE EAR TENSILE STR	3795.21
OPERATING VALVE EAR SHEAR STRES	244.962
OPERATING EAR BOLT SHEAR STRESS	2963.25
OPERATING EAR BOLT TENSILE STR	2615.86

[illegible]-906.782
s2f= 1150
t3f=-2.57873E-3
n1f=-7906.15
m2f=-6234.1
tt3f=-12328.8

DYNAMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A	15094.5
DRIVE ROD TENSILE STRESS AT B	23086.2
BUSHING PRESSURE	294.409
VALVE EAR TENSILE STRESS	14765.9
VALVE EAR SHEAR STRESS	967.76
EAR BOLT SHEAR STRESS	11706.8
EAR BOLT TENSILE STRESS	14229.2

s1d= 2711.27
s2d= 2541.76
t3d= 1798.16
n1d= 59281.6
m2d= 22662.6
tt3d= 68555.7

[illegible]XED PLUS DYNAMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A	20620.1
DRIVE ROD TENSILE STRESS AT B	31628.7
BUSHING PRESSURE	392.874
VALVE EAR TENSILE STRESS	18561.1
VALVE EAR SHEAR STRESS	1212.72

EAR BOLT SHEAR STRESS 14670
EAR BOLT TENSILE STRESS 16845.1

s1t= 3618.06
s2t= 3691.76
t3t= 1798.16
[illegible] 67187.8
[illegible] 28896.7
tt3t= 80884.5

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-5

④
UT GLOBAL ACCELERATIONS
.96,3.17,4.19

INPUT DATA

;LOBAL G-LEVELS =	2.96		3.17	4.19
IORTH VECTOR ANGLES =	90		90	180
)ERTICAL VECTOR ANGLES=	0	90	90	
:AST VECTOR ANGLES =	90		180	90
JEIGHT VECTOR ANGLES =	180		90	90

LOCAL G-LEVELS

-1.12915E-5	3.17	-1.59836E-5
-1.12915E-5	-1.20926E-5	-4.19
-2.96	-1.20926E-5	-1.59836E-5

)PERATING DRIVE ROD STRESS AT A	5525.52
)PERATING DRIVE ROD STRESS AT B	8542.57
IPERATING CYLINDER BRG PRESSURE	-98.4646
)PERATING VALVE EAR TENSILE STR	3795.21
IPERATING VALVE EAR SHEAR STRES	244.962
)PERATING EAR BOLT SHEAR STRESS	2963.25
IPERATING EAR BOLT TENSILE STR	2615.86

AMIC COMPONENTS

RIVE ROD TENSILE STRESS AT A	16003.2
RIVE ROD TENSILE STRESS AT B	24476
USHING PRESSURE	312.133
ALVE EAR TENSILE STRESS	15743
ALVE EAR SHEAR STRESS	1034.29
:AR BOLT SHEAR STRESS	12511.6
:AR BOLT TENSILE STRESS	15776.8

FIXED PLUS DYNAMIC COMPONENTS

RIVE ROD TENSILE STRESS AT A	21528.7
RIVE ROD TENSILE STRESS AT B	33018.6
USHING PRESSURE	410.597
ALVE EAR TENSILE STRESS	19538.2
ALVE EAR SHEAR STRESS	1279.26
:AR BOLT SHEAR STRESS	15474.9
AR BOLT TENSILE STRESS	18392.7

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 0T.01/F
SHEET NO. A-6

UT GLOBAL ACCELERATIONS ④
'6,3.17,4.19

FAULTED (WELD)

INPUT DATA

3LOBAL G-LEVELS	=	2.96	3.17	4.19
IORTH VECTOR ANGLES	=	90	90	180
/ERTICAL VECTOR ANGLES	=	0 90	90	
:AST VECTOR ANGLES	=	90	180	90
JEIGHT VECTOR ANGLES	=	180	90	90

LOCAL G-LEVELS

-1.12915E-5	3.17	-1.59836E-5
-1.12915E-5	-1.20926E-5	-4.19
-2.96	-1.20926E-5	-1.59836E-5

)PERATING DRIVE ROD STRESS AT A	5525.52
)PERATING DRIVE ROD STRESS AT B	8542.57
)PERATING CYLINDER BRG PRESSURE	-98.4646
JFERATING EAR WELD TENSILE STR	4338.59
)PERATING EAR WELD SHEAR STRES	519.72
)PERATING EAR BOLT SHEAR STRESS	2963.24
)PERATING EAR BOLT TENSILE STR	2615.86

MIC COMPONENTS

)RIVE ROD TENSILE STRESS AT A	16003.2
)RIVE ROD TENSILE STRESS AT B	24476
3USHING PRESSURE	312.133
:AR WELD TENSILE STRESS	17548.3
:AR WELD SHEAR STRESS	2194.4
:AR BOLT SHEAR STRESS	12511.6
:AR BOLT TENSILE STRESS	15776.8

FIXED PLUS DYNAMIC COMPONENTS

)RIVE ROD TENSILE STRESS AT A	21528.7
)RIVE ROD TENSILE STRESS AT B	33018.6
'USHING PRESSURE	410.597
:AR WELD TENSILE STRESS	21886.9
:AR WELD SHEAR STRESS	2714.12
:AR BOLT SHEAR STRESS	15474.9
:AR BOLT TENSILE STRESS	18392.7

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 0T.01.F
SHEET NO. A-7

```
csp34
[illegible]UT GLOBAL ACCELERATIONS
[illegible]96,3.17,4.19

 INPUT DATA

GLOBAL G-LEVELS          =  2.96              3.17          4.19
NORTH VECTOR ANGLES      =  90                90            180
VERTICAL VECTOR ANGLES= 0    90               90
EAST VECTOR ANGLES       =  90                180           90
WEIGHT VECTOR ANGLES     =  180               90            90


 LOCAL G-LEVELS

-1.12915E-5   3.17          -1.59836E-5
-1.12915E-5  -1.20926E-5    -4.19
-2.96        -1.20926E-5    -1.59836E-5

OPERATING DRIVE ROD STRESS AT A   5525.52
OPERATING DRIVE ROD STRESS AT B   8542.57
OPERATING CYLINDER BRG PRESSURE -98.4646
OPERATING VALVE EAR TENSILE STR   3795.21
OPERATING VALVE EAR SHEAR STRES   244.962
OPERATING EAR BOLT SHEAR STRESS   2963.25
OPERATING EAR BOLT TENSILE   STR  2615.86

[illegible]-906.782
[illegible] 1150
t3f=-2.57873E-3
n1f=-7906.15
n2f=-6234.1
tt3f=-12328.8


 DYNAMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A 16003.2
DRIVE ROD TENSILE STRESS AT B 24476
BUSHING PRESSURE              312.133
VALVE EAR TENSILE STRESS      15743
VALVE EAR SHEAR STRESS        1034.29
EAR BOLT SHEAR STRESS         12511.6
EAR BOLT TENSILE STRESS       15776.8

s1d= 2874.49
s2d= 2832.44
t3d= 2000.96
n1d= 65975.4
n2d= 24418.8
tt3d= 72951.2


[illegible]ED PLUS DYNAMIC COMPONENTS

[illegible]VE ROD TENSILE STRESS AT A 21528.7
DRIVE ROD TENSILE STRESS AT B 33018.6
BUSHING PRESSURE              410.597
VALVE EAR TENSILE STRESS      19538.2
VALVE EAR SHEAR STRESS        1279.26
EAR BOLT SHEAR STRESS         15474.9
```

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. DT.01.F
SHEET NO. A-8

EAR BOLT TENSILE STRESS 18392.7

s1t= 3781.28
s2t= 3982.44
t3t= 2000.96
... = 73881.5
... 30652.9
... = 85280

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT, 01, F
SHEET NO. A-9

④ ...JT GLOBAL ACCELERATIONS   EMERGENCY (ENVELOPES CSA V-3)
...0,1.97,1.71

INPUT DATA

...LOBAL G-LEVELS	=	2.8	1.97	1.71
...ORTH VECTOR ANGLES	=	90	90	180
...ERTICAL VECTOR ANGLES	=	0 90	90	
...AST VECTOR ANGLES	=	90	180	90
...EIGHT VECTOR ANGLES	=	180	90	90

LOCAL G-LEVELS

1.06811E-5	1.97	-6.52313E-6
1.06811E-5	-7.51495E-6	-1.71
2.8	-7.51495E-6	-6.52313E-6

...PERATING DRIVE ROD STRESS AT A	5525.52
...PERATING DRIVE ROD STRESS AT B	8542.57
...PERATING CYLINDER BRG PRESSURE	-98.4646
...PERATING EAR WELD TENSILE STR	4338.59
...PERATING EAR WELD SHEAR STRES	519.72
...PERATING EAR BOLT SHEAR STRESS	2963.24
...PERATING EAR BOLT TENSILE STR	2615.86

...MIC COMPONENTS

...RIVE ROD TENSILE STRESS AT A	9945.23
...RIVE ROD TENSILE STRESS AT B	15210.7
...USHING PRESSURE	193.975
...AR WELD TENSILE STRESS	10668.6
...AR WELD SHEAR STRESS	1296.94
...AR BOLT SHEAR STRESS	7394.64
...AR BOLT TENSILE STRESS	14365.1

FIXED PLUS DYNAMIC COMPONENTS

RIVE ROD TENSILE STRESS AT A	15470.8
RIVE ROD TENSILE STRESS AT B	23753.2
USHING PRESSURE	292.44
AR WELD TENSILE STRESS	15007.2
AR WELD SHEAR STRESS	1816.66
AR BOLT SHEAR STRESS	10357.9
AR BOLT TENSILE STRESS	16980.9

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.E
SHEET NO. A-10

csp3(4)

INPUT GLOBAL ACCELERATIONS   UPSET   , ENVELOPES CSP V-3)

.14,1.40,1.5

INPUT DATA

```
GLOBAL G-LEVELS          =  1.14          1.4      1.5
NORTH VECTOR ANGLES      =  90            90       180
VERTICAL VECTOR ANGLES=  0     90         90
EAST VECTOR ANGLES       =  90            180      90
WEIGHT VECTOR ANGLES     =  180           90       90
```

LOCAL G-LEVELS

```
-4.34875E-6   1.4           -5.72204E-6
-4.34875E-6   -5.34057E-6   -1.5
-1.14         -5.34057E-6   -5.72204E-6
```

```
OPERATING DRIVE ROD STRESS AT A  5525.52
OPERATING DRIVE ROD STRESS AT B  8542.57
OPERATING CYLINDER BRG PRESSURE -98.4646
OPERATING EAR WELD  TENSILE STR  4338.59
OPERATING EAR WELD  SHEAR STRES  519.72
OPERATING EAR BOLT SHEAR STRESS  2963.24
OPERATING EAR BOLT TENSILE  STR  2615.86
```

DYNAMIC COMPONENTS

```
DRIVE ROD TENSILE STRESS AT A 7067.68
DRIVE ROD TENSILE STRESS AT B 10809.6
BUSHING PRESSURE              137.85
EAR WELD  TENSILE STRESS      7558.92
EAR WELD  SHEAR STRESS        940.809
EAR BOLT SHEAR STRESS         5364.13
EAR BOLT TENSILE STRESS       6129.04
```

FIXED PLUS DYNAMIC COMPONENTS

```
DRIVE ROD TENSILE STRESS AT A 12593.2
DRIVE ROD TENSILE STRESS AT B 19352.2
BUSHING PRESSURE              236.315
EAR WELD  TENSILE STRESS      11897.5
EAR WELD  SHEAR STRESS        1460.53
EAR BOLT SHEAR STRESS         8327.37
EAR BOLT TENSILE STRESS       8744.9
```

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. A-11

```
sbasic csp5
     tm
S-BASIC Compiler Version 5.4b

REM***** BIF VALVE AND AIR OPERATOR SEISMIC STRESS *****
REM*************** CSP-V/AO-5 **************************
REM
var i,j,k = integer
var lrod,lcg,x,phi,lave,ablt,l1,l2,e1,e2,e3,e4,e5 = real
var fst2, ca,ia,cb,ib,aa,ab,d1,d2,c1,i1,c2,i2=real
var lrodo,lcgo,ldr,d, abush, pbush=real
var fcof, fco, ma,mb, siga, sigb, fcdr, fcdrf,maf, mbf=real
var dear, fcear,fr, f11,f22,la, ci12,ci21,stt3,sem1=real
var sem2,set3,ses1,ses2,sr,tau11,tau22,tauear,aear=real
var btens, taublt, set3f,sem1f,sem2f,fcearf, frf,f11f=real
var f22f,stt3f,ses1f,ses2f,srf,tau1f,tau2f,taurf=real
var taubf,btf, dsr,dtaur,dtaub,dbten,dsa,dsb,dpb=real
var sdraf,sdrbf,pbushf,tau11f,tau22f=real
var wao,wbr,ftr1,watr1,s1,s1f,s2,s2f,m1,m1f,m2=real
var m2f,t3,t3f,tt3,tt3f,lbr,wtot=real
var bs1,bs2,bt3,bm1,bm2,btt3=real
dim real av(3)
dim real wa(3)
dim real wb(3)
REM
REM *** BURNS 7 ROE EAR FORCES ARE bs1 etc TURN ON WITH K=1***
REM
REM
dim real a(3,3)
dim real b(3)
dim real glc(3,3)
1   data 7.5, 10, .75, 1.95, 1.25, .7
2   data 25,14.46,.531,53.,7.125,.31,1.5,2.5
3   data 0.,.875,.46,.648,.138,2.41,1.4
4   data 399,277,5.25,8.5,28.5,15.,6.875
5   data 40.,10.96,26.5,30.5,2.075
6   data 42.5,47.5,90.,90.,90.,0.
7   data 47.5,137.5,90.,180.,90.,90.
REM DATA 6&7 FOR VALVE/GLOBAL-G ORIENTATIONS AND WEIGHT VECTOR
restore
read d1,d2,c1,i1,c2,i2
restore 2
read lrod,lcg,x,phi,lave,ablt,l1,l2
restore 3
read fst2,ca,ia,cb,ib,aa,ab
restore 4
read wao,wbr,e1,e2,e3,e4,e5
restore 5
read lrodo,lcgo,ldr,d,abush
restore 6
read  a(1,1),a(2,1),a(3,1),a(1,2),a(2,2),a(3,2)
restore 7
read  a(1,3),a(2,3),a(3,3),av(1),av(2),av(3)
text 0,& INPUT GLOBAL ACCELERATIONS &
input b(1),b(2),b(3)
print
text 0,& INPUT DATA &
```

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/E
SHEET NO. A-12

5
'UT GLOBAL ACCELERATIONS
.96,3.44,5.42

INPUT DATA

3LOBAL G-LEVELS	=	2.96	3.44	5.42
JORTH VECTOR ANGLES	=	42.5	47.5	90
/ERTICAL VECTOR ANGLES	=	90	90	0
EAST VECTOR ANGLES	=	47.5	137.5	90
JEIGHT VECTOR ANGLES	=	180	90	90

LOCAL G-LEVELS

2.18234	-1.31225E-5	3.66169
1.99974	-1.31225E-5	-3.99606
-1.12915E-5	3.44	-2.06756E-5

)PERATING DRIVE ROD STRESS AT A	5048.35
)PERATING DRIVE ROD STRESS AT B	7721.14
)PERATING CYLINDER BRG PRESSURE	-98.4646
)PERATING VALVE EAR TENSILE STR	4664.25
)PERATING VALVE EAR SHEAR STRES	297.614
)PERATING EAR BOLT SHEAR STRESS	3600.17
)PERATING EAR BOLT TENSILE STR	1340.69

.AMIC COMPONENTS

)RIVE ROD TENSILE STRESS AT A	21519.6
)RIVE ROD TENSILE STRESS AT B	32912.8
3USHING PRESSURE	419.724
/ALVE EAR TENSILE STRESS	20190.5
/ALVE EAR SHEAR STRESS	1312.91
EAR BOLT SHEAR STRESS	15882
EAR BOLT TENSILE STRESS	19507

FIXED PLUS DYNAMIC COMPONENTS

)RIVE ROD TENSILE STRESS AT A	26567.9
)RIVE ROD TENSILE STRESS AT B	40633.9
'USHING PRESSURE	518.189
/ALVE EAR TENSILE STRESS	24854.8
/ALVE EAR SHEAR STRESS	1610.53
EAR BOLT SHEAR STRESS	19482.2
EAR BOLT TENSILE STRESS	20847.7

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 0T.01/F
SHEET NO. A-13

csp5

?UT GLOBAL ACCELERATIONS   FAULTED WELD STRESS)

?6,3.44,5.42

INPUT DATA

GLOBAL G-LEVELS	=	2.96	3.44	5.42
?ORTH VECTOR ANGLES	=	42.5	47.5	90
?ERTICAL VECTOR ANGLES	=	90	90	0
?AST VECTOR ANGLES	=	47.5	137.5	90
?EIGHT VECTOR ANGLES	=	180	90	90

LOCAL G-LEVELS

2.18234	-1.31225E-5	3.66169
1.99974	-1.31225E-5	-3.99606
-1.12915E-5	3.44	-2.06756E-5

?PERATING DRIVE ROD STRESS AT A	5048.35
?PERATING DRIVE ROD STRESS AT B	7721.14
?PERATING CYLINDER BRG PRESSURE	-98.4646
?PERATING EAR WELD TENSILE STR	5107.51
?PERATING EAR WELD SHEAR STRES	631.431
?PERATING EAR BOLT SHEAR STRESS	3600.17
?PERATING EAR BOLT TENSILE STR	1340.69

?MIC COMPONENTS

?RIVE ROD TENSILE STRESS AT A	21519.6
?RIVE ROD TENSILE STRESS AT B	32912.8
?USHING PRESSURE	419.724
?AR WELD TENSILE STRESS	22736.7
?AR WELD SHEAR STRESS	2785.52
?AR BOLT SHEAR STRESS	15882
?AR BOLT TENSILE STRESS	19507

FIXED PLUS DYNAMIC COMPONENTS

?RIVE ROD TENSILE STRESS AT A	26567.9
?RIVE ROD TENSILE STRESS AT B	40633.9
?USHING PRESSURE	518.189
?AR WELD TENSILE STRESS	27844.2
?AR WELD SHEAR STRESS	3416.95
?AR BOLT SHEAR STRESS	19482.2
?AR BOLT TENSILE STRESS	20847.7

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. A-14

cs65

```
[illegible]UT GLOBAL ACCELERATIONS
[illegible]76,3.44,5.42

 INPUT DATA

3LOBAL G-LEVELS          =  2.96                3.44           5.42
NORTH VECTOR ANGLES      =  42.5                47.5           90
/ERTICAL VECTOR ANGLES=     90                  90            0
EAST VECTOR ANGLES       =  47.5                137.5          90
WEIGHT VECTOR ANGLES     =  180                 90             90


 LOCAL G-LEVELS

 2.18234      -1.31225E-5     3.66169
 1.99974      -1.31225E-5    -3.99606
-1.12915E-5    3.44          -2.06756E-5

OPERATING DRIVE ROD STRESS AT A  5048.35
OPERATING DRIVE ROD STRESS AT B  7721.14
OPERATING CYLINDER BRG PRESSURE -98.4646
OPERATING VALVE EAR TENSILE STR  4664.25
OPERATING VALVE EAR SHEAR STRES  297.614
OPERATING EAR BOLT SHEAR STRESS  3600.17
OPERATING EAR BOLT TENSILE  STR  1340.69

[illegible]-906.782
[illegible]=-2.57874E-3
t3f=-2.57873E-3
n1f= 9.89667E-2
n2f=-6234.1
:t3f=-22103.8


 DYNAMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A 21519.6
DRIVE ROD TENSILE STRESS AT B 32912.8
BUSHING PRESSURE              419.724
/ALVE EAR TENSILE STRESS      20190.5
/ALVE EAR SHEAR STRESS        1312.91
EAR_BOLT SHEAR STRESS         15882
EAR BOLT TENSILE STRESS       19507

s1d= 3865.34
s2d= 3020.7
t3d= 2325.44
n1d= 76145
n2d= 31369.7
:t3d= 84539.5


[illegible]ED PLUS DYNAMIC COMPONENTS

[illegible]VE ROD TENSILE STRESS AT A 26567.9
DRIVE ROD TENSILE STRESS AT B 40633.9
BUSHING PRESSURE              518.189
/ALVE EAR TENSILE STRESS      24854.8
/ALVE EAR SHEAR STRESS        1610.53
[illegible]
```

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-15

EAR BOLT SHEAR STRESS 19482.2
EAR BOLT TENSILE STRESS 20847.7

s1t= 4772.12
s2t= 3020.7
s3t= 2325.44
= 76145
37603.8
:tot= 1.06643E+5

:sp5

UT GLOBAL ACCELERATIONS   EMERGENCY
?0,2.69,5.32

INPUT DATA

;LOBAL G-LEVELS =	2.8	2.69	5.32
IORTH VECTOR ANGLES =	42.5	47.5	90
/ERTICAL VECTOR ANGLES=	90	90	0
:AST VECTOR ANGLES =	47.5	137.5	90
JEIGHT VECTOR ANGLES =	180	90	90

LOCAL G-LEVELS

2.06437	-1.02615E-5	3.59413
1.89165	-1.02615E-5	-3.92233
-1.06811E-5	2.69	-2.02942E-5

)PERATING DRIVE ROD STRESS AT A	5048.35
)PERATING DRIVE ROD STRESS AT B	7721.14
)PERATING CYLINDER BRG PRESSURE	-98.4646
)PERATING EAR WELD TENSILE STR	5107.51
)PERATING EAR WELD SHEAR STRES	631.431
)PERATING EAR BOLT SHEAR STRESS	3600.17
)PERATING EAR BOLT TENSILE STR	1340.69

MIC COMPONENTS

RIVE ROD TENSILE STRESS AT A	20924.4
)RIVE ROD TENSILE STRESS AT B	32002.6
;USHING PRESSURE	408.116
:AR WELD TENSILE STRESS	21934.6
:AR WELD SHEAR STRESS	2693.88
:AR BOLT SHEAR STRESS	15359.5
:AR BOLT TENSILE STRESS	16131.4

FIXED PLUS DYNAMIC COMPONENTS

RIVE ROD TENSILE STRESS AT A	25972.8
RIVE ROD TENSILE STRESS AT B	39723.7
USHING PRESSURE	506.581
:AR WELD TENSILE STRESS	27042.1
AR WELD SHEAR STRESS	3325.31
:AR BOLT SHEAR STRESS	18959.6
AR BOLT TENSILE STRESS	17472.1

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. A-17

:sp5

INPUT GLOBAL ACCELERATIONS UPSET
?7,1.4,1.71

INPUT DATA

LOBAL G-LEVELS	=	.97	1.4	1.71
IORTH VECTOR ANGLES	=	42.5	47.5	90
'ERTICAL VECTOR ANGLES	=	90	90	0
:AST VECTOR ANGLES	=	47.5	137.5	90
JEIGHT VECTOR ANGLES	=	180	90	90

LOCAL G-LEVELS

.715158	-5.34057E-6	1.15526
.655321	-5.34057E-6	-1.26075
-3.70025E-6	1.4	-6.52313E-6

IPERATING DRIVE ROD STRESS AT A	5048.35
IPERATING DRIVE ROD STRESS AT B	7721.14
IPERATING CYLINDER BRG PRESSURE	-98.4646
IPERATING EAR WELD TENSILE STR	5107.51
IPERATING EAR WELD SHEAR STRES	631.431
IPERATING EAR BOLT SHEAR STRESS	3600.17
PERATING EAR BOLT TENSILE STR	1340.69

?AMIC COMPONENTS

RIVE ROD TENSILE STRESS AT A	6859.18
RIVE ROD TENSILE STRESS AT B	10490.7
USHING PRESSURE	133.784
AR WELD TENSILE STRESS	7323.31
AR WELD SHEAR STRESS	892.936
AR BOLT SHEAR STRESS	5091.16
AR BOLT TENSILE STRESS	7599.75

FIXED PLUS DYNAMIC COMPONENTS

RIVE ROD TENSILE STRESS AT A	11907.5
RIVE ROD TENSILE STRESS AT B	18211.9
USHING PRESSURE	232.249
AR WELD TENSILE STRESS	12430.8
AR WELD SHEAR STRESS	1524.37
AR BOLT SHEAR STRESS	8691.33
AR BOLT TENSILE STRESS	8940.43

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-18

```
  . . sbasic csp6
     tm
 -BASIC Compiler Version 5.4b

REM***** BIF VALVE AND AIR OPERATOR SEISMIC STRESS *****
REM*************** CSP-V/AO-6 *************************
REM
var i,j,K = integer
var lrod,lcg,x,phi,lave,ablt,l1,l2,e1,e2,e3,e4,e5 = real
var fst2, ca,ia,cb,ib,aa,ab,d1,d2,c1,i1,c2,i2=real
var lrodo,lcgo,ldr,d, abush, pbush=real
var fcof, fco, ma,mb, siga, sigb, fcdr, fcdrf,maf, mbf=real
var dear, fcear,fr, f11,f22,la, ci12,ci21,stt3,sem1=real
var sem2,set3,ses1,ses2,sr,tau11,tau22,tauear,aear=real
var btens, taublt, set3f,sem1f,sem2f,fcearf, frf,f11f=real
var f22f,stt3f,ses1f,ses2f,srf,tau1f,tau2f,taurf=real
var taubf,btf, dsr,dtaur,dtaub,dbten,dsa,dsb,dpb=real
var sdraf,sdrbf,pbushf,tau11f,tau22f=real
var wao,wbr,ftr1,watr1,s1,s1f,s2,s2f,m1,m1f,m2=real
var m2f,t3,t3f,tt3,tt3f,lbr,wtot=real
var bs1,bs2,bt3,bm1,bm2,btt3=real
dim real av(3)
dim real wa(3)
dim real wb(3)
REM
REM *** BURNS 7 ROE EAR FORCES ARE bs1 etc TURN ON WITH K=1***
REM
REM
dim real a(3,3)
dim real b(3)
dim real glc(3,3)
1   data 7.5, 10, .75, 1.95, 1.25, .7
2   data 25,14.46,.531,53.,7.125,.31,1.5,2.5
3   data 0.,.875,.46,.648,.138,2.41,1.4
4   data 399,277,5.25,8.5,28.5,15.,6.875
5   data 40.,10.96,26.5,30.5,2.075
6   data 90.,90.,0.,0.,90.,90.
7   data 90.,0.,90.,180.,90.,90.
REM DATA 6&7 FOR VALVE/GLOBAL-G ORIENTATIONS AND WEIGHT VECTOR
restore
read d1,d2,c1,i1,c2,i2
restore 2
read lrod,lcg,x,phi,lave,ablt,l1,l2
restore 3
read fst2,ca,ia,cb,ib,aa,ab
restore 4
read wao,wbr,e1,e2,e3,e4,e5
restore 5
read lrodo,lcgo,ldr,d,abush
restore 6
read  a(1,1),a(2,1),a(3,1),a(1,2),a(2,2),a(3,2)
restore 7
read  a(1,3),a(2,3),a(3,3),av(1),av(2),av(3)
text 0,& INPUT GLOBAL ACCELERATIONS &
input b(1),b(2),b(3)
print
text 0,& INPUT DATA &
print
print "GLOBAL G-LEVELS        = ";b(1),b(2),b(3)
print "NORTH VECTOR ANGLES    = ";a(1,1),a(2,1),a(3,1)
```

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01/E
SHEET NO. A-19

```
print
for i=1 to 3
for j=1 to 3
  a(j,i)=a(j,i)*2.*3.1416/360.
  glc(j,i)=b(i)*cos(a(j,i))
next j
next i
for j=1 to 3
av(j)=av(j)*2.*3.1416/360.
next j
print
text 0,& LOCAL G-LEVELS &
print
print glc(1,1),glc(1,2),glc(1,3)
print glc(2,1),glc(2,2),glc(2,3)
print glc(3,1),glc(3,2),glc(3,3)
REM WEIGHT COMPONENTS
for j=1 to 3
wa(j)=wao*cos(av(j))
wb(j)=wbr*cos(av(j))
next j
phi=phi*2.*3.1416/360.
la=lave/2
ci12=c1/i2
ci21=c2/i1
aear=l1*l2
REM CALCULATE EAR FORCES USE B&R LOADS AS OPTION LATER
REM FIXED COMPONENTS ARE ALWAYS THERE
lbr=lrod+lcg
watr1=lbr*wa(1)/lrod
s1f=wb(1)+watr1
wtot=wao+wbr
s2f=wb(2)+wa(2)+fst2
t3f=wa(3)+wb(3)
m1f=-(wa(2)+wb(2)+fst2)*e5-wa(3)*(e3+lcg)-wb(3)*e4
m2f=(watr1+wb(1))*e5-wa(3)*e2-wb(3)*e1
tt3f=watr1*e3+(wa(2)+fst2)*e2+wb(1)*e4+wb(2)*e1
fcdrf=lcg*wa(1)/lrod
maf=fcdrf*(lrod-13.5)
mbf=fcdrf*7.125
sdraf=fst2/aa+abs(maf*ca/ia)
sdrbf=fst2/ab+abs(mbf*cb/ib)
fcof=lcgo*wa(1)/lrodo
pbushf=fcof*(ldr+d)/(d*abush)
REM STRESSES FROM FIXED COMPONENTS
dear=(d1*d1+d2*d2)**.5
set3f=abs(t3f/(4*aear))
sem1f=abs(m1f/(2*d2*aear))
sem2f=abs(m2f/(2*d1*aear))
fcearf=tt3f/(2*dear)
frf=x*fcearf
f11f=-(fcearf*sin(phi)-frf*cos(phi))
f22f=fcearf*cos(phi)+frf*sin(phi)
stt3f=abs(f11f*la*ci12)+abs(f22f*la*ci21)
ses1f=abs(s1f*ci12*la/4.)
ses2f=abs(s2f*ci21*la/4.)
srf=set3f+sem1f+sem2f+ses1f+ses2f+stt3f
REM EAR SHEAR
tau11f=abs(s1f/(4*aear))+abs(f11f/aear)
tau22f=abs(s2f/(4*aear))+abs(f22f/aear)
taurf=(tau11f*tau11f+tau22f*tau22f)**.5
taubf=taurf*aear/ablt
REM EARBOLT TENSION
btf=(set3f+sem1f+sem2f)*aear/ablt
print
print"OPERATING DRIVE ROD STRESS AT A ";sdraf
print"OPERATING DRIVE ROD STRESS AT B ";sdrbf
```

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 4T.01/E
SHEET NO. A-90

```
0126:00 print"OPERATING CYLINDER BRG PRESSURE ";pbushf
0127:00 print"OPERATING VALVE EAR TENSILE STR ";srf
0128:00 print"OPERATING VALVE EAR SHEAR STRES ";taurf
0129:00 print"OPERATING EAR BOLT SHEAR STRESS ";taubf
0130:00 print"OPERATING EAR BOLT TENSILE  STR ";btf
0131:00 print
0132:00 REM
0133:00 REM CALCULATE VARIABLE COMPONENTS
0134:00 REM
0135:00 dsr=0.
0136:00 dtaur=0.
0137:00 dtaub=0.
0138:00 dbten=0.
0139:00 dsa=0.
0140:00 dsb=0.
0141:00 dpb=0.
0142:00 for j=1 to 3
0143:01 fco=lcgo*wao*glc(1,j)/lrodo
0144:01 pbush=fco*(ldr+d)/(d*abush)
0145:01 ftr1=lbr*wao*glc(1,j)/lrod
0146:01 s1=ftr1+wbr*glc(1,j)
0147:01 s2=wtot*glc(2,j)
0148:01 t3=wtot*glc(3,j)
0149:01 m1=-wtot*glc(2,j)*e5-wao*glc(3,j)*(e3+lcg)-wbr*glc(3,j)*e4
0150:01 m2=(ftr1+wbr*glc(1,j))*e5-(wao*e2+wbr*e1)*glc(3,j)
0151:01 tt3=ftr1*e3+wbr*glc(1,j)*e4+glc(2,j)*(wao*e2+wbr*e1)
0152:01 fcdr=lcg*wao*glc(1,j)/lrod
0153:01 ma=fcdr*(lrod-13.5)
0154:01 mb=fcdr*7.125
0155:01 siga=ma*ca/ia
0156:01 sigb=mb*cb/ib
0157:01 REM CALCULATE EAR TENSION
0158:01 set3=abs(t3/(4*aear))
0159:01 sem1=abs(m1/(2*d2*aear))
0160:01 sem2=abs(m2/(2*d1*aear))
0161:01 fcear=tt3/(2*dear)
0162:01 fr=x*fcear
0163:01 f11=-(fcear*sin(phi)-fr*cos(phi))
0164:01 f22=fcear*cos(phi)+fr*sin(phi)
0165:01 stt3=abs(f11*la*ci12)+abs(f22*la*ci21)
0166:01 ses1=abs(s1*ci12*la/4.)
0167:01 ses2=abs(s2*ci21*la/4.)
0168:01 sr=set3+sem1+sem2+ses1+ses2+stt3
0169:01 REM EAR SHEAR
0170:01 tau11=abs(s1/(4.*aear))+abs(f11/aear)
0171:01 tau22=abs(s2/(4.*aear))+abs(f22/aear)
0172:01 tauear=(tau11*tau11+tau22*tau22)**.5
0173:01 taublt=tauear*aear/ablt
0174:01 REM EARBOLT TENSION
0175:01 btens=(set3+sem1+sem2)*aear/ablt
0176:01 dsa=dsa+siga*siga
0177:01 dsb=dsb+sigb*sigb
0178:01 dpb=dpb+pbush*pbush
0179:01 dsr=dsr+sr*sr
0180:01 dtaur=dtaur+tauear*tauear
0181:01 dtaub=dtaub+taublt*taublt
0182:01 dbten=dbten+btens*btens
0183:01 next j
0184:00 REM COMBINE STRESSES
0185:00 dsa=dsa**.5
0186:00 dsb=dsb**.5
0187:00 dpb=dpb**.5
0188:00 dsr=dsr**.5
0189:00 dtaur=dtaur**.5
0190:00 dtaub=dtaub**.5
0191:00 dbten=dbten**.5
```

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. A-21

```
print
text 0,& DYNAMIC COMPONENTS &
print
print "DRIVE ROD TENSILE STRESS AT A";dsa
print "DRIVE ROD TENSILE STRESS AT B";dsb
print "BUSHING PRESSURE              ";dpb
print "VALVE EAR TENSILE STRESS      ";dsr
print "VALVE EAR SHEAR STRESS        ";dtaur
print "EAR BOLT SHEAR STRESS         ";dtaub
print "EAR BOLT TENSILE STRESS       ";dbten
dsa=dsa+abs(sdraf)
dsb=dsb+abs(sdrbf)
dpb=dpb+abs(pbushf)
dsr=dsr+abs(srf)
dtaur=dtaur+abs(taurf)
dtaub=dtaub+abs(taubf)
dbten=dbten+abs(btf)
print
text 0,& FIXED PLUS DYNAMIC COMPONENTS &
print
print "DRIVE ROD TENSILE STRESS AT A";dsa
print "DRIVE ROD TENSILE STRESS AT B";dsb
print "PUSHING PRESSURE              ";dpb
print "VALVE EAR TENSILE STRESS      ";dsr
print "VALVE EAR SHEAR STRESS        ";dtaur
print "EAR BOLT SHEAR STRESS         ";dtaub
print "EAR BOLT TENSILE STRESS       ";dbten
end




          ****** End of program ******
```

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. A-12

csp6

INPUT GLOBAL ACCELERATIONS

11.39,3.33,5.85

INPUT DATA

GLOBAL G-LEVELS =	11.39	3.33	5.85
NORTH VECTOR ANGLES =	90	90	0
VERTICAL VECTOR ANGLES=	0 90	90	
EAST VECTOR ANGLES =	90	0	90

LOCAL G-LEVELS

-4.34494E-5	3.33	-2.2316E-5
-4.34494E-5	-1.27029E-5	5.85
11.39	-1.27029E-5	-2.2316E-5

OPERATING DRIVE ROD STRESS AT A	5048.35
OPERATING DRIVE ROD STRESS AT B	7721.14
OPERATING CYLINDER BRG PRESSURE	-98.4646
OPERATING VALVE EAR TENSILE STR	4664.25
OPERATING VALVE EAR SHEAR STRES	297.614
OPERATING EAR BOLT SHEAR STRESS	3600.17
OPERATING EAR BOLT TENSILE STR	1340.69

DYNAMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A	16811
DRIVE ROD TENSILE STRESS AT B	25711.4
BUSHING PRESSURE	327.887
VALVE EAR TENSILE STRESS	17822.1
VALVE EAR SHEAR STRESS	1154.32
EAR BOLT SHEAR STRESS	13963.6
EAR BOLT TENSILE STRESS	57543

FIXED PLUS DYNAMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A	21859.4
DRIVE ROD TENSILE STRESS AT B	33432.5
BUSHING PRESSURE	426.352
VALVE EAR TENSILE STRESS	22486.4
VALVE EAR SHEAR STRESS	1451.93
EAR BOLT SHEAR STRESS	17563.7
EAR BOLT TENSILE STRESS	58883.7

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.011F
SHEET NO. A-23

csp6

INPUT GLOBAL ACCELERATIONS
11.39,3.33,5.85

INPUT DATA

GLOBAL G-LEVELS =	11.39	3.33	5.85
NORTH VECTOR ANGLES =	90	90	0
VERTICAL VECTOR ANGLES=	0 90	90	
EAST VECTOR ANGLES =	90	0	90

LOCAL G-LEVELS

-4.34494E-5	3.33	-2.2316E-5
-4.34494E-5	-1.27029E-5	5.85
11.39	-1.27029E-5	-2.2316E-5

OPERATING DRIVE ROD STRESS AT A	5048.35
OPERATING DRIVE ROD STRESS AT B	7721.14
OPERATING CYLINDER BRG PRESSURE	-98.4646
OPERATING EAR WELD TENSILE STR	5107.51
OPERATING EAR WELD SHEAR STRES	631.431
OPERATING EAR BOLT SHEAR STRESS	3600.17
OPERATING EAR BOLT TENSILE STR	1340.69

DYNAMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A	16811
DRIVE ROD TENSILE STRESS AT B	25711.4
BUSHING PRESSURE	327.887
EAR WELD TENSILE STRESS	21586.2
EAR WELD SHEAR STRESS	2449.05
EAR BOLT SHEAR STRESS	13963.6
EAR BOLT TENSILE STRESS	57543

FIXED PLUS DYNAMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A	21859.4
DRIVE ROD TENSILE STRESS AT B	33432.5
BUSHING PRESSURE	426.352
EAR WELD TENSILE STRESS	26693.7
EAR WELD SHEAR STRESS	3080.48
EAR BOLT SHEAR STRESS	17563.7
EAR BOLT TENSILE STRESS	58883.7

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-24

--p6
UT GLOBAL ACCELERATIONS
.39,3.33,5.85

INPUT DATA

;LOBAL G-LEVELS	=	11.39	3.33	5.85
IORTH VECTOR ANGLES	=	90	90	0
'ERTICAL VECTOR ANGLES	=	0 90	90	
:AST VECTOR ANGLES	=	90	0	90

LOCAL G-LEVELS

·4.34494E-5	3.33	-2.2316E-5
·4.34494E-5	-1.27029E-5	5.85
11.39	-1.27029E-5	-2.2316E-5

)PERATING DRIVE ROD STRESS AT A	5048.35
)PERATING DRIVE ROD STRESS AT B	7721.14
)PERATING CYLINDER BRG PRESSURE	-98.4646
)PERATING VALVE EAR TENSILE STR	4664.25
)PERATING VALVE EAR SHEAR STRES	297.614
)PERATING EAR BOLT SHEAR STRESS	3600.17
)PERATING EAR BOLT TENSILE STR	1340.69

-906.782
-2.57874E-3
f=-2.57873E-3
ı1f= 9.89667E-2
ı2f=-6234.1
:t3f=-22103.8

DYNAMIC COMPONENTS

'RIVE ROD TENSILE STRESS AT A	16811
'RIVE ROD TENSILE STRESS AT B	25711.4
;USHING PRESSURE	327.887
'ALVE EAR TENSILE STRESS	17822.1
'ALVE EAR SHEAR STRESS	1154.32
:AR BOLT SHEAR STRESS	13963.6
:AR BOLT TENSILE STRESS	57543

.1d= 3019.58
.2d= 3954.6
3d= 7699.63
ı1d= 2.44083E+5
2d=-58968.3
t3d= 78875.3

F ED PLUS DYNAMIC COMPONENTS

E ROD TENSILE STRESS AT A	21859.4
RIVE ROD TENSILE STRESS AT B	33432.5
USHING PRESSURE	426.352
ALVE EAR TENSILE STRESS	22486.4
ALVE EAR SHEAR STRESS	1451.93
AR BOLT SHEAR STRESS	17563.7

EAR BOLT TENSILE STRESS 58883.7

s1t= 3926.36
s2t= 3954.6
:3t= 7699.64
[illegible]= 2.44083E+5
[illegible] 65202.4
[illegible] = 1.00979E+5

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-26

·T GLOBAL ACCELERATIONS EMERGENCY
› 11.37,3.18,5.83

INPUT DATA

;LOBAL G-LEVELS	=	11.37	3.18	5.83
IORTH VECTOR ANGLES	=	90	90	0
'ERTICAL VECTOR ANGLES=	0	90	90	
:AST VECTOR ANGLES	=	90	0	90

LOCAL G-LEVELS

·4.33731E-5	3.18	-2.22397E-5
·4.33731E-5	-1.21307E-5	5.83
11.37	-1.21307E-5	-2.22397E-5

)PERATING DRIVE ROD STRESS AT A	5048.35
)PERATING DRIVE ROD STRESS AT B	7721.14
)PERATING CYLINDER BRG PRESSURE	-98.4646
)PERATING EAR WELD TENSILE STR	5107.51
)PERATING EAR WELD SHEAR STRES	631.431
)PERATING EAR BOLT SHEAR STRESS	3600.17
)PERATING EAR BOLT TENSILE STR	1340.69

.MIC COMPONENTS

'RIVE ROD TENSILE STRESS AT A	16053.7
'RIVE ROD TENSILE STRESS AT B	24553.2
;USHING PRESSURE	313.117
:AR WELD TENSILE STRESS	20967
:AR WELD SHEAR STRESS	2365.96
;AR BOLT SHEAR STRESS	13489.8
:AR BOLT TENSILE STRESS	57426.5

FIXED PLUS DYNAMIC COMPONENTS

'RIVE ROD TENSILE STRESS AT A	21102.1
'RIVE ROD TENSILE STRESS AT B	32274.4
'USHING PRESSURE	411.582
AR WELD TENSILE STRESS	26074.5
:AR WELD SHEAR STRESS	2997.39
AR BOLT SHEAR STRESS	17090
:AR BOLT TENSILE STRESS	58767.2

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 0T.01.F
SHEET NO. A-27

:sp6
INPUT GLOBAL ACCELERATIONS. UPSET
69,3.09,1.48

IN. JT DATA

;LOBAL G-LEVELS =	2.69	3.09	1.48
IORTH VECTOR ANGLES =	90	90	0
'ERTICAL VECTOR ANGLES=	0 90	90	
:AST VECTOR ANGLES =	90	0	90

LOCAL G-LEVELS

·1.02615E-5	3.09	-5.64575E-6
·1.02615E-5	-1.17874E-5	1.48
2.69	-1.17874E-5	-5.64575E-6

IPERATING DRIVE ROD STRESS AT A	5048.35
:PERATING DRIVE ROD STRESS AT B	7721.14
IPERATING CYLINDER BRG PRESSURE	-98.4646
·PERATING EAR WELD TENSILE STR	5107.51 ✓
IPERATING EAR WELD SHEAR STRES	631.431 ✓
:PERATING EAR BOLT SHEAR STRESS	3600.17.
IPERATING EAR BOLT TENSILE STR	1340.69

DYNAMIC COMPONENTS

: ROD TENSILE STRESS AT A	15599.4
E ROD TENSILE STRESS AT B	23858.3
:USHING PRESSURE	304.256
:AR WELD TENSILE STRESS	16110.8
:AR WELD SHEAR STRESS	1976.81
:AR BOLT SHEAR STRESS	11271
:AR BOLT TENSILE STRESS	14173.8

FIXED PLUS DYNAMIC COMPONENTS

'RIVE ROD TENSILE STRESS AT A	20647.7
RIVE ROD TENSILE STRESS AT B	31579.4
'USHING PRESSURE	402.72
AR WELD TENSILE STRESS	21218.3
'AR WELD SHEAR STRESS	2608.24
AR BOLT SHEAR STRESS	14871.2
AR BOLT TENSILE STRESS	15514.5

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. A-28

```
print "WEIGHT VECTOR ANGLES  = ";av(1),av(2),av(3)
```

```
sbasic cep3a
      tm
S-BASIC Compiler Version 5.4b

REM***** BIF VALVE AND AIR OPERATOR SEISMIC STRESS *****
REM*************** CEP-V/AO-3A ************************
REM
var i,j,k = integer
var lrod,lcg,x,phi,lave,ablt,l1,l2,e1,e2,e3,e4,e5 = real
var fst2, ca,ia,cb,ib,aa,ab,d1,d2,c1,i1,c2,i2=real
var lrodo,lcgo,ldr,d, abush, pbush=real
var fcof, fco, ma,mb, siga, sigb, fcdr, fcdrf,maf, mbf=real
var dear, fcear,fr, f11,f22,la, ci12,ci21,stt3,sem1=real
var sem2,set3,ses1,ses2,sr,tau11,tau22,tauear,aear=real
var btens, taublt, set3f,sem1f,sem2f,fcearf, frf,f11f=real
var f22f,stt3f,ses1f,ses2f,srf,tau1f,tau2f,taurf=real
var taubf,btf, dsr,dtaur,dtaub,dbten,dsa,dsb,dpb=real
var sdraf,sdrbf,pbushf,tau11f,tau22f=real
var wao,wbr,ftr1,watr1,s1,s1f,s2,s2f,m1,m1f,m2=real
var m2f,t3,t3f,tt3,tt3f,lbr,wtot=real
var bs1,bs2,bt3,bm1,bm2,btt3=real
dim real av(3)
dim real wa(3)
dim real wb(3)
REM
REM *** BURNS 7 ROE EAR FORCES ARE bs1 etc TURN ON WITH K=1***
REM
REM
dim real a(3,3)
dim real b(3)
dim real glc(3,3)
1   data 7.5, 10, .75, 1.95, 1.25, .7
2   data 25,14.46,.531,53.,7.125,.31,1.5,2.5
3   data 1150.,.875,.46,.648,.138,2.41,1.4
4   data 399,277,5.25,8.5,28.5,15.,6.875
5   data 40.,10.96,26.5,30.5,2.075
6   data 90.,90.,0.,90.,0.,90.
7   data 180.,90.,90.,90.,180.,90.
REM DATA 6&7 FOR VALVE/GLOBAL-G ORIENTATIONS AND WEIGHT VECTOR
restore
read d1,d2,c1,i1,c2,i2
restore 2
read lrod,lcg,x,phi,lave,ablt,l1,l2
restore 3
read fst2,ca,ia,cb,ib,aa,ab
restore 4
read wao,wbr,e1,e2,e3,e4,e5
restore 5
read lrodo,lcgo,ldr,d,abush
restore 6
read  a(1,1),a(2,1),a(3,1),a(1,2),a(2,2),a(3,2)
restore 7
read  a(1,3),a(2,3),a(3,3),av(1),av(2),av(3)
text 0,& INPUT GLOBAL ACCELERATIONS &
input b(1),b(2),b(3)
print
text 0,& INPUT DATA &
print
print "GLOBAL G-LEVELS        = ";b(1),b(2),b(3)
print "NORTH VECTOR ANGLES    = ";a(1,1),a(2,1),a(3,1)
print "VERTICAL VECTOR ANGLES= ";a(1,2),a(2,2),a(3,2)
print "EAST VECTOR ANGLES     = ";a(1,3),a(2,3),a(3,3)
```

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01/F
SHEET NO. A-24

...pilation complete

a

INPUT GLOBAL ACCELERATIONS   CEP-V-3A (FAULTED)

? 4.57,1.26,.86

INPUT DATA

GLOBAL G-LEVELS	=	4.57	1.26	.86
NORTH VECTOR ANGLES	=	90	90	0
VERTICAL VECTOR ANGLES	=	90	0	90
EAST VECTOR ANGLES	=	180	90	90
WEIGHT VECTOR ANGLES	=	90	180	90

LOCAL G-LEVELS

-1.74332E-5	-4.80652E-6	-.86
-1.74332E-5	1.26	-3.28064E-6
4.57	-4.80652E-6	-3.28064E-6

OPERATING DRIVE ROD STRESS AT A	477.198
OPERATING DRIVE ROD STRESS AT B	821.458
OPERATING CYLINDER BRG PRESSURE	-3.75613E-4
OPERATING VALVE EAR TENSILE STR	1136.52
OPERATING VALVE EAR SHEAR STRES	89.1706
OPERATING EAR BOLT SHEAR STRESS	1078.68
...RATING EAR BOLT TENSILE STR	525.595

s1f=-3.4591E-3
s2f= 474
t3f=-2.57873E-3
n1f=-3258.67
n2f=-5.29623E-3
tt3f= 4929.17

DYNAMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A	4341.57
DRIVE ROD TENSILE STRESS AT B	6640.18
BUSHING PRESSURE	84.6795
VALVE EAR TENSILE STRESS	4711.31
VALVE EAR SHEAR STRESS	285.935
EAR BOLT SHEAR STRESS	3458.89
EAR BOLT TENSILE STRESS	22999.3

s1d= 779.831
s2d= 851.76
t3d= 3089.31
n1d= 97498.6
n2d= 22785
... = 19965.7

FIXED PLUS DYNAMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A	4818.76
DRIVE ROD TENSILE STRESS AT B	7461.64
BUSHING PRESSURE	84.6799

VALVE EAR TENSILE STRESS	5847.84
VALVE EAR SHEAR STRESS	375.106
EAR BOLT SHEAR STRESS	4537.57
EAR BOLT TENSILE STRESS	23524.9

[illegible]= 779.835
[illegible]= 1325.76
[illegible] .3089.32
m1t= 1.00757E+5
m2t= 22785
tt3t= 24894.9

cmpilation complete

I... GLOBAL ACCELERATIONS
4.57,1.26,0.86

INPUT DATA

LOBAL G-LEVELS =	4.57	1.26	.86
ORTH VECTOR ANGLES =	90	90	0
ERTICAL VECTOR ANGLES=	90	0	90
AST VECTOR ANGLES =	180	90	90
EIGHT VECTOR ANGLES =	90	180	90

.OCAL G-LEVELS

1.74332E-5	-4.80652E-6	-.86
1.74332E-5	1.26	-3.28064E-6
4.57	-4.80652E-6	-3.28064E-6

PERATING DRIVE ROD STRESS AT A	477.198
PERATING DRIVE ROD STRESS AT B	821.458
PERATING CYLINDER BRG PRESSURE	-3.75613E-4
PERATING EAR WELD TENSILE STR	1326.01
PERATING EAR WELD SHEAR STRES	189.188
PERATING EAR BOLT SHEAR STRESS	1078.68
PERATING EAR BOLT TENSILE STR	525.595

DYNAMIC COMPONENTS

RIVE ROD TENSILE STRESS AT A	4341.57
RIVE ROD TENSILE STRESS AT B	6640.18
JSHING PRESSURE	84.6795
AR WELD TENSILE STRESS	6247.02
AR WELD SHEAR STRESS	606.65
AR BOLT SHEAR STRESS	3458.89
AR BOLT TENSILE STRESS	22999.3

FIXED PLUS DYNAMIC COMPONENTS

RIVE ROD TENSILE STRESS AT A	4818.76
RIVE ROD TENSILE STRESS AT B	7461.64
JSHING PRESSURE	84.6799
AR WELD TENSILE STRESS	7573.03
AR WELD SHEAR STRESS	795.838
AR BOLT SHEAR STRESS	4537.57
AR BOLT TENSILE STRESS	23524.9

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 0T.01.F
SHEET NO. A-32

```
sbasic cep4a
      tm
S-BASIC Compiler Version 5.4b

REM***** BIF VALVE AND AIR OPERATOR SEISMIC STRESS *****
REM************** CEP-V/AO-4A **************************
REM
var i,j,K = integer
var lrod,lcg,x,phi,lave,ablt,l1,l2,e1,e2,e3,e4,e5 = real
var fst2, ca,ia,cb,ib,aa,ab,d1,d2,c1,i1,c2,i2=real
var lrodo,lcgo,ldr,d, abush, pbush=real
var fcof, fco, ma,mb, siga, sigb, fcdr, fcdrf,maf, mbf=real
var dear, fcear,fr, f11,f22,la, ci12,ci21,stt3,sem1=real
var sem2,set3,ses1,ses2,sr,tau11,tau22,tauear,aear=real
var btens, taublt, set3f,sem1f,sem2f,fcearf, frf,f11f=real
var f22f,stt3f,ses1f,ses2f,srf,tau1f,tau2f,taurf=real
var taubf,btf, dsr,dtaur,dtaub,dbten,dsa,dsb,dpb=real
var sdraf,sdrbf,pbushf,tau11f,tau22f=real
var wao,wbr,ftr1,watr1,s1,s1f,s2,s2f,m1,m1f,m2=real
var m2f,t3,t3f,tt3,tt3f,lbr,wtot=real
var bs1,bs2,bt3,bm1,bm2,btt3=real
dim real av(3)
dim real wa(3)
dim real wb(3)
REM
REM *** BURNS 7 ROE EAR FORCES ARE bs1 etc TURN ON WITH K=1***
REM
REM
dim real a(3,3)
dim real b(3)
dim real glc(3,3)
1   data 7.5, 10, .75, 1.95, 1.25, .7
2   data 25,14.46,.531,53.,7.125,.31,1.5,2.5
3   data 1150.,.875,.46,.648,.138,2.41,1.4
4   data 399,277,5.25,8.5,28.5,15.,6.875
5   data 40.,10.96,26.5,30.5,2.075
6   data 90.,-38.,52.,90.,52.,142.
7   data 180.,90.,90.,90.,-128.,-38.
REM DATA 6&7 FOR VALVE/GLOBAL-G ORIENTATIONS AND WEIGHT VECTOR
restore
read d1,d2,c1,i1,c2,i2
restore 2
read lrod,lcg,x,phi,lave,ablt,l1,l2
restore 3
read fst2,ca,ia,cb,ib,aa,ab
restore 4
read wao,wbr,e1,e2,e3,e4,e5
restore 5
read lrodo,lcgo,ldr,d,abush
restore 6
read  a(1,1),a(2,1),a(3,1),a(1,2),a(2,2),a(3,2)
restore 7
read  a(1,3),a(2,3),a(3,3),av(1),av(2),av(3)
text 0,& INPUT GLOBAL ACCELERATIONS &
input b(1),b(2),b(3)
print
text 0,& INPUT DATA &
print
print "GLOBAL G-LEVELS        = ";b(1),b(2),b(3)
print "NORTH VECTOR ANGLES    = ";a(1,1),a(2,1),a(3,1)
print "VERTICAL VECTOR ANGLES= ";a(1,2),a(2,2),a(3,2)
print "EAST VECTOR ANGLES     = ";a(1,3),a(2,3),a(3,3)
```

```
0059:00 print "WEIGHT VECTOR ANGLES  = ";av(1),av(2),av(3)
0060:00 print
0061:00 for i=1 to 3
0062:01 for j=1 to 3
0063:02   a(j,i)=a(j,i)*2.*3.1416/360.
0064:02   glc(j,i)=b(i)*cos(a(j,i))
0065:02 next j
0066:01 next i
0067:00 for j=1 to 3
0068:01 av(j)=av(j)*2.*3.1416/360.
0069:01 next j
0070:00 print
0071:00 text 0,& LOCAL G-LEVELS &
0072:00 print
0073:00 print glc(1,1),glc(1,2),glc(1,3)
0074:00 print glc(2,1),glc(2,2),glc(2,3)
0075:00 print glc(3,1),glc(3,2),glc(3,3)
0076:00 REM WEIGHT COMPONENTS
0077:00 for j=1 to 3
0078:01 wa(j)=wao*cos(av(j))
0079:01 wb(j)=wbr*cos(av(j))
0080:01 next j
0081:00 phi=phi*2.*3.1416/360.
0082:00 la=lave/2
0083:00 ci12=c1/i2
0084:00 ci21=c2/i1
0085:00 aear=l1*l2
0086:00 REM CALCULATE EAR FORCES USE B&R LOADS AS OPTION LATER
0087:00 REM FIXED COMPONENTS ARE ALWAYS THERE
0088:00 lbr=lrod+lcg
0089:00 watr1=lbr*wa(1)/lrod
0090:00 s1f=wb(1)+watr1
0091:00 wtot=wao+wbr
0092:00 s2f=wb(2)+wa(2)+fst2
0093:00 t3f=wa(3)+wb(3)
0094:00 m1f=-(wa(2)+wb(2)+fst2)*e5-wa(3)*(e3+lcg)-wb(3)*e4
0095:00 m2f=(watr1+wb(1))*e5-wa(3)*e2-wb(3)*e1
0096:00 tt3f=watr1*e3+(wa(2)+fst2)*e2+wb(1)*e4+wb(2)*e1
0097:00 fcdrf=lcg*wa(1)/lrod
0098:00 maf=fcdrf*(lrod-13.5)
0099:00 mbf=fcdrf*7.125
0100:00 sdraf=fst2/aa+abs(maf*ca/ia)
0101:00 sdrbf=fst2/ab+abs(mbf*cb/ib)
0102:00 fcof=lcgo*wa(1)/lrodo
0103:00 pbushf=fcof*(ldr+d)/(d*abush)
0104:00 REM STRESSES FROM FIXED COMPONENTS
0105:00 dear=(d1*d1+d2*d2)**.5
0106:00 set3f=abs(t3f/(4*aear))
0107:00 sem1f=abs(m1f/(2*d2*aear))
0108:00 sem2f=abs(m2f/(2*d1*aear))
0109:00 fcearf=tt3f/(2*dear)
0110:00 frf=x*fcearf
0111:00 f11f=-(fcearf*sin(phi)-frf*cos(phi))
0112:00 f22f=fcearf*cos(phi)+frf*sin(phi)
0113:00 stt3f=abs(f11f*la*ci12)+abs(f22f*la*ci21)
0114:00 ses1f=abs(s1f*ci12*la/4.)
0115:00 ses2f=abs(s2f*ci21*la/4.)
0116:00 srf=set3f+sem1f+sem2f+ses1f+ses2f+stt3f
0117:00 REM EAR SHEAR
0118:00 tau11f=abs(s1f/(4*aear))+abs(f11f/aear)
0119:00 tau22f=abs(s2f/(4*aear))+abs(f22f/aear)
0120:00 taurf=(tau11f*tau11f+tau22f*tau22f)**.5
0121:00 taubf=taurf*aear/ablt
0122:00 REM EARBOLT TENSION
0123:00 btf=(set3f+sem1f+sem2f)*aear/ablt
0124:00 print
```

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/E
SHEET NO. A-34

```
0125:00 print"OPERATING DRIVE ROD STRESS AT A ";sdraf
0126:00 print"OPERATING DRIVE ROD STRESS AT B ";sdrbf
0127:00 print"OPERATING CYLINDER BRG PRESSURE ";pbushf
0128:00 print"OPERATING VALVE EAR TENSILE STR ";srf
0129:00 print"OPERATING VALVE EAR SHEAR STRES ";taurf
0130:00 print"OPERATING EAR BOLT SHEAR STRESS ";taubf
0131:00 print"OPERATING EAR BOLT TENSILE  STR ";btf
0132:00 print
0133:00 REM
0134:00 REM CALCULATE VARIABLE COMPONENTS
0135:00 REM
0136:00 dsr=0.
0137:00 dtaur=0.
0138:00 dtaub=0.
0139:00 dbten=0.
0140:00 dsa=0.
0141:00 dsb=0.
0142:00 dpb=0.
0143:00 for j=1 to 3
0144:01 fco=lcgo*wao*glc(1,j)/lrodo
0145:01 pbush=fco*(ldr+d)/(d*abush)
0146:01 ftr1=lbr*wao*glc(1,j)/lrod
0147:01 s1=ftr1+wbr*glc(1,j)
0148:01 s2=wtot*glc(2,j)
0149:01 t3=wtot*glc(3,j)
0150:01 m1=-wtot*glc(2,j)*e5-wao*glc(3,j)*(e3+lcg)-wbr*glc(3,j)*e4
0151:01 m2=(ftr1+wbr*glc(1,j))*e5-(wao*e2+wbr*e1)*glc(3,j)
0152:01 tt3=ftr1*e3+wbr*glc(1,j)*e4+glc(2,j)*(wao*e2+wbr*e1)
0153:01 fcdr=lcg*wao*glc(1,j)/lrod
0154:01 ma=fcdr*(lrod-13.5)
0155:01 mb=fcdr*7.125
0156:01 siga=ma*ca/ia
0157:01 sigb=mb*cb/ib
0158:01 REM CALCULATE EAR TENSION
0159:01 set3=abs(t3/(4*aear))
0160:01 sem1=abs(m1/(2*d2*aear))
0161:01 sem2=abs(m2/(2*d1*aear))
0162:01 fcear=tt3/(2*dear)
0163:01 fr=x*fcear
0164:01 f11=-(fcear*sin(phi)-fr*cos(phi))
0165:01 f22=fcear*cos(phi)+fr*sin(phi)
0166:01 stt3=abs(f11*la*ci12)+abs(f22*la*ci21)
0167:01 ses1=abs(s1*ci12*la/4.)
0168:01 ses2=abs(s2*ci21*la/4.)
0169:01 sr=set3+sem1+sem2+ses1+ses2+stt3
0170:01 REM EAR SHEAR
0171:01 tau11=abs(s1/(4.*aear))+abs(f11/aear)
0172:01 tau22=abs(s2/(4.*aear))+abs(f22/aear)
0173:01 tauear=(tau11*tau11+tau22*tau22)**.5
0174:01 taublt=tauear*aear/ablt
0175:01 REM EARBOLT TENSION
0176:01 btens=(set3+sem1+sem2)*aear/ablt
0177:01 dsa=dsa+siga*siga
0178:01 dsb=dsb+sigb*sigb
0179:01 dpb=dpb+pbush*pbush
0180:01 dsr=dsr+sr*sr
0181:01 dtaur=dtaur+tauear*tauear
0182:01 dtaub=dtaub+taublt*taublt
0183:01 dbten=dbten+btens*btens
0184:01 next j
0185:00 REM COMBINE STRESSES
0186:00 dsa=dsa**.5
0187:00 dsb=dsb**.5
0188:00 dpb=dpb**.5
0189:00 dsr=dsr**.5
0190:00 dtaur=dtaur**.5
```

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. A-35

```
dtaub=dtaub**.5
dbten=dbten**.5
print
text 0,& DYNAMIC COMPONENTS &
print
print "DRIVE ROD TENSILE STRESS AT A";dsa
print "DRIVE ROD TENSILE STRESS AT B";dsb
print "BUSHING PRESSURE              ";dpb
print "VALVE EAR TENSILE STRESS      ";dsr
print "VALVE EAR SHEAR STRESS        ";dtaur
print "EAR BOLT SHEAR STRESS         ";dtaub
print "EAR BOLT TENSILE STRESS       ";dbten
dsa=dsa+abs(sdraf)
dsb=dsb+abs(sdrbf)
dpb=dpb+abs(pbushf)
dsr=dsr+abs(srf)
dtaur=dtaur+abs(taurf)
dtaub=dtaub+abs(taubf)
dbten=dbten+abs(btf)
print
text 0,& FIXED PLUS DYNAMIC COMPONENTS &
print
print "DRIVE ROD TENSILE STRESS AT A";dsa
print "DRIVE ROD TENSILE STRESS AT B";dsb
print "PUSHING PRESSURE              ";dpb
print "VALVE EAR TENSILE STRESS      ";dsr
print "VALVE EAR SHEAR STRESS        ";dtaur
print "EAR BOLT SHEAR STRESS         ";dtaub
print "EAR BOLT TENSILE STRESS       ";dbten
end

        ****** End of program ******
```

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. A-36

cep4a
INPUT GLOBAL ACCELERATIONS
? 3.35,1.34,.86

INPUT DATA

GLOBAL G-LEVELS	=	3.35	1.34	.86
NORTH VECTOR ANGLES	=	90	-38	52
VERTICAL VECTOR ANGLES	=	90	52	142
EAST VECTOR ANGLES	=	180	90	90
WEIGHT VECTOR ANGLES	=	90	-128	-38

LOCAL G-LEVELS

-1.27792E-5	-5.11169E-6	-.86
2.63983	.824984	-3.28064E-6
2.06246	-1.05594	-3.28064E-6

OPERATING DRIVE ROD STRESS AT A	477.198
OPERATING DRIVE ROD STRESS AT B	821.458
OPERATING CYLINDER BRG PRESSURE	-3.75613E-4
OPERATING VALVE EAR TENSILE STR	1946.57
OPERATING VALVE EAR SHEAR STRES	128.033
OPERATING EAR BOLT SHEAR STRESS	1548.79
OPERATING EAR BOLT TENSILE STR	4771.17

DYNAMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A	4341.57
DRIVE ROD TENSILE STRESS AT B	6640.18
BUSHING PRESSURE	84.6795
VALVE EAR TENSILE STRESS	5948.81
VALVE EAR SHEAR STRESS	379.211
EAR BOLT SHEAR STRESS	4587.24
EAR BOLT TENSILE STRESS	13246.5

FIXED PLUS DYNAMIC COMPONENTS

DRIVE ROD TENSILE STRESS AT A	4818.76
DRIVE ROD TENSILE STRESS AT B	7461.64
BUSHING PRESSURE	84.6799
VALVE EAR TENSILE STRESS	7895.38
VALVE EAR SHEAR STRESS	507.244
EAR BOLT SHEAR STRESS	6136.03
EAR BOLT TENSILE STRESS	18017.7

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. A-37

A>b:
B>cep4a
[illegible]UT GLOBAL ACCELERATIONS
[illegible]35,1.34,.86

FAULTED (WELD)

INPUT DATA

3LOBAL G-LEVELS	=	3.35	1.34	.86
ORTH VECTOR ANGLES	=	90	-38	52
/ERTICAL VECTOR ANGLES	=	90	52	142
EAST VECTOR ANGLES	=	180	90	90
WEIGHT VECTOR ANGLES	=	90	-128	-38

LOCAL G-LEVELS

-1.27792E-5	-5.11169E-6	-.86
2.63983	.824984	-3.28064E-6
2.06246	-1.05594	-3.28064E-6

)PERATING DRIVE ROD STRESS AT A	477.198
)PERATING DRIVE ROD STRESS AT B	821.458
)PERATING CYLINDER BRG PRESSURE	-3.75613E-4
)PERATING EAR WELD TENSILE STR	2592.98
)PERATING EAR WELD SHEAR STRES	271.64
)PERATING EAR BOLT SHEAR STRESS	1548.79
)PERATING EAR BOLT TENSILE STR	4771.17

[illegible]AMIC COMPONENTS

)RIVE ROD TENSILE STRESS AT A	4341.57
)RIVE ROD TENSILE STRESS AT B	6640.18
3USHING PRESSURE	84.6795
EAR WELD TENSILE STRESS	7493.12
EAR WELD SHEAR STRESS	804.547
EAR BOLT SHEAR STRESS	4587.22
EAR BOLT TENSILE STRESS	13246.5

FIXED PLUS DYNAMIC COMPONENTS

)RIVE ROD TENSILE STRESS AT A	4818.76
)RIVE ROD TENSILE STRESS AT B	7461.64
'USHING PRESSURE	84.6799
EAR WELD TENSILE STRESS	10086.1
EAR WELD SHEAR STRESS	1076.19
EAR BOLT SHEAR STRESS	6136.01
EAR BOLT TENSILE STRESS	18017.7

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 0T.01.F
SHEET NO. A-38

:ep
?P?

cep4a

INPUT GLOBAL ACCELERATIONS
? 3.35,1.34,.86

INPUT DATA

;LOBAL G-LEVELS	=	3.35	1.34	.86
IORTH VECTOR ANGLES	=	90	-38	52
/ERTICAL VECTOR ANGLES	=	90	52	142
:AST VECTOR ANGLES	=	180	90	90
IEIGHT VECTOR ANGLES	=	90	-128	-38

LOCAL G-LEVELS

-1.27792E-5	-5.11169E-6	-.86
2.63983	.824984	-3.28064E-6
2.06246	-1.05594	-3.28064E-6

)PERATING DRIVE ROD STRESS AT A	477.198
)PERATING DRIVE ROD STRESS AT B	821.458
)PERATING CYLINDER BRG PRESSURE	-3.75613E-4
)PERATING VALVE EAR TENSILE STR	1946.57
)PERATING VALVE EAR SHEAR STRES	128.033
)PERATING EAR BOLT SHEAR STRESS	1548.79
ATING EAR BOLT TENSILE STR	4771.17

;1f=-3.4591E-3
:2f= 733.811
:3f= 532.695
ı1f=-21826.4
ı2f=-3818.52
t3f= 6791.56

DYNAMIC COMPONENTS

RIVE ROD TENSILE STRESS AT A	4341.57
RIVE ROD TENSILE STRESS AT B	6640.18
USHING PRESSURE	84.6795
'ALVE EAR TENSILE STRESS	5948.81
ALVE EAR SHEAR STRESS	379.211
:AR BOLT SHEAR STRESS	4587.24
AR BOLT TENSILE STRESS	13246.5

ı1d= 779.831
2d= 1869.64
3d= 1566.33
1d= 59205.9
2d= 12442.3
t = 23258.6

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. A-39

FIXED PLUS DYNAMIC COMPONENTS

RIVE ROD TENSILE STRESS AT A	4818.76
RIVE ROD TENSILE STRESS AT B	7461.64
USHING PRESSURE	84.6799

VALVE EAR TENSILE STRESS	7895.38
VALVE EAR SHEAR STRESS	507.244
EAR BOLT SHEAR STRESS	6136.03
EAR BOLT TENSILE STRESS	18017.7

t= 779.835
2603.45
2099.02
n1t= 81032.3
n2t= 16260.8
tt3t= 30050.1

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-40

APPENDIX B

VALVE/AIR OPERATOR MODEL FOR FINAL PIPING RESPONSE G-LEVEL CALCULATION.

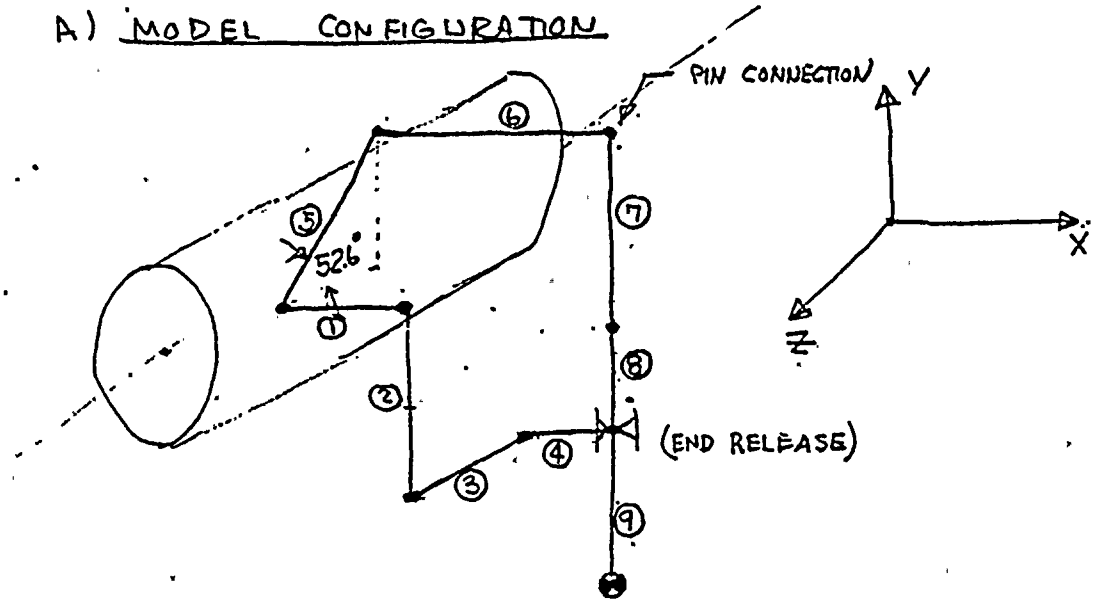
CYGNA

Calculation Sheet

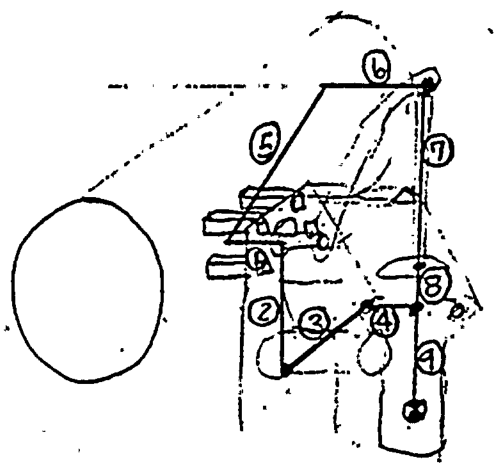
Project: WPPSS EQ		Prepared By: J E R[illegible]	Date: 1/3/83
Subject: BIF VALVE / ACTUATOR MODEL SUMMARY		Checked By: W. E. Searle	Date: 3/24/83
System: CSP		Job No. 82044	File No. OT.01/F
Analysis No. 361104 + 106	Rev. No. 0	Sheet No. 361106-4.3-B1	

SUMMARY

A) MODEL CONFIGURATION



B) ACTUAL STRUCTURE



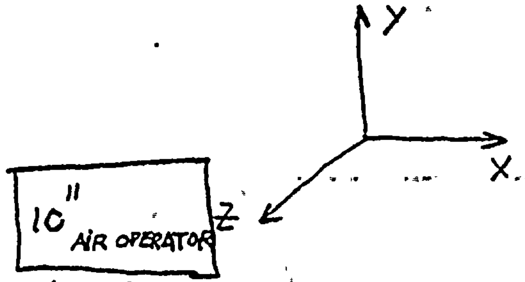
STRUCTURAL MEMBER DIRECTIONS

①	+X
②	−Y
③	−Z
④	+X
⑤	YZ-PLANE
⑥	+X
⑦	+Y
⑧	+Y
⑨	−Y

CYGNA

Calculation Sheet

Project: WPPSS		Prepared By: [signature]	Date: 1/3/83
Subject: BIF VALVE / ACTUATOR MODEL SUMMARY		Checked By: [signature]	Date: 3/24/83
System: CSP		Job No. 82044	File No. OT.01/F
Analysis No. 361104-6 361106	Rev. No. 0	Sheet No. 361106-4.3-B2	



① VALVE EARS

8" CYL (24" VALVE) — (10" AIR OPERATOR)

$A_x = A_y = A_z = 15\ IN^2$ (21)
$I_{xx} = 106\ IN^4$ (657)
$I_{yy} = 11.2$ " (21.4)
$I_{zz} = 31.2$ " (63)
$C_y = 5.60$ (5.25)
$C_z = 3.75$ (4.75) ✓
$E = 28 \times 10^6$ PSI, $E_s = 11.6 \times 10^6$ PSI
$\ell = 7.125$" (4.85")

② BRACKET

(Put e = 0 & add 277# 15" down) 321#
$A_x = A_y = A_z = 6.84\ IN^2$ (8.5)
$I_{xx} = 102\ IN^4$ (255)
$I_{yy} = 1000\ IN^4$ (1000 IN^4)
$I_{zz} = 2.16\ IN^4$ (4.22 IN^4)
$C_x = .25$ IN (.313)
$C_z = 6.84$ IN (8.5) ✓
$E = 28 \times 10^6$ PSI $E_s = 11.6 \times 10^6$ PSI
$\ell = 28.5$" (15" down to CG)

③ & ④ BRACKET OFFSETS $L_3 = 8.8$" (8.5") $L_4 = 6.875$ (8.0")

③ MASSLESS, RIGID LINK, 8.8" LONG (8.5)
④ " " , 6.875" " (8.0)
(END RELEASE FOR ROTATION θ_{xx} ON ④)

1008 00

Calculation Sheet

Project	WPPSS EQ	Prepared By: E Rabinowitz	Date 1/3/83
Subject	BIF VALVE/ACTUATOR MODEL SUMMARY	Checked By: D.E. Searle	Date 3/24/83
System	CSP	Job No. 82044	File No. OT.01/F
Analysis No. 361106 + 361104	Rev. No. 0	Sheet No. 361106-4.3-B3	

⑤ SHAFT OFFSET

RIGID LINK 14.48" LONG (14.30)
AT 52.6° ↑ AS SHOWN

⑥ SHAFT

$A_x = A_y = A_z = 3.98\ IN^2$ (4.91)
$I_{xx} = 2.52\ IN^4$ (3.04)
$I_{yy} = 4$ " (5.75)
$I_{zz} = 1.26$ " (1.92)
$C_y = 1.125$ (1.25)
$C_z = 1.125$ (1.25)
$E = 29 \times 10^6$ PSI $E_s = 11.6 \times 10^6$ PSI
$\ell = 14$ in. (12.85")

⑦ DRIVE ROD

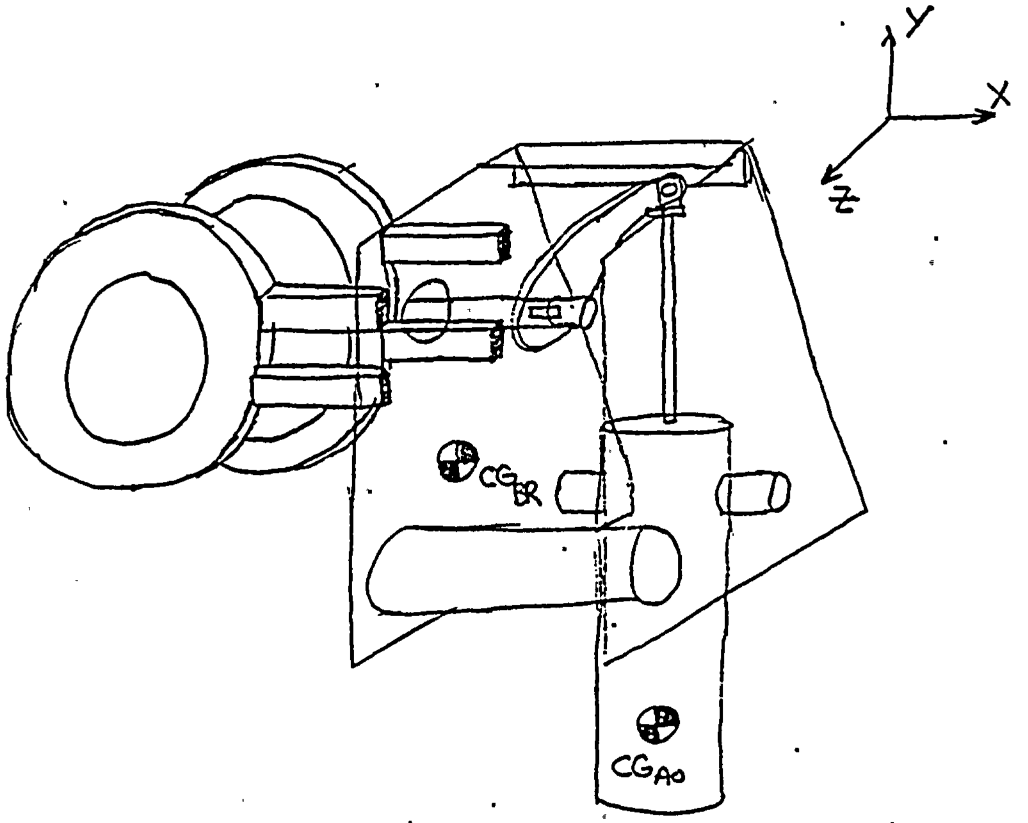
$A_x = 2.41$ $A_y = 2.41$ $A_z = 2.41\ IN^2$ ($2.41\ IN^2$)
$I_{xx} = I_{zz} = .46\ IN^4$ ($.46\ IN^4$)
$I_{yy} = .92\ IN^4$ ($.92\ IN^4$)
$C_x = C_z = .875$ IN (.875 IN)
HIGH STREN. ☆ $E = 30 \times 10^6$ PSI $E_s = 12 \times 10^6$ PSI

⑧ & ⑨ CYLINDER
(PUT ρ=0 + ADD 399# AT END) → (593#)
$L_⑧ = 13.5"$ (13.5")
$L_⑨ = 14.0"$ (19")
$I_{yy} = 74\ IN^4$ ($180\ IN^4$)
$I_{xx} = I_{zz} = 52\ IN^4$ ($127\ IN^4$)
$A_x = A_y = A_z = 50\ IN^2$ ($78\ IN^2$)
$C_x = C_z = 4"$ (5 IN)

CYGNA

Calculation Sheet

Project: WPPSS EQ		Prepared By: L.E. Rakowski	Date: 1/3/83
Subject: SAP MODEL - BIF VALVE/AO		Checked By: W.E. Searle	Date: 3/24/83
System: CSP		Job No. 82044	File No. OT.OF/01
Analysis No. 361104 + 361106	Rev. No. 0	Sheet No. 361106-4.3-B4	



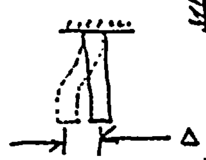
DESCRIPTION OF AO MODEL INCLUDING 4 VALVE EARS:

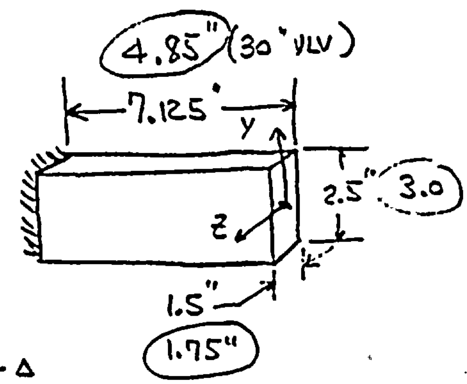
8" AO

① Derive Ear Model

$K_{zz} = 4 * \text{stiffness of 1 ear}$
$= 4 * F_z / \Delta_z$

Use Roark, Pg 96, #1 b.:





Calculation Sheet

CYGNA

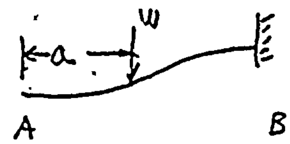
Project: WPPSS EQ		Prepared By: E. R...	Date: 1/3/83
Subject: BTF VALVE/ACTUATOR MODEL SUMMARY		Checked By: D. E. Searle	Date: 3/24/83
System: CSP		Job No. 82044	File No. OT.01/F
Analysis No. 361104 & 106	Rev. No. 0	Sheet No. 361106-4.3-B5	△3

△3 [signature] 4/8/83, [signature] 6/9/83

NOTE: SEE PAGE 4.3-53 OF REVISION 3

$M_A = \frac{W(l-a)^2}{2l}$ $\theta_A = 0$

$y_A = -\frac{W}{12EI}(l-a)^2(l+2a) = -\frac{W}{12EI}l^3$



$\therefore \frac{F_z}{\Delta z} = \frac{12EI}{(l)^3} \quad (a=0)$ =

$= \frac{12 * 29*10^6 * 0.7}{(7.125)^3 = 361.7} = .673*10^6$ (4.08) (1.34) lb/in

$((4.85)^3 = 114.08)$ 10"

(rewrite: $\frac{F}{L^2} * \frac{L^4}{L^3} \cdot \frac{F}{L}$ (OK))

$E_{bar} \cong 29*10^6$ PSI

$l = 7.125''$ (4.85")

I_{min} (for z-axis) = $0.70 in^4$

$(\frac{1}{12} \cdot 3 \cdot 1.75^3 = 1.34)$

I_{max} (for y-axis) = $1.95 in^4$

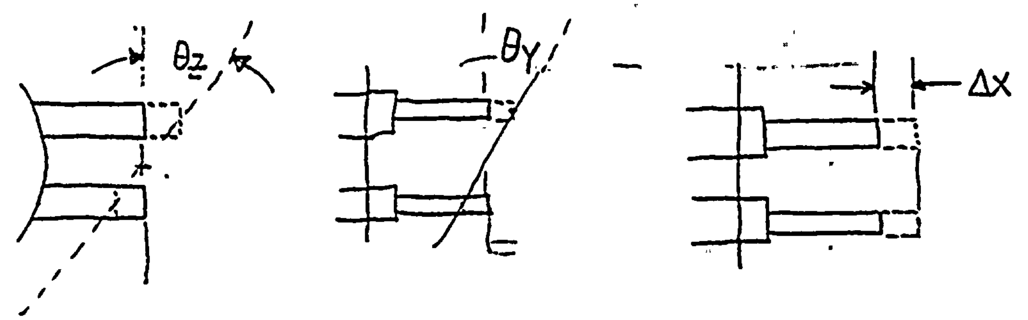
$(\frac{1}{12} \cdot 1.75 \cdot 3^3 = 3.94)$

THE SECOND VALUES IN PARENTHESIS ARE FOR 30" VALVES INSTEAD OF 24"

$K_{zz} = 4 * \frac{F_z}{\Delta z} = 2.694 * 10^6$ (16.34) lb/in

$K_{yy} = 4 * \frac{F_y}{\Delta y} = \frac{4*12 EI_{max}}{l^3} = K_{zz} * \frac{1.95}{.7} = 7.50 * 10^6$ lb/in (3.94/1.34 = 48)

θ:



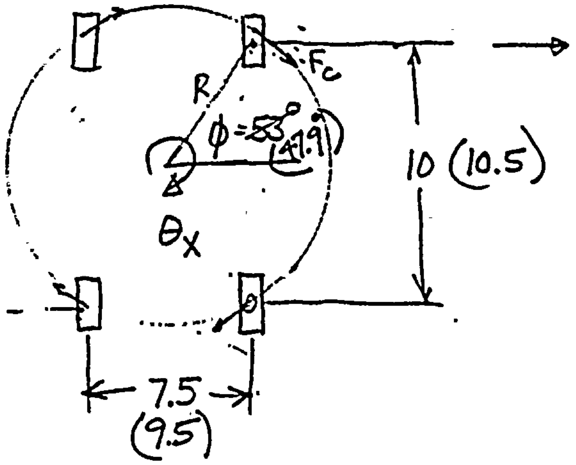
CONSIDER THE EAR-SYSTEM STIFFNESS IN THESE MODES VERY LARGE, BECAUSE OPERATOR BRACKET BENDING WILL CONTROL

1006.00

Calculation Sheet

CYGNA

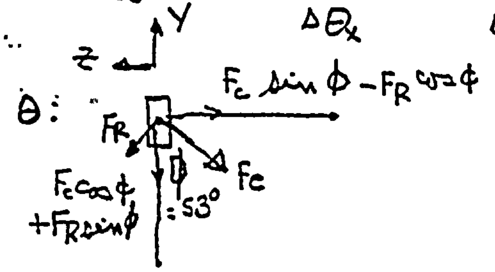
Project: WPPSS EQ		Prepared By: [signature]	Date: 1/3/83
Subject: BIF VALVE/ACTUATOR MODEL SUMMARY		Checked By: [signature]	Date: 3/24/83
System: CSP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361104 & 106	Rev. No.: 0	Sheet No.: 361106-4.3-B6	



The attached plate forces the ears to deflect tangent to the circle. The force on each ear is:

$$4F_cR = T \quad , \quad R = \left[3.75^2 + 25\right]^{\frac{1}{2}} = 6.25'' \quad (4.75^2 + 5.25^2 = 7.08)$$

$$\text{Stiffness} = \frac{T}{\Delta\theta_x} = \frac{4F_c\,(7.08)}{\Delta\theta_x}$$



There is a restraint force which acts through the plate keeping the ear deflection on the circle. This must be a radially-directed force: F_R (no torque contribution)

$$\text{Deflection:} \quad \Delta Y = -\left(F_c\cos\phi + F_R\sin\phi\right)\left[\frac{\ell^3}{12EI_{max}} + \frac{\ell}{(k=1.5)A(G=.4E)}\right]$$

$\frac{\ell^3}{1.5 \cdot .4 \ell A E}$

$$\Delta Z = -\left(F_c\sin\phi - F_R\cos\phi\right)\frac{\ell^3}{12EI_{min}}$$

$12I_{max} = 23.4$
$1.5 \cdot .4 \ell^2 A = 14.22$
∴ Shear not sig.

CYGNA

Calculation Sheet

Project: WPPSS EQ		Prepared By: [signature]	Date: 1/3/83
Subject: BIF VALVE/ACTUATOR MODEL SUMMARY		Checked By: W.E. Searle	Date: 3/24/83
System: CSP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361104 & 106	Rev. No.: 0	Sheet No.: 361106-4.3-B7	

$$\tan\phi = \frac{-\Delta Z}{-\Delta Y} = \frac{\Delta Z}{\Delta Y} = \frac{I_{max}}{I_{min}}\frac{(F_c \sin\phi - F_R\cos\phi)}{(F_c\cos\phi + F_R\sin\phi)} = 1.327 \; (1.105)$$

$$\frac{I_{max}}{I_{min}} = \frac{\cancel{1.95}\;(3.94)}{.70\;(1.34)} = 2.786 \;(2.94), \quad \sin\phi = .799 \;(.742), \quad \cos\phi = .602 \;(.671)$$

$$\therefore \frac{1.327\;(1.105)}{2.786\;(2.94)} = \frac{F_c\,.799\,(.742) - .602\,(.671)\,F_R}{.602\,(.671)\,F_c + .799\,(.742)\,F_R} = .476 \;(.376)$$

$$.799\,(.742)\,F_c - .602\,(.671)\,F_R = .278\,(.252)\,F_c + .380\,(.279)\,F_R$$

$$.521\,(.464)\,F_c = .982\,(.950)\,F_R$$

$$\boxed{F_R = .531\,F_c}\;(.488)$$

NOTE: Another force FR acts on valve ears - include in stress analysis.

2 ☆ SIGN CHANGES FOR F_R ON ALTERNATE EARS.

To find θ:

$$\Delta\theta = \frac{\Delta c}{R} = \frac{-\Delta Y}{R\cos\phi} = \frac{+(F_c\cos\phi + F_R\sin\phi)\,\frac{\ell^3}{12EI_{max}}}{R\cos\phi}$$

$$= \frac{\ell^3}{12EI_{max}}\left(\frac{F_c}{R} + \frac{.531\,(.488)\,F_c}{R}\tan\phi\right), \quad \tan\phi = 1.327\;(1.1051)$$

$$\Delta\theta_x = \frac{\ell^3}{12REI_{max}}F_c\left(\begin{matrix}1.540\\1.704\end{matrix}\right) = \frac{51.362\,(14.64)\,F_c}{REI_{max}}$$

$$K_{\theta_x\theta_x} = \frac{T}{\Delta\theta_x} = \frac{4\cancel{F_c}R}{\frac{51.362\cancel{F_c}}{REI_{max}}} = \frac{4}{51.362\;(14.64)}R^2EI_{max}$$

$$= \frac{L^2 L^4}{L^2 (L^3)} = FL^4 = FL \text{ (OK)}$$

1006.00

CYGNA

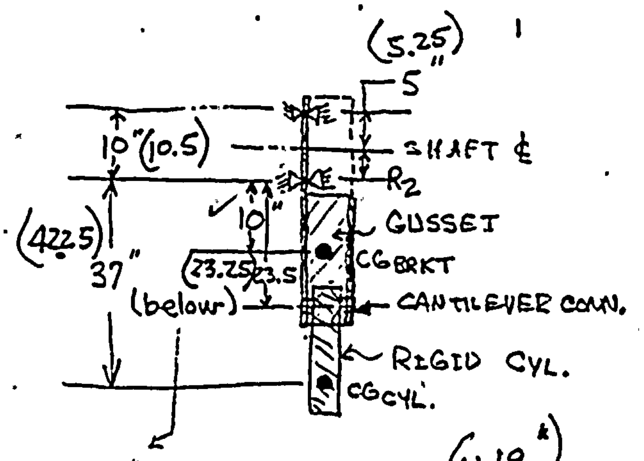
Calculation Sheet

Project WPPSS-EQ		Prepared By: [signature]	Date 3/25/83
Subject B/F VALVE-ACTUATOR MODEL SUMMARY		Checked By: [signature]	Date 3/24/83
System CSP		Job No. 82044	File No. 0T.01/F
Analysis No. 361104 & 361106	Rev. No. 0	Sheet No. 361106-4.3-B8	

$$K_{\theta\theta} = \frac{.078(6.25)^2(29)(10)^6}{(7.08)} \frac{(1.95)}{(3.94)} = \frac{172(10)^6}{(1565)} \text{ in lb/rad}$$

$$K_{\theta\theta} = 1.72(10)^8 \text{ in lb/rad}$$
$$(1.565(10)^9) \text{ "}$$

SUPPORT BRACKET PLATE BENDING



28.5" shaft → tr. pin + ~ 13.5" to CG (~19")
= 42" − 5" = 37".

FOR CALCULATION OF BRACKET FLEXIBILITY, THE FOLLOWING MEASUREMENTS WERE TAKEN ON CSP-AO-5 & 3. DATA IS APPROXIMATE.

DEFLECTION AT END OF CYL (IN):	.125,	.125,	.150
FORCE AT END OF CYL (LB):	85,	150,	100

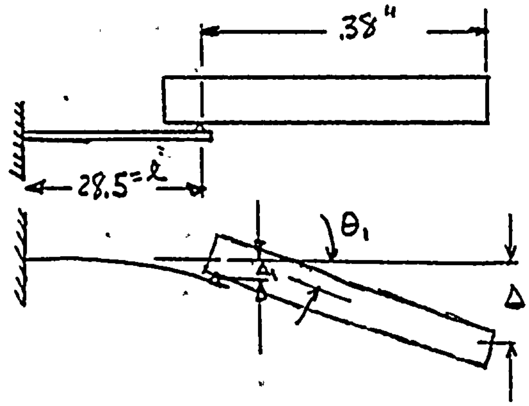
Calculation Sheet

CYGNA

Project WPPSS-EQ		Prepared By: J E Rabowski	Date 3/24/83
Subject B/F Valve/Actuator Model Summary		Checked By: D E Searle	Date 3/24/83
System CSP		Job No. 82044	File No. OT.01/F
Analysis No. 361104+361106	Rev. No. 0	Sheet No. 361106-4.3-B9	

AVERAGE FLEXIBILITY $= 1.27(10)^{-3}$ in/lb

CALCULATE EFFECTIVE MOMENT OF INERTIA OF A CANTILEVER BEAM USED TO REPRESENT THE BRACKET. USE THE FOLLOWING DIMENSIONS



$\Delta = \Delta_1 + 38\theta_1 = 150^{\#} * .00127\ in/\# = 0.190$ (use $150^{\#}$ as F)

$$\Delta_1 = \frac{F\ell^3}{3EI} + \frac{(38F)\ell^2}{2EI} = \frac{F\ell^2}{EI}\left(\frac{\ell}{3}+19\right) = \frac{F\ell^2}{EI}\left(\frac{28.5}{3}+19\right)$$

$$\frac{F\ell^2}{EI} = \frac{150*(28.5)^2}{2.9(10)^7 I_{zz}} = \frac{4.2(10)^4(10)^{-7}}{I_{zz}} = \frac{.0042}{I_{zz}}$$

$$\Delta_1 = \frac{.0042}{I_{zz}} * \left(\frac{28.5}{3}+19\right) = \frac{.120}{I_{zz}}\ in$$

$$\Delta = \frac{.120}{I_{zz}} + 38\theta_1$$

CYGNA

Calculation Sheet

Project: WPPSS-EQ | Prepared By: J E Rakowski | Date: 3/24/83

Subject: B/F VALVE/ACTUATOR MODEL SUMMARY | Checked By: W E Searle | Date: 3/24/83

System: CSP | Job No.: 82044 | File No.: OT.01/F

Analysis No.: 361104 & 361106 | Rev. No.: 0 | Sheet No.: 361106-4.3-B10

$\theta_1 = \theta_1$ due to F + θ_1 due to $M = 38F$

$$= \frac{F\ell^2}{2EI} + \frac{(38F)\ell}{EI} = \frac{F\ell}{EI_{zz}}\left(\frac{\ell}{2} + 38\right)$$

$$\theta_1 = \frac{150\,(28.5)}{2.9(10)^7\,I_{zz}}\left(\frac{28.5}{2} + 38\right) = \frac{7.7(10)^4 * 10^{-7}}{I_{zz}} = \frac{7.7(10)^{-3}}{I_{zz}}$$

$$38\,\theta_1 = \frac{.293}{I_{zz}}$$

$$\therefore\ \Delta = \frac{.122}{I_{zz}} + \frac{.293}{I_{zz}} = .19$$

$$\frac{.415}{I_{zz}} = .19$$

$$\boxed{I_{zz} = 2.16\ \text{IN}^4}\quad 8''\ A/O$$

FOR THE 10" CYLINDER, RATIO UP INERTIA, I.E.

$$I_{zz}\Big|_{10} = I_{zz}\Big|_8 * \frac{(5/8)^3}{(1/2)^3} = I_{zz}\Big|_8 * 1.95$$

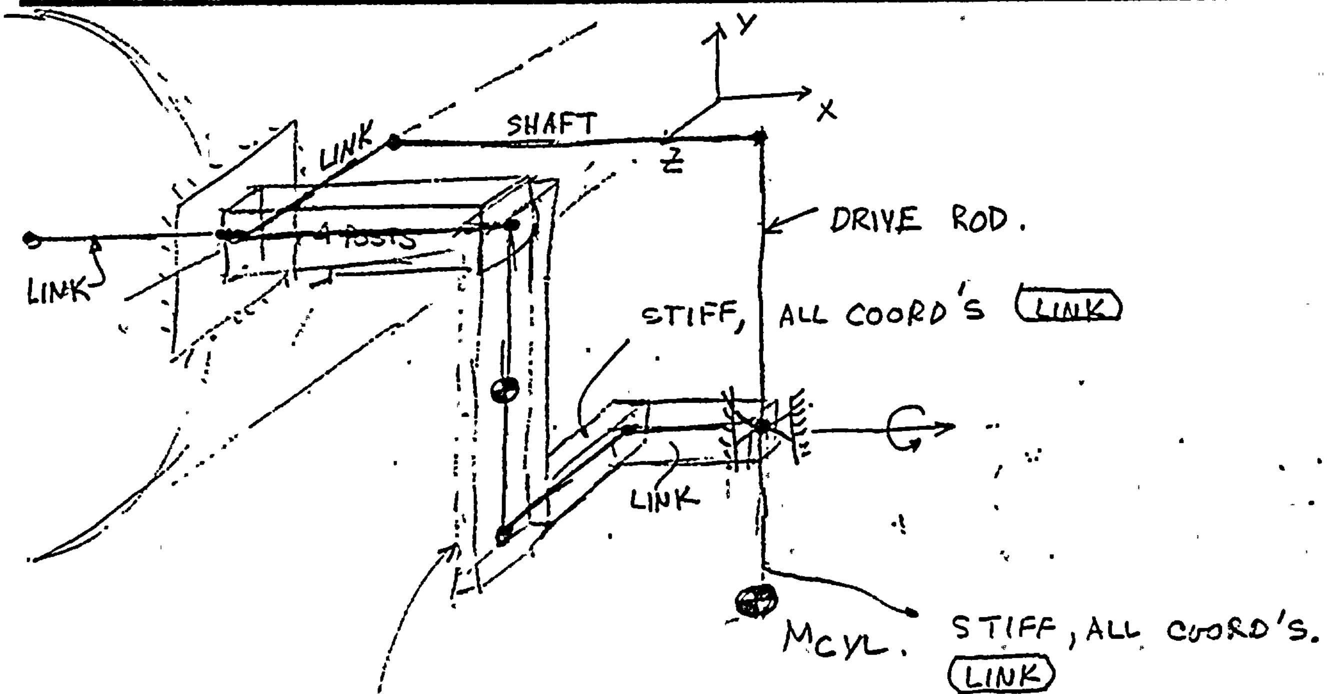
$$\boxed{I_{zz}\Big|_{10''} = 4.22\ \text{IN}^4}$$

BRACKET TORSIONAL RESISTANCE: SET TO A HIGH VALUE SINCE BENDING + TORSION BOTH REPRESENTED IN ABOVE FLEXIBILITY. ($1000\ \text{IN}^4$)

CYGNA

Calculation Sheet

Project WPPSS - EQ		Prepared By: D E Rakowski	Date 1/3/83
Subject BIF VALVE/ACTUATOR MODEL SUMMARY		Checked By: D E Searle	Date 3/24/83
System CSP		Job No. 82044	File No. OT.01/F
Analysis No. 361104 & 106	Rev. No. 0	Sheet No. 361106-4.3-B11	



ZZ Bending, Flex calc.'d.
XX - Stiff
I_{yy} - TORSIONAL STIFFNESS

Pick I's & A's for proper STIFFNESSES, THEN DO OTHERS.

GO TO 4-EARS

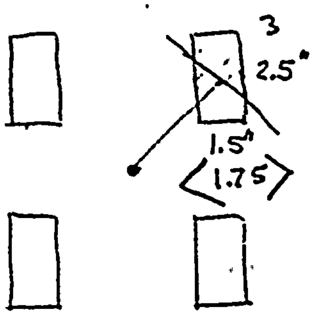
Calculation Sheet

CYGNA

Project: WPPSS - EQ		Prepared By: [signature]	Date: 1/3/83
Subject: BIF VALVE/ACTUATOR MODEL SUMMARY		Checked By: [signature]	Date: 3/24/83
System: CSP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361104 & 106	Rev. No.: 0	Sheet No.: 361106-4.3-B12	

① EARS:

⟨ ⟩ = VALUES FOR 10" OPERATORS



$A_x = 1.5 \times 2.5 \times 4 = 15 \; IN^2$ ⟨21⟩

INERTIAS:

$I_{xx} = J$

Define I_{xx} for proper $\phi = \frac{T\ell}{G I_x}$

$I_{xx} = \frac{T\ell}{\phi G}$

From page 5: $K_{\theta_x\theta_x} = 1.72(10)^8 \; \frac{in\#}{rad} = \frac{T}{\phi}$ ⟨$1.565(10)^9$⟩

$\therefore \; I_{xx} = \frac{\ell}{G} K_{\theta_x\theta_x} = \frac{7.125 \langle 4.85 \rangle}{.4(10)^6 * 29} * 1.72(10)^8 \langle 1.565(10)^9 \rangle \langle 15.65(10)^8 \rangle$

UNITS: $\frac{F*L*L}{-\frac{F}{L^2}} = L^4$ OK

$I_{xx} = 1.06 * 10^2 \; in^4 = 106 \; IN^4$

$\langle 106 * \frac{15.65}{1.72} * \frac{4.85}{7.125} = 657 \; IN^4 \rangle$

CYGNA

Calculation Sheet

Project: WPPSS EQ		Prepared By: J E Rolupski (signature)	Date: 1/3/83
Subject: BIF VALVE / ACTUATOR MODEL SUMMARY		Checked By: D E Searle (signature)	Date: 3/24/83
System: CSP		Job No. 82044	File No. 0T.01/F
Analysis No. 361104 & 106	Rev. No. 0	Sheet No. 361106-4-3-B13	

△3 (signature) 6/8/83 J C Fernandez 6/9/83

$I_z = 4 * I_{MAX}$ (1.95) ⟨3.94⟩

$I_z = 7.80\ in^4$ ⟨$15.76\ IN^4$⟩

$I_y = 4\ I_{min}$ (0.70) ⟨1.34⟩ $= 2.80\ IN^4$ ⟨$5.36\ IN^4$⟩

$C_z = 3.75\ IN$ ⟨4.75⟩ , $C_y = 5.00\ IN$ ⟨5.25⟩

$E = 29 * 10^6\ PSI$, $G = E_s = 11.6 * 10^6\ PSI$

BECAUSE OF BENDING OF EARS IN MODE BELOW, ADJUST I_y & I_z TO ACCOUNT. (THIS WAS DONE IN ANALYSIS FOR $K_{\theta x, \theta x}$): NOTE: SEE PAGE 4.3-53 REV 3 △3

$Y_{max} = \frac{-w}{12EI} l^3$ FOR EARS:

$Y_{max} = -\frac{w}{6EI}(2l^3)$ for

∴ $Y_{max-ear} = \frac{1}{4} Y_{max}$ (model beam)

Since $Y_{max} \propto \frac{1}{I}$, multiply $I_{model\ beam}$ by 4.

$I_z = 7.8$ ⟨15.76⟩ $* 4 = 31.2\ IN^4$ ⟨63⟩

$I_y = 2.8$ ⟨5.36⟩ $* 4 = 11.2\ IN^4$ ⟨21.4⟩

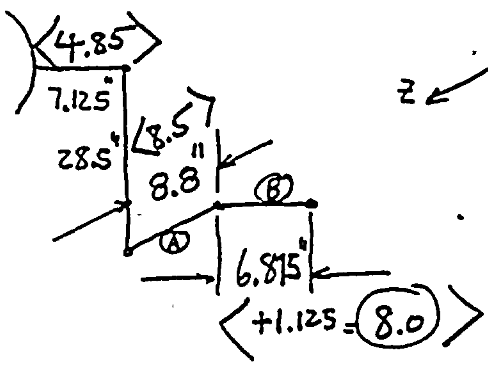
1006.00

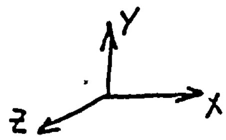
CYGNA

Calculation Sheet

Project: WPPSS EQ		Prepared By: E Rakumadi	Date: 1/3/83
Subject: BIF VALVE / ACTUATOR MODEL SUMMARY		Checked By: D E Searle	Date: 3/24/83
System: CSP		Job No.: 82044	File No.: 0T.01/F
Analysis No.: 361104 & 106	Rev. No.: 0	Sheet No.: 361106-4.3-B14	

BRACKET OFFSETS





Ⓐ & Ⓑ ARE MASSLESS, RIGID LINKS

SHAFT

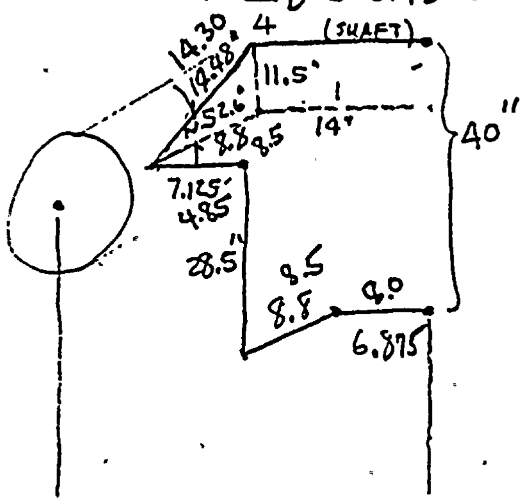
DIA = 7.25" <2.50> (from McPherson, 24" valve <(30")>):

C = 1.125" <1.25>

I = 1.26 IN^4 = I_{yy} <1.92>

$I_{xx} = \sqrt{2}\, I_{yy} = 2.52\ IN^4$ <3.84>

$A = \frac{\pi D^2}{4} = 3.98\ IN^2$ <4.91>



<4.85> <8> = <12.85">

L = 7.125 + 6.875 = 14"

SHAFT TO BE SOFT FOR Y-DEFLECTION & STIFF FOR Z-DEFECTION (L NOT IMPORTANT.) (NO STRESS)

THEREFORE; SINCE SHAFT IS MODELED HERE OF GREATER THAN ACTUAL LENGTH, USE:

I_{XX} = 1.78 IN^4 <2.72>

I_{YY} = 3 * I_{ZZ} ≅ 4 IN^4 <5.75>

I_{ZZ} = 1.26 IN^4 <1.92>

CYGNA

Calculation Sheet

Project: WPPSS- EQ		Prepared By: J E Rolowski	Date: 3/24/83
Subject: B/F VALVE/ACTUATOR MODEL SUMMARY		Checked By: [signature]	Date: 3/24/83
System: CSP		Job No. 82044	File No. OT.01/F
Analysis No. 361104 & 361106	Rev. No. 0	Sheet No. 361106-4.3-B15	

FOR THE BRACKET ELEMENT:

(MAKE $e = 0$ & PUT 277# 15" DOWN) <(321#)>

LENGTH	= 28.5 (15 + 13.5)		<✓28.5>
WEIGHT	= 277 LB		<321 #>
$A_x = A_y = A_z$	= 6.84 IN^2		<10.6 IN^2>
C_z	= 6.84 IN		<8.5 IN>
C_x	= .25 IN		<.313 IN>
I_{xx}	= 102 IN^4	(BELOW)	<255 IN^4>
I_{yy}	= 1000 IN^4	(PAGE 7/13)	<1000 IN^4>
I_{zz}	= 2.16 IN^4	(PAGE 7/13)	<4.22 IN^4>

IN PLANE BENDING INERTIA OF BRACKET PLATE:

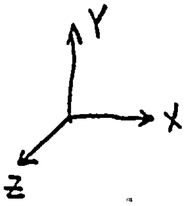
$$I_{xx} = \frac{1}{12} b l^3 = \frac{1}{12} (0.5)(13.5)^3 = 102 \text{ IN}^4$$

<.625 17> <255>

CYGNA

Calculation Sheet

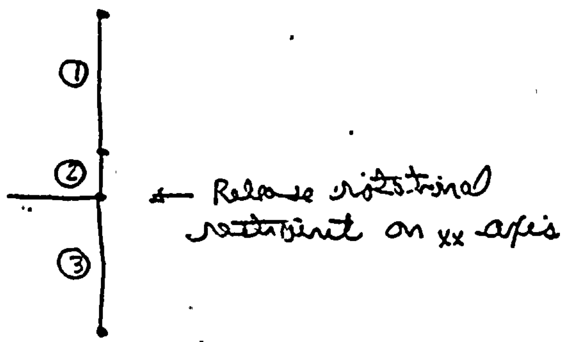
Project: WPPSS EQ		Prepared By: J E Robynski	Date: 1/3/83
Subject: BIF VALVE/ACTUATOR MODEL SUMMARY		Checked By: A E Searle	Date: 3/24/83
System: CSP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361104 & 106	Rev. No.: 0	Sheet No.: 361106-4.3-B16	

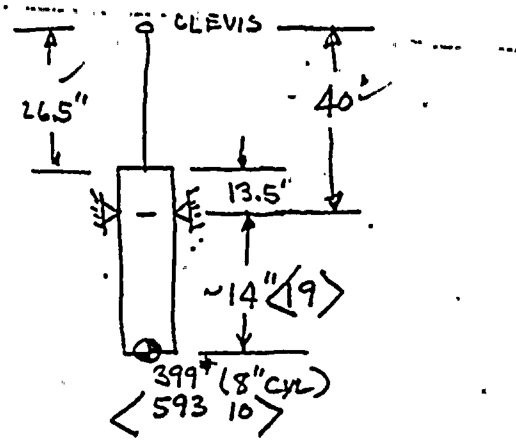


DRIVE ROD & CYLINDER:

IMPORTANT DISTANCES ARE:

MODEL:





①: DRIVE ROD:

$L = 26.5''$ ✓

$A = \pi/4\ D^2 = 2.41\ IN^2$ ✓

$C = .875''$ ✓

$I = .46\ IN^4 = I_{xx} = I_{zz}$ ✓

$I_{yy} = \sqrt{2} * I_{xx} = .92\ IN^4$ ✓ ⟨0.92 for 10"⟩

② ③ ⟨10⟩ 8" CYL: (Say $\rho = 0$ AND PUT ⟨593#⟩ 399# AT CG)

$I_{yy} = \quad = 74\ IN^4$ ⟨180⟩

$I_{xx} = I_{zz} \quad = 52.2\ IN^4$ (large ⟨(1.25)^4⟩)

$L② = 13.5$ ✓

$L③ = 14.0$ ⟨19⟩

$A = \pi/4\ 8^2 = 50.3\ IN^2$ ⟨78⟩ = ⟨127⟩

$C = 4''$ ⟨5⟩

APPENDIX C

SAMPLE HAND CALCULATIONS
TO CHECK PROGRAM
CEP-V-3A

Calculation Sheet

Prepared By: E Rabzwski Date 3/25/83
Checked By: A E Searle Date 3/30/83
Job No. 82044 File No. OT.01/F.

361106-C-I

```
nbif CEP-V- 3A
 INPUT GLOBAL ACCELERATIONS
? 13.89,1.66,1.04
 INPUT ANGLES OF NORTH VECTOR
? 90,90,0
 INPUT ANGLES OF VERTICAL VECTOR
? 90,0,90
 INPUT ANGLES OF EAST VECTOR
? 0,90,90

 INPUT DATA

GLOBAL G-LEVELS          =  13.89          1.66          1.04
NORTH VECTOR ANGLES      =  90             90            0
VERTICAL VECTOR ANGLES=  90            0             90
EAST VECTOR ANGLES       = 0    90         90

 INPUT ANGLES OF WEIGHT VECTOR
? 90,180,90

 LOCAL G-LEVELS

-5.29861E-5  -6.33239E-6    1.04
-5.29861E-5   1.66         -3.96728E-6
 13.89       -6.33239E-6   -3.96728E-6

OPERATING DRIVE ROD STRESS AT A  477.198
OPERATING DRIVE ROD STRESS AT B  821.458
OPERATING CYLINDER BRG PRESSURE -3.75613E-4
OPERATING VALVE EAR TENSILE STR  [1136.52]
OPERATING VALVE EAR SHEAR STRES  89.1706
OPERATING EAR BOLT SHEAR STRESS  1078.68
OPERATING EAR BOLT TENSILE  STR  525.595

glc(1,j)= j=-5.29861E-5 ✓    1
fcdr=        -1.22282E-2
siga= -.267492
sigb= -.409114
Fc due to T3=-5.71181E-2
f11= 2.73638E-2
f22=-5.85968E-2
dsa= .071552
dsr= 3.3257E+7
dbten= 4.86604E+9
glc(1,j)= j=-6.33239E-6      2
fcdr=        -1.4614E-3
siga= -3.19681E-2
sigb= -4.88934E-2
Fc due to T3= [321.752]
f11=[-154.143]
f22=[ 330.082]          (NEXT PAGE)
dsa= .072574
dsr= 3.7607E+7
dbten= 4.86759E+9
glc(1,j)= j= 1.04            3
fcdr=         240.013
siga=  5250.28
sigb=  8029.99
Fc due to T3= [919.516]
f11=-440.516
f22= 943.322
dsa= 2.75454E+7
```

SAMPLE CHECK CALC'S.

EAR TENSILE STRESS

$T_{3F} = (F_{ST} - W_{AO}) * 8.5 - 277 * 5.25$

$= (1150 - 399) * 8.5 - 277 * 5.25$

$T_{3F} = 4939$, $F_c = \frac{4939}{25} = 198\#$

$F_{11} = -.48 * T_{3F} = -95$

$F_{22} = +1.03 * T_{3F} = 203$

$S_{ttif} = \left| -95 * \frac{7.125}{2} * \frac{.75}{.70} \right| + \left| 203 * \frac{7.125}{2} * \frac{1.25}{1.95} \right|$

$= 826$ PSI

M_1 due to dwd bending $= (W_{AO} + W_{BR} - F_{ST2}) * e_5$

$\tau_{M1} = M_1 / 2 d_2 * l_1 l_2 = \frac{3259}{2*10*1.5*2.5} = 44$ PSI

τ due to dwd shear $= \frac{(W_{AO} + W_{BR} - F_{ST2})}{4} * \frac{c_2}{I_1} * \frac{l_{aw}}{2}$

τ due to shear $= \frac{474}{4} * \frac{1.25}{1.95} * \frac{7.125}{2} = 271$ PSI

TOTAL DWD EAR TENSILE STRESS.

$826 + 44 + 271 = 1141$ VS ~ 1137 (OK)

CHECK F_c:

$F_{TR1} = \left(\frac{25 + 14.46}{25}\right) * 399 * 1.04 = 655\#$

$T_3 = (655 * 28.5 + 277 * 1.04 * 15)/25 = 919.25$ (OK)

CYGNA

Calculation Sheet

Project	WPPSS-EQUIPMENT QUALIFICATION	Prepared By: E.R. [signature]	Date 3/25/83
Subject	24" BIF. BUTTERFLY VALVES	Checked By: D.E. Searle	Date 3/30/83
System	CEP & CSP	Job No. 82044	File No. OT.01/F
Analysis No.	361106 Rev. No. 0	Sheet No.	361106-C-2

CHECK EAR TENSILE STRESS CALCS:

$\frac{f_{11}}{f_c} = \frac{-154}{322} = -.48$ ✓ $\frac{+330}{322} = +1.03$ ✓ (OK)

SIGNS (OK)

$T_3 = 2D\,F_c = 2 * 12.5 * 322 = 8050$ "#

CHECK:

$T_3 = F_{TR1} * 28.5 + \bar{W}_{BR} * g_1 * 15 + \bar{W}_{AO} * g_2 * 8.5 + \bar{W}_{BR} * g_2 * 5.25$

$= \sim 0$ (i.e. $g_{1,2} \approx 0$) $+ 399 * 1.66 * 8.5 + 277 * 1.66 * 5.25$

$T_3 = 8044$ "# vs 8050 "# (OK)

CONCLUSIONS OF CHECK CASE CEP-V-3A:

1. FIXED STRESSES ON EARS CHECK
2. NEW VALVE EAR BENDING STRESS COMPONENTS CHECK
3. BEARING PRESSURE CHECKS (NOT SHOWN)
4. DRIVE ROD STRESS CHECKS (NOT SHOWN)
5. BOLT TENSION CHECKS (NOT SHOWN)

5.0 APPENDICES TO REQUALIFICATION ANALYSES

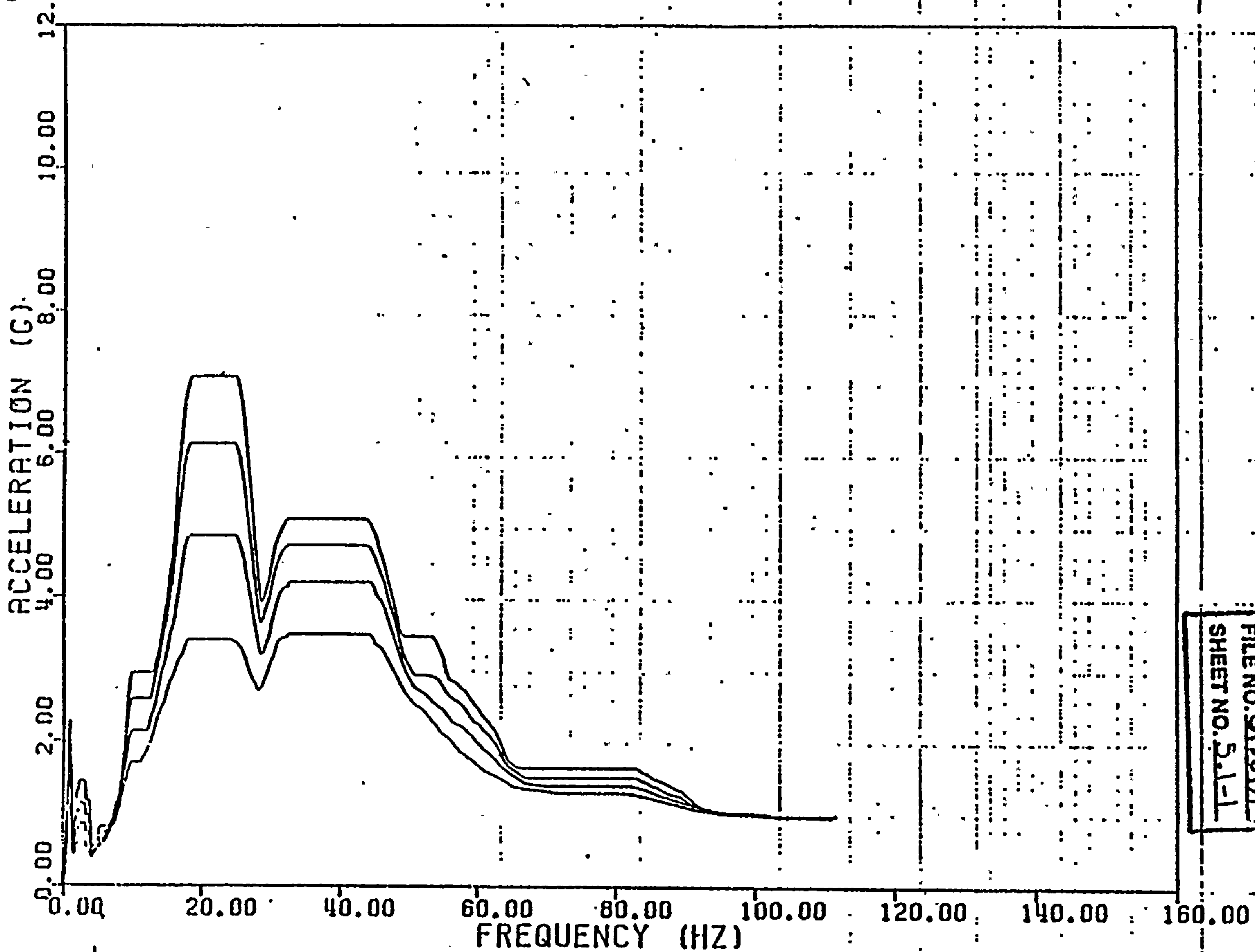
SECTION 5.0 QID# 361106

APPENDICES

CONTENTS

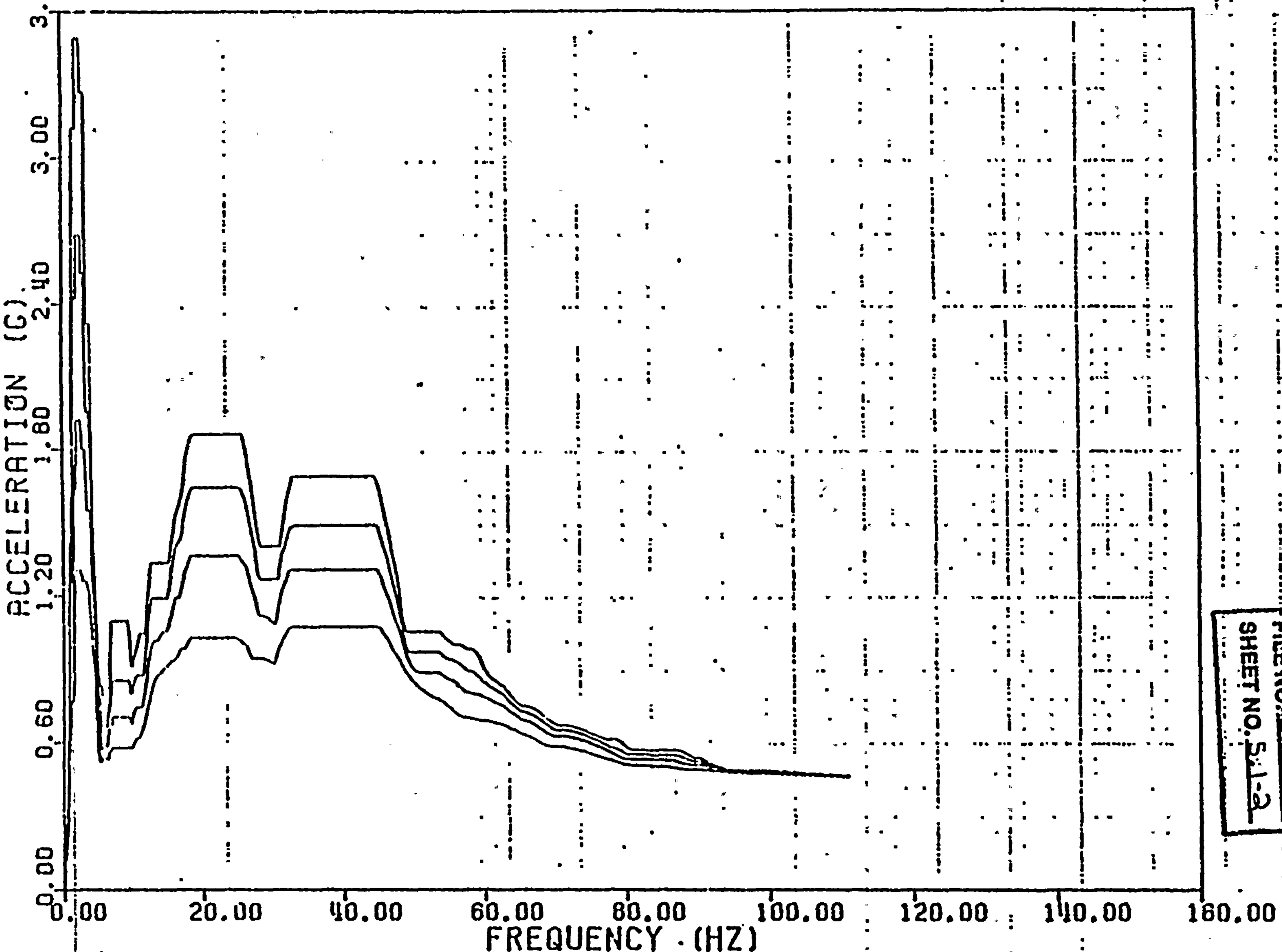
Revision 3

5.1 Response Spectra



WPPSS REACTOR BLDG. SRSS OF SRV SSE AP/CHUG.
MASS NO. 182 EL. 500 FT. HORIZ. TRANSLATION
CONTAINMENT VESSEL DAMPING= .005,.01,.02,.04

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 97.01VE
SHEET NO. 5.1-1



WPPSS REACTOR BLDG. SRSS OF SRV SSE AP/CHUG.
MASS NO. 182 EL. 500 FT. VERT. TRANSLATION
CONTAINMENT VESSEL DAMPING= .005,.01,.02,.04

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. 5.1-2

5.2 Walkdown Sheets

△

EQUIPMENT QUALIFICATION WALKDOWN VERIFICATION FORM

CYGNA

EPN# CSP-V-3

QID# 361106

BLDG R FLOOR EL 501 - 7. COORDS M.1/7.6

M.R. BTF COMPONENT EL 481 DSCRP 24" BFLY Cont Isol Valve

MOD# ~~DWG A20764~~ 0657 SERIAL# N27235-1 MAT'L SA-516-GR-70

150 PSI @ 275 °F LBS N/F SIZE 24"

ASME CLASS N/F

YOKE ORIENTATION

⊥ TO AXIS OF PIPE (✓)

// TO AXIS OF PIPE (✓)

YOKE LENGTH 0'-4 1/2" (FLANGE TO FLANGE)

MOUNTING CONDITION

NO OF BOLTS N/A

BOLT TYPE N/A BOLT Ø N/A

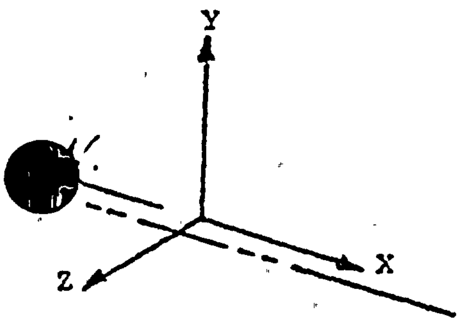
WELD TYPE & SIZE N/A

PIPE MOUNTED YES (✓) NO ( )

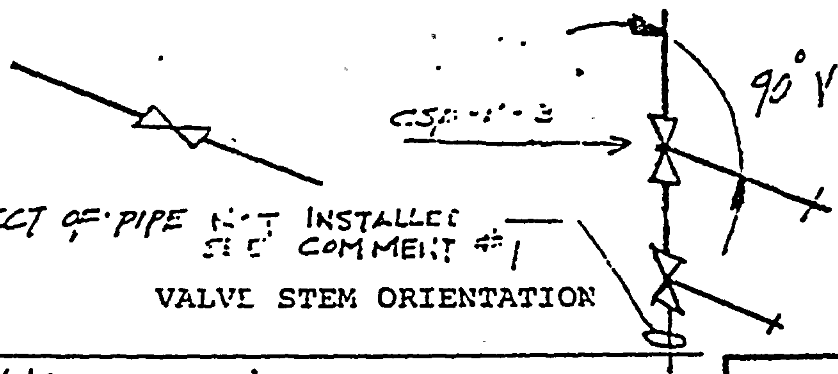
PERMANENT OBSTRUCTION (WITHIN 2") YES ( ) NO (✓)

IS COMP BETWEEN CONT & 1ST ANC (FULL 6 WAY ANC) YES ( ) NO ( ) N/F

DO MULTIPLE SUPPORTS EXIST BETWEEN CONT & COMP YES ( ) NO ( ) N/F



GLOBAL CO-ORDINATE SYSTEM



VALVE STEM ORIENTATION

OPERATOR EPN COVERED W/ PLASTIC MANUFACTURER
MODEL NO SERIAL NO
TYPE SIZE ORDER NO

MOTOR EPN N/A NOT MOTOR OPERATED MANUFACTURER
MODEL NO SERIAL NO
NO INS CLASS 1-PHASE ( ) 3-PHASE ( ) AC DC

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. 5.2-1

COMMENTS: Definition (N/F = Not Found)

CSP-LMS-3

1. LENGTH OF PIPE HAS NOT BEEN INSTALLED FROM VALVE TO CONTAINMENT.

PREPARED BY William Cunha (SIGNATURE) DATE 7/21/82 REVIEWED BY Doug True (SIGNATURE) DATE 7/21/82

William Cunha Doug True

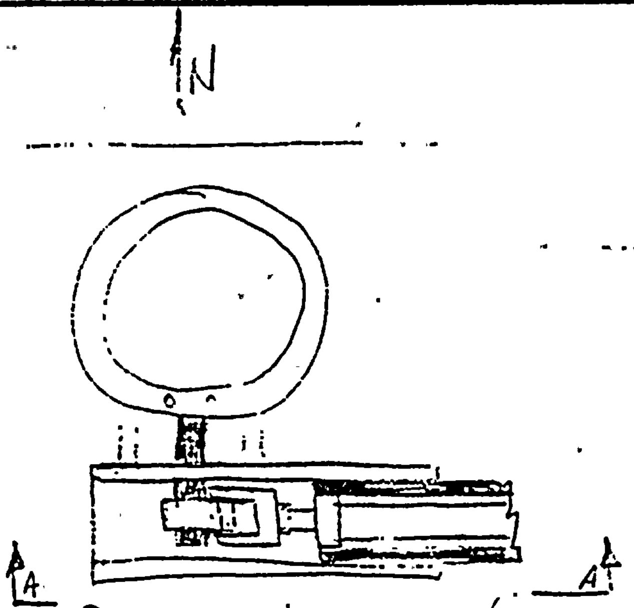
△ D. Searle 1/5/83

CYGNA

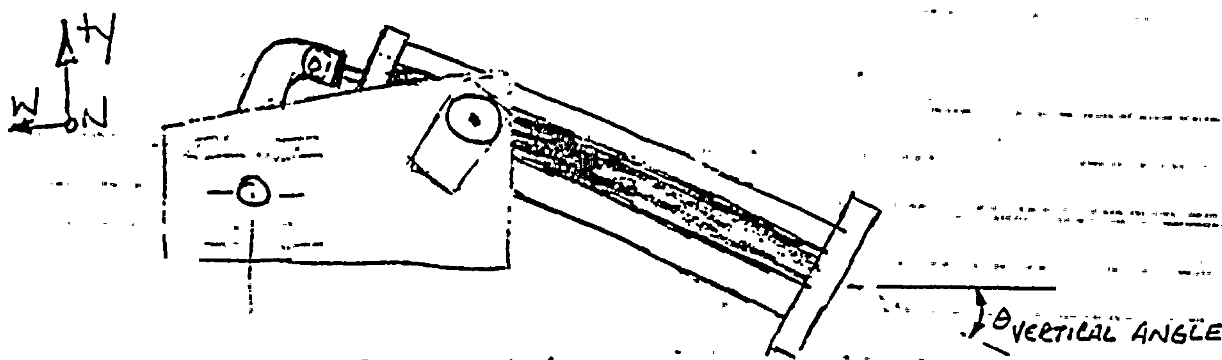
Calculation Sheet

Project WNP#2		Prepared By: [signature]	Date 12/22/82
Subject Equip. Qualification		Checked By: J E Rakowski	Date 1/4/83
System CEP/CSP		Job No. 82044	File No.
Analysis No. QID#361106	Rev. No.	Sheet No.	

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. 5-2-2



PLAN CSP-V-3,4 (TYP VIEW)



SECTION A-A

CSP-V-3 — θ ~ 7°
CSP-V-4 — θ ~ 6°

FIELD SKETCH (FOR THE PURPOSE OF DEPICTING OPERATOR ORIENTATION ONLY)

1006 00

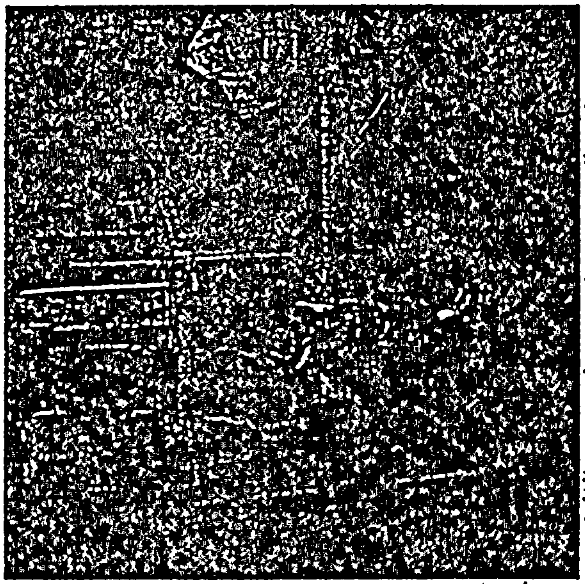
CYGNA

Calculation Sheet

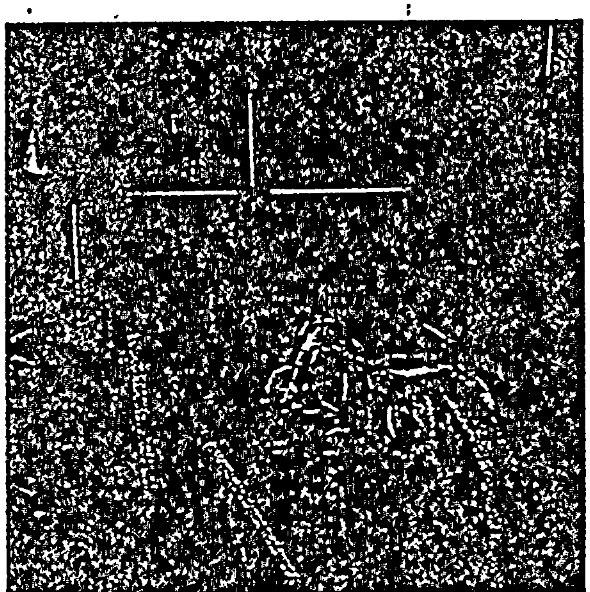
Project: WPPSS Mechanical Equipment Qualification	Prepared By:	Date: 1/10/83	
Subject: 24" Butterfly Valves	Checked By: Don Shank	Date: 3/22/83	
System: CSP and CEP	Job No. 82044	File No. OT 01/F	
Analysis No. 361106	Rev. No.	Sheet No.	

SUPPLEMENTAL INFORMATION: (AIR OPERATOR PICTURES)

CSP-AO-3



CSP-AO-3 (CLOSE-UP) SUPPORT BRACKET & DRIVE LEVER



CSP-AO-3 (MILLER OPERATOR) VIEW LOOKING SOUTH-EAST

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. S.2-3

1006 00

CYGNA

EQUIPMENT QUALIFICATION WALKDOWN VERIFICATION FORM

△

EPN# CSP-V-4

QID# 361106

BLDG R

FLOOR EL 471

COORDS 7.6 / M.6

MFR BIF

COMPONENT EL 478

DSCRP 24" BFLY CNT. ISOL VALVE

MOD# DWG 0657

SERIAL# 772-35-2

MAT'L SA-516-GR-70

150 PSI @ 225 °F

LBS N/F

SIZE 24"

ASME CLASS N/F

YOKE ORIENTATION

⊥ TO AXIS OF PIPE (✓)

// TO AXIS OF PIPE (✓)

YOKE LENGTH 6'-4½" (FLANGE TO FLANGE)

MOUNTING CONDITION

NO OF BOLTS N/A

BOLT TYPE N/A BOLT Ø N/A

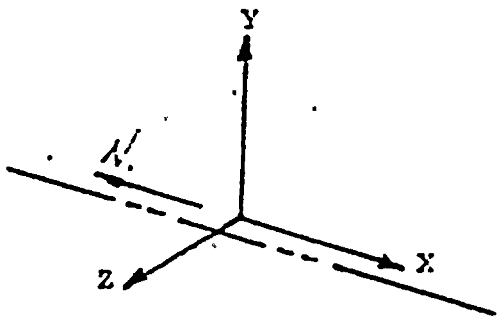
WELD TYPE & SIZE N/A

PIPE MOUNTED YES (✓) NO ( )

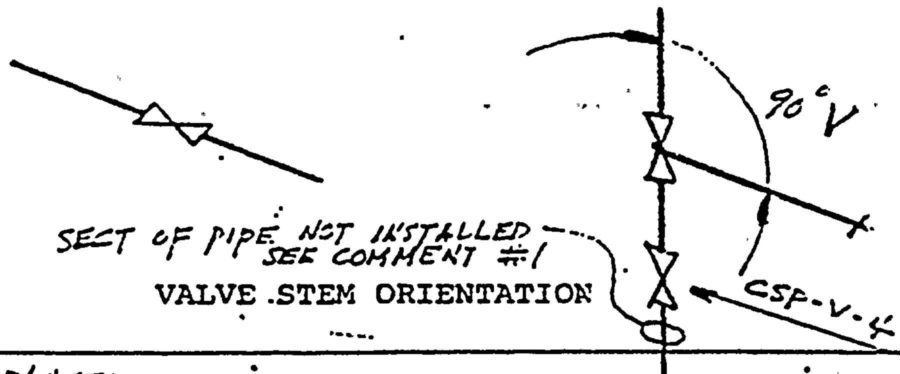
PERMANENT OBSTRUCTION (WITHIN 2") YES ( ) NO (✓)

IS COMP BETWEEN CONT & 1ST ANC (FULL 6 WAY ANC) YES ( ) NO ( ) N/F

DO MULTIPLE SUPPORTS EXIST BETWEEN CONT & COMP YES ( ) NO ( ) N/F



GLOBAL CO-ORDINATE SYSTEM



VALVE STEM ORIENTATION

OPERATOR EPN COVERED W/ PLASTIC

MANUFACTURER

MODEL NO

SERIAL NO

TYPE

SIZE

ORDER NO

MOTOR EPN N/A NOT MOTOR OPERATED

MANUFACTURER

MODEL NO

SERIAL NO

ID NO

INS CLASS

1-PHASE ( ) 3-PHASE ( )

CYGNA ATTACHMENT

JOB NO. 82044

FILE NO. QT.01/F

SHEET NO. 5.2-4

COMMENTS: Definition (N/F = Not Found).

1. LENGTH OF PIPE HAS NOT BEEN INSTALLED FROM VALVE TO CONTAINMENT.

PREPARED BY [signature] DATE 7/21/82 REVIEWED BY [signature] DATE 7/21/82

(SIGNATURE) (SIGNATURE)

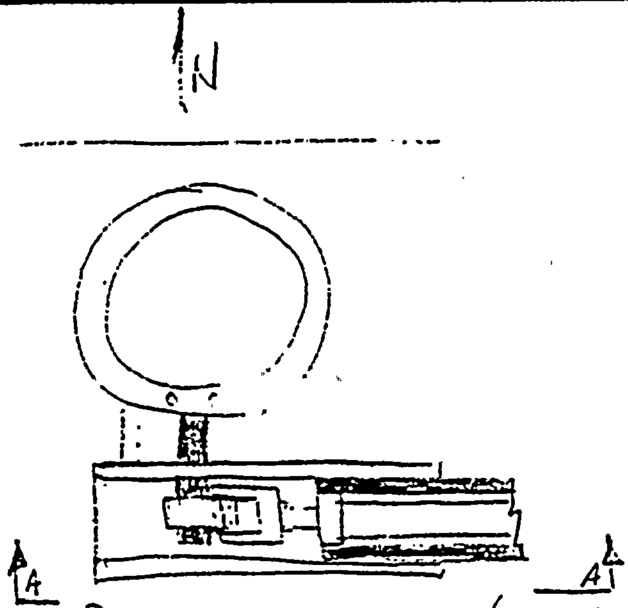
△ [signature] 1/5/83

Doug True

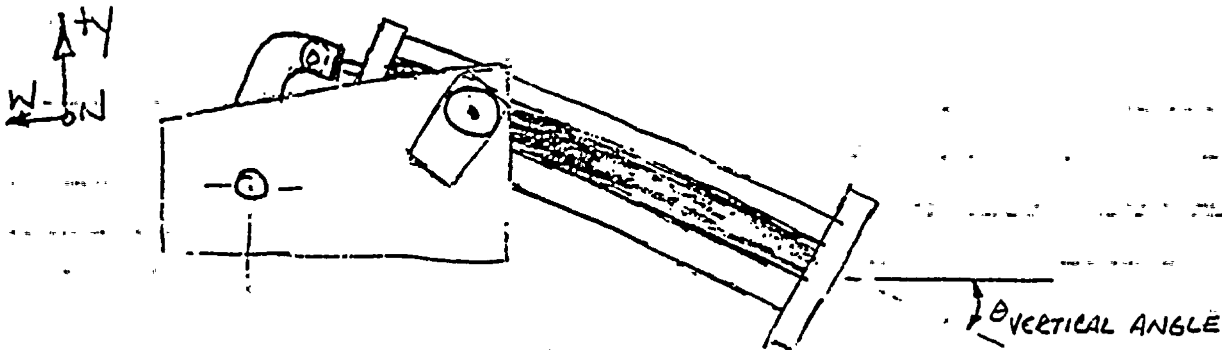
Calculation Sheet

Project WNP#2		Prepared By: [signature]	Date 12/22/82
Subject EQUIP. QUALIFICATION		Checked By: J E Rakowski	Date 1/4/83
System CEP/CSP		Job No. 82044	File No.
Analysis No. QID#361106	Rev. No.	Sheet No.	

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. QT.01/F
SHEET NO. 5.2-5



PLAN CSP-V-3,4 (TYP VIEW)



SECTION A-A

CSP-V-3 — θ ~ 7°
CSP-V-4 — θ ~ 6°

FIELD SKETCH (FOR THE PURPOSE OF DEPICTING OPERATOR ORIENTATION ONLY)

1006 00

EQUIPMENT QUALIFICATION WALKDOWN VERIFICATION FORM

EPN# CSP-V-5

QID# 361106

BLDG R FLOOR EL 471 COORDS M.7 / 8.3

MFR BIF COMPONENT EL 475 DSCRP 24" BFLY

MOD# DWG A20765 SERIAL# 27236-1 MAT'L ______

______ PSI @ ______ °F LBS ______ SIZE ______

ASME CLASS ______

YOKE ORIENTATION

⊥ TO AXIS OF PIPE ( )

// TO AXIS OF PIPE ( )

YOKE LENGTH ______
(FLANGE TO FLANGE)

MOUNTING CONDITION

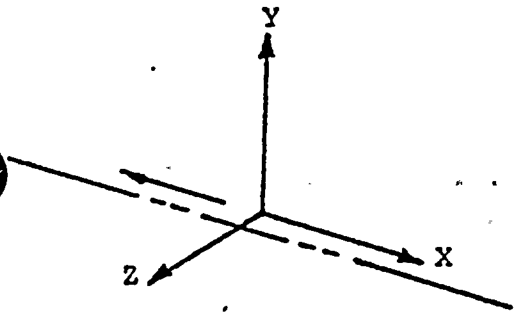
NO OF BOLTS ______

BOLT TYPE ______ BOLT Ø ______

WELD TYPE & SIZE ______

PIPE MOUNTED YES ( ) NO ( )

PERMANENT OBSTRUCTION (WITHIN 2") YES ( ) NO ( )
IS COMP BETWEEN CONT & 1ST ANC (FULL 6 WAY ANC) YES ( ) NO ( )
DO MULTIPLE SUPPORTS EXIST BETWEEN CONT & COMP YES ( ) NO ( )



GLOBAL CO-ORDINATE SYSTEM

VALVE STEM ORIENTATION

OPERATOR EPN ______ MANUFACTURER ______
MODEL NO ______ SERIAL NO ______
TYPE ______ SIZE ______ ORDER NO ______

MOTOR EPN ______ MANUFACTURER ______
MODEL NO ______ SERIAL NO ______
ID NO ______ INS CLASS ______ 1-PHASE ( ) 3-PHASE ( ) AC ______ DC ______

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. QT.01/F
SHEET NO. 5.2-6

⚠ VISUAL INSPECTION MADE 12/22/82 & IT WAS NOTED VALVE INSTALLED SEE SHEET 2 OF 2

COMMENTS: Definition (N/F = Not Found)

Valve not installed as of 7/21/82

PREPARED BY William Cuba (SIGNATURE) DATE 7/21/82 REVIEWED BY Doug True (SIGNATURE) DATE 7/21/82

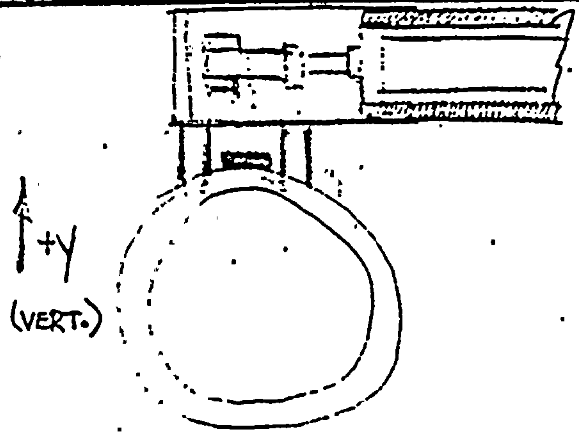
William Cuba — Doug True

⚠ A. Searle 1/5/83

CYGNA

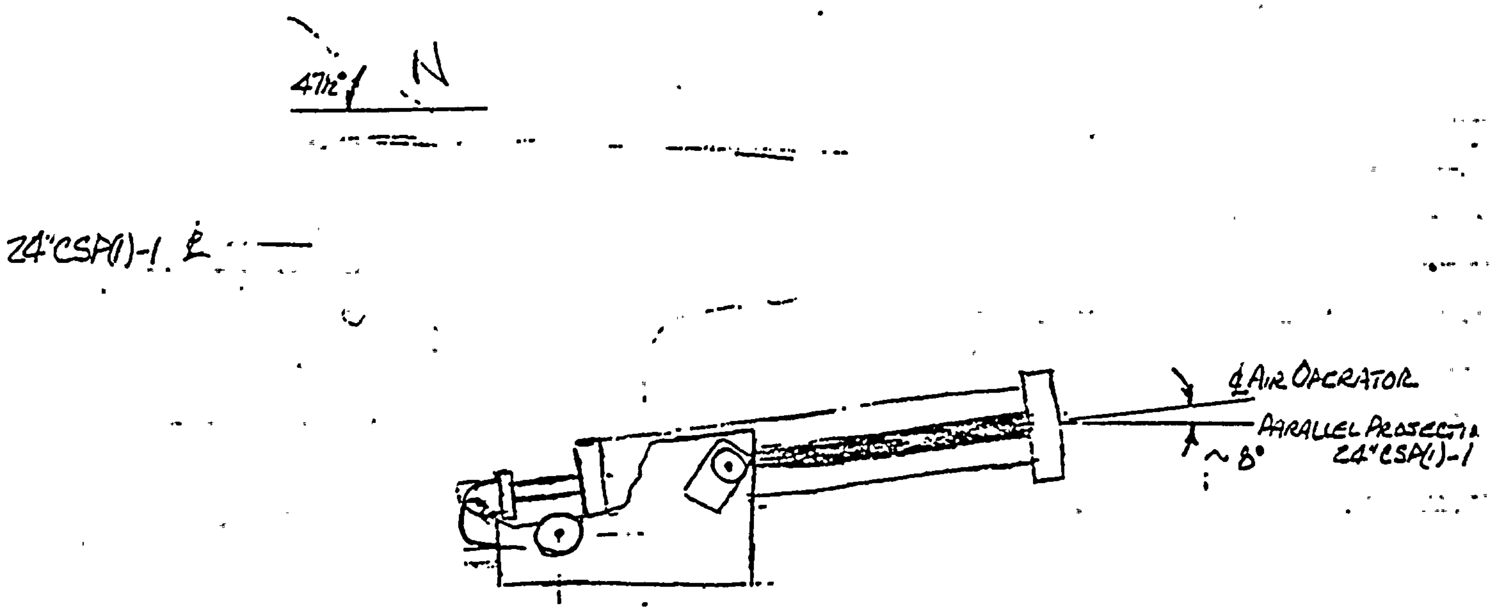
Calculation Sheet

Project WNP #2		Prepared By: [signature]	Date 12/22/82
Subject EQUIP QUALIFICATION		Checked By: [signature]	Date 1/4/83
System		Job No. 82044	File No.
Analysis No. QID #36-1106	Rev. No.	Sheet No. 2 OF 2	



CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. 5.2-7

CSP-V-5



PLAN VIEW

FIELD SKETCH (FOR THE PURPOSE OF SHOWING OPERATOR ORIENTATION ONLY)

EQUIPMENT QUALIFICATION WALKDOWN VERIFICATION FORM

EPN# CSP-V-6

QID# 361106

△ COORDS ~~N.5/7.7~~ 4.5/5.

BLDG R | FLOOR EL 471 | DSCRP 24" BFLY

MFR BIF | COMPONENT EL 480 | MAT'L

MOD# A-206765 | SERIAL#

_____ PSI @ _____ °F | LBS _____ SIZE _____

ASME CLASS _____

YOKE ORIENTATION

⊥ TO AXIS OF PIPE ( )

// TO AXIS OF PIPE ( )

YOKE LENGTH _____
(FLANGE TO FLANGE)

MOUNTING CONDITION

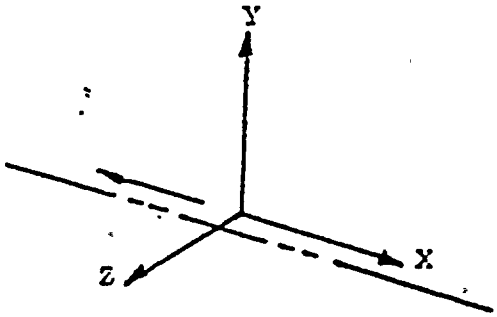
NO OF BOLTS _____

BOLT TYPE _____ BOLT Ø _____

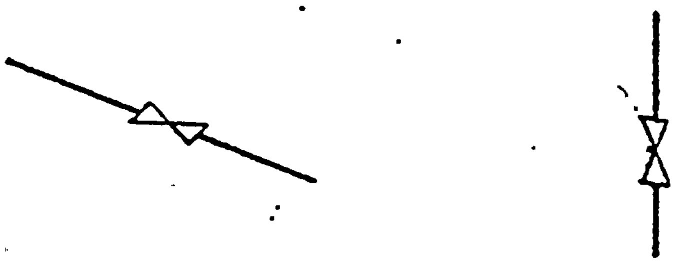
WELD TYPE & SIZE _____

PIPE MOUNTED YES ( ) NO ( )

PERMANENT OBSTRUCTION (WITHIN 2") YES ( ) NO ( )
IS COMP BETWEEN CONT & 1ST ANC (FULL 6 WAY ANC) YES ( ) NO ( )
DO MULTIPLE SUPPORTS EXIST BETWEEN CONT & COMP YES ( ) NO ( )



GLOBAL CO-ORDINATE SYSTEM



VALVE STEM ORIENTATION

OPERATOR EPN _____ | MANUFACTURER _____
MODEL NO _____ | SERIAL NO _____
TYPE _____ SIZE _____ | ORDER NO _____

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. 5.2-8

MOTOR EPN _____ | MANUFACTURER _____
MODEL NO _____ | SERIAL NO _____
ID NO _____ INS CLASS _____ | 1-PHASE ( ) 3-PHASE ( ) AC _____ DC _____

COMMENTS: Definition (N/F = Not Found)

X CSP-LMS-6

1. Not installed as of 7/21/82

△ VISUAL INSPECTION MADE 12/22/82 & IT WAS NOTED VALVE INSTALLED SEE SHEET 2 OF 2

PREPARED BY [signature] DATE 7/21/82 REVIEWED BY [signature] DATE 7/21/82
(SIGNATURE) (SIGNATURE)

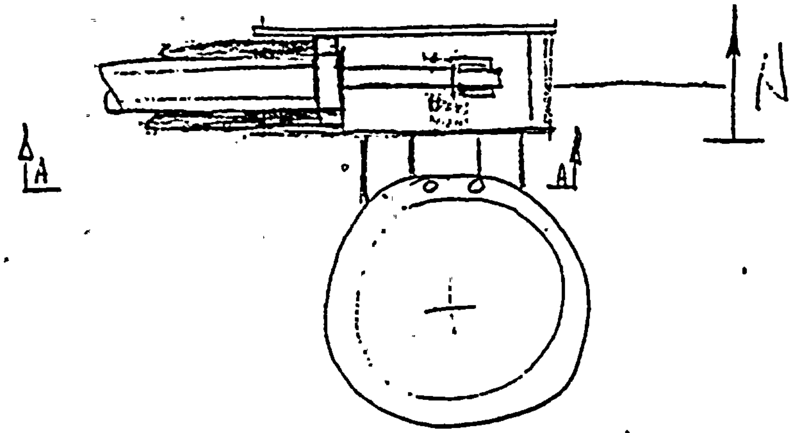
WILLIAM CONER [signature] 1/5/83 Doug True

CYGNA

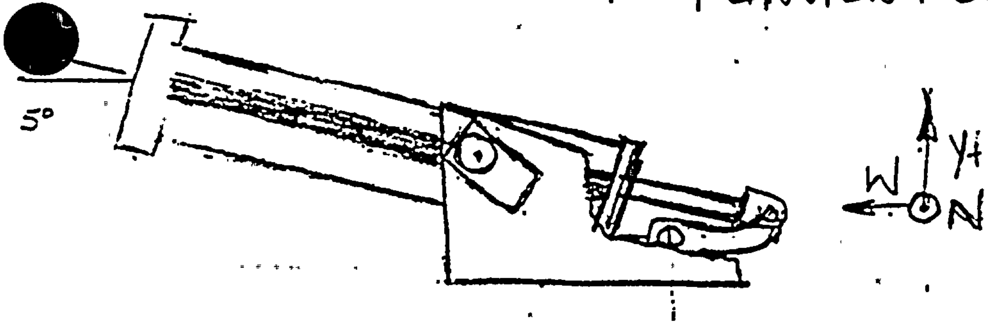
Calculation Sheet

Project: WNP#2		Prepared By: [signature]	Date: 12/22/82
Subject: EQUIP. QUALIFICATION		Checked By: [signature]	Date: 1/4/83
System: CEP/CES		Job No.: 82044	File No.
Analysis No.: QID#361106	Rev. No.	Sheet No.: 2 OF 2	

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. 5.2-9



PLAN VIEW. CSP-V-6



SECTION A-A

FIELD SKETCH (FOR THE PURPOSE OF DEPICTING OPERATOR ORIENTATION ONLY)

CYGNA

EQUIPMENT QUALIFICATION
WALKDOWN VERIFICATION FORM

EPN# CSP V-4

QID# 361106

BLDG R FLOOR EL 471 COORDS M9/5.1

MFR BIF COMPONENT EL 490 DSCRP 24" BFLY

MOD# A20765 SERIAL# ____ MAT'L ____

____ PSI @ ____ °F LBS ____ SIZE ____

ASME CLASS ____

YOKE ORIENTATION

⊥ TO AXIS OF PIPE ( )

// TO AXIS OF PIPE ( )

YOKE LENGTH ____
(FLANGE TO FLANGE)

MOUNTING CONDITION

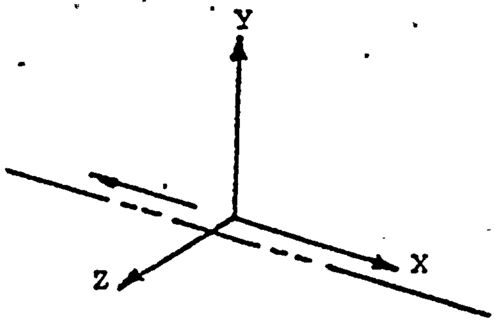
NO OF BOLTS ____

BOLT TYPE ____ BOLT Ø ____

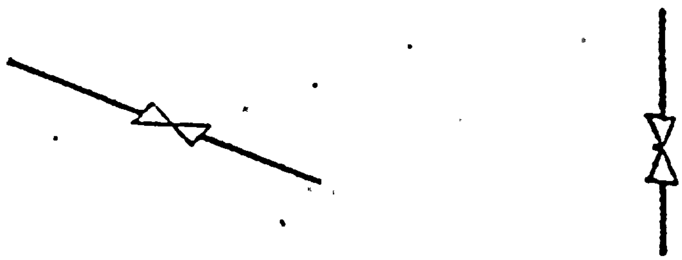
WELD TYPE & SIZE ____

PIPE MOUNTED YES ( ) NO ( )

PERMANENT OBSTRUCTION (WITHIN 2") YES ( ) NO ( )
IS COMP BETWEEN CONT & 1ST ANC (FULL 6 WAY ANC) YES ( ) NO ( )
DO MULTIPLE SUPPORTS EXIST BETWEEN CONT & COMP YES ( ) NO ( )



GLOBAL CO-ORDINATE SYSTEM



VALVE STEM ORIENTATION

OPERATOR EPN ____ MANUFACTURER ____
MODEL NO ____ SERIAL NO ____
TYPE ____ SIZE ____ ORDER NO ____

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. 5.2-10

MOTOR EPN ____ MANUFACTURER ____
MODEL NO ____ SERIAL NO ____
ID NO ____ INS CLASS ____ 1-PHASE ( ) 3-PHASE ( ) AC ____ DC ____

COMMENTS: Definition (N/F = Not Found)

Note: not installed as of 7/21/82

PREPARED BY [signature] (SIGNATURE) DATE 7/21/82 REVIEWED BY [signature] (SIGNATURE) DATE 7/21/82

William Cunha Doug True

EQUIPMENT QUALIFICATION
WALKDOWN VERIFICATION FORM

EPN# CEP-V-7A

OID# 36106

BLDG R | FLOOR EL 471 | COORDS H.5/5.4

MFR BTF | COMPONENT EL 495 | DSCRP 24. BLFY SUPP Chamber Exhaust

MOD# ~~DWG A-201764~~ 0657 | SERIAL# N27235-3 | MAT'L SA-516 GR - N/F

150 PSI @ 275 °F | LBS N/F SIZE 24"

ASME CLASS N/F

YOKE ORIENTATION

⊥ TO AXIS OF PIPE (✓)

// TO AXIS OF PIPE (✓)

YOKE LENGTH 0'-4 1/2"
(FLANGE TO FLANGE)

MOUNTING CONDITION

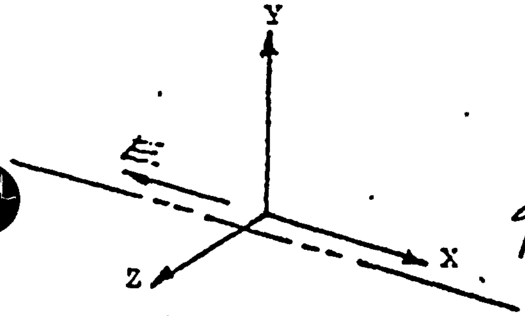
NO OF BOLTS N/A

BOLT TYPE N/A BOLT Ø N/A

WELD TYPE & SIZE N/A

PIPE MOUNTED YES (✓) NO ( )

PERMANENT OBSTRUCTION (WITHIN 2") YES ( ) NO (✓)
IS COMP BETWEEN CONT & 1ST ANC (FULL 6 WAY ANC) YES (✓) NO ( )
DO MULTIPLE SUPPORTS EXIST BETWEEN CONT & COMP YES ( ) NO (✓)



GLOBAL CO-ORDINATE SYSTEM

VALVE STEM ORIENTATION

OPERATOR EPN N/A | MANUFACTURER
MODEL NO | SERIAL NO
TYPE SIZE | ORDER NO

MOTOR EPN N/A | MANUFACTURER
MODEL NO | SERIAL NO
ID NO INS CLASS | 1-PHASE ( ) 3-PHASE ( ) AC DC

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. 5.2.11

COMMENTS: Definition (N/F = Not Found)
* CEP-LMS-3A
△ SEE SHEET 2 OF 2 FOR OPERATOR ORIENTATION

PREPARED BY William Cunha DATE 7/21/82 REVIEWED BY Doug True DATE 7/21/82
(SIGNATURE) (SIGNATURE)

WILLIAM CUNHA
△ [signature] 1/5/83

Doug True

CYGNA

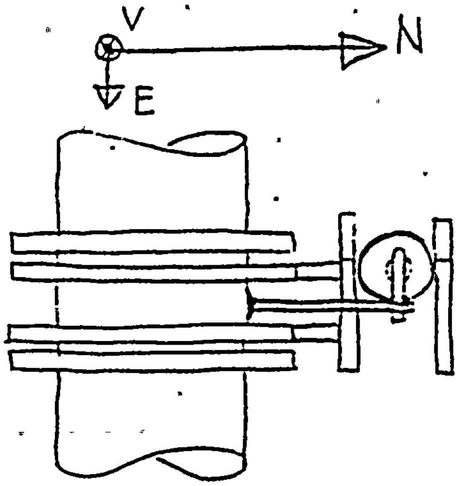
Calculation Sheet

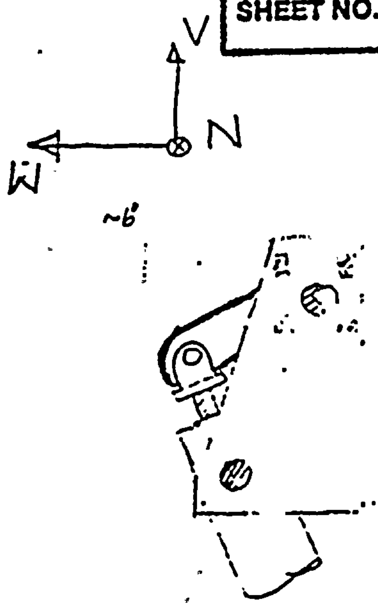
Project: WPPS MECH. E.Q.		Prepared By: J E Rakowski	Date: 12/18/82
Subject: B/F VALVE & AO		Checked By: R. E. Jirak	Date: 12/20/82
System: CSP / CEP		Job No.: 82044	File No.
Analysis No.	Rev No.	Sheet No: 2/2	

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.017F
SHEET NO. 5-2-12

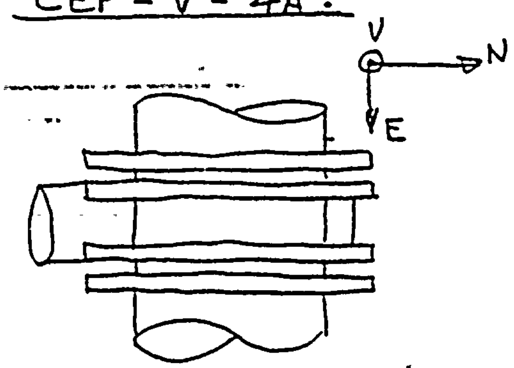
WALKDOWN
VALVE & OPERATOR ORIENTATIONS
CEP-V-3A & 4A

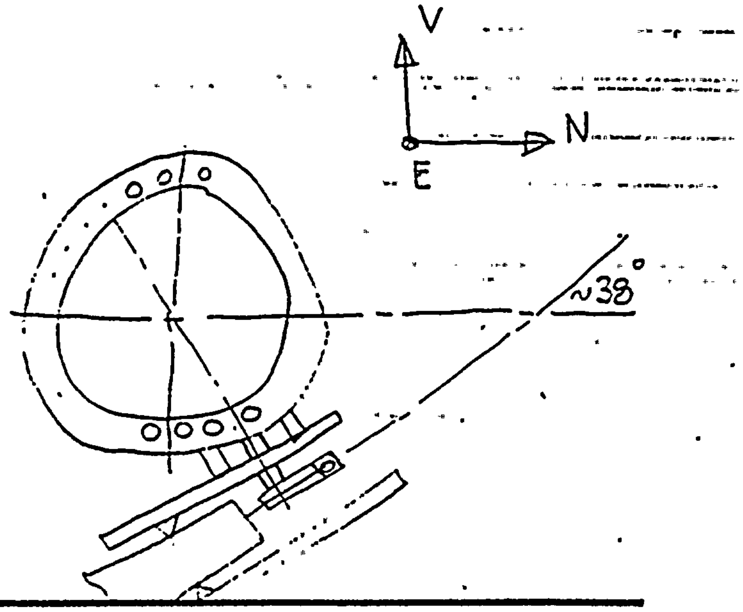
CEP-V-3A:





CEP-V-4A:





1006 CC

EQUIPMENT QUALIFICATION
WALKDOWN VERIFICATION FORM

△

EPN# CEP-V-4A

QID# 361106

COORDS K.5/5.4

BLDG R — FLOOR EL 471

MFR BIF — COMPONENT EL 495

MOD# ~~DWG A 206764~~ 0657 — SERIAL# N 27235-4

150 PSI @ 275 °F

DSCRP 24" BFLY

MAT'L SA-516 GR-N/F

LBS N/F SIZE 24"

ASME CLASS N/F

YOKE ORIENTATION

⊥ TO AXIS OF PIPE (✓)

// TO AXIS OF PIPE (✓)

YOKE LENGTH 0'-4½"
(FLANGE TO FLANGE)

MOUNTING CONDITION

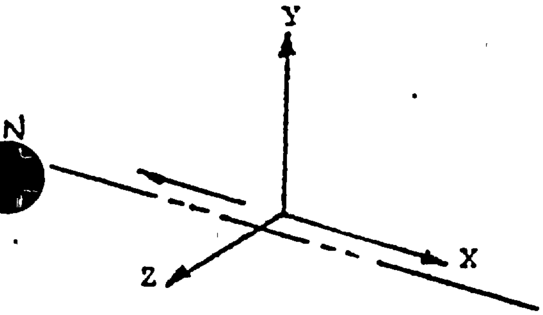
NO OF BOLTS N/A

BOLT TYPE N/A BOLT Ø N/A

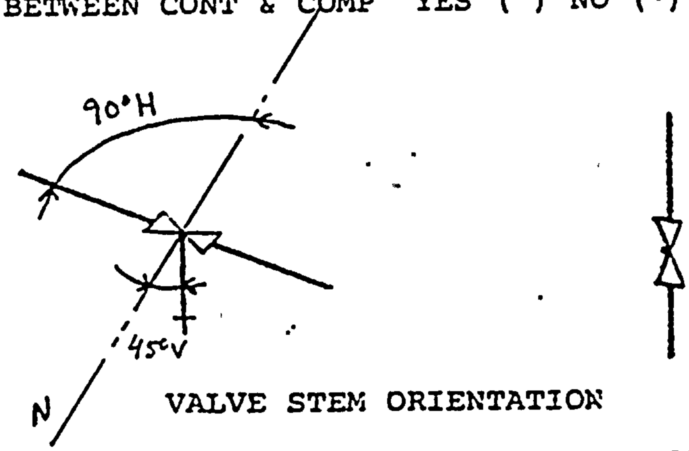
WELD TYPE & SIZE N/A

PIPE MOUNTED YES (✓) NO ( )

PERMANENT OBSTRUCTION (WITHIN 2") YES ( ) NO (✓)
IS COMP BETWEEN CONT & 1ST ANC (FULL 6 WAY ANC) YES (✓) NO ( )
DO MULTIPLE SUPPORTS EXIST BETWEEN CONT & COMP YES ( ) NO (✓)



GLOBAL CO-ORDINATE SYSTEM



VALVE STEM ORIENTATION

OPERATOR EPN N/A		MANUFACTURER	
MODEL NO		SERIAL NO	
TYPE	SIZE	ORDER NO	

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. 5.2-13

MOTOR EPN N/A		MANUFACTURER	
MODEL NO		SERIAL NO	
ID NO	INS CLASS	1-PHASE ( ) 3-PHASE ( )	AC DC

COMMENTS: Definition (N/F = Not Found)

* CEP-LMS-4A not found

△ SEE SHEET 2 OF 2 FOR OPERATOR ORIENTATION

PREPARED BY [signature] DATE 7/1/82 REVIEWED BY [signature] DATE 7/21/82
(SIGNATURE) (SIGNATURE)

WILLIAM COLLER △ [signature] 1/5/83 DOUG TRUE

CYGNA

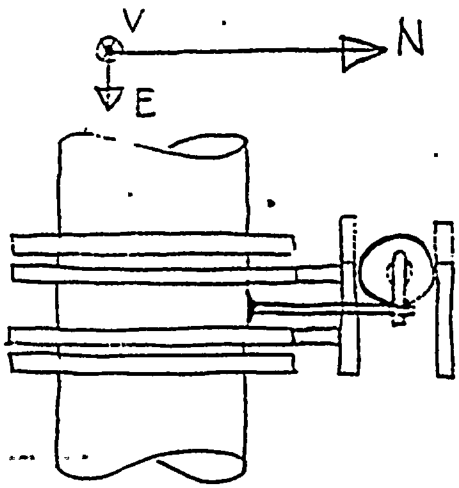
Calculation Sheet

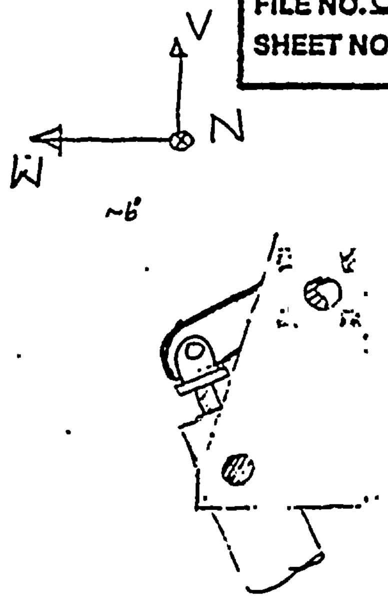
Project: WPPS MECH. E.Q.		Prepared By: J E Rakowski	Date: 12/18/82
Subject: BIF VALVE & AO		Checked By: R. E. Searle	Date: 12/20/82
System: CSP / CEP		Job No.: 82044	File No.
Analysis No	Rev. No.	Sheet No.: 2/2	

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. 5-2-14

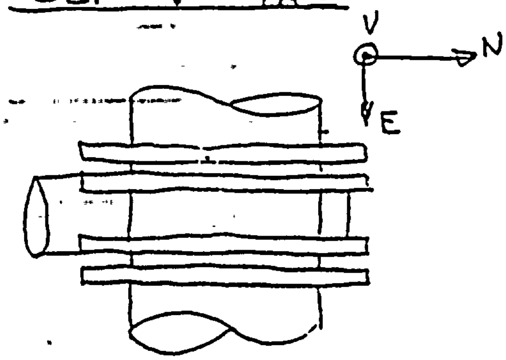
WALKDOWN
VALVE & OPERATOR ORIENTATIONS
CEP – V – 3A & 4A

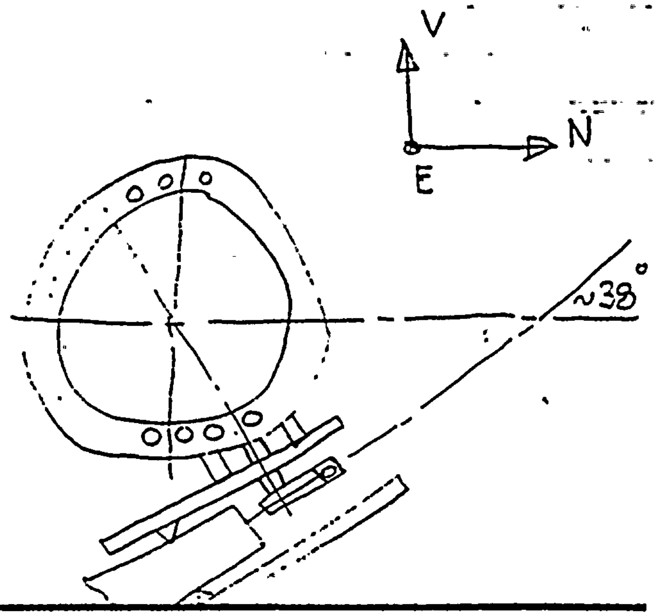
CEP – V – 3A:





CEP – V – 4A:





1006 OC

EQUIPMENT QUALIFICATION
WALKDOWN VERIFICATION FORM

EPN: CSP-V-3

LOCATION: WITHIN FIRST ANCHOR TO CONTAINMENT: YES ( ) NO ( )

BUILDING REACTOR ELEVATION 482 COORDINATES M6/7.6

2. MANUFACTURER BIF
3. MODEL NUMBER A-206765 N 27 235-1
4. SERIAL NUMBER 0657
5. DESCRIPTION 24" CYLINDER OPERATED VALVE
6. FIELD MOUNTING CONDITIONS, SKETCH MADE? ____

(✓) BOLTS, NUMBER? 20 EACH SIDE SIZE? 1¼" TYPE? HEX

( ) WELD, LENGTH ____ TYPE? ____

(✓) PIPE MOUNTED (SIZE) 24", ( ) FLOOR MOUNTED, ( ) WALL MOUNTED

( ) RACK, (DESCRIBE: NUMBER & LOCATION IF APPLICABLE)

( ) OTHER (SEE SKETCH)

7. ADJACENT EQUIPMENT: IMPACT POSSIBLE? ____

(PIPES, SUPPORTS, STRUCTURE ETC.) (DESCRIBE)

8. RIGID CONDUIT ENTRANCE LOCATION? (DESCRIBE)

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 5.2.15

9. MOTOR:

MODEL NUMBER ____

SERIAL NUMBER ____

INSULATION CLASS ____

✗ PARTIALLY INSTALLED 8-25/81

SIGNATURE DATE

EQUIPMENT QUALIFICATION
WALKDOWN VERIFICATION FORM

EPN: CSP-V-4

1. LOCATION: WITHIN FIRST ANCHOR TO CONTAINMENT: YES ( ) NO ( )

BUILDING REACTOR ELEVATION 479 COORDINATES M6/7.6

2. MANUFACTURER BIF

3. MODEL NUMBER A-206765 27235-2

4. SERIAL NUMBER 0657

5. DESCRIPTION 24" CYLINDER OPERATED VALVE

6. FIELD MOUNTING CONDITIONS, SKETCH MADE? ____

(✓) BOLTS, NUMBER? ______ SIZE? ______ TYPE? ______

( ) WELD, LENGTH ______ TYPE? ______

(✓) PIPE MOUNTED (SIZE) ______, ( ) FLOOR MOUNTED, ( ) WALL MOUNTED

( ) RACK, (DESCRIBE: NUMBER & LOCATION IF APPLICABLE)

( ) OTHER (SEE SKETCH)

7. ADJACENT EQUIPMENT: IMPACT POSSIBLE? ______

(PIPES, SUPPORTS, STRUCTURE ETC.) (DESCRIBE)

8. RIGID CONDUIT ENTRANCE LOCATION? (DESCRIBE)

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 5.2.16

9. MOTOR:

MODEL NUMBER ______

SERIAL NUMBER ______

INSULATION CLASS ______

* PARTIALLY INSTALLED 8.25/81

SIGNATURE DATE

EQUIPMENT QUALIFICATION
WALKDOWN VERIFICATION FORM

EPN: CSP-V.-5

LOCATION: WITHIN FIRST ANCHOR TO CONTAINMENT: YES ( ) NO ( )

BUILDING REACTOR ELEVATION 473 COORDINATES M6/7.7

2. MANUFACTURER BIF

3. MODEL NUMBER A-206765

4. SERIAL NUMBER 27236-1

5. DESCRIPTION 24" CYLINDER OPERATED VALVE

6. FIELD MOUNTING CONDITIONS, SKETCH MADE? ____

(✓) BOLTS, NUMBER?________ SIZE?________ TYPE?________

( ) WELD, LENGTH________ TYPE?________

(✓) PIPE MOUNTED (SIZE)______, ( ) FLOOR MOUNTED, ( ) WALL MOUNTED

( ) RACK, (DESCRIBE: NUMBER & LOCATION IF APPLICABLE)

( ) OTHER (SEE SKETCH)

7. ADJACENT EQUIPMENT: IMPACT POSSIBLE?________

(PIPES, SUPPORTS, STRUCTURE ETC.) (DESCRIBE)

8. RIGID CONDUIT ENTRANCE LOCATION? (DESCRIBE)

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 52-17

9. MOTOR:

MODEL NUMBER________

SERIAL NUMBER________

INSULATION CLASS________

PARTIALLY INSTALLED

SIGNATURE DATE

EQUIPMENT QUALIFICATION
WALKDOWN VERIFICATION FORM

EPN: CSP-V-6 N.F. Not Located Assumed Not Installed

1. LOCATION: WITHIN FIRST ANCHOR TO CONTAINMENT: YES ( ) NO ( )

BUILDING REACTOR ELEVATION 488 COORDINATES 46/6.1

2. MANUFACTURER BIF

3. MODEL NUMBER A-206765

4. SERIAL NUMBER

5. DESCRIPTION 24" CYLINDER OPERATED VALVE

6. FIELD MOUNTING CONDITIONS, SKETCH MADE? ____

( ) BOLTS, NUMBER? ______ SIZE? ______ TYPE? ______

( ) WELD, LENGTH ______ TYPE? ______

( ) PIPE MOUNTED (SIZE) ______, ( ) FLOOR MOUNTED, ( ) WALL MOUNTED

( ) RACK, (DESCRIBE: NUMBER & LOCATION IF APPLICABLE)

( ) OTHER (SEE SKETCH)

7. ADJACENT EQUIPMENT: IMPACT POSSIBLE? ______

(PIPES, SUPPORTS, STRUCTURE ETC.) (DESCRIBE)

8. RIGID CONDUIT ENTRANCE LOCATION? (DESCRIBE)

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 5.2.18

9. MOTOR:

MODEL NUMBER ______

SERIAL NUMBER ______

INSULATION CLASS ______

SIGNATURE DATE

EQUIPMENT QUALIFICATION
WALKDOWN VERIFICATION FORM

EPN: CSP-V-9 *Not Installed*

LOCATION: WITHIN FIRST ANCHOR TO CONTAINMENT: YES ( ) NO ( )

BUILDING REACTOR ELEVATION 491 COORDINATES ______

2. MANUFACTURER BIF
3. MODEL NUMBER A-206765
4. SERIAL NUMBER ______
5. DESCRIPTION 24" CYLINDER OPERATED VALVE
6. FIELD MOUNTING CONDITIONS, SKETCH MADE? ____

( ) BOLTS, NUMBER? ______ SIZE? ______ TYPE? ______

( ) WELD, LENGTH ______ TYPE? ______

( ) PIPE MOUNTED (SIZE) ____, ( ) FLOOR MOUNTED, ( ) WALL MOUNTED

( ) RACK, (DESCRIBE: NUMBER & LOCATION IF APPLICABLE)

( ) OTHER (SEE SKETCH)

7. ADJACENT EQUIPMENT: IMPACT POSSIBLE? ______

(PIPES, SUPPORTS, STRUCTURE ETC.) (DESCRIBE)

8. RIGID CONDUIT ENTRANCE LOCATION? (DESCRIBE)

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 01.01.F
SHEET NO. 5.2.19

9. MOTOR:

MODEL NUMBER ______

SERIAL NUMBER ______

INSULATION CLASS ______

SIGNATURE DATE

EQUIPMENT QUALIFICATION
WALKDOWN VERIFICATION FORM

EPN: CEP-V-3A

1. LOCATION: WITHIN FIRST ANCHOR TO CONTAINMENT: YES ( ) NO (✓)

BUILDING ~~[illegible]~~ REACTOR ELEVATION 491 COORDINATES H/5/5.6

2. MANUFACTURER BIF

3. MODEL NUMBER ~~A-206765~~ N27235-3

4. SERIAL NUMBER 0657

5. DESCRIPTION 24" CYLINDER OPERATED VALVE

6. FIELD MOUNTING CONDITIONS, SKETCH MADE? ____

FLANGE (✓) BOLTS, NUMBER? 20 EACH SIDE SIZE? 1 1/4" TYPE? HEX

( ) WELD, LENGTH ____ TYPE? ____

(✓) PIPE MOUNTED (SIZE) 24", ( ) FLOOR MOUNTED, ( ) WALL MOUNTED

( ) RACK, (DESCRIBE: NUMBER & LOCATION IF APPLICABLE)

( ) OTHER (SEE SKETCH)

7. ADJACENT EQUIPMENT: IMPACT POSSIBLE? ____

(PIPES, SUPPORTS, STRUCTURE ETC.) (DESCRIBE)

8. RIGID CONDUIT ENTRANCE LOCATION? (DESCRIBE)

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 5.2.20

9. MOTOR:

MODEL NUMBER ____

SERIAL NUMBER ____

INSULATION CLASS ____

SIGNATURE M. Andersen DATE 8-25-81

EQUIPMENT QUALIFICATION
WALKDOWN VERIFICATION FORM

1. EPN: CEP-V-4A

LOCATION: WITHIN FIRST ANCHOR TO CONTAINMENT: YES ( ) NO (✓)

BUILDING ~~[illegible]~~ REACTOR ELEVATION 491 COORDINATES H6/5.7

2. MANUFACTURER BIF

3. MODEL NUMBER ~~A-206765~~ N27235-4

4. SERIAL NUMBER 0657

5. DESCRIPTION 24" CYLINDER OPERATED VALVE

6. FIELD MOUNTING CONDITIONS, SKETCH MADE? YES

FLANGE (✓) BOLTS, NUMBER? 20 EACH SIDE SIZE? 1 1/4" TYPE? HEX

(~~[illegible]~~) WELD, LENGTH ~~[illegible]~~ TYPE?

(✓) PIPE MOUNTED (SIZE) 24", ( ) FLOOR MOUNTED, ( ) WALL MOUNTED

( ) RACK, (DESCRIBE: NUMBER & LOCATION IF APPLICABLE)

(✓) OTHER (SEE SKETCH)

7. ADJACENT EQUIPMENT: IMPACT POSSIBLE?

(PIPES, SUPPORTS, STRUCTURE ETC.) (DESCRIBE)

8. RIGID CONDUIT ENTRANCE LOCATION? (DESCRIBE)

* electrical not connected
** valve not tightened down yet

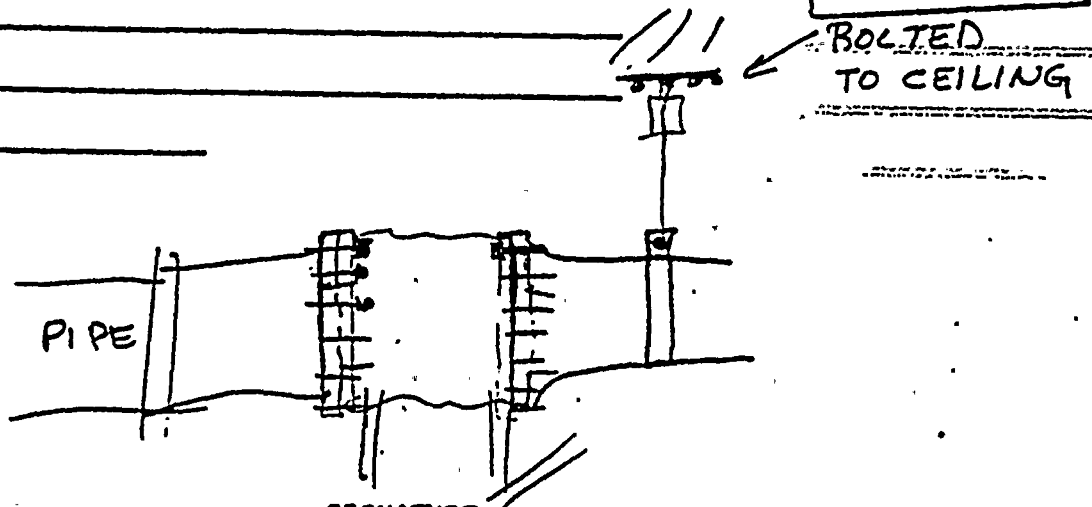
CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. 5.2.21

9. MOTOR:

MODEL NUMBER

SERIAL NUMBER

INSULATION CLASS



SIGNATURE DATE

5.3 Valve Local Coordinate Systems

CSP-V-3

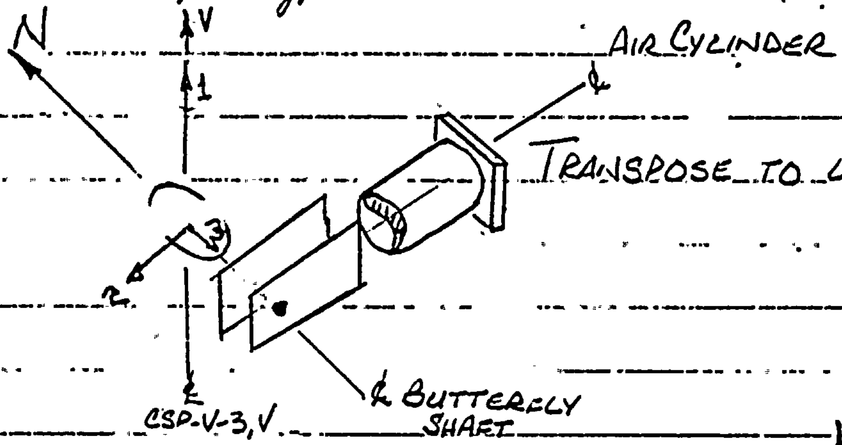
CSP-V-4

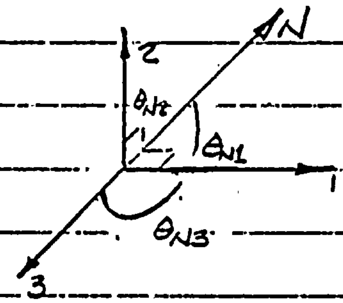
CSP-V-5

CSP-V-6

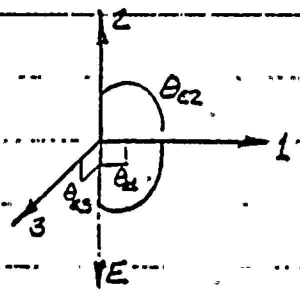
PREPARED BY: D. Searle 2/11/83
REVIEWED BY: J E Rolowski 2/11/83

CSP-V-3,4 (typical)

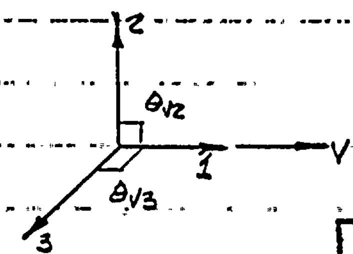




$\theta_{N1} = 90°$ ✓ $\cos\theta_{N1} = 0$ ✓
$\theta_{N2} = 90°$ ✓ $\cos\theta_{N2} = 0$ ✓
$\theta_{N3} = 180°$ ✓ $\cos\theta_{N3} = -1$



$\theta_{E1} = 90°$ $\cos\theta_{E1} = 0$
$\theta_{E2} = 180°$ $\cos\theta_{E2} = -1$
$\theta_{E3} = 90°$ $\cos\theta_{E3} = 0$

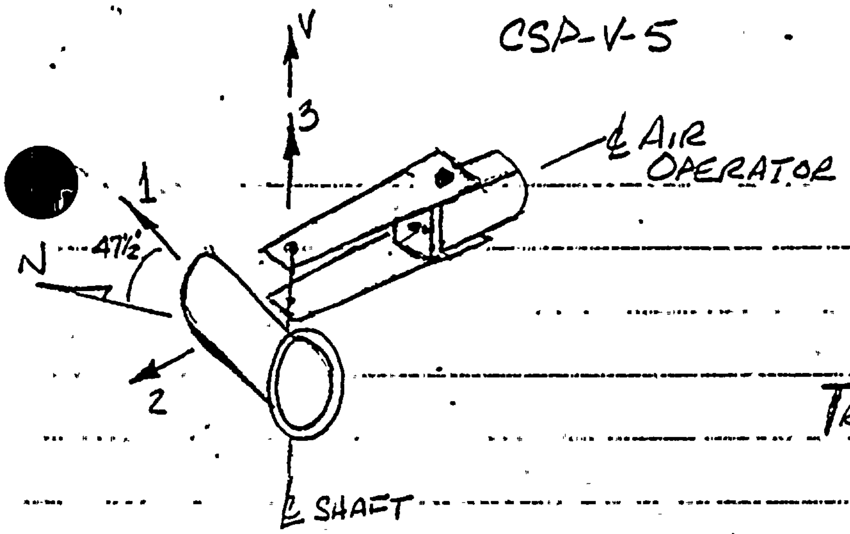


$\theta_{V1} = 0°$ $\cos\theta_{V1} = 1$
$\theta_{V2} = 90°$ $\cos\theta_{V2} = 0$
$\theta_{V3} = 90°$ $\cos\theta_{V3} = 0$

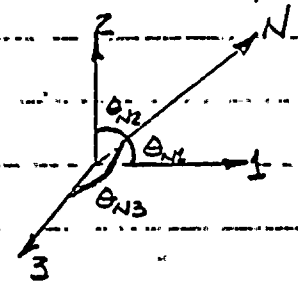
CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. 5.3-1

CSP-V-5

PREPARED BY: D. Searle 2/11/83
REVIEWED BY: D E Rakowski 2/11/83



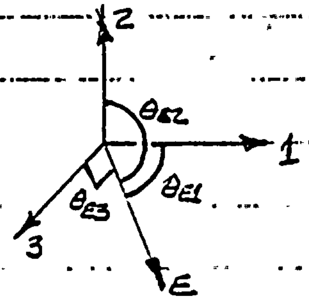
TRANSPOSE TO LOCAL COORDINATE SYSTEM



$\theta_{N1} = 42½°$ $\cos\theta_{N1} = 0.737$

$\theta_{N2} = 47½°$ $\cos\theta_{N2} = 0.676$

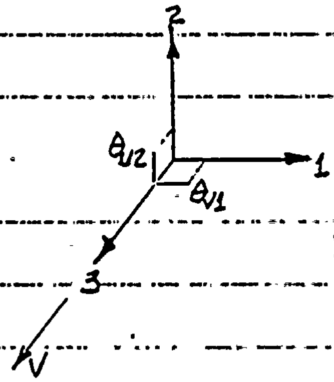
$\theta_{N3} = 90°$ $\cos\theta_{N3} = 0$



$\theta_{E1} = 47½°$ $\cos\theta_{E1} = 0.676$

$\theta_{E2} = 137½°$ $\cos\theta_{E2} = -0.737$

$\theta_{E3} = 90°$ $\cos\theta_{E3} = 0$



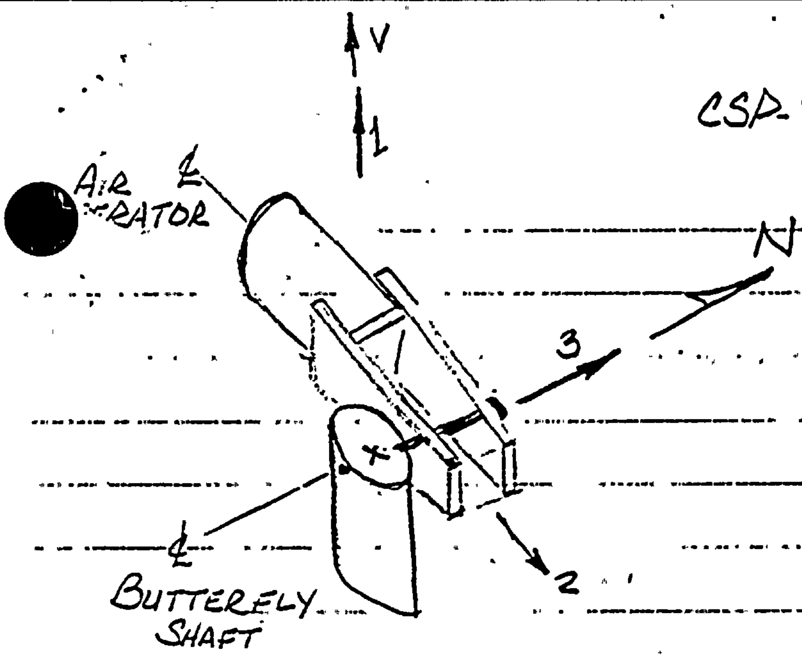
$\theta_{V1} = 90°$ $\cos\theta_{V1} = 0$

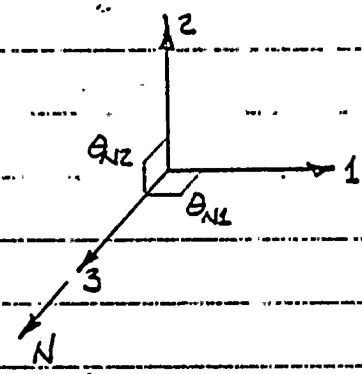
$\theta_{V2} = 90°$ $\cos\theta_{V2} = 0$

$\theta_{V3} = 0°$ $\cos\theta_{V3} = 1$

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 01.01/F
SHEET NO. 5.3-2

CSP-V-6 PREPARED BY: [signature] 2/11/83
REVIEWED BY: [signature] 2/11/83

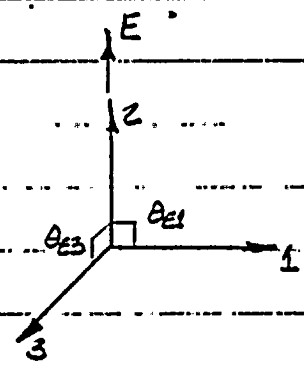




$\theta_{N1} = 90°$ $\cos\theta_{N1} = 0$

$\theta_{N2} = 90°$ $\cos\theta_{N2} = 0$

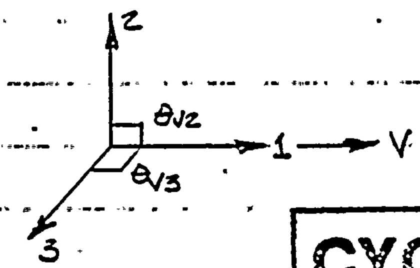
$\theta_{N3} = 0°$ $\cos\theta_{N3} = 1$



$\theta_{E1} = 90°$ $\cos\theta_{E1} = 0$

$\theta_{E2} = 0°$ $\cos\theta_{E2} = 1$

$\theta_{E3} = 90°$ $\cos\theta_{E3} = 0$



$\theta_{V1} = 0°$ $\cos\theta_{V1} = 1$

$\theta_{V2} = 90°$ $\cos\theta_{V2} = 0$

$\theta_{V3} = 90°$ $\cos\theta_{V3} = 0$

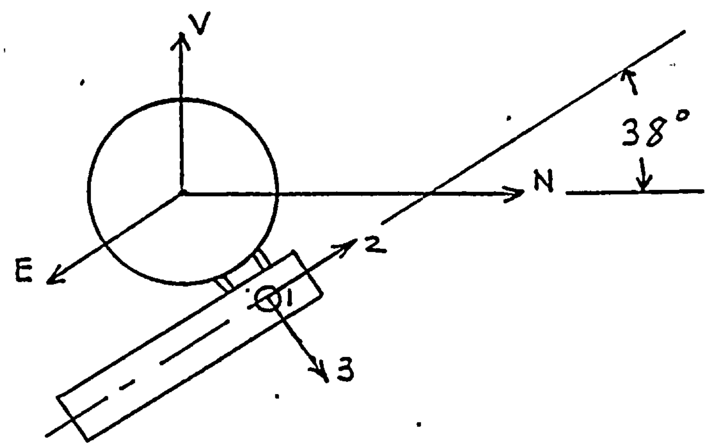
CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT:01/F
SHEET NO. 5.3-3

CYGNA

Calculation Sheet

Project: WPPSS EQ		Prepared By: J E Rakowski	Date: 2/15/83
Subject: BIF VALUES / MILLER A/O		Checked By: D. Searle	Date: 2/15/83
System: CEP		Job No.: 82044	File No.: OT.01/F
Analysis No.: 361106	Rev. No.: 0	Sheet No.:	

CEP-V-4A



ANGLES

	(1-AXIS)	(2-AXIS)	(3-AXIS)
NORTH	90	-38	52
VERTICAL	90	52	142
EAST	180	90	90
WEIGHT	90	-128	-38

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01/F
SHEET NO. 5.3-4

5.4 SRM Sheets

user number 43. date/time 02/10/83 09:08

function NEX -SRM MASTER EQUIPMENT LIST-

EPN	COMPOSITE EPN
2-CSP-V-3	2-CSP-V-3+

CONTRACT	MFG	MODEL	SERIAL NUMBER
68	B250	DWG A-206764	N27235-1

DESCRIPTION

24" BFLY CONTAINMENT ISOL VALVE

LEVEL	EC	USE	HOURS	SAFETY FUNCTION	ACCURACY
2	A	2 3	4320	B1, F	

A/E DRAWING	AE ZONE	BLDG	ELEV	DETAIL	ZONE	ROOM
M543	D5	R	481	M. 6/7. 6	R43	

HL	SEIS. TEST	QUAL ANL	F/O	C	ENV. AGING	QUAL DBE	C	QUAL SEIS	STATUS ENV	TM	FREQ	QID
~~N~~ Y		01		9				~~C~~ A		P	10	361106

MESSAGE

CYGNA

PROJECT WPPSS, WNP-2

TITLE Summary Sheets

PREPARED BY: L.C. FERNANDEZ

DATE 6/9/83

CHECKED BY: [signature]

DATE 6/9/83

JOB NO. 82044

FILE NO. 07.01.F

SHEET NO. 5.4.1

user number 43 date/time 02/10/83 09:08

function NEX -SRM MASTER EQUIPMENT LIST-

EPN	COMPOSITE EPN
2-CSP-V-4	2-CSP-V-4+

CONTRACT	MFG	MODEL	SERIAL NUMBER
68	B250	DWG A-206764	272-35-2

DESCRIPTION
24" BFLY CONTAINMENT ISOL VALVE

LEVEL	EC	USE	HOURS	SAFETY FUNCTION	ACCURACY
2	A	2 3	4320	B1, F	

A/E DRAWING	AE ZONE	BLDG	ELEV	DETAIL	ZONE	ROOM
M543	C5	R	478	7.6/M.6	R33	

HL	SEIS. TEST	QUAL ANL	F/O	C	ENV. AGING	QUAL DBE	C	QUAL SEIS	STATUS ENV	TM	FREQ	QID
~~N~~ Y		01		9				~~C~~ A		P	10	361106

MESSAGE

CYGNA
PROJECT WPPSS, WNP-2
TITLE Summary Sheets
PREPARED BY: L.C. FERNANDEZ
DATE 6/9/83
CHECKED BY: [signature]
DATE 6/9/83
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. S.4.2

user number 43 date/time 02/10/83 09:08

-function NEX -SRM MASTER EQUIPMENT LIST-

EPN	COMPOSITE EPN
2-CSP-V-5	2-CSP-V-5+

CONTRACT	MFG	MODEL	SERIAL NUMBER
68	B250	DWG A-206764	27236-1

DESCRIPTION

24" BFLY CONTAINMENT ISOL VALVE

LEVEL	EC	USE	HOURS	SAFETY FUNCTION	ACCURACY
2	A	1 3	4320	B1,F	

A/E DRAWING	AE ZONE	BLDG	ELEV	DETAIL	ZONE	ROOM
M543	C5	R	475	M.7/8.3	R33	

HL	SEIS. QUAL TEST	ANL	F/O	C	ENV. AGING	QUAL DBE	C	QUAL SEIS	STATUS ENV	TM	FREQ	GID
~~N~~ Y		01		9				~~C~~ A		P	10	361106

MESSAGE

CYGNA
PROJECT WPPSS, WNP-2
TITLE Summary Sheets
PREPARED BY: L.C. FERNANDEZ
DATE 6/9/83
CHECKED BY: [signature]
DATE 6/9/83
JOB NO. 82044
FILE NO. 01.01.F
SHEET NO. 5.4.3

user number 43 date/time 02/10/83 09:08

function NEX -SRM MASTER EQUIPMENT LIST-

EPN	COMPOSITE EPN
2-CSP-V-6	2-CSP-V-6+

CONTRACT	MFG	MODEL	SERIAL NUMBER
68	B250	DWG A-206765	

DESCRIPTION

24" BFLY CONTAINMENT ISOL VALVE

LEVEL	EC	USE	HOURS	SAFETY FUNCTION	ACCURACY
2	A	1 3	4320	B1,F	

A/E DRAWING	AE ZONE	BLDG	ELEV	DETAIL	ZONE	ROOM
M543	B14	R	480	N.5/7.7	R32	

HL	SEIS. QUAL TEST	ANL	F/O	C	ENV. AGING	QUAL DBE	C	QUAL SEIS	STATUS ENV	TM	FREQ	GID
~~N~~ Y		01		9				~~Q~~ A		P	10	361106

MESSAGE

CYGNA

PROJECT WPPSS WNP-2

TITLE Summary Sheets

PREPARED BY: L.C. FERNANDEZ

DATE 6/9/83

CHECKED BY: [signature]

DATE 6/9/83

JOB NO. 82044

FILE NO. 07.01.E

SHEET NO. 5.4.4

user number 43 date/time 02/10/83 09:10

function FIN -SRM MASTER EQUIPMENT LIST-

EPN	COMPOSITE EPN
2-CSP-V-9	2-CSP-V-9+

CONTRACT	MFG	MODEL	SERIAL NUMBER
68	B250	DWG A-206764	

DESCRIPTION

24"BFLY VAC RELIEF TO SUPP CHAMB

LEVEL	EC	USE	HOURS	SAFETY FUNCTION	ACCURACY
2	A	1 3	4320	B1, F	

A/E DRAWING	AE ZONE	BLDG	ELEV	DETAIL	ZONE	ROOM
M543	C6	R	490	M, 9/5.1	R33	

HL	SEIS. QUAL TEST	SEIS. QUAL ANL	F/O	C	ENV. AGING	QUAL DBE	C	QUAL STATUS SEIS	QUAL STATUS ENV	TM	FREQ	QID
Y		01		9				~~C~~ A		P	10	361106

MESSAGE

CYGNA
PROJECT WPPSS WNP-2
TITLE Summary Sheets
PREPARED BY: L.C. FERNANDEZ
DATE 6/9/83
CHECKED BY: [signature]
DATE 6/3/83
JOB NO. 82044
FILE NO. 07.01.7
SHEET NO. 5.4.5

user number 43 date/time 02/10/83 09:13

function FIN -SRM MASTER EQUIPMENT LIST-

EPN	COMPOSITE EPN
2-CEP-V-3A	2-CEP-V-3A+

CONTRACT	MFG	MODEL	SERIAL NUMBER
2	B250	DWG A-206764	N27235-3

DESCRIPTION

24" AO BLFY SUPP. CHAMBER EXHAUST

LEVEL	EC	USE	HOURS	SAFETY FUNCTION	ACCURACY
2	A	1 3	4320	B1, F	

A/E DRAWING	AE ZONE	BLDG	ELEV	DETAIL	ZONE	ROOM
M543	C14	R	495	H. 5/5. 4	R32	

HL	SEIS. TEST	QUAL ANL	F/O	C	ENV. AGING	QUAL DBE	C	QUAL SEIS	STATUS ENV	TM	FREQ	QID
Y		01		9				A		P	10	361106

MESSAGE

CYGNA
PROJECT WPPSS WNP-2
TITLE Summary Sheets
PREPARED BY: L.C. FERNANDEZ
DATE 6/9/83
CHECKED BY: [signature]
DATE 6/8/83
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 5.4.6

user number 43 date/time 02/10/83 09:13

function FIN -SRM MASTER EQUIPMENT LIST-

EPN	COMPOSITE EPN
2-CEP-V-4A	2-CEP-V-4A+

CONTRACT	MFG	MODEL	SERIAL NUMBER
2	B250	DWG A-206764	N27235-4

DESCRIPTION

24" AO BFLY SUPP. CHAMBER EXHAUST

LEVEL	EC	USE	HOURS	SAFETY FUNCTION	ACCURACY
2	A	1 3	4320	B1; F	

A/E DRAWING	AE ZONE	BLDG	ELEV	DETAIL	ZONE	ROOM
M543	C14	R	495	H. 5/5. 4	R32	

HL	SEIS. QUAL TEST	ANL	F/O	C	ENV. AGING	QUAL DBE	C	QUAL SEIS	STATUS ENV	TM	FREQ	QID
Y ~~N~~		01		9				A		P	10	361106

MESSAGE

CYGNA

PROJECT WPPSS, WNP-2

TITLE Summary Sheets

PREPARED BY: L. C. FERNANDEZ

DATE 6/9/83

CHECKED BY [signature]

DATE 6/9/85

JOB NO. 82044

FILE NO. 07.01.F

SHEET NO. 5.4.7

5.5 Final Pipe-Mounted Equipment Response G-Levels

MAY 11 1983

RECEIVED

MAY 31 1983

CYGNA-RICHLAND

Subject: W. O. 3900/4000
Washington Public Power Supply System
WNP-2
Qualification of Mechanical Pipe
Mounted Equipment; Forwarding of
Information

April 29, 1983
BRWP-83-078

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 5.5.1

Mr. L. T. Harrold
Assistant Director
Washington Public Power Supply System
3000 George Washington Way
Richland, Washington 99352

Attention: Mr. B. A. Holmberg

References: (a) WPBR-83-17, dated 3/16/83.
(b) WPBR-83-28, dated 4/12/83.
(c) WPBR-83-29, dated 4/12/83.
(d) Telecopy, B. A. Holmberg to J. J. Verderber, dated 4/4/83.

Gentlemen:

In response to the request of references (a), (b), (c) and (d), this letter is forwarding refined valve accelerations. The valve acceleration sheets for the five (5) CSP valves represent the second iteration of the refinement task. Valve sheets for the other four (4) valves represent the first iteration of the refinement task. Please inform the Woodbury Office if efforts should be made to reduce accelerations further.

Very truly yours,

ORIGINAL SIGNED BY J. J. VERDERBER

John J. Verderber
Project Engineering Manager

JJV/BPM/es
Att.

CC: Mr. W. S. Chin - BPA - 1 w/1
Mr. J. R. Rhodes - WPPSS - 1 w/1
Mr. F. Buck - WPPSS - 1 w/1 Mail Drop 575

ATTACHMENT

Data forwarded with BRWP-83-078, dated April 29, 1983

Valve #	Anchor Group	Calc. No.
CSP-V-1	125	8.14.129
CSP-V-2	125	8.14.129
CSP-V-3	125	8.14.129
CSP-V-4	125	8.14.129
CSP-V-5	125	8.14.129
RCIC-V-31	107	8.14.112A
RHR-V-17B	31	8.14.121
RHR-V-53A	29	8.14.62C
RHR-V-53B	31	8.14.121B

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 5.5.2

W.O. No. 3900-10 Date 4/12/83 Book No. 8,14,129 Page No. ___
Drawing No. M200 Sh.172 Rev. 3A Calc. No. 8,14,129 Sheet ___ of ___
By PS Checked ___ Approved ___
Title WNP-2 Status As-Built Verification of Piping Calculation

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F1
SHEET NO. 5.5.3

CSP-V-3 Valve Qualification

B&R File No. Dwg 68-00-0009 Operation I.D. No. ________

B&R M200 Iso No. 172 Anchor Group 125

VALVE ACCELERATIONS

Location	Nodal Pt. No.	Mass Wt. (lb.)	Condition	Accelerations (g) X	Y	Z	Comments
Valve Operator (Bracket)	86	277	Upset	0.72	-1.37	0.70	
			Emergency	2.48	1.77	1.14	
			Faulted	2.66	2.81	1.53	
Valve Operator (Cylinder)	95	399	Upset	1.23	1.86	0.96	
			Emergency	1.80	2.30	3.62	
			Faulted	2.04	3.17	3.76	

BURNS AND ROE, INC.

W.O. No. 3900-10 Date 4/12/83 Book No. 8, 14, 129 Page No. ___ Sheet ___ of ___

Drawing No. M200 Sh. 172 Rev 31 Calc. No. 3.14.129

By PS Checked ___ Approved ___

Title WNP-2 Status As-Built Verification of Piping Calculation

CYGNA ATTACHMENT
JOB NO. 83044
FILE NO. DT.01.F1
SHEET NO. 5.54

CSP-V-4 Valve Qualification

B&R File No. Dwg. 68-00-0009 Operation I.D. No. ______

B&R M200 Iso No. 172 Anchor Group 125

VALVE ACCELERATIONS

Location	Nodal Pt. No.	Mass Wt. (lb.)	Condition	Accelerations (g) X	Y	Z	Comments
Valve Operator (Bracket)	103	277	Upset	1.01	1.40	0.85	
			Emergency	3.10	1.97	1.71	
			Faulted	3.25	2.94	1.99	
Valve Operator (Cylinder)	111	399	Upset	1.14	1.49	1.50	
			Emergency	1.60	1.87	4.07	
			Faulted	1.87	2.87	4.19	

BURNS AND ROE, INC.

W.O. No. 3900-10 Date 4/12/83 Calc. No. C.7. Book No. 8.14.129 Page No. ___ Sheet ___ of ___
Drawing No. M201 Sh. 172 Rev. 3A 8.14.129
By P.S. Checked ___ Approved ___
Title WNP-2 Status As-Built Verification of Piping Calculation

CYGNA ATTACHMENT
JOB NO. 84042
FILE NO. 07.01.F
SHEET NO. 55.5

CSP-V-5 Valve Qualification

B&R File No. Dwg 68:00-0010 Operation I.D. No. ________

B&R M200 Iso No. 172 Anchor Group 125

VALVE ACCELERATIONS

Location	Nodal Pt. No.	Mass Wt. (lb.)	Condition	Accelerations (g) X	Y	Z	Comments
Valve Operator (Bracket)	128	277	Upset	0.95	1.31	-1.71	
			Emergency	2.80	1.82	-5.32	
			Faulted	2.96	2.84	-5.42	
Valve Operator (Cylinder)	132	399	Upset	0.97	1.54	1.60	
			Emergency	1.29	2.77	-2.34	
			Faulted	1.62	3.52	2.55	

BURNS AND ROE, INC.

W.O. No. 3900-10 Date 3/31/83 Book No. 8.14.125 Page No. ____
Drawing No. M200 Sh. 168 Rev 24 Calc. No. 8.14.125 Sheet ____ of ____
By PS Checked GT Approved
Title WNP-2 Status As-Built Verification of Piping Calculation

CSP-V-6 Valve Qualification

B&R File No. ________ Operation I.D. No. ________

B&R M200 Iso No. 168 Anchor Group V23

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 1.P.01.F
SHEET NO. 5.5.6

VALVE ACCELERATIONS

Location	Nodal Pt. No.	Mass Wt. (lb.)	Condition	Accelarations X	Y	Z	Comments
Valve Operator (Bracket)	74	277	Upset	2.69	1.24	0.38	
			Emergency	11.37	1.50	0.55	
			Faulted	11.39	1.78	0.75	
Valve Operator (Cylinder)	71	399	Upset	2.33	3.09	1.48	
			Emergency	2.49	3.18	5.83	
			Faulted	2.55	3.33	5.85	

Form BR 8002-2

CEP-V-3A Valve Qualification

B&R File No. ______ Operation I.D. No. ______

B&R M200 Iso No. 168 Anchor Group 123

VALVE ACCELERATIONS

Location	Nodal Pt. No.	Mass Wt. (lb.)	Condition	Accelarations (g)			Comments
				X	Y	Z	
Valve Body	21	847	Upset	0.90	0.70	0.51	
			Emergency	3.06	0.78	0.74	
			Faulted	3.10	1.25	0.90	
Valve Operator	24	626	Upset	1.20	0.74	0.41	
			Emergency	4.54	0.81	0.69	
			Faulted	4.57	1.26	0.86	

BURNS AND ROE, INC.

W.O. No. 3900-10 Date 3/31/23 Book No. 8.14.125 Page No. ___
Drawing No. M200 Sh. 168 Rev 2A Calc. No. 8.14.125 Sheet ___ of ___
By [illegible] Checked [illegible] Approved ___
Title WNP-2 Status As-Built Verification of Piping Calculation

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 1P01IF
SHEET NO. 551

Form BR 8002-2

BURNS AND ROE, INC.

W.O. No. 3900-10 Date 3/31/83 Book No. 2.14.125 Page No. ___ Sheet ___ of ___
Drawing No. M200 Sh. 168 Rev 2A Calc. No. 2.14.125
By ___ Checked CT Approved ___
Title WNP-2 Status As-Built Verification of Piping Calculation

CYCLA ATTACHMENT
JOB NO. 82044
FILE NO. 1P01F
SHEET NO. 55.8

CEP-V-4A Valve Qualification

B&R File No. ______ Operation I.D. No. ______

B&R M200 Iso No. 168 Anchor Group 12.3

VALVE ACCELERATIONS

Location	Nodal Pt. No.	Mass Wt. (lb.)	Condition	Accelarations (g)			Comments
				X	Y	Z	
Valve Body	31	847	Upset	1.05	0.84	0.51	
			Emergency	3.66	0.90	0.73	
			Faulted	3.71	1.33	0.89	
Valve Operator	34	626	Upset	0.94	0.89	0.40	
			Emergency	3.31	0.93	0.69	
			Faulted	3.35	1.34	0.86	

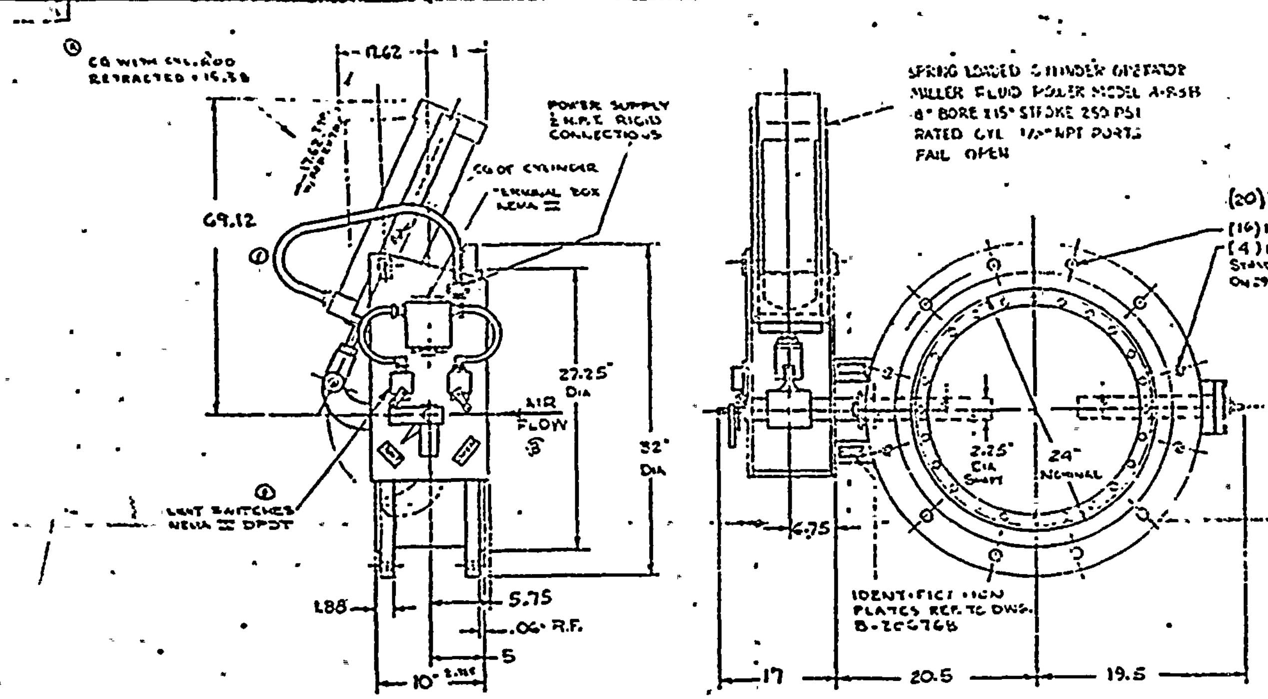
Form BR 8002-2

6.0 DRAWINGS USED FOR REQUALIFICATION

QID# 361106

DRAWINGS SUBMITTED TO SUPPLY SYSTEM
IN ORIGINAL PACKAGE

Johnson Controls	
D-220-0310-IR-64	Rev 0
Flick-Reedy Corp	
C-26096	Rev 0
BIF	
D-207110-H	Rev B
D-207110-G	Rev A
A-206767	Rev C
Bovee & Crail	
CSP-807-8.10	Rev 4
CSP-809-1.2	Rev 4
CEP-625-3.4	Rev 6
CEP-625-1.2	Rev 3



VERTICAL AIR FLOW CSP-V-6
HORIZONTAL AIR FLOW CSP-V-5 & CSP-V-9

6. VALVE TO BE DESIGNED, FABRICATED, TESTED AND STAMPED IN ACCORDANCE WITH THE REQUIREMENTS OF THE ASME BOILER AND PRESSURE VESSEL CODE, SECTION III, SUBSECTION NC FOR CLASS 2 NUCLEAR COMPONENTS.

5. FLOW DIRECTION IS AS SHOWN, HOWEVER FLOW IS ALLOWED IN EITHER DIRECTION.

4. TOTAL WEIGHT 1473 LBS.

3. ASSEMBLED VALVE SHALL BE HYDROSTATICALLY TESTED IN ACCORDANCE WITH [illegible]-3.

2. ASSEMBLED VALVE SHALL BE [illegible] PERFORMANCE TESTED IN ACCORDANCE WITH [illegible]

1. WALL THICKNESS TESTS SHALL BE IN ACCORDANCE WITH [illegible]

NOTES: UNLESS OTHERWISE [illegible]

24" PRIMARY CONTAINMENT VACUUM RELIEF ISOLATION VALVES
TAG: CSP-V-5, CSP-V-6, CSP-V-9 -(3) REQ'D

PRC APERTURE CARD

68

KS /PG 3/4/80

00.0010

02-69-00 13

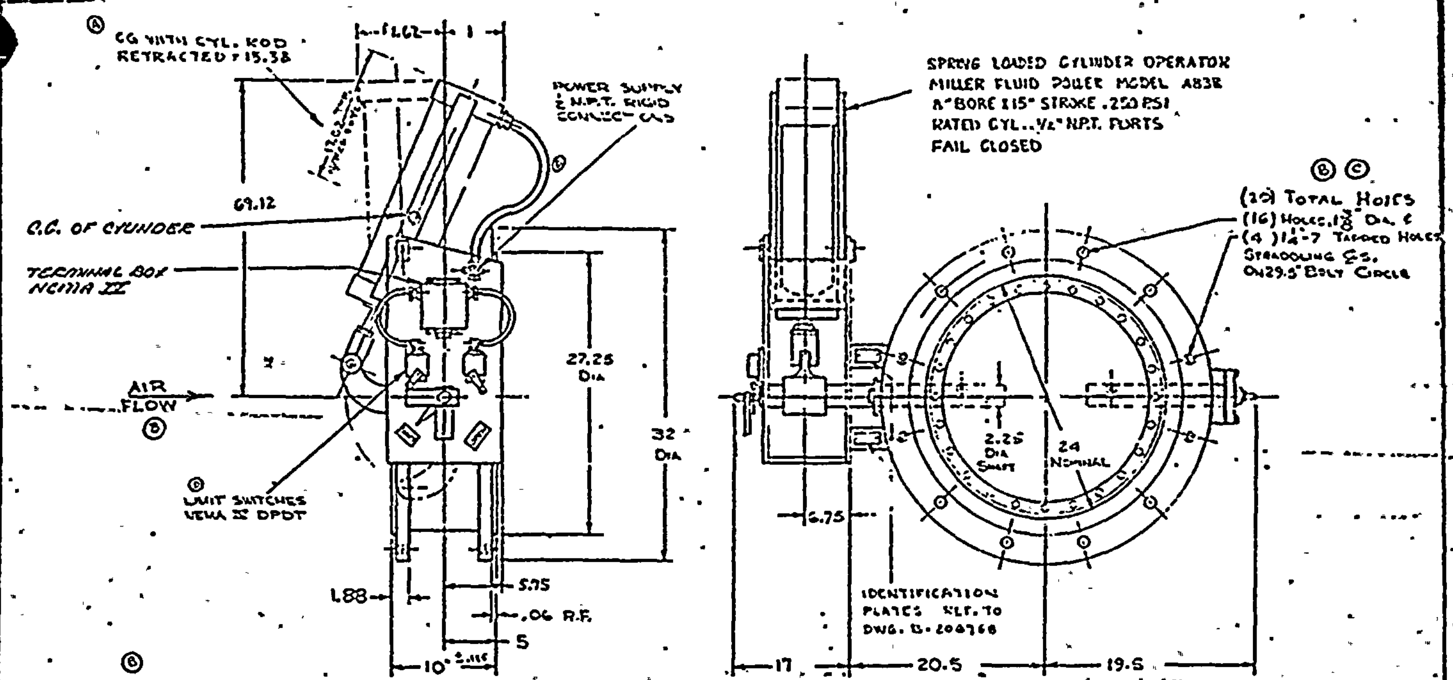
WASHINGTON PUBLIC POWER SUPPLY SYSTEM [illegible]

B-206765

Received 7-14-83
SHD 36106
CYGNA RBS

8312300162 -01

[illegible]



HORIZONTAL AIR FLOW-CEP-V-3A & 4A
VERTICAL AIR FLOW-CEP-V-3 & 4

6. VALVES TO BE DESIGNED FABRICATED, TESTED AND STAMPED IN ACCORDANCE WITH THE REQUIREMENTS OF ASME BOILER AND PRESSURE VESSEL CODE, SECTION III, SUBSECTION NC FOR CLASS 2 NUCLEAR COMPONENTS.
5. FLOW DIRECTION IS AS SHOWN, HOWEVER FLOW IS ALLOWED IN EITHER DIRECTION
4. TOTAL WEIGHT = 1473 LBS
3. ASSEMBLED VALVE SHALL BE HYDROSTATICALLY TESTED IN ACCORDANCE WITH GFM-305-HT-3
2. ASSEMBLED VALVE SHALL BE LEAK AND PERFORMANCE TESTED IN ACCORDANCE WITH SP-305-3
1. WALL THICKNESS TESTS SHALL BE IN ACCORDANCE WITH D 206000

NOTES: UNLESS OTHERWISE SPECIFIED

24" PRIMARY CONTAINMENT BUTTERFLY ISOLATION VALVES (4) REQ'D
TAG: CEP-V-3, CEP-V-4, CEP-V-3A, CEP-V-4A

PRC APERTURE CARD

KS/PG 3/4/80

02-68-00 | 12 | 3

68 00 0009

WPPSS NUCLEAR PROJECT NO. 2
WASHINGTON PUBLIC POWER SUPPLY SYSTEM

A-206764

Received 6-11-82
36106

General Arrangement
8"x15" Cylinder
Size 24" Class 2

8312300162-02

7.0 PRIOR CALCULATIONS USED FOR REQUALIFICATION

QID# 361106

7.0 TRANSMITTAL, PRIOR CALCULATIONS AND REPORTS

CONTENTS

Revision 3

CYGNA

QID# 361106

7.1 Communication Reports & Correspondence

CYGNA

Communications Report

Company: CES ☒ Telecon ☐ Conference Report

Project: WPPSS EQ

Job No.

Date: Below

Subject: BIF VALVE DIMENSIONS

Time: Below

Place: RBO

Participants:

Jim Foley of CES - BAO

Rick Ricoppito 401-885-1000 of BIF

Jim Rokowski of CES - BAO

Item	Comments	Req'd Action By
	2/10/83 – J. Foley / J. Rokowski	
	BIF VALVE FLANGE DIMENSIONS	
	24": thickness 1.78" 30": 2.125"	
	i.d. 25" 31"	
	o.d. 32" 38.75"	
	BOLTS: 1 3/8" (20) 1 3/8" (28)	
	2/11/83 – Rick Ricoppito / J. Rokowski	
	Radial Clearance of 24" & 30" valves.	
	— approx 1/8 inch —	

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 7.1.1

Signed: Page of

Distribution:

1020.00

Washington Public Power Supply System
P.O. Box 968 3000 George Washington Way Richland, Washington 99352 (509) 372-5000

December 17, 1982
GE-02-RWH-82-018

Cygna Energy Services
141 Battery Street
Suite 400
San Francisco, CA 94111

Attention: Mr. T. Wittig, Project Manager

Subject: NUCLEAR PROJECT 2
CONTRACT C-0892

Investigation of the CSB and CEB systems shows that during a dynamic event the systems are not degraded in any way by the butterfly valves fluttering. Therefore, all work on Work Release Nos. 14 and 17 which address valve stability should be terminated.

RWHickman

R. W. Hickman - 575
Senior Engineer,
Equipment Qualification

RWH/sms

cc: F. Khanachet, Cygna Richland

CYGNA

Hsieh

Communications Report

CR-030

Company: CES	☒ Telecon	☐ Conference Report	
Project: WPPSS		Job No.	82044
		Date:	7/29/82
Subject: QID 361110 - 18" BUTTERFLY VALVE		Time:	9:40 A.M.
		Place:	SDAO

Participants:

Dick Hickman of Supply System

Hal Reeser of CES, SDAO

of

Item	Comments	Req'd Action By
	I called Dick re. dynamic instability of BIF valve while in open position. I also requested permission to contact GE re. use of faulted or upset allowables for RHR valves.	
	o Dick said we should complete the requalification analysis of the valves and flag the dynamic instability issue as a separate subject that will require Supply System action for resolution.	
	o Supply System has granted a contract to BIF for operability studies on their valves. The contract admistrator at BIF is John McDonald (401/885-1000). Our action should be to determine the scope of the BIF study and to make certain that we do not overlap our efforts with theirs. Also we should attempt to assure that our work does not conflict with the BIF effort.	H. Abolhoda
	o Dick said we may contact GE direct. Our contact at GE for the decision on faulted or upset allowables is: Arlan DeVault (408/925-2208).	M. Rajan*
	*ACTION: Rajan, this resolution should be documented via revised criteria in our Project Manual.	

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. 7.1.3

HR/sak HR

Signed: H. Reeser Page 1 of 1

Distribution: T. Wittig, H. Abolhoda, F. Khanachet, P. Guglielmo, B. Schlafer, M. Rajan, J. Minichiello, P. Patel, Project Files (SD), (SF), (RB)

1020.00

CYGNA

Communications Report

CR-027

Company: CES ☒ Telecon ☐ Conference Report

Project: WPPSS

Job No. 82046

Date: 7/20/82

Subject: APPLICABILITY OF HYDRODYNAMIC LOADS

Time: P.M.

Place: SDAO

Participants:

W. Schlafer of CES, SDAO

H. Reeser of CES, RBO

of

Item	Comments	Req'd Action By
1.	The Hydrodynamic Load Column in the WPPSS SRM list is known to have errors. A "no" listing is not to be trusted.	
2.	For packages in analysis Cygna will trace down the P & ID to determine the applicability of hydrodynamic loads to line mounted equipment.	
3.	To accomplish this, Cygna will:	
	a. Check the line routing to see if it penetrates the primary containment. If not, hydrodynamic loads do not apply.	
	b. If the line penetrates the primary containment, hydrodynamic loads will apply unless:	
	1. An anchor point appears first in that line, or	
	2. The line first connects with floor mounted equipment outside the primary containment and it is sufficiently sturdy to eliminate the propagation of pipe line hydrodynamic loads beyond it.	
4.	If a line mounted equipment fails to qualify due to hydrodynamic loads, estimate it's fragility level. This information will be used by WPPSS when they receive the B & R final piping analysis and examine actual pipe accelerations.	

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. 7.1.4

WS/sak

Signed: W. Schlafer HReese

Page 1 of 2.

Distribution: L. Kammerzell, J. Read, P. Guglielmino, J. Minichiello, P. Patel, M. Rajan, H. Abolhoda, [redacted] P. Curry, H. Reeser, T. Wittig, F. Khanachet

1020.00

CYGNA

Communications Report

CR-027

Company: CES	☒ Telecon	☐ Conference Report
Project: WPPSS		Job No.
		Date:
Subject: APPLICABILITY OF HYDRODYNAMIC LOADS		Time:
		Place:

Participants:

of

of

of

Item	Comments	Req'd Action By
5.	For packages whose analysis is complete and where hydrodynamic loads were not considered because the SRM said "No": a. Review the line as in 3 (first page of this telecon). b. If we feel hydrodynamic loads really do apply, send a memo to the S. S. indicating the package may need rework. c. Send memo to F. Khanachet requesting supply system concurrence that hydro loads do apply and added analysis is required.	

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. DT.01.F
SHEET NO. 7.1.5

Signed: W. Schlafer Page 2 of 2

Distribution:

1020.00

CYGNA

Communications Report

CR-023

Company: CES ☒ Telecon ☐ Conference Report

Project: WPPSS

Job No. 82046

Date: July 20, 1982

Subject: Hydrodynamic Loads

Time: 9 A.M.

Place: San Diego

Participants:

J. Minnachiello of SFAO

P. K. Patel of SDAO

of

Item	Comments	Req'd Action By
	During the conversation we discussed the following:	
1.	If attenuation data on hydrodynamic loads are not available, one does not have any choice but to take into account hydrodynamic loads on all line mounted equipments.	
2.	One should use 1.5X peak acceleration unless the system frequency (line plus equipment) indicates otherwise.	
3.	If the equipment satisfies the allowable stress limits, then one should perform fatigue analysis using the fatigue design curves given for Class 1 components. To calculate the fatigue damage for normal operation (excluding all dynamic events) one might take a conservative approach by assuming the calculated stresses are equal to the allowable stress limits.	

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 7.1.6

Signed: P. K. Patel Page 1 of 1

Distribution: H. Reeser, [redacted] Rajan, H. Abolhoda, P. Curry

1020.00

HSIEH COPY

BIF

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 1.1.1

RECEIVED
JUL 13 1982
CYGNA - SAN ...

July 7, 1982

Sygna Energy Service
225 Stevens Street
Solana Beach, CA 92075

Attention: Mr. "Bill" Schlafer

Subject: Butterfly Valves for Nuclear Applications with IEEE Qualification Requirements

Dear Sir:

This information is provided in response to your recent phone call.

1. Enclosed please find some catalog information describing BIF's line of butterfly valves, including our current models as well as our new Model 0668 design (which will shortly replace our 0652 and 0658 models).

2. The following are our best estimates for budget purposes only of what it would cost to replace the valves and operators originally furnished to WPPSS in the 1970's (which did not require IEEE qualifications) with valves and operators that are fully qualified to IEEE-382-1972, IEEE-323-1971 and IEEE-344-1975.

   It is almost impossible to obtain prices from IEEE qualified actuator vendors without a detailed specification showing exactly what is required; therefore, these are our best guestimates of what the replacements would cost. They could be high or low by 10 to 20%, depending upon the wording used in the engineer's resultant specification.

   Replacements for Valves Furnished Originally on N-27232

   14 - 18" BV's with electric operators (See NODS - 11/1/79) — $40,000 ea. if qty. = 1 or $25,000 ea. if qty. = 14

   Replacements for Valves Furnished Originally on N-27233

   2 - 18" BV's with spring to open cylinder operators — $60,000 ea. if qty. = 1 or $45,000 ea. if qty. = 2

1600 DIVISION ROAD • WEST WARWICK, RI 02893 • BOX 217 • 401-885-1000
CABLE: BIFWRWKRI • TWX 710-382-0402 • TELEX 927-631

Replacements for Valves Furnished Originally on N-27234

4 - 30" BV's with spring to close cylinder operators — $75,000 ea. if qty. = 1 or $60,000 ea. if qty. = 4

Replacements for Valves Furnished Originally on N-27235

4 - 24" BV's with spring to close cylinder operators — $60,000 ea. if qty. = 1 or $50,000 ea. if qty. = 4

Replacements for Valves Furnished Originally on N-27236

3 - 24" BV's with spring to open cylinder operators — $60,000 ea. if qty. = 1 or $50,000 ea. if qty. = 3

We trust that this information will be of some help to you, and are sorry that our prices cannot be more precise.

Sincerely,

George E. Sayer

George E. Sayer
BV Sales Applications Engineer

Enclosures: 650.20-4
BPD-668-45-1
BPD-668-1
NODS-11/1/79

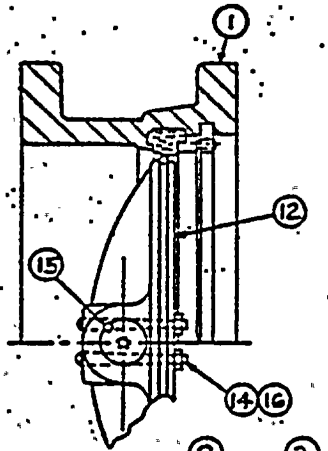
CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 7.1.8

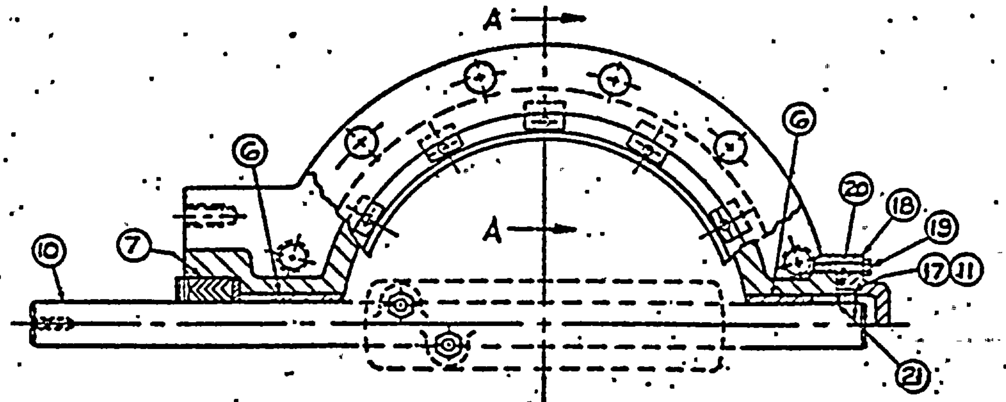
BIF

A UNIT OF GENERAL SIGNAL CORPORATION

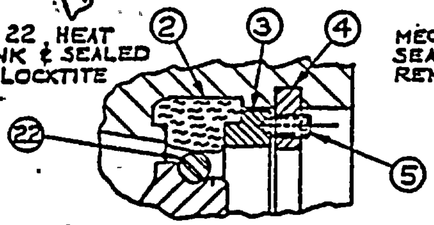
BUTTERFLY VALVES MODEL 668
12"-24" THRU SHAFT

PARTS





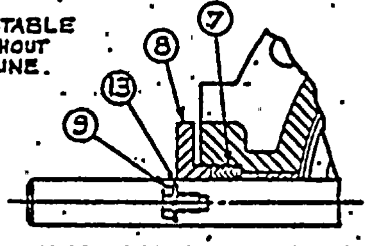
ITEM 22 HEAT SHRUNK & SEALED WITH LOCKTITE



SECTION A-A

MECHANICALLY RETAINED ADJUSTABLE SEAT, FIELD REPLACEABLE WITHOUT REMOVING VALVE FROM PIPE LINE.

ITEM 5 SECURED WITH NYLOK INSERT



ALTERNATE ADJUSTABLE VEE PACKING

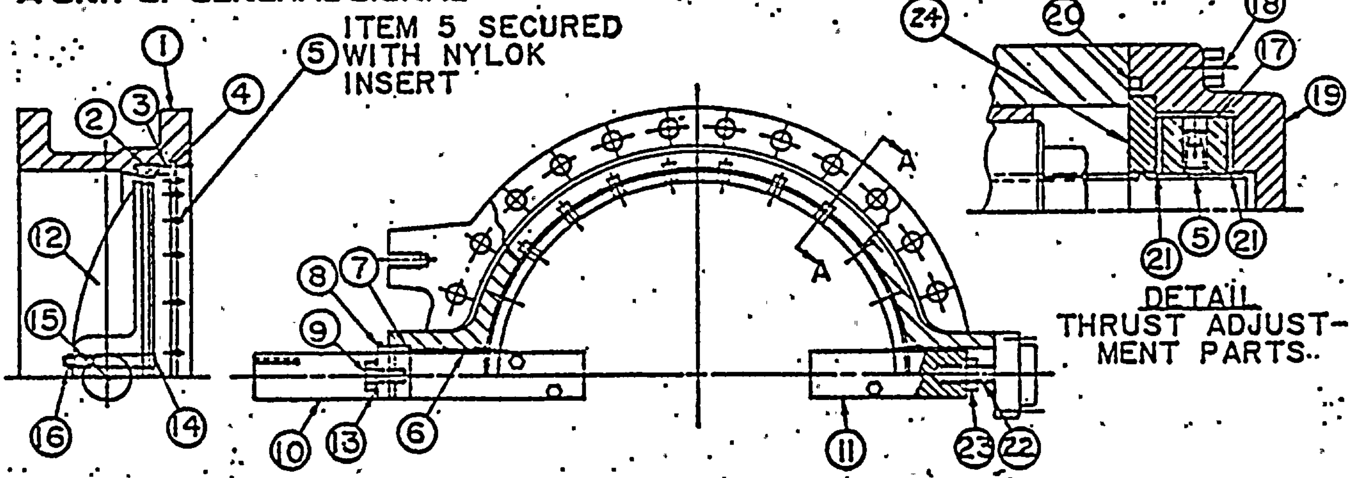
ITEM	MATERIAL	MATERIAL
1	VALVE BODY	CAST IRON ASTM A126 CL B
2	RUBBER SEAT	BUNA-N ASTM D2000
3	CLAMPING RING	TYPE 304 ST. ST'L
4	CLAMPING RING LOCK	TYPE 304 ST. ST'L
5	HALF DOG POINT SET SCREW	TYPE 304 ST. ST'L
6	SHAFT BEARING	REINFORCED TEFLON BRZ OR PHENOLIC BACKED
7	STUFFING BOX PACKING	VEE PACKING , BUNA-N
8	STUFFING BOX GLAND	CAST BRONZE ASTM B62
9	HEX HEAD CAP SCREW	TYPE 304 ST. ST'L
10	OPERATOR SHAFT	TYPE 304 ST. ST'L
11	HALF DOG POINT SET SCREW	TYPE 304 ST. ST'L
12	VALVE DISC	CAST IRON ASTM A48 CL40 OR DUCTILE IRON ASTM A536 GR. 65-45-12
13	WASHER	TYPE 18-8 ST.ST'L
14	DISC PIN	TYPE 304 ST.ST'L
15	KEY	ST'L
16	HEX NUT	TYPE 304 ST. ST'L
17	THRUST COLLAR	TYPE 303 ST. ST'L
18	THRUST BEARING COVER	CAST IRON ASTM A126 CL B
19	HEX HEAD CAP SCREW	TYPE 304 ST. ST'L
20	O-RING	BUNA-N
21	THRUST BEARING	REINFORCED TEFLON, ~~PHENOLIC BACKED~~
22	DISC SEATING RING	TYPE 316 ST. ST'L

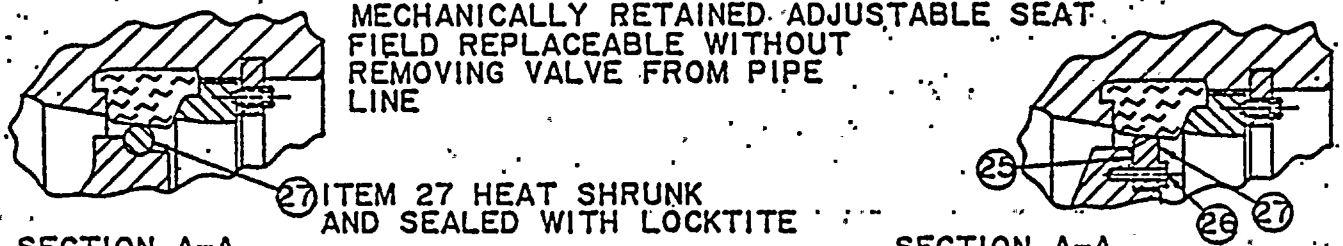
CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. DT.01.P
SHEET NO. 7.1.9

7-6-82

BIF
A UNIT OF GENERAL SIGNAL

AWWA BUTTERFLY VALVES
MODEL 0668 30" THRU 120"
PARTS





SECTION A-A
(FOR 30" THRU 48" B.V)

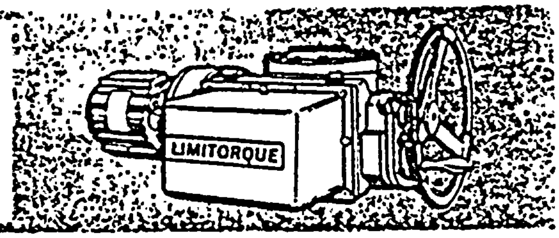
SECTION A-A
(FOR 54" THRU 120" B.V.)

ITEM	MATERIAL	MATERIAL
1	VALVE BODY	CAST IRON ASTM A126 CL B
2	RUBBER SEAT	BUNA-N ASTM D2000
3	CLAMPING RING	TYPE 304 ST. ST'L
4	CLAMPING RING LOCK	TYPE 304 ST. ST'L
5	HALF DOG POINT SET SCREW	TYPE 304 ST. ST'L
6	SHAFT BEARING	REINFORCED TEFLON BRZ OR PHENOLIC BACKED
7	STUFFING BOX PACKING	VEE PACKING, BUNA-N
8	STUFFING BOX GLAND	CAST BRONZE ASTM B62
9	HEX HEAD CAP SCREW	TYPE 304 ST. ST'L
10	OPERATOR SHAFT	TYPE 304 ST. ST'L
11	STUB SHAFT	TYPE 304 ST. ST'L
12	VALVE DISC	CAST IRON ASTM A48 CL40 OR DUCTILE IRON ASTM A536 GR. 65-45-12
13	WASHER	TYPE 18-8 ST.ST'L
14	DISC PIN	TYPE 304 ST.ST'L
15	KEY	ST'L
16	HEX NUT	TYPE 304 ST. ST'L
17	THRUST COLLAR	TYPE 303 ST. ST'L
18	THRUST BEARING COVER	CAST IRON ASTM A126 CL B
19	HEX HEAD CAP SCREW	TYPE 304 ST. ST'L
20	O-RING	BUNA-N
21	THRUST BEARING	PEINFORCED TEFLON, PHENOLIC BACKED
22	THRUST ADJUSTING SCREW	TYPE 304 ST. ST'L
23	JAM NUT	TYPE 304 ST. ST'L
24	THRUST BEARING PLATE	STEEL ASTM A36
25	SEAL	SILICONE RUBBER
26	HEX HEAD CAP SCREW	TYPE 304 ST. ST'L
27	SEATING EDGE	TYPE 316 ST.ST'L

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.P
SHEET NO. 7.1.10

1-13-82

LIMITORQUE VALVE CONTROLS



LIMITORQUE CORPORATION • P. O. BOX 11318 • LYNCHBURG, VIRGINIA 24506

IEEE 323 (1974) and IEEE 382 (1972)
NUCLEAR QUALIFICATION DATA
FOR SAFETY RELATED SERVICE

	THREE PHASE ONLY		D.C.
	Nuclear Containment (See Option 8 Price Adders)	Outside Containment (Standard Prices)††	Containment—Inside or Outside (See Option 8 Price Adders)
Design Life	40 years (2000 cycles)*	40 years (2000 cycles)*	40 years (2000 cycles)*
Ambient Temperature (Continuous)	140°F	120°F	120°F
Ambient Humidity	60-100%	30-100%	30-100%
Aging	Motor Stator only 180°C for 100 hours	Entire Unit 165°F for 200 hours at 100% relative humidity	Motor Armature, Field Coils, & Brush Box only 180°C for 100 hours
Total Radiation (40 yrs. integrated)	2.04×10^8 rads	2×10^7 rads	1.0×10^7 rads
Seismic Ref: IEEE344	**6.0 g's (SMB/SB) ***3.0 g's (SMB/HBC) ****6.0 g's (SMB/HBC)	** 6.0 g's (SMB/SB) *** 3.0 g's (SMB/HBC) **** 6.0 g's (SMB/HBC)	†6.0 g's (SMB/SB) ***3.0 g's (SMB/HBC) ****6.0 g's (SMB/HBC)
'umber of transients	2	2	1
Transient Temperature	340°F (BWR) 300°F (PWR)	250°F	340°F
Test Humidity	100% (saturated)	100% (saturated)	100% (saturated)
Profile	PWR/IEEE382-73, Page 12, Table 1 BWR/IEEE382-73, Page 12, Table 2	ANSI (yet to be published)	Special
Length of Test	30 Days	15 Days	25 Hours
Completed Test Date	PWR—September 1974 (600456) BWR—September 1972 (6000376)	February 1975 (600461)	October 31, 1975 (B0009)

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. 7.1.11

*During BWR test, 500 cycles were used as a design life per IEEE382.

During PWR test, 2000 cycles were used as a design life of which 500 were incorporated prior to test and 1500 after test.

During test for outside containment, 200 cycles were incorporated while the actuators were being aged, and 1800 were added prior to irradiating.

During D.C. test, all 2000 cycles were incorporated prior to irradiating.

**As of 7/26/75, seismic tests were completed to IEEE344-1975 for both SMB and SB units to 6.0 g's vertical and 3.2 g's horizontal. Since no cross coupling was noted between axes, the test qualifies the SMB/SB to 6.0 g's in both vertical and horizontal axis. Maximum g-level dwells in each of the three axes qualify the units for any mounting position. (Seismic Qualification Report No. B0021). Qualification extends through 35 Hz.

††Standard Class "B" insulated motors only.

**Standard units without spur attachments.

****Standard units with seismic support bracket and without spur attachments.

NOTE: SMC-04 and SMC-05 actuators are qualified for "Outside Containment" service per above levels based on their similarity to the SMB actuator.

Communications Report

CYGNA

Company:	CES	☒ Telecon	☐ Conference Report
Project:	WPPSS	Job No.	82046/CR-019
		Date:	7/1/82
Subject:	Hydrodynamic Loads for Line Mounted Equipment	Time:	11:20 a.m.
		Place:	SDAO

Participants:

Bruce Linderman & Don Harkness of Bechtel, Norwalk, CA

W. Schlafer of CES, SDAO

of

Item	Comments	Req'd Action By
1.	Called the Seismic Qualification Working Group to determine their current criteria for line mounted equipment subjected to hydrodynamic loads.	
2.	Their current test requirements for in line equipment subjected to hydrodynamic loads are: a) One SSE + SRV Event: Required Input Motion (RIM) of sine beat testing at 1/3 Octave Intervals from 1 to 200 Hertz, each for 15 seconds, at 6.0 g. b) Two OBE + SRV Events: Required Input Motion (RIM) of two sine sweeps at 1 Octave/Minute from 2 to 200 to 2 Hertz at 2/3*6.0 g = 4.0 g. c) In-Plant Vibration: Required Input Motion of sine sweep testing at 2 Octaves/Minute from 5 to 200 to 5 Hertz for 90 minutes at .75 g.	
3.	This type of environment is distinctly more severe and more correct than that proposed in the WPPSS interim dynamics criteria memo # 856. Eventually WPPSS will need to be informed of current industry practice such as this.	

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. 7.1.12

WS:lgn

Signed: W. Schlafer WS

Distribution: Messrs. Kammerzell, Read, Reeser, Wittig, Minichiello, Guglielmino, Bosch, Hsieh, Patel, Rajan, Abolhoda, Curry

1020.00

CYGNA

Communications Report

Company: CES   X Telecon   ☐ Conference Report

Project: WPPSS

Job No. 82046/CR-018

Date: 6/29/82

Subject: EQ of BIF Butterfly Valves QID 361104, 361106

Time: 12:05 p.m.

Place: SDAO

Participants:

Bill Schlafer of CES, SDAO

John Henry of John Henry Associates

Item	Comments	Req'd Action By
1.	Called John Henry because he was the engineer who approved the original seismic calculations for BIF Butterfly Valves.	
2.	His recollection of these analyses was vague but did mention they, as consulting engineers, never tried to assure operability. Operability was the manufacturer's responsibility.	
3.	He recommended testing a similar valve.	

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. 7.1.13

BS:lgn

Signed: Bill Schlafer BS   Page 1 of 1

Distribution: L. Kammerzell, J. Read, H. Abolhoda, R. [redacted] P. Patel, P. Curry

1020.00

CYGNA

Communications Report

Company: CES	☒ Telecon	☐ Conference Report

Project: WPPSS

Job No. 82046/CR017

Date: 6/29/82

Subject: EQ of BIF Butterfly Valves
QID 361104, 361106

Time: a.m.

Place: SDAO

Participants:

Bill Schlafer	of CES, SDAO
George Sayer	of BIF, 401-885-1000
	of

Item	Comments	Req'd Action By
1.	Called George Sayer, the BIF sales agent to get a budget price for BIF 18", 24", 30" air-operated butterfly valves and an 18" motor actuated butterfly valve. These valves are similar to ones in WPPSS QID files but do not use the same air-actuators. The original BIF valve serial numbers (for reference) are N-27234-F, N-27235-F, N-27236-F and N-27232-1.	
2.	He required a few days to work out a price and will also send descriptive brochures.	

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 7.1.14

BS:lgn

Signed: Bill Schlafer BS   Page 1 of 1

Distribution: L. Kammerzell, J. Read, H. Abolhoda, ~~R. Hsieh,~~ P. Patel, P. Curry

1020.00

Communications Report

CYGNA

Company: CES ☒ Telecon ☐ Conference Report

Project: WPPSS

Job No. 82046/CR016

Date: 6/29/82

Subject: EQ of BIF Butterfly Valves QID 761104, 361106

Time: a.m.

Place: SDAO

Participants:

Bill Schlafer of CES, SDAO

Allan Berger of BIF 401-885-1000

of

Item	Comments	Req'd Action By
1.	Called Allan Berger, a BIF engineer, to get technical drawings for the 18", 24" and 30" air-operated butterfly valve actuators.	
2.	Requested drawings of Miller air cylinders showing details of a) Cylinder dimensions b) Piston dimensions c) Rod/piston connections	
3.	Conversation indicated a) There is a bearing and seal around the piston rod where it exits the cylinder b) The piston rod fits through a clearance hole in the piston and is bolted on. c) No seismic functional tests have been done on the Miller air cylinder d) For dimensional data to verify functional operability of the motor actuated valve, contact Limitorque in Lynchburg, Virginia	
BS:lgn		

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. 7.1.15

Signed: Bill Schlafer BS **Page** 1 **of** 1

Distribution: L. Kammerzell, J. Read, H. Abolhoda [redacted], P. Patel, P. Curry

1020.00

CYGNA

Memorandum

PROJECT MEMO: SDCM-002 T.001

To: H. Reisn

Date: 6/17/82

From: R. Hsieh

Job No: 82046 WPPSS

Subject: MISSING DATA REQUEST (QID# 361106, Pkg# T)

Copies: Project File

1. DRAWING A-208293 (CYL. SUPPT. BRACKET)
2. DRAWING D-206661 (MILLER CYL.)
3. SPEC # 2808-68
4. DRAWING B-211830 (DRIVE LEVER)
5. DRAWING B-211832-1 (CLEVIS)

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 7.1.16

NOTE: Please sign and return the attached copy of this memorandum as acknowledgement of receipt of this memo. THANK YOU.

Received by: ____________________

Date Received: ____________________

CYGNA

Memorandum

To: P. Guglielmino
J. Minichiello

Date: June 17, 1982

From: W. Schlafer, PK. Patel ok W/S

Job No: 82046/SDM-003

Subject: Analysis for Operability

Copies: L. Kammerzell
J. Read
H. Reeser
G. Shipway (Wyle)
T. Wittig
Project File

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. 7.1.17

In order to assess operability by analysis of mechanical equipment which can be modelled to correctly predict its stress and deformation responses relevant to operation, the following criteria are to be considered in conjunction with Section 3.E.1 of the Design Criteria.

If an equipment in Group II is expected to perform during the seismic and/or hydrodynamic event then the following requirements shall be met:

(1) Elastic displacement calculations shall be performed to assure non-interference between mating parts, and

(2) The calculated stresses shall be within the allowable stress limits.

If the calculated stresses for any service loading are such that permanent deformations might have occurred due to high allowable stress limits, a displacement analysis as in (3) shall be performed.

(3) A comprehensive elastic-plastic analysis should be conducted in these cases to assure non-interference between between mating parts.

For an equipment in Group I which is expected to operate after the seismic and/or hydrodynamic event then the following requirements shall be met:

(4) Total stresses in the part must be limited to a yield strength of the material, OR

(5) Satisfy the requirements of Group II equipment.

WS:lgn

CYGNA

Communications Report

Company: CES ☒ Telecon ☐ Conference Report

Project: WPPSS

Job No. 82046/CR-014

Date: 6/16/82

Subject: Wyle Data Bank

Time: a.m.

Place: SDAO

Participants: W. Schlafer of CES, SDAO

G. Shipway of Wyle, Norco

of

Item	Comments	Req'd Action By
1.	Asked George to initiate a search in their testing data bank for seismic or seismic/hydrodynamic tests on BIF 18", 24" & 30" Butterfly Valves.	G. Shipway
2.	These valves are in QID files 361106 and 361104.	
3.	George is skeptical test data exists for those butterfly valves experiencing the extended frequency range of the hydrodynamic event.	

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. DT.01.F
SHEET NO. 1.1.18

WS:lgn

Signed: W.Schlafer WLS

Page 1 of 1

Distribution: L. Kammerzell, J. Read, H. Abolhoda, R. [redacted], Project File

1020.00

RECEIVED

COPY JUN 28 1982

CYGNA - SAN DIEGO

Communications Report

Group Leader
Lourdes

Company: Cygna/Wyle ☒ Telecon ☐ Conference Report

Project: Equipment Seismic/Hydrodynamic Requalification

Job No. 82044

Date. 6/15/82

Subject: Interim Dynamic Loads Criteria and Fatigue Criteria

Time. 11:00

Place: Richland Office

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 7.1.19

Participants:

Joe Braverman of Burns & Roe

Jim Foreman of Wyle Laboratories

of

Item	Comments	Req'd Action By
	Joe Braverman of Burns and Roe was contacted by telephone on June 15, 1982 to get a clarification on the subject criteria for use in the Requalification of Equipment for Seismic and Hydrodynamic effects.	
	Joe concurred that the acceleration values shown in the table of the attachment to the conference notes were intended to be used for rigid line mounted components only and not for flexible components. i.e., those having natural frequencies below the cutoff frequency. To be consistent with B&R recommendation for qualification of line mounted components by test would indicate that for the analysis of flexible line mounted components a static load would be applied at the C.G. of the extended structure equal to the amplification factor for sinsusoidal motion at a justifiable damping value. For example, for an SSE condition the amplification at 3% damping would be 50 divided by 3 = 16.7. This loading may be in some cases present a very conservative loading on the line mounted components. A somewhat more realistic input motion would be	

Signed: KJF

Page 1 of 3

Distribution: Standard Distribution ~~[illegible]~~, Patel, Abolhoda, Raian, Curry

CYGNA

Communications Report

Company: Cygna/Wyle	☒ Telecon	☐ Conference Report	
Project: Equipment Seismic/Hydrodynamic Requalification		Job No.	82044
		Date:	6/15/82
Subject: Interim Dynamic Loads Criteria and Fatigue Criteria		Time:	11:00
		Place:	Richland Office

Participants:

Joe Braverman	of Burns and Roe
Jim Foreman	of Wyle Laboratories
	of

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. 01.01.F
SHEET NO. 7.1.20

Item	Comments	Req'd Action By
	continuous sine beats of 12-15 ocsillations per beat as recommended by the IEEE-382 draft "American Standard of Safety Related Valve Actuators". The amplification for a 15 oscillation sine beat at resonance for 3% damping is approximately 11.5.	
	If the static loadings given above show an overstressed condition or deflections which would cause operational malfunction, the alternative to develop a more realistic approach would be to perform in situ testing from which the data could be used to develop response spectra at valve locations. The in-situ tests would allow the determination of the natural frequencies and mode shapes of a sufficient part of the piping system along with the valve and extended structure to validate the mathematical models used to generate response spectra at the valve location and/or component locations on the extended structure. The response spectra at component locations allow direct comparisons with component test data. It is felt that a combined test and analysis would be a feasible and cost effective approach.	

Signed: JWF

Distribution: Standard Distribution

1020.00

CYGNA

Communications Report

Company: Cygna/Wyle ☒ Telecon ☐ Conference Report

Project: Equipment Seismic/Hydrodynamic Requalification

Job No. 82044

Date: 6/15/82

Subject: Interim Dynamic Loads Criteria and Fatigue Criteria

Time: 11:00

Place: Richland Office

Participants:

Joe Braverman of Burns and Roe

Jim Foreman of Wyle Laboratories

of

Item	Comments	Req'd Action By
	Burns and Roe is checking to see if fatigue criteria have been developed for WNP-2 and will notify Cygna/Wyle not later than June 17, 1982 if such criteria exists.	

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. 07.21.F
SHEET NO. 7.1.21

Signed: JWF

Distribution: Standard Distribution

1020.00

6/25/82 Whittaker

Why In-situ Testing By G. Shipway

1. Verify analytical model
2. Verify rigidity
3. Reduce stress analysis conservatism
4. Demonstrate operability
5. Include piping influences into modeling

Considerations

1. Must be closely coupled with analytical work.
2. Previous in-situ programs will be reviewed for possible guidance.
3- Assume site accessibility is no problem.

Which items

First estimate attached

Refine 1st guess with walk down inspection

Refine again with similarity review.

Refine again with review of analytical work

Methods

Select desired scenario depending on objective + items.

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. 7.1.22

WYLE LABORATORIES

In-situ Scenario's

1. Static equivalent pull test for operability.

   a. From analytical analysis, compute static equivalent load to be applied to actuator c.g., and the direction of the load.

   ~~c.~~ Determine location of, and access to, the item in question.

   d. Consider potential synergisms of pressure, temperature, flow, etc.

   ~~e.~~ If the absence of any of the potential synergistic parameters cannot be justified, the effect of that parameter must be accounted for.

   ~~f.~~ Apply required static load.

   ~~g.~~ Monitor operation of item as required to verify acceptable operation.

   b. Determine acceptance criteria for operation of the item.

A) Caution - a static pull test may at SSE levels cause permanent [illegible]. Assume valve will now operate

In-situ Scenarios

2. Resonance frequency determination

[To be used to verify rigidity, i.e., the absence of resonances at low frequencies.]

a. Determine location of, and access to, the item in question.

b. Determine the mounting arrangement and any other interfaces for the item.

c. Compare the in-situ mounting + interfaces with that used in the analytical model

d. Consider the probability of the item having no low frequency resonances. (If the probability of rigidity is not high this technique may not be the best choice.)

e. Using an appropriate size of hammer and a rubber pad, impact excite the item at the location(s) most likely to produce resonance responses.

f. Monitor the response of the item with an accelerometer and the micro FFT analyzer to determine the lowest frequency of amplified response motion.

g. Care must be used to insure the excitation of the lowest response frequency by proper use of the hammer and the location of the impact.

In-situ Scenarios

3. Modal Survey

a. Determine location of, and access to, the item in question.

b. Determine the mounting arrangement and any other interfaces for the item.

c. Compare the in-situ mounting and interface with that used in the analytical model.

d. Determine the mode shapes and frequencies predicted by the analytical work, and use this information as a guide for the experimental work.

f. If the item is relatively simple, and has low impedance, use an instrumented hammer for excitation. Otherwise, use a 30 to 50 lb shaker for excitation.

e. Determine the frequency range of interest, i.e. with, or without, hydrodynamic loads.

g. Using the HP 5423, monitor the item response at selected locations to gather experimental modal data for comparison with the analytical data.

h. Iterate analytical and experimental results to achieve convergence.

Prepared by HPR Date 24 June 82 Subject
WPPSS WNP-2 Safety Related Mechanical ~~Equipment~~

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 0T.01.F
SHEET NO. 7.1.26

Potential In Situ Test Items

QID No	DESCRIPTION	EQUIPMENT NO	LOCATION	TEST
118002	Engine/P.P. Elect	DSA-ENG. 1A2	D441, P.2/7.0	F
		1B2	D443, P.7/6.7	—
128002	Filter/Electro Motive	DLO-F-1A1	D441, P.3/6.0	F
		DLO-F-1A2	D441, R.5/6.0	
	DG-ENG. 1A, 1B	DLO-F-1B1	D441, P.3/8.0	
	Lube Oil Filter	DLO-F-1B2	D441, R.5/8.0	3 F2
	Inlet Filter	DLO-F-2A1	D441, P.3/6.0	
	Turbo Charger Supply	F-2A2	" R.5/6.2	
	Filter Intake	F-2B1	" P.3/8.0	
		F-2B2	" R.5/8.0	
		F-3A1	" P.3/6.2	
		F-3A2	" R.5/6.0	
		F-3B1	" P.3/8.0	
		F-3B2	" R.5/8.0	F
133001	FC Valve/Fischer	CAC-FCV-1B	R575 M2/5.2	F, S
	Flow Control X-99	-1B	R564 J.6/6.7	3 F, 18 F, 1 S
	2.5" Flow Control	-3A	R495 M.8/4.7	
		-3B	R496 J.0/7.4	
		-4A	R495 N.4/6.0	
		-4B	R495 N.4/6.0	F, S
133002	FC Valve/Fisher	RHR-FCV-64B	R443 H.0/9.1	F, S 2 F
	3.0" MO Globe	-64C	R443 J.0/4.9	F, S 1 S
	RHR Min Flow			

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. 7.1.27

WYLE LABORATORIES California Testing Division

Prepared by ______ Date ______ Subject ______

QID No.	DESCRIPTION	EQUIPMENT NO	LOCATION	TEST
133004	FC Valves/Fisher Flow Control (2.5")	CAC-FCV-2A	R560 M.1/7.7	F, S 2F2
		-2B	R558 M.5/6.6	F, S 1S
193001	Valve/Fisher Line from Heat Exch. 2.5" Globe Line	RHR-LCV-65A	R481 7.9/K	F, S 2F2
		-65B	R475 L3/8.1	F, S 1S
236004	PC Valve/Fisher E CONTV PIC SONIC FLOW	RHR-PCV-51A	R578 J/9.3	F, S 2F2
		-51B	R575 M.8/9.3	F, S 1S
361103	Valve/BIF 18" MO BFLY	SGT-V-1A	R583 H8/5.3	F, S
		SGT-V-1B	R583 J3/5.3	2F3
		SGT-V-3A1	R576 H8/7.7	8F2
		3A2	R576 J.0/7.7	2S
		3B1	R576 J3/6.8	
		3B2	R576 J3/7.4	
		4A1	R587 H8/7.1	
		4A2	R587 J.0/7.0	
		4B1	R585 J2/5.1	
		4B2	R585 J6/7.1	
		5A1	R587 H.6/7.0	
		5A2	R587 J/7.1	
		5B1	R587 J2/7	
		5B2	R585 J6/7	F, S
361104	Valve/BIF 30" BFLY	CEP-V-1A	R558 J.4/5.4	F, S 1F3
		CEP-V-2A	R558 J.4/5.4	F, S 2F2
		CSP-V-1	R508 M.5/7.6	F, S 1S
		CSP-V-2	R508 M.5/7.4	F, S

Prepared by ______ Date ______ Subject ______

QID No.	DESCRIPTION	EQUIPMENT NO.	LOCATION	TEST
361106	Valve / BIF 24" BFLY	CEP-V-3A	R495 H.5/5.4	F, S
		-4A	R495 H.5/5.4	4 F, 1 S
		CSP-V-3	R481 M.6/7.6	
		-4	R478 7.6/M.6	
		-5	R475 M.7/8.3	
		-6	R480 N.5/7.7	
		-9	R490 M.9/5.1	F, S
361110	Valve / BIF	SGT-V-2A	R580 H7/5.3	F, S 2 F, 1 S
		-2B	J3/5.3	F, S

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 7.1.28

CYGNA

Communications Report

Company:	CES	X Telecon	☐ Conference Report
Project:	WPPSS	Job No.	82046/CR-008
		Date:	6/11/82
Subject:	Qualification of Line Mounted Equip.	Time:	a.m.
		Place:	SDAO
Participants:	H. Reeser	of	CES, Richland
	W. Schlafer	of	CES, SDAO
		of	

Item	Comments	Req'd Action By
1.	The new work authorization had not yet been released. Use the Initial Analysis EQ-12-3000 number for the week-ending Friday 6/11/82.	
2.	Hal recommends that as a result of using our best engineering judgment in the qualification of line mounted equipment, it is more prudent to fail a few items first before presenting WPPSS with our concern for a more well defined position on line mounted equipment qualification. At that time, we can present a planned approach for additional analytical and/or in-situ testing to be conducted which will yield data needed for a more accurate definition of the dynamic input to line mounted equipment.	
3.	An examination of the preliminary horizontal OBE and SSE response spectra outside the containment building for a frequency of 8Hz, indicate that the g levels from Attachment 1 (of the Interim Dynamic Loads Criteria) to be used in the static analysis of line mounted equipment not affected by hydrodynamic loads, may already have a multiplicative factor incorporated in them. This factor may not yet still address the issue of a possible resonance condition of the line mounted equipment which would result in even higher g levels for use in analysis.	

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 7.1.29

WS:lgn

Signed: W. Schlafer WS   Page 1 of 1

Distribution: L. Kammerzell, J. Read, H. Reeser, J. Minichiello, P. Guglielmino, P.K. Patel[redacted], M.K.S. Rajan, A. Abolhoda, P. Curry, Project

1020.00

CYGNA

Communications Report

Company: CES ☒ Telecon ☐ Conference Report

Project: WPPSS Equipment Qualification

Job No. 82046/CR-005

Date: June 8, 1982

Subject: Response Spectra & WPPSS E.Q. Documents

Time: pm

Place: SDAO

Participants:

Participant		Of
H. Reeser	of	CES, Richland
J. Forman	of	Wyle (CES, Richland)
W. Schlafer	of	CES, SDAO

Item	Comments	Req'd Action By
1.	Hal has asked Jim Forman to help Cygna obtain the following information form WPPSS or from similar data available within Wyle: a) Separate SRV Response Spectra for use in fatugue stress analysis. b) Time histories used in deriving the SRV response spectra for use in determining the number of significant stress cycles and duration of an SRV loading. c) The number of SRV events. d) The number of significant stress cycles and duration of the hydrodynamic loads (AP/Chugging) associated with the LOCA event.	
2.	The large compilation of Response Spectra for OBE, SSE and combined hydrodynamic events recently received by the BAO, SDAO and the SFAO are to be considered preliminary. Hal will update and transmit an official copy of response spectra to be used for analysis/testing.	
3.	Hal is also sending the WPPSS a) FSAR Section 3.10 and Appendices b) The 2/12/82 submittal to the NRC concerning Equipment qualification.	

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. 7.1.30

Signed: W. Schlafer Page 1 of 1

Distribution: Kammerzell, Read, Patel, [redacted] Rajan, Abolhoda, Curry, Minichiello, Guglielmino Reeser, PROJECT FILE

1020.00

CYGNA

Communications Report

Company: CES	☒ Telecon	☐ Conference Report
Project: WPPSS Equipment Qualification		Job No. 82046/CR-004
		Date: June 8, 1982
Subject: QID File Review		Time: am
		Place: SDAO

Participants:

P. Guglielmino of BAO

W. Schlafer of SDAO

of

Item	Comments	Req'd Action By
1.	In the review of a QID file, if errors in other than seismic analysis are discovered which adversly affect the equipment's qualification, these too must be noted and corrected or justified.	
2.	If the error is such that the equipment can still be qualified, note the error and the fact it does not adversly affect qualification, but avoid the expense of altering that portion of the analysis.	
3.	Both Peter and myself feel that a better defensible position needs to be investigated for the loads used in the analysis of line mounted equipment.	

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. 7.1.31

Signed: W. Schlafer   Page 1 of 1

Distribution: Kammerzell, Read, Patel, [redacted] Rajan, Abolhoda, Curry, Minichiello, Reeser

1020.00   PROJECT FILE

CYGNA

Communications Report

Company: CES ☒ Telecon ☐ Conference Report

Project: WPPSS Equipment Qualification

Job No. 82046/CR-003

Date: June 3, 1982

Subject:

Time: pm

Place:

Participants:

H. Reeser of CES, Richland

W. Schlafer of CES, San Diego

of

Item	Comments	Req'd Action By
1.	Hal questioned his immediate contact at WPPSS, Dennis Armstrong, about the number of SRV events and number of cycles. Their reply was "we don't know".	
2.	Hal has suggested that Cygna investigate these issues, formulate a position, and then get WPPSS concurrence. Since WPPSS has generated combined response spectra for seismic and SRV events, I suggested to Hal he obtain separate SRV response spectra and time histories from which they were derived. This will help in determining the length an SRV event and the number of significant cycles. The number of SRV events is more difficult to determine and possibly needs a more thorough understanding of the BWR's systems.	HGR
3.	Hal will be our contact in Richland to submit our Action Plan and cost estimates for approval.	

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. 7.1.32

Signed: W. Schlafer WS

Page 1 of 1

Distribution: Kammerzell, Read, Patel, [redacted], Rajan, Abolhoda, Curry, Guglielmino, Minichiello, Reeser, PROJECT FILE

WS:ib

1020.00

Communications Report

Company: CES	☒ Telecon	☐ Conference Report
Project: WNP-2 Equipment Qualification		Job No. 82044
		Date: 4/28/83
Subject: Weld size at Valve Flange/Ear Interface		Time: 2:00 p.m.
		Place: Richland
Participants: Don Searle		of CES/RBO
Rick Ricappito		of BIF 401-885-1000
		of

Item	Comments	Req'd Action By
	Requested and received information concerning the attachment of the rectangular shaped "ears" to the valve body flanges. Rick informed me that all of these items were affixed to the valve flange by means of welding. a) 0.31" fillet weld three sides b) 0.31" "J"/Groove weld on side flush with flange face Reference: BIF Order No: PN27234, PN27235 BIF Assembly Drawing: A-206767	

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 7.1.33

Signed: D. Searle

Distribution: T. Wittig, F. Khanachet, D. Armstrong, M. Scott, R. Hickman, Project File, FD Searle, Office File

1020 CK

July 16, 1974

Conference Notes No. 258

RECEIVED JUN 17 1982
RECEIVED JUL 23 1974
CYGNA-RICHLAND

MZizza
JJByrnes
JJVerderber
THendrickson
FJPatti
HSechster
JBHodskey
JRoberts
PPerry
MHroncich
DMurphy
HReh
CVesy (PT&O)
RLuken
RECamp
JHagan
HDoon
RWoodward
JBlas (2)
HSybil
JO'Donnell
AWChamos
MGoodman
SFox
JVZalavadia
DSheikh
BBedrosian
RBaldwin
EFerrari (6)
MKahn
pf
db
pc

Subject: W.O. 2808
Washington Public Power Supply System
WPPSS Nuclear Project No. 2
Contract No. 68
[redacted]

Date: [redacted]

Place: B.I.F.
Providence, Rhode Island

Purpose: [redacted] Review Meeting

Present: B.I.F

J.P. Cunningham - Product Engr-Butterfly Valves
*T. Masse - Engr. Product Mgr. - Butterfly Valves
*G.F. MacDonald - Director Nuclear Q.A.
*T. Wolfe - Marketing Manager - Butterfly Valves

Burns and Roe

D. Sheikh
J. V. Zalavadia

* Part Time

WNP NO. 2 | K HALE | W VAUGHAN | DE TRAPP | GE GEGAN | Cutler

Notes: 1. Documents to BIF

Burns and Roe Comments on Q.A. Manual-
Burns and Roe letter BRBIF-68-74-011, dated
March 19, 1974.

2. Seismic Calculations - B&R Comments

Burns and Roe [redacted]

a. Change [redacted] allowed per Contract Specification.

b. Submit the [redacted]

c. Submit the calculations for the detail of seating torque value, used in design calculations

d. [redacted]

e. Consideration [redacted] when [redacted]

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. 7.1.34

f. [redacted] specification. The seismic calculations include stress analysis only. The analysis for strain/deformation is also required as a proof that there will be no loss of function.

g. Submit analysis or proof that radiation will not [redacted]dversly affect the yield point of the material.

[redacted] Submit analysis and design for 72" and 84" valves considering normal load with the combination of ½ SSE stresses shall be maintained within the normal allowable working stress limit as mentioned in paragraph 3.3.1.1 of specification.

3. <u>Mandatory Testing for Seismic Qualifications</u>

[redacted] tested the same type of equipment for greater accelerations than Burns and Roe specified and that they will submit the test data for Burns and Roe review and approval.

4. <u>Stardyne Model used in Seismic Calculations</u>

[redacted]

[redacted] n.
[redacted] requirements.

6. [redacted]

[redacted] ble eccent[redacted], inste[redacted] 24" valv[redacted]

7. [redacted]

Burns and Roe asked BIF to submit the natural fundamental frequency of 18", 24", and 30" valves. [redacted] cost for this work. Burns and Roe stated that after reviewing their quotation and after WPPSS's approval Burns and Roe will notify BIF if additional work is authorized. (BIF informed Mr. D. Sh[illegible] on July 9, 1974 by telephone that the cost of

additional work will be $300.00).

8. General-BIF Comments

BIF indicated as follows:

a. If operation or accidental temperature is high, the rubber seal should be on valve disc, correctly specified by Burns and Roe, instead of valve body. Rubber seal if on valve body, is fixed by glue, which cannot resist high temperature. Rubber seal on valve disc is fixed in-between metal pieces.

b. If water or any other fluid is supposed to flow in the pipe, the shaft in the valve should be vertical. The vertical shaft would mean C.G. of pressure due to fluid will be on the axis and hence much less driving force is required to operate the valves. But in case of air or steam it makes no difference.

9. Quality Assurance Manual

Burns and Roe stated that Burns and Roe comments on BIF Quality Assurance Manual was mailed to BIF on March 19, 1974 (BRBIF-68-74-011) and was classified "Not Approved". The response to these comments has not been received as of this date. BIF stated that the BIF Plant is on vacation for 2 weeks (July 1 thru July 12). Mr. MacDonald will start updating QA Manual on July 15 and he expects to complete by July 19, 1974. BIF will revise their Q.A. Manual and/or provide necessary supplements to the manual as per Burns and Roe comments. Burns and Roe comments were discussed. Mr. MacDonald will call Mr. Sheldon Paige of Burns and Roe on July 15, for the clarification of the following Burns and Roe comments:

a. Corrective action
b. Audit of Purchase Reqs./P.O.'s/change orders
c. Compliance to supplier Quality Control Program
d. Compliance to Lower Tier Procurement
e. Welding Process Sheet Form N-152 (BIF) and the forms of Contract Specification 17A-30 and 17A-31

10. Inservice Inspection Requirements

Burns and Roe questioned regarding the requirements of "calibration blocks" in accordance with the draft of the 1974 Edition of ASME Section XI, Article I-3000 "Preparation for Calibration" for Inservice Inspection. BIF stated that the special calibration blocks are not required. They will submit detailed method of Inservice Inspection with Standard Calibration blocks.

11. Item Owed to BIF by B&R

Decision on BIF quotation on calculations on natural frequencies of 18", 24" and 30" valves (Item No. 7).

12 [redacted]

a. [redacted]

b. Submission of revised Q.A. Manual (Item No. 9)

c. Inservice Inspection Requirements (Item No. 10)

JJV/JVZ/dcw

Prepared by J. V. Zalarndis

Submitted by

cc: Mr. J. E. Woolsey - WPPSS -3
Mr. P. C. Otness - BPA -1

CYGNA

QID# 361106

7.2 Old Requalification & SQRT Forms

WPPSS NUCLEAR PLANT UNIT 2

361108

SEISMIC AND HYDRODYNAMIC LOADS

REQUALIFICATION CERTIFICATION

JOB NO. 2808

EQUIPMENT NAME: 24" Cylinder Operated Butterfly Valve SPEC. NO: 68

EQUIPMENT NO: CSP-V-3,4,5,6,9; CEP-V-3A,4A

LOCATION: ~~Reactor Bldg.~~, El. 482'0", 479'0", 473'0", 488'0", 491'0", El. 491'0", 491'0"

EQUIPMENT CLASSIFICATION: ☒ ACTIVE ☐ PASSIVE

SEISMIC QUALIFICATION REPORT REFERENCE:

1. Report No. TR-~~74~~-7, Design and seismic analysis of 24" cylinder operated butterfly valve (rev. 2) dated 4/17/78, by McPherson Associates, Inc., Trans 24
2. Dynatech Project No. BIF-14 Deflection Analysis of Butterfly Valves by Dynatech R/D Co. 4/12/76, Trans 1313

THE ABOVE SEISMIC QUALIFICATION REPORT(S) HAVE BEEN REEVALUATED AND REQUALIFIED WHERE NECESSARY TO SHOW THAT THE ABOVE-MENTIONED COMPONENT IS CAPABLE OF PERFORMING ITS INTENDED SAFETY FUNCTION UNDER ALL THE APPLICABLE LOADING COMBINATIONS INCLUDING THE POOL DYNAMIC LOADS.

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. 7.2.1

PREPARED: __________

APPROVED: __________

DATE: __________

nutech
San Jose, California

Project WNP-2 File No.

Owner Washington Public Power Supply System

Client Washington Public Power Supply System

CYGNA ATTACHMENT
JOB NO. 81044
FILE NO. 05.01.F
SHEET NO. 722

Tag No.: CSP-V-3
CSP-V-4
CSP-V-5
CSP-V-6
CSP-V-9
CEP-V-3A
CEP-V-4A
Class I, Active

24" Cylinder Operated Butterfly Valve

I. Original qualification method

A. Static analysis

II. Re-evaluation results

A. The natural frequencies were not calcuated.

B. Valve operability was verified by deflection calculation.

C. Calculated stress margins are within allowables.

D. RRS not used, but seismic coefficients used in analysis do not envelop the interim SQRT criteria. ?

III. Conclusion

A. The 24" cylinder operated butterfly valve does not comply with interim SQRT requirements.

1. The seismic coefficients used in the analysis do not envelop the interim SQRT requirements.

IV. Recommendations

A. Analyze valve to SQRT requirements.

V. Comments on the original analysis

A. Accelerations used were 3g horizontal and 2g vertical. They were combined using SRSS.

B. The natural frequencies were not evaluated.

C. Maximum critical deflection was 0.064" vs. 0.50" allowable.

Revision	0					Page 1 of 1
Prepared By/Date	CBR 7/18/81					
Checked By/Date	EAC 7/21					

Tag no. CSP-V-3
CSP-V-4
CSP-V-5
CSP-V-6
CSP-V-9
CEP-V-3A
CEP-V-4A

Not in 3 TR-74-7 Rev. 1

Qualification Summary of Equipment

I. Plant Name: WNP-2

Type:

1. Utility: Washington Public Power Supply System

PWR

2. NSSS: GE 3. A/E: Burns & Roe

BWR 5, Mark II

II. Component Name 24" cylinder operated butterfly valve

1. Scope: [ ] NSSS [X] BOP ?

2. Model Number: A-206765 Quantity: 7

3. Vendor: BIF

4. If the component is a cabinet or panel, name and model No. of the devices included: N/A

5. Physical Description a. Appearance Valve

b. Dimensions

c. Weight 399 lbs

6. Location: Building: Reactor Bldg., Containment Bldg.

Elevation: 482'0", 479'0", 473'0", 488'0", 491'0", 491'0", 491'0"

7. Field Mounting Conditions [x] Bolt (No. 20 Each Size 1¼")*
[ ] Weld (Length)
[ ]

8. a. System in which located: Containment Supply Purge System Containment Exhaust Purge System

b. Functional Description: Isolation & Vac. relief to Supply Chamber exhaust, Containment Chamber

c. Is the equipment required for [ ] Hot Standby [ ] Cold Shutdown

[ ] Both [ ] Neither

9. Pertinent Reference Design Specifications:

2808-68

Prepared by: 7/18/81

Checked by: 7/21/81

CYGNA ATTACHMENT
JOB NO. 81044
FILE NO. 07.01.F
SHEET NO. 7.2.3

3/81

*NOTE: Some bolts not installed

***III. Is Equipment Available for Inspection in the Plant: [X] Yes [ ] No

IV. Equipment Qualification Method:

[ ] Test [X] Analysis [ ] Combination of Test and Analysis

Qualification Report*: Contract 68, Transmittal 24
(No., Title and Date) Report No. TR-74-7 (Rev. 2), dated 4/17/78, Design & Seismic Analysis of 24" Cylinder Operated Butterfly Valve

Company that Prepared Report: McPherson Assoc. Inc.

Company that Reviewed Report: Burns & Roe/NUTECH

V. Vibration Input:

1. Loads considered: a. [X] Seismic only

   b. [ ] Hydrodynamic only

   **c. [X] Combination of (a) and (b)

2. Method of Combining RRS: [ ] Absolute Sum [X] SRSS** [ ] ______ (other, specify)

3. Required Response Spectra (attach the graphs): Attached

4. Damping Corresponding to RRS: OBE ______ SSE ½%

5. Required Acceleration in Each Direction: [ ] ZPA [X] Other Attachment 1 (specify)

OBE	S/S =	F/B =	V =	
SSE	S/S = 1.36g	F/B = 1.36g	V = 1.36g	
~~For CSP-V-9~~	3.2g	3.2g	1.3g	

*NOTE: If more than one report complete items IV thru VII for each report.

~~**NOTE: For valve CSP-V-9 only.~~
***NOTE: SCP-V-9, CSP-V-6 not installed

CYGNA
ATTACHMENT
JOB NO. 91044
FILE NO. 01.01.F
SHEET NO. 7.2.4

III. Is Equipment Available for Inspection in the Plant: [X] Yes [ ] No

IV. Equipment Qualification Method:

[ ] Test [x] Analysis [ ] Combination of Test and Analysis

Qualification Report*: Contract# 68 Transmittal# 13B

(No., Title and Date) BIF-I4 Deflection Analysis 4/12/76

Company that Prepared Report: Dynatech R/D Co.

Company that Reviewed Report: Burns & Roe/Nutech

V. Vibration Input:

1. Loads considered: a. [ ] Seismic only

b. [ ] Hydrodynamic only

c. [ ] Combination of (a) and (b)

2. Method of Combining RRS: [ ] Absolute Sum [ ] SRSS [ ] ________ (other, specify)

3. Required Response Spectra (attach the graphs): ________

4. Damping Corresponding to RRS: OBE ________ SSE ________

5. Required Acceleration in Each Direction: [ ] ZPA [ ] Other ________ (specify)

OBE S/S = ________ F/B = ________ V = ________
SSE S/S = ________ F/B = ________ V = ________

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*NOTE: If more than one report complete items IV thru VII for each report.

VI. If Qualification by Test, then Complete*: N/A

1. [ ] Single Frequency [ ] Multi-Frequency: [ ] random [ ] sine beat [ ] ______

2. [ ] Single Axis [ ] Multi-Axis

3. No. of Qualification Tests: OBE ______ SSE ______ Other ______ (specify)

4. Frequency Range: ______

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

S/S = ______ F/B = ______ V = ______

6. Method of Determining Natural Frequencies

[ ] Lab Test [ ] In-Situ Test [ ] Analysis

7. TRS enveloping RRS using Multi-Frequency Test [ ] Yes (Attach TRS & RRS graphs) [ ] No

8. Input g-level Test: OBE S/S = ______ F/B = ______ V = ______

SSE S/S = ______ F/B = ______ V = ______

9. Laboratory Mounting:

1. [ ] Bolt (No. ______, Size ______) [ ] Weld (Length ______) [ ] ______

10. Functional operability verified: [ ] Yes [ ] No [ ] Not Applicable

11. Test Results including modifications made: ______

______

12. Other test performed (such as aging or fragility test, including results):

______

______

*Note: If qualification by a combination of test and analysis also complete Item VII.

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12/80

VII. If Qualification by Analysis, then complete:

1. Method of Analysis:

[x] Static Analysis $g_h=3g$, $g_v=2g$ [ ] Equivalent Static Analysis

[ ] Dynamic Analysis: [ ] Time-History [ ] Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical): Not Calculated

S/S = ________ F/B = ________ V = ________

3. Model Type: [ ] 3D [ ] 2D [ ] 1D

[ ] Finite Element [ ] Beam [x] Closed Form Solution

4. [ ] Computer Codes: None

Frequency Range and No. of modes considered: ________

[ ] Hand Calculations

5. Method of Combining Dynamic Responses: [ ] Absolute Sum [x] SRSS
[ ] Other: ________ (specify)

6. Damping: OBE ________ SSE ________ Basis for the damping used: N/A

7. Support Considerations in the model: Pipe Mounted

8. Critical Structural Elements:

A. Identification	Location	Governing Load or Response Combination	Seismic Stress	(PSI) Total Stress	(PSI) Stress Allowable
Driver lever (σ)		Operating & SSE		40,444	45,000
Valve body (S.I.)		Operating & SSE		17,330	18,000

B. Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
0.064"	Disk	0.50 See V.C. Page 1/1

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SHEET NO. 7.2.7

Attachment 1

Static Seismic "G" calculations (Stick Model)
OBE Level, 1/2% Critical Damping, frequency cut-off * and above
SSE Value = 2 x OBE Value

Building	Area Elevation (Ft.)	Horizontal OBE, g	Horizontal SSE, g	Vertical OBE, g	Vertica SSE, g
Reactor Building *8 Hz	653**	1.25	2.50	1.00	2.00
	567	.53	1.16	1.00	2.00
	547	.57	1.14	.95	1.90
	521	.57	1.14	.87	1.74
	500	.68	1.36	.68	1.36
	470	.80	1.60	.60	1.20
	443	.87	1.74	.60	1.20
	434**	1.00	2.00	.40	.80
Diesel Gen.	414**	1.00	2.00	.40	.80
*10 Hz/15 Hz	472	3.5/.60	7.0/1.2	2.6/1.6	5.2/3.2
	454	3.2/.70	6.4/1.4	2.5/1.0	5.0/2.0
	437	2.2/.90	4.4/1.8	2.4/1.1	4.8/2.2
Radwaste *8 Hz/10 Hz	541	1.5/1.5	3.0/3.0	2.0/1.1	4.0/2.2
	524	1.1/1.1	2.2/2.2	1.7/.8	3.4/1.6
	500	1.0/.65	2.0/1.3	1.8/.65	3.6/1.3
	466	1.1/.60	2.2/1.3	1.7/.50	3.4/1.2

Building	Area Elevation (Ft.)	Horizontal OBE, g	Horizontal SSE, g N/S	Horizontal SSE, g E/W	Vertical OBE, g	Vertica SSE, g
Reactor Building Primary Cont. *8 Hz	492'-11 5/8"		3.2	3.2		1.3
	480'-4"		3.2	3.0		1.3
	467'-3"		3.0	2.8		1.3
	455'-3"		4.0	3.0		1.3

**From RRS at additional elevations (by NuTech)

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SHEET NO. 7.2.8

QID# 361106

7.3 BIF Report

B I F A UNIT OF GENERAL SIGNAL
1600 DIVISION ROAD
WEST WARWICK, R.I. 02893

QUALIFICATION OF PRIMARY CONTAINMENT BUTTERFLY ISOLATION VALVES UNDER LOCA CONDITION.

DYNAMIC TORQUE CALCULATION OF BUTTERFLY VALVE

PREPARED FOR:

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

VALVE SIZES 30", and 24"
WPPSS CONTRACT NO. 68
BIF ORDER NO.: PN27234 & PN27235
WPPSS IDENTIFICATION NO. CSP-V-1 & 2, and
CSP-V-3 & 4

Prepared by: Debendra K. Das *Debendra K. Das*
Date: Nov. 10, 1982
Checked by: Dezso Szilagyi *Dezso Szilagyi*
Date: Nov. 10. 1982

REPORT NO. TR-27234 And
TR-27235

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TABLE OF CONTENTS

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SUMMARY

This report contains the dynamic torque analysis of two butterfly valves of sizes 30, and 24 inch. The analysis is performed for LOCA (loss of Coolant Accident) per WPPSS Specification, reference 1 on page six of this report. The analytical procedure and the assumptions are outlined in the section beginning on page seven. Dynamic torque calculations have been performed for two media, namely, air and saturated steam for various angles of opening of these valves.

The results of the analysis tabulated on page two through five of the report indicate that the dynamic torques developed under the specified flow conditions are less than the design torques used in the original Seismic and Stress analysis of these valves. Therefore the valves are safe against the action of dynamic torque in the event of a LOCA.

SUMMARY OF RESULTS

Table - 1, 30 Inch Valve, airflow

Time s	Angle α deg.	Dynamic Torque in-lb
1.0	90 (Full open)	11020
1.5	78.75	23098
2.0	67.50	18138
2.5	56.25	14747
3.0	45.00	12428
3.5	33.75	10780
4.0	22.50	8014
4.5	11.25	3972
5.0	9.0 (Full closed)	0.0 *

T_{Net} = 22174 in-lb

* At full closed position the dynamic torque is zero and the net torque is due to seating and bearing friction.

NOTE: The design torque used in the Seismic analysis report No. TR-74-8 by McPherson Associates for this valve is 27800 in-lb. Therefore the design is safe.

SUMMARY OF RESULTS

Table - 2. 30 Inch Valve Steam flow

Time s	Angle ∝ deg.	Dynamic Torque in-lb
1.0	90 (Full open)	11032
1.5	78.75	23175
2.0	67.50	18142
2.5	56.25	14668
3.0	45.00	12424
3.5	33.75	10580
4.0	22.50	7809
4.5	11.25	3867
5.0	9.0 (Full closed)	0.0 *

T_{Net} = 22174 in-lb

* At full closed position the dynamic torque is zero and the net torque is due to seating and bearing friction.

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SUMMARY OF RESULTS

Table - 3, 24 Inch Valve, Air flow

Time s	Angle α deg.	Dynamic Torque in-lb
1.0	90 (Full open)	5525
1.5	78.75	11692
2.0	67.50	9095
2.5	56.25	7428
3.0	45.00	6239
3.5	33.75	5430
4.0	22.50	4043
4.5	11.25	2020
5.0	9.0 (Full closed)	0.0 *

T_{Net} = 13808 in-lb

* At full closed position the dynamic torque is zero and the net torque is due to seating and bearing friction.

Note: The design torque used in the Seismic analysis report No. TR-74-7 by McPherson Associate for this valve is 17000 in-lb. Therefore the deisgn is safe.

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SUMMARY OF RESULTS

Table - 4, 24 Inch Valve, Steam flow

Time s	Angle α deg.	Dynamic Torque in-lb
1.0	90 (Full open)	5425
1.5	78.75	11394
2.0	67.50	8921
2.5	56.25	7213
3.0	45.00	6109
3.5	33.75	5202
4.0	22.50	3842
4.5	11.25	1902
5.0	9.0 (Full closed)	0.0 *

T_{Net} = 13808 in-lb

* At full closed position the dynamic torque is zero and the net torque is due to seating and bearing friction.

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SHEET NO. A-7

REFERENCES

1. WPPSS Specification 2808-68, Calc. No. ME-02-83-08-0, Sheets 1 thru 9, dated 10/8/82.

   LOCA Temperature Curve Fig. 6.2-2.
   LOCA Pressure Curve Fig. 6.2-3.

2. ANSI/AWWA C504-80, AWWA Standard for Rubber-Seated Butterfly Valves. American Water Works ASsociation,Colo.

3. Beard,C., Final Control Elements, Valves and Actuators, First Edition, Rimbach Publications, 1969.

4. Hutchison, J. W., ISA Handbook of Control Valves, 2nd Edition.

5. Torque and Sizing Calculation for BIF Butterfly Valves, No. D-214590, dated 1/9/75 for WPPSS Contract #68.

6. B I F Test Report for Dynamic Torque and Head Loss Tests of Cast Iron Streamline Disc versus Fabricated Flat Plate Disc dated May 13, 1974.

7. B I F Test Report #TR-0650-43, Hydrodynamic and Headloss Test of 12" - 150 Lb. Butterfly Valve with directly connected short radius elbow upstream, dated 2/24/82.

8. B I F Drawings: 30 inch Valve General Arrangement Drawing A-206763
   24 inch Valve General Arrangement Drawing A-206764

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FILE NO. OT.01.F
SHEET NO. A-8

ANALYTICAL PROCEDURE

The valves analysed in this report are primary containment isolation Butterfly Valves used in the purge system. Valve sizes considered here are 30 inch and 24 inch.

During the normal operation these valves are in full open position and should close completely in case of an accident. In the event of a LOCA (Loss of Coolant Accident) the valves have to close against ascending differential pressure. During the closing operation the valve disc will be in semi-open positions and will experience fluid dynamic forces due to uneven pressure distribution across the faces of the disc.

The pressure rise and temperature rise inside the containment with respect to time, is given in WPPSS addendum (reference 1). The flow through the valve causes aerodynamic effect on the disc that gives rise to the dynamic torque. This dynamic torque is given by the formula:

$$T_D = C_T \ (\Delta P) \ D^3 \qquad \text{(Ref. 2)..............(1)}$$

Where T_D = Dynamic Torque (in.-Lb.)

C_T = Coefficient of dynamic torque obtained from test (Dimensionless constant)(Ref. 7)

ΔP = Differential pressure across the valve (psi)

D = Disc diameter (in.)

During the closing operation of the valve C_T and ΔP will be changing for varying closing angles of the disc. The dynamic torque will tend to close the valve where as the shaft bearing friction torque will oppose it. The bearing friction torque is given by the formula:

$$T_b = \frac{\pi D^2}{4} \left[f_b \ (d/2) \ \Delta p \right] \qquad \text{(Ref. 2)......}$$

T_b = Shaft bearing friction torque (LB-in.)

D = Valve Port diameter (in.)

f_b = Bearing friction coefficient (dimensionless constant)

d = Shaft diameter (in.)

Δp = Differential pressure (psi)

Therefore the net unbalanced torque is

$$T_N = T_D - T_b$$

The differential pressure Δp across the valve shall be calculated from the data on volumetric flow rate under LOCA Condition supplied to us by WPPSS. The equation used will be the one for sub-sonic gas flow recommended by the Fluid Controls Institute:

$$Q = 963\ C_V \sqrt{\frac{P_1^2 - P_2^2}{GT_1}} \qquad \text{(Ref. 3 and 4)} \ldots\ldots\ldots\ldots (3)$$

Where Q = Gasflow in SCFH

P_1 = Valve upstream pressure (psia)

P_2 = Valve downstream pressure (psia)

G = Specific gravity (air =1 at 60°F and 1 atm. pressure)

T_1 = Upstream temperature in ° Rankine

C_V = Valve coefficient = $\dfrac{29.9D^2}{\sqrt{K_V}}$

D = Valve Port diameter (in.)

K_V = Coefficient of flow (dimensionless constant) (Ref. 7)

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WPPSS recommends that with the occurrence of LOCA inside containment, a signal is sent to the main control which automatically sends the valves to the failure mode. The time delay (instrumentation time) before the Butterfly valve starts to close is given to be less than one second. We have conservatively assumed this delay to be one full second. Time of closure from the full-open position to full-close position is four seconds. This closure time was the original requirement of the valve operator and has been tested at B I F for several valves and is noted to be often less than four seconds and even as low as one and a half seconds. A smaller closing time will obviously cause less flow due to lower containment pressure and a lower dynamic torque. However, the maximum closure time of four seconds is used in this analysis. Therefore, from the onset of LOCA to the full closure of the valve the time duration is five seconds.

Using this time period we have abstracted the pressure and temperature response under a LOCA condition from WPPSS curves of Reference 1, Fig. 6.2-2 and Fig. 6.2-3. The drywell pressure and temperature are used which are considerably higher than the wetwell values. The enlarged plots for the period of interest are shown on pages 10 and 11. The specific volume and the volumetric flow rate of both saturated steam and air are also presented in WPPSS addendum, reference 1. These quantities are also plotted against time for both steam and air as shown in pages 10, thru 15. For saturated steam the specific volume or specific weight are obtained fro the steam table.
The period of closure of the valve has been divided into eight equal divisions each of 0.5 second duration representing 11.25 degree of closure of the butterfly valve at a uniform rate. This division facilitates in

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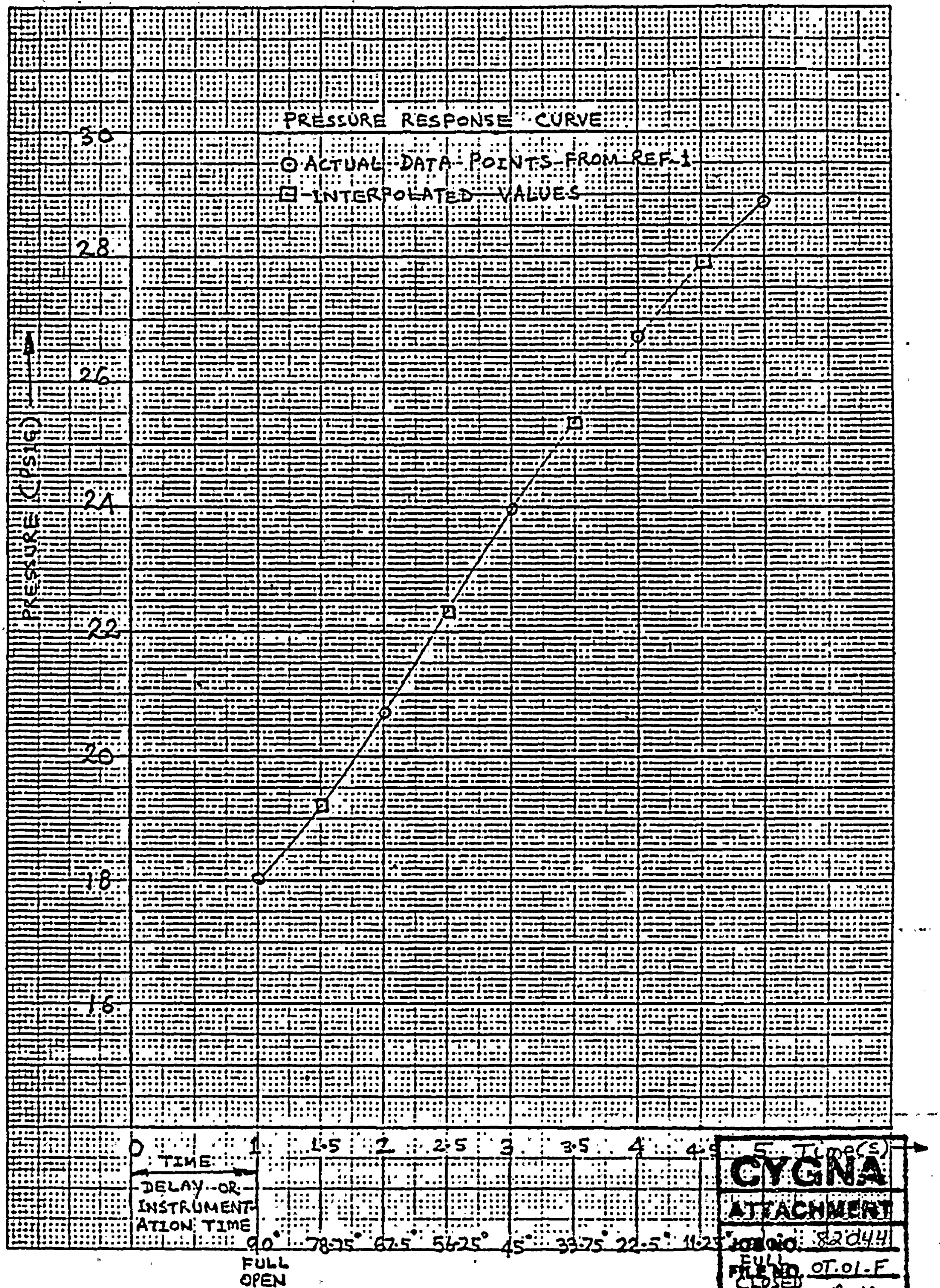
SHEET NO. A-11



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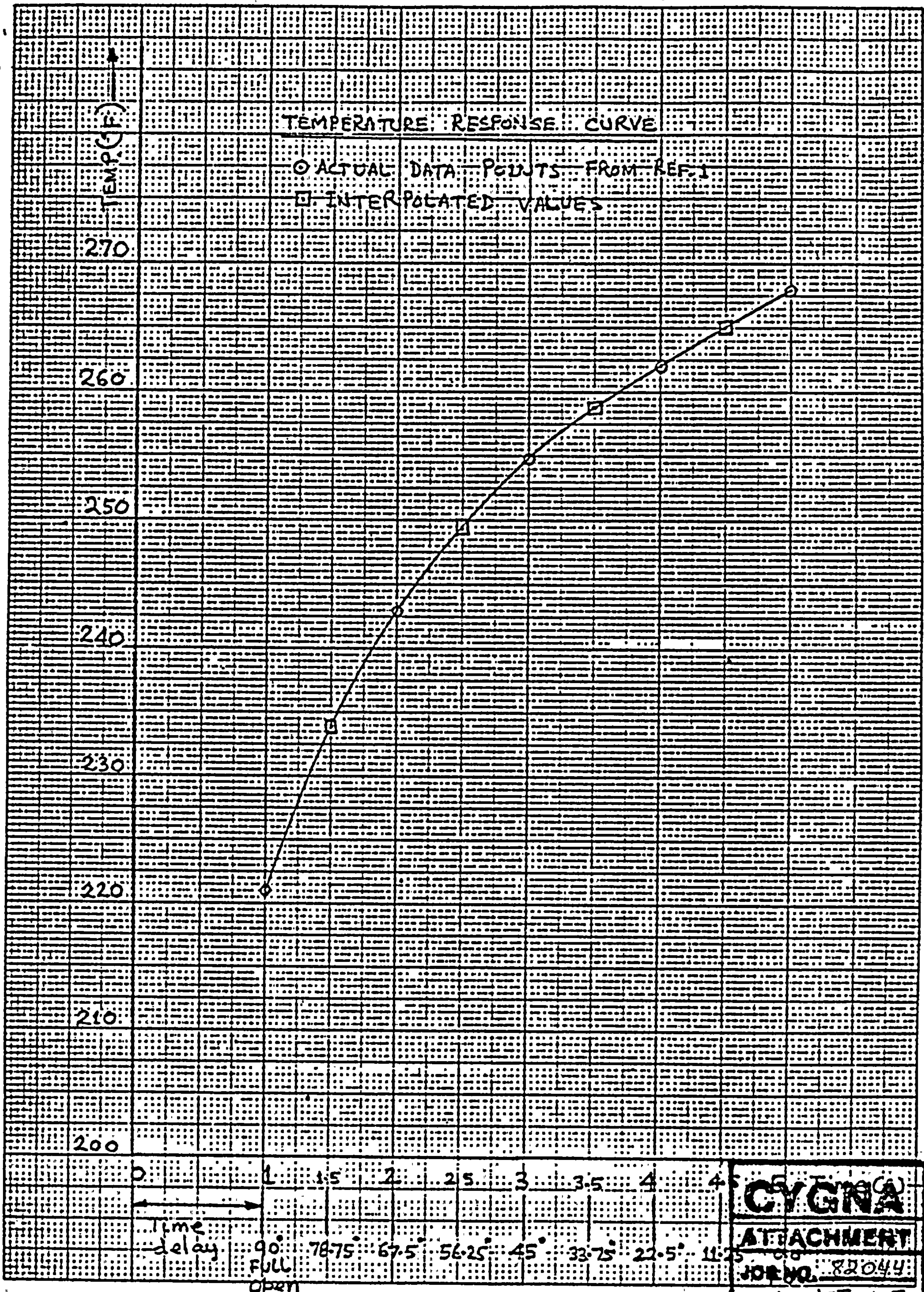
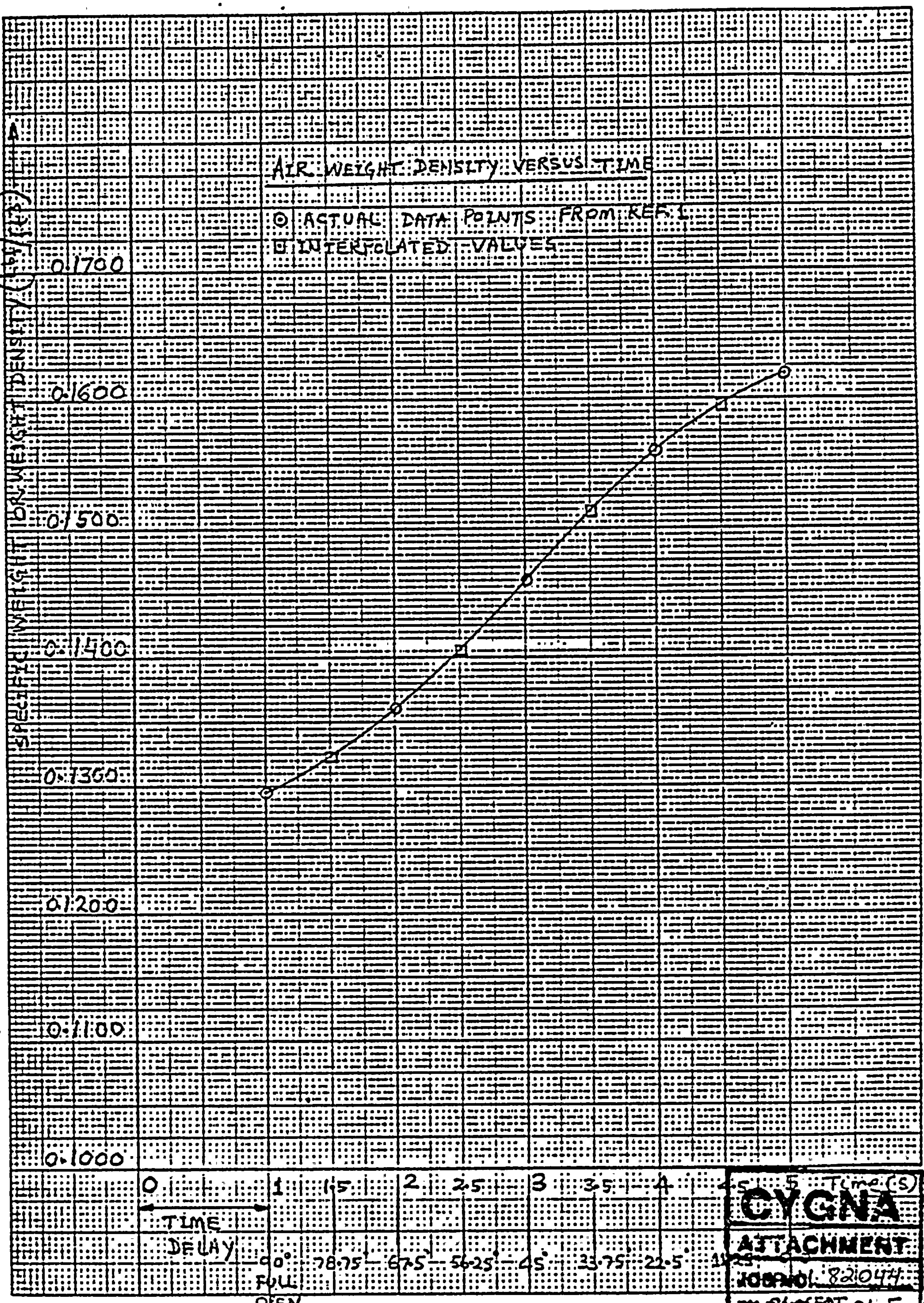


TEMPERATURE RESPONSE CURVE
ACTUAL DATA POINTS FROM REF. 1
INTERPOLATED VALUES
TEMP (°F)
270
260
250
240
230
220
210
200
0
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (s)
Time delay
90° Full open
78.75°
67.5°
56.25°
45°
33.75°
22.5°
11.25



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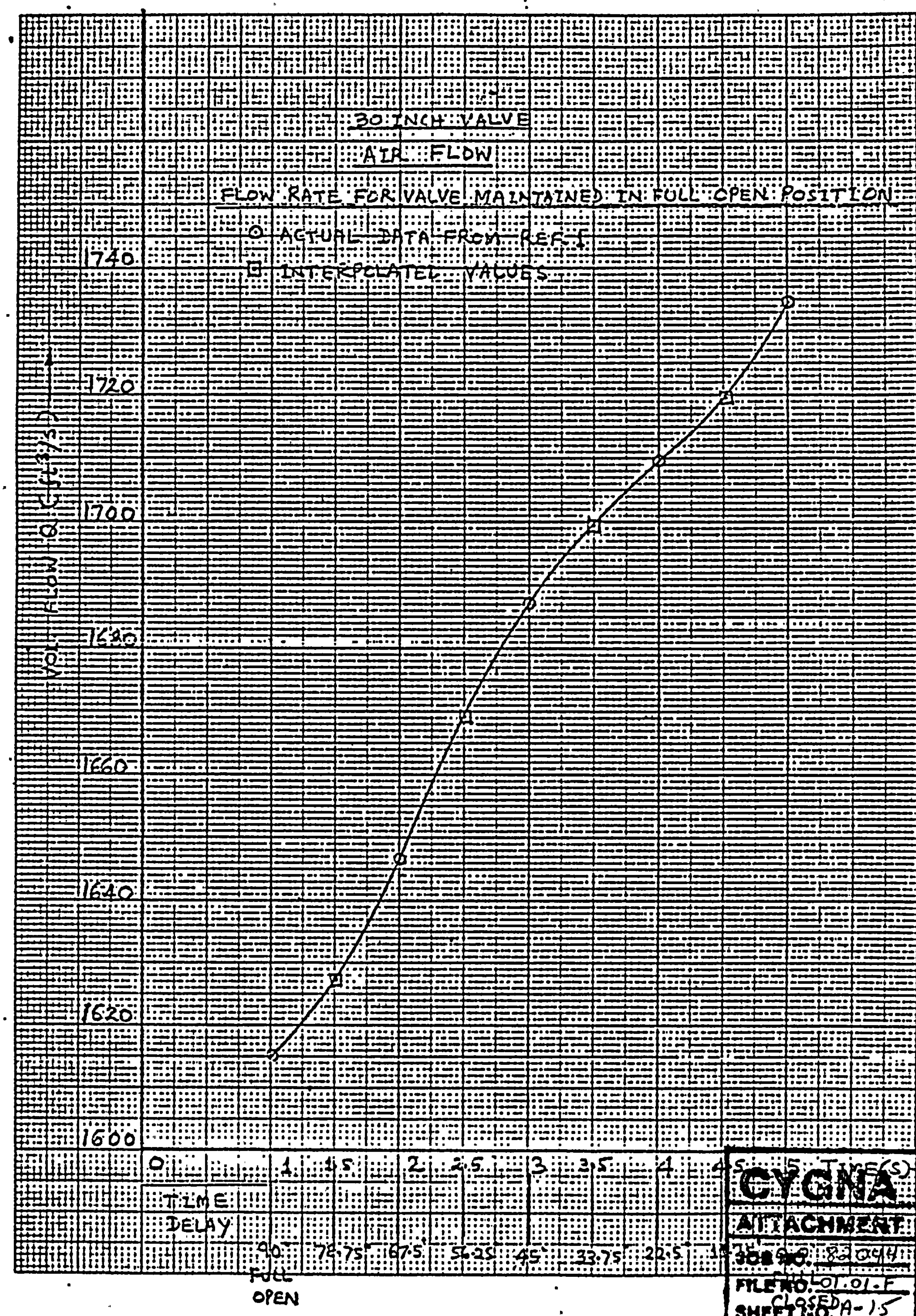
SHEET NO. A-14


30 INCH VALVE
AIR FLOW
FLOW RATE FOR VALVE MAINTAINED IN FULL OPEN POSITION
⊙ ACTUAL DATA FROM REF. 1
⊡ INTERPOLATED VALUES
VOL. FLOW Q (ft³/s)
1740
1720
1700
1680
1660
1640
1620
1600
0 1 1.5 2 2.5 3 3.5 4 4.5 5 TIME(S)
TIME DELAY
90 78.75 67.5 56.25 45 33.75 22.5 11.25 0
FULL OPEN
FULL CLOSED
CYGNA
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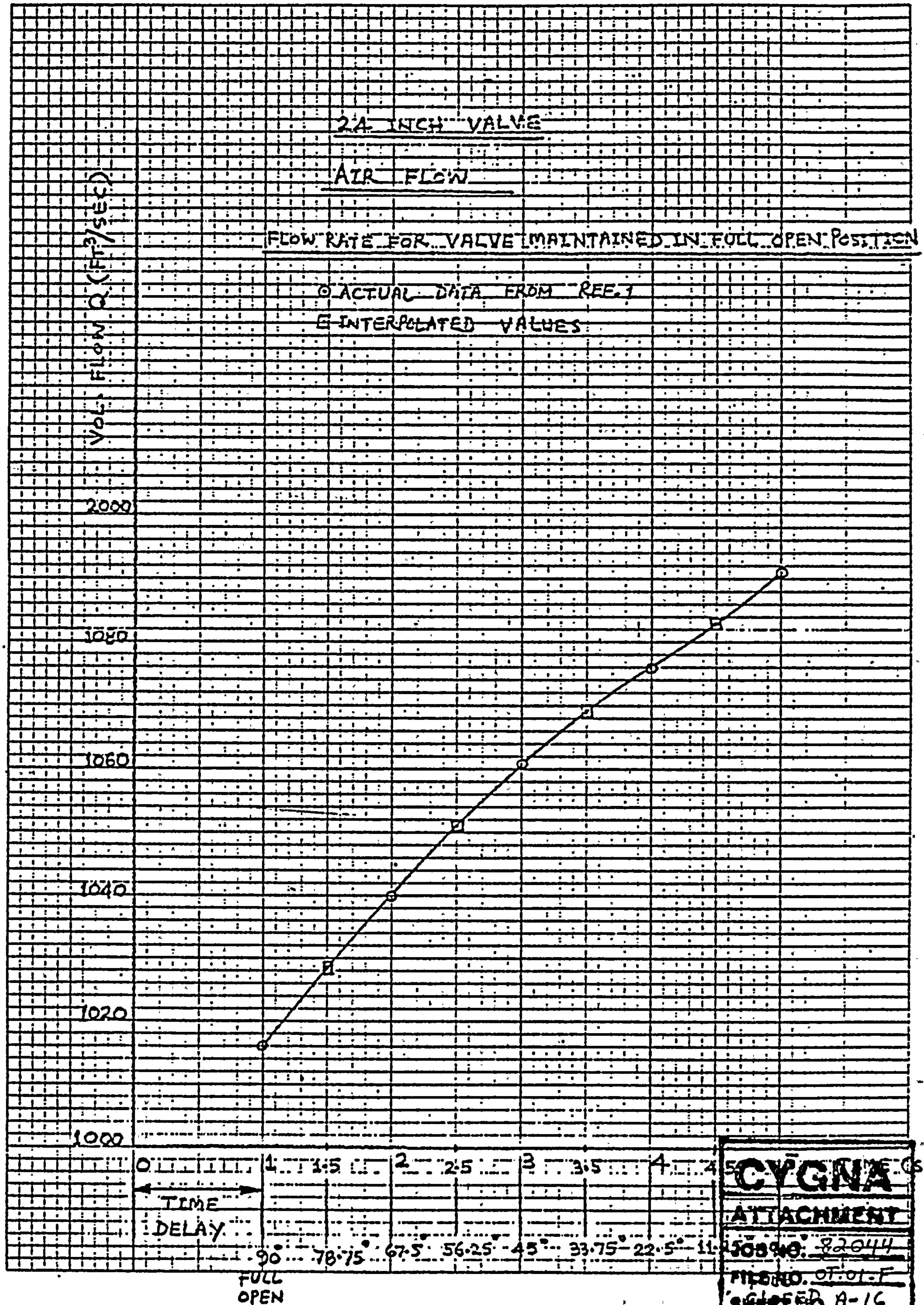
FILE NO. 01.01.F
SHEET NO. A-15



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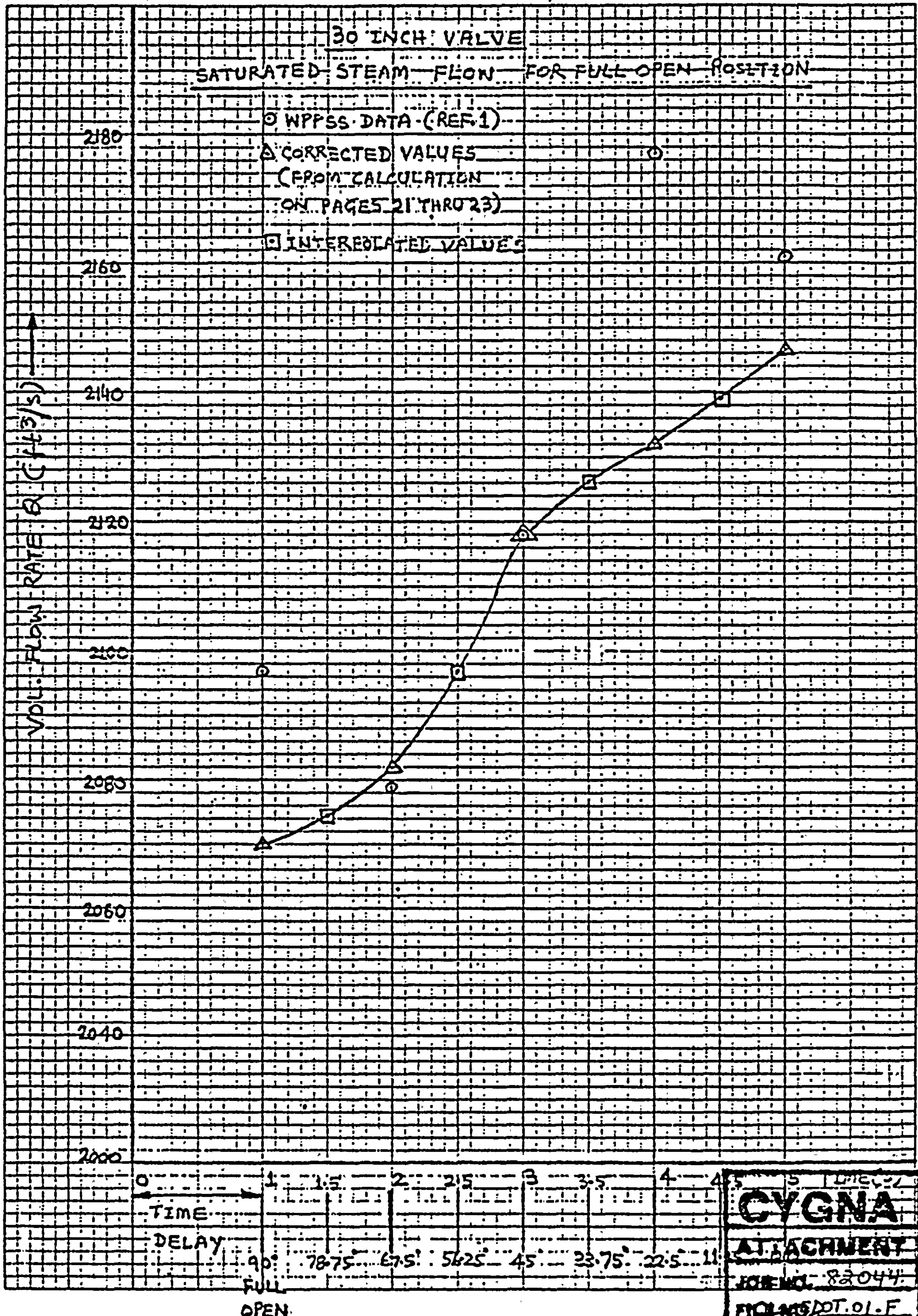

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SHEET NO. A-17

reading the interpolated values of pressure, temperature density and volumetric flow as can be seen from the plots on pages 10 thru 15. Data obtained from reference 1, and the interpolated values are presented below. 8 equal intervals representing 11.25° rotation of the disc are considered.

TABLE - 1

Time s	Angle deg.	Pressure psig	Temp. °F	Air density Lbf/ft^3	Sat.Steam density Lbf/ft^3
1.0	90(Full open)	18	221	0.1295	0.0789
1.5	78.75	19.2*	234*	0.1325*	0.0818
2.0	67.50	20.7	243	0.1359	0.085
2.5	56.25	22.3*	249.5*	0.1405*	0.0886
3.0	45.00	24.0	255	0.1460	0.0926
3.5	33.75	25.4*	259*	0.1515*	0.0953
4.0	22.50	26.7	262	0.156	0.0984
4.5	11.25	27.9*	265*	0.1595*	0.1009
5.0	0.0(full closed)	28.9	268	0.1618	0.1033
*Interpolated from graphs.		↑ Page 10	↑ Page 11	↑ Page 12	↑ For saturated steam from ste table at the given pressure

Coefficient of flow K_v and the dynamic torque coefficient C_T for different angles of valve opening are obtained from the test report reference 7. B I F has conducted extensive test on different types of disc geometry and

disc and shaft orientation with respect to the direction of flow which are summarized in reference 6 and 7. The test medium is water and no air test is undertaken. Reference 6 is for two types of discs, namely, cast iron streamline disc and fabricated flat plate disc. Measurements have been made for dynamic torque coefficient and flow coefficient for both flatside upstream and flatside downstream of the disc. The comparison indicates that the disc orientation of flatside down stream always causes higher dynamic torque. Reference 7 incorporates a directly connected short radius elbow upstream to study the effect of flow non-uniformity on dynamic torque. Several tests have been performed with shaft vertical and shaft horizontal, counter clockwise opening and clock wise opening, with flatside upstream and flatside downstream. These test data are also compared with that of a straight pipe without any elbow upstream of the valve. A careful study of these experimental results indicate that the most severe case is a vertical shaft orientation (i.e. perpendicular to the plane of the elbow) with flatside of the disc downstream with a clockwise rotation of the disc.

This orientation results in approximately 30% increase in maximum dynamic torque coefficient than that obtained for a straight pipe. In this report this most severe case is used to obtain torque coefficients at various angle of valve opening. This approach results in higher torque values and represents the worst condition. The test data are presented in the tabular form.

TABLE - 6

Time Sec.	Angle(α) Deg.	K_v	C_T
1.0	90	0.55	0.275
1.5	78.75	0.70	0.560
2.0	67.50	1.10	0.35
2.5	56.25	2.30	0.175
3.0	45.00	5.20	0.09
3.5	33.75	14.00	0.045
4.0	22.50	45.00	0.02
4.5	11.25	170.00	0.01
5.0	0.0	Closed	0.0

The volume and mass flow rate through the valve due to ascending differential pressure is presented by WPPSS in reference1. We note that this is the flow rate for valve in fully open position. However, the valve is closing gradually and the flow rate should decrease accordingly and when the valve is fully shut the flow rate should reduce to zero. This would occur at the end of 5 seconds. Therefore, we have to obtain the percentage of full open flow corresponding to the appropriate percentage of opening. Reference 3 and 4 provide such information. In reference 3, page 38, the flow characteristic of a butterfly valve is presented. This is a plot of percent of flow versus percent open which shows an equal percentage curve for the firt 25% of flow a linear curve thereafter for the remaining 75% of flow. In reference 4,

page 166, the flow characteristic of Butterfly valve is shown to fall between the linear and equal percentage curve. Therefore from these plots the fraction of maximum flow at a percentage opening can be determined. Before deciding whether to use the linear or equal percentage curve some careful consideration has been given to determine which one should give the worst dynamic torque. Upon some reflection it is observed from equation (1) that the dynamic torque increases when the pressure drop increases. It is also apparent from equation (3) that the pressure drop is greater when the flow rate is greater. This is achieved by using the linear curve which predicts higher flow than the equal percentage curve. Therefore on the basis of this argument following flow rates are established for different degree of opening of the Butterfly valve.

TABLE -7
For 30 inch valve Air flow

Time s	Angle deg.	Percentage open %	Full open Flow ft^3/s	Percentage Flow ft^3/s
1.0	90 Full open	100	1614.9	1614.9
1.5	78.75	87.5	1625*	1423.6
2.0	67.5	75	1646.4	1234.8
2.5	56.25	62.5	2669.5*	1043.4
3.0	45	50	1687.2	843.6
3.5	33.75	37.5	1700*	637.5
4.0	22.5	25	1709.9	427.5
4.5	11.25	12.5	1719.5*	214.9
5.0	0.0 Full Closed	0.0	1734.3	0.0

*Interpolated from graph

Page 13 Ref. 3 and 4

For the 24 inch WPPSS recommends that in order to establish the flow rate same velocity as that of 30 inch valve be used; Therefore following flow rates are obtained from the velocity data of WPPSS.

TABLE-8
For 24 inch valve air flow

Time s	Angled deg.	Velocity ft/s	Full open Flow ft^3/s	Percentage flc ft^3/s
1	90 Full open	352	1015.6	1015.6
1.5	78.75	--(1)	1028*	899.5
2.0	67.5	358.9	1035.5	776.6
2.5	56.25	--	1052*	657.5
3.0	45.00	367.8	1061.2	530.6
3.5	33.75	--	1070*	401.3
4.0	22.5	372.8	1075.6	268.9
4.5	11.20	--	1085*	135.6
5.0	0.0 Full closed	378.1	1090.9	0.0
		Ref.1	Page 14	

(1) Not given

* Interpolated from graph

24 inch valve 1.d = 23 inch

Area = 2.8852 Ft^2

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SHEET NO. A-22

For saturated steam flow data of WPPSS some discrepanceis are observed. Calculations presented on Sheet no. 7 of 9 and 8 of 9 and the table on Sheet 9 of 9 indicate that the flow rate is decreasing with respect to time especially at time 2 and 5 seconds. These data points are plotted on page 15 of this report. Since the containment pressure is rising with respect to time the flow rate should increase. This can be seen from the behavior of the air flow results. Therefore steam flow rates were re-calculated to establish the corrected flow rates. The results are as follows:

Reference 1. Sheet No. 7 of 9 and 8 of 9

30 inch valve saturated steam flow

$$W = 0.525\, y\, d^2 \sqrt{\frac{\Delta P}{K \bar{V}}} \qquad d = 29 \text{ inch, } K=6.0$$

$$q = W \bar{V}$$

At 1 sec. $\Delta p = 18$ psi

$P_1 = 32.7$ psia

$\frac{\Delta P}{P_1} = 0.55$

$Y = 0.76$

$\bar{V} = 12.68$ ft³/Lbf

$$q = W \bar{V} = \left[0.525\,(0.76)\,(29)^2 \sqrt{\frac{18}{6(12.68)}}\right](12.68) = 2070 \text{ ft}^3/\text{s}$$

Steam flow - continued

At 2 Sec.

$\Delta P = 20.7$ psi

$P_1 = 35.4$ psia

$\frac{\Delta P}{P_1} = 0.585$

$Y = 0.74$

$\bar{V} = 11.7222\ ft^3/Lbf$

$$q = \left[0.525\ (0.74)(29)^2 \sqrt{\frac{20.7}{6.0(11.772)}}\right](11.772) = 2082\ ft^3/s$$

Very close to WPPSS result.

At 3 Sec.

Same as WPPSS result $= 2118.2\ ft^3/s$

At 4 Sec.

$\Delta P = 26.7$ psi

$P_1 = 41.4$ psia

$\frac{\Delta P}{P_1} = 0.645$

$Y = 0.718$

$\bar{V} = 10.165\ ft^3/lbf$

$$q = \left[0.525(0.718)(29)^2 \sqrt{\frac{26.7}{6(10.165)}}\right](19.165) = 2132\ ft^3/s$$

10.165

At 5 Sec.

$\Delta P = 28.9$ psi

$P_1 = 43.6$ psia

$\frac{\Delta P}{P_1} = 0.663$

$Y = 0.712$

$\bar{V} = 9.683\ ft^3/lbf$

$$q = \left[0.525(0.712)(29)^2 \sqrt{\frac{28.9}{6(9.683)}}\right](9.683) = 2147\ ft^3/s$$

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These corrected values of steam flow rate is plotted earlier on page 15. From this plot the intermediate values are interpolated.

TABLE-9
30 inch valve, Saturated Steam flow

Time s	Angle deg.	Full open flow ft^3/s	Percentage flow ft^3/s
1.0	90	2070	2070
1.5	78.75	2074*	1814.8
2.0	67.5	2082	1561.5
2.5	56.25	2097*	1310.6
3.0	45	2118.2	1059.1
3.5	33.75	2126*	797.3
4.0	22.50	2132	533.0
4.5	11.25	2139*	267.4
5.0	0.0	2147	0.0

From pages 21 & 22 and reference 1

* Interpolated from the graph on page 15.

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SUMMARY OF RESULTS

Table - 3, 24 Inch Valve, Air flow

Time s	Angle α deg.	Dynamic Torque in-lb
1.0	90 (Full open)	5525
1.5	78.75	11692
2.0	67.50	9095
2.5	56.25	7428
3.0	45.00	6239
3.5	33.75	5430
4.0	22.50	4043
4.5	11.25	2020
5.0	9.0 (Full closed)	0.0 *

T_{Net} = 13808 in-lb

* At full closed position the dynamic torque is zero and the net torque is due to seating and bearing friction.

Note: The design torque used in the Seismic analysis report No. TR-74-7 by McPherson Associate for this valve is 17000 in-lb. Therefore the deisgn is safe.

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SHEET NO. A-6

The corrected values of Steam flow rate obtained for the 30 inch valve were used to arrrive at the proper flow rate for the 24 inch valve based upon the criterion of same velocities in both the valves. The results are presented below.

TABLE 10
25 inch valve, Saturated Steam flow

Time s	Angle deg.	Full open flow for 30" valve, ft^3/s	Full open flow for 24" valve, ft^3/s	Percentage flow, ft^3/s
1.0	90	2070	1289.6	1289.6
1.5	78.75	2074	1291	1130.5
2.0	67.5	2082	1297	972.8
2.5	56.25	2097	1306.4	816.5
3.0	45	2118.2	1319.6	659.8
3.5	33.75	2126	1324.4	496.7
4.0	22.50	2132	1328.2	332.1
4.5	11.25	2139	1332.54	166.6
5.0	0.0	2147	1337.5	0.0

From Page 23 — Shown below

$$\text{Velocity in 30 inch VALVE} = \frac{Q_{30"}}{A_{30"}} = \frac{Q_{30"}}{4.631338} = \text{same velocity in 24 inch valve}$$

$$\text{Full open flow in 24 inch valve} = \frac{Q_{30"}}{A_{30"}}\left(A_{24"}\right) = Q_{30"}\ (0.62297)$$

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SHEET NO. A-26

When the valve shuts off completely the flow through the valve ceases and therefore the dynamic torque vanishes. In this position the differential pressure across the valve disc is the containment absolute pressure minus the atmospheric pressure. This is equal to the gage pressure inside the containment. Thus the necessary torque to completely close the valve and maintain it in the fully-shut condition against the existing differential pressure is due to the sum of the shaft bearing friction torque and the rubber seat friction torque called the seating torque.

The shaft bearing friction torque is presented as equation 2 earlier. The seating torque is given by

$$T_s = C_s D^2 \quad \text{(Ref.2)} \ldots\ldots\ldots\ldots (4)$$

Where

T_s = Seating or unseating torque (in-lb)

C_s = Coefficient of seating or unseating torque (Ref.5)

D = Valve part diameter (inch)

With all data available the necessary calculation is performed using equation (1) through (4). Dynamic torque is calculated for each angular position to determine its maximum value and at what angle it occurs. There are two valves (30 inch and 24 inch) and for each 9 sets of calculation has to be made. Furthermore two flowing media are considered, namely, air and satruated steam. Therefore altogether it requires 36 sets of calculation. For this repetitive type of work a computer program is written following the methodology described earlier in the analytical procedure Section. In order to validate

the computer program hand calculation of several test cases are performed in the beginning. Subsequently the computer results are presented including the input and output. Comparisions with the test cases show there is full agreement with the manual calculation thus verifying the validity of computer program.

SAMPLE CALCULATION

VALVE SIZE: 30 Inch

Medium: Air

Valve opening angle of 90 degree occurring at 1.0 second

Inlet pressure from pressure curve = 18.0 + 14.7 = 32.7 psia

Inlet temperature from temperature curve = 221 + 460 = 681 °R

Note that the higher pressure and temperature are used from the Drywell curves.

Density from the density curve for air or from steam table for Saturated Steam = 0.1295 Lbf/ft³

Full open vlume flow rate from flowrate curve = 1614.9 ft³/s

Percentage flow at percentage opening = (1614.9)(1) = 1614.9 ft³/s

Flow rate in SCFH $Q_s = (5.8136)10^6 \left[\frac{520(32.7)}{14.7(681)}\right] = 9.8749 \times 10^6$ ft³/hr.

Valve coefficient $C_v = \frac{29.9D^2}{\sqrt{K_v}} = \frac{29.9(29.14)^2}{\sqrt{0.55}} = 34.2349 \times 10^3$ $K_v = 0.55$ (Ref.7

Specific gravity $G = \frac{0.1295}{0.0766} = 1.691$ based on air wieght density at 60°F and 1 atm. pressure.

Downstream pressure $p_2 = \sqrt{32.7^2 - \left[\frac{(9.8749)10^6}{963(34.2349)10^3}\right]^2 (1.691)(681)} = 31.08$ psia

Therefore pressure drop $\Delta p = p_1 - p_2 = 1.62$ psi

Dynamic torque $T_D = C_T \Delta P D^3 = 11023$ in-lb $C_T = .275$ (Ref. 7 elbow effect plus most adverse shaft orientation and disc rotation)

CYGNA
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FILE NO. OT.01.F
SHEET NO. A-29

The shaft friction torque $T_b = \frac{\pi}{4}(29.14)^2\left[0.004(2.5/2)(1.62)\right]$

$= 5.402$ in-lb (NEGLIGIBLY SMALL)[1]

Therefore the net unbalanced torque is $T_N = T_D - T_b = 11017.6$ in-lb

This is a set of calculation for one valve angle.
Similar calcualations are performed for different angles and presented in subsequent pages.

(1) THE SHAFT FRICTION TORQUE IS NEGLIGIBLY SMALL. THEREFORE NO FURTHER CALCULATION OF THIS TORQUE WOULD BE MADE. SINCE THIS IS SUBTRACTED FROM THE DYNAMIC TORQUE TO OBTAIN THE NET TORQUE AT ANY ANGULAR POSITION THIS APPROACH IS CONSERVATIVE.

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-30

SAMPLE CALCULATION

VALVE SIZE: 30 Inch

Medium: Air

Valve opening angle of 78.75 degree occurring at 1.5 second

Inlet pressure from pressure curve = 19.2 + 14.7 = 33.9 psia

Inlet temperature from temperature curve = 234 + 460 = 694 °R

Note that the higher pressure and temperature are used from the Drywell curves.

Density from the density curve for air or from steam table for Saturated Steam = 0.1325 lbf/ft^3

Full open volume flow rate from flowrate curve = 1627 ft^3/s

Percentage flow at percentage opening = (1627)(0.875) = 1423.6 ft^3/s

Flow rate in SCFH $Q_S = (5.1249)10^6 \left[\frac{520(33.9)}{14.7(694)}\right] = 8.8555 \times 10^6$ ft^3/hr

Valve coefficient $C_V = \frac{29.9D^2}{\sqrt{K_V}} = \frac{29.9(29.14)^2}{\sqrt{0.70}} = 30.346 \times 10^3$ $K_V = 0.70$ (Ref.7

Specific gravity $G = \frac{0.1325}{0.0766} = 1.73$ based on air wieght density at 60°F and 1 atm. pressure.

Downstream pressure $p_2 = \sqrt{33.9^2 - \left[\frac{(8.8555)10^6}{963(30.346)10^3}\right]^2 (1.73)(694)} = 32.23$ psia

Therefore pressure drop $\Delta p = P_1 - P_2 = 1.667$ psi

Dynamic torque $T_D = C_T \Delta P D^3 = 23098$ in-lb $C_T = .56$ (Ref. 7 elbow effect plus most adverse shaft orientation and disc rotation)

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-31

RUN

VALVE 17:18 SUN 07 NOV 82 30 INCH VALVE, AIR FLOW

ENTER THE NUMBER OF DATA SETS
?9

FOR EACH DATA SET ENTER THE FOLLOWING DATA IN ITS
RESPECTIVE ORDER SEPERATED BY A COMMA OR A BLANK.

A) UPSTREAM PRESSURE IN PSIG
B) UPSTREAM TEMPERATURE IN DEG. F
C) DENSITY IN LB/FT**3
D) ACTUAL FLOW RATE IN FT**3/SEC
E) LOSS COEFFICIENT
F) TORQUE COEFFICIENT

ENTER DATA FOR SET NO. 1
?18 221 .1295 1614.9 .55 .275

ENTER DATA FOR SET NO. 2
?19.2 234 .1325 1423.6 .7 .56

ENTER DATA FOR SET NO. 3
?20.7 243 .1359 1234.8 1.1 .35

ENTER DATA FOR SET NO. 4
?22.3 249.5 .1405 1043.4 2.3 .175

ENTER DATA FOR SET NO. 5
?24 255 .146 843.6 5.2 .09

ENTER DATA FOR SET NO. 6
?25.4 259 .1515 637.5 14 .045

ENTER DATA FOR SET NO. 7
?26.7 262 .156 427.5 45 .02

ENTER DATA FOR SET NO. 8
?27.9 265 .1595 214.9 170 .01

ENTER DATA FOR SET NO. 9
?28.9 268 .1618 0 CLOSED .0

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-32

IE INPUT IS AS FOLLOWS:

:T NO.	P PSI	T DEG. F	RO LB/FT**3	QA FT**3/SEC	KV	CT
1	18.0	221.0	0.1295	1614.9	0.55	0.275
2	19.2	234.0	0.1325	1423.6	0.70	0.560
3	20.7	243.0	0.1359	1234.8	1.10	0.350
4	22.3	249.5	0.1405	1043.4	2.30	0.175
5	24.0	255.0	0.1460	843.6	5.20	0.090
6	25.4	259.0	0.1515	637.5	14.00	0.045
	26.7	262.0	0.1560	427.5	45.00	0.020
8	27.9	265.0	0.1595	214.9	170.00	0.010
9	28.9	268.0	0.1618	0.0	CLOSED	0.0

! YOU W ISH TO MAKE ANY CHANGES?
!O

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-33

CALCULATION AT ANGLE = 90 DEG. OCCURING AT TIME = 1.0 S

ABSOLUTE UPSTREAM PRESSURE P1 = 32.7 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 681.0 DEG. R

FLOW RATE IN SCFH = 9874936. FT**3/HR

VALVE COEFFICIENT CV = 34234.9

SPECIFIC GRAVITY G = 1.691

CALCULATED DOWNSTREAM PRESSURE P2 = 31.1 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 1.620 PSI

DYNAMIC TORQUE TD = 11020. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-34

CALCULATION AT ANGLE = 73.75 DEG. OCCURING AT TIME = 1.5 S

ABSOLUTE UPSTREAM PRESSURE P1 = 33.9 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 694.0 DEG. R

FLOW RATE IN SCFH = 8855571. FT**3/HR

VALVE COEFFICIENT CV = 30346.0

SPECIFIC GRAVITY G = 1.730

CALCULATED DOWNSTREAM PRESSURE P2 = 32.2 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 1.667 PSI

DYNAMIC TORQUE TD = 23098. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-35

CALCULATION AT ANGLE = 67.5 DEG. OCCURING AT TIME = 2.0 SE

ABSOLUTE UPSTREAM PRESSURE P1 = 35.4 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 703.0 DEG. R

FLOW RATE IN SCFH = 7918319. FT**3/HR

VALVE COEFFICIENT CV = 24207.7

SPECIFIC GRAVITY G = 1.774

CALCULATED DOWNSTREAM PRESSURE P2 = 33.3 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 2.094 PSI

DYNAMIC TORQUE TD = 18138. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-36

CALCULATION AT ANGLE = 56.25 DEG. OCCURING AT TIME = 2.5 SI

ABSOLUTE UPSTREAM PRESSURE P1 = 37.0 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 709.5 DEG. R

FLOW RATE IN SCFH = 6929288. FT**3/HR

VALVE COEFFICIENT CV = 16741.2

SPECIFIC GRAVITY G = 1.834

CALCULATED DOWNSTREAM PRESSURE P2 = 33.6 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 3.406 PSI

DYNAMIC TORQUE TD = 14747. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-37

CALCULATION AT ANGLE = 45 DEG. OCCURING AT TIME = 3.0 SI

ABSOLUTE UPSTREAM PRESSURE P1 = 38.7 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 715.0 DEG. R

FLOW RATE IN SCFH = 5814734. FT**3/HR

VALVE COEFFICIENT CV = 11133.9

SPECIFIC GRAVITY G = 1.906

CALCULATED DOWNSTREAM PRESSURE P2 = 33.1 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 5.581 PSI

DYNAMIC TORQUE TD = 12428. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-38

CALCULATION AT ANGLE = 33.75 DEG. OCCURING AT TIME = 3.5 S

ABSOLUTE UPSTREAM PRESSURE P1 = 40.1 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 719.0 DEG. R

FLOW RATE IN SCFH = 4527766. FT**3/HR

VALVE COEFFICIENT CV = 6785.6

SPECIFIC GRAVITY G = 1.978

CALCULATED DOWNSTREAM PRESSURE P2 = 30.4 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 9.682 PSI

DYNAMIC TORQUE TD = 10780. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-39

CALCULATION AT ANGLE = 22.5 DEG. OCCURING AT TIME = 4.0 SE

ABSOLUTE UPSTREAM PRESSURE P1 = 41.4 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 722.0 DEG. R

FLOW RATE IN SCFH = 3121673. FT**3/HR

VALVE COEFFICIENT CV = 3784.8

SPECIFIC GRAVITY G = 2.037

CALCULATED DOWNSTREAM PRESSURE P2 = 25.2 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 16.194 PSI

DYNAMIC TORQUE TD = 8014. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-40

CALCULATION AT ANGLE = 11.25 DEG. OCCURING AT TIME = 4.5 S

ABSOLUTE UPSTREAM PRESSURE P1 = 42.6 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 725.0 DEG. R

FLOW RATE IN SCFH = 1608037. FT**3/HR

VALVE COEFFICIENT CV = 1947.3

SPECIFIC GRAVITY G = 2.082

CALCULATED DOWNSTREAM PRESSURE P2 = 26.5 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 16.054 PSI

DYNAMIC TORQUE TD = 3972. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-41

CALCULATION AT ANGLE = 0 DEG. OCCURING AT TIME = 5.0 SE

ABSOLUTE UPSTREAM PRESSURE P1 = 43.6 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 728.0 DEG. R

FLOW RATE IN SCFH = 0. FT**3/HR

VALVE COEFFICIENT CV = 0.0

SPECIFIC GRAVITY G = 2.112

PRESSURE DROP ACCROSS THE VALVE DP = 0.000 PSI

DYNAMIC TORQUE TD = 0. LB-IN

SEE NEXT PAGE FOR SEATING TORQUE.

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-42

Valve in full closed position. Angle $\alpha = 0^\circ$

This occurs at 5.0 second

Upstream pressure = 28.9 + 14.7 = 43.6 psia

Downstream pressure = Atmospheric = 14.7 psia, valve fully shut downstream is exposed to atmosphere.

Differential pressure Δp = 43.6 - 14.7 = 28.9 psi

Flow rate is zero since the valve is fully closed. Therefore the dynamic torque is zero.

Friction torque at the shaft bearing is

$$T_b = \frac{\pi}{8} (D^2)(f_b d) \Delta p$$

$$= \frac{\pi}{8}(29.14)^2(0.004)(2.5)(28.9) \quad \text{(Ref. 5)}$$

$$= 96.4 \quad \text{in-lb}$$

Valve seating torque due to rubber friction is

$$T_s = D^2 K$$

$$= (29.14)^2(26) = 22077.6 \text{ in-lb} \quad \text{(Ref. 5)}$$

Net torque $T_N = T_b + T_s$ = 22174 in-lb

NOTE THAT RUBBER FRICTION COEFFICIENT K WOULD BE LESS THAN 26 OBTAINED FROM REF. 5. THIS VALUE IS FOR A DIFFERENTIAL PRESSURE OF 45 PSI WHICH IS GREATER THAN THE VALUE OF 28.9 PSI. THEREFORE THE VALUE OF T_s IS CONSERVATIVE.

SAMPLE CALCULATION

VALVE SIZE: 30 Inch

Medium: Saturated Steam

Valve opening angle of 78.75 degree occurring at 1.5 second

Inlet pressure from pressure curve = 19.2 + 14.7 = 33.9 psia

Inlet temperature from temperature curve = 234 + 460 = 694 °R

Note that the higher pressure and temperature are used from the Drywell curves.

Density from the density curve for air or from steam table for Saturated Steam = 0.0818 Lbf/ft^3

Full open volume flow rate from flowrate curve = 2074 ft^3/s

Percentage flow at percentage opening = (2074)(.875) = 1814.8 ft^3/s

Flow rate in SCFH $Q_S = (6.533)10^6 \left[\frac{520(33.9)}{14.7(694)}\right] = 11.289 \times 10^6$ ft^3/hr

Valve coefficient $C_V = \frac{29.9D^2}{\sqrt{K_V}} = \frac{29.9(28.14)^2}{\sqrt{0.70}} = 30.346 \times 10^3$ $K_V = 0.70$ (Ref.7)

Specific gravity $G = \frac{0.0818}{0.0766} = 1.068$ based on air wieght density at 60°F and 1 atm. pressure.

Downstream pressure $p_2 = \sqrt{33.9^2 - \left[\frac{(11.289)10^6}{963(30.346)10^3}\right]^2 (1.068)(694)} = 32.2275$ psia

Therefore pressure drop $\Delta p = p_1 - p_2 = 1.6725$ psi

Dynamic torque $T_D = C_T \Delta p D^{\cdot 3} = 23175$ in-lb $C_T = .56$ (Ref. 7 elbow effect plus most adverse shaft orientation and disc rotation)

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-44

SAMPLE CALCULATION

VALVE SIZE: 30 Inch

Medium: Saturated Steam

Valve opening angle of 67.5 degree occurring at 2.0 second

Inlet pressure from pressure curve = 20.7 + 14.7 = 35.4 psia

Inlet temperature from temperature curve = 243 + 460 = 703 °R

Note that the higher pressure and temperature are used from the Drywell curves.

Density from the density curve for air or from steam table for Saturated Steam = 0.085 Lbf/ft^3

Full open volume flow rate from flowrate curve = 2082 ft^3/s

Percentage flow at percentage opening = (2082)(0.75)= 1561.5 ft^3/s

Flow rate in SCFH $Q_s = (5.621)10^6 \left[\frac{520(35.4)}{14.7(703)}\right] = 10.0133 \times 10^6$ ft^3/hr.

Valve coefficient $C_v = \frac{29.9D^2}{\sqrt{K_v}} = \frac{29.9(29.14)^2}{\sqrt{1.1}} = 24.2077 \times 10^3$ $K_v = 1.1$ (Ref.7

Specific gravity $G = \frac{0.085}{0.0766} = 1.11$ based on air wieght density at 60°F and 1 atm. pressure.

Downstream pressure $p_2 = \sqrt{35.4^2 - \left[\frac{(10.0133)10^6}{963(24.207)10^3}\right]^2 (1.11)(703)} = 33.31$ psia

Therefore pressure drop $\Delta p = p_1 - p_2 = 2.09$ psi

Dynamic torque $T_D = C_T \Delta P D^3 = 18100$ in-Lb $C_T = .35$ (Ref. 7 elbow effect plus most adverse shaft orientation and disc rotation)

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-45

RUN

VALVE . 17:28 SUN 07 NOV 82 . 30 INCH VALVE

STEAM FLOW

42

ENTER THE NUMBER OF DATA SETS

FOR EACH DATA SET ENTER THE FOLLOWING DATA IN ITS RESPECTIVE ORDER SEPERATED BY A COMMA OR A BLANK.

A) UPSTREAM PRESSURE IN PSIG
B) UPSTREAM TEMPERATURE IN DEG. F
C) DENSITY IN LB/FT**3
D) ACTUAL FLOW RATE IN FT**3/SEC
E) LOSS COEFFICIENT
F) TORQUE COEFFICIENT

ENTER DATA FOR SET NO. 1
?18 221 .0789 2070 .55 .275

ENTER DATA FOR SET NO. 2
?19.2 234 .0818 1814.8 .7 .56

ENTER DATA FOR SET NO. 3
?20.7 243 .085 1561.5 1.1 .35

ENTER DATA FOR SET NO. 4
?22.3 249.5 .0886 1310.6 2.3 .175

ENTER DATA FOR SET NO. 5
?24 255 .0926 1059.1 5.2 .09

ENTER DATA FOR SET NO. 6
?25.4 259 .0953 797.3 14 .045

ENTER DATA FOR SET NO. 7
?26.7 262 .0984 533 45 .02

ENTER DATA FOR SET NO. 8
?27.9 265 .1009 267.4 170 .01

ENTER DATA FOR SET NO. 9
?28.9 268 .1033 0 CLOSED 0

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-46

THE INPUT IS AS FOLLOWS:

SET NO.	P PSI	T DEG. F	RO LB/FT**3	QA FT**3/SEC	KV	CT
1	18.0	221.0	0.0789	2070.0	0.55	0.275
2	19.2	234.0	0.0818	1814.8	0.70	0.560
3	20.7	243.0	0.0850	1561.5	1.10	0.350
4	22.3	249.5	0.0886	1310.6	2.30	0.175
5	24.0	255.0	0.0926	1059.1	5.20	0.090
6	25.4	259.0	0.0953	797.3	14.00	0.045
7	26.7	262.0	0.0984	533.0	45.00	0.020
8	27.9	265.0	0.1009	267.4	170.00	0.010
9	28.9	268.0	0.1033	0.0	CLOSED	0.0

DO YOU W'ISH TO MAKE ANY CHANGES?
?NO

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-47

CALCULATION AT ANGLE = 90 DEG. OCCURING AT TIME = 1.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 32.7 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 681.0 DEG. R

FLOW RATE IN SCFH = 12657823. FT**3/HR

VALVE COEFFICIENT CV = 34234.9

SPECIFIC GRAVITY G = 1.030

CALCULATED DOWNSTREAM PRESSURE P2 = 31.1 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 1.621 PSI

DYNAMIC TORQUE TD = 11032. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-48

CALCULATION AT ANGLE = 78.75 DEG. OCCURING AT TIME = 1.5 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 33.9 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 694.0 DEG. R

FLOW RATE IN SCFH = 11289048. FT**3/HR

VALVE COEFFICIENT CV = 30346.0

SPECIFIC GRAVITY G = 1.068

CALCULATED DOWNSTREAM PRESSURE P2 = 32.2 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 1.673 PSI

DYNAMIC TORQUE TD = 23175. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-49

CALCULATION AT ANGLE = 67.5 DEG. OCCURING AT TIME = 2.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 35.4 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 703.0 DEG. R

FLOW RATE IN SCFH = 10013326. FT**3/HR

VALVE COEFFICIENT CV = 24207.7

SPECIFIC GRAVITY G = 1.110

CALCULATED DOWNSTREAM PRESSURE P2 = 33.3 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 2.095 PSI

DYNAMIC TORQUE TD = 18142. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-50

CALCULATION AT ANGLE = 56.25 DEG. OCCURING AT TIME = 2.5 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 37.0 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 709.5 DEG. R

FLOW RATE IN SCFH = 8703782. FT**3/HR

VALVE COEFFICIENT CV = 16741.2

SPECIFIC GRAVITY G = 1.157

CALCULATED DOWNSTREAM PRESSURE P2 = 33.6 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 3.387 PSI

DYNAMIC TORQUE TD = 14668. LB-IN

CALCULATION AT ANGLE = 45 DEG. OCCURING AT TIME = 3.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 38.7 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 715.0 DEG. R

FLOW RATE IN SCFH = 7300124. FT**3/HR

VALVE COEFFICIENT CV = 11133.9

SPECIFIC GRAVITY G = 1.209

CALCULATED DOWNSTREAM PRESSURE P2 = 33.1 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 5.579 PSI

DYNAMIC TORQUE TD = 12424. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-52

CALCULATION AT ANGLE = 33.75 DEG. OCCURING AT TIME = 3.5 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 40.1 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 719.0 DEG. R

FLOW RATE IN SCFH = 5662727. FT**3/HR

VALVE COEFFICIENT CV = 6785.6

SPECIFIC GRAVITY G = 1.244

CALCULATED DOWNSTREAM PRESSURE P2 = 30.6 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 9.502 PSI

DYNAMIC TORQUE TD = 10580. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-53

[illegible]

CALCULATION AT ANGLE = 22.5 DEG. OCCURING AT TIME = 4.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 41.4 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 722.0 DEG. R

FLOW RATE IN SCFH = 3892051. FT**3/HR

VALVE COEFFICIENT CV = 3784.8

SPECIFIC GRAVITY G = 1.285

CALCULATED DOWNSTREAM PRESSURE P2 = 25.6 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 15.780 PSI

DYNAMIC TORQUE TD = 7809. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-54

CALCULATION AT ANGLE = 11.25 DEG. OCCURING AT TIME = 4.5 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 42.6 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 725.0 DEG. R

FLOW RATE IN SCFH = 2000880. FT**3/HR

VALVE COEFFICIENT CV = 1947.3

SPECIFIC GRAVITY G = 1.317

CALCULATED DOWNSTREAM PRESSURE P2 = 27.0 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 15.628 PSI

DYNAMIC TORQUE TD = 3867. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-55

CALCULATION AT ANGLE = 0.0 DEG. OCCURING AT TIME = 5.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 43.6 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 728.0 DEG. R

FLOW RATE IN SCFH = 0. FT**3/HR

VALVE COEFFICIENT CV = 0.0

SPECIFIC GRAVITY G = 1.349

PRESSURE DROP ACCROSS THE VALVE DP = 0.000 PSI

DYNAMIC TORQUE TD = 0. LB-IN

SEATING TORQUE IS SAME AS SHOWN IN PAGE 39

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-52

SAMPLE CALCULATION

VALVE SIZE: 24 Inch

Medium: AIR

Valve opening angle of 78.75 degree occurring at 1.5 second

Inlet pressure from pressure curve = 19.2 + 14.7 = 33.9 psia

Inlet temperature from temperature curve = 234 + 460 = 694 °R

Note that the higher pressure and temperature are used from the Drywell curves.

Density from the density curve for air or from steam table for Saturated Steam = 0.1325 Lbf/ft^3

Full open volume flow rate from flowrate curve = 1028 ft^3/s

Percentage flow at percentage opening = (1028)(.875) = 899.5 ft^3/s

Flow rate in SCFH $Q_S = (3.228)10^6 \left[\frac{520(33.9)}{14.7(694)}\right] = 5.59538 \times 10^6$ ft^3/hr.

Valve coefficient $C_V = \frac{29.9D^2}{\sqrt{K_V}} = \frac{29.9(23.0)^2}{\sqrt{0.70}} = 18.905 \times 10^3$ $K_V = 0.70$ (Ref. 7)

Specific gravity $G = \frac{0.1325}{0.0766} = 1.73$ based on air wieght density at 60°F and 1 atm. pressure.

Downstream pressure $p_2 = \sqrt{33.9^2 - \left[\frac{(5.59538)10^6}{963(18.905)10^3}\right]^2 (1.73)(694)} = 32.184$ psia

Therefore pressure drop $\Delta p = p_1 - p_2 = 1.716$ psi

Dynamic torque $T_D = C_T \Delta p \, D^3 = 11692$ in-Lb $C_T = .56$ (Ref. 7 elbow effect plus most adverse shaft orientation and disc rotation)

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-57

SAMPLE CALCULATION

VALVE SIZE: 24 Inch

Medium: AIR

Valve opening angle of 56.25 degree occurring at 2.5 second

Inlet pressure from pressure curve = 22.3 + 14.7 = 37 psia

Inlet temperature from temperature curve = 249.5 + 460 = 709.5 °R

Note that the higher pressure and temperature are used from the Drywell curves.

Density from the density curve for air or from steam table for Saturated Steam = 0.1405 lbf/ft³

Full open volume flow rate from flowrate curve = 1052 ft³/s

Percentage flow at percentage opening = (1052)(0.625) = 657.5 ft³/s

Flow rate in SCFH $Q_S = (2.367)10^6 \left[\frac{520(37)}{14.7(709.5)}\right] = 4.3665 \times 10^6$ ft³/hr

Valve coefficient $C_V = \frac{29.9D^2}{\sqrt{K_V}} = \frac{29.9(23)^2}{\sqrt{2.3}} = 10.4295 \times 10^3$ $K_V = 2.3$ (Ref. 7

Specific gravity $G = \frac{0.1405}{0.0766} = 1.834$ based on air wieght density at 60°F and 1 atm. pressure.

Downstream pressure $p_2 = \sqrt{37^2 - \left[\frac{(4.3665)10^6}{963(10.4295)10^3}\right]^2 (1.834)(709.5)} = 33.512$ psia

Therefore pressure drop $\Delta p = P_1 - P_2 = 3.488$ psi

Dynamic torque $T_D = C_T \Delta P D^3 = 7427$ in-lb $C_T = .175$ (Ref. 7 elbow effect plus most adverse shaft orientation and disc rotation)

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-58

RUN

VALVE 17:39 SUN 07 NOV 82 24 INCH VALVE 55

AIR FLOW

ENTER THE NUMBER OF DATA SETS

?9

FOR EACH DATA SET ENTER THE FOLLOWING DATA IN ITS RESPECTIVE ORDER SEPERATED BY A COMMA OR A BLANK.

A) UPSTREAM PRESSURE IN PSIG
B) UPSTREAM TEMPERATURE IN DEG. F
C) DENSITY IN LB/FT**3
D) ACTUAL FLOW RATE IN FT**3/SEC
E) LOSS COEFFICIENT
F) TORQUE COEFFICIENT

ENTER DATA FOR SET NO. 1
?18 221 .1295 1015.6 .55 .275

ENTER DATA FOR SET NO. 2
?19.2 234 .1325 899.5 .7 .56

ENTER DATA FOR SET NO. 3
?20.7 243 .1359 776.6 1.1 .35

ENTER DATA FOR SET NO. 4
?22.3 249.5 .1405 657.5 2.3 .175

ENTER DATA FOR SET NO. 5
?24 255 .146 530.6 5.2 .09

ENTER DATA FOR SET NO. 6
?25.4 259 .1515 401.3 14 .045

ENTER DATA FOR SET NO. 7
?26.7 262 .156 268.9 45 .02

ENTER DATA FOR SET NO. 8
?27.9 265 .1595 135.6 170 .01

ENTER DATA FOR SET NO. 9
?28.9 268 .1618 0 CLOSED 0

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-57

THE INPUT IS AS FOLLOWS:

SET NO.	P PSI	T DEG. F	RO LB/FT**3	QA FT**3/SEC	KV	CT
1	18.0	221.0	0.1295	1015.6	0.55	0.275
2	19.2	234.0	0.1325	899.5	0.70	0.560
3	20.7	243.0	0.1359	776.6	1.10	0.350
4	22.3	249.5	0.1405	657.5	2.30	0.175
5	24.0	255.0	0.1460	530.6	5.20	0.090
6	25.4	259.0	0.1515	401.3	14.00	0.045
7	26.7	262.0	0.1560	268.9	45.00	0.020
8	27.9	265.0	0.1595	135.6	170.00	0.010
9	28.9	268.0	0.1618	0.0	CLOSED	0.0

DO YOU WISH TO MAKE ANY CHANGES?
?NO

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-60

CALCULATION AT ANGLE = 90 DEG. OCCURING AT TIME = 1.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 32.7 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 681.0 DEG. R

FLOW RATE IN SCFH = 6210283. FT**3/HR

VALVE COEFFICIENT CV = 21327.8

SPECIFIC GRAVITY G = 1.691

CALCULATED DOWNSTREAM PRESSURE P2 = 31.0 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 1.651 PSI

DYNAMIC TORQUE TD = 5525. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-61

CALCULATION AT ANGLE = 78.75 DEG. OCCURING AT TIME = 1.5 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 33.9 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 694.0 DEG. R

FLOW RATE IN SCFH = 5595381. FT**3/HR

VALVE COEFFICIENT CV = 18905.0

SPECIFIC GRAVITY G = 1.730

CALCULATED DOWNSTREAM PRESSURE P2 = 32.2 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 1.716 PSI

DYNAMIC TORQUE TD = 11692. LB-IN

CALCULATION AT ANGLE = 67.5 DEG. OCCURING AT TIME = 2.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 35.4 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 703.0 DEG. R

FLOW RATE IN SCFH = 4980051. FT**3/HR

VALVE COEFFICIENT CV = 15081.0

SPECIFIC GRAVITY G = 1.774

CALCULATED DOWNSTREAM PRESSURE P2 = 33.3 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 2.136 PSI

DYNAMIC TORQUE TD = 9095. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-63

CALCULATION AT ANGLE = 56.25 DEG. OCCURING AT TIME = 2.5 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 37.0 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 709.5 DEG. R

FLOW RATE IN SCFH = 4366501. FT**3/HR

VALVE COEFFICIENT CV = 10429.5

SPECIFIC GRAVITY G = 1.834

CALCULATED DOWNSTREAM PRESSURE P2 = 33.5 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 3.488 PSI

DYNAMIC TORQUE TD = 7428. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-64

CALCULATION AT ANGLE = 45 DEG. OCCURING AT TIME = 3.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 38.7 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 715.0 DEG. R

FLOW RATE IN SCFH = 3657300. FT**3/HR

VALVE COEFFICIENT CV = 6936.3

SPECIFIC GRAVITY G = 1.906

CALCULATED DOWNSTREAM PRESSURE P2 = 33.0 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 5.698 PSI

DYNAMIC TORQUE TD = 6239. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-65

CALCULATION AT ANGLE = 33.75 DEG. OCCURING AT TIME = 3.5 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 40.1 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 719.0 DEG. R

FLOW RATE IN SCFH = 2850185. FT**3/HR

VALVE COEFFICIENT CV = 4227.3

SPECIFIC GRAVITY G = 1.978

CALCULATED DOWNSTREAM PRESSURE P2 = 30.2 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 9.918 PSI

DYNAMIC TORQUE TD = 5430. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-6.6

CALCULATION AT ANGLE = 22.5 DEG. OCCURING AT TIME = 4.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 41.4 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 722.0 DEG. R

FLOW RATE IN SCFH = 1963550. FT**3/HR

VALVE COEFFICIENT CV = 2357.9

SPECIFIC GRAVITY G = 2.037

CALCULATED DOWNSTREAM PRESSURE P2 = 24.8 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 16.613 PSI

DYNAMIC TORQUE TD = 4043. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-67

CALCULATION AT ANGLE = 11.25 DEG. OCCURING AT TIME = 4.5 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 42.6 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 725.0 DEG. R

FLOW RATE IN SCFH = 1014658. FT**3/HR

VALVE COEFFICIENT CV = 1213.1

SPECIFIC GRAVITY G = 2.082

CALCULATED DOWNSTREAM PRESSURE P2 = 26.0 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 16.601 PSI

DYNAMIC TORQUE TD = 2020. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-62

CALCULATION AT ANGLE = 0. DEG. OCCURING AT TIME = 5.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 43.6 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 728.0 DEG. R

FLOW RATE IN SCFH = 0. FT**3/HR

VALVE COEFFICIENT CV = 0.0

SPECIFIC GRAVITY G = 2.112

PRESSURE DROP ACCROSS THE VALVE DP = 0.000 PSI

DYNAMIC TORQUE TD = 0. LB-IN

SEE NEXT PAGE FOR SEATING TORQUE.

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT-01-F
SHEET NO. A-C9

Valve in full closed position. Angle $\alpha = 0°$

This occurs at 5.0 second

Upstream pressure = 28.9 + 14.7 = 43.6 psia

Downstream pressure = Atmospheric = 14.7 psia, valve fully shut downstream is exposed to atmosphere.

Differential pressure Δp = 43.6 - 14.7 = 28.9 psi

Flow rate is zero since the valve is fully closed. Therefore the dynamic torque is zero.

Friction torque at the shaft bearing is

$$T_b = \frac{\pi}{8} (D^2) (f_b\ d) \Delta p$$

$$= \frac{\pi}{8} (23)^2 (0.004)(2.25)(28.9) \quad \text{(Ref. 5)}$$

$$= 54 \quad \text{in-lb}$$

Valve seating torque due to rubber friction is

$$T_s = D^2 K$$

$$= (23)^2 (26) \quad \text{(Ref. 5)}$$

Net torque $T_N = T_b + T_s$ = 13808 in-lb

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-70

SAMPLE CALCULATION

VALVE SIZE: 24 Inch

Medium: saturated Steam

Valve opening angle of 78.75 degree occurring at 1.5 second

Inlet pressure from pressure curve = 19.2 + 14.7 = 33.9 psia

Inlet temperature from temperature curve = 234 + 460 = 694 °R

Note that the higher pressure and temperature are used from the Drywell curves.

Density from the density curve for air or from steam table for Saturated Steam = 0.0818 Lbf/ft³

Full open vlume flow rate from flowrate curve = 1292 ft³/s

Percentage flow at percentage opening = (1292)(.875) = 1130.5 ft³/s

Flow rate in SCFH $Q_S = (4.0698)10^6 \left[\frac{520(33.9)}{14.7(694)}\right] = 7.0323 \times 10^6$ ft³/hr

Valve coefficient $C_V = \frac{29.9D^2}{\sqrt{K_V}} = \frac{29.9(23)^2}{\sqrt{0.70}} = 18.905 \times 10^3$ $K_V = 0.70$ (Ref.7)

Specific gravity $G = \frac{0.0818}{0.0766} = 1.0683$ based on air wieght density at 60°F and 1 atm. pressure.

Downstream pressure $p_2 = \sqrt{33.9^2 - \left[\frac{(7.0233)10^6}{963(18.905)10^3}\right]^2 (1.063)(694)} = 32.228$ psia

Therefore pressure drop $\Delta p = p_1 - p_2 = 1.672$ psi

Dynamic torque $T_D = C_T \Delta P D^3 = 11394$ in-Lb $C_T = .56$ (Ref. 7 elbow effect plus most adverse shaft orientation and disc rotation)

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-71

SAMPLE CALCULATION

VALVE SIZE: 24 Inch

Medium: Saturated steam

Valve opening angle of 22.5 degree occurring at 4 second

Inlet pressure from pressure curve = 26.7 + 14.7 = 41.4 psia

Inlet temperature from temperature curve = 262 + 460 = 722 °R

Note that the higher pressure and temperature are used from the Drywell curves.

Density from the density curve for air or from steam table for Saturated Steam = 0.0984 Lbf/ft³

Full open volume flow rate from flowrate curve = 1328.2 ft³/s

Percentage flow at percentage opening = (1328.2)(0.25) = 332.05 ft³/s

Flow rate in SCFH $Q_s = (1.1954)10^6\left[\frac{520(41.4)}{14.7(722)}\right] = 2.4247\times10^6$ ft³/hr

Valve coefficient $C_v = \frac{29.9D^2}{\sqrt{K_v}} = \frac{29.9(23)^2}{\sqrt{45}} = 2.3579\times10^3$ $K_v = 45$ (Ref. 7)

Specific gravity $G = \frac{0.0984}{0.0766} = 1.2843$ based on air wieght density at 60°F and 1 atm. pressure.

Downstream pressure $p_2 = \sqrt{41.4^2 - \left[\frac{(2.4247)10^6}{963(2.3579)10^3}\right]^2 (1.2843)(722)} = 25.62$ psia

Therefore pressure drop $\Delta P = P_1 - P_2 = 15.78$ psi

Dynamic torque $T_D = C_T \Delta P\, D^3 = 3840$ in-Lb $C_T = .02$ (Ref. 7 elbow effect plus most adverse shaft orientation and disc rotation)

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-72

RUN

VALVE 17:54 SUN 07 NOV 82 24 INCH VALVE
STEAM FLOW

ENTER THE NUMBER OF DATA SETS

FOR EACH DATA SET ENTER THE FOLLOWING DATA IN ITS
RESPECTIVE ORDER SEPERATED BY A COMMA OR A BLANK.

A) UPSTREAM PRESSURE IN PSIG
B) UPSTREAM TEMPERATURE IN DEG. F
C) DENSITY IN LB/FT**3
D) ACTUAL FLOW RATE IN FT**3/SEC
E) LOSS COEFFICIENT
F) TORQUE COEFFICIENT

ENTER DATA FOR SET NO. 1
?18 221 .0789 1289.6 .55 .275

ENTER DATA FOR SET NO. 2
?19.2 234 .0818 1130.5 .7 .56

ENTER DATA FOR SET NO. 3
?20.7 243 .085 972.8 1.1 .35

ENTER DATA FOR SET NO. 4
?22.3 249.5 .0886 816.5 2.3 .175

ENTER DATA FOR SET NO. 5
?24 255 .0926 659.8 5.2 .09

ENTER DATA FOR SET NO. 6
?25.4 259 .0953 496.7 14 .045

ENTER DATA FOR SET NO. 7
?26.7 262 .0984 332.1 45 .02

ENTER DATA FOR SET NO. 8
?27.9 265 .1009 166.6 170 .01

ENTER DATA FOR SET NO. 9
?28.9 268 .1033 0 0

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-73

INPUT IS AS FOLLOWS:

SET NO.	P PSI	T DEG. F	RO LB/FT**3	QA FT**3/SEC	KV	CT
1	18.0	221.0	0.0789	1289.6	0.55	0.275
2	19.2	234.0	0.0818	1130.5	0.70	0.560
3	20.7	243.0	0.0850	972.8	1.10	0.350
4	22.3	249.5	0.0886	816.5	2.30	0.175
5	24.0	255.0	0.0926	659.8	5.20	0.090
6	25.4	259.0	0.0953	496.7	14.00	0.045
7	26.7	262.0	0.0984	332.1	45.00	0.020
8	27.9	265.0	0.1009	166.6	170.00	0.010
9	28.9	268.0	0.1033	0.0	CLOSED	0.0

DO YOU WISH TO MAKE ANY CHANGES?
?NO

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-74

CALCULATION AT ANGLE = 90 . DEG. OCCURING AT TIME = 1.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 32.7 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 681.0 DEG. R

FLOW RATE IN SCFH = 7885763. FT**3/HR

VALVE COEFFICIENT CV = 21327.8

SPECIFIC GRAVITY G = 1.030

CALCULATED DOWNSTREAM PRESSURE P2 = 31.1 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 1.621 PSI

DYNAMIC TORQUE TD = 5425. LB-IN

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-75

CALCULATION AT ANGLE = 78.75 DEG. OCCURING AT TIME = 1.5 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 33.9 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 694.0 DEG. R

FLOW RATE IN SCFH = 7032328. FT**3/HR

VALVE COEFFICIENT CV = 18905.0

SPECIFIC GRAVITY G = 1.068

CALCULATED DOWNSTREAM PRESSURE P2 = 32.2 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 1.672 PSI

DYNAMIC TORQUE TD = 11394. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-76

CALCULATION AT ANGLE = 67.5 DEG. OCCURING AT TIME = 2.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 35.4 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 703.0 DEG. R

FLOW RATE IN SCFH = 6238209. FT**3/HR

VALVE COEFFICIENT CV = 15081.0

SPECIFIC GRAVITY G = 1.110

CALCULATED DOWNSTREAM PRESSURE P2 = 33.3 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 2.095 PSI

DYNAMIC TORQUE TD = 8921. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-77

CALCULATION AT ANGLE = 56.25 DEG. OCCURING AT TIME = 2.5 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 37.0 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 709.5 DEG. R

FLOW RATE IN SCFH = 5422430. FT**3/HR

VALVE COEFFICIENT CV = 10429.5

SPECIFIC GRAVITY G = 1.157

CALCULATED DOWNSTREAM PRESSURE P2 = 33.6 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 3.388 PSI

DYNAMIC TORQUE TD = 7213. LB-IN

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-78

CALCULATION AT ANGLE = 45 DEG. OCCURING AT TIME = 3.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 38.7 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 715.0 DEG. R

FLOW RATE IN SCFH = 4547844. FT**3/HR

VALVE COEFFICIENT CV = 6936.3

SPECIFIC GRAVITY G = 1.209

CALCULATED DOWNSTREAM PRESSURE P2 = 33.1 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 5.579 PSI

DYNAMIC TORQUE TD = 6109. LB-IN

CYGNA
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JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-79

CALCULATION AT ANGLE = 33.75 DEG. OCCURING AT TIME = 3.5 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 40.1 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 719.0 DEG. R

FLOW RATE IN SCFH = 3527751. FT**3/HR

VALVE COEFFICIENT CV = 4227.3

SPECIFIC GRAVITY G = 1.244

CALCULATED DOWNSTREAM PRESSURE P2 = 30.6 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 9.502 PSI

DYNAMIC TORQUE TD = 5202. LB-IN

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SHEET NO. A-20

CALCULATION AT ANGLE = 22.50 DEG. OCCURING AT TIME = 4.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 41.4 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 722.0 DEG. R

FLOW RATE IN SCFH = 2425048. FT**3/HR

VALVE COEFFICIENT CV = 2357.9

SPECIFIC GRAVITY G = 1.285

CALCULATED DOWNSTREAM PRESSURE P2 = 25.6 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 15.787 PSI

DYNAMIC TORQUE TD = 3842. LB-IN

CALCULATION AT ANGLE = 11.25 DEG. OCCURING AT TIME = 4.5 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 42.6 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 725.0 DEG. R

FLOW RATE IN SCFH = 1246622. FT**3/HR

VALVE COEFFICIENT CV = 1213.1

SPECIFIC GRAVITY G = 1.317

CALCULATED DOWNSTREAM PRESSURE P2 = 27.0 PSI

PRESSURE DROP ACCROSS THE VALVE DP = 15.631 PSI

DYNAMIC TORQUE TD = 1902. LB-IN

CALCULATION AT ANGLE = 0 DEG. OCCURING AT TIME = 5.0 SEC

ABSOLUTE UPSTREAM PRESSURE P1 = 43.6 PSI

ABSOLUTE UPSTREAM TEMPERATURE T1 = 728.0 DEG. R

FLOW RATE IN SCFH = 0. FT**3/HR

VALUE COEFFICIENT CV = 0.0

SPECIFIC GRAVITY G = 1.349

PRESSURE DROP ACCROSS THE VALVE DP = 0.000 PSI

DYNAMIC TORQUE TD = 0. LB-IN

SEATING TORQUE IS SAME AS SHOWN ON PAGE 66.

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SHEET NO. A-83

APPENDIX

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JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-5

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

WPPSS

CALCULATION COVER SHEET

SHEET 1 OF 9

PROJECT	DISCIPLINE	CALC. NO.
WNP-2	MECH.	ME-02-82-08-0
CONTRACT	**SPECIFICATION**	**QUALITY CLASS**
	2808-68	1

TITLE

MASS FLOW RATES + VELOCITIES THROUGH CEP 30" BUTTERFLY VALVES

ACTION REQUIRED

☐ SAR CHANGE ☐ SPEC. CHANGE ☒ OTHER (IDENTIFY)

VALUES TO BE USED BY VALVE VENDOR (BIF) IN CALCULATING VALVE CLOSING TORQUES NEEDED FOR VALVE QUALIFICATION

ATTACHMENTS

☐ COMPUTER PRINTOUT ☒ OTHER (IDENTIFY)

FSAR FIGURE 6.2-2

FSAR FIGURE 6.2-3

☐ PRELIMINARY ☒ FINAL

SUPERSEDED BY

SUPERSEDES

REV. NO.	REVISION DESCRIPTION	CALCULATION BY	DATE	REVIEWED	DATE	APPROVED	DATE
0	ORIGINAL	R L Heind	10/4/82	[signature]	10/5/82		

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-35

WP-809 R3

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

CALC. NO.

SHEET NO. 2 OF 9

PERFORMED BY R. L. HEID | DATE OCT. 1, 1982

ADDITIONAL INFORMATION IF REQUIRED

MASS FLOW RATES + VELOCITIES THROUGH CEP 30" BUTTERFLY VALVES

GIVEN: CONTAINMENT PRESSURES AND TEMPERATURES AT t = 1, 2, 3, 4, 5 AND 18 SEC. AFTER A LOCA AS FOLLOWS:

TIME (SEC.)	CONT PRESSURE PSIG	PSIA	TEMP. °F	SP VOLUME ft³/LB AIR	STM	
1	18	32.7	221	7.72	12.68	LOCA PRESSURES AND TEMPERATURES FROM REF. 5+6, RESPECTIVELY
2	20.7	35.4	243	7.36	11.49	
3	24	38.7	255	6.85	10.8	
4	26.7	41.4	262	6.41	10.4	
5	28.9	43.6	268	6.18	9.6	
18	34.7	49.4	278	5.53	8.6	

FIND: MASS FLOW RATES AND VELOCITIES FOR AIR AND SAT. STEAM FROM CONTAINMENT, AT THE PRESSURES AND TEMPERATURES LISTED ABOVE, TO THE ATMOSPHERE THROUGH THE 30" PIPING AND 34"×34" DUCT CEP SYSTEM AS SHOWN ON ISOMETRIC DWGS; CEP-625-5.8, -9, -10, -11.12, M-810 AND M-812.

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SHEET NO. A-76

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JOB NO. 82044
FILE NO. 07.01.F
CHECKED INITIALS/DATE
SHEET NO. 10/8/82

SYSTEM RESISTANCE COEFFICIENT (K) VALUES

PIPING K VALUES

K_P

ID = 29.0" = 2.42'

f = .011 [P.A-4, REF.1] $K = f\frac{L}{D} = .011 \times \frac{60.5}{2.42}$ = .28

L = 60.5 ft.

90° ELLS (2) K = .185 AT r/d = 1.5 [FIG. 3.2.1, P-15, REF.2] = .37

45° ELLS (1) K = .09 AT r/d = 1.5 [FIG 3.2.1, P-15, REF.2] = .09

VALVES (3) 30" BUTTERFLY VALVES K = .27 [REF.3] = .81

TEE'S 30x30

(1) FLOW THROUGH BRANCH TO RUN; K_B = 1.2 [P.266, REF 4] = 1.75
K_R = .55

(1) FLOW FROM RUN TO BRANCH K = .9x1.45 [P.280, REF.4] = 1.3

ENTRANCE EFFECT (1) K = 0.5 [P.92, REF.4] = .5

TOTAL PIPING RESISTANCE 5.10

DUCT K VALUES (34x36 : ORDINARY GALVANIZED)

L = 54.75 ft

$R_H = \frac{34 \times 36}{2(34+36)} = 8.74"$ $D_H = 4 R_H = 34.97" = 2.91'$

e = .006 [P.63, REF 4] $e/D = \frac{.006}{34.97}$ = .0002 (ASSUMING $R_e \geq 10^6$)

f = .013 [P.68, REF 4]

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SHEET NO. A-87

CYGNA ATTACHMENT
JOB NO. 82044
INITIALS/DATE
FILE NO. 07.01.F
SHEET NO. 8/11/82

DUCTING $K = f\frac{L}{D} = .013 \times \frac{54.75}{2.91} =$ .245

ELLS

45° (1) $K = A_1 \times B_1 \times C_1 = .6 \times .17 \times 1.0 =$ .102

[P.208, REF.4]

90° (2) $K = A_1 B_1 C_1 = 1.0 \times .15 \times 1.0 \times 2$ .30

[P.208, REF 4]

TEE (1)

BRANCH TO RUN $K_B = .50$, $K_R = -.25$ $K_T = K_B + K_R =$ .25

[P. 278, 279, REF 4]

EXIT LOSS $K = 1.0$ [P.416, REF.4] 1.0

K_D = TOTAL DUCT RESISTANCE 1.90

34.97" DUCT LOSS IN TERMS OF 29.0" PIPE

$$K_{29} = K_{34.97}\left(\frac{D_{29}}{D_{34.97}}\right)^4 = 1.9\left(\frac{29}{34.97}\right) = 0.9 \qquad K_D = 0.9$$

[P.3-4, REF. 1]

TOTAL CEP PIPING RESISTANCE FROM PENETRATION X-3

TO EXHAUST PLENUM

$$K_T = K_P + K_D = 5.10 + .9 = \underline{6.0}$$

MASS FLOW RATE AND VELOCITIES (100% AIR)

AT 1 SEC.

$\omega = 0.525\, Y d_1^2 \sqrt{\frac{\Delta P}{K \bar{V}}}$ [P. 3-4, REF. 1] (CRANE)

$= .525 \times .76 \times 29^2 \sqrt{\frac{18}{6.0 \times 7.72}}$

$\omega = \underline{209.2 \text{ LB/SEC}}$

$q = 209.2 \times 7.72 = \underline{1614.9 \text{ ft}^3/\text{SEC}}$

VELOCITY

$V = q/A = 1548 \frac{\text{ft}^3}{\text{SEC}} \times \frac{1}{4.587} = \underline{352 \text{ FPS}}$

$d = 29$ IN.
$\Delta P = 18.0$ PSI
$\bar{V} = 7.72$ ft³/LB
$K = 6.0$
$P_1 = 32.7$ PSIA
$\Delta P/P = .55$
$Y = .76$ [P. A-22, REF. 1]
$A = 4.587$ ft²

AT 2 SEC. (100% AIR)

$\omega = .525 \times .74 \times 841 \sqrt{\frac{20.7}{6.0 \times 7.36}}$

$\omega = \underline{223.7 \text{ LB/SEC}}$

$q = 223.7 \times 7.36 = \underline{1646.4 \text{ ft}^3/\text{SEC}}$

$V = \frac{1646.4}{4.587} = \underline{358.9 \text{ FPS}}$

$\Delta P = 20.7$ PSI
$P_1 = 35.4$ PSIA
$\Delta P/P_1 = .596$
$Y = .74$
$K = 6.53$
$\bar{V} = 7.36$ ft³/LB

AT 3 SEC. (100% AIR)

$\omega = .525 \times .73 \times 841 \sqrt{\frac{24}{6.53 \times 6.85}}$

$\omega = \underline{246.3 \text{ LB/SEC}}$

$q = 246.3 \times 6.85 = \underline{1687.2 \text{ ft}^3/\text{SEC}}$

$V = \frac{1687.2}{4.587} = \underline{367.8 \text{ FPS}}$

$\Delta P = 24$ PSI
$P_1 = 38.7$ PSIA
$\Delta P/P_1 = .62$
$Y = .73$
$K = 6.0$
$\bar{V} = 6.85$ ft³/LB

At 4 Sec (100% Air)

$w = .525 \times .725 \times 841 \sqrt{\frac{26.7}{6.0 \times 6.41}}$

$w = $ 266.8 LB/SEC

$Q = 266.8 \times 6.41 = $ 1709.9 ft^3/sec

$V = \frac{1709.9}{4.587} = $ 372.8 fps

$\Delta P = 26.7$ PSI
$P_1 = 41.4$ PSIA
$\Delta P/P = .64$
$Y = .725$
$K = 6.0$
$\bar{V} = 6.41\ ft^3/LB$
$A = 4.587\ ft^2$

At 5 Sec. (100% Air)

$w = .525 \times .72 \times 841 \sqrt{\frac{28.9}{6.0 \times 6.18}}$

$w = $ 280.6 LB/SEC

$Q = 280.6 \times 6.18 = $ 1734.3 ft^3/sec

$V = \frac{1734.3}{4.587} = $ 378.1' fps

$\Delta P = 28.9$ PSI
$P_1 = 43.6$ PSIA
$\Delta P/P = .66$
$K = 6.0$
$Y = .72$
$V = 6.18\ ft^3/LB$
$A = 4.587\ ft^2$

At 18 Sec. (100% Air), P_1, T Max.

$w = .525 \times .69 \times 841 \sqrt{\frac{34.7}{6.0 \times 5.53}}$

$w = $ 311.5 LB/SEC

$Q = 311.5 \times 5.53 = $ 1722.6 ft^3/sec

$V = \frac{1722.6}{4.587} = $ 375.5 fps

$\Delta P = 34.7$ PSI
$P_1 = 49.4$ PSIA
$\Delta P/P = .70$
$Y = .69$
$V = 5.53\ ft^3/LB$
$A = 4.587\ ft^2$
$K = 6.0$

Mass Flow Rates And Velocities (Sat. Steam)

At 1 Sec.

$\omega = 0.525\, Y d^2 \sqrt{\frac{\Delta P}{K \bar{V}}}$ [P. 3-4, Ref. 1]

$= .525 \times .77 \times 29^2 \sqrt{\frac{18}{6.0 \times 12.68}}$

$\omega = \underline{165.4 \text{ LB/SEC}}$

$Q = 165.4 \frac{LB}{SEC} \times 12.68 \frac{ft^3}{LB} = \underline{2097.3 \text{ ft}^3/\text{SEC}}$

$V_{EL.} = Q/A = 2097.3 \frac{ft^3}{SE} \times \frac{1}{4.587} = \underline{457.2 \text{ FPS}}$

$d = 29$ IN
$\Delta P = 18$ PSI
$P_1 = 32.7$ PSIA
$\Delta P/P = .55$
$Y = .77$
$K = 6.0$
$\bar{V} = 12.68$ ft³/LB
$A = 4.587$ ft²

At 2 Sec. (Sat Stm)

$\omega = .525 \times .74 \times 841 \sqrt{\frac{20.7}{6.0 \times 11.8}}$

$\omega = \underline{176.2 \text{ LB/SEC}}$

$Q = 176.2 \times 11.8 = \underline{2079.2 \text{ ft}^3/\text{SEC}}$

$V = \frac{2079.2}{4.587} = \underline{453.3 \text{ FPS}}$

$\Delta P = 20.7$ PSI
$P' = 35.4$ PSIA
$\Delta P/P = .58$
$K = 6.0$
$Y = .74$
$\bar{V} = 11.8$ ft³/LB
$A = 4.587$ ft²

At 3 Sec. (Sat. Stm.)

$\omega = .525 \times .73 \times 841 \sqrt{\frac{24}{6.0 \times 10.8}}$

$\omega = \underline{196.2 \text{ LB/SEC}}$

$Q = 196.2 \times 10.8 = \underline{2118.2 \text{ ft}^3/\text{LB}}$

$V = \frac{2118.2}{4.587} = \underline{461.8 \text{ FPS}}$

$\Delta P = 24$ PSI
$P = 38.7$ PSIA
$\Delta P/P = .62$
$K = 6.0$
$Y = .73$
$\bar{V} = 10.8$ ft³/LB
$A = 4.587$ ft²

AT 4 SEC. (SAT. STM.)

$\omega = .525 \times .725 \times 841 \sqrt{\frac{26.7}{6.0 \times 10.4}}$

$\omega = 209.4$ LB/SEC

$Q = 209.4 \times 10.4 = 2177.5$ ft³/SEC

$V = \frac{2177.5}{4.587} = 474.7$ FPS

$\Delta P = 26.7$ PSI
$P' = 41.4$ PSIA
$K = 6.53$
$\Delta P/P = .645$
$Y = .725$
$\bar{V} = 10.4$ ft³/LB
$A = 4.587$ ft²

AT 5 SEC.

$\omega = .525 \times .72 \times 841 \sqrt{\frac{28.9}{6.0 \times 9.6}}$

$\omega = 225.2$ LB/SEC

$Q = 225.2 \times 9.6 = 2161.7$ ft³/SEC.

$V = \frac{2161.7}{4.587} = 471.3$ FPS

$\Delta P = 28.9$ PSI
$P' = 43.6$ PSIA
$\Delta P/P = .66$
$K = 6.0$
$Y = .72$
$\bar{V} = 9.6$ ft³/LB
$A = 4.587$ ft²

AT 18 SEC. (MAX. LOCA P, T)

$\omega = .525 \times .70 \times 841 \sqrt{\frac{34.7}{6.0 \times 8.6}}$

$\omega = 253.4$ LB/SEC

$Q = 253.4 \times 8.6 = 2179.6$ ft³/SEC

$V = \frac{2179.6}{4.587} = 475.2$ FPS

$\Delta P = 34.7$ PSI
$P' = 49.4$ PSIA
$\Delta P/P = .7$
$K = 6.0$
$Y = .70$
$\bar{V} = 8.6$ ft³/LB
$A = 4.587$ ft²

TABULATED RESULTS

TIME (SEC.)	AIR			STEAM		
	FLOW RATE		VELOCITY	FLOW RATE		VELOCITY
	LB/sec	ft³/sec	fps	LB/sec	ft³/sec	fps
1	209.2	1614.9	352	165.4	2097.3	457.2
2	223.7	1646.4	358.9	176.7	2079.2	453.3
3	246.3	1687.2	367.8	196.2	2118.2	461.8
4	266.8	1709.9	372.8	209.4	2177.5	474.7
5	280.6	1734.3	378.1	225.2	2161.7	471.3
18	311.5	1722.6	375.5	253.4	2179.6	475.2

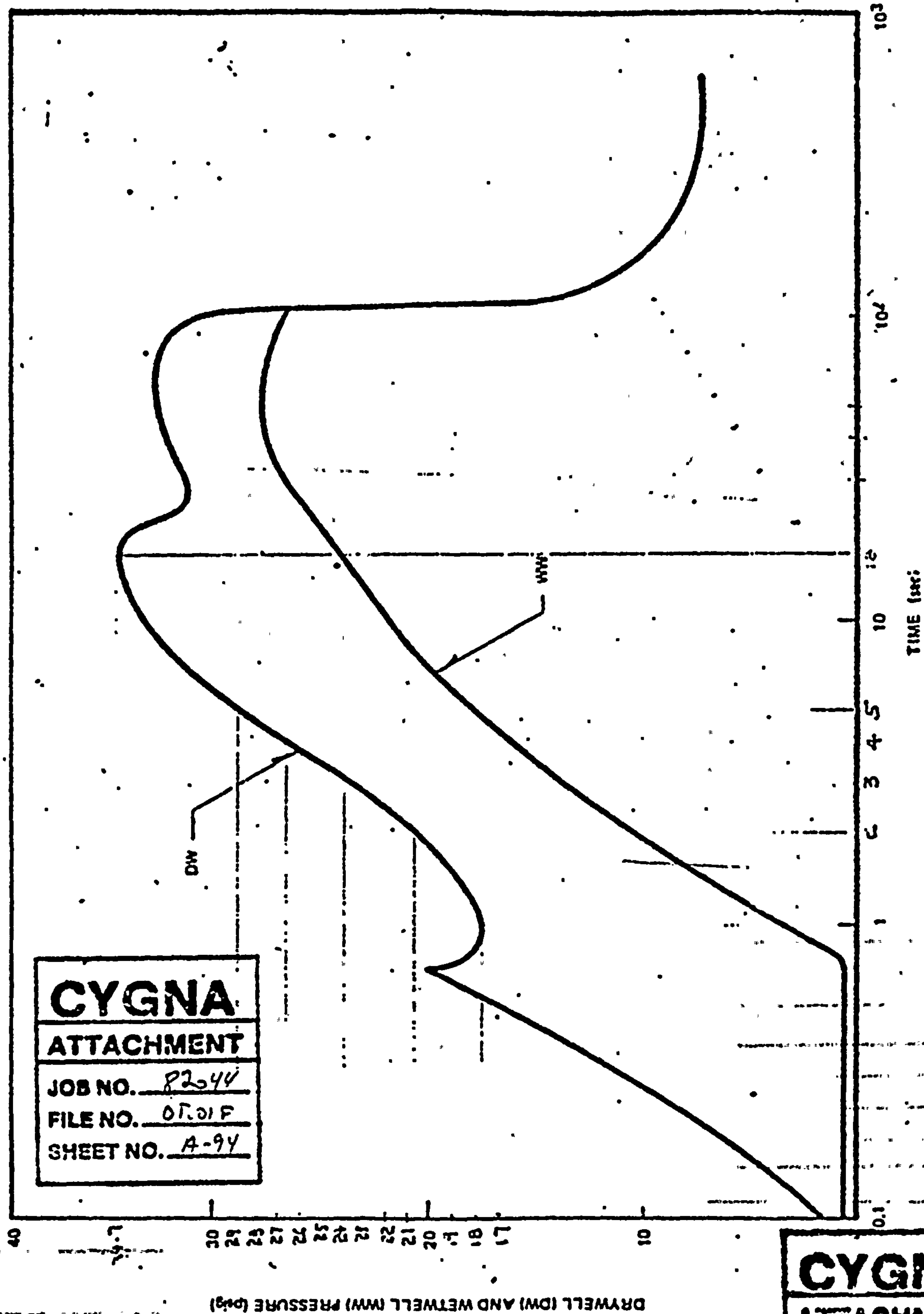
CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F.
SHEET NO. A-93

REFERENCES

1. CRANE TECHNICAL PAPER No. 410
2. INTERNAL FLOW, D.S. MILLER
3. BIF VALVE DATA SHEET # D-207110-F
4. HANDBOOK OF HYD. RESISTANCE, COEFFICIENTS OF LOCAL RESISTANCES AND OF FRICTION, I.E. IDEL'CHICK, 1960
5. PRESSURE RESPONSE FOR RECIRCULATION LINE BREAK WNP-2 FSAR, FIG. 6.2-2
6. TEMPERATURE RESPONSE FOR RECIRCULATION LINE BREAK WNP-2 FSAR, FIG. 6.2-7

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F.
SHEET NO. A-

ATTACHMENT # 1

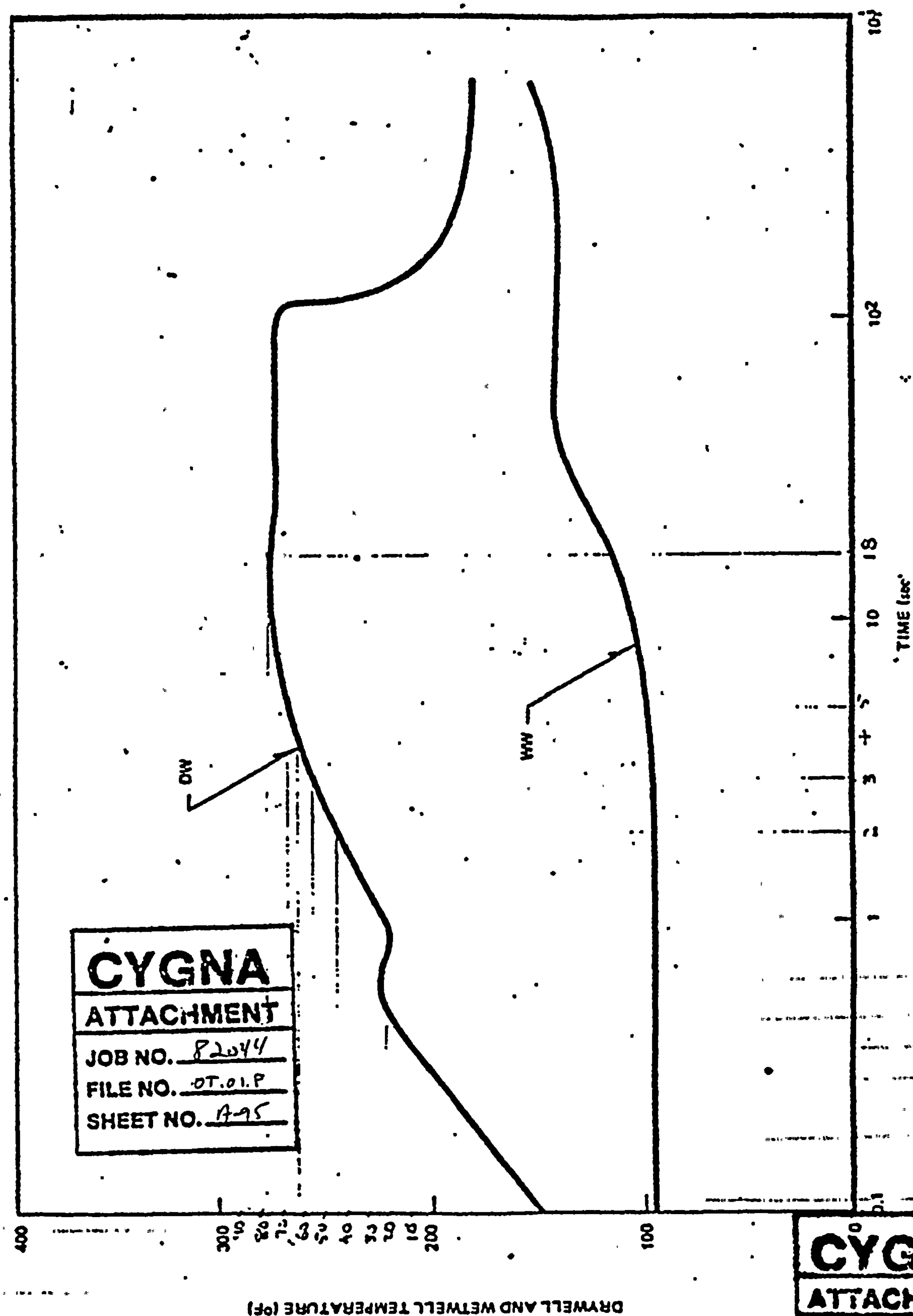


CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01F
SHEET NO. A-94

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT FIGURE
SHEET NO. A6.2-2

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	PRESSURE RESPONSE FOR RECIRCULATION LINE BREAK

Attachment # 2



CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.P
SHEET NO. A-95

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	TEMPERATURE RESPONSE FOR RECIRCULATION LINE BREAK	FIGURE

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT. FIGURE
SHEET NO. Att. 2-2

Washington Public Power Supply System
P.O. Box 968 3000 George Washington Way Richland, Washington 99352 (509) 372-5000

October 22, 1982
SE-02-RWH-82-032

BIF Industries
1600 Division Road
Warwick, RI 02893

Attention: J. McDonald

Subject: NUCLEAR PROJECT 2
CONFIRMATION OF INFORMATION

This letter confirms the following information transmitted by R. W. Hickman to Rick Ricapato on October 19, 1982 by telephone.

1. The purge and vent valves which BIF is analyzing for closing torque will receive the signal to begin closing prior to one (1) second after a LOCA.

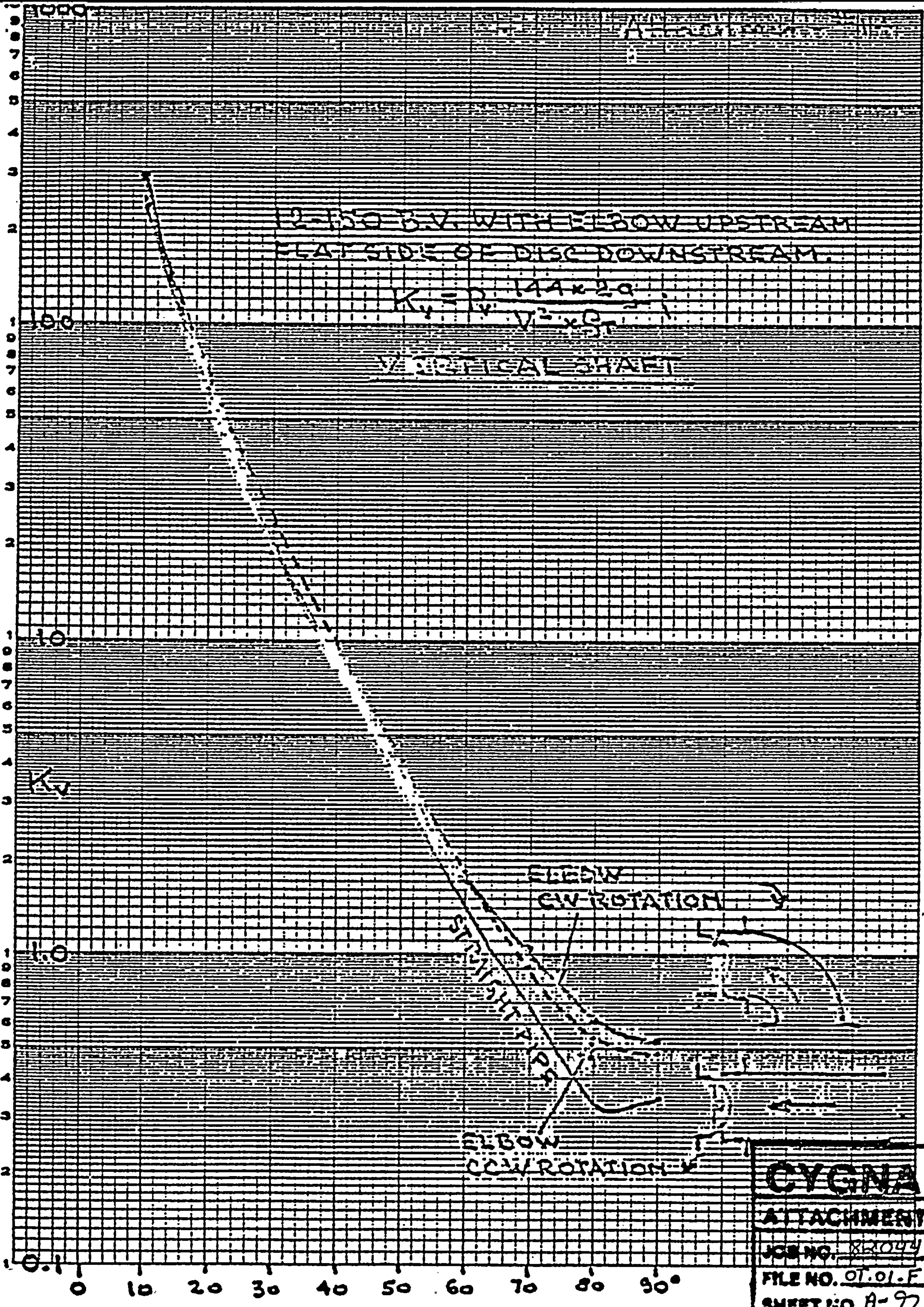
2. For the analysis of the 24-inch valve, use the same velocities which were established in WPPSS Calculation ME-02-82-08-0 which were transmitted on October 9, 1982 by TWX.

Please do everything within your power to see that the November 10, 1982 completion date which Mr. Ricapato gave Mr. Hickman is met. We are committed to have the results for the NRC by October 15, 1982.

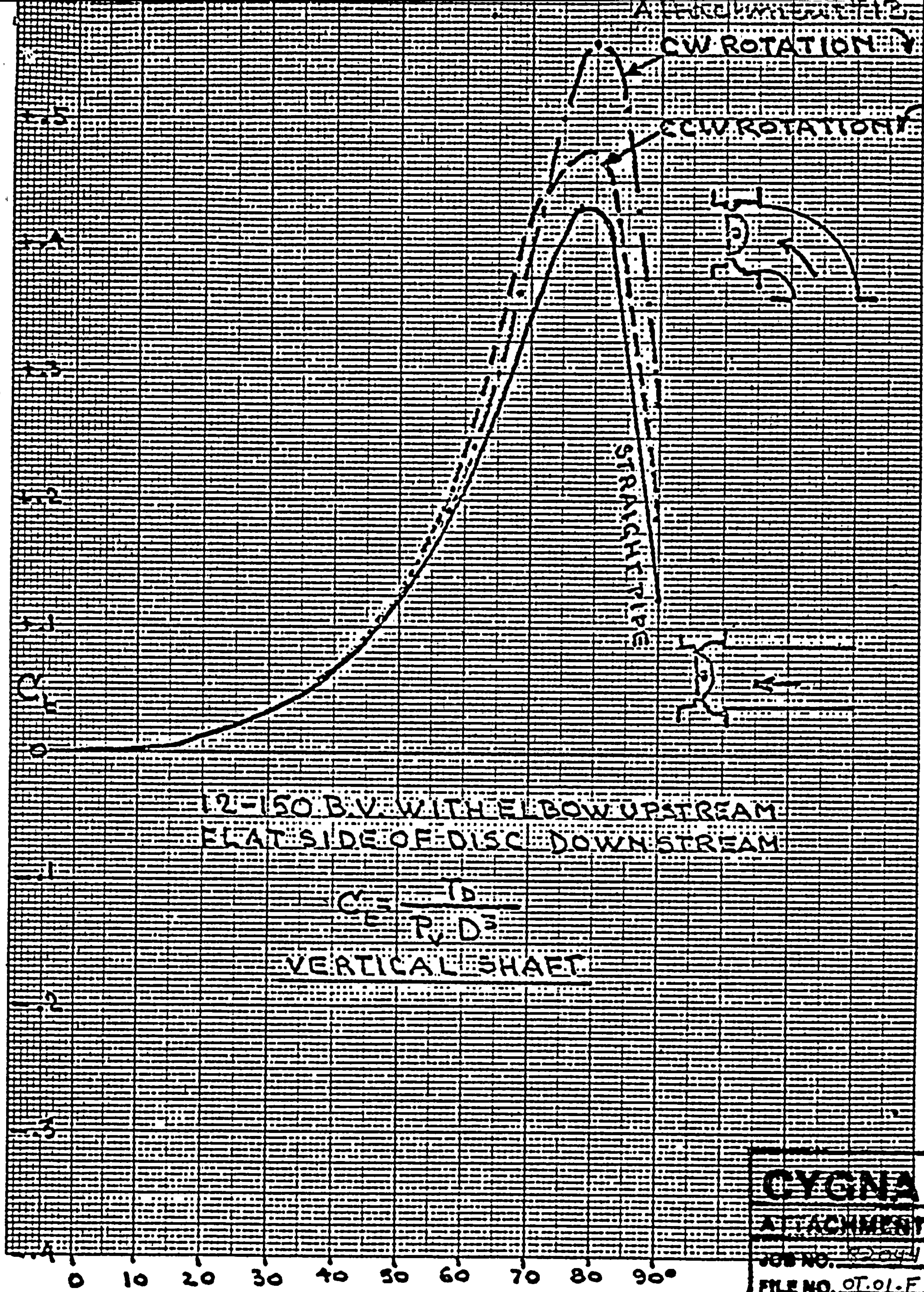
R. A. Holmberg / SGGD
Manager, WNP-2 Engineering

RWH/sms

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. A-76



CYGNA
ATTACHMENT
JOB NO. 83044
FILE NO. 01.01.F
SHEET NO. A-97



$$C_T = \frac{T_D}{P_v D^3}$$

QID# 361106

7.4 McPherson Associates Analysis

23.2401.0127

BIF A UNIT OF GENERAL SIGNAL
1600 DIVISION ROAD
WEST WARWICK, R.I. 02893

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-1

DESIGN AND SEISMIC ANALYSIS
OF
24" CYLINDER OPERATED BUTTERFLY VALVE
FOR
WASHINGTON PUBLIC POWER SUPPLY SYSTEM
AND
BURNS AND ROE

NUCLEAR

CUSTOMER P.O. CONTRACT 68

BIF SHOP ORDER NO'S PN27235-U-0708
PN27236-U-0808

BIF SERIAL NO'S PN27235-1 thru 4
PN27236-1 thru 3

REPORT NO. TR-74-7
PREPARED BY McPHERSON ASSOCIATES, INC.

APPROVED BY: [signature] 3/7/74

REAPPROVED: [signature] 1/5/76 (REV 1)

FILE NUMBER 68 00 0050

DESIGN AND SEISMIC ANALYSIS OF 24" CYLINDER OPERATED BUTTERFLY VALVE A-206765

22 February 1974

Prepared For:

BIF
A Unit of General Signal Corporation

Prepared By:

Thomas M. Riley
John R. Henry

BIF
A Unit of General Signal Corporation
Purchase Order No. 84908-63

McPherson Associates, Inc.
Report No. TR-74-7 - REV. 1 12/31/75

McPherson Associates, Inc.
400 Totten Pond Road
Waltham, Massachusetts 02154

NUCLEAR

DESIGN AND
SEISMIC ANALYSIS
OF
24" CYLINDER OPERATED
BUTTERFLY VALVE
A-206765

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-3

BIF
A Unit of General Signal Corporation
Purchase Order No. 84908-63

NUCLEAR

McPherson Associates, Inc.
Report No. TR-74-7 - REV. 1 12/31/75

FOR 24" VALVES

BIF Contract No.	BIF S.O. No.	Valve Tag No's
68	N 27235-F N 27236-F	CSP-V-3 CSP-V-4 CEP-V-3A CEP-V-4A CSP-V-5 CSP-V-6

REVISION RECORD

NUS REPORT TR-74-7

REVISION 1 12/31/75

Page 3
- a) Mat'l was ASTM A-126 & A-48
- b) Allowable Stress Value corrected

Page 5
- a) Drive Lever was B-184005-6
- b) Clevis was D-146578

Page 9
- a) Mat'l was ASTM A-126, Class C
- b) Corrected yield stress allowable
- c) Deleted ASTM A-48

Page 32
- a) Ref. drawings were B-184005-6 & D-14578

Pages 33, 35, 36 & 37
- a) Mat'l was ASTM A-126
- b) Corrected Stress Allowable

NUCLEAR

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-4

TABLE OF CONTENTS

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-5

NUCLEAR

Certification

McPherson Associates, Inc. certifies that the 24" Butterfly Valve, A-206765, as shown on the customer drawings was analyzed in accordance with Washington Public Power Supply System Specification No. 2808-68 and to the best of our knowledge and belief, meets the requirements of Paragraphs 3.2, 3.3, and 3.5.2.4 of this document and Reference 3 of Section 4.0 of this report.

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-6

NUCLEAR

John R. Henry
Registered Professional Engineer
Mass. Registration No. 25929

Section 1.0

INTRODUCTION

The purpose of this report is to determine the structural adequacy of a 24" Butterfly Valve Assembly when subjected to seismic accelerations as described in Reference 1 and to insure the valve design is in accordance with Reference 3 of this report.

The seismic plus operating analysis is performed in accordance with Washington Public Power Supply System Specification No. 2808-68, Reference 1, and all applicable information as described in Section 4.0 of this report.

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-8

Section 2.0

SUMMARY OF RESULTS

NUCLEAR

BY THE DATE 2-21-74 SUBJECT 24" B.F.V. SHEET NO. 201 OF

CHKD. BY JH DATE 2-21-74 — SUMMARY — JOB NO.

COMPONENT	PAGE	STRESS COMPARISON (PSI) & MATERIAL
TRUNNION PINS	19	$\tau = 1919 < .6 S_y = 11100$ (SA-276, 304)
CYL. OPERATOR DRIVE ROD	22	$\sigma = 52113 < S_y = 90000$ (AISI-4140)
CYL. SUPPORT BRACKET	28	$\sigma = 1319 < S_y = 36000$ (ASTM A-36)
CLEVIS	33	$\tau = 1233 < .6 S_y = 36,000$ (ASTM A 325) ①
CLEVIS PIN	33	$\tau = 1136 < .6 S_y = 9900$ (SA-276, 304)
DRIVE LEVER	37	$\sigma = 40449 < S_y = 45000$ (ASTM A 376)
VALVE BODY "EARS"	42	$\sigma = 18761 < S_y = 23000.$ (SA-516, ...)
HARDWARE	45	$\sigma = 12927 < S_y = 23333$ (SA-307)
SHAFT	50	$S.I. = 18387 < 1.8 S_m = 27180$ (SA-479)
DISC	51	$S.I. = 3871 < S_m = 15000$ (SA-516, GR-55)
TAPER PINS	53	$\tau_{max} = 10753 < .8 S_m = 12000$ (SA-276)
VALVE BODY	65	$S.I. = 17330 < 1.2 S_m = 18000$ (SA-516, GR 60)
GLAND FOLLOWER	67	THICKNESS CHECK ONLY
THRUST BEARING COVER	69	THICKNESS CHECK ONLY

THE TERM "S.I." REFERS TO STRESS INTENSITY

1) ASME ... Allowable stress ...

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. B-9

NUCLEAR

Section 3.0

CONCLUSIONS

McPherson Associates, Inc. concludes that all components for the 24" Butterfly Valve, as analyzed in this report, meet the requirements of all governing specifications for seismic and operating considerations as defined in References 1, and 3 of this report.

Section 4.0

REFERENCES

1. Washington Public Power Supply System Specification No. 2808-68.

2. BIF Drawings

Drawing No.	Revision	Description
A-206765	B	24" Butterfly Valve-General Arrangements
A-900523	-	Body, Fabricated
A-900524	-	Body, Machining
A-900339	-	Disc, Fabricated
A-900340	-	Disc, Machined
A-208293	-	Cylinder Support Bracket
B-900521, B-900522	-	Operator Shafts
B-211830	-	Drive Lever
D-211832-1	-	Clevis
D-206661	-	Miller Cylinder

3. Section III, Nuclear Power Plant Components, ASME Boiler and Pressure Vessel Code, 1971 with Addenda.

4. Virgil Moring Faires, Design of Machine Elements, 4th Edition, The MacMillan Co., N.Y., 1965.

5. Raymond J. Roark, Formulas for Stress and Strain, 4th Edition, McGraw Hill Book Co., 1965.

6. Laddish Catalog No. 55.

7. Grinnel, Piping and Engineering, 3rd Edition, 1971.

8. 1963 Supplement to Screw Thread Standards for Federal Services.

9. Baumeister & Marks, Standard Handbook for Mechanical Engineers, 7th Edition, McGraw Hill Book Company.

10. Kent, Mechanical Engineers Handbook.

11. A.S.T.M. Standards - Part 2.

12. A.S.M. Metals Handbook.

13. Timoshenko and Goodier, Theory of Elasticity, 3rd Edition, McGraw Hill Book Co., 1970.

14. Seely and Smith, Advanced Mechanics of Materials, 2nd Edition, John Wiley & Son, Inc., 1966.

15. MacHinery's Handbook, 17th Edition, The Industrial Press, 1964.

16. Section VIII, Pressure Vessels, Division 2 - Alternative Rules, A.S.M.E. Boiler and Pressure Vessel Code, 1971.

17. Chemical Rubber Publishing Co., Standard Mathematics Tables, Twelfth Edition.

18. American National Standards Institute - Document B16.5 titled "Steel Pipe Flanges and Flanged Fittings."

BY ________ DATE ________ SUBJECT ________ SHEET NO. ____ OF ____
CHKD. BY ________ DATE ________ JOB NO. ________

SECTION 5.0

DESIGN DATA

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-13

NUCLEAR

IN GENERAL:

IN THIS REPORT, TENSILE AND BENDING ALLOWABLES, FOR DUCTILE MATERIALS OUTSIDE THE VALVE PRESSURE BOUNDARY ARE BASED ON YIELD STRESS; SHEAR ALLOWABLES FOR SUCH MATERIAL ARE HELD TO (.6) x (YIELD STRESS)

For what loading condition

ASME $\frac{2}{3} F_y$ or $\frac{1}{4} F_u$, AISC $\frac{2}{3} F_y$ or 0.6

WHEN BRITTLE MATERIALS ARE ENCOUNTERED OUTSIDE THE VALVE PRESSURE BOUNDARY ALLOWABLE STRESSES ARE BASED ON ULTIMATE STRESS. ? For what loading cond

FOR MATERIALS WITHIN THE PRESSURE BOUNDARY "ALLOWABLE STRESSES" AS DEFINED IN REFERENCES 3 AND 16 OF THIS REPORT ARE EMPLOYED.

ON THE FOLLOWING PAGE IS PRESENTED A TABLE OF STRESS ALLOWABLES FOR THE VARIOUS MATERIALS USED IN THE VALVE:

IN THE CASE OF "ALLOWABLE STRESS" VALUES, THE STRESS ALLOWABLES AS PRESENTED ARE BASE NUMBERS AND ARE ADJUSTED IN VALUE DEPENDING ON THE STRESS COMPARISON [e.g. EARTHQUAKE → (1.2) (S_m)] ?

CHKD. BY ___ DATE ___ JOB NO. ___

Max. Temperature, Process Air = 340 °F
Max. Pressure (ΔP) = 45 psi

MATERIAL	†YIELD STRESS (PSI)
AISI-4140, HEAT TREATED	90000 ✓
SA-276, GR 304	18500 ✓
ASTM A 395-60-45-15	45,000 ✓
SA-276, GR 304	* 15000
SA 516, GR 60	* 15000
SA-307	23300 ✓
AISI 1018	*** 35000
SA-479, 304 S.S.	* 15100
SA-193, GR B-8, 304 S.S.	31000

† UNLESS NOTED (@ TEMP)

* ALLOWABLE STRESS @ TEMPERATURE

*** MINIMUM YIELD

BY TMR DATE 2-20-79 SUBJECT 24 B.T.V. SHEET NO. 6.0 OF
CHKD. BY DATE JOB NO.

SECTION 6.0

ANALYSIS

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-16

NUCLEAR

BY TMR DATE 2-20-74 SUBJECT GENERAL DISCUSSION - ANALYSIS - SHEET NO. 6.0.1 OF
CHKD. BY JH DATE 2-21-74 JOB NO.

THE APPROACH TAKEN IN DETERMINING SEISMIC LOADS AND STRESSES IS TO ANALYZE ON A "WORST CASE" BASIS WHENEVER POSSIBLE.

THE ORDER OF ANALYSIS AS PRESENTED ON THE FOLLOWING PAGES CONSISTS IN FIRST DEFINING WHAT ORIENTATIONS AND ACCELERATIONS PRODUCE "WORST CASE" CONDITIONS AND THEN ESTABLISHING STRESSES FOR THE VARIOUS COMPONENTS ON THIS BASIS.

IN GENERAL, LOADS ACTING AT A POINT ARE ADDED DIRECTLY REGARDLESS OF LINE OF ACTION.

MAXIMUM ACCELERATIONS ARE USED AS OPPOSED TO LESSER "REAL" ACCELERATIONS WHENEVER POSSIBLE.

SEISMIC ACCELERATIONS ARE ASSUMED TO OCCUR WHEN MAXIMUM NORMAL/ABNORMAL OPERATING STRESSES EXIST ON THE APPARATUS.

VALVE SIZING AND COMBINED OPERATING PLUS SEISMIC STRESS ANALYSIS IS PROVIDED IN THE LATTER SECTIONS OF THE REPORT.

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. 07.01.F
SHEET NO. B-11

NUCLEAR

BY TAR DATE 1-29-74 SUBJECT SEISMIC ANALYSIS SHEET NO. 62 OF ____

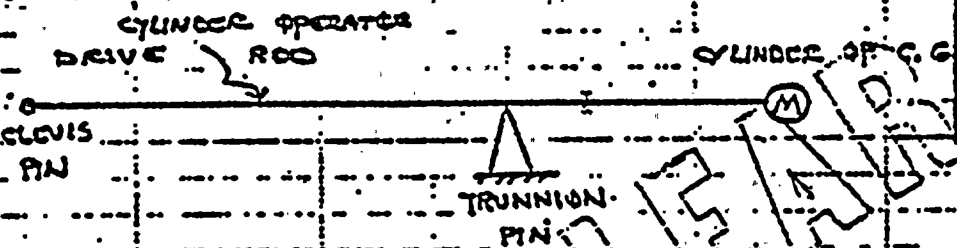
CHKD. BY DKG DATE 1-30-74 JOB NO. ____

GENERAL EXPRESSIONS FOR

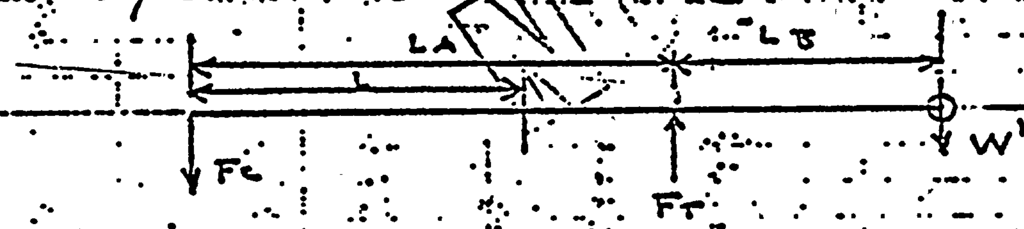
FULCRUM & CLEVIS REACTIONS TREATING CYLINDER OPERATOR

AS A BEAM WITH A TIP MASS.

THE FOLLOWING MODEL IS REPRESENTATIVE OF THE CYLINDER OPERATOR AND ITS SUSPENSION: (LATERAL ACCELERATION ONLY)



BECAUSE OF THE NATURE OF THE SUPPORTS THE FREE BODY DIAGRAM IS:



$$\sum M_{\text{TRUNNION PIN}} = 0 \quad F_C (L_A) = W' L_B$$

$$F_C = \left(\frac{L_B}{L_A}\right) W'$$

AS "L_B", THE DISTANCE BETWEEN THE CYL. OP. C.G. & THE TRUNNION PIN IS ROUGHLY FIXED, "F_C" IS MAXIMIZED WHEN "L_A" IS MINIMUM. (MIN. EXTENSION OF CYL. OP.)

OVER →

BY THR DATE 1-28-74 SUBJECT SEISMIC ANALYSIS SHEET NO. 6.0 OF
CHKD. BY PKG DATE 2-6-74 JOB NO.

$\Sigma \overset{\curvearrowleft}{M}_{\text{CLEVIS PIN}} = 0$; $(F_T)(L_A) = (W')(L_A + L_B)$

$$F_T = \left(\frac{L_A}{L_A} + \frac{L_B}{L_A}\right) W'$$

"FT" IS MAXIMIZED WHEN "LA" APPROACHES "LB".
(CYLINDER OPERATOR AT MINIMUM EXTENSION)

W', AS PRESENTED ABOVE, IS A FUNCTION OF BOTH THE DEAD WEIGHT AND SEISMIC ACCELERATION. FOR R THE MAXIMUM HORIZONTAL ACCELERATION PRODUCES A SEISMIC LOAD OF 3.0 W ; THE MAXIMUM VERTICAL ACCELERATION PRODUCES A SEISMIC LOAD OF 2.0 W. + 1.0 G. DEAD WT.

THE RESULTING LATERAL (HORIZONTAL) & VERTICAL ACCELERATIONS ARE 3G x 3G.

DEPENDING ON THE ANALYSIS BEING PERFORMED W' MAY BE CONSIDERED TO FALL BETWEEN (3)(W) & $\sqrt{(3)^2 + (3)^2}\,(W) = (4.24)(W)$.

THE MINIMUM EXTENSION OF THE CYLINDER OPERATOR DRIVE ROD IS DEFINED AS THE FREE LENGTH OF THE DRIVE ROD PLUS APPLICABLE CLEVIS LENGTH IN THE TRUE "VALVE CLOSED" POSITION.

WHEN EVER POSSIBLE, CONSERVATIVE SEISMIC LOADS WILL BE DETERMINED. SHOULD THESE LOADS PROVE EXCESSIVE, ACTUAL LOADS WILL BE DETERMINED.

BY ______ DATE ______ SUBJECT ______ SHEET NO. ______ OF ______
CHKD. BY ______ DATE ______ — ORDER OF ANALYSIS — JOB NO. ______

SECTION 6.1

CYLINDER OPERATOR ASSEMBLY:

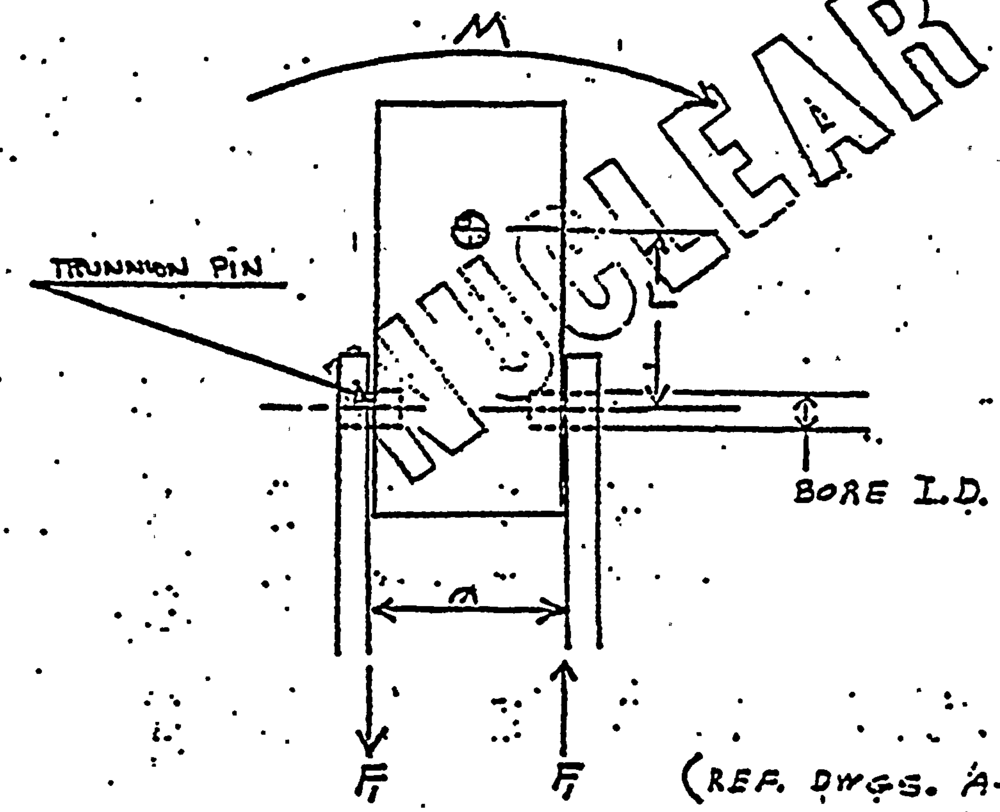
a) TRUNNION PINS
b) TRUNNION PIN LUGS
c) CYLINDER OPERATOR DRIVE LEVER

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-20

NUCLEAR

TRUNNION PIN

THE TRUNNION PINS ARE IN SINGLE SHEAR AND ARE ASSUMED TO HAVE THE SAME O.D. AS THE RECEIVER BORE I.D. THE PINS ARE MOST SEVERELY LOADED WHEN THE CYLINDER OPERATOR IS OVERTURNED SUCH THAT THE PINS RESIST OVERTURNING VIA COUPLE ACTION.



(REF. DWGS. A-208293, D-206661)

$$M = W g L$$
$$= 399(3)(22.62)$$
$$= 27,076 \text{ IN.-LB.}$$

$F_1 = \frac{M}{X}$

$= 27,076/12.75$

$= 2,124$ LBS.

ACTING SIMULTANEOUSLY IS THE VERTICAL SEISMIC EFFECT OF (2 g + 1 g DEAD WT.)
= 3 g

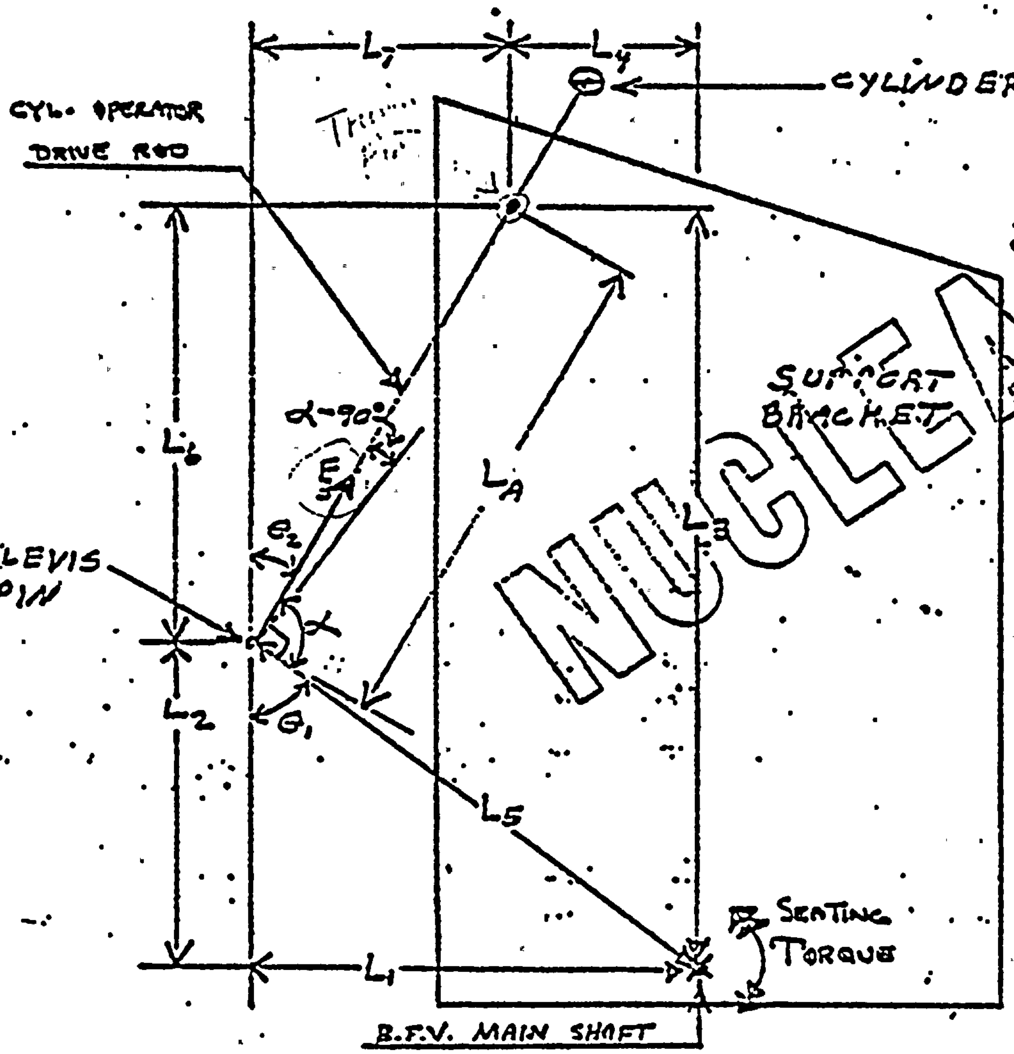
$F_2 = 3 (W)$

$= 1,197$ LB

$= 599$ LB./PIN

SEE NEXT PAGE FOR THE CALCULATIONS TO DETERMINE THE FORCE ON THE TRUNNION PINS DUE TO SEATING TORQUE

LOADING DETERMINATION USED FOR CALCULATION OF TRUNNION PIN REACTION DUE TO SEATING TORQUE (VALVE CLOSED POSITION)



$$F_3 = \frac{(\text{SEATING TORQUE})}{L_5} \Big/ [\cos(\alpha - 90)]$$

BY DKG DATE 2-5-74 SUBJECT 24" B.F.V. SHEET NO. 665 OF
CHKD. BY TMC DATE 2-7-74 OPERATING TORQUE JOB NO.
EFFECT

$L_1 = 11.18 \quad L_2 = 3.625 \quad L_3 = 28.5 \quad L_4 = 8.5$

$L_5 = (L_1^2 + L_2^2)^{1/2} = (11.18^2 + 3.625^2)^{1/2}$
$= 11.753$

$L_6 = L_3 - L_2 = 28.5 - 3.625$
$= 24.875$

$L_7 = L_1 - L_4 = 11.18 - 8.5$
$= 2.68$

$\theta_1 = TAN^{-1}\ L_1/L_2 = TAN^{-1}\ 11.18/3.625$
$= TAN^{-1}\ 3.084$
$= 72.035°$

$\theta_2 = TAN^{-1}\ L_7/L_6 = TAN^{-1}\ 2.68/24.875$
$= TAN^{-1}\ .1077$
$= 6.149°$

$\alpha = 180° - \theta_1 - \theta_2 = 180° - 72.035° - 6.149°$
$= 101.816°$

$\alpha - 90° = 11.816°$

Clade B&F = 13808 in lb

$F_3 = \dfrac{17{,}000}{11.753} \Big/ \cos 11.816°$
$= 1{,}478$ LBS.
$= 739$ LBS./PIN

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. QT.01.F
SHEET NO. B-24

NUCLEAR

BY DKG DATE 2-6-74 SUBJECT 24" Z.F.V. SHEET NO. 666 OF
CHKD. BY TAK DATE 2-7-74 SEISMIC + DEAD WT. + OPERATING STRESS JOB NO.

THE TOTAL LOAD PER PIN $= \sum_{1}^{3} F_i$

$= 2,124 + 599 + 739$

$= 3,462 LB.$ (vertical force)

THE MAXIMUM SHEAR STRESS FOR SOLID CIRCULAR CROSS SECTIONS IS DEFINED AS

$$\tau = \frac{4}{3}\frac{V}{A}$$

$$= \frac{4}{3}\cdot\frac{(3,462)}{\frac{\pi(1.75)^2}{4}}$$

$$= 1,919 \text{ PSI}$$

1919 psi < .6 Sy = 11100 psi
(SA-216, 304 SS @ 340)

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-26

NUCLEAR

BY THC DATE 3-6-74 SUBJECT SEISMIC ANALYSIS SHEET NO 6.17 OF
CHKD. BY DHG DATE 3-7-74 24" B.F.V. JOB NO.

CYLINDER OPERATOR DRIVE ROD

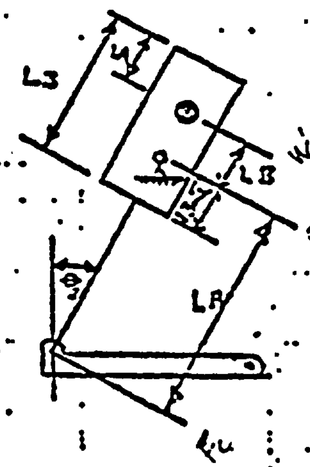
THE DRIVE ROD IS ANALYZED FOR COMBINED SEISMIC PLUS DEAD WT. PLUS OPERATING STRESS

THREADED CYL. OPERATOR DRIVE ROD

FOR CONSERVATISM THE LATERAL ACCELERATION (HORIZONTAL) IS COMBINED WITH THE VERTICAL ACCELERATION TO PROVIDE THE LARGEST POSSIBLE ACCELERATION INDUCING BENDING.

$\vec{3.0\,G} + (2.0\,G + 1.0\,G) = 4.24\,G$

FROM PG ___ THE MAXIMUM CLEVIS REACTION IS $F_C = \frac{L_B}{L_A} W'$ WHERE $W' = (4.24)W$



(REF DWGS. B-184005, D-206661)

$L_B = L_3 - (L_4 + 13.5)$ $L_3 = 51.5''$ $L_4 = 15.38''$

$L_B = 22.62''$

FROM PG II. $L_A = L_6 / \cos\theta_2$

$L_6 = 24.875''$

$\theta_2 = 6.15°$

$L_A = 25.02''$

BY: [illegible] DATE [illegible] SUBJECT: SEISMIC ANALYSIS 24" B.F.V. SHEET NO. [illegible] OF
CHKD. BY DMG DATE 2-7-74 JOB NO.

$$F_c = \frac{22.62}{25.02}(4.24)(399) \qquad F_c = 1530 \text{ lbf}$$

CALCULATING MOMENT @ POINT WHERE DRIVE ROD ENTERS CYLINDER:

$$M = F_c\,(L_A - 13.5") = 17620 \text{ in-lbf}$$

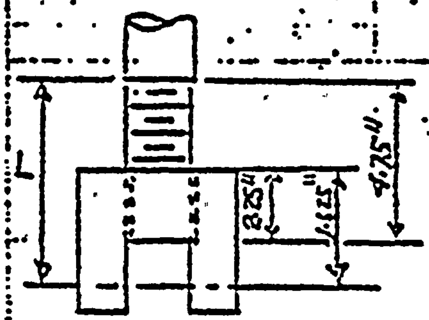
CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-27

$$\sigma = \frac{Mc}{I} \qquad c = D/2 = 1.75/2 = .875" \qquad I = .4604 \text{ in}^4$$

$$\sigma = 33487 \text{ psi} < S_y\ (90000 \text{ psi})$$
(A151-4140)

NUCLEAR

FOR THE THD'D REGION OF THE DRIVE ROD:



$$L = (4.625 - 2.25) + (4.75)$$

$$L = 7.125 \text{ in.}$$

* (DRIVE ROD ASSUMED TO OCCUPY ALL OF THD'D CLEVIS)

THE RESULTING MOMENT IS:

$$(1530)(7.125 \text{ in}) = 10901 \text{ in-lbf}$$

BY TMR DATE 2-6-74 SUBJECT SEISMIC ANALYSIS SHEET NO. 29 OF
CHKD. BY PWU DATE 2-21-74 24" B.F.V. JOB NO.

FOR THE THREADED REGION THE MINOR DIA. FOR A 1 1/2"-6 THREAD IS:

$D_{MINOR} = 1.2955$ IN. REF 8

$C = D/2 = .6478$ IN.

$I = .1383$ IN.^{4}

S = 0.2135

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-28

$\sigma = \frac{Mc}{I} = \frac{(10901)(.6478)}{.1383} = 51061$ psi

FROM PG 18 THE OPERATING CONDITION LOAD DUE TO VALVE SEATING TORQUE IS:

$F_3 = 1478$ lbs

TENSILE/COMPRESSIVE STRESS, $\sigma = \frac{F_3}{A}$

A = TENSILE STRESS AREA = 1.405 IN^2 (REF)

$\therefore \sigma = 1{,}052$ psi

THE COMBINED BENDING + AXIAL STRESS IS:

52,113 psi < S_Y = 90000 psi
(AISI-4140)

BY TMR DATE 3-20-74 SUBJECT 24" B.F.V.
CHKD. BY ____ DATE ____ — ORDER OF ANALYSIS —

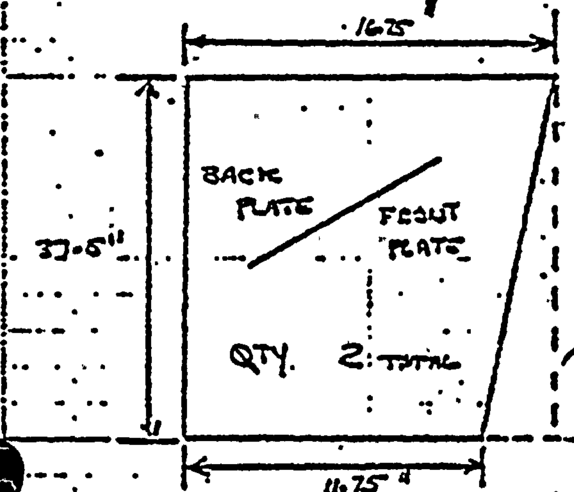
SECTION 6.2

a) CYLINDER SUPPORT BRACKET

BY TMR DATE 1/22/74 SUBJECT SEISMIC ANALYSIS SHEET NO. 6-2-2 OF
CHKD. BY DKG DATE 1-29-74 24" VALVE JOB NO.

DETERMINATION OF APPROXIMATE WEIGHT
OF CYLINDER OPERATOR BRACKET

DWNG A- 208293



TOTAL AREA = A1 - A2

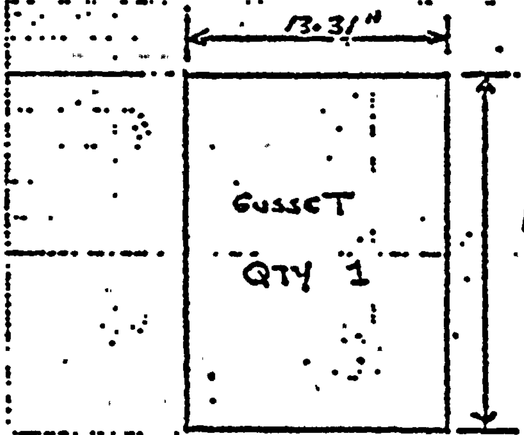
A1 = 16.75 × 37.5 = 628.13 [partly covered by stamp]

A2 = 1/2 × 5 × 37.5 = 93.75 [partly covered by stamp]

A TOTAL PER PLATE = 534.38 IN²

TOTAL VOLUME = AT × t

= 534.38 × .5 = 267.19 IN³



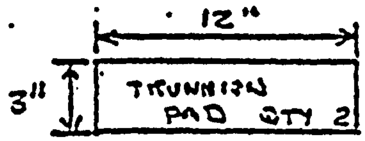
TOTAL AREA = A1

A1 = 13.31 × 16.0

A TOTAL = 212.96 IN²

TOTAL VOLUME = AT × t

= 212.96 × .5 = 106.48 IN³

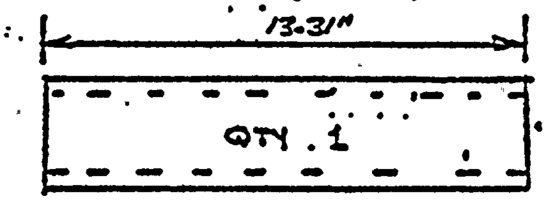


A TOTAL = 3 × 12
= 36 IN²

TOTAL VOLUME = AT × t
= 36 × .75 = 27 IN³

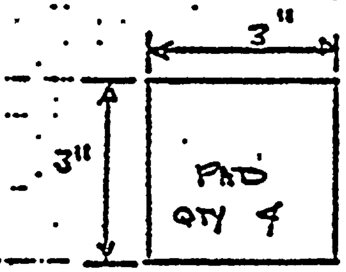
BY TRP DATE 1/22/74 SUBJECT Seismic Analysis SHEET NO. 6.2.3 OF
CHKD. BY DKG DATE 1-29-74 24" Valve JOB NO.

6" SCH 40 S. PIPE



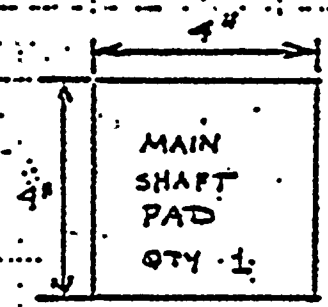
WEIGHT = 18.97 lb/ft
Grinnel (Ref 7) P. 187

TOTAL PIPE WT = $\frac{13.31}{12} \times 18.97 = 21.04$ lb.



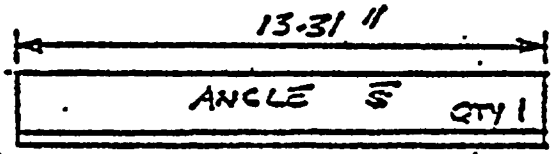
$A_{TOTAL} = 3 \times 3 = 9 \text{ in}^2$

$V_{TOTAL} = 9 \times .38 = 3.42 \text{ in}^3$



$A_T = 4 \times 4 = 16 \text{ in}^2$

$V_T = 16 \times .62 = 9.92 \text{ in}^3$



WT = 1.92 lb/FT.

TOTAL WT = $\frac{13.31}{12} \times 1.92 = 2.13$ lb

ITEM 9 DWNG A-208195 IS IGNORED WRT WEIGHT
NO WEIGHT ALLOWANCE FOR THRU-HOLES IS PROVIDED,
THUS THE TOTAL APPROXIMATED WT IS CONSERVATIVELY
HIGH.

BY TMK DATE 1/22/14 SUBJECT SEISMIC ANALYSIS SHEET NO. G-3.4 OF
CHKD. BY DKG DATE 1-31-74 24" VALVE JOB NO.

TOTAL APPROXIMATED WT IS CALCULATED AS:

$V_{TOTAL} \times \rho$ WHERE $\rho = .283\ lb/in^3$

$$W_{TOTAL} = \left\{ (.283)\left[(2)(267.19) + (1)(106.48) + (2)(27) + (4)(3.42) + (1)(9.82)\right] + 21.04\ lb + 213\ lb \right.$$

W_{TOTAL} (APPROXIMATE) = 227 lb

NOTE: THIS WT. WILL BE ARBITRARILY APPLIED IN SUCH A WAY AS TO MAXIMIZE SEISMIC STRESS EFFECTS AS OPPOSED TO JUST CONSIDERING THIS WT @ THE TRUE C.G. OF THE CYLINDER OPERATOR BRACKET.

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-32

NUCLEAR

SC JOB NO. CHKD. BY

SEISMIC + OPERATING STRESS JOB NO.

= 1.5 IN. D = 1.75 IN

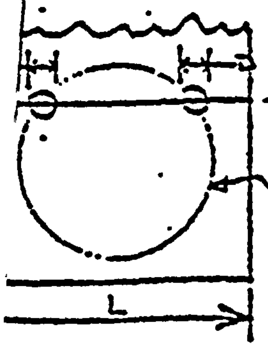
A_B = 2.625 IN^2

EARING STRESS = σ_{BRNG} = F_{TOTAL} / A_B

σ = 1319. psi

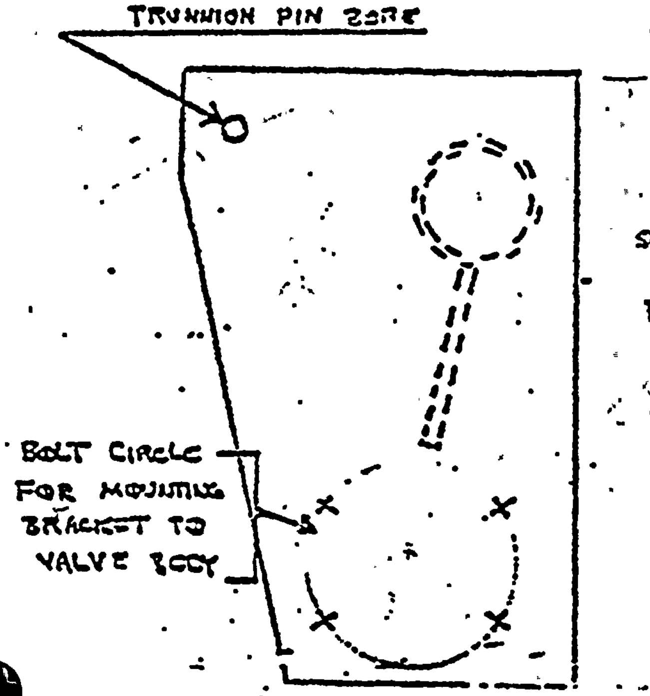
1319. psi < S_y = 36000 psi (ASTM A-36)

INIMUM" SECTION OF THE BRACKET IS DEFINED LINE DRAWN THROUGH THE UPPER TWO MOUNTING ARE BOLT HOLES THE RESULTING SECTION IS ERED TO CARRY SEISMIC + OPERATING LOADS BASED E ASSUMPTION THAT THE BRACKET IS SECURELY TO THE VALVE BODY.



BENDING EFFECT CAUSED BY SEISMIC OVERTURNING E CYLINDER OPERATOR IS CARRIED AS A COUPLE THE MINIMUM SECTION; PLUS THE ACCELERATED BRACKET WT. CARRIED AS A COUPLE AT THE MIN. SECTION

CYLINDER SUPPORT BRACKET



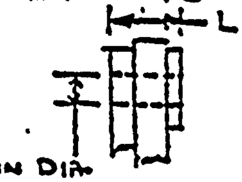
GENERAL ARRANGEMENT
CYL. OPERATOR SUPPORT BRACKET

THE CYLINDER OPERATOR SUPPORT BRACKET IS ANALYZED FOR BEARING AT THE TRUNNION BORE & SHEAR & BENDING EFFECTS ACROSS THE MINIMUM SECTION OF THE BRACKET.

FROM PG. 19, THE COMBINED SEISMIC PLUS OPERATING CONDITION LOAD ON A GIVEN TRUNNION PIN IS:

$$F_{TOTAL} = 3462 \text{ lbs}$$

THE BEARING AREA PRESENTED BY THE TRUNNION BORE IS:



$A_B = L\,D$ WHERE D = TRUNNION PIN DIA.

(REF DWNGS A-208293 & D-206661)

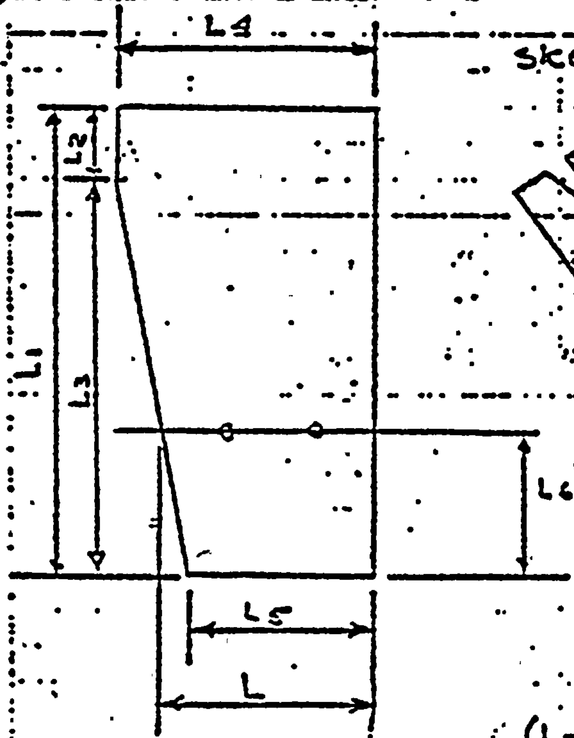
FOR CONSERVATISM, THE MAGNITUDE OF THE FORCE IN THE RESULTING COUPLE IS EQUAL TO "F_{TOTAL}" CALCULATED PREVIOUSLY PLUS $\frac{(4.24)(\text{BRACKET WT})(L_{MAX})}{W}$

(WHERE L_{MAX} IS CONSERVATIVELY CHOSEN AS $(L_3 - L_6)$ —BELOW— AND "W" IS THE WIDTH BETWEEN BRACKET PLATES —BELOW—)

THE TENSILE AREA @ THE MINIMUM SECTION (ONE SIDE OF BRACKET) IS:

$(L - 2D)\,t$ WHERE t = PLATE THICKNESS
D = THRU-HOLE DIA.

IN DETERMINING "L" & "L_{MAX}" THE ACCOMPANYING SKETCH IS USED.



$L_1 = 37.5$ IN. $L_2 = 3.5$ IN.

$L_3 = (L_1 - L_2) = 34.0$ IN.

$L_4 = 16.75$ IN. $L_5 = 11.75$ IN.

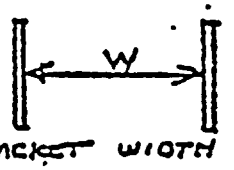
$L_6 = 12.0$ IN., $W = 13.25$ IN.

∴ FROM SIMILAR TRIANGLES

$$\frac{L_3}{(L_4 - L_5)} = \frac{L_6}{(L - L_5)}$$

$$(L - L_5) = \frac{(L_6)(L_4 - L_5)}{L_3} = 1.76$$

$$L = (1.76) + L_5$$



$L = 13.5$ IN. $L_{max} = 22.0$ IN.

BY RAW DATE 2/2/79 SUBJECT 24" B.F.V. SHEET NO. 6-2.8 OF
CHKD. BY [illegible] DATE 7/-/- SEISMIC + OPERATING JOB NO.
STRESS

TENSILE AREA = (13.5 − 1.62)(0.50)

A_T = 5.94 IN²

AXIAL STRESS = σ_A = $\left[3462. + \frac{(4.24)(227.)(22.0)}{(13.25)}\right] / A_T$

σ_A = 852. psi

852. psi < S_u = 36000 psi
(ASTM A-36)

THE LARGEST VALUE OF SHEAR LOAD IS CONSERVATIVELY CALCULATED AS V = 4.24 (W_1 + W_2)

W_1 (CYLINDER WT) = 238. lbs, W_2 (BRACKET WT) = 227. lbs

∴ V = 1972. lbs

THE SHEAR AREA IS TWICE THE CALCULATED TENSILE AREA IN THIS CASE THUS

$\tau = \frac{V}{A} = \frac{V}{2A_T} = \frac{1972.}{(2)(5.94)}$

τ = 166. psi

166. psi < .6 S_u = 21600 psi
(ASTM A-36)

SECTION 6.3

CLEVIS ASSEMBLY AND DRIVE LEVER:

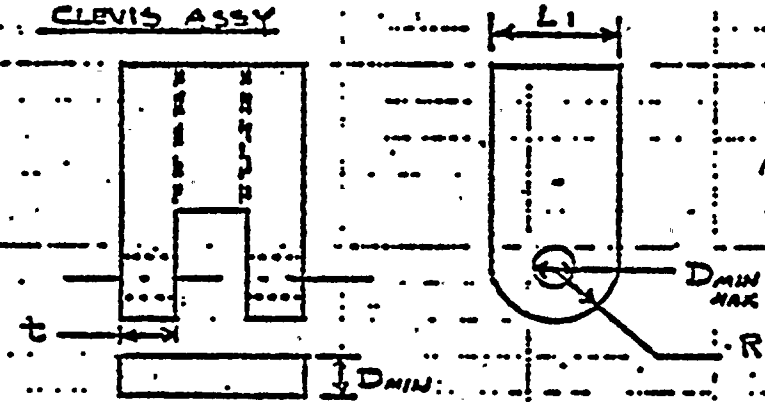
a) CLEVIS PIN
b) CLEVIS
c) DRIVE LEVER
d) KEY

BY ______ DATE ______ SUBJECT ______ SHEET NO. ______ OF ______
CHKD. BY ______ DATE ______ SEISMIC + OPERATING STRESS JOB NO. ______

CLEVIS ASSY. AND DRIVE LEVER

(REF DWNGS B-211830 & D211832-1) ①

CLEVIS ASSY



THE CLEVIS PIN IS ASSUMED TO HAVE THE SAME O.D. AS THE MINIMUM I.D. CLEVIS

CYGNA ATTACHMENT
JOB NO 82044
FILE NO OT.01.F
SHEET NO. B-38

THE CLEVIS PIN IS IN DOUBLE SHEAR AND PRESENTS A TOTAL SHEAR AREA OF:

$$A_s = 2\left(\frac{\pi D^2}{4}\right) \qquad D = 1.5 \text{ IN}$$

$$A_s = 3.53 \text{ IN}^2$$

NUCLEAR

THE TOTAL SEISMIC PLUS OPERATING CONDITION LOAD ON THE CLEVIS PIN IS CONSERVATIVELY CHOSEN AS THE ALGEBRAIC SUM OF CLEVIS SEISMIC REACTION AND SEATING TORQUE REACTION

CLEVIS SEISMIC LOAD (Pg 21) = 1530. lbf (Error)

CLEVIS (TRUNNION PIN) SEATING TORQUE LOAD (Pg 18) = 1478. lbf

$F_{TOTAL} = 3008.$ lbf

BY: [illegible] DATE: [illegible] SUBJECT: SEISMIC + OPERATING STRESS SHEET NO. JOB NO.
CHKD. BY: EDS DATE: [illegible]

THE RESULTING MAXIMUM SHEAR STRESS IN THE CLEVIS PIN IS:

$$\tau = \frac{4}{3}\frac{V}{A_s} = \frac{4}{3}\frac{(3008)}{(3.53)}$$

$\tau = 1136.$ psi $< .6 S_y = 9900$ psi (A479, 304 S.S @340°F)

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-39

THE CLEVIS ITSELF CAN FAIL IN ONE OF SEVERAL MODES:

TENSILE FAILURE: $A_{TENSILE} = 2(L_1 - D_{MAX})(t)$

$L_1 = 3.0$ $D_{MAX} = 1.5$ in. $t = 0.813$

$A_T = 2.44$ in^2

BEARING FAILURE: $A_{BRNG} = 2(D_{MIN})(t)$

$A_{BRNG} = 2.44$ in^2

PUNCH SHEAR: $A_S = 4(R - D_{MAX}/2)(t)$

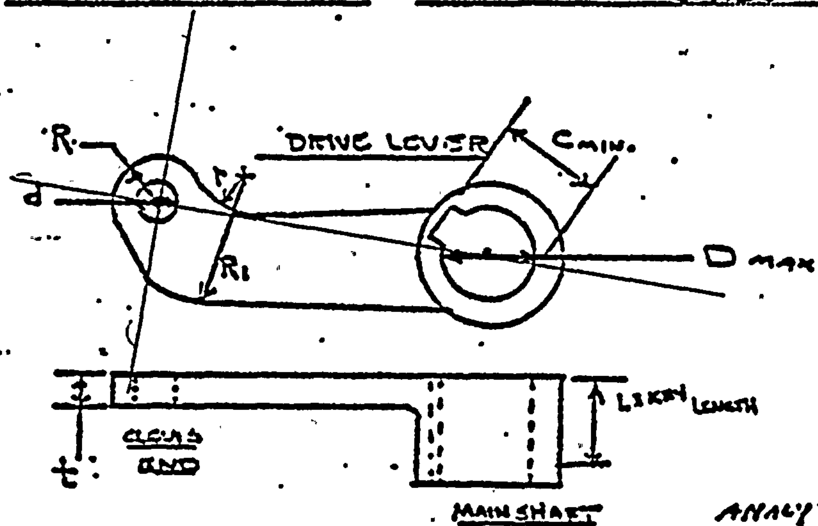
$A_S = 2.44$ in^2

THE TOTAL LOAD ON THE CLEVIS IS F_{TOTAL} AS CALCULATED ON THE PREVIOUS PAGE.

THE GOVERNING STRESS IS: $\frac{3008}{2.44}$

1233. psi $< .6 S_y = 27,000$ psi
33 (ASTM A395) ①

CHKD. BY PWC DATE 2/1/74 SEISMIC + OPERATING STRESS SHEET NUMBER OF JOB NO.



$(R_1-r)=2.586$
$t=\frac{4.5}{4.32\ in^2}$ no problem

critical is keydrive bearing stress

THE DRIVE LEVER IS ANALYZED FOR GOVERNING STRESS CONDITIONS AT THE "CLEVIS END", IS ANALYZED FOR COMBINED TENSILE PLUS BENDING AT THAT SECTION DEFINED AS $(R_1 - r)$ AND IS ANALYZED FOR BEARING STRESS AT THE KEYWAY ON THE "MAINSHAFT END".

FROM PG 32, THE MAXIMUM CLEVIS REACTION (TRUNNION PIN REACTION) IS

$F_{TRIAL} = 3008.$ lbs ~~~ 2136.5 = new Torque + dis
torque only = 1200.46

AT THE CLEVIS END, SEVERAL MODES OF FAILURE EXIST:

TENSILE FAILURE: $A_T = (2R-d)t$ R = 1.5 IN. d = 1.75 IN t = 1.5 IN

$A_T = 1.875\ IN^2$

BEARING FAILURE: $A_{BRNG} =$ (CLEVIS PIN DIA.) (t) $D_{C.P.} = 1.5$ IN.

✓ $A_{BRNG} = 2.25\ IN^2$

PUNCH SHEAR: $A_S = (R - d/2)(t)(2)$

$A_S = 1.875\ IN^2$

THE GOVERNING STRESS IS :

$$= \frac{F_{TOTAL}}{A_I} = \frac{3008}{1.875}$$

$= 1604.$ psi $< .6\ S_y$ (ASTM 395) (?)

Say critical, $\frac{2377 + 1200 = 3577}{1.875}$ = ~~1908 PSI~~

TENSILE + BENDING STRESS

FOR THE SECTION DESCRIBED AS $(R_1 - r)$ THE MOMENT OF INERTIA IS :

$$I = \frac{bh^3}{12}$$

$b = t = 1.5$ IN.

$h = (R_1 - r) = 2.88$ IN.

$I = 2.99\ in^4$

THE LARGEST MOMENT THE DRIVE LEVER CAN GENERATE IS EQUAL TO THE SEATING TORQUE. (ABOVE THIS TORQUE LEVEL THE VALVE UNSEATS)

$\sigma_B = \frac{Mc}{I}$ WHERE $M = 17000.$ in-lbs (Seating torque above)

$c = (R_1 - r)/2 = 1.44$ IN.

$\sigma_B = 8187.$ psi $\quad 17000 * \frac{1.44}{2.99} = 8187 * \frac{13.8}{17} = 6646$ PSI

IN ADDITION TO THE BENDING STRESS AN AXIAL STRESS CAN EXIST. FOR CONSERVATISM THE FORCE PRODUCING THIS STRESS IS F_{TOTAL} AS DEFINED ABOVE.

BY: [illegible] DATE: 7/2/[illegible] SUBJECT: 24" B.F.V. SEISMIC + OPERATING STRESS SHEET NO. C-1-6 OF ___
CHKD. BY: PWC DATE: [illegible] JOB NO. ___

THE MINIMUM AREA CARRYING THIS TENSILE LOAD IS $A_T = (R_1 - r)(t) = 2.88(1.5) = 4.32$

THE AXIAL STRESS $\sigma_A = \frac{F_{TOTAL}}{A_T} = 696$ psi

THE TOTAL BENDING + TENSILE STRESS IS:

$\sigma_A + \sigma_B = 8,883$ psi $<$ S_y ~~45,000~~ 28,800 (1) (ASTM A 395)

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-42

KEYWAY BEARING STRESS

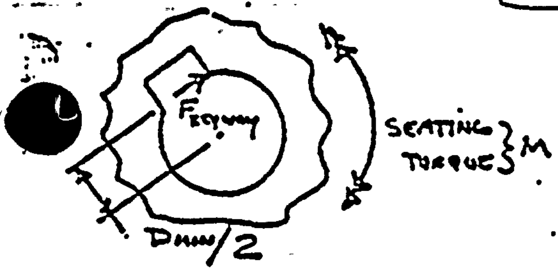
THE MINIMUM BEARING AREA PRESENTED BY THE KEYWAY IS, FROM THE SKETCH ON PG 34,:

$A_B = (C - D)\,L$ WHERE $C = 2.413$ IN.
$D = 2.25$ IN.
$L = 2.75$ IN.

$A_B = 0.448\ \text{IN.}^2$

NUCLEAR

THE COMBINED FORCE ACTING ON THE KEYWAY IS CONSERVATIVELY ASSUMED TO BE THE COMBINATION OF SEATING TORQUE REACTION PLUS THE MAXIMUM CLEVIS REACTION LOAD



$(F_{KEYWAY})(D_{MIN}/2) = M$

$\frac{D_{MIN}}{2} = 1.125$ IN.

$M = 17000.$ IN-lbf

from [illegible]

Fkeyway = 15111. lbf - & From Previous Pg:

Ftotal = 3008. lbf

THE COMBINED FORCE = Fkeyway + Ftotal = 18119. lbf.

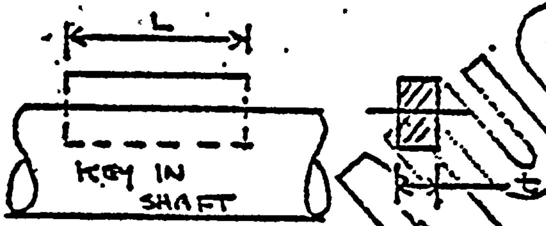
BEARING STRESS = σ_{BRNG} = F combined / As

[illegible] 40444 × 15.111/18.119 × 13.8/17 = 27,380.

40444 × 1200/3008 = 16,139

σ_{BRNG} = 40444. psi < Sy = 45 ksi (ASTM A395) ①

THE COMBINED FORCE AS CALCULATED ABOVE IS APPLIED TO THE KEY AS A SHEAR LOAD.



THE SHEAR AREA OF THE KEY IS:

As = Lt where L = 2.75 IN t = 0.50 IN

As = 1.33 IN²

τ = F combined / As = 18119 / 1.38

τ = 13129. psi < .6 Sy = 21000 psi (AISI-1018)

SECTION 6.4

VALVE BODY SUPPORT "EARS" AND ASSOCIATED HARDWARE

a) "EARS"

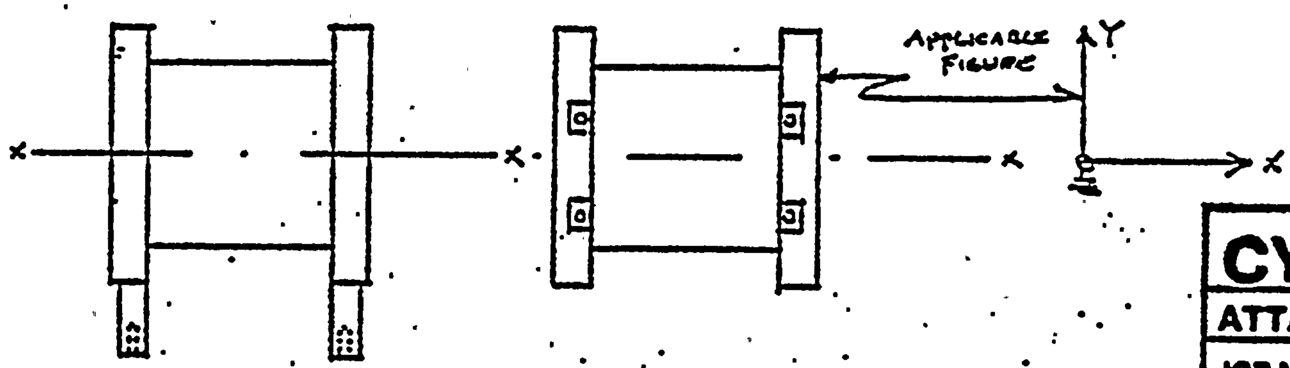
b) BOLTING HARDWARE

BY K.M.G. DATE 2-12-74 SUBJECT 24" B.F.V. SHEET NO. 644 OF

CHKD. BY PWC DATE 2-21-74 SEISMIC PLUS OPERATING STRESS JOB NO.

VALVE BODY SUPPORT "EARS"

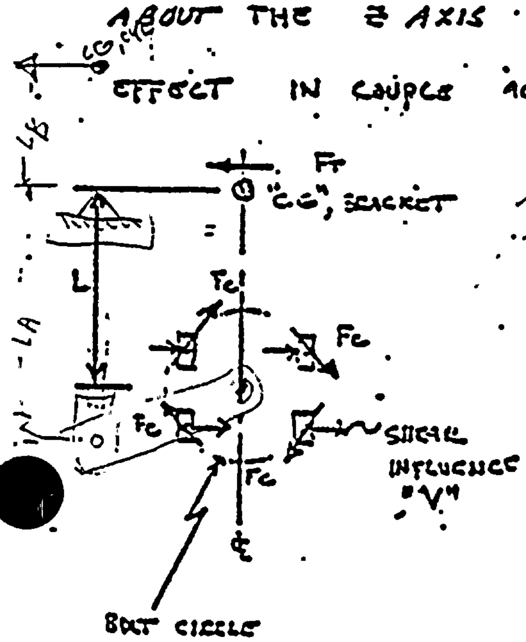
AND CYL. OPERATOR BRACKET TO BODY HARDWARE



THE "EARS" OF THE VALVE BODY SUPPORT THE CYLINDER OPERATOR/BRACKET ASSY. AND ARE ANALYZED HERE FOR TORSIONAL, BENDING AND SHEAR EFFECTS

TORSIONAL EFFECT

WHEN CYL. OPERATOR & BRACKET TEND TO OVERTURN ABOUT THE Z AXIS THE VALVE "EARS" REACT OUT THE TORQUE EFFECT IN COUPLE ACTION.



THE SEISMIC PORTION OF THE TRUNNION REACTION IS: $F_{T_S} = \left(\frac{L_A}{L_A} + \frac{L_B}{L_A}\right) W'$ (PG 13) ; THE SEATING TORQUE EFFECT IS "F3" (PG 18) ; ; $W' = 4.24\,(W_{cyl})$

<1478#

$L_A = 25.02$ IN.

$L_B = 22.62$ IN.

$F_T = F_{T_S} + F_3 = 4,699$ lbs (seating torq.) ✓

$3229^{\#} + 1478^{\#}$

$F_{T_S} = 3229^{\#}$

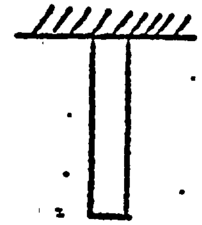
BRACKET WT = 227 lbs (PG 26)

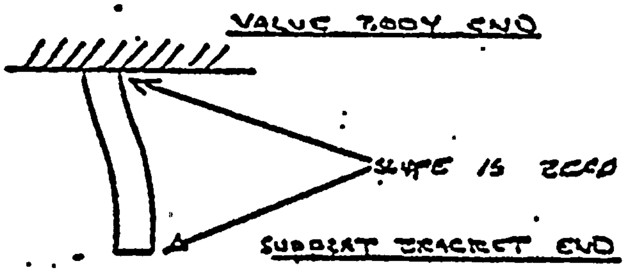
IT IS ASSUMED THE BRACKET C.G. IS LOCATED AS SHOWN IN FIGURE SUPPLIED AND THAT L REPRESENTS LENGTH FROM TRUNNION BORE TO MAINSHAFT ℄

L = 28.5 IN.

BY [illegible] DATE [illegible] SUBJECT 6" B.F.V. SHEET NO. 6.4.3 OF

CHKD. BY PJC DATE 2-21-74 SEISMIC PLUS OPERATING STRESS JOB NO.





EAR BEFORE COUPLE ACTION

EAR IN COUPLE ACTION (RESTRAINED)

THE ABOVE CONDITION EXISTS DUE TO THE FACT THAT BOTH THE VALVE BODY & THE SUPPORT BRACKET ARE CONSIDERED PERFECTLY RIGID.

THE TOTAL TORQUE RESISTED BY THE VALVE "EARS" IS

4763 x 28.5" + 4.24 x 227# x 28.5"

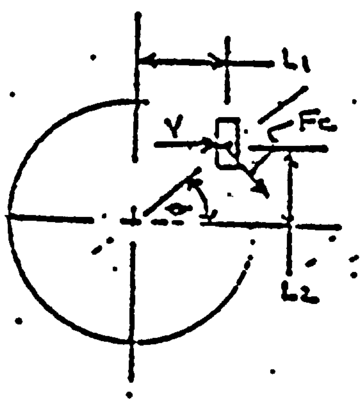
$$T = (F_T)(L) + (4.24)(W)(L) = 161357^{\#}$$

THE RESULTING VALUE OF Fc IS

$$2F_c = T / \text{DIA BOLT CIRCLE} \qquad \text{WHERE } DIA_{BOLT\ CIRCLE} = 12.5 \text{ IN}$$

$$T = 161{,}352 \text{ in.-lbf} \qquad F_c = 6{,}454 \text{ lbf.}$$

BENDING OF THE VALVE BODY EARS ABOUT THE Y-AXIS AS SHOWN ON THE PREVIOUS PAGE, IS THE WEAKEST PLANE OF BENDING



(REF DWNG A-900323+... 4)

$$L_1 = 3.75 \text{ IN.}$$

$$L_2 = 5. \text{ IN.}$$

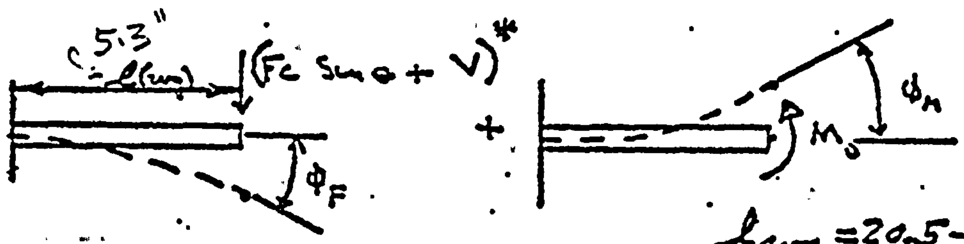
$$\theta = \tan^{-1} L_2/L_1 = 53.13°$$

$\theta = 53.13°$

$V + F_c \sin\theta$ = FORCE PRODUCING BENDING ABOUT Y-AXIS

IN ORDER TO MAINTAIN A ZERO SLOPE @ BRACKET END OF "EMR"

A MOMENT IS INDUCED SUCH THAT:



$$\phi_F + \phi_M = 0$$

$$\ell_{avg} = 20.5 - \sqrt{\left(\frac{32}{2}\right)^2 - 5.^2}$$

$$= 5.3$$

FROM REF 5 PG'S 104 & 10.6:

FOR AN END LOAD OF Fc Sin θ + V:

$$\phi_F = \frac{1}{2}\frac{W\ell^2}{EI}$$

FOR AN END MOMENT (Mo):

$$\phi_M = \frac{M_o\,\ell}{EI}$$

$$\frac{1}{2}\frac{W\ell^2}{EI} + \frac{M_o\,\ell}{EI} = 0$$

SOLVING FOR Mo:

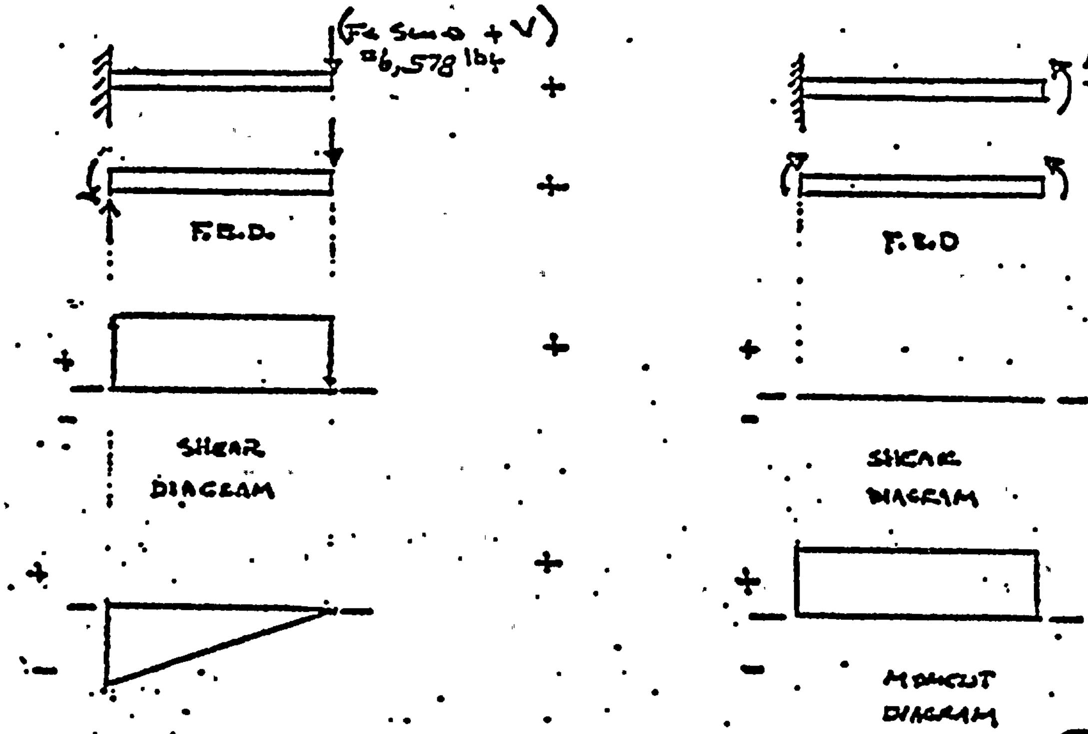
$$M_o = -\left(\frac{W\ell^2}{2}\right)\left(\frac{1}{\ell}\right)$$

$$M_o = -\frac{W\ell}{2} = -(F_c \sin\theta + V)\frac{\ell}{2}$$

* V IS THE SHEAR EFFECT = $(F_T + 4.24\,W_2)\,1/4$

W_2 (BRACKET) = 227 lbs

V = 1,415 lbs



THE MAXIMUM MOMENT OCCURS AT THE CANTILEVERED END AND EQUALS:

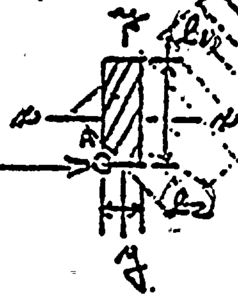
$$M = (F_c \sin\theta + V)(l_{..}) - M_o$$

$$= 17,432 \text{ IN-lbs}$$

THE RESULTING BENDING STRESS PER EAR IS:

$$\sigma_B = \frac{Mc}{I}$$

BENDING STRESS CALCULATED HERE (PT. A)



$c = l_2/2$

$$I_{yy} = \frac{l h^3}{12} = \frac{l_1 l_2^3}{12}$$

$l_1 = 2.5$ IN.

$l_2 = 1.5$ IN.

$$\sigma_B = \frac{(17,432)(.75)}{(.703)} = 18,597 \text{ psi}$$

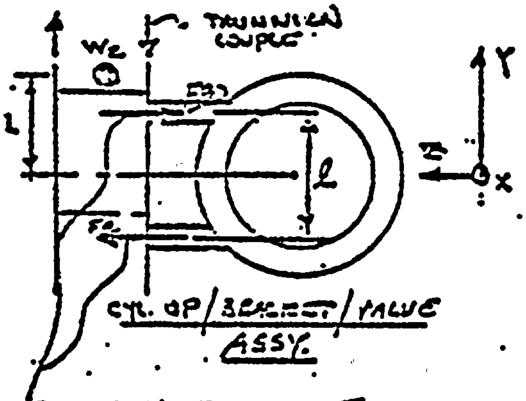
$\tau_{AVG} = \frac{F_c \sin\theta + V}{AS} = \frac{6578}{375} = 1754$ psi ; CONSERVATIVELY COMBINING τ_{AVG} & σ_B :

$\sigma_{MAX} = 18761$ psi < S_y = 28000 psi @ 240 (STATIC REQD)

CHKD. BY CLC DATE 2-21-74 — SEISMIC PLUS OPERATING STRESS — JOB NO.

BENDING EFFECT

WHEN THE CYLINDER OPERATOR IS "OVERTURNED" INTO THE VALVE BODY AS IN SECTION 6.1, THE COMBINED MOMENT EFFECT OF CYLINDER OPERATOR & BRACKET IS TAKEN OUT IN THE "EARS" AS AXIAL TENSION/COMPRESSION



L = 28.5" (SEE PG 39)

TRUNNION COUPLE = 27076 in-lbf (SEE PG 15)

BRACKET WT = W_2 = 227 lbf (SEE PG ...)

CYL. OP. WT = W_1 = 399 lbf (SEE PG 15)

REACTION FORCES, F_B, TO BENDING EFFECT

THE TOTAL SEISMIC + OPERATING MOMENT IS

M = TRUNNION COUPLE + $(4.24)(W_2)(L)$ ~~...~~ conservative

Moment due to gv: $M = 54{,}507$ IN-lbf

$\therefore F_B = \frac{M}{\ell}$ WHERE $\ell = 10$ IN.

i.e.

$F_B = 5{,}451$ lbf ; THE STRAIGHT WT EFFECT IS $4.24(W_1 + W_2)$ = F_A = 2654 LB. (CYL WT, BRACKET WT)

AS TWO "EARS" ARE IN TENSION: do $\sigma = \frac{5451+2654}{2A_3}$ 1081 vs 904

$\sigma_T = \sigma_{TOTAL} = \frac{.5F_B + .25F_A}{A_T}$ WHERE $A_T = (\ell_1)(\ell_2)$ (REFER PREVIOUS PG)

σ_{TOTAL} = 904 psi ≪ S_y = 28000 psi (SA-516, GR 70 @ 340°F)

SHEAR LOADING

THE COMBINED SEISMIC EFFECT OF CYLINDER OPERATOR WT. & BRACKET WT. IS:

$\therefore F_S = 4.24 (W_1 + W_2)$ W_1 (CYL) = 399 lbf.
W_2 (BRACKET) = 227 lbf.

FROM PG. 18 THE TRUNNION REACTION AS A RESULT OF OPERATING TORQUE IS:

$F_3 = 1,478$ lbf.

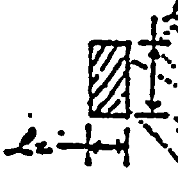
CONSERVATIVELY SUMMING FOR A TOTAL SHEAR LOAD:

$V = F_S + F_3 = (2,654) + (1,478)$

$V = 4,132$ lbf.

V IS ASSUMED TO BE SHARED EQUALLY BY EACH OF THE FOUR "EARS".

$\therefore \tau = \frac{V}{A_S}$



$A_S = (4)(\ell_1)(\ell_2)$

$A_S = 15 \text{ IN}^2$

$\tau = \frac{(4,132)}{(15)} = 275$ PSI

COMBINING σ_{TOTAL} (PREVIOUS PG) PLUS τ (ABOVE):

MAX STRESS (CONSERVATIVE) $= \frac{\sigma_T}{2} + \sqrt{\left(\frac{\sigma_T}{2}\right)^2 + (\tau)^2}$

OVER →

CHKD. BY PVC DATE 2-21-74 SEISMIC PLUS OPERATING STRESS JOB NO.

MAX. STRESS = 981 psi ≪ Sy = 28000 psi (SA-516, GR-60 @ 340°F)

BRACKET HARDWARE:

REALISTICALLY REVIEWING THE LOADING ON THE BOLTS:

(A) SHEAR DUE TO CYL & BRACKET = (4.24)/4 (Wcyl + Wbrack)

= .664 lbs

(B) TORQUE DUE TO CYLINDER = (3)(1 + 22.62/25.02) ...

= 64957 in-lbs

∴ Fc DUE TO CYL = 64957 / (2)(12.5) = 2598 lbs

SHEAR DUE TO (A) & (B) ABOVE = 3262 lbs

(C) THE TRUE LOCATION OF THE C.G. IS APPROX. 22" ABOVE THE BOLT CIRCLE ℄.

TORQUE INFLUENCE IS (22)(225)(3) / (2)(12.5) = 594 lbs

SHEAR DUE TO (A)+(B)+(C) = 3856 lbs.

THE RESULTING SHEAR STRESS IS: $\tau = \frac{3856}{A_s}$; $A_s = \frac{\pi D_{min}^2}{4}$

BOLT = 3/4"-10 D_{MIN} = .6273 Ref

τ = 12467 psi ; FROM Pg 43 THE TENSILE STRESS IS 904 psi

$$\sigma_{MAX} = \frac{904}{2} \pm \sqrt{\left(\frac{904}{2}\right)^2 + (12467)^2}$$

= +12927 psi < Sy (SA-307 @ 212°F) = S allowable 7000 / .3 = 23333 psi

CYGNA ATTACHMENT JOB NO. 82044 FILE NO. OT.01.F SHEET NO. 51

NUCLEAR

BY TTR DATE 2-20-74 SUBJECT 24" B.F.V. SHEET NO. 6.5.1 OF
CHKD. BY DATE — ORDER OF ANALYSIS — JOB NO.

SECTION 6.5

SHAFT AND DISC ASSEMBLY :

a) FRONT SHAFT

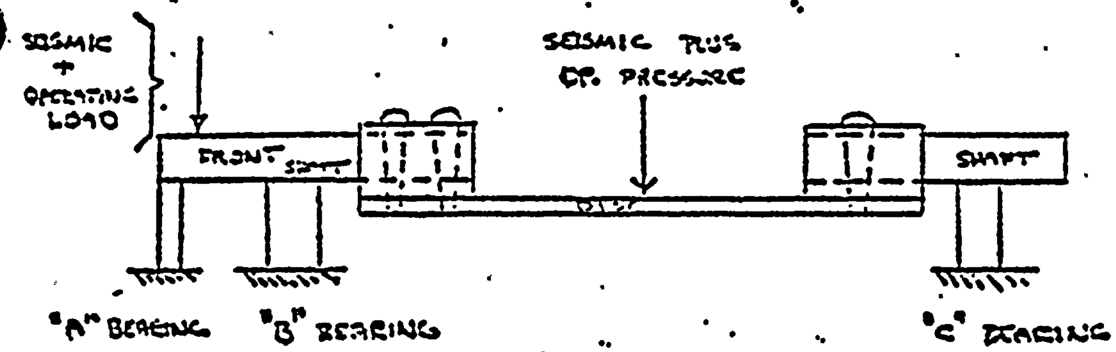
b) DISC

c) TAPER PINS

d) BOLTING HARDWARE

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-52

NUCLEAR



SHAFT AND DISC ASSEMBLY

FROM PG 21, THE MAXIMUM SEISMIC CLEVIS/DRIVE LEVER LOAD IS F_C = 1530 lbf.

FROM PG 18, THE SEATING TORQUE LOAD ON THE CLEVIS/DRIVE LEVER IS F_{ST} = 1478 lbf.

$F_C + F_{ST}$ = COMBINED SEISMIC + OPERATING EFFECT = 3008 lbf.

FROM BIF THE SEATING TORQUE IS 17000 IN-lbf.

FROM BIF THE COMBINED WEIGHTS OF THE SHAFTS AND DISC ARE $W_{COMBINED}$ = 224 lbf.

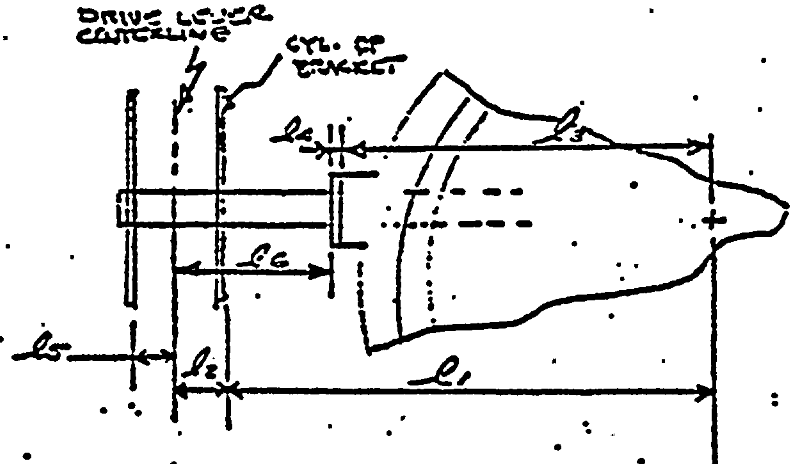
THE MAXIMUM SEISMIC INFLUENCE ON THE DISC IS

$$4.24(W_c) = 4.24(224) = 950 \text{ lbf.}$$

BASED ON THE TRUE SHAFT/DISC SUSPENSION SYSTEM, THE FRONT SHAFT IS ASSUMED SIMPLY SUPPORTED FROM THE FRONT FACE OF THE GLAND FOLLOWER AND THE FREE END OUTER SHAFT BEARING

BY. [illegible] DATE [illegible] SUBJECT [illegible] SHEET [illegible]
CHKD. BY. PWC DATE 2-21-74 SEISMIC PLUS OPERATING STRESS JOB NO.

SEISMIC & OPERATING FORCES ARE CONSIDERED TO ACT ON THE FRONT SHAFT @ THE INTERSECTION OF FRONT SHAFT & CENTERLINE OF THE DRIVE LEVER.



CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-54

(DWNGS: GEN'L ARRANGEMENT, A-206765 ; TODY, FABRICATED, A-900523,
GLAND FOLLOWER, B-900537 .. CYL. SUPPT BRACKET A-208293)

l_6 = FREE SPAN LENGTH $= (l_1 + l_2) - (l_3 + l_4)$

$l_1 = 24.5$ IN; $l_2 = 6.75$ IN; $l_3 = 16.25$ IN; $l_4 = .69$ IN.

$l_5 \cong 6.005$ IN; $\therefore$ $l_6 = 10.31$ IN.

FROM THE PREVIOUS PG, THE MAXIMUM SEISMIC + OPERATING LOAD ON THE CLEVIS IS $F_C + F_{OP} = F_{COMBINED}$ = 3008 lbf (CONSERVATIVE)

FROM REF. PG 106, CASE 12;

THE MAXIMUM BENDING MOMENT IS $M = W\frac{ab}{L}$ @ LOAD POINT

$a \equiv l_5$, $b \equiv l_6$, $L \equiv l_6 + l_5$, $W = F_{COMBINED}$

$\therefore M = \frac{(3008)(6.005)(10.31)}{(16.315)}$; $M = 11{,}415$ IN lbf

MIN. SHAFT DIA. = D_{MIN} = 2.2496 IN $\therefore$ $c = \frac{D_{MIN}}{2} = 1.1248$ IN. $I = \frac{\pi D_{MIN}^4}{64} = 1.257$ IN^4

BENDING STRESS = $\sigma_B = \frac{Mc}{I} = 10215$ psi

BY ___ DATE ___ SUBJECT ___ SHEET NO. ___ OF ___
CHKD. BY PWC DATE 5-21-74 SEISMIC PLUS OPERATING STRESS JOB NO. ___

IN ADDITION TO BENDING, $F_{COMBINED}$ PRODUCES AN AVERAGE SHEAR STRESS ACROSS THE SHAFT EQUAL TO: D=2.25

$$\tau_{AVG} = \frac{F_{COMBINED}}{A} \quad \text{WHERE } A = \frac{\pi D_{MIN}^2}{4} = 3.97 \text{ IN}^2$$

$$\tau_{AVG} = 757 \text{ psi}$$

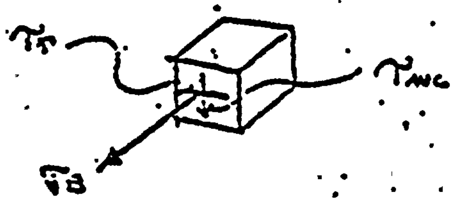
F_c = 3008

THE OPERATING TORQUE PRODUCES A TORSIONAL SHEAR OF:

$$\tau_T = \frac{T\rho}{J}; \quad \rho = c = 1.1248 \text{ IN}; \quad J = 2I = 2.514$$

$$\tau_T = 7606 \text{ psi}$$

T = 17,000



THE RESULTING STRESS CUBE IS VIEWED AS TRIAXIAL IN STRESS STATE. (CONSERVATIVE)

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-55

FROM REF 5 Pg 95, CASE 7:

GENERAL TRIAXIAL STRESS CASE

$$S^3 - (S_1+S_2+S_3)S^2 + (S_1S_2 + S_2S_3 + S_1S_3 - S_{s_1}^2 - S_{s_2}^2 - S_{s_3}^2)S - (S_1S_2S_3 + 2S_{s_1}S_{s_2}S_{s_3} - S_1S_{s_1}^2 - S_2S_{s_2}^2 - S_3S_{s_3}^2) = 0$$

$S_1 = \sigma_B$, $S_2 = 0$, $S_3 = 0$

$S_{s1} = 0$, $S_{s2} = \tau_T$, $S_{s3} = \tau_{AVG}$

NUCLEAR

$\therefore$

$$S^3 - (S_1)S^2 + (-S_{s2}^2 - S_{s3}^2)S = 0$$

OR $S^2 - S_1 S + (-S_{s2}^2 - S_{s3}^2) = 0$. THIS SIMPLIFIED EQTN IS OF THE FORM $a\mu^2 + b\mu + c = 0$

BY ____ DATE ____ SUBJECT ____ SHEET NO. ____ OF ____
CHKD. BY PWC DATE 2-21-74
SEISMIC PLUS OPERATING STRESS
JOB NO. ____

THE SOLUTION OF THIS QUADRATIC IS

$$\sigma = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$a = 1, \quad b = \sigma_B, \quad c = (-S_{s2}^2 - S_{s3}^2)$ WHERE

$\therefore c = -58429986$ $\qquad S_{s2} = \tau_T = 7606$ psi

$S_{s3} = \tau_{av} = 757$

$$\sigma = \frac{-(10215) \pm \sqrt{(10215)^2 - 4(1)(-58429986)}}{2(1)}$$

$$\sigma = \frac{-(10215) \pm (18386)}{2(1)}$$

$$= +\frac{8171}{2}, \quad = -\frac{28601}{2}$$

$\sigma = +4086$

$= -14301$

$= 0$

MAX. STRESS INTENSITY = 18387 psi ✓

18387 psi < (1.2)(1.5) S_m = 27180 psi
(@ 340)

OK

NUCLEAR

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-56

BY. JME DATE [illegible] SUBJECT: SEISMIC PLUS OPERATING STRESS SHEET NO. OF JOB NO.
CHKD. BY. PUC DATE 7-21-74

THE DISC ITSELF UNDERGOES BENDING DUE TO THE COMBINED EFFECT OF SEISMIC & OPERATING LOADS.

THE DISC IS ASSUMED TO BE SIMPLY SUPPORTED @ IT'S EDGES & CARRYING A UNIFORM LOAD ACROSS ITS FACE.

FROM REF 5 PG 216 CASE 1.

STRESSES ARE MAX @ CENTER:

MAX Sr (RADIAL STRESS) = MAX St (TANGENTIAL STRESS)

$$= \frac{3W}{8\pi m t^2}(3m+1)$$

WHERE $m = \frac{1}{.3} = 3.33$

t = DISC THICKNESS = 1.38 IN.

$W = 4.24 (W_{DISC} + W_{SHAFT}) + P \pi a^2$; P = 45 PSI

DISC RADIUS = a = 11.21 IN. (SCALED) SEE 300M, MACHINING DWG A-900524

W = 18715 lbs.

$$S_r = S_t = \frac{(3)(18715)}{8\pi(3.33)(1.38)^2}\left[(3)(3.33)+1\right]$$

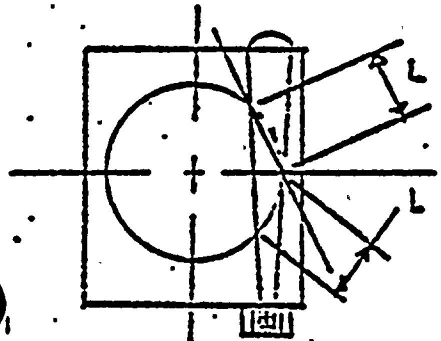
$S_{r-\theta}$ = STRESS INTENSITY = 3871 psi < Sm = 15000 psi (SA-216, WCB @ 340)

Seating Torque not

TAPER PINS

FOR ALL INTENSIVE PURPOSES THE TAPER PINS ONLY CARRY THE VALVE SEATING TORQUE IN SHEAR.

IN SHEAR, 50% OF THE TOTAL TORQUE IS ASSUMED CARRIED BY THE FIRST PIN.

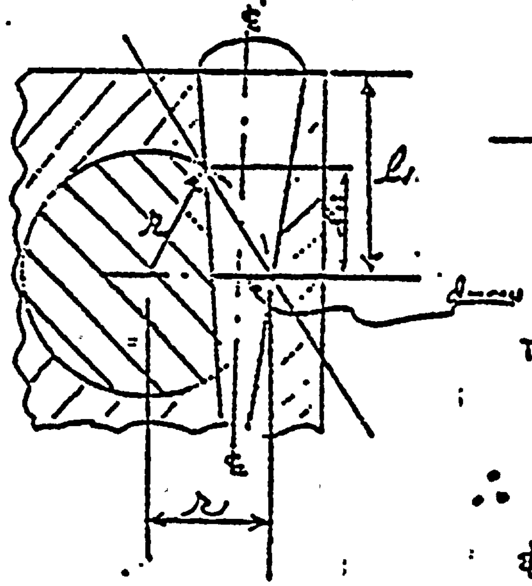


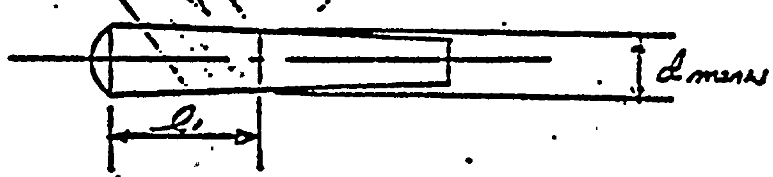
TAPER PIN, SHAFT & HUB

IN SHEAR, THE SHAFT TENDS TO ROTATE THROUGH THE PIN ALONG A PATH WHICH IS DEFINED BY "L".

THE TAPER PIN IS DEFINED BY A ... CIRCULAR PIN OF AVERAGE DIA.

d_{mean} = TAPER PIN MEAN DIA. = .541 IN. (DWNG B-900536 PIN, DISC)

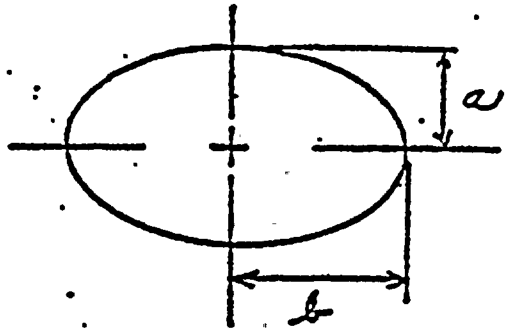




BASED ON GEOMETRY CONSIDERATIONS, THE MEAN DIA. OF THE PIN OCCURS, AS SHOWN, RELATIVE TO THE SHAFT

$\therefore$ ① $d_{mean}^2 + \ell_2^2 = L^2$

& ② $\ell_2^2 + (r - d_{mean})^2 = (r)^2$



AREA OF ELLIPSE IS :

$$A_s = \pi\, a\, b \qquad \text{REF IV}, \text{Pg } 399$$

WHERE $a = \frac{d_{mean}}{2}$ } conservative

$b = \frac{L}{2}$

$$\therefore \; ③ \; A_s = \pi \, \frac{d_{mean}}{2} \, \frac{L}{2}$$

COMBINING EQUATIONS ① + ② :

$$L = \sqrt{(2R)(d_{mean})} = \sqrt{(D_{SHAFT})(d_{mean})}$$

SUBSTITUTING INTO EQTN. ③ :
(REF III F)

$$A_{s_{TOTAL}} = (2)\pi \, \frac{d_{mean}}{4} \sqrt{(D_S)(d_m)} = \text{SHEAR AREA CARRYING } 50\% \text{ OF TOTAL TORQUE}$$

$$A_s = .937 \text{ in}^2$$

use T = 1700 #

THE SHEAR LOAD IS $V = \frac{\text{TORQUE}}{D_S/2} (.5) = 7556 \text{ lbs}$

shaft

D... main shaft

$$\tau_{max} = \frac{4}{3} \frac{V}{A_S} = \frac{4}{3} \frac{(7556)}{(.937)}$$

$$\tau = 10753 \text{ psi} < .8\, S_Y \underset{(\text{SA182 304 @ 340})}{} = 12000 \text{ psi}$$

For Seating screw only

CHKD. BY. PJC DATE 5-31-74 SEISMIC PLUG OPERATING STRESS JOB NO.

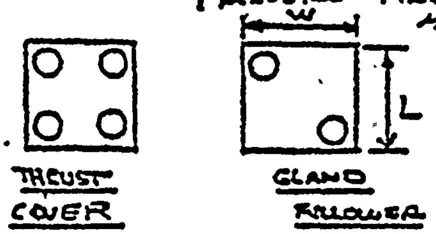
THRUST BEARING COVER & STUFFING BOX GLAND FOLLOWER HARDWARE

THIS ANALYSIS IS PERFORMED CONSIDERING THE THE VALVE PRESSURE EFFECT ON THRUST BEARING COVER AND STUFFING BOX HARDWARE.

THE MAX. PRESSURE AREA FOR EITHER COVER IS DETERMINED & THE RESULTING PRESSURE FORCE APPLIED TO (2) BOLTS OF THE SMALLEST TENSILE AREA OF EITHER STUFFING BOX OR THRUST BEARING HARDWARE.

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-60

$$\text{PRESSURE AREA}_{MAX} = (L)(W) = (4.5)^2 = 20.25\ \text{IN}^2$$



NUCLEAR

MINIMUM BOLT SIZE = $\frac{1}{2}$-13 UNC ;

$\therefore A_{TENSILE} = .1419\ \text{IN}^2$ (REF 8)

$$\text{TENSILE STRESS} = \sigma_T = \frac{(A_{PRESSURE})(P)}{(2)(A_T)}\ ;\ P = 45\ \text{psi}$$

$$\sigma_T = 3211\ \text{psi} < S_M = 25000\ \text{psi}\ \binom{\text{SA-193}}{@\ 340}$$

SECTION 6.6

VALVE SIZING AND STRESS ANALYSIS CONSIDERING COMBINED OPERATING AND SEISMIC CONDITIONS

BY RJR DATE 1/29/74 SUBJECT 24 INCH PRIMARY CONTAINMENT SHEET NO. [illegible] OF
CHKD. BY THE DATE 1/30/74 BUTTERFLY ISOLATION VALVES JOB NO. 81F-2
BODY ANALYSIS

THE 24 INCH PRIMARY CONTAINMENT BUTTERFLY ISOLATION VALVES ARE CLASS 2 VALVES. THEREFORE, THE DESIGN MUST CONFORM TO THE APPLICABLE REQUIREMENTS OF ANSI-B16.5 AS PER REF 3.

FIRST, THE PRESSURE-TEMPERATURE RATING FOR THE DESIGNATED PRIMARY SERVICE PRESSURE RATING OF 150 lb (REF 1).

FROM REF 1, TABLE 3, WE FIND THAT THE SERVICE TEMPERATURE IS 275°F. ∴ FROM REF. 18, TABLE 2, WE FIND THAT THE MAXIMUM SERVICE PRESSURE ALLOWED IS 217 PSI. SINCE THE MAXIMUM SERVICE PRESSURE THAT THE VALVE IS SUBJECTED TO IS 45 psi, THIS VALVE SATISFIES THE PRESSURE-TEMPERATURE RATING.

NEXT, THE FLANGE DIMENSIONS ARE ANALYZED.

REFERENCE	FLANGE O.D	FLANGE THICK.	BOLT CIRCLE DIA.	BOLT HOLE DIA.	No. OF BOLTS	BOLT DIA.
DRWG NO. A 900524	32.0	1.88	29.50	(16) 1.375 (4) 1.25 (TAP)	20	1.25
ANSI B16.5 (TABLES 13 + 14)	32.0	1.88	29.50	1.375	20	1.25

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO: OT.01.F
SHEET NO. B-62

NUCLEAR

4 BOLT HOLES IN THE FLANGES ARE TAPPED TO ACCEPT SHORT BOLTS DUE TO LATERAL EXTENSION OF THE VALVE HUBS. THE BOLTING AREA FOR THIS CONFIGURATION IS EQUAL TO THE BOLTING AREA AS REQUIRED BY ANSI, THE FLANGE DIMENSIONS SATISFY THE REQUIREMENTS OF REF 18 (ANSI).

WE NEXT ANALYZE THE VALVE WALL THICKNESS.

FROM DRWG NO. A-900,524

THE VALVE WALL THICKNESS = .5 IN. OD-ID 25"-24" / 2 = 0.5"

FROM Pg 3, REF 18, THE WALL THICKNESS IS DETERMINED FROM THE FOLLOWING FORMULA:

$$t = 1.5\left[\frac{Pd}{2(S) - (1.2)P}\right]$$

WHERE

t = CALCULATED THICKNESS (IN)

P - PRIMARY SERVICE PRESSURE (PSI)

d - VALVE I.D.

S - STRESS OF 7000 PSI

P = 150 PSI

d = 23.25 IN

S = 7000 PSI

SUBJECT ... SHEET NO. ... OF ...

CHKD. BY ... DATE 1/30/74 — SIZING — JOB NO. ...

∴ THE MINIMUM ALLOWABLE THICKNESS IS

$$t = 1.5\left[\frac{(150)(23.25)}{2(7000) - (1.2)(150)}\right]$$

$t = 0.252$ IN

$t_{min} = t + t_{corr.\ allow.}$

$= 0.252 + 0.0625$

$= 0.315$ IN

∴ THE BODY WALL THICKNESS SATISFIES THE REQUIREMENTS OF REF. B

CYGNA ATTACHMENT

JOB NO. 82044

FILE NO. OT.01.F

SHEET NO. B-64

NUCLEAR

BY ___ DATE ___ CHKD. BY PNC DATE 2/1/74 | (24" & 30") PRIMARY CONTAINMENT ISOLATION VALVES | JOB NO. ___

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-6

LOAD DETERMINATION

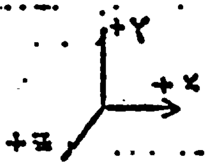
FROM THE APPLICABLE SPECIFICATION (REF 1), PIPE LOADS AS APPLIED TO THE BUTTERFLY VALVE, ARE DETERMINED AS FOLLOWS:

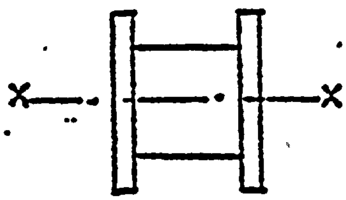
FROM PG 15A-5, REF 1

TYPE LOAD	VALUE
BENDING MOMENT	750 Z ft-lb.
TORSIONAL MOMENT	750 Z ft-lb.
FORCE	75 Z lb

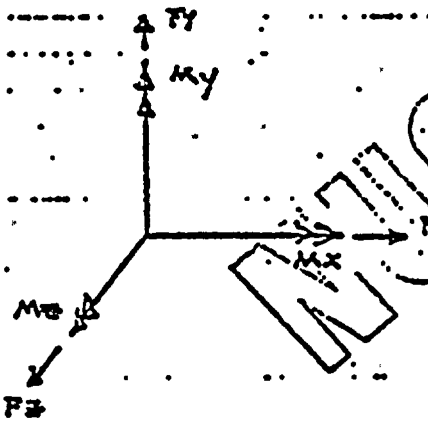
WHERE Z = SECTION MODULUS (IN^3)

AS ALL MOMENTS AND FORCES ARE APPLIED SIMULTANEOUSLY IN EACH OF (3) ORTHOGANAL DIRECTIONS, LOADING APPEARS AS SHOWN:





VALVE BODY



NOTE: LOADS ARE APPLIED AT VALVE FLANGES.

FOR THE COORDINATE SYSTEM SHOWN, FY & FZ ARE SHEARING LOADS ON THE VALVE BODY & MAY BE COMBINED

FOR THE COORDINATE SYSTEM SHOWN MY & MZ ARE ALSO COMBINED

OVER →

BY [illegible] DATE 1/25/74 SUBJECT DPE LOAD EFFECT SHEET NO. 666 OF
CHKD. BY PNC DATE 2/1/74 JOB NO.

$$\vec{F_Y} + \vec{F_Z} = \sqrt{(75\equiv)^2 + (75\equiv)^2}$$

$$= F_{SHEAR} = 106.1 \equiv \text{ lb} \qquad = F_S$$

$$\vec{M_Y} + \vec{M_Z} = \sqrt{(750\equiv)^2 + (750\equiv)^2}$$

$$= M_{BENDING} = 1060.66\equiv \text{ ft-lb} \qquad = M_B$$

CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-66

$F_X = F_{TENSION/COMPRESSION}$

$$F_{T/C} = 75 \equiv \text{ lb} \qquad = F_{T/C}$$

$M_X = M_{TORSION}$

$$M_{TORSION} = 750 \equiv \text{ ft-lb} \qquad = M_T$$

AS ALL VALUES ARE SHORT IN LENGTH RELATIVE TO THEIR DIAMETER IT IS ASSUMED THAT MOMENTS AND FORCES ARE CONSTANT ALONG THE VALVE BODY LENGTH.

FOR THE VALVE BODY, $I = \frac{\pi}{64}\left[D_o^4 - D_i^4\right]$

$$C = \frac{D_o}{2}$$

$I = 2887.$ in^4
$Z = 231.$ in^3
$750 \times Z =$ [illegible]

VALVE SIZE	D_o IN.	D_i IN.	$I = \frac{\pi}{64}(D_o^4 - D_i^4)$ $IN.^4$	$C = D_o/2$ IN.	$Z = I/C$ $IN.^3$	$F_{TK} = 75Z$ LB.	$F_S = 106.1Z$ LB.	$M_B = 1060.7Z$ FT.-LB.	$M_T = 750Z$ FT.-LB.
24"	25.	24.	2,889.	12.5	231.1	17,332.	24,520.	245,127.	173,324.
							$\sqrt{2} \times 75Z$	$1.414 M_T$ $\sqrt{2} \times 750Z$	
30"	31.	30.	5,572.	15.5	359.5	26,963.	38,144.	381,335.	269,634.

61

BY D.K.G. DATE 1-25-74
CHKD. BY [illegible] DATE 2-21-74
SUBJECT PIPE LOAD EFFECT
SHEET NO. 1 OF ___
JOB NO. ___

CHKD. BY PNC DATE 2/21/74 JOB NO.

24"

$\sigma_{T/C} = \frac{F_{T/C}}{A}$ WHERE $A = \frac{\pi}{4}\left(D_o^2 - D_i^2\right)$

$= \frac{17{,}332}{\frac{\pi}{4}(25^2 - 24^2)}$

$= 450.$ psi

CYGNA
ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-68

$\tau_s = \frac{4}{3}\frac{V}{A}\left[1 + \frac{D_o D_i}{D_o^2 + D_i^2}\right]$

$= \frac{4}{3}\left(\frac{24{,}520}{\frac{\pi}{4}(25^2 - 24^2)}\right)\left[1 + \frac{25(24)}{25^2 + 24^2}\right]$

$= 1{,}274.$ psi

$\sigma_B = \frac{Mc}{I}$

$= \frac{245{,}127\,(12.5)(12)}{2{,}889}$

$= 12{,}727.$ psi

NUCLEAR

$\tau_T = \frac{T\rho}{J}$

$= \frac{173{,}324\,(12.5)(12)}{2{,}889\,(2)}$

$= 4500$ psi

THE VALVE BODY IS TREATED AS A THIN WALLED CYLINDER

PRESSURE STRESSES :

HOOP STRESS = $\frac{PR}{t}$; LONGITUDINAL STRESS = $\frac{PR}{2t}$

TRANSVERSE STRESS = $\frac{-P}{2}$

P = 45 psi

R = 12.25 IN.

t = .5 IN.

∴ Hoop Stress, σ_H = 1103 psi

Long. Stress, σ_L = 551 psi

Trans. Stress σ_T = −23 psi

IN ADDITION TO PRESSURE STRESSES, PIPE LOAD STRESSES AS CALCULATED ON THE PRECEEDING PAGE EXIST AS WELL AS A SEISMIC SHEAR STRESS. (THE VALVE BEHAVES AS A RING IN SEISMIC "DEAD" WEIGHT)

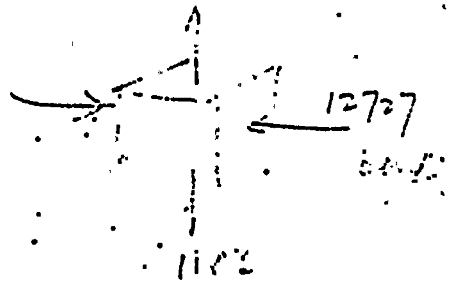
FROM PG 62, THE STRESSES DUE TO PIPE LOADS ARE:

$\sigma_{T/C}$ = 450 psi

σ_B = 12727 psi Bend.

τ_0 = 1274 psi

τ_T = 4500 psi



THE SEISMIC SHEAR STRESS IS:

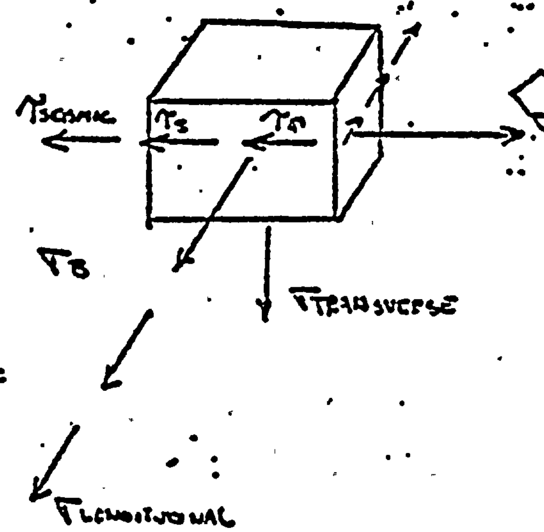
(4.24)(W_{ASSY}) / AS WHERE W_{ASSY} = 1473 lbf (REF B1)

$A_S = \frac{\pi (D_o^2 - D_i^2)}{4}$, D_o = 25, D_i = 24

∴ A_S = 38.5 IN^2

$\tau_{SEISMIC\ SHEAR}$ = 162 psi

CONSERVATIVELY COMBINING PRESSURE, PIPE AND SEISMIC STRESSES:



$\sigma_A = (\sigma_L + \sigma_{T/C} + \sigma_B)$ = 13728 psi

$\sigma_B = (\sigma_H)$ = 1103 psi

$\sigma_C = (\sigma_{TR})$ = -23 psi

$\tau = (\tau_{SEISMIC} + \tau_S + \tau_T)$ = 5936 psi

BY TMR DATE 2-21-74 SUBJECT 24" T.F.V. SHEET NO. ___ OF ___
CHKD. BY PWC DATE 2-21-74 — VALVE BODY / COMBINED STRESS — JOB NO. ___

$$\sigma_{\frac{1}{2}} = \frac{\sigma_A + \sigma_B}{2} \pm \sqrt{\left(\frac{\sigma_A - \sigma_B}{2}\right)^2 + \tau^2}$$

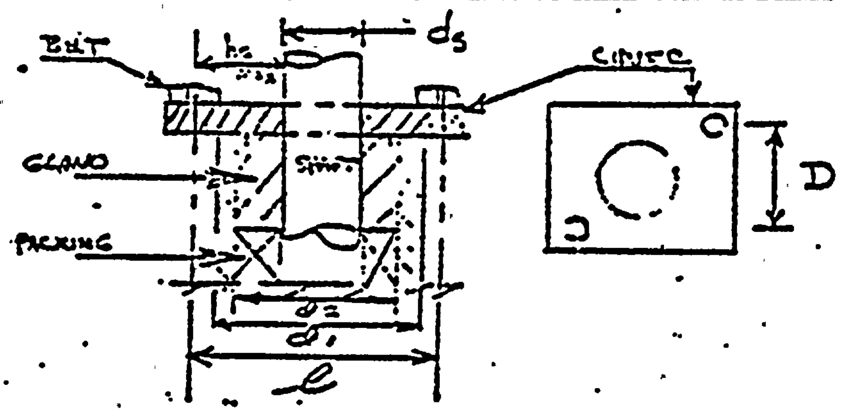
$\sigma_3 = \sigma_C = \sigma_{\text{THRU WALL}} =$ 23 psi

$\sigma_{\frac{1}{2}} =$ 7418 ± (8665) ; $\sigma_1 =$ 16,0__ ; $\sigma_2 = -$ ___

STRESS INTENSITY = 17330 psi < 1.8 $S_{\text{ALLOWABLE}}$ = 27000 psi
(SA-516, GR 60 @ 340°F)

CHK'D. BY THC DATE 3/1/74 JOB NO.

GLAND FOLLOWER COVER



(FOLLOWER IS SQUARE)

THE PACKING IS CRANE TYPE 187-I (FIBRE) AND THE COVER ARRANGEMENT IS CONSERVATIVELY MODELED AS CASE (k) OF FIG. UG-34 SECTION VIII DIV. 1.

t = COVER (GLAND FOLLOWER) THICKNESS

$$t = d\sqrt{\frac{ZCP}{S} + \frac{6Wh_G}{SLd^2}}$$

REFER TO TABLE UA-49.1 SECTION VIII, DIV. 1

FOR THE GLAND FOLLOWER:

$d \cong d_2 = 2.81$ IN, $Z = 2.5$ MAX ; $C = 0.3$; $S = S_m = 17,000$ PSI (SA-240, 304 @ 340°F)

$h_G = 0.875$ IN, $P = 45$ PSI ; $L = 4D = 11.3$ IN

W EQUALS THE LARGER OF EQTNS. 3, 4, PG 220, SEC. VIII, DIV. 1.

EQ. 3: $W_{m1} = .785\,G^2 P + (2b\pi G m P)$

$G \simeq d_2 = 2.81$

$b = \frac{W}{8}$ & $W = \frac{d_2 - d_S}{2} = 0.28$ IN. ∴ $b_o \leq 1/4$ IN

∴ $b = b_o = 0.035$ IN. $m = 1.75$

∴ $W_{m1} = 328$ lbs 66

EQ. 4 :

$$W = \frac{(A_m + A_b) S_a}{2}$$

$$A_{m_1} = \frac{W_{m1}}{S_b} = 0.025 \text{ in}^2$$

$A_b = 0.284 \text{ in}^2$

$$A_{m2} = \frac{W_{m2}}{S_a} = 0.023$$

$S_b = 13000$ psi (SA-193 @ 340°F)

$S_a = 15000$ psi (SA-193 @ 70°F)

$W_{m2} = \pi b G y$ where $y = 1100$ psi (Pa Sec. ...)

$= 340$ lbf

$\therefore W = 2318$ lbf

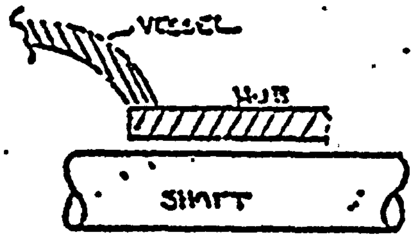
$W_{max} = 2318$ lbs

$$\therefore t = (2.81)\sqrt{\frac{(2.5)(0.3)(45)}{(15000)} + \frac{(6)(2318)(0.375)}{(15000)(11.3)(2.81)^2}}$$

$t_{REQUIRED} = 0.299$ in $< t_{ACTUAL} = 0.69$ IN.

BY: [illegible] DATE 3/6/[illegible] SUBJECT
CHKD. BY [illegible] DATE 3/6/[illegible] JOB NO.

HUB REINFORCEMENT



FROM SEC VIII, DIV 1 WITH APPLICABLE PAGES DESCRIBED:

t_r = REQD NOZZLE THICKNESS = $\frac{PR}{SE - .6P}$; P = 45 psi; R = (12 + .0625), S = 15000 psi, E = 1 (PG 11)

t_r = .036 IN.

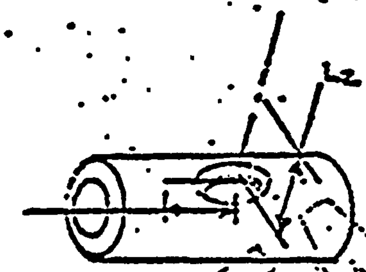
REQUIRED CROSS-SECTIONAL AREA OF REINFORCEMENT, VESSEL:

A = (d)(t_r)(F); d = (3.5007 + .125); F = 1 (PG 27)

∴ A = .131 IN².

LIMITS OF REINFORCEMENT:

L_1 = d = 3.626 IN. (PG 28) (LONGITUDINAL)



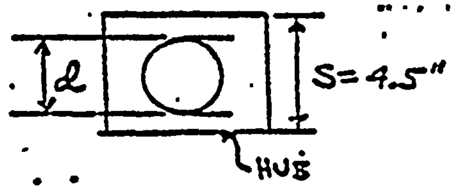
L_2 = 2.5 (.5 − .0625) = 1.09 IN. < HUB HEIGHT (RADIAL) ALSO 2d = 7.252 > √25² = 6.37"

AVAILABLE METAL / VESSEL WALL:

A_1 = (E_1 t − F t_r) d; E_1 = 1, t = (.5 − .0625), F = 1, (PG 28)

A_1 = 1.46 IN². > A = .131 IN² ∴ VESSEL O.K.

AS A_1 > A THERE IS SUFFICIENT REINFORCING



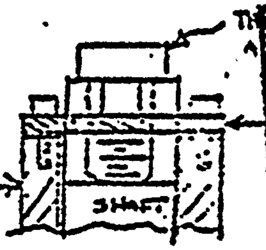
CHK'D. BY [illegible] DATE 3/1/79 JOB NO.

THRUST BEARING COVER

DUE TO THE MANNER IN WHICH THE THRUST BEARING COVER IS SECURED TO THE VALVE BODY IT IS CONSIDERED TO BE SIMILAR IN MOUNTING TO CASE (P), FIG UG-34 SECTION VIII, DIV. 1

t = THRUST BEARING COVER THICKNESS

$$t = d\sqrt{\frac{ZCP}{S}}$$



CYGNA ATTACHMENT
JOB NO. 82044
FILE NO. OT.01.F
SHEET NO. B-75

d = 2.83 IN, Z = 2.5 max; C = 0.25;

$S = S_m$ = 15000 psi; $P = P_{EQUIVALENT}$ = f (PRESSURE & SEISMIC LOAD)
(SA-240, 304 @ 340 °F)

$$P = 45 \text{ psi} + \frac{4.24 \text{ (DISC + SHAFT WEIGHT)}}{\frac{\pi D_e^2}{4}}$$

WHERE D_e EQUALS AN EQUIVALENT DIA. (INSCRIBED CIRCLE WHOSE DIAMETER IS CONSERVATIVELY CHOSEN AS THE SAME DIAMETER AS THE SHAFT)

DISC + SHAFT WT = 224 lbf

D_e = 2.2495 IN.

∴ P = 284 psi

& $t_{REQUIRED}$ = .308 IN. < $t_{ACTUAL\ (MINIMUM)}$ ≅ .6 IN.

(SPOT FACE ASSUMED 1/32" IN DEPTH COUNTER-SINK EFFECT INCLUDED)