14th Floor, Centre Tower
3300 Bloor Street West
Toronto, Ontario
Canada M8X 2X4
Tel.: 416.734.3300
Fax: 416.231.1626
Toll Free: 1.877.682.8772

www.tssa.org

July 26, 2013

Mr. DAVID COON
VALVTECHNOLOGIES INC
5904 BINGLE
HOUSTON TX 77092
US

Service Request Type: BPV-Nuclear Fitting Reg
Service Request No.: 1079066
Your Reference No.: 121551
Registered to: VALVTECHNOLOGIES INC

Dear Mr. DAVID COON,

Technical Standards and Safety Authority (TSSA) is pleased to inform you that your submission has been reviewed and registered as follows:

CRN No.: NFC-2-5926.5
Main Design No.: 121551-001 Rev.2
Expiry Date: N/A

Please be advised that a valid quality control system must be maintained for the nuclear fitting registration to remain valid.

The stamped copy of the approved registration and the invoice are mailed separately. Should you have any questions or require further assistance, please contact a Customer Service Advisor at 1.877.682.TSSA (8772) or e-mail customerservices@tssa.org. We will be happy to assist you. When contacting TSSA regarding this file, please refer to the Service Request number provided above.

Yours truly,

Brian Chan, P.Eng.
Mechanical Engineer – Nuclear, BPV
Tel. : 416-734-3427
Fax : 416-231-6183
Email : BChan@tssa.org

TSSA — TECHNICAL STANDARDS & SAFETY AUTHORITY

TECHNICAL STANDARDS &
SAFETY AUTHORITY
14th Floor, Centre Tower
3300 Bloor Street West
Toronto, Ontario
Canada M8X 2X4

Show facsimile of manufacturer's logo or trademark, as it will appear on the fitting, in the space below

STATUTORY DECLARATION
Registration of Fittings

I, David R. Coon, Nuclear Quality Assurance Manager
(Name and Position, e.g. President, Plant Manager, Chief Engineer)

of VALVtechnologies, LLC
(Name of Manufacturer)

Located at 5904 Bingle Road, Houston, Texas 77092 — 713-715-5577 — 713-860-0499
(Plant Address) *(Telephone No.)* *(Fax No.)*

☑ do solemnly declare that the fittings listed hereunder, which are subject to the ***Technical Standards and Safety Act***, Boilers and Pressure Vessels Regulation, comply with all of the requirements of
ASME Section III NC 2007 Edition, No Addenda
(Title of recognized North American Standard)
which specifies the dimensions, materials of construction, pressure/temperature ratings, identification marking the fittings and service;

☐ or are not covered by the provisions of a recognized North American standard and are therefore manufactured to comply with ______ as supported by the attached data which identifies the dimensions, material of construction, pressure/temperature ratings and the basis for such ratings, the marking of the fitting for identification and service.

I further declare that the manufacture of these fittings is controlled by a quality system meeting the requirements of ASME NCA-4000 which has been verified by the following authority, American Society of Mechanical Engineers.

The items covered by this declaration, for which I seek registration, are category C type fittings. In support of this application, the following information and/or test data are attached as follows:
valve data sheet and technical specification. Design report, and drawing
(drawings, calculations, test reports, etc.)

Declared before me at 5904 Bingle Road in the State of Texas
the 25th day of April AD 2013.

AUDREY RAMSEY
MY COMMISSION EXPIRES
July 27, 2014

Commissioner for Oaths:
Audrey Ramsey
(Printed name)
[signature]
(Signature)

[signature]
(Signature of Declarer)

Technical Standards and Safety Authority — Boilers and Pressure Vessels Safety Program

REGISTERED
C.R.N.: NFC-2-5926.5
Signed: Dorian Chan
Date: 2013-07-26

FOR OFFICE USE ONLY

To the best of my knowledge and belief, the application meets the requirements of the ***Technical Standards and Safety Act***, Boilers and Pressure Vessels Regulation, and CSA Standard ~~B51~~ N285.0 and is accepted for registration in Category NFC

CRN: NFC-2-5926.5

Registered by: Dorian Chan

Dated: 2013-07-26

NOTE: This registration expires on N/A

Note:
1. Bruce Power B-SPEC-04940-00004 Rev. 001
B-SPEC-01370-00001 Rev. 001
B-PES-00000658506 Rev. 001
2. Drawing no. 121551-001 Rev. 2
Design report no. 19228-001-QC-02 Rev. 2

PV 09553 (06/04)

THIS REGISTRATION IS SUBJECT TO AN ACCEPTABLE QUALITY PROGRAM IN FORCE AT THE PLACE OF MANUFACTURE

The American Society of Mechanical Engineers

ASME

NPT

CERTIFICATE OF AUTHORIZATION

The named company is authorized by the American Society of Mechanical Engineers (ASME) for the scope of activity shown below in accordance with the applicable rules of the ASME Boiler and Pressure Vessel Code. The use of the certification mark and the authority granted by this Certificate of Authorization are subject to the provisions of the agreement set forth in the application. Any construction stamped with this certification mark shall have been built strictly in accordance with the provisions of the ASME Boiler and Pressure Vessel Code.

COMPANY:

Valvtechnologies, Inc
5904 Bingle Road
Houston, Texas 77092

SCOPE:

Class 1, 2 & 3 fabrication with design responsibility for appurtenances at the above location only

AUTHORIZED: **March 23, 2012**
EXPIRES: **March 6, 2015**
CERTIFICATE NUMBER: **N-3329**

BOILERS & PRESSURE VESSELS SAFETY DIV... REGISTERED SE... ...ORY DECLARATION ...ORM FOR C.R. NUMBER TSSA

Vice President, Conformity Assessment

Director, Conformity Assessment

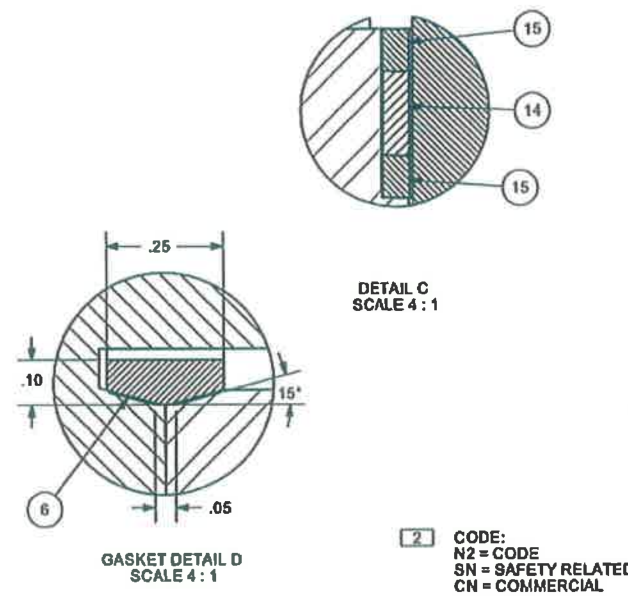
CUSTOMER: BRUCE POWER L.P.
P.O. NO,: 00176474 REV 001
BRUCE A & B DRAIN VALVES

NOTES:

[2] 1. VALVE DESIGNED IN ACCORDANCE WITH:
   A. ASME SECTION III, DIV I, SUBSECTION NC (CLASS 2), 2007 EDITION, NO ADDENDA, & CODE CASE N-62-7.
   B. DESIGN SPECIFICATION B-PES-0000688506 REV. 001
   C. SEISMIC QUALIFICATION PER B-SPEC-01370-00001 REV. 001, DBE CAT-B
2. VALVE: 3/4" CLASS 900 LIMITED, SCH 160, 0.38" BORE
3. TYPE: BALL VALVE, METAL SEATED
4. OPERATOR: HANDWHEEL-OPEN COUNTER CLOCKWISE/CLOSE CLOCKWISE W/ POSILATCH
5. Cv: 4.5
6. PRESSURE RATING: 2031 psig @ 220° F
7. DESIGN PRESSURE: 1900 psig
8. DESIGN TEMPURATURE: 220° F

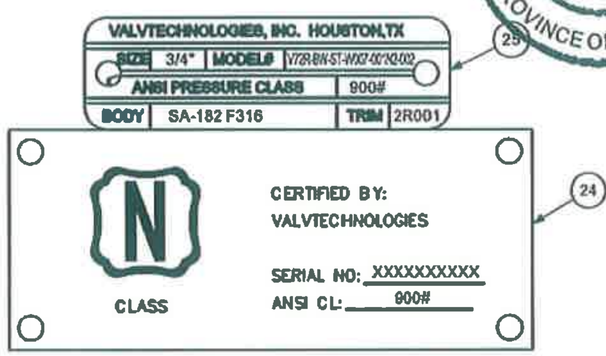
[2] 9. MINIMUM WALL THICKNESS PER ASME B16.34(3/8" BORE) : 0.15"
10. TORQUE TO OPERATE: 260 In. \ lbs.
11. CAT ID #: 0000688506
12. CRN #: TBD
13. APPROX. WEIGHT: VALVE - 7lbs.
    HANDWHEEL - 3 lbs.
    TOTAL - 10 lbs.

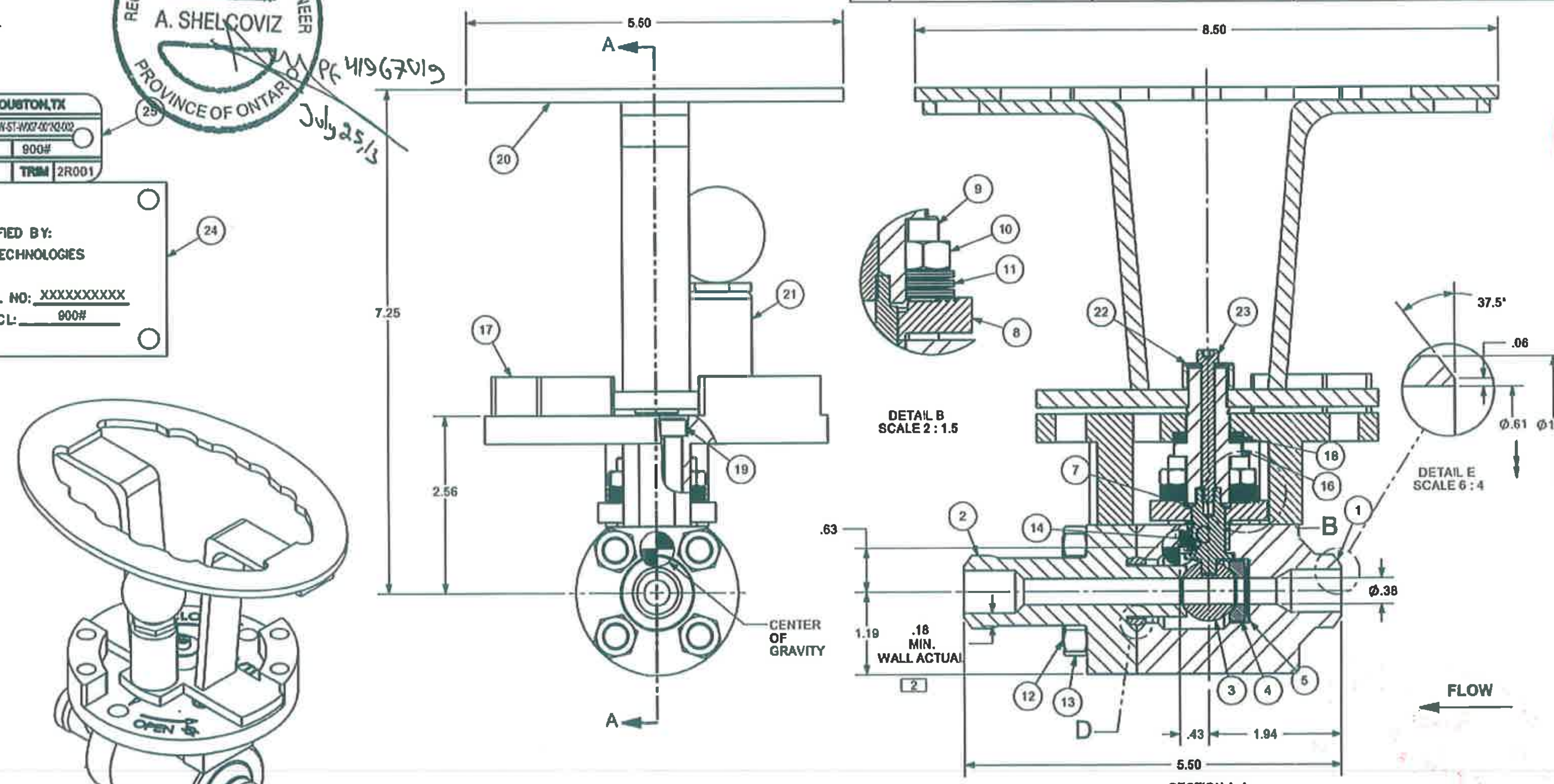
REGISTERED PROFESSIONAL ENGINEER
A. SHELCOVIZ
PROVINCE OF ONTARIO
PE 41967019
July 25/13



BILL OF MATERIALS					
ITEM	PART NUMBER	MATERIALS	DESCRIPTION	QTY.	CODE
1	B03W2XAV-211ZZ1N2-B01	SA-182 Gr. F316	BODY	1	N2
2	E03W2XAV-211Z11N2-B01	SA-182 Gr. F316 / RAM31	END CAP	1	N2
3	Y03X2AVV-231Z11N2-001	SA-182 Gr. F6a / RAM31	BALL	1	N2
4	U031VMVZ-211Z11CN-001	SA-182 Gr. F316 / RAM31	UPSTREAM SEAT	1	CN
5	MB03AVZZ-MA1ZZ1CN-001	SB-637 ALLOY UNS N07718	BELLEVILLE SPRING	1	CN
6	C03AVVZZ-712K01CN-001	17-4 / PT24	BODY SEAL	1	CN
7	S03004VV-911Z11SN-B01	SA-638 660 TYP.1 / RAM31	STEM	1	CN
8	G03004AV-211KA1SN-001	SA-182 Gr. F316	GLAND	1	SN
9	MFSS004-012-V31SN-000	SA-193 Gr. B8M	STUD	4	SN
10	MFNS-004-W31ZZ1SN-000	SA-194 Gr. 8M	NUT	4	SN
11	MGS-00500-038-242-CN1	SA-182 Gr. 302	GLAND SPRING	24	CN
12	MFSS006-014-V31N2-000	SA-193 Gr. B8M	STUD	4	N2
13	MFNS-006-W31ZZ1N2-000	SA-194 Gr. 8M	NUT	4	N2
14	MSP00A00806-RG1CN-001	GRAFOIL	GLAND PACKING	1	CN
15	MSP00A00806-RG1CN-001	SA-182 Gr. 316	GLAND PACKING	2	CN
16	MD03AVVZ-112ZZ1CN-001	SA-29 Gr. 4130 (H.T.)	DRIVE SLEEVE	1	CN
17	MS03-X2V-0B1ZZ1CN-001	SA-216 WCB	YOKE PLATE	1	CN
18	MT03VVZZ-0A1KA1CN-001	SA-29 Gr. 1020	THRUST BEARING	1	CN
19	MFCC004-014-V16CN-000	SA-574	CAP SCREW	4	CN
20	MHO-03XV-0A1ZZ1CN-002	SA-29 Gr. 1020	OVAL HANDWHEEL	1	CN
21	MM-03-LPZZ-2X100-001	STAINLESS STEEL	POSILATCH	1	CN
22	MFWF-E00FLT-W15CN-002	CARBON STEEL	FLAT WASHER	1	CN
23	MFCCE00-020-V16CN-000	SA-574	CAP SCREW	1	CN
24	MTAG-NSAENV-2X100-001	STAINLESS STEEL	STANDARD N TAG	1	CN
25	MTAG-AAAENV-2X100-002	STAINLESS STEEL	STANDARD TAG	1	CN

[2] CODE:
N2 = CODE
SN = SAFETY RELATED
CN = COMMERCIAL





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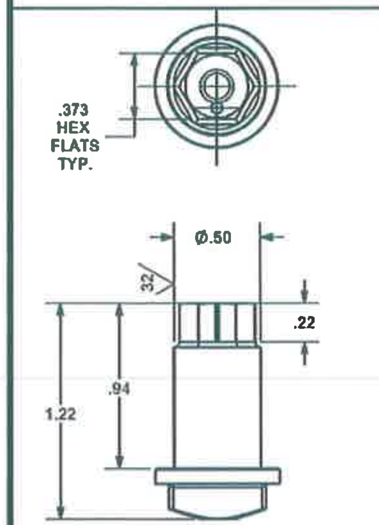

STEM DETAIL

TORQUE TABLE			
ITEM #	ITEM	SIZE	TORQUE
9	GLAND PACKING	1/4-20 UNC X 1.25" LONG	2.5 ft./lbs.
12	BODY	3/8-24UNC X 1.50" LONG	10 ft./lbs.
19	STOP PLATE	1/4-20UNC X 1.50" LONG	10 ft.lbs.
23	HANDWHEEL	#10-24UNC X 2.00" LONG	2 ft./lbs.

THIRD ANGLE PROJECTION

REV	DATE	DESCRIPTION	ECN	BY	CHK	APR
-	-	-	-	-	-	-
-	-	-	-	-	-	-
2	11/16/12	REVISED PER CUSTOMERCOMMENTS	04	DS	DS	CM
1	10/22/12	REVISED PER CUSTOMER MARKUPS	01	BS	DS	CM
0	09/05/12	INITIAL RELEASE		BS	DS	CM

DIMENSIONS ARE IN INCHES
REMOVE BURRS AND BREAK EDGES
UNLESS OTHERWISE SPECIFIED

CORNER RADII .03 MAX
.X= ±.030
.XX= ±.015
.XXX= ±.005
CONCENTRICITY .010 T.I.R.
ANGULAR= ±1/2°
SURFACE TEXTURE 125 RMS
MIN. INTERNAL FILLETS .015

SCALE 3:4 | MODEL FILE 121551-001 | SIZE C

DRAWN BY BS DATE 08/29/12
CHECKED BY DS DATE 08/30/12
ENGINEER DS DATE 08/30/12
APPROVED BY CM DATE 09/05/12

VALVTECHNOLOGIES
5904 BINGLE ROAD, HOUSTON TEXAS 77092
PH: (713) 860-0400 FAX: (713) 860-0499

TITLE V72R-BW-ST-W007-001N2-002
ANSI 900#, WITH OVAL HANDWHEEL

121551-001 SH 1 OF 1 REV 2

TECHNICAL SPECIFICATION

VALVES FOR USE IN NUCLEAR SYSTEMS

B-SPEC-04940-00004

BOILERS & PRESSURE VESSELS SAFETY DIVISION
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UNITS - ALL

Prepared by/Revised by:	Verified by:	Approved by:
Mike Séguin CNUS, Division of Canatom NPM	M. Jansen P Eng. CNUS, Division of Canatom NPM	J. Slawson P Eng. Senior Technical Engineer/Officer
Date: 2004-11-22	Date: 2004 11 23	Date: 2004-12-20

SEISMIC QUALIFICATION OF MECHANICAL EQUIPMENT		B - SPEC - 01370-00001	Page 1 of 8
REV - 001	UNITS ALL		

Bruce Power

TECHNICAL SPECIFICATION

B-SPEC-01370-00001

SEISMIC QUALIFICATION OF MECHANICAL EQUIPMENT

UNITS ALL

BOILERS & PRESSURE VESSELS SAFETY DIVISION
REGISTERED
SEE STATUTORY DECLARATION FORM FOR C.R. NUMBER
TSSA

PX

Revised by:	Verified by:	Approved by:
R. Hamilton, P.Eng. CPUS	M.J. Jansen, P.Eng. CPUS	D.J. Armchuk, P.Eng. Bruce Power
Date: 2005 05 02	Date: 2005/05/02	Date: 5 May 2005

BRUCE A and BRUCE B VALVE SPECIFICATION SHEET

Bruce Power

Rev: 001 **Project:** Bruce A and Bruce B

File:
Cat ID: 688506
Spec. Sheet: B-PES-0000688506
Drawing No.: NK21-DRAW-33310-10011
Drawing No.: NK29-DRAW-33310-10006
Maint. Man.: B-MMM-33310-10003

General		
1	Description: VALVE, BALL, 3/4", Nuclear CL 2, ASME/ANSI Class 900+, BW, SS, Manual, SCH160	CRN: Required*
2	Program: Bruce NK21 and NK29	Units: See Table 1
3	Code: ASME Section III, DIV. 1	Eff. Date: 2007 Edition: Nuclear Class 2 per CSA N285.0-08
4	QA Standard: CSA Z299.2 or Equivalent *	Date: 1985 *
5	Technical Specification: B-SPEC-04940-00004, Rev 001	
6	Manufacturer: TBD	
Body		
7	Type: Ball / Nominal size: 3/4"	Port Size: *
8	Material: SA-182 Gr. F316 or F316L (See Note 4)*	Connecting Pipe material: SA 312 TP 304L
9	End Connections: Butt welded to 3/4", SCH 160 pipe	Rating: ASME/ANSI CL 900+(Interpolated) (See Note 8)
Bonnet		
10	B/B Joint Type: See Note 3	Handwheel/Lever: ☒ Yes ☐ No (See Note 6)
11	Material: Same as Body	Live loading: ☒ Yes ☐ No
12	Gasket: *	Bellows Seal: ☐ Yes ☒ No
13	Stem Packing: Graphite to Supplier's Std. Mtl per B-SPEC-04940-00001, Rev. 001 *	Packing Blowout: ☐ Yes ☒ No
14	Packing Leak-off: ☐ Yes ☒ No	Seal Weld: ☐ Yes ☒ No
Trim		
15	Seat Material: Metal * (See Note 11) Hard faced	Disc Material: Ball SS (See Note 11) Hard faced
16	Disc Form: Ball	Guiding: ☐ Yes ☒ No
17	Back Seat: ☐ Yes ☒ No	Minimum Required C_v: / Actual C_v: *
18	Trim Characteristic: See Note 3.	Flow to: ☐ Open ☐ Close
Actuator		
19	Type: Manual	
20	Operating Supply:	
21	Supply Failure Position: ☐ Open ☐ Closed	☐ As Is
22	Limit Switch for Valve: ☐ Open Qty ☐ Closed Qty	Ext. Switches Valve Open Qty:
23	Torque Switches Actuated When Valve ☐ Opens ☐ Closes	Ext. Switches Valve Closed Qty:
Auxiliary		
24	Stem Position Indication By: Pointer and scale ☒ Open	☒ Closed
25	Disc Position Indication By: ☐ Open ☐ Closed	
26	Description:	
Service Conditions		
27	Line Fluid: D2O (D2O Specific gravity at 60 °F: 1.106)	
28	Design Pressure: 1900 psig (See Note 8)	Design Temperature: 220°F (See Note 8)
29	Shutoff Pressure Differential: 1900 psid (See Note 8)	To Stroke Open/Closed at: 1900 psid (See Note 8)
Tests (See Note 9)		
30	Hydrostatic Shell: ☒ Yes ☐ No	Seat Leakage: ☒ Yes ☐ No
31	Gas Leak: Helium ☒ Yes ☐ No	Seat He Test: ☒ Yes ☐ No
32	Lowest System Temperature (Ref. Charpy Impact Test): N/A	
Miscellaneous		
33	Seismic Specification: B-SPEC-01370-00001 R001 (See Note 10)	Seismic Category: DBE ☐ A ☒ B ☐ C
34	Seismicity: Site Acceleration (g) Level ☐ Low ☐ Med	
35	Seismic Support Category: ☐ Rigid ☐ Semi-rigid ☐ Flexible	
36	Seismic Qual. Tests: ☒Static OR ☒Dynamic OR ☒Seismic Analysis (See Note 10)	
37	If Dynamic: ☐ Valve Operates During Earthquake	☐ Valve Operates After Earthquake
38	If Dynamic: ☐ Normally Closed Valve (Test to Open)	☐ Normally Open Valve (Test to Close)
39	Design Report: ☒ Yes ☐ No	
40	Environment Radiation: 0.1 Mrad (gamma) /30 years (Note 12)	Environment Temperature: 27 °C (Note 12)
41	Inaugural Inspection: ☐ Yes ☒ No	Environmental Qualification: ☐ Yes ☒No

BOILERS & PRESSURE VESSELS SAFETY DIVISION
REGISTERED
SEE STATUTORY DECLARATION FORM FOR C.R. NUMBER
TSSA

Prepared by:	Reviewed by:	Verified by:	Approved by:
C. Graham	K. Robertson	A. Choudhry	J. Slawson
Date: 14JUN2012	Date: 14 JUN 2012	Date: 14 JUN 2012.	Date: 22JUN 2012

Master Created: 14Jun2012 3:01

CURTISS WRIGHT
Flow Control Company
SCIENTECH

Document Number 19228-001-QC-02	Revision 2	Project Number 19228.0001	Page 1
Customer: VALVTechnologies			
Title: ASME Code and Seismic Qualification of Bruce A&B Drain Valves			

Bruce Power

- [x] ACCEPTED
- [ ] NOT ACCEPTED
- [ ] ACCEPTED AS NOTED RESUBMITTAL REQUIRED
- [ ] ACCEPTED AS NOTED NO RESUBMITTAL REQUIRED

Date 5 Apr 2013

Signed

ACCEPTANCE OF THIS DOCUMENT DOES NOT RELIEVE THE CONTRACTOR OF RESPONSIBILITY FOR ANY ERRORS OR OMISSIONS

ASME Code and Seismic Qualification of Bruce A&B Drain Valves – VALVTechnologies ¾" - 900# Model V72R-BW-ST-W007-001N2-002

Prepared
For
VALVTechnologies

Bruce Power P.O. No: 00176474

VTI P.O. No: 074949
SO#121551

Alton Reich Prepared By:	10 April 2013 Date
Jason Moon Checked / Reviewed By:	4/10/2013 Date
Cesar Mejia Approved By:	4/10/2013 Date

BOILERS & PRESSURE VESSELS SAFETY DIVISION
REGISTERED
SEE STATUTORY DECLARATION FORM FOR C.R. NUMBER
TSSA

ASME-RPE Certification Page is Required:	N	Controlled Computer Program Log Page is Required:	N

CURTISS WRIGHT Flow Control Company
SCIENTECH

Document Number 19228-001-QC-02	Revision 2	Project Number 19228.0001	Page 1
Customer: VALVTechnologies			
Title: ASME Code and Seismic Qualification of Bruce A&B Drain Valves			

ASME Code and Seismic Qualification of Bruce A&B Drain Valves – VALVTechnologies ¾" - 900# Model V72R-BW-ST-W007-001N2-002

Prepared
For
VALVTechnologies

Bruce Power P.O. No: 00176474

VTI P.O. No: 074949
SO#121551

Alton Reich	10 April 2013
Prepared By:	Date
Jason Moon	4/10/2013
Checked / Reviewed By:	Date
Cesar Mejia	4/11/2013
Approved By:	Date

ASME-RPE Certification Page is Required:	N	Controlled Computer Program Log Page is Required:	N

PE CERTIFICATION

I, the undersigned, being a Registered Professional Engineer competent in the applicable field of design and using the certified Design Specification and the drawings identified below as a basis for design, do hereby certify that to the best of my knowledge and belief the Design Report is complete and accurate and complies with the design requirements of the ASME Boiler and Pressure Vessel Code, Section III, Division 1, 2007 Edition.

Design Specification and Revision: Bruce Power Company technical design specification B-SPEC-01370-00001, "Seismic Qualification of Mechanical Equipment", Rev. 001.

Drawings and Revision: See referenced valve drawings in Section 2.0

Design Report and Revision: 19228-001-QC-02, Revision 2.

Avi Shelcoviz

June 7, 2013
Date

419 67019
Registration Number

REGISTERED PROFESSIONAL ENGINEER
A. SHELCOVIZ
PROVINCE OF ONTARIO

CURTISS WRIGHT Flow Control Company
SCIENTECH

Document Number 19228-001-QC-02	Revision 2	Project Number 19228.0001	Page 3
Customer: VALVTechnologies			
Title: ASME Code and Seismic Qualification of Bruce A&B Drain Valves			

REVISION SUMMARY SHEET

Rev.	Summary
0	Initial Issue
1	Incorporated Bruce Power comments (CAT ID 0000688506) and minor editorial comments from ValvTechnologies. Revised Pages: 1, 2, 3, 4, 6, 7, 15, 16, A3 Added Pages: 2, 19,20 Replaced Pages: None Voided / Deleted Pages: None
2	Incorporated comments from Bruce Power (CAT ID 688506, AR # 28301414-07). Revised Pages: 1 through 6, 10, 11, 15 through 17, 20 Added Page: 21 Replaced Pages: None Voided / Deleted Pages: None

RECORD OF REVISION

Rev. Level	Prepared By	Date	Checked by	Date	Approval	Date
0	Alton Reich	10-9-12	Jason Moon	10-16-12	Mahesh Patel	10-16-12
1	Alton Reich	12-9-12	Jason Moon	12-11-12	Mahesh Patel	12-13-12
2	Alton Reich	4-5-12	Jason Moon	4-10-12	Cesar Mejia	4/11/13

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this analysis is to verify the structural adequacy of the VALVTechnologies 3/4" 900#-class metal seated ball valve with oval handwheel (shown on VALVTechnologies drawing 121551 (V72R-BW-ST-007-001N2-002) [2.1]) per the requirements of valve specification sheet B-PES-0000688506 [2.3], and for the seismic loads specified in Bruce Power Company design specification B-SPEC-01370-00001 [2.2]. | 1

2.0 SPECIFICATIONS / REFERENCES / DESIGN INPUTS

2.1 VALVTechnologies, Drawing 121551, "V72R-BW-ST-W007-001N2-002 - ANSI 900# with Oval Handwheel", Rev 2.

2.2 Bruce Power Company technical design specification B-SPEC-01370-00001, "Seismic Qualification of Mechanical Equipment", Rev. 001.

2.3 Bruce A and Bruce B Valve specification sheet B-PES-0000688506.

2.4 ValvTechnologies, Drawing MHO-03XV-CNW1, 3/8" Oval Handwheel w/ Lockout Device Commercial Nuclear (Welding), Rev. 1.

2.5 ValvTechnologies, Drawing E03W2XAV-N2B1, 3/8" Endcap 900#-3100# with ¾ SCH 160 BW Prep for Nuclear Class Use, Rev. 1.

2.6 VALVTechnologies, Drawing B03W2XAV-N2B1, 3/8" Body 900#-3100# with 3/4# SCH 160 BW Prep for Nuclear Class Use, Rev. 1.

2.7 Crane Technical Paper 410, "Flow of Fluids Through Valves, Fittings, and Pipe", 11/2009 printing.

2.8 ASME Section II, 2007 Edition.

2.9 Mark's Standard Handbook for Mechanical Engineers, 11th edition.

2.10 Lindeburg, M., Mechanical Engineering Reference Manual, 9th edition.

2.11 VALVTechnologies, Drawing S03004VV-911KA1SN-B01 | 1

2.12 US NRC Reg Guide 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis", Rev. 2.

2.13 American Institute of Steel Construction, Load and Resistance Factor Design, 2nd Edition.

2.14 Beer, F. and Johnson, E., Mechanics of Materials, 1981.

2.15 ASME Section III, 2007 Edition.

2.16 ASME B16.34a, 1998 Edition, Valves – Flanged, Threaded and Welding End. | 2

2.17 Young, W., et. al., Roark's Formulas for Stress and Strain, 8th Edition.

2.18 ASME Code Case N-62-7, Internal and External Valve Items, Section III, Division 1, Classes 1, 2, and 3.

2.19 CAN3 N289.3, Design Procedures for Seismic Qualification of CANDU Nuclear Power Plants.

3.0 ASSUMPTIONS

3.1 The connecting pipe was assumed to be SA-312, TP304L, Schedule 160.

3.2 Minor conservative assumptions are described within the calculations. 1

4.0 METHOD OF ANALYSIS

The VALVTechnologies ball valve under consideration is required to comply with ASME Section III Class 2 (NC), 2007 Edition [2.15] which references ASME B16.34a, 1998 Edition [2.16], and the plant-specific seismic requirements [2.2] which reference the CANDU seismic qualification procedures in CAN3-N289.3 [2.19]. 2

ASME Section III, subsection NC-3500 provides the rules related to valve design. Specifically, NC-3513 Alternative Design Rules for Special Class valves are used, since Limited Class valves are a subset of Special Class valves. This dictates compliance with the wall thickness requirements of ANSI B16.34.

In accordance with NC-3521(c), if the valve assembly consists of extended parts attached to the valve body and/or end cap, an analysis should be performed based on static forces resulting from equivalent earthquake accelerations acting at the center of gravity of the extended mass. The ball valve evaluated in this calculation has extended part structures. The extended mass consists of the yoke post and hand wheel assembly. In the seismic response calculations, the entire extended part mass is considered to be concentrated at its center of gravity.

Also, if the fundamental (lowest) natural frequency of the valve is calculated and is shown to be greater than the rigid frequency of 33 Hz, the valve is considered rigid and the required accelerations will be applied to the valve's lumped mass without multi-modal amplifications. The seismic adequacy of the valve is established using analytical methods. The seismic integrity of various portions will be demonstrated using classical engineering analysis techniques.

The following are the design requirements for valve assemblies:

- The pipe system and not the valve shall be the limiting factor in the designing. The valve body will be demonstrated to be adequate to withstand piping end loads by meeting the following conditions:
  - The section modulus and area at a plane normal to the flow passage through the region of the body crotch shall be at least 110% of that for the piping connected to the valve body inlet and outlet nozzles.
  - The allowable stress for valve body material shall be equal to or greater than the allowable stress of the connecting pipe material at the pipe temperature. If this is not the case, then the body section modulus and area shall be reduced by the ratio of allowable body stress divided by the allowable piping material stress.
- The valve body shall satisfy the minimum wall requirements of ASME B16.34a 1998 Edition. 2
- The valve must be operable during and after a seismic event. This criteria will be met by demonstrating that the valve stresses are below the applicable allowable under seismic loading.
- The valve extended parts shall meet the following requirements:
  - The natural frequency of vibration of the valve extended parts for all valve assemblies shall be greater than 33 Hz.

  - The valve extended parts shall withstand the operating loads and a Required Response Spectrum load consisting of a ZPA acceleration of 2.16g's horizontal (each of two axes) and 2.75g's vertical (1.75g +1g gravity), applied simultaneously per the seismic specification [2.2]. When the equivalent static load method is used, the seismic load will be found by multiplying by a factor of 1.5 per CAN3-N289.3 [2.19].

The following evaluations are performed in this calculation to ensure Code compliance:

- Computation of valve body minimum wall thickness and comparison to the required thickness.
- Comparison of valve body wall area and section modulus vs. connecting pipe wall thickness.
- Computation of valve natural frequency
- Seismic evaluations
  - Evaluation of connections
  - Stress evaluation

These calculations are provided in Section 5 of this report.

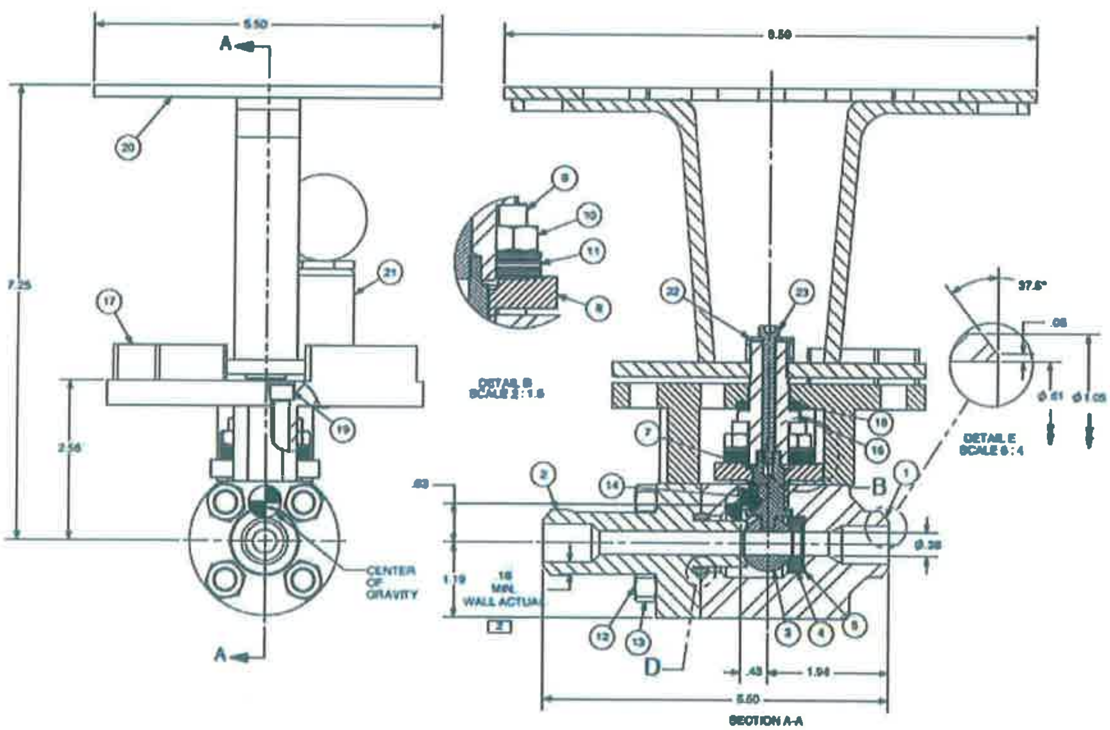


Figure 1: Overview of the 3/4" 900# Metal Seated Ball Valve with handwheel. [2.1] 1

4.1 Design Input Information

The following is a general description of the valve: a 3/4" ball valve Nuclear Class 2 (NC), ASME/ANSI Class 900 Limited, butt welded, stainless steel, manually operated, for SCH 160 piping. The material of the body is SA-182 Gr. F316 The connecting pipe material is SA 312 TP 304L and the end connections are butt welded to the 3/4", SCH 160 pipe. Design conditions are as follows: the design pressure is

1900 psig and the design temperature is to 220°F. The valve design details are provided in the manufacturer drawings, References [2.1, 2.4-2.6]

4.2 Design Criteria

The design criteria are provided in the Bruce specification [2.2].

- Horizontal acceleration: 2.16g
- Vertical acceleration: 1.75g (Not including acceleration due to gravity.) 1
- A multiplier of 1.5 will be used when calculating the static load when the equivalent static load method is used.
- The valve must be qualified to withstand the acceleration applied simultaneously in each of three directions.
- The valve shall be considered in the worst possible orientation.
- The mass of the valve, operator, and other appurtenances shall be considered in the seismic analysis.
- The valve shall be designed to have a minimum natural frequency that is greater than 33 Hz so that it may be considered rigid and a static seismic analysis can be performed.
- The valve shall be operable during and after a seismic event.

5.0 EVALUATION / CALCULATION

The valve is qualified based on the requirements of the ASME Code and the plant seismic specification.

5.1 Minimum Wall Thickness

The valve body is analyzed to ensure that it conforms to the requirements of ASME Code, Section III, Sub-article NC-3500 that refers to ASME B16.34 in NC-3513. The analysis presented below shows that the valve body satisfies the minimum wall requirements for an SA-182, F316, 900 lb Class Limited Valve.

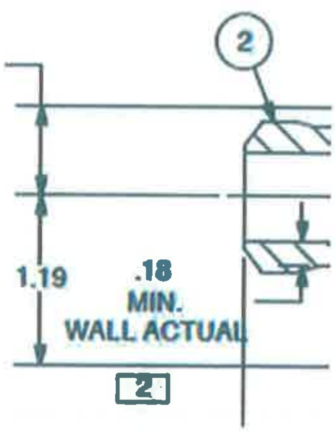
Per Section 6.1.2 of ASME B16.34 [2.16] the inside diameter used for the purpose of determining the minimum wall thickness is the greater of the minimum diameter of the flow passage or 90% of the valve inside diameter at the end. For this valve the minimum diameter of the flow passage is 0.38", and 90% of the valve inside diameter at the end is: $0.90 * 0.61" = 0.55"$ Therefore, an inside diameter of 0.55" is used for determining the minimum wall thickness. The minimum wall thickness required per Table 3-B of B16.34 for a 3/4" diameter, 900 lb Class valve with an inside diameter of 0.56" is as follows:

$$t_m := 0.18\ inch$$

A minimum thickness of 0.77*tm is required at a distance of 1.33*tm from each end of the valve body per Para 6.1.5 and 6.2.1.

$$1.33 * t_m = 0.239\ inch$$
$$0.77 * t_m = 0.139\ inch$$

The actual wall thickness is provided on the valve drawing [2.1]:



$$t_{body} = 0.18\ inch = t_m = 0.18\ inch$$

Since the valve body thickness meets or exceeds the minimum required thickness it meets the Code requirements and is acceptable.

5.2 Properties of Valve Body

The material properties of valve 121551-001 are SA-182 316. This evaluation considers the valve cross sectional area and section modulus in the crotch region in comparison to the connecting pipe properties.

$S_{body} := 20000\,psi$ Allowable stress limits for SA-182 at 300°F

$d_{ODb} = 1.050\,inch$

$d_{IDb} := 0.38 inch$

$A_{body} := \frac{\pi * \left(d_{ODb}^2 - d_{IDb}^2\right)}{4} = 0.752\,inch^2$ Area of Valve Body

$Z_{body} := \frac{\pi * \left(d_{ODb}^4 - d_{IDb}^4\right)}{32 * d_{ODb}} = 0.112\,inch^3$ Section Modulus

5.2.1 Properties of Pipe

Material of Pipe is SA-312 TP 304L, Pipe Size ¾ inch.

$S_{pipe} := 16700 psi$ Allowable Stress Limits for SA-312 TP304L

$d_{ODp} := 1.05 inch$

$d_{IDp} := 0.612 inch$

$A_{pipe} := \frac{\pi * \left(d_{ODp}^2 - d_{IDp}^2\right)}{4} = 0.572\,inch^2$ Area of Pipe

$Z_{pipe} := \frac{\pi * \left(d_{ODp}^4 - d_{IDp}^4\right)}{32 * d_{ODp}} = 0.101\,inch^3$ Section Modulus of Pipe

5.2.2 Comparison of Properties of Pipe to Valve Body in the Crotch Region

$\frac{A_{body}}{A_{pipe}} = 1.316$ $\frac{Z_{body}}{Z_{pipe}} = 1.111$

$S_{body} = 20{,}000.000\ psi$ $S_{pipe} = 16{,}700.000\ psi$

$S_{body} > S_{pipe} = true$

No reduction required due to material strength. The valve body area and section modulus satisfy the requirements.

5.3 Piping Loads

Seismic qualification of the valve is performed to verify the valve assembly will operate maintain its structural integrity during a seismic event. The qualification method is by static analysis. This method is acceptable since the valve assembly is rigid as demonstrated in Section 5.4. Component adequacy is verified by comparing the maximum seismic stress with the appropriate allowable stress. The valve is intended to operate during and after a design seismic event. 2

The following structures of the valve assembly are analyzed:

- Handwheel
- Valve Body
- Stem
- Ball

The weight of each individual valve assembly component is listed below:

- Valve: 7 lbf
- Hand-wheel: 3 lbf
- Total valve assembly weight: 10 lbf

The valve is qualified by:

- Ensuring that it is capable of withstanding any applied piping loads.
- Ensuring that the valve natural frequencies are in the rigid range, which allows a static seismic analysis using the ZPA acceleration to be used.
- Performing the static seismic analysis.

5.4 Dynamic Analysis

The following dynamic analysis is performed to show that the valve assembly is rigid (natural frequencies > 33Hz [2.2]). The sections of the valve with the lowest natural frequencies are analyzed (the valve body and the valve stem) [2.10].

5.4.1 Valve Body

The valve body is conservatively evaluated to support the entire weight of the valve, gearbox and remote valve operator. The valve body is conservatively modeled as a pipe with fixed ends with the entire valve assembly weight focused at the center of the pipe. The minimum valve area and moment of inertia of the valve body occurs at the location of the valve adjacent to the end flanges. This area is used as the pipe cross-sectional area for the entire length of the valve for simplicity and conservatism.

5.4.1.1 Natural Frequency Due to Flexure:

The natural frequency of the valve body due to flexure is calculated based on treating it as a cantilever beam with a constant, hollow circular cross section, with the entire valve mass concentrated at the free end. The natural frequency is calculated using Case 3a in Table 16.1 of Roark's [2.17].

Inputs:

$W_v := 10lbf$	total valve weight
$E := 2.8 * 10^7\,psi$	modulus of elasticity for stainless steel
$OD_v := d_{ODe} = 0.975\,inch$	valve outer diameter (using low end tolerance is conservative)
$ID_v := d_{IDe} = 0.380\,inch$	valve inside diameter
$L_v := 5.5inch$	valve length

$g := 32.2 ft/s^2$ acceleration of gravity

Calculation:

The valve moment of inertia is: $I_v := \frac{\pi}{64}\left(OD_v^4 - ID_v^4\right) = 0.043\ inch^4$

The natural frequency is: $f_{nf} := \frac{1.732}{2\pi}\sqrt{\frac{EI_v g}{W_v L_v^3}} = 146.334 Hz$

Since $f_{nf} > 33Hz = true$ the valve can be treated as rigid for seismic analysis.

5.4.1.2 Natural Frequency Due to Torsion:

The natural frequency of the valve body due to torsion is calculated using Case 8a in Table 16.1 of [2.17].

Additional inputs:

$m_v := 10 lb$	Mass of the valve
$d_{CG} := 0.63 inch$	distance from valve centerline to the center of gravity
$G := 1.1 * 10^7\ psi$	shear modulus for stainless steel

Calculation:

The torsional stiffness of the valve body is calculated using Case 10 of Table 10.1 of Roark's [2.17]:

$K_v := \frac{\pi}{32}\left(OD_v^4 - ID_v^4\right) = 0.087\ inch^4$

The mass moment of inertia of the valve is computed based on the outside and inside diameter, and the distance to the CG based on the parallel axis theorem:

$J_v := m_v\left(\frac{\left(OD_v^2 + ID_v^2\right)}{8} + d_{CG}^2\right) = 5.338\ lbinch^2$

The torsional natural frequency is: $f_{nt} := \frac{1}{2\pi}\sqrt{\frac{GK_v}{J_v L_v}} = 563.558 Hz$

Since $f_{nt} > 33Hz = true$ the valve can be treated as rigid for seismic analysis.

5.4.2 Valve Stem

The valve stem and sleeve assembly support the weight of the hand-wheel. Therefore, the valve stem and sleeve is analyzed for seismic loads. The valve stem and sleeve geometry is treated as a cylinder. The mass of the handwheel (3 lbm) is conservatively lumped at the top of the handwheel 7.25" above the centerline of the valve. The required shaft size for a natural frequency of 33Hz is calculated and then compared to the actual shaft size.

5.4.2.1 Natural Frequency of Valve Stem Due to Flexure:

The valve stem and sleeve assembly support the weight of the hand-wheel. Therefore, the valve stem and sleeve is analyzed for seismic loads. The valve stem and sleeve geometry is treated as a cylinder. The mass of the handwheel (3 lb) is conservatively lumped at the top of the handwheel 7.25" above the centerline of the valve. The natural frequency is calculated using Case 3a in Table 16.8 of Roark's [2.17].

Inputs:

$W_h := 3lbf$ handwheel weight

$E := 2.8*10^7\,psi$ modulus of elasticity for stainless steel

$OD_s := 0.5inch$ valve stem outside diameter (conservative)

$L_s := 7.25inch$ distance from the centerline of the valve from the top of the handwheel

Calculation:

The valve stem moment of inertia is: $I_s := \frac{\pi}{64}\left(OD_s^4\right) = 0.003\,inch^4$

The natural frequency is: $f_{ns} := \frac{1.732}{2\pi}\sqrt{\frac{EI_s g}{W_h L_s^3}} = 46.970Hz$

Since $f_{ns} > 33Hz = true$ the valve stem can be treated as rigid for seismic analysis.

5.5 Stem

The weight of the handwheel is 3 lbf. It is conservatively modeled that the seismic and gravitational loading of the handwheel is transmitted through the stem only. The analysis of the stem is conservative since it neglects the structural support of the yoke. The calculation is performed assuming the worst case installation configuration, which is upside down (gravity and the vertical seismic load acting in the same direction).

The figure below shows the cross-section of the stem. The worst case stress occurs at the location identified. Therefore only the stress at this location is calculated.

Figure 5.5.1 - Location of highest stem stress for worst case valve assembly configuration.

Nomenclature:

$L_1 := 7.25 inch$ (distance between centerline of valve and top of handwheel in the z direction)

σ = stem tensile stress

τ = stem shear stress

$W_1 = 3.000\ lbf$ weight of the handwheel

$a_v := 2.75$ vertical acceleration, including gravity

$a_h := 2.16$ horizontal acceleration

$F_z := 1.5 * a_v * W_1 = 12.375\ lbf$ vertical seismic loading (including static load factor)

$F_x := 1.5 * a_h * W_1 = 9.720\ lbf$ and $F_y := F_x = 9.720\ lbf$ horizontal loading (including static load factor)

M = moment created by force of interest

$d_{stem} := 0.5 inch$ stem diameter at the base

$c := \frac{d_{stem}}{2}$, $c = 0.250\ inch$, half of stem diameter

V = shear force due to force of interest

$Q := \frac{d_{stem}^3}{12}$, for circular cross-section [2.14]

$I := \left(\frac{\pi}{64}\right) * d_{stem}^4 = 0.003\ inch^4$, moment of inertia for circular cross-section

$t := d_{stem}$, for circular cross-section

T= torque due to force of interest

$J := \frac{\left(\pi * d_{stem}^4\right)}{32} = 0.006\ inch^4$, polar moment of inertia of valve stem

Fundamental stress equations are used for analysis [2.14].

Stress due to Fx:

Tensile stress in the stem due to moment created by Fx:

σ_x= Mc/I, therefore $\sigma_x := \frac{32 * F_x * L_1}{\left(\pi * d_{stem}^3\right)}$, $\sigma_x = 5{,}742.412\ psi$

Shear stress in stem due to force Fx:

τ_x=VQ/IT, $\tau_x := \frac{16 * F_x}{\left(3 * \pi * d_{stem}^2\right)}$, $\tau_x = 66.005\ psi$

Stresses due to Fy:

The tensile stress due to the moment (at the location of interest) is zero.
Shear stress in stem due to Fy:

τ_y =VQ/IT, therefore, $\tau_y := \frac{16 * F_y}{\left(3 * \pi * d_{stem}^2\right)}$, $\tau_y = 66.005\ psi$

τ_y =VQ/IT, therefore, $\tau_y := \frac{16 * F_y}{\left(3 * \pi * d_{stem}^2\right)}$, $\tau_y = 66.005\ psi$

Stresses due to Fz:

Tensile stress due to force Fz (includes gravity):

σ_z=Fz/A, therefore, $\sigma_z := \frac{4 * F_z}{\left(\pi * d_{stem}^2\right)}$, $\sigma_z = 63.025\ psi$

Stress due to the valve operating torque:

$T_{OP} := 196 inch * lbf$ valve operating torque at maximum allowable working pressure (per VALVETechnologies) 2

The shear stress due to the torque is: 2

$$\tau_{OP} := \frac{2T_{OP}}{\pi\left(d_{stem}/2\right)^3} = 7{,}985.758\ psi$$

The stresses within the valve stem are summarized in Table 2.

Table 2: Summary of Stem Stress

Force	Tensile Stress (σ)	Shear Stress (τ_x)	Shear Stress (τ_y)
Fx (seismic)	$\sigma_x = 5{,}742.412\ psi$	$\tau_x = 66.005\ psi$	0
Fy (seismic)	0	0	$\tau_y = 66.005\ psi$
Fz (seismic)	$\sigma_z = 63.025\ psi$	0	0
Fg (gravity)	Included in σ_z	0	0
T_{OP} (operating torque)		$\tau_{OP} = 7{,}985.758\ psi$	

2

The seismic stresses in the stem are combined using the SRSS method [2.12] and added to the stem stress due to gravity.

The total tensile stress is calculated from Table 2:

$\sigma_{total} := \sqrt{\left(\sigma_x^2 + \sigma_z^2\right)}$, $\sigma_{total} = 5{,}742.758\ psi$

The total shear is calculated from Table 2:

$\tau_{total} := \sqrt{\left(\tau_x^2 + \tau_y^2 + \tau_{OP}^2\right)}$, $\tau_{total} = 7{,}986.304\ psi$ 2

Using Mohr's circle methodology, the maximum tensile and shear stress are calculated and compared to the allowable stress.

The allowable tensile stress for the stem, SA-639 Grade 660, at a conservative temperature of 300°F is $\sigma_{allowable} := 37100 psi$ [2.8]. The allowable shear stress is 40% of the allowable yield strength at the design temperature ($\tau_{allowable} := 0.4 * \sigma_{allowable} = 14{,}840.000\ psi$) [2.15, 2.13].

Note: Using the design temperature is conservative since the location of maximum stress in the stem occurs several inches away from the wetted part of the valve.

The maximum shear stress is calculated using its definition as the radius of Mohr's Circle:

$\tau_{max} := \sqrt{[0.5(\sigma_x - \sigma_z)]^2 + \tau_{total}^2}$ $\tau_{max} = 8{,}476.138\ psi < \tau_{allowable} = 14{,}840.000\ psi$ ACCEPTABLE 2

Factor of safety, $FS_\tau := \frac{\tau_{allowable}}{\tau_{max}} = 1.751$

The maximum principal stress is:

$\sigma_{max} := 0.5 * (\sigma_x + \sigma_z) + \tau_{max}$ $\sigma_{max} = 11{,}378.856\ psi < \sigma_{allowable} = 37{,}100.000\ psi$ ACCEPTABLE 2

Factor of safety, $FS_\sigma := \frac{\sigma_{allowable}}{\sigma_{max}} = 3.260$

5.6 Stem to Ball Connection

Pressure loads on the ball are transmitted from the ball to the body. The loading on the stem to ball connection due to pressure is negligible. Since the ball and stem are supported by the valve body and operator, there is no significant seismic or pressure loading on the stem to ball connection. Based on the valve design, there is no credible failure mode of the stem to ball connection due to pressure or seismic loading.

5.7 Ball

The ball is lightweight, of robust geometry and is supported by the valve assembly. Therefore the seismic loads on the ball are negligible. The Service Level D loads on the ball are addressed in Section 5.9. 2

5.8 Body Bolting

The body bolts must meet the requirements of section 6.4.2.1 of B16.34 [2.16]. This specifies a minimum bolt tensile area in relation to the pressure area.

$P_{class} := 900$	valve class
$d_{IDb} = 0.380\ inch$	inside diameter exposed to pressure
$A_{ID} := \frac{\pi d_{IDb}^2}{4} = 0.113\ inch^2$	inside area
$A_{bolt} := 0.0678 inch^2$	conservatively using the cross sectional area at the minor diameter
$n_{bolt} := 4$	number of body bolts

$A_{totalB} := n_{bolt} A_{bolt} = 0.271\, inch^2$ total bolt area

$S_{bolt} := 15600\, psi$ bolt allowable, conservatively taken at 300°F

$$P_{class} \frac{A_{ID}}{A_{totalB}} = 376.366$$

Since $P_{class} \frac{A_{ID}}{A_{totalB}} < S_{bolt} 0.35 / psi = true$, the requirements of section 6.4.2.1 of B16.34 are met.

The body bolting is checked due to the force that act to separate the halves of the valve. These are the pressure force on the ball when it is closed and the seismic force acting on the end cap. The bolting material is SA193 GR B8M.

Pressure force:

$P_d := 1900\, psi$ design pressure

$F_P := P_d A_{ID} = 215.482\, lbf$ force due to the pressure

Seismic force:

The analysis is performed with the valve installed vertically so that the vertical seismic force acts in the same direction as gravity. The horizontal seismic force produces a shear load in the studs.

$W_{EC} := 1.04 lbf$ weight of the end cap

$F_{ECv} := 1.5 * a_v * W_{EC} = 4.290\, lbf$ vertical force (including static load factor)

$F_{ECh} := 1.5 * a_h * W_{EC} = 3.370\, lbf$ horizontal force (including static load factor)

The horizontal force will also produce a bending moment that will be reacted out as a force couple on the studs. Assuming that the entire mass of the end cap is lumped at the end, the moment at the attachment point is:

$L_{EC} := 2.5 inch$ length of the end cap [2.5]

$M_{EC} := F_{ECh} * L_{EC} = 8.424\, inch\, lbf$ moment due to horizontal acceleration

The magnitude of the force couple is computed based on the distance between the studs. The studs are 90° apart on a 1.75" diameter bolt circle.

$d_{stud} := 1.75 inch(\sin(45 deg)) = 1.237\, inch$ distance between the studs

$F_{ECc} := \frac{M_{EC}}{d_{stud}} = 6.808\, lbf$ tensile force on a stud due to the bending moment

One stud will experience tensile force from acceleration in both horizontal directions. This will be added to the other tensile forces noted above.

The total tensile force is: $F_{Bt} := F_P + F_{ECv} + 2F_{ECc} = 233.387\,lbf$

$$\sigma_{boltT} := \frac{F_{Bt}}{n_{bolt} A_{bolt}} = 860.572\ psi$$ bolt tensile stress

$$\sigma_{boltS} := \frac{\sqrt{(2)}F_{ECh}}{n_{bolt} A_{bolt}} = 17.571\,psi$$ bolt shear stress

$$\sigma_{bolt} := \sqrt{\sigma_{boltT}^2 + \sigma_{boltS}^2} = 860.751\,psi$$ total bolt stress

The bolt stress is significantly less than the bolt allowable stress of 15,600 psi at 300°F.

5.9 Service Level D Loading

Note 8(c) of the valve specification, Reference 2.3, describes a Level D service condition with a pressure of 15,100 psia at a temperature of 302°F downstream of the valve. Under this condition, the valve is closed and not required to open, but must maintain pressure integrity. 1

For Level D Service Loadings NC-3521 of ASME Section III (Reference 2.15) refers to Table NC-3521-1. The table specifies that the membrane stress limit for Service Level D conditions is 2.0S, where S is the material allowable stress provided in ASME Section II (Reference 2.8) at the appropriate temperature. The ends of the valve can be treated as a pipe for the purpose of computing the required wall thickness for the Service Level D pressure. NC-3641.1 is used to check the thickness of the valve endcap (location of the minimum thickness):

$D_o := 0.980inch$ outside diameter (Reference 2.5)

$D_i := 0.614inch$ inside diameter (Reference 2.5)

$$t_a := \frac{(D_o - D_i)}{2} = 0.183\ inch$$ actual wall thickness

Since the wall thickness ratio, $\frac{D_o}{t_a} = 5.355$, is less than 6, equation 6 in NC-3641.1 is used to compute

the coefficient y: $$y := \frac{D_i}{(D_i + D_o)} = 0.385$$

$P := 15100psi$ Service Level D pressure

$S := 20000psi$ Allowable stress for SA-182, F316 at 302°F 1

$S_d := 2S = 40{,}000.000\ psi$ for Service Level D the allowable is twice the basic allowable per Table NC-3521-1

The required minimum wall thickness is computed using equation 3 in NC-3641.1:

$$t_m := \frac{PD_o}{2(S_d + Py)} = 0.161\ inch$$

Since the minimum actual wall thickness per the valve drawing (0.18 inch) is greater than the required minimum thickness, the valve meets the Service Level D requirements.

The valve ball is also checked for the Service Level D loading. The postulated failure mode of the ball, which is in the closed position, is a shear failure along the projected area of the endcap ID due to the high pressure acting on the surface of the ball. The area that the shear force would act on is calculated based on the outer diameter of the ball and the inner diameter of the endcap. 2

Shear surface area of the postulated failure for Service Level D pressure from the CAD model of the ball.

The surface area that the shear force acts upon is a cylinder with a diameter that matches the ID of the endcap as shown in the figure above. Conservatively, half of the area extracted from the CAD model is used.

$$A_{shear} := \frac{0.63\,inch^2}{2} = 0.315\,inch^2$$

The force due to the Service Level D pressure and the inside diameter of the endcap is:

$$ID_{ec} := 0.375\,inch$$

$$F_{SLD} := P\left(\frac{\pi ID_{ec}^2}{4}\right) = 1{,}667.744\ lbf$$

The shear stress due to this force is:

$$\sigma_{SLD} := \frac{F_{SLD}}{A_{shear}} = 5{,}294.425\ psi$$

Since this is less than the Service Level D allowable, $\sigma_{SLD} < S_d = true$, the ball will withstand the Service Level D loading.

6.0 SUMMARY / CONCLUSION

An ASME Code and seismic qualification of the ¾" VALVTech ball valve has been performed for the Bruce A&B drain valve application. The results of this qualification are summarized below.

Item	Report Section	Actual Valve	Required / Limit Value	Notes
Valve body thickness	5.1	0.18"	0.18"	Requirement met
Valve cross sectional area vs. pipe	5.2	131%	110%	Requirement met
Valve section modulus vs. pipe	5.2	111%	110%	Requirement met
Valve body natural frequency	5.4	563.56 Hz	33 Hz	Allows static seismic analysis
Valve stem natural frequency	5.4	46.97 Hz	33 Hz	Ensures stem natural frequency > 33 Hz
Stem stress	5.5	11,379 psi	37,100 psi	Requirement met
Body bolts	5.8	861 psi	15,600 psi	Requirement met
Service level D – valve thickness	5.9	0.18"	0.16"	Requirement met
Service level D – ball stress	5.9	5,294 psi	40,000 psi	Requirement met 2

This analysis has demonstrated that the 3/4" ball valve [2.1] meets the ASME Code, Subsection NC, Class 2 requirements [2.15] and seismic requirements of the Bruce specification [2.2, 2.3]. Based on this analysis, the valve will be operable during and following a seismic event. 1

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ATTACHMENT A

Design Verification Review Checklist

CURTISS WRIGHT Flow Control Company
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Customer: VALVTechnologies

Title: ASME Code and Seismic Qualification of Bruce A&B Drain Valves

ATTACHMENT A

DESIGN VERIFICATION REVIEW CHECKLIST

Item	Criteria to Be Reviewed	Not Applicable	Reviewed and Accepted	Date
1a	Are the Design Inputs consistent with the Project Requirements?		√	4/10/12
1b	Have all Design Inputs been correctly incorporated into the calculation?		√	4/10/12
1c	Are the sources of all Design Inputs clearly and correctly identified?		√	4/10/12
2a	Have all assumptions been identified and described within the Assumptions Section?		√	4/10/12
2b	Have all assumptions been provided with sufficient basis for verification?		√	4/10/12
2c	Have all assumptions been verified, identified for re-verification, or otherwise justified?		√	4/10/12
3	Have all appropriate quality and quality assurance requirements been specified and satisfied within the bounds of the calculation?		√	4/10/12
4a	Are the applicable codes, standards, and regulatory requirements adequately referenced?		√	4/10/12
4b	Are the latest applicable revisions/issues/addenda/editions of all References used?		√	4/10/12
4c	Have all References been provided with sufficient detail to permit independent verification?		√	4/10/12
4d	Have all References been listed?		√	4/10/12
5	Have applicable design, construction and operating experience been considered?		√	4/10/12
6	Have design interface requirements been satisfied?		√	4/10/12
7a	Is the Method of Analysis appropriate and consistent with Project Criteria?		√	4/10/12
7b	Has the Method of Analysis been clearly described?		√	4/10/12
7c	Have all limitations associated with the Method of Analysis been identified?		√	4/10/12
8a	Is the Purpose clearly stated and consistent with Project requirements?		√	4/10/12
8b	Is the output/results reasonable when compared to the inputs?		√	4/10/12
8c	Is the calculation summary clear and understandable?		√	4/10/12
8d	Does the conclusion fully address and support the stated Purpose?		√	4/10/12
9	Are the specified parts, equipment and processes suitable for the required application?		√	4/10/12
10	Are the specified materials compatible with design requirements, environmental conditions and each other?		√	4/10/12
11a	Have adequate design features and accessibility been provided to perform inspection, maintenance and repair?	N/A		4/10/12
11b	Have adequate maintenance requirements and inspection requirements been identified?	N/A		4/10/12
12	Are accessibly and other design provisions adequate for performance of needed maintenance and repair?	N/A		4/10/12
13	Has adequate accessibility been provided to perform the inservice inspection expected to be required during plant life?	N/A		4/10/12

CURTISS WRIGHT Flow Control Company
SCIENTECH

Document Number 19228-001-QC-02	Revision 2	Project Number 19228.0001	Page A3

Customer: VALVTechnologies

Title: ASME Code and Seismic Qualification of Bruce A&B Drain Valves

ATTACHMENT A

DESIGN VERIFICATION REVIEW CHECKLIST

Item	Criteria to Be Reviewed	Not Applicable	Reviewed and Accepted	Date
14	Has the design and installation properly considered all hazardous exposures to the public and plant personnel?	N/A		4/10/12
15	Are the acceptance criteria sufficient to allow verification that design requirements have been satisfactorily accomplished?		√	4/10/12
16	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	N/A		4/10/12
17	Are adequate handling, storage, cleaning and shipping requirements specified?	N/A		4/10/12
18	Are adequate identification requirements specified?		√	4/10/12
19a	Are requirements for record preparation, review, and approval properly identified on the document?		√	4/10/12
19b	Are requirements for record retention adequately specified?		√	4/10/12
20	Are all attachments identified and complete?		√	4/10/12

Item	Comments		

REVIEW AND ACCEPTANCE OF ABOVE CRITERA			
	PRINTED NAME	SIGNATURE	DATE
Checked / Reviewed By:	Jason Moon	[signature]	4/10/2013
Engineering Approval By:	Cesar Mejia	[signature]	4/11/2013

ATTACHMENT B

Email with Valve Component Information

From: Daniel Schurman [mailto:dschurman@valv.com]
Sent: Wednesday, September 26, 2012 11:45 AM
To: Cesar Mejia; Patel, Mahesh
Cc: Patel, Mahesh
Subject: RE: Design and Seismic Report for Bruce Power

Mahesh,

See attached drawings for body, endcap, and handwheel.

Body weighs 2.43 lbs
Endcap weighs 1.04 lbs
Handwheel weighs 2.19 lbs

Material type is on the customer drawing Cesar submitted to you.

C of G for assembly is on the drawing as well.

Studs are standard SA-193 B8M 3/8-16 UNC x 1.75" end-to-end.

Let me know if you have any other questions.

Thanks,
Dan

Appendix 01

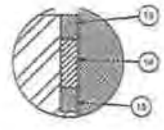
Valve Drawings (5 Total)

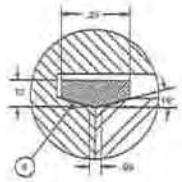
CUSTOMER: BRUCE POWER L.P.
P.O. NO,: 00176474 REV 001
BRUCE A & B DRAIN VALVES

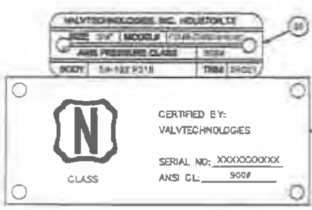
NOTES.

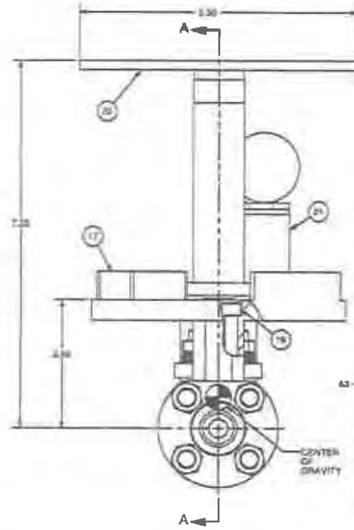
1. VALVE DESIGNED IN ACCORDANCE WITH
   - A ASME SECTION III, DIV I. SUBSECTION NC (CLASS 2), 2007 EDITION, NO ADDENDA, & CODE CASE N-62-7
   - B DESIGN SPECIFICATION B-PES-0000688506 REV 001
   - C SEISMIC QUALIFICATION PER B-SPEC-01070-00001 REV 001, DBE CAT-B
2. VALVE: 3/4" CLASS 900 LIMITED, SCH 160, 0.38" BORE
3. TYPE: BALL VALVE, METAL SEATED
4. OPERATOR: HANDWHEEL-OPEN COUNTER CLOCKWISE/CLOSE CLOCKWISE W/ POSILATCH
5. Cv: 4.5
6. PRESSURE RATING: 2031 psig @ 220°F
7. DESIGN PRESSURE 1900 psig
8. DESIGN TEMPURATURE 220°F
9. MINIMUM WALL THICKNESS PER ASME B16.34(3/8" BORE) : 0.15"
10. TORQUE TO OPERATE: 260 in. lbs
11. CAT ID #: 0000688026
12. CRN #: TBD
13. APPROX. WEIGHT: VALVE - 7lbs
    HANDWHEEL - 3 lbs
    TOTAL - 10 lbs.

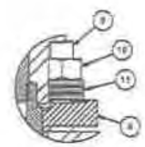
BILL OF MATERIALS					
ITEM	PART NUMBER	MATERIALS	DESCRIPTION	QTY	CODE
1	BDSWZXAV-211ZZ1N2-001	SA-182 Gr. F316	BODY	1	N2
2	EDSWZXAV-211Z11N2-B01	SA-182 Gr. F316 / RAM31	END CAP	1	N2
3	YSDXZAVV-231Z11N2-001	SA-182 Gr. F6a / RAM31	BALL	1	N2
4	USS1VMVZ-211Z11CN-001	SA-182 Gr. F316 / RAM31	UPSTREAM SEAT	1	CN
5	MSSSAVZZ-MA1ZZ1CN-001	SB-637 ALLOY UNS N07718	BELLEVILLE SPRING	1	CN
6	CSSAVVZZ-712X01CN-007	17-4 / PT24	BODY SEAL	1	CN
7	SCS004VV-011Z11SN-001	SA-638 660 TYP. 1 / RAM31	STEM	1	CN
8	GSS004AV-211KA1SN-001	SA-182 Gr. F316	GLAND	1	SN
9	MFSS004-012-V315N-000	SA-193 Gr. B8M	STUD	4	SN
10	MFNS-004-W01ZZ1SN-000	SA-194 Gr. 8M	NUT	4	SN
11	MGS-00550-036-042-CN1	SA-182 Gr. 302	GLAND SPRING	24	CN
12	MFSS006-014-Y31N2-000	SA-193 Gr. B8M	STUD	4	N2
13	MFNS-006-W01ZZ1N2-000	SA-194 Gr. 8M	NUT	4	N2
14	MSPB0A00806-RG1CN-001	GRAFOIL	GLAND PACKING	1	CN
15	MSPB0A00806-RG1CN-001	SA-182 Gr. 316	GLAND PACKING	2	CN
16	MDSSAVVZ-112ZZ1CN-001	SA-29 Gr. 4130 (H.T.)	DRIVE SLEEVE	1	CN
17	MSSS-X2V-001ZZ1CN-001	SA-216 WCB	YOKE PLATE	1	CN
18	MTBVVZZ-0A1KA1CN-001	SA-29 Gr. 1820	THRUST BEARING	1	CN
19	MFCC004-014-V18CN-000	SA-574	CAP SCREW	4	CN
20	MHC-03XV-001ZZ1CN-002	SA-29 Gr. 1020	OVAL HANDWHEEL	1	CN
21	MM-03-LFZZ-0X100-001	STAINLESS STEEL	POSILATCH	1	CN
22	MFWF-E00FLT-W15CN-002	CARBON STEEL	FLAT WASHER	1	CN
23	MFCC000-020-V18CN-000	SA-574	CAP SCREW	1	CN
24	MTAG-NAAENV-0X100-001	STAINLESS STEEL	STANDARD N TAG	1	CN
25	MTAG-AAAENV-0X100-002	STAINLESS STEEL	STANDARD TAG	1	CN

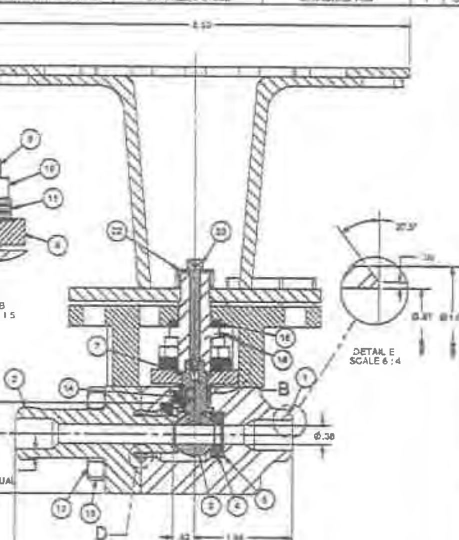


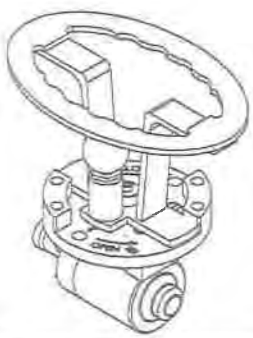


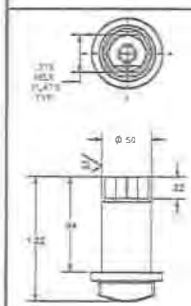












STEM DETAIL

ITEM #	TORQUE TABLE		
	ITEM	SIZE	TORQUE
9	GLAND PACKING	1/4-20 UNC X 1.25" LONG	2.5 ft-lbs
12	BODY	3/8-24UNC X 1.50" LONG	19 ft-lbs
19	STOP PLATE	1/4-20UNC X 1.50" LONG	10 ft-lbs
23	HANDWHEEL	#10-24UNC X 2.00" LONG	3.5 lbs

DIMENSIONS ARE IN INCHES
REMOVE BURRS AND BREAK EDGES
UNLESS OTHERWISE SPECIFIED

VALVTECHNOLOGIES

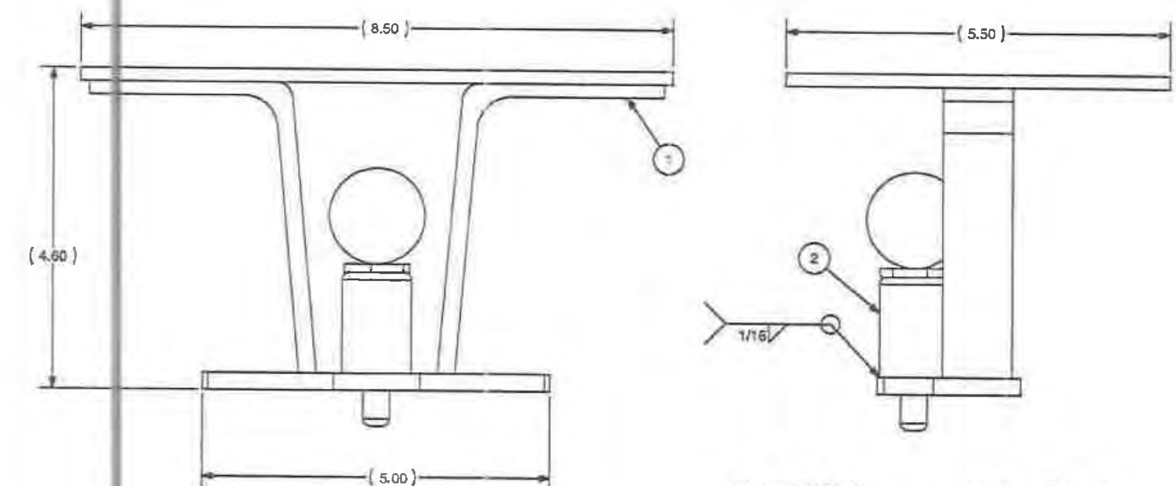
V72R-BW-ST-W007-001N2-002
ANSI 900#, WITH OVAL HANDWHEEL

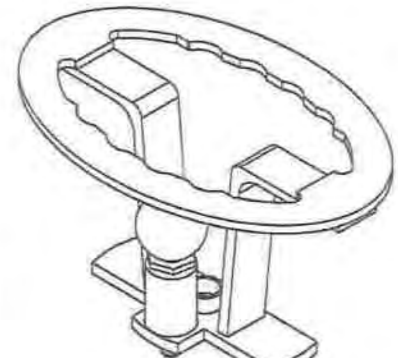
121551-001

2

MHO-03XV-CNW1.SLDDRW (Uncontrolled Current Copy as of 09/26/2012)

NOTES:
1. WELDING TO BE PER AWS D1.1





NOTE: PIN TO BE WELDED IN THE DOWN POSITION TO ENSURE PROPER FITMENT AND ABILITY TO ACTUATE.

BILL OF MATERIALS

ITEM	PART NUMBER	DESCRIPTION	QTY.
1	MHO-03XV-CN01	OVAL HANDWHEEL	1
2	MM-03-LPZZ-2X100-001	LOCKING MECHANISM	1
		-	1

RELEASED FOR MANUFACTURE

APPROVED:______ DATE:______
W/O#:______ MATERIAL:______
P.O.#:______ QUANTITY:______
S.O.#:______
J.O.#:______

THIRD ANGLE PROJECTION

[illegible]

REV	DATE	DESCRIPTION	ECN	BY	CHK	APR
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

DIMENSIONS ARE IN INCHES
REMOVE BURRS AND BREAK EDGES
UNLESS OTHERWISE SPECIFIED

CORNER RADII .03 MAX
.X= ±.030
.XX= ±.015
.XXX= ±.005
CONCENTRICITY .010 T.I.R.
ANGULAR= ±1/2°
SURFACE TEXTURE 125 RMS
MIN. INTERNAL FILLETS .015

SCALE 2/3 | MODEL FILE [illegible] | SIZE B

MATERIAL -
FINISH -

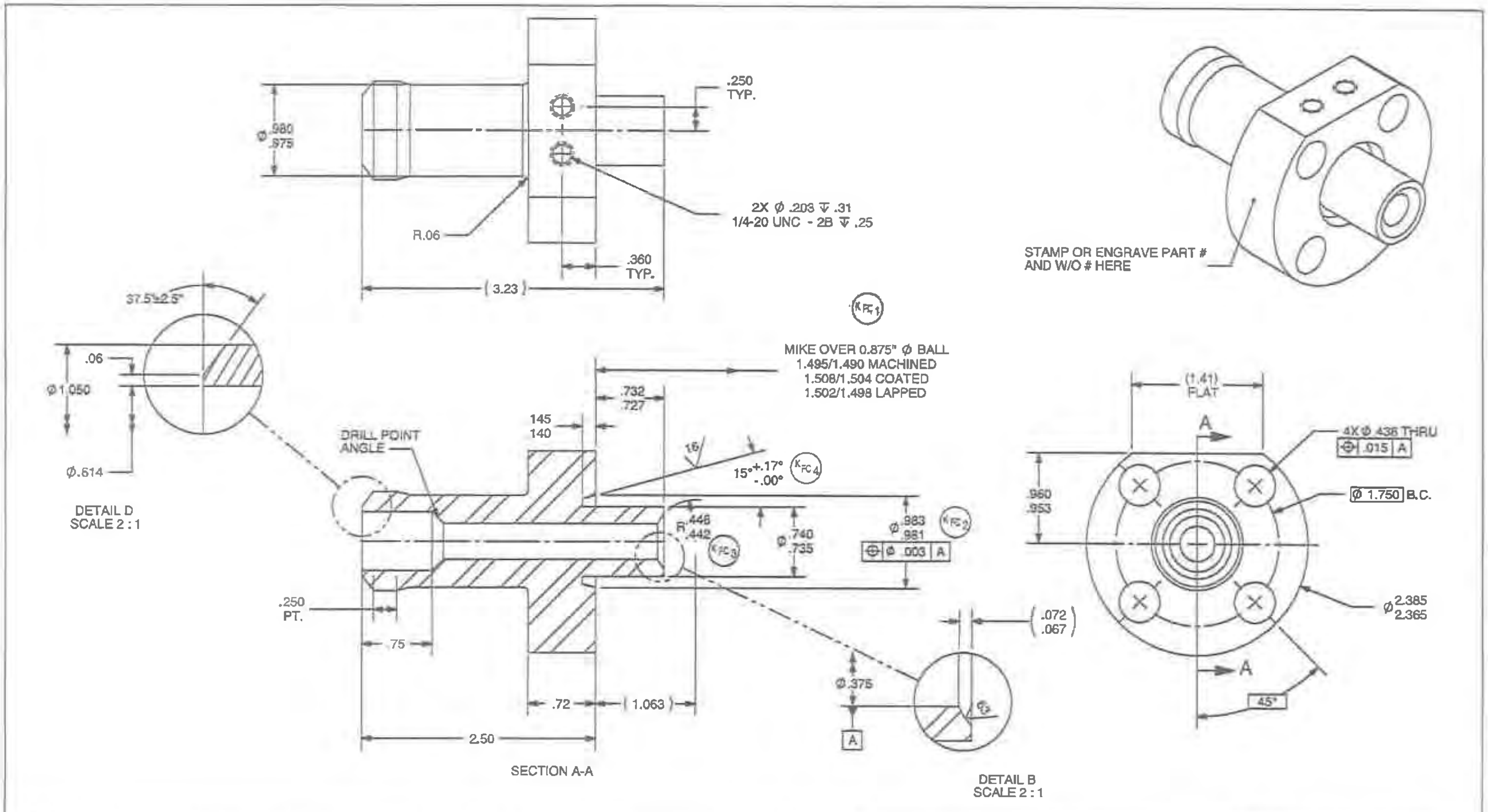
DRAWN BY	DS	DATE	08/31/12
CHECKED BY	DS	DATE	09/11/12
ENGINEER	DS	DATE	09/11/12
APPROVED BY	DS	DATE	09/11/12

VALVTECHNOLOGIES

[illegible] ROAD, HOUSTON, TEXAS [illegible]
PH: (713) [illegible] FAX: (713) [illegible]

TITLE
3/8" OVAL HANDWHEEL
W/ LOCKOUT DEVICE
COMMERCIAL NUCLEAR (WELDING)

MHO-03XV-CNW1 SH 1 OF 1 REV 1



RELEASED FOR MANUFACTURE

APPROVED:______ DATE:_____
W/O#:______ MATERIAL:_____
P.O.#:______ QUANTITY:_____
S.O.#:______
J.O.#:______

THIRD ANGLE PROJECTION

REV	DATE	DESCRIPTION	ECN	BY	CHK	APR
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

DIMENSIONS ARE IN INCHES
REMOVE BURRS AND BREAK EDGES
UNLESS OTHERWISE SPECIFIED

CORNER RADII: .03 MAX
.X= ±.030
.XX= ±.015
.XXX= ±.005
CONCENTRICITY .010 T.I.R.
ANGULAR= ±1/2°
SURFACE TEXTURE 125 RMS
MIN. INTERNAL FILLETS .015

SCALE 1:1 — MODEL FILE: E03W2XAV-N2B1 — SIZE B

DRAWN BY	BS	DATE	08/28/12
	DS	DATE	09/11/12
	DS	DATE	09/11/12
APPROVED BY	DS	DATE	09/11/12

VALVTECHNOLOGIES

3/8" ENDCAP 900#-3100#
WITH 3/4" SCH 160 BW PREP.
FOR NUCLEAR CLASS USE

E03W2XAV-N2B1 — 1

B03W2XAV-N2B1.SLDDRW (Uncontrolled Current Copy as of 09/26/2012)