Fisher Controls

FISHER QUALIFICATION REPORT

Alvin W. Vogtle Nuclear Plant
Georgia Power
Bechtel Power Corporation

FQP-11AB-7
Revision B
October 31, 1985

Page 1 of 12

QUALIFICATION REPORT FQP-11AB-7

Group VII Control Valves

for

ALVIN W. VOGTLE NUCLEAR PLANT
UNITS 1 & 2
GEORGIA POWER

IMPORTANT NOTE

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PROPRIETARY

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Control Valve Assemblies per FQP-11AB

Alvin W. Vogtle Nuclear Power Plant, Units 1 & 2
Georgia Power Company
Bechtel Power Corp. Purchase Order No.: PAV-206, PAV 2-34
Design Specification No.: X5AC03, Rev. 11, App. EA, Rev. 3, & App. QG, Rev. 0
Seismic Category/Class: Seismic Category I, Nuclear Class 2
Fisher Representative Order No.: 22B-X5AC03-N1T, N2T, N1U, & N2U
  Qualification Group: VII
  Environmental Designators: IB-R-111, V-R-117, V-R-125
  Order Items: see table page 5
  Serial Numbers: see table page 5
  Tag Numbers: see table page 5
  Bechtel Data Sheets: CX5DL-98, 110, 148, 150

This is to certify that, to the best of my knowledge and belief, the qualification information listed in the Table of Contents (Page 3) or referenced in the following qualification summary is complete and accurate. The information meets the requirements and intent of the above design specification, as interpreted by the applicable Fisher Qualification Plan, FQP-11AB.

Dave Stanze
Dave Stanze
Senior Engineer

I certify that I accept responsibility for the adequacy of this document, which was prepared by others, to the same degree that I would if I had prepared it, and that I am a duly Registered Professional Engineer under the laws of the State of Iowa.

John Dresser
John Dresser Reg. No: 7547
Registered Professional Engineer

Date: 10-31-85

JOHN C. DRESSER
7547

Certified and Approved by:

Floyd D. Jury
Floyd D. Jury, Manager
Engineering Qualification and Analysis

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4. Static Side Load Test of Vogtle Item 149, 14" 9280 Butterfly Valves with Bettis Actuator Model No. NT316B-SR2-M3, Fisher Lab Problem 1662, Report 70
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8. Valve Closure Test of a 6" Prototypye Snupps Butterfly Valve; Wyle Report Number 44503-0
9. Combined Loads Shaft Analysis, dated December 5, 1984
10. ES 199, Rev. A, Verification of Rotary Valve Shaft Stress Analysis Program
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Note: Report FQP-11A, a separate related volume entitled "Vogtle Environmental Qualification Report for Type 9200 Butterfly Control Valve Assembly" has been previously furnished under separate cover.

1.0 PURPOSE AND SCOPE

1.1 This Qualification Summary is submitted to verify qualification of the following Nuclear Code Class 2 active control valve assemblies for Seismic Category I service. Information presented and referenced in this report is in accordance with the specification listed above, as interpreted by Fisher Qualification Plan: FQP-11AB.

1.2 The valves covered by this report are designated active valves, Nuclear Safety Class 2, Nuclear Code Class 2, and Seismic Category I (Bechtel Project Class 212). These on-off service containment isolation valves are located in the sprayed vapor region of the containment building or in the equipment building.

2.0 VALVE ASSEMBLY DESCRIPTION

The valves shown to be qualified by this report are 14" ANSI Class 150, Type 9280, butterfly valve assemblies. Actuators are Bettis NT316B-SR2-M3 pneumatic piston actuators. Specific production valves covered by this report are as follows:

Item No.	Unit 1 Serial No.	Unit 1 Tag No.	Item No.	Unit 2 Serial No.	Unit 2 Tag No.
179	8669191	1-HV-2626B	147	8670354	2-HV-2626B
180	8672366	1-HV-2627B	148	8672368	2-HV-2627B
181	8672365	1-HV-2628B	149	8670355	2-HV-2628B
182	8672367	1-HV-2629B	150	8672369	2-HV-2629B

3.0 REQUIREMENTS

The requirements for Group VII valves are as follows:

3.1 Rigid Valve Requirement - The lowest resonant frequency of these valves must be shown to be greater than or equal to 33 Hz (see FQP-11AB, Paragraph 2.3.2.).

3.2 Structural Integrity Requirements - It must be shown that extended structure stress levels meet the acceptance criteria of Fisher Engineering Standard ES 117 (Attachment 3, FQP-11AB), when the assemblies are loaded with a 4.5 g triaxial load (see FQP-11AB Paragraphs 2.2 and 3.3.1; also see Paragraph 3.5 of FQP-11AB for pressure-retaining part stress calculation procedure, per SAG 1034).

3.3 Environmental Requirements - It must be shown that the environmental conditions listed in Appendices EA-1 Rev. 3 and EA-5 Rev. 3 of Bechtel Specification for Environmental Designators IB-R-111, V-R-117, and V-R-125 can be met by the subject valves without affecting the pressure retaining integrity of the valve assemblies or interfering with the safety-related function. (see FQP-11AB, Paragraph 6.3).

3.4 Operability requirements - Capability of the subject "active" valves to perform the designated safety-related function must be shown in keeping with the FQP-11AB, Paragraph 5.1, requirements. The safety-related function of these Bettis actuator valve assemblies is to provide a "fail-closed" disc position upon loss of air pressure to the cylinder.

4.0 RESULTS

The ability of the subject valves to satisfy the requirements listed in Section 3 above is demonstrated in the following manner:

4.1 The lowest resonant frequency of these valves has been determined by impulsive excitation test and by analysis. The testing was done in the Fisher Laboratory as reported in Lab Problem 1667, Report 192. The analysis was done (9-24-84) according to Fisher Engineering Standard, ES 117, Rev. F (Attachment 3, FQP-11AB). ES 136, Rev. D is an algorithm verification of ES 117, Rev. F and is included as Attachment 4, FQP-11AB. The lowest resonant frequency as determined by test is 43.5 Hz, and the calculated lowest resonant frequency for the test unit is 37 Hz. The resonant frequency test report and ES 117, Rev. F analysis are included as Attachments 1 and 2 to this final report. The lowest resonant frequency is above 33 Hz as required and is within 20% of the calculated lowest resonant frequency value.

4.2 The seismic analysis (done at 9.5 g triaxial) and certification are included as Attachment 2 to this report. The analysis printout provided is for a horizontal shaft orientation in a vertical pipeline. This orientation has been determined to be the most highly stressed orientation possible and therefore verifies that this valve assembly is qualified for any orientation, with respect to seismic extended structure stresses. This is provided per Paragraph 4.1.1, Part 5 of the X5AC03 Specification. Supplementary stress calculations for pressure retaining valve parts are included as Attachment 3 to this report (see FQP-11AB, Paragraph 3.5). All stress levels are shown to be acceptable. Actuators are being qualified by Bettis in accordance with Section 2.6 of FQP-11AB.

4.3 The environmental requirements (per Attachments EA-1 Rev. 3 and EA-5 Rev. 3) for Normal/Abnormal conditions are as follows:

Temperature: 135/35°F
Pressure: 11.7 psia to 60 Psig
Radiation: $5X10^5$ Rads
Relative Humidity: 90%

These levels are within the conditions considered during valve design and can be met without exception. Valve design is in accordance with Section III of the ASME Boiler and Pressure Vessel Code and body pipeline connections mate with standard ANSI Class 150 flanges.

The maximum DBA/Post-DBA temperature/pressure conditions are listed in Paragraphs 4.4.2 and 4.4.3 of this report, and it is explained there how the levels can be met. The maximum DBA/Post-DBA radiation level is $2 X 10^8$ rads, and Laboratory Report 1685-3, Report 8 shows how a similar valve with a T-ring of identical EPDM material performed at this radiation dosage. Lab Report 1685-3, Report 8 is included as Attachment 7 to this report. Also, the maximum DBA/Post-DBA relative humidity is 100%, and the valve-assemblies are in the sprayed vapor region. However, there would be no detrimental effect to the safety mode (fail-closed position) performance of the valve-assemblies by exposure to 100% humidity, vapor, or spray.

4.3.1 Similarity between the Vogtle production valves, covered in this report, and the environmental test valve discussed in FQP-11A, permits applying the elastomer test results to the valves of this Vogtle group. Attachment A-3 of FQP-11A discusses modifications and exceptions to the environmental test program that adapt it to the Vogtle project.

4.3.2 The elastomer T-ring disc seal in these Vogtle valves is made of EPDM (ethylene propylene) suitable for a design temperature range of 0°F to +300°F. EPDM T-ring seals are satisfactory without significant loss of function for radiation dosages up to $1 x 10^7$ rads, but should be replaced, along with any other elastomeric parts, at intervals of four years or less, depending upon continous service temperatures experienced, or when cumulative radiation exposure exceeds $1 X 10^7$ rads.

4.3.3 The shaft packing used in these production valves consists of Grafoil ribbon and filament rings. The packing is suitable for the maximum design pressures and temperatures involved (60 psig, 300°F) and for the environmental conditions specified for Environmental Designators IB-R-111, V-R-117, and V-R-125.

4.4 Margin allowances are addressed as follows.

4.4.1 Normal/Abnormal Temperature -- The maximum external Normal/Abnormal environmental temperature for this valve group is 135°F. The maximum internal temperature is 120°F. Since the lowest valve design temperature is 300°F, the margin provided for Normal/ Abnormal conditions is 165°F, well in excess of the 15°F margin suggested in IEEE 323-1974.

4.4.2 DBA/Post-DBA Temperature - The maximum external DBA/Post-DBA environmental temperature is 400°F for slightly less than 15 minutes per Figure 9 (Attachment EA-84 Rev. 3) to Specification Number X5AC03. The T-ring seal is the only elastomeric component in the Group VII valve-assemblies exclusive of the Bettis Actuator. Its capability to withstand these temperatures has been demonstrated by testing done by Wyle Laboratories using a test valve of similar T-ring seal design. The temperature level results achieved in the Wyle test program (per Report Number 45390-1) to show the capability to withstand air temperatures of 400°F for 15 minutes are provided in Attachment 4 to Attachment 9 (NA-42) of Qualification Plan FQP-11AB. Also, see Paragraphs 1.2 and 5.5 of FQP-11A* for a description of the extension of these environmental test results in meeting the Vogtle requirements. Since the tested time duration at high temperature levels meets or exceeds the Vogtle time duration requirements, margin has been provided for these short-term, one-time temperature conditions.

4.4.3 Pressure - The maximum external Normal/Abnormal/DBA/Post-DBA environmental pressure is 60 psig, and the maximum internal pressure is 0.18 psig. These pressures are either equal to or below the valve design pressure rating of 60 psig.

4.4.4 Frequency - Reference is made to Paragraph 4.1, the margin regarding resonant frequency is 4.0 Hz above the required 33 Hz.

4.4.5 Vibration - The level of seismic loading included in the static side load test was 10.0 g uniaxial (5.8 g triaxial equivalent), furnishing a margin of 1.3 g seismic excitation over the required 4.5 g triaxial.

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* FQP-11A, a separate volume titled "Vogtle Environmental Qualification Report for Type 9200 Butterfly Control Valve Assembly", was furnished previously under separate cover.

4.5 Bettis Actuator data for the pneumatic piston actuators associated with the Group VII valve assemblies is maintained in the Fisher QA files, and copies will be furnished to Bechtel under separate cover, according to the submittal schedule. However, copies of the specific Bettis Certifications and Valve Assembly Test Reports are included in Attachment 5 of this report, showing the results of production test, including bi-directional seat leakage tests and stroking time tests.

4.6 Operability Results

4.6.1 Operability tests were performed before, during, and after each application of side load force to evaluate performance of the valve under similated seismic conditions, in accordance with the requirements of test procedure FTP-33, Rev. D (Attachment 11 to FQP-11AB).

4.6.2 Functional tests consisted of packing leakage tests, bi-directional seat leakage tests, stroking time tests, and verification of the "fail-closed position" safety-related function. Complete procedures followed during all tests are presented in Fisher Lab Problem 1662, Report 70 included as Attachment 4 of this report.

4.6.3 Side load applied at the center-of-gravity of the extended structure was the equivalent of a 10.0 g uniaxial load (2446 lbs) applied in the weakest direction. This load level corresponds to a 5.8 g triaxial load, which is more than 1.0 g above the required 4.5 g triaxial; therefore, the operability test qualifies the valve assembly for any orientation.

4.6.4 No packing leakage was noted during any of the functional testing. Packing leakage tests were run at 180 psig.

4.6.5 Seat Leakage was not detected in either flow direction during the functional tests. A 60 psig pressure drop was maintained during the seat leakage testing.

4.6.6 The test unit showed no structural damage after the tests and maintained the required "fail-safe" position without deviation (fail-closed position).

5.0 SUPPLEMENTARY QUALIFICATION

The ability of these valves to meet the additional functional tests required as set forth in Paragraphs 5.3.3.4 and 5.3.3.5 of Bechtel Specification X5AC03 Rev. 11 are addressed as follows: △B

5.1 A combined loads shaft analysis considering dynamic (flow-induced) loads, shutoff loads, and seismic loads from the disc is provided in Attachment 9. The most critical stress concentration is at the shaft pin location. The stress due to shear is 21703 psi which is less than the allowable of 25725 psi and therefore demonstrates the adequacy of the most critical component (the valve shaft) under the most severe conditions. (See FQP-11AB, Paragraph 5.3.1)

5.1.1 Verification of the Corapolis Shaft Program (printout included in Attachment 9) is provided in ES 199 (Attachment 10), using applicable analysis examples. The reason for the examples used in the program is presented, followed by manual calculations and a comparison of the manual and computer calculations.

5.1.2 A statement from Swanson Analysis Systems, Inc. is included as Attachment 11, assuring that an independent Quality Assurance (Q.A.) Department at Swanson has responsibility for verification of all ANSYS versions, with a Q.A. manual issued and in force. △B

5.1.3 Fisher has a standard in effect defining computer program documentation and Q.A. procedures for Fisher FCS engineering analytical applications. This engineering standard (ES 121) is included as Attachment 12 to this report and applies to Fisher originated programs as well as to purchased or leased programs such as ANSYS.

5.2 A 60 psid bi-directional shut-off test on each of the eight production valves was conducted. (See Assembly Test Reports, Attachment 5). The results (0 leakage) demonstrate the seat leakage integrity of the closed valves. (Reference FQP-11AB, Paragraph 5.3.2)

5.3 No-flow valve closure data as presented in the Assembly Test Reports (Attachment 5) does not not consider the effect of full-flow conditions. Based upon the provisions set forth in FQP-11AB, Paragraph 5.3.3, the no-flow closure times will be correctd to account for full-flow effects. Table I of the Valve Closure Test of a 6" Prototype Snupps Butterfly Valve (Wyle Report No. 44503-0) indicates that the worst test case yields a factor of 1.24 (1.25 / 1.01). (See Attachment 8). Applying this factor (1.24) to the worst no-flow closure time (3.5 sec) results in a full-flow closure time value of 4.34 sec. This is still less than the specified 5 sec maximum closure time allowed and is therefore adequate.

5.4 Bechtel Power Corporation has assembled a document relating to the subject valve assemblies entitled "Operability Qualification of Purge and Vent Valves", based on Fisher-furnished data, documentation, and calculations. A copy is furnished in Attachment 13, together with related correspondence. This was issued to satisfy the requirements of NUREG-0737 for containment purge and vent valves, i.e. demonstrate valve closure from an open position during a DBA. 3

6.0 MAINTENANCE AND QUALIFIED LIFE

6.1 Qualified Life of these Vogtle project valves is limited by the elastomeric parts. To address this, Fisher has conducted an activation energy testing program as reported in Attachment A-7 of Report FQP-11A. That data covers common elastomeric materials, including those used for O-rings, T-ring seals, packing components, and gaskets for the valves in this qualification group. These elastomeric parts, gaskets, and packing components are all identified as recommended spare parts on the valve-assembly Bill-of-Material Drawings for the Group VII Valves (48A9881, 48A9882, 48A9883, and 48A9884).

6.2 The lowest activation energy for any of the elastomeric materials was found to be 0.79 eV. Based on the results of a prior environmental test program, it is recommended that all elastomeric parts be replaced on a regular four-year cycle, assuming a maximum continous normal service temperature of 131°F or less. (See calculation in Attachment 6 of this report). However, if the service temperature is maintained continuously at 135°F, the qualified life becomes 3 years, 120 days and the replacement cycle should be modified accordingly. (See calculation in Attachment 6 of this report). Elastomers should also be replaced if the cumulative radiation exposure exceeds $1x10^7$ rads.

6.3 The normal service qualified life for Fisher equipment can be renewed for another service period by replacement of all elastomeric components listed in Paragraph 6.1 above, in accordance with the procedures provided in Fisher instruction manuals. Successive renewals of qualified life can be attained in increments up to the intended life of the plant or to 41 years, whichever is less.

6.3.1 Each time the valve assembly is disassembled, new packing and gaskets should be used upon re-assembly.

6.3.2 Replacement of the elastomeric parts in the Bettis actuator should comply with the specified Bettis procedures and schedules furnished from Bettis.

6.4 Even though the specified orientation (pipeline vertical, shaft horizontal) has been primarily considered in the qualification documentation provided in this report, there are no qualification restrictions for any orientation as far as the Fisher supplied comments are concerned.

6.5 Additional calculations and further qualification rationale are provided in FQP-11A.

7.0 STATEMENT OF QUALIFICATION

The qualification data presented herein for the Group VII valves meet the requirements and intent of Bechtel Power Corp., Specification No. X5AC03, Rev. 11, including Appendices EA, Rev. 3, and QG, Rev. 0, as interpreted by Fisher Qualification Plan FQP-11AB. △B

John Dresser
John Dresser
Engineering Reviewer

Dave Stanze
Dave Stanze
Senior Engineer

ATTACHMENT 1

FQP-11AB-7

Resonant Frequency Test Report

Fisher Lab Problem 1667, Report 192

Project 78EC07 Proj. File

Fisher Controls

FISHER

Laboratory Report

Problem	1667
Report	192
Page	1
Date	9-25-84

DISTRIBUTION RESTRICTED

By Jon Milliken

PRODUCTION
RESONANT FREQUENCY TEST
OF VOGTLE ITEM 149

PROJECT NUMBER: 78EC07
PROJECT NAME: Vogtle
PROJECT ENGINEER: Don Winnike
TEST ENGINEER: Jon Milliken
ITEM: 149
ORDER NUMBER: 22B-X5AC03-N2T
SERIAL NUMBER: 8670355
EM/FS NUMBER:
BILL OF MATERIALS DWG.: 39A2460
DIMENSIONED ASSEMBLY DWG.: 48A9882

ACTUATOR TYPE: Bettis
ACTUATOR SIZE: NT316-SR-2-M3
BONNET STYLE:
BONNET SIZE:
BONNET CLASS:
BODY DESIGN: 9280
BODY SIZE: 14"
BODY CLASS: 150

APPURTENANCES: 2 NAMCO Limit Switches 180-31302/32302, ASCO Solenoid NPK8316A74E, Type 262C Air Filter, Type 95H Regulator, Type H120 Relief Valve, Ashcroft Pressure Gage

OTHER SPECIAL IDENTIFICATION: Actuator S/N 83-9045-4

PURPOSE: Model Verification

LOWEST CALCULATED RESONANT FREQUENCY OF TEST ITEM: 37.1 Hz/X-Axis

TEST PROCEDURE: Production Testing Per FTP-5

RESULTS: X-Axis - 43.95 Hz
Y-Axis - 72.75 Hz
Z-Axis - 43.46 Hz

CONCLUSIONS AND RECOMMENDATIONS: The calculated lowest resonant frequency of 37.1 Hz in the X-axis is 18.5% lower than the measured resonant frequency of 43.95 Hz in the X-axis. This is acceptable.

Note: The GenRad test data results yielded a frequency of 43.5 Hz for the Z-axis and 43.0 Hz for the X-axis. The resolution limit for both the Zonic FFT and the GenRad is 0.5 Hz. This indicates that the X and Z axis frequencies could be the same and the Y-axis rotation is the appropriate mode.

Jon Milliken
J.B. Milliken
Evaluation & Analysis Department

REP24/23

INSTRUMENTATION EQUIPMENT SHEET

DATE 9-14-84 PROBLEM NO. 1667 REPORT NO. 192 TEST AREA Seismic

TECHNICIAN Bob Roe TEST ENGINEER Jon Milliken TEST DESCRIPTION Resonant Frequency

NO.	INSTRUMENT	MANUFACTURER	MODEL NO.	SERIAL NO.	FISHER CONTROL NO.	USEABLE RANGE	ACCURACY	CALIBRATION	
								ON	DUE
1	Data Memory Sys	Zonics	5003	465	7006-1			1-83	1-85
2	Hammer & Force Tr	PCB	205M08	175	9401-1	±5000 Lb		11-82	11-84
3	Accelerometer	PCB	308B	3535	9701-7	3KHz/50G	<±3.5%	1-83	1-85

CALIBRATION GUIDELINES PER FTP-26

CHECKED BY Jon Milliken

PROBLEM NO. 1667

REPORT NO. 192

Prob. 1667
Rep. 192
Fig. 1

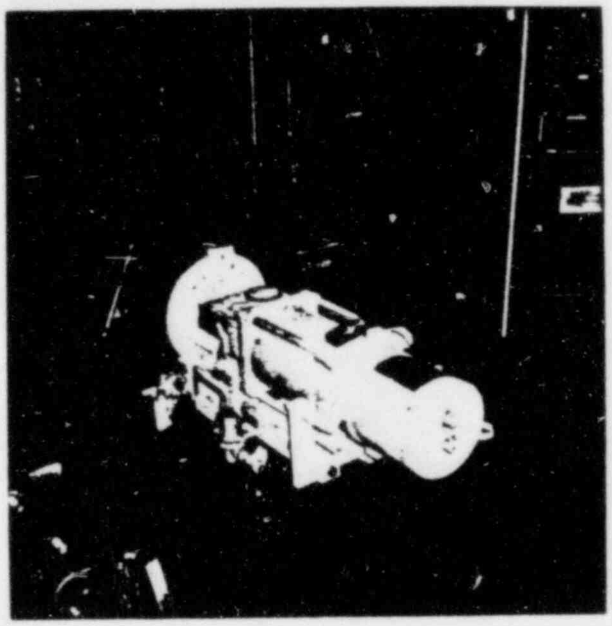


Figure 1

X-Axis - 43.95 Hz.
Y-Axis - 72.75 Hz.
Z-Axis - 43.46 Hz.

Tape Data Location Reel No. 78EC07D
X Data Begins 1540-1600
Y Data Begins 1600-1640
Z Data Begins 1640-1700
Recorder - HP3964A

ATTACHMENT 2

FQP-11AB-7

ES 117 Analysis and Seismic Certification

a) Seismic Certification Letter for Group VII Vogtle Valves dated December 4, 1984

b) Analysis Model Drawings for Group VII Valves Extended Structure

c) Assembly Drawings 48A9881, 48A9882, 48A9883, and 48A9884

d) ES 117, Rev. F Computer Printout for Group IIV Vogtle Valves dated September 24, 1984

Fisher Controls International, Inc.
P.O. Box 11
Marshalltown, Iowa 50158
Phone 515/754-3011

FISHER

Fisher Controls

December 4, 1984

Seismic Certification for:
Representative Order: 22B-X5AC03-N1T, N2T
Customer Order: PAV-206, Pav-2-34
Georgia Power Company
Vogtle Nuclear Plant - Units 1 & 2
Active Butterfly Valve Assemblies per FQP-11AB

Item Number	Tag Number	Serial Number	Description
179	1-HV-2626B	8669191	14" Type 9280 Valve Body
180	1-HV-2627B	8672366	NT316B-SR2-M3
181	1-HV-2628B	8672365	Bettis Actuator
182	1-HV-2629B	8672367	
147	2-HV-2626B	8670354	
148	2-HV-2627B	8672368	
149	2-HV-2628B	8670355	
150	2-HV-2629B	8672369	

Enclosed are the stresses and resonant frequency calculations for the above items. In accordance with Bechtel Specification X5AC03, Fisher Qualification Plan (FQP-11AB), and Paragraph VIII of Fisher Engineering Standard 117, the items are considered capable of maintaining their structural integrity when submitted to a triaxial load of 9.5 g's. Acceptable stress limits for materials are considered to be allowable stresses found in ASME Boiler and Pressure Vessel Code, Section III, for Code Class 2, per the Winter 75 Addenda.

The calculated resonant frequencies are well above the acceptable limit (33 Hz), and verified by test (see Report FQP-11AB-7).

Jon Whitesell
Jon Whitesell
Qualification Analyst

Don Winnike
Don Winnike
Qualification Engineer

FISHER CONTROLS COMPANY

SEISMIC-4

SEISMIC ANALYSIS

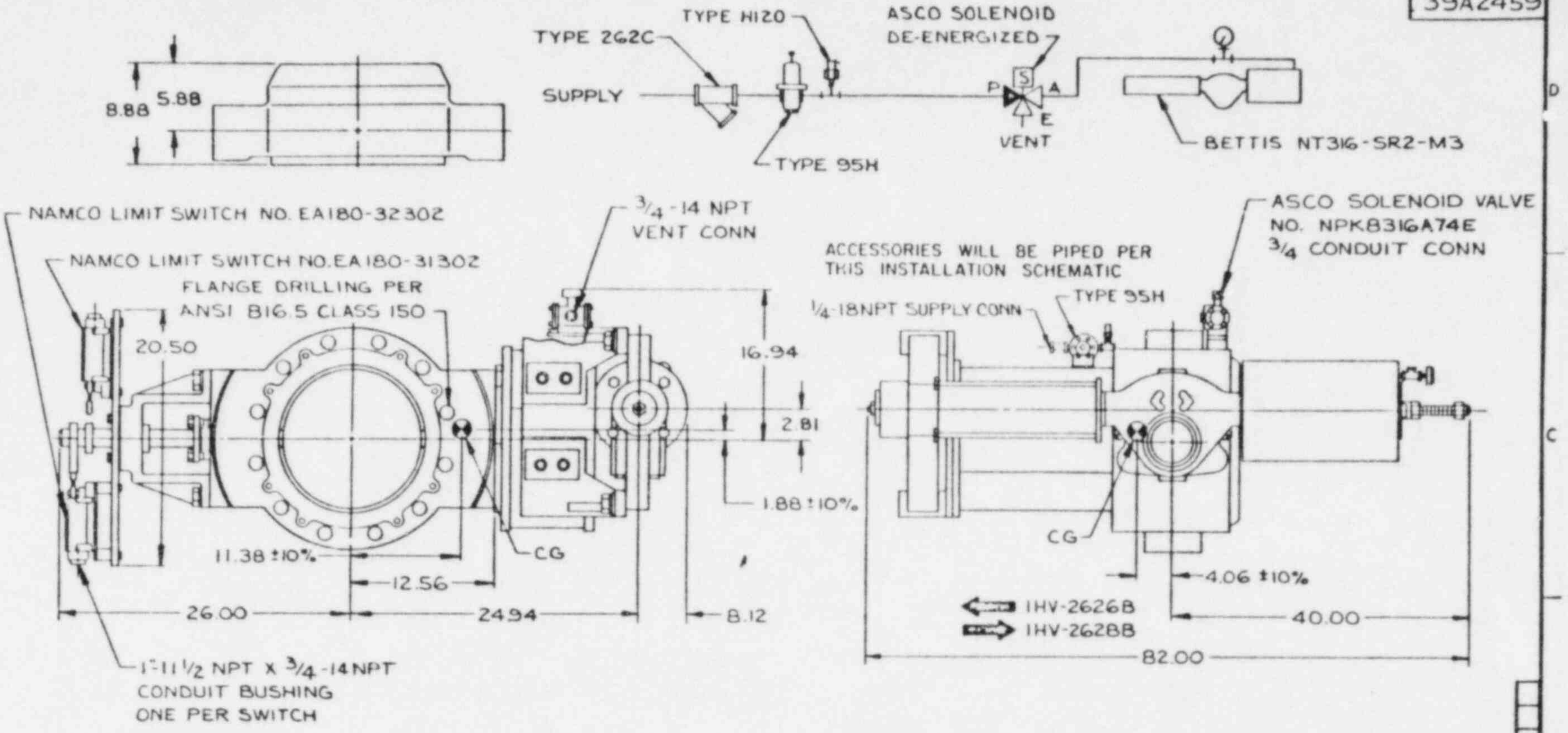
OF

CONTROL VALVE ASSEMBLIES

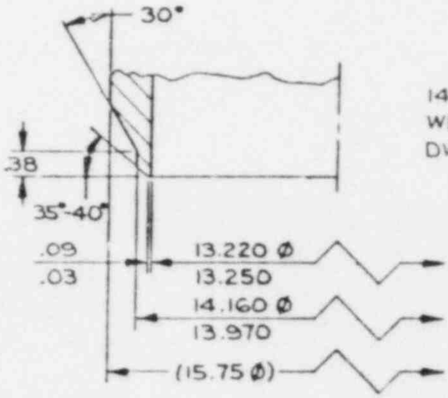
(REV F)

F

39A2459



DISC CHORDAL SWING Ø AT THE VALVE FACE IS 11.81
TOTAL VALVE WEIGHT: 925 LBS ±10%



14 SCHED STD BUTT
WELD END PER BECHTEL
DWG CX4DG02

UNLESS OTHERWISE SPECIFIED:
UNIT OF MEASURE: INCHES
ENVELOPE DIMENSIONS ARE ±.25

REVISIONS			
DATE			
7-8-83	A	FIRST DRAWN	
11-10-83	B	REVISE FLOW ORIENTATION	WGR 11-10-83
12-13-83	C	REVISED ACCESSORY ORIENTATION	MAS 12-13-83

DIMENSIONS CERTIFIED CORRECT BY Kevin A DATE 7-22-83

VALVE PRESS/TEMP RATING ANSI B16.34-1977 CLASS 150

CUST. GEORGIA POWER COMPANY
P.O. NO.: PAV-206 VOGTLE UNIT 1
ORDER NO.: 22B-X5AC03-N1T
TAG NO.: 1HV-2626B, 1HV-2628B

SERIAL NO.: 8669191, 8672365

14" BODY
NT316-SR2-M3-9280
BETTIS ACTUATED
CONTROL VALVE
CW TO CLOSE VALVE
SHAFT ROTATION
HORIZ PIPE, VERT SHAFT

FISHER

Fisher Controls
Marshalltown, Iowa USA

DWN	WGR	7-8-83
CHKD	KAL	7-22-83
APVD	JCD	8-1-83

ITEM 179, 181

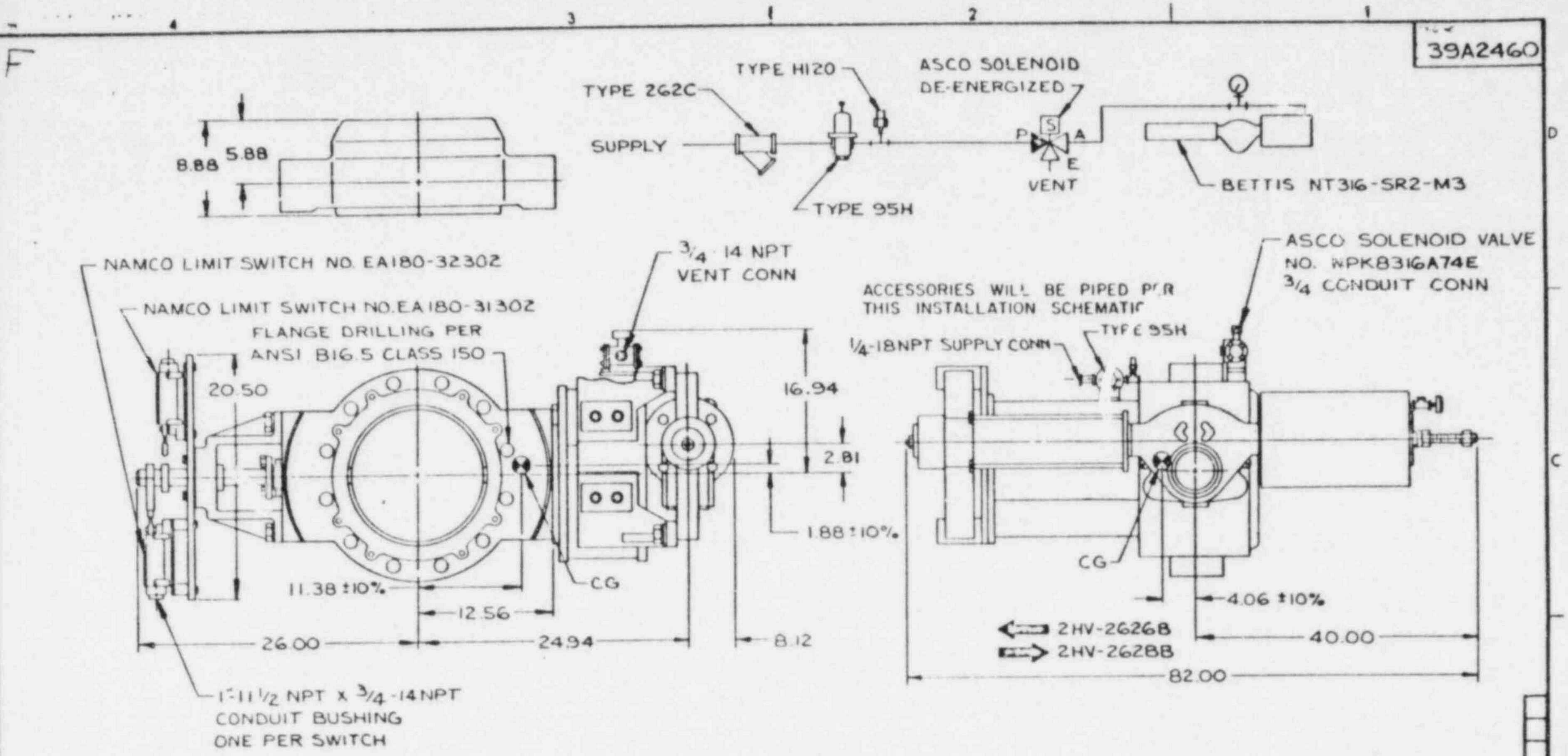
SCALE NONE

DWG NO 39A2459 REV C

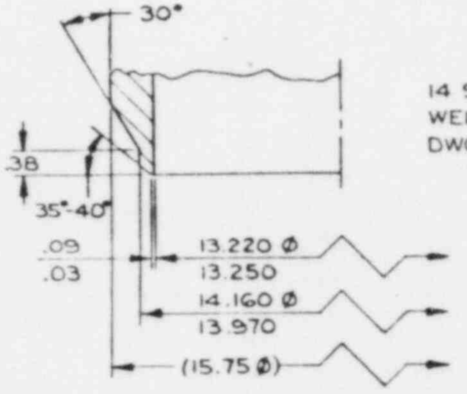
9510-AX5AC03-5151-2 020

F

39A2460



DISC CHORDAL SWING Ø AT THE VALVE FACE IS 11.81
TOTAL VALVE WEIGHT: 925 LBS ±10%



14 SCHED STD BUTT
WELD END PER BECHTEL
DWG CX4DG02

UNLESS OTHERWISE SPECIFIED
UNIT OF MEASURE: INCHES
ENVELOPE DIMENSIONS ARE ± 25

DIMENSIONS CERTIFIED CORRECT BY Kevin A. Loquahutz DATE 7-22-83

VALVE PRESS/TEMP RATING ANSI B16.34-1977 CLASS 150

CUST GEORGIA POWER COMPANY
P.O. NO.: PAV 2-34 VOGTLE UNIT II
ORDER NO.: 22B-X5AC03-N2T
TAG NO.: 2HV-2626B, 2HV-2628B
SERIAL NO.: B670354, B670355

14" BODY
NT316-SR2-M3-9280
BETTIS ACTUATED
CONTROL VALVE
CW TO CLOSE VALVE
SHAFT ROTATION
HORIZ PIPE VERT SHAFT

DATE		REVISIONS
7-8-83	A	FIRST DRAWN
11-11-83	B	REVISE FLOW ORIENTATION
12-13-83	C	REVISED ACCESSORY ORIENTATION

C	SMS	12-13-83
B	WGR	11-11-83

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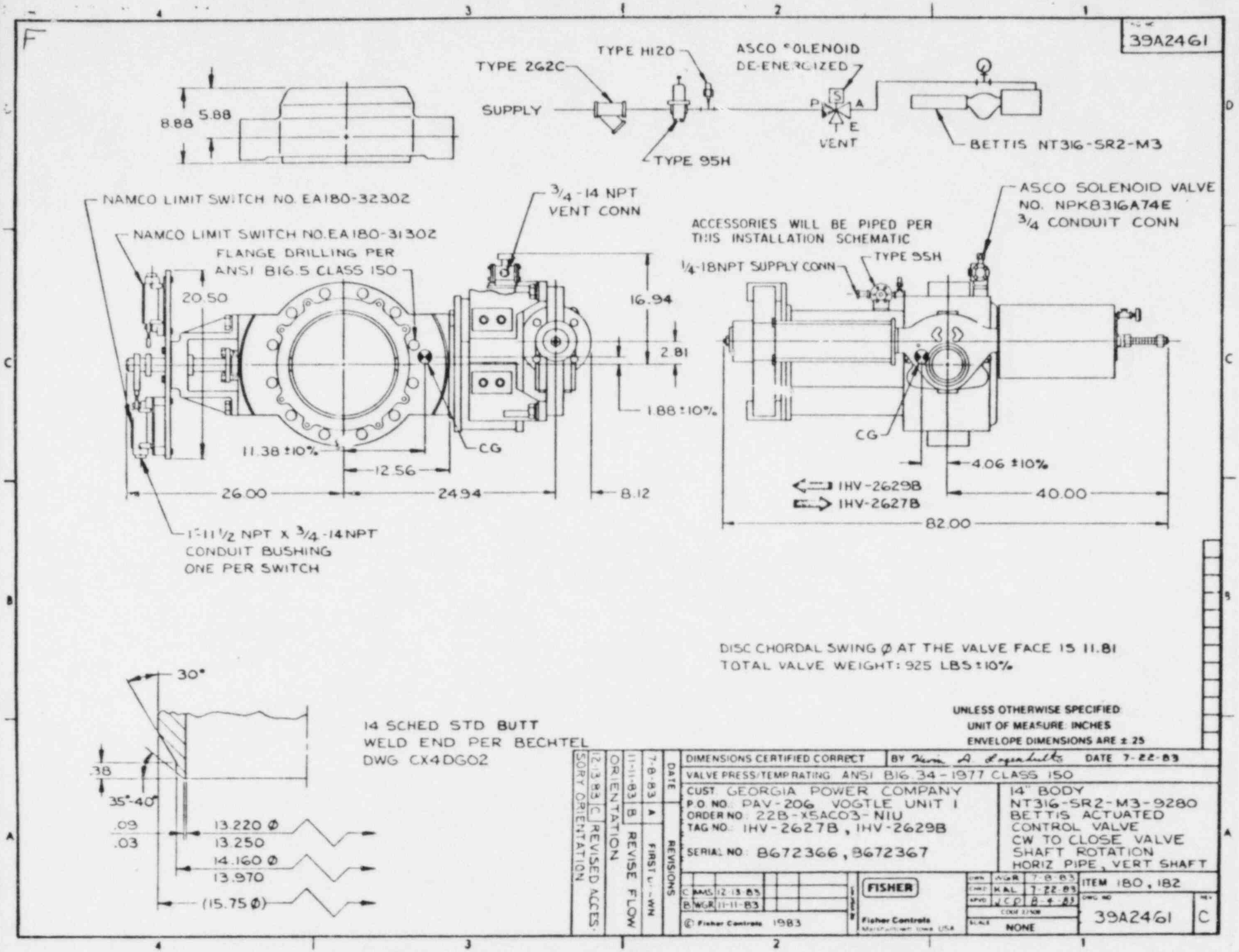
DWN	WGR	7-8-83
CHKD	KAL	7-22-83
APVD	JCP	8-4-83

SCALE NONE

ITEM 147, 149

DWG NO 39A2460 REV C

9310-AX5AC03-S151-2 021



14 SCHED STD BUTT
WELD END PER BECHTEL
DWG CX4DG02

DISC CHORDAL SWING Ø AT THE VALVE FACE IS 11.81
TOTAL VALVE WEIGHT: 925 LBS ±10%

UNLESS OTHERWISE SPECIFIED
UNIT OF MEASURE: INCHES
ENVELOPE DIMENSIONS ARE ± .25

REVISIONS		
7-8-83	A	FIRST ... WN
11-11-83	B	REVISE FLOW ORIENTATION
12-13-83	C	REVISED ACCESSORY ORIENTATION

DIMENSIONS CERTIFIED CORRECT BY Kevin A. Logenbuhl DATE 7-22-83

VALVE PRESS/TEMP RATING ANSI B16.34-1977 CLASS 150

CUST. GEORGIA POWER COMPANY
P.O. NO. PAV-206 VOGTLE UNIT 1
ORDER NO. 22B-X5AC03-N1U
TAG NO. 1HV-2627B, 1HV-2629B

SERIAL NO. 8672366, 8672367

14" BODY
NT316-SR2-M3-9280
BETTIS ACTUATED
CONTROL VALVE
CW TO CLOSE VALVE
SHAFT ROTATION
HORIZ PIPE, VERT SHAFT

C AMS 12-13-83
B WGR 11-11-83

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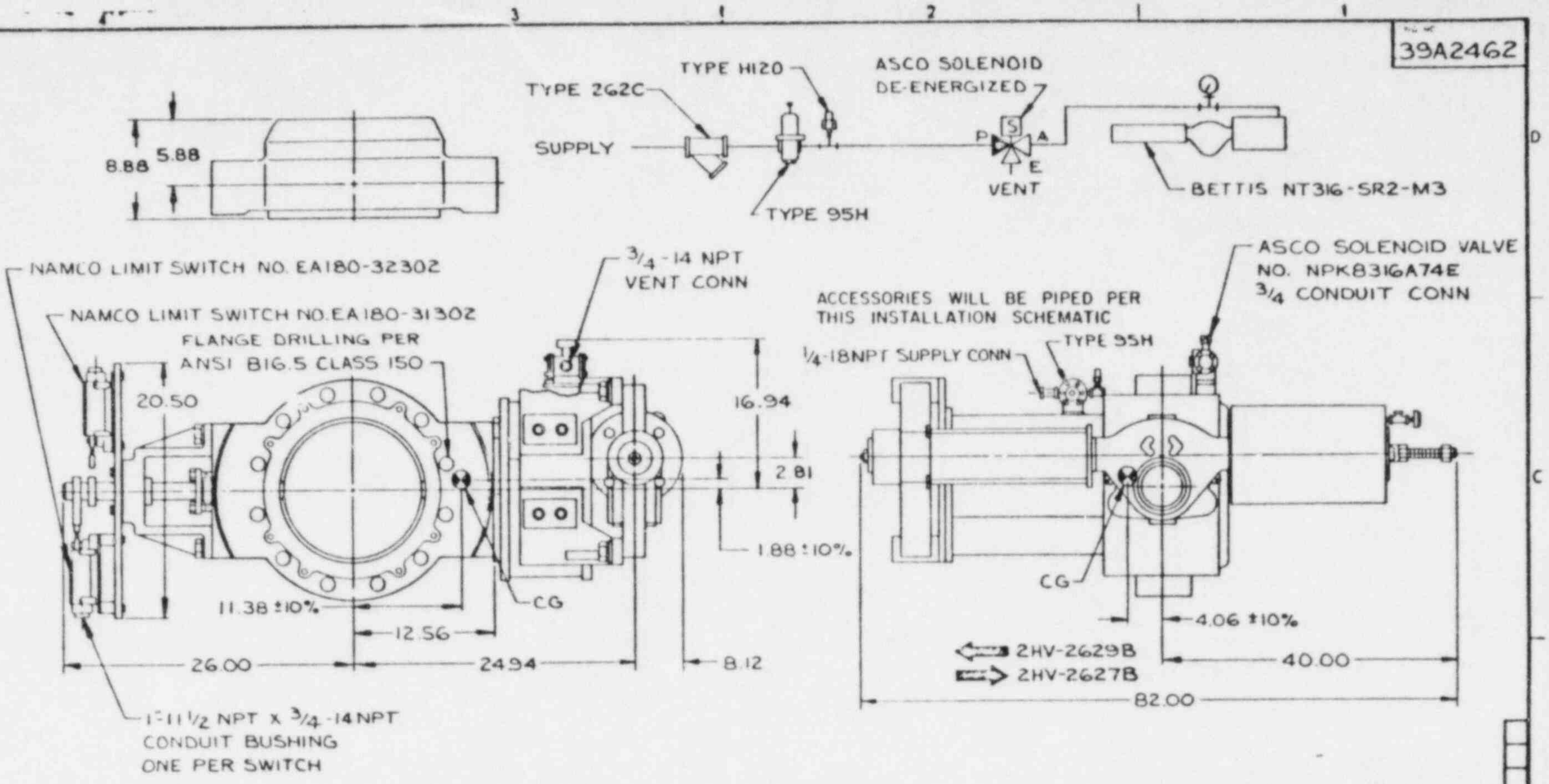
FISHER
Fisher Controls
Marshalltown Iowa USA

DWN WGR 7-8-83
CHKD KAL 7-22-83
APVD JCP 8-4-83
SCALE NONE

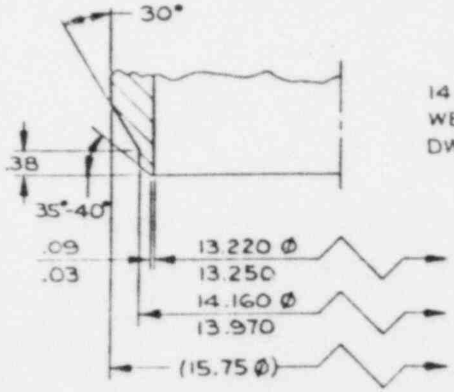
ITEM 180, 182
DWG NO 39A2461 REV C

9510-AX5AC03-5151-2 022

39A2462



DISC CHORDAL SWING Ø AT THE VALVE FACE IS 11.81
TOTAL VALVE WEIGHT: 925 LBS ±10%



14 SCHED STD BUTT
WELD END PER BECHTEL
DWG CX4DG02

UNLESS OTHERWISE SPECIFIED:
UNIT OF MEASURE: INCHES
ENVELOPE DIMENSIONS ARE ± 25

DATE	REVISIONS
7-8-83	A FIRST DRAWN
11-11-83	B REVISE FLOW ORIENTATION
12-13-83	C REVISED ACCESSORY ORIENTATION

DIMENSIONS CERTIFIED CORRECT BY Kevin A. Lagerhult DATE 7-22-83
VALVE PRESS/TEMP RATING ANSI B16.34-1977 CLASS 150

CUST GEORGIA POWER COMPANY
P.O. NO: PAV 2-314 VOGTLE UNIT II
ORDER NO: 22B-X5AC03-N2U
TAG NO: 2HV-2627B, 2HV-2629B
SERIAL NO. 8672368, 8672369

14" BODY
NT316-SR2-M3-9280
BETTIS ACTUATED
CONTROL VALVE
CW TO CLOSE VALVE
SHAFT ROTATION
HORIZ PIPE, VERT SHAFT

C	MMS	12-13-83
B	WGR	11-11-83

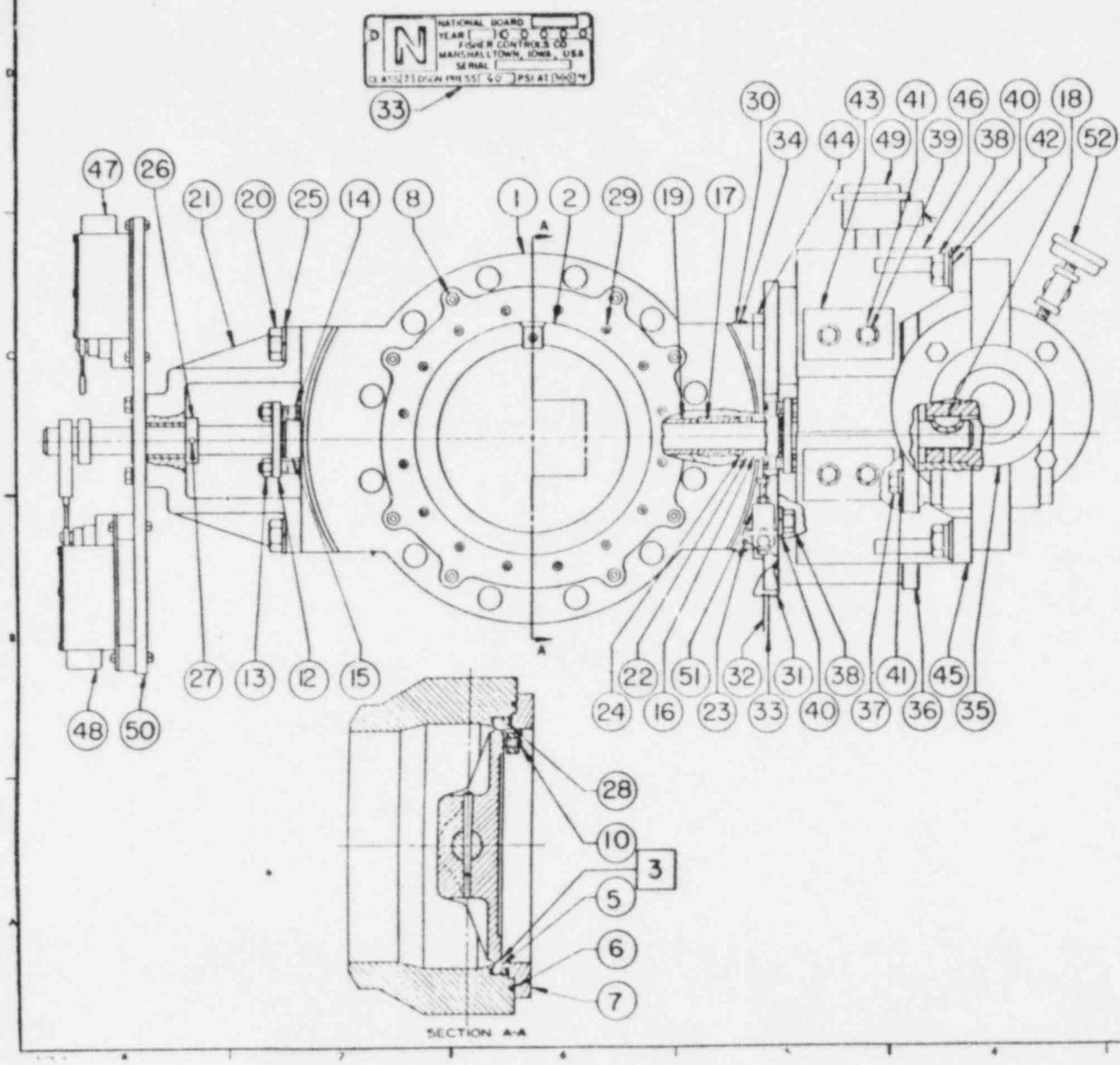
FISHER
Fisher Controls
Marshalltown, Iowa USA

DWN	AGR	7-8-83
CHKD	KAL	7-22-83
APVD	JCP	8-9-83

SCALE NONE

ITEM 148, 150
DWG NO 39A2462 REV C

4... 7881



FIND NO.	NO. REQD	PART NUMBER	DESCRIPTION	MATERIAL SPECS
R 1	1	57A6401X022	VALVE BODY	S31600 ASME SA-182
2	1	37A6411X022	DISC & SHAFT ASSEMBLY	
F *	2	G1724935362	TAPER PIN	S17400 ASME SA-564, H1075 31-39RC
F	1	27A6410X012	SHAFT	S17400 ASME SA-564 H1075 31-39RC
R	1	47A6403X022	VALVE DISC	316 SST ASME SA-351-CF8M
3□		1M528306992	SILICONE LUBRICANT	DOW CORNING COMPOUND 111
5*	1	L1302205552	T-RING	EPDM 70 DURO (CMS 0MAC)
6*	1	16A7320X022	O-RING	ETHYLENE/PROPYLENE
R 7	1	27A6409X022	RETAINING RING ASSEMBLY	
	1	L17794X0022	DISC STOP	S31600 ASME SA-479, FMS 20B20 BHN 165-195
	1	37A6407X022	RETAINING RING	316 SST ASME SA-351-CF8M
8	8	1W4006X0032	CAP SCREW	18-8 SST
10	1	F63415X0022	SET SCREW	18-8 SST
12	2	22A9048X012	PACKING FLANGE	STEEL, NON-WELD, FMS 20B13/ZN PL
13	4	1A341224112	HEX NUT	STEEL ASME SA-194-2H/ZN PL
14	4	12A8926X012	STUD	STEEL ALLOY ASME SA-193-B7/ZN PL
15	2	12A9150X012	PACKING FOLLOWER	S31600 ASME SA-479, FMS 20B20 BHN 165-195
16*	6	12A9140X022	PACKING RING	GRAPHITE MOLDED RIBBON LOW CHLORIDE FMS 17016
17	2	16A7299X012	PACKING BOX RING	S31600 ASME SA-479, FMS 20B20 BHN 165-195
F18*	1	F1358231252	WOODRUFF KEY	STEEL ALLOY ASTM A304-H86300
19	3	J1500118722	BUSHING	BRONZE-GRAPHITE
20	4	1A885724052	CAP SCREW	STEEL SAE GR 5/ZN PL
21	1	46A7337X012	BEARING BRACKET	STEEL ASME SA-216-WCB
22*	8	16A9772X012	PACKING WASHER	ZINC ASTM B69 TYPE 1
23	1	L1155438982	DRIVE SCREW	18-8 SST
24*	4	12A9158X032	PACKING RING	GRAPHITE FILAMENT YARN-FMS 17019-17016 LOW CHLORIDE
25	4	1A549328982	LOCKWASHER	CARBON STEEL
26	2	L1507818022	COLLAR	BRONZE ASTM B584-C93200
27	2	H1361738992	SPRING PIN	SST
28	1	L13035X0022	COMPRESSION RING	18-8 SST
29	16	12A5230X012	SET SCREW	18-8 SST
30	2	1V1060389B2	FLOW ARROW	18-8 SST
31	1	L1159638982	CABLE ASSY	18-8 SST
32	1	16A8264X012	NAMEPLATE	18-8 SST
33	1	12A0542X012	NUCLEAR NAMEPLATE	18-8 SST
34	4	1A3682289B2	DRIVE SCREW	18-8 SST
F35	1	37A6601X112	BETTIS ACTUATOR NT316B-SR2-M3	ASSEMBLY
F36	1	47A7168X012	ACTUATOR BRACKET	STEEL/WELDABLE/FMS 20B14
37	4	1C292824052	CAP SCREW	STEEL SAE GR5/ZN PL
F38	6	1A5671X0012	CAP SCREW	STEEL SAE GR5/ZN PL
39	4	1H576424052	CAP SCREW	STEEL SAE GR5/ZN PL
40	10	1A5493289B2	LOCKWASHER	CARBON STEEL-PLATED
41	4	1C6351X0012	LOCKWASHER	CARBON STEEL-PLATED
42	2	1A3757289 92	WASHER	CARBON STEEL
43	2	F66762X0012	MOUNTING BLOCK	STEEL/NON-WELD/FMS 20B13
44	8	F69343X0012	ANTI-ROTATION BLOCK	STEEL/WELDABLE/FMS 20B14
45	1	27A7174X012	SUPPORT BRACKET	STEEL/WELDABLE/FMS 20B14
46	1	27A7175X012	SUPPORT BRACKET	STEEL/WELDABLE/FMS 20B14
47	1	15A8157X022	NAMCO LIMIT SWITCH, EA180-31302	ASSEMBLY
48	1	15A5650X392	NAMCO LIMIT SWITCH, EA180-32302	ASSEMBLY
49	1	1M3429X0452	ASCO SOLENOID NO. NPKB316A74E	ASSEMBLY
50	1	48A8108X012	MOUNTING BRACKET	STEEL/NON-WELD/FMS 20B13
51	1	TYPE 95H W/	REGULATOR	ASSEMBLY
	1	262C	FILTER (NIPPLE MTD IN INLET)	
	1	H120	RELIEF VALVE (NIPPLE MTD IN OUTLET)	
52	1	15A8419X032	GAUGE	ASSEMBLY

* - RECOMMENDED SPARE PART
□ - APPLY LUBRICANT PER INSTRUCTION MANUAL
R - PRESSURE RETAINING PART
F - ESSENTIAL TO FUNCTION PART
- COMMERCIAL QUALITY PART

BOM2-1/6

NOTE: THIS DRAWING IS FOR USE IN PART IDENTIFICATION ONLY.

UNLESS OTHERWISE SPECIFIED
UNIT OF MEASURE INCHES
ENVELOPE DIMENSIONS ARE ± .25

DATE		REVISIONS
7-5-83	A	FIRST DRAWN
11-10-83	B	SWITCHED PART NO. 37 & 38

DIMENSIONS CERTIFIED CORRECT BY Karen R. Logan DATE 7-22-83
VALVE PRESS/TEMP RATING ANSI B16.34-1977 CLASS 150
CUST GEORGIA POWER COMPANY
P.O. NO. PAV-206 VOGTLE UNIT 1
ORDER NO. 22B-X6AC03-NIT
TAG NO. 1HV-2626B, 1HV-2628B
SERIAL NO. 8669191, 8672365

14 BODY
NT316-SR2-M3-9280
BETTIS ACTUATED
CONTROL VALVE

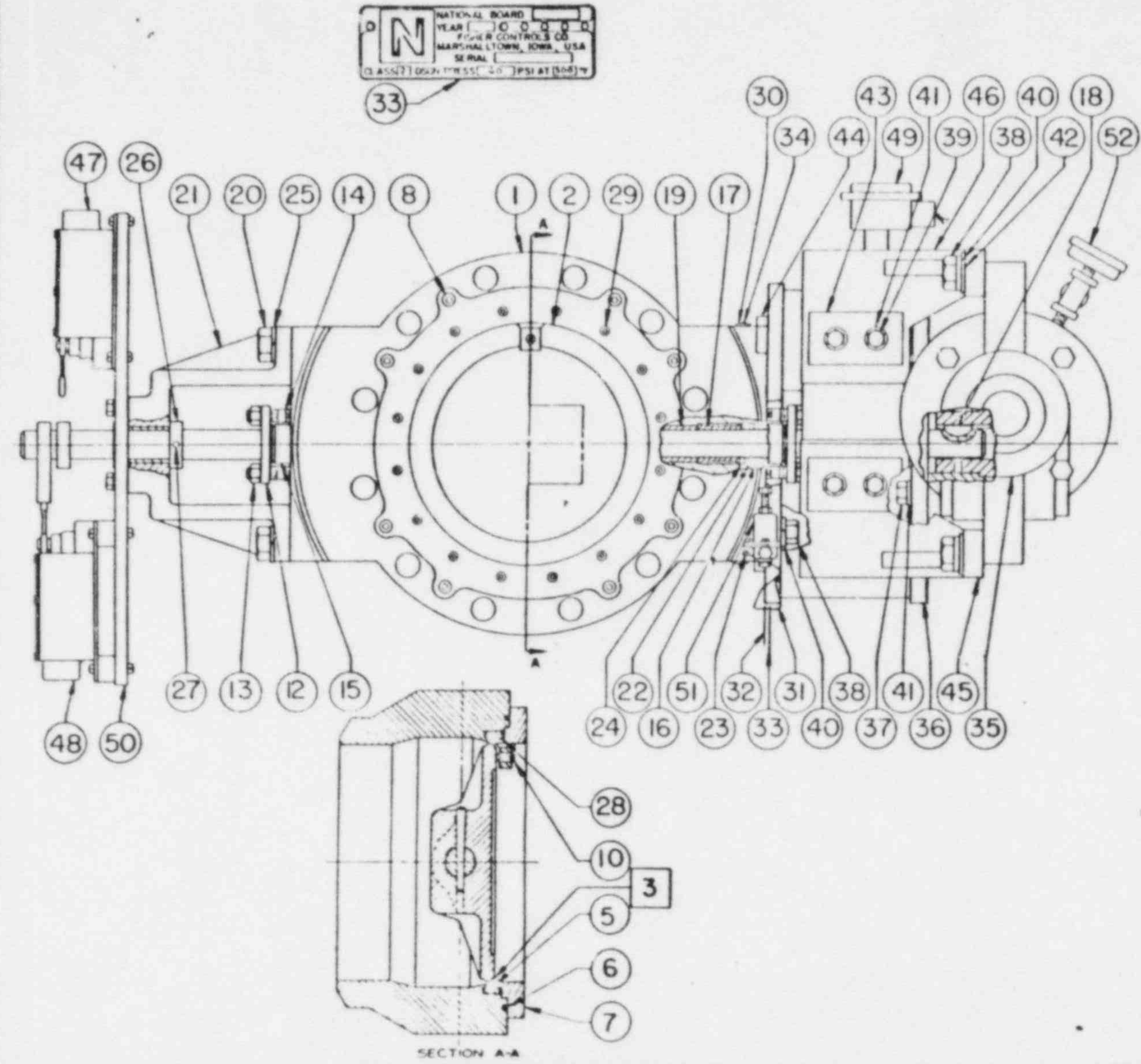
FISHER
Fisher Controls

ITEM 179, 181
48A9881 B

48A9881

48A9881

48A9882



FIND NO.	NO. REQD	PART NUMBER	DESCRIPTION	MATERIAL SPECS
R 1	1	57A6401X022	VALVE BODY	S31600 ASME SA-182
2	1	37A6411X022	DISC & SHAFT ASSEMBLY	
F *	2	G1724935362	TAPER PIN	S17400 ASME SA-564, H1075 31-39RC
F	1	27A6410X012	SHAFT	S17400 ASME SA-564, H1075 31-39RC
R	1	47A6403X022	VALVE DISC	316 SST ASME SA-351-CF8M
3☐		1H5283X6992	SILICONE LUBRICANT	DOW CORNING COMPOUND 111
5*	1	L1302205552	T-RING	EPDM 70 DURO (CMS 0AAC)
6*	1	16A7320X022	O-RING	ETHYLENE/PROPYLENE
R 7	1	27A6409X022	RETAINING RING ASSEMBLY	
	1	L17794K0022	DISC STOP	S31600 ASME SA-479, FMS 20B20 BHN 165-195
	1	37A6407X022	RETAINING RING	316 SST ASME SA-351-CF8M
8	8	1H4006X0032	CAP SCREW	18-8 SST
10	1	F6241SK0022	SET SCREW	18-8 SST
12	2	22A9048X012	PACKING FLANGE	STEEL, NON-WELD, FMS 20B13/ZN PL
13	4	1A3412X4112	HEX NUT	STEEL ASME SA-194-2H/ZN PL
14	4	12A8926X012	STUD	STEEL ALLOY ASME SA-193-B7/ZN PL
15	2	12A9050X012	PACKING FOLLOWER	S31600 ASME SA-479, FMS 20B20 BHN 165-195
16*	6	12A9140X022	PACKING RING	GRAPHITE MOLDED RIBBON LOW CHLORIDE FMS 17D16
17	2	16A7299X012	PACKING BOX RING	S31600 ASME SA-479, FMS 20B20 BHN 165-195
F 18*	1	F1358231252	WOODRUFF KEY	STEEL ALLOY ASTM A304-H86300
19	3	J1500118222	BUSHING	BRONZE-GRAPHITE
20	4	1A4857240S2	CAP SCREW	STEEL SAE GR 5/ZN PL
21	1	46A7337X012	BEARING BRACKET	STEEL ASME SA-216-WCB
22*	8	14A9772X012	PACKING WASHER	ZINC ASTM B69 TYPE 1
23	1	L1155438982	DRIVE SCREW	18-8 SST
24*	4	12A9158X032	PACKING RING	GRAPHITE FILAMENT YARN-FMS 17D19-17D16 LOW CHLORIDE
25	4	1A5493289B2	LOCKWASHER	CARBON STEEL
26	2	L1507818022	COLLAR	BRONZE ASTM B584-C93200
27	2	H1361738992	SPRING PIN	SST
28	1	L1303540022	COMPRESSION RING	18-8 SST
29	16	12A5230X012	SET SCREW	18-8 SST
30	2	1V1060389B2	FLOW ARROW	18-8 SST
31	1	L1159838982	CABLE ASSY	18-8 SST
32	1	16A4264X012	NAMEPLATE	18-8 SST
33	1	12A0542X012	NUCLEAR NAMEPLATE	18-8 SST
34	4	1A3682289B2	DRIVE SCREW	18-8 SST
F 35	1	17A6601X112	BETTIS ACTUATOR NT316B-SR2-M3	ASSEMBLY
F 36	1	47A7168X012	ACTUATOR BRACKET	STEEL/WELDABLE/FMS 20B14
37	4	1C292824052	CAP SCREW	STEEL SAE GR5/ZN PL
F 38	6	1A5671X0012	CAP SCREW	STEEL SAE GR5/ZN PL
39	4	1H5764240S2	CAP SCREW	STEEL SAE GR5/ZN PL
40	10	1A5493289B2	LOCKWASHER	CARBON STEEL-PLATED
41	4	1C6351X0012	LOCKWASHER	CARBON STEEL-PLATED
42	2	1A3757X6992	WASHER	CARBON STEEL
43	2	F6676 2X0012	MOUNTING BLOCK	STEEL/NON-WELD/FMS 20B13
44	6	F6934 3X0012	ANTI-ROTATION BLOCK	STEEL/WELDABLE/FMS 20B14
45	1	27A7174X012	SUPPORT BRACKET	STEEL/WELDABLE/FMS 20B14
46	1	27A7175X012	SUPPORT BRACKET	STEEL/WELDABLE/FMS 20B14
47	1	15A8157X022	NAMCO LIMIT SWITCH, EA180-31302	ASSEMBLY
48	1	15A5650X392	NAMCO LIMIT SWITCH, EA180-32302	ASSEMBLY
49	1	3H3429X0452	ASCO SOLENOID NO. NPKB316A74E	ASSEMBLY
50	1	48A8100X012	MOUNTING BRACKET	STEEL/NON-WELD/FMS 20B13
51	1	TYPE 95H W/	REGULATOR	ASSEMBLY
	1	262C	FILTER (NIPPLE MTD IN INLET)	
	1	H110	RELIEF VALVE (NIPPLE MTD IN OUTLET)	
52	1	15A8419X032	GAUGE	ASSEMBLY

* - RECOMMENDED SPARE PART
☐ - APPLY LUBRICANT PER INSTRUCTION MANUAL
R - PRESSURE RETAINING PART
F - ESSENTIAL TO FUNCTION PART
- COMMERCIAL QUALITY PART

B0M2-1/6

NOTE: THIS DRAWING IS FOR USE IN PART IDENTIFICATION ONLY.

UNLESS OTHERWISE SPECIFIED
UNIT OF MEASURE INCHES
ENVELOPE DIMENSIONS ARE ± .25

DATE	REVISIONS
7-5-83 A	FIRST DRAWN
11-11-83 B	SWITCHED PART NO. 37, 38

DIMENSIONS CERTIFIED CORRECT BY Thomas A. Logan LTB DATE 7-22-83
VALVE PRESS TEMP RATING ANSI B16.34-1977 CLASS 150

CUST GEORGIA POWER COMPANY
P.O. NO PAV Z-34 VOGTLE UNIT II
ORDER NO 22B-X5AC03-N2T
TAG NO 2HV-2626B, 2HV-2628B
SERIAL NO B670354, B670355

14 BODY
NT316-SR2-M3-9280
BETTIS ACTUATED
CONTROL VALVE

FISHER

© Fisher Controls 1983

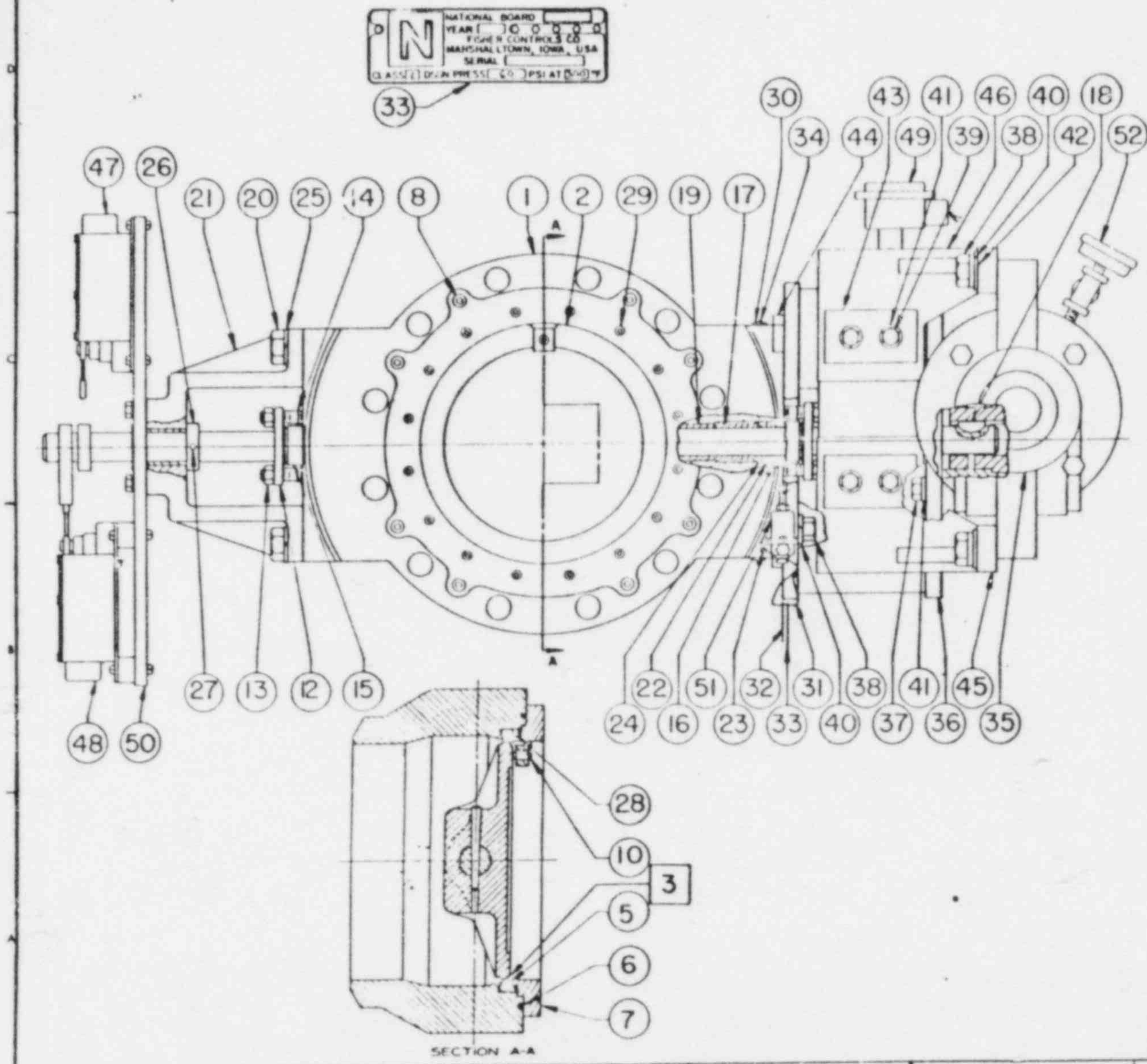
NONE

ITEM 147, 149

48A9882 B

48A9882

48A9883



FIND NO.	NO. REQD	PART NUMBER	DESCRIPTION	MATERIAL SPECS
B 1	1	57A6401X022	VALVE BODY	S31600 ASME SA-182
2	1	37A6411X022	DISC & SHAFT ASSEMBLY	
F *	2	G1724935362	TAPER PIN	S17400 ASME SA-564, H1075 31-39RC
F	1	27A6410X012	SHAFT	S17400 ASME SA-564, H1075 31-39RC
B	1	47A6423X022	VALVE DISC	316 SST ASME SA-351-CF8M
3□		1M528306992	SILICONE LUBRICANT	DOW CORNING COMPOUND 111
5*	1	L1302705552	T-RING	EPDM 70 DURO (CMS 06AC)
6*	1	16A7320X022	O-RING	ETHYLENE/PROPYLENE
B 7	1	27A6409X022	RETAINING RING ASSEMBLY	
	1	L1779080022	DISC STOP	S31600 ASME SA-479, FMS 20B20 BHN 165-195
	1	37A6407X022	RETAINING RING	316 SST ASME SA-351-CF8M
8	8	1N8006X0012	CAP SCREW	18-8 SST
10	1	F6341SX0022	SET SCREW	18-8 SST
12	2	22A9048X012	PACKING FLANGE	STEEL, NON-WELD, FMS 20B13/ZN PL
13	4	1A3412241I2	HEX NUT	STEEL ASME SA-194-2H/ZN PL
14	4	12A8926X012	STUD	STEEL ALLOY ASME SA-193-B7/ZN PL
15	2	12A9050X012	PACKING FOLLOWER	S31600 ASME SA-479, FMS 20B20 BHN 165-195
16*	6	12A9140X022	PACKING RING	GRAPHITE MOLDED RIBBON LOW CHLORIDE FMS 17D16
17	2	16A7299X012	PACKING BOX RING	S31600 ASME SA-479, FMS 20B20 BHN 165-195
F18*	1	F1358231252	WOODRUFF KEY	STEEL ALLOY ASTM A304-H8630D
19	3	J1500118222	BUSHING	BRONZE-GRAPHITE
20	4	1A8857240S2	CAP SCREW	STEEL SAE GR 5/ZN PL
21	1	46A7337X012	BEARING BRACKET	STEEL ASME SA-216-WCB
22*	8	14A9772X012	PACKING WASHER	ZINC ASTM B69 TYPE 1
23	1	L1155438982	DRIVE SCREW	18-8 SST
24*	4	12A9158X032	PACKING RING	GRAPHITE FILAMENT YARN-FMS 17D19-17D16 LOW CHLORIDE
25	4	1A5493288 82	LOCKWASHER	CARBON STEEL
26	2	L1507818022	COLLAR	BRONZE ASTM B584-C93200
27	2	H1361738992	SPRING PIN	SST
28	1	L1303540022	COMPRESSION RING	18-8 SST
29	16	12A5730X012	SET SCREW	18-8 SST
30	2	1V1060388982	FLOW ARROW	18-8 SST
31	1	L1159838982	CABLE ASSY	18-8 SST
32	1	16A4764X012	NAMEPLATE	18-8 SST
33	1	12A0542X012	NUCLEAR NAMEPLATE	18-8 SST
34	4	1A3682 25982	DRIVE SCREW	18-8 SST
F35	1	17A6601X112	BETTIS ACTUATOR NT316B-SR2-M3	ASSEMBLY
F36	1	47A7168X012	ACTUATOR BRACKET	STEEL/WELDABLE/FMS 20B14
37	4	1C292824052	CAP SCREW	STEEL SAE GR5/ZN PL
F38	6	1R5671X0012	CAP SCREW	STEEL SAE GR5/ZN PL
39	4	1H5764240S2	CAP SCREW	STEEL SAE GR5/ZN PL
40	10	1A5493[illegible]982	LOCKWASHER	CARBON STEEL-PLATED
41	4	1C6351X0012	LOCKWASHER	CARBON STEEL-PLATED
42	2	1A3757280992	WASHER	CARBON STEEL
43	2	F6676 7X0012	MOUNTING BLOCK	STEEL/NON-WELD/FMS 20B13
44	6	F6934IX0012	ANTI-ROTATION BLOCK	STEEL/WELDABLE/FMS 20B14
45	1	27A7174X012	SUPPORT BRACKET	STEEL/WELDABLE/FMS 20B14
46	1	27A7175X012	SUPPORT BRACKET	STEEL/WELDABLE/FMS 20B14
47	1	15A4157X022	NAMCO LIMIT SWITCH, EA180-31302	ASSEMBLY
48	1	15A5650X392	NAMCO LIMIT SWITCH, EA180-32302	ASSEMBLY
49	1	1M3429X0452	ASCO SOLENOID NO. NP8831WA7NE	ASSEMBLY
50	1	48A8106X012	MOUNTING BRACKET	STEEL/NON-WELD/FMS 20B13
51	1	TYPE 95H W/	REGULATOR	ASSEMBLY
	1	267C	FILTER (NIPPLE MTD IN INLET)	
	1	H120	RELIEF VALVE (NIPPLE MTD IN OUTLET)	
52	1	15A8419X032	GAUGE	ASSEMBLY

* - RECOMMENDED SPARE PART
□ - APPLY LUBRICANT PER INSTRUCTION MANUAL
B - PRESSURE RETAINING PART
F - ESSENTIAL TO FUNCTION PART
- COMMERCIAL QUALITY PART

80M2-1/6

NOTE: THIS DRAWING IS FOR USE IN PART IDENTIFICATION ONLY.

UNLESS OTHERWISE SPECIFIED:
UNIT OF MEASURE INCHES
ENVELOPE DIMENSIONS ARE ± .25

DATE		REVISIONS
7-5-83	A	FIRST DRAWN
11-11-83	B	SWITCHED
		PART NO. 37,38

DIMENSIONS CERTIFIED CORRECT BY [illegible] DATE 7-22-83
VALVE PRESS-TEMP RATING ANSI B16.34-1977 CLASS 150

CUST GEORGIA POWER COMPANY
P O NO PAV-206 VOGTLE UNIT 1
ORDER NO 22B-X5AC03-N1U
TAG NO 1HV-2627B, 1HV-2629B
SERIAL NO B672366, B672367

14 BODY
NT316-SR2-M3-9280
BETTIS ACTUATED
CONTROL VALVE

FISHER

Fisher Controls

© Fisher Controls 1983

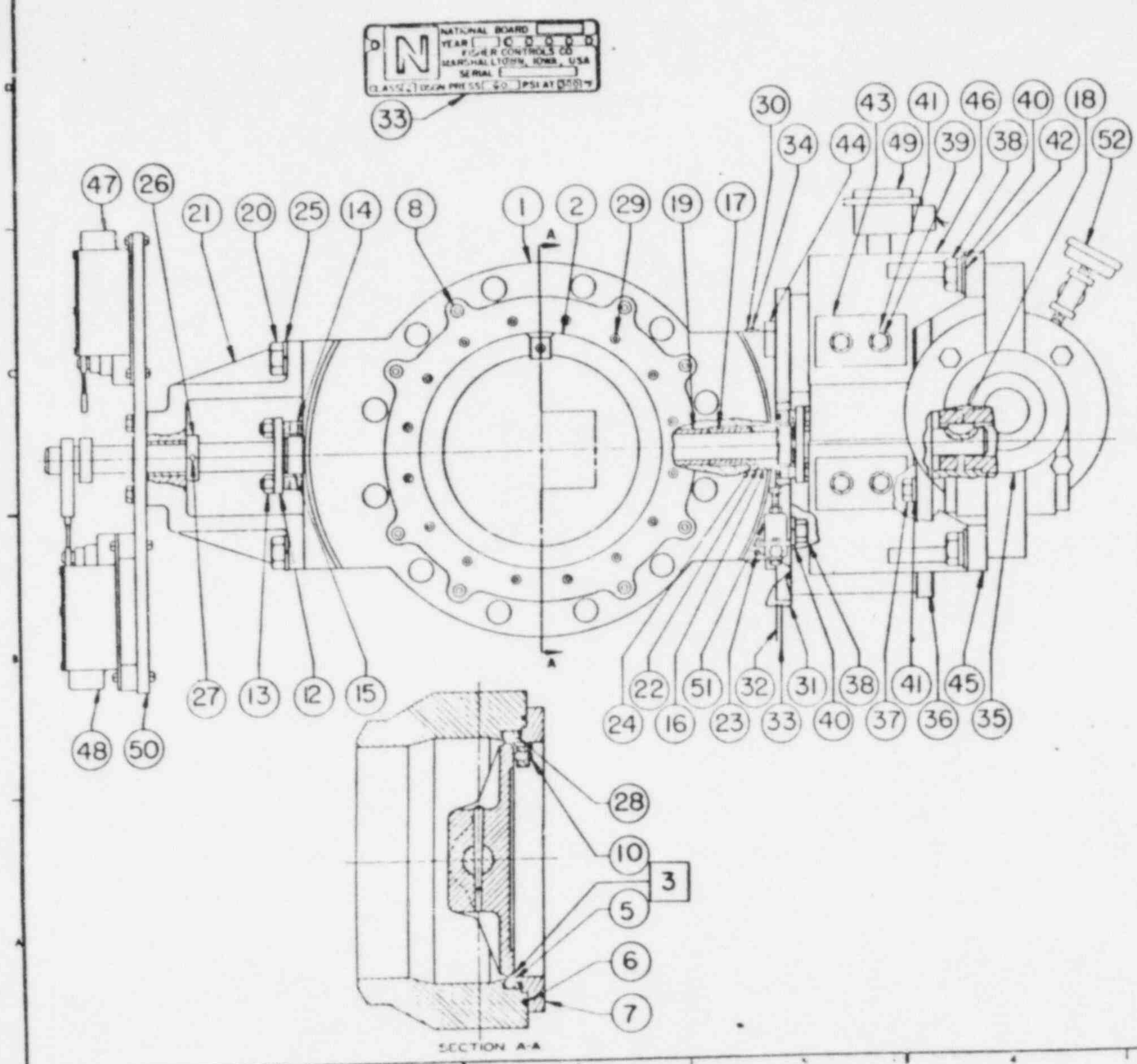
SCALE NONE

ITEM 180, 182

DWG NO 48A9883 REV B

1E-4041

48A9884



FIND NO.	NO. REQD	PART NUMBER	DESCRIPTION	MATERIAL SPECS
R 1	1	57A6401X022	VALVE BODY	S31600 ASME SA-182
2	1	37A6411X022	DISC & SHAFT ASSEMBLY	
F *	2	G1724935362	TAPER PIN	S17400 ASME SA-564, H1075 31-39RC
F	1	27A6410X012	SHAFT	S17400 ASME SA-564, H1075 31-39RC
R	1	47A6403X022	VALVE DISC	316 SST ASME SA-351-CF8M
3○		1H528306992	SILICONE LUBRICANT	DOW CORNING COMPOUND 111
5*	1	L1302205552	T-RING	EPDM 70 DURO (CMS D6AC)
6*	1	16A7320X022	O-RING	ETHYLENE/PROPYLENE
R 7	1	27A6409X022	RETAINING RING ASSEMBLY	
	1	L17194X0022	DISC STOP	S31600 ASME SA-479, FMS 20820 BHN 165-195
	1	37A6407X022	RETAINING RING	316 SST ASME SA-351-CF8M
8	8	1H4006X0032	CAP SCREW	18-8 SST
10	1	F63415X0022	SET SCREW	18-8 SST
12	2	22A9048X012	PACKING FLANGE	STEEL, NON-WELD, FMS 20813/ZN PL
13	4	1A341224112	HEX NUT	STEEL ASME SA-194-2H/ZN PL
14	4	12A8926X012	STUD	STEEL ALLOY ASME SA-193-B7/ZN PL
15	2	12A9050X012	PACKING FOLLOWER	S31600 ASME SA-479, FMS 20820 BHN 165-195
16*	6	12A9140X022	PACKING RING	GRAPHITE MOLDED RIBBON LOW CHLORIDE FMS 17016
17	2	16A7299X012	PACKING BOX RING	S31600 ASME SA-479, FMS 20820 BHN 165-195
F 18*	1	F1358231252	WOODRUFF KEY	STEEL ALLOY ASTM A304-H86300
19	3	15500116222	BUSHING	BRONZE-GRAPHITE
20	4	1A485728052	CAP SCREW	STEEL SAE GR 5/ZN PL
21	1	46A7337X012	BEARING BRACKET	STEEL ASME SA-216-WCB
22*	8	14A9772X012	PACKING WASHER	ZINC ASTM B69 TYPE 1
23	1	L1155438582	DRIVE SCREW	18-8 SST
24*	4	12A9158X032	PACKING RING	GRAPHITE FILAMENT YARN-FMS 17019-17016 LOW CHLORIDE
25	4	1A545328982	LOCKWASHER	CARBON STEEL
26	2	L150781X022	COLLAR	BRONZE ASTM B584-C93200
27	2	H1361738992	SPRING PIN	SST
28	1	L130358X022	COMPRESSION RING	18-8 SST
29	16	12A5230X012	SET SCREW	18-8 SST
30	2	1V306038982	FLOW ARROW	18-8 SST
31	1	L1159838982	CABLE ASSY	18-8 SST
32	1	16A4264X012	NAMEPLATE	18-8 SST
33	1	12A0542X012	NUCLEAR NAMEPLATE	18-8 SST
34	4	1A368228982	DRIVE SCREW	18-8 SST
F 35	1	17A6601X112	BETTIS ACTUATOR NT3168-SR2-MC	ASSEMBLY
F 36	1	47A7168X012	ACTUATOR BRACKET	STEEL/WELDABLE/FMS 20816
37	4	1C292824052	CAP SCREW	STEEL SAE GR5/ZN PL
F 38	6	1B567110012	CAP SCREW	STEEL SAE GR5/ZN PL
39	4	1H576424052	CAP SCREW	STEEL SAE GR5/ZN PL
40	10	1A549328982	LOCKWASHER	CARBON STEEL-PLATED
41	4	1C6351X0012	LOCKWASHER	CARBON STEEL-PLATED
42	2	14375728992	WASHER	CARBON STEEL
43	2	F66762X0012	MOUNTING BLOCK	STEEL/NON-WELD/FMS 20813
44	6	F69341X0012	ANTI-ROTATION BLOCK	STEEL/WELDABLE/FMS 20814
45	1	27A7178X012	SUPPORT BRACKET	STEEL/WELDABLE/FMS 20814
46	1	27A7175X012	SUPPORT BRACKET	STEEL/WELDABLE/FMS 20814
47	1	15A4157X022	NAMCO LIMIT SWITCH, EA180-31302	ASSEMBLY
48	1	15A5650X392	NAMCO LIMIT SWITCH, EA180-32302	ASSEMBLY
49	1	1R3429X0452	ASCO SOLENOID NO. NPX8316A E	ASSEMBLY
50	1	48A8108X012	MOUNTING BRACKET	STEEL/NON-WELD/FMS 20813
51	1	TYPE 95H W/	REGULATOR	ASSEMBLY
	1	762C	FILTER (NIPPLE MTD IN INLET)	
	1	H120	RELIEF VALVE (NIPPLE MTD IN OUTLET)	
52	1	15A8418X032	GAUGE	ASSEMBLY

* - RECOMMENDED SPARE PART
○ - APPLY LUBRICANT PER INSTRUCTION MANUAL
R - PRESSURE RETAINING PART
F - ESSENTIAL TO FUNCTION PART
 - COMMERCIAL QUALITY PART

8042-1/6

NOTE: THIS DRAWING IS FOR USE IN PART IDENTIFICATION **ONLY.**

UNLESS OTHERWISE SPECIFIED
UNIT OF MEASURE INCHES
ENVELOPE DIMENSIONS ARE ± .25

DIMENSIONS CERTIFIED CORRECT BY Jesus A. Ly... DATE 7-22-83
VALVE PRESS-TEMP RATING ANSI B16.34-1977 CLASS 150
CUST GEORGIA POWER COMPANY
P O NO PAV 34 VOGTLE UNIT II
ORDER NO 3 XSAC03-N2U
TAG NO 2HV-2627B, 2HV-2629B
SERIAL NO 8672368, 8672369

14 BODY
NT316-SR2-M3-9280
BETTIS ACTUATED
CONTROL VALVE

ITEM 148,150

FISHER
Fisher Controls

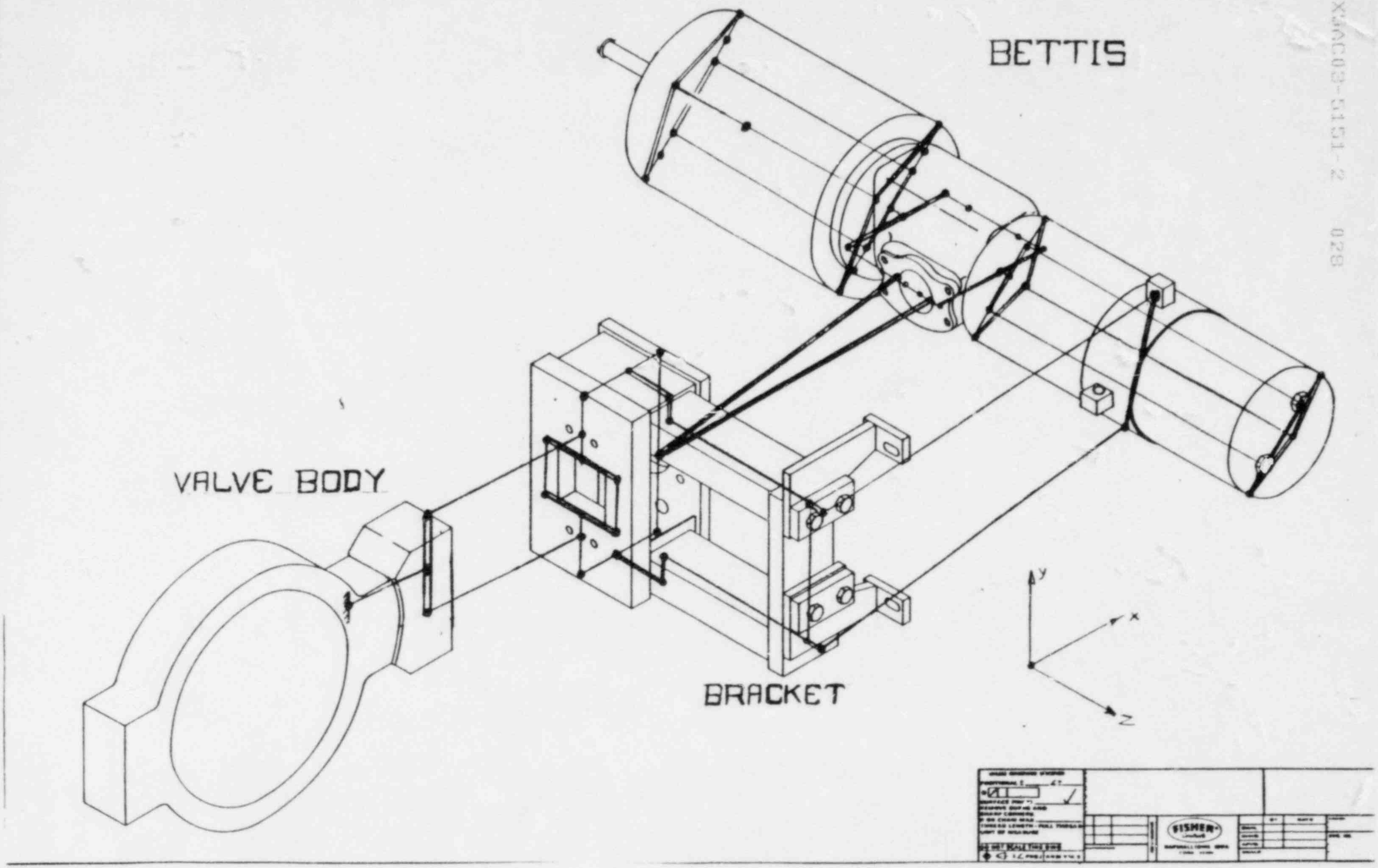
NONE

48A9884 B

DATE	REVISIONS
7-5-83 A	FIRST DRAWN
11-11-83 B	SWITCHED PART TAG. 37,38

9510 XSAC03-5151-2 027

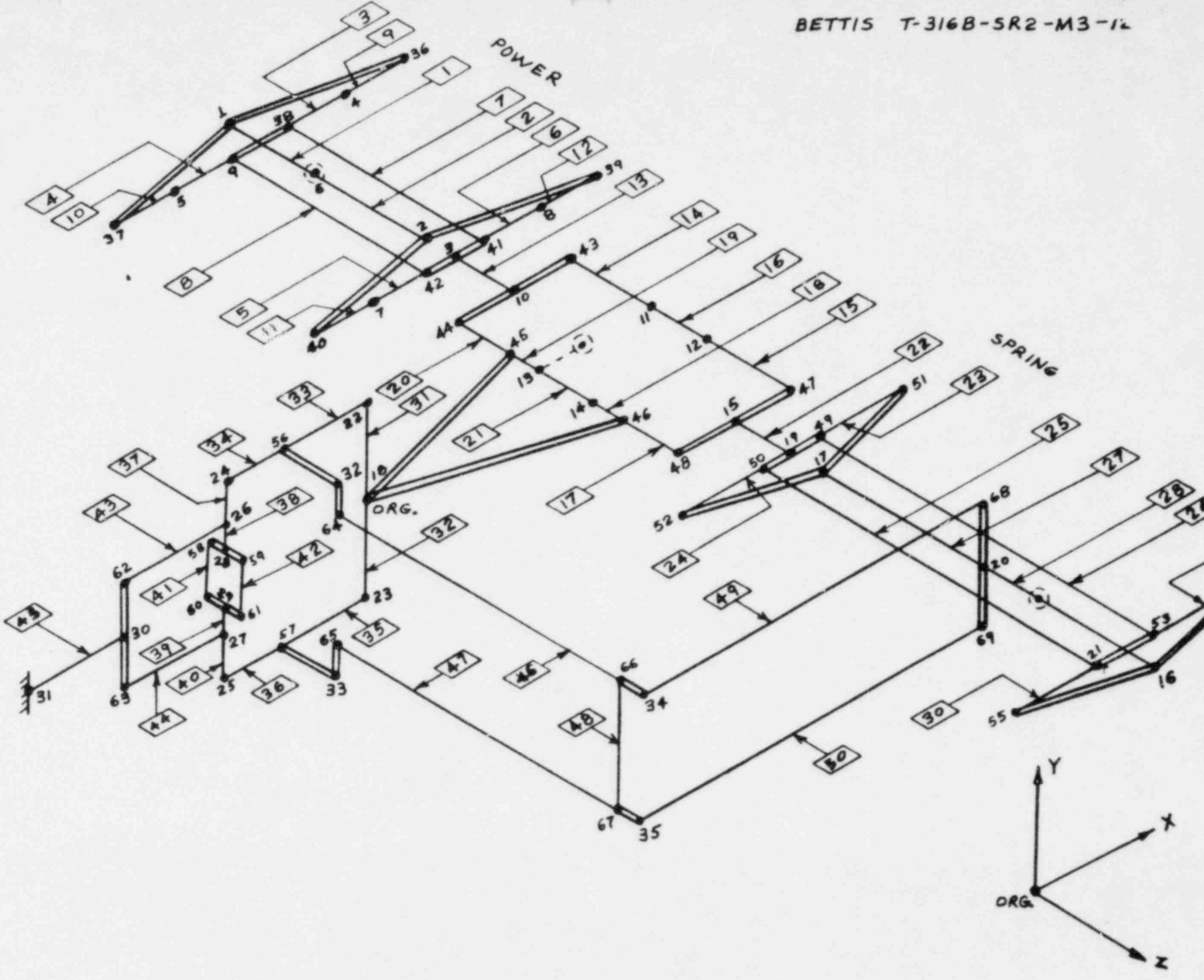
1EA1254


BETTIS
VALVE BODY
BRACKET
y
x
z
FISHER

BY .... DATE .... SUBJECT .... SHEET NO. .... OF ....

CHKD. BY .... DATE .... JOB NO. ....

BETTIS T-316B-SR2-M3-12



```
                     ** FISHER CONTROLS COMPANY **
GEORGIA POWER COMPANY                  ASSEMBLY 48A9881, 48A9882
                                                48A9883, 48A9884
                                       ORIENTATION 39A2459, 39A2460
                                                   39A2461, 39A2462
REP ORDER 228-X5AC03-N1T,N2T,N1U,N2U   CODE CLASS 2
CUSTOMER ORDER PAV-206, PAV-2-34
SERIAL NO.              TAG NO.                ITEM NO.
          8670354               2HV-2626B               147
          8670355               2HV-2628B               149
          8669191               1HV-2626B               179
          8672365               1HV-2628B               181
          8672368               2HV-2627B               148
          8672369               2HV-2629B               150
          8672366               1HV-2627B               180
          8672367               1HV-2629B               182
                    ** VALVE DESCRIPTION **
14"    NT316B-SR2-M3-12-9280           CODE CLASS 2
BRACKET 47A7168                        BETTIS ACTUATOR
ACCESSORIES: ASCO SOLENOID NPK8316A74E
             TYPE 95H REGULATOR
DESIGN CONDITIONS: 60 PSIG AT 300 DEG F
ACTUATOR TORQUE: 9800 IN-LBS
REQUIRED FREQUENCY: 33 HERTZ           MAX ALLOWABLE TRI-AXIAL G-LOADING


              DATE OF THIS REPORT /    SEPT. 24, 1984

 C O N T R O L   I N P U T   D A T A

   MANUAL INPUT GENERATION FOR VALVE ANALYSIS

   SEISMIC STRESSES ARE SUPERIMPOSED BY SQUARE ROOT OF SUM OF SQUARES

   STRESS ALLOWABLES ARE COMPARED TO MAXIMUM PRINCIPAL STRESS

   MASS, STIFFNESS, LOAD AND STRESS MATRICES ARE NOT PRINTED

   STATIC SEISMIC ANALYSIS TO BE PERFORMED

   OPERATIONAL LOAD ANALYSIS TO BE PERFORMED

   DYNAMIC MODAL ANALYSIS TO BE PERFORMED

 C R O S S - S E C T I O N   D A T A

 EL. CROSS-SECTION
 NO.  DESCRIPTION                  PARAMETERS
  1   TUBE         A =  16.00    , T =  .2100    ,
  2   SAME AS LAST
```

```
                         QUAL GROUP VII                                                   PAGE  2

      3   MANUAL DATA
      4   SAME AS LAST
      5   SAME AS LAST
      6   SAME AS LAST
      7   SOLID CIRCLE   A =  .8750     ,
      8   SAME AS LAST
      9   MANUAL DATA
     10   SAME AS LAST
     11   SAME AS LAST
     12   SAME AS LAST
     13   RECTANG.BOX    A =  4.250     ,  T =  1.312     ,  B =  4.250     ,
                         T1=  1.312     ,  R1=  .2500     ,
     14   CHANNEL        A =  8.125     ,  T =  .3120     ,  B =  1.312     ,
                         T1=  .3120     ,  R1=  .3120     ,
     15   SAME AS LAST
     16   CHANNEL        A =  10.13     ,  T =  .3120     ,  B =  1.312     ,
                         T1=  .3120     ,  R1=  .3120     ,
     17   MANUAL DATA
     18   SAME AS LAST
     19   SAME AS LAST
     20   SAME AS LAST
     21   SAME AS LAST
     22   RECTANG.BOX    A =  4.250     ,  T =  1.312     ,  B =  4.250     ,
                         T1=  1.312     ,  R1=  .2500     ,
     23   MANUAL DATA
     24   SAME AS LAST
     25   SOLID CIRCLE   A =  .8750     ,
     26   SAME AS LAST
     27   TUBE           A =  10.00     ,  T =  .2500     ,
     28   SAME AS LAST
     29   MANUAL DATA
     30   SAME AS LAST
     31   RECTANGULAR    A =  11.00     ,  T =  1.125     ,
     32   SAME AS LAST
     33   CHANNEL        A =  10.00     ,  T =  .7940     ,  B =  4.375     ,
                         T1=  .5750     ,  R1=  .0        ,
     34   SAME AS LAST
     35   CHANNEL        A =  10.00     ,  T =  .7940     ,  B =  4.375     ,
                         T1=  .5750     ,  R1=  .0        ,
     36   SAME AS LAST
     37   RECTANGULAR    A =  11.00     ,  T =  1.875     ,
     38   RECTANGULAR    A =  11.00     ,  T =  1.875     ,
     39   RECTANGULAR    A =  11.00     ,  T =  1.875     ,
     40   SAME AS LAST
     41   RECTANGULAR    A =  2.875     ,  T =  1.875     ,
     42   SAME AS LAST
     43   SOLID CIRCLE   A =  2.000     ,
     44   SOLID CIRCLE   A =  2.000     ,
     45   RECTANG.BOX    A =  5.000     ,  T =  4.875     ,  B =  12.00     ,
                         T1=  1.375     ,  R1=  1.125     ,
     46   RECTANG.BOX    A =  5.000     ,  T =  .2500     ,  B =  3.000     ,
                         T1=  .2500     ,  R1=  .2500     ,
     47   SAME AS LAST
     48   RECTANGULAR    A =  5.000     ,  T =  .7500     ,
     49   RECTANGULAR    A =  .7500     ,  T =  4.500     ,
     50   SAME AS LAST
```

```
JOINT  COORDINATE  DATA

JOINT                 X            Y            Z
 NO.

  1              4.401000     2.812000   -20.906006
  2              4.501000     2.812000    -7.312000
  3              4.501000     2.812000    -7.312000
  4              7.939000     2.812000   -20.906006
  5              1.064000     2.812000   -20.906006
  6              4.501000     2.812000   -18.906006
  7              1.064000     2.812000    -7.312000
  8              7.939000     2.812000    -7.312000
  9              3.064000     2.812000   -20.906006
 10              4.501000     2.812000    -5.000000
 11              7.730000     0.0         -2.250000
 12              7.730000     0.0          2.250000
 13              1.345000     0.0         -2.250000
 14              1.345000     0.0          2.250000
 15              4.501000     2.812000     5.000000
 16              4.501000     2.812000    35.188004
 17              4.501000     2.812000     7.250000
 18              0.0          0.0          0.0
 19              4.501000     2.812000     7.250000
 20              4.501000     2.812000    22.625000
 21              3.064000     2.812000    35.188004
 22              0.0          7.265000     0.0
 23              0.0         -7.265000     0.0
 24             -7.000000     7.265000     0.0
 25             -7.000000    -7.265000     0.0
 26             -7.000000     4.750000     0.0
 27             -7.000000    -4.750000     0.0
 28             -7.000000     2.625000     0.0
 29             -7.000000    -2.625000     0.0
 30             -7.936000     0.0          0.0
 31            -10.000000     0.0          0.0
 32             -3.562500     7.265000     5.000000
 33             -3.562500    -7.265000     5.000000
 34             -3.562500     6.500000    20.375000
 35             -3.562500    -6.500000    20.375000
 36             12.396000     2.812000   -20.906006
 37             -3.394000     2.812000   -20.906006
 38              5.939000     2.812000   -20.906006
 39             12.396000     2.812000    -7.312000
 40             -3.394000     2.812000    -7.312000
 41              5.939000     2.812000    -7.312000
 42              3.064000     2.812000    -7.312000
 43              7.730000     0.0         -5.000000
 44              1.345000     0.0         -5.000000
 45              1.345000     0.0         -3.462000
 46              1.345000     0.0          3.462000
 47              7.730000     0.0          5.000000
 48              1.345000     0.0          5.000000
```

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 49                 5.939000   2.812000   7.250000
 50                 3.064000   2.812000   7.250000
 51                 9.751000   2.812000   7.250000
 52                -0.749000   2.812000   7.250000
 53                 5.939000   2.812000  35.188004
 54                 9.751000   2.812000  35.188004
 55                -0.749000   2.812000  35.188004
 56                -3.562500   7.265000   0.0
 57                -3.562500  -7.265000   0.0
 58                -7.000000   2.625000  -4.062500
 59                -7.000000   2.625000   4.062500
 60                -7.000000  -2.625000  -4.062500
 61                -7.000000  -2.625000   4.062500
 62                -7.938000   4.750000   0.0
 63                -7.938000  -4.750000   0.0
 64                -3.562500   6.500000   5.000000
 65                -3.562500  -6.500000  -5.000000
 66                -3.562500   6.500000  19.875000
 67                -3.562500  -6.500000  19.875000
 68                 4.501000   6.500000  22.625000
 69                 4.501000  -6.500000  22.625000


B O U N D A R Y,  S P R I N G  &  B O L T  J O I N T  D A T A

JOINT TYPE-MAT PLANE-DIRECTION   SPRING & BOLT JOINT PARAMETERS
 NO.  /FIXITY  OR DESCRIPTION

 31    111111      BODY
 30   PAD   2    A     -X -Z  N.T=  2.10  ,D/A=  0.7500, YB=  1.1250
                              YO=  2.7500,YSH=  0.0    ,  S=  9.5000
                              ZT=  1.2500, ZB=  1.2500,ZSH=  0.0


C O N C E N T R A T E D  M A S S  D A T A

JOINT   LUMPED  FOR  SHIFT DISTANCE OR MOMENT OF INERTIA
 NO.     MASS   DIR.        X            Y           Z

 16    0.375259 XYZ    0.0         0.0        -11.800000
  6    0.090580 XYZ    0.0         0.0          0.0
 13    0.080228 XYZ    1.230000    1.500000     0.0
 22    0.012940 XYZ    0.0         0.0         -5.500000
 64    0.049172 XYZ    0.0         0.0          2.000000


C O N C E N T R A T E D  L O A D  D A T A

JOINT       . . . . FORCES. . . .               . . . .MOMENTS. . . .
 NO.        X           Y           Z           X           Y           Z

 18        0.0         0.0         0.0       9500.0        0.0         0.0
```

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J O I N T   R E L E A S E   D A T A

                     SPRING CONSTANTS FOR ELEMENT FORCES & MOMENTS
ELM.                 (K= 0., NO RELEASE;       K=-1., FULL RELEASE)
NO. END     K(F1)      K(F2)      K(F3)      K(M1)      K(M2)      K(M3)

 30  2         0.         0.         0.        -1.         0.         0.
 29  1         0.         0.         0.        -1.         0.         0.
 24  2         0.         0.         0.        -1.         0.         0.
 23  1         0.         0.         0.        -1.         0.         0.
  6  1         0.         0.         0.        -1.         0.         0.
  5  2         0.         0.         0.        -1.         0.         0.
  4  1         0.         0.         0.        -1.         0.         0.
  3  1         0.         0.         0.        -1.         0.         0.
```

```
ELEMENT  INPUT  DATA

EL. JOINTS LENGTH ANGLE     AREA     MOMENTS OF INERTIA       MATERIAL
NO.         /RADIUS                   I-11     I-22     I-33   DESCRIPTION

  1   1  6   2.002              10.4    324.7    649.4    324.7  STEEL
  2   6  2  11.594              10.4    324.7    649.4    324.7  STEEL
  3  38  4   2.000              18.8      2.5     24.7    354.9  STEEL
  4   9  5   2.000              18.8      2.5     24.7    354.9  STEEL
  5   7 42   2.000              18.8      2.5     24.7    354.9  STEEL
  6  41  8   2.000              18.8      2.5     24.7    354.9  STEEL
  7  38 41  13.594            0.6013   0.0288   0.0575   0.0288  STEEL
  8   9 42  13.594            0.6013   0.0288   0.0575   0.0288  STEEL
  9   4 36   4.457              19.6      2.7     24.1    384.3  STEEL
 10  37  5   4.458              19.6      2.7     24.1    384.3  STEEL
 11  40  7   4.458              19.6      2.7     24.1    384.3  STEEL
 12   8 39   4.457              19.6      2.7     24.1    384.3  STEEL
 13   3 10   2.312           15.4186  26.6053  35.6168  26.6053  DUCTILE IRON
 14  43 11   2.750            3.1590  23.4735   0.1111   0.2880  DUCTILE IRON
 15  12 47   2.750            3.1590  23.4735   0.1111   0.2880  DUCTILE IRON
 16  11 12   4.500            3.7630  42.0143   0.1313   0.3019  DUCTILE IRON
 17  46 48   1.538              13.0    126.4      7.5     22.1  DUCTILE IRON
 18  14 46   1.212              13.0    126.4      7.5     22.1  DUCTILE IRON
 19  45 13   1.212              13.0    126.4      7.5     22.1  DUCTILE IRON
 20  44 45   1.538              13.0    126.4      7.5     22.1  DUCTILE IRON
 21  13 14   4.500              13.0    126.4      7.5     22.1  DUCTILE IRON
 22  15 19   2.250           15.4186  26.6053  35.6168  26.6053  DUCTILE IRON
 23  49 51   3.812              10.8      0.8      1.6    116.1  STEEL
 24  52 50   3.813              10.8      0.8      1.6    116.1  STEEL
 25  50 21  27.938            0.6013   0.0288   0.0575   0.0288  STEEL
 26  49 53  27.938            0.6013   0.0288   0.0575   0.0288  STEEL
 27  17 20  15.375               7.7     91.1    182.1     91.1  STEEL
 28  20 16  12.563               7.7     91.1    182.1     91.1  STEEL
 29  53 54   3.812            8.6610   0.2510   2.6500  75.0200  STEEL
 30  55 21   3.813            8.6610   0.2510   2.6500  75.0200  STEEL
 31  22 18   7.265              12.4      1.3      4.9    124.8  STEEL
 32  18 23   7.265              12.4      1.3      4.9    124.8  STEEL
 33  22 56   3.563              12.1    157.7      2.0     17.8  STEEL
 34  56 24   3.438              12.1    157.7      2.0     17.8  STEEL
 35  23 57   3.563              12.1    157.7      2.0     17.8  STEEL
 36  57 25   3.438              12.1    157.7      2.0     17.8  STEEL
 37  24 26   2.515              20.6      6.0     21.6    208.0  STEEL
 38  26 28   2.125              20.6      6.0     21.6    208.0  STEEL
 39  29 27   2.125              20.6      6.0     21.6    208.0  STEEL
 40  27 25   2.515              20.6      6.0     21.6    208.0  STEEL
 41  58 60   5.250            5.3906   1.5793   3.7607   3.7131  STEEL
 42  59 61   5.250            5.3906   1.5793   3.7607   3.7131  STEEL
 43  26 62   0.938            3.1416   0.7854   1.5708   0.7854 STIFF ELEMENT
 44  27 63   0.938            3.1416   0.7854   1.5708   0.7854 STIFF ELEMENT
 45  30 31   2.062              54.9    122.9    281.0    717.9  STEEL
 46  64 66  14.875            3.7500  12.2656  11.3873   5.3906  STEEL
 47  65 67  24.875            3.7500  12.2656  11.3873   5.3906  STEEL
 48  66 67  13.000            3.7500   0.1758   0.6367   7.8125  STEEL
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49   34 68  8.372           3.3750  5.6953  0.5664  0.1582  STEEL
50   35 69  8.372           3.3750  5.6953  0.5664  0.1582  STEEL
     36  1                   RIGID LINK
     37  1                   RIGID LINK
     38  9                   RIGID LINK
     39  2                   RIGID LINK
     40  2                   RIGID LINK
     41  3                   RIGID LINK
     42  3                   RIGID LINK
     43 10                   RIGID LINK
     44 10                   RIGID LINK
     45 18                   RIGID LINK
     46 18                   RIGID LINK
     47 15                   RIGID LINK
     48 15                   RIGID LINK
     49 19                   RIGID LINK
     50 19                   RIGID LINK
     51 17                   RIGID LINK
     52 17                   RIGID LINK
     54 16                   RIGID LINK
     55 16                   RIGID LINK
     53 21                   RIGID LINK
     56 32                   RIGID LINK
     57 33                   RIGID LINK
     64 32                   RIGID LINK
     65 33                   RIGID LINK
     58 28                   RIGID LINK
     59 28                   RIGID LINK
     60 29                   RIGID LINK
     61 29                   RIGID LINK
     62 30                   RIGID LINK
     63 30                   RIGID LINK
     66 34                   RIGID LINK
     67 35                   RIGID LINK
     68 20                   RIGID LINK
     69 20                   RIGID LINK
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STATIC  ANALYSIS

DEFORMATION RESPONSE TO 1 G  GRAVITATIONAL LOAD IN VALVE SYSTEM X DIR.

JOINT        . . .DEFLECTION . . .                    . . . ROTATION  . . .
 NO.        X           Y           Z               X           Y           Z

  1    0.004834 -0.000338 -0.000223        -0.000015 -0.000318 -0.000012
  2    0.000483 -0.000130 -0.000191        -0.000015 -0.000318 -0.000012
  3    0.000483 -0.000130 -0.000191        -0.000015 -0.000063 -0.000012
  4    0.004834 -0.000380  0.000792        -0.000015 -0.000359 -0.000012
  5    0.004834 -0.000299 -0.001174        -0.000015 -0.000359 -0.000012
  6    0.004196 -0.000309 -0.000191        -0.000015 -0.000318 -0.000012
  7    0.000483 -0.000089 -0.001082        -0.000015 -0.000393 -0.000012
  8    0.000483 -0.000171  0.000700        -0.000015 -0.000393 -0.000012
  9    0.004834 -0.000322 -0.000447        -0.000015 -0.000178 -0.000012
 10    0.000338 -0.000094 -0.000191        -0.000015 -0.000056 -0.000012
 11    0.000157 -0.000085  0.000025        -0.000016 -0.000053 -0.000012
 12   -0.000081 -0.000009  0.000015        -0.000016 -0.000053 -0.000006
 13    0.000152 -0.000039 -0.000323        -0.000015 -0.000053 -0.000002
 14   -0.000086  0.000029 -0.000323        -0.000015 -0.000053 -0.000001
 15   -0.000208  0.000061 -0.000203        -0.000015 -0.000052 -0.000007
 16    0.002425  0.000065 -0.000255         0.000001  0.000093 -0.000004
 17   -0.000317  0.000095 -0.000249         0.000000  0.000095 -0.000006
 18    0.000033 -0.000004 -0.000394        -0.000015 -0.000053 -0.000001
 19   -0.000317  0.000095 -0.000204        -0.000015 -0.000048 -0.000006
 20    0.001174  0.000081 -0.000256         0.000001  0.000096 -0.000004
 21    0.002425  0.000071 -0.000209         0.000001  0.000010 -0.000004
 22    0.000017 -0.000004 -0.000274         0.000029  0.000030  0.000000
 23    0.000009 -0.000005 -0.000155        -0.000037  0.000011 -0.000002
 24    0.000010 -0.000001 -0.000005        -0.000000  0.000028 -0.000001
 25    0.000004 -0.000000 -0.000003        -0.000000  0.000010  0.000000
 26    0.000002 -0.000000 -0.000004        -0.000000  0.000003 -0.000001
 27    0.000000 -0.000000 -0.000004        -0.000000  0.000002  0.000000
 28    0.000001 -0.000000 -0.000004        -0.000000  0.000003 -0.000001
 29    0.000000 -0.000000 -0.000004        -0.000000  0.000002  0.000000
 30    0.000001 -0.000000 -0.000002        -0.000000  0.000002 -0.000000
 31    0.0        0.0        0.0            0.0        0.0        0.0
 32    0.000166  0.000024 -0.000095        -0.000005  0.000030 -0.000000
 33    0.000062  0.000033 -0.000053        -0.000007  0.000011 -0.000001
 34    0.001129  0.000109 -0.000079        -0.000005  0.000068 -0.000004
 35    0.001069  0.000110 -0.000047        -0.000005  0.000054 -0.000004
 36    0.004834 -0.000433  0.002321        -0.000015 -0.000318 -0.000012
 37    0.004834 -0.000246 -0.002704        -0.000015 -0.000318 -0.000012
 38    0.004834 -0.000357  0.000065        -0.000015 -0.000178 -0.000012
 39    0.000483 -0.000223  0.002320        -0.000015 -0.000318 -0.000012
 40    0.000483 -0.000036 -0.002703        -0.000015 -0.000318 -0.000012
 41    0.000483 -0.000147 -0.000100        -0.000015 -0.000063 -0.000012
 42    0.000483 -0.000113 -0.000282        -0.000015 -0.000063 -0.000012
 43    0.000305 -0.000132  0.000033        -0.000015 -0.000056 -0.000012
 44    0.000305 -0.000057 -0.000325        -0.000015 -0.000056 -0.000012
 45    0.000215 -0.000059 -0.000323        -0.000015 -0.000053 -0.000001
```

```
 46   -0.000150  0.000047 -0.000323    -0.000015 -0.000053 -0.000001
 47   -0.000227  0.000039  0.000007    -0.000015 -0.000052 -0.000007
 48   -0.000227  0.000083 -0.000323    -0.000015 -0.000052 -0.000007
 49   -0.000317  0.000087 -0.000136    -0.000015 -0.000048 -0.000006
 50   -0.000317  0.000103 -0.000273    -0.000015 -0.000048 -0.000006
 51   -0.000317  0.000066 -0.000745     0.000000  0.000095 -0.000006
 52   -0.000317  0.000124  0.000248     0.000000  0.000095 -0.000006
 53    0.002425  0.000059 -0.000238     0.000001  0.000010 -0.000004
 54    0.002425  0.000043 -0.000743     0.000001  0.000093 -0.000004
 55    0.002425  0.000087  0.000233     0.000001  0.000093 -0.000004
 56    0.000014 -0.000003 -0.000095    -0.000005  0.000030 -0.000000
 57    0.000007 -0.000000 -0.000053    -0.000007  0.000011 -0.000001
 58   -0.000010 -0.000001 -0.000004    -0.000000  0.000003 -0.000001
 59    0.000012 -0.000000 -0.000004    -0.000000  0.000003 -0.000001
 60   -0.000010 -0.000000 -0.000004    -0.000000  0.000002  0.000000
 61    0.000010 -0.000000 -0.000004    -0.000000  0.000002  0.000000
 62    0.000002 -0.000000 -0.000002    -0.000000  0.000002 -0.000000
 63    0.000000 -0.000000 -0.000002    -0.000000  0.000002 -0.000000
 64    0.000166  0.000024 -0.000091    -0.000005  0.000030 -0.000000
 65   -0.000047 -0.000034 -0.000058    -0.000007  0.000011 -0.000001
 66    0.001095  0.000107 -0.000079    -0.000005  0.000068 -0.000004
 67    0.001042  0.000107 -0.000047    -0.000005  0.000054 -0.000004
 68    0.001190  0.000081 -0.000251     0.000001  0.000096 -0.000004
 69    0.001135  0.000081 -0.000268     0.000001  0.000096 -0.000004
```

```
DEFORMATION RESPONSE TO 1 G  GRAVITATIONAL LOAD IN VALVE SYSTEM Y DIR.

JOINT       . . .DEFLECTION . . .                  . . . ROTATION  . . .
 NO.          X          Y          Z              X          Y          Z

   1   -0.000254  0.000815 -0.000041        0.000041  0.000011  0.000006
   2   -0.000098  0.000239 -0.000042        0.000040  0.000011  0.000006
   3   -0.000098  0.000236 -0.000042        0.000021  0.000011  0.000006
   4   -0.000254  0.000836 -0.000082        0.000041  0.000012  0.000006
   5   -0.000254  0.000794 -0.000003        0.000041  0.000012  0.000006
   6   -0.000231  0.000732 -0.000042        0.000041  0.000011  0.000006
   7   -0.000098  0.000215 -0.000003        0.000027  0.000012  0.000006
   8   -0.000098  0.000259 -0.000082        0.000027  0.000012  0.000006
   9   -0.000254  0.000807 -0.000026        0.000041  0.000011  0.000006
  10   -0.000072  0.000190 -0.000042        0.000014  0.000011  0.000006
  11   -0.000024  0.000171 -0.000117        0.000014  0.000011  0.000004
  12    0.000025  0.000109 -0.000117        0.000013  0.000011 -0.000001
  13   -0.000024  0.000135 -0.000046        0.000013  0.000011  0.000004
  14    0.000025  0.000077 -0.000046        0.000013  0.000011  0.000004
  15    0.000047  0.000062 -0.000049        0.000012  0.000011  0.000003
  16   -0.000008  0.003852 -0.000066       -0.000129 -0.000003 -0.000003
  17    0.000072  0.000051 -0.000064       -0.000131 -0.000003  0.000000
  18    0.000000  0.000098 -0.000032        0.000013  0.000011  0.000005
  19    0.000072  0.000048 -0.000049        0.000006  0.000011  0.000000
  20    0.000031  0.002148 -0.000067       -0.000132 -0.000003 -0.000003
  21   -0.000008  0.003857 -0.000049       -0.000129  0.000005 -0.000003
  22   -0.000016  0.000093 -0.000032       -0.000019 -0.000000  0.000005
  23    0.000018  0.000092  0.000014       -0.000020  0.000001  0.000005
  24   -0.000013  0.000008 -0.000036       -0.000015 -0.000000  0.000002
  25    0.000013  0.000008  0.000031       -0.000011  0.000000  0.000002
  26   -0.000004  0.000007 -0.000010       -0.000003  0.000000  0.000002
  27    0.000004  0.000007  0.000010       -0.000002 -0.000000  0.000002
  28   -0.000001  0.000007 -0.000005       -0.000002  0.000000  0.000002
  29    0.000001  0.000007  0.000005       -0.000002  0.000000  0.000002
  30   -0.000000  0.000005 -0.000000       -0.000002  0.000000  0.000001
  31    0.0       0.0       0.0               0.0       0.0       0.0
  32   -0.000019  0.000402  0.000072       -0.000070 -0.000001  0.000008
  33    0.000019  0.000194 -0.000000       -0.000029  0.000001  0.000008
  34   -0.000132  0.001785  0.000108       -0.000087 -0.000006  0.000028
  35    0.000314  0.001782  0.000018       -0.000080  0.000008  0.000030
  36   -0.000254  0.000866 -0.000133        0.000041  0.000011  0.000006
  37   -0.000254  0.000765  0.000048        0.000041  0.000011  0.000006
  38   -0.000254  0.000825 -0.000059        0.000041  0.000011  0.000006
  39   -0.000098  0.000290 -0.000133        0.000040  0.000011  0.000006
  40   -0.000098  0.000189  0.000048        0.000040  0.000011  0.000006
  41   -0.000098  0.000245 -0.000058        0.000021  0.000011  0.000006
  42   -0.000098  0.000227 -0.000027        0.000021  0.000011  0.000006
  43   -0.000054  0.000210 -0.000117        0.000014  0.000011  0.000006
  44   -0.000054  0.000170 -0.000046        0.000014  0.000011  0.000006
  45   -0.000037  0.000148 -0.000046        0.000013  0.000011  0.000005
  46    0.000038  0.000061 -0.000046        0.000013  0.000011  0.000005
  47    0.000055  0.000070 -0.000117        0.000012  0.000011  0.000003
  48    0.000055  0.000053 -0.000047        0.000012  0.000011  0.000003
```

```
49     0.000072  0.000048 -0.000064      0.000006  0.000011  0.000000
50     0.000072  0.000047 -0.000034      0.000006  0.000011  0.000000
51     0.000072  0.000052 -0.000051     -0.000131 -0.000003  0.000000
52     0.000072  0.000051 -0.000077     -0.000131 -0.000003  0.000000
53    -0.000008  0.003849 -0.000062     -0.000129  0.000005 -0.000003
54    -0.000008  0.003838 -0.000050     -0.000129 -0.000003 -0.000003
55    -0.000008  0.003867 -0.000082     -0.000129 -0.000003 -0.000003
56    -0.000016  0.000051  0.000072     -0.000070 -0.000001  0.000008
57     0.000016  0.000050 -0.000000     -0.000029  0.000001  0.000008
58    -0.000001 -0.000003 -0.000005     -0.000002  0.000000  0.000002
59    -0.000001  0.000016 -0.000005     -0.000002  0.000000  0.000002
60     0.000001 -0.000003  0.000005     -0.000002  0.000000  0.000002
61     0.000001  0.000016  0.000005     -0.000002  0.000000  0.000002
62    -0.000004  0.000005 -0.000010     -0.000002  0.000000  0.000001
63     0.000004  0.000005  0.000010     -0.000002  0.000000  0.000001
64    -0.000013  0.000402  0.000126     -0.000070 -0.000001  0.000008
65     0.000007 -0.000095 -0.000022     -0.000029  0.000001  0.000008
66    -0.000129  0.001741  0.000108     -0.000087 -0.000006  0.000028
67     0.000310  0.001742  0.000018     -0.000080  0.000008  0.000030
68     0.000041  0.002148 -0.000554     -0.000132 -0.000003 -0.000003
69     0.000006  0.002148  0.001164     -0.000132 -0.000003 -0.000003
```

```
DEFORMATION RESPONSE TO 1 G  GRAVITATIONAL LOAD IN VALVE SYSTEM Z DIR.

JOINT        . . .DEFLECTION . . .                   . . . ROTATION  . . .
 NO.        X           Y           Z              X           Y           Z

  1     0.002376   0.000576   0.001932         0.000028 -0.000115 -0.000002
  2     0.000814   0.000200   0.001942         0.000028 -0.000115 -0.000002
  3     0.000814   0.000200   0.001880         0.000028 -0.000111 -0.000002
  4     0.002376   0.000570   0.002320         0.000028 -0.000122 -0.000002
  5     0.002376   0.000581   0.001534         0.000028 -0.000109 -0.000002
  6     0.002146   0.000520   0.001944         0.000028 -0.000115 -0.000002
  7     0.000814   0.000205   0.001517         0.000028 -0.000103 -0.000002
  8     0.000814   0.000194   0.002301         0.000028 -0.000129 -0.000002
  9     0.002376   0.000578   0.001750         0.000028 -0.000113 -0.000002
 10     0.000557   0.000136   0.001879         0.000028 -0.000111 -0.000002
 11     0.000250   0.000053   0.002158         0.000028 -0.000110 -0.000001
 12    -0.000242 -0.000074   0.002156         0.000028 -0.000109 -0.000004
 13     0.000250   0.000062   0.001450         0.000027 -0.000110 -0.000000
 14    -0.000243 -0.000061   0.001450         0.000027 -0.000110 -0.000000
 15    -0.000532 -0.000138   0.001875         0.000027 -0.000110 -0.000004
 16    -0.002716 -0.000560   0.001910         0.000014 -0.000071 -0.000005
 17    -0.000776 -0.000198   0.001899         0.000013 -0.000069 -0.000005
 18     0.000004   0.000001   0.001302         0.000027 -0.000110 -0.000000
 19    -0.000777 -0.000198   0.001876         0.000027 -0.000109 -0.000005
 20    -0.001824 -0.000388   0.001901         0.000014 -0.000071 -0.000005
 21    -0.002716 -0.000553   0.001762         0.000014 -0.000092 -0.000005
 22     0.000000   0.000000   0.000731        -0.000121 -0.000053  0.000000
 23     0.000000   0.000001   0.000592         0.000126 -0.000040 -0.000000
 24     0.000000 -0.000000   0.000057         0.000020 -0.000049 -0.000000
 25     0.000000   0.000000   0.000026        -0.000008 -0.000037  0.000000
 26     0.000000 -0.000000   0.000021         0.000002 -0.000007 -0.000000
 27    -0.000000   0.000000   0.000012         0.000001 -0.000006  0.000000
 28    -0.000000 -0.000000   0.000019         0.000001 -0.000007 -0.000000
 29    -0.000000   0.000000   0.000014         0.000001 -0.000007  0.000000
 30     0.000000 -0.000000   0.000011         0.000001 -0.000005 -0.000000
 31     0.0        0.0        0.0              0.0       0.0       0.0
 32    -0.000259   0.000027   0.000300        -0.000006 -0.000052 -0.000000
 33    -0.000196 -0.000248   0.000289         0.000050 -0.000039 -0.000000
 34    -0.001349 -0.000289   0.000320         0.000024 -0.000082 -0.000007
 35    -0.001474 -0.000287   0.000347         0.000010 -0.000083 -0.000010
 36     0.002376   0.000563   0.002851         0.000028 -0.000115 -0.000002
 37     0.002376   0.000588   0.001037         0.000026 -0.000115 -0.000002
 38     0.002376   0.000573   0.002074         0.000028 -0.000113 -0.000002
 39     0.000814   0.000187   0.002849         0.000028 -0.000115 -0.000002
 40     0.000814   0.000212   0.001035         0.000028 -0.000115 -0.000002
 41     0.000814   0.000197   0.002040         0.000028 -0.000111 -0.000002
 42     0.000814   0.000202   0.001721         0.000028 -0.000111 -0.000002
 43     0.000553   0.000131   0.002159         0.000028 -0.000111 -0.000002
 44     0.000553   0.000141   0.001451         0.000028 -0.000111 -0.000002
 45     0.000383   0.000095   0.001450         0.000027 -0.000110 -0.000000
 46    -0.000376 -0.000094   0.001450         0.000027 -0.000110 -0.000000
 47    -0.000543 -0.000151   0.002154         0.000027 -0.000110 -0.000004
 48    -0.000543 -0.000126   0.001451         0.000027 -0.000110 -0.000004
```

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49   -0.000777 -0.000205  0.002032       0.000027 -0.000109 -0.000005
50   -0.000777 -0.000192  0.001719       0.000027 -0.000109 -0.000005
51   -0.000776 -0.000222  0.002263       0.000013 -0.000069 -0.000005
52   -0.000776 -0.000173  0.001536       0.000013 -0.000069 -0.000005
53   -0.002716 -0.000568  0.002027       0.000014 -0.000092 -0.000005
54   -0.002716 -0.000588  0.002283       0.000014 -0.000071 -0.000005
55   -0.002716 -0.000533  0.001537       0.000014 -0.000071 -0.000005
56    0.000000 -0.000002  0.000300      -0.000006 -0.000052 -0.000000
57    0.000000  0.000001  0.000289       0.000050 -0.000039 -0.000000
58    0.000027  0.000004  0.000019       0.000001 -0.000007 -0.000000
59   -0.000027 -0.000004  0.000019       0.000001 -0.000007 -0.000000
60    0.000026  0.000004  0.000014       0.000001 -0.000007  0.000000
61   -0.000027 -0.000004  0.000014       0.000001 -0.000007  0.000000
62    0.000000 -0.000000  0.000016       0.000001 -0.000005 -0.000000
63   -0.000000 -0.000000  0.000007       0.000001 -0.000005 -0.000000
64   -0.000259  0.000027  0.000304      -0.000006 -0.000052 -0.000000
65    0.000196  0.000251  0.000327       0.000050 -0.000039 -0.000000
66   -0.001308 -0.000277  0.000320       0.000024 -0.000082 -0.000007
67   -0.001432 -0.000282  0.000347       0.000010 -0.000083 -0.000010
68   -0.001805 -0.000388  0.001952       0.000014 -0.000071 -0.000005
69   -0.001873 -0.000388  0.001773       0.000014 -0.000071 -0.000005
```

```
DEFORMATION RESPONSE TO OPERATIONAL LOADS (NOT INCLUDING DEADWEIGHT)

JOINT        . . .DEFLECTION . . .                   . . . ROTATION  . . .
 NO.        X            Y            Z             X            Y            Z

   1   -0.000034   0.005611   0.000572         0.000268   0.000002  -0.000001
   2   -0.000010   0.001970   0.000572         0.000268   0.000002  -0.000001
   3   -0.000010   0.001970   0.000572         0.000268   0.000002  -0.000001
   4   -0.000034   0.005608   0.000566         0.000268   0.000002  -0.000001
   5   -0.000034   0.005614   0.000578         0.000268   0.000002  -0.000001
   6   -0.000031   0.005075   0.000572         0.000268   0.000002  -0.000001
   7   -0.000010   0.001972   0.000578         0.000268   0.000002  -0.000001
   8   -0.000010   0.001967   0.000566         0.000268   0.000002  -0.000001
   9   -0.000034   0.005612   0.000575         0.000268   0.000002  -0.000001
  10   -0.000007   0.001350   0.000572         0.000268   0.000002  -0.000001
  11   -0.000004   0.000609  -0.000187         0.000268   0.000002  -0.000000
  12    0.000004  -0.000597  -0.000187         0.000267   0.000002  -0.000002
  13   -0.000004   0.000613  -0.000176         0.000268   0.000002   0.000000
  14    0.000004  -0.000594  -0.000176         0.000268   0.000002   0.000000
  15    0.000014  -0.001327   0.000568         0.000267   0.000002  -0.000002
  16   -0.000915  -0.003063   0.000547         0.000042  -0.000033  -0.000006
  17    0.000017  -0.001911   0.000550         0.000048  -0.000033  -0.000004
  18    0.000000   0.000009  -0.000174         0.000268   0.000002   0.000000
  19    0.000017  -0.001914   0.000568         0.000258   0.000001  -0.000004
  20   -0.000493  -0.002535   0.000547         0.000042  -0.000034  -0.000006
  21   -0.000915  -0.003054   0.000539         0.000040  -0.000014  -0.000006
  22   -0.000000   0.000007   0.000388        -0.000018  -0.000022   0.000000
  23    0.000000   0.000008  -0.000487        -0.000073   0.000022   0.000000
  24    0.000000  -0.000000   0.000093         0.000035  -0.000021   0.000000
  25   -0.000000   0.000000  -0.000087         0.000031   0.000021   0.000000
  26    0.000000  -0.000000   0.000030         0.000007  -0.000001   0.000000
  27   -0.000000  -0.000000  -0.000030         0.000007   0.000001   0.000000
  28    0.000000  -0.000000   0.000015         0.000006  -0.000000   0.000000
  29   -0.000000  -0.000000  -0.000016         0.000006   0.000000   0.000000
  30    0.000000  -0.000000  -0.000000         0.000006   0.000000  -0.000000
  31    0.0         0.0         0.0              0.0         0.0         0.0
  32   -0.000109  -0.000438   0.000079         0.000088  -0.000022   0.000001
  33    0.000109  -0.000181  -0.000168         0.000036   0.000022   0.000001
  34   -0.000292  -0.002263   0.000026         0.000116  -0.000012  -0.000008
  35   -0.000456  -0.002261  -0.000152         0.000108  -0.000029  -0.000010
  36   -0.000034   0.005605   0.000558         0.000268   0.000002  -0.000001
  37   -0.000034   0.005617   0.000586         0.000268   0.000002  -0.000001
  38   -0.000034   0.005610   0.000570         0.000268   0.000002  -0.000001
  39   -0.000010   0.001964   0.000558         0.000268   0.000002  -0.000001
  40   -0.000010   0.001976   0.000586         0.000268   0.000002  -0.000001
  41   -0.000010   0.001969   0.000570         0.000268   0.000002  -0.000001
  42   -0.000010   0.001971   0.000575         0.000268   0.000002  -0.000001
  43   -0.000009   0.001347  -0.000187         0.000268   0.000002  -0.000001
  44   -0.000009   0.001352  -0.000176         0.000268   0.000002  -0.000001
  45   -0.000006   0.000938  -0.000176         0.000268   0.000002   0.000000
  46    0.000006  -0.000919  -0.000176         0.000268   0.000002   0.000000
  47    0.000009  -0.001333  -0.000187         0.000267   0.000002  -0.000002
  48    0.000009  -0.001321  -0.000177         0.000267   0.000002  -0.000002
```

```
 49    0.000017 -0.001919  0.000567     0.000258  0.000001 -0.000004
 50    0.000017 -0.001908  0.000569     0.000258  0.000001 -0.000004
 51    0.000017 -0.001932  0.000721     0.000048 -0.000033 -0.000004
 52    0.000017 -0.001890  0.000378     0.000048 -0.000033 -0.000004
 53   -0.000915 -0.003071  0.000581     0.000040 -0.000014 -0.000006
 54   -0.000915 -0.003094  0.000723     0.000042 -0.000033 -0.000006
 55   -0.000915 -0.003031  0.000371     0.000042 -0.000033 -0.000006
 56    0.000000  0.000000  0.000079     0.000088 -0.000022  0.000001
 57   -0.000000  0.000001 -0.000168     0.000036  0.000022  0.000001
 58    0.000001  0.000026  0.000015     0.000006 -0.000000  0.000000
 59   -0.000001 -0.000026  0.000015     0.000006 -0.000000  0.000000
 60   -0.000001  0.000026 -0.000016     0.000006  0.000000  0.000000
 61    0.000001 -0.000026 -0.000016     0.000006  0.000000  0.000000
 62    0.000000 -0.000000  0.000029     0.000006  0.000000 -0.000000
 63   -0.000000 -0.000000 -0.000029     0.000006  0.000000 -0.000000
 64   -0.000108 -0.000438  0.000012     0.000088 -0.000022  0.000001
 65   -0.000110  0.000184 -0.000140     0.000036  0.000022  0.000001
 66   -0.000285 -0.002205  0.000026     0.000116 -0.000012 -0.000008
 67   -0.000441 -0.002207 -0.000152     0.000108 -0.000029 -0.000010
 68   -0.000471 -0.002535  0.000701     0.000042 -0.000034 -0.000006
 69   -0.000549 -0.002535  0.000156     0.000042 -0.000034 -0.000006
```

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D Y N A M I C   A N A L Y S I S

RESONANT FREQUENCY   =   37.0 HERTZ  (IN X-DIRECTION OR Y-ROTATION)

                    * * * * NORMALIZED EIGENVECTOR * * * *

JOINT       . . .DEFLECTION . . .                   . . . ROTATION  . . .
 NO.        X          Y          Z               X          Y          Z

  1     0.999983  0.044365  0.138987         0.002238 -0.061543 -0.001100
  2     0.160372  0.013709  0.145119         0.002231 -0.061509 -0.001099
  3     0.160284  0.013694  0.143900         0.002113 -0.022364 -0.001099
  4     1.000000  0.040475  0.339425         0.002240 -0.067931 -0.001100
  5     0.999999  0.048040 -0.049743         0.002240 -0.067668 -0.001100
  6     0.876630  0.039764  0.145154         0.002238 -0.061554 -0.001100
  7     0.160313  0.017477 -0.035871         0.002149 -0.072700 -0.001099
  8     0.160313  0.009920  0.324835         0.002149 -0.073211 -0.001099
  9     0.999998  0.045840  0.086819         0.002241 -0.040156 -0.001100
 10     0.109292  0.008835  0.143871         0.002068 -0.021279 -0.001090
 11     0.048363 -0.000025  0.205856         0.002025 -0.020882 -0.001136
 12    -0.044829 -0.008912  0.204608         0.002025 -0.020656 -0.000741
 13     0.048295  0.004157  0.070999         0.002075 -0.020719 -0.000095
 14    -0.044942 -0.005189  0.070998         0.002075 -0.020719 -0.000091
 15    -0.099511 -0.011778  0.142468         0.002070 -0.020763 -0.000769
 16    -0.268285 -0.095575  0.142029         0.002816 -0.004512 -0.000659
 17    -0.145407 -0.016454  0.141956         0.002784 -0.004495 -0.000716
 18     0.001675 -0.000401  0.043131         0.002075 -0.020718 -0.000090
 19    -0.145470 -0.016459  0.142462         0.002096 -0.020333 -0.000719
 20    -0.209550 -0.059487  0.141827         0.002837 -0.004514 -0.000659
 21    -0.268291 -0.094632  0.123477         0.002812 -0.013172 -0.000659
 22     0.000476 -0.000405  0.043905        -0.000644 -0.005604  0.000027
 23     0.000152 -0.000420  0.028850         0.001873 -0.003688 -0.000138
 24     0.000195 -0.000032  0.002480         0.000659 -0.005188 -0.000026
 25     0.000020 -0.000016  0.000400         0.000162 -0.003382 -0.000007
 26     0.000040 -0.000024  0.001330         0.000087 -0.000613 -0.000017
 27    -0.000011 -0.000018  0.000667         0.000068 -0.000544 -0.000005
 28     0.000009 -0.000023  0.001163         0.000072 -0.000587 -0.000016
 29    -0.000005 -0.000019  0.000813         0.000071 -0.000570 -0.000004
 30     0.000014 -0.000013  0.000525         0.000066 -0.000429 -0.000005
 31     0.0       0.0       0.0              0.0       0.0       0.0
 32    -0.027268 -0.008138  0.019436         0.001562 -0.005508 -0.000075
 33    -0.017882 -0.008739  0.015588         0.001724 -0.003587 -0.000069
 34    -0.169163 -0.045374  0.018953         0.002455 -0.010583 -0.001220
 35    -0.187647 -0.045282  0.017143         0.002069 -0.010197 -0.001322
 36     0.999983  0.035567  0.631026         0.002238 -0.061543 -0.001100
 37     0.999983  0.052942 -0.340743         0.002238 -0.061543 -0.001100
 38     0.999998  0.042676  0.202268         0.002241 -0.040156 -0.001100
 39     0.160372  0.005031  0.630734         0.002231 -0.061509 -0.001099
 40     0.160372  0.022388 -0.340496         0.002231 -0.061509 -0.001099
 41     0.160284  0.012114  0.176059         0.002113 -0.022364 -0.001099
 42     0.160284  0.015273  0.111764         0.002113 -0.022364 -0.001099
 43     0.106226  0.005315  0.206765         0.002068 -0.021279 -0.001090
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 44     0.106226  0.012277  0.070698      0.002068 -0.021279 -0.001090
 45     0.073402  0.006660  0.070997      0.002075 -0.020718 -0.000090
 46    -0.070053 -0.007706  0.070997      0.002075 -0.020718 -0.000090
 47    -0.101674 -0.014263  0.203692      0.002070 -0.020763 -0.000769
 48    -0.101674 -0.009351  0.071118      0.002070 -0.020763 -0.000769
 49    -0.145470 -0.017494  0.171701      0.002096 -0.020333 -0.000719
 50    -0.145470 -0.015426  0.113243      0.002096 -0.020333 -0.000719
 51    -0.145407 -0.020213  0.165554      0.002784 -0.004495 -0.000716
 52    -0.145407 -0.012695  0.118357      0.002784 -0.004495 -0.000716
 53    -0.268291 -0.096527  0.161348      0.002812 -0.013172 -0.000659
 54    -0.268285 -0.099035  0.165719      0.002816 -0.004512 -0.000659
 55    -0.268285 -0.092116  0.118338      0.002816 -0.004512 -0.000659
 56     0.000271 -0.000331  0.019436      0.001562 -0.005508 -0.000075
 57     0.000053 -0.000119  0.015588      0.001724 -0.003587 -0.000069
 58     0.002394  0.000269  0.001163      0.000072 -0.000587 -0.000016
 59    -0.002375 -0.000315  0.001163      0.000072 -0.000587 -0.000016
 60     0.002309  0.000270  0.000813      0.000071 -0.000570 -0.000004
 61    -0.002319 -0.000306  0.000813      0.000071 -0.000570 -0.000004
 62     0.000040 -0.000013  0.000839      0.000066 -0.000429 -0.000005
 63    -0.000011 -0.000013  0.000211      0.000066 -0.000429 -0.000005
 64    -0.027325 -0.008138  0.018241      0.001562 -0.005508 -0.000075
 65     0.018041  0.008502  0.016907      0.001724 -0.003587 -0.000069
 66    -0.163872 -0.044147  0.018953      0.002455 -0.010583 -0.001220
 67    -0.182548 -0.044247  0.017143      0.002069 -0.010197 -0.001322
 68    -0.207122 -0.059487  0.152289       .002837 -0.004514 -0.000659
 69    -0.215683 -0.059487  0.115412       .002837 -0.004514 -0.000659
```

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S T A T I C   S E I S M I C   A N A L Y S I S

THE VALVE AXIS IS POSITIONED Z-UP

ACCELERATION OF GRAVITY, G = 386.400

DIRECTION OF      NO.   COMPONENTS OF UNIT ACCELERATION
  SEISMIC         OF       IN  VALVE COORDINATE SYSTEM
ACCELERATION      G'S       X-COMP.  Y-COMP.  Z-COMP.

HORIZONTAL(1)   9.500       0.0      1.0000   0.0
HORIZONTAL(2)   9.500       1.0000   0.0      0.0
VERTICAL        9.500       0.0      0.0     -1.0000
```

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REACTION RESPCNSE TO STATIC SEISMIC LOAD IN HORIZ(1) DIRECTION

ELT.      JNT.       . .ELEMENT FORCES. .              . ELEMENT  MOMENTS .
 NO.       NO.      F1          F2          F3            M1          M2          M3

    1         1         -1.          0.        672.           11.        -67.         -7.
              6          1.         -0.       -728.        -1414.         67.          5.
    2         6         -2.         -0.       1061.         1416.          2.         -5.
              2          2.          0.      -1382.       -15574.          -2        -14.
    3        38          4.          1.          3.            0.         -6.        357.
              4       -104.         -1.         -3.           -5.          6.       -249.
    4         9          5.         -1.          3.           -0.          6.        359.
              5       -105.          1.         -3.           -5.         -6.       -250.
    5         7        923.          1.          5.          -10.      -7786.       -958.
             42      -1023.         -1.         -5.            0.       7786.       2903.
    6        41      -1023.         -1.          5.            0.       7787.      -2900.
              8        923.          1.         -5.          -10.      -7787.        955.
    7        38         -0.          3.         -5.           -6.         -0.         -1.
             41          0.         -3.        -17.          -79.          0.         -1.
    8         9         -5.         -3.          0.           -1.         -0.          6.
             42        -17.          3.         -0.           -1.          0.         79.
    9         4        105.          1.          3.            5.         -6.        251.
             36       -337.         -1.         -3.          -17.          6.        734.
   10        37       -337.         -1.          3.          -17.          6.       -735.
              5        105.          1.         -3.            5.         -6.       -250.
   11        40        691.          1.          5.          -31.      -7786.       2640.
              7       -923.         -1.         -5.           10.       7786.        957.
   12         8       -923.         -1.          5.           10.       7787.       -954.
             39        691.          1.         -5.          -31.      -7787.      -2642.
   13         3         -2.         -0.       2080.        15730.          3.         26.
             10          2.          0.      -2167.       -20640.         -3.        -31.
   14        43         -0.         14.       -221.         -174.       -104.         -3.
             11          0.        -14.        243.          812.        104.          2.
   15        12         -0.         14.       -285.        -1999.       -104.          1.
             47          0.        -14.        306.         2811.        104.         -2.
   16        11         -0.         14.       -243.         -812.       -104.         -2.
             12          0.        -14.        285.         1999.        104.         -1.
   17        46         15.       -450.      -2350.        19810.       4480.       -204.
             48        -14.        450.       2301.       -16234.      -4480.        227.
   18        14         -4.         -0.        121.           96.        -58.          3.
             46          5.          0.       -160.         -267.         58.         -8.
   19        45         12.          0.       -356.          283.        304.         10.
             13        -11.         -0.        317.          125.       -304.          3.
   20        44        -66.        -14.       1945.        20457.      -5327.        607.
             45         68.         14.      -1994.       -23487.       5327.       -711.
   21        13          1.          0.        -23.         -125.        -58.         -4.
             14          4.          0.       -121.          -97.         58.         -3.
   22        15        -61.       -436.      -1994.        17803.      -3700.        704.
             19         61.        436.       1908.       -13412.       3700.       -841.
   23        49       -787.         32.        -47.            0.      -6433.        -34.
             51        678.        -32.         47.          180.       6433.      -2757.
   24        52        949.        -32.       -403.         1536.       6431.        483.
             50      -1058.         32.        403.            0.      -6431.       3344.
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25     50        1.      -94.      -32.        274.       -1.       20.
       21       -1.       94.      -13.        -13.        1.       17.
26     49        1.       14.      -32.        274.       -1.       20.
       53       -1.      -14.      -13.        -13.        1.       17.
27     17      -64.     -356.    -1627.      12864.    -3698.      647.
       20       64.      356.     1314.       9742.     3698.    -1626.
28     20       -3.       80.    -1834.       5151.        1.     -154.
       16        3.      -80.     1578.      16280.       -1.      121.
29     53       13.       -1.       -2.          0.      -13.       80.
       54     -100.        1.        2.          8.       13.      134.
30     55     -101.        1.      -82.        313.       13.     -136.
       21       13.       -1.       82.          0.      -13.      -81.
31     22     2357.    -2578.      235.      -2451.     -848.     8966.
       18    -2357.     2339.     -235.        741.      848.     8160.
32     18     2416.     2523.     -201.       2405.      757.     8549.
       23    -2416.    -2762.      201.       -945.     -757.     9005.
33     22    -2625.    -2357.     -235.       -848.     2712.    -8966.
       56     2739.     2357.      235.       1687.    -2712.     -589.
34     56    -3537.    -2838.    -1514.       5563.    -6604.     1915.
       24     3647.     2838.     1514.       -360.     6604.   -14262.
35     23     2762.     2416.      201.        757.      945.     9006.
       57    -2876.    -2416.     -201.      -1473.     -945.     1036.
36     57     3455.     2836.    -1513.       5610.    -4184.    -1839.
       25    -3565.    -2836.     1513.       -410.     4184.    13903.
37     24    -2838.     3647.    -1514.      -6604.     -360.    14262.
       26     2836.    -3785.     1514.      10411.      360.   -21400.
38     26      567.     -188.       62.       -334.       12.     2698.
       28     -567.       71.      -62.        202.      -12.    -1494.
39     29      567.       79.       62.        125.       12.    -1481.
       27     -567.     -196.      -62.       -258.      -12.     2685.
40     27    -2836.    -3703.    -1513.       7989.     -410.   -21036.
       25     2836.     3565.     1513.      -4184.      410.    13903.
41     58      282.      -40.       31.        -82.        1.      743.
       60     -282.      -35.      -31.        -61.       -1.      737.
42     59      285.      -31.       31.        -82.        1.      750.
       61     -285.      -44.      -31.        -61.       -1.      744.
43     26     3973.    -3404.     1575.       -372.   -10076.   -18702.
       62    -3973.     3404.    -1575.      -1105.    10076.    22429.
44     27     3899.     3403.    -1575.        422.    -7731.   -18350.
       63    -3899.    -3403.     1575.       1055.     7731.    22008.
45     30     7872.       -2.        1.         51.   -32775.   -76771.
       31    -8173.        2.       -1.        -52.    32775.    93314.
46     64     -617.    -1278.     -481.       4847.     1693.    -5940.
       66      469.     1278.      481.       2303.    -1693.    -2134.
47     65     -579.     1714.      420.      -6236.     1123.    -9331.
       67      331.    -1714.     -420.      -4203.    -1123.    -1976.
48     66     -539.     -152.      318.      -2096.      -76.    -3846.
       67      539.       22.     -318.      -2043.       76.    -3162.
49     34      650.    -1240.      317.       2126.     -389.     2737.
       68     -650.     1240.     -242.      -4466.      389.     2707.
50     35    -1086.     1299.      353.       1993.     -443.    -4607.
       69     1066.    -1299.     -278.      -4631.      443.    -4487.
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TYPE     JNT.      . . . . . BOUNDARY OR JUNCTION REACTION . . . . .
          NO.      FX        FY        FZ         MX        MY       MZ

BODY      31        2.    -8173.        1.      32775.      -52.  -93314.
Δ    -X-Z 30       -2.     7872.       -1.     -32775.       51.   76771.
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REACTION RESPONSE TO STATIC SEISMIC LOAD IN HORIZ(2) DIRECTION

 ELT.     JNT.      . .ELEMENT FORCES. .             . ELEMENT  MOMENTS .
 NO.      NO.       F1        F2        F3           M1        M2        M3

  1        1        511.      -26.        1.         -1.       -1.     4769.
           6       -566.       29.       -1.         -2.        1.    -3686.
  2        6        901.       -1.        1.         -0.       -1.     3669.
           2      -1222.        1.       -1.         -6.        1.     6638.
  3       38         -0.       95.    -1650.          0.        0.        1.
           4          0.       10.     1650.       3300.       -0.       -1.
  4        9         -0.      -95.    -1650.          0.       -0.       -0.
           5          0.      -10.     1650.       3301.        0.        0.
  5        7          0.     -843.    -3003.       6005.       -3.        1.
          42         -0.      943.     3003.          0.        3.       -0.
  6       41         -0.      946.    -3003.          0.        3.       -1.
           8          0.     -846.     3003.       6006.       -3.        1.
  7       38         94.    -2082.        0.         -0.       -0.      621.
          41       -116.     2082.       -0.         -0.        0.      809.
  8        9          0.     2082.      -94.        621.       -0.        0.
          42         -0.    -2082.      116.        809.        0.        0.
  9        4         -0.      -28.    -1650.      -3299.        0.        1.
          35          0.      260.     1650.      10653.        0.       -0.
 10       37          0.      261.    -1651.      10658.        0.       -0.
           5         -0.      -29.     1651.      -3299.        0.        1.
 11       40          0.     -611.    -3002.      19388.       -3.        1.
           7         -0.      843.     3002.      -6004.        3.        0.
 12        8         -0.      843.    -3004.      -6006.        3.       -1.
          39          0.     -610.     3004.      19392.       -3.       -0.
 13        3       2119.       -0.        1.          6.       -2.   -16236.
          10      -2207.        0.       -1.         -9.        2.    21238.
 14       43         47.    -1971.      343.      -1716.      136.      122.
          11        -25.     1971.     -343.        772.     -136.      -23.
 15       12        -17.    -1971.      343.        773.      136.        4.
          47         36.     1971.     -343.      -1716.     -136.      -79.
 16       11         25.    -1971.      343.       -772.      136.       23.
          12         17.     1971.     -343.       -772.     -136.       -4.
 17       46      -1094.      677.      328.       3414.    -3356.    -4189.
          48       1045.     -677.     -329.      -3919.     3356.     2543.
 18       14        114.        1.        4.          4.       78.      -79.
          46       -153.       -1.       -5.        -10.      -78.      241.
 19       45       -364.       -1.      -12.          9.     -364.     -310.
          13        325.        1.       10.          5.      364.     -107.
 20       44       2241.     1972.      418.      -1427.     3874.    -8584.
          45      -2290.    -1972.     -420.        783.    -3874.    12068.
 21       13        -31.        0.       -1.         -4.       77.      108.
          14       -114.        0.       -4.         -3.      -77.       79.
 22       15       -995.    -1292.       20.      -1523.     1834.   -11250.
          19        910.     1292.      -20.       1478.    -1834.     9106.
 23       49        -58.      418.     2957.         -0.      720.     -803.
          51         58.     -309.    -2957.     -11272.     -720.      581.
 24       52        -76.     -309.     1902.      -7254.     -720.      546.
          50         76.      418.    -1902.         -0.      720.     -837.
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25     50      -37.      393.        1.       -19.        0.     -326.
       21       -8.     -393.       -1.        -9.       -0.      -84.
26     49      -37.     -629.        1.       -18.        0.     -326.
       53       -8.      629.       -1.        -9.       -0.      -84.
27     17     -617.    -1055.       18.     -1441.     1833.    -6985.
       20      304.     1055.      -18.      1163.    -1833.      -97.
28     20    -1622.      237.       -2.         7.       -1.    -3726.
       16     1566.     -237.        2.        18.        1.   -17555.
29     53        1.       -7.      571.        -0.       -9.        2.
       54       -1.       94.     -571.     -2175.        9.        2.
30     55       -1.       95.      334.     -1273.        9.       -2.
       21        1.       -8.     -334.        -0.       -9.       -2.
31     22    -2665.      190.      771.      -547.     6168.    -1070.
       18     2426.     -190.     -771.     -5051.    -6168.   -17420.
32     18     1477.      171.     -530.      3044.    -4731.     9724.
       23    -1716.     -171.      530.       806.     4731.     1874.
33     22      190.     2712.     -770.      6430.      547.     1070.
       56     -190.    -2826.      770.     -3685.     -547.     -393.
34     56      170.     4473.       34.    -24421.     -258.     1333.
       24     -170.    -4583.      -34.     24302.      258.     -748.
35     23      171.     1716.      530.     -4731.     -806.     1874.
       57     -171.    -1830.     -530.      2842.      806.    -1264.
36     57      171.     2558.       44.      7570.     -312.     1992.
       25     -171.    -2668.      -44.     -7721.      312.    -1403.
37     24     4583.     -170.       34.      -258.    24302.      748.
       26    -4721.      170.      -34.       172.   -24302.    10952.
38     26     -258.     -125.       -4.        20.      282.     -911.
       28      142.      125.        4.       -11.     -282.      486.
39     29        9.     -125.       -4.       -10.      282.     -137.
       27     -125.      125.        4.        19.     -282.      280.
40     27    -2668.     -171.       44.       201.    -7721.    -5480.
       25     2668.      171.      -44.      -312.     7721.    -1403.
41     58     -102.      -62.       -2.         5.       13.     -325.
       60       27.       62.        2.         5.      -13.      -14.
42     59      -39.      -62.       -2.         5.       13.     -161.
       61      -36.       62.        2.         5.      -13.      151.
43     26      -46.     4979.      -39.     24020.     -192.    10042.
       62       46.    -4979.       39.    -23984.      192.   -10084.
44     27       47.     2931.       48.      8003.     -221.    -5200.
       63      -47.    -2931.      -48.     -8048.      221.     5244.
45     30        1.     7910.        9.     32032.       -0.    14569.
       31       -1.    -8211.       -9.    -32051.        0.   -14567.
46     64      -20.      805.     1467.    -19509.     -320.      -88.
       66       20.     -805.    -1318.     -1204.      320.     -211.
47     65        0.      486.      728.    -14050.     -171.      122.
       67       -0.     -486.     -480.      -967.      171.     -122.
48     66      -68.      -28.        8.       -52.       80.      -72.
       67      -61.       28.       -8.       -51.      -80.       28.
49     34     -447.     1423.       -8.       419.       44.    -1750.
       68      467.    -1350.        8.      -352.      -44.    -2080.
50     35     -348.      531.       26.       161.       43.    -1256.
       69      368.     -459.      -28.      -396.      -43.    -1743.
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TYPE     JNT.      . . . . . BOUNDARY OR JUNCTION REACTION . . . . .
          NO.      FX         FY         FZ          MX        MY        MZ

BODY      31     -8211.      -1.         9.          0.   -32051.    14567.
A    -X-Z 30      7910.       1.        -9.         -0.    32032.   -14569.
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REACTION RESPONSE TO STATIC SEISMIC LOAD IN VERTICAL DIRECTION

ELT.     JNT.       . .ELEMENT FORCES. .              . ELEMENT  MOMENTS .
 NO.      NO.       F1        F2         F3              M1         M2          M3

  1        1      -19.     -109.         1.             -1.         1.        -81.
           6       16.       54.        -1.             -1.        -1.         45.
  2        6      -15.      276.         1.             -1.         1.        -46.
           2       15.     -597.        -1.            -10.        -1.       -130.
  3       38        0.       -1.       412.             -1.         0.          0.
           4       -0.        1.      -311.           -722.        -0.         -0.
  4        9       -0.        2.      -363.              1.        -0.         -0.
           5        0.       -2.       263.            625.         0.         -1.
  5        7        1.        8.      -487.           1075.        -6.         -1.
          42       -1.       -8.       568.              0.         6.          2.
  6       41       -1.      -10.       677.             -1.         6.         -2.
           8        1.       10.      -577.          -1253.        -6.          0.
  7       38       -2.      417.         0.             -0.         0.        -10.
          41        2.     -439.        -0.             -0.        -0.        -12.
  8        9        0.      356.         2.            -10.         0.          0.
          42       -0.     -377.        -2.            -12.        -0.          0.
  9        4       -0.        7.       311.            719.        -0.         -0.
          36        0.       -7.       -79.          -1566.         0.         -0.
 10       37       -0.       -8.       -30.           1273.         0.         -0.
           5        0.        8.       262.           -622.        -0.         -0.
 11       40        1.        7.      -254.           2724.        -5.          1.
           7       -1.       -7.       486.          -1074.         5.          1.
 12        8       -0.       -7.       576.           1251.         6.          0.
          39        0.        7.      -343.          -3299.        -6.         -2.
 13        3      -19.     2079.         2.             11.         1.        241.
          10       19.    -2167.        -2.            -15.        -1.       -286.
 14       43       -7.      383.       138.           -521.        55.        -40.
          11        7.     -404.      -138.            141.       -55.         21.
 15       12       -7.      447.       138.            482.        55.         10.
          47        7.     -468.      -138.           -862.       -55.        -28.
 16       11       -7.      405.       138.           -141.        55.        -21.
          12        7.     -447.      -138.           -482.       -55.        -10.
 17       46      604.    -1523.       485.            954.       636.      -1239.
          48     -604.     1474.      -485.          -1701.      -636.       2167.
 18       14       16.      123.         5.            -67.       -11.         25.
          46      -16.     -162.        -5.             61.        11.         -6.
 19       45       16.     -354.         5.            357.       -11.       -232.
          13      -16.      316.        -5.           -363.        11.        251.
 20       44      -30.     1782.       139.          -6729.      -997.       4373.
          45       30.    -1831.      -139.           6514.       997.      -4419.
 21       13       16.      -20.         5.            -90.       -11.         96.
          14      -16.     -124.        -5.             69.        11.        -26.
 22       15      626.     -998.       327.          -2056.       847.       3899.
          19     -626.      912.      -327.           1320.      -847.      -2491.
 23       49      132.     -309.      -357.             -0.       644.        -69.
          51     -132.      309.       466.           1569.      -644.        570.
 24       52     -194.      309.      -887.           3589.      -644.        -50.
          50      194.     -309.       996.              0.       644.       -689.
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  25      50       4.    -285.       1.      -17.       0.      59.
          21      -4.     240.      -1.       -9.      -0.      50.
  26      49       4.      13.       1.      -16.       0.      59.
          53      -4.     -57.      -1.       -9.      -0.      50.
  27      17     617.    -420.     325.    -1288.     847.    1945.
          20    -617.     107.    -325.    -3712.    -847.    7544.
  28      20      -5.   -1626.      -2.        4.      -0.    -398.
          16       5.    1370.       2.       18.       0.     329.
  29      53       1.      -4.     -23.       -0.      -9.       2.
          54      -1.       4.     111.      255.       9.       2.
  30      55      -1.       3.    -118.      618.       9.      -2.
          21       1.      -3.     206.       -0.      -9.      -2.
  31      22     385.     313.    2616.    -1609.   -4260.     -37.
          18    -385.    -313.   -2377.   -16527.    4260.    2834.
  32      18    -260.     -12.   -1522.    10893.    5205.   -1038.
          23     260.      12.    1761.     1033.   -5205.    -249.
  33      22     313.    -385.   -2663.    -4259.    1609.      37.
          56    -313.     385.    2778.    13951.   -1609.    1078.
  34      56    -212.       8.   -4181.   -25901.   -6958.    -173.
          24     212.      -8.    4291.    40460.    6958.    -557.
  35      23     -12.    -259.    1761.     5205.   -1034.    -249.
          57      12.     259.   -1875.   -11682.    1034.     206.
  36      57    -211.     -30.    2848.    19551.    2173.    -529.
          25     211.      30.   -2958.   -29531.   -2173.    -196.
  37      24       8.     212.   -4291.    -6958.   40461.     557.
          26      -8.    -212.    4429.    17922.  -40461.    -536.
  38      26       3.      12.     215.     -715.     197.      31.
          28      -3.     -12.     -99.      381.    -197.     -24.
  39      29       3.      12.     -51.     -256.     197.       7.
          27      -3.     -12.     168.      489.    -197.       0.
  40      27      30.     211.    3096.    -9788.  -29531.     271.
          25     -30.    -211.   -2959.     2174.   29531.    -196.
  41      58     -20.     -25.      50.      -66.       9.     -45.
          60      20.      25.      26.        4.      -9.     -61.
  42      59      24.      37.      50.      -66.       9.      70.
          61     -24.     -37.      26.        4.      -9.      54.
  43      26     200.       5.    4642.    40264.  -17207.    -504.
          62    -200.      -5.   -4642.   -44618.   17207.     692.
  44      27    -199.     -27.    3264.    29728.    9299.     271.
          63     199.      27.   -3264.   -32790.   -9299.    -457.
  45      30       2.     -22.    7907.    77408.  -14462.     -85.
          31      -2.      22.   -8208.   -94023.   14462.      88.
  46      64    -525.   -1222.     394.    -9979.     604.   -7012.
          66     525.    1074.    -394.     4118.    -604.    -802.
  47      65     198.    -972.     230.    -9013.     498.    4944.
          67    -198.     725.    -230.     3297.    -498.      -8.
  48      66    -102.    -431.     132.     -634.      -7.   -1105.
          67     102.     431.      -3.     -242.       7.    -215.
  49      34     985.      28.      95.      540.      73.    3965.
          68    -913.     -49.     -95.    -1333.     -73.    3981.
  50      35     789.     123.     232.     -304.     -37.    3138.
          69    -717.    -144.    -232.    -1639.      37.    3167.
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TYPE     JNT.       . . . . . BOUNDARY OR JUNCTION REACTION . . . . .
          NO.      FX         FY         FZ          MX         MY         MZ

BODY      31         22.        -2.     8208.      14462.   -94023.       -88.
A    -X-Z 30        -22.         2.    -7907.     -14462.    77408.        85.
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REACTION RESPONSE TO OPERATIONAL LOADS (INCLUDING DEADWEIGHT)

ELT.     JNT.      . .ELEMENT FORCES. .            . ELEMENT  MOMENTS .
 NO.      NO.      F1          F2          F3          M1          M2          M3

   1       1       -2.        -11.         -1.         -1.         -1.         -9.
           6        2.          6.          1.          3.          1.          5.
   2       6       -2.         29.         -1.          1.         -1.         -5.
           2        2.        -63.          1.          9.          1.        -14.
   3      38        0.         -0.         43.         -0.         -0.         -0.
           4       -0.          0.        -33.        -76.          0.          0.
   4       9        1.          0.        -38.          0.          0.          1.
           5       -1.         -0.         28.         66.         -0.          0.
   5       7       -1.          1.        -51.        113.          5.          1.
          42        1.         -1.         62.          0.         -5.         -2.
   6      41        1.         -1.         71.         -0.         -5.          1.
           8       -1.          1.        -61.       -132.          5.         -0.
   7      38       -0.         44.         -0.          0.         -0.         -1.
          41        0.        -46.          0.          0.          0.         -1.
   8       9       -0.         37.          0.         -1.         -0.         -0.
          42        0.        -40.         -0.         -1.          0.         -0.
   9       4        0.          1.         33.         76.         -0.          0.
          36       -0.         -1.         -8.       -167.          0.         -0.
  10      37        0.         -1.         -3.        134.          0.          0.
           5       -0.          1.         28.        -66.         -0.          0.
  11      40       -0.          1.        -27.        287.          5.         -1.
           7        0.         -1.         51.       -113.         -5.         -1.
  12       8        0.         -1.         61.        132.         -5.          0.
          39       -0.          1.        -36.       -348.          5.          2.
  13       3       -2.        219.         -2.        -11.         -1.         26.
          10        2.       -228.          2.         14.          1.        -30.
  14      43       -1.         45.          1.        -78.          1.         -4.
          11        1.        -48.         -1.         75.         -1.          2.
  15      12       -1.         52.          1.        -70.          1.          1.
          47        1.        -55.         -1.         67.         -1.         -2.
  16      11       -1.         48.          1.        -75.          1.         -2.
          12        1.        -52.         -1.         70.         -1.         -1.
  17      46       70.       -222.       -105.       2798.        318.        -27.
          48      -70.        217.        105.      -2637.       -318.        134.
  18      14        2.         13.          1.         -9.         -2.          3.
          46       -2.        -17.         -1.          6.          2.         -1.
  19      45        2.        -37.          1.         39.         -1.        -24.
          13       -2.         33.         -1.        -40.          1.         26.
  20      44       -3.        183.         -1.       -749.         -9.        429.
          45        3.       -188.          1.        750.          9.       -433.
  21      13        2.         -2.          1.        -10.         -1.         10.
          14       -2.        -13.         -1.          7.          1.         -3.
  22      15       67.       -161.       -108.       2240.       -203.        636.
          19      -67.        152.        108.      -1996.        203.       -486.
  23      49      -45.        -33.        -75.          0.       -973.        -10.
          51       45.         33.         86.        306.        973.       -163.
  24      52       60.         33.       -176.        694.        973.         38.
          50      -60.        -33.        188.          0.       -973.        192.
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   25       50         1.     -49.      -1.        25.      -0.      12.
            21        -1.      44.       1.        12.       0.      10.
   26       49         1.      10.      -1.        25.      -0.      12.
            53        -1.     -15.       1.        12.       0.      10.
   27       17        65.     -90.    -106.      1946.    -203.     377.
            20       -65.      57.     106.      -319.     203.     625.
   28       20        -1.    -161.       3.        -8.       0.     -83.
            16         1.     134.      -3.       -25.      -0.      66.
   29       53        -1.      -1.      -8.        -0.      12.      -2.
            54         1.       1.      17.        49.     -12.      -3.
   30       55         1.       1.     -29.       126.     -12.       2.
            21        -1.      -1.      38.        -0.      12.       3.
   31       22        85.     -44.    -119.      -281.    -637.     145.
            18       -85.      44.     144.      1237.     637.     470.
   32       18        16.      63.    -611.      4624.     386.       2.
            23       -16.     -63.     636.       -93.    -386.     113.
   33       22       -44.     -85.     114.      -637.     280.    -145.
            56        44.      85.    -102.       252.    -280.     -11.
   34       56       -16.      13.      65.     -2448.     646.      69.
            24        16.     -13.     -53.      2244.    -646.    -123.
   35       23        63.      16.     636.       386.      93.     113.
            57       -63.     -16.    -648.     -2674.     -93.     112.
   36       57       -17.     -15.     805.      2344.    1293.    -130.
            25        17.      15.    -817.     -5131.   -1293.      71.
   37       24        13.      16.      53.       646.    2245.     123.
            26       -13.     -16.     -39.      -762.   -2245.     -90.
   38       26         2.       1.       7.         3.     -56.       8.
            28        -2.      -1.       5.        -5.      56.      -5.
   39       29         2.       1.     -21.       -62.     -56.      -3.
            27        -2.      -1.      33.       119.      56.       6.
   40       27        15.      17.     831.     -3365.   -5131.     -32.
            25       -15.     -17.    -817.      1293.    5131.      71.
   41       58         7.      -2.      -2.        13.      -3.      19.
            60        -7.       2.      10.        21.       3.      18.
   42       59        -6.       3.      -2.        13.      -3.     -14.
            61         6.      -3.      10.        21.       3.     -15.
   43       26        15.      12.     -31.      2301.     759.     -82.
            62       -15.     -12.      31.     -2272.    -759.      95.
   44       27       -16.     -14.     864.      5075.    3246.     -26.
            63        16.      14.    -864.     -5865.   -3246.      11.
   45       30        -2.      -2.     833.      8157.    8260.      14.
            31         2.       2.    -864.     -9906.   -8260.     -18.
   46       64        28.     -18.      98.     -1706.     -16.     195.
            66       -28.       2.     -98.       254.      16.     224.
   47       65        80.    -157.     -31.       486.      -6.    1721.
            67       -80.     131.      31.       286.       6.     275.
   48       66        20.     -29.     -23.       174.       9.     117.
            67       -20.      29.      36.       208.      -9.     143.
   49       34        56.     107.     -57.      -118.     -49.     204.
            68       -48.    -109.      57.       595.      49.     230.
   50       35        77.     -75.     -52.      -157.     -53.     303.
            69       -70.      72.      52.       589.      53.     312.
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TYPE      JNT.      . . . . . BOUNDARY OR JUNCTION REACTION . . . . .
          NO.     FX         FY         FZ          MX        MY          MZ

BODY      31         2.         2.       864.      -8260.    -9906.        18.
A   -X-Z  30        -2.        -2.      -833.       8260.     8157.       -14.
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DEFORMATION RESPONSE TO STATIC SEISMIC LOAD IN HORIZ(1) DIRECTION

JOINT        . . .DEFLECTION . . .               . . . ROTATION  . . .
 NO.         X           Y          Z            X          Y          Z

   1   -0.002411   0.007741 -0.000392      0.000387   0.000109   0.000061
   2   -0.000930   0.002274 -0.000403      0.000377   0.000109   0.000061
   3   -0.000930   0.002243 -0.000403      0.000200   0.000105   0.000061
   4   -0.002411   0.007962 -0.000776      0.000387   0.000110   0.000061
   5   -0.002411   0.007543 -0.000030      0.000387   0.000110   0.000061
   6   -0.002193   0.006950 -0.000403      0.000387   0.000109   0.000061
   7   -0.000930   0.002045 -0.000032      0.000254   0.000110   0.000061
   8   -0.000930   0.002463 -0.000774      0.000254   0.000110   0.000061
   9   -0.002411   0.007666 -0.000250      0.000387   0.000107   0.000061
  10   -0.000687   0.001803 -0.000403      0.000131   0.000105   0.000061
  11   -0.000229   0.001627 -0.001111      0.000129   0.000104   0.000033
  12    0.000237   0.001037 -0.001110      0.000122   0.000104  -0.000010
  13   -0.000229   0.001285 -0.000441      0.000120   0.000103   0.000038
  14    0.000235   0.000734 -0.000441      0.000120   0.000103   0.000042
  15    0.000450   0.000585 -0.000463      0.000110   0.000104   0.000026
  16   -0.000078   0.036598 -0.000628     -0.001229  -0.000030  -0.000026
  17    0.000663   0.000466 -0.000608     -0.001249  -0.000024   0.000001
  18    0.000003   0.000928 -0.000302      0.000120   0.000103   0.000046
  19    0.000683   0.000453 -0.000466      0.000053   0.000101   0.000002
  20    0.000297   0.020409 -0.000632     -0.001256  -0.000030  -0.000026
  21   -0.000078   0.036637 -0.000465     -0.001227   0.000044  -0.000026
  22   -0.000175   0.000880 -0.000303     -0.000176  -0.000005   0.000047
  23    0.000175   0.000876  0.000134     -0.000191   0.000007   0.000047
  24   -0.000125   0.000077 -0.000339     -0.000143  -0.000003   0.000024
  25    0.000125   0.000077  0.000294     -0.000108   0.000004   0.000023
  26   -0.000039   0.000062 -0.000098     -0.000025   0.000000   0.000016
  27    0.000039   0.000062  0.000098     -0.000024  -0.000000   0.000016
  28   -0.000011   0.000063 -0.000050     -0.000021   0.000000   0.000016
  29    0.000011   0.000063  0.000051     -0.000021   0.000000   0.000015
  30   -0.000000   0.000050 -0.000000     -0.000021   0.000000   0.000008
  31    0.0        0.0        0.0           0.0        0.0        0.0
  32   -0.000180   0.003817  0.000684     -0.000667  -0.000006   0.000075
  33    0.000182   0.001840 -0.000003     -0.000274   0.000006   0.000074
  34   -0.001257   0.016954  0.001026     -0.000826  -0.000057   0.000265
  35    0.002985   0.016931  0.000167     -0.000761   0.000075   0.000284
  36   -0.002411   0.008228 -0.001263      0.000387   0.000109   0.000061
  37   -0.002411   0.007267  0.000457      0.000387   0.000109   0.000061
  38   -0.002411   0.007841 -0.00055.      0.000387   0.000107   0.000061
  39   -0.000930   0.002755 -0.001263      0.000377   0.000109   0.000061
  40   -0.000930   0.001794  0.000457      0.000377   0.000109   0.000061
  41   -0.000930   0.002331 -0.000554      0.000200   0.000105   0.000061
  42   -0.000930   0.002156 -0.000252      0.000200   0.000105   0.000061
  43   -0.000516   0.002000 -0.001111      0.000131   0.000105   0.000061
  44   -0.000516   0.001611 -0.000441      0.000131   0.000105   0.000061
  45   -0.000355   0.001405 -0.000441      0.000120   0.000103   0.000046
  46    0.000360   0.000576 -0.000441      0.000120   0.000103   0.000046
  47    0.000523   0.000669 -0.001109      0.000110   0.000104   0.000026
  48    0.000523   0.000503 -0.000444      0.000110   0.000104   0.000026
```

```
 49     0.000683  0.000456 -0.000612      0.000053  0.000101  0.000002
 50     0.000683  0.000449 -0.000320      0.000053  0.000101  0.000002
 51     0.000683  0.000490 -0.000483     -0.001249 -0.000024  0.000001
 52     0.000683  0.000481 -0.000733     -0.001249 -0.000024  0.000001
 53    -0.000078  0.036563 -0.000590     -0.001227  0.000044 -0.000026
 54    -0.000078  0.036462 -0.000472     -0.001229 -0.000030 -0.000026
 55    -0.000078  0.036733 -0.000783     -0.001229 -0.000030 -0.000026
 56    -0.000152  0.000480  0.000684     -0.000667 -0.000006  0.000075
 57     0.000152  0.000471 -0.000003     -0.000274  0.000006  0.000074
 58    -0.000011 -0.000024 -0.000050     -0.000021  0.000000  0.000016
 59    -0.000011  0.000150 -0.000050     -0.000021  0.000000  0.000016
 60     0.000011 -0.000024  0.000051     -0.000021  0.000000  0.000015
 61     0.000011  0.000150  0.000051     -0.000021  0.000000  0.000015
 62    -0.000039  0.000050 -0.000098     -0.000021  0.000000  0.000008
 63     0.000039  0.000050  0.000098     -0.000021  0.000000  0.000008
 64    -0.000122  0.003817  0.001195     -0.000667 -0.000006  0.000075
 65     0.000064 -0.000898 -0.000212     -0.000274  0.000006  0.000074
 66    -0.001228  0.016541  0.001026     -0.000826 -0.000057  0.000265
 67     0.002947  0.016551  0.000167     -0.000761  0.000075  0.000284
 68     0.000392  0.020409 -0.005263     -0.001256 -0.000030 -0.000026
 69     0.000057  0.020409  0.011061     -0.001256 -0.000030 -0.000026
```

```
DEFORMATION RESPONSE TO STATIC SEISMIC LOAD IN HORIZ(2) DIRECTION

JOINT        . . .DEFLECTION . . .                  . . . ROTATION  . . .
 NO.        X           Y           Z              X           Y           Z

   1     0.045925 -0.003214 -0.002120       -0.000147 -0.003024 -0.000113
   2     0.004593 -0.001233 -0.001817       -0.000147 -0.003022 -0.000113
   3     0.004584 -0.001233 -0.001815       -0.000147 -0.000603 -0.000113
   4     0.045927 -0.003612  0.007522       -0.000147 -0.003412 -0.000113
   5     0.045927 -0.002838 -0.011153       -0.000147 -0.003412 -0.000113
   6     0.039860 -0.002932 -0.001817       -0.000147 -0.003024 -0.000113
   7     0.004587 -0.000846 -0.010280       -0.000147 -0.003729 -0.000113
   8     0.004587 -0.001620  0.006650       -0.000147 -0.003729 -0.000113
   9     0.045926 -0.003063 -0.004251       -0.000147 -0.001694 -0.000113
  10     0.003213 -0.000894 -0.001815       -0.000147 -0.000532 -0.000113
  11     0.001493 -0.000805  0.000241       -0.000153 -0.000504 -0.000117
  12    -0.000773 -0.000085  0.000139       -0.000153 -0.000506 -0.000061
  13     0.001443 -0.000368 -0.003073       -0.000145 -0.000501 -0.000018
  14    -0.000615  0.000273 -0.003073       -0.000145 -0.000501 -0.000013
  15    -0.001976  0.000580 -0.001933       -0.000147 -0.000491 -0.000066
  16     0.023034  0.000615 -0.002419        0.000012  0.000883 -0.000040
  17    -0.003009  0.000902 -0.002361        0.000005  0.000899 -0.000053
  18     0.000309 -0.000041 -0.003747       -0.000145 -0.000501 -0.000012
  19    -0.003014  0.000903 -0.001941       -0.000141 -0.000453 -0.000054
  20     0.011154  0.000766 -0.002432        0.000012  0.000916 -0.000040
  21     0.023034  0.000673 -0.001984        0.000013  0.000097 -0.000040
  22     0.000163 -0.000037 -0.002607        0.000273  0.000284  0.000004
  23     0.000084 -0.000044 -0.001474       -0.000353  0.000101 -0.000020
  24     0.000093 -0.000005 -0.000043       -0.000003  0.000270 -0.000007
  25     0.000041 -0.000001 -0.000033       -0.000004  0.000098  0.000001
  26     0.000017 -0.000005 -0.000040       -0.000000  0.000027 -0.000005
  27     0.000004 -0.000002 -0.000037       -0.000000  0.000021  0.000001
  28     0.000008 -0.000004 -0.000039       -0.000000  0.000025 -0.000005
  29     0.000003 -0.000002 -0.000037       -0.000000  0.000023  0.000001
  30     0.000010 -0.000001 -0.000019       -0.000000  0.000018 -0.000001
  31     0.0        0.0        0.0             0.0        0.0        0.0
  32     0.001573  0.000228 -0.000901       -0.000052  0.000287 -0.000001
  33     0.000584  0.000313 -0.000502       -0.000063  0.000104 -0.000009
  34     0.010726  0.001039 -0.000755       -0.000046  0.000650 -0.000036
  35     0.010154  0.001042 -0.000443       -0.000044  0.000511 -0.000041
  36     0.045925 -0.004114  0.022054       -0.000147 -0.003024 -0.000113
  37     0.045925 -0.002336 -0.025689       -0.000147 -0.003024 -0.000113
  38     0.045926 -0.003387  0.000620       -0.000147 -0.001694 -0.000113
  39     0.004593 -0.002122  0.022041       -0.000147 -0.003022 -0.000113
  40     0.004593 -0.000344 -0.025675       -0.000147 -0.003022 -0.000113
  41     0.004584 -0.001395 -0.000948       -0.000147 -0.000603 -0.000113
  42     0.004584 -0.001071 -0.002682       -0.000147 -0.000603 -0.000113
  43     0.002897 -0.001258  0.000316       -0.000147 -0.000532 -0.000113
  44     0.002897 -0.000539 -0.003083       -0.000147 -0.000532 -0.000113
  45     0.002044 -0.000559 -0.003073       -0.000145 -0.000501 -0.000012
  46    -0.001425  0.000445 -0.003073       -0.000145 -0.000501 -0.000012
  47    -0.002160  0.000368  0.000064       -0.000147 -0.000491 -0.000066
  48    -0.002160  0.000786 -0.003069       -0.000147 -0.000491 -0.000066
```

```
 49   -0.003014  0.000825 -0.001289    -0.000141 -0.000453 -0.000054
 50   -0.003014  0.000980 -0.002592    -0.000141 -0.000453 -0.000054
 51   -0.003009  0.000624 -0.007081     0.000005  0.000899 -0.000053
 52   -0.003009  0.001181  0.002358     0.000005  0.000899 -0.000053
 53    0.023034  0.000558 -0.002264     0.000013  0.000097 -0.000040
 54    0.023034  0.000406 -0.007055     0.000012  0.000883 -0.000040
 55    0.023034  0.000825  0.002217     0.000012  0.000883 -0.000040
 56    0.000136 -0.000030 -0.000901    -0.000052  0.000287 -0.000001
 57    0.000066 -0.000004 -0.000502    -0.000063  0.000104 -0.000009
 58   -0.000094 -0.000005 -0.000039    -0.000000  0.000025 -0.000005
 59    0.000110 -0.000003 -0.000039    -0.000000  0.000025 -0.000005
 60   -0.000092 -0.000003 -0.000037    -0.000000  0.000023  0.000001
 61    0.000099 -0.000001 -0.000037    -0.000000  0.000023  0.000001
 62    0.000017 -0.000001 -0.000019    -0.000000  0.000018 -0.000001
 63    0.000003 -0.000001 -0.000019    -0.000000  0.000018 -0.000001
 64    0.001572  0.000228 -0.000861    -0.000052  0.000287 -0.000001
 65   -0.000445 -0.000320 -0.000551    -0.000063  0.000104 -0.000009
 66    0.010401  0.001016 -0.000755    -0.000046  0.000650 -0.000036
 67    0.009899  0.001020 -0.000443    -0.000044  0.000511 -0.000041
 68    0.011301  0.000766 -0.002388     0.000012  0.000916 -0.000040
 69    0.010783  0.000766 -0.002544     0.000012  0.000916 -0.000040
```

```
DEFORMATION RESPONSE TO STATIC SEISMIC LOAD IN VERTICAL DIRECTION

JOINT       . . .DEFLECTION . . .                    . . . ROTATION  . . .
 NO.       X           Y           Z               X           Y           Z

  1   -0.022572 -0.005468 -0.018356        -0.000263  0.001091  0.000015
  2   -0.007733 -0.001898 -0.018450        -0.000263  0.001091  0.000015
  3   -0.007733 -0.001898 -0.017863        -0.000263  0.001056  0.000015
  4   -0.022572 -0.005415 -0.022041        -0.000263  0.001160  0.000015
  5   -0.022572 -0.005517 -0.014569        -0.000263  0.001034  0.000015
  6   -0.020389 -0.004941 -0.018466        -0.000263  0.001091  0.000015
  7   -0.007733 -0.001949 -0.014410        -0.000263  0.000981  0.000015
  8   -0.007733 -0.001846 -0.021856        -0.000263  0.001223  0.000015
  9   -0.022572 -0.005488 -0.016622        -0.000263  0.001072  0.000015
 10   -0.005293 -0.001290 -0.017849        -0.000263  0.001055  0.000015
 11   -0.002373 -0.000502 -0.020500        -0.000264  0.001042  0.000014
 12    0.002297  0.000699 -0.020478        -0.000264  0.001038  0.000039
 13   -0.002376 -0.000592 -0.013774        -0.000260  0.001042  0.000001
 14    0.002309  0.000577 -0.013773        -0.000260  0.001041  0.000001
 15    0.005053  0.001313 -0.017814        -0.000260  0.001046  0.000038
 16    0.025806  0.005322 -0.018142        -0.000130  0.000675  0.000050
 17    0.007374  0.001877 -0.018043        -0.000124  0.000658  0.000044
 18   -0.000034 -0.000009 -0.012372        -0.000260  0.001041  0.000001
 19    0.007378  0.001883 -0.017820        -0.000254  0.001035  0.000043
 20    0.017330  0.003683 -0.018060        -0.000130  0.000674  0.000050
 21    0.025806  0.005251 -0.016740        -0.000129  0.000874  0.000050
 22   -0.000005 -0.000003 -0.006946         0.001151  0.000499 -0.000002
 23   -0.000004 -0.000009 -0.005627        -0.001201  0.000379  0.000002
 24   -0.000001  0.000001 -0.000546        -0.000188  0.000466  0.000000
 25   -0.000001 -0.000001 -0.000265         0.000077  0.000355 -0.000000
 26   -0.000000  0.000000 -0.000203        -0.000016  0.000065  0.000000
 27    0.000000 -0.000000 -0.000114        -0.000005  0.000060 -0.000000
 28    0.000000  0.000000 -0.000178        -0.000010  0.000063  0.000000
 29    0.000000 -0.000000 -0.000132        -0.000010  0.000062 -0.000000
 30   -0.000000  0.000000 -0.000106        -0.000009  0.000048  0.000000
 31    0.0        0.0        0.0            0.0        0.0        0.0
 32    0.002461 -0.000253 -0.002849         0.000054  0.000492  0.000002
 33    0.001862  0.002359 -0.002743        -0.000475  0.000373  0.000001
 34    0.012819  0.002745 -0.003042        -0.000231  0.000777  0.000069
 35    0.014000  0.002726 -0.003294        -0.000094  0.000789  0.000094
 36   -0.022572 -0.005349 -0.027082        -0.000263  0.001091  0.000015
 37   -0.022572 -0.005584 -0.009849        -0.000263  0.001091  0.000015
 38   -0.022572 -0.005445 -0.019703        -0.000263  0.001072  0.000015
 39   -0.007733 -0.001780 -0.027066        -0.000263  0.001091  0.000015
 40   -0.007733 -0.002015 -0.009834        -0.000263  0.001091  0.000015
 41   -0.007733 -0.001876 -0.019380        -0.000263  0.001056  0.000015
 42   -0.007733 -0.001919 -0.016346        -0.000263  0.001056  0.000015
 43   -0.005251 -0.001242 -0.020515        -0.000263  0.001055  0.000015
 44   -0.005251 -0.001337 -0.013782        -0.000263  0.001055  0.000015
 45   -0.003638 -0.000906 -0.013773        -0.000260  0.001041  0.000001
 46    0.003571  0.000891 -0.013773        -0.000260  0.001041  0.000001
 47    0.005159  0.001435 -0.020461        -0.000260  0.001046  0.000036
 48    0.005159  0.001193 -0.013780        -0.000260  0.001046  0.000038
```

```
 49     0.007378  0.001945 -0.019308     -0.000254  0.001035  0.000043
 50     0.007378  0.001821 -0.016333     -0.000254  0.001035  0.000043
 51     0.007374  0.002105 -0.021497     -0.000124  0.000658  0.000044
 52     0.007374  0.001648 -0.014589     -0.000124  0.000658  0.000044
 53     0.025806  0.005394 -0.019253     -0.000129  0.000874  0.000050
 54     0.025806  0.005583 -0.021688     -0.000130  0.000675  0.000050
 55     0.025806  0.005062 -0.014597     -0.000130  0.000675  0.000050
 56    -0.000001  0.000019 -0.002849      0.000054  0.000492  0.000002
 57    -0.000001 -0.000014 -0.002743     -0.000475  0.000373  0.000001
 58    -0.000256 -0.000039 -0.000178     -0.000010  0.000063  0.000000
 59     0.000257  0.000040 -0.000178     -0.000010  0.000063  0.000000
 60    -0.000252 -0.000039 -0.000132     -0.000010  0.000062 -0.000000
 61     0.000252  0.000039 -0.000132     -0.000010  0.000062 -0.000000
 62    -0.000000  0.000000 -0.000149     -0.000009  0.000048  0.000000
 63     0.000000  0.000000 -0.000063     -0.000009  0.000048  0.000000
 64     0.002462 -0.000253 -0.002890      0.000054  0.000492  0.000002
 65    -0.001865 -0.002386 -0.003106     -0.000475  0.000373  0.000001
 66     0.012430  0.002630 -0.003042     -0.000231  0.000777  0.000069
 67     0.013606  0.002679 -0.003294     -0.000094  0.000789  0.000094
 68     0.017147  0.003683 -0.018542     -0.000130  0.000674  0.000050
 69     0.017793  0.003683 -0.016845     -0.000130  0.000674  0.000050
```

```
DEFORMATION RESPONSE TO OPERATIONAL LOADS (INCLUDING DEADWEIGHT)

JOINT       . . .DEFLECTION . . .                 . . . ROTATION  . . .
 NO.        X           Y           Z              X           Y           Z

  1   -0.002410  0.005036 -0.001360       0.000240  0.000117  0.000001
  2   -0.000825  0.001770 -0.001370       0.000240  0.000117  0.000001
  3   -0.000824  0.001770 -0.001308       0.000240  0.000113  0.000001
  4   -0.002410  0.005038 -0.001754       0.000240  0.000124  0.000001
  5   -0.002410  0.005033 -0.000956       0.000240  0.000111  0.000001
  6   -0.002177  0.004555 -0.001372       0.000240  0.000117  0.000001
  7   -0.000824  0.001767 -0.000939       0.000240  0.000105  0.000001
  8   -0.000824  0.001773 -0.001734       0.000240  0.000130  0.000001
  9   -0.002410  0.005035 -0.001175       0.000240  0.000115  0.000001
 10   -0.000564  0.001214 -0.001307       0.000240  0.000113  0.000001
 11   -0.000254  0.000556 -0.002345       0.000240  0.000112  0.000001
 12    0.000246 -0.000523 -0.002342       0.000240  0.000111  0.000002
 13   -0.000254  0.000550 -0.001626       0.000241  0.000111  0.000001
 14    0.000247 -0.000533 -0.001626       0.000241  0.000111  0.000001
 15    0.000546 -0.001189 -0.001307       0.000239  0.000112  0.000002
 16    0.001802 -0.002502 -0.001362       0.000028  0.000038 -0.000001
 17    0.000793 -0.001714 -0.001350       0.000035  0.000037  0.000001
 18   -0.000004  0.000008 -0.001476       0.000241  0.000111  0.000001
 19    0.000793 -0.001716 -0.001308       0.000232  0.000110  0.000001
 20    0.001331 -0.002148 -0.001354       0.000028  0.000037 -0.000001
 21    0.001802 -0.002501 -0.001223       0.000027  0.000078 -0.000001
 22   -0.000001  0.000007 -0.000344       0.000103  0.000030  0.000000
 23   -0.000000  0.000007 -0.001079      -0.000200  0.000062  0.000001
 24    0.000000  0.000000  0.000035       0.000015  0.000028  0.000000
 25   -0.000000 -0.000000 -0.000115       0.000039  0.000058  0.000000
 26    0.000000  0.000000  0.000008       0.000005  0.000006  0.000000
 27   -0.000000 -0.000000 -0.000042       0.000006  0.000007  0.000000
 28    0.000000  0.000000 -0.000003       0.000005  0.000006  0.000000
 29   -0.000000 -0.000000 -0.000029       0.000005  0.000007  0.000000
 30   -0.000000 -0.000000 -0.000011       0.000005  0.000005 -0.000000
 31    0.0       0.0       0.0            0.0       0.0       0.0
 32    0.000150 -0.000465 -0.000221       0.000093  0.000030  0.000001
 33    0.000305  0.000067 -0.000457      -0.000013  0.000061  0.000001
 34    0.001058 -0.001974 -0.000294       0.000092  0.000070 -0.000001
 35    0.001018 -0.001974 -0.000499       0.000098  0.000054 -0.000000
 36   -0.002410  0.005042 -0.002292       0.000240  0.000117  0.000001
 37   -0.002410  0.005029 -0.000451       0.000240  0.000117  0.000001
 38   -0.002410  0.005037 -0.001504       0.000240  0.000115  0.000001
 39   -0.000825  0.001776 -0.002291       0.000240  0.000117  0.000001
 40   -0.000825  0.001764 -0.000449       0.000240  0.000117  0.000001
 41   -0.000824  0.001771 -0.001470       0.000240  0.000113  0.000001
 42   -0.000824  0.001769 -0.001146       0.000240  0.000113  0.000001
 43   -0.000562  0.001217 -0.002347       0.000240  0.000113  0.000001
 44   -0.000562  0.001212 -0.001627       0.000240  0.000113  0.000001
 45   -0.000389  0.000842 -0.001626       0.000241  0.000111  0.000001
 46    0.000382 -0.000825 -0.001626       0.000241  0.000111  0.000001
 47    0.000552 -0.001182 -0.002340       0.000239  0.000112  0.000002
 48    0.000552 -0.001195 -0.001627       0.000239  0.000112  0.000002
```

```
 49    0.000793 -0.001714 -0.001465     0.000232  0.000110  0.000001
 50    0.000793 -0.001717 -0.001150     0.000232  0.000110  0.000001
 51    0.000793 -0.001710 -0.001541     0.000035  0.000037  0.000001
 52    0.000793 -0.001717 -0.001158     0.000035  0.000037  0.000001
 53    0.001802 -0.002504 -0.001446     0.000027  0.000078 -0.000001
 54    0.001802 -0.002507 -0.001560     0.000028  0.000038 -0.000001
 55    0.001802 -0.002498 -0.001165     0.000028  0.000038 -0.000001
 56    0.000000  0.000002 -0.000221     0.000093  0.000030  0.000001
 57   -0.000000  0.000000 -0.000457    -0.000013  0.000061  0.000001
 58   -0.000026  0.000022 -0.000003     0.000005  0.000006  0.000000
 59    0.000026 -0.000022 -0.000003     0.000005  0.000006  0.000000
 60   -0.000027  0.000022 -0.000029     0.000005  0.000007  0.000000
 61    0.000027 -0.000022 -0.000029     0.000005  0.000007  0.000000
 62    0.000000 -0.000000  0.000013     0.000005  0.000005 -0.000000
 63   -0.000000 -0.000000 -0.000036     0.000005  0.000005 -0.000000
 64    0.000151 -0.000465 -0.000293     0.000093  0.000030  0.000001
 65   -0.000306 -0.000067 -0.000467    -0.000013  0.000061  0.000001
 66    0.001023 -0.001928 -0.000294     0.000092  0.000070 -0.000001
 67    0.000991 -0.001925 -0.000499     0.000098  0.000054 -0.000000
 68    0.001334 -0.002148 -0.001250     0.000028  0.000037 -0.000001
 69    0.001324 -0.002148 -0.001617     0.000028  0.000037 -0.000001
```

```
E V A L U A T I O N   O F   V A L V E


DEFORMATION RESPONSE OF COMBINED STATIC SEISMIC AND OPERATIONAL LOADS

JOINT        . . .DEFLECTION . . .              . . . ROTATION  . . .
 NO.         X         Y         Z              X         Y         Z

   1  -0.053640  0.015043 -0.019843       0.000730  0.003333  0.000130
   2  -0.009867  0.004978 -0.019914       0.000722  0.003331  0.000130
   3  -0.009862  0.004956 -0.019267       0.000602  0.001333  0.000130
   4  -0.053641  0.015322 -0.025056       0.000730  0.003729  0.000130
   5  -0.053641  0.014800 -0.019304       0.000730  0.003678  0.000130
   6  -0.047002  0.013573 -0.019931       0.000730  0.003334  0.000130
   7  -0.009864  0.004716 -0.018640       0.000634  0.003962  0.000129
   8  -0.009864  0.005252 -0.024593       0.000634  0.004056  0.000130
   9  -0.053641  0.014947 -0.018334       0.000730  0.002122  0.000130
  10  -0.006794  0.003605 -0.019252       0.000569  0.001299  0.000130
  11  -0.003066  0.002439 -0.022877       0.000572  0.001274  0.000124
  12   0.002681 -0.001776 -0.022851       0.000568  0.001271  0.000074
  13  -0.003044  0.002012 -0.015746       0.000561  0.001272  0.000043
  14   0.002707 -0.001506 -0.015745       0.000561  0.001272  0.000045
  15   0.005990 -0.002738 -0.019231       0.000558  0.001272  0.000082
  16   0.036392 -0.039490 -0.019676       0.001264  0.001150 -0.000069
  17   0.008787 -0.003652 -0.019556       0.001290  0.001151  0.000069
  18  -0.000315  0.000937 -0.014407       0.000561  0.001271  0.000049
  19   0.008792 -0.003852 -0.019239       0.000527  0.001244  0.000070
  20   0.021942 -0.022901 -0.019589       0.001291  0.001175 -0.000069
  21   0.036393 -0.039519 -0.018087       0.001261  0.000958 -0.000069
  22  -0.000240  0.000888 -0.007769       0.001299  0.000605  0.000048
  23  -0.000194  0.000884 -0.006898      -0.001466  0.000454  0.000052
  24   0.000156  0.000078  0.000679       0.000251  0.000569  0.000025
  25  -0.000131 -0.000077 -0.000512       0.000172  0.000427  0.000023
  26   0.000043  0.000062  0.000237       0.000035  0.000076  0.000017
  27  -0.000039 -0.000062 -0.000197       0.000031  0.000071  0.000016
  28   0.000014  0.000063 -0.000192       0.000029  0.000074  0.000016
  29  -0.000012 -0.000063 -0.000176       0.000029  0.000073  0.000015
  30  -0.000010 -0.000050 -0.000118       0.000028  0.000056 -0.000008
  31   0.0        0.0        0.0            0.0        0.0        0.0
  32   0.003077 -0.004297 -0.003286       0.000765  0.000600  0.000076
  33   0.002265  0.003075 -0.003246      -0.000565  0.000448  0.000075
  34   0.017819 -0.019180 -0.003592       0.000951  0.001085 -0.000277
  35   0.018568 -0.019155 -0.003827       0.000865  0.000997 -0.000302
  36  -0.053640  0.015683 -0.037241       0.000730  0.003333  0.000130
  37  -0.053640  0.014487 -0.027967       0.000730  0.003333  0.000130
  38  -0.053641  0.015166 -0.021225       0.000730  0.002122  0.000130
  39  -0.009867  0.005683 -0.037219       0.000722  0.003331  0.000130
  40  -0.009867  0.004483 -0.027947       0.000722  0.003331  0.000130
  41  -0.009862  0.005072 -0.020882       0.000602  0.001333  0.000130
  42  -0.009862  0.004847 -0.017712       0.000602  0.001333  0.000130
  43  -0.006581  0.003886 -0.022894       0.000569  0.001299  0.000130
  44  -0.006581  0.003374 -0.015756       0.000569  0.001299  0.000130
```

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 45   -0.004577  0.002605 -0.015744      0.000561  0.001271  0.000049
 46    0.004243 -0.001976 -0.015744      0.000561  0.001271  0.000049
 47    0.006170 -0.002808 -0.022831      0.000558  0.001272  0.000082
 48    0.006170 -0.002710 -0.015752      0.000558  0.001272  0.000082
 49    0.008792 -0.003876 -0.020826      0.000527  0.001244  0.000070
 50    0.008792 -0.003833 -0.017691      0.000527  0.001244  0.000070
 51    0.008787 -0.003960 -0.024180      0.001290  0.001151  0.000069
 52    0.008787 -0.003801 -0.015954      0.001290  0.001151  0.000069
 53    0.036393 -0.039467 -0.020841      0.001261  0.000958 -0.000069
 54    0.036392 -0.039396 -0.024371      0.001264  0.001150 -0.000069
 55    0.036392 -0.039587 -0.015950      0.001264  0.001150 -0.000069
 56    0.000204  0.000484 -0.003286      0.000765  0.000600  0.000076
 57   -0.000166  0.000471 -0.003246     -0.000565  0.000448  0.000075
 58   -0.000299  0.000069 -0.000192      0.000029  0.000074  0.000016
 59    0.000306 -0.000177 -0.000192      0.000029  0.000074  0.000016
 60   -0.000296  0.000068 -0.000176      0.000029  0.000073  0.000015
 61    0.000299 -0.000177 -0.000176      0.000029  0.000073  0.000015
 62    0.000042 -0.000050  0.000193      0.000028  0.000056 -0.000008
 63   -0.000039 -0.000050 -0.000153      0.000028  0.000056 -0.000008
 64    0.003075 -0.004297 -0.003536      0.000765  0.000600  0.000076
 65   -0.002225 -0.002637 -0.003629     -0.000565  0.000448  0.000075
 66    0.017277 -0.018708 -0.003592      0.000951  0.001085 -0.000277
 67    0.018072 -0.018722 -0.003827      0.000865  0.000997 -0.000302
 68    0.021874 -0.022901 -0.020672      0.001291  0.001175 -0.000069
 69    0.022129 -0.022901 -0.021929      0.001291  0.001175 -0.000069
```

```
BEAM STRESS FOR COMBINED STATIC AND OPERATIONAL LOADS

ELM JNT SPT   C1    C2     C3   STRESS/10(3)     MATERIAL        SMAX NOTE
NO. NO. NO.   K    FAC1  FAC3/2  SMAX   SAL     DESCRIPTION      /SAL

 31  18  6   0.0   0.0   -0.56    8.6  27.0   STEEL              0.32
             1.12  1.50   1.00
 32  18  6   0.0   0.0   -0.56    7.6  27.0   STEEL              0.28
             1.12  1.50   1.00
 33  56 11 -0.73   0.0   -5.00    2.6  27.0   STEEL              0.10
             0.83  3.50   1.00
 34  24  9 -0.73   0.0    5.00    6.4  27.0   STEEL              0.24
             0.83  3.50   1.00
 35  23  1   3.23  0.0    5.00    2.0  27.0   STEEL              0.07
             0.0   1.00   1.00
 36  25 11 -0.73   0.0   -5.00    4.4  27.0   STEEL              0.16
             0.83  3.50   1.00
 37  26  5   0.0   0.0    0.94    6.6  27.0   STEEL              0.25
             1.84  1.50   1.00
 38  26  3 -5.50   0.0   -0.94    0.2  27.0   STEEL              0.01
             0.0   1.00   1.00
 39  27  3 -5.50   0.0   -0.94    0.2  27.0   STEEL              0.01
             0.0   1.00   1.00
 40  27  5   0.0   0.0    0.94    4.9  27.0   STEEL              0.18
             1.84  1.50   1.00
 41  58  3 -1.44   0.0   -0.94    0.4  27.0   STEEL              0.01
             0.0   1.00   1.00
 42  59  3 -1.44   0.0   -0.94    0.4  27.0   STEEL              0.01
             0.0   1.00   1.00
 45  31  5   3.52  0.0   -2.38    3.3  27.0   STEEL              0.12
             8.99  2.42   1.37
 46  64  2   1.50  0.0   -2.50    6.2  27.0   STEEL              0.23
             0.0   1.00   1.00
 47  65  4 -1.50   0.0    2.50    5.9  27.0   STEEL              0.22
             0.0   1.00   1.00
 48  66  4   2.50  0.0   -0.38    6.4  27.0   STEEL              0.24
             0.0   1.00   1.00
 49  68  1   0.38  0.0    2.25   14.4  27.0   STEEL              0.53
             0.0   1.00   1.00
 50  69  4   0.38  0.0   -2.25   16.2  27.0   STEEL              0.60
             0.0   1.00   1.00


BOLTED JOINT STRESS FOR COMBINED STATIC AND OPERATIONAL LOADS
           (N=NUMBER OF BOLTS, AREA=AREA PER BOLT)

BOLT JOINT DESCRIPTION,BOLT STRESS/10(3)     MATERIAL      SMAX NOTE
JNT LOC. TYPE  N  AREA  NO.  SMAX   SAL     DESCRIPTION    /SAL

30   A    PAD  4  0.31   4   45.9  46.0   SAE GR5          1.00
```

THIS EQUIPMENT IS ACCEPTABLE FOR THE SPECIFIED SEISMIC DISTURBANCE

THIS REPORT HAS BEEN PREPARED BY /

BARRY L GAARDER
SENIOR DRAFTSMAN

FISHER CONTROLS COMPANY

VERSION 04/22/82

ATTACHMENT 3

FQP-11AB-7

Pressure Retaining Parts Stress Calculations for 14-inch Type 9280 Valves

Vogtle Group VII

NA-140

FISHER Controls MARSHALLTOWN, IOWA	BUTTERFLY VALVE TYPE 9280	NO. SAG 1034
	Calculation Procedure for Pressure Retaining Parts	BY BLG 9-5-8 JHW 9-27- PAGE 1 OF 15
		REV

Following are stress calculations to determine:

1. Valve body hoop and bending stress NA-140, Page 1, Rev. A
2. Retaining ring hoop stress
3. Shaft torsional, bending, and shear stress
4. Disc bending stress

These calculations are for a Type 9280 Butterfly Valve constructed of the following materials:

1. Body SA-182
2. Disc SA-351-CF8M
3. Retaining ring SA-351-CF8M
4. Shaft SA-564 H1075

Reference:

Order No. 22B-X5AC03-N1T, N2T

P.O. PAV-206, PAV-2-34

Item No. 147-150, 179-182

Category Seismic Category I

Type 14" 9280

Valve Serial [redacted] No's.	Tag [redacted] No's.
8672365, 66, 67, 68, 69	1HV-2628B, 1HV-2627B, 1HV-2629B 2HV-2627B, 2HV-2629B
8669191	1HV-2626B
8670354, 55	2HV-2626B 2HV-2628B

NA-140, Page 2, Rev. A

Design Conditions:

(Design) 1. Pressure 60 PSIG

(Max) 2. Pressure Drop 60 PSI

(Design) 3. Temperature 300 °F

(Required) 4. Actuator Torque 9800 In-Lb

Allowable Design Stresses for Materials of Construction:

1. Body 25,650. PSI
2. Disc 25,650. PSI
3. Retaining Ring 25,650. PSI
4. Shaft 54300. PSI (Torsion)
   27150. PSI (Shear)

Order of Calculations:

1. Body hoop and bending stress
2. Retaining ring hoop stress
3. Shaft torsional, bending, and shear stress
4. Disc bending stress

Following the calculations is a summary of allowable stresses vs. calculated stresses.

5. Code Case 1635-1

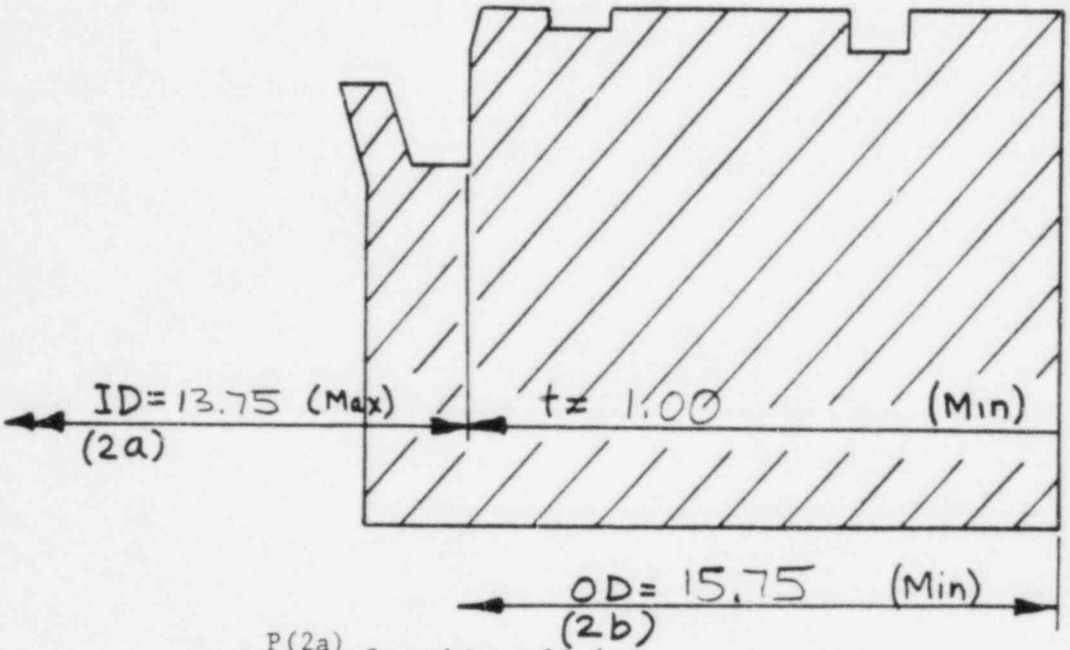
FISHER® Controls
MARSHALLTOWN, IOWA

BUTTERFLY VALVE TYPE 9280

Calculation Procedure
for
Pressure Retaining Parts

NO. SAG 1034
BY BLG 9-5-8
9-27-8
PAGE 3 OF 15
REV

1. Body Hoop & Bending Stress



$\sigma_h = \frac{P(2a)}{2t}$ for thin cylinder

$= \frac{P(b^2 + a^2)}{(b^2 - a^2)}$ for thick cylinder

$$= \frac{60(7.875^2 + 6.875^2)}{7.875^2 - 6.875^2}$$

$= 445$ psi

Where

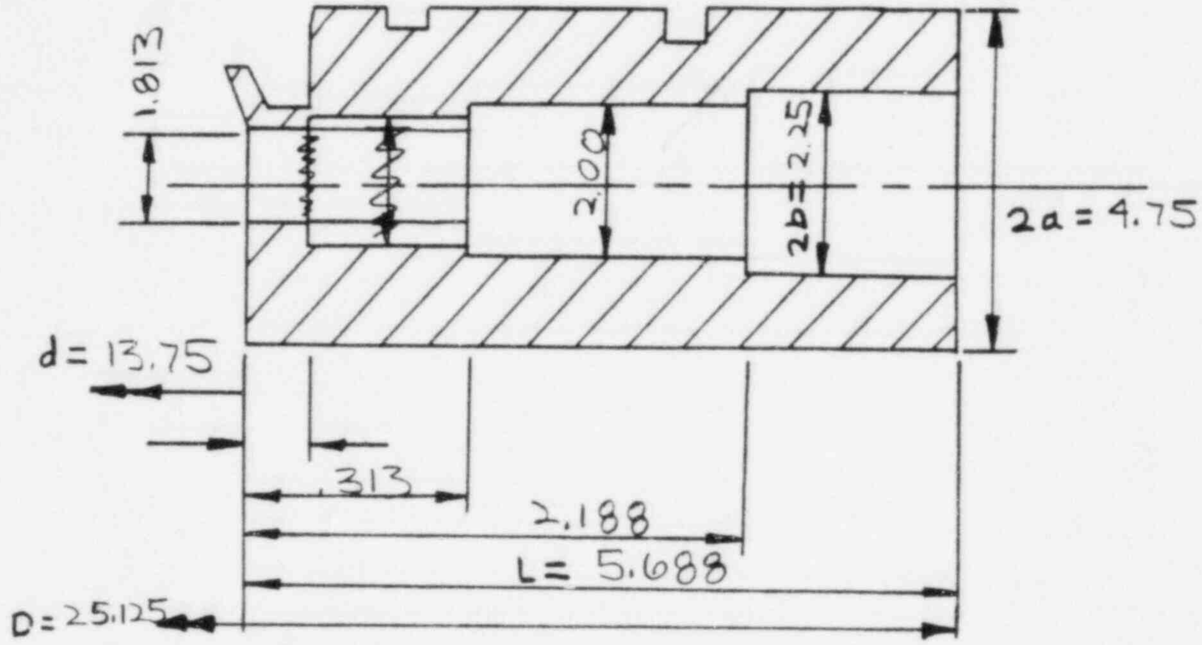
P = Internal pressure (PSIG)
2a = Inside diameter (In)
2b = Outside diameter (In)
t = Wall thickness (In)
σ_h = Hoop stress in Body (PSI)

Sr = -P

= -60 PSI

NOTE: The body is considered to be a thick walled cylinder since b/t < 10.

Hoop Stress at Shaft Hole



$$\sigma = P \frac{d^2(1-2\lambda) + D^2(1+\lambda)}{D^2 - d^2} \quad *$$

$$\sigma = 60 \frac{13.75^2[1-2(.3)] + 25.125^2(1+.3)}{25.125^2 - 13.75^2}$$

$= 122$ psi

Where

P = Internal Pressure (PSIG)

d = Inside Diameter (In)

D = Outside Diameter (In)

λ = Poissons Ratio (0.3 for Steel)

σ = Maximum Unit Stress (PSI)

---

*Clavarinos formula for thick walled cylinder d/(2t) < 10), King, R. C. and Crocker, "Piping Handbook", Pages 3-13. Fifth Edition, McGraw-Hill, New York, 1967.

NA-140, Page 5, Rev. A

To conservatively allow for shaft hole, unit stress for solid block (L by 2a) should be multipled by the ratio of the face to face dimension (2a) over that value minus the packing hole diameter.

$$\sigma_s = \sigma\left(\frac{2a}{2a - 2b}\right) = 122\left(\frac{4.75}{4.75 - 2.25}\right) = 232 \text{ psi}$$

$$\sigma_h = P\,\frac{a^2 + b^2}{a^2 - b^2}$$

(This expression includes a ratio of the cross-sectional areas available to carry the hoop stress load.)

$$= 60\left(\frac{2.375^2 + 1.125^2}{2.375^2 - 1.125^2}\right)$$

$$= 95 \text{ psi}$$

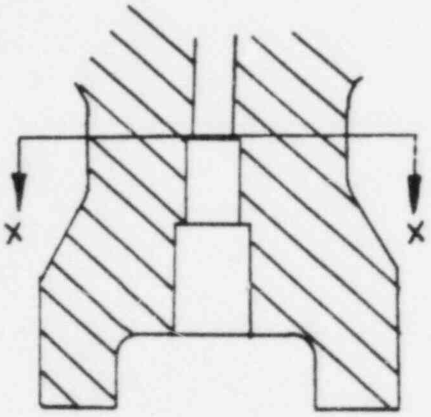
Where:

a = Outside Radius of Shaft Hole (In)

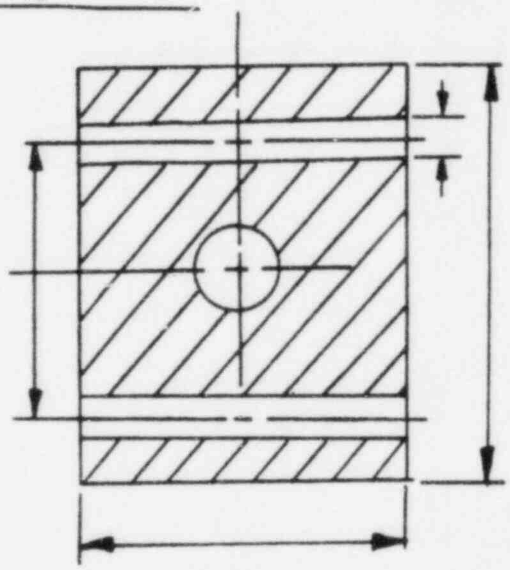
b = Inside Radius of Shaft Hole (In)(Largest)

σ_h = Hoop Stress of Shaft Hole (PSI)

Body bending stress at weakest supporting section:



Bending Moment



Section X-X

Bending Moment

$$M = W\,(G_{Load} + 1)\,D$$

Where

G_{Load} = Seismic Acceleration in g's

W = Weight of Extended Structure (Lb)

D = Distance to Extended Structure C.G. (I

$$= 864(4.5 + 1)\,10.63$$

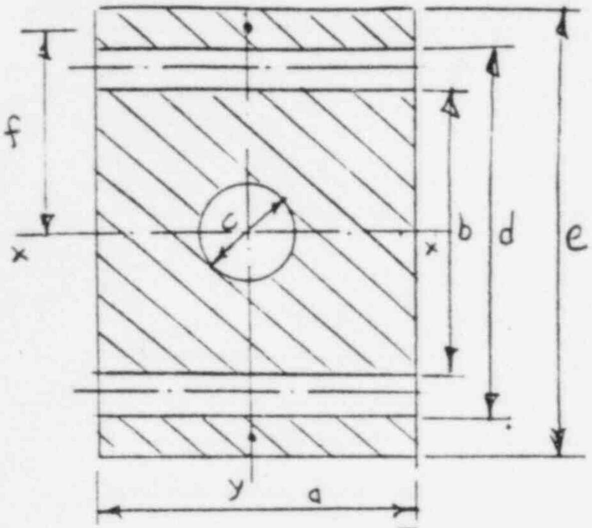
$$= 50514 \quad \text{In-Lb}$$

FISHER Controls
MARSHALLTOWN, IOWA

BUTTERFLY VALVE TYPE 9280

Calculation Procedure
for
Pressure Retaining Parts

NO. SAG 1034
BY BLG 9-6-8
9-27-8
PAGE 6 OF 15
REV



a = 4.75 NA-740, Page 6, Rev. A

b = 3.727

c = 2.250

d = 5.977

e = 12.00

$f = \frac{d + e}{4} = \frac{5.977 + 12.00}{4} = 4.494$

$$I_{xx} = \frac{ab^3}{12} - \frac{\pi(c)^4}{64} + 2\left[\frac{a(\frac{e-d}{2})^3}{12} + (\frac{e-d}{2})(a)(f)^2\right]$$

$$= \frac{4.75(3.727)^3}{12} - \frac{\pi(2.25)^4}{64} + 2\left[\frac{4.75(\frac{12.00-5.977}{2})^3}{12} + (\frac{12.00-5.977}{2})(4.75)(4.494)^2\right]$$

$$= 618.65 \text{ in}^4$$

$$\text{Bending Stress } (\sigma_{xx}) = \frac{M(e/2)}{I_{xx}}$$

(Based upon 4.5 G Load)

$$= \frac{50514(\frac{12.00}{2})}{618.65}$$

$$\sigma_{xx} = 490 \text{ PSI}$$

Assume weight of extended structure acts 90° from previous calculation:

$$I_{yy} = \frac{(b)(a)^3}{12} - \frac{\pi(c)^4}{64} + 2\left[\frac{(\frac{e-d}{2})(a)^3}{12}\right]$$

$$= \frac{3.727(4.75)^3}{12} - \frac{\pi(2.25)^4}{64} + 2\left[\frac{(\frac{12.00-5.977}{2})(4.75)^3}{12}\right]$$

$$= 85.92 \text{ in}^4$$

Bending Stress (based on a 4.5 G load)

NA-740; Page 7, Rev. A

$$\sigma_{yy} = \frac{M(a/2)}{I_{yy}}$$

$$= \frac{50514\left(\frac{4.75}{2}\right)}{85.82}$$

$$= 1409 \text{ PSI}$$

Consider an accident condition with bending about the xx and yy axes simultaneously:

$$\sigma = \sigma_{xx} + \sigma_{yy}$$

$$= 490 + 1409$$

$$= 1899 \text{ PSI}$$

This value is conservative because it includes the 1G load (weight) of the actuator and bracket in the yy axis. However, the stress is significantly below the allowable stress of 25650 PSI.

Torsional Shear Stress

Conservatively omitting the load carrying capacity of material on outside of bolt holes and modeling shaft hole as a rectangle.

$$\tau_1 = \frac{4T}{(a^2 - c^2)(b + c)}$$

$$\frac{4(9800)}{(4.75^2 - 2.25^2)(3.727 + 2.25)}$$

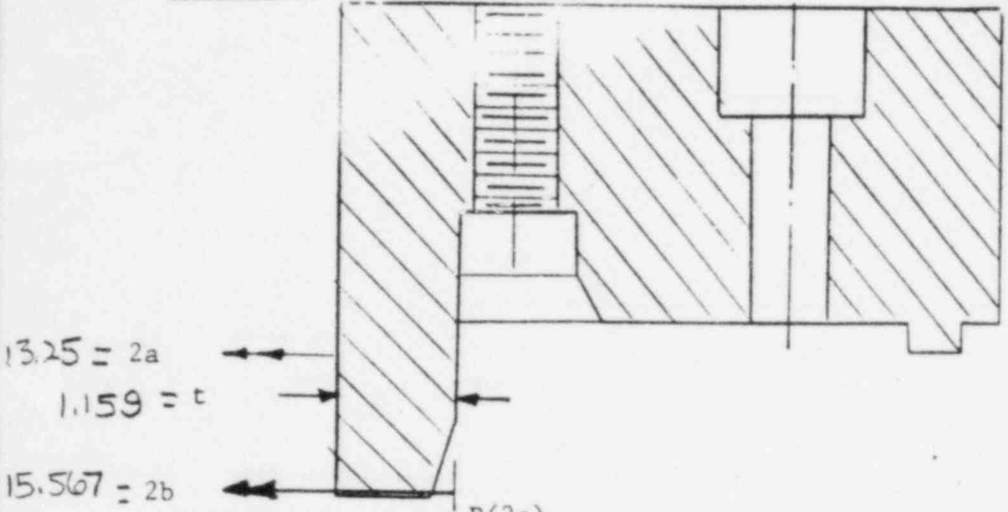
$$= 375 \text{ psi}$$

$$\tau_2 = \frac{4T}{(b^2 - c^2)(a + c)} = \frac{4(9800)}{(3.727^2 - 2.25^2)(4.75 + 2.25)}$$

$$635 \text{ PSI}$$

NA-740; Page 8, Rev. A

2. Retaining Ring Hoop Stress



Hoop Stress $(S_t) = \frac{P(2a)}{2t}$ for thin ring

$= \frac{a^2 P}{b^2 - a^2}\left(1 + \frac{b^2}{\rho^2}\right)$ for thick ring

S_{tmax} at $\rho = a$

$= \frac{6.625^2 60}{7.784^2 - 6.625^2}\left(1 + \frac{7.784^2}{6.625^2}\right)$

$= 376$ PSI

P = Internal Pressure

2a = Inside Diameter

t = Min. Wall Thickness

2b = Outside Diameter

Note: The ring is considered to be a thick walled cylinder since $a/t < 10$.

3. Shaft Torsional, Bending, & Shear Stresses

NA-140, Page 9, Rev. A

Maximum Torsional Shear Stress (Ss) = $\frac{T(d/2)}{J}$

$J = \frac{\pi d^4}{32}$

$J = \frac{\pi (1.75)^4}{32}$

$J = .9208 \text{ In}^4$

Where

T = Torque

d = Shaft Diameter

J = Polar moment of inertia

$S_s = \frac{T(d/2)}{J}$

$S_s = \frac{9800\left(\frac{1.75}{2}\right)}{.9208}$

$S_s = 9313$ PSI

Bending Stress (σ_B) = $\frac{M(d/2)}{I}$

Force (F) = ΔP.A

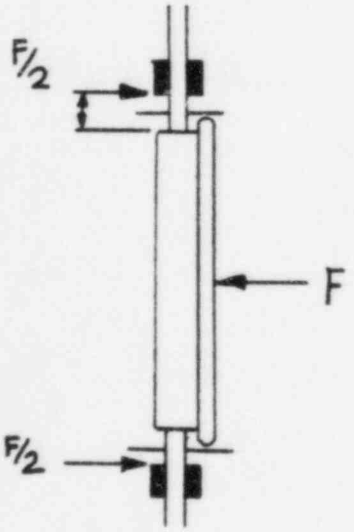
$I = \frac{\pi d^4}{64}$

Moment (M) = (F/2)L

Where A is area of disc

Where d is dia. of shaft

Where L is the distance from outer edge of bushing to edge of disc



$I = \frac{\pi (1.75)^4}{64} = .4604$

$F = 60(138) = 8280$

$M = \left(\frac{8280}{2}\right) .875 = 3623$

$\sigma_B = (\sigma_x) = \frac{3623\left(\frac{1.75}{2}\right)}{.4604} = 6886 \text{psi}$

Max. Shear Stress at neutral axis due to shear load:

NA-140, Page 10, Rev. A

$\tau_{max} = 1.38 \frac{2F}{\pi d^2}$ from experimental results

$= 1.38 \frac{2(8280)}{\pi(1.75)^2}$

$= 2376$ PSI

Combine max. torsional shear and max. shear stresses:

$\tau_{comb} = S_s + \tau_{max}$

$= 9313 + 2376$

$= 11689$ PSI

Combine max. torsional shear and bending stress using maximum shear stress theory of failure:

$\sigma_x = \sigma_B = 6886$ PSI

$\sigma_y = 0$ PSI

$\tau_{xy} = S_s = 9313$ PSI

Principal stresses

$$\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$= \frac{6886+0}{2} + \sqrt{\left(\frac{6886-0}{2}\right)^2 + 9313^2}$$

$\sigma_1 = 13372$ PSI

FISHER Controls
MARSHALLTOWN, IOWA

BUTTERFLY VALVE TYPE 9280

Calculation Procedure
for
Pressure Retaining Parts

NO. SAG 1034
BY BLG 9-6-8
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$$\sigma_2 = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (\tau_{xy})^2}$$

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$$= \frac{6886+0}{2} - \sqrt{\left(\frac{6886+0}{2}\right)^2 + 9313^2}$$

$\sigma_2 =$ -6486 PSI

Then $\tau_{max} = \frac{\sigma_1 - \sigma_2}{2}$

$$\tau_{max} = \frac{13372 - -6486}{2}$$

$\tau_{max} =$ 9929 PSI

The factor of safety by the maximum shear stress theory is:

$$N = \frac{S_{yt}}{2\tau_{max}}$$

Where N = Factor of safety
S_{yt} = Maximum code allowable stress

$$= \frac{59300}{2(9929)}$$

$N = 2.7344$

FISHER® Controls MARSHALLTOWN, IOWA	BUTTERFLY VALVE TYPE 9280 Calculation Procedure for Pressure Retaining Parts	NO. SAG 1034 BY BLG 9-6-8 9-27-8 PAGE 12 OF 15 REV

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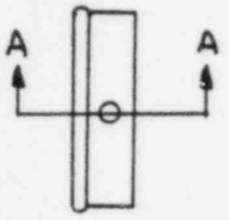
4. Disc Bending Stress

(A) Bending stress (σ) = $\frac{M(h_1/2)}{I}$ @ Sect AA

Bending Moment (M) = $0.083(\Delta P)(D^3)^*$

$$I = \frac{Dh^3}{12} = \frac{D[h_1^3 - h_2^3]}{12}$$

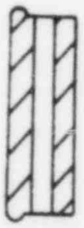


Where h_1 = Total width

h_2 = Diameter of hole

D = Diameter of disc

ΔP = Pressure drop



Section A-A

$M = .083(60)13.25^3 = 11585$

$I = \frac{13.25[3.625^3 - 1.75^3]}{12} = 47$

$\sigma = \frac{11585\left(\frac{3.625}{2}\right)}{47} = 447$

(B) Bending stress (σ_B) = $\frac{M(h_1/2)}{I}$ @ Sect BB

Bending moment (M) = $0.3927\ D^2\ \Delta P\ [L_0 + 0.2878D]^*$

$$I = \frac{Dh_1^3}{12} - \frac{\pi h_2^4}{64}$$

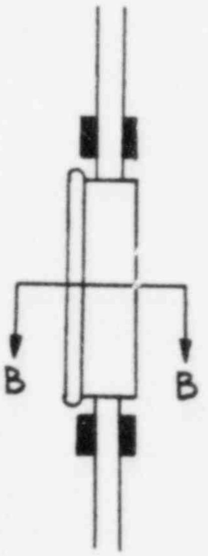
Where

h_1 = Total width

h_2 = Diameter of hole

D = Diameter of disc

L_0 = Distance from center of the bushing to the edge of disc



$M = .3927(13.25)^2\ 60\ [1.813 + .2878(13.25)]$

$= 23274$

$I = \frac{13.25(3.625)^3}{12} - \frac{\pi(1.75)^4}{64}$

$= 52.14$

---

* See Appendix 1 for derivation.

FISHER Controls **MARSHALLTOWN, IOWA**	BUTTERFLY VALVE TYPE 9280	NO. SAC 1034
	Calculation Procedure for Pressure Retaining Parts	BY BLG 9-6-8 JHM 9-27-8 PAGE 13 OF 15
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Section
BB

$$\sigma_B = \frac{23274\left(\frac{3.625}{2}\right)}{52.14}$$

$$= 810 \text{ psi}$$

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SUMMARY OF STRESSES

COMPONENT	MATERIAL SPECIFICATION	STRESS CALCULATION	ALLOWABLE (DESIGN) STRESS (PSI)	CALCULATED (ACTUAL) STRESS (PSI)
BODY	SA-182	HOOP	25650	445
		HOOP @ SHAFT	25650	95
		BENDING	25650	1899
RETAINING RING	SA-351-CF8M	HOOP	25650	376
SHAFT	SA-564 H1075	TORSIONAL SHEAR	27150	9313
		BENDING	54300	6886
		SHEAR	27150	11689
		MAX SHEAR BY FAILURE THEORY	27150	9929
DISC	SA-351-CF8M	BENDING @ SHAFT	25650	447
		BENDING PERPEN SHAFT	25650	810

FISHER Controls
MARSHALLTOWN, IOWA

BUTTERFLY VALVE TYPE 9280
Calculation Procedure
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5. ASME CODE CASE 1635-1

Section Modulus of Piping:

Pipe Size 14" Schedule STD

O.D. = 14.00

I.D. = 13.25

$$Z_p = \frac{\pi(d_o^4 - d_i^4)}{32\ d_o}$$

$$= \frac{\pi(14.00^4 - 13.25^4)}{32(14.00)}$$

$$= 53.26 \text{ In}^3$$

Sectional Modulus of Valve Body:

O.D. = 15.75

I.D. = 13.25

$$Z_v = \frac{\pi(d_o^4 - d_i^4)}{32\ d_o}$$

$$= \frac{\pi(15.75^4 - 13.25^4)}{32(13.75)}$$

$$= 220$$

$$\text{Ratio} = \frac{Z_v}{Z_p} = \frac{220}{53.26} = 4.14$$

Allowable Stress for SA312-TP309 Piping = 30000 PSI

Allowable Stress for SA-182 Body = 25650 PSI

Based upon this information, this valve meets the conditions set forth in Code Case 1635-1.

APPENDIX A

EQUATION DERIVATION

FISHER® Controls
MARSHALLTOWN, IOWA

BUTTERFLY VALVE TYPE 9280

Calculation Procedure
for
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Derivation of disc bending moment equations

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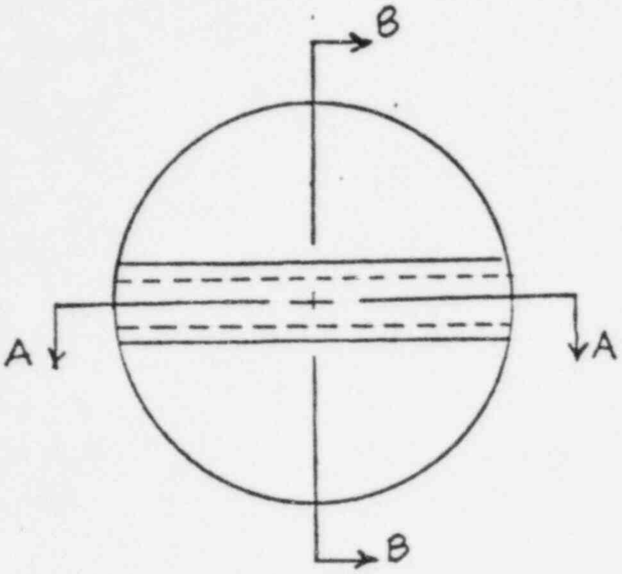
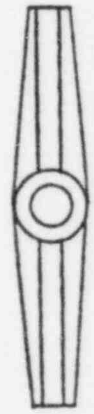
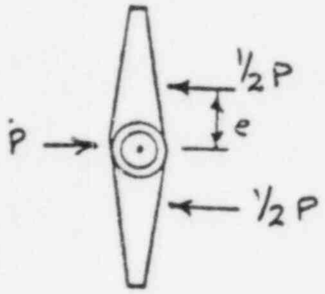




Section "AA"



$$\Sigma M_{AA} = \tfrac{1}{2}P_e$$

Where: P = Load on Disc = (ΔPA)

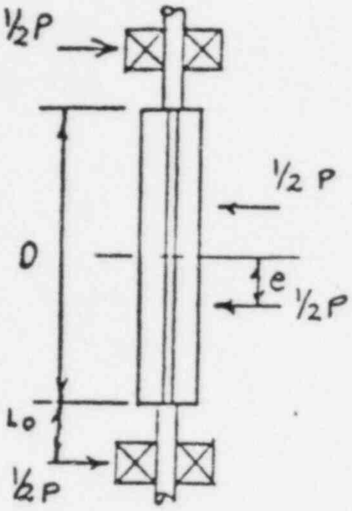
e = Distance to Centroid

$= .2122D = \frac{2D}{3\pi}$

$$\Sigma M_{AA} = \tfrac{1}{2}\ \Delta P\ \frac{\pi D^2}{4}\ (.2122D)$$

$$= .083\ \Delta P D^3$$

SECTION "BB"



$$\Sigma M_{BB} = \tfrac{1}{2}P\,(\tfrac{1}{2}D + L_o) - \tfrac{1}{2}P(e)$$

WHERE: P = Load on disc = (ΔPA)

D = Disc Diameter

e = Distance to Centroid

L_o = Hub to Bushing Length

$$M_{BB} = \tfrac{1}{2}\,\frac{\pi}{4}\,D^2\,\Delta P\,(\tfrac{1}{2}D + L_o) - \tfrac{1}{2}\,\frac{\pi}{4}\,D^2\,\Delta P\,(.2122D)$$

$$= \frac{\pi}{8}\,D^2\,\Delta P\,(L_o + .2878\,D)$$

$$= .3927\,D^2\,\Delta P\,(L_o + .2878\,D)$$

Calculations prepared by Barry L. Gaarder

Title Senior Draftsman

Calculations checked by Jerry H. McDaniel

Title ENGINEER SPECIALIST

ATTACHMENT 4

FQP-11AB-7

Static Sideload Test of Vogtle Item 149

14" Type 9280 Butterfly Valve with
Bettis NT316B-SR2-M3 Actuator

Fisher Lab Problem 1662, Report 70

Project 78EC07 Proj. File

Fisher Controls

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By Jon Milliken

STATIC SIDELOAD TEST OF VOGTLE ITEM 149
14" TYPE 9280 BFV WITH BETTIS ACTUATOR MODEL NO. NT316B-SR2-M3

ABSTRACT

A static sideload test was performed on a 14" Type 9280 BFV with Bettis actuator Model No. NT316B-SR2-M3. This valve was a production valve intended for service in the Vogtle Nuclear Power Plant (Rep. Order No. 22B-X5AC03-N2T; Item No. 149; S/N 8670355; Project No. 78EC07). A sideload force equivalent to 10g acceleration was applied near the center-of-gravity of the extended structure of the valve assembly. This load was applied along the axis of least rigidity as determined by an earlier resonant frequency test (Problem 1667, Report 192). The static sideload was intended to conservatively simulate dynamic loads encountered in a seismic event as specified by Bechtel (A&E for the Vogtle Project). Operability tests were performed before, during and after application of the sideload as a means of evaluating performance of the valve assembly during a simulated seismic event. Testing was performed according to FTP-33, Rev. D and the results of the tests successfully satisfied all criteria required by tnis procedure and the associated requirements in the Test Valve Data Sheet.

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Tables, Sketches and Photos

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INTRODUCTION

The test of Item 149, Vogtle Project, was requested by the Nuclear Qualification Group via the test request letter included in this report. The purpose of this report is to evaluate the operability of the valve assembly when subjected to a sideload of the magnitude specified in the Test Valve Data Sheet included in this report. The test valve was in a fully operational mode with the valve body in a pressurized test fixture. A baseline series of functional tests were performed prior to the application of the sideload. The sideload was then applied in increments of 50%, 75% and 100%. At 100% sideload functional tests were then again conducted and recorded. The sideload was then incrementally removed in reverse sequence. At zero sideload a final series of functional tests was performed. Every functional test consisted of a packing leakage test, a bidirectional seat leakage test, limit switch trip point test, and a series of stroking time tests which included verification of the "fail-safe" mode. Deflection measurements of the extended structure were made during the incremental application and incremental release of the sideload. This series of before, during and after tests provided a method of comparing normal operation under no sideload to operation during sideload. This test also allowed a comparison of before and after performance to see the detrimental effects, if any, caused by the sideload. Structural yield, binding of internal components, and loss of pressure retaining ability would be revealed, if present, by this test. A full evaluation of the valve assembly is presented in the Conclusion to this report.

TEST PROCEDURE

The detailed test procedure is presented in FTP-33, Rev. D. A brief summary of the test procedure, aided by Sketch 1, is presented in this section.

The pre-functional and post-functional tests consisted of the same procedure. The packing leakage test was performed first at a pressure of 180 psi with tap water as the test fluid. The valve disc was at mid-travel during this test. The test pressure was held for 5 minutes and all gasketing and packing was checked for leaks.

Next a bidirectional seat leakage was performed with tap water. First the inlet was pressurized to 60 psig with the valve disc closed and the outlet at atmospheric pressure. The test fixture was previously filled with water to evacuate all air pockets. The vertical fittings shown in Sketch 1 were used to observe any leakage to atmosphere. After a period of 10 minutes at these conditions a 2 minute period followed for measurement of seat leakage. This test was then repeated with the outlet at 60 psig and the inlet at atmospheric pressure.

Finally, a stroking time test was conducted. The actuation signal (solenoid: 0-125 VDC) and direct stem movement were recorded on adjacent channels of a strip chart recorder. An RVDT was used to record the true stem position. A

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pressure transducer was used to record the piston pressure in the actuator. The limit switch points were recorded using a 5V power supply to each limit switch.

The following sequence of operational cycles were recorded on the strip chart recorder:

Cycle 1; CLOSE TO OPEN
OPEN TO CLOSE
Cycle 2; CLOSE TO OPEN
OPEN TO CLOSE
Cycle 3; CLOSE TO OPEN
OPEN TO CLOSE
Cycle 4; CLOSE TO OPEN
OPEN TO CLOSE

Each half cycle stroking time was recorded to make sure that the required stroking time (Test Valve Data Sheet) was never exceeded. Average stroking times were computed for each half cycle (CL→OP and OP→CL).

Stroking time constants (time required to travel from the closed or open position to 63.2% of full travel in the direction opposite of the starting position) were also determined so that changes in stroking speed could be evaluated throughout the testing.

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The overall testing sequence was as follows: Pre-Functional→Sideload→Post-Functional. In the previously described functional tests, packing leakage, bidirectional seat leakage and operational cycles were done for each of the three portions of the test, however, the sideload portion had the following additional test steps for measurement of deflection due to the sideload application:

1) Measurement of deflections with disc closed at 50%, 75% and 100% of the sideload.
2) Functionals as previously described.
3) Measurement of deflection with the disc at Fail-Safe position for 100%, 75%, 50% and 0% of the sideload.

During application and release of the sideload the valve body was not pressurized.

The magnitude of the sideload force equivalent to 10g at the center-of-gravity of the extended structure was determined as 2446 lb. (100% sideload). The distance from the center of the shaft to the center-of-gravity was 4.75 inches in the Z axis as given in the Test Valve Data Sheet. The actual point of application of the sideload was 19.125 inches from the center-of-gravity representing a moment arm of 19.125 inches. Since the Z axis of the actuator was in the horizontal direction and the sideload was applied in the vertical direction, the sideload magnitude was determined by S=RW+W from FTP-33 where S was the sideload force at the c.g., R was the resultant g load, and W was the weight of the extended structure. Since the force, F, at the point of application had to create the same moment at the shaft axis as the force S at the c.g. produced at the shaft axis, then,

F = S(S moment arm)/(F moment arm)

F = [(10g)(895) + 895] (4.75)/(19.125) = 2446 lb.

The values for R and W are given in the Test Valve Data Sheet.

RESULTS

The results of all tests described in the previous section are presented in Tables 1, 2 and 3. Table 1 gives the results of the Pre-Functional Tests. Table 2 gives the results of the Sideload Tests. Table 3 gives the results of the Post-Functional Tests.

At no time during any of the tests did any packing or seat leakage occur. All valve closure times were less than the required 5 seconds. The average close-to-open stroking time was 10.0 seconds. The average open-to-close stroking time was 2.92 seconds. All stroking time constants deviations were well within the +20% criteria. No yielding or any other structural damage was observed. All limit switch trip points were well within the allowable deviation of ±2° degrees of valve travel. When fail-safe operation was required, it was maintained without deviation during the incremental release of the sideload.

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TABLE 1
SIDELOAD TEST RESULTS

PRE-FUNCTIONAL TEST RESULTS

1) PACKING LEAKAGE @ 180 psi: CRITERIA No Leakage TEST No Leakage

2) BIDIRECTIONAL SEAT LEAKAGE @ 60 ΔPSI: CRITERIA No Leakage

DIRECTION OF FLOW TEST No Leakage
REVERSE FLOW TEST No Leakage

3) STROKING TIMES & STROKING TIME CONSTANTS: CRITERIA Closing Time < 5 Sec.

			ACTUATOR SUPPLY PRESSURE	STROKING TIME	STROKING TIME CONSTANT	
A) CYCLE 1,	ΔP= 60	, CL→OP	80 psi	10.05	6.75	*
	P= 60	, OP→CL	0	2.95	2.15	*
B) CYCLE 2,	ΔP= 60	, CL→OP	80 psi	10.0	6.7	
	P= 60	, OP→CL	0	2.9	2.15	
C) CYCLE 3,	ΔP= 60	, CL→OP	80 psi	10.0	6.75	
	P= 60	, OP→CL	0	2.9	2.2	
D) CYCLE 4,	ΔP= 60	, CL→OP	80 psi	10.05	6.75	
	P= 60	, OP→CL	0	2.95	2.2	
E) AVG TIME	ΔP= 60	, CL→OP	80 psi	10.03	6.74	
	P= 60	, OP→CL	0	2.93	2.18	

F) MAXIMUM STROKING TIME CONSTANT CHANGE 2.3 %OF INITIAL VALUE

* TEST FLUID Water
**INITIAL VALUE

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TABLE 2
SIDELOAD TEST RESULTS

SIDELOAD TEST RESULTS (1-3 @ 100% SIDELOAD ONLY)

1) PACKING LEAKAGE @ 180 psi: CRITERIA No Leakage TEST No Leakage

2) BIDIRECTIONAL SEAT LEAKAGE @ 60 ΔPSI: CRITERIA No Leakage

DIRECTION OF FLOW TEST No Leakage
REVERSE FLOW TEST No Leakage

3) STROKING TIMES & STROKING TIME CONSTANTS: CRITERIA Closing Time < 5 Sec.

			ACTUATOR SUPPLY PRESSURE	STROKING TIME	STROKING TIME CONSTANT
A) CYCLE 1,	ΔP= 60	, CL→OP	80 psi	10.0	6.75
	P= 60	, OP→CL	0	2.9	2.2
B) CYCLE 2,	ΔP= 60	, CL→OP	80 psi	10.0	6.75
	P= 60	, OP→CL	0	2.95	2.2
C) CYCLE 3,	ΔP= 60	, CL→OP	80 psi	10.0	6.75
	P= 60	, OP→CL	0	2.9	2.15
D) CYCLE 4,	ΔP= 60	, CL→OP	80 psi	10.0	6.75
	P= 60	, OP→CL	0	2.9	2.2
E) AVG. TIME	ΔP= 60	, CL→OP	80 psi	10.0	6.75
	P= 60	, OP→CL	0	2.91	2.19

F) MAXIMUM STROKING TIME CONSTANT CHANGE 2.3 % OF INITIAL VALUE**

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TABLE 2 (CONTINUED)

4) DEFLECTION MEASUREMENTS: CRITERIA No Structural Damage
TEST No Damage

% Side Load	Force	Gage 1	Gage 2	Gage 3	Gage 4	Gage 5	Disc
0	223	0	0	0	0	0	CLOSED
50	1223	.012	.003	.0015	-.005	0	CLOSED
75	1835	.0195	.004	.0025	-.0015	0	CLOSED
100	2446	.029	.007	.004	-.011	.0005	CLOSED
75	1835	.020	.0045	.0025	-.0075	0	CLOSED
50	1223	.013	.003	.0015	-.0075	0	CLOSED
0	223	.0005	0	0	0	0	CLOSED

DIAL INDICATOR LOCATIONS #1(+35-3/4); #2(+8-7/8"); #3(+4-3/4"); #4(-21-1/8"); #5(On Limit Switch Plate) [Ref. Shaft Axis, Upstream: +]

5) FAIL-SAFE OPERATION DURING DECREASING SIDELOAD Maintained Safety-related Position without Measureable Deviation

*Test Fluid Water
**See Table 1 for Initial Stroking Time Constants

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TABLE 3
SIDELOAD TEST RESULTS

POST-FUNCTIONAL TEST RESULTS*

1) PACKING LEAKAGE @ 180 psi: CRITERIA No Leakage TEST No Leakage

2) BIDIRECTIONAL SEAT LEAKAGE @ 60 ΔPSI: CRITERIA No Leakage

DIRECTION OF FLOW TEST No Leakage
REVERSE FLOW TEST No Leakage

3) STROKING TIMES & STROKING TIME CONSTANTS: CRITERIA Closing Time < 5 Sec.

			ACTUATOR SUPPLY PRESSURE	STROKING TIME	STROKING TIME CONSTANT
A) CYCLE 1,	ΔP= 60	CL→OP	80 psi	9.95	6.8
	P= 60	OP→CL	0	2.9	2.2
B) CYCLE 2,	ΔP= 60	CL→OP	80 psi	10.0	6.75
	P= 60	OP→CL	0	2.95	2.2
C) CYCLE 3,	ΔP= 60	CL→OP	80 psi	9.95	6.7
	P= 60	OP→CL	0	2.9	2.2
D) CYCLE 4,	ΔP= 60	CL→OP	80 psi	10.0	6.75
	P= 60	OP→CL	0	2.9	2.2
E) AVG. TIME	ΔP= 60	CL→OP	80 psi	9.98	6.75
	P= 60	OP→CL	0	2.91	2.2

F) MAXIMUM STROKING TIME CONSTANT CHANGE 2.3 % OF INITIAL VALUE**

*TEST FLUID Water
**SEE TABLE 1 FOR INITIAL STROKING TIME CONSTANTS

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CONCLUSION

All applicable criteria given in FTP-33 and in the Test Valve Data Sheet have been successfully met without exception by Vogtle Item 149.

Jon Milliken
J.B. Milliken
Evaluation & Analysis Department

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INSTRUMENTATION EQUIPMENT SHEET

DATE 9-24-84 PROBLEM NO. 1662 REPORT NO. 70 TEST AREA Seismic

TECHNICIAN Bob Roe TEST ENGINEER Jon Milliken TEST DESCRIPTION Static Sideload

NO.	INSTRUMENT	MANUFACTURER	MODEL NO.	SERIAL NO.	FISHER CONTROL NO.	USEABLE RANGE	ACCURACY	CALIBRATION	
								ON	DUE
1	Power Supply	Instant Instru.	LD5.2	None	None	+5V.			
2	" "	" "	LD15.2	"	"	±15V.			
3	RVDT		600-000	C-7	"				
4	Oscillograph	Gould	2007-6690	747	7514-2			7-84	1-85
5	DC Preamp	".	13-4615-00	9214	7526-4			9-84	3-85
6	" "	"	13-4615-10	9217	7521-8			"	"
7	" "	"	13-4615-10	1568	7521-6			7-84	1-85
8	Bridge Amp.	"	13-4615-30	827	7522-4			9-84	3-85
9	Power Supply	Hewlett Packard	6443B	None	2049-1	0-125V.	--	SET WITH FLUKE METER 4033-23 (7-84 New)	
10	Force Gage	Dillon	X-CT	9412	9405-1	+5000 Lb.		9-84	9-85
11	3/4" Turnbuckle	None	None	None	None				
12	I-Beam	"	"	"	"				
13	Bell Flanges	Ladish	"	"	"				
14	Bookend Pair	Fabricated	"	"	"				
15	Pressure Tank		"	"	"				
16	Pressure Gage	Marsh	2358	"	9609-2	0-300psi	±1% F.S.	5-84	5-85
17	Pressure Gage	"	"	"	9608-2	0-160psi	±1% F.S.	5-84	5-85
18	Dial Indicator	Starrett	25-3041	None	9902-6	0-2.25	±0.001	1-84	1-85

CALIBRATION GUIDELINES PER FTP-26

CHECKED BY Jon Milliken

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PROBLEM NO. 1662

REPORT NO. 70

INSTRUMENTATION EQUIPMENT SHEET

DATE 9-24-84 PROBLEM NO. 1662 REPORT NO. 70 TEST AREA Seismic

TECHNICIAN Bob Roe TEST ENGINEER Jon Milliken TEST DESCRIPTION Static Sideload

NO.	INSTRUMENT	MANUFACTURER	MODEL NO.	SERIAL NO.	FISHER CONTROL NO.	USEABLE RANGE	ACCURACY	CALIBRATION	
								ON	DUE
19	Dial Indicator	Starrett	25-3041	None	9902-4	0-3"	±0.001	1-84	1-85
20	" "	"	"	"	9902-5	0-3"	"	"	"
21	" "	"	"	"	9902-2	0-3"	"	"	"
22	" "	"	25-441	"	9901-2	0-1"	"	"	"
23	Pressure Transducer	C.E.C.	4-326-00	10932	--	0-100psi	CALIBRATED TO PRESS. GAGE #9806-2, EQUIP. ITEM#L&(±1F.S.)		
24	Box Beam	Fabricated	None	None	None				
25	Pressure Gauge	Marsh		"	9608-1	0-160	±1% F.S.	5-84	5-85
26	DC Preamp	Gould	13-4615-00	4861	7521-3			9-84	3-85

CALIBRATION GUIDELINES PER FTP-26 CHECKED BY Jon Milliken

PROBLEM NO. 1662

REPORT NO. 70

TEST VALVE DATA SHEET

Item No. 149 S/N 8670355 Assembly Drwg. 48A9882

Order No. 228-X5AC03-N2T Installation Drwg. 39A2460

Valve Body:	Actuator:	Appurtenances:
14" Type 9280 (RF X BWE)	Bettis NT316B-SR2-M3 (per 17A6601)	Namco EA 180-31302/32302 ASCO NPK8316A74E Type 262C Air Filter Type 95H Regulator Type H120 Relief Valve Ashcroft Pressure Gauge

ANSI B16.34 Body Class	Class 150
Rated Pressure at 100°F	275 Psig
Nominal Valve Stroke	90°
Valve Closure Time	5 Seconds
Nominal Actuator Supply	80 Psig
Allowable Seat Leakage	0
Seat Leak Test	60 Psid/5 Min.
Bi-Directional Seat Leak Test	60 Psid
Service Condition Pressure	-4.75 Inches W.C.
Service Pressure Drop	0.86 Inches W.C.
Valve Safety Related Function	Spring to Close
Measured Extended Structure Weight	895 Pounds
Measured Extended Structure C.G. (From Shaft Axis)	4.75 Inches
Extended Structure Uniaxial G-load	10.0 g
Calculated Lowest Natural Frequency/Axis	37.1 Hz/X
P_B (Shaft Packing)	180 Psig
P_L (Seat Leak)	60 Psid
P_S (Body Pressure for Stroking Tests)	60 Psig
Test Fluid	Water

NI1-32/ 1

NEAL RINEHART 15
7-23-82

FISHER

Memorandum

JB
7-23-82

To: Tom Buresh

From: Cynthia Alexander

Date: July 23, 1982

cc: Floyd Jury

Subject: Natural Frequency and Static Sideload Testing ; VOGTLE JON MILLIKEN

Reference: Vogtle 78EC07 PCO-1 (LWS 7-2-82 LIST)

PCO-1

Tom,

Since the time I submitted my request for lab work for the Vogtle project, several valves have been released from customer hold. A current list of required testing is attached. Please forward this list to the test engineer.

Thank you.

Cynthia Alexander

Cynthia Alexander

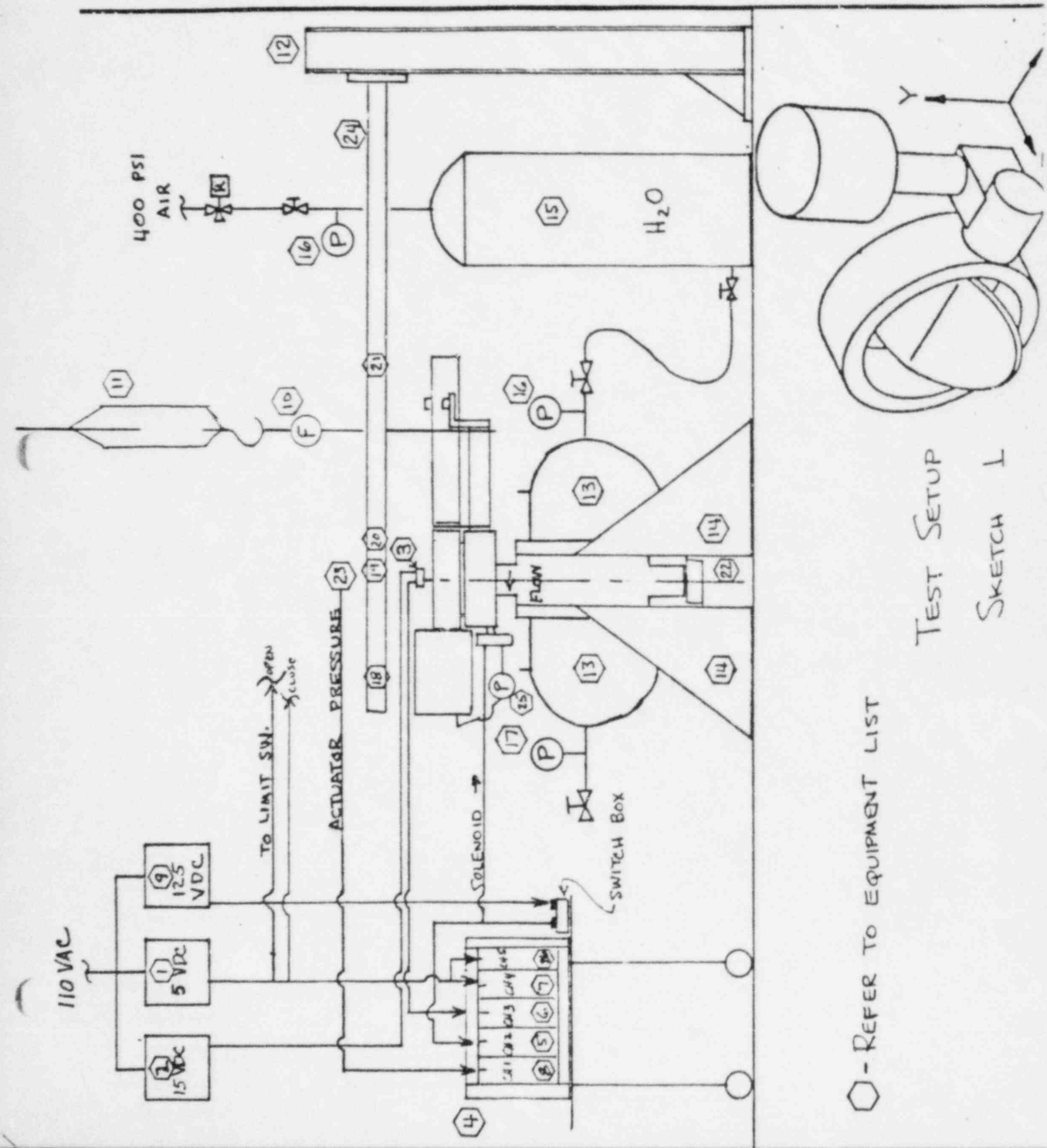
CA/ew

Fisher Controls

FISHER

Laboratory Report

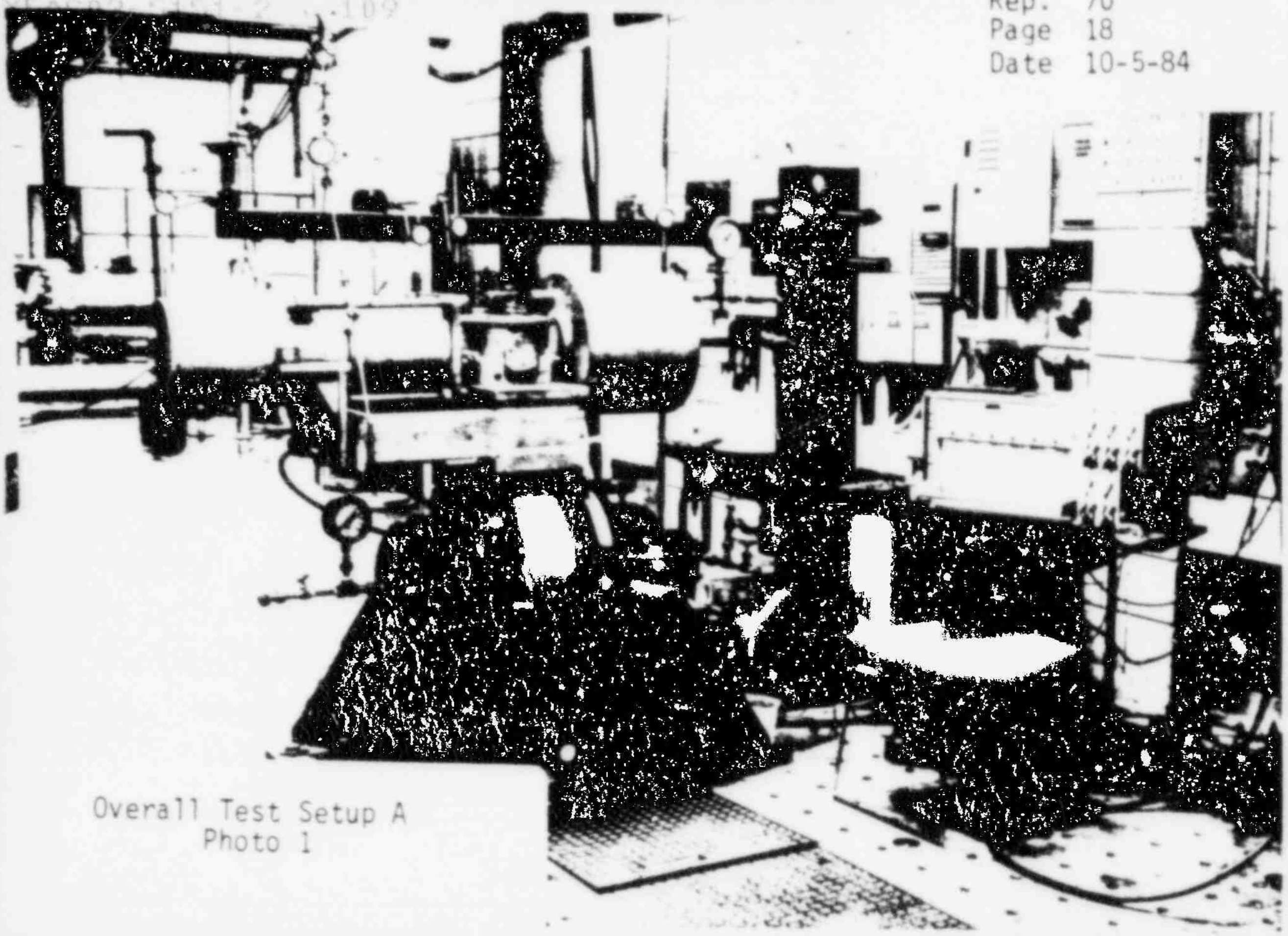
Problem	1662
Report	70
Page	17
Date	10-5-84



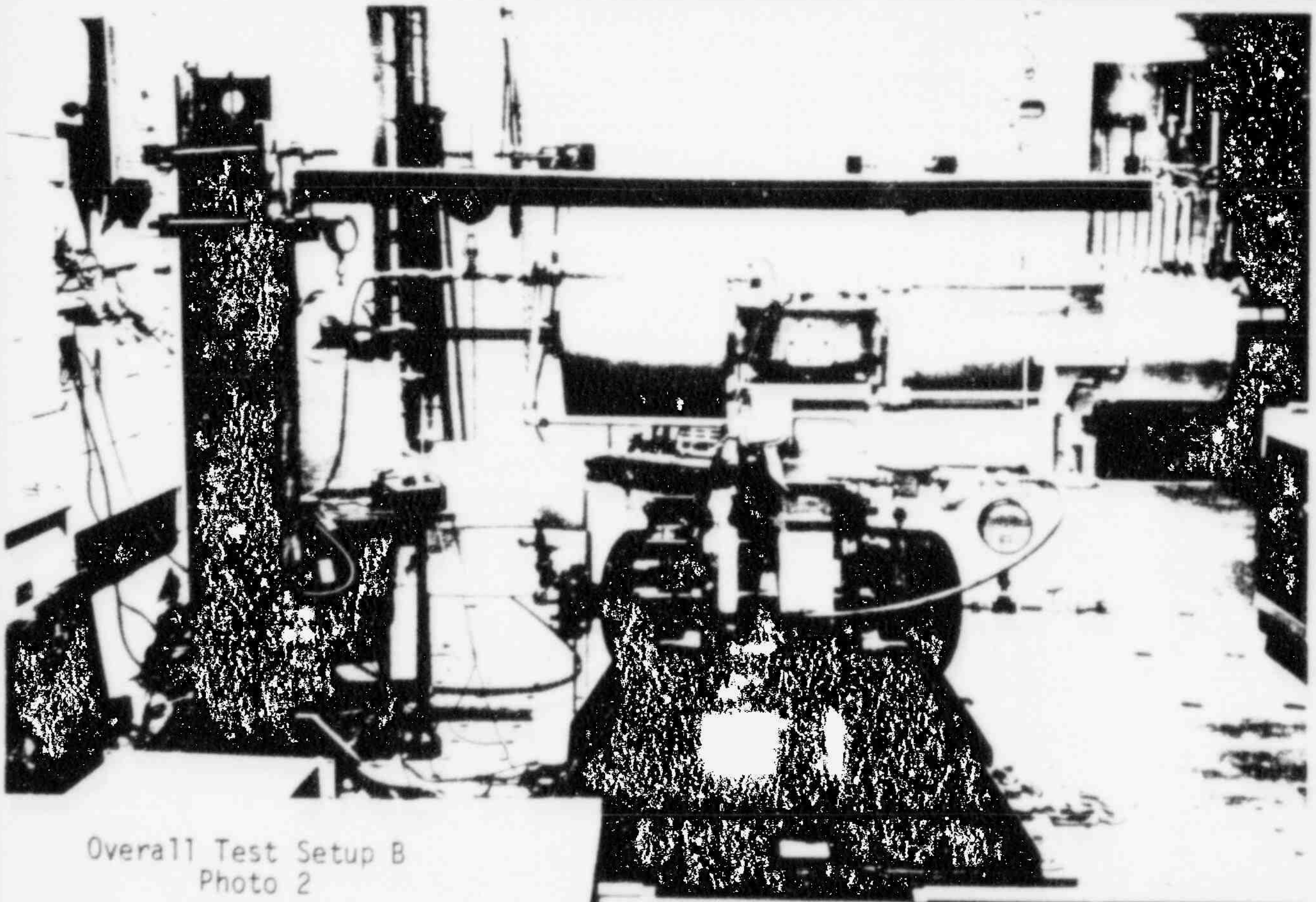
TEST SETUP

SKETCH 1

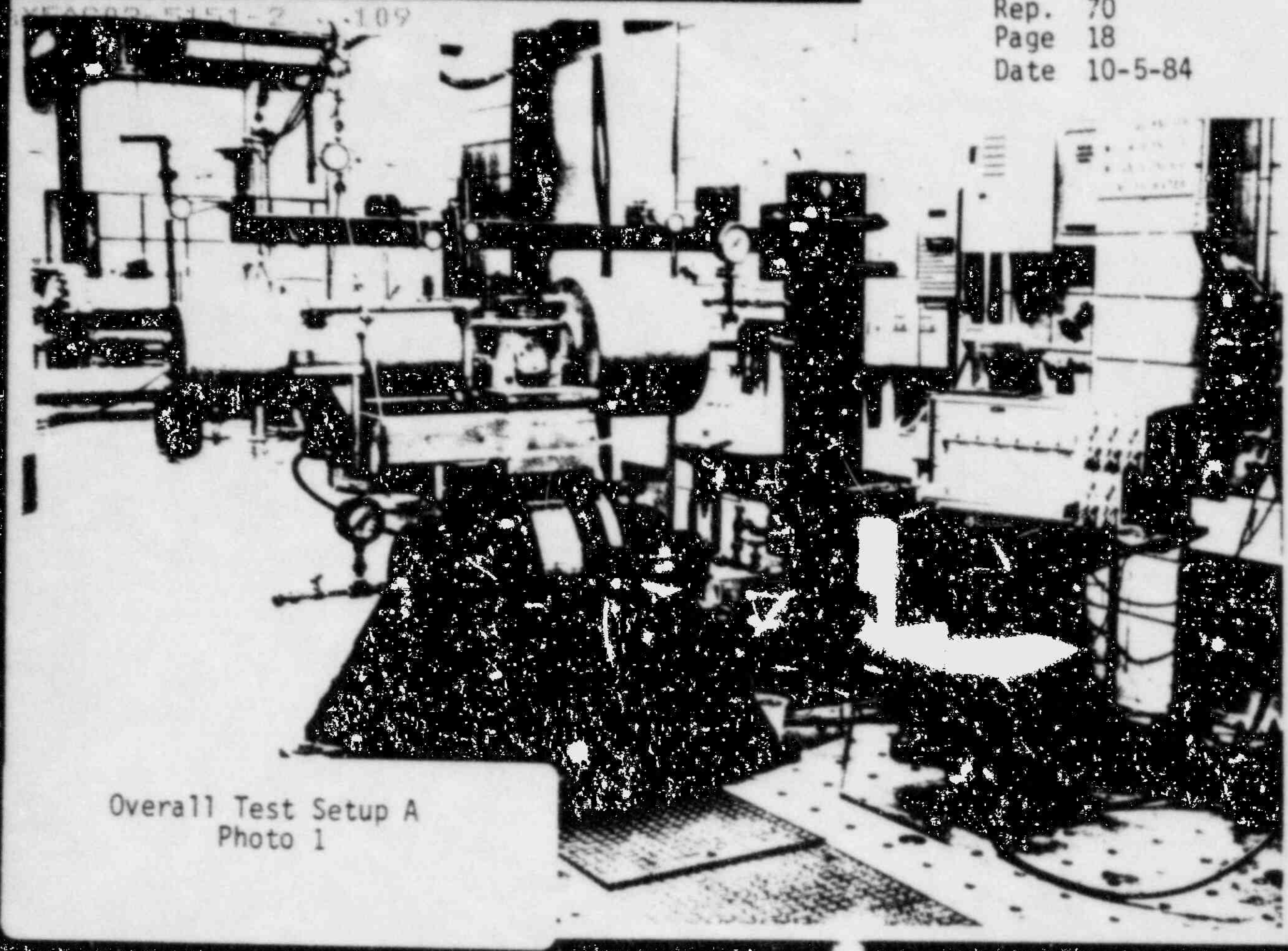
⬡ - REFER TO EQUIPMENT LIST



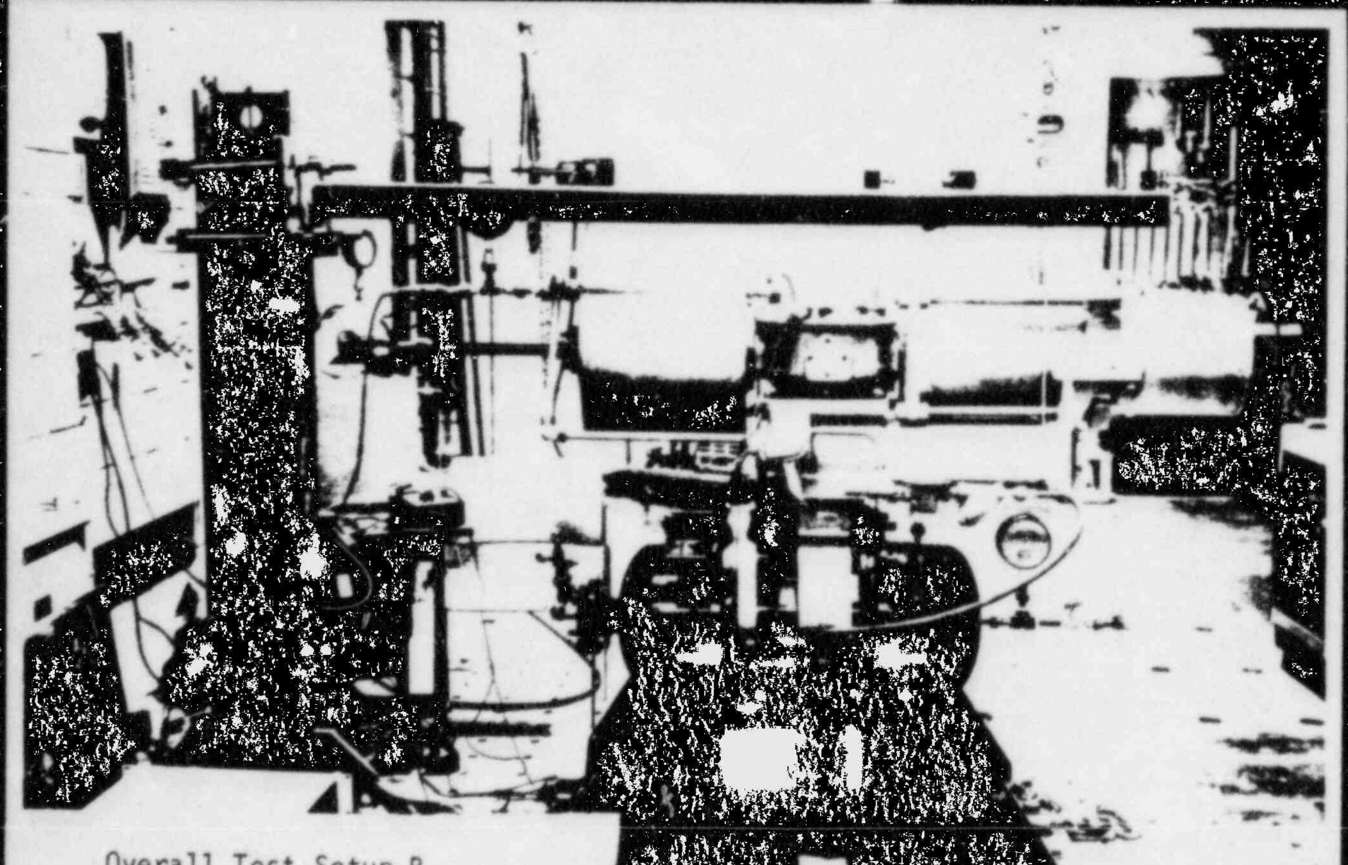
Overall Test Setup A
Photo 1



Overall Test Setup B
Photo 2



Overall Test Setup A
Photo 1



Overall Test Setup B
Photo 2

Dial Indicator Location
Photo 3

Revised
October 31, 1985

ATTACHMENT 5

FQP-11AB-7

Certificates of Compliance and Related Documentation

Bettis Actuators: NT-316-SR2-M3

NAMCO Limit Switches: EA180-31302/32302

ASCO Solenoids: NPK8316A74E

FISHER

Assembly Test Report

VALVE SERIAL NO 8669191	SIZE AND TYPE 14" 9280	CUSTOMER ORDER NO PAV-206	APR NO 79P126-2	DRAWING ~~NO.~~ 31A2459 48A9881	REV. 3
	CODE ASME BOILER & PRESSURE VESSEL CODE		TAG NO 1HV-2626B	REP. ORDER NO 22B-X5AC03-NIT	ITEM NO 179
	SECT III 19 74 EDITION WINTER 19 75 ADDENDA		STAMP ☒ YES ☐ NO CLASS 2	NCR NO'S	

ATh 79P126-2-2 REV. 0

ISSUED BY F. Hubbard DATE 11/7/83

REVISED BY DATE

CONTROLLED PARTS VERIFICATION

PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.
BODY	✓	AC6450-1	1G3801-1	Retaining Ring	✓	AC6448-1	P4506-2	Solenoid	✓	825446-1	
BONNET	✓			Disc	✓	AC6442-1	D4498-1	Solenoid	✓	570265-1	
VALVE PLUG				Disc Stop	✓	AC6447-1	2HTL SPEC A GR. 7[illegible]54-1				
STUDS				Switch	✓	780593-1					
NUTS				Switch	✓	780592-1					

PARTS VERIFIED BY ______________ Quality Assurance ______ Date ______________ Authorized Inspector ______ Date

SPECIAL PROCESSING, TESTING AND RESULTS

HOLD/WIT PTS ✓	CUST. INSP	HOLD PTS ✓	AUTH. INSP	DESCRIPTION	✓	PROCEDURE	REV	AMENDMENT	REV	TEST PRESSURE	TIME (MIN)	ALLOW LEAKAGE	FINAL RESULTS	SIGNATURE/DATE ASSEMBLER	FISHER INSP.
✓	See Attached ATR			HYDROSTATIC TEST	✓	FMP 2X14	1	AM-6	2	See Attached ATR					
✓				SEAT LEAK TEST 1st	✓	FMP 2X16	3	AM-8	1						
				DISC HYDRO	✓	FMP 2X14.1	0	AM-7	0	66	2	—	0 leak	Edwards	11/9/83
✓				seat Leak 2nd Direction	✓	FMP 2X16	3	AM-8	1	60	60	0	0 leak	Edwards	11/9/83
				DIAPH TO CASE LEAK TEST	✓	FMP 206.2	3	AM-21	0	— N/A —					
✓	12/22/83			OPERATIONAL TEST						SIGNAL:	TIME OPEN 12.50 sec	TIME CLOSE 3.30 sec			12-22-83
				HYSTERESIS TEST						MAX. ERROR:					
				Complete form FC 3790	✓										
✓	See Attached ATR			CLEANING PRIOR TO ASSEMBLY	✓	—		APR III.A		See Attached ATR					
				PAINTING	✓			APR IV.B							
				FINAL CLEANING											
				SEAL ENDS	✓	FMP 10L2	3	AM-12 APR V.B.	0					Edwards	12-22-83
✓			1-6-84	FINAL INSPECTION	✓										1/6/84
				ASME STAMP	✓									1-5-84	
✓				PACKAGING	✓	FMP 11A2	3	APR V.C							1-17-84

HOLD ANI

NOTE: Notify Customer Service for customer hold points. Notify authorized inspector for authorized inspector hold points.

APPROVED ______ DATE 11-7-83

REVIEWED AUTHORIZED INSPECTOR Kent Cocking DATE NOV 17 1983

Form 3131D

S/N 8669191

S/N 8669191

FISHER Controls

ASSEMBLY TEST REPORT

APR NO 79ITDC 2

ATR 79ITDC 2 1 REV 1

VALVE SERIAL NO 8669191

SIZE AND TYPE 14" 9280

CUSTOMER ORDER NO PAV-206

TAG NO 1HV-2626B

DRAWING NO 39A2459 48A9881 REV A A

REP ORDER NO 22B-X5AC03-NIT

ITEM NO 179

ISSUED BY EIH DATE 2/5/82

CODE ASME BOILER & PRESSURE VESSEL CODE

SECT III 19 74 EDITION, WINTER 19 75 ADDENDA

STAMP ☒ YES ☐ NO

CLASS 2

NCR NO'S

REVISED BY FJH DATE 4/28/82

CONTROLLED PARTS VERIFICATION

PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.	PART	✓	
BODY	✓	AC6450-1	1G3801-1	RETAINING RING	✓	AC6448-1	D4506-2	SOLENOID	✓	825446-1
BONNET				DISC	✓	AC6442-1	D4498-1	SOLENOID	✓	570265-1
VALVE PLUG				DISC STOP	✓	AC6447-1	75854-1			
STUDS				SWITCH	✓	780593-1				
NUTS				SWITCH	✓	780592-1				

PARTS VERIFIED BY Quality Assurance 9-13-83 Date

Authorized Inspector

GAGE # 216

Date

SPECIAL PROCESSING, TESTING AND RESULTS

HOLD ANI

HOLD/WIT PTS ✓	CUST. INSP	HOLD PTS ✓	AUTH INSP	DESCRIPTION	✓	PROCEDURE	REV	AMENDMENT	REV	TEST PRESSURE	TIME (MIN)	ALLOW LEAKAGE	FINAL RESULTS	SIGNATURE/DATE ASSEMBLER	SIGNATURE/DATE FISHER INSP	
✓				HYDROSTATIC TEST	✓	FMP 2X14	1	Am-6	2	450	29	0	0-Leak			10/5/83
✓				SEAT LEAK TEST	✓	FMP 2X16	3	Am-8	1	60	5	0	0-LEAK	Edwards		11/3/83
				DISC HYDRO												
				DIAPH TO CASE LEAK TEST												
✓				OPERATIONAL TEST	✓	FMP 206.2	3	Am-21	0	SIGNAL:	TIME OPEN 12.50 SEC	TIME CLOSE 3.30 SEC			—	
				HYSTERESIS TEST						MAX. ERROR:						
				COMPLETE FORM FC 3790	✓											
				CLEANING PRIOR TO ASSEMBLY	✓	APR III.A								Edwards	10-28-83	
				PAINTING	✓	APR IV A 1A	2									
				FINAL CLEANING												
				SEAL ENDS	✓	APR V. D.										
✓				FINAL INSPECTION	✓											1/6/84
				ASME STAMP	✓									1-5-84		
✓				PACKAGING	✓	APR V.C.										

HOLD ANI

NOTE: Notify Customer Service for customer hold points. Notify authorized inspector for authorized inspector hold points.

APPROVED QUALITY ASSURANCE 2-5-82 DATE

Kent Cockerig REVIEWED AUTHORIZED INSPECTOR SEP 7 1983 DATE

Form 31310

S/N 866919|

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY Tom L. DATE 1/3/83

PURCHASE ORDER NO. S181294-002

PURCHASE REQ. NO. 780592

REP. ORDER NO. 22B-XSP:03-NIT

ITEM NO. 0179

QUANTITY 1

RIPTION [illegible]

SIZE 14

TYPE 9280

MATERIAL TYPE supplier Standard

PROJECT NO. 79P126

PIECE SERIAL NO. 780592-1

A4157X022P

ROUGH DRAWING NO. ——————

REV.

FINISHED DRAWING NO. 15A4157

REV B

EGS 13A1, 13F1

____ 19 ___ EDITION ____ 19 ___ ADDENDA

NUC. CLASS NA

STAMP ☐ YES ☒ NO

HOLD POINTS			INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
CUST. INSP.	✓	AUTH. INSP.			
			INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	G. Muller	1-24-83
			RECORD HEAT NUMBER ____ LOT NUMBER 5282K33611 VENDOR Manno Controls	G. Muller	1-24-83
			STAMP PIECE SERIAL NO. ON PART		
			STORE MATERIAL		
			Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ____ DATE ____ A.I. REVIEW ____ DATE ____

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

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S/N 866919I

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY Tom L. DATE 11/3/82

PURCHASE ORDER NO. S181294-002

PURCHASE REQ. NO. 780592

REP. ORDER NO. 22B-XSAC03-NIT

ITEM NO. 0179

QUANTITY 1

DESCRIPTION MED Switch

SIZE 14

TYPE 9280

MATERIAL TYPE Supplier Standard

PROJECT NO. 79P126

PIECE SERIAL NO. 780592-1

PART NO. 15A4157X0221

ROUGH DRAWING NO. ______

REV

FINISHED DRAWING NO. 15A4157

REV B

CODE: EGI 13A1, 13F1

SECT ______ 19 ___ EDITION ______ 19 ___ ADDENDA

NUC. CLASS NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
√	CUST. INSP.	√	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	G. Muller	1-24-83
				RECORD HEAT NUMBER ______ LOT NUMBER 5282K33611 VENDOR Manno Controls	G. Muller	1-24-83
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ______ DATE ______

A.I. REVIEW ______ DATE ______

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

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8510-AX5AC03-5151-2 115

NAMCO CONTROLS
an Acme-Cleveland Company
1300 Burris Road (P. O. Box 730)
Newton, NC 28658

S/N 8669191

QUALITY CONTROL PROCEDURE

Certification of Compliance

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. A. Documentation Department

PURCHASE ORDER NUMBER S 181294 ITEM NUMBER 000

CUSTOMER PART NUMBER 15A4157X022

NAMCO PART NUMBER EA180-31302 B/M REV. K QTY. 2

LOT NUMBER 33611 DATE CODE 5282

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-41769 DATE SHIPPED 1/14/83

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS.

NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2, AS APPLICABLE.

NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180 SWITCH SERIES, WHICH WAS QUALIFIED TO IEEE STANDARDS 323(1974), 344(1975), AND 382(1972), PER REPORT NO. QTR-105.

1/14/83
DATE

Frank J Napoli
QUALITY ASSURANCE MANAGER

9510-AX5AC03-5151-2 116

S/N 866919I

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S			ISSUED BY Tom L.	DATE 11/3/82
PURCHASE ORDER NO. S181286-002	PURCHASE REQ. NO. 780593	REP. ORDER NO. 228-X5AC03-NIT	ITEM NO. 0179	QUANTITY 1

DESCRIPTION amco Switch	SIZE 14	TYPE 9280	MATERIAL TYPE Supplier Standard	PROJECT NO. 79P126	PIECE SERIAL NO. 780593-1

PART NO. 15A5650X392P	ROUGH DRAWING NO. ———	REV.	FINISHED DRAWING NO. 15A5650	REV NA

CODE FGS 13A1, 13F1

SECT ________ 19 ____ EDITION ____________ 19 ____ ADDENDA

NUC. CLASS NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	G Miller	1-24-83
				RECORD HEAT NUMBER ________ LOT NUMBER 0283K32101 VENDOR Ramco controls	G. Miller	1-24-83
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL	FCG QA LRH	
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ____________ DATE ________ A.I. REVIEW ____________ DATE ________

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

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S/N 8669191

NAMCO CONTROLS
an Acme-Cleveland Company
1300 Burris Road (P. O. Box 730)
Newton, NC 28658

QUALITY CONTROL PROCEDURE

Certification of Compliance

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. A. Documentation Department

PURCHASE ORDER NUMBER S 181286 ITEM NUMBER 000

CUSTOMER PART NUMBER

NAMCO PART NUMBER EA180-32302 B/M REV. K QTY. 2

LOT NUMBER 32101 DATE CODE 0283

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-41768 DATE SHIPPED 1/14/83

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS.

NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2, AS APPLICABLE.

NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180 SWITCH SERIES, WHICH WAS QUALIFIED TO IEEE STANDARDS 323(1974), 344(1975), AND 382(1972), PER REPORT NO. QTR-105.

1/14/83
DATE

Frank J. Napoli
QUALITY ASSURANCE MANAGER

S/N 8669191

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.:
ISSUED BY: Tom L
DATE: 6/22/83

PURCHASE ORDER NO.	PURCHASE REQ. NO.	REP. ORDER NO.	ITEM NO.	QUANTITY
S181979-104	570265	22B-X5AC03-NIT	0179	1

DESCRIPTION	SIZE	TYPE	MATERIAL TYPE	PROJECT NO.	PIECE SERIAL NO.
Solenoid	14	9280	suppliers Standard	79P126	570265-1

PART NO.	ROUGH DRAWING NO.	REV.	FINISHED DRAWING NO.	REV.
1M3429X0452	———		1M3429	NA

CODE: FGS 13A1, 13E10
SECT ____ 19 ____ EDITION ____ 19 ____ ADDENDA
NUC. CLASS: NA
STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	L. Schwenebart	8/24/83
				RECORD HEAT NUMBER ____ LOT NUMBER 43243M-4 VENDOR Automatic Switch	L. Schwenebart	8/24/83
				STAMP PIECE SERIAL NO. ON PART	FC AUG 24 1983	
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ____ DATE ____ A.I. REVIEW ____ DATE ____

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

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S/N 8669191

Automatic Switch Co.

Manufacturers of
DEPENDABLE CONTROL
Since 1888

ASCO

FLORHAM PARK, NEW JERSEY 07932 · N.J. (201) 966-2000 / N.Y. (212) 344-3765

CERTIFICATE OF COMPLIANCE

Customer Name FISHER CONTROLS INTERNATIONAL, INC.

Customer P.O. No. S181979

Consignee

Consignee P.O. No.

ASCO Shop Order No. 43243M

ASCO Part No. NPK 8316A-74-E Quantity 5

Voltage 125/DC Eng. Job No.

This is to certify that the subject valve(s) meet the performance requirments of IEEE-323-1974, IEEE-344-1975, IEEE-382-1980 (Revision of IEEE-382-1972) and IEEE-627-1980, as substantiated by testing valves of generically equal design in accordance with ASCO Qualification Specification AQS-21680/Rev. C, dated July 13, 1981. The following test levels were included in this qualification test program:

I. Aging Simulation Phases:

- A. Thermal Aging Simulation - 250°F for 18¼ days. These aging parameters were determined by Arrhenius calculations to simulate a minimum of 8 years in a 140°F continuous ambient. Refer to Figure 1 for additional information regarding service periods for elastomeric components and Figure 2 for additional information regarding service periods for solenoid coils.
- B. Wear Aging Simulation - 20,000 operations at maximum operating pressure differential and nominal voltage. Ten percent of the wear aging simulation (2,000 cycles) was conducted concurrently with the thermal aging simulation.
- C. Pressurization Aging Simulation - 15 ambient pressure excursions from atmospheric pressure to 80 psig to simulate the expected periodic pressurization of the containment for leak testing during the life of the plant.
- D. Radiation Aging Simulation - 20 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate expected non-accident radiation exposure.
- E. Vibration Aging Simulation - Continuous sinusoidal sweeps from 5 to 200 to 5 Hz at a rate of 2 octaves per minute, with a minimum peak acceleration level of 0.75g (except at low frequencies where the acceleration level was reduced such that the displacement did not exceed 0.025" double amplitude), for a minimum of 90 minutes in each of three orthogonal axes. The test valves were alternately de-energized or energized every 15 minutes during this exposure. The valves were attached to the shaker table by rigid test fixtures using the standard valve mounting provisions with the solenoids (Solenoid 'A' for NP8323 valves) vertical and upright. Flexible hoses were used on all ports; therefore, the set-up did not affect the rigidity or mass of the valves being tested.
- F. Seismic Aging (OBE) Simulation and Resonance Testing - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to two sinusoidal sweeps from 1 to 35 to 1 Hz, with a peak acceleration level (within machine limits) of 3g, in each of three orthogonal axes at a rate of not more than 1 octave per minute. One sweep in each axis was conducted with the valves energized and the other with the valves de-energized. These sinusoidal sweeps are considered to provide the equivalent dynamic effect of 5 OBE's. During this testing, accelerometers were attached to the solenoids of the test valves to determine if the valves exhibited any resonance. Resonance is defined as a response with a magnitude of acceleration at least twice as great as the input acceleration. No valve resonances were detected.

ASCO SHOP ORDER NO. 43243M

S/N 8669191

II. Design Basis Event (DBE) Phases:

A. Seismic DBE (SSE) Simulation - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to a series of single-frequency, single-axis sine-beat tests at 37 test frequencies between 1 and 35 Hz. The excitation was in the form of a continuous series of sine beats, with 12-15 oscillations per beat, for a minimum duration of 15 seconds at each test frequency. The successive beats were phased such that any superposition of response motion was additive. At each test frequency, the peak input acceleration was increased (up to 15g maximum) and the g-levels were recorded at which the cylinder port pressure (zero when de-energized and full inlet pressure when energized for a normally closed valve, opposite for a normally open valve) differed from the nominal by 0%, 5% and 10% of inlet pressure. The valves are considered to function properly up to a 10% change in cylinder port pressure. This level was selected as being sufficiently low to prevent spurious shifting of the customer's main valve or other equipment. Motion was applied at the same frequency and acceleration limits in each of the three orthogonal axes separately. Based on this testing and/or additional testing conducted by ASCO using single-frequency continuous sinusoidal inputs (after consideration of margin as suggested in IEEE-323-1974), the following acceptable maximum acceleration levels have been determined:

11.2g

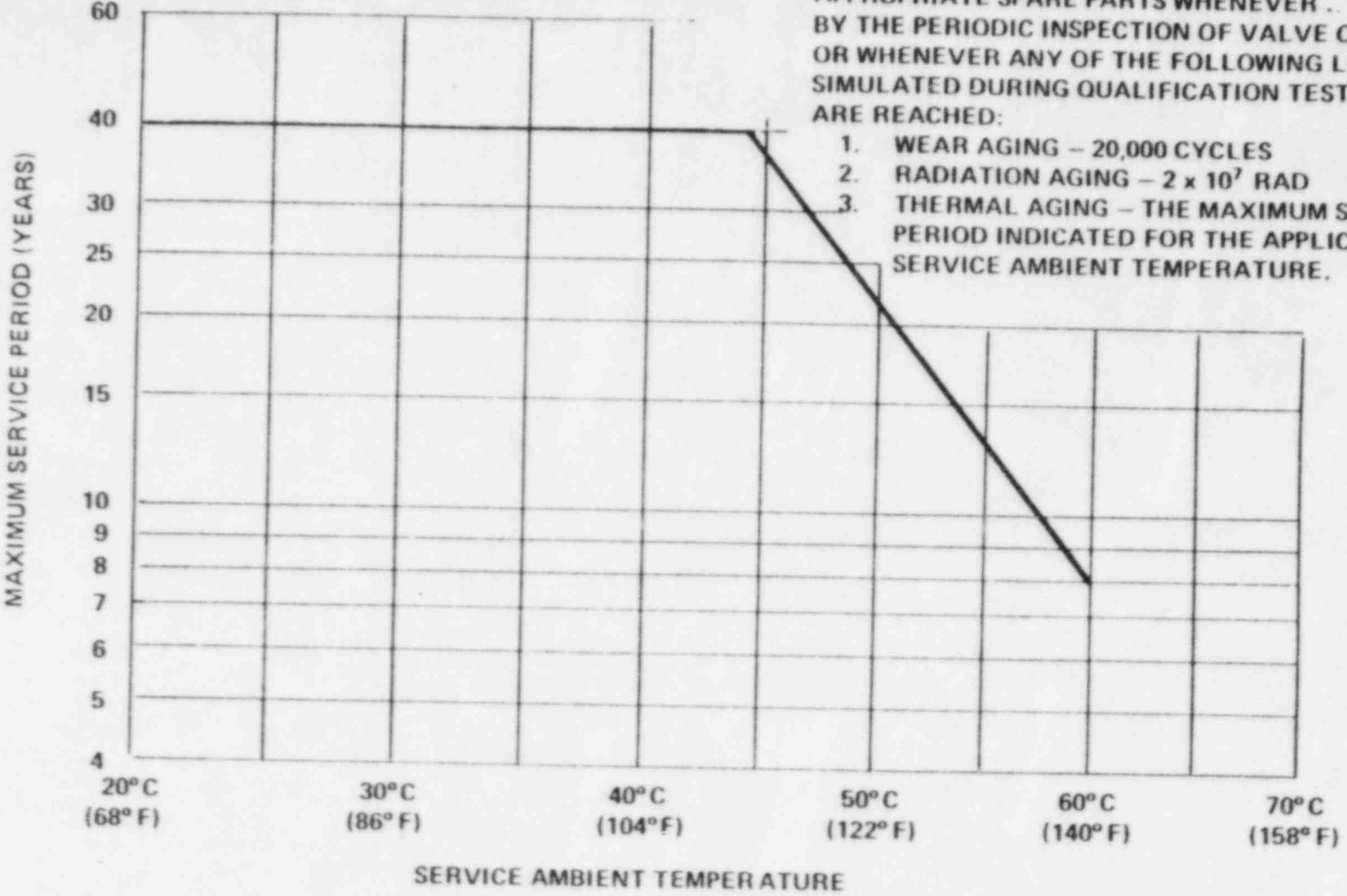
B. Radiation DBE Simulation - 180 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate (after consideration of margin as suggested in IEEE-323-1974) at least 163 megarads of accident radiation exposure.

C. Environmental DBE Simulation - The valves were installed in a pressure vessel and subjected to a 30-day exposure to steam, chemical spray and clear water spray simulating a combined loss-of-coolant accident/high-energy-line-break event and post event cool-down. The peak ambient temperature of the simulation was 420°F and the peak ambient pressure was 70 psig. The valves were pressurized to maximum operating pressure and continuously energized for 4 hours prior to the first transient (to produce thermal saturation of the solenoid coils). They were de-energized when the temperature of the first transient reached 420°F (to demonstrate the ability to perform a typical safety function) and were normally de-energized but were cycled periodically during the 30-day exposure to demonstrate the ability to operate on demand. The qualified temperature profile demonstrated by this simulation (after consideration of margin as suggested in IEEE-323-1974) is shown in Figure 3.

Test Report AQR-67368 is on file at Automatic Switch Company in Florham Park, N.J., and is available for customer perusal.

Dated AUGUST 15, 1983 Authorized Signature

QUALITY CONTROL MANAGER



NP-1 VALVES SHOULD BE REBUILT USIN[illegible] THE APPROPRIATE SPARE PARTS WHENEVER [illegible]CATED BY THE PERIODIC INSPECTION OF VALVE COMPONENTS OR WHENEVER ANY OF THE FOLLOWING LEVELS SIMULATED DURING QUALIFICATION TESTING, ARE REACHED:

1. WEAR AGING – 20,000 CYCLES
2. RADIATION AGING – 2×10^7 RAD
3. THERMAL AGING – THE MAXIMUM SERVICE PERIOD INDICATED FOR THE APPLICABLE SERVICE AMBIENT TEMPERATURE.

FIGURE 1

MAXIMUM SERVICE PERIODS FOR ELASTOMERIC COMPONENTS IN ASCO CATALOG NP-1 VALVES

Page 3 of 5

Form VE 3239R1

S/N 56691

9510-AXSAC03-5151-2 122

S/N 8669191

AUTOMATIC SWITCH CO.

Florham Park, N.J. 0 32

NUCLEAR VALVE TEST LOG

ORDER DATA
(To be completed by Valve Sales)

CUSTOMER Fisher Controls

P.O. NO. 181979 S. O. NO. 43243M

CATALOG NO. NPK 8316A74E QTY. ____

CONSIGNEE Fisher Controls

CONSIGNEE P.O. ____

SALES ENGINEER
(Signed) T. Hays DATE 8-12-83

TEST DATA
(To be completed by Test Dept. Supervisor)

ASCO DWG. NO. NVA 208 279 CHG. LTR —

ASCO TEST PROCEDURE NP8316 CHG. LTR G

TEST MEDIUM Air

TEST .080 AMPS/V[illegible]E (Cross Out One)

TEST DEPT. (Signed) Browne DATE 8-12-83

CONFORMANCE TO TEST REQUIREMENT. (To be completed by Test Dept.) – a check (✓) indicates conformance to test requirements as listed in above test procedure.

SERIAL NUMBER	COIL TEST	SEAT LEAKAGE				OPERATIONAL TEST		EXTERNAL LEAKAGE	HYPOT TEST	NOISE TEST	
		DE-ENERGIZED		ENERGIZED							
43242M	[illegible]/Volts 644	● 175 PSIG	● 10 PSIG	● 175 PSIG	● 10 PSIG	175 PSIG MAX	10 PSIG MIN	SEAM TEST 250 PSIG	(Volts/Time) 1250 V 1 MIN.	N/A	
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
4	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
5	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	

I HEREBY CERTIFY THE ABOVE RESULTS ARE A TRUE RECORD OF EACH ITEM INDICATED

☐ TESTER (Signed) Robert Evans DATE 8/15/83

☐ ASCO QUALITY CONTROL (Signed) ____ DATE ____

☐ CUSTOMER REPRESENTATIVE (Signed) ____ DATE ____

☐ GOV'T. QUALITY ASSURANCE REPRESENTATIVE (Signed) ____ DATE ____

Form Mfg 3273N

S/N 8669191

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S		ISSUED BY Tom L.	DATE 11/3/86	
PURCHASE ORDER NO. S181282-002	PURCHASE REQ. NO. 780590	REP. ORDER NO. 22B-X5AC03-NIT	ITEM NO. 0179	QUANTITY 1

T DESCRIPTION Bettis Actuator	SIZE 14	TYPE 9280	MATERIAL TYPE suppliers Standard	PROJECT NO. 79P126	PIECE SERIAL NO. 780590-1

PART NO. 17A6601X112P	ROUGH DRAWING NO. —	REV.	FINISHED DRAWING NO. 17A6601	REV B

CODE: EGS 13A1, 13C1

SECT ______ 19 ____ EDITION ______ 19 ____ ADDENDA

NUC. CLASS: NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55		6/09/83
				RECORD HEAT NUMBER ______ Ser. NUMBER 82-9056-2 VENDOR Bettis Corp.		6/09/83
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL	FCI QA JUN 9 1983	
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ______ DATE ______

A.I. REVIEW ______ DATE ______

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

258 Printed in U.S.A.

7510-AX5AL03-5151-2 124

S/N 8669191

GH BETTIS

A Galveston-Houston Company

4901 Woodway
P.O. Box 849
Houston, Texas 77001
(713) 960-9494 Telex 76 2713

May 31, 1983

Fisher Control Co.
P. O. Box 190
Marshalltown, Iowa 50158

Attention: Mr. Larry Rathje

Subject: Certification of Compliance for the Fisher Control Purchase Order 181282; G.H. Bettis Sales Order 82-9056-00

Dear Mr. Rathje:

This letter is to certify that the equipment furnished on line number 01 our sales order, item 1 your purchase order, were manufactured, assembled, and tested in accordance with written G.H. Bettis Engineering Specifications and Standards, and the G.H. Bettis Qualification Test Report 37274.

Units Shipped:

Qty.	Model	G.H. Bettis P/N	Serial Number
2	NT-316-SR2-M3	49470	1 & 2

Cordially,
GH BETTIS COMPANY

Anthony T. Locascio

Anthony T. Locascio
Quality Assurance Manager

ATL:jw
cc: File

S/N. 8672366

FISHER

Assembly Test Report

R NO. 79P126-2

DRAWING NO. 39A2461 48A9883

REV. 4

ATR 79P126-2-2

REV. 0

SIZE AND TYPE 14" 9280

CUSTOMER ORDER NO. PAV-206

TAG NO. 1HV-2627B

REP. ORDER NO. 22B-XSAC03-NIU

ITEM NO. 180

ISSUED BY F. Hubbard DATE 11/7/83

VALVE SERIAL NO. 8672366

CODE ASME BOILER & PRESSURE VESSEL CODE

SECT. III 19 74 EDITION WINTER 19 75 ADDENDA

STAMP ☒ YES ☐ NO

CLASS 2

NCR NO.'S

REVISED BY DATE

CONTROLLED PARTS VERIFICATION

PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.
BODY	✓	AC7219-1	1G3801-3	Retaining Ring	✓	AC7217-1	D4442-1				
BONNET	✓			Disc	✓	AC7211-1	D4086-1				
VALVE PLUG				Disc Stop	✓	AC7216-1	MATL SPEC A GR. 75854-1				
STUDS											
NUTS											

PARTS VERIFIED BY ______ Quality Assurance ______ Date ______ Authorized Inspector ______ Date

SPECIAL PROCESSING, TESTING AND RESULTS

HOLD/WIT PTS CUST. INSP.	HOLD PTS AUTH. INSP.	DESCRIPTION	✓	PROCEDURE	REV	AMENDMENT	REV	TEST PRESSURE	TIME (MIN)	ALLOW LEAKAGE	FINAL RESULTS	SIGNATURE/DATE ASSEMBLER	SIGNATURE/DATE FISHER INSP.
✓ See Attached ATR		HYDROSTATIC TEST	✓	FMP 2X14	1	AM-6	2	—	See	Attached		ATR	
		SEAT LEAK TEST 1st	✓	FMP 2X16	3	AM-8	1	60	5	0	0 leak	Edward	11/10/83
		DISC HYDRO	✓	FMP 2X14.1	0	AM-7	0	66	2	—	0 leak	Edward	11/10/83
		Seat Leak 2nd Direction	✓	FMP 2X16	3	AM-8	1	60	40	0	0 leak	Edward	11/10/83
		DIAPH TO CASE LEAK TEST	✓	FMP 206.2	3	AM-21	0	—	N/A				
12-20-83		OPERATIONAL TEST						SIGNAL:	TIME OPEN 6.70	TIME CLOSE 2.9		12-20-83	12-29-83 B. Dickens
		HYSTERESIS TEST						MAX. ERROR:					
		Complete Per EC 3790	✓										
✓ See Attached ATR		CLEANING PRIOR TO ASSEMBLY	✓	—		APR III.A		— See Attached				ATR	
		PAINTING	✓			APR IV.B					OK		1-20-84
		FINAL CLEANING											
12-21-83		SEAL ENDS	✓	FMP 10L2	3	AM-12 APR V.B.	0					Edward	12-21-83
	1-6-84	FINAL INSPECTION	✓										1/6/84
	HOLD AN I	STAMP	✓									1-5-84	
		PACKAGING	✓	FMP 11A2	3	APR V.C							1-24-84

NOTE: Notify Customer Service for customer hold points. Notify authorized inspector for authorized inspector hold points.

F. Perez APPROVED

11-7-83 DATE

Kent Cocking REVIEWED AUTHORIZED INSPECTOR

NOV 9 1983 DATE

1-24-84

Form 3131D

S/N 8672366

FISHER Controls

ASSEMBLY TEST REPORT

VALVE SERIAL NO 8672366	SIZE AND TYPE 14" 9280	CUSTOMER ORDER NO PAV-206	APR NO 79P12C 2 TAG NO 1HV-2627B	DRAWING NO 39A 2461 48A 9883 REP ORDER NO 22B-XSAC03-NIU	REV A A ITEM NO 180	ATR 79P12C 2-1 REV 1 ISSUED BY EJH DATE 2/5/82 REVISED BY FJH DATE 4/28/82

CODE ASME Boiler & Pressure Vessel Code

SECT III 19 74 EDITION Winter 19 75 ADDENDA

STAMP ☒ YES ☐ NO CLASS 2

NCR NO S

CONTROLLED PARTS VERIFICATION

PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.	PART	✓
BODY	✓	AC7219-1	1G3801-3	Retaining Ring	✓	AC7217-1	P4442-1		
BONNET				Disc	✓	AC7211-1	P4086-1		
VALVE PLUG				Disc Stop	✓	AC7216-1	75854-1		
STUDS									
NUTS									

PARTS VERIFIED BY D. Crenzon 9-13-82 GAGE 216
Quality Assurance Date Authorized Inspector Date

SPECIAL PROCESSING, TESTING AND RESULTS

HOLD/WIT CUST ✓	HOLD PTS AUTH. INSP	DESCRIPTION	✓	PROCEDURE	REV	AMENDMENT	REV	TEST PRESSURE	TIME (MIN)	ALLOW LEAKAGE	FINAL RESULTS	SIGNATURE/DATE ASSEMBLER	SIGNATURE/DATE FISHER INSP.
✓ HOLD ANI		10-26-83 HYDROSTATIC TEST	✓	FMP 2X14	1	Am-6	2	450	29	0	no leak		Bud Simio 10/26/83
✓		SEAT LEAK TEST	✓	FMP 2X16	3	Am-8	1	60	5	0			
		DISC HYDRO											
		DIAPH TO CASE LEAK TEST											
✓		OPERATIONAL TEST	✓	FMP 226-2	3	Am-21	0	SIGNAL:	TIME OPEN 12.7 sec.	TIME CLOSE 29 sec		12-20-83	B. Vickers 12-20-83
		HYSTERESIS TEST						MAX. ERROR:					
		complete form FC 3280	✓										
		CLEANING PRIOR TO ASSEMBLY	✓	APR III A								Edward	10-27-83
		PAINTING	✓	APR IV A2	2	Am-33	0						
		FINAL CLEANING											
		SEAL ENDS	✓	APR V B.									
✓ HOLD ANI		FINAL INSPECTION	✓										J Hatcher
		ASME STAMP	✓									1-5-84	1/6/84
✓		PACKAGING	✓	APR X C.									

NOTE: Notify Customer Service for customer hold points. Notify authorized inspector for authorized inspector hold points.

F Perez 2-5-82 Kent Cocking SEP 7 1983
APPROVED QUALITY ASSURANCE DATE REVIEWED AUTHORIZED INSPECTOR DATE

S/N 8672366

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY: Tony
DATE: 3/24/83

PURCHASE ORDER NO.	PURCHASE REQ. NO.	REP. ORDER NO.	ITEM NO.	QUANTITY
S181676-001	829415	226-XSAC03-N1M	0180	1

DESCRIPTION	SIZE	TYPE	MATERIAL TYPE	PROJECT NO.	PIECE SERIAL NO.
Amco Switch		EA180-31302	Suppliers Standard	79P126	829415-1

PART NO.	ROUGH DRAWING NO.	REV.	FINISHED DRAWING NO.	REV.
15A4157X022P	———		15A4157	6

CODE: NA

SECT ______ 19 ___ EDITION ______ 19 ___ ADDENDA

NUC. CLASS: NA

STAMP ☐ YES ☒ NO

HOLD POINTS ✓	CUST. INSP.	✓	AUTH. INSP.	INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	Mike Wood	4-8-83
				RECORD HEAT NUMBER ______ LOT NUMBER ______ VENDOR ______		
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL	FCC QA APR 13 1983 LRH	
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ______ DATE ______ A.I. REVIEW ______ DATE ______

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

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951 151-2 128
NAMCO CONTROLS
an Acme-Cleveland Company
1300 Burris Road (P. O. Box 730)
Newton, NC 28658

S/N 8672366

QUALITY CONTROL PROCEDURE

Certification of Compliance

Fisher Controls Companh
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. A. Documentation Dept.

PURCHASE ORDER NUMBER S 181676 ITEM NUMBER 001

CUSTOMER PART NUMBER 15A4157X022

NAMCO PART NUMBER EA180-31302 B/M REV. K QTY. 1

LOT NUMBER 31648 DATE CODE 1283

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-43331 DATE SHIPPED 3/30/83

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS.

NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2, AS APPLICABLE.

NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180 SWITCH SERIES, WHICH WAS QUALIFIED TO IEEE STANDARDS 323(1974), 344(1975), AND 382(1972), PER REPORT NO. QTR-105.

3/30/83
DATE

Frank J Napoli
QUALITY ASSURANCE MANAGER

9510-AX5AC03-5151-2   128

S/N 8672366

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY Tmd   DATE 10/13/82

PURCHASE ORDER NO. S181172-002

PURCHASE REQ. NO. 781899

REP. ORDER NO. 228-X5AC03-N1U

ITEM NO. 0180

QUANTITY 1

DESCRIPTION MANCO Switch

SIZE 14

TYPE 9280

MATERIAL TYPE Supplier Standard

PROJECT NO. 79P126

PIECE SERIAL NO. 781899-1

PART NO. 15A5650X392

ROUGH DRAWING NO. ____________

REV.

FINISHED DRAWING NO. 15A5650

REV. NA

CODE: FGS 13A1, 13E1

SECT ______ 19 ___ EDITION ______ 19 ___ ADDENDA

NUC. CLASS NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
√	CUST. INSP.	√	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	Revel York	11/29/82
				RECORD HEAT NUMBER ____ LOT NUMBER ____ VENDOR 3953	Revel York	11/29/82
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ____________ DATE ______ A.I. REVIEW ____________ DATE ______

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

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S/N 8672366

Namco Controls
An Acme-Cleveland Company
1300 Burris Road (P.O. Box 730)
Newton, NC 28658

QUALITY CONTROL PROCEDURE

CERTIFICATION OF COMPLIANCE

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. A. Documentation Dept.

PURCHASE ORDER NUMBER 181172 ITEM NUMBER 000

CUSTOMER PART NUMBER 15A5650X392 P REV

NAMCO PART NUMBER EA180-32302 B/M REV. K QTY. 6

LOT NUMBER 29501 DATE CODE 4682

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-40379 DATE SHIPPED 11/17/82

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS. NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2 AS APPLICABLE.
NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180-11302, REV. H, WHICH WAS QUALIFIED TO IEEE STANDARDS 323 (1974), 344 (1975), AND 382 (1972), PER REPORT NO. QTR-105.

11/17/82
DATE

QUALITY CONTROL MANAGER

S/N 8672366

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY Tom L DATE 6/22/83

PURCHASE ORDER NO. S181979-002

PURCHASE REQ. NO. 576110

REP. ORDER NO. 22B-X5AC03-NILL

ITEM NO. 0180

QUANTITY 1

DESCRIPTION C. Solenoil

SIZE 14

TYPE 9280

MATERIAL TYPE Suppliers Standard

PROJECT NO. 79P126

PIECE SERIAL NO. 576110-1

PART NO. 1M3429X0452

ROUGH DRAWING NO. ———

REV.

FINISHED DRAWING NO. 1M3429

REV. NA

CODE FGS 13A1, 13E10

SECT ____ 19 ___ EDITION ____ 19 ___ ADDENDA

NUC. CLASS NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	Schwarzebart	8/24/83
				RECORD HEAT NUMBER ____ LOT NUMBER 43243 M-2 VENDOR Automatic Switch	Schwarzebart	8/24/83
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL	[illegible] 83	
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ____ DATE ____ A.I. REVIEW ____ DATE ____

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

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9510-0X50C03-5151-2 132

S/N 8672366

Automatic Switch Co.

Manufacturers of
DEPENDABLE CONTROL
Since 1888

ASCO

FLORHAM PARK, NEW JERSEY 07932 · N.J. (201) 966-2000 / N.Y. (212) 344-3765

CERTIFICATE OF COMPLIANCE

Customer Name FISHER CONTROLS INTERNATIONAL, INC.

Customer P.O. No. S181979

Consignee

Consignee P.O. No.

ASCO Shop Order No. 43243M

ASCO Part No. NPK 8316A-74-E Quantity 5

Voltage 125/DC Eng. Job No.

This is to certify that the subject valve(s) meet the performance requirments of IEEE-323-1974, IEEE-344-1975, IEEE-382-1980 (Revision of IEEE-382-1972) and IEEE-627-1980, as substantiated by testing valves of generically equal design in accordance with ASCO Qualification Specification AQS-21680/Rev. C, dated July 13, 1981. The following test levels were included in this qualification test program:

I. Aging Simulation Phases:

A. Thermal Aging Simulation - 250°F for 18¼ days. These aging parameters were determined by Arrhenius calculations to simulate a minimum of 8 years in a 140°F continuous ambient. Refer to Figure 1 for additional information regarding service periods for elastomeric components and Figure 2 for additional information regarding service periods for solenoid coils.

B. Wear Aging Simulation - 20,000 operations at maximum operating pressure differential and nominal voltage. Ten percent of the wear aging simulation (2,000 cycles) was conducted concurrently with the thermal aging simulation.

C. Pressurization Aging Simulation - 15 ambient pressure excursions from atmospheric pressure to 80 psig to simulate the expected periodic pressurization of the containment for leak testing during the life of the plant.

D. Radiation Aging Simulation - 20 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate expected non-accident radiation exposure.

E. Vibration Aging Simulation - Continuous sinusoidal sweeps from 5 to 200 to 5 Hz at a rate of 2 octaves per minute, with a minimum peak acceleration level of 0.75g (except at low frequencies where the acceleration level was reduced such that the displacement did not exceed 0.025" double amplitude), for a minimum of 90 minutes in each of three orthogonal axes. The test valves were alternately de-energized or energized every 15 minutes during this exposure. The valves were attached to the shaker table by rigid test fixtures using the standard valve mounting provisions with the solenoids (Solenoid 'A' for NP8323 valves) vertical and upright. Flexible hoses were used on all ports; therefore, the set-up did not affect the rigidity or mass of the valves being tested.

F. Seismic Aging (OBE) Simulation and Resonance Testing - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to two sinusoidal sweeps from 1 to 35 to 1 Hz, with a peak acceleration level (within machine limits) of 3g, in each of three orthogonal axes at a rate of not more than 1 octave per minute. One sweep in each axis was conducted with the valves energized and the other with the valves de-energized. These sinusoidal sweeps are considered to provide the equivalent dynamic effect of 5 OBE's. During this testing, accelerometers were attached to the solenoids of the test valves to determine if the valves exhibited any resonance. Resonance is defined as a response with a magnitude of acceleration at least twice as great as the input acceleration. No valve resonances were detected.

S/N 8672366

II. Design Basis Event (DBE) Phases:

A. Seismic DBE (SSE) Simulation - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to a series of single-frequency, single-axis sine-beat tests at 37 test frequencies between 1 and 35 Hz. The excitation was in the form of a continuous series of sine beats, with 12-15 oscillations per beat, for a minimum duration of 15 seconds at each test frequency. The successive beats were phased such that any superposition of response motion was additive. At each test frequency, the peak input acceleration was increased (up to 15g maximum) and the g-levels were recorded at which the cylinder port pressure (zero when de-energized and full inlet pressure when energized for a normally closed valve, opposite for a normally open valve) differed from the nominal by 0%, 5% and 10% of inlet pressure. The valves are considered to function properly up to a 10% change in cylinder port pressure. This level was selected as being sufficiently low to prevent spurious shifting of the customer's main valve or other equipment. Motion was applied at the same frequency and acceleration limits in each of the three orthogonal axes separately. Based on this testing and/or additional testing conducted by ASCO using single-frequency continuous sinusoidal inputs (after consideration of margin as suggested in IEEE-323-1974), the following acceptable maximum acceleration levels have been determined:

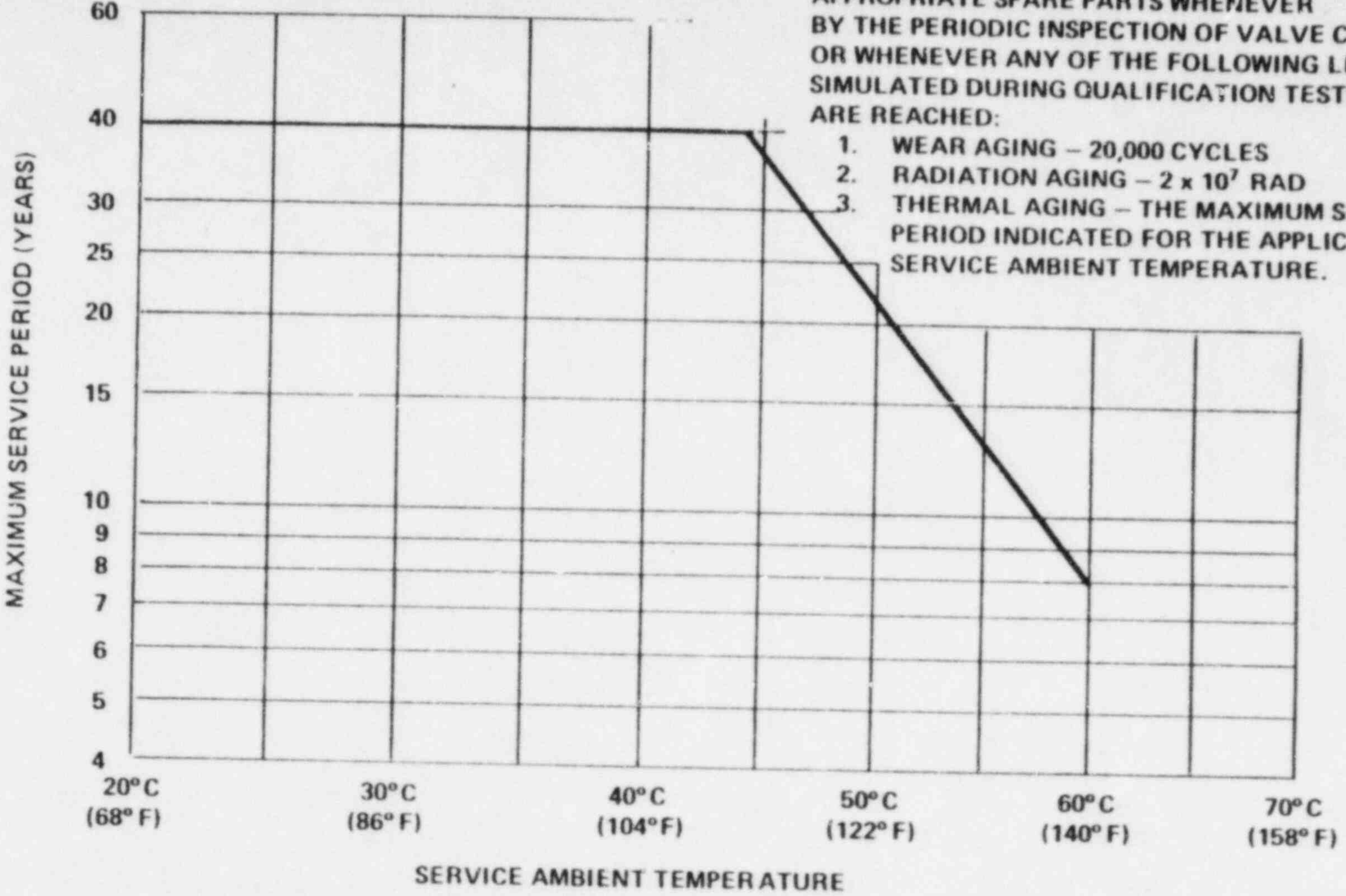
11.2g

B. Radiation DBE Simulation - 180 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate (after consideration of margin as suggested in IEEE-323-1974) at least 163 megarads of accident radiation exposure.

C. Environmental DBE Simulation - The valves were installed in a pressure vessel and subjected to a 30-day exposure to steam, chemical spray and clear water spray simulating a combined loss-of-coolant accident/high-energy-line-break event and post event cool-down. The peak ambient temperature of the simulation was 420°F and the peak ambient pressure was 70 psig. The valves were pressurized to maximum operating pressure and continuously energized for 4 hours prior to the first transient (to produce thermal saturation of the solenoid coils). They were de-energized when the temperature of the first transient reached 420°F (to demonstrate the ability to perform a typical safety function) and were normally de-energized but were cycled periodically during the 30-day exposure to demonstrate the ability to operate on demand. The qualified temperature profile demonstrated by this simulation (after consideration of margin as suggested in IEEE-323-1974) is shown in Figure 3.

Test Report AQR-67368 is on file at Automatic Switch Company in Florham Park, N.J., and is available for customer perusal.

Dated AUGUST 15, 1983 Authorized Signature
QUALITY CONTROL MANAGER



VALVES SHOULD BE REBUILT USIN
APPROPRIATE SPARE PARTS WHENEVER [illegible]CATED
BY THE PERIODIC INSPECTION OF VALVE COMPONENTS
OR WHENEVER ANY OF THE FOLLOWING LEVELS
SIMULATED DURING QUALIFICATION TESTING,
ARE REACHED:

1. WEAR AGING – 20,000 CYCLES
2. RADIATION AGING – 2×10^7 RAD
3. THERMAL AGING – THE MAXIMUM SERVICE PERIOD INDICATED FOR THE APPLICABLE SERVICE AMBIENT TEMPERATURE.

FIGURE 1

MAXIMUM SERVICE PERIODS FOR ELASTOMERIC
COMPONENTS IN ASCO CATALOG NP-1 VALVES

S/N 8672266

9510-AX5AC03-5151-2 135

S/N 8672 366

AUTOMATIC SWITCH CO.

Florham Park, N.J. 0 932

NUCLEAR VALVE TEST LOG

ORDER DATA
(To be completed by Valve Sales)

CUSTOMER Fisher Controls

P.O. NO. 181979 S. O. NO. 43243M

CATALOG NO. NPK8316A74E QTY.

CONSIGNEE Fisher Controls

CONSIGNEE P.O.

SALES ENGINEER
(Signed) T. Hays DATE 8-12-83

TEST DATA
(To be completed by Test Dept. Supervisor)

ASCO DWG. NO. NVA 208 279 CHG. LTR. —

ASCO TEST PROCEDURE NP8316 CHG. LTR. G

TEST MEDIUM Air

TEST .080 AMPS/~~VOLTAGE~~ (Cross Out One)

TEST DEPT. (Signed) Browne DATE 8-12-8

CONFORMANCE TO TEST REQUIREMENT. (To be completed by Test Dept.) – a check (✓) indicates conformance to test requirements as listed in above test procedure.

SERIAL NUMBER	COIL TEST /Volts	SEAT LEAKAGE				OPERATIONAL TEST		EXTERNAL LEAKAGE	HYPOT TEST (Volts/Time)	NOISE TEST	
		DE-ENERGIZED		ENERGIZED				SEAM TEST	1250 V		
43243M	644	● 175 PSIG	● 10 PSIG	● 175 PSIG	● 10 PSIG	175 PSIG MAX.	10 PSIG MIN.	250 PSIG	1MIN	N/A	
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
4	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
5	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	

I HEREBY CERTIFY THE ABOVE RESULTS ARE A TRUE RECORD OF EACH ITEM INDICATED

☐ TESTER (Signed) Robert Evan DATE 8/15/83

☐ ASCO QUALITY CONTROL (Signed) DATE

☐ CUSTOMER REPRESENTATIVE (Signed) DATE

☐ GOV'T. QUALITY ASSURANCE REPRESENTATIVE (Signed) DATE

FISHER

Assembly Test Report

NO. 1/79P126-2

DRAWING NO. 39A2459 / 48A9881

REV. B

ATR 79P126-1

REV. 0

VALVE SERIAL NO. 8672365

SIZE AND TYPE 14" 9280

CUSTOMER ORDER NO. PAV-206

TAG NO. 1HV-2628B

REP. ORDER NO. 22B-X5AC03-N1T

ITEM NO 181A

ISSUED BY F. Hubbard DATE 11/7/83

CODE ASME BOILER & PRESSURE VESSEL CODE

STAMP ☒ YES ☐ NO

CLASS 2

NCR NO.'S

REVISED BY DATE

SECT III 1974 EDITION WINTER 1975 ADDENDA

CONTROLLED PARTS VERIFICATION

PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.
BODY	✓	AC8820-1	1G3801-7	Retaining Ring	✓	AC8818-1	D4506-3	Solenoid	✓	785426-1	
BONNET	✓			Disc	✓	AC8812-1	D4498-2	Solenoid	✓	570313-1	
VALVE PLUG				Disc Stop	✓	AC8817-1	MATL SPEC & GR. 75854-7				
STUDS				Switch	✓	785423-1	—				
NUTS				Switch	✓	785424-1	—				

PARTS VERIFIED BY D. [illegible] Quality Assurance 9-15-83 Date ______ Authorized Inspector ______ Date

GAGE 222

SPECIAL PROCESSING, TESTING AND RESULTS

HOLD/WIT PTS CUST	HOLD/WIT PTS AUTH. INSP	DESCRIPTION	✓	PROCEDURE	REV	AMENDMENT	REV	TEST PRESSURE	TIME (MIN)	ALLOW LEAKAGE	FINAL RESULTS	ASSEMBLER	FISHER INSP.
✓ HOLD ANI		11-22-83 HYDROSTATIC TEST	✓	FMP 2X14	1	AM-6	2	450	29	0	0 Leak	Edwards	11/22/83
✓ O Brock	Bechtel	SEAT LEAK TEST 1st	✓	FMP 2X16	3	AM-8	1	40	5	0	0 LEAK	Edwards	12/1/83
		DISC HYDRO	✓	FMP 2X14.1	0	AM-7	0	46	2	—	0 leak	Edwards	12/1/83
✓	Bechtel	Seat Leak 2nd Direction	✓	FMP 2X16	3	AM-8	1	40	60	0	0 LEAK	Edwards	12/1/83
		DIAPH TO CASE LEAK TEST	✓	FMP 2C6.2	3	AM-21	0	—	N/A				
✓ Bechtel 12/20/83		OPERATIONAL TEST		FMP2C6.2	3	AM-21	0	SIGNAL:	TIME OPEN 12	TIME CLOSE 3 15			B. [illegible] 12-20-83
		HYSTERESIS TEST						MAX. ERROR:					
		Complete per FC 3790	✓										
	Bechtel	CLEANING PRIOR TO ASSEMBLY	✓	—		APR III.A						Edwards	11-28-83
	Bechtel	PAINTING	✓			APR IV.B					OK		1-20-84
		FINAL CLEANING											
		SEAL ENDS	✓	FMP 10L2	3	Am-12 APR V.B.	0					Edwards	12-21-83
	1-6-84	FINAL INSPECTION	✓										
HOLD ANI		ASME STAMP	✓									1-5-84	12/21/83
	Bechtel	PACKAGING	✓	FMP11A2	3	APR V.C							1-24-84

NOTE: Notify Customer Service for customer hold points. Notify authorized inspector for authorized inspector hold points.

F. Perez APPROVED 11-7-83 DATE Kent Cockerig REVIEWED AUTHORIZED INSPECTOR NOV 9 1983 DATE

1-24-84

S/N 8672365

Form 3131D

5510-AX5AC03-5151-2 136

S/N 8672365

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY Tom L. DATE 11/31/82

PURCHASE ORDER NO. S181294-001

PURCHASE REQ. NO. 785423

REP. ORDER NO. 22B-XSAC03-NIT

ITEM NO. 181A

QUANTITY 1

T DESCRIPTION Namco Switch

SIZE 14

TYPE 9280

MATERIAL TYPE Suppliers Standard

PROJECT NO. 79P126

PIECE SERIAL NO. 785423-1

PART NO. 15A4157X022P

ROUGH DRAWING NO. ________

REV.

FINISHED DRAWING NO. 15A4157

REV B

CODE: EGI 13A1, 13F1

SECT ________ 19 ____ EDITION ________ 19 ____ ADDENDA

NUC. CLASS NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
√	CUST. INSP.	√	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	G. Muller	1-24-83
				RECORD HEAT NUMBER ________ LOT NUMBER 52[illegible]K33611 VENDOR Namco Controls	G. Muller	1-24-83
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL	JAN LRH	
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ________ DATE ________

A.I. REVIEW ________ DATE ________

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

1258 Printed in U.S.A.

S/N 8672365

NAMCO CONTROLS
an Acme-Cleveland Company
1300 Burris Road (P. O. Box 730)
Newton, NC 28658

QUALITY CONTROL PROCEDURE

Certification of Compliance

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. A. Documentation Department

PURCHASE ORDER NUMBER S 181294 ITEM NUMBER 000

CUSTOMER PART NUMBER 15A4157X022

NAMCO PART NUMBER EA180-31302 B/M REV. K QTY. 2

LOT NUMBER 33611 DATE CODE 5282

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-41769 DATE SHIPPED 1/14/83

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS.

NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2, AS APPLICABLE.

NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180 SWITCH SERIES, WHICH WAS QUALIFIED TO IEEE STANDARDS 323(1974), 344(1975), AND 382(1972), PER REPORT NO. QTR-105.

1/14/83
DATE

Frank J Napoli
QUALITY ASSURANCE MANAGER

S/N 8672365

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY: Tomc.
DATE: 11/3/82

PURCHASE ORDER NO.: S181286-001
PURCHASE REQ. NO.: 785424
REP. ORDER NO.: 228-XSAC03-NIT
ITEM NO.: 181A
QUANTITY: 1

RT DESCRIPTION: Namco Switch
SIZE: 14
TYPE: 9280
MATERIAL TYPE: Supplier Standard
PROJECT NO.: 79P126
PIECE SERIAL NO.: 785424-1

PART NO.: 1EA5650X392P
ROUGH DRAWING NO.: ——————
REV.
FINISHED DRAWING NO.: 15A5650
REV: NA

CODE: FGI 13A1, 13F1
SECT ______ 19 ____ EDITION ______ 19 ____ ADDENDA
NUC. CLASS: NA
STAMP: ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	G. Muller	1-24-83
				RECORD HEAT NUMBER ______ LOT NUMBER 0283K32101 VENDOR Namco controls	G. Muller	1-24-83
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ______ DATE ______

A.I. REVIEW ______ DATE ______

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

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S/N 8672365

NAMCO CONTROLS
an Acme-Cleveland Company
1300 Burris Road (P. O. Box 730)
Newton, NC 28658

QUALITY CONTROL PROCEDURE

Certification of Compliance

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. A. Documentation Department

PURCHASE ORDER NUMBER S 181286 ITEM NUMBER 000

CUSTOMER PART NUMBER

NAMCO PART NUMBER EA180-32302 B/M REV. K QTY. 2

LOT NUMBER 32101 DATE CODE 0283

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-41768 DATE SHIPPED 1/14/83

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS.

NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2, AS APPLICABLE.

NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180 SWITCH SERIES, WHICH WAS QUALIFIED TO IEEE STANDARDS 323(1974), 344(1975), AND 382(1972), PER REPORT NO. QTR-105.

1/14/83
DATE

Frank J. Napoli
QUALITY ASSURANCE MANAGER

S/N 8672365

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY Tom L DATE 6/15/83

PURCHASE ORDER NO. S181963-001

PURCHASE REQ. NO. 570313

REP. ORDER NO. 22B-XSAC03-NIT

ITEM NO. 181A

QUANTITY 1

DESCRIPTION Solenoid

SIZE 14

TYPE 9280

MATERIAL TYPE supplies STANDARD

PROJECT NO. 79P126

PIECE SERIAL NO. 570313-1

PART NO. 1M3429X0452

ROUGH DRAWING NO. ______

REV.

FINISHED DRAWING NO. 1M3429

REV.

CODE FGS 13A1, 13E10

SECT ______ 19 ____ EDITION ______ 19 ____ ADDENDA

NUC. CLASS NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	Wayne Boston	8-25-83
				RECORD HEAT NUMBER ______ LOT NUMBER NPK8316A74E VENDOR 0910	Wayne Boston	8-25-83
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ______ DATE ______ A.I. REVIEW ______ DATE ______

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

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S/N 8672365

Automatic Switch Co.

Manufacturers of
DEPENDABLE CONTROL
Since 1888

ASCO

FLORHAM PARK, NEW JERSEY 07932 · N.J.-(201) 966-2000 / N.Y.-(212) 344-3765

CERTIFICATE OF COMPLIANCE

Customer Name FISHER CONTROLS INTERNATIONAL, INC.

Customer P.O. No. S181963

Consignee

Consignee P.O. No.

ASCO Shop Order No. 41826M

ASCO Part No. NP K 8316A-74-E Quantity 1

Voltage 125/DC Eng. Job No.

This is to certify that the subject valve(s) meet the performance requirments of IEEE-323-1974, IEEE-344-1975, IEEE-382-1980 (Revision of IEEE-382-1972) and IEEE-627-1980, as substantiated by testing valves of generically equal design in accordance with ASCO Qualification Specification AQS-21680/Rev. C, dated July 13, 1981. The following test levels were included in this qualification test program:

I. Aging Simulation Phases:

A. Thermal Aging Simulation - 250°F for 18¼ days. These aging parameters were determined by Arrhenius calculations to simulate a minimum of 8 years in a 140°F continuous ambient. Refer to Figure 1 for additional information regarding service periods for elastomeric components and Figure 2 for additional information regarding service periods for solenoid coils.

B. Wear Aging Simulation - 20,000 operations at maximum operating pressure differential and nominal voltage. Ten percent of the wear aging simulation (2,000 cycles) was conducted concurrently with the thermal aging simulation.

C. Pressurization Aging Simulation - 15 ambient pressure excursions from atmospheric pressure to 80 psig to simulate the expected periodic pressurization of the containment for leak testing during the life of the plant.

D. Radiation Aging Simulation - 20 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate expected non-accident radiation exposure.

E. Vibration Aging Simulation - Continuous sinusoidal sweeps from 5 to 200 to 5 Hz at a rate of 2 octaves per minute, with a minimum peak acceleration level of 0.75g (except at low frequencies where the acceleration level was reduced such that the displacement did not exceed 0.025" double amplitude), for a minimum of 90 minutes in each of three orthogonal axes. The test valves were alternately de-energized or energized every 15 minutes during this exposure. The valves were attached to the shaker table by rigid test fixtures using the standard valve mounting provisions with the solenoids (Solenoid 'A' for NP8323 valves) vertical and upright. Flexible hoses were used on all ports; therefore, the set-up did not affect the rigidity or mass of the valves being tested.

F. Seismic Aging (OBE) Simulation and Resonance Testing - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to two sinusoidal sweeps from 1 to 35 to 1 Hz, with a peak acceleration level (within machine limits) of 3g, in each of three orthogonal axes at a rate of not more than 1 octave per minute. One sweep in each axis was conducted with the valves energized and the other with the valves de-energized. These sinusoidal sweeps are considered to provide the equivalent dynamic effect of 5 OBE's. During this testing, accelerometers were attached to the solenoids of the test valves to determine if the valves exhibited any resonance. Resonance is defined as a response with a magnitude of acceleration at least twice as great as the input acceleration. No valve resonances were detected.

S/N 8672365

ASCO SHOP ORDER NO. 41826M

II. Design Basis Event (DBE) Phases:

A. Seismic DBE (SSE) Simulation - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to a series of single-frequency, single-axis sine-beat tests at 37 test frequencies between 1 and 35 Hz. The excitation was in the form of a continuous series of sine beats, with 12-15 oscillations per beat, for a minimum duration of 15 seconds at each test frequency. The successive beats were phased such that any superposition of response motion was additive. At each test frequency, the peak input acceleration was increased (up to 15g maximum) and the g-levels were recorded at which the cylinder port pressure (zero when de-energized and full inlet pressure when energized for a normally closed valve, opposite for a normally open valve) differed from the nominal by 0%, 5% and 10% of inlet pressure. The valves are considered to function properly up to a 10% change in cylinder port pressure. This level was selected as being sufficiently low to prevent spurious shifting of the customer's main valve or other equipment. Motion was applied at the same frequency and acceleration limits in each of the three orthogonal axes separately. Based on this testing and/or additional testing conducted by ASCO using single-frequency continuous sinusoidal inputs (after consideration of margin as suggested in IEEE-323-1974), the following acceptable maximum acceleration levels have been determined:

11.2g

B. Radiation DBE Simulation - 180 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate (after consideration of margin as suggested in IEEE-323-1974) at least 163 megarads of accident radiation exposure.

C. Environmental DBE Simulation - The valves were installed in a pressure vessel and subjected to a 30-day exposure to steam, chemical spray and clear water spray simulating a combined loss-of-coolant accident/high-energy-line-break event and post event cool-down. The peak ambient temperature of the simulation was 420°F and the peak ambient pressure was 70 psig. The valves were pressurized to maximum operating pressure and continuously energized for 4 hours prior to the first transient (to produce thermal saturation of the solenoid coils). They were de-energized when the temperature of the first transient reached 420°F (to demonstrate the ability to perform a typical safety function) and were normally de-energized but were cycled periodically during the 30-day exposure to demonstrate the ability to operate on demand. The qualified temperature profile demonstrated by this simulation (after consideration of margin as suggested in IEEE-323-1974) is shown in Figure 3.

Test Report AQR-67368 is on file at Automatic Switch Company in Florham Park, N.J., and is available for customer perusal.

Dated AUGUST 12, 1983 Authorized Signature

QUALITY CONTROL MANAGER

NOTE: IN ORDER TO MAINTAIN QUALIFICATION, CATALOG NP-1 VALVES SHOULD BE REBUILT USING THE APPROPRIATE SPARE PARTS WHENEVER INDICATED BY THE PERIODIC INSPECTION OF VALVE COMPONENTS OR WHENEVER ANY OF THE FOLLOWING LEVELS SIMULATED DURING QUALIFICATION TESTING, ARE REACHED:

1. WEAR AGING – 20,000 CYCLES
2. RADIATION AGING – 2 x 10^7 RAD
3. THERMAL AGING – THE MAXIMUM SERVICE PERIOD INDICATED FOR THE APPLICABLE SERVICE AMBIENT TEMPERATURE.

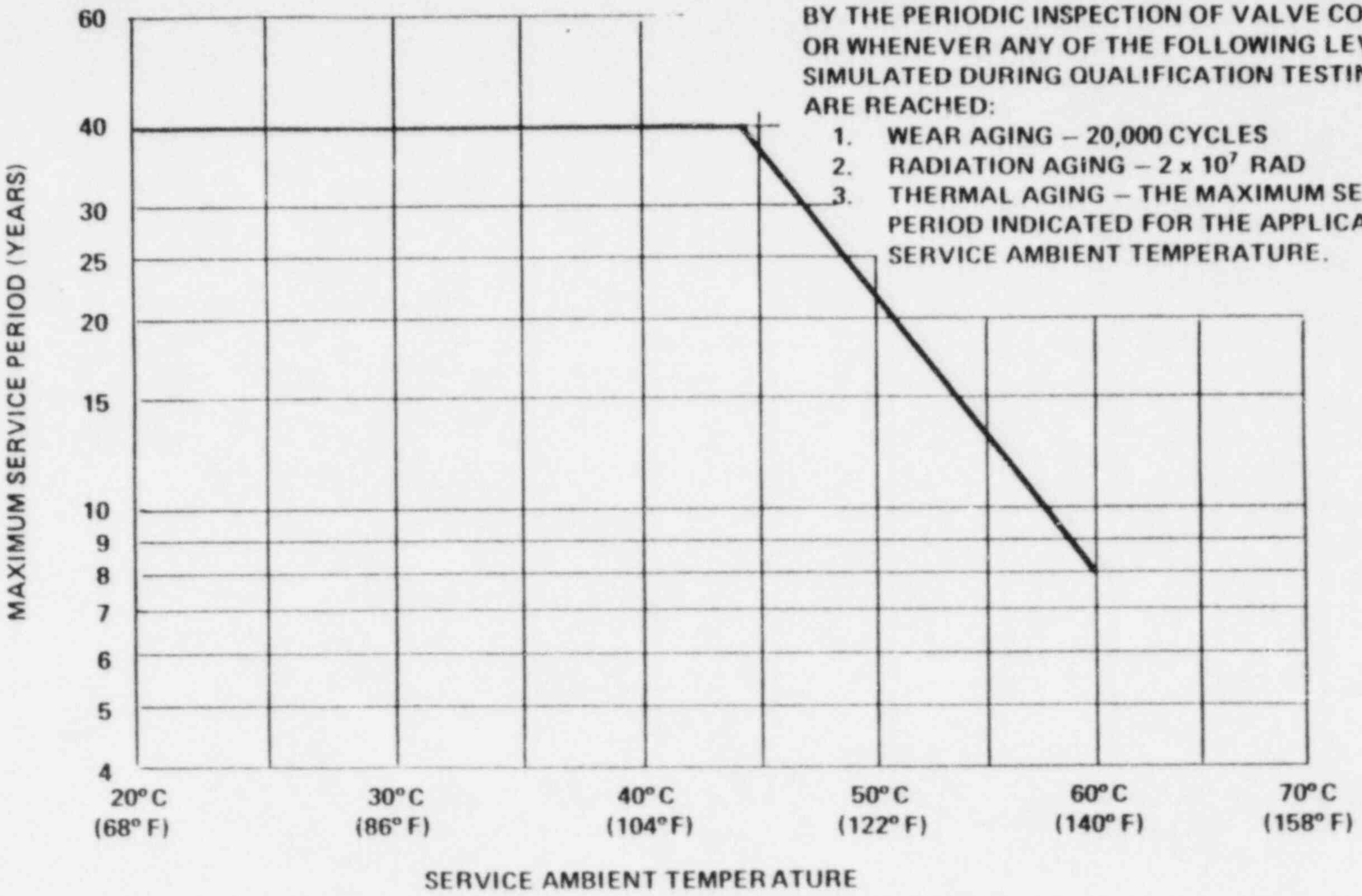
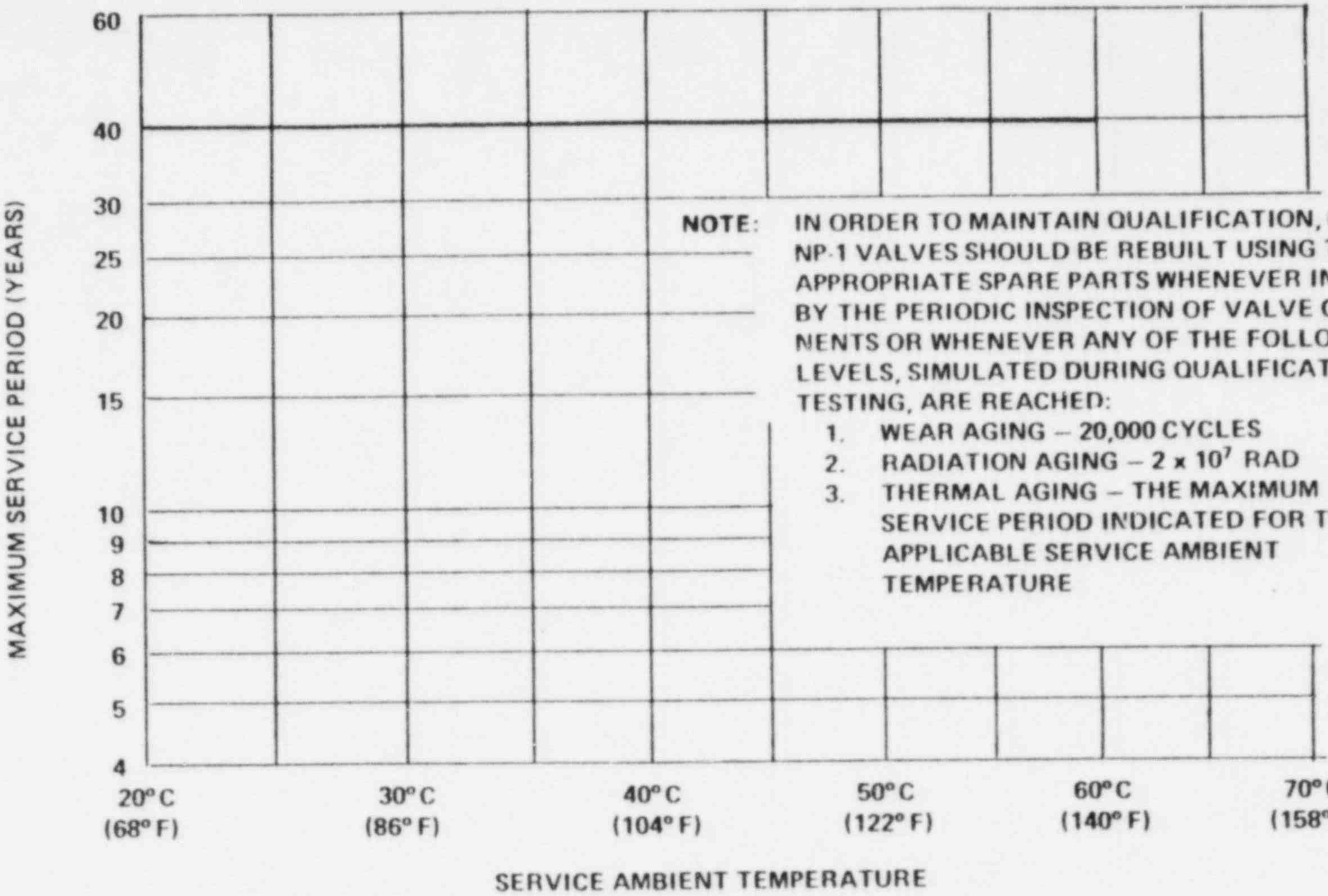


FIGURE 1

MAXIMUM SERVICE PERIODS FOR ELASTOMERIC COMPONENTS IN ASCO CATALOG NP-1 VALVES

S/N 8672365

S/N 8672365



NOTE: IN ORDER TO MAINTAIN QUALIFICATION, CATALOG NP-1 VALVES SHOULD BE REBUILT USING THE APPROPRIATE SPARE PARTS WHENEVER INDICATED BY THE PERIODIC INSPECTION OF VALVE COMPONENTS OR WHENEVER ANY OF THE FOLLOWING LEVELS, SIMULATED DURING QUALIFICATION TESTING, ARE REACHED:

1. WEAR AGING – 20,000 CYCLES
2. RADIATION AGING – 2×10^7 RAD
3. THERMAL AGING – THE MAXIMUM SERVICE PERIOD INDICATED FOR THE APPLICABLE SERVICE AMBIENT TEMPERATURE

FIGURE 2

MAXIMUM SERVICE PERIODS FOR SOLENOID COILS IN ASCO CATALOG NP-1 VALVES

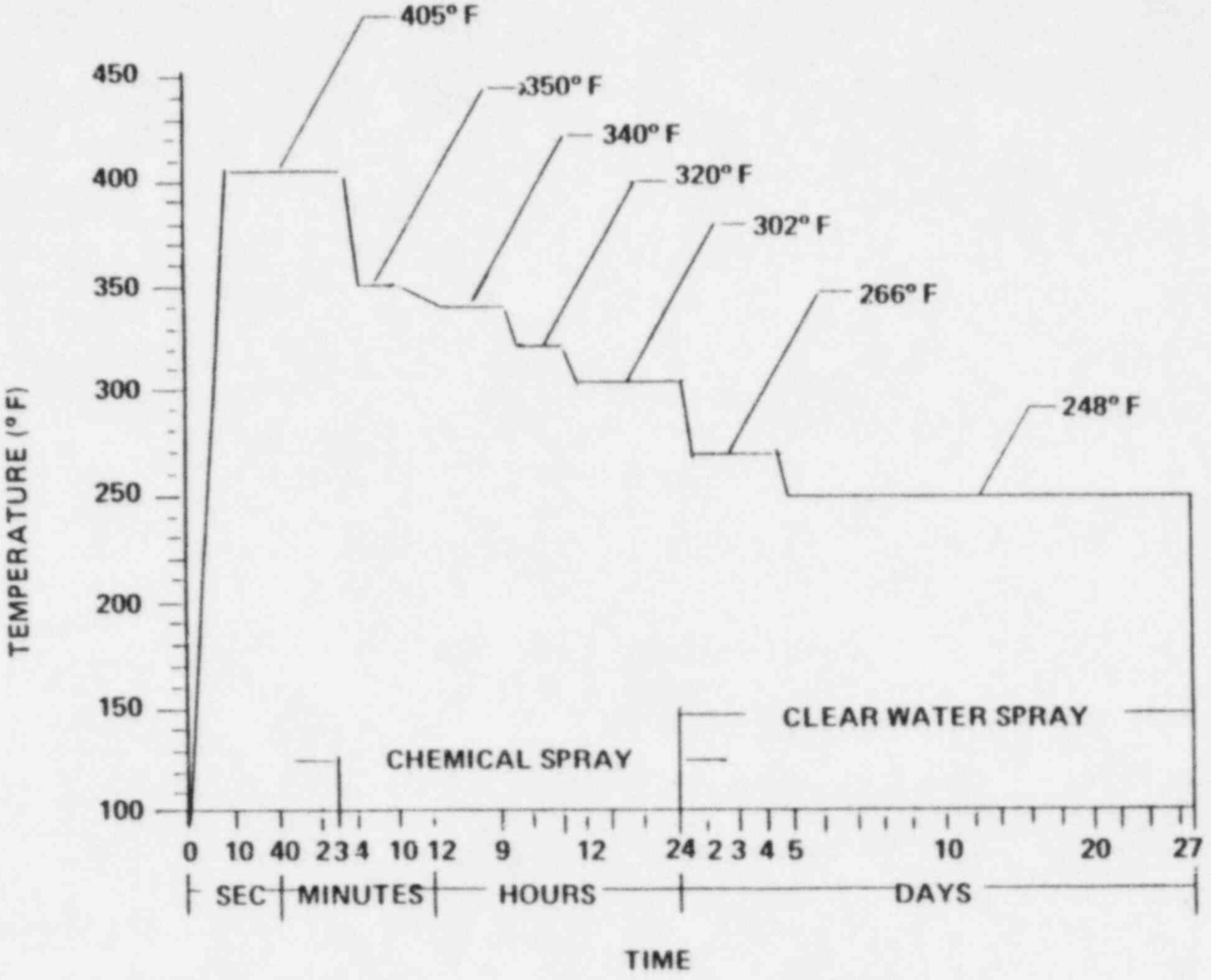


FIGURE 3

QUALIFIED AMBIENT TEMPERATURE PROFILE DEMONSTRATED BY THE COMBINED LOSS-OF-COOLANT ACCIDENT (LOCA)/HIGH-ENERGY-LINE BREAK (HELB) SIMULATION (AFTER APPLICATION OF ALL MARGIN SUGGESTED IN IEEE 323-1974)

S/N 8672365

S/N 8672365

9510-AX5AC03-5151-2 147

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY Tom L. DATE 11/3/82

PURCHASE ORDER NO. S181282-001
PURCHASE REQ. NO. 785421
REP. ORDER NO. 226-X5AC03-NIT
ITEM NO. 18/A
QUANTITY 1

DESCRIPTION Bettis Actuator
SIZE 14
TYPE 9280
MATERIAL TYPE suppliers Standard
PROJECT NO. 79P126
PIECE SERIAL NO. 785421-1

PART NO. 17A6601X112P
ROUGH DRAWING NO. ______
REV.
FINISHED DRAWING NO. 17A6601
REV. B

CODE: EGS 13A1, 13C1
SECT ______ 19 ___ EDITION ______ 19 ___ ADDENDA
NUC. CLASS NA
STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55		6/09/83
				RECORD HEAT NUMBER ______ ~~LOT~~ Serial NUMBER 82-9056-1 VENDOR Bettis Corp.		6/09/83
				STAMP PIECE SERIAL NO. ON PART	FCI QC JUN 9 1983 LRM	
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ______ DATE ______ A.I. REVIEW ______ DATE ______

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

258 Printed in U.S.A.

P518-AX5AC03-5151-2 148

S/N 8672365

GH BETTIS

A Galveston-Houston Company

4900 Woodway
P.O. Box 849
Houston, Texas 77001
(713) 960-9494 Telex 76 2713

May 31, 1983

Fisher Control Co.
P. O. Box 190
Marshalltown, Iowa 50158

Attention: Mr. Larry Rathje

Subject: Certification of Compliance for the Fisher Control Purchase Order 181282; G.H. Bettis Sales Order 82-9056-00

Dear Mr. Rathje:

This letter is to certify that the equipment furnished on line number 01 our sales order, item 1 your purchase order, were manufactured, assembled, and tested in accordance with written G.H. Bettis Engineering Specifications and Standards, and the G.H. Bettis Qualification Test Report 37274.

Units Shipped:

Qty.	Model	G.H. Bettis P/N	Serial Number
2	NT-316-SR2-M3	49470	1 & 2

Cordially,
GH BETTIS COMPANY

Anthony T. Locascio

Anthony T. Locascio
Quality Assurance Manager

ATL:jw
cc: File

FISHER

Assembly Test Report

NO. 79P126-2

DRAWING NO. 34A 2461
 48A 9343

REV. C

ATR 79P126-2-2

REV. 0

VALVE SERIAL NO. 86723[illegible]

SIZE AND TYPE 14" 9280

CUSTOMER ORDER NO. PAV-206

TAG NO. 1HV-2629B

REP. ORDER NO. 22B-X6AC03-N1U

ITEM NO. 182

ISSUED BY F. Hubbard DATE 11/7/83

CODE ASME BOILER & PRESSURE VESSEL CODE

SECT. III 1974 EDITION WINTER 1975 ADDENDA

STAMP ☒ YES ☐ NO

CLASS 2

NCR NO.'S

REVISED BY DATE

CONTROLLED PARTS VERIFICATION

PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.
BODY	✓	AC7231-1	1G 3801-4	Retaining Ring	✓	AC7229-1	D4442-2	Solenoid	✓	781926-1	
BONNET	✓			Disc	✓	AC7223-1	E5190-4	Solenoid	✓	5761327-1	
VALVE PLUG				Disc Stop	✓	AC7228-1	MATL SPEC & GR. 75854-4				
STUDS				Switch	✓	781924-1					
NUTS				Switch	✓	781923-1					

PARTS VERIFIED BY ______ Quality Assurance ______ Date ______ Authorized Inspector ______ Date

SPECIAL PROCESSING, TESTING AND RESULTS

HOLD/WIT PTS CUST. INSP.	HOLD PTS AUTH. INSP.	DESCRIPTION	✓	PROCEDURE	REV	AMENDMENT	REV	TEST PRESSURE	TIME (MIN)	ALLOW LEAKAGE	FINAL RESULTS	SIGNATURE/DATE ASSEMBLER	SIGNATURE/DATE FISHER INSP.
✓ See Attached ATR		HYDROSTATIC TEST	✓	FMP 2X14	1	AM-6	2	See Attached ATR					
✓		SEAT LEAK TEST 1st	✓	FMP 2X16	3	AM-8	1						
		DISC HYDRO	✓	FMP 2X14.1	0	AM-7	0	46	2	—	0 Leak	Edward	11/16/83
		Seat Leak 2nd Section	✓	FMP 2X16	3	AM-8	1	60	60	0	0 Leak	11-15-83	11/18/83
		DIAPH TO CASE LEAK TEST	✓	FMP 206.2	3	AM-21	0	—	N/A	—			
✓		OPERATIONAL TEST						SIGNAL:	TIME OPEN 15.5 sec	TIME CLOSE 3.5 sec			
		HYSTERESIS TEST						MAX. ERROR:					
		Complete per EC 3790	✓										
✓ See Attached ATR		CLEANING PRIOR TO ASSEMBLY	✓	—		APR III.A		See Attached ATR					
		PAINTING	✓			APR IV.B							-20-84
		FINAL CLEANING											
		SEAL ENDS	✓	FMP 10L2	3	Am-12 APR V.B.	0					Edward	12-22-83
		FINAL INSPECTION	✓										
HOLD		N STAMP										-5-84	
✓		PACKAGING	✓	FMP 11A2	3	APR V.C							1-09-84

NOTE: Notify Customer Service for customer hold points. Notify authorized inspector for authorized inspector hold points.

F. Perez APPROVED

11-7-83 DATE

Kent Cocking REVIEWED AUTHORIZED INSPECTOR

NOV 9 DATE

Form 3131D

S/N 8672367

9510-AX5AC03-5151-2 150

S/N 8672367

FISHER Controls

ASSEMBLY TEST REPORT

VALVE SERIAL NO: 8672367
SIZE AND TYPE: 14" 9280
CUSTOMER ORDER NO: PAV-206
CODE: ASME BOILER & PRESSURE VESSEL CODE
SECT. III 19 74 EDITION, WINTER 19 75 ADDENDA
APR NO: 781726 2
DRAWING NO: 34A 2461 / 4DA 9883 REV A / 4
ATR: 781726 2-1 REV 1
TAG NO: 1HV-2629B
REP ORDER NO: 22B-X5AC03-NIU
ITEM NO: 182
ISSUED BY: FJH DATE: 2/5/82
STAMP: ☒ YES ☐ NO
CLASS: 2
NCR NO'S:
REVISED BY: FJH DATE: 4/28/82

CONTROLLED PARTS VERIFICATION

PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.	PART	✓	
BODY	✓	AC7231-1	1G3801-4	RETAINING RING	✓	AC7229-1	D4442-2	SOLENOID	✓	781926-1
BONNET				DISC	✓	AC7223-1	E5190-4	SOLENOID	✓	576137-1
VALVE PLUG				DISC STOP	✓	AC7228-1	75854-4			
STUDS				Switch	✓	781924-1				
NUTS				Switch	✓	781923-1				

PARTS VERIFIED BY D Bunyan 9-13-83
Quality Assurance Date
Authorized Inspector Date

SPECIAL PROCESSING, TESTING AND RESULTS

HOLD/WIT PTS ✓ CUST. INSP.	HOLD PTS ✓ AUTH. INSP	DESCRIPTION	✓	PROCEDURE	REV	AMENDMENT	REV	TEST PRESSURE	TIME (MIN)	ALLOW LEAKAGE	FINAL RESULTS	ASSEMBLER	FISHER INSP
[illegible]	HOLD ANI 10-19-83	HYDROSTATIC TEST	✓	FMP 2X14	1	AM-6	2	420	29	0	0-LEAK	Charles Ervin 10-19-83	I Thatcher 10/19/83
[illegible]	HOLD ANI 11-18-83	SEAT LEAK TEST	✓	FMP 2X16	3	AM-8	1	60	5	0	0 Leak	Charles Ervin 11-18-83	Bud Simms 11/18/83
		DISC HYDRO											
		DIAPH TO CASE LEAK TEST											
✓ [illegible] 10-22-83		OPERATIONAL TEST	✓	FMP 2C6-2	3	AM-21	0	SIGNAL:	TIME OPEN 15.5 sec	TIME 3.5 sec CLOSE		Ed Ross	10-22-83 B. Vickers
		HYSTERESIS TEST						MAX. ERROR:					
		COMPLETE FORM FC 3750	✓										
[illegible]		CLEANING PRIOR TO ASSEMBLY	✓	APR III. A								Edward	10-21-83
		PAINTING	✓	APR IV A2	2	AM-33	0						
		FINAL CLEANING											
		SEAL ENDS	✓	APR V. B.									
✓	HOLD ANI	FINAL INSPECTION	✓										I Thatcher 1/6/84
		ANI STAMP	✓									1-5-84	
✓		PACKAGING	✓	APR V. C.									

NOTE: Notify Customer Service for customer hold points. Notify authorized inspector for authorized inspector hold points.

F Perez 2-5-82 Kent Carling SEP 1983
APPROVED QUALITY ASSURANCE DATE REVIEWED AUTHORIZED INSPECTOR DATE

Form 31318 Printed in U.S.A.

S/N 8672367

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S		ISSUED BY Tom L	DATE 11/23/82	
PURCHASE ORDER NO. S181170-005	PURCHASE REQ. NO. 781923	REP. ORDER NO. 228-XSAC03-N1U	ITEM NO. 0182	QUANTITY 1

PA. DESCRIPTION Mamco Switch	SIZE 14	TYPE 9380	MATERIAL TYPE Supplier Standard	PROJECT NO. 79P126	PIECE SERIAL NO. 781923-1
PART NO. 15A4157X022P			ROUGH DRAWING NO.	REV.	FINISHED DRAWING NO. 15A4157 — REV. B

CODE: EGS 13A1, 13F1

SECT ______ 19 ___ EDITION. ____________ 19 ____ ADDENDA

NUC. CLASS NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	G. Miller	12-1-82
				RECORD HEAT NUMBER ____ LOT NUMBER 4682K31119 VENDOR ____	G. Miller	12-1-82
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION	✓ FCC-QA DEC 1 1982	

Q.A. APPROVAL ____________ DATE ________ A.I. REVIEW ____________ DATE ________

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

Form . Printed in U.S.A.

S/N 8672367

Namco Controls
· **An Acme-Cleveland** Company
1300 Burris Road (P.O. Box 730)
Newton, NC 28658

QUALITY CONTROL PROCEDURE

CERTIFICATION OF COMPLIANCE

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. C. Documentation Dept.

PURCHASE ORDER NUMBER S 181170 **ITEM NUMBER** 000

CUSTOMER PART NUMBER 15A4157X022

NAMCO PART NUMBER EA180-31302 **B/M REV.** K **QTY.** 6

LOT NUMBER 31119 **DATE CODE** 4682

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-40380 **DATE SHIPPED** 11/19/82

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS. NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2 AS APPLICABLE.
NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180-11302, REV. H, WHICH WAS QUALIFIED TO IEEE STANDARDS 323 (1974), 344 (1975), AND 382 (1972), PER REPORT NO. QTR-105.

11/19/82
DATE

Frank J.
QUALITY CONTROL MANAGER

[redacted]

S/N 8672367

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY: Tom L

DATE: 11/13/82

PURCHASE ORDER NO.: S181172-004

PURCHASE REQ. NO.: 781924

REP. ORDER NO.: 22B-XSAC03-NIU

ITEM NO.: 0182

QUANTITY: 1

PART DESCRIPTION: NAMCO Switch

SIZE: 14

TYPE: 9200

MATERIAL TYPE: Supplier Standard

PROJECT NO.: 79P126

PIECE SERIAL NO.: 781924-1

PART NO.: 15A5650X392 T

ROUGH DRAWING NO.: ______

REV.

FINISHED DRAWING NO.: 15A5650

REV.

CODE: FGS 13A1, 13E1

SECT ______ 19 ___ EDITION ______ 19 ___ ADDENDA

NUC. CLASS: NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	Duval York	11/29/82
				RECORD HEAT NUMBER ______ LOT NUMBER 4682 K 29501 VENDOR 3953	Duval York	11/29/82
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ______ DATE ______ A.I. REVIEW ______ DATE ______

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

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S/N 8672367

Namco Controls
An Acme-Cleveland Company
1300 Burris Road (P.O. Box 730)
Newton, NC 28658

QUALITY CONTROL PROCEDURE

CERTIFICATION OF COMPLIANCE

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. A. Documentation Dept.

PURCHASE ORDER NUMBER 181172 **ITEM NUMBER** 000

CUSTOMER PART NUMBER 15A5650X392 P REV

NAMCO PART NUMBER EA180-32302 **B/M REV.** K **QTY.** 6

LOT NUMBER 29501 **DATE CODE** 4682

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-40379 **DATE SHIPPED** 11/17/82

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS. NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2 AS APPLICABLE.
NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180-11302, REV. H, WHICH WAS QUALIFIED TO IEEE STANDARDS 323 (1974), 344 (1975), AND 382 (1972), PER REPORT NO. QTR-105.

11/17/82
DATE

Frank J Nicoli
QUALITY CONTROL MANAGER

S/N 8672367

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY: Tom L

DATE: 6/22/83

PURCHASE ORDER NO.	PURCHASE REQ. NO.	REP. ORDER NO.	ITEM NO.	QUANTITY
S181979-001	576137	228-X5AC03-NIU	0182	1

DESCRIPTION	SIZE	TYPE	MATERIAL TYPE	PROJECT NO.	PIECE SERIAL NO.
Solenoid	14	9280	Suppliers Standard	79P126	576137-1

PART NO.	ROUGH DRAWING NO.	REV.	FINISHED DRAWING NO.	REV.
1M3429X0452	————		1M3429	NA

CODE: FGS 13A1, 13E10

SECT ______ 19 ____ EDITION ______ 19 ____ ADDENDA

NUC. CLASS: NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	LSchwienebart	8/24/83
				RECORD HEAT NUMBER ______ LOT NUMBER 43243 M-1 VENDOR Automatic Switch	LSchwienebart	8/24/83
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL	FISHER AUG 24 1983	
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ______ DATE ______ A.I. REVIEW ______ DATE ______

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

1258 Printed in U.S.A.

S/N 8672367

Automatic Switch Co.

Manufacturers of
DEPENDABLE CONTROL
Since 1888

ASCO®

FLORHAM PARK, NEW JERSEY 07932 - N.J.-(201) 966-2000 / N.Y.-(212) 344-3765

CERTIFICATE OF COMPLIANCE

Customer Name FISHER CONTROLS INTERNATIONAL, INC.

Customer P.O. No. S181979

Consignee

Consignee P.O. No.

ASCO Shop Order No. 43243M

ASCO Part No. NPK 8316A-74-E Quantity 5

Voltage 125/DC Eng. Job No.

This is to certify that the subject valve(s) meet the performance requirments of IEEE-323-1974, IEEE-344-1975, IEEE-382-1980 (Revision of IEEE-382-1972) and IEEE-627-1980, as substantiated by testing valves of generically equal design in accordance with ASCO Qualification Specification AQS-21680/Rev. C, dated July 13, 1981. The following test levels were included in this qualification test program:

I. Aging Simulation Phases:

A. Thermal Aging Simulation - 250°F for 18¼ days. These aging parameters were determined by Arrhenius calculations to simulate a minimum of 8 years in a 140°F continuous ambient. Refer to Figure 1 for additional information regarding service periods for elastomeric components and Figure 2 for additional information regarding service periods for solenoid coils.

B. Wear Aging Simulation - 20,000 operations at maximum operating pressure differential and nominal voltage. Ten percent of the wear aging simulation (2,000 cycles) was conducted concurrently with the thermal aging simulation.

C. Pressurization Aging Simulation - 15 ambient pressure excursions from atmospheric pressure to 80 psig to simulate the expected periodic pressurization of the containment for leak testing during the life of the plant.

D. Radiation Aging Simulation - 20 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate expected non-accident radiation exposure.

E. Vibration Aging Simulation - Continuous sinusoidal sweeps from 5 to 200 to 5 Hz at a rate of 2 octaves per minute, with a minimum peak acceleration level of 0.75g (except at low frequencies where the acceleration level was reduced such that the displacement did not exceed 0.025" double amplitude), for a minimum of 90 minutes in each of three orthogonal axes. The test valves were alternately de-energized or energized every 15 minutes during this exposure. The valves were attached to the shaker table by rigid test fixtures using the standard valve mounting provisions with the solenoids (Solenoid 'A' for NP8323 valves) vertical and upright. Flexible hoses were used on all ports; therefore, the set-up did not affect the rigidity or mass of the valves being tested.

F. Seismic Aging (OBE) Simulation and Resonance Testing - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to two sinusoidal sweeps from 1 to 35 to 1 Hz, with a peak acceleration level (within machine limits) of 3g, in each of three orthogonal axes at a rate of not more than 1 octave per minute. One sweep in each axis was conducted with the valves energized and the other with the valves de-energized. These sinusoidal sweeps are considered to provide the equivalent dynamic effect of 5 OBE's. During this testing, accelerometers were attached to the solenoids of the test valves to determine if the valves exhibited any resonance. Resonance is defined as a response with a magnitude of acceleration at least twice as great as the input acceleration. No valve resonances were detected.

9510-AX50C03-5151-2 157

ASCO SHOP ORDER NO. 43243M

S/N 8672367

II. Design Basis Event (DBE) Phases:

A. Seismic DBE (SSE) Simulation - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to a series of single-frequency, single-axis sine-beat tests at 37 test frequencies between 1 and 35 Hz. The excitation was in the form of a continuous series of sine beats, with 12-15 oscillations per beat, for a minimum duration of 15 seconds at each test frequency. The successive beats were phased such that any superposition of response motion was additive. At each test frequency, the peak input acceleration was increased (up to 15g maximum) and the g-levels were recorded at which the cylinder port pressure (zero when de-energized and full inlet pressure when energized for a normally closed valve, opposite for a normally open valve) differed from the nominal by 0%, 5% and 10% of inlet pressure. The valves are considered to function properly up to a 10% change in cylinder port pressure. This level was selected as being sufficiently low to prevent spurious shifting of the customer's main valve or other equipment. Motion was applied at the same frequency and acceleration limits in each of the three orthogonal axes separately. Based on this testing and/or additional testing conducted by ASCO using single-frequency continuous sinusoidal inputs (after consideration of margin as suggested in IEEE-323-1974), the following acceptable maximum acceleration levels have been determined:

11.2g

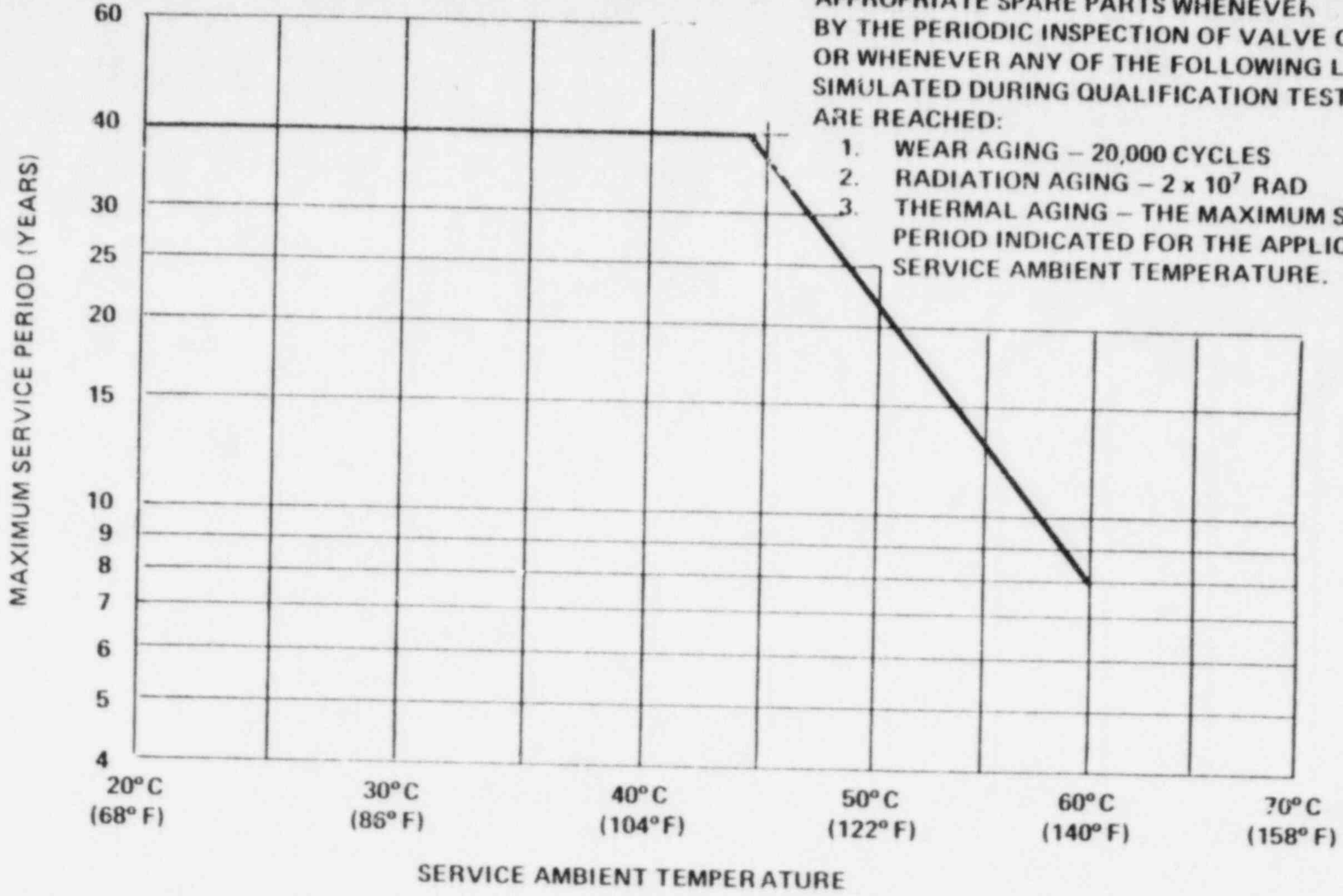
B. Radiation DBE Simulation - 180 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate (after consideration of margin as suggested in IEEE-323-1974) at least 163 megarads of accident radiation exposure.

C. Environmental DBE Simulation - The valves were installed in a pressure vessel and subjected to a 30-day exposure to steam, chemical spray and clear water spray simulating a combined loss-of-coolant accident/high-energy-line-break event and post event cool-down. The peak ambient temperature of the simulation was 420°F and the peak ambient pressure was 70 psig. The valves were pressurized to maximum operating pressure and continuously energized for 4 hours prior to the first transient (to produce thermal saturation of the solenoid coils). They were de-energized when the temperature of the first transient reached 420°F (to demonstrate the ability to perform a typical safety function) and were normally de-energized but were cycled periodically during the 30-day exposure to demonstrate the ability to operate on demand. The qualified temperature profile demonstrated by this simulation (after consideration of margin as suggested in IEEE-323-1974) is shown in Figure 3.

Test Report AQR-67368 is on file at Automatic Switch Company in Florham Park, N.J., and is available for customer perusal.

Dated AUGUST 15, 1983 Authorized Signature

QUALITY CONTROL MANAGER



NP-1 VALVES SHOULD BE REBUILT USING THE APPROPRIATE SPARE PARTS WHENEVER [illegible]CATED BY THE PERIODIC INSPECTION OF VALVE COMPONENTS OR WHENEVER ANY OF THE FOLLOWING LEVELS SIMULATED DURING QUALIFICATION TESTING, ARE REACHED:

1. WEAR AGING – 20,000 CYCLES
2. RADIATION AGING – 2 x 10^7 RAD
3. THERMAL AGING – THE MAXIMUM SERVICE PERIOD INDICATED FOR THE APPLICABLE SERVICE AMBIENT TEMPERATURE.

FIGURE 1

MAXIMUM SERVICE PERIODS FOR ELASTOMERIC COMPONENTS IN ASCO CATALOG NP-1 VALVES

S/N 867236 7

9518-AX5AC03-5151-2 159

S/N 8672367

AUTOMATIC SWITCH CO.

Florham Park, N.J. 0 932

NUCLEAR VALVE TEST LOG

ORDER DATA
(To be completed by Valve Sales)

CUSTOMER Fisher Controls

P.O. NO. 181979 S.O. NO. 43243M

CATALOG NO. NPK 8316A74E QTY.

CONSIGNEE Fisher Controls

CONSIGNEE P.O.

SALES ENGINEER
(Signed) T. Hays DATE 8-12-83

TEST DATA
(To be completed by Test Dept. Supervisor)

ASCO DWG. NO. NVA 208 279 CHG. LTR. –

ASCO TEST PROCEDURE NP8316 CHG. LTR. G

TEST MEDIUM Air

TEST .080 AMPS/~~VOLTS~~. (Cross Out One)

TEST DEPT. (Signed) Browne DATE 8-12-8

CONFORMANCE TO TEST REQUIREMENT. (To be completed by Test Dept.) – a check (✓) indicates conformance to test requirements as listed in above test procedure.

SERIAL NUMBER	COIL TEST Volts	SEAT LEAKAGE				OPERATIONAL TEST		EXTERNAL LEAKAGE	HYPOT TEST (Volts/Time)	NOISE TEST	
		DE-ENERGIZED		ENERGIZED				5 E.A.M. TEST	1250 V		
43243M	644	● 175 PSIG	● 10 PSIG	● 175 PSIG	● 10 PSIG	175 PSIG MAX	10 PSIG MIN	250 PSIG	1 MIN	N/A	
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	–	
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	–	
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	–	
4	✓	✓	✓	✓	✓	✓	✓	✓	✓	–	
5	✓	✓	✓	✓	✓	✓	✓	✓	✓	–	

I HEREBY CERTIFY THE ABOVE RESULTS ARE A TRUE RECORD OF EACH ITEM INDICATED

☐ TESTER (Signed) Robert Evans DATE 9/15/83

☐ ASCO QUALITY CONTROL (Signed) DATE

☐ CUSTOMER REPRESENTATIVE (Signed) DATE

☐ GOV'T. QUALITY ASSURANCE REPRESENTATIVE (Signed) DATE

Form Mfg. 3273A

9510-AX5AC03-5151-2 160

S/N 8670 354

ASSEMBLY TEST REPORT

FISHER Controls

VALVE SERIAL NO 8670354	SIZE AND TYPE 14" 9280	CUSTOMER ORDER NO PAV 2-34	APR NO 79P12C 2	DRAWING NO 39A 2460 48A 9882	REV A A	ATR 79P12C 2 1 · REV 1
			TAG NO 2-HV-2626B	REP ORDER NO 22B-XSAC03-N2T	ITEM NO 147	ISSUED BY E.I.H. DATE 2/5/82
	CODE: ASME Boiler & Pressure Vessel Code		STAMP ☒ YES ☐ NO · CLASS 2	NCR NO'S		REVISED BY FJH DATE 4/28/82
	SECT. III 19 74 EDITION, Winter 19 75 ADDENDA					

CONTROLLED PARTS VERIFICATION

PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.	PART	✓
BODY	✓	AC 6619-1	16 3801-2	RETAINING RING	✓	AC 6617-1	B6693-1		
BONNET				DISC	✓	AC 6611-1	D4086-2		
VALVE PLUG				DISC STOP	✓	AC 6616-1	MATR S.P. & GE 75854-2		
STUDS				SWITCH	✓	780979-1			
NUTS				SWITCH	✓	780978-1			

PARTS VERIFIED BY D. Quezar 9-15-83 GAGE 2/16

Quality Assurance · Date · Authorized Inspector · Date

SPECIAL PROCESSING, TESTING AND RESULTS

HOLD/WIT PTS CUST.	HOLD PTS AUTH. INSP.	DESCRIPTION	✓	PROCEDURE	REV	AMENDMENT	REV	TEST PRESSURE	TIME (MIN)	ALLOW LEAKAGE	FINAL RESULTS	SIGNATURE/DATE ASSEMBLER	SIGNATURE/DATE FISHER INSP.
✓ 10/26	HOLD ANI 10-26-83	HYDROSTATIC TEST	✓	FMP 2X14	1	Am-6	2	450	29	0	O Leak		10/26/83
✓		SEAT LEAK TEST	✓	FMP 2X16	3	Am-8	1	60	5	0			
		DISC HYDRO											
		DIAPH TO CASE LEAK TEST											
✓		OPERATIONAL TEST	✓	FMP 2C6.2	3	Am-21	0	SIGNAL:	TIME OPEN	TIME CLOSE			
		HYSTERESIS TEST						MAX. ERROR:					
		complete form FC 3720	✓										
		CLEANING PRIOR TO ASSEMBLY	✓	APR III.A								Edwards	8-28-83
		PAINTING	✓	APR IV.A.1.A	2								
		FINAL CLEANING											
		SEAL ENDS	✓	APR V.B.									
✓		FINAL INSPECTION	✓										1/6/84
	HOLD ANI	ASME STAMP	✓									1-5-84	
✓		PACKAGING	✓	APR V.C.									

NOTE: Notify Customer Service for customer hold points. Notify authorized inspector for authorized inspector hold points.

F Percy 2-5-82

APPROVED QUALITY ASSURANCE · DATE

Kent Cocking SEP 7 1983

REVIEWED AUTHORIZED INSPECTOR · DATE

Form 31316 · Printed in U.S.A.

FISHER

Assembly Test Report

PR NO. 79P126-2

DRAWING NO. 39A 2460 / 48A 9882

REV. C / A

ATR 79P126 2

REV. 0

SIZE AND TYPE 14" 9280

CUSTOMER ORDER NO. PAY2-34

TAG NO. 2-HV-2626B

REP. ORDER NO. 22B-XSAC03-N2T

ITEM NO 147

ISSUED BY F. Hubbord DATE 11/7/83

VALVE SERIAL NO 8670354

CODE ASME BOILER & PRESSURE VESSEL CODE

SECT. III 1974 EDITION. WINTER 1975 ADDENDA

STAMP ☒ YES ☐ NO

CLASS 2

NCR NO.'S

REVISED BY DATE

CONTROLLED PARTS VERIFICATION

PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.
BODY	✓	AC6619-1	1G3801-2	Retaining Ring	✓	AC6617-1	R6693-1				
BONNET	✓			Disc	✓	AC6611-1	P4086-2				
VALVE PLUG				Disc Stop	✓	AC6616-1	MATL SPEC & GR. 75854-2				
STUDS				Switch	✓	780979-1					
NUTS				Switch	✓	780978-1					

PARTS VERIFIED BY ______ Quality Assurance ______ Date ______ Authorized Inspector ______ Date

SPECIAL PROCESSING, TESTING AND RESULTS

HOLD/WIT PTS ✓	CUST. INSP.	HOLD PTS ✓	AUTH. INSP.	DESCRIPTION	✓	PROCEDURE	REV	AMENDMENT	REV	TEST PRESSURE	TIME (MIN)	ALLOW LEAKAGE	FINAL RESULTS	SIGNATURE/DATE ASSEMBLER	SIGNATURE/DATE FISHER INSP.
✓	See Atta		ched ATR	HYDROSTATIC TEST	✓	FMP 2X14	1	AM-6	2	—	See	Attached		ATR	
✓				SEAT LEAK TEST 1st	✓	FMP 2X16	3	AM-8	1	60	5	0	0 Leak	Edward	Bud Ennis 11/28/83
				DISC HYDRO	✓	FMP 2X14.1	0	AM-7	0	66	2	—	0 Leak	Edward	Bud Ennis 11/28/83
✓				Seat Leak 2nd Direction	✓	FMP 2X16	3	AM-8	1	60	60	0	0 Leak	McCain 11-30-83	Bill Vikus 11/30/83
	12/20/83			DIAPH TO CASE LEAK TEST	✓	FMP 2C6.2	3	AM-21	0	—	N/A	—			
✓				OPERATIONAL TEST						SIGNAL:	TIME OPEN 930	TIME CLOSE 3.25		D Meling	12-20-83 B Vikus
				HYSTERESIS TEST						MAX. ERROR:					
				Complete for FC 3790	✓										
✓	See Atta		ched ATR	CLEANING PRIOR TO ASSEMBLY	✓	—		APR III.A		See		Attached		ATR	
				PAINTING	✓			APR IV.B						M.L. Barton	
				FINAL CLEANING											
				SEAL ENDS	✓	FMP 10C2	3	AM-12 APR V.B.	0					Edward	12-21-83
✓			1-6-84	FINAL INSPECTION	✓										
				ASME STAMP	✓									1-5-84	1/6/84
✓				PACKAGING	✓	FMP 11A2	3	APR V.C							1-17-84

HOLD ANI

NOTE: Notify Customer Service for customer hold points. Notify authorized inspector for authorized inspector hold points.

F. Perez APPROVED 11-7-83 DATE

Kent Cocking REVIEWED AUTHORIZED INSPECTOR NOV 8 1983 DATE

Form 3131D

Printed in U.S.A.

S/N 8670354

8510-0X5AC03-5151-2 161

S/N 8670354

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO S:

ISSUED BY: Tom L DATE: 10/13/82

PURCHASE ORDER NO.: S181170-003

PURCHASE REQ. NO.: 780978

REP. ORDER NO.: 22B-XSAC03-N2T

ITEM NO.: 0147

QUANTITY: 1

DESCRIPTION: MAMCO Switch

SIZE: 14

TYPE: 9280

MATERIAL TYPE: supplier Standard

PROJECT NO.: 79P126

PIECE SERIAL NO.: 780978-1

PART NO.: 15A4157X022P

ROUGH DRAWING NO.: ______

REV.:

FINISHED DRAWING NO.: 15A4157

REV.: B

CODE: EGS 13A1, 13F1

SECT ______ 19 ___ EDITION ______ ___ 19 ___ ADDENDA

NUC. CLASS: NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	G. Muller	12-1-82
				RECORD HEAT NUMBER ______ LOT NUMBER 4682 K 31119 VENDOR ______	G. Muller	12-1-82
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL	FCC-QA	
				Q.A. DOCUMENTATION VERIFICATION	DEC 1 1982 LRH	

______ Q.A. APPROVAL ______ DATE ______ A.I. REVIEW ______ DATE

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

Printed in U.S.A.

S/N 8670354

Namco Controls
An Acme-Cleveland Company
1300 Burris Road (P.O. Box 730)
Newton, NC 28658

QUALITY CONTROL PROCEDURE

CERTIFICATION OF COMPLIANCE

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. C. Documentation Dept.

PURCHASE ORDER NUMBER S 181170 **ITEM NUMBER** 000

CUSTOMER PART NUMBER 15A4157X022

NAMCO PART NUMBER EA180-31302 **B/M REV.** K **QTY.** 6

LOT NUMBER 31119 **DATE CODE** 4682

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-40380 **DATE SHIPPED** 11/19/82

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS. NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2 AS APPLICABLE.
NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180-11302, REV. H, WHICH WAS QUALIFIED TO IEEE STANDARDS 323 (1974), 344 (1975), AND 382 (1972), PER REPORT NO. QTR-105.

11/19/82
DATE

Frank J. [illegible]
QUALITY CONTROL MANAGER

9510-AXSAC03-5151-2 164

S/N 8670354

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY: Tom L DATE: 10/13/82

PURCHASE ORDER NO.: 5181172-006

PURCHASE REQ. NO.: 780979

REP. ORDER NO.: 228-XSAC03-N2T

ITEM NO.: 014T

QUANTITY: 1

DESCRIPTION: NAMCO Switch

SIZE: 14

TYPE: 9280

MATERIAL TYPE: Supplier Standard

PROJECT NO.: 79P126

PIECE SERIAL NO.: 780979-1

PART NO.: 15A5650X392

ROUGH DRAWING NO.: ——————

REV.:

FINISHED DRAWING NO.: 15A5650

REV.:

CODE: FGS 13A1, 13E1

SECT ______ 19 ___ EDITION ______ 19 ___ ADDENDA

NUC. CLASS: NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	David York	11/29/82
				RECORD HEAT NUMBER ______ LOT NUMBER ______ VENDOR 3953	David York	11/29/82
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ______ DATE ______ A.I. REVIEW ______ DATE ______

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

Printed in U.S.A.

S/N 8670354

Namco Controls
An Acme-Cleveland Company
1300 Burris Road (P.O. Box 730)
Newton, NC 28658

QUALITY CONTROL PROCEDURE

CERTIFICATION OF COMPLIANCE

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. A. Documentation Dept.

PURCHASE ORDER NUMBER 181172 ITEM NUMBER 000

CUSTOMER PART NUMBER 15A5650X392 P REV

NAMCO PART NUMBER EA180-32302 B/M REV. K QTY. 6

LOT NUMBER 29501 DATE CODE 4682

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-40379 DATE SHIPPED 11/17/82

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS. NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2 AS APPLICABLE.
NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180-11302, REV. H, WHICH WAS QUALIFIED TO IEEE STANDARDS 323 (1974), 344 (1975), AND 382 (1972), PER REPORT NO. QTR-105.

11/17/82
DATE

Frank J Nezoli
QUALITY CONTROL MANAGER

S/N 8670354

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY: Tom L DATE: 6/22/83

PURCHASE ORDER NO.	PURCHASE REQ. NO.	REP. ORDER NO.	ITEM NO.	QUANTITY
518979-005	576164	228-X5AC03-N2T	0147	1

DESCRIPTION	SIZE	TYPE	MATERIAL TYPE	PROJECT NO.	PIECE SERIAL NO.
C. Solenoid	14	9280	Suppliers Standard	79P126	576164-1

PART NO.	ROUGH DRAWING NO.	REV.	FINISHED DRAWING NO.	REV.
1M3429X0452	—		1M3429	NA

CODE: FGS 13A1, 13E10

SECT ______ 19 ____ EDITION ______ 19 ____ ADDENDA

NUC. CLASS: NA

STAMP: ☐ YES ☒ NO

HOLD POINTS ✓	CUST. INSP.	✓	AUTH. INSP.	INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	L Schwenibart	8/24/83
				RECORD HEAT NUMBER ______ LOT NUMBER 43243M-5 VENDOR Automatic Switch	L Schwenibart	8/24/83
				STAMP PIECE SERIAL NO. ON PART	FCI QA AUG 24 1983	
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ______ DATE ______ A.I. REVIEW ______ DATE ______

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

Form 31258 Printed in U.S.A.

9510-AX5AC03-5151-2 167

S/N 8670354

Automatic Switch Co.

Manufacturers of
DEPENDABLE CONTROL
Since 1888

ASCO®

FLORHAM PARK, NEW JERSEY 07932 · N.J.-(201) 966-2000 / N.Y.-(212) 344-3765

CERTIFICATE OF COMPLIANCE

Customer Name FISHER CONTROLS INTERNATIONAL, INC.

Customer P.O. No. S181979

Consignee

Consignee P.O. No.

ASCO Shop Order No. 43243M

ASCO Part No. NPK 8316A-74-E Quantity 5

Voltage 125/DC Eng. Job No.

This is to certify that the subject valve(s) meet the performance requirments of IEEE-323-1974, IEEE-344-1975, IEEE-382-1980 (Revision of IEEE-382-1972) and IEEE-627-1980, as substantiated by testing valves of generically equal design in accordance with ASCO Qualification Specification AQS-21680/Rev. C, dated July 13, 1981. The following test levels were included in this qualification test program:

I. Aging Simulation Phases:

A. Thermal Aging Simulation - 250°F for 18¼ days. These aging parameters were determined by Arrhenius calculations to simulate a minimum of 8 years in a 140°F continuous ambient. Refer to Figure 1 for additional information regarding service periods for elastomeric components and Figure 2 for additional information regarding service periods for solenoid coils.

B. Wear Aging Simulation - 20,000 operations at maximum operating pressure differential and nominal voltage. Ten percent of the wear aging simulation (2,000 cycles) was conducted concurrently with the thermal aging simulation.

C. Pressurization Aging Simulation - 15 ambient pressure excursions from atmospheric pressure to 80 psig to simulate the expected periodic pressurization of the containment for leak testing during the life of the plant.

D. Radiation Aging Simulation - 20 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate expected non-accident radiation exposure.

E. Vibration Aging Simulation - Continuous sinusoidal sweeps from 5 to 200 to 5 Hz at a rate of 2 octaves per minute, with a minimum peak acceleration level of 0.75g (except at low frequencies where the acceleration level was reduced such that the displacement did not exceed 0.025" double amplitude), for a minimum of 90 minutes in each of three orthogonal axes. The test valves were alternately de-energized or energized every 15 minutes during this exposure. The valves were attached to the shaker table by rigid test fixtures using the standard valve mounting provisions with the solenoids (Solenoid 'A' for NP8323 valves) vertical and upright. Flexible hoses were used on all ports; therefore, the set-up did not affect the rigidity or mass of the valves being tested.

F. Seismic Aging (OBE) Simulation and Resonance Testing - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to two sinusoidal sweeps from 1 to 35 to 1 Hz, with a peak acceleration level (within machine limits) of 3g, in each of three orthogonal axes at a rate of not more than 1 octave per minute. One sweep in each axis was conducted with the valves energized and the other with the valves de-energized. These sinusoidal sweeps are considered to provide the equivalent dynamic effect of 5 OBE's. During this testing, accelerometers were attached to the solenoids of the test valves to determine if the valves exhibited any resonance. Resonance is defined as a response with a magnitude of acceleration at least twice as great as the input acceleration. No valve resonances were detected.

ASCO SHOP ORDER NO. 43243M

S/N 8670354

II. Design Basis Event (DBE) Phases:

A. Seismic DBE (SSE) Simulation - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to a series of single-frequency, single-axis sine-beat tests at 37 test frequencies between 1 and 35 Hz. The excitation was in the form of a continuous series of sine beats, with 12-15 oscillations per beat, for a minimum duration of 15 seconds at each test frequency. The successive beats were phased such that any superposition of response motion was additive. At each test frequency, the peak input acceleration was increased (up to 15g maximum) and the g-levels were recorded at which the cylinder port pressure (zero when de-energized and full inlet pressure when energized for a normally closed valve, opposite for a normally open valve) differed from the nominal by 0%, 5% and 10% of inlet pressure. The valves are considered to function properly up to a 10% change in cylinder port pressure. This level was selected as being sufficiently low to prevent spurious shifting of the customer's main valve or other equipment. Motion was applied at the same frequency and acceleration limits in each of the three orthogonal axes separately. Based on this testing and/or additional testing conducted by ASCO using single-frequency continuous sinusoidal inputs (after consideration of margin as suggested in IEEE-323-1974), the following acceptable maximum acceleration levels have been determined:

11.2g

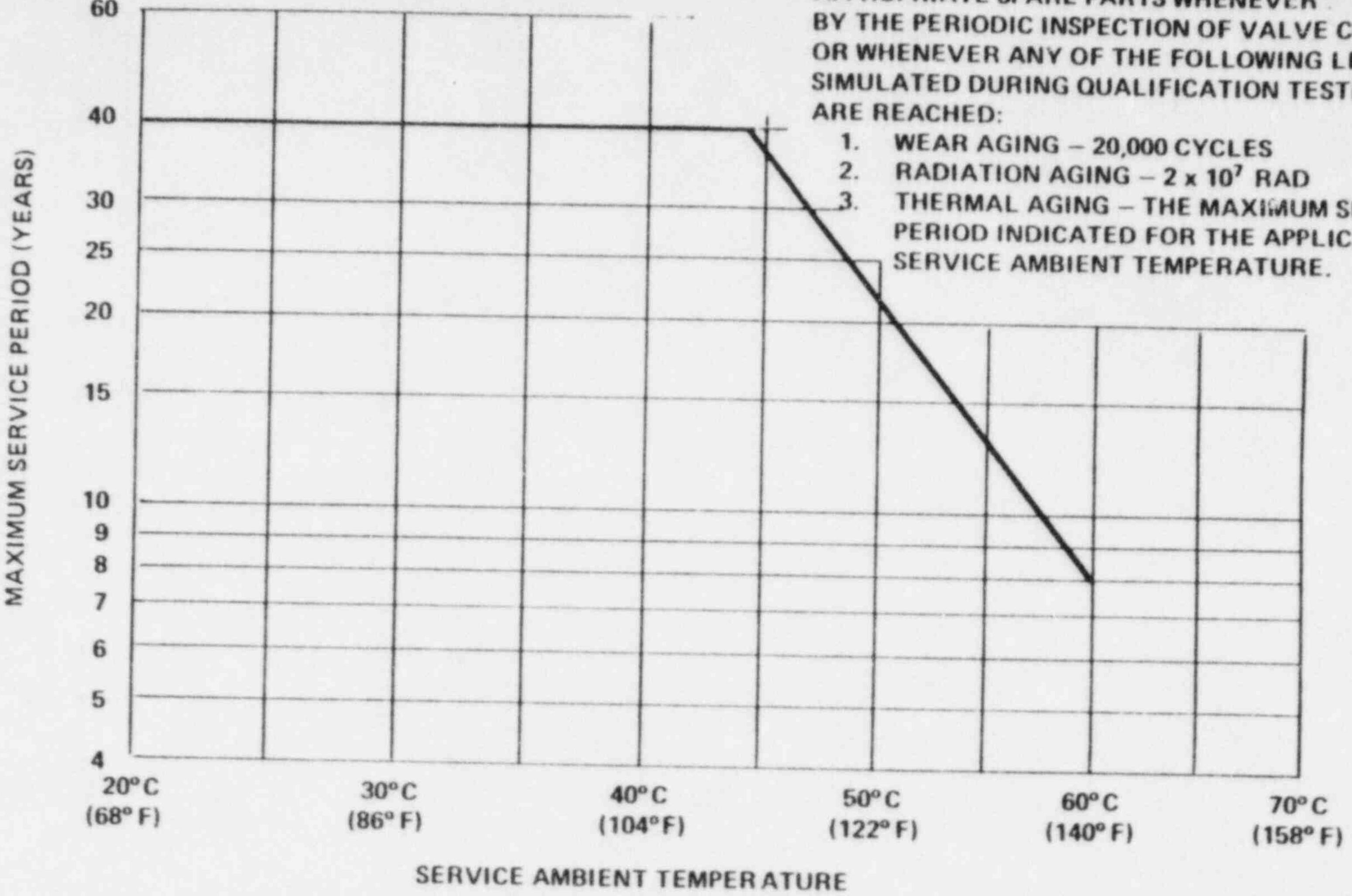
B. Radiation DBE Simulation - 180 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate (after consideration of margin as suggested in IEEE-323-1974) at least 163 megarads of accident radiation exposure.

C. Environmental DBE Simulation - The valves were installed in a pressure vessel and subjected to a 30-day exposure to steam, chemical spray and clear water spray simulating a combined loss-of-coolant accident/high-energy-line-break event and post event cool-down. The peak ambient temperature of the simulation was 420°F and the peak ambient pressure was 70 psig. The valves were pressurized to maximum operating pressure and continuously energized for 4 hours prior to the first transient (to produce thermal saturation of the solenoid coils). They were de-energized when the temperature of the first transient reached 420°F (to demonstrate the ability to perform a typical safety function) and were normally de-energized but were cycled periodically during the 30-day exposure to demonstrate the ability to operate on demand. The qualified temperature profile demonstrated by this simulation (after consideration of margin as suggested in IEEE-323-1974) is shown in Figure 3.

Test Report AQR-67368 is on file at Automatic Switch Company in Florham Park, N.J., and is available for customer perusal.

Dated AUGUST 15, 1983 Authorized Signature

QUALITY CONTROL MANAGER



NP-1 VALVES SHOULD BE REBUILT USING THE APPROPRIATE SPARE PARTS WHENEVER [illegible]CATED BY THE PERIODIC INSPECTION OF VALVE COMPONENTS OR WHENEVER ANY OF THE FOLLOWING LEVELS SIMULATED DURING QUALIFICATION TESTING, ARE REACHED:

1. WEAR AGING – 20,000 CYCLES
2. RADIATION AGING – 2 x 10^7 RAD
3. THERMAL AGING – THE MAXIMUM SERVICE PERIOD INDICATED FOR THE APPLICABLE SERVICE AMBIENT TEMPERATURE.

FIGURE 1

MAXIMUM SERVICE PERIODS FOR ELASTOMERIC COMPONENTS IN ASCO CATALOG NP-1 VALVES

S/N 8670354

Form VE 3239R1

S/N 8670354

AUTOMATIC SWITCH CO.

Florham Park, N.J. [illegible]32

NUCLEAR VALVE TEST LOG

ORDER DATA
(To be completed by Valve Sales)

CUSTOMER Fisher Controls

P.O. NO. 181979 S. O. NO. 432434

CATALOG NO. NPK8316A74E QTY.

CONSIGNEE Fisher Controls

CONSIGNEE P.O.

SALES ENGINEER (Signed) T. Hays DATE 8-12-83

TEST DATA
(To be completed by Test Dept. Supervisor)

ASCO DWG. NO. NVA208279 CHG. LTR. —

ASCO TEST PROCEDURE NP8316 CHG. LTR. G

TEST MEDIUM Air

TEST .080 AMPS/[illegible]E (Cross Out One)

TEST DEPT. (Signed) Browne DATE 8-12-83

CONFORMANCE TO TEST REQUIREMENT. (To be completed by Test Dept.) – a check (✓) indicates conformance to test requirements as listed in above test procedure.

SERIAL NUMBER	COIL TEST [illegible]/Volts	SEAT LEAKAGE				OPERATIONAL TEST		EXTERNAL LEAKAGE	HYPOT TEST (Volts/Time)	NOISE TEST	
		DE-ENERGIZED		ENERGIZED							
432434	644	● 175 PSIG	● 10 PSIG	● 175 PSIG	● 10 PSIG	175 PSIG MAX.	10 PSIG MIN.	Seram Test 250 PSIG	1250 V 1 MIN.	N/A	
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
4	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
5	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	

I HEREBY CERTIFY THE ABOVE RESULTS ARE A TRUE RECORD OF EACH ITEM INDICATED

☐ TESTER (Signed) Robert Evan DATE 8/15/83

☐ ASCO QUALITY CONTROL (Signed) DATE

☐ CUSTOMER REPRESENTATIVE (Signed) DATE

☐ GOV'T. QUALITY ASSURANCE REPRESENTATIVE (Signed) DATE

S/N 8672368

FISHER Controls

ASSEMBLY TEST REPORT

APR NO 79P12C 2

DRAWING NO 3AA 2463 / 48A 9884

REV A / A

ATR 79P12C 2 1

REV 1

VALVE SERIAL NO 86[illegible]368

SIZE AND TYPE 14" 9280

CUSTOMER ORDER NO. PAV 2-34

TAG NO 2HV-2627B

REP. ORDER NO 22B-XSAC03-N2U

ITEM NO 148

ISSUED BY EJH DATE 2/5/82

CODE ASME BOILER & PRESSURE VESSEL CODE

SECT. III 1974 EDITION, WINTER 1975 ADDENDA

STAMP ☒ YES ☐ NO

CLASS 2

NCR NO'S

REVISED BY FJH DATE 4/28/82

CONTROLLED PARTS VERIFICATION

PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.	PART	✓	
BODY	✓	AC 7243-1	1G 3801-S	RETAINING RING	✓	AC7241-1	D4442-3	Solenoid	✓	781951-1
BONNET				DISC	✓	AC 7235-1	E5190-2			
VALVE PLUG				DISC STOP	✓	AC7240-1	MATL SIZE & CC 75854-5			
STUDS				Switch	✓	781948-1				
NUTS				Switch	✓	781949-1				

PARTS VERIFIED BY D. Rogan 9-15-83 GAGE #216

Quality Assurance — Date — Authorized Inspector — Date

SPECIAL PROCESSING, TESTING AND RESULTS

HOLD/WIT PTS ✓ CUST. INSP.	HOLD PTS AUTH. INSP.	DESCRIPTION	✓	PROCEDURE	REV	AMENDMENT	REV	TEST PRESSURE	TIME (MIN)	ALLOW LEAKAGE	FINAL RESULTS	SIGNATURE/DATE ASSEMBLER	SIGNATURE/DATE FISHER INSP.
✓ 10/5 HOLD ANI	10-5-83	HYDROSTATIC TEST	✓	FMP 2X14	1	Am-6	2	450	29	0	Ok	[illegible]	[illegible] 10/5/83
11/19	Bartlett	SEAT LEAK TEST	✓	FMP 2X16	3	Am-8	1	60	5	0	0-LEAK	[illegible] 11-19-83	J [illegible] 11/19/83
		DISC HYDRO											
		DIAPH TO CASE LEAK TEST											
✓		OPERATIONAL TEST	✓	FMP 226.2	3	Am-21	0	SIGNAL:	TIME OPEN		TIME CLOSE		
		HYSTERESIS TEST						MAX. ERROR:					
		COMPLETE FORM FC 3780	✓										
✓ [illegible] 1/16	Bartlett	CLEANING PRIOR TO ASSEMBLY	✓	APR III. A									
		PAINTING	✓	APR IV A2	2	Am-33	0						
		FINAL CLEANING											
		SEAL ENDS	✓	APR V. B.									
✓ HOLD ANI		FINAL INSPECTION	✓										J [illegible]
		ASME STAMP	✓									[illegible] 1-5-84	1/6/84
✓		PACKAGING	✓	APR I.C.									

NOTE: Notify Customer Service for customer hold points. Notify authorized inspector for authorized inspector hold points.

F Perez — 2-5-82 — Kent Cocking — SEP 7 1983

APPROVED QUALITY ASSURANCE — DATE — REVIEWED AUTHORIZED INSPECTOR — DATE

FISHER

Assembly Test Report

NO. 19P126-2

DRAWING NO. 39A2462 48A9884

REV. 6 / 8

ATR 79P126-2

REV. 0

VALVE SERIAL NO. 8672368

SIZE AND TYPE 14" 9280

CUSTOMER ORDER NO. PAV 2-34

TAG NO. 2HV-2627B

REP. ORDER NO. 22B-XSAC03-N2U

ITEM NO. 148

ISSUED BY F. Hubbard DATE 11/7/83

CODE ASME BOILER & PRESSURE VESSEL CODE

SECT. III 19 74 EDITION. WINTER 19 75 ADDENDA

STAMP ☒ YES ☐ NO

CLASS 2

NCR NO.'S

REVISED BY DATE

CONTROLLED PARTS VERIFICATION

PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.
BODY	✓	AC7243-1	163801-5	Retaining Ring	✓	AC7241-1	D4442-3	Solenoid	✓	7R1951-1	
BONNET	✓	–		Disc	✓	AC7235-1	F5190-2				
VALVE PLUG				Disc Stop	✓	AC7240-1	MATL SPEC A Gr. 758 54-5				
STUDS				Switch	✓	781948-1					
NUTS				Switch	✓	781949-1					

PARTS VERIFIED BY ______ Quality Assurance ______ Date ______ Authorized Inspector ______ Date

SPECIAL PROCESSING, TESTING AND RESULTS

HOLD/WIT PTS ✓	CUST. INSP.	HOLD PTS ✓	AUTH. INSP.	DESCRIPTION	✓	PROCEDURE	REV	AMENDMENT	REV	TEST PRESSURE	TIME (MIN)	ALLOW LEAKAGE	FINAL RESULTS	SIGNATURE/DATE ASSEMBLER	SIGNATURE/DATE FISHER INSP.
✓	See Attached ATR			HYDROSTATIC TEST	✓	FMP 2X14	1	AM-6	2	—	See Attached			ATR	—
				SEAT LEAK TEST 1st	✓	FMP 2X16	3	AM-8	1	60	5	0	0-LEAK	11-9-83	11/17
				DISC HYDRO	✓	FMP 2X14.1	0	AM-7	0	66	2	—	0-leak	Edward	11/21/83
✓				Seat Leak 2nd Direction	✓	FMP 2X16	3	AM-8	1	60	60	0	0 leak	Edward	Bud Innis 11/21/83
				DIAPH TO CASE LEAK TEST	✓	FMP 2C6.2	3	AM-21	0	—	N/A				
✓	12/20/83			OPERATIONAL TEST						SIGNAL: 100#	TIME OPEN 20.2 Sec	TIME CLOSE 3.5 Sec		12-20-83	B. Vickers 12-20-83
				HYSTERESIS TEST						MAX. ERROR:					
				Complete per EC 3790	✓										
✓	See Attached ATR			CLEANING PRIOR TO ASSEMBLY	✓	—		APR III.A		See Attached				ATR	—
				PAINTING	✓			APR IV.B					OK	M. Burton	1-24-84
				FINAL CLEANING											
	12/21/83			SEAL ENDS	✓	FMP 10L2	3	AM-12 APR VI.B.	0					Edwards	12-21-83
			1-6-84	FINAL INSPECTION	✓										1/6/84
	HOLD ANI			STAMP	✓									1-5-84	
✓				PACKAGING	✓	FMP 11A2	3	APR V.C							1-25-84

NOTE: Notify Customer Service for customer hold points. Notify authorized inspector for authorized inspector hold points.

F. Perez 11-7-83 Kent Cocking NOV - 9 1983

APPROVED DATE REVIEWED AUTHORIZED INSPECTOR DATE

1-25-84

Form 3131D

8510-AX5AC03-5151-2 172

S/N 8672368

X5AC03-5151-2 173

S/N 8672366

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY Tom L DATE 10/13/82

PURCHASE ORDER NO. S181170-001

PURCHASE REQ. NO. 781948

REP. ORDER NO. 22B-XSAC03-A62U

ITEM NO. 0148

QUANTITY 1

DESCRIPTION Manco Switch

SIZE 14

TYPE 9280

MATERIAL TYPE suppliers Standard

PROJECT NO. 79P126

PIECE SERIAL NO. 781948-1

PART NO. 15A4157X022P

ROUGH DRAWING NO. ______

REV.

FINISHED DRAWING NO. 15A4157

REV. B

CODE: EGS 13A1, 13E1

SECT ______ 19 ____ EDITION. ______ 19 ____ ADDENDA

NUC. CLASS NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	G. Muller	12-1-82
				RECORD HEAT NUMBER ______ LOT NUMBER 4682K3119 VENDOR ______	G. Muller	12-1-82
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION	FCC QA DEC 1 1982	

______ Q.A. APPROVAL ______ DATE ______ A.I. REVIEW ______ DATE

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

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S/N 8672368

Namco Controls
· **An Acme-Cleveland** Company
1300 Burris Road (P.O. Box 730)
Newton, NC 28658

QUALITY CONTROL PROCEDURE

CERTIFICATION OF COMPLIANCE

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. C. Documentation Dept.

PURCHASE ORDER NUMBER S 181170 **ITEM NUMBER** 000

CUSTOMER PART NUMBER 15A4157X022

NAMCO PART NUMBER EA180-31302 **B/M REV.** K **QTY.** 6

LOT NUMBER 31119 **DATE CODE** 4682

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-40380 **DATE SHIPPED** 11/19/82

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS. NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2 AS APPLICABLE.
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11/19/82
DATE

Frank J [illegible]
QUALITY CONTROL MANAGER

9510-AX5AC03-5151-2 175

S/N 8672368

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY: Tom L DATE: 10/13/82

PURCHASE ORDER NO.: S181172-001

PURCHASE REQ. NO.: 781949

REP. ORDER NO.: 22B-X5AC03-N2U

ITEM NO.: 0148

QUANTITY: 1

DESCRIPTION: NAMCO Switch

SIZE: 14

TYPE: 9280

MATERIAL TYPE: Supplier Standard

PROJECT NO.: 79P126

PIECE SERIAL NO.: 781949-1

PART NO.: 15A5650X392 T

ROUGH DRAWING NO.: ———

REV.

FINISHED DRAWING NO.: 15A5650

REV.

CODE: EGS 13A1, 13E1

SECT ______ 19 ___ EDITION. ______ 19 ___ ADDENDA

NUC. CLASS: NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	Ural York	11/29/82
				RECORD HEAT NUMBER ______ LOT NUMBER ______ VENDOR 3953	Ural York	11/29/82
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ______ DATE ______ A.I. REVIEW ______ DATE ______

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

58 Printed in U.S.A.

S/N 8672368

Namco Controls
An Acme-Cleveland Company
1300 Burris Road (P.O. Box 730)
Newton, NC 28658

QUALITY CONTROL PROCEDURE

CERTIFICATION OF COMPLIANCE

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. A. Documentation Dept.

PURCHASE ORDER NUMBER 181172 **ITEM NUMBER** 000

CUSTOMER PART NUMBER 15A5650X392 P REV

NAMCO PART NUMBER EA180-32302 **B/M REV.** K **QTY.** 6

LOT NUMBER 29501 **DATE CODE** 4682

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-40379 **DATE SHIPPED** 11/17/82

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS. NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2 AS APPLICABLE.
NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180-11302, REV. H, WHICH WAS QUALIFIED TO IEEE STANDARDS 323 (1974), 344 (1975), AND 382 (1972), PER REPORT NO. QTR-105.

11/17/82
DATE

Frank J Nicoli
QUALITY CONTROL MANAGER

S/N 8672368

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY Tom L DATE 11/9/83

PURCHASE ORDER NO. 5182014-002
PURCHASE REQ. NO. 576218
REP. ORDER NO. 228-X5AC03-N24
ITEM NO. 0148
QUANTITY 1

DESCRIPTION Solenoid
SIZE 14
TYPE 9280
MATERIAL TYPE Suppliers Standard
PROJECT NO. 79P126
PIECE SERIAL NO. 576218-1

PART NO. 1M3429X0452
ROUGH DRAWING NO.
REV.
FINISHED DRAWING NO. 1M3429
REV. NA

CODE: FGS 13A1, 13E10
SECT ________ 19 ____ EDITION ________ 19 ____ ADDENDA
NUC CLASS NA
STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	Mike Wood	11-22-83
				RECORD HEAT NUMBER ________ LOT NUMBER ________ VENDOR ________		
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL	RECEIVED MAR 8 1984	
				Q.A. DOCUMENTATION VERIFICATION		

________ Q.A. APPROVAL ________ DATE ________ A.I. REVIEW ________ DATE

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

Form 1258 Printed in U.S.A.

9510-AX5AC03-5151-2 178

S/N 8672368

Automatic Switch Co.

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Since 1888

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CERTIFICATE OF COMPLIANCE

Customer Name FISHER CONTROLS INTERNATIONAL, INC.

Customer P.O. No. S182014

Consignee

Consignee P.O. No.

ASCO Shop Order No. 57589M

ASCO Part No. NP K 8316A-74-E Quantity 1

Voltage 125/DC Eng. Job No.

This is to certify that the subject valve(s) meet the performance requirements of IEEE-323-1974, IEEE-344-1975, and IEEE-382-1972, as substantiated by testing valves of generically equal design in accordance with ASCO Qualification Specification AQS-21678, Revision "B", dated February 15, 1978. The following test levels were included in this qualification test program:

I. Aging Simulation Phases:

A. Thermal Aging Simulation - 268°F for 12 days. These aging parameters were determined by Arrhenius calculations to simulate a minimum of 10 years in a 140°F continuous ambient. Refer to Figure 1 for additional information regarding service periods for elastomeric components and solenoid coils.

B. Radiation Aging Simulation - 50 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate expected non-accident radiation exposure.

C. Wear Aging Simulation - 40,000 operations at maximum operating pressure differential and nominal voltage.

D. Vibration Aging Simulation - 1 million cycles, distributed equally among the three orthogonal axes, between 50 and 100 Hz, at an input acceleration level of 0.75g. The valves were cycled once every 15 minutes during the test. The valves were attached to the shaker table by rigid test fixtures using the standard valve mounting provisions with the solenoids vertical and upright. Flexible hoses were used on all ports; therefore, the set-up did not affect the rigidity or mass of the valves being tested.

E. Seismic Aging (OBE) Simulation - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to two sinusoidal sweeps from 1 to 33 to 1 Hz, with a peak acceleration level of 3g within machine limits, in each of three orthogonal axes at a rate of 1 octave per minute. One sweep in each axis was conducted with the valves energized and the other with the valves de-energized. These sinusoidal sweeps are considered to provide the equivalent dynamic effect of 5 OBE's.

S/N8672368

ASCO SHOP ORDER NO. 57589M

II. Design Basis Event (DBE) Phases:

A. Seismic DBE (SSE) Simulation - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to single frequency sinusoidal tests at ⅓ octave frequency interval dwell points from 1-40 Hz. At each test frequency, the peak input acceleration was increased and the g-levels were recorded at which the cylinder port pressure (zero when de-energized and full inlet pressure when energized for a normally closed valve, opposite for a normally open valve) differed from the nominal by 0%, 5% and 10% of inlet pressure (up to 10g maximum). The valves are considered to function properly up to a 10% change in cylinder port pressure. This level was selected as being sufficiently low to prevent spurious shifting of the customer's main valve or other equipment. Motion was applied at the same frequency and acceleration limits in each of the three orthogonal axes separately. Based on this testing and/or additional testing conducted by ASCO (after consideration of margin as suggested in IEEE-323-1974), the following acceptable maximum acceleration levels have been determined:

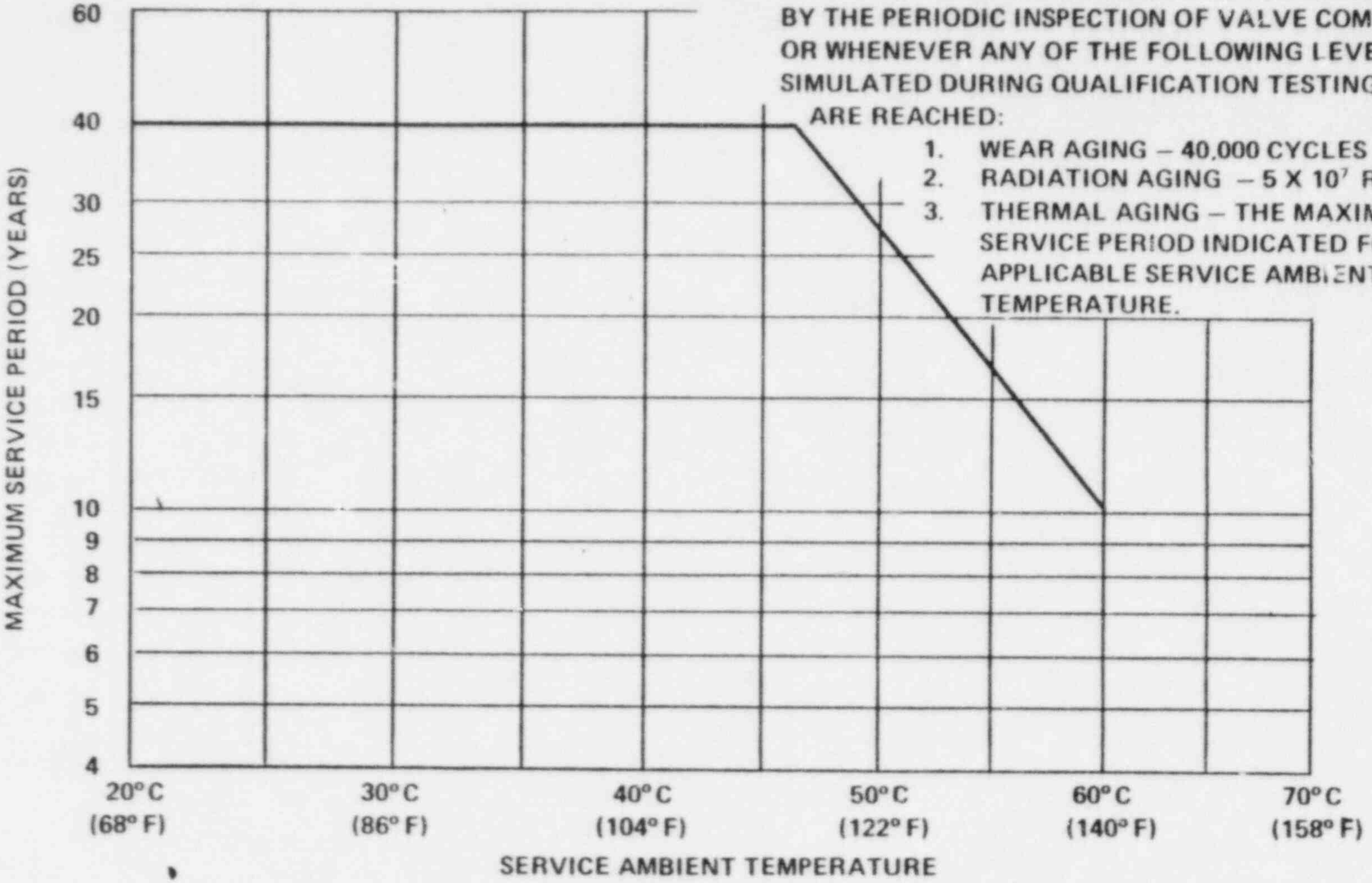
11.2g

B. Radiation DBE Simulation - 150 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate (after consideration of margin as suggested in IEEE-323-1974) at least 136 megarads of accident radiation exposure.

C. Environmental DBE (LOCA/HELB) Simulation - The valves were installed in a pressure vessel and subjected to a 30-day exposure of steam and chemical spray following the suggestions of IEEE-382-1972 (chemical spray per Table 1(b) and test chamber temperature profile per Figure 1 and Table 2). The valves had been pressurized to maximum operating pressure and continuously energized for 4 hours prior to the first transient (to produce coil saturation). They were de-energized when the temperature of the first transient reached 280°F, to show satisfactory shifting for demonstration of safety function. The valves were kept pressurized and were cycled during the 30-day exposure, as suggested in IEEE-382-1972, to demonstrate their ability to operate on demand during the LOCA or HELB.

Test report AQS-21678/TR, Rev. A, is on file at Automatic Switch Company in Florham Park, New Jersey, and is available for customer perusal.

Dated NOVEMBER 10, 1983 Authorized Signature
ASST. QUALITY CONTROL MANAGER



NOTE: IN ORDER TO MAINTAIN QUALIFICATION, CATALOG NP-1 VALVES SHOULD BE REBUILT USING THE APPROPRIATE SPARE PARTS WHENEVER INDICATED BY THE PERIODIC INSPECTION OF VALVE COMPONENTS OR WHENEVER ANY OF THE FOLLOWING LEVELS, SIMULATED DURING QUALIFICATION TESTING, ARE REACHED:

1. WEAR AGING – 40,000 CYCLES
2. RADIATION AGING – 5×10^7 RAD
3. THERMAL AGING – THE MAXIMUM SERVICE PERIOD INDICATED FOR THE APPLICABLE SERVICE AMBIENT TEMPERATURE.

FIGURE 1

MAXIMUM SERVICE PERIODS FOR ELASTOMERIC COMPONENTS AND SOLENOID COILS IN ASCO CATALOG NP-1 VALVES

S/N 8672368

S/N 8670355

FISHER

Assembly Test Report

APR NO 79P126-2
DRAWING NO 38A2460 48A9882
REV. C
ATR 79P126-2-2
REV 0

VALVE SERIAL NO 8670355
SIZE AND TYPE 14" 9280
CUSTOMER ORDER NO PAY2-34
TAG NO 2HV-2628B
REP ORDER NO 22B-XSAC03-N2T
ITEM NO 149
ISSUED BY F. Hubbard
DATE 11/7/83
CODE ASME BOILER & PRESSURE VESSEL CODE
SECT III 19 74 EDITION WINTER 19 75 ADDENDA
STAMP ☒ YES ☐ NO
CLASS 2
NCR NO'S
REVISED BY
DATE

CONTROLLED PARTS VERIFICATION

PART	✓	PIECE S/N	HEAT NO	PART	✓	PIECE S/N	HEAT NO	PART	✓	PIECE S/N	HEAT NO
BODY	✓	AC 6632-1	IG 3801-1	Retaining Ring	✓	AC 6630-1	P4152-1	Switch	✓	781002-L	4682K31119
BONNET	✓			Disc	✓	AC 6624-1	ES190-1	Switch	✓	781003-1	4682K29501
VALVE PLUG				Disc Stop	✓	AC 6629-1	MATL SPEC & GT. 75854-3	Solenoid	✓	817949-1	97771K-5
STUDS								Solenoid	✓	576191-1	43243M-3
NUTS											

PARTS VERIFIED BY O. Cinzon 5-9-84
Quality Assurance Date Authorized Inspector Date

SPECIAL PROCESSING, TESTING AND RESULTS

HOLD ANI 5-15-84

HOLD/WIT PTS CUST INSP	HOLD PTS ANI INSP	DESCRIPTION	✓	PROCEDURE	REV	AMENDMENT	REV	TEST PRESSURE	TIME (MIN)	ALLOW LEAKAGE	FINAL RESULTS	SIGNATURE/DATE ASSEMBLER	SIGNATURE/DATE FISHER INSP.
		HYDROSTATIC TEST	✓	FMP 2X14	1	AM-6	2	450	29	0	0 Leak	4-15-84	Thatcher 5/15/84
	Bartho	SEAT LEAK TEST 1st	✓	FMP 2X16	3	AM-8	1	60	5	0	0 Leak	Edwards	8/20/84
		DISC HYDRO	✓	FMP 2X14.1	0	AM-7	0	66	2	—	0 Leak	Edwards	8/20/84
	Bartho	Seat Leak 2nd Direction	✓	FMP 2X16	3	AM-8	1	40	40	0	0 Leak	Edwards	8/20/84
		DIAPH TO CASE LEAK TEST	✓	FMP 206.2	3	AM-21	0	N/A					
4/21	Bartho	OPERATIONAL TEST						SIGNAL: 100#	~~TIME~~ OPEN 20.5		~~TIME~~ 8-21-84 CLOSE 3.3 sec	OK John	8/21/84
		HYSTERESIS TEST						MAX. ERROR					
		Complete per EC 3790	✓										
	Bartho	CLEANING PRIOR TO ASSEMBLY	✓	—		APR Ⅲ.A						Edwards	
		PAINTING	✓			APR Ⅳ.B							
		FINAL CLEANING											
9/27	Bartho	SEAL ENDS	✓	FMP 10L2	3	AM-12 APR Ⅴ.B.	0					Edward	9-27-84
	10-3-84	FINAL INSPECTION	✓								OK		10/3/84
	HOLD ANI	N STAMP	✓										10-3-84
10	15	PACKAGING	✓	FMP 11A2	3	APR Ⅴ.C							10-15-84

NOTE: Notify Customer Service for customer hold points. Notify authorized inspector horized inspector hold points.

F. Perez 11-7-83 Kent Corbin MAY 9 1984
APPROVED DATE REVIEWED AUTHORIZED INSPECTOR DATE

Form 31310

9[redacted]003 5151-2 182 S/N 8670355 ~~[illegible]~~

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY: Tom L DATE: 10/13/82

PURCHASE ORDER NO.	PURCHASE REQ. NO.	REP. ORDER NO.	ITEM NO.	QUANTITY
S181170-006	78 1002	22B-XSAC03-N2T	0149	1

PART DESCRIPTION	SIZE	TYPE	MATERIAL TYPE	PROJECT NO.	PIECE SERIAL NO.
micro Switch	14	9280	supplier Standard	79P126	781002-1

PART NO.	ROUGH DRAWING NO.	REV.	FINISHED DRAWING NO.	REV.
15A4157X022P			15A4157	B

CODE: EGS 13A1, 13F1

SECT ______ 19 ___ EDITION ______ 19 ___ ADDENDA

NUC. CLASS: NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	G. Muller	12-1-82
				RECORD HEAT NUMBER ______ LOT NUMBER 4682 K31119 VENDOR ______	G. Muller	12-1-82
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION	F&C Q.A. DEC 1 1982	

Q.A. APPROVAL ______ DATE ______ A.I. REVIEW ______ DATE ______

Inspection activities required are checked. Return this form to Quality Documentation Coordinator after part is stored.

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Namco Controls
· An Acme-Cleveland Company
1300 Burris Road (P.O. Box 730)
Newton, NC 28658

QUALITY CONTROL PROCEDURE

CERTIFICATION OF COMPLIANCE

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. C. Documentation Dept.

PURCHASE ORDER NUMBER S 181170 **ITEM NUMBER** 000

CUSTOMER PART NUMBEI 15A4157X022

NAMCO PART NUMBER EA180-31302 **B/M REV.** K **QTY.** 6

LOT NUMBER 31119 **DATE CODE** 4682

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-40380 **DATE SHIPPED** 11/19/82

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS. NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2 AS APPLICABLE.
NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180-11302, REV. H, WHICH WAS QUALIFIED TO IEEE STANDARDS 323 (1974), 344 (1975), AND 382 (1972), PER REPORT NO. QTR-105.

11/19/82
DATE

Frank J
QUALITY CONTROL MANAGER

9510 AX5AC03-5151-2 184

S/N 8670355

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

FISHER Controls

NCR NO.S

ISSUED BY: Tom L DATE: 10/13/82

PURCHASE ORDER NO.: S181172-005

PURCHASE REQ. NO.: 781003

REP. ORDER NO.: 22B-X5AC03-N2T

ITEM NO.: 0149

QUANTITY: 1

DESCRIPTION: NAMCO SWITCH

SIZE: 14

TYPE: 9280

MATERIAL TYPE: Supplier Standard

PROJECT NO.: 79P126

PIECE SERIAL NO.: 781003-1

PART NO.: 15A5650X392 C

ROUGH DRAWING NO.: ——————

REV.:

FINISHED DRAWING NO.: 15A5650

REV.:

CODE: EGS 13A1, 13E1

SECT ______ 19 ____ EDITION ______ 19 ____ ADDENDA

NUC. CLASS: NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	David York	11/29/82
				RECORD HEAT NUMBER ______ LOT NUMBER ______ VENDOR 3953	David York	11/29/82
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ______ DATE ______ A.I. REVIEW ______ DATE ______

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S/N 8670355

Namco Controls
An Acme-Cleveland Company
1300 Burris Road (P.O. Box 730)
Newton, NC 28658

QUALITY CONTROL PROCEDURE

CERTIFICATION OF COMPLIANCE

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. A. Documentation Dept.

PURCHASE ORDER NUMBER 181172 **ITEM NUMBER** 000

CUSTOMER PART NUMBER 15A5650X392 P REV

NAMCO PART NUMBER EA180-32302 **B/M REV.** K **QTY.** 6

LOT NUMBER 29501 **DATE CODE** 4682

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-40379 **DATE SHIPPED** 11/17/82

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS. NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2 AS APPLICABLE.
NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180-11302, REV. H, WHICH WAS QUALIFIED TO IEEE STANDARDS 323 (1974), 344 (1975), AND 382 (1972), PER REPORT NO. QTR-105.

11/17/82
DATE

Frank J [illegible]
QUALITY CONTROL MANAGER

S/N 8670355

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S				ISSUED BY Tom L	DATE 6/22/83
PURCHASE ORDER NO. S181979-003	PURCHASE REQ. NO. 576191	REP. ORDER NO. 22B-X5AC03-N2T		ITEM NO. 0149	QUANTITY 1
DESCRIPTION Co Solenoid	SIZE 14	TYPE 9280	MATERIAL TYPE Suppliers Standard	PROJECT NO. 79P126	PIECE SERIAL NO. 576191-1
PART NO. 1M3429X0452	ROUGH DRAWING NO. ——	REV.	FINISHED DRAWING NO. 1M3429	REV. NA	

CODE: FGS 13A1, 13E10

SECT ______ 19 ____ EDITION ______ 19 ____ ADDENDA

NUC. CLASS: NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	L Schweinhart	8/24/83
				RECORD HEAT NUMBER ______ LOT NUMBER 43243M-3 VENDOR Automatic Switch	L Schweinhart	8/24/83
				STAMP PIECE SERIAL NO. ON PART	ECI QA AUG 24 1983 LPM	
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ______ DATE ______ A.I. REVIEW ______ DATE ______

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S/N 8670355

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CERTIFICATE OF COMPLIANCE

Customer Name FISHER CONTROLS INTERNATIONAL, INC.

Customer P.O. No. S181979

Consignee

Consignee P.O. No.

ASCO Shop Order No. 43243M

ASCO Part No. NPK 8316A-74-E Quantity 5

Voltage 125/DC Eng. Job No.

This is to certify that the subject valve(s) meet the performance requirements of IEEE-323-1974, IEEE-344-1975, IEEE-382-1980 (Revision of IEEE-382-1972) and IEEE-627-1980, as substantiated by testing valves of generically equal design in accordance with ASCO Qualification Specification AQS-21680/Rev. C, dated July 13, 1981. The following test levels were included in this qualification test program:

I. Aging Simulation Phases:

A. Thermal Aging Simulation - 250°F for 18¼ days. These aging parameters were determined by Arrhenius calculations to simulate a minimum of 8 years in a 140°F continuous ambient. Refer to Figure 1 for additional information regarding service periods for elastomeric components and Figure 2 for additional information regarding service periods for solenoid coils.

B. Wear Aging Simulation - 20,000 operations at maximum operating pressure differential and nominal voltage. Ten percent of the wear aging simulation (2,000 cycles) was conducted concurrently with the thermal aging simulation.

C. Pressurization Aging Simulation - 15 ambient pressure excursions from atmospheric pressure to 80 psig to simulate the expected periodic pressurization of the containment for leak testing during the life of the plant.

D. Radiation Aging Simulation - 20 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate expected non-accident radiation exposure.

E. Vibration Aging Simulation - Continuous sinusoidal sweeps from 5 to 200 to 5 Hz at a rate of 2 octaves per minute, with a minimum peak acceleration level of 0.75g (except at low frequencies where the acceleration level was reduced such that the displacement did not exceed 0.025" double amplitude), for a minimum of 90 minutes in each of three orthogonal axes. The test valves were alternately de-energized or energized every 15 minutes during this exposure. The valves were attached to the shaker table by rigid test fixtures using the standard valve mounting provisions with the solenoids (Solenoid 'A' for NP8323 valves) vertical and upright. Flexible hoses were used on all ports; therefore, the set-up did not affect the rigidity or mass of the valves being tested.

F. Seismic Aging (OBE) Simulation and Resonance Testing - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to two sinusoidal sweeps from 1 to 35 to 1 Hz, with a peak acceleration level (within machine limits) of 3g, in each of three orthogonal axes at a rate of not more than 1 octave per minute. One sweep in each axis was conducted with the valves energized and the other with the valves de-energized. These sinusoidal sweeps are considered to provide the equivalent dynamic effect of 5 OBE's. During this testing, accelerometers were attached to the solenoids of the test valves to determine if the valves exhibited any resonance. Resonance is defined as a response with a magnitude of acceleration at least twice as great as the input acceleration. No valve resonances were detected.

S/N 8670355

II. Design Basis Event (DBE) Phases:

A. Seismic DBE (SSE) Simulation - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to a series of single-frequency, single-axis sine-beat tests at 37 test frequencies between 1 and 35 Hz. The excitation was in the form of a continuous series of sine beats, with 12-15 oscillations per beat, for a minimum duration of 15 seconds at each test frequency. The successive beats were phased such that any superposition of response motion was additive. At each test frequency, the peak input acceleration was increased (up to 15g maximum) and the g-levels were recorded at which the cylinder port pressure (zero when de-energized and full inlet pressure when energized for a normally closed valve, opposite for a normally open valve) differed from the nominal by 0%, 5% and 10% of inlet pressure. The valves are considered to function properly up to a 10% change in cylinder port pressure. This level was selected as being sufficiently low to prevent spurious shifting of the customer's main valve or other equipment. Motion was applied at the same frequency and acceleration limits in each of the three orthogonal axes separately. Based on this testing and/or additional testing conducted by ASCO using single-frequency continuous sinusoidal inputs (after consideration of margin as suggested in IEEE-323-1974), the following acceptable maximum acceleration levels have been determined:

11.2g

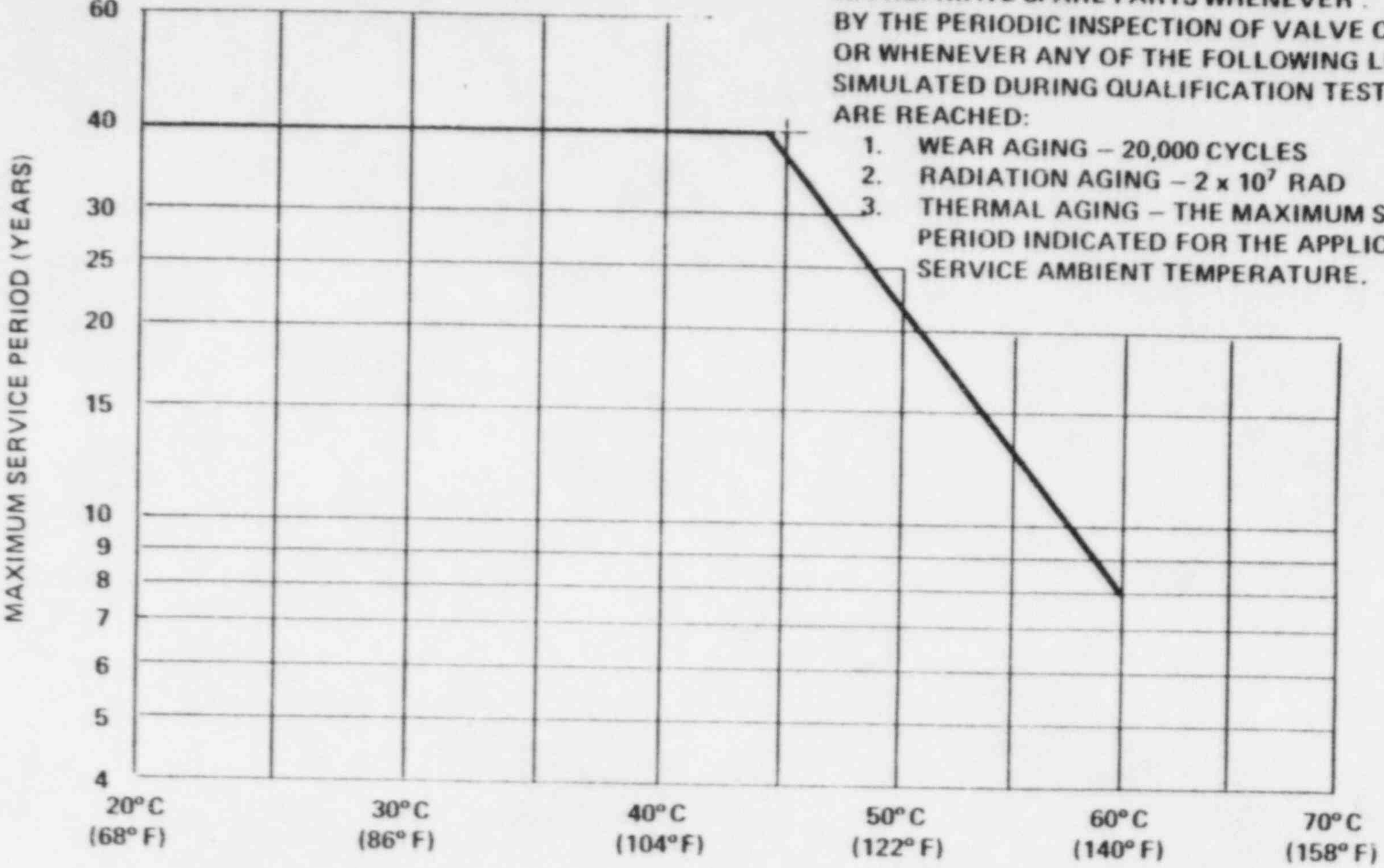
B. Radiation DBE Simulation - 180 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate (after consideration of margin as suggested in IEEE-323-1974) at least 163 megarads of accident radiation exposure.

C. Environmental DBE Simulation - The valves were installed in a pressure vessel and subjected to a 30-day exposure to steam, chemical spray and clear water spray simulating a combined loss-of-coolant accident/high-energy-line-break event and post event cool-down. The peak ambient temperature of the simulation was 420°F and the peak ambient pressure was 70 psig. The valves were pressurized to maximum operating pressure and continuously energized for 4 hours prior to the first transient (to produce thermal saturation of the solenoid coils). They were de-energized when the temperature of the first transient reached 420°F (to demonstrate the ability to perform a typical safety function) and were normally de-energized but were cycled periodically during the 30-day exposure to demonstrate the ability to operate on demand. The qualified temperature profile demonstrated by this simulation (after consideration of margin as suggested in IEEE-323-1974) is shown in Figure 3.

Test Report AQR-67368 is on file at Automatic Switch Company in Florham Park, N.J., and is available for customer perusal.

Dated AUGUST 15, 1983 Authorized Signature

QUALITY CONTROL MANAGER



NP-1 VALVES SHOULD BE REBUILT USING THE APPROPRIATE SPARE PARTS WHENEVER [illegible]CATED BY THE PERIODIC INSPECTION OF VALVE COMPONENTS OR WHENEVER ANY OF THE FOLLOWING LEVELS SIMULATED DURING QUALIFICATION TESTING, ARE REACHED:

1. WEAR AGING – 20,000 CYCLES
2. RADIATION AGING – 2 x 10^7 RAD
3. THERMAL AGING – THE MAXIMUM SERVICE PERIOD INDICATED FOR THE APPLICABLE SERVICE AMBIENT TEMPERATURE.

SERVICE AMBIENT TEMPERATURE

FIGURE 1

MAXIMUM SERVICE PERIODS FOR ELASTOMERIC COMPONENTS IN ASCO CATALOG NP-1 VALVES

S/N 8620355

9511-AX5AC02-5151-2 198

S/N 8670255

AUTOMATIC SWITCH CO.

Florham Park, N.J. 0 932

NUCLEAR VALVE TEST LOG

ORDER DATA
(To be completed by Valve Sales)

CUSTOMER Fisher Controls

P.O. NO. 181979 S. O. NO. 43243M

CATALOG NO. NPK 8316A74E QTY.

CONSIGNEE Fisher Controls

CONSIGNEE P.O.

SALES ENGINEER
(Signed) T. Hays DATE 8-12-83

TEST DATA
(To be completed by Test Dept. Supervisor)

ASCO DWG. NO. NVA 208 279 CHG. LTR —

ASCO TEST PROCEDURE NP8316 CHG. LTR G

TEST MEDIUM Air

TEST .080 AMPS/~~VOLTAGE~~ (Cross Out One)

TEST DEPT. (Signed) Browne DATE 8-12-83

CONFORMANCE TO TEST REQUIREMENT. (To be completed by Test Dept.) – a check (✓) indicates conformance to test requirements as listed in above test procedure.

SERIAL NUMBER	COIL TEST /Volts	SEAT LEAKAGE				OPERATIONAL TEST		EXTERNAL LEAKAGE	HYPOT TEST (Volts/Time)	NOISE TEST	
		DE-ENERGIZED		ENERGIZED							
43243M	644	● 175 PSIG	● 10 PSIG	● 175 PSIG	● 10 PSIG	175 PSIG MAX.	10 PSIG MIN.	Seam Test 250 PSIG	1250 V 1 Min.	N/A	
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
4	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	
5	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	

I HEREBY CERTIFY THE ABOVE RESULTS ARE A TRUE RECORD OF EACH ITEM INDICATED

☐ TESTER (Signed) Robert Evans DATE 8/15/83

☐ ASCO QUALITY CONTROL (Signed) DATE

☐ CUSTOMER REPRESENTATIVE (Signed) DATE

☐ GOV'T. QUALITY ASSURANCE REPRESENTATIVE (Signed) DATE

Form Mfg. 3273N

FISHER

Assembly Test Report

APR NO. 79P126-2

DRAWING NO. 39A 2462 / 48A 9884

REV. 0

AT 79 Per. 2-2 REV. C

SIZE AND TYPE 14" 9280

CUSTOMER ORDER NO. PAV 2-34

TAG NO. 2HV-2629B

REP. ORDER NO. 22B-XSAC03-N2U

ITEM NO 150

ISSUED BY F. Hubbard DATE 11/7/83

VALVE SERIAL NO. 8672369

CODE ASME BOILER & PRESSURE VESSEL CODE

SECT III 19 74 EDITION WINTER 19 75 ADDENDA

STAMP ☒ YES ☐ NO

CLASS 2

NCR NO.'S

REVISED BY DATE

CONTROLLED PARTS VERIFICATION

PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.	PART	✓	PIECE S/N	HEAT NO.
BODY	✓	AC7666-1	IG 3801-6	Retaining Ring	✓	AC 7664-1	D4443-4	SoLeNoid	✓	782767-1	
BONNET	✓			Disc	✓	AC 7658-1	ES190-3				
VALVE PLUG				Disc Stop	✓	AC7663-1	MATL SPEC & GR. 75854-2				
STUDS				SWITCH	✓	782764-1					
NUTS				SWITCH	✓	782765-1					

PARTS VERIFIED BY ______ Quality Assurance ______ Date ______ Authorized Inspector GAGE 227 ______ Date

SPECIAL PROCESSING, TESTING AND RESULTS

HOLD/WITNESS	HOLD PTS AUTH. INSP	DESCRIPTION	✓	PROCEDURE	REV	AMENDMENT	REV	TEST PRESSURE	TIME (MIN)	ALLOW LEAKAGE	FINAL RESULTS	ASSEMBLER	FISHER INSP.
✓ HOLD ANI		11-22-83 HYDROSTATIC TEST	✓	FMP 2X14	1	Am-6	2	450	39	0	0 Leak	Edward	11/22/83
✓		SEAT LEAK TEST 1st	✓	FMP 2X16	3	AM-8	1	60	5	0	0 LEAK	Edward	Thatcher 12/5/83
		DISC HYDRO	✓	FMP 2X14.1	0	AM-7	0	66	2	—	0 LEAK	Edward	Thatcher
✓		Seat Leak 2nd Direction	✓	FMP 2X16	3	Am-8	1	60	60	0	0 LEAK	Edward	Thatcher 12/3/83
		DIAPH TO CASE LEAK TEST											
		OPERATIONAL TEST	✓	FMP 3660	3	AM-21	0	SIGNAL:	TIME OPEN 13.5 sec	TIME CLOSE 3 sec			B. Vi 1-18-84
		HYSTERESIS TEST						MAX. ERROR:					
		Complete per EC 3790	✓										
✓ See Attached ATR		CLEANING PRIOR TO ASSEMBLY	✓	—		APR III.A		— See Attached ATR —					
		PAINTING	✓			APR IV.B						Burton	
		FINAL CLEANING											
		SEAL ENDS	✓	FMP 10L2	3	Am-12 APR V.B.	0					DeFrance	1-19-84
	1-25-84	FINAL INSPECTION	✓										Thatcher
HOLD ANI		ASME STAMP	✓								OK	1-24-84	1/26/84
✓		PACKAGING	✓	FMP 11A2	3	APR V.C						J. Catron	2/9/84

NOTE: Notify Customer Service for customer hold points. Notify authorized inspector for authorized inspector hold points.

F. Perez 11-7-83 Kent Corking NOV 2 1983

APPROVED DATE REVIEWED AUTHORIZED INSPECTOR DATE

Form 3131D

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S/N 8672369

[redacted]AC03-5151-2 192

S/N 8672369

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY Tom L DATE 10/13/82

PURCHASE ORDER NO. 5181170-004

PURCHASE REQ. NO. 782764

REP. ORDER NO. 328-XSAC03-NEW

ITEM NO. 050

QUANTITY 1

PART DESCRIPTION NAMCO Switch

SIZE 14

TYPE 9280

MATERIAL TYPE supplier Standard

PROJECT NO. 79P126

PIECE SERIAL NO. 782764-1

PART NO. 15A4157X022P

ROUGH DRAWING NO. ——————

REV.

FINISHED DRAWING NO. 15A4157

REV. B

CODE: EGS BA1, BF1

SECT ____ 19 ____ EDITION ____ 19 ____ ADDENDA

NUC. CLASS NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	G. Miller	12-1-82
				RECORD HEAT NUMBER LOT NUMBER 4682K 31119 VENDOR	G. Miller	12-1-8
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION	F.C.C.-Q.A. DEC 1 1982 LBH	

Q.A. APPROVAL ____ DATE ____ A.I. REVIEW ____ DATE ____

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S/N 8672369

Namco Controls
An Acme-Cleveland Company
1300 Burris Road (P.O. Box 730)
Newton, NC 28658

QUALITY CONTROL PROCEDURE

CERTIFICATION OF COMPLIANCE

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. C. Documentation Dept.

PURCHASE ORDER NUMBER S 181170 ITEM NUMBER 000

CUSTOMER PART NUMBER 15A4157X022

NAMCO PART NUMBER EA180-31302 B/M REV. K QTY. 6

LOT NUMBER 31119 DATE CODE 4682

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-40380 DATE SHIPPED 11/19/82

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS. NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2 AS APPLICABLE.
NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180-11302, REV. H, WHICH WAS QUALIFIED TO IEEE STANDARDS 323 (1974), 344 (1975), AND 382 (1972), PER REPORT NO. QTR-105.

11/19/82
DATE

Frank J.
QUALITY CONTROL MANAGER

9510-AXSAC03-5151-2 194

S/N 8672369

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S			ISSUED BY Tom L	DATE 11/13/82
PURCHASE ORDER NO. 5181172-003	PURCHASE REQ. NO. 782765	REP. ORDER NO. 228-XSAC03-N2C1	ITEM NO. 0150	QUANTITY 1

DESCRIPTION NAMCO Switch	SIZE 14	TYPE 9280	MATERIAL TYPE Supplier Standard	PROJECT NO. 79P126	PIECE SERIAL NO. 782765-1

PART NO. 15A5650X392	ROUGH DRAWING NO. ____________	REV.	FINISHED DRAWING NO. 15A5650	REV.

CODE: FGS 13A1, 13E1

SECT ______ 19 ____ EDITION ____________ 19 ____ ADDENDA

NUC. CLASS NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	Neral York	11/29/82
				RECORD HEAT NUMBER ____________ LOT NUMBER ____________ VENDOR 3953	Neral York	11/29/82
				STAMP PIECE SERIAL NO. ON PART		
				STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ____________ DATE ________ A.I. REVIEW ____________ DATE ________

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S/N 8672369

Namco Controls
An Acme-Cleveland Company
1300 Burris Road (P.O. Box 730)
Newton, NC 28658

QUALITY CONTROL PROCEDURE

CERTIFICATION OF COMPLIANCE

Fisher Controls Company
205 South Center Street
Marshalltown, Iowa 50158
Attn: Q. A. Documentation Dept.

PURCHASE ORDER NUMBER 181172 **ITEM NUMBER** 000

CUSTOMER PART NUMBER 15A5650X392 P REV

NAMCO PART NUMBER EA180-32302 **B/M REV.** K **QTY.** 6

LOT NUMBER 29501 **DATE CODE** 4682

NAME LIMIT SWITCH

NAMCO SHIPPER NUMBER E-40379 **DATE SHIPPED** 11/17/82

NAMCO CONTROLS CERTIFIES THAT SWITCHES FURNISHED HAVE BEEN MANUFACTURED, INSPECTED, TESTED, AND FOUND TO MEET APPLICABLE B/M AND DRAWING SPECIFICATIONS. NAMCO QUALITY ASSURANCE MANUAL, REV. "F", INCORPORATES 10CFR50(B) AND ANSI 45.2 AS APPLICABLE.
NAMCO FURTHER CERTIFIES THAT THESE SWITCHES WERE MANUFACTURED TO THE SAME SPECIFICATIONS AS SWITCH MODEL EA180-11302, REV. H, WHICH WAS QUALIFIED TO IEEE STANDARDS 323 (1974), 344 (1975), AND 382 (1972), PER REPORT NO. QTR-105.

11/17/82
DATE

Frank J Nicoli
QUALITY CONTROL MANAGER

S/N 8672369

FISHER Controls

ROUGH STOCK/PURCHASE PARTS INSPECTION REPORT

NCR NO.S

ISSUED BY: Tom L

DATE: 9/7/83

PURCHASE ORDER NO.	PURCHASE REQ. NO.	REP. ORDER NO.	ITEM NO.	QUANTITY
S182014-001	818590	228-X5AC03-N24	0150	1

T DESCRIPTION	SIZE	TYPE	MATERIAL TYPE	PROJECT NO.	PIECE SERIAL NO.
Solenoid	14	9230	Suppliers Standard	79P126	818590-1

PART NO.	ROUGH DRAWING NO.	REV.	FINISHED DRAWING NO.	REV.
1M3429X 0452			1M3429	

CODE: FCS 13A1, 13E10

SECT ______ 19 ____ EDITION ______ 19 ____ ADDENDA

NUC. CLASS: NA

STAMP ☐ YES ☒ NO

HOLD POINTS				INSPECTION OPERATION	OPERATION PERFORMED BY	DATE
✓	CUST. INSP.	✓	AUTH. INSP.			
				INSPECT PER Q.A. MANUAL, SECTION 11 ☐ NUCLEAR ☒ STANDARD ☐ MSS-SP-55	Wayne Boston	10-10-83
				RECORD HEAT NUMBER ______ LOT NUMBER ______ VENDOR 0910	Wayne Boston	10-10-83
				STAMP PIECE SERIAL NO. ON PART		
		=		STORE MATERIAL		
				Q.A. DOCUMENTATION VERIFICATION		

Q.A. APPROVAL ______ DATE ______

A.I. REVIEW ______ DATE ______

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S/N 8672369

Automatic Switch Co.

Manufacturers of
DEPENDABLE CONTROL
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ASCO

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CERTIFICATE OF COMPLIANCE

Customer Name FISHER CONTROLS INTERNATIONAL, INC.

Customer P.O. No. S182014

Consignee

Consignee P.O. No.

ASCO Shop Order No. 45945M

ASCO Part No. NP K 8316A-74-E Quantity 1

Voltage 125/DC Eng. Job No.

This is to certify that the subject valve(s) meet the performance requirements of IEEE-323-1974, IEEE-344-1975, and IEEE-382-1972, as substantiated by testing valves of generically equal design in accordance with ASCO Qualification Specification AQS-21678, Revision "B", dated February 15, 1978. The following test levels were included in this qualification test program:

I. Aging Simulation Phases:

A. Thermal Aging Simulation - 268°F for 12 days. These aging parameters were determined by Arrhenius calculations to simulate a minimum of 10 years in a 140°F continuous ambient. Refer to Figure 1 for additional information regarding service periods for elastomeric components and solenoid coils.

B. Radiation Aging Simulation - 50 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate expected non-accident radiation exposure.

C. Wear Aging Simulation - 40,000 operations at maximum operating pressure differential and nominal voltage.

D. Vibration Aging Simulation - 1 million cycles, distributed equally among the three orthogonal axes, between 50 and 100 Hz, at an input acceleration level of 0.75g. The valves were cycled once every 15 minutes during the test. The valves were attached to the shaker table by rigid test fixtures using the standard valve mounting provisions with the solenoids vertical and upright. Flexible hoses were used on all ports; therefore, the set-up did not affect the rigidity or mass of the valves being tested.

E. Seismic Aging (OBE) Simulation - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to two sinusoidal sweeps from 1 to 33 to 1 Hz, with a peak acceleration level of 3g within machine limits, in each of three orthogonal axes at a rate of 1 octave per minute. One sweep in each axis was conducted with the valves energized and the other with the valves de-energized. These sinusoidal sweeps are considered to provide the equivalent dynamic effect of 5 OBE's.

S/N 8672369

ASCO SHOP ORDER NO. 45945M

II. Design Basis Event (DBE) Phases:

A. Seismic DBE (SSE) Simulation - The valves were mounted to the shaker table as described for the vibration aging simulation and were exposed to single frequency sinusoidal tests at ⅓ octave frequency interval dwell points from 1-40 Hz. At each test frequency, the peak input acceleration was increased and the g-levels were recorded at which the cylinder port pressure (zero when de-energized and full inlet pressure when energized for a normally closed valve, opposite for a normally open valve) differed from the nominal by 0%, 5% and 10% of inlet pressure (up to 10g maximum). The valves are considered to function properly up to a 10% change in cylinder port pressure. This level was selected as being sufficiently low to prevent spurious shifting of the customer's main valve or other equipment. Motion was applied at the same frequency and acceleration limits in each of the three orthogonal axes separately. Based on this testing and/or additional testing conducted by ASCO (after consideration of margin as suggested in IEEE-323-1974), the following acceptable maximum acceleration levels have been determined:

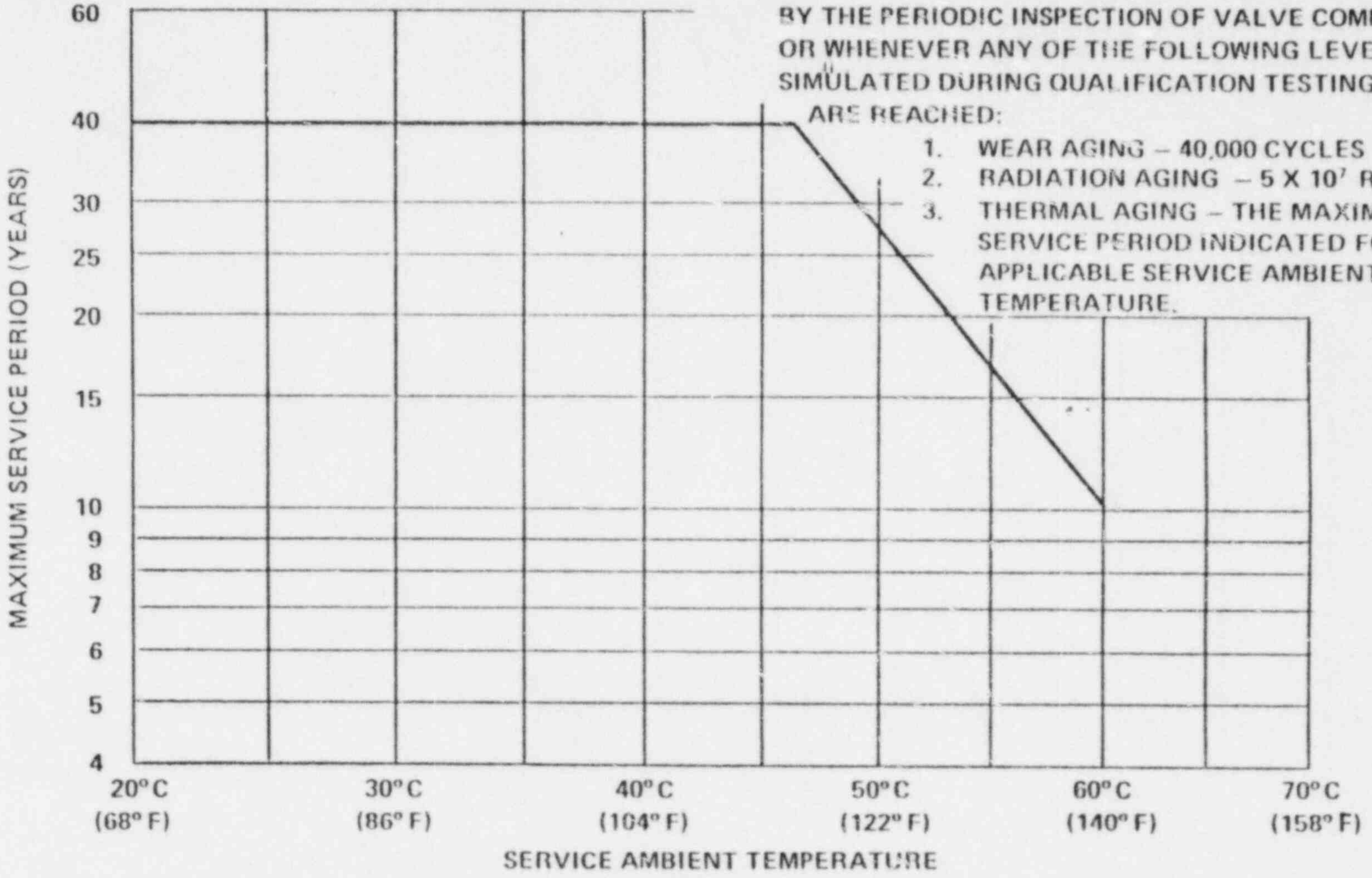
11.2g

B. Radiation DBE Simulation - 150 megarads of gamma radiation at a rate not exceeding 1 megarad per hour to simulate (after consideration of margin as suggested in IEEE-323-1974) at least 136 megarads of accident radiation exposure.

C. Environmental DBE (LOCA/HELB) Simulation - The valves were installed in a pressure vessel and subjected to a 30-day exposure of steam and chemical spray following the suggestions of IEEE-382-1972 (chemical spray per Table 1(b) and test chamber temperature profile per Figure 1 and Table 2). The valves had been pressurized to maximum operating pressure and continuously energized for 4 hours prior to the first transient (to produce coil saturation). They were de-energized when the temperature of the first transient reached 280°F, to show satisfactory shifting for demonstration of safety function. The valves were kept pressurized and were cycled during the 30-day exposure, as suggested in IEEE-382-1972, to demonstrate their ability to operate on demand during the LOCA or HELB.

Test report AQS-21678/TR, Rev. A, is on file at Automatic Switch Company in Florham Park, New Jersey, and is available for customer perusal.

Dated SEPTEMBER 28, 1983 Authorized Signature Q.A. TECH.



NOTE: IN ORDER TO MAINTAIN QUALIFICATION, CATALOG NP-1 VALVES SHOULD BE REBUILT USING THE APPROPRIATE SPARE PARTS WHENEVER INDICATED BY THE PERIODIC INSPECTION OF VALVE COMPONENTS OR WHENEVER ANY OF THE FOLLOWING LEVELS, SIMULATED DURING QUALIFICATION TESTING, ARE REACHED:

1. WEAR AGING – 40,000 CYCLES
2. RADIATION AGING – 5 X 10^7 RAD
3. THERMAL AGING – THE MAXIMUM SERVICE PERIOD INDICATED FOR THE APPLICABLE SERVICE AMBIENT TEMPERATURE.

FIGURE 1

MAXIMUM SERVICE PERIODS FOR ELASTOMERIC COMPONENTS AND SOLENOID COILS IN ASCO CATALOG NP-1 VALVES

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ATTACHMENT 6

FQP-11AB-7

Arrhenius Rate Equation Calculation

Arrhenius Rate Equation Calculations

The Arrhenius rate equation as referenced in IEEE 382 can be expressed as follows:

$$\frac{t_1}{t_2} = e^{\frac{\emptyset}{K}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)}$$

where: t_1 = service life

t_2 = test duration

T_1 = service temperature

T_2 = test temperature

$\emptyset$ = activation energy

K = Boltzman's constant = 0.8617×10^{-4} eV/K

Values determined by the aging segment of the Wyle Test Report No. 45088-1, Fisher Lab Problem 1685-3, Report 11, and Bechtel Specification X5AC03, Appendix EA, result in the following numbers for a service temperature of 135°F.

t_2 = 28.5 days

T_1 = 135 °F = 330.2 K

T_2 = 227.8 °F = 381.8 K

$\emptyset$ = 0.79 eV

hence:

$$t_1 = (t_2)e^{\frac{\emptyset}{K}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)}$$

$$t_1 = (28.5)\text{days} \quad e^{\frac{(0.79)\text{eV}}{(0.8617\times10^{-4})\text{eV/K}}\left(\frac{1}{330.2}\text{K} - \frac{1}{381.8}\text{K}\right)}$$

t_1 = 1215 days = 3 years 120 days

ARRHENIUS ACCELERATED-AGING RULE TEMPERATURE CALCULATION
of
MAXIMUM-ALLOWABLE NORMAL-SERVICE TEMPERATURE
to
ASSURE FOUR-YEAR LIFE OF NUCLEAR-SERVICE EQUIPMENT ELASTOMERIC MATERIALS
(Limited to ethylene propylene T-rings and graphoil packing)

This calculation is based on an accelerated-aging high-temperature test conducted by Fisher Controls Company. The test temperature was held constant at 227.8°F for the complete 28.5-day test. The four-year life calculation, below, utilizes the activation energy constant for ethylene propylene (0.79 eV) which is the most limiting of the regular nuclear-service butterfly-valve materials.

The unknown-time form of Arrhenius accelerated-aging equation is given below:

$$t_1 = (t_2)e^{\frac{\phi}{K}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]}$$

where:

ϕ (activation energy constant) = 0.79 eV
K (Boltzman's constant) = 0.8617×10^{-4}
t_1 (normal service-temperature life) = 4 years = 1461 days
t_2 (test duration) = 28.5 days
T_1 (maximum allowable service temperature) = unknown
T_2 (test temperature) = 227.8°F

Rearranging the equation to the inverse-temperature form:

$$\frac{1}{T_1} = \frac{1}{T_2} + \frac{K}{\phi} \ln \frac{t_1}{t_2}$$

Substituting above values into equation:

$$\frac{1}{T_1} = \frac{1}{382} + \frac{0.8617 \times 10^{-4}}{0.79} \ln \frac{1461}{28.5}$$

Solving for the four-year life temperature:

$$T_1 = 328.17°K = 131.3°F$$

ATTACHMENT 7

FQP-11AB-7

Effects of Gamma Radiation Exposure to 200 Mrads on 20" Type 9220 Valve With Bettis Actuator

Fisher Lab Problem 1685-3, Report 8

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By W.H. Haslett

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R. A. ENGEL TECH CENTER

FISHER CONTROLS COMPANY
MARSHALLTOWN, IOWA

Project 78EC07

PROB. 1685-3
REPORT 8
PAGE 1
DATE 2-17-81

LABORATORY REPORT

EFFECTS OF GAMMA RADIATION EXPOSURE TO 200 Mrads ON 20" TYPE 9220 VALVE WITH BETTIS ACTUATOR

ABSTRACT

The SNUPPS environmental test valve (20" Type 9220 with Bettis T420B-SR2) was exposed to a total of 200 Mrads of Cobalt-60 (gamma) radiation. Testing was performed after completion of the qualification testing per FQP-19 without changing or readjusting the T-ring. A dramatic increase in air leak rate occurred between 10 Mrads and 100 Mrads exposure over the entire test range (2.5 psid to 75 psid). With the addition of another 100 Mrads, the leak rate at the low ΔP again increased sharply. However, at the high end of the ΔP range there was essentially no further change in leak rate.

INTRODUCTION

1.0 - This report covers work performed at Isomedix Inc., Parsippany, New Jersey on the SNUPPS Environmental Test Valve. The test valve was a 20" Type 9220 with a Bettis T-420B-SR2 actuator and associated appurtenances. Prior to this test sequence, the valve assembly had undergone the entire test sequence described in Fisher Controls Environmental Qualification Plan FQP-19 (reference 1) up to, but not including, the post-DBE (Design Basis Event) Radiation Exposure Test (see Section 9.3, p. 28, of above mentioned document). In addition, the valve assembly was subjected to an extra thermal exposure of 400°F for 15 minutes in an air oven, in accordance with FGS 14A2 (reference 1). The testing reported here essentially completes the intent of FQP-19 and extends the radiation testing by an additional 100 Mrads. The procedures were modified somewhat due to factors described below.

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REPORT 8
PAGE 2
DATE 2-17-81

LABORATORY REPORT

During the post-DBE functional testing (Section 9.2, FQP-19), the Versa valve remained in the exhaust mode (the fail-safe position) thus preventing the opening of the test valve. Since the remaining tests were for information only, it was decided to eliminate the stroking time tests and to monitor leak rates only in determining radiation effects. Also, since no test chamber was available at Isomedix, the leak rates were determined at ambient conditions instead of at 120°F as called for in FQP-19. This necessitated running an additional baseline leak test prior to irradiation. There was no readjustment of the EPDM T-ring nor had there been since the post-thermal aging adjustment early in the testing sequence. In other words, the elastomeric seal ring had been adjusted for zero leakage at 75 psid and ambient temperature after a 50 day thermal and humidity aging sequence and then the valve assembly had undergone (1) 10 Mrads of gamma radiation, (2) seismic vibration testing, and (3) a design basis event (DBE) which consisted of a 30 day loss-of-coolant-accident (LOCA) simulation, and now, with this study, two additional doses of gamma radiation (90 Mrads and 100 Mrads) without touching the T-ring adjustment.

TEST PROCEDURE

2.0 - A complete description of the SNUPPS environmental test valve can be found in FQP-19, Rev. F (reference 1). The condition of the valve assembly at the start of this test sequence and details of prior testing can be found in Wyle Labs Test Reports No. 45088-1 and No. 45390-1 (references 2 and 3). The test valve was shipped directly from Wyle Labs, Huntsville, Alabama to Isomedix Inc., Parsippany, New Jersey. The two spool flanges had been removed prior to shipment.

PREPARATION FOR TESTING

2.1 - The two spool flanges with blind flanges already attached were rebolted across the test valve. The bolting was torqued to 540 ft-lbs, which was the same torque used previously at Wyle Labs.

BASELINE LEAK TEST

2.2 - Throughout this test sequence the valve assembly was oriented in the same manner as in the LOCA chamber (i.e., the disc was horizontal with the inlet side up). (See Figure 3.) The inlet air line was connected from a portable air compressor through a regulator to the top blind flange. The outlet air line was connected to the bottom blind flange with the other end submerged in water. Air leak rates were measured by noting the time required to displace a known quantity of water with air when an inverted water-filled container was held over the end of the outlet air line. This technique worked well for all the baseline leak tests. One problem was encountered with the test setup regulator in that its maximum output was about 35 psig. To obtain leak rates above 30 psig, the regulator was removed from the inlet air line and the inlet pressure was "controlled" using a needle valve located at the compressor volume tank.

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REPORT 8
PAGE 4
DATE 2-17-81

LABORATORY REPORT

PREPARATION FOR RADIATION EXPOSURE (90 Mrad Dose)

2.3 - The two blind flanges were removed from the inlet and outlet spool flanges to prepare the valve assembly for irradiation. The two spool flanges were left on the valve. At this point the valve assembly was turned over to Isomedix for radiation exposure.

RADIATION EXPOSURE

2.4 - The radiation exposure of 90 Mrads equivalent air dose was carried out as described in FCS14C1 (reference 4) and as reported in Isomedix letter dated February 3, 1981 (see Appendix C).

POST-RADIATION LEAK TESTS

2.5 - On completion of the radiation exposure the valve assembly was removed from the radiation chamber and the two blind flanges were reinstalled. Air leak tests were run using the same technique described in Paragraph 2.2. However, at high flow rates the technique was modified to a dry-fill measurement. (i.e., The outlet air flow was collected in a collapsed plastic bag. The time to inflate the bag to a known volume was measured.) Also, at the high leak rates it became obvious that the pressure drop in the outlet air line was significant. Hence, the pressure (P_2) at the outlet blind flange was measured for several tests and these values were plotted to obtain correction factors for the other leak tests. (See plot in Appendix A.)

PREPARATION FOR SECOND RADIATION EXPOSURE (100 Mrad Dose)

2.6 - The procedure was identical to that described in Paragraph 2.3.

RADIATION EXPOSURE

2.7 - The radiation exposure of 100 Mrads equivalent air dose was carried out as described in FGS14C2 (reference 5) and as reported in Isomedix letter dated February 3, 1981 (See Appendix C).

POST-RADIATION LEAK TESTS

2.8 - On the completion of the radiation exposure, the valve assembly was removed from the radiation chamber and the two blind flanges were reinstalled. Air leakage was measured by two techniques: (1) the water displacement technique described in paragraph 2.2 and (2) using an orifice well flowmeter. The calibratio curves for the orifice sizes used are included in Appendix B.

INSPECTION

2.9 - At the completion of the leak testing, the two spool flanges were removed and the valve assembly inspected for visual damage. The valve disc was rotated to the open position by applying air pressure directly to the actuator cylinder. (i.e., Bypassing the solenoid and the Versa valve.)

3.0 - DISCUSSION OF RESULTS

AIR LEAK RATE TESTS

3.1 - The air leak rate test results for the baseline test and the two post-radiation tests are summarized in Table I. The individual data sheets for each test are included in Appendix A. In Figure 1, the leak rates are plotted versus the differential pressure for all three runs. (The use of log-log plot is for convenience only and is not otherwise significant.) The four different curves for the 200 Mrads data represent four different "fresh starts" (i.e., starting at zero pressure and increasing P_1 incrementally). Both post-radiation tests (100 Mrad & 200 Mrad total dosage) showed a pronouced leakage increase over the entire pressure range as compared with the baseline test (10 Mrad level). Additionally, for the 200 Mrad test there was a certain amount of instability in the 10 to 20 psig inlet pressure range with the leak rate starting high and then dropping down to a lower level in a matter of minutes. This was probably due to a slight movement of the disc into a more favorable position in the seal ring. For 30 psid and above the leak rates after 100 Mrads and 200 Mrads were practically identical.

In Figure 2, the leakage at 2.5 psid is plotted versus total radiation dose. Here again, there is the obvious radiation effect, but compared with the SNUPPS post-DBE leakage criteria (reference 1) only the 200 Mrad test exceeds the allowabl leakage level. If this test had been performed at 100°F instead of less than 70°F it might well have been within the allowable level.

VISUAL INSPECTION

3.2 - The entire valve assembly was visually inspected for obvious damage. There was much rust and scale on almost every surface. Very little of the original paint was intact. A photograph of the general condition of the valve assembly is shown in Figure 3. Actually most, if not all, of the degradation reported here was due to the thermal/humidity aging and the LOCA simulation.

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REPORT 8
PAGE 7
DATE 2-17-81

LABORATORY REPORT

Removing the spool flanges revealed much evidence of corrosion on the valve internals. Figure 4 is a photo of the inlet side of the disc showing much rust and scale. Also, Figure 5 is a close-up of the scale and debris that was in the sealing area, first noticed when the valve was stroked open. The only damage to the T-ring was a small cut in one of the "rub" areas near the shaft (see Figure 6). There was some wear, but it was not really excessive for the 1000 plus open/close cycles the valve had been subjected to. There was a very pronounced "permanent set" to the T-ring due to the disc pressing into the rubber T-ring throughout most of the test sequence. (See Figures 7 and 8). Again, this phenomenon was not due to radiation exposure alone, but to the sum total of the thermal/humidity aging, the LOCA simulation and the radiation.

CONCLUSION

4.0 - While the test sequence was performed for information only, it is important to note that after 100 Mrads total radiation dose, the leak rate at 2.5 psid was still within the SNUPPS acceptance criteria for the post-DBE leakage as specified on Page 39.1 in FQP-19 (reference 1). Also, after 200 Mrads, the 2.5 psid leak rate was only moderately larger than this same acceptance level, which was specified for 100°F. Had the post-200 Mrad test been performed at 100°F instead of less than 70°F, the actual leakage would have been less and probably would have been close to the allowable 2944 cc/minute.

LABORATORY REPORT

It is also important to note that there was a dramatic radiation effect, with the greatest change occurring in the 10 to 20 psid range between the baseline (10 Mrads) and the 100 Mrads dose.

RECOMMENDATION

5.0 - In the past, 10 Mrads of radiation dosage was considered a safe maximum level for valve or appurtenances containing elastomeric materials (including Ethylene-propylene rubber [EPDM]). The results of this test sequence would tend to substantiate this 10 Mrad limit. In any application where a valve might receive greater than 10 Mrads total radiation, the customer should be cautioned that a certain loss of pressure retaining properties would be expected.

W. H. Haslett

W.H. Haslett
Evaluation & Analysis Department

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REPORT 8
PAGE 9
DATE 2-17-81

LABORATORY REPORT

REFERENCES

1. Fisher Controls Environmental Qualification Plan, FQP-19, Rev. F, dated April 14, 1980 modified by "Change of Scope to P.O. 217770" - dated October 28, 1980. Further modified by Fisher Controls Test Program FGS14A2, dated October 28, 1980. Referenced to P.O. No. 220272, Test Part No. 1R0101X0022.
2. Wyle Laboratory Report No. 45088-1, dated November 21, 1980.
3. Wyle Laboratory Report No. 45390-1, dated November 7, 1980.
4. Fisher Controls General Specification, FGS 14C1, Rev. A dated November 20, 1980. "Subcontracted Services, Isomedix Inc. Environmental Performance Testing (90 Mrad) 20" Type 9220 with Bettis T420B-SR2".
5. Fisher Controls General Specifications, FGS 14C2, Rev. A., dated November 20, 1980. "Environmental Performance Testing 100 Mrad Radiation Exposure 20" Type 9220 with a Bettis T420B-SR2".

TABLE I. - SUMMARY OF POST-DBE (RADIATION EFFECTS) LEAK TESTS

TESTS PERFORMED AT ISOMEDIX, INC., PARSIPPANY, N.J.

TEST FLUID : AIR   TEST TEMP. : ROOM AMBIENT (~65°F)

P_1 INLET PRESSURE	BASELINE (10 MRADS PREV. DOSE)				AFTER ADD'T'L. 90 MRADS (100 TOTAL)				AFTER ADD'T'L. 100 MRADS (200 TOTAL)			
	P_2 AT OUTLET	ΔP	LEAK RATE		P_L AT OUTLET	ΔP	LEAK RATE		P_L AT OUTLET	ΔP	LEAK RATE	
psig	psig	psid	cc/min.	SCFH	psig	psid	cc/min.	SCFH	psig	psid	cc/min.	SCFH
2.5	0	2.5	215	0.46	0.2	2.3	875	1.85	0 0.2	2.5 2.3	4315 4250	9.1 9.0
2.8	—	—	—	—	0.3	2.5	1270	2.7	—	—	—	—
10	0.1	9.9	510	1.08	2.6	7.4	14,400	30.6	1.2 2.5 3.9	8.8 7.5 6.1	94,400 16,300 20,300	200 345 43
20	0.2	19.8	884	1.87	2.6	17.4	14,300	30.3	0.4 1.25 5.0 0.75	19.6 18.75 15.0 19.25	56,600 11,300 86,400 33,500	120 24 183 71
30	0.5	29.5	2160	4.57	3.8	26.2	23,100	48.9	0.9	29.1	36,800	78
40	—	—	—	—	6.0	34.0	36,400	77.2	1.5	38.5	46,300	98
50	—	—	—	—	7.2	42.8	49,400	105	2.4	47.6	58,300	124
55	2.3	52.7	12,250	26.0	—	—	—	—	—	—	—	—
60	—	—	—	—	10.0	50.0	76,900	163	3.9	56.1	76,500	162
75	3.6	71.4	21,000	44.5	14.0	61.0	107,800	228	—*	—	—	—

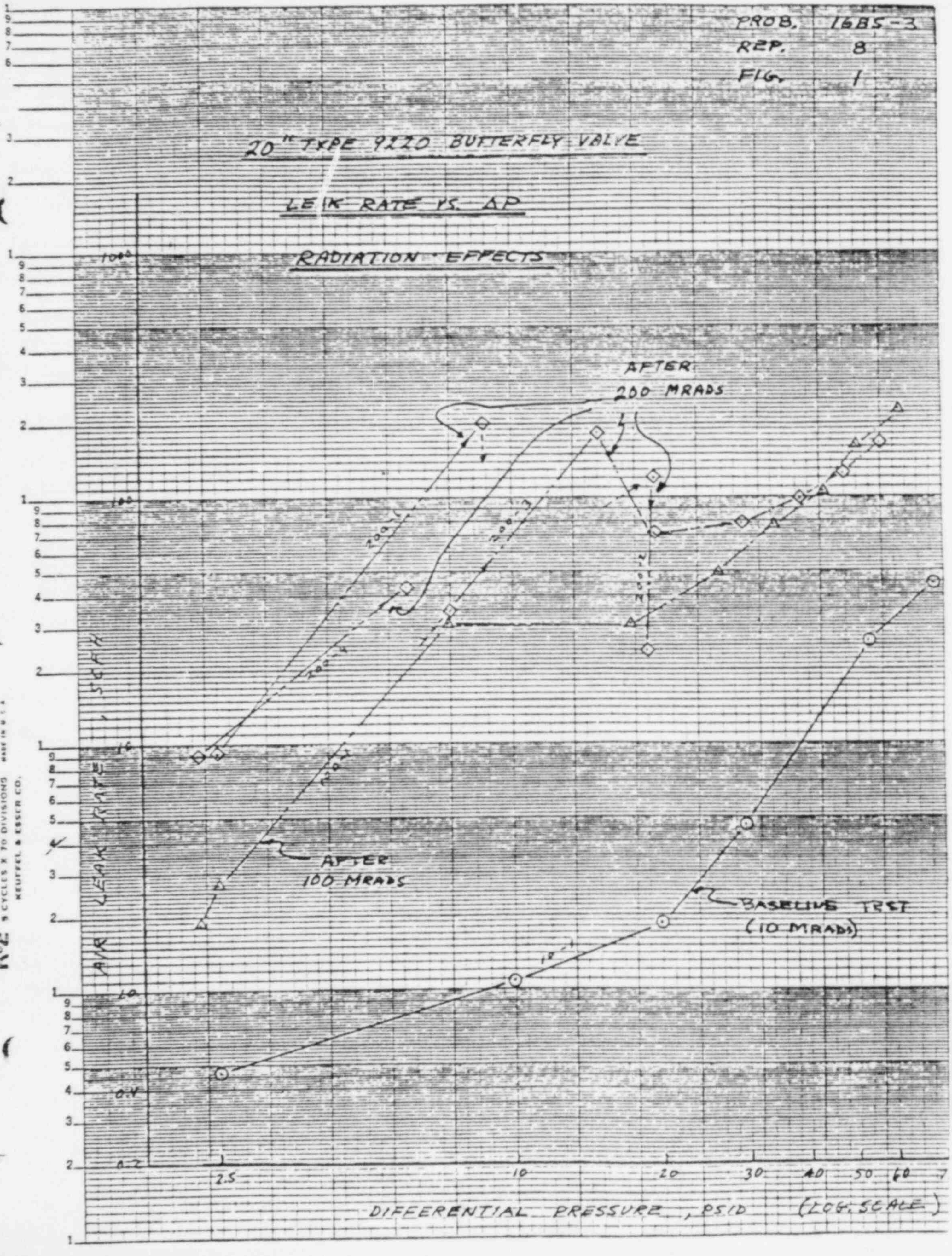
* MAX. PRESSURE POSSIBLE WAS 62 PSIG DUE TO LIMITATIONS OF THE AIR COMPRESSOR.

PROB. 1685-3
REP. 8
FIG. 1

20" TYPE 9220 BUTTERFLY VALVE

LEAK RATE VS. ΔP

RADIATION EFFECTS



FISHER CONTROLS CO.

PROB. 1685-3
REP. 8
FIG. 2

20" TYPE 9220

EFFECT OF RADIATION DOSE
ON LEAK RATE
AT 2.5 PSID

TEST TEMP: <70°F

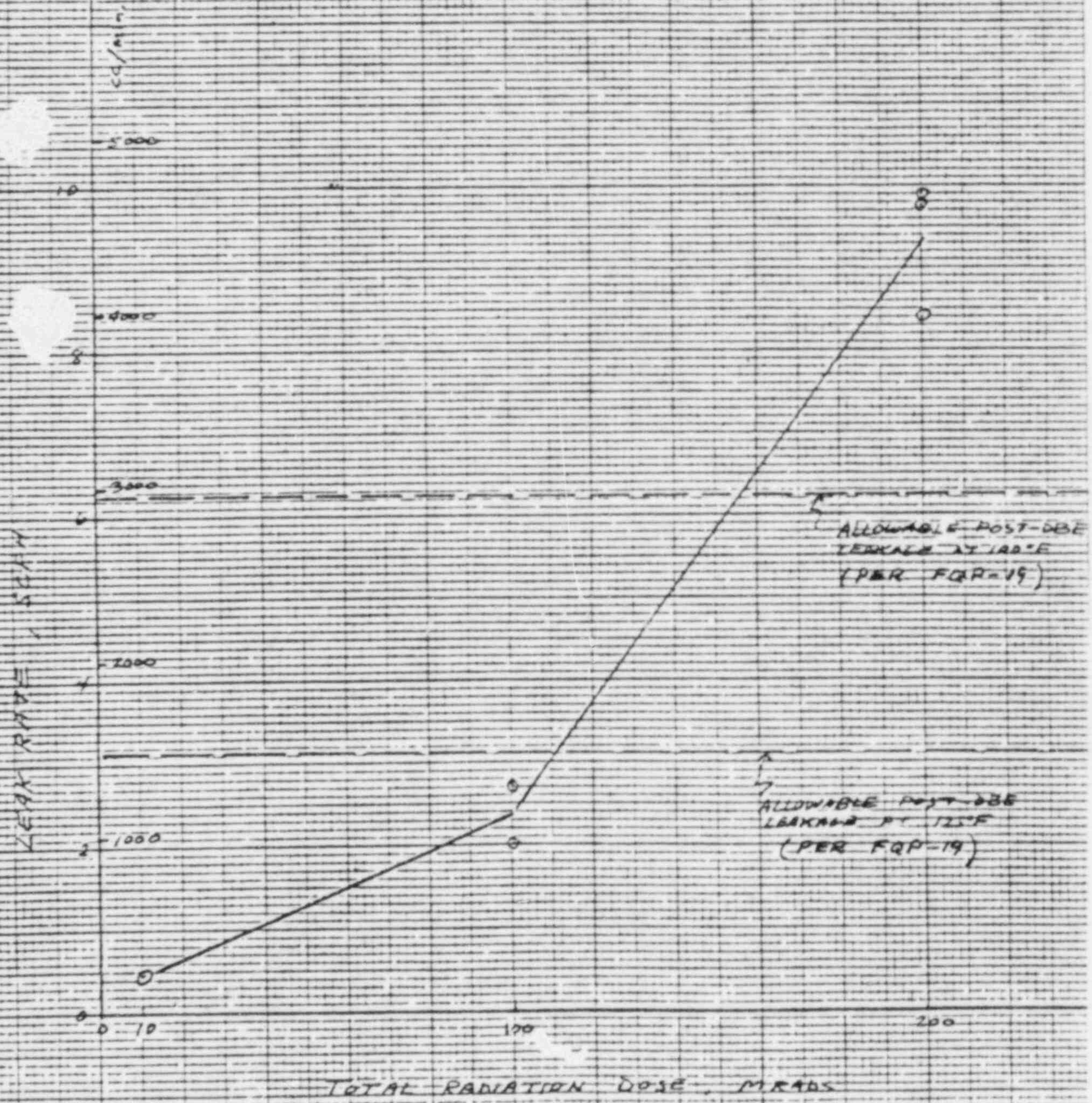
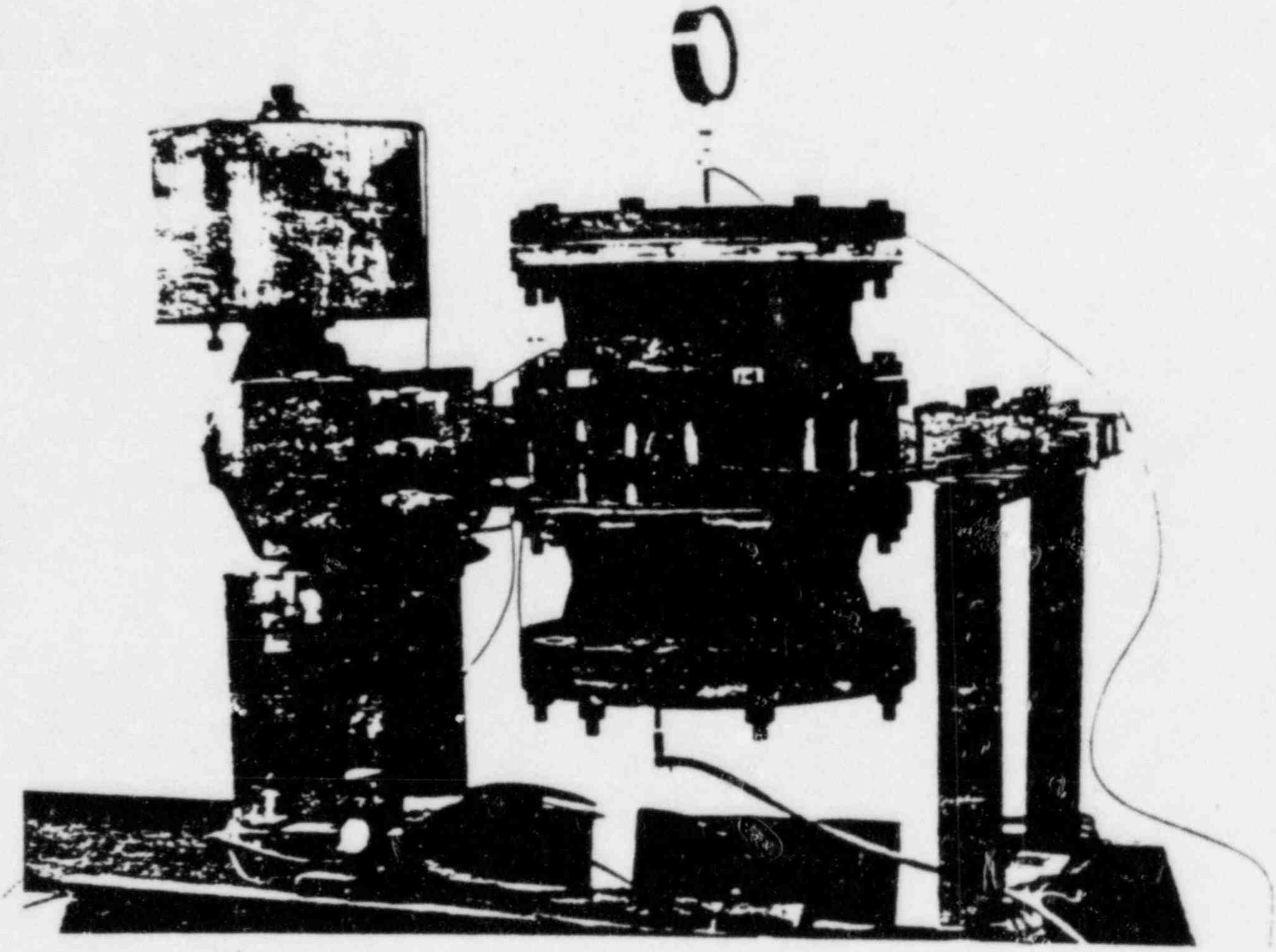
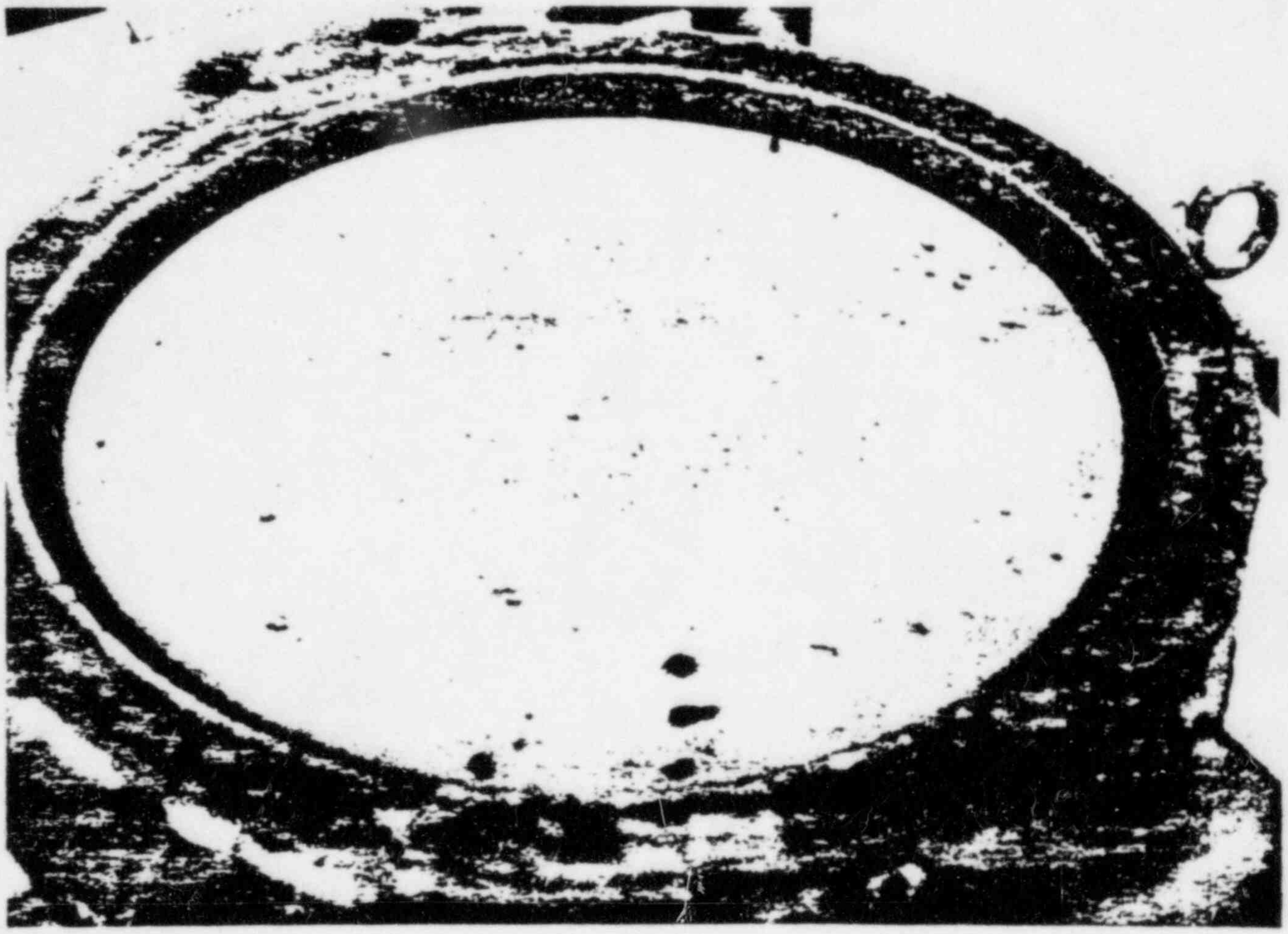


Fig. 3

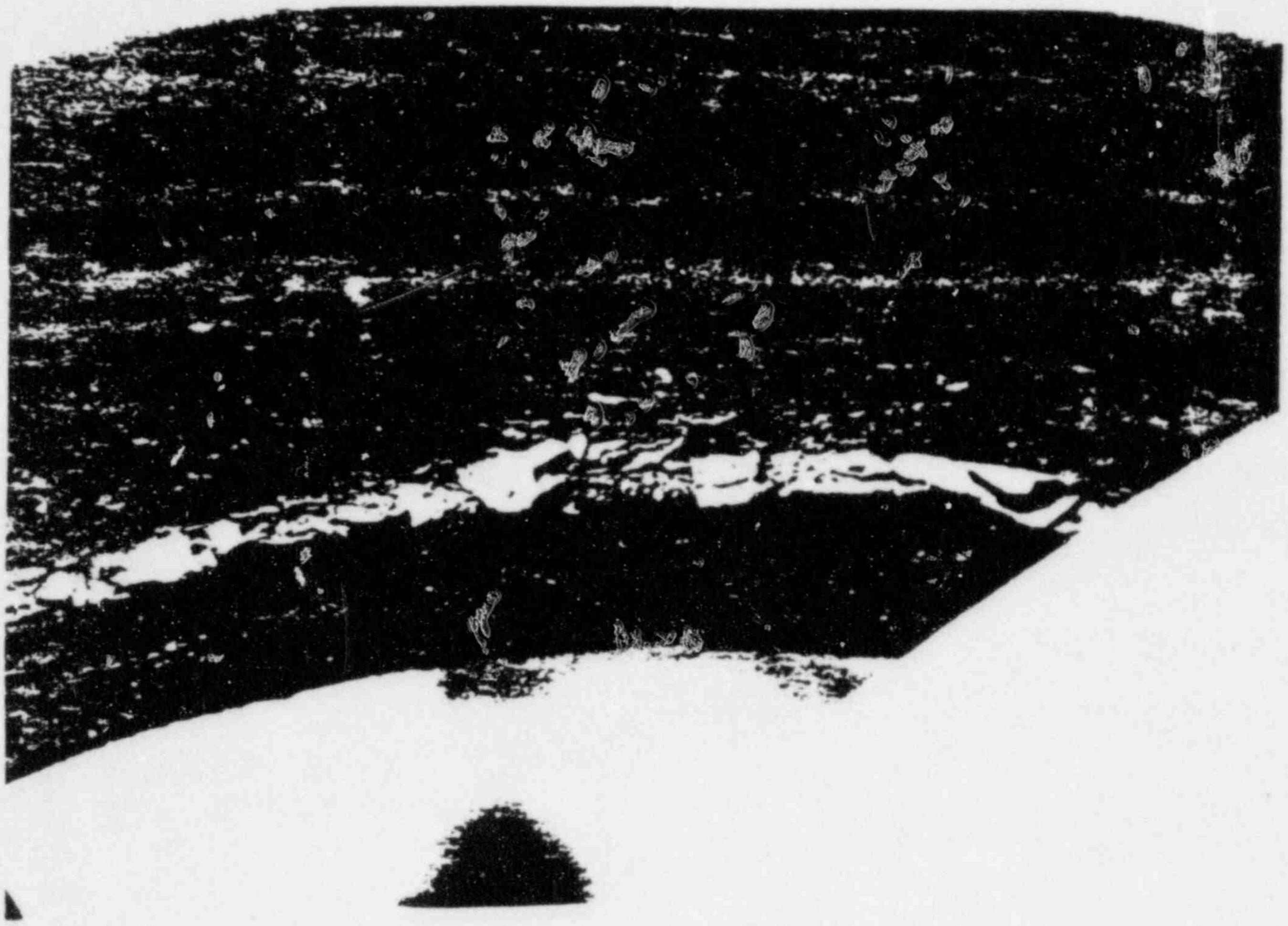


Overall view of valve assembly with spool flanges attached.

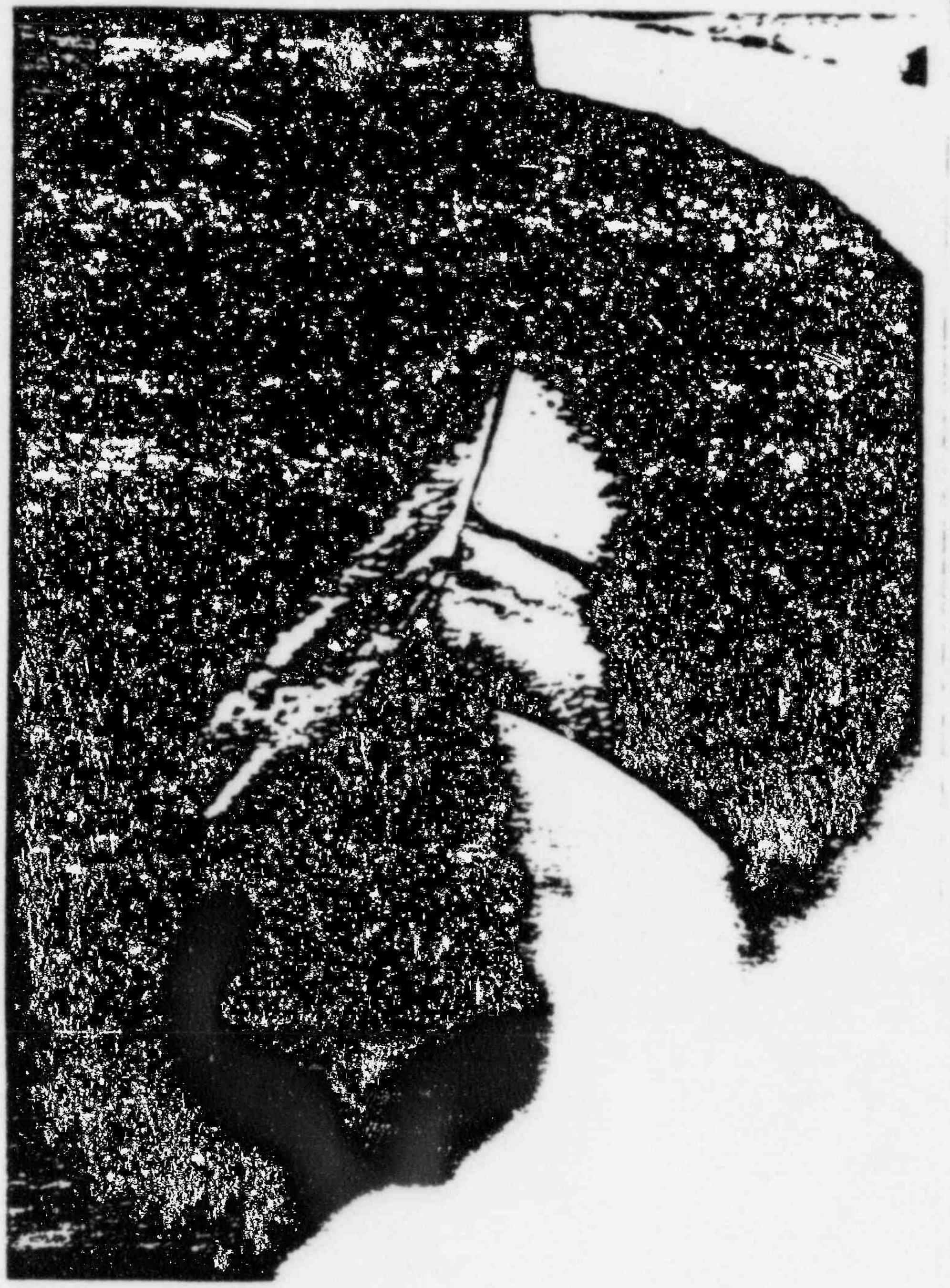


Photograph of inlet side of disc after radiation. Corrosive damage due primarily to previous test conditions. (Thermal/humidity aging and loss-of-coolant-accident, LOCA.)

Rep. 6
Fig. 5



Close-up of sealing area with disc open.



View showing small cut in T-ring.

Same view as Figure 6, but with different lighting to show "permanent set" of T-ring.

Another close-up of T-ring showing indentation or "permanent set".

ATTACHMENT 8

FQP-11AB-7

Valve Closure Test
6" Prototype Snupps Butterfly Valve

Wyle Report Number 44503-0

Valve Closure Test
Six-Inch Prototype
Snupps Butterfly Valve

For

Fisher Controls Company
Marshalltown, Iowa

TABLE OF CONTENTS

TEST REPORT

WYLE LABORATORIES
IENTIFIC SERVICES AND SYSTEMS GROUP
HUNTSVILLE, ALABAMA

Fisher Controls Company
P. O. Box 190
Marshalltown, Iowa 50158

REPORT NO. 44503-0
OUR JOB NO. 44503
YOUR P. O. NO. 213517 Change Order #1
CONTRACT N/A
PAGE 1 of 39 PAGE REPORT
DATE November 29, 1979

1.0 PURPOSE

The purpose of this report is to present the requirements, procedures, and results of a test program conducted to determine the closure time, flow capability, and subsequent leakage of a six-inch prototype butterfly valve.

2.0 REFERENCES

2.1 Wyle Laboratories Quotation 546/1048/CP dated October 9, 1978.

2.2 Fisher Controls Company Purchase Order Number 213517 dated August 14, 1979 and Change Order Number 1.

2.3 Fisher Controls Company, "Prototype Closure Test Procedure," FQP-24, Revision B.

3.0 MANUFACTURER

Fisher Controls Company
P. O. Box 190
Marshalltown, Iowa 50158

4.0 TEST SPECIMEN

The test specimen was a Fisher Controls Company, normally closed, Six-inch Type 6221, Butterfly Control Valve equipped with an air operated, solenoid controlled actuator. (Prototype).

5.0 SUMMARY

During system checkout and testing,. the test specimen was closed a total of 10 times without steam flow and four times with steam flow.

STATE OF ALABAMA
COUNTY OF MADISON } ss

William W. Holbrook being duly sworn eposes and says: The information contained in this report is the result of complete carefully conducted tests and is to the best of his knowledge true and correct in espects.

SEAL William W. Holbrook
SUBSCRIBED and sworn to before me this 4th day of Dec 19 79
Judy S. Malloy
Notary Public in and for the State of Alabama at large
My Commission expires 6-21 19 81

TEST BY Steam Services
L. Mullins F. H. Mosly
L. J. Mullins
WYLE Q. A. M. Kimbrell
M. J. Kimbrell
QAS DCAS WYLE

7.0 PROCEDURES AND RESULTS (Continued)

7.2 (Continued)

the open marker. This condition was reported to the Fisher Controls Company (FCC) representatives. The condition did not affect the operation of the test specimen disc since the disc rotated away from the disc stop which was installed on the upstream side of the disc.

7.3 The test specimen was then cycled five additional times to verify recording equipment, air pressure recovery time, and closure time.

7.4 The system was pressurized to 40 psig with saturated steam and the control valve opened with the test specimen in the open position. Recorded data showed that the upstream pressure was 10 psig rather than the required 20 psig. Since the test specimen was exhausting to atmosphere, it was decided to install a tailpipe and gate valve so that sufficient backpressure could be obtained to increase the upstream pressure to 20 psig. A pressure transducer was also installed on the tailpipe.

7.5 Four closure tests were conducted and the data for each test is shown in Table I. It was necessary to increase the test specimen upstream pressure above 20 psig, however, in order to obtain the desired steam flow rate.

7.6 . Data recordings for each test run are included in the appendix.

7.7 Flow rates were obtained by measuring the upstream pressure and differential pressure across a sharp edged orifice installed in an 8-inch diameter pipe and calculating the flow as follows:

$$W_h = ID^2 \sqrt{hw/v}$$

Where:

W_h = Steam flow rate (pph)

I = ASME meter constant

D = Inside diameter of pipe

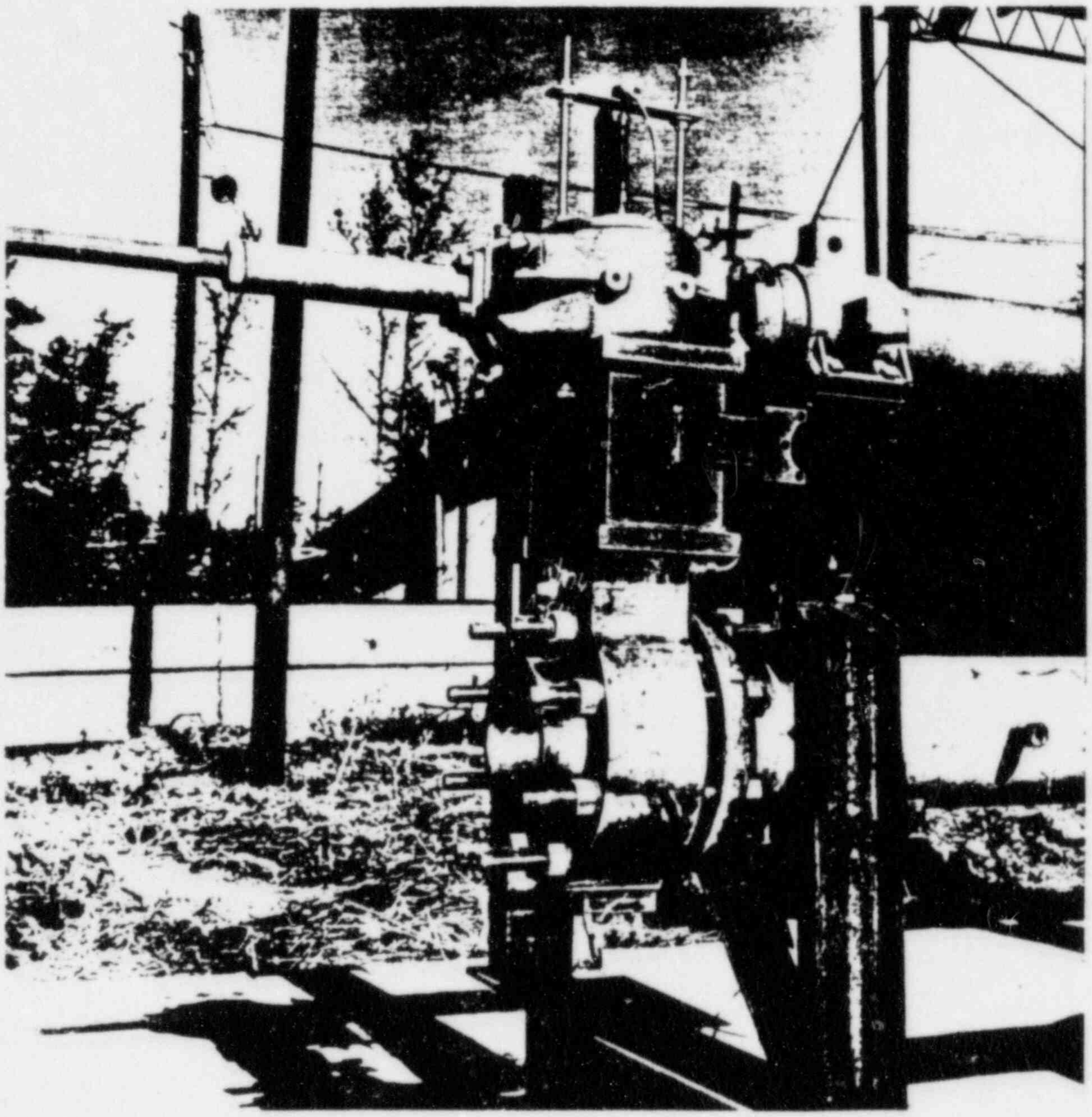
hw = Differential pressure (in. of water)

v = Specific volume of saturated steam at orifice inlet.

TABLE I

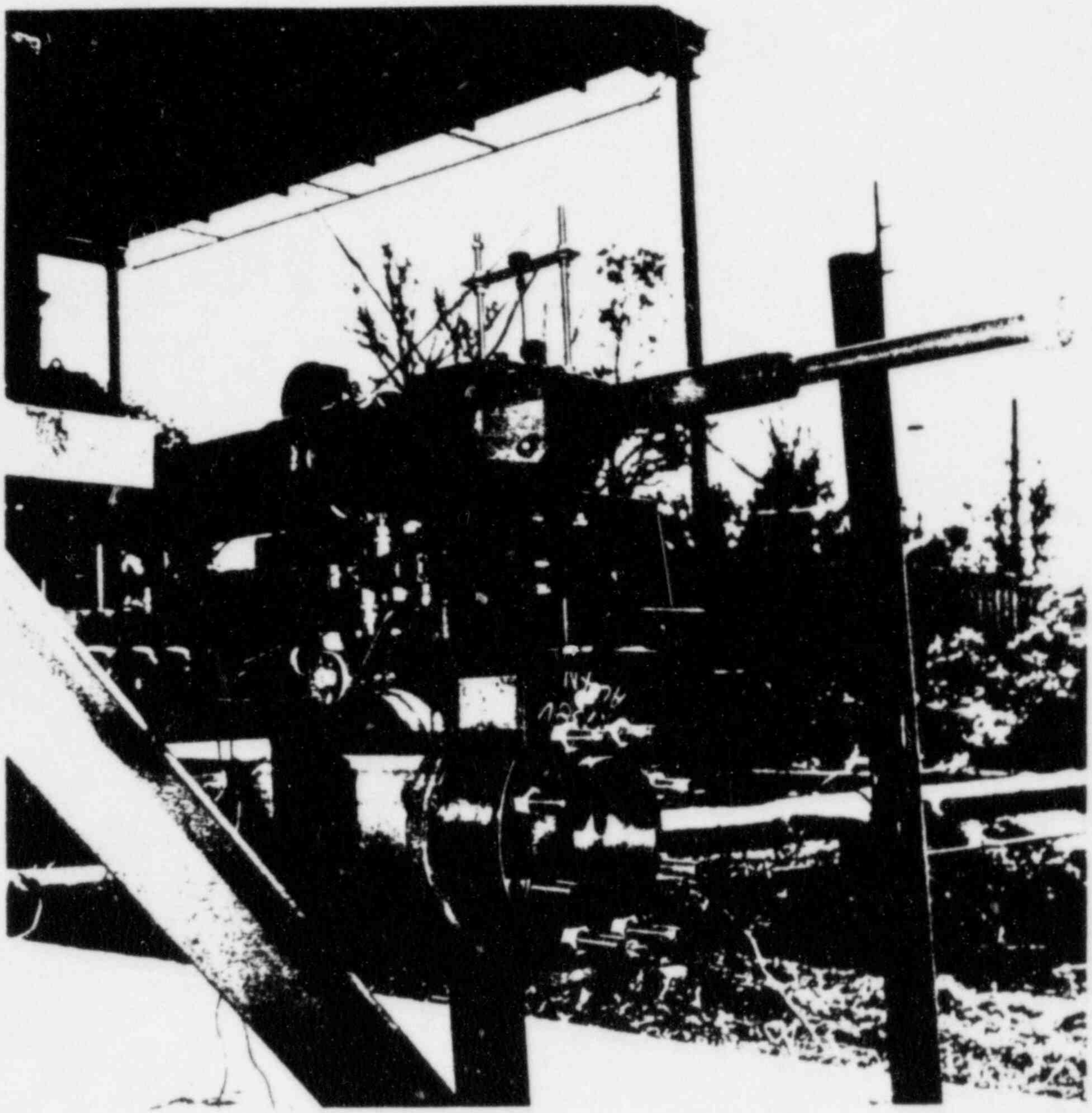
TEST DATA
AT CLOSURE SIGNAL

TEST NO.	UPSTREAM PRESSURE (PSIG)	DOWNSTREAM PRESSURE (PSIG)	⊿ P (PSI)	STEAM FLOW pph	STEAM TEMP (°F)	CLOSING TIME(SEC)		ACTUATOR PRESSURE (PSIG)
						WITH FLOW	WITHOUT FLOW	
1	18	8	10	25,360	265	1.25	1.01	70
2	21	8	13	32,557	272	1.16	1.06	70
3	25	11	14	31,130	279	1.21	1.10	70
4	24	10	14	30,764	272	1.25	1.12	70



PHOTOGRAPH 1

TEST SPECIMEN



PHOTOGRAPH 3

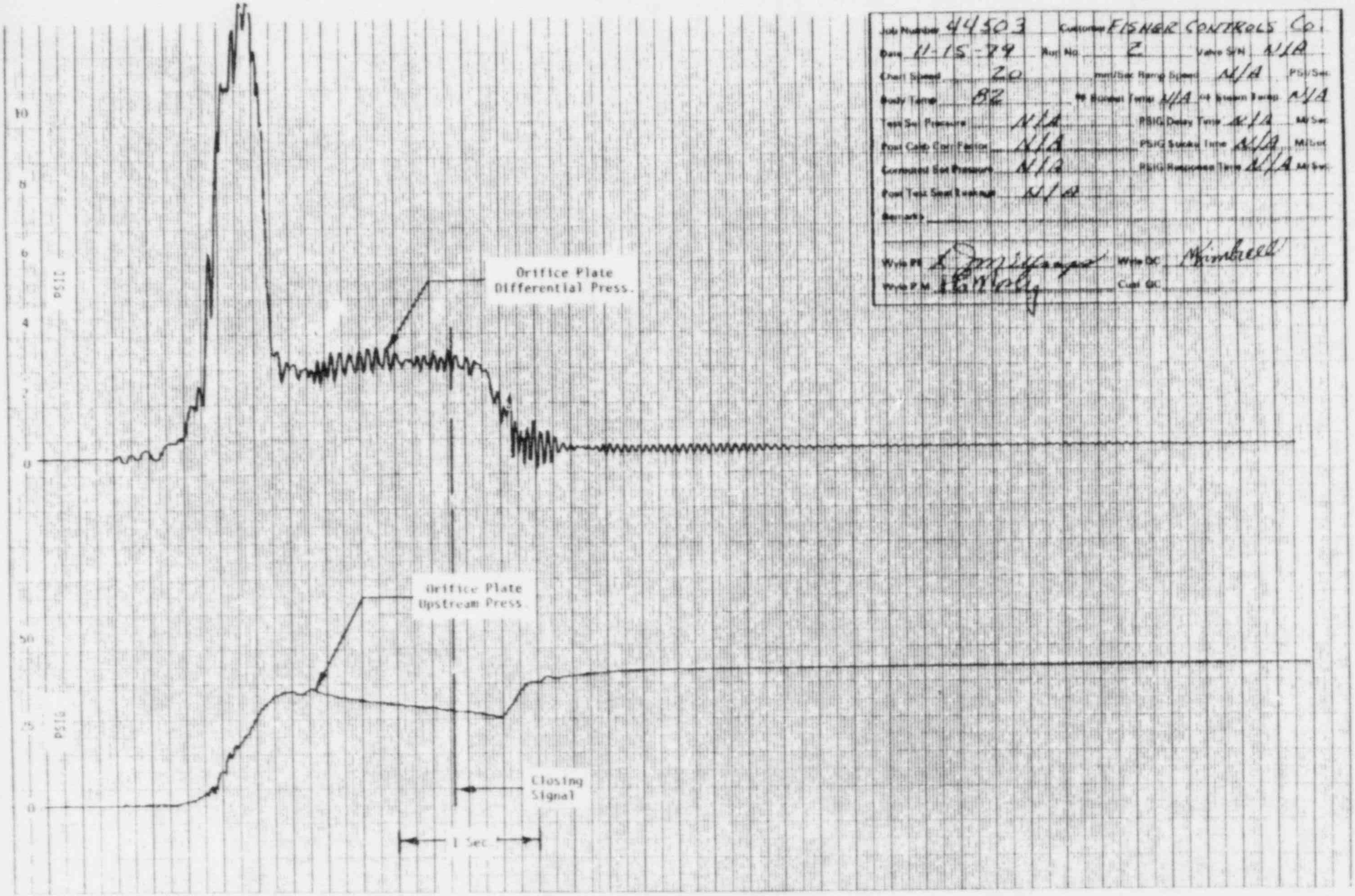
TEST SPECIMEN IN FLOW SYSTEM

APPENDIX I

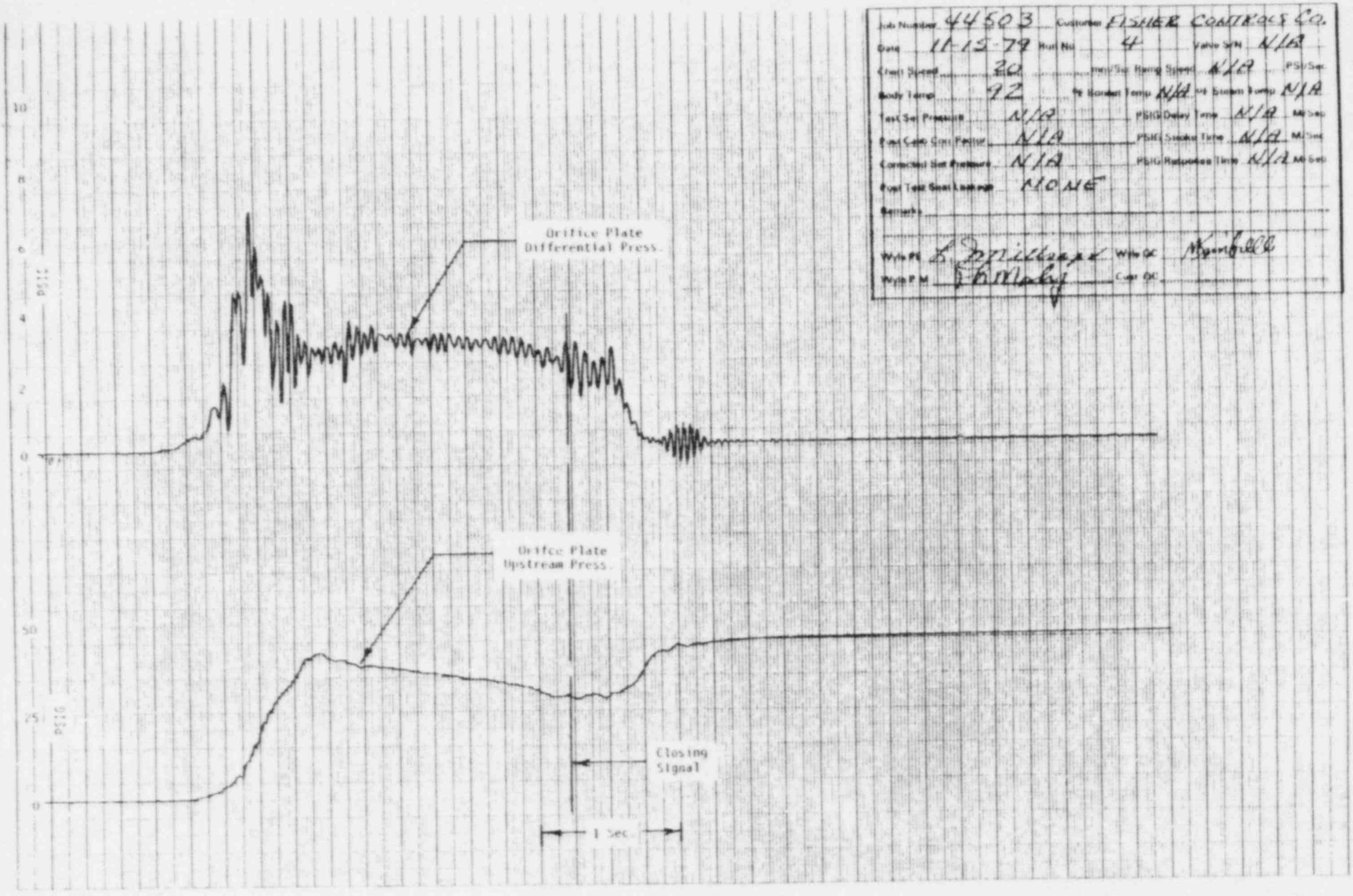
INSTRUMENTATION EQUIPMENT SHEET

APPENDIX II

FLOW DATA



Job Number 44503 Customer FISHER CONTROLS Co.
Date 11-15-79 Run No. 2 Valve S/N N/A
Chart Speed 20 mm/Sec Ramp Speed N/A PSI/Sec
Body Temp 82 °F Ambient Temp N/A °F Steam Temp N/A
Test Set Pressure N/A PSIG Delay Time N/A M/Sec
Post Calib Corr Factor N/A PSIG Stroke Time N/A M/Sec
Corrected Set Pressure N/A PSIG Response Time N/A M/Sec
Post Test Seat Leakage N/A
Remarks
Wyle PE Wyle QC
Wyle P.M. Cust QC



Job Number 44503 Customer FISHER CONTROLS CO.
Date 11-15-79 Run No 4 Valve S/N N/A
Chart Speed 20 mm/Sec Ramp Speed N/A PSI/Sec
Body Temp 92 °F Bonnet Temp N/A °F Steam Temp N/A
Test Set Pressure N/A PSIG Delay Time N/A MSec
Post Calib Corr Factor N/A PSIG Stroke Time N/A MSec
Corrected Set Pressure N/A PSIG Response Time N/A MSec
Post Test Seat Leakage NONE
Remarks
Wyle PE Wyle QC
Wyle PM Cust QC

EXHIBIT I

FQP-24, REVISION B

PROTOTYPE CLOSURE TEST PROCEDURE
FOR
SNUPPS BUTTERFLY VALVE

FQP-24

PROTOTYPE CLOSURE TEST PROCEDURE

FOR

FISHER CONTROLS COMPANY

CONTINENTAL DIVISION

BUTTERFLY CONTROL VALVES

PER

BECHTEL POWER CORPORATION ORDER 10466-M-237

DATE: July 9, 1979 Revision B
March 15, 1978 Revision A

PREPARED BY: Richard C. Sekerchak
Richard C. Sekerchak, Project Engineer

REVIEWED BY: Carl D. Wilson
Carl D. Wilson, Senior Engineer

APPROVED BY: Richard Hoober
Richard E. Hoober, Manager of Engineering

1.0 SCOPE:

This procedure delineates the method to be used by Wyle Laboratories of Huntsville, Alabama, to perform a prototype closure test on a 6" Type 9221 Fisher Controls Company Butterfly Control Valve per Bechtel Power Corporation Specification No. 10466-M-237.

The intent of this procedure is to demonstrate the capability of an 18" Type 9221 to close within 3 seconds, should a Design Basis Event occur when the valve is in the full open position, by extrapolation of the test results for the 6" Type 9221 prototype valve.

3.0 ANALYSIS:

The results of the closure test for the prototype 6" Type 9221 will be extrapolated to determine the closing time for the 18" Type 9221 by utilization of the following equation:

$$\begin{array}{l}\text{Closing time for}\\ \text{18" W/flow}\end{array} \cong \begin{array}{l}\text{(Closing time for}\\ \text{18" W/O flow)}\end{array} \times \left(\frac{\text{Closing time for 6" W/flow}}{\text{Closing time for 6" W/O flow}}\right)$$

3.1 Verification of Structural Integrity:

Structural integrity will be verified by way of the stress calculation format which has been submitted for Bechtel information only. These calculations will be included as Appendix A.

3.2 The analysis will include a description of the geometric similiarity between the prototype 6" Type 9221 and the 18" Type 9221.

formed per Fisher Controls, Continental Test Specification, CTS 1.21, Rev. 0, with Appendix CCN 6F133-21, Unidirectional Seat Leak Test Procedure for Elastomer and Teflon Seated, Adjustable Type 9200 T-Ring Valves (all valves 20" or less and larger valves for use in vertical pipelines, or in horizontal pipelines with shafts vertical). This specification is included as Appendix B.

5.5 Test Equipment Used, Calibration, and Equipment Accuracy (to be supplied by Wyle Laboratories).

5.6 Closure time for 18" Type 9221 with no flow = ________ seconds

7.0 CONCLUSIONS:

APPENDIX B

(FQP-24)

UNIDIRECTIONAL SEAT LEAK TEST PROCEDURE FOR ELASTOMER AND TEFLON, ADJUSTABLE TYPE 9200 T-RING VALVES, CTS 1.21, REV. 0, WITH APPEDIX CCN 6F133-21.

CONTINENTAL DIV.	CONTINENTAL TEST SPECIFICATION	NO. CTS-1.21 REV: 0
	UNIDIRECTIONAL SEAT LEAK TEST PROCEDURE FOR ELASTOMER AND TEFLON SEATED, ADJUSTABLE TYPE 9200 T-RING VALVES (all valves 20" or less, & larger valves for use in vertical pipelines, or in horizontal pipelines with shafts vertical)	DATE 9/10/75
		DIST. EDL-17
JOB NO. CD73-168		PAGE 2 OF 5

5. POLICY:

- Order entry documents shall reference this test specification and shall describe position of valve and actuator when in service.
- Type 9200 T-ring valves covered by this specification are tested with the valve body and shaft horizontal.
- Thrust collars are provided on the valve shaft to prevent disc and shaft movement along the shaft axis.
- Seat leak testing follows any body or disc hydrostatic testing that may be required.
- Provision for liquid leak testing of Teflon seated valves is included. Liquid leak testing is performed however only as provided by appendices to this specification and as a substitute to the air leak test.
- Seat leak testing is unidirectional with pressure applied to the shaft side of the seal.
- It is not necessary to verify disc material and taper pin leak tightness on valves which have previously passed a disc hydrostatic test.
- Neolube lubricant is placed on adjusting set screw threads and the threaded holes for these set screws prior to initial adjustment.

6. TEST CONDITIONS:

6.1 Valve Assembly - The valve shall be fully assembled, except that the actuator need not be mounted.

SPECIAL PROVISIONS TO ENSURE PERSONNEL SAFETY MAY BE EMPLOYED TO PREVENT ACCIDENTAL DISC OPENING WHILE UNDER PRESSURE.

APPROVED BY:		WRITTEN BY:
Manager, Quality Assurance E. L. Becchini	Manager, Sales & Marketing	EH:sb Ed Holtzgraver
Manager, Materials NOT REQUIRED	Manager, Manufacturing Don O Boole	Manager, Engineering Ed Holtzgraver

FISHER Controls CONTINENTAL DIV.	CONTINENTAL TEST SPECIFICATION	NO. CTS-1.21 REV: 0
	UNIDIRECTIONAL SEAT LEAK TEST PROCEDURE FOR ELASTOMER AND TEFLON SEATED, ADJUSTABLE TYPE 9200 T-RING VALVES (all valves 20" or less, & larger valves for use in vertical pipelines, or in horizontal pipelines with shafts vertical)	DATE 9/10/75 DIST. EDL-17
JOB NO. CD73-168		PAGE 4 OF 5

Packing Seal - No visible leakage in the form of bubbles or spray is permitted upon application of the leak detecting fluid. Two applications of leak detecting fluid are required with the second following the first by a period no less than 5 minutes.

Taper Pins and Disc Material - No visible leakage in the form of bubbles or spray is permitted for a period not less than 2 minutes.

Seat - No visible leakage in the form of bubbles or spray is permitted for a period not less than 10 minutes.

b. Teflon T-Ring

Packing Seal - Same as elastomer T-ring air test

Taper Pins and Disc Material - Test not required

Seat - Leakage past the disc may not exceed the amounts shown in Table I. Interpolation for intermediate pressures is permitted.

VALVE SIZE	TEST PRESSURE (PSI) 10	20	40	60	80	100
2-6	5.00	7.00	11.00	15.00	19.00	23.00
8-12	12.50	17.50	27.50	37.50	47.50	57.50
14-18	20.00	28.00	44.00	60.00	76.00	92.00
20-24	27.50	38.50	60.50	82.50	104.50	126.50
30-36	42.50	59.50	93.50	127.50	161.50	195.50
42-48	57.50	80.50	126.50	172.50	218.50	264.50

TABLE I - MAXIMUM ACCEPTABLE
AIR LEAK RATES FOR TEFLON T-RING, SCFH

APPROVED BY:		WRITTEN BY:
Manager, Quality Assurance E. L. Rechin	Manager, Sales & Marketing	Ed Holtgrewe EH:sb
Manager, Materials NOT REQUIRED	Manager, Manufacturing Dan A. Brile	Manager, Engineering Ed Holtgrewe

9510-[illegible]

SPECIFICATION/PROCEDURE APPENDIX NUMBER CCN 6F133-21

FISHER Controls
CONTINENTAL DIVISION

UNIDIRECTIONAL SEAT LEAK TEST PROCEDURE
FOR ELASTOMER AND TEFLON SEATED, ADJUSTABLE
TYPE 9200 T-RING VALVES (All valves 20" or less, &
larger valves for use in vertical pipelines, or in
horizontal pipelines with shafts vertical)

Nuclear Class ---
Quality Level ---
Revision 0
Date 3 15 78
Page 1 of 1

Page No. 39
Report No. 44503-0

I. SCOPE:

This appendix modifies and shall only be used with CTS 1.21, Rev. 0 in order to conform to the applicable Bechtel Power Corporation specifications.

II. REFERENCE DOCUMENTS:

A. Bechtel Spec. No. 10466-M-237(Q)
B.
C.

III. MODIFICATIONS TO CTS 1.21 :

A. The test pressure differential is to be 70 PSIG.

B. Duration of seat leak test is to be 15 minutes.

C. Allowable seat leakage - (Bubble Tight)

D. Actuator will be mounted on valves during test.

WRITTEN BY Richard C Sekerchak

APPROVED BY John Weekley

PROJECT ENGINEER	MANAGER, ENGINEERING	MANAGER, MANUFACTURING	MANAGER, QUALITY ASSURANCE
R C Sekerchak	Richard Hoober	Wam O. Beale	E L Rechison

FORM CC 217—1/75

ATTACHMENT 9

FQP-11AB-7

Combined Loads Shaft Analysis

ABSTRACT OF STRESS DETERMINATION

Loads due to pressure and seismic disturbance were used in an ANSYS finite element model of the 14 inch butterfly, Bettis actuated, control valve. The torsional shear stress and bearing stresses were generated with the "shaft" sizing program. Data were generated for both open and closed positions. Stresses from the two computer programs were manually combined according to the maximum shear theory. Stresses were found to peak at the butterfly disc hub and the pin connection to the shaft. In all cases the maximum normal, shear, and bearing stresses were below the allowables.

PROBLEM STATEMENT

The object of this analysis is to determine that the B.F.V. shafts have sufficient strength to withstand a simultaneous combination of pressure drop and seismic loads. Fully closed and fully open positions of the valve are to be investigated.

ANALYSIS PROCEDURE

A worst case scenario was chosen for this analysis: a 4.5 triaxial "g" load acts in the direction of gravity and the valve is installed in such fashion that the pressure load on the disc is both coincident and colinear with the "g" load. The pressure load was determined for the closed position (0°) as the product of the disc area and stagnation pressure (60 psig). When the valve is open (90°) the pressure drop already includes the frontal area and drag coefficient product so that the pressure drop times disc area yields the dynamic direct shear force on the disc. These resultant loads are assumed transferred to the shaft equally, at both hub locations of the disc. The force due to seismic activity and gravity is simmply summed with the pressure load. The weight of the disc is estimated with the aid of the casting drawing. ANSYS, a finite element program is used to obtain the bending stresses and shear forces which result from the application of these loads. For this analysis the shaft was modeled as 22 segments with tenth point moment printed out in order to scan for the areas which will result in highest bending and shear stress. Multiple runs were made with model, changing the various shaft clearances through their tolerance range and observing which combination resulted in the severest stresses. These normally occur near the bearing edge, disc hub and disc pin connections. The bending stress must be combined with the shear stress according to the maximum shear principle in order to determine the maximum stress. ANSYS gives the transverse shear force from which the shear stress as a result of bending is calculated; however it does not provide the torsional stress in the shaft. For this the Coraopolis shaft sizing program is employed. This program gives the concentrated shear stress at the pin location from which the torsional stress between the pin and bearing can be found by simply dividing by the concentration factor.

$$\frac{\mathrm{STRS4}}{K_T} = \tau_T$$

Where "STRS4" is the concentrated shear stress near the pin and K_T is the factor of stress concentration. K_T and the similar K_M are both taken from the ASME code for the design of transmission shafting, B17C-1927. The bearing compressive stress was also output by the program when the material (Graphite-Bronze) and 320°F temperature was given. This stress can be directly compared to allowables which is internally generated by the program. When the bending, direct shear, and torsional shear stresses are combined in the appropriate manner, the maximum normal and shear stresses are found. These are compared to the allowables generated internal to the program and was based on the 17-4PH shaft material at 320°F.

RESULTS

Shaft stresses were greatest at the disc hub location and, because of the concentration factor, at the pin connection. Normal stress and maximum shear stress was computed on the neutral axis and the extreme fiber position for each location along the shaft. The calculations were performed for both a full open and closed valve. The load carrying limitation of the shaft results from the maximum shear stress at the pin hole location when the valve is in a fully open position. In all cases the normal, shear and bearing stresses in this shaft were below the allowable stresses.

Jerry McDaniel

Jerry McDaniel
Stress Analyst
December 5, 1984

Reviewed by: Barry L. Gaarder

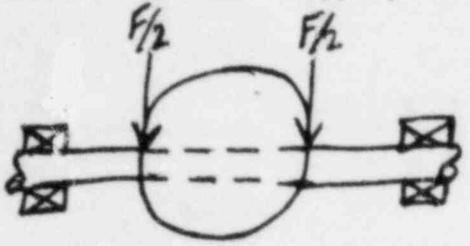
Barry Gaarder
Qualification Analyst

VOGTLE-BFV

J.MCDANIEL 11/16/84

B.L.G.

CALCULATION OF SHAFT LOADS



- PRESSURE : $F_P = \frac{\pi}{4}(DISC)^2 \, \Delta P$

CLOSED: $F_{P_1} = \frac{\pi}{4}(13.244)^2 \times 60 = 8{,}266$ Lb

OPEN: $F_{P2} = \frac{\pi}{4}(13.244)^2 \times 50 = 6{,}888$ Lb

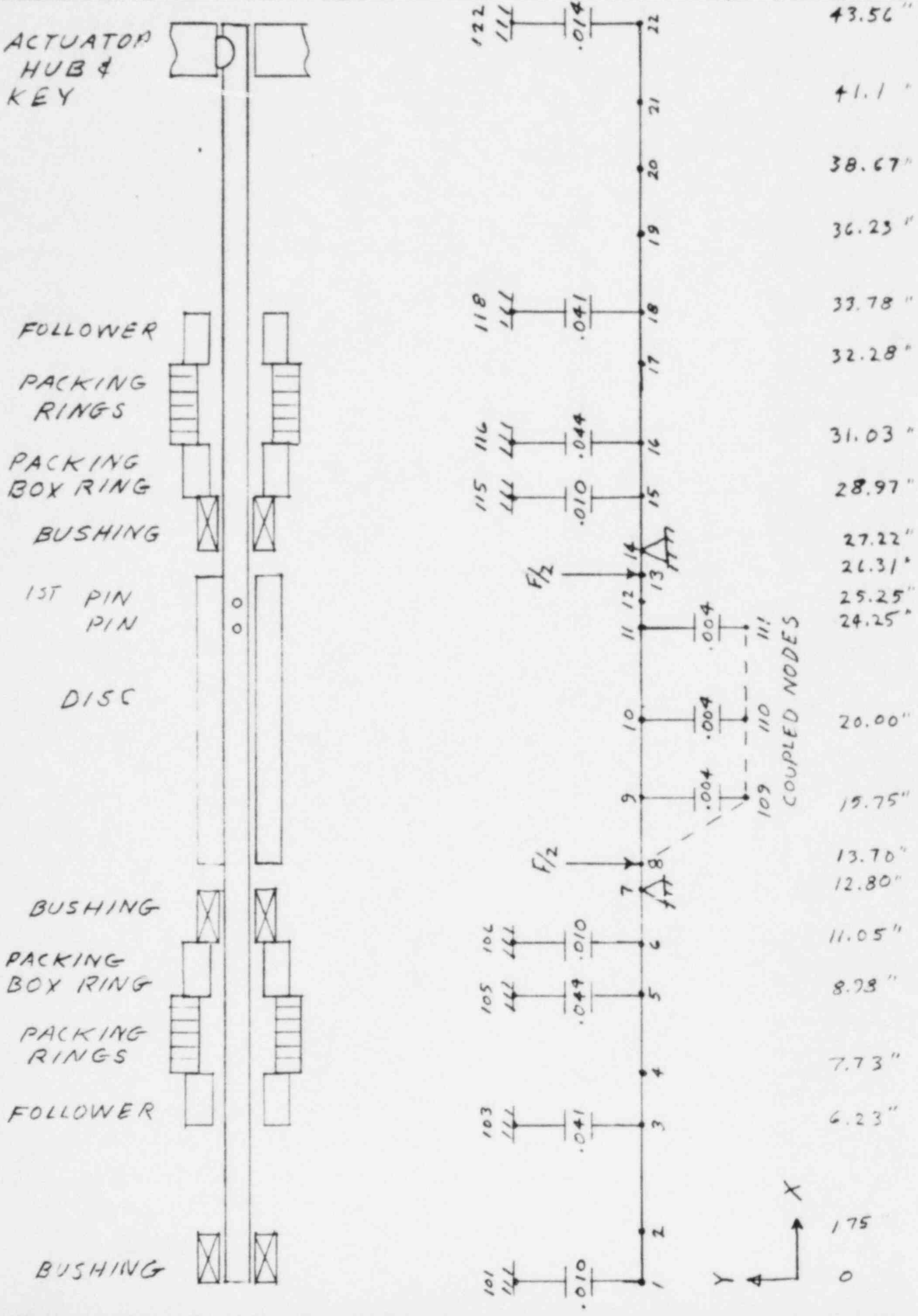
- SEISMIC : $F_S = \frac{W}{g} \times a = \frac{73}{g} \times 4.5\sqrt{3}\, g = 569$ Lb

ASSUME AS A WORSE CASE THAT ALL LOADS ARE COINCIDENT IN THE DIRECTION OF GRAVITY.

VALVE CLOSED: $F = 8{,}266 + 569 + 73 = 8{,}908$ Lb

VALVE OPEN : $F = 6{,}888 + 569 + 73 = 7{,}530$ Lb

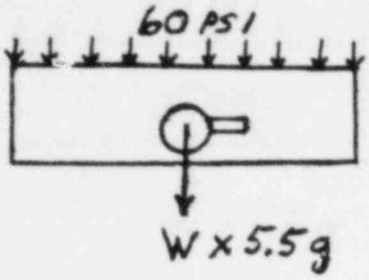
JDM
11/29/84 BLG

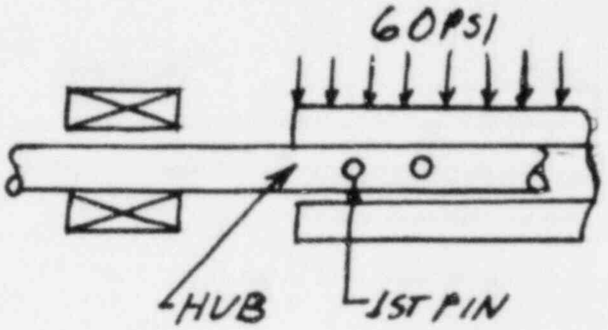


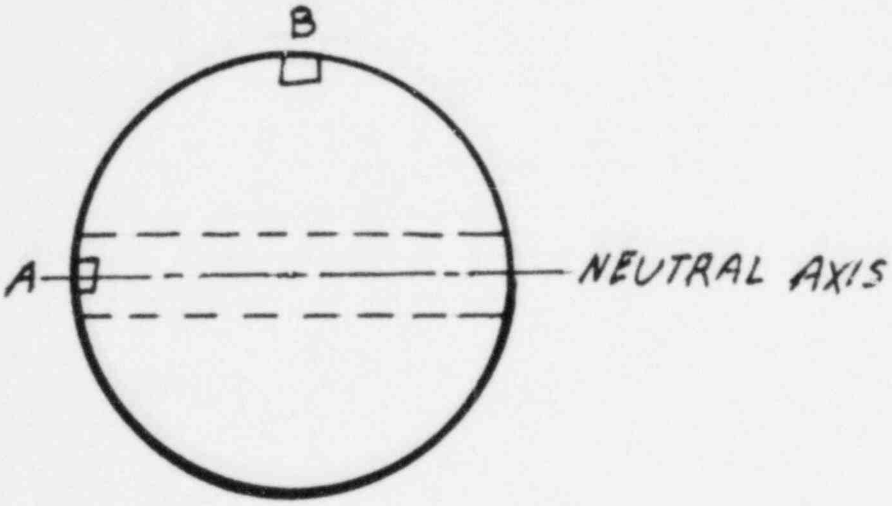
COMBINED SEISMIC AND PRESSURE LOADS

JDM
11/29/84
B.L.G.

1. FULLY CLOSED (0°)







SHAFT CROSS SECTION

σ_b = BENDING STRESS DUE TO SIMULTANEOUS AND COLINEAR PRESSURE AND SEISMIC LOADS.

τ_T = SHEAR STRESS DUE TO SHAFT TORQUE

τ_V = SHEAR STRESS DUE TO SHAFT BENDING.

V = SHEAR FORCE ON SHAFT

K_t = STRESS RISER DUE TO SHEAR PIN HOLE FOR SHEAR.

K_M = " " " " " " " " BENDING.

A = SHAFT CROSS SECTIONAL AREA

ST = NORMAL STRESS ≤ 51,450 PSI ALLOWABLE

SS = SHEAR STRESS ≤ 25,725 PSI ALLOWABLE

COMBINED CONT.

JDM
11/29/84 BLG.

SHAFT STRESSES AT THE HUB LOCATION, 0° CLOSED

AT POINT A:

$\sigma_b = 0$

$\tau_T = 2745$ PSI FROM "SHAFT" PROGRAM

$V = 4,382$ Lb FROM ANSYS PROGRAM

$$\tau_V = \frac{4}{3}\frac{V}{A} = \frac{4 \times 4382}{3 \times \frac{\pi}{4}(1.748)^2} = 2,435 \text{ PSI}$$

$K_T = 0$

$K_M = 0$

$$ST = \frac{\sigma_b}{2} + \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + (\tau_T + \tau_V)^2} = 5,180 \text{ PSI} < 51,450 \text{ PSI}$$

$$SS = \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + (\tau_T + \tau_V)^2} = 5,180 \text{ PSI} < 25,725 \text{ PSI}$$

AT POINT B:

$\sigma_b = 5,433$ PSI FROM ANSYS PROGRAM

$\tau_T = 2,745$ PSI FROM "SHAFT" PROGRAM

$\tau_V = 0$

$K_T = 0$

$K_M = 0$

$$ST = \frac{\sigma_b}{2} + \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + (\tau_T + \tau_V)^2} = 6,578 \text{ PSI} < 51,450 \text{ PSI}$$

$$SS = \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + (\tau_T + \tau_V)^2} = 3,862 \text{ PSI} < 25,725 \text{ PSI}$$

COMBINED CONT.

JDM
11/29/84 B.L.G.

SHAFT STRESSES AT THE PIN CONNECTION, 0° CLOSED

AT POINT A :

$\sigma_b = 0$

$\tau_T = 2{,}745$ PSI FROM "SHAFT" PROGRAM

$V = 71.7$ Lb FROM ANSYS PROGRAM

$\tau_V = \frac{4}{3}\frac{V}{A} = \frac{4 \times 71.7}{3 \times \frac{\pi}{4}(1.748)^2} = 40$ PSI

$K_T = 2.0$

$K_M = 2.0$

$ST = \frac{K_m \sigma_b}{2} + \sqrt{\left(\frac{K_m}{2}\sigma_b\right)^2 + \left(K_T\tau_T + K_T\tau_V\right)^2} = 5{,}570$ PSI $< 51{,}450$ P.

$SS = \sqrt{\left(\frac{K_m}{2}\sigma_b\right)^2 + \left(K_T\tau_T + K_T\tau_V\right)^2} = 5{,}570$ PSI $< 25{,}725$ PSI

AT POINT B:

$\sigma_b = 5{,}288$ PSI FROM ANSYS PROGRAM

$\tau_T = 2{,}745$ PSI FROM "SHAFT" PROGRAM

$\tau_V = 0$

$K_T = 2.0$

$K_M = 2.0$

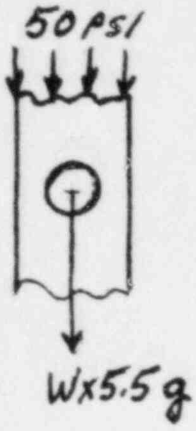
$ST = \frac{K_m \sigma_b}{2} + \sqrt{\left(\frac{K_m \sigma_b}{2}\right)^2 + \left(K_T\tau_T + K_T\tau_V\right)^2} = 12{,}910 < 51{,}450$ PSI

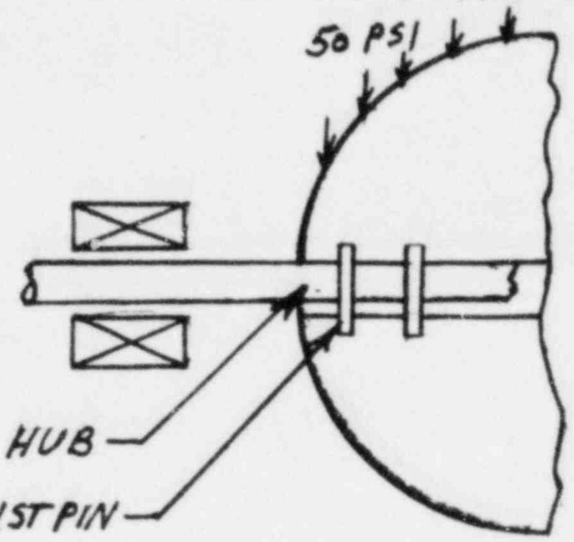
$SS = \sqrt{\left(\frac{K_m}{2}\sigma_b\right)^2 + \left(K_T\tau_T + K_T\tau_V\right)^2} = 7{,}623$ PSI $< 25{,}725$ PSI

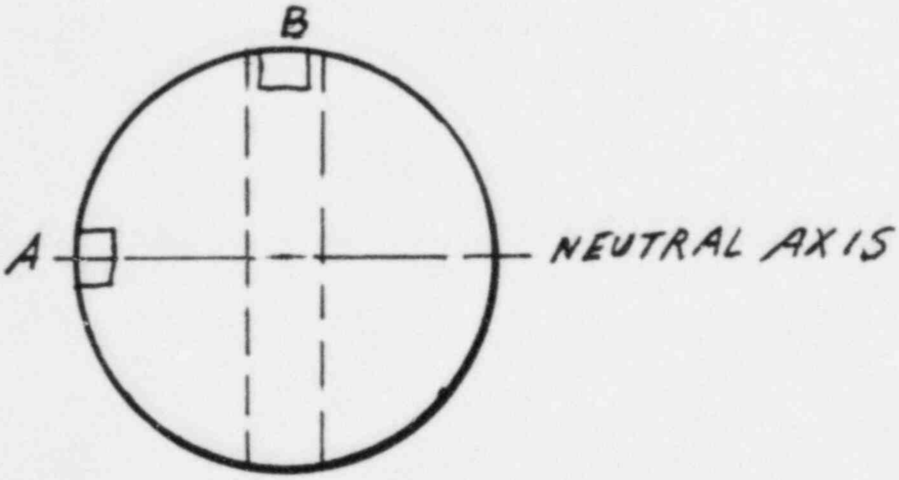
COMBINED CONT.

JDM
11/29/84 B.L.G.

2. FULLY OPEN (90°)







SHAFT CROSS SECTION

. SYMBOL DEFINITION THE SAME AS WHEN BUTTERFLY VALVE IS FULLY CLOSED.

COMBINED CONT

JDM
11/29/84 B.L.G.

SHAFT STRESSES AT THE HUB LOCATION, 90° OPEN

AT POINT A:

$\sigma_b = 0$

$\tau_T = 10{,}592$ PSI FROM "SHAFT" PROGRAM

$V = 3{,}741$ Lb FROM ANSYS PROGRAM

$$\tau_V = \frac{4}{3}\frac{V}{A} = \frac{4 \times 3741}{3 \times \frac{\pi}{4}(1.748)^2} = 2{,}079 \text{ PSI}$$

$K_T = 0$

$K_m = 0$

$$ST = \frac{\sigma_b}{2} + \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + (\tau_T + \tau_V)^2} = 12{,}671 \text{ PSI} < 51{,}450 \text{ PSI}$$

$$SS = \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + (\tau_T + \tau_V)^2} = 12{,}671 \text{ PSI} < 25{,}725 \text{ PSI}$$

AT POINT B:

$\sigma_b = 4{,}769$ PSI FROM ANSYS PROGRAM

$\tau_T = 10{,}592$ FROM "SHAFT" PROGRAM

$\tau_V = 0$

$K_T = 0$

$K_m = 0$

$$ST = \frac{\sigma_b}{2} + \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + (\tau_T + \tau_V)^2} = 13{,}242 \text{ PSI} < 51{,}450 \text{ PSI}$$

$$SS = \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + (\tau_T + \tau_V)^2} = 10{,}857 \text{ PSI} < 25{,}725 \text{ PSI}$$

COMBINED CONT.

J DM
11/29/84 B.L.G.

SHAFT STRESSES AT THE PIN LOCATION, 90° OPEN

AT POINT A:

$\sigma_b = 0$

$\tau_T = 10,592$ PSI FROM "SHAFT" PROGRAM

$V = 24$ Lb FROM ANSYS PROGRAM

$$\tau_V = \frac{4}{3}\frac{V}{A} = \frac{4 \times 24}{3 \times \frac{\pi}{4}(1.748)^2} = 13 \text{ PSI}$$

$K_T = 2.0$

$K_m = 2.0$

$$ST = \frac{K_m \sigma_b}{2} + \sqrt{\left(\frac{K_m \sigma_b}{2}\right)^2 + (K_T \tau_T + K_T \tau_V)^2} = 21,210 < 51,450 \text{ PSI}$$

$$SS = \sqrt{\left(\frac{K_m \sigma_b}{2}\right)^2 + (K_T \tau_T + K_T \tau_V)^2} = 21,210 \text{ PSI} < 25,725 \text{ PSI}$$

AT POINT B:

$\sigma_b = 4,720$ PSI FROM ANSYS PROGRAM

$\tau_T = 10,592$ PSI FROM "SHAFT" PROGRAM

$\tau_V = 0$

$K_T = 2.0$

$K_m = 2.0$

$$ST = \frac{K_m \sigma_b}{2} + \sqrt{\left(\frac{K_m \sigma_b}{2}\right)^2 + (K_T \tau_T + K_T \tau_V)^2} = 26,423 \text{ PSI} < 51,450 \text{ PSI}$$

$$SS = \sqrt{\left(\frac{K_m \sigma_b}{2}\right)^2 + (K_T \tau_T + K_T \tau_V)^2} = 21,703 \text{ PSI} < 25,725 \text{ PSI}$$

RAOPOLIS SHAFT PROGRAM.

```
ACTUATOR TORQUE CALCULATIONS      REV. B

REF. NO. CASE 4                      TEMP. 320 DEG F
VALVE TYPE 9280                      VALVE SIZE 14 INCH
SHAFT MAT. SA-564. H1675 31-39       BUSH. MAT. BRONZE/GRAPHITE
DISC-SHAFT CON. PINNED               DRIVE-SHAFT CON. KEYED
FLOW DIR. TOWARD HUB
DATE 11-8-84                         BY JON WHITESELL

INPUT DATA

ANG          0.0       56.000      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0

DDISC       13.244     13.244      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
DELTP       60.000     50.000      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
DLO          0.906      0.906      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
TS        2037.000      0.0        0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
TI           0.0        0.0        0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
DM           0.0        0.0        0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
DTF          0.0     1145.000      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
DPIN        60.000     50.000      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
DELTPF      60.000      0.140      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
STSH        98.000     98.000      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
SBUSH       85.000     85.000      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
C1           0.500      0.500      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
C2           0.750      0.750      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
BSHTYP           2          2          0         0         0         0         0         0         0         0
DSHFT        1.748      1.748      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0


GENERATED VARIABLES

ST        51450.00   51450.00      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
SS        25725.00   25725.00      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
SH         8500.00    8500.00      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0

OUTPUT

ACT.TORQ   3714.0564  11607.4687    0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0



STRS1      8087.2656  13981.1289 ***  0.0     0.0       0.0       0.0       0.0       0.0       0.0       0.0
STRS2      4509.1367  10999.3555    0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
STRS3      5044.8261  12504.8906    0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
STRS4      5490.2148  21183.5664 INC  0.0     0.0       0.0       0.0       0.0       0.0       0.0       0.0
STRS5      4730.4961  15038.6750    0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
STRS6      1353.6267   1128.0229    0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
```

VOGT 1, FULL CLOSED, 60 PSI & 4.5 g SEISMIC, 320°F

DISC/SHAFT GAP MIN = ,004"

BEARING/SHAFT GAP MIN = 0.010" (NODE 1)

ACTUATOR HUB / SHAFT GAP MAX = 0.014" (EST, NODE 22)

τ_{MAX} @ NODE 13 = 5,433 PSI

@ NODE 8 = 4,871 PSI

```
           ANSYS - ENGINEERING ANALYSIS SYSTEM  REVISION 4.1      B      FISHER CONTROLS  JAN 1,1983        .
     SWANSON ANALYSIS SYSTEMS, INC.        HOUSTON, PENNSYLVANIA 15342   PHONE (412)746-3304  TWX 510-690-8655

VOGT1                                                                          10.2140  11/28/84 CP=     35.780


 ***** DISPLACEMENT SOLUTION *****  TIME =  0.00000E+00  LOAD STEP=   1  ITERATION=    10  CUM. ITER.=    6
  NODE        UX                  UY                 ROTZ
    1    0.286049E-05     0.100012E-01    -0.521495E-03
    2    0.293595E-05     0.908006E-02    -0.536089E-03
    3    0.292119E-05     0.636818E-02    -0.706453E-03
    4    0.276430E-05     0.523634E-02    -0.806241E-03
    5    0.253255E-05     0.416788E-02    -0.905779E-03
    6    0.186699E-05     0.209546E-02    -0.110336E-02
    7    0.922589E-06     0.000000E+00    -0.130178E-02
    8    0.398209E-06    -0.117565E-02    -0.126483E-02
    9   -0.376561E-06    -0.334672E-02    -0.849544E-03
   10    0.000000E+00    -0.517662E-02    -0.176443E-04
   11   -0.353072E-06    -0.344889E-02     0.847996E-03
   12   -0.811950E-06    -0.249199E-02     0.106677E-02
   13   -0.155373E-05    -0.124208E-02     0.130380E-02
   14   -0.231462E-05     0.000000E+00     0.136520E-02
   15   -0.376588E-05     0.225249E-02     0.121052E-02
   16   -0.508065E-05     0.457767E-02     0.105097E-02
   17   -0.571671E-05     0.583732E-02     0.965966E-03
   18   -0.635271E-05     0.721699E-02     0.875745E-03
   19   -0.716462E-05     0.920891E-02     0.756024E-03
   20   -0.772257E-05     0.109428E-01     0.670368E-03
   21   -0.828591E-05     0.125042E-01     0.619858E-03
   22   -0.874273E-05     0.140007E-01     0.602575E-03
  101    0.000000E+00     0.000000E+00     0.000000E+00
  103    0.000000E+00     0.000000E+00     0.000000E+00
  105    0.000000E+00     0.000000E+00     0.000000E+00
  106    0.000000E+00     0.000000E+00     0.000000E+00
  109                    -0.117565E-02
  110    0.000000E+00    -0.117565E-02
  111                    -0.117565E-02
  115    0.000000E+00     0.000000E+00     0.000000E+00
  116    0.000000E+00     0.000000E+00     0.000000E+00
  113    0.000000E+00     0.000000E+00     0.000000E+00
  122    0.000000E+00     0.000000E+00     0.000000E+00

MAXIMUMS
NODE           22                 22                14
VALUE   -0.874273E-05     0.140007E-01     0.136520E-02
```

```
        ANSYS - ENGINEERING ANALYSIS SYSTEM  REVISION 4.1       B       FISHER CONTROLS  JAN 1,1983
     SWANSON ANALYSIS SYSTEMS, INC.        HOUSTON, PENNSYLVANIA 15342   PHONE (412)746-3304  TWX 510-690-8655

VOGT1                                                                         10.2144  11/28/84 CP=     36.570

  ***** ELEMENT STRESSES *****  TIME =  0.000000E+00   LOAD STEP=    1   ITERATION=    10   CUM. ITER.=    6

EL=     1  NODES=     1     2  MAT=  1  TTOP,TBOT=     0.0      0.0  LOAD= 0.00000E+00                          2-D BEAM    3
END         FORCE          SDIR            MOM           SBEND          SDPB          SDMB
   I     11.827        4.9278       0.12506E-11  0.23917E-11    4.9278        4.9278
   J     11.827        4.9278        -208.09       -397.96       -393.03        402.89
TENTH POINT MOMENTS
  0.125E-11  -20.8       -41.6        -62.4        -83.2        -104.       -125.       -146.       -166.       -187.       -208.
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE        1   11.8893        118.900        0.125056E-11
 STATIC FORCES ON NODE        2  -11.8893       -118.900        208.086

EL=     2  NODES=     2     3  MAT=  1  TTOP,TBOT=     0.0      0.0  LOAD= 0.00000E+00                          2-D BEAM    3
END         FORCE          SDIR            MOM           SBEND          SDPB          SDMB
   I     11.817        4.9239        -208.09       -397.96       -393.04        402.88
   J     11.817        4.9239        -740.79       -1416.7       -1411.8        1421.7
TENTH POINT MOMENTS
  -208.       -261.       -315.        -368.        -421.        -474.       -528.       -581.       -634.       -688.       -741.
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE        2   11.8893        118.900        -208.086
 STATIC FORCES ON NODE        3  -11.8893       -118.900        740.792

EL=     3  NODES=     3     4  MAT=  1  TTOP,TBOT=     0.0      0.0  LOAD= 0.00000E+00                          2-D BEAM    3
END         FORCE          SDIR            MOM           SBEND          SDPB          SDMB
   I     11.800        4.9165        -740.79       -1416.7       -1411.8        1421.7
   J     11.300        4.9165        -919.16       -1757.9       -1752.9        1762.8
TENTH POINT MOMENTS
  -741.       -759.       -776.        -794.        -812.        -830.       -848.       -866.       -883.       -901.       -919.
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE        3   11.8893        118.900        -740.792
 STATIC FORCES ON NODE        4  -11.8893       -118.900        919.155

EL=     4  NODES=     4     5  MAT=  1  TTOP,TBOT=     0.0      0.0  LOAD= 0.00000E+00                          2-D BEAM    3
END         FORCE          SDIR            MOM           SBEND          SDPB          SDMB
   I     11.788        4.9115        -919.16       -1757.9       -1752.9        1762.8
   J     11.788        4.9115        -1067.8       -2042.1       -2037.2        2047.0
TENTH POINT MOMENTS
  -919.       -934.       -949.        -964.        -979.        -993.      -0.101E+04 -0.102E+04 -0.104E+04 -0.105E+04 -0.107E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE        4   11.8893        118.900        -919.155
 STATIC FORCES ON NODE        5  -11.8893       -118.900        1067.79

EL=     5  NODES=     5     6  MAT=  1  TTOP,TBOT=     0.0      0.0  LOAD= 0.00000E+00                          2-D BEAM    3
END         FORCE          SDIR            MOM           SBEND          SDPB          SDMB
   I     11.770        4.9043        -1067.8       -2042.1       -2037.2        2047.0
   J     11.770        4.9043        -1313.9       -2512.9       -2508.0        2517.8
TENTH POINT MOMENTS
 -0.107E+04 -0.109E+04 -0.112E+04 -0.114E+04 -0.117E+04 -0.119E+04 -0.122E+04 -0.124E+04 -0.126E+04 -0.129E+04 -0.131E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE        5   11.8893        118.900        -1067.79
 STATIC FORCES ON NODE        6  -11.8893       -118.900        1313.94

EL=     6  NODES=     6     7  MAT=  1  TTOP,TBOT=     0.0      0.0  LOAD= 0.00000E+00                          2-D BEAM    3
END         FORCE          SDIR            MOM           SBEND          SDPB          SDMB
   I     11.747        4.8944        -1313.9       -2512.9       -2508.0        2517.8
   J     11.747        4.3944        -1521.6       -2910.0       -2905.1        2914.8
```

```
TENTH POINT MOMENTS
 -0.131E+04 -0.133E+04 -0.136E+04 -0.138E+04 -0.140E+04 -0.142E+04 -0.144E+04 -0.146E+04 -0.148E+04 -0.150E+04 -0.152E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE       6   11.8893        118.900        -1313.94
 STATIC FORCES ON NODE       7  -11.8893       -118.900         1521.57

EL=     7  NODES=     7     8  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                    2-D BEAM    3
END         FORCE          SDIR            MOM          SBEND           SDPB          SDMB
   I      17.808        7.4199        -1521.6        -2910.0        -2902.5        2917.4
   J      17.808        7.4199         2547.0         4871.1         4878.6       -4863.7
TENTH POINT MOMENTS
 -0.152E+04 -0.111E+04  -708.       -301.        106.        513.        920.      0.133E+04  0.173E+04  0.214E+04  0.255E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE       7   11.8893       -4525.71        -1521.57
 STATIC FORCES ON NODE       8  -11.8893        4525.71        -2547.03

EL=     8  NODES=     8     9  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                    2-D BEAM    3
END         FORCE          SDIR            MOM          SBEND           SDPB          SDMB
   I      11.863        4.9428         2547.0         4871.1         4876.1       -4866.2
   J      11.863        4.9428         2495.4         4772.4         4777.4       -4767.5
TENTH POINT MOMENTS
  0.255E+04  0.254E+04  0.254E+04  0.253E+04  0.253E+04  0.252E+04  0.252E+04  0.251E+04  0.251E+04  0.250E+04  0.250E+04
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE       8   11.8893        25.0979         2547.03
 STATIC FORCES ON NODE       9  -11.8893       -25.0979        -2495.43

EL=     9  NODES=     9    10  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                    2-D BEAM    3
END         FORCE          SDIR            MOM          SBEND           SDPB          SDMB
   I      11.879        4.9494         2495.4         4772.4         4777.4       -4767.5
   J      11.879        4.9494         2388.7         4568.4         4573.4       -4563.5
TENTH POINT MOMENTS
  0.250E+04  0.248E+04  0.247E+04  0.246E+04  0.245E+04  0.244E+04  0.243E+04  0.242E+04  0.241E+04  0.240E+04  0.239E+04
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE       9   11.8893        25.0979         2495.43
 STATIC FORCES ON NODE      10  -11.8893       -25.0979        -2388.74

EL=    10  NODES=    10    11  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                    2-D BEAM    3
END         FORCE          SDIR            MOM          SBEND           SDPB          SDMB
   I    -0.29153E-01 -0.12147E-01   2388.7         4568.4         4568.4       -4568.4
   J    -0.29153E-01 -0.12147E-01   2693.5         5151.3         5151.3       -5151.3
TENTH POINT MOMENTS
  0.239E+04  0.242E+04  0.245E+04  0.248E+04  0.251E+04  0.254E+04  0.257E+04  0.260E+04  0.263E+04  0.266E+04  0.269E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE      10  0.382749E-13  -71.7135         2388.74
 STATIC FORCES ON NODE      11 -0.382749E-13   71.7135        -2693.53

EL=    11  NODES=    11    12  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                    2-D BEAM    3
END         FORCE          SDIR            MOM          SBEND           SDPB          SDMB
   I    -0.68623E-01 -0.28593E-01   2693.5         5151.3         5151.3       -5151.3
   J    -0.68623E-01 -0.28593E-01   2765.2         5288.4         5288.4       -5288.5
TENTH POINT MOMENTS
  0.269E+04  0.270E+04  0.271E+04  0.272E+04  0.272E+04  0.273E+04  0.274E+04  0.274E+04  0.275E+04  0.276E+04  0.277E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE      11  0.426326E-13  -71.7135         2693.53
 STATIC FORCES ON NODE      12 -0.426326E-13   71.7135        -2765.24

EL=    12  NODES=    12    13  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                    2-D BEAM    3
END         FORCE          SDIR            MOM          SBEND           SDPB          SDMB
   I    -0.84962E-01 -0.35401E-01   2765.2         5288.4         5288.4       -5288.5
   J    -0.84962E-01 -0.35401E-01   2840.9         5433.1         5433.1       -5433.2
TENTH POINT MOMENTS
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  0.277E+04  0.277E+04  0.278E+04  0.279E+04  0.280E+04  0.280E+04  0.281E+04  0.282E+04  0.283E+04  0.283E+04  0.284E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE      12  0.337508E-13  -71.7135        2765.24
 STATIC FORCES ON NODE      13 -0.337508E-13   71.7135       -2840.90

EL=   13  NODES=   13   14  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                        2-D BEAM   3
END         FORCE         SDIR           MOM          SBEND          SDPB           SDMB
   I      5.9553        2.4814        2840.9         5433.1        5435.6        -5430.7
   J      5.9553        2.4814       -1164.5        -2227.1       -2224.6         2229.6
TENTH POINT MOMENTS
  0.284E+04  0.244E+04  0.204E+04  0.164E+04  0.124E+04  838.       438.       37.1       -363.      -764.      -0.116E+04
MAXIMUM MOMENT IS AT END I                 Fx          Fy              Mz
 STATIC FORCES ON NODE      13  0.319744E-13   4332.29        2840.90
 STATIC FORCES ON NODE      14 -0.319744E-13  -4382.29        1164.51

EL=   14  NODES=   14   15  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                        2-D BEAM   3
END         FORCE         SDIR           MOM          SBEND          SDPB           SDMB
   I   -0.91673E-01 -0.33197E-01  -1164.5        -2227.1       -2227.1         2227.1
   J   -0.91673E-01 -0.33197E-01  -1039.7        -1988.5       -1988.5         1988.4
TENTH POINT MOMENTS
 -0.116E+04 -0.115E+04 -0.114E+04 -0.113E+04 -0.111E+04 -0.110E+04 -0.109E+04 -0.108E+04 -0.106E+04 -0.105E+04 -0.104E+04
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      14  0.337508E-13  -71.2631       -1164.51
 STATIC FORCES ON NODE      15 -0.337508E-13   71.2631        1039.73

EL=   15  NODES=   15   16  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                        2-D BEAM   3
END         FORCE         SDIR           MOM          SBEND          SDPB           SDMB
   I   -0.80436E-01 -0.33515E-01  -1039.7        -1988.5       -1988.5         1988.4
   J   -0.80436E-01 -0.33515E-01  -892.93        -1707.7       -1707.7         1707.7
TENTH POINT MOMENTS
 -0.104E+04 -0.103E+04 -0.101E+04  -996.       -981.       -966.       -952.       -937.       -922.       -908.       -893.
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      15  0.328626E-13  -71.2631       -1039.73
 STATIC FORCES ON NODE      16 -0.328626E-13   71.2631        892.926

EL=   16  NODES=   16   17  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                        2-D BEAM   3
END         FORCE         SDIR           MOM          SBEND          SDPB           SDMB
   I   -0.71815E-01 -0.29922E-01  -892.93        -1707.7       -1707.7         1707.7
   J   -0.71815E-01 -0.29922E-01  -803.85        -1537.3       -1537.4         1537.3
TENTH POINT MOMENTS
  -893.      -884.      -875.      -866.      -857.      -848.      -839.      -831.      -822.      -813.      -804.
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      16  0.355271E-13  -71.2631       -892.926
 STATIC FORCES ON NODE      17 -0.234217E-13   71.2631        803.848

EL=   17  NODES=   17   18  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                        2-D BEAM   3
END         FORCE         SDIR           MOM          SBEND          SDPB           SDMB
   I   -0.65547E-01 -0.27311E-01  -803.85        -1537.3       -1537.4         1537.3
   J   -0.65547E-01 -0.27311E-01  -696.95        -1332.9       -1332.9         1332.9
TENTH POINT MOMENTS
  -804.      -793.      -782.      -772.      -761.      -750.      -740.      -729.      -718.      -708.      -697.
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      17  0.328626E-13  -71.2631       -803.848
 STATIC FORCES ON NODE      18 -0.328626E-13   71.2631        696.953

EL=   18  NODES=   18   19  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                        2-D BEAM   3
END         FORCE         SDIR           MOM          SBEND          SDPB           SDMB
   I   -0.57939E-01 -0.24141E-01  -696.95        -1332.9       -1332.9         1332.9
   J   -0.57939E-01 -0.24141E-01  -522.36        -999.00       -999.02         998.97
TENTH POINT MOMENTS
  -697.      -679.      -662.      -645.      -627.      -610.      -592.      -575.      -557.      -540.      -522.
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MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      18  0.777156E-15  -71.2631       -696.953
 STATIC FORCES ON NODE      19 -0.777156E-15   71.2631        522.358

EL=   19  NODES=   19   20  MAT=  1  TTOP,TBOT=    0.0     0.0  LOAD= 0.00000E+00                                        2-D BEAM   3
END        FORCE          SDIR          MOM          SBEND          SDPB         SDMB
   I   -0.50640E-01 -0.21100E-01  -522.36       -999.00       -999.02       998.98
   J   -0.50640E-01 -0.21100E-01  -348.48       -666.45       -666.47       666.43
TENTH POINT MOMENTS
  -522.       -505.       -488.       -470.       -453.       -435.       -418.       -401.       -383.       -366.       -348.
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      19  0.732747E-14  -71.2631       -522.358
 STATIC FORCES ON NODE      20 -0.732747E-14   71.2631        348.476

EL=   20  NODES=   20   21  MAT=  1  TTOP,TBOT=    0.0     0.0  LOAD= 0.00000E+00                                        2-D BEAM   3
END        FORCE          SDIR          MOM          SBEND          SDPB         SDMB
   I   -0.45790E-01 -0.19079E-01  -348.48       -666.45       -666.47       666.43
   J   -0.45790E-01 -0.19079E-01  -175.31       -335.27       -335.29       335.25
TENTH POINT MOMENTS
  -348.       -331.       -314.       -297.       -279.       -262.       -245.       -227.       -210.       -193.       -175.
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      20  0.158762E-13  -71.2631       -348.476
 STATIC FORCES ON NODE      21 -0.158762E-13   71.2631        175.307

EL=   21  NODES=   21   22  MAT=  1  TTOP,TBOT=    0.0     0.0  LOAD= 0.00000E+00                                        2-D BEAM   3
END        FORCE          SDIR          MOM          SBEND          SDPB         SDMB
   I   -0.43352E-01 -0.18063E-01  -175.31       -335.27       -335.29       335.25
   J   -0.43352E-01 -0.18063E-01  0.54570E-11  0.10436E-10 -0.18063E-01 -0.18063E-01
TENTH POINT MOMENTS
  -175.       -158.       -140.       -123.       -105.       -87.7       -70.1       -52.6       -35.1       -17.5       0.546E-11
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      21  0.455191E-14  -71.2631       -175.307
 STATIC FORCES ON NODE      22 -0.455191E-14   71.2631       -0.545697E-11

EL=   23  NODES=    1  101  USEP=-0.000001  USLIDE=-0.000003  FN= -118.90      FS= -11.890      STAT= -2  OLDST= -2   2-D GAP  12
 STATIC FORCES ON NODE       1  -11.8893       -118.900
 STATIC FORCES ON NODE     101   11.8893        118.900

EL=   24  NODES=    6  106  USEP= 0.007905  USLIDE=-0.000002  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3   2-D GAP  12
 STATIC FORCES ON NODE       6  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE     106  0.000000E+00  0.000000E+00

EL=   25  NODES=   15  115  USEP= 0.007748  USLIDE= 0.000004  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3   2-D GAP  12
 STATIC FORCES ON NODE      15  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE     115  0.000000E+00  0.000000E+00

EL=   26  NODES=    3  103  USEP= 0.034632  USLIDE=-0.000003  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3   2-D GAP  12
 STATIC FORCES ON NODE       3  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE     103  0.000000E+00  0.000000E+00

EL=   27  NODES=   18  118  USEP= 0.033783  USLIDE= 0.000006  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3   2-D GAP  12
 STATIC FORCES ON NODE      18  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE     118  0.000000E+00  0.000000E+00

EL=   28  NODES=    5  105  USEP= 0.039832  USLIDE=-0.000003  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3   2-D GAP  12
 STATIC FORCES ON NODE       5  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE     105  0.000000E+00  0.000000E+00

EL=   29  NODES=   16  116  USEP= 0.039422  USLIDE= 0.000005  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3   2-D GAP  12
 STATIC FORCES ON NODE      16  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE     116  0.000000E+00  0.000000E+00
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```
EL=   31  NODES=  110   10  USEP=-0.000001  USLIDE= 0.000000  FN= -96.811       FS= 0.00000E+00  STAT=  1  OLDST=  1   2-D GAP  12
 STATIC FORCES ON NODE     110  0.000000E+00  -96.8114
 STATIC FORCES ON NODE      10  0.000000E+00   96.8114

EL=   32  NODES=  109    9  USEP= 0.007829  USLIDE= 0.000000  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3   2-D GAP  12
 STATIC FORCES ON NODE     109  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE       9  0.000000E+00  0.000000E+00

EL=   33  NODES=  111   11  USEP= 0.007727  USLIDE= 0.000000  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3   2-D GAP  12
 STATIC FORCES ON NODE     111  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE      11  0.000000E+00  0.000000E+00

EL=   35  NODES=   22  122  USEP=-0.000001  USLIDE= 0.000009  FN= -71.263       FS= 0.00000E+00  STAT=  2  OLDST= -2   2-D GAP  12
 STATIC FORCES ON NODE      22  0.000000E+00  -71.2631
 STATIC FORCES ON NODE     122  0.000000E+00   71.2631
```

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          ANSYS - ENGINEERING ANALYSIS SYSTEM  REVISION 4.1       8       FISHER CONTROLS  JAN 1,1983
     SWANSON ANALYSIS SYSTEMS, INC.         HOUSTON, PENNSYLVANIA 15342   PHONE (412)746-3304  TWX 510-690-8655

VOGT1                                                                       10.2152  11/28/84 CP=      39.120

 ***** REACTION FORCES *****    TIME =  0.00000E+00  LOAD STEP=    1  ITERATION= 10  CUM. ITER.=     6

 NOTE - REACTION FORCES ARE IN THE NODAL COORDINATE SYSTEM


   NODE       FX                FY                MZ

     7                        4644.61
    10      11.8893
    14                        4453.55
   101     -11.8893          -118.900          0.000000E+00
   103     0.000000E+00      0.000000E+00      0.000000E+00
   105     0.000000E+00      0.000000E+00      0.000000E+00
   106     0.000000E+00      0.000000E+00      0.000000E+00
   115     0.000000E+00      0.000000E+00      0.000000E+00
   116     0.000000E+00      0.000000E+00      0.000000E+00
   118     0.000000E+00      0.000000E+00      0.000000E+00
   122     0.000000E+00      -71.2631          0.000000E+00

TOTAL    -0.466294E-13      8908.00          0.000000E+00

 STATUS CHANGED FOR     0 BILINEAR ELEM THIS ITER
      DISPLACEMENT INCREMENT  =  0.27641E-05 AT NODE      1      CRITERION =  0.10000E-02
*** LOAD STEP     1    ITER     10  COMPLETED.  TIME=  0.000000E+00  TIME INC=  0.000000E+00 NEW TRIANG MATRIX  CUM. ITER.=     6

END OF INPUT ENCOUNTERED ON FILE27

***** INPUT FILE SWITCHED FROM FILE27 TO FILE 5
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          ANSYS - ENGINEERING ANALYSIS SYSTEM  REVISION 4.1       B     FISHER CONTROLS  JAN 1,1983
     SWANSON ANALYSIS SYSTEMS, INC.        HOUSTON, PENNSYLVANIA 15342   PHONE (412)746-3304  TWX 510-690-8655
VOGT1                                                                       10.2156  11/28/84 CP=     39.620

          ***** ANSYS RUN TIME ESTIMATOR *****


***** ANSYS RUN TIME ESTIMATOR *****

COMPUTER = VAX 11/780             NUMBER OF MASTER DOF =    0
ANALYSIS TYPE =  0                RMS WAVE FRONT =    23
NUMBER OF NODES =      21         TOTAL NO. OF ITERATIONS =      1
MAX. DOF PER NODE =  3            STIFF. MATRIX SAVE KEY = 0
NUMBER OF MATRICES = 1            ELEM. MATRIX SAVE KEY = 0
NUMBER OF STRESS SOLUTIONS=    1  ROTATED NODE FRACTION= 0.000

  STIF   NUMBER    FORM. TIME  STRESS TIME    NAME
    3      21        0.053        0.067   ELASTIC BEAM, 2-D
   12      11        0.015        0.040   INTERFACE ELEM. 2-D

  ANALYSIS PHASE          FIRST     SUBSEQUENT
                        ITERATION   ITERATIONS       TOTAL

ELEMENT FORMULATION        1.06         1.06         1.06
WAVE FRONT SOLUTION        0.42         0.42         0.42
BACK SUBSTITUTION          0.12         0.12         0.12
ELEMENT STRESSES           1.54         1.54         1.54

    TOTAL TIME (SEC)       3.14         3.14         3.14


***** ROUTINE COMPLETED *****  CP =         39.730

END OF INPUT ENCOUNTERED ON FILE 5


***** RUN COMPLETED *****  CP=        39.8200   TIME=   10.2157
```

VOGTL

FULL OPEN (90°), 50 PSI. & 4.5g SEISMIC, 320 °F

DISC/SHAFT GAP MIN = 0.004"

BEARING/SHAFT GAP MIN = 0.010"

ACTUATOR HUB/SHAFT GAP MAX PLUS = 0.014" (ESTIMATED)

σ_{MAX} AT NODE 13 = 4,769 PSI

$\sigma_{AT\ NODE\ 8}$ = 4,187 PSI

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              ANSYS - ENGINEERING ANALYSIS SYSTEM  REVISION 4.1      B      FISHER CONTROLS  JAN 1,1983
        SWANSON ANALYSIS SYSTEMS, INC.        HOUSTON, PENNSYLVANIA 15342   PHONE (412)746-3304  TWX 510-690-8655
VOGT1
                                                                                 11.1286  11/28/84 CP=     31.970

 ***** DISPLACEMENT SOLUTION *****  TIME =  0.00000E+00  LOAD STEP=   1  ITERATION=    10  CUM. ITER.=    5
   NODE       UX                  UY                 ROTZ
     1    0.316473E-05      0.100010E-01      -0.573473E-03
     2    0.312565E-05      0.899056E-02      -0.585150E-03
     3    0.285281E-05      0.612090E-02      -0.721456E-03
     4    0.263578E-05      0.498098E-02      -0.801294E-03
     5    0.237461E-05      0.393083E-02      -0.880932E-03
     6    0.172385E-05      0.194932E-02      -0.103902E-02
     7    0.866337E-06      0.000000E+00      -0.119776E-02
     8    0.431230E-06     -0.107944E-02      -0.116275E-02
     9   -0.258727E-05     -0.309562E-02      -0.798101E-03
    10    0.000000E+00     -0.484230E-02      -0.180440E-04
    11   -0.318111E-06     -0.319950E-02       0.776952E-03
    12   -0.719143E-06     -0.230428E-02       0.993793E-03
    13   -0.135610E-05     -0.114537E-02       0.120356E-02
    14   -0.200836E-05      0.000000E+00       0.126098E-02
    15   -0.326739E-05      0.209828E-02       0.113800E-02
    16   -0.445511E-05      0.430860E-02       0.101115E-02
    17   -0.505247E-05      0.552957E-02       0.943576E-03
    18   -0.567044E-05      0.688986E-02       0.871850E-03
    19   -0.649967E-05      0.890373E-02       0.776669E-03
    20   -0.717053E-05      0.107107E-01       0.708969E-03
    21   -0.774451E-05      0.123788E-01       0.668415E-03
    22   -0.828049E-05      0.140006E-01       0.654675E-03
   101    0.000000E+00      0.000000E+00       0.000000E+00
   103    0.000000E+00      0.000000E+00       0.000000E+00
   105    0.000000E+00      0.000000E+00       0.000000E+00
   106    0.000000E+00      0.000000E+00       0.000000E+00
   109                     -0.107944E-02
   110                     -0.107944E-02
   111                     -0.107944E-02
   115    0.000000E+00      0.000000E+00       0.000000E+00
   116    0.000000E+00      0.000000E+00       0.000000E+00
   118    0.000000E+00      0.000000E+00       0.000000E+00
   122    0.000000E+00      0.000000E+00       0.000000E+00

 MAXIMUMS
 NODE          22                22                 14
 VALUE   -0.828049E-05      0.140006E-01       0.126098E-02
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          ANSYS - ENGINEERING ANALYSIS SYSTEM  REVISION 4.1       B      FISHER CONTROLS  JAN 1,1983
     SWANSON ANALYSIS SYSTEMS, INC.        HOUSTON, PENNSYLVANIA 15342   PHONE (412)746-3304  TWX 510-690-8655

VOGT1                                                                    11.1291  11/28/84 CP=      32.800

  ***** ELEMENT STRESSES *****  TIME =  0.000000E+00   LOAD STEP=    1   ITERATION=    10   CUM. ITER.=    5

EL=    1  NODES=    1     2  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                              2-D BEAM    3
END         FORCE          SDIR           MOM          SBEND            SDPB            SDMB
   I      9.4572        3.9405      -0.22737E-12 -0.43485E-12  3.9405          3.9405
   J      9.4572        3.9405        -166.49       -318.40       -314.46          322.34
TENTH POINT MOMENTS
 -0.227E-12  -16.6       -33.3        -49.9        -66.6        -83.2        -99.9        -117.        -133.        -150.        -166.
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE       1   9.51215        95.1296       -0.227374E-12
 STATIC FORCES ON NODE       2  -9.51215       -95.1296         166.486

EL=    2  NODES=    2     3  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                              2-D BEAM    3
END         FORCE          SDIR           MOM          SBEND            SDPB            SDMB
   1      9.4512        3.9330        -166.49       -318.40       -314.46          322.34
   J      9.4512        3.9380        -592.69       -1133.5       -1129.6          1137.4
TENTH POINT MOMENTS
  -166.       -209.       -252.        -294.        -337.        -380.        -422.        -465.        -507.        -550.        -593.
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE       2   9.51215        95.1296        -166.486
 STATIC FORCES ON NODE       3  -9.51215       -95.1296         592.694

EL=    3  NODES=    3     4  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                              2-D BEAM    3
END         FORCE          SDIR           MOM          SBEND            SDPB            SDMB
   I      9.4399        3.9333        -592.69       -1133.5       -1129.6          1137.4
   J      9.4399        3.9333        -735.40       -1406.4       -1402.5          1410.4
TENTH POINT MOMENTS
  -593.       -607.       -621.        -636.        -650.        -664.        -678.        -693.        -707.        -721.        -735.
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE       3   9.51215        95.1296        -592.694
 STATIC FORCES ON NODE       4  -9.51215       -95.1296         735.400

EL=    4  NODES=    4     5  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                              2-D BEAM    3
END         FORCE          SDIR           MOM          SBEND            SDPB            SDMB
   I      9.4322        3.9301        -735.40       -1406.4       -1402.5          1410.4
   J      9.4322        3.9301        -854.32       -1633.9       -1629.9          1637.8
TENTH POINT MOMENTS
  -735.       -747.       -759.        -771.        -783.        -795.        -807.        -819.        -831.        -842.        -854.
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE       4   9.51215        95.1296        -735.400
 STATIC FORCES ON NODE       5  -9.51215       -95.1296         854.322

EL=    5  NODES=    5     6  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                              2-D BEAM    3
END         FORCE          SDIR           MOM          SBEND            SDPB            SDMB
   I      9.4211        3.9255        -854.32       -1633.9       -1629.9          1637.8
   J      9.4211        3.9255        -1051.3       -2010.5       -2006.6          2014.4
TENTH POINT MOMENTS
  -854.       -874.       -894.        -913.        -933.        -953.        -972.        -992.     -0.101E+04 -0.103E+04 -0.105E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE       5   9.51215        95.1296        -854.322
 STATIC FORCES ON NODE       6  -9.51215       -95.1296         1051.26

EL=    6  NODES=    6     7  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                              2-D BEAM    3
END         FORCE          SDIR           MOM          SBEND            SDPB            SDMB
   1      9.4059        3.9191        -1051.3       -2010.5       -2006.6          2014.4
   J      9.4059        3.9191        -1217.4       -2328.2       -2[illegible]3          2332.1
```

```
TENTH POINT MOMENTS
 -0.105E+04 -0.107E+04 -0.108E+04 -0.110E+04 -0.112E+04 -0.113E+04 -0.115E+04 -0.117E+04 -0.118E+04 -0.120E+04 -0.122E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE        6   9.51215         95.1296        -1051.26
 STATIC FORCES ON NODE        7  -9.51215        -95.1296         1217.37

EL=     7  NODES=     7     8  MAT=  1  TTOP,TBOT=    0.0      0.0  LOAD= 0.00000E+00                               2-D BEAM    3
END          FORCE            SDIR            MOM          SBEND           SDPB           SDMB
   I       14.062           5.3591        -1217.4        -2328.2        -2322.3         2334.1
   J       14.062           5.3591         2189.0         4186.5         4192.3        -4180.6
TENTH POINT MOMENTS
 -0.122E+04  -877.        -536.          -195.          145.           486.          826.       0.117E+04  0.151E+04  0.185E+04  0.219E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE        7   9.51215       -3789.13        -1217.37
 STATIC FORCES ON NODE        8  -9.51215        3789.13        -2189.05

EL=     8  NODES=     8     9  MAT=  1  TTOP,TBOT=    0.0      0.0  LOAD= 0.00000E+00                               2-D BEAM    3
END          FORCE            SDIR            MOM          SBEND           SDPB           SDMB
   I       9.5358           3.9733         2189.0         4186.5         4190.5        -4182.5
   J       9.5358           3.9733         2238.6         4281.3         4285.3        -4277.3
TENTH POINT MOMENTS
  0.219E+04  0.219E+04  0.220E+04  0.220E+04  0.221E+04  0.221E+04  0.222E+04  0.222E+04  0.223E+04  0.223E+04  0.224E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE        8   9.51215        -24.1344         2189.05
 STATIC FORCES ON NODE        9  -9.51215         24.1344        -2238.62

EL=     9  NODES=     9    10  MAT=  1  TTOP,TBOT=    0.0      0.0  LOAD= 0.00000E+00                               2-D BEAM    3
END          FORCE            SDIR            MOM          SBEND           SDPB           SDMB
   I       9.5221           3.9675         2238.6         4281.3         4285.3        -4277.3
   J       9.5221           3.9675         2341.2         4477.4         4481.4        -4473.5
TENTH POINT MOMENTS
  0.224E+04  0.225E+04  0.226E+04  0.227E+04  0.228E+04  0.229E+04  0.230E+04  0.231E+04  0.232E+04  0.233E+04  0.234E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE        9   9.51215        -24.1344         2238.62
 STATIC FORCES ON NODE       10  -9.51215         24.1344        -2341.18

EL=    10  NODES=    10    11  MAT=  1  TTOP,TBOT=    0.0      0.0  LOAD= 0.00000E+00                               2-D BEAM    3
END          FORCE            SDIR            MOM          SBEND           SDPB           SDMB
   I    -0.93289E-02 -0.38870E-02   2341.2         4477.4         4477.4        -4477.4
   J    -0.93289E-02 -0.38870E-02   2443.7         4673.6         4673.6        -4673.6
TENTH POINT MOMENTS
  0.234E+04  0.235E+04  0.236E+04  0.237E+04  0.238E+04  0.239E+04  0.240E+04  0.241E+04  0.242E+04  0.243E+04  0.244E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE       10  0.115186E-13  -24.1344         2341.18
 STATIC FORCES ON NODE       11 -0.115186E-13   24.1344        -2443.75

EL=    11  NODES=    11    12  MAT=  1  TTOP,TBOT=    0.0      0.0  LOAD= 0.00000E+00                               2-D BEAM    3
END          FORCE            SDIR            MOM          SBEND           SDPB           SDMB
   I    -0.21605E-01 -0.90022E-02   2443.7         4673.6         4673.6        -4673.6
   J    -0.21605E-01 -0.90022E-02   2467.9         4719.8         4719.7        -4719.8
TENTH POINT MOMENTS
  0.244E+04  0.245E+04  0.245E+04  0.245E+04  0.245E+04  0.246E+04  0.246E+04  0.246E+04  0.246E+04  0.247E+04  0.247E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE       11  0.710543E-14  -24.1344         2443.75
 STATIC FORCES ON NODE       12 -0.177636E-13   24.1344        -2467.88

EL=    12  NODES=    12    13  MAT=  1  TTOP,TBOT=    0.0      0.0  LOAD= 0.00000E+00                               2-D BEAM    3
END          FORCE            SDIR            MOM          SBEND           SDPB           SDMB
   I    -0.26511E-01 -0.11046E-01   2467.9         4719.8         4719.7        -4719.8
   J    -0.26511E-01 -0.11046E-01   2493.3         4768.5         4768.4        -4768.5
TENTH POINT MOMENTS
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  0.247E+04  0.247E+04  0.247E+C4  0.248E+04  0.248E+04  0.248E+04  0.248E+04  0.249E+04  0.249E+04  0.249E+04  0.249E+04
MAXIMUM MOMENT IS AT END J
 STATIC FORCES ON NODE      12  0.106581E-13  -24.1344        2467.88
 STATIC FORCES ON NODE      13 -0.355271E-14   24.1344       -2493.34

EL=    13  NODES=    13    14  MAT=  1  TTOP,TBOT=     0.0      0.0  LOAD= 0.00000E+00                                      2-D BEAM    3
END         FORCE           SDIR           MOM          SBEND          SDPB          SDMB
   I      4.6378         1.9533         2493.3         4768.5         4770.4       -4766.5
   J      4.6378         1.9533        -925.80        -1770.6        -1768.6        1772.5
TENTH POINT MOMENTS
  0.249E+04  0.215E+04  0.181E+04  0.147E+04  0.113E+04   784.        442.        99.9       -242.       -584.       -926.
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      13  0.142109E-13   3740.87        2493.34
 STATIC FORCES ON NODE      14 -0.142109E-13  -3740.87        925.804

EL=    14  NODES=    14    15  MAT=  1  TTOP,TBOT=     0.0      0.0  LOAD= 0.00000E+00                                      2-D BEAM    3
END         FORCE           SDIR           MOM          SBEND          SDPB          SDMB
   I   -0.67892E-01 -0.28288E-01  -925.80        -1770.6        -1770.6        1770.5
   J   -0.67892E-01 -0.28288E-01  -826.60        -1580.9        -1580.9        1580.8
TENTH POINT MOMENTS
  -926.       -916.       -906.       -896.       -886.       -876.       -866.       -856.       -846.       -837.       -827.
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      14  0.150990E-13  -56.6553       -925.804
 STATIC FORCES ON NODE      15 -0.150990E-13   56.6553        826.601

EL=    15  NODES=    15    16  MAT=  1  TTOP,TBOT=     0.0      0.0  LOAD= 0.00000E+00                                      2-D BEAM    3
END         FORCE           SDIR           MOM          SBEND          SDPB          SDMB
   I   -0.60790E-01 -0.25329E-01  -826.60        -1580.9        -1580.9        1580.8
   J   -0.60790E-01 -0.25329E-01  -709.89        -1357.6        -1357.7        1357.6
TENTH POINT MOMENTS
  -827.       -815.       -803.       -792.       -780.       -768.       -757.       -745.       -733.       -722.       -710.
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      15  0.102141E-13  -56.6553       -826.601
 STATIC FORCES ON NODE      16 -0.102141E-13   56.6553        709.891

EL=    16  NODES=    16    17  MAT=  1  TTOP,TBOT=     0.0      0.0  LOAD= 0.00000E+00                                      2-D BEAM    3
END         FORCE           SDIR           MOM          SBEND          SDPB          SDMB
   I   -0.55339E-01 -0.23058E-01  -709.89        -1357.6        -1357.7        1357.6
   J   -0.55339E-01 -0.23058E-01  -639.07        -1222.2        -1222.2        1222.2
TENTH POINT MOMENTS
  -710.       -703.       -696.       -689.       -682.       -674.       -667.       -660.       -653.       -646.       -639.
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      16  0.799361E-14  -56.6553       -709.891
 STATIC FORCES ON NODE      17  0.621725E-14   56.6553        639.072

EL=    17  NODES=    17    18  MAT=  1  TTOP,TBOT=     0.0      0.0  LOAD= 0.00000E+00                                      2-D BEAM    3
END         FORCE           SDIR           MOM          SBEND          SDPB          SDMB
   I   -0.51379E-01 -0.21408E-01  -639.07        -1222.2        -1222.2        1222.2
   J   -0.51379E-01 -0.21408E-01  -554.09        -1059.7        -1059.7        1059.7
TENTH POINT MOMENTS
  -639.       -631.       -622.       -614.       -605.       -597.       -588.       -580.       -571.       -563.       -554.
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      17  0.888178E-14  -56.6553       -639.072
 STATIC FORCES ON NODE      18 -0.888178E-14   56.6553        554.089

EL=    18  NODES=    18    19  MAT=  1  TTOP,TBOT=     0.0      0.0  LOAD= 0.00000E+00                                      2-D BEAM    3
END         FORCE           SDIR           MOM          SBEND          SDPB          SDMB
   I   -0.46570E-01 -0.19404E-01  -554.09        -1059.7        -1059.7        1059.7
   J   -0.46570E-01 -0.19404E-01  -415.28        -794.22        -794.24         794.20
TENTH POINT MOMENTS
  -55         -540.       -526.       -512.       -499.       -485.       -471.       -457.       -443.       -429.       -415.
```

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MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      18 -0.119904E-13  -56.6553       -554.089
 STATIC FORCES ON NODE      19  0.843769E-14   56.6553        415.284

EL=   19  NODES=   19   20  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                       2-D BEAM   3
END        FORCE          SDIR            MOM          SBEND          SDPB          SDMB
   I   -0.41957E-01 -0.17482E-01  -415.28       -794.22       -794.24        794.20
   J   -0.41957E-01 -0.17482E-01  -277.04       -529.84       -529.86        529.82
TENTH POINT MOMENTS
  -415.       -401.       -388.       -374.       -360.       -346.       -332.       -319.       -305.       -291.       -277.
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      19  0.333067E-14  -56.6553       -415.284
 STATIC FORCES ON NODE      20 -0.333067E-14   56.6553        277.045

EL=   20  NODES=   20   21  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                       2-D BEAM   3
END        FORCE          SDIR            MOM          SBEND          SDPB          SDMB
   I   -0.38892E-01 -0.15205E-01  -277.04       -529.84       -529.86        529.82
   J   -0.38892E-01 -0.15205E-01  -139.37       -266.55       -266.56        266.53
TENTH POINT MOMENTS
  -277.       -263.       -250.       -236.       -222.       -208.       -194.       -181.       -167.       -153.       -139.
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      20 -0.277556E-14  -56.6553       -277.045
 STATIC FORCES ON NODE      21  0.277556E-14   56.6553        139.372

EL=   21  NODES=   21   22  MAT=  1  TTOP,TBOT=     0.0     0.0  LOAD= 0.00000E+00                                       2-D BEAM   3
END        FORCE          SDIR            MOM          SBEND          SDPB          SDMB
   I   -0.37350E-01 -0.15563E-01  -139.37       -266.55       -266.56        266.53
   J   -0.37350E-01 -0.15563E-01 -0.27285E-11 -0.52182E-11 -0.15563E-01 -0.15563E-01
TENTH POINT MOMENTS
  -139.       -125.       -111.       -97.6       -83.6       -69.7       -55.7       -41.8       -27.9       -13.9      -0.273E-11
MAXIMUM MOMENT IS AT END I
 STATIC FORCES ON NODE      21  0.144329E-14  -56.6553       -139.372
 STATIC FORCES ON NODE      22 -0.499600E-14   56.6553       0.272848E-11

EL=   23  NODES=    1  101  USEP=-0.000001  USLIDE=-0.000003  FN= -95.130       FS= -9.5130       STAT= -2  OLDST= -2    2-D GAP  12
 STATIC FORCES ON NODE       1  -9.51215        -95.1296
 STATIC FORCES ON NODE     101   9.51215         95.1296

EL=   24  NODES=    6  106  USEP= 0.008051  USLIDE=-0.000002  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3    2-D GAP  12
 STATIC FORCES ON NODE       6  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE     106  0.000000E+00  0.000000E+00

EL=   25  NODES=   15  115  USEP= 0.007902  USLIDE= 0.000003  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3    2-D GAP  12
 STATIC FORCES ON NODE      15  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE     115  0.000000E+00  0.000000E+00

EL=   26  NODES=    3  103  USEP= 0.034879  USLIDE=-0.000003  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3    2-D GAP  12
 STATIC FORCES ON NODE       3  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE     103  0.000000E+00  0.000000E+00

EL=   27  NODES=   18  118  USEP= 0.034110  USLIDE= 0.000006  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3    2-D GAP  12
 STATIC FORCES ON NODE      18  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE     118  0.000000E+00  0.000000E+00

EL=   28  NODES=    5  105  USEP= 0.040069  USLIDE=-0.000002  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3    2-D GAP  12
 STATIC FORCES ON NODE       5  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE     105  0.000000E+00  0.000000E+00

EL=   29  NODES=   16  116  USEP= 0.039691  USLIDE= 0.000004  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3    2-D GAP  12
 STATIC FORCES ON NODE      16  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE     116  0.000000E+00  0.000000E+00
```

```
EL=   31  NODES=  110   10  USEP= 0.000237  USLIDE= 0.000000  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3   2-D GAP  12
 STATIC FORCES ON NODE      110  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE       10  0.000000E+00  0.000000E+00

EL=   32  NODES=  109    9  USEP= 0.007934  USLIDE= 0.000000  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3   2-D GAP  12
 STATIC FORCES ON NODE      109  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE        9  0.000000E+00  0.000000E+00

EL=   33  NODES=  111   11  USEP= 0.007880  USLIDE= 0.000000  FN= 0.00000E+00  FS= 0.00000E+00  STAT=  3  OLDST=  3   2-D GAP  12
 STATIC FORCES ON NODE      111  0.000000E+00  0.000000E+00
 STATIC FORCES ON NODE       11  0.000000E+00  0.000000E+00

EL=   35  NODES=   22  122  USEP=-0.000001  USLIDE= 0.000008  FN= -56.655      FS= 0.00000E+00  STAT=  2  OLDST=  2   2-D GAP  12
 STATIC FORCES ON NODE       22  0.000000E+00  -56.6553
 STATIC FORCES ON NODE      122  0.000000E+00   56.6553
```

```
             ANSYS - ENGINEERING ANALYSIS SYSTEM  REVISION 4.1       B       FISHER CONTROLS  JAN 1,1983
        SWANSON ANALYSIS SYSTEMS, INC.        HOUSTON, PENNSYLVANIA 15342   PHONE (412)746-3304  TWX 510-690-8655

 VOGT1                                                                           11.1300  11/28/84 CP=      35.470

  ***** REACTION FORCES *****    TIME =  0.00000E+00  LOAD STEP=    1  ITERATION= 10  CUM. ITER.=     5

  NOTE - REACTION FORCES ARE IN THE NODAL COORDINATE SYSTEM


    NODE        FX                  FY                 MZ

      7                           3834.26
     10      9.51215
     14                           3797.52
    101     -9.51215            -95.1296          0.000000E+00
    103      0.000000E+00        0.000000E+00      0.000000E+00
    105      0.000000E+00        0.000000E+00      0.000000E+00
    106      0.000000E+00        0.000000E+00      0.000000E+00
    115      0.000000E+00        0.000000E+00      0.000000E+00
    116      0.000000E+00        0.000000E+00      0.000000E+00
    118      0.000000E+00        0.000000E+00      0.000000E+00
    122      0.000000E+00       -56.6553          0.000000E+00

 TOTAL    -0.104361E-13       7530.00          0.000000E+00

  STATUS CHANGED FOR     0 BILINEAR ELEM THIS ITER
      DISPLACEMENT INCREMENT  =  0.29725E-05 AT NODE      1      CRITERION =  0.10000E-02
 *** LOAD STEP    1    ITER    10  COMPLETED.  TIME=  0.000000E+00  TIME INC=  0.000000E+00 NEW TRIANG MATRIX  CUM. ITER.=     5

 END OF INPUT ENCOUNTERED ON FILE27

 ***** INPUT FILE SWITCHED FROM FILE27 TO FILE 5
```

ATTACHMENT 10

FQP-11AB-7

ES 199, Rev. A

Verification of Rotary Valve Shaft Stress Analysis Program

9510-AX5AC03-5151-2 296

Fisher Controls

Document Cover Sheet

FISHER

No. ES 199 A

By DCB 10-29-85

Apvd 10-29-85

Page 1 of

Rev

Title:

VERIFICATION OF ROTARY VALVE SHAFT STRESS ANALYSIS PROGRAM

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7	A						
8	A						
9	A						
10	A						
11	A						
12	A						
13	A						
14	A						

NOTE: Revision of this document shall be approved by the Manager, Engineering Qualification and Analysis.

This page is the cover sheet of all documents containing 3 or more pages of specifications. The table above shows the revision level of each page of this document. A revision of this page will be made when any page of this document is revised When referring to this document specify the revision level o this page.

TABLE OF CONTENTS

1. SCOPE

Verify the programing accuracy of the Rotary Valve Shaft Stress Analysis Program.

2. INTRODUCTION

The purpose of ES 199 is to provide assurance that the shaft analysis procedures are properly executed by the Rotary Valve Shaft Stress Analysis Program.

3. VERIFICATION PROCEDURE

Verification of the programing accuracy of Rotary Valve Shaft Stress Analysis Program is accomplished by a comparison of the computer generated values and manual calculations. The following two examples are chosen to exercise the two options that are present in the program. Verification Example 1 is chosen for conditions present when the valve disc is seated (ANG is zero). For a seated valve disc, the seating torque (TQS) is represented in the torque equations and the dynamic torque (TQD) is not. Verification Example 2 is chosen for conditions present when the valve disc is not seated (ANG is greater than zero). For an unseated valve disc, the dynamic torque is present in the torque equations and the seating torque is not.

3.1 Verification Example 1. Verification Example 1 is used for verification of the program for conditions present when the valve disc is seated (seating torque is present in the equations and the dynamic torque is not). This example also shows application of cam forces due to an offset disc (DM) and inertial forces due to fast stroking times (TQI). The conditions of disc offset and fast stroking time may or may not be present in particular applications. Because of a difference in seal arrangements and service conditions for different valves with specified service factors, TQS and TQI are data inputs and are calculated prior to runnning the program. Verification Example 1 is a special 14" Type 9280 with Adjustable T-Ring. The seat material is EPDM. The 17-4PH Class 4 shaft is pinned (C1 = 0.5) at the cast disc and keyed (C2 = 0.75) to the drive lever. The bushing material is bronze/graphite (Bushing Type 2). Gas flow direction is toward the hub. Process temperature is 320°F. The stroking time is 0.25 seconds.

3.1.1 Data Input. The following table presents the input variables and the values used for Verification Example 1.

Variable	Value	Description
ANG	0.0	Angle opening, deg.
DDISC	13.244	Valve disc diameter, in.
DELTP	60.0	Pressure drop, psi
DLO	0.906	Disc hub to bushing distance, in.
TQS	1805.89	Seating torque (0° only), in-lbf
TQI	60.67	Inertial torque, in-lbf
DM	0.020	Amount of disc offset, in.
DTF	0.0	Dynamic torque factor, dimensionless
DPIN	60.0	Inlet pressure, psi
DELTPF	60.0	Effective pressure drop factor, dimensionless
C1	0.5	Disc/shaft connection factor, dimensionless
C2	0.75	Drive/shaft connection factor, dimensionless
BSHTYP	2	Bushing type identification code(sets DMU=0.2)
DSHFT	1.748	Shaft diameter, in.

3.1.2 Torque Calculations

(a) TQF: Valve Bushing Friction Torque (in-lbf)

$$TQF = (DMU)(0.393)(DDISC)^{2}(DELTP)(DSHFT) \qquad (1)$$

$$TQF = (0.2)(0.393)(13.244)^{2}(60.0)(1.748)$$

$$TQF = 1445.95$$

(b) TQP: Packing Torque (in-lbf)

$$TQP = 100(DSHFT)^{1.5} \qquad (2)$$

$$TQP = 100(1.748)^{1.5}$$

$$TQP = 231.11$$

(c) TQC: Cam Torque (in-lbf)

$$TQC = (0.785)(DDISC)^{2}(DELTP)(DM) \qquad (3)$$

$$TQC = (0.785)(13.244)^{2}(60.0)(0.020)$$

$$TQC = 165.23$$

(d) TQD: Dynamic Torque (in-lbf)

DELTPE = DELTP (for ANG = 0.0)

DELTP = 60.00

DELTPE = 60.00

TQD = DTF{smaller value of DELTP and DELTPE} (4)

TQD = 0.0{60.0 }

TQD = 0.0

(e) TQV: Valve Torque at Drive End of Shaft (in-lbf)

TQV = TQF + TQP + TQS + TQI + TQC + TQD (5)

TQV = 1445.95 + 231.11 + 1805.89 + 60.67 + 165.23 + 0.0

TQV = 3708.85

(f) TA: Shaft Torque at Point A (in-lbf)

TA = TQV (6)

TA = 3708.85

(g) TB: Shaft Torque at Point B (in-lbf)

TB = TQV - TQP/2 - TQF/2 (7)

TB = 3708.85 - 231.11/2 - 1445.95/2

TB = 2870.32

(h) TC: Shaft Torque at Point C (in-lbf)

TC = TQV - TQP/2 - TQF/2 (8)

TC = 3708.85 - 231.11/2 - 1445.95/2

TC = 2870.32

3.1.3 Stress Calculations

(a) STRS1: Point B_1 Normal Bending and Torsion Stress (psi)

$$M = (0.393)(DDISC)^2(DELTP)(DLO) \quad (9)$$

$$M = (0.393)(13.244)^2(60.0)(0.906)$$

$$M = 3747.23$$

$$STRS1 = \{(5.1)/(DSHFT)^3\}\{M + \{(M)^2 + (TB)^2\}^{0.5}\} \quad (10)$$

$$STRS1 = \{(5.1)/(1.748)^3\}\{3747.23 + \{(3747.23)^2 + (2870.32)^2\}^{0.5}\}$$

$$STRS1 = 8085.34$$

(b) STRS2: Point B_1 Bending and Torsion Shear Stress (psi)

$$STRS2 = \{(5.1)/(DSHFT)^3\}\{(M)^2 + (TB)^2\}^{0.5} \quad (11)$$

$$STRS2 = \{(5.1)/(1.748)^3\}\{(3747.23)^2 + (2870.32)^2\}^{0.5}$$

$$STRS2 = 4507.21$$

(c) STRS3: Point B_2 Torsion and Direct Shear Stress (psi)

$$STRS3 = (5.1)(TB/(DSHFT)^3) + (2/3)((DDISC)^2(DELTP)/(DSHFT)^2) \quad (12)$$

$$STRS3 = (5.1)(2870.32/(1.748)^3) + (2/3)((13.244)^2(60.0)/(1.748)^2)$$

$$STRS3 = 5037.02$$

(d) STRS4: Point C Torsion Load Shear Stress (psi)

$$STRS4 = (5.1)\{(TC)/((C1)(DSHFT)^3)\} \quad (13)$$

$$STRS4 = (5.1)\{(2870.32)/((0.5)(1.748)^3)\}$$

$$STRS4 = 5481.59$$

(e) STRS5: Point A Torsion Load Shear Stress (psi)

$$STRS5 = (5.1)\{(TA)/((C2)(DSHFT)^3)\} \quad (14)$$

$$STRS5 = (5.1)\{(3708.85)/((0.75)(1.748)^3)\}$$

$$STRS5 = 4721.98$$

(f) STRS6: Bushing Load Stress (psi)

$$STRS6 = (0.393)(DDISC)^2(DELTP)/(DSHFT)^2 \qquad (15)$$

$$STRS6 = (0.393)(13.244)^2(60.0)/(1.748)^2$$

$$STRS6 = 1353.63$$

3.1.4 Calculation Comparison. A sample run of the Rotary Valve Shaft Stress Analysis Program was run 10/23/85 using the same input conditions that were used in this analysis. See Exhibit 1 for a copy of the Verification Example 1 program output. The following table shows the difference between the manually calculated values and the computer generated values, for the case of ANG = 0.0°.

(a) Valve Torque

Variable	Manual	Computer	% Difference
TQV	3,708.85	3708.85	0.0

(b) Stress Calculations

Variable	Manual	Computer	% Difference
STRS1	8,085.34	8,084.23	0.0
STRS2	4,507.21	4,506.11	0.0
STRS3	5,037.02	5,039.85	0.0
STRS4	5,481.59	5,480.26	0.0
STRS5	4,721.98	4,723.86	0.0
STRS6	1,353.63	1,353.63	0.0

3.2 Verification Example 2. Verification Example 2 is used for verification of the program for conditions present when the valve disc is not seated (dynamic torque is present in the torque equations and the seating torque is not). This example also shows applications when the cam forces due to an offset disc (DM) and inertial forces due to fast stroking times (TQI) are not present. The conditions of disc offset and fast stroking times may or may not be present in particular applications. Because of a difference in seal arrangements and service conditions for different valves with specified service factors, TQS and TQI are data inputs and are calculated prior to running the program. Verification Example 2 is a special 14" Type 9280 with Adjustable T-Ring. The seat material is EPDM. The 17-4PH Class 4 shaft is pinned (C1 = 0.5) at the cast disc and keyed (C2 = 0.75) to the drive lever. The bushing material is bronze/graphite (Bushing Type 2). Gas flow direction is toward the hub. Process temperature is 320°F. The stroking time is greater than 0.5 seconds.

3.2.1 Data Input. The following table presents the input variables and the values used for Verification Example 2.

Variable	Value	Description
ANG	30.0	Angle opening, deg.
DDISC	13.244	Valve disc diameter, in.
DELTP	50.0	Pressure drop, psi
DLO	0.906	Disc hub to bushing distance, in.
TQS	0.0	Seating torque (0° only), in-lbf
TQI	0.0	Inertial torque, in-lbf
DM	0.0	Amount of disc offset, in.
DTF	49.5	Dynamic torque factor, dimensionless
DPIN	50.0	Inlet pressure, psi
DELTPF	0.25	Effective pressure drop factor, dimensionless
C1	0.5	Disc/shaft connection factor, dimensionless
C2	0.75	Drive/shaft connection factor, dimensionless
BSHTYP	2	Bushing type identification code
DSHFT	1.748	Shaft diameter, in.

3.2.2 Torque Calculations

(a) TQF: Valve Bushing Friction Torque (in-lbf)

$$TQF = (DMU)(0.393)(DDISC)^2(DELTP)(DSHFT) \quad (16)$$

$$TQF = (0.2)(0.393)(13.244)^2(50.0)(1.748)$$

$$TQF = 1204.96$$

(b) TQP: Packing Torque (in-lbf)

$$TQP = 100(DSHFT)^{1.5} \quad (17)$$

$$TQP = 100(1.748)^{1.5}$$

$$TQP = 231.11$$

(c) TQC: Cam Torque (in-lbf)

$$TQC = (0.785)(DDISC)^2(DELTP)(DM) \quad (18)$$

$$TQC = (0.785)(13.244)^2(60.0)(0.0)$$

$$TQC = 0.0$$

(d) TQD: Dynamic Torque (in-lbf)

$$DELTPE = (DELTPF)(DPIN + 14.7)$$

$$DELTPE = (0.25)(50.0 + 14.7)$$

$$DELTPE = 16.18$$

$$TQD = DTF\{\text{smaller value of } DELTP \text{ and } DELTPE\} \quad (19)$$

$$TQD = 49.5\{\text{smaller value of } 50.0 \text{ and } 16.18\}$$

$$TQD = 800.66$$

(e) TQV: Valve Torque at Drive End of Shaft (in-lbf)

$$TQV = TQF + TQP + TQS + TQI + TQC + TQD \quad (26)$$

$$TQV = 1204.96 + 231.11 + 0.0 + 0.0 + 0.0 + 800.66$$

$$TQV = 2236.73$$

(f) TA: Shaft Torque at Point A (in-lbf)

$$TA = TQV \tag{21}$$

$$TA = 2236.73$$

(g) TB: Shaft Torque at Point B (in-lbf)

$$TB = TQV - TQP/2 - TQF/2 \tag{22}$$

$$TB = 2236.73 - 231.11/2 - 1204.96/2$$

$$TB = 1518.70$$

(h) TC: Shaft Torque at Point C (in-lbf)

$$TC = TQV - TQP/2 - TQF/2 \tag{23}$$

$$TC = 2236.73 - 231.11/2 - 1204.96/2$$

$$TC = 1518.70$$

3.2.3 Stress Calculations

(a) STRS1: Point B_1 Normal and Torsion Stress (psi)

$$M = (0.393)(DDISC)^2(DELTP)(DLO) \tag{24}$$

$$M = (0.393)(13.244)^2(50.0)(0.906)$$

$$M = 3122.70$$

$$STRS1 = \{(5.1)/(DSHFT)^3\}\{M + \{(M)^2 + (TB)^2\}^{0.5}\} \tag{25}$$

$$STRS1 = \{(5.1)/(1.748)^3\}\{3122.70 + \{(3122.70)^2 + (1518.70)^2\}^{0.5}\}$$

$$STRS1 = 6297.51$$

(b) STRS2: Point B_1 Bending and Torsion Shear Stress (psi)

$$STRS2 = \{(5.1)/(DSHFT)^3\}\{(M)^2 + (TB)^2\}^{0.5} \tag{26}$$

$$STRS2 = \{(5.1)/(1.748)^3\}\{(3122.70)^2 + (1518.70)^2\}^{0.5}$$

$$STRS2 = 3315.72$$

(c) STRS3: Point B_2 Torsion and Direct Shear Stress (psi)

$$STRS3 = (5.1)(TB/(DSHFT)^3) + (2/_3)((DDISC)^2(DELTP)/(DSHFT)^2) \quad (27)$$

$$STRS3 = (5.1)(1518.70/(1.748)^3) + (2/_3)((13.244)^2(50.0)/(1.748)^2)$$

$$STRS3 = 3363.69$$

(d) STRS4: Point C Torsion Load Shear Stress (psi)

$$STRS4 = (5.1)\{(TC)/((C1)(DSHFT)^3)\} \quad (28)$$

$$STRS4 = (5.1)\{(1518.70)/((0.5)(1.748)^3)\}$$

$$STRS4 = 2900.33$$

(e) STRS5: Point A Torsion Load Shear Stress (psi)

$$STRS5 = (5.1)\{(TA)/((C2)(DSHFT)^3)\} \quad (29)$$

$$STRS5 = (5.1)\{(2236.73)/((0.75)(1.748)^3)\}$$

$$STRS5 = 2847.73$$

(f) STRS6: Bearing Load Stress (psi)

$$STRS6 = (0.393)(DDISC)^2(DELTP)/(DSHFT)^2 \quad (30)$$

$$STRS6 = (0.393)(13.244)^2(50.0)/(1.748)^2$$

$$STRS6 = 1128.02$$

3.2.4 Calculation Comparison. A sample run of the Rotary Valve Shaft Stress Analysis was run 10/23/85 using the same input conditions that were used in this analysis. See Exhibit 2 for a copy of the Example 2 program output. The following table shows the difference between the manually calculated values and the computer generated values, for the case of ANG = 30.0°.

(a) Valve Torque

Variable	Manual	Computer	% Difference
TQV	2,236.73	2,236.73	0.0

(b) Stress Calculations

Variable	Manual	Computer	% Difference
STRS1	6,297.51	6,296.82	0.0
STRS2	3,315.72	3,315.05	0.0
STRS3	3,363.69	3,366.05	0.0
STRS4	2,900.33	2,898.55	0.0
STRS5	2,847.73	2,848.86	0.0
STRS6	1,128.02	1,128.02	0.0

3.3 Verification. The Calculation Comparison in Sections 3.1.4 and 3.2.4 indicates that there is no difference between the computer generated values and the manually calculated values. These examples verifiy the accuracy of the Rotary Valve Shaft Stress Analysis.

EXHIBIT 1
Verification Example 1

```
ACTUATOR TORQUE CALCULATIONS     REV. B

REF. NO. EXAMPLE 1                  TEMP. 320 DEG F
VALVE TYPE 9280                     VALVE SIZE 14 INCH
SHAFT MAT. SA-564 H1075 RC31-39     BUSH. MAT. BRONZE/GRAPHITE
DISC-SHAFT CON. PINNED              DRIVE-SHAFT CON. KEYED
FLOW DIR. TOWARD HUB
DATE OCTOBER 23,1985                BY DAVE STANZE

INPUT DATA

ANG          0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000

ODISC       13.244    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
DELTP       60.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
DLO          0.906    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
TS        1805.890    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
TI          60.670    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
DM           0.020    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
DTF          0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
DPIN        60.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
DELTPF      60.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
STSH        98.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
SBUSH       85.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
C1           0.500    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
C2           0.750    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
BSHTYP           2        0        0        0        0        0        0        0        0        0
DSHFT        1.748    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000

GENERATED VARIABLES

ST        51450.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
SS        25725.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
SB         8500.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00

OUTPUT

ACT.TORQ  3708.8462   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


STRS1     8084.2344   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
STRS2     4506.1055   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
STRS3     5039.8516   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
STRS4     5480.2578   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
STRS5     4723.8594   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
STRS6     1353.6267   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
```

EXHIBIT 2
Verification Example 2

```
ACTUATOR TORQUE CALCULATIONS     REV. 0

REF. NO. EXAMPLE 2                    TEMP. 320 DEG F
VALVE TYPE 9280                       VALVE SIZE 14 INCH
SHAFT MAT. SA-564 H1075 RC31-39       BUSH. MAT. BRONZE/GRAPHITE
DISC-SHAFT CON. PINNED                DRIVE-SHAFT CON. KEYED
FLOW DIR. TOWARD HUB
DATE OCTOBER 23, 1985                 BY DAVE STANZE

INPUT DATA

ANG          30.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000

DDISC        13.244     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
DELTP        50.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
DLO           0.906     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
TS            0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
TI            0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
DM            0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
DTF          49.500     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
DPIN         50.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
DELTPF        0.250     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
STSH         98.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
SBUSH        85.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
C1            0.500     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
C2            0.750     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
BSHTYP            2         0         0         0         0         0         0         0         0         0
DSHFT         1.748     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000

GENERATED VARIABLES

ST         51450.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
SS         25725.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
SW          8500.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00

OUTPUT

ACT.TORQ  2236.7266    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000



STRS1     6296.8242    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
STRS2     3315.0520    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
STRS3     3366.0481    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
STRS4     2898.5540    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
STRS5     2848.8613    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
STRS6     1128.0229    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
```

ATTACHMENT 11

FQP-11AB-7

ANSYS Program Q.A. Statement

(Swanson Analysis Systems, Inc.)
(letter dated 8-27-85 (M. J. Wheeler) to Fisher Controls (D. Stanze))

9510-AX5AC03-5151-2 311

Swanson Analysis Systems, Inc.

Johnson Road, P.O. Box 65 Houston, PA 15342-0065

TWX 510-690-8655
PHONE (412) 746-3304

August 27, 1985

Mr. Dave Stanze
Senior Engineer
Fischer Controls
P. O. Box 190
Marshaltown, IA 50158

Dear Mr. Stanze:

Swanson Analysis has had an independent Quality Assurance department since 1983. The primary responsibility of this department has been to define and implement an independent verification process for all ANSYS versions. A Quality Assurance Manual and Technical Procedures Manual have been issued to clearly define everyone's responsibilities. All applicable employees have been trained in quality related areas.

Sincerely yours,
SWANSON ANALYSIS SYSTEMS, INC.

Mike Wheeler

Michael J. Wheeler, Manager
Quality Assurance

ktc

ATTACHMENT 12

FQP-11AB-7

ES 121, Rev. D

Control and Maintenance Procedures
for FCS Engineering Analytical Computer Programs and Data Bases

Fisher Controls

Document Cover Sheet

No.	ES 121	D
By JBM	11-27-78	
Apvd dlh	11-28-78	
Page 1	of	
Rev JcD	10-30-8	

FISHER®

Title:

CONTROL AND MAINTENANCE PROCEDURES
FOR FCS ENGINEERING ANALYTICAL
COMPUTER PROGRAMS AND DATA BASES

Page Number	Revision Level	Page Number	Revision Level	Page Number	Revision Level	Page Number	Revision Level
1	D						
2	B						
3	B						
4	B						
5	C						
6	B						
7	B						
8	B						
9	B						
10	B						
11	B						
12	B						
13	B						
14 deleted	B						
15 deleted	C						
16 deleted	A						

This page is the cover sheet of all documents containing 3 or more pages of specifications. The table above shows the revision level of each page of this document. A revision of this page will be made when any page of this document is revise When referring to this document specify the revision level this page.

TABLE OF CONTENTS

1. SCOPE

1.1 This engineering standard provides a procedure for documenting, revising, and maintaining FCS Engineering analytical computer programs and databases. Outlined in this standard are the procedures to follow in establishing a program or database with the necessary documentation file. In addition, applicable guidelines recommended by the following standards are incorporated:

ANSI/ASME NQA-1-1983. "Quality Assurance Program Requirements for Nuclear Facilities".

ANSI N413-1974. "Guidelines for the Documentation of Digital Computer Programs"

ANSI/ANS 10.2-1982. "Recommended Programming Practices to Facilitate the Portability of Scientific Computer Programs"

ANSI/ANS 10.5-1979. "Guidelines for Considering User Needs in Computer Program Development"

1.2 A secondary objective of this engineering standard is to present the format to be used for the Fisher Computer/database documentation file so that all of the necessary information will be provided in a logical and consistent manner.

1.3 Finally, an Installation Report form is described for documenting installatio of programs and databases in either the Fisher Controls (Marshalltown) computer system or in the Monsanto Management Information System (MIS) using the St. Louis Monsanto Terminal Station (MTS). This report provides a check between what is documented and what resides in the computers.

2. REQUIREMENTS AND RESPONSIBILITIES FOR DOCUMENTATION OF COMPUTER PROGRAMS AND DATABASES

2.1 Any FCS Engineering analytical computer program (with associated database) used in the design of Fisher products in general applications will require documentation under a project file number (XXJAXX series). Any FCS Engineering computer program used to qualify equipment to Fisher customer specifications will also require similar documentation and project file number assignment.

2.2 It will be the responsibility of the Program Author to determine when the program/database qualifies for project file number assignment and documentation control and maintenance per this Engineering Standard. In general, if the computer program or database is to be released for use by anyone other than the Program Author, then the requirements of this standard must be met.

2.3 If this standard is to be followed, it is the Program Author's responsibility to contact the Engineering Qualification and Analysis Group for assignment of a Program Controller who will initiate program/database installation and documentation procedures. At that time, a general description of the program/database content and its intended or expected application should be provided to the Program Controller by the Program Author. (See Section 6 of this standard for a summary of the responsibilities of the Program Author and Program Controller, respectively.)

3. INSTALLING AND REVISING COMPUTER PROGRAMS AND DATABASES

3.1 Program Controller. Installation of programs and databases will be the responsibility of an individual (henceforth referred to as the "Program Controller") designated by the Manager, Engineering Qualification and Analysis. A draft of the program/database should be submitted to the Program Controller for program/database installation on the selected computer system. The Program Controller will fill out the installation report form (See Exhibit 1), keeping a copy for insertion in the program/database file.

3.2 Program Documentation File. In all cases, the Program Controller must provide and/or assemble the XXJAXX Documentation File for the program or database. The use of the program or database may be denied the author or any other user until the documentation file is assembled and the project file number assignment is completed. The XXJAXX Documentation File will then be transferred to the Fisher Information Center for custody. In addition, the Manager, Engineering Qualification and Analysis Group (or designee) will maintain a current index file of the approved programs and databases with their associated project file numbers; this index will be circulated periodically in the FCS Engineering Department.

3.3 Fisher Controls Computer System

3.3.1 Installation procedures for Fisher-documented FCS Engineering programs will be dependent upon the host system being used. Examples of FCS Engineering programs subject to these documentation procedures are: ANSYS (VAX-based) or TK!SOLVER (PC-based). Note that purchased or leased programs are included, as well as Fisher-originated programs.

3.3.2 Purchased or leased programs will be installed following the installation procedures recommended by the program vendor. System ownership will be assigned to the installed program with "read-only" privileges for users, to avoid inadvertant erasure. A backup copy of the program will be maintained on separate media.

3.3.3 The following will be used when installing Fisher-originated programs. As above, system ownership will be assigned to the installed program with "read-only" priviledges, and a backup copy will be maintained on separate media. In addition to the executable image of the installed program, an ASCII text file of the program will be maintained in the Installation User ID (UID) file. Also included in the Installation UID file will be any data sets used in execution of the program and any user-written sub-routines external to the program. An on-line "help" file will also be provided, outlining the purpose of the program and the steps necessary to use the program.

3.4 St. Louis Monsanto/MIS Computer System

3.4.1 The Program Controller will place the source code on the "USERID"[1] called "FSHLIB", unless special restrictions or other arrangements are made as noted on the Installation Report. The source code will then be copied to microfiche (or paper if the listing is less than about 50 pages) and will be included in the project file. This source code will be compiled and link-edited and placed on the same database ("FSHLIB") under the same name. In all cases, one hard copy backup will be maintained by the Program Controller. ("FSHLIB" is a restricted access data set that is password-protected, permitting read-only availability to users.) A copy of the program or database will also be made for the tape librarian, and this library copy is automatically backed up by St. Louis Monsanto MIS.

3.4.2 Examples of St. Louis Monsanto MIS programs subject to these documentation procedures are: SEISMIC3, SEISMIC4.

4. FORMAT REQUIREMENTS FOR COMPUTER PROGRAM FILES

This section describes the format for the FCS Engineering XXJAXX Computer Program Documentation File. A consistent format is necessary both for proper control and maintenance and also for ease in referencing and accessing the information by the user. The format for the documentation file is comprised of the following sections:

- (a) Section 1: Standards and Specifications Cover Sheet.
- (b) Section 2: Table of Contents.
- (c) Section 3: Abstract.
- (d) Section 4: Job Control Language (JCL), if applicable.
- (e) Section 5: Source Code Listing (on paper, microfiche or magnetic tape, diskette) or Source Code Location.
- (f) Section 6: Description of Program Logic/Content or Program Documentation Reference.
- (g) Section 7: Verification Documentation.
- (h) Section 8: Input Data
- (i) Section 9: Output Data/Example
- (j) Section 10: Installation Report
- (k) Appendix A: Current Benchmark Problem/Installation Log Record
- (l) Appendix B: Documentation File Change Records
- (m) Appendix C: Project Records

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[1] "USERID" refers to a data set available through St. Louis MIS.

If a program is written for Fisher through a subcontracted vendor or if an established, commercially-available program is used by Fisher Controls, vendor documentation is needed; in these cases, the above format can be altered to incorporate a program user's manual. Sections 1,2,3,4,5,7,10 along with the program user's manual may be used to satisfy requirements as long as the Program Controller finds the complete package acceptable. Section 10 of the program documentation should be filled out by the Program Controller using the special form in Exhibit 1; it is the Program Controller's responsibility to incorporate this report in the program documentation file.

4.1 Section 1: Standards and Specifications Cover Sheet

The purpose of the cover sheet(s) is to indicate the revision level of the project documentation file, and the corresponding revision level of the constituent pages or documents. Each sheet or document in the bound file should be listed, except for the Appendices. (In the case of Appendices, only the Appendix title page need be listed.) If an already page-numbered document is included (such as ES 117, ES 136, etc.), only the document and its overall revision level need be listed. Whenever a revision or change is made in the project documentation file, the appropriate changes in page or document revision levels should be entered on the cover sheet, and the revision level of the project file should be advanced and designated on the cover sheet; change record sheets must be completed (including checking and signatures) and should be filed in Appendix B of the program documentation file (see Section 4.12).

4.2 Section 2: Table of Contents

The Table of Contents should immediately follow the cover sheet, identifying the major constituents of the file and the corresponding page or section number.

4.3 Section 3: Abstract

4.3.1 The function of the computer program abstract is to give a summary of the program regarding its capabilities, purpose, and intended application or use. The following topics should be included in the abstract:

(a) Program identification. Give the program name and current revision.

(b) Describe the program function or purpose and define the type of problems to be solved.

(c) Restrictions. Mention any limitations due to the program algorithms or computing facilities.

(d) Programming language. Indicate the language or languages used.

(e) Author. Give the name and address of the Program Author.

The abstract should be as brief as possible and to the point. A sentence or two addressing each topic should be adequate.

4.4 Section 4: Job Control Language (JCL)

The Program Controller shall provide listing of all the JCL requirements for the program, if applicable. Any data sets used should be referenced (with project file numbers if applicable). Explanations should be included to clarify the JCL usage for the user. (It is recognized that JCL is not used with many computer systems such as VAX.)

4.5 Section 5: Source Code Listing

The Source Code Listing means the list of program instructions in the selected program language (such as FORTRAN). The source listing is normally maintained on the program user ID disc. A source code backup must be maintained. The preferred method is magnetic tape with the tape location identified on the computer Program/Database Installation Report (Appendix A of ES121). Alternate methods are hard copy paper or microfiche. The Program Author will advise the Program Controller of the Source Code Listing backup mode and its location. Paper or microfiche copies will be included in the XXJAXX Program Documentation File by the Program Controller, and the magnetic tape location will be noted as applicable.

4.6 Section 6: Description of Program Logic

4.6.1 The Program Author shall provide a description of program logic demonstrating how the general problem solution method is carried out within the program. This section may contain a detailed flowchart or detailed prose specification or a self-contained Engineering Standard such as ES 117, which should reference the appropriate Program Documentation File Number (XXJAXX).

4.6.2 The Program Logic Section documentation should include the detailed mathematical method of solution. All of the mathematical techniques, equations, and algorithms used for solutions should be listed in sequence, with all equations numbered. Any auxiliary programs or external data files required for program utilization should also be listed. Related reference material should also be listed as appropriate. The Program Controller will include the Program Logic Description in the XXJAXX Program Documentation File.

4.7 Section 7: Verification Documentation

4.7.1 The Program Author is responsible for providing program verification documentation to the Program Controller for inclusion in the XXJAXX Program Documentation File. This should consist of validation information and examples to give credibility to the computer program. All sources for the mathematical models and derivations used in the program should be referenced, with assumptions and limitations clearly noted. Justification for the validity of all equations, algorithms, models, etc. used should be clearly presented. Equations should be numbered and tied to the contents of the source code and the output format. For all computer programs (except leased programs), benchmark problems should be provided for program verification, comparing results from the new program to accepted hand calculations, test results, or previously-verified computer programs. Benchmark problem sets should be run initially as well as before and after any program revisions. If the verification data is lengthy and complex, this should be presented in an Engineering Standard (for example: ES 136) for ready reference, in lieu of unassembled separate pages or sections; this Engineering Standard should reference the appropriate Program Documentation File Number (XXJAXX). The Engineering Qualification and analysis Group will assist in the verification process upon request, and will provide the independent review and check which is necessary to satisfy the requirements of Section 4, Supplement 3S-1 of ANSI/ASME NQA-1-1983.

4.7.2 The Program Controller is responsible for maintaining a continuing quality assurance (QA)check on program integrity. To accomplish this, the same benchmark problems sets used in the verification documentation noted above should be re-run at intervals of not more than one year following the last revision. In the case of leased programs, a new program input tape copy may be obtained and installed yearly in lieu of re-doing benchmark problems. The current benchmark problem output or installation log (for leased programs) should be dated and filed in Appendix A of the XXJAXX Program Documentation File; any previous problem output or installation log may be discarded after verifying that there has been no change (see Section 4.11 below).

4.8 Section 8: Input Data

A list of the input data necessary for the user to supply to the program should be furnished by the Program Author. Normally, program inputs are made in response to program prompts. However, if special input procedures or pre-input calculations are required, these should be identified. The Program Controller will incorporate the input data information provided into the XXJAXX Program Documentation File.

4.9 Section 9: Output Data/Example

4.9.1 In this section, the Program Author should include a discussion of the program output, relating input variables to the output format options and to appropriate equations in the logic and verification sections; a sample problem output should be provided. A benchmark problem or a well-defined example should be chosen as an illustration. The sample output should be re-run after each program change.

4.9.2 The output section should also include information about typical or expected computer running time and costs, so that a user can estimate job costs and execution time for particular problems.

4.10 Section 10: Installation Report

The installation report form is illustrated in Exhibit 1 of this Engineering Standard. All necessary information regarding the accessing and usage of the program is documented in this report. It is the responsibility of the Program Controller to fill out this report, submit it to the Program Author for review and include it in the XXJAXX Program Documentation File.

4.11 Appendix A: Current Benchmark Problem/Installation Log Record

This is the repository for the current program quality documentation (Benchmark Problems or Installation Log) as described in Paragraph 4.7.2 of this Engineering Standard. Superseded problems and installation logs should be discarded. This appendix may be filed as a separate book, to facilitate documentation changes.

4.12 Appendix B: Documentation File Change Records

This is the repository for the change record sheets associated with the XXJAXX Program Documentation File. When a controlled page is revised (as shown on the Standards and Specifications Cover Sheet), the old version should be marked showing the changes, and the Major Revision stamp should be applied. The reason for the change should be noted, and then the marked page should be routed for review by the checker and approver. The Program Controller or designee should check all documentation revisions, and the Manager, Engineering Qualification and Analysis should approve documentation changes, initialing the appropriate blocks on the Major Revision stamp.

These approvals constitute authority for making the documentation change and for insuring that the changes have been made as marked. All these change record sheets should be retained and filed in Appendix B, in order, so that they may be readily found. The only exception is for controlled documents such as Engineering Standards, which may be included as an integral part of the documentation files. Revision documentation provisions for these are already established, and revision records are maintained in the Fisher change record files. If an ES document included in the XXJAXX Program Documentation File has been revised, this should be noted in the Program Controller's annual review of the documentation file, and the appropriate ES revision should be noted on the documentation file Standards and Specifications Cover Sheet, as a file revision. All Program Documentation File change records should be retained in this Appendix permanently. This appendix may be filed as a separate book to facilitate documentation additions.

4.13 Appendix C: Project Records

This is the repository for the Project XXJAXX records such as the Initial Information sheet, Final Summary, Supplementary Information sheets, and project time charge and cost records, as applicable, together with any project notes or correspondence. This Appendix may be filed as a separate book to facilitate additions and changes.

5. FORMAT REQUIREMENTS FOR DATABASE DOCUMENTATION FILE

The content of the database documentation file will consist of the following sections:

(a) Section 1: Standards and Specifications Cover Sheet
(b) Section 2: Abstract
(c) Section 3: Listing
(d) Section 4: Format
(e) Section 5: Installation Report
(f) Appendix A: Documentation File Change Records
(g) Appendix B: Project Records

Most databases are for specific purposes and not for general applications, so most users will actually be the authors. It will still be necessary to prepare an abstract and provide a listing of the database (microfiche, or magnetic tape) if not already included in a documented program. A XXJAXX series file number will be assigned to the Database Documentation File also.

5.1 Section 1: Abstract

The abstract should, first of all, give the purpose for creating the database. The names and project file numbers of computer programs accessing the database should be listed. Intended use or application of the database should be discussed, and the format of the data should be briefly mentioned.

5.2 Section 2: Listing

If the database is of small to moderate size (less than 500 records of 80 character length), then a hard copy (paper) listing should be included in the documentation file. Hard copy (paper) listing is not needed for large databases, but the name and location of the magnetic tape backup should be noted in the documentation file.

5.3 Section 3: Format

In all cases, the input format for the database computer file will be identified. This may be on an individual record basis or for a group of records having varying format requirements. All of this should be clearly outlined. Whenever dimensional units are required, they should be defined.

5.4 Section 4: Installation Report

The installation report is illustrated in Exhibit 1 of this Engineering Standard. The same requirements apply to the database as to the computer program (See Paragraph 4.10: Installation Report).

5.5 Appendix A: Documentation File Change Records

This is the repository for Change Record Sheets associated with the XXJAXX Database Documentation File. The provisions of Paragraph 4.12 apply to the Database Documentation File also.

5.6 Appendix B: Project Records

This is the repository for the Project XXJAXX records as listed under Paragraph 4.13 above.

6. RESPONSIBILITY SUMMARY

6.1 General

As an aid in implementing the requirements of this standard, the following itemized summary of responsibilities is provided. In general the Program Author is responsible for program/database origination and verification, and the Program Controller is responsible for entering the program into the computer system with apropriate backup and for assembly and maintenance of the computer program file.

6.2 Program Author

(a) Program/database origination and description.
(b) Decide if ES 121 Control is to apply. (if not, no further action per ES 121). (Para. 2.2)
(c) Contact Engineering Qualification and Analysis Group for Program Controller assignment. (Para. 2.3)
(d) Provide program/database description and application summary.(Para. 2.3)
(e) Provide Source Code listing information to the Program Controller, for the program file. (Para. 4.5)
(f) Provide the Program Logic Description to the Program Controller, for the program file. (Para. 4.6)
(g) Provide verification documentation to the Program Controller for inclusion in the program file. This should include benchmark problems which the Program Controller can periodically repeat for verifying program integrity. (Para. 4.7.1)
(h) Provide the input data list and any special input data procedures or calculations for the input map documentation for inclusion in the file. (Para. 4.8)
(i) Provide the output data/example to the Program Controller for inclusions in the file. Expected computer running time should also be provided so the Program Controller can provide an estimate of computer run cost. (Para. 4.9)
(j) Review the Installation Report (Exhibit 1 to ES 121) for accuracy and completeness. (Para. 4.10)

6.3 Program Controller

(a) Obtain program/database description and application information from the Program Author. (Para. 2.3)
(b) Take out XXJAXX Series Project/File number by issuing an initial information sheet. This project number will be used to charge time spent (by the Program Author, Program Controller, and others) in program/database documentation activities per ES 121 (initial file, revisions, reviews) as long as the program/database is in active use. (Para. 2.1)
(c) Add program/database to the Engineering Qualification and Analysis Group index file. (Para. 3.2)
(d) Prepare and/or assemble data for the XXJAXX Program Documentation File (Cover sheet, Table of Contents, Abstract, JCL requirements, Source Code listing Location, Logic and Verification data, Input list, Output data and examples, expected program/database computer run cost). (Section 4)
(e) Install program/database and run initial benchmark problems or printout to confirm correct installation. (Para. 3.1, 4.7.2)
(f) Fill out Installation Report (Form 3475B) illustrated in Exhibit 1 of ES 121. Submit to the Program Author for review and include it in the XXJAXX documentation file. (Para. 4.10)
(g) Establish an annual program/database review schedule and furnish a copy to the Program Author and to the Manager, Engineering Qualification and Analysis Group. [The annual reviews will include re-runs of the benchmark problem sets to demonstrate program integrity (or installation of new program input tapes for leased programs). Also any changes in the documentation file (such as ES document revisions) will be incorporated as a XXJAXX documentation file revision] (Para. 4.7.2)
(h) Transfer the assembled XXJAXX Documentation File to the Fisher Information Center for Custody. (Para. 3.2)
(i) When a program/database becomes inactive or obsolete, fill out a final summary, and close the XXJAXX project.

7. REFERENCES

7.1 ANSI/ASME NQA-1-1983. Quality Assurance Program Requirements for Nuclear Facilities.

7.2 ANSI/ANS 10.2-1982. Recommended Programming Practices to Facilitate the Portability of Scientific Computer Programs.

7.3 ANSI/ANS 10.5-1979. Guidelines for considering User Needs in Computer Program Development.

7.4 ANSI N413-1974. Guidelines for the Documentation of Digital Computer Programs.

EXHIBIT 1
Installation Report Form

COMPUTER PROGRAM / DATA BASE INSTALLATION REPORT

Subject of Report: ☐ computer program
☐ data base

Project File No. ☐☐ J A ☐☐

Name : ____________________

Author(s) : ____________________
____

Module Name : ____________________

Origin : ☐ Fisher
☐ Monsanto
☐ other ____________

Source Code	Location
☐ microfiche	____________
☐ paper	____________
☐ mag tape	____________
☐ diskette	____________

Program Location (compiled version) :

☐ FSHLIB (ST. Louis system)
☐ VAX (Fisher Controls system)
☐ P. C. (Fisher Controls system)
☐ other ____________

Comments : ____
____
____
____

Program Author Review : ______________________ Date : ________

Program Controller Approval : ______________________ Date : ________

Form 3475B

ATTACHMENT 13

FQP-11AB-7

OPERABILITY QUALIFICATION DATA

a. BPC letter (Log BV 10286) to Fisher Controls dated 3-5-85 with BPC "Operability Qualification of Purge and Vent Valves".

b. BPC letter (Log BV 10318) to Fisher Controls dated 3-25-85 concerning operability documentation.

c. Fisher Controls memo dated 4-15-85, Whitsell to Pothast, with review of Bettis' torque values presented in the BPC "Operability Qualification of Purge and Vent Valves".

9510-AX5AC03-5151-2   327

Bechtel Power Corporation
Engineers — Constructors
12440 East Imperial Highway
Norwalk, California 90650
MAIL ADDRESS
P.O. BOX 60860 · TERMINAL ANNEX LOS ANGELES CALIFORNIA 90060
TELEPHONE (213) 807-2000

March 5, 1985

Mr. Doug Potnast
Fisher Controls, Inc.
Marshalltown, IOWA 50158

Subject: Georgia Power Company
Plant Vogtle - Units 1 and 2
Bechtel Job 9510-001
P.O. Nos. PAV-206 and PAV-34
Butterfly Valves
File: X5AC03
Log: BV 10286

References:
A. Meeting between Fisher Controls, Inc. and Bechtel Corporation on February 15, 1985 at Marshalltown, Iowa (MN-1623)
B. Bechtel Power Corporation letter to Fisher Controls, Inc., BV-10211, dated February 7, 1985

Dear Mr. Potnast:

Attached for your records is the final draft of the "Operability Qualification of Purge and Vent Valves" incorporating the information agreed upon in reference A. This satisfies the requirement for information previously requested in reference B.

If you have any questions, please contact us.

Very truly yours,

BECHTEL POWER CORPORATION

Al Lini for

H. G. Gronroos
Project Engineer
Western Power Division

FWK/NCB/WHJ/mel

Attachment: A. "Operability Qualification of Purge and Vent Valves"

xc: O. Batum w/att.
V-RMS w/att.

Operability Qualification of Purge and Vent Valves

Demonstration of operability of the containment purge and vent valves and the ability of these valves to close during a design basis accident is necessary to assure containment isolation. This demonstration of operability is required by NUREG-0737, "Clarification of TMI Action Plan Requirements," II.E.4.2 for containment purge and vent valves which are not sealed closed during operational conditions 1, 2, 3 and 4.

1. For each purge and vent valve covered in the scope of this review, the following documentation demonstrating compliance with the "Guidelines for Demonstration of Operability of Purge and Vent Valves" (Attachment 2) is to be submitted for staff review:

A. Dynamic Torque Coefficient Test Reports

(Butterfly valves only) - including a description of the test setup.

Response

Testing has been performed by the butterfly valve supplier to obtain dynamic torque coefficients. See attachment 2.

B. Operability Demonstration or In-situ Test Reports (when used)

Response

Not Applicable

C. Stress Reports

Response

The stress analysis for these valves are provided as part of the attachments.

D. Seismic Reports for Valve Assembly (valve and operator) and associated parts.

Response

The seismic reports for the valve assemblies are provided as part of the attachments.

E. Sketch or description of each valve installation showing the following (Butterfly valves only):

1. direction of flow
2. disc closure direction
3. curved side of disc, upstream or downstream (asymmetric discs)
4. orientation and distance of elbows, tees, bends, etc. within 20 pipe diameters of valve
5. shaft orientation
6. distance between valves

<u>Response</u>

See Table 1.

F. Demonstration that the maximum combined torque developed by the valve is below the actuator rating.

<u>Response</u>

YOKE ARM (DEGREES)	REQUIRED ACTUATOR TORQUE (in-lb.)	BETTIS ACTUATOR SPRING TORQUE (in-lb.)
0	3714.05	18828
10	1834.61	16628
20	2057.18	15602
30	2244.81	14268
40	3182.96	14345
50	3946.42	14952
60	6197.98	16088
70	8157.09	18845
80	11807.46	23362
90	11807.46	29640

See Table 2 and 3

2. The applicant should respond to the "Specific Valve Type Questions" (Attachment 1) which relate to his valve.

<u>Response</u>

See attachment 1.

3. Analysis, if used, should be supported by tests which establish torque coefficients of the valve at various angles. As torque coefficients in butterfly valves are dependent on disc shape, aspect ratio, angle of closure flow direction and approach flow, these things should be accurately represented during tests. Specifically, piping installations (upstream and downstream of the valve) during the test should be representative of actual field installations. For example, non-symmetric approach flow from an elbow upstream of a valve can result in fluid dynamic torques of double the magnitude of those found for a valve with straight piping upstream and downstream.

   Response

   Although testing was not performed to establish torque coefficients at various valve angles, analytical techniques used by the valve supplier are based on model testing experience and scaling developed over many years. More information is presented in attachment 2.

4. In-situ tests, when performed on a representative valve, should be performed on a valve of each size/type which is determined to represent the worst case load. Worst case flow direction, for example, should be considered.

   Response

   Not applicable. In-situ tests are not performed.

5. For two valves in series where the second valve is a butterfly valve, the effect of non-symmetric flow from the first valve should be considered if the valves are within 15 pipe diameters of each other.

   Response

   The valves are located 22'-5" and 22'-9 9/16" from each other (HV-2626B to HV-2627B and HV-2628B to HV-2629B respectively) or approximately a distance of 19 pipe diameters, which is not within the 15 pipe diameters limitation.

6. If the applicant takes credit for closure time vs. the buildup of containment pressure, he must demonstrate that the method is conservative with respect to the actual valve closure rate. Actual valve closure rate is to be determined under both loaded and unloaded conditions (if valves close faster at all angles of opening under loaded conditions, no load closure time may be used as conservative) and periodic inspection under tech. spec. requirements should be performed to assure closure rate does not increase with time or use.

Response

No credit was taken for closure time vs. the buildup of containment pressure. See attachment 2.

TABLE 1

Valve Tag Number	HV-2626B	HV2627B	HV2628B	HV2629B
1. Direction of Flow	Inlet-butt weld end outlet-raised face	Inlet-raised face outlet-butt weld end	Inlet-raised face outlet-butt weld end	Inlet-butt weld end outlet-raised face
2. Disc closure Direction	Clockwise	Clockwise	Clockwise	Clockwise
3. Curved side of disc	Upstream	Downstream	Downstream	Upstream
4. Orientation and distance of elbows, tee, bend within 20 pipe diameter of valve.	Tee-19'5" upstream, horizontal line 90° elbow-11'-6-1/4" upstream horizontal line. Tee-6'-9-11/16" upstream, vertical line. 90° elbow-2'8-11/16 upstream, vertical line. Flow orifice-23'-6-5/8 upstream, vertical line. Flow orifice-1'-10-1/4" downstream, horizontal line.	Tee-3'-0" downstream horizontal line. 90° elbow-10'-10-3/4" downstream, horizontal line. Tee-15'-7-5/16" downstream, vertical line. 90° elbow-19'-8-5/16" downstream vertical line. Flow orifice-1'-1-5/8" upstream, vertical line. Flow orifice-24'-3-1/4" downstream, horizontal line.	Tee-18'-9-9/16 upstream, horizontal line. 90° elbow-11'-9-3/4" upsream, horizontal line. Tee-3'-9-3/4" upstream, vertical line. 90° elbow-1'-8-3/4" upstream, vertical line. Flow orifice-25'-4-9/16" upstream, horizontal line. Flow orifice-1'10-1/8" downstream, horizontal line. Flow orifice-1'-10-1/8" downstream, horizontal line.	Tee-4'-0" downstream, horizontal line. 90° elbow-10'11-13/16 downstream horizontal line. Tee-16'-11'-3/16 downstream vertical line. 90° elbow-21-0-3/16" downstream, vertical line. Flow orifice-2'-7" upstream, horizontal line. Flow orifice-24'-7-10/16" downstream, horizontal line.
90 5. Shaft orientation.	Vertical	Vertical	Vertical	Vertical
6. Distance between valves.	22'-5" (between - V-2626B & 2627B)		22'-9-9/16" (between HV-2628B & 2629B)	

TABLE

```
ACTUATOR TORQUE CALCULATIONS      REV. B


REF. NO. CASE 4                          TEMP. 320 DEG F
VALVE TYPE 9280                          VALVE SIZE 14 INCH
SHAFT MAT. SA-564 H1075 31-39            BUSH. MAT. BRONZE/GRAPHITE
DISC-SHAFT CON. PINNED                   DRIVE-SHAFT CON. KEYED
FLOW DIR. TOWARD HUB
DATE 02-11-85                            BY JON C. WHITESELL

INPUT DATA

ANG            0.0        10.000        20.000        30.000        40.000        50.000        60.000        70.000        80.000        90.000

DDISC        13.244       13.244        13.244        13.244        13.244        13.244        13.244        13.244        13.244        13.244
DELTP        60.000       50.000        50.000        50.000        50.000        50.000        50.000        50.000        50.000        50.000
DLO           0.906        0.906         0.906         0.906         0.906         0.906         0.906         0.906         0.906         0.906
TS         2037.000        0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
TI            0.0          0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
DM            0.0          0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
DTF           0.0         15.400        32.000        50.000       108.000       194.000       368.000       742.000      1145.000      1145.000
DPIN         60.000       50.000        50.000        50.000        50.000        50.000        50.000        50.000        50.000        50.000
DELTPF       60.000        0.400         0.300         0.250         0.250         0.200         0.200         0.140         0.140         0.140
STSH         98.000       98.000        98.000        98.000        98.000        98.000        98.000        98.000        98.000        98.000
SBUSH        85.000       85.000        85.000        85.000        85.000        85.000        85.000        85.000        85.000        85.000
C1            0.500        0.500         0.500         0.500         0.500         0.500         0.500         0.500         0.500         0.500
C2            0.750        0.750         0.750         0.750         0.750         0.750         0.750         0.750         0.750         0.750
BSHTYP            2            2             2             2             2             2             2             2             2             2
DSHFT         1.748        1.748         1.748         1.748         1.748         1.748         1.748         1.748         1.748         1.748


GENERATED VARIABLES

ST         51450.00     51450.00      51450.00      51450.00      51450.00      51450.00      51450.00      51450.00      51450.00      51450.00
SS         25725.00     25725.00      25725.00      25725.00      25725.00      25725.00      25725.00      25725.00      25725.00      25725.00
SB          8500.00      8500.00       8500.00       8500.00       8500.00       8500.00       8500.00       8500.00       8500.00       8500.00

OUTPUT

ACT.TORQ  3714.0564    1834.6165     2057.1843     2244.8140     3182.9634     3946.4241     6197.9805     8157.0937    11807.4687    11807.4687



STRS1     8087.2656    6147.9375     6225.5703     6300.2148     6779.6562     7269.5391     9003.0859    10684.2070    13981.1289    13981.1289
STRS2     4509.1367    3166.1660     3243.7979     3318.4426     3797.8850     4287.7695     6021.3125     7702.4336    10999.3555    10999.3555
STRS3     5044.8281    2982.0837     3194.6082     3373.7705     4269.5820     4998.5898     7148.5391     9019.2461    12504.8906    12504.8906
STRS4     5490.2148    2130.3176     2555.5364     2914.0049     4706.3477     6164.9492    10466.5742    14209.4844    21183.5664    21183.5664
STRS5     4730.4961    2336.7039     2620.1831     2859.1621     4654.0593     5026.4570     7894.2109    10389.4844    15038.8750    15038.8750
STRS6     1353.6267    1128.0229     1128.0229     1128.0229     1128.0229     1128.0229     1128.0229     1128.0229     1128.0229     1128.0229
```

TABLE 2

VARIABLE NAME	VARIABLE DESCRIPTION
	INPUT DATA
ANG	ANGLE IN DEGREE
DDISC	DISC DIAMETER (UNITS: IN)
DELTP DSHFT DSHFT	PRESSURE DROP IF ITYP = 1 (UNITS: PSI) SHAFT DIAMETER IF ITYP = 2 (UNITS: IN) SHAFT DIAMETER IF ITYP = 3 (UNITS: IN)
DLO	HUB TO BUSH DISTANCE (UNITS: IN) FROM DRAWING 
TS	SEATING TORQUE (UNITS: IN-LBS)(FOR 0 DEGREE ANGLE ONLY) REFER TO TEST REPORT #92.3-44 SIZING EQUATION FOR 9200 (NEW EQUATION)
TI	INERTIAL TORQUE (UNITS: IN-LBS)(FOR FAST STROKING SPEED ONLY , LESS THAN $\frac{1}{2}$ SIG)
DM	AMOUNT OF CAM (UNITS: IN) FROM DRAWING 
DTF	DYNAMIC TORQUE FACTOR FROM SALES HANDBOOK: CFG 40B-10, C VALUES FOR 9200 SERIES, FLOW AGAINST HUB USE 1.5 C
DPIN	INLET PRESSURE (UNITS: PSIG) FROM REQUISITION IF ITYP = 3 LEAVE IT BLANK
DELTPF	EFFECTIVE PRESSURE DROP FACTOR FROM SALES HANDBOOK: CFG 40B-10, TABLE 1 (DO NOT INCLUDE P_1, ONLY COEFFICIENT)
STSH	SHAFT STRENGTH FACTOR % FROM SALES HANDBOOK: CFG 20D-10
SBUSH	BUSH. STRENGTH FACTOR % FROM SALES HANDBOOK: CFG 20D-10
C1	DISC TO SHAFT CONCENTRATION FACTOR FOR PIN = 0.5, KEY = 0.75
C2	DRIVE TO SHAFT CONCENTRATION FACTOR FOR PIN = 0.5, KEY = 0.75

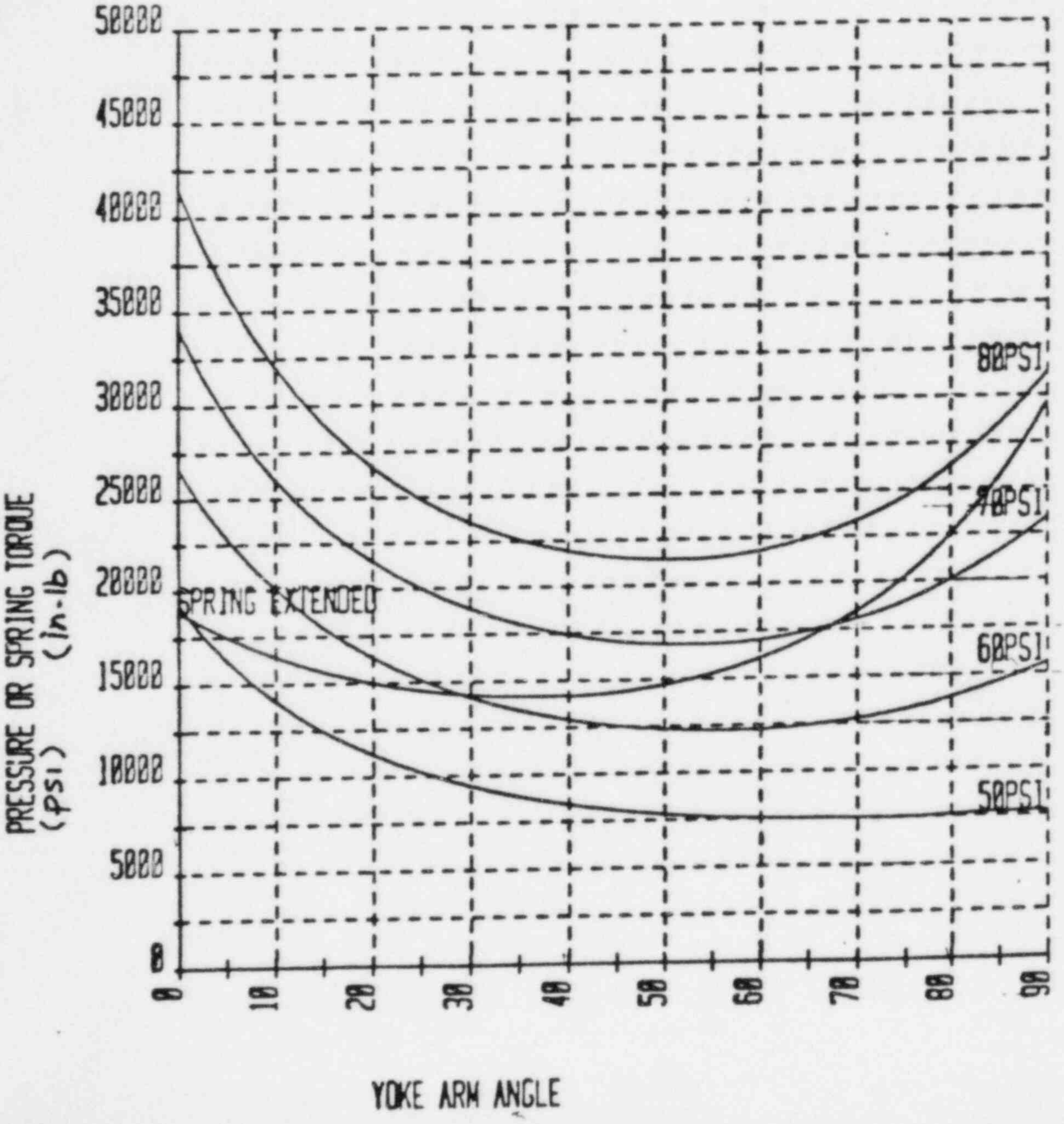
TABLE 2

VARIABLE NAME	VARIABLE DESCRIPTION
BSHTYP	BUSH.TYPE.NO. FROM SALES HANDBOOK: CFG 20D-10 NOTE: 1. ALL ARE REAL NUMBERS EXCEPT BSHTYP (BSHTYP-INTEGER) 2. REPEAT CARDS 2 THROUGH 3 FOR NUMBER OF SHAFT CALCULATIONS 3. REPEAT CARDS 3A AND 3B FOR NUMBER OF ANGLES FOR EACH SHAFT CALCULATION .

TABLE 3

T316 SR2

YOKE ARM ANGLE (degrees)	SPRING TORQUE (in lb)	PRESSURE TORQUE (50)psi	PRESSURE TORQUE (60)psi	PRESSURE TORQUE (70)psi	PRESSURE TORQUE (80)psi
0	18828	19187	26587	33986	41386
15	15602	12435	17949	23463	28977
30	14268	9444	14147	18851	23554
45	14394	8053	12542	17031	21521
60	16088	7532	12300	17069	21837
75	20224	7572	13256	18941	24625
90	29640	7778	15600	23422	31245.



ATTACHMENT 1

SPECIFIC VALVE TYPE QUESTIONS AND RESPONSES FOR VEGP PURGE VALVES

Operability Qualification of Purge and Vent Valves

Specific Valve Type Questions

The following questions apply to specific valve types only and need to be answered only where applicable. If not applicable, state so.

A. Torque Due to Containment Backpressure Effect (TCB)

For those air operated valves located inside containment, is the operator design of a type that can be affected by the containment pressure rise (backpressure effect) i.e., where the containment pressure acts to reduce the operator torque capability due to TCB. Discuss the operator design with respect to the air vent and bleeds. Show how TCB was calculated (if applicable).

<u>Response</u>

a. The valves are equipped with BETTIS NT316B-SR2-M3 spring-return actuators. The spring side of the cylinder actuator is vented to the local ambient conditions; if the pressure side is vented (through the solenoid) to the same local ambient conditions, no pressure differential will exist across the cylinder as a result of surrounding local pressure rise. The spring will still drive the actuator to the safety-mode (closed) position and maintain that position as long as the solenoid remains de-energized and as long as no subsequent re-opening signal is received.

In the event of a delay in solenoid de-energization, a local ambient pressure rise will reduce the ΔP across the cylinder, which will initially partially close the valve. When the solenoid subsequently de-energizes and vents, the spring would complete the closure stroke.

b. In the event the external ambient pressure is maintained at an elevated level for a prolonged period with the solenoid still energized, and providing the regulator is vented to the same ambient level with a sufficiently high supply, the regulator would eventually adjust the air supply to the cylinder actuator to re-establish the initial full-open position.

c. Adequate spring-driven torque output is available from the actuator to control the valve from any open or closed position (regardless of external ambient pressure), providing the cylinder casing is vented (locally). The torque available is well within the capabilities of the NT316B-SR2-M3.

B. Where air operated valve assemblies use accumulators as the fail safe feature, describe the accumulator air system configuration and its operation. Discuss active electrical components in the accumulator system, and the basis used to determine their qualification for the environmental conditions experienced. Is this system seismically designed? How is the allowable leakage from the accumulators determined and monitored?

Response - Not Applicable.

C. For valve assemblies requiring a seal pressurization system (inflatable main seal), describe the air pressurization system configuration and operation including means used to determine their qualification for the environmental condition experienced. Is this system seismically designed?

Response - Not Applicable.

D. Where electric motor operators are used to close the valve has the minimum available voltage to the electric operator under both normal or emergency modes been determined and specified to the operator manufacturer to assure the adequacy of the operator to stroke the valve at accident conditions with these lower limit voltages available? Does this reduce voltage operation result in any significant change in stroke timing? Describe the emergency mode power source used.

Response - Not Applicable.

E. Where electric motor and air operator units are equipped with handwheels, does their design provide for automatic re-engagement of the motor operator following the handwheel mode of operation? If not, what steps are taken to preclude the possibility of the valve being left in the handwheel mode following some maintenance, test, etc. type operation?

Response - Not Applicable.

F. For electric motor operated valves have the torques developed during operation been found to be less than the torque limiting settings?

Response - Not Applicable.

ATTACHMENT 2

VEGP DEMONSTRATION OF OPERABILITY OF PURGE AND VENT VALVES

Guidelines for Demonstration of Operability of Purge and Vent Valves

Operability

In order to establish operability, it must be shown that the valve actuator's torque capability has sufficient margin to overcome or resist the torques and/or forces (i.e., fluid dynamic, bearing, seating, friction) that resist closure when stroking from the initial open position to full seated (bubble tight) in the time limit specified. This should be predicted on the pressure(s) established in the containment following a design basis LOCA. Considerations which should be addressed in assuring valve design adequacy include:

1. Valve closure rate versus time - i.e., constant rate or other.

Response

In the case of a cylinder, spring-return actuator (such as the BETTIS NT316B-SR2-M3, Push Down to Open), full travel is achieved at a cylinder pressure of approximately 60 psig. Cylinder pressurization up to 60 psig is done to provide the maximum torque capability (hold-open torque) at 90 travel. Therefore the spring will not start to move the valve shaft linkage until some cylinder pressure bleed-down through the solenoid occurs (when the solenoid is de-energized).

When calculations were done to determine the allowable P at open angles, the assumption was made that the peak containment pressure (50 psig) was present immediately at the onset of the LOCA accident condition. This is a conservative approach since the buildup from ambient to 50 psig has been specified to occur in 5 seconds. No time-history study was made, since maximum conditions were assumed at the onset.

The Type NT316B-SR2-M3 actuator cylinder pressurized volume has to be expelled through a 3/4" NPT connection (Cv=7.5) connected to a NP831674E solenoid, in order for closure action to occur. There is minimal restriction in the solenoid (Cv=5.5), so that the pressure line to the actuator is immediately vented when the normally closed solenoid is de-energized upon receipt of the closure (safety-mode) signal .

Production valve stroking times were demonstrated as required (for each valve assembly) prior to shipment. At this point, the best stroking time data could be obtained by timing the installed valve assemblies during a field stroking test, conducted at the plant site.

When stroking time calculations or testing is done, lag times due to cylinder overpressure venting are considered and included when supplying stroking data, i.e. the closure/opening times are noted from the time the solenoid signal is received, not from the time the actuator starts to move.

2. Flow direction through valve; P across valve.

Response

Peak containment (LOCA) pressure (50 psig, @ 320°F) was used in determining the fluid conditions across the valve at all open angles of rotation (10° to 90°). P across the valve was considered equal to peak containment pressure (PSIG). Material properties were evaluated at peak containment temperatures. The effect of compressible flow in sizing Fisher butterfly valves is best explained by the following:

AIR VS WATER SERVICE

> Whenever a Fisher butterfly valve is in a gas flow application, the effects due to compressible flow are taken into consideration while determining the dynamic torque effects for each individual valve selection. This consideration is built into our valve selection procedures and requires a conscious liquid or gas decision in calculating the effective pressure drop of wich the dynamic torque is a function.
>
> Fisher's philosophy concerning the effects of compressible flow on butterfly valves is presented in ISA Transactions, Vol. 8, No. 4 entitled, "Effect of Fluid Compressibility on Torque in Butterfly Valves", written by Floyd P. Harthun (Manager, Product Evaluation, Fisher Controls Co. (Attachment 4).

3. Single valve closure (inside containment or outside containment valve) or simultaneous closure. Establish worst case.

Response

No credit is taken for reduced pressure due to valves in series. Vogtle valves are designed for the maximum in-containment pressure.

4. Containment back pressure effect on closing torque margins of air operated valve which vent pilot air inside containment.

Response

See response to Item A in attachment 1.

5. Adequacy of accumulator (when used) sizing and initial charge for valve closure requirements.

Response - Not Applicable.

6. For valve operators using torque limiting devices - are the settings of the devices compatible with the torques required to operate the valve during the design basis condition.

Response - Not Applicable.

7. The effect of the piping system (turns, branches) upstream and downstream of all valve installations.

<u>Response</u>

All Fisher sizing data is based on dynamic torque determination tests which were performed with uniform flow profiles and on valve discs with representative geometries. The effects of a non-uniform flow profile, due to piping elbows, "T"-connections, etc., upstream, are discussed below.

The concern over geometrical piping system effects is relevant, since Fisher typically sizes butterfly valves assuming a uniform < line [illegible] could produce a non-uniform flow as illustrated by Figure A of Attachment 3.

a. <u>Valve/Flow Orientation, Figure A</u>

The plant layout is such that the valve is oriented to the flow as depicted in Fig. A (Attachment 3), the non-uniform fluid profile will not produce an additional torque on the valve disc since both "wings" of the disc (as split by the shaft) will be subjected to the same flow with respect to time.

8. The effect of butterfly valve disc and shaft orientation to the fluid mixture egressing from the containment.

<u>Response</u>

See Item No. 7 response above.

Demonstration

Demonstration of the various aspects of operability of purge and vent valves may be by analysis, bench testing, in-situ testing or a combination of these means.

Purge and vent valve structural elements (valve/actuator assembly) must be evaluated to have sufficient stress margins to withstand loads imposed while valve closes during a design basis accident. Torsional shear, shear, bending, tension and compression loads/ stresses should be considered. Seismic loading should be addressed.

Once valve closure and structural integrity are assured by analysis, testing or a suitable combination, a determination of the sealing integrity after closure and long term exposure to the containment environment should be evaluated. Emphasis should be directed at the effect of radiation and of the containment spray chemical solutions on seal material. Other aspects such as the effect on sealing from outside ambient temperatures and debris should be considered.

The following considerations apply when testing is chosen as a means for demonstrating valve operability:

Bench Testing

A. Bench testing can be used to demonstrate suitability of the in-service valve by reason of its traceability in design to a test valve. The following factors should be considered when qualifying valves through bench testing.

   1. Whether a valve was qualified by testing of an identical valve assembly or by extrapolation of data from a similarly designed valve.

   #### Response

   In determining allowable pressure drops across a particular butterfly valve at various angles of the disc, Fisher Controls uses classical "mechanics of materials" type equations to calculate stress levels at various worst-case locations in the valve assembly (specifically, various locations along the valve shaft). The approach to the analysis, the equations used, and the combination of the calculated stresses all make up a portion of Fisher's design philosophy for butterfly valves. This analysis approach addresses all of the different states of shear and stress which are applicable to the loading conditions defined.

   Establishing the loads that actually exist makes up the remaining portion of our design philosophy for butterfly valves. These loads range from easily calculated loads, such as bending due to pressure differential across the disc, to loads such as packing and dynamic torques which require a certain amount of testing combined with scaling in order to analyze all valve sizes. It is the factor of dynamic torque that produces different stresses at different disc rotations and disc geometries. Through testing and scaling, Fisher has produced dynamic torque factors for incremental disc rotations.

The model tests used to establish the dynamic torque values used in sizing were conducted using 4" and 6" test valves with various aspect ratios ranging from 2:1 to 14:1 (such as 3:1, 4:1, 5:1, 8:1, 11:1, and 14:1). The dimensionless aspect ratio (defined as the ratio of the disc diameter to the hub diameter) was judged to be a significant parameter for evaluation of dynamic torques at various opening angles. The tests were conducted using the Fluid Controls Institute (FCI) specifications for test arrangement and conduct, per FCI paper 58-2.

No published data is available describing the precise scaling procedure used in establishing the sizing tables. However, the general approach is described in some detail in ISA Transactions, Vol. 8, No. 4, "Effects of Fluid Compressibility on Torque in Butterfly Valves" (Attachment 4). All of the testing, scaling and analytical results referenced above have been compiled and tabulated for all available valve sizes, classes, and materials, making it relatively easy to determine the allowable pressure drops, torque requirements, and capacities for specific constructions.

2. Whether measures were taken to assure that piping upstream and downstream and valve orientation are simulated.

<u>Response</u>

No credit was taken for downstream back pressure on the design of these valves. All design constraints for upstream piping provided by the valve supplier are factored into the system design.

3. Whether the following load and environmental factors were considered

   a. Simulation of LOCA
   b. Seismic loading
   c. Temperature soak
   d. Radiation exposure
   e. Chemical exposure
   f. Debris

Response

Simulation of LOCA, seismic loading, temperature soak, radiation exposure, and chemical exposure are delineated in Fisher Qualification Report FQP-11A. Debris was not considered because debris screens have been provided upstream of the valves to prevent debris from interfering with valve closure. Seismic loading is supplemented by seismic analysis, resonant frequency search testing, and seismic static loading of a Vogtle production valve.

B. Bench testing of installed valves to demonstrate the suitability of the specific valve to perform its required function during the postulated design basis accident is acceptable.

1. The factors listed in Items A.2 and A.3 should be considered when taking this approach.

Response - Not Applicable.

In-Situ Testing

In-situ testing of purge and vent valves may be performed to confirm the suitability of the valve under actual conditions. When performing such tests, the conditions (loading, environment) to which the valve(s) will be subjected during the test should simulate the design basis accident.

NOTE: Post test valve examination should be performed to establish structural integrity of the key valve/actuator components.

Response - Not Applicable.

Attachment 3: Piping System Sketches, Figures A and B

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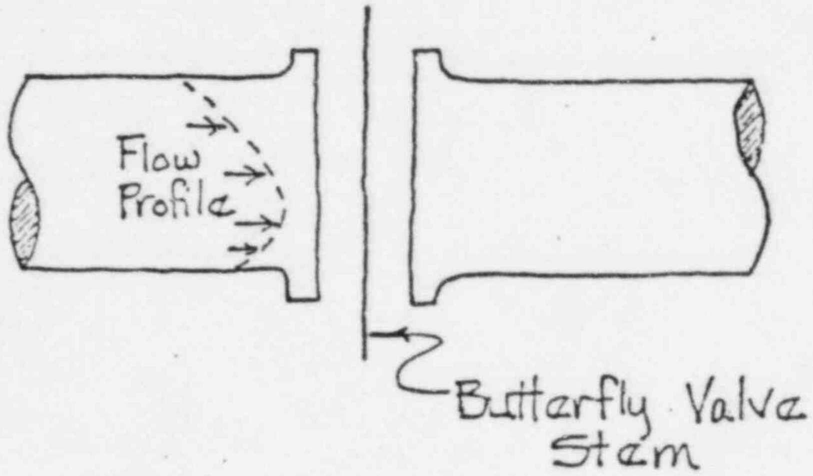

FIGURE A

Attachment 4: ISA TRANSACTIONS, Vol. 8, No. 4,
"Effects of Fluid Compressibility
on Torque in Butterfly Valves"

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Volume 8, Number 4

1969

ISA TRANSACTIONS

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of
AMERICA

Effect of Fluid Compressibility on Torque in Butterfly Valves

FLOYD P. HARTHUN

Compliments of Fisher Controls Company

ISA TRANSACTIONS 8 (281-286) 1969

Effect of Fluid Compressibility on Torque in Butterfly Valves*

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Fisher Governor Company
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▶ A technique is presented by which the shaft torque resulting from fluid flow through butterfly valves can be determined with reasonable accuracy for both compressible and incompressible flow. First, the general torque relationship for incompressible flow is established. Then, an effective pressure differential is defined to extend this relationship to include the effect of fluid compressibility. The application of this technique showed very good agreement with experimental test results.

INTRODUCTION

THE APPLICATION of butterfly valves in various automatic control systems requires proper actuator sizing for efficient control. Thus, a thorough knowledge of the fluid reaction forces acting on the valve disc is required. Extensive experimental work$^{(1)}$ has been performed in the past to establish a relationship to determine these forces and thus determine the resultant shaft torque. The general form of this relationship has been established and confirmed. However, by using the classical fluid momentum approach, a similar relationship can be obtained in which the torque is shown to be directly proportional to the measured valve pressure differential for a given disc position. This relationship along with most of the previously published torque information is adequate for incompressible flow. Although the effect of fluid compressibility on torque has been recognized, no useful relationship has been developed. The primary objective of this investigation is to extend the established torque relationship to include the effect of fluid compressibility.

DEVELOPMENT OF GENERAL TORQUE RELATIONSHIP

The total shaft torque required to operate butterfly valves can be separated into two major components:

1. Dynamic torque—that portion of the total operating torque attributable to the fluid reaction force of the flowing medium acting on the valve disc.
2. Friction torque—that portion of the total operating torque attributable to friction in the packing and bushings.

Since each of these components is independent of the other, a separate evaluation of each component affords the best approach to this problem. This investigation is limited to an evaluation of the dynamic torque component. If the friction on the valve shaft is assumed to be independent of direction of rotation, it can be readily isolated. The torque required to rotate the valve disc is measured in a clockwise and a counterclockwise direction through full travel. Since friction always opposes motion the difference between these values will be twice the actual shaft friction.

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*Presented at the 1968 ISA Annual Conference; revised August, 1969.

†Research Engineer.

The dynamic torque for butterfly valves is a function of the fluid reaction forces acting on the valve disc. It would be difficult to determine these forces by purely analytical techniques. Experimental determination of the pressures and velocity profiles in the immediate area of the disc would also be quite difficult. However, if a control volume is selected so the boundaries are points of known pressure and velocity, an analysis of these forces can be made from the change in fluid momentum through this control volume.

INCOMPRESSIBLE FLOW

An expression for dynamic torque is developed assuming incompressible flow. This torque is a function of the fluid reaction force, F, and a moment arm, D, which is a characteristic dimension of the valve disc.

$$T_D = f(F, D) \tag{1}$$

Using the fluid momentum approach, the force, F, is given by:

$$F = M\Delta V \tag{2}$$

where

F = sum of external forces acting on fluid
M = mass flow rate
ΔV = fluid velocity change through the control volume

The mass flow rate, M, is given by

$$M = \rho A V \tag{3}$$

By using a proportionality constant, B_1, the mass flow rate can also be defined as

$$M = B_1 A(\rho \Delta P)^{1/2} \tag{4}$$

Equations (3) and (4) are combined to obtain the following expression for fluid velocity:

$$V = B_1(\Delta P/\rho)^{1/2} \tag{5}$$

The velocity change through the control volume, ΔV, in Equation (2) can be expressed in terms of the velocity at the valve disc by use of a proportionality constant, B_2

$$F = B_2 M V \tag{6}$$

By substituting the expressions for mass flow rate Equation (4) and fluid velocity Equation (5) into Equation (6) the force on the valve disc is

$$F = B_1{}^2 B_2 A \Delta P \tag{7}$$

For a given valve size, the flow area, A, for any angle of disc rotation, θ, can be written as

$$A = B_\theta \frac{\pi D^2}{4} \tag{8}$$

The force, F, acts upon a moment arm which is a function of the disc diameter, D. Now, the dynamic torque can be written as

$$T_D = B_3 F D \tag{9}$$

Combining Equations (7), (8), and (9)

$$T_D = \frac{B_1{}^2 B_2 B_3 B_\theta \pi D^3 \Delta P}{4} \tag{10}$$

or

$$T_D = K_1 D^3 \Delta P \tag{10-A}$$

where

$$K_1 = \frac{B_1{}^2 B_2 B_3 B_\theta \pi}{4} = \frac{T_D}{D^3 \Delta P} \tag{10-B}$$

Equation (10-B) is defined as the dimensionless torque coefficient which can be determined experimentally from tests conducted with incompressible flow.

COMPRESSIBLE FLOW

The dynamic torque for butterfly valves is proportional to the mass flow rate and velocity change through a selected control volume for both compressible and incompressible flow (i.e., $T_D \propto M\Delta V$). Therefore, the approach used to obtain an expression for this torque assuming incompressible flow can be extended to compressible flow by re-defining these two variables.

First, assume that the velocity at the valve disc, V_d, is proportional to the velocity change through the control volume. Then, the dynamic torque can be expressed as

$$T_D \propto M V_d \tag{11}$$

The velocity at the valve disc is given by

$$V_d = \frac{M}{\rho_d A} \tag{12}$$

By combining Equations (11) and (12) the dynamic torque is shown to vary directly as the square of the mass flow rate and inversely with the fluid density at the valve disc.

$$T_D \propto \frac{M^2}{\rho_d} \tag{13}$$

Determining the flow rate of a compressible fluid through a control valve by analytical techniques is quite difficult because of valve geometry. The major problem is to establish the pressure differential between the valve inlet and the vena contracta. However, by defining the physical system in which the valve is installed to conform with specifications given by the Fluid Controls Institute (FCI),[2] empirical relationships developed specifically for determining flow rate for control valves can be considered. Several such empirical relationships have been developed; however, only one, the Universal Gas Sizing Equation,[3] has been shown to accurately define the flow rate for any valve configuration. This equation is given by

$$Q = \sqrt{\frac{520}{GT}} P_1 C_1 C_2 C_v \sin\left[\frac{59.64}{C_1 C_2}\sqrt{\frac{\Delta P}{P_1}}\right]_{rad} \tag{14}$$

Equation (14) can be rewritten to obtain an equivalent expression for mass flow rate,

$$M = 1.06\sqrt{\rho_1 P_1}C_1C_2C_v \sin\left[\frac{59.64}{C_1C_2}\sqrt{\frac{\Delta P}{P_1}}\right]_{\text{rad}} \qquad (15)$$

The sine function in Equations (14) and (15) is used to define the transition between incompressible flow occurring at low pressure ratios ($\Delta P/P_1$) and critical flow.

Let

$$\theta = \left[\frac{59.64}{C_1C_2}\sqrt{\frac{\Delta P}{P_1}}\right]_{\text{rad}} \qquad (16)$$

Rewriting Equation (15) in the following manner:

$$M = 1.06\sqrt{\rho_1 P_1}C_1C_2C_vF \qquad (17)$$

The factor, F, is bounded by the following:

$$\begin{aligned} F &= \sin\theta \quad &\text{for } \theta < \pi/2 \\ F &= 1.0 \quad &\text{for } \theta \geq \pi/2 \end{aligned} \qquad (18)$$

By substituting Equation (17) for the mass flow rate in Equation (13), the dynamic torque for a given valve is given by

$$T_D \propto \frac{\rho_1 P_1(C_1C_2 \sin\theta)^2}{\rho_d} \qquad (19)$$

The only parameter in Equation (10) that cannot be readily obtained is the density at the valve disc, ρ_d. Assuming that the change in the ratio of fluid density at the valve inlet to fluid density at the valve disc with increasing pressure ratio is small relative to the total change in mass flow rate, the torque expression can be simplified in the following manner:

$$T_D \propto P_1(C_1C_2 \sin\theta)^2 \qquad (20)$$

Therefore, for compressible flow:

$$T_D = K_2P_1(C_1C_2 \sin\theta)^2 \qquad (21)$$

For small values of pressure ratio ($\Delta P/P_1$) Equation (21) reduces to the incompressible torque relationship given by Equation (10-A).

As $\Delta P/P_1 \to 0$

$\sin\theta = \theta$ (radians)

$$T_D = K_2\,(59.64)^2\Delta P \qquad (22)$$

The expression in Equation (22) is equivalent to the expression in Equation (10-A):

$$K_2(59.64)^2\Delta P = K_1D^3\Delta P$$

$$K_2 = \frac{K_1D^3}{(59.64)^2} \qquad (23)$$

By substituting the expression in Equation (23) for the coefficient K_2 in Equation (21), a general expression for dynamic torque for compressible flow is obtained using the dimensionless torque coefficient established for incompressible flow.

$$T_D = K_1D^3P_1\left[\frac{C_1C_2}{59.64}\right]^2 \sin^2\theta \qquad (24)$$

For convenience the form of Equation (24) is simplified,

$$T_D = K_1D^3\Delta P_e \qquad (25)$$

where

$$\Delta P_e = P_1\left[\frac{C_1C_2}{59.64}\right]^2 \sin^2\theta \qquad (26)$$

Equation (26) is defined as the pressure differential contributing to the dynamic torque on butterfly valves with conditions of compressible flow.

EXPERIMENTAL RESULTS

The first step in the experimental evaluation was to establish the dimensionless torque coefficient, K_1, as a function of valve disc rotation as defined by Equation (10-B). A test was conducted on a 4-in. valve under the following controlled conditions:

1. The valve was installed in a 4-in. test line with a minimum of 12 pipe diameters of straight pipe upstream.
2. The pressure taps were located according to FCI specifications and attached to the test line according to specifications in the *ASME Power and Test Code*.[4]
3. Water at ambient temperature was used as the flowing medium.
4. The inlet pressure and outlet pressure were held constant.
5. The test was conducted at a low pressure ratio ($\Delta P/P_1 = 0.088$) to ensure incompressible flow.

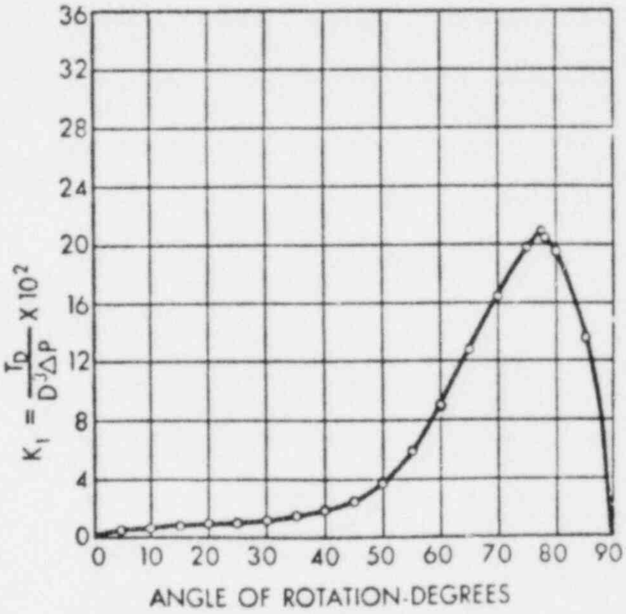

Figure 1. Dimensionless torque coefficient, 4-in. butterfly valve incompressible flow: $P_1 = 100$ psig, $P = \Delta 10$ psi.

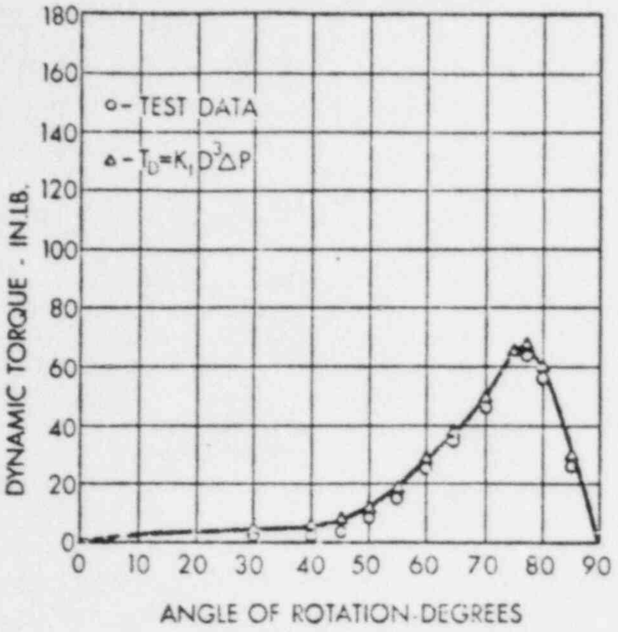

Figure 2. Dynamic torque vs. angle of disc rotation, 4-in. butterfly valve, comparison of experimental results with calculated torque, incompressible flow: $P_1 = 100$ psig, $\Delta P = 5$ psi.

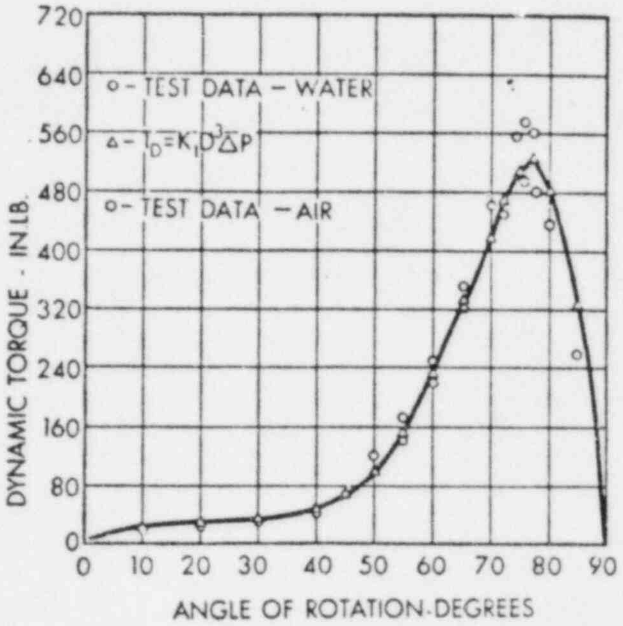

Figure 4. Dynamic torque vs. angle of disc rotation, 8-in. butterfly valve, comparison of experimental results with calculated torque, incompressible flow: $P_1 = 100$ psig, $\Delta P = 5$ psi.

Torque measurements were made at selected increments of disc rotation (0-90°). A transducer, consisting of a steel bar with strain gages attached, was fixed to the valve shaft and used in conjunction with an oscillograph to measure and record the shaft torque. The data from this test were used to determine the dimensionless torque coefficient plotted as a function of disc rotation on Figure 1. The curves plotted on Figure 2 show excellent agreement between measured torque and the torque calculated using this coefficient.

The next step was to verify that the torque coefficient is indeed applicable to other valve sizes provided geometric similarity is reasonably well maintained. The results on Figures 3 and 4 again show very good agreement between measured torque and calculated torque for two 8-in. valves.

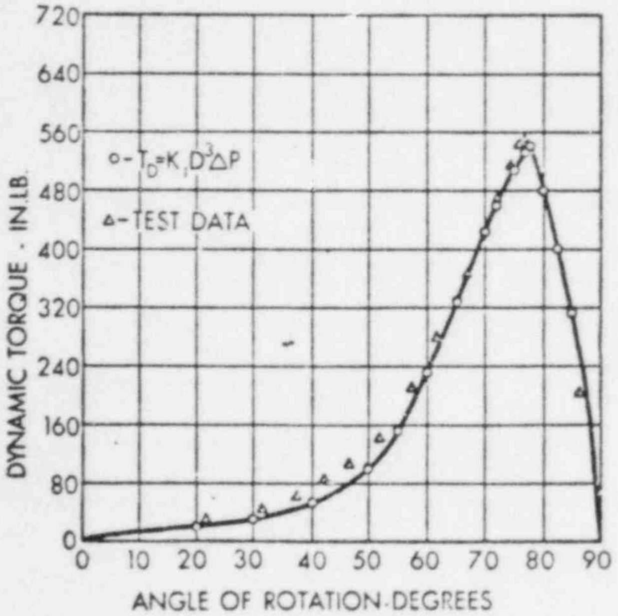

Figure 3. Dynamic torque vs. angle of disc rotation, 8-in. butterfly valve, comparison of experimental results with calculated torque, incompressible flow: $P_1 = 100$ psig, $\Delta P = 5$ psi.

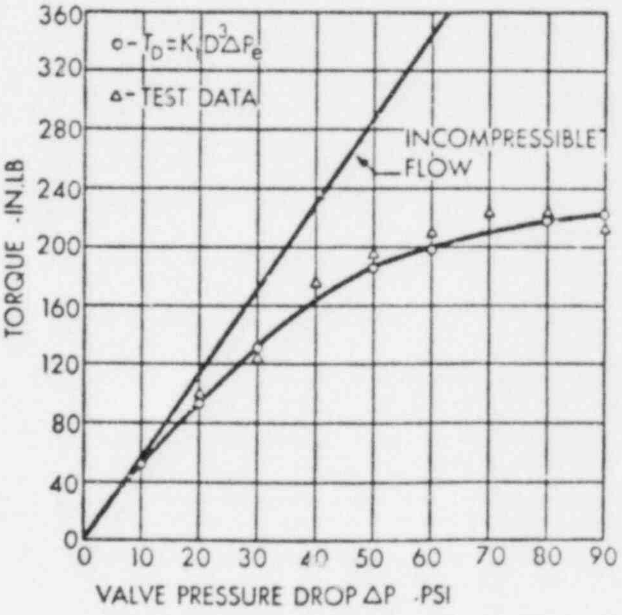

Figure 5. Dynamic torque vs. valve pressure drop, 4-in. butterfly valve, 60° disc rotation, comparison of experimental results with calculated torque, compressible flow: $P_1 = 214.4$ psia, flowing medium = air.

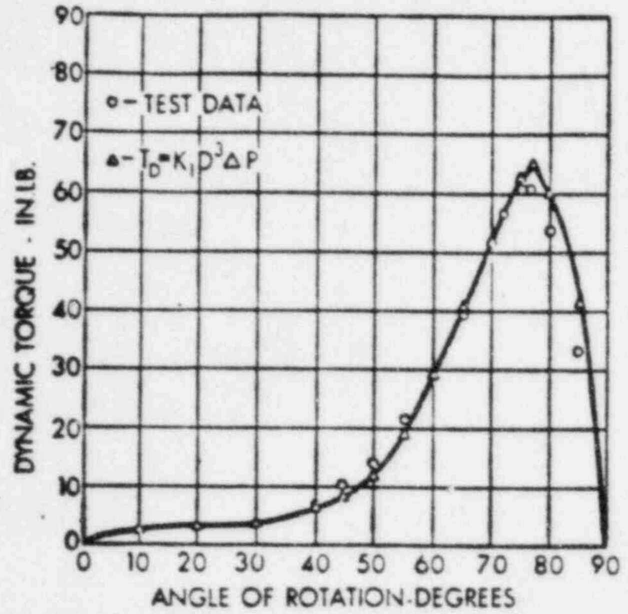

Figure 6. Dynamic torque vs. angle of disc rotation, 4-in. butterfly valve, comparison of experimental results with calculated torque, compressible flow: P_1 = 114.4 psia, ΔP = 5 psi ($\Delta P/P_1$ = 0.0446), flowing medium = air.

It should be noted that discs in the two 8-in. valves were of substantially different geometric shape. Using the ratio of disc diameter to hub diameter as an indicator, these ratios were 4.56 : 1 and 3.55 : 1 for the valves used to obtain the data for Figures 3 and 4, respectively. The difference in torque magnitude for these valves with a 5 psi pressure differential shown in Figures 3 and 4 is the result of this difference in geometry. The disc in the 8-in. valve used for the test in Figure 3 was geometrically similar to the disc in the 4-in. test valve used to establish the torque coefficient, K_1.

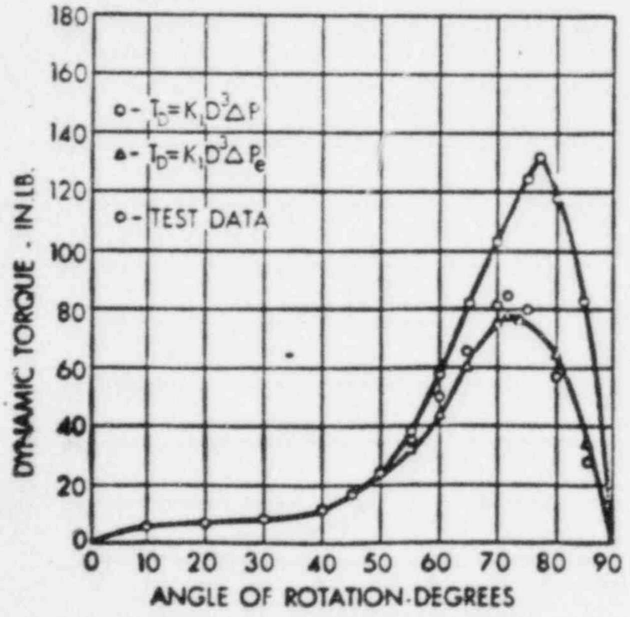

Figure 7. Dynamic torque vs. angle of disc rotation, 4-in. butterfly valve, comparison of experimental results with calculated torque, compressible flow: P_1 = 64.4 psia, ΔP = 10 psi ($\Delta P/P_1$ = 0.115), flowing medium = air.

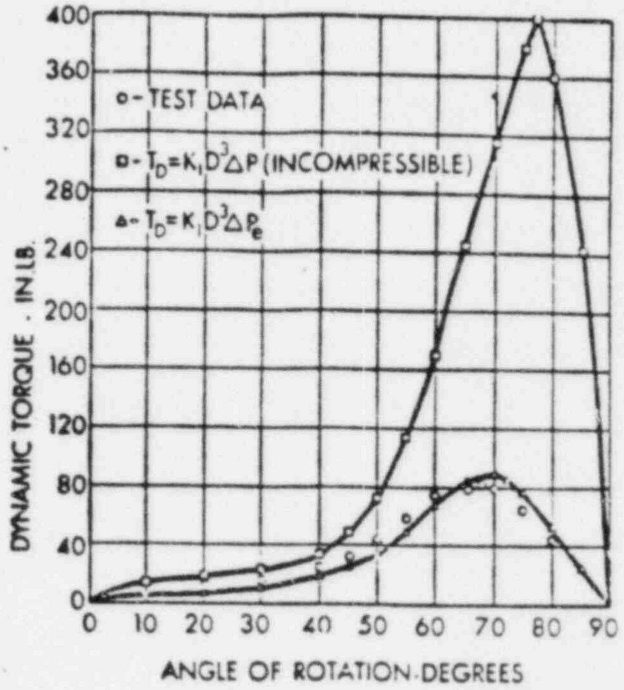

Figure 8. Dynamic torque vs. angle of disc rotation, 4-in. butterfly valve, comparison of test results with calculated torque, compressible flow: P_1 = 64.4 psia, ΔP = 30 psi ($\Delta P/P_1$ = 0.466), (critical flow) flowing medium = air.

The extension of the dynamic torque relationship to include the effect of fluid compressibility is accomplished by defining an effective pressure differential as shown in Equation (25). The curves on Figure 5 show the transition from incompressible flow to critical flow with increasing pressure ratio for a 4-in. valve set at 60° disc rotation. Here again there is very good agreement between the torque calculated using Equation (24) and the experimental results. The incompressible torque curve is also shown on Figure 5 to emphasize the effect of fluid compressibility.

The curves on Figures 6 through 8 are presented to compare experimental results with torque calculated using Equation (24) for full 90° disc rotation. At low pressure ratios, the torque using air as the flowing medium is essentially equal to the torque for incompressible flow (Figure 6). As the pressure ratio is increased, the effect of fluid compressibility becomes more pronounced as shown in Figure 7. Once critical flow has been attained, no further increase in torque is realized by increasing the valve pressure differential as shown on Figure 8.

CONCLUSIONS

A technique is presented which can be used to determine the dynamic torque for butterfly valves with reasonable accuracy. The basic torque relationship developed for incompressible flow is extended to include the effect of fluid compressibility. The method presented is developed using the Universal Gas Sizing Equation to define an effective pressure differential for the transition from incompressible flow to critical flow. Application of this method shows excellent agreement with experimental test results.

NOTATION

A = Flow area, in.^{2}
$B_1, B_2,$
B_3, B_4 = Constants of proportionality
C_1 = C_g/C_v
C_2 = Correction factor for variation in specific heat ratio
C_g = Gas sizing coefficient
C_v = Flow coefficient
D = Nominal valve diameter, in.
F = Force, lb
G = Specific gravity
K_1 = Dimensionless torque coefficient
M = Mass flow rate, lb/s
P_1 = Inlet pressure, psia
ΔP = Valve pressure differential, psi
ΔP_e = Pressure differential affecting dynamic torque
Q_i = Flow rate incompressible fluid, scfh
Q_c = Flow rate compressible fluid, scfh
T = Absolute temperature, °R
T_D = Dynamic torque, in. lb
V = Fluid velocity, in./s
ρ_1 = Fluid density at upstream pressure tap, lb/in.^{3}
ρ_d = Fluid density at valve disc, lb/in.^{3}

REFERENCES

1. Keller, I. C., and Salzmann, I. F. January 1936. "Aerodynamic Model Tests on Butterfly Valves." *Escher-Wyss News* 9.
2. *Recommended Voluntary Standards for Measurement Procedure for Determining Control Valve Flow Capacity*. 1958. Fluid Controls Institute, Inc., paper FCI 58-2.
3. Buresh, J. F., and Schuder, C. B. October 1964. "The Development of a Universal Gas Sizing Equation for Control Valves." *ISA Trans.* 3:322-328.
4. *Flow Measurement: Instruments and Apparatus. Supplement to the ASME Power Test Codes.* ASME report PTC 19.5, 4-1959.

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TELEPHONE (213) 807-2000

March 25, 1985

Mr. Doug Pothast (Vendor)
Fisher Controls, Inc.
Marshalltown, Iowa 50158

Subject: Georgia Power Company
Plant Vogtle Units 1 and 2
Bechtel Job 9510
Butterfly Valves
P.O. Nos. PAV206 and PAV234
File: X5AC03
Log: BV 10318

Reference: Meeting between Fisher Controls, Inc. and Bechtel Corp. on Feb. 15, 1985 at Marshalltown, Iowa (MN-1623)

Dear Mr. Pothast:

Attached is a better quality copy of Bettis Actuator Torque Data.

Please remove table 3, from the "Operability Qualification of Purge and Vent Valves", and replace with the attached better copy of Torque Data.

We are requesting Fisher to submit an original signed document to support the figures interpolated by Bechtel. Your prompt attention to this matter will be appreciated.

If you have any questions, please contact us.

Very truly yours,

BECHTEL POWER CORPORATION

Al Lim for
H. G. Gronroos
Project Engineer
Western Power Division

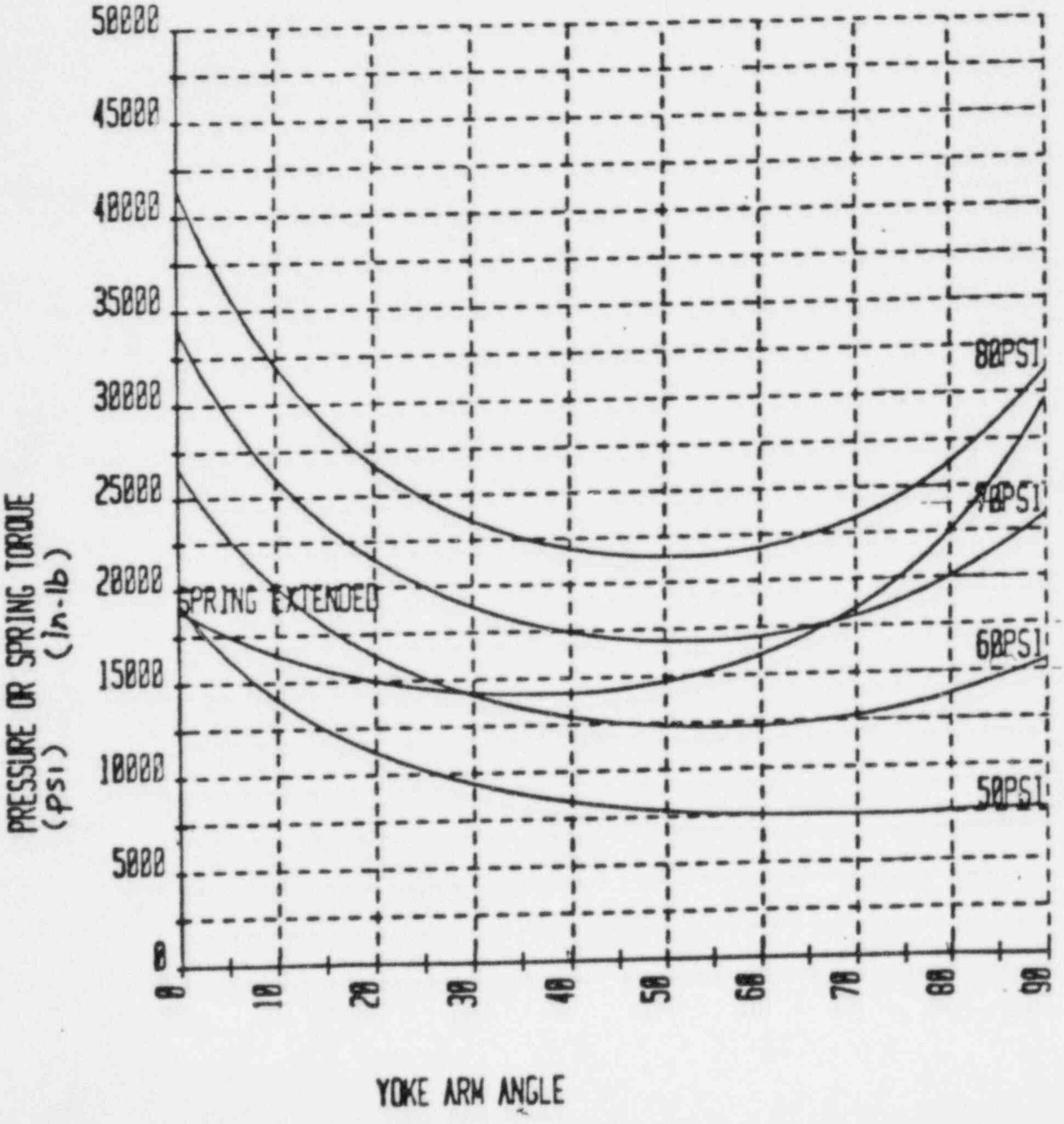
NCB/WHJ/cb
Attachments: Bettis Actuator Torque Data, Table 3.

xc: O. Batum, w/att.
VRMS, w/att.

TABLE 3

T316 SR2

YOKE ARM ANGLE (degrees)	SPRING TORQUE (in lb)	PRESSURE TORQUE (50)psi	PRESSURE TORQUE (60)psi	PRESSURE TORQUE (70)psi	PRESSURE TORQUE (80)psi
0	18828	19187	26587	33986	41386
15	15602	12435	17949	23463	28977
30	14268	9444	14147	18851	23554
45	14394	8053	12542	17031	21521
60	16088	7532	12300	17069	21837
75	20224	7572	13256	18941	24625
90	29640	7778	15600	23422	31245.



ATTACHMENT 6

Includes: Fisher (G. H. Bettes Qualification Test)
Report 37274

(BPC Log # X5AC03-5093-4)

DOC. #16 ~~2~~

ATTACHMENT 6

INDEX SHEET

Log Number AX5AC03-5093

Document Number 37274 Document Title G.H. BETTIS QUAL. TEST REPORT

Original Number of Shts. 698 Date Rec'd 2-10-83, Sub. No. 1

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VOGTLE ELECTRIC GENERATING PLANT JOB NO. 9510

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ACTIVITY NO. N/A

SYSTEM NO. VARIOUS

CATEGORY NO. 4G/A7

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Bechtel Log No. 9510

AX5AC03-5093-4

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4 ☐ INFORMATION ONLY DISTRIBUTION REQ'D? ☐ YES

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BOOK NUMBER 68
ISSUED TO Mr Larry Rathje
COMPANY Fisher Control Co.
DATE December 1, 1982
PROJECT
CUSTOMER P.O. 181173
GH-BETTIS S.O. 82-9045-00

Report No. 37274
Revision 3
12 August 1980

NUCLEAR QUALIFICATION TEST REPORT

NUMBER 37274

GH-BETTIS CORPORATION

HOUSTON, TEXAS

This qualification test program was started in mid-year 1977 and completed January 1980. A number of revisions and additions were made to the test program; typically to reflect the continuously changing requirements demanded by the Nuclear industry. These included additional wear aging and thermal aging as qualification requirements were upgraded.

All qualification testing was conducted at Southwest Research Institute, San Antonio, Texas and Wyle Laboratories, Huntsville, Alabama.

The final results of this nuclear qualification test program show that all "N-Series" actuators manufactured by GH-Bettis are qualified for use in Nuclear Power Plants and will equal or exceed the requirements of the following standards:

> IEEE 323-1974, Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations.
>
> IEEE 344-1975, Guide for Seismic Qualification of Class I Electrical Equipment for Nuclear Power Generating Stations.
>
> IEEE 382 (ANSI N278.2.1, Draft 3, Rev. 0, February, 1977) American National Standard for Qualification of Safety Related Valve Actuators.

Four (4) actuator models were chosen for type of testing.

(1) N732C-SR80-12 to qualify all NHD series actuators

(2) NT420B-SR1-12 to qualify all NT series actuators (except NT-5 and NT-8 series actuators, seismically)

(3) NT520B-SR1-12 to qualify NT5 and NT8 series actuators, seismically

(4) NCB-520-SR80-12 to qualify all NCB series actuators.

These four (4) models chosen to be the type tested units since they best represent all of the variable affecting environmental qualification as well as exhibiting the lowest natural frequencies within their series based on their respective mass, centers-of-gravity and size and also, to exhibit the highest stress levels during operation.

It should be noted that the elastomer seal materials and lubricants used in all actuators in this report are generically identical. Justification showing relationship between type tested and generic model actuators is shown in Appendix A.

This qualification test report is presently made up of six (6) principle sections or volumes. It is anticipated that additional sections may be added when further testing is done to meet future qualification requirements yet to be established. A short summary of each volume is as follows:

VOLUME I, THERMAL AGING, DYNAMIC FUNCTIONAL DATA

The purpose of Thermal Aging was to show that the ethylene propylene seals used in all "N-Series" nuclear actuators were suitable for a qualified service life of five (5) years. The original test parameters were established as 200°F for 200 hours at 100 percent humidity. Subsequent thermal aging (Volume V) of a Model NCB520-SR80-12 was performed at 250°F for 294 hours at 100 percent humidity. By Arrhenius Equation with continuous temperature of 120°F and an activation energy of 0.8eV, this shows that the ethylene propylene seals have qualified life expectancy of 6.5 years. Since the seals of lubricants used in NHD and NT Series actuators are generically the same as used in the NCB models, they to are considered to be covered by this subsequent thermal aging test. Based on this, elastomer seals in all GH-Bettis "N-Series" actuator must be changed every 5 years to maintain qualified.

Dynamic Functional Data was also obtained, in the beginning as baseline-date, and after each phase of testing to determine what effects, if any, that the various tests had on the operating capabilities of the actuators. It should be noted that throughout the test program a number of test equipment and control failures occurred including torque transducers, solenoid valves and limit switches. None of these items are part of the actuators being qualified, but are pieces of equipment used to test and operate the actuators themselves during qualification testing. (ASCO solenoid valves and NAMCO limit switches supplied by GH-Bettis are nuclear pre-qualified by their respective manufacturers.) NHD and NT Series actuators continued to perform throughout the test program at acceptable levels of torque output nad speeds of operation.

VOLUME II, WEAR AGING, RADIATION AGING

The NCB520-SR80-12 actuator was originally operated 5000 cycles without maintenance while the N732C-SR80-12 and NT420-SR1-12 actuators were operated 2005 cycles. An additional 3000 cycles were added to these same N732C-SR80-12 and NT420B-SR1-12 units (Volume VI). Based on this, all "N-Series" actuators (less seals and lubricants) are suitable for a design service life of 5000 cycles or 40 years, whichever occurs first.

All actuators were irradiated for a minimum total dosage of 1.4x10^8 rads (air equivalent) after thermal aging and wear aging with no noticable affects on operability.

VOLUME III, SEISMIC TESTING

Each of the type tested units were subjected to a resonant search, plant induced vibration simulation and ramdom biaxial excitation. There were no signs of cracking or yielding in the actuators and they performed normally during and after the tests. The Model NT520B-SR1-12 was added to the program to varify that the larger NT series actuators were suitably qualified.

VOLUME IV, LOCA TESTING

The Models N732C-SR80-12, NT-420B-SR1-12 and NCB520-SR80-12 actuators were shipped from Southwest Research Institute to Wyle Laboratories for Design Basis Event (LOCA) Testing. The Model NT520-SR1-12 was not tested since the seals and lubricants are generically identical to those used in the Model NT420B-SR1-12 unit. The Model N732C-SR80-12 and NT420B-SR1-12 actuators successfully passed LOCA simulation with only a minor decrease in torque output (approx. 10%). This is judged to be expected and acceptable. The Model NCB520-SR80-12 actuator was removed from testing after 9 hours because of excessive piston seal leakage. Post-test examination showed the piston seal to be damaged. A subsequent test of a re-designed NCB520-SR80-12 was successfully performed at a later date (Volume V).

It should again be noted that there were several failures of torque transducers, solenoid valves and limit switches. None of these items are part of the actuator and their performance failure and replacement should not be construed as a failure of the actuators. ASCO solenoid valves and NAMCO limit switches are separately qualified for nuclear service by their respective manufacturers.

VOLUME V, THERMAL AGING, WEAR AGING, RADIATION AND LOCA SIMULATION MODEL NCB520-SR80-12

A redesigned Model NCB520-SR80-12 actuator was submitted to Wyle Laboratories for Thermal Aging, Wear Aging, Radiation and LOCA Simulation. A comparison of post-test torque outputs with initial base line data shows no decrease in performance. Seismic testing was not re-done since the design changes in the piston seal and piston seal groove would not materially affect the seismic response of the actuator. With new thermal aging parameters of 294 hours at 250°F and 100% humidity the seals in the NCB520-SR80-12 actuator are suitable for 5 year service life without maintenance (Appendix E, Arrhenius Law). Likewise, the seals in Model N732C-SR80-12 and NT420B-SR1-12 actuators are also suitable for 5 years service life since they are generically identical.

VOLUME VI, 3000 ADDITIONAL WEAR AGE CYCLES - N732C-SR80-12 AND NT420B-SR1-12

The original Model N732C-SR80-12 and NT420B-SR1-80 actuators previously wear aged, thermal aged, irradiated and seismically tested at Southwest Research Institute (Volumes I, II, III) and subjected to LOCA simulation at Wyle Laboratories (Volume IV) were returned to Wyle Laboratories for additional wear aging of 3000 cylces. No appreciable differences in torque output was noted at the end of testing. Based on this, GH-Bettis believes all NCB, NHD and NT-Series actuators are suitable for 40 years design life (except seals and lubricants) and/or 5000 cycles, whichever occurs first.

Appendix A

GENERIC QUALIFICATION

Generic qualification of GH-Bettis nuclear rated valve actuators is accomplished in the following manner.

Three generic parent test actuators; NCB520-SR80-12, N732C-SR80-12 and NT-420B-SR1-12; were submitted to all facets of nuclear qualification testing in accordance with the requirements of IEEE 382 (ANSI N278.2.1, Draft 3, Rev. 0, February 1977). Testing was conducted at Southwest Research Institute and Wyle Laboratories. An additional actuator, NT-520B-SR1-12, was tested to the seismic requirements of that document.

Actuator Model NCB520-SR80-12 serves as the generic parent of all NCB model actuators for all nuclear environments. They share the following design similarities.

1. Housings are of gray iron and are of a single design with only three basic sizes available; 1½", 2" and 2½". The generic parent contains the 2" housing.
2. The housing is an integral part of the pressurized section of this model.
3. A ductile iron piston of a single design is incorporated in NCB series actuators and is guided by the center bar.
4. Lateral loading imposed by the scotch yoke mechanism is supported by the center bar.
5. Ductile iron yokes are of one design and are available in three sizes; 1½", 2" and 2½".
6. Yoke pins are of a single design; guided by a roll pin.
7. NCB series actuators share the same unit assembly configuration (e.g. the entire unit is held together and supported by a single center bar).
8. NCB seals are of one design and are provided in compounds successfully qualified by testing.
9. Coatings and lubricants are the same for all NCB models and are identical with those of the tested unit.

Actuator model N-732C-SR80-12 is the generic parent test actuator of all nuclear rated Heavy Duty (HD) model actuators. They share the following design similarities.

1. Cast ductile iron housings and housing covers are of a single design and are available in two sizes; 2" and 3". The generic parent utilized the 3" housing.

2. Pressure and spring cylinders are threaded into cast adapters which are in turn bolted into the housing with ferry head cap screws.

3. A single piston rod is utilized which traverses the housing and is supported at both ends of the housing by a bronze bushing.

4. The piston rod absorbs all lateral loading imposed by the scotch yoke mechanism.

5. Cast ductile iron yokes are of one design and are available in two sizes; 2" and 3". The parent test actuator contained the 3" yoke.

6. Yoke pins are of one design and are guided by cast ridges in the housing and cover.

7. HD series actuators share a common unit assembly configuration.

8. U-cup piston seals and polypak rod seals of qualified ethylene propylene compounds are unique to the heavy duty design.

9. Coatings and lubricants are the same for all nuclear rated HD models and are the same as those used in the tested unit.

Actuator Model NT-420B-SR1-12 serves as the generic parent test actuator of all NT series models for all nuclear environments excepting the seismic environment. It serves as the seismic generic parent of all NT3-SR and NT4-SR models. Following are design similarities shared by these models.

1. Ductile iron housings and housing covers are of a single design and are available in four sizes; 3", 4", 5" and 8". The generic parent utilized the 4" housing.

2. Pressure cylinders are of three piece construction; two end caps and a cylinder. These parts are attached together and to the actuator housing by two tie bars.

3. NT3-SR and NT4-SR spring cylinders are attached to a brace plate utilizing two tie bars and four symmetrically located external brace rods. The brace plate is attached to the actuator housing by four cap screws.

4. Piston rods and spring push rods are separate pieces, attached by threaded connections at the yoke pin nut.

5. Lateral loading imposed by the scotch yoke mechanism is absorbed by the yoke pin and rollers which are guided and supported by tracks located in the housing and housing cover.

6. Ductile iron yokes are of one design and are available in four sizes; 3", 4", 5" and 8". The parent test actuator utilized the 4" size.

7. NT3-SR and NT4-SR model actuators share a common unit assembly configuration.

8. All seals (piston T-seal, pressure cylinder end cap seals, rod seals, etc.) are of the same design and are molded of qualified ethylene propylene compounds.

9. Coatings and lubricants are the same for all nuclear rated T-series actuators; the same as those used in the generic parent.

Actuator Model NT-520B-SR1-12 serves as the seismic generic parent of all NT5-SR and NT8-SR series actuators. These models share the same spring cylinder support design, as follows. The spring cylinder is attached to the brace plate by two tie bars and two external brace rods located above the spring cylinder. The brace plate is attached to the housing by six cap screws and two shear pins.

Seismic analyses are provided for nuclear rated actuators at the request of the customer. All generic parent test actuators are believed to be the models which are the least rigid.

ATTACHMENT 7

Includes:

Fisher Qualification Report FQP-11AB-5

(BPC Log # X5AC03-5161-2)

INDEX SHEET

ATTACHMENT No 7. Doc.# 5

Log Number AX5AC03-5161

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