the pressure equipment safety authority

9410 - 20 Ave N.W.
Edmonton, Alberta, Canada T6N 0A4
Tel: (780) 437-9100 / Fax: (780) 437-7787

June 23, 2021

Attention: Jeremy M. Payne
ASHCROFT INC
250 EAST MAIN STREET
STRATFORD, CT 06614

The design submission, tracking number 2021-02831, originally received on May 24, 2021 was surveyed and accepted for registration as follows:

CRN : 0F14836.52 **Accepted on:** June 23, 2021

Reg Type: RENEWAL **Expiry Date:** March 09, 2031

Drawing No. : SOR-A-SERIES REV.1, PRP03-AC-PS REV.2 As Noted

Fitting type: A-SERIES PRESSURE SWITCHES

Description	MAWP	Design Temperature
See Scope of Registration		

The registration is conditional on your compliance with the following notes:

As indicated on AB-41 Statutory Declaration form and submitted documentation, the code of construction is ASME B31.3.

- It is our understanding that the fitting(s), included as the scope of this submission, that is(are) subject to the Safety Codes Act shall comply with the requirements of the indicated Standard or Code of Construction on the AB-41 Statutory Declaration as supported by the attached data which identifies the dimensions, materials of construction, press./temp. ratings and the basis for such ratings, and the identification marking of the fittings.
- This registration is valid only for fittings fabricated at the location(s) covered by the QC certificate attached to the accepted AB-41 Statutory Declaration form.
- This registration is valid only until the indicated expiry date and only if the Manufacturer maintains a valid quality management system approved by an acceptable third-party agency until that date.
- Should the approval of the quality management system lapse before the expiry date indicated above, this registration shall become void.

An invoice covering survey and registration fees will be forwarded from our Revenue Accounts.

If you have any question don't hesitate to contact me by phone at (780) 433-0281 ext 3306 or fax (780) 437-7787 or e-mail Wangi@absa.ca.

Sincerely,

WANG, IAN, P. Eng.
DOP Cert. No. D00009643

STATUTORY DECLARATION
Registration of Fittings
Single or Multiple Fitting Designs within one Fitting Category

In this space, show facsimile of manufacturer's logo or trademark as it will appear on the fitting.

ASHCROFT
Trust the shield

I, Jeremy Payne (name of applicant), Materials and test engineer manager (position title) (must be in a position of authority)

of Ashcroft, Inc. (name of manufacturer)

located at 250 East Main Street, Stratford, CT 06614-5145, USA (plant address)

do solemnly declare that the fittings listed hereunder, which are subject to the Safety Codes Act (select only one)

☐ comply with the requirements of _____ (title of recognized North American Standard) which specifies the dimensions, materials of construction, pressure/temperature ratings and identification marking of the fittings, or

☒ are not covered by the provisions of a recognized North American standard and are therefore manufactured to comply with ASME B31.3 - 2020 (title of code of construction or other applicable document) as supported by the attached data which identifies the dimensions, materials of construction, pressure/temperature ratings and the basis for such ratings, and the identification marking of the fittings.

I further declare that the manufacture of these fittings is controlled by a quality control program which has been verified as described in the below Table as being suitable for the manufacturing of these fittings to the stated standard, regulation, code, guideline or other applicable document. The fittings covered by the declaration for which I seek registration are as provided in the Supplementary Sheet(s) attached.

Quality Program Verification and Manufacturing Sites

A copy of the Quality Certificate from each manufacturing site must be included

Item #	Product Description, Model or Series	Quality Program	Scope of Certification	Expiry Date	Verifying Organization	Location(s) Plant Name and address
1.	SOR-A-SERIES-REV1	ISO 9001:2015	SEE QA CERT	2021-01-31	LLoyd's Register	SEE QA CERT.
2.						

Tracking #: 2021-02831

In support of this application, the following information, calculations and/or test data are attached:

PRP03-AC-PS, Rev. 2 ; SOR-A-Series, Rev. 1, (CRN 0F14836.52 renewal) based on CRN 0F14836.5R1 renewal

(Signature of the Declarer)

June 23, 2021
(Date)

DECLARED before me at _____ (city) in the _____ of _____ (province, territory, or state)

this _____ day of _____ (Month), _____ (Year)

(print) _____
(a Commissioner of Oaths or Notary Public)

DUE TO COVID NOTARIZATION IS NOT POSSIBLE

(sign) _____
(a Commissioner of Oaths or Notary Public)

_____
(expiry date (mm/dd/yy))

Commissioner of Oaths / Notary Public in and for: _____
(province, territory, or state)

For ABSA Office Use Only:

NOTES: _____

To the best of my knowledge and belief, the application meets the requirements of the Safety Codes Act and CSA Standard B51, Part 1, Clause 4.2, and is accepted for registration in Category _____.

CRN: _____

Registered Date: _____

Expiry Date: Mar 09, 2031

Signature: _____
(Signature of the Administrator/SCO)

The information you provide is necessary only for the administration of the programs as required by the Alberta Safety Codes Act and Regulations in the Pressure Equipment Discipline

2021-02831
ABSA
SAFETY CODES ACT - PROVINCE OF ALBERTA
ACCEPTED: 0F14836.52
See acceptance letter for conditions of registration.
Date: 2021-06-23 By:
IAN WANG, P. Eng.

This stamp and signature have been affixed electronically to this registered design as required by Section 20(1) of the Pressure Equipment Safety Regulation, in accordance with the Electronic Transactions Act.

Tracking #: 2021-02831

Table 1 Scope of Fitting Designs**

Item #	Primary Pressure Bearing / Retaining Component	Material of Construction	Port Connections and Size Range	MDMT	Rated Pressure		Pressure Class(es) / Schedule(s)	Design Code(s) of Construction	Reference Catalogue (pages) or Drawing(s)
					At Ambient Temperature	At Maximum Temperature			
1	FITTING	SEE SCOPE SUMMARY SOR-A-Series, Rev. 1		PER CODE MAT'L	SEE SCOPE SUMMARY SOR-A-Series, Rev. 1			ASME B31.3-2018	SOR-A-Series, Rev 1

Table 2 Additional Scope Information

List/Attach Additional Detail and References (Product Configurations, Options, Illustrations, etc.)
Example: Series X Options

** For additional alternatives of Table 1, refer to Form AB-41a, Guide for Completing Form AB-41

2021-02831

Tracking #:_____

Ashcroft A-Series Pressure Switch - Scope of Registration
SOR-A-Series, Rev1

ASHCROFT INC

Pressure Switch Type	Drawing	Model	Process Connections	Maximum Allowable Working Pressure	Maximum Temperature (°F) [1]	Wetted Materials	Code of Construction
Watertight & Explosion Proof	50C411 & 50C412	BV-1	1/4" NPT M/F 1/8" NPT M/F 7/16-20 SAE VCR, VCO 3/4" Sanitary Blank Socket	200	-18.4 to 212	Type 316L, A240/A358, UNS 31603	ASME B31.3 2020)
		S-2		200	-40 to 212		
		BV-3	1/4" NPT Male 1/8" NPT Male 7/16-20 SAE Blank Socket	7500			
		BV-2		2000			

notes:
1 Refer to Ashcroft PRP03-AC-PS-Rev.1 for calculations.

Signed:

Dated: February 22, 2021

2021-02831

ABSA

SAFETY CODES ACT - PROVINCE OF ALBERTA

ACCEPTED: 0F14836.52

See acceptance letter for conditions of registration.

Date: 2021-06-23 By:

IAN WANG, P. Eng.

This stamp and signature have been affixed electronically to this registered design as required by Section 20(1) of the Pressure Equipment Safety Regulation, in accordance with the Electronic Transactions Act.

Ashcroft Inc.
250 East Main Street
Stratford, CT
06614-5145, USA

PRESSURE REGISTRATION PACKAGE

PRP03-AC-PS, Rev. 2

Component Registration Support

Manufacturer:	Ashcroft Inc. 250 East Main Street Stratford, CT 06614-5145, USA
Product Category:	CSA B51-2019, Fitting
Products:	A-Series Pressure Switches Watertight BV-1, BV-2, BV-3, S-2, Explosion Proof H-2, H-3, H-4, H-5, S-2, S-3
CODES OF CONSTRUCTION:	ASME B31.3 – 202-

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06614-5145, USA

TABLE OF CONTENTS

Ashcroft Inc.
250 East Main Street
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SECTION 1

REVISION RECORD

Ashcroft Inc.
250 East Main Street
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REVISION RECORD

Revision	Date	Description	Manufacturer/Date
0 1 2	24/05/2011 12/08/2011 06/19/2021	New Tests Added ABSA request	**Ashcroft Inc**  Date: June 23, 2021

By signing above, Ashcroft Inc. acknowledges that the signatory is an authorized person of Ashcroft Inc. responsible for the compliance of the product to the requirements set out herein. Furthermore, the signatory confirms that he/she has read, understood, checked and agreed with the contents of this report and the associated requirements of the referenced code(s) of construction.

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SECTION 2

Executive Summary of Results

2 EXECUTIVE SUMMARY OF RESULTS

2.1 Summary of Analytical Approach

With the A-series pressure switch process connection threaded to the pressurized process piping, Ashcroft pressure switches are subjected to the process piping internal pressure. A photograph of typical units is shown in **Figure 1**.

Figure 1 Typical Ashcroft A-series Pressure Switch (Watertight shown)

Ashcroft A-Series pressure switches in the scope of this registration are for the watertight (general purpose) version (drawing 50C411, Rev. A) and hazardous locations version (drawing 50C412, Rev. 3) whose pressure boundary parts are identical to each other, and therefore the distinction between hazardous locations and watertight (general purpose) versions is not relevant to the analysis here, and is therefore provided for information only.

The common pressure boundary parts under the scope of this registration are described in drawing 50C411, Rev. A and drawing 50C412, Rev. 3. Four unique pressure boundary assemblies represent all possible pressure bearing ranges, and are described below by the four diagrams in **Figure 2**, **Figure 3**, **Figure 4**, and **Figure 5**.

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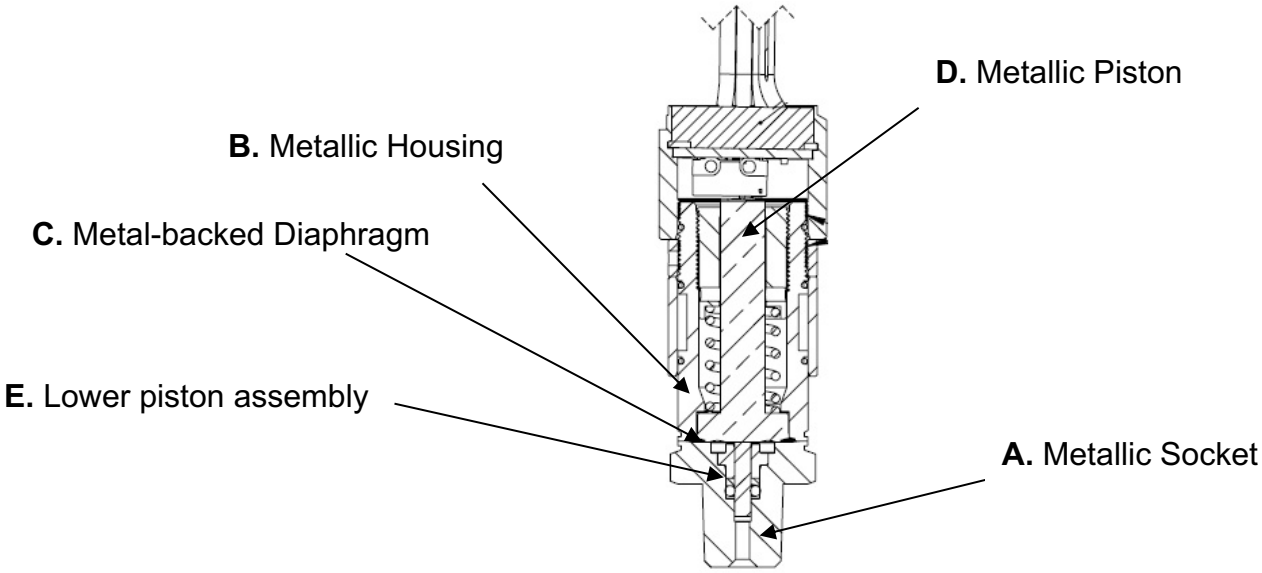

Figure 2 Typical A-Series Pressure Switch BV-3 5000-7500 psi

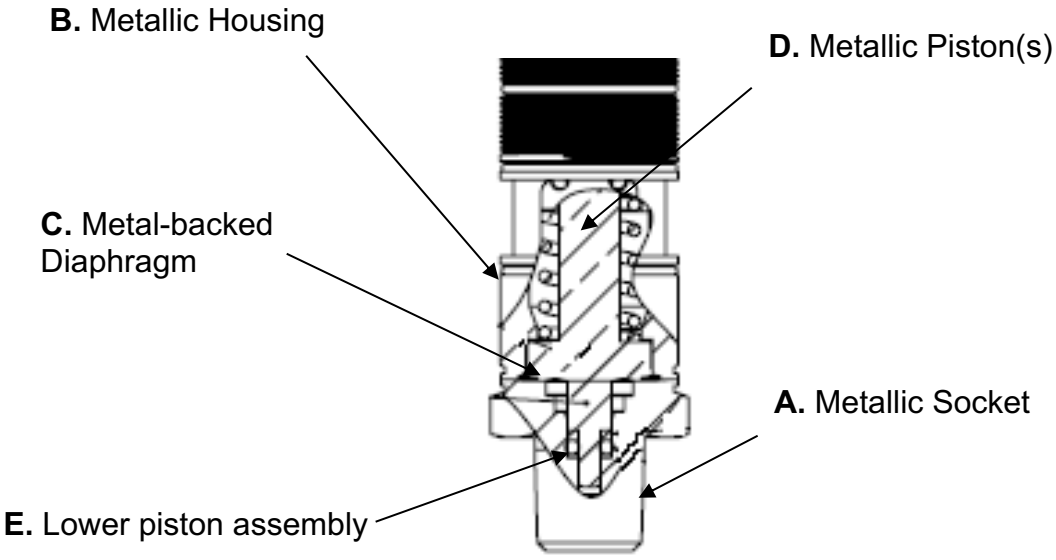

Figure 3 Typical A-Series Pressure Switch BV-2 500-2000 psi.

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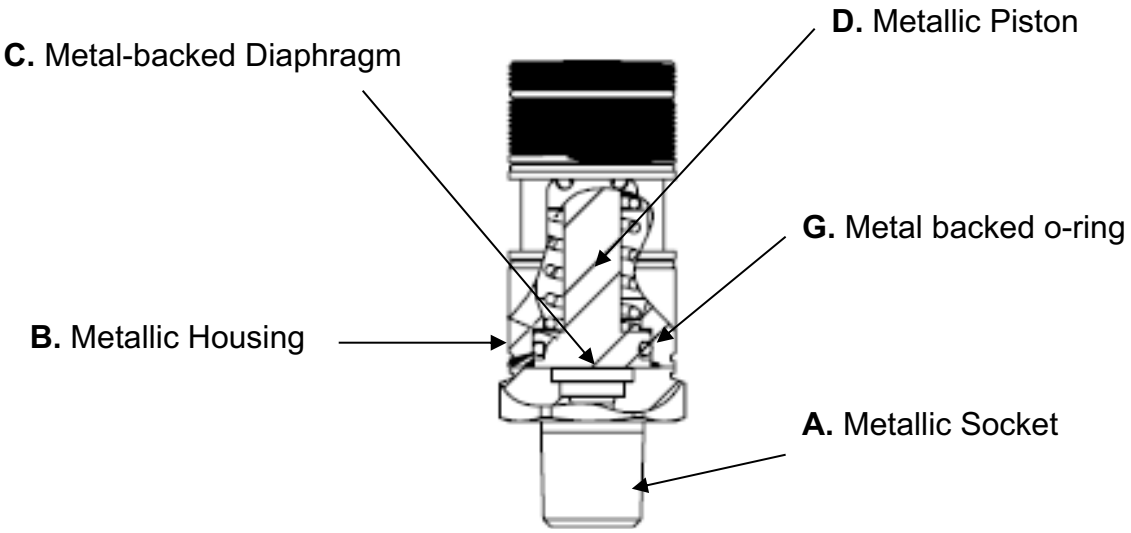

Figure 4 Typical A-Series Pressure Switch BV-2 100-200 psi.

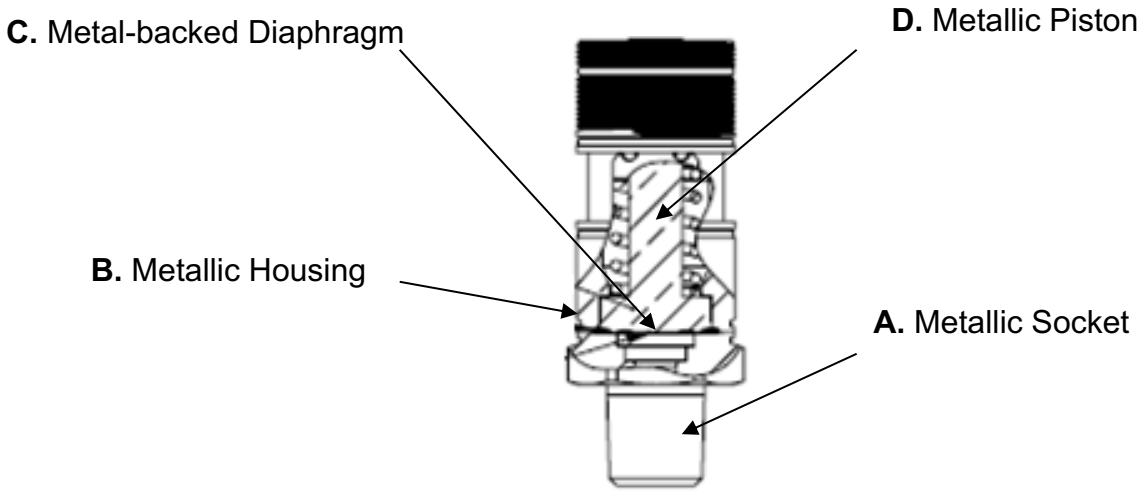

Figure 5 Typical A-Series Pressure Switch BV-2 30-200 psi.

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With referenced to **Figures 2, 3, 4 & 5 above** the Ashcroft pressure switches considered herein share common pressure boundary components as follows:

A. Metallic socket connects to piping. The socket is a wetted part subject to internal pressure and is shown in **section 3.4** of this report to comply with ASME B31.3 paragraph 304.1.1 for internal pressure of the thinnest wall. Threaded sockets are also reviewed in **section 3.3** of this report per ASME B31.3 para. 314.1.2(a):

   The socket is available in the following versions described in drawing 141B445:
   - Threaded – per **section 3.3** of this report, reviewed per ASME B31.3 para. 314.1.2(a):
     - 1/8" male NPT, ¼" male NPT, 1/8" female NPT, ¼" female NPT, 7/16-20 SAE.
   - Blank Socket – **section 3.4** per ASME B31.3, paragraph 304.1.1.
   - Sanitary Seals Socket – **section 3.4** per ASME B31.3, paragraph 304.1.1.
   - Weld-able socket - **section 3.4** per ASME B31.3, paragraph 304.1.1.

B. Metallic housing is not wetted, and is therefore not subjected to direct internal process pressure. The internal wall of the metallic housing acts to prevent the piston stroke from exceeding its limit, and is subject to a force from the piston. This is examined in **section 3.4** of this report. The internal thread withstands a force, and is calculated in **section 3.5** per ASME B1.1 for information. If the piston stroke is exceeded, the diaphragm seal will be compromised. The interaction fo the diaphragm, piston and housing is essential as a means of ensuring pressure is retained by the switch. Therefore in **section 4** the material used in the construction of the metallic housing, namely UNS S31603, A 240/A A276, 316L, is the control material for the ASME Section VIII, Div. 1, UG-101 (m) burst testing, per ASME B31.3, paragraph 304.7.2(c).

C. Diaphragm acting as a seal which is backed by the metallic piston, which is in –turn backed by the housing. In **section 4** of this report the weakest diaphragm is Buna which is qualified by witnessed burst testing per ASME Section VIII, Div. 1, UG-101(m) per ASME B31.3 paragraph 304.7.2 (c) to test its ability to seal against the metallic piston and metallic housing.

D. Metallic piston actuates switches, but is stopped by the internal wall of the metallic housing, and not subject to direct process pressure but is subject to a shear force from the process pressure. The piston shear is calculated herein for information.

E. Lower piston assembly exists only in the BV-2 and BV-3 types, and serve to distribute pressure evenly against the diaphragm. These parts cannot be computed with a reasonable assurance of accuracy and are therefore subject to burst testing in **section 4** of this report per ASME B31.3 paragraph 304.7.2, ASME Boiler and Pressure Vessel Code, Section VIII, Div.1, UG-101(m).

Material properties are derived from ASME B31.3 - 2010 with respect to calculation of internal pressure retaining capacity of a pipe for more rigorous design.

2.2 Contents of report

The following is a brief description of the contents of this report.

Section 3 Design Calculations:

- NPT Threadability per ASME B1.20.1 and B36.19.
- MAWPs determination per ASME B31.3 para 104.
- Piston head shear.
- Housing and VCR/VCO fitting thread shear.

Section 4 Witnessed Burst-Test Calculations

- Section VIII, Div. 1, UG-101 witnessed burst-test calculations.

Section 5 Conclusions and Summary

Appendix A ASME BPVC Section VIII, Div. 1, UG-101 witnessed burst-test results.

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2.3 Scope of Registration

The following shows the products included in this design registration.

Table 1 Ashcroft Pressure Switch Scope of Registration

Pressure Switch Type	Drawing	Model	Process Connection Sizes (in)	Maximum Pressure @ ambient (psi)	Maximum Temperature (°F)	Materials						Code of Construction
						Upper Piston	Lower Piston	Piston Seal	Diaphragm	Sleeve	Backup Ring	
Watertight	50C411	**BV-1**	1/4 NPT, 1/8 NPT, 7/16-20 UNF 2A, Sanitary	**200**	212 **[1]**	316L	- - -	Buna, Viton	- - -	- - -	- - -	ASME B31.3 - 2020
		BV-2		**2000**	212 **[1]**	Brass	316L	Buna, Viton	- - -	- - -	Teflon	
		BV-3		**7,500**	212 **[1]**	Brass	316L	Buna, Viton	- - -	316L	Teflon	
		S-2		**200**	212	Brass	- - -	- - -	316L	- - -	Silicone	
Explosion proof	50C412	**H-2**		**100**	185	316L	- - -	Buna	- - -	- - -	- - -	
		H-3		**400**	185	316L	- - -	Buna	- - -	- - -	- - -	
		H-4		**1000**	185	Aluminum	316L	Buna	- - -	- - -	Teflon	
		H-5		**7,500**	185	Aluminum	316L	Buna	- - -	316L	Teflon	
		S-2		**100**	185	Aluminum	- - -	- - -	316L	- - -	- - -	
		S-3		**400**	185	Aluminum	- - -	- - -	316L	- - -	- - -	

[1] 185°F for Buna seal.

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Stratford, CT
06614-5145, USA

SECTION 3
DESIGN CALCULATIONS

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3.1 Design Conditions

The design temperature is governed by the component with the lowest allowable design temperature. The following design data is of the pressure switch configuration and is tabulated from several references:

Table 2 Material Specifications and Design Temperatures

Part	Material	Temperature Range
Piston	ASTM A479 UNS S31603 (S.S. 316L) ASTM B16 UNS C36000 (Brass) (Aluminum)	-20°F to +212°F
Diaphragm	ASTM A240 UNS S31603 (S.S. 316L)	-20°F to +212°F
Sleeve	ASTM A479 UNS S31603 (S.S. 316L)	-20°F to +212°F

Assumptions:

a. The user is cautioned that if conditions exist which may result in corrosion or erosion of pressure boundary materials, fatigue, shock, chemical incompatibility, and/or low temperature impact, a suitable de-rating shall be applied to the Maximum Allowable Working Pressure (MAWP) of these components which shall be advised by the factory and are outside of the scope of the analysis herein. The analysis herein is for non-nuclear service. Lethal service per ASME Boiler and Pressure Vessel Code is not considered.

b. Provisions of ASME B31.3 – 2020 and its referenced codes of construction relating to, and not limited to post production hydrostatic testing, heat treatment, non-destructive testing, welding qualifications and procedures are the responsibility of the manufacturer and shall be followed by the manufacturer. Updates to the ASME B31.3 and its referenced codes of construction are to be monitored by the manufacturer as changes pertain to this registration and the registration updated accordingly by the manufacturer.

c. Production units associated with this report through a Canadian registration number shall be of duplicate of similar parts and comply with ASME B31.3 and its referenced codes of construction.

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3.2 Weld Analysis

Housings are welded to sockets per drawing 50C411 sheet 2 of 4, and the BV-3 stop portion of the lower piston assembly is laser beam welded (LBW, see Drawing 84A518). As the welded assembly strength cannot be computed with ar reasonable assurance of accuracy, they are tested in **section 4** of this report per ASME B31.3 – paragraph 304.7.2 (c), Section VIII, Div. 1, UG-101(m).

3.3 Process Connection Thread Mounting

3.3.1 General

Threaded joints shall not be used where severe corrosion, crevice corrosion, shock or vibration is expected to occur.

Wall thickness less than that of standard weight of ASME B36.10/B36.19 stainless steel pipe shall not be threaded, regardless of service. Pipe schedules below 40S (Standard) shall not be threaded. This is in accordance with threading requirements per ASME B31.3 para. 314.1.2(a) and ASME B1.20.1 for NPT process connections.

3.3.2 Analysis

The following example calculation provides assurance of the sufficiency of the pipe wall thickness for threading. The example is for standard size ¼" NPT, Drawing 141B445 Sheet 1 of 5.

NPS	=	Nominal Pipe Size of connection	
	=	0.25	(1/4–18 NPT)
O.D.	=	Minimum outer diameter	
	=	0.54"	(Drawing 141B445 Sheet 1 of 5)
I.D.	=	Maximum inner diameter	
	=	0.228"	(*Ibid.*)
Thick.	=	Minimum wall thickness	
	=	(O.D. – I.D.) / 2	
	=	0.156"	
T	=	Nominal Min. Wall thickness	
	=	Thick. – 12.5%	(ASME B16.11 para. 2.1.1)
	=	0.137"	

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t = Required Minimum Wall Thickness per ASME B36.19/B36.10 Schedule 40 (STD) for the given NPS.
= 0.088”

Case Validation:

T > t ?
0.137 > 0.088 ? **Yes. Therefore OK.**

Table 3 below shows the thread mounting calculations for all seal connections included in the scope of this design registration.

Table 3 Process Connection Thread Mounting per ASME B31.3 para. 314.1.2(a)

A-Series Switch Process Connection	Drawing	Equivalent NPS (in)	O.D. (in)	I.D. (in)	Thick. (in)	T (in)	B36.19/10 Sched. 40(STD) t (in)	Pass?
1/4 MNPT	141B445 1of5	0.25	0.540	0.228	0.156	**0.137**	**0.088**	**YES**
1/8 MNPT	141B445 2of5	0.125	0.405	0.228	0.089	**0.077**	**0.068**	**YES**
1/4 FNPT	141B445 3of5	0.25	0.840	0.340	0.250	**0.219**	**0.088**	**YES**
1/8 FNPT	141B445 4of5	0.125	0.840	0.228	0.306	**0.268**	**0.068**	**YES**
7/16-20 SAE	141B445 2of5	0.5	0.4375	0.228	0.105	**0.092**	**0.068**	**YES**

Therefore, by inspection, all the seals listed in Table 3 are constructed of process connections that are acceptable for threading per ASME B31.3 para. 314.1.2(a) and ASME B1.20.1 by falling under pipe schedule greater than 40 (STD).

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3.4 Minimum Wall thickness requirements: Socket

The housing wall is behind the diaphragm, and is therefore not subject to process pressure. Therefore the following analysis was performed to confirm that the socket, drawing 141B455 is wall is thick enough to meet the requirements of ASME B31.3 under paragraph 304.1.1 for internal pressure of the thinnest wall.

Socket, drawing 141B455 (common thinnest wall for all thread sizes and types):

P = 7,500 psi {Table 2.3 above}

S = Basic Allowable Stress
= 16,700 psi {ASME B31.3 Table A-1, note 37, A276 refers to A240 316L, design temperature 212°F}

E = Quality Factor
= 1 {ASME B31.3 Table A-1B, A182}

W = Weld Joint Strength Reduction Factor
= 1.0 {ASME B31.3 para. 302.3.5(e), Temperature < 950°F}

c = Sum of Mechanical Allowances
= 0.02 {minimum}

T = Min. wall thickness
= (D – d) / 2
= 0.193”

D = Min. Outer Diameter {Drawing 141B455}
= 0.830 – 0.007(tolerance)
= 0.823”

d = Max. Inner Diameter {*Ibid.*}
= 0.430 + 0.007 (tolerance)
= 0.437”

Y = Temperature Coefficient
= (d+2c) / (D+d+2c) *for T<D/6* {ASME B31.3 Table 304.1.1}
= 0.4

t_1 = Minimum Required Wall Thickness according to equation (3a)
= P*D / [2 (S*E*W + P*Y)] {ASME B31.3 para. 304.1.2(a) Eq. (3a)}
= 0.1587”

t_2 = Minimum Required Wall Thickness according to equation (3b)
= P(d + c) / {2 [SEW – P(1 – Y)]} {*Ibid.* Eq. (3b)}
= 0.1497”

t_m = Minimum Required Wall Thickness {*Ibid.* para. 304.1.1 Eq. (2)}
= MAX (t_1, t_2) + c
= 0.1787”

Case Validation:

T	>	t_m	
0.193”	>	0.1787”	**YES. Therefore OK.**

Therefore, the thinnest pipe is designed for the rated pressure per ASME B31.3 - 2010.

3.4 Piston Head Shear

Upper piston head shear strength against the housing walls may be calculated with reasonable assurance of accuracy.

With reference to **Figure 3** below, the upper piston head, drawing 344184 experiences a shear force due to internal pressure acting on the base as it stops against the housing wall, drawing 476B217. By inspection the housing wall is thicker than the piston. The shear force at the sidewalls of the piston head where it meets the housing is therefore calculated. The internal pressure is assumed to act entirely at the piston head diameter, and the piston head walls in contact with the housing are assumed to resist the resulting shear force entirely.

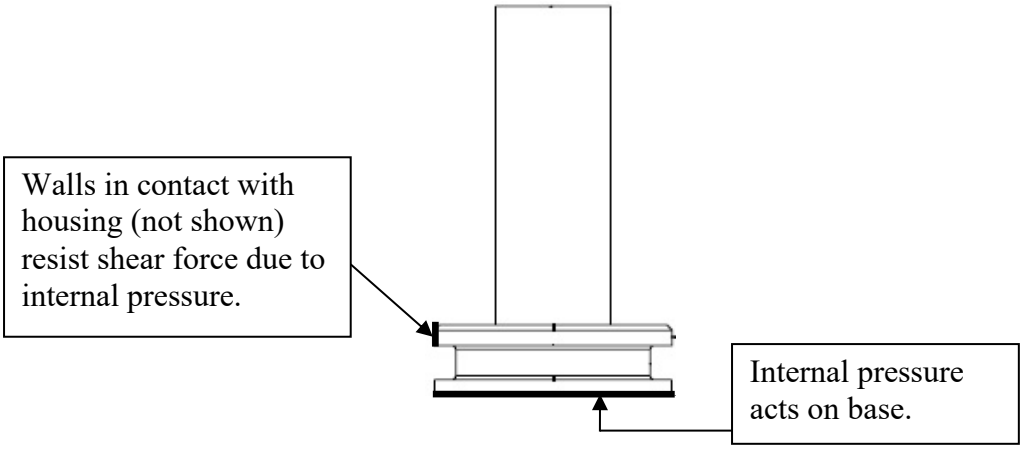

Figure 3 Piston Head Shear Analysis
(Drawing 344A184 Sheet 1 of 2 shown)

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The calculation below is for worst case 7500 psi rating brass upper piston, Drawing 344A184 Sheet 2 of 2. **Table 4** then shows tabular calculations for all pistons included in this registration.

P = maximum rated pressure + 25%
= 7500 + 25%
= 9,375 psi

D = maximum piston head diameter
= 0.621” {Drawing 344A184 Sheet 2 of 2}

F = safe shear force due to internal pressure
= $P * \pi D^2/4$
= 2,840 lbf

D_c = minimum contact diameter at piston head
= 0.621 – 0.002
= 0.619” {*Ibid.*}

L_c = minimum contact length at piston head
= 0.134 – 0.007
= 0.127” {*Ibid.*}

A_c = Minimum contact surface area under shear
= $\pi * D_c * L_c$
= 0.247 in^2

S_s = Maximum shear stress at piston head
= F / A_c
= 11,497 psi

Y = maximum allowable material yield stress at design temperature
= 20,000 {ASME B31.1 Case 175, Table 1, B16 C36000}

$S_{s,allow}$ = maximum allowable material shear stress
= 0.6 * Y {acceptable practice}
= 12,000 psi

Case Validation:

$S_{s,allow}$	>	S_s	
12,000	>	11,497	**YES. Therefore OK.**

Table 4 below shows tabular calculations for shear of all pistons included in this registration.

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Table 4 Piston Head Shear Analysis

Piston Drawing	P (psi)	D (in)	F (lbf)	D_c (in)	L_c (in)	A_c (in^2)	S_s (psi)	Y [1] (psi)	$S_{s,allow}$ (psi)	Pass?
344A184 Sheet 1 of 2	500	0.617	149	0.612	0.097	0.1865	**802**	20,000	**12,000**	**YES**
344A184 Sheet 2 of 2	9375	0.621	2840	0.619	0.127	0.247	**11,497**	20,000	**12,000**	**YES**
344A185	9375	0.227	379	0.109	0.2 **[2]**	0.0685	**5,540**	25,000	**15,000**	**YES**
344A186	9375	0.11	89	0.108	0.2 **[2]**	0.0679	**1,313**	25,000	**15,000**	**YES**

Notes
[1] Y=20ksi for B16 C36000 brass from ASME B31.1, Case 175, Table 1, <1". Y=25ksi for A276/182 S31603 S.S. from ASME B31.3 Table A-1.
[2] Conservative underestimates.

Therefore, by inspection, piston head shear strength is satisfactory for all piston configurations and for worst case pressure, dimensional, and material conditions.

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3.5 Housing Thread Shear

Housing thread shear strength against the force due to internal pressure may be calculated with reasonable assurance of accuracy per ASME B1.1 Appendix B.

With reference to **Figure 4** below, the housing experiences a force due to internal pressure acting at the diameter of the threads. This results in a shear force at the threads of the housing. The internal pressure is assumed to act entirely at the thread major diameter, and the engaged threads are assumed to resist the resulting shear force entirely.

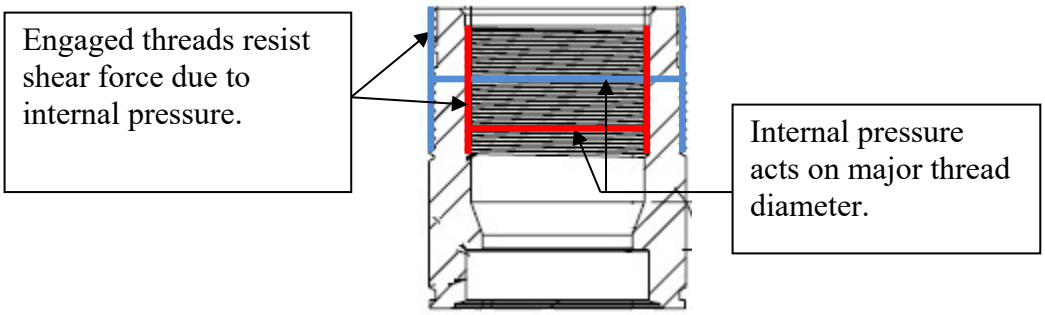

Figure 4 Housing Thread Shear Analysis (Drawing 476B217)

The following example calculation is for shear of the external thread, 7/8-32 UN 2A at worst case 7500 psi, followed by shear of the internal thread, 5/8-32 UN 2B.

P = max. rated pressure + 25%
= 7500 + 25%
= 9,375 psi

D = thread major diameter
= 0.625” {7/8-32 UN 2A}

A = cross section area
= $PI*D^2/4$
= 0.307 in^2

F = max. shear force on threads
= P*A
= 2876 lbf

D_{1max} = max. minor diameter of internal thread
= 0.8490” {ASME B1.1, 7/8-32 UN 2A}

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d_{2min} = min. pitch diameter of external thread
= 0.8499” {*Ibid.*}

n = number of threads per inch
= 32 {*Ibid.*}

LE = min. thread engagement length
= 0.490” {Drawing 476B217}

AS_s = external thread shear area per B1.1 Appendix B
= $PI * n * LE * D_{1max} * [1/2n + 0.57735*(d_{2min} – D_{1max})]$
= 0.6752 in^2

S_s = max. thread shear stress
= F/AS_s
= **4,260 psi**

For the internal thread:

F = 2876 lbf {as above}

d_{min} = min. major diameter of external thread
= 0.6179” {ASME B1.1, 5/8-32 UN 2B}

D_{2max} = max. pitch diameter of internal thread
= 0.6093” {*Ibid.*}

n = 32 {as above}

LE = 0.520” {Drawing 476B217}

AS_n = internal thread shear area per B1.1 Appendix B
= $PI * n * LE * d_{min} * [1/2n + 0.57735*(d_{min} – D_{2max})]$
= 0.6651 in^2

S_s = max. thread shear stress
= F/AS_n
= **4,325 psi**

Y = material min. yield stress
= 25,000 psi {ASME B31.3 Table A-1, A2776/182 316L}

$S_{s,allow}$ = max. allowable shear stress
= 0.6*Y {acceptable practice}
= **15,000 psi**

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Case Validaton:

S_s	<	$S_{s,allow}$	?
4260 or 4235	<	15000	**YES. Therefore OK.**

In addition, the tabulation below shows that thread shear is also acceptable for the VCR/VCO fittings included, drawings 141A341 & 141A342. Nomenclature is per the example above.

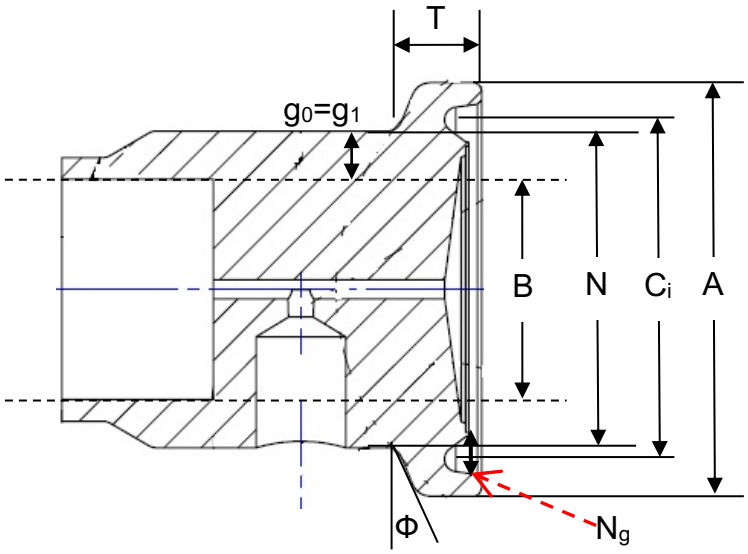
Drawing	Housing Thread (EXTERNAL)	P (psi)	D (in)	A (in^2)	F (lbf)	D_{1max} (in)	d_{2min} (in)	n	LE (in)	AS_s (in^2)	S_s (psi)
141A341/2	9/16-18 UNF	9,375	0.563	0.249	2330	0.5150	0.5182	18	0.200	0.1726	**13,502**

Weakest Material	Y (psi)	$S_{s,allow}$ (psi)	S_s<$S_{s,allow}$?
A276 S31603	25,000	**15,000**	**YES**

Hence, the shear of housing and VCR/VCO fitting threads are acceptable per ASME B1.1 Appendix B.

3.5 Sanitary Clamp per ASME BPVC, Section VIII, Division 1, Mandatory Appendix 24.

Sanitary clamp, Drawing 48A263, is checked for compliance with ASME Section VII, Appendix 24 – Design Rules for Clamp Connections. **Figure 5** below is extracted from Drawing 560B490 and shows dimensions equivalent to those depicted in Appendix 24, Fig. 24-1(c). The calculation next is for worst case dimensions, and a 500 psi rated pressure was assumed applicable, i.e. no diaphragm was considered and the pressure was assumed to fully act internally on the clamp.



.Figure 5 ASME Section VIII, Appendix 24 Illustration

Given Geometry {Drawing 560B490}

A = outside hub diameter
= 0.98”

B = inside hub diameter
= 0.521” {worst case}

N = hub neck outside diameter
= 0.5”

C_i = clamp inside diameter, assembled
= 0.75” {assumed at gasket mean diameter}

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g_0 = hub neck thickness at small end
= 0.3525”

g_1 = hub neck thickness at intersection with hub shoulder
= g_0 {Appendix 24, Figure 24-1(c)}
= 0.3525”

T = hub shoulder thickness
= 0.224”

Φ = clamp shoulder angle
= 22.5 degrees

μ = friction angle
= Φ – 5 {Appendix 24, para. 24-4(b)(4), results independent}
= 17.5 degrees

Calculated Geometry

g_2 = hub shoulder height
= (A – N)/2
= 0.115”

C = diameter of effective clamp-hub reaction circle
= (A + Ci)/2
= 0.865”

N_g = gasket seating width used to determine b_0 below
{ASME Section VIII, Appendix 2, Table 2-5.2(1a) notation ‘N’}
= 0.126” {worst case maximum}

b_0 = basic gasket seating width {*ibid.* with notation ‘b_o’}
= $N_g/2$
= 0.063”

b = effective gasket seating width {*ibid.* with notation ‘b’}
= b_0 for b_0 <= 0.25; $0.5\sqrt{b_0}$ for b_0 > 0.25
= 0.063”

G = diameter at location of gasket load reaction
= mean gasket contact face diameter for b_0 <= 0.25,
outside gasket contact face diameter less 2b for b_0 > 0.25
= 0.75” {at C_i}

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Calculated Moments

P = maximum internal design pressure
= 500 psig {worst case maximum}

H_D = hydrostatic end force on bore area
= $0.785\ B^2\ P$
= 106.5 lbf

h_D = radial distance from C to circle where H_D acts
= $[C - (B + g_1)]/2$
= -0.0042”

M_D = moment due to H_D
= $H_D\ h_D$
= -0.5 in-lbf

H = total hydrostatic end force
= $0.785\ G^2\ P$
= 253.7 lbf

H_T = difference between hydrostatic end forces
= $H - H_D$
= 147.2 lbf

h_T = radial distance from C to circle where H_T acts
= $[C - (B + G)]/2$
= 0.1013”

M_T = moment due to H_T
= $H_T\ h_T$
= 14.9 in-lbf

M_F = offset moment
= $H_D(g_1 - g_0)/2$
= 0 in-lbf

h_2 = average thickness of hub shoulder
= $T - (g_2 \tan \Phi)/2$
= 0.2002”

$\bar{h}$ = axial distance from hub face to hub shoulder ring centroid
= $\dfrac{T^2 g_1 + h_2^2 g_2}{2\,(T g_1 + h_2 g_2)}$
= 0.1093”

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M_P = pressure moment
= 3.14 PBT (T/2 – ħ)
= 0.5 in-lbf

m = gasket factor {ASME BPVC Section VIII, Appendix 2, Table 2-5.1}
= 1 {>=75A Shore durometer}

H_p = total joint contact surface compression load
= 2 b*3.14 GmP
= 159 lbf

W_{m1} = minimum required total bolt load for operating condition
= $0.637 (H + H_p) \tan(\Phi - \mu)$
= 23 lbf

y = gasket seating stress {BPVC Section VIII, App. 2, Table 2-5.1}
= 200 psi {>=75A Shore durometer}

H_m = total axial seating requirements for makeup
= 3.14 bGy
= 31.8 lbf

W_{m2} = minimum required total bolt load for gasket seating
= $0.637 H_m \tan(\Phi + \mu)$
= 17 lbf

W_{m3} = minimum required total bolt load for assembly
= $0.637(H + H_p) \tan(\Phi + \mu)$
= 220.6 lbf

W_o = total design bolt load for operating condition
= W_{m1} {Appendix 24, para. 24-4(d) Equation (4)}
= 23 lbf

S_a = maximum allowable design stress of bolt material at room Temp.
= 25000 psi {assumed value, results independent}

S_b = maximum allowable design stress of bolt material at design Temp.
= 25000 psi {assumed value, results independent}

A_{m1} = total cross-section area of bolts per clamp lug at thread root or section of least diameter under stress, required for operating condition
= $W_{m1}/ 2S_b$

= 0.00046 in^2

A_{m2} = total cross-section area of bolts per clamp lug at thread root or section of least diameter under stress, required for gasket seating
= $W_{m2}/ 2S_a$
= 0.00034 in^2

A_{m3} = total cross-section area of bolts per clamp lug at thread root or section of least diameter under stress, required for assembly
= $W_{m3}/ 2S_a$
= 0.00441 in^2

A_{mL} = total cross-section area of bolts per clamp lug
= MAX (A_{m1}, A_{m2}, A_{m3})
= 0.00441 in^2

A_{bL} = total cross-section area of bolts per clamp lug using the smaller of the root diameter of thread or least diameter of unthreaded portion
= A_{mL} {assumed value, results independent}
= 0.00441 in^2

W_a = total design bolt load for assembly condition
= $(A_{mL} + A_{bL}) S_a$ {Appendix 24, para. 24-4(d) Equation (5)}
= 220.6 lbf {equal to W_{m3}}

H_{Go} = difference between total effective axial clamping preload and sum of H and H_p, operating
= $1.571 W_o/\tan(\Phi + \mu) – (H + H_p)$
= - 369.7 lbf

H_{Ga} = difference between total effective axial clamping preload and sum of H and H_p, assembly
= $1.571 W_a/\tan(\Phi + \mu) – (H + H_p)$
= 0.3 lbf

h_{Go} = radial distance from C to where H_{Go} acts
= 0 {full face contact geometry}

h_{Ga} = radial distance from C to where H_{Ga} acts
= 0 {full face contact geometry}

M_{Go} = moment due to H_{Go}
= $H_{Go}\ h_{Go}$
= 0 in-lbf

M_{Ga} = moment due to H_{Ga}
= $H_{Ga}\ h_{Ga}$
= 0 in-lbf

M_{Ro} = radial clamp equilibriating moment, operating
= $1.571\ W_o\ \{ħ - T + [(C - N)\tan\Phi]/2$
= - 3.3 in-lbf

M_{Ra} = radial clamp equilibriating moment, assembly
= $1.571\ W_a\ \{ħ - T + [(C - N)\tan\Phi]/2$
= - 31.5 in-lbf

M_{Oo} = total rotational moment on hub, operating
= $0.785\ W_o(C - G) / \tan(\Phi + \mu)$ {App 24, para. 24-5(d) Equation (6)}
= 1.3 in-lbf

M_{Oa} = total rotational moment on hub, assembly
= $0.785\ W_a(C - G) / \tan(\Phi + \mu)$ (*Ibid.*)
= 12.6 in-lbf

I_h = moment of inertia of hub relative to its neutral axis
= $g_1T^3/3 + g_2h_2^3/3 - (g_2h_2 + g_1T)ħ^2$
= 0.000410 in^4

ğ = radial distance from B to hub shoulder ring centroid
= $\dfrac{Tg_1^2 + h_2g_2(2g_1 + g_2)}{2\ (Tg_1 + h_2g_2)}$
= 0.22902”

M_{Ho} = reaction moment at hub neck, operating
= $M_{Oo} / \{ 1 + [1.818/\sqrt{(Bg_1)}]\ [T - ħ + 3.305{*}I_h/(g_1^2(B/2 + ğ))] \}$
= 0.8 in-lbf

M_{Ha} = reaction moment at hub neck, assembly
= $M_{Oa} / \{ 1 + [1.818/\sqrt{(Bg_1)}]\ [T - ħ + 3.305{*}I_h/(g_1^2(B/2 + ğ))] \}$
= 8 in-lbf

Calculated Hub Stresses (Appendix 24, para. 24-6 & 24-7)

f = hub stress correction factor
= 1.0 {BPVC Section VIII, Appendix 2, Figure 2-7.6, g_1/g_0=1}

S_{1o} = hub longitudinal stress, operating
= $f\ \{ PB^2/[4g_1(B + g_1)] + 1.91M_{Ho}/[g_1^2(B + g_1)] \}$
= 124.8 psi

S_{1a} = hub longitudinal stress, assembly
= $f \{ PB^2/[4g_1(B + g_1)] + 1.91M_{Ha}/[g_1^2(B + g_1)] \}$
= 250.3 psi

S_2 = hub hoop stress
= $P (N^2 + B^2)/(N^2 – B^2)$
= 1432.6 psi

Z_o = clamp-hub taper angle, operating
= $\Phi – \mu$
= 5 degrees

Z_g = clamp-hub taper angle, gasket seating and preload
= $\Phi + \mu$
= 40 degrees

S_{3o} = hub axial shear stress, operating
= $0.75 W_o / [T (B + 2g_1) \tan Z_o]$
= 718.1 psi

S_{3a} = hub axial shear stress, assembly
= $0.75 W_a / [T (B + 2g_1) \tan Z_g]$
= 718.1 psi
{this would increase for a larger assumed value of A_{bL}, however order of magnitude variations do not affect the validation below}

Q_o = reaction shear force at hub neck, operating
= $1.818M_{Ho} / \sqrt{(Bg_1)}$
= 3.5 lbf

Q_a = reaction shear force at hub neck, assembly
= $1.818M_{Ha} / \sqrt{(Bg_1)}$
= 33.8 lbf

S_{4o} = hub radial shear stress, operating
= $0.477Q_o / [g_1(B + g_1)]$
= 5.5 psi

S_{4a} = hub radial shear stress, assembly
= $0.477Q_a / [g_1(B + g_1)]$
= 52.3 psi {*Ibid.*}

S_{9o} = bearing stress at clamp-to-hub contact, operating
= $W_o / [(A – C_i)C \tan Z_o]$

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= 1321.6 psi

S_{9a} = bearing stress at clamp-to-hub contact, assembly
= $W_a / [(A - C_i)C \tan Z_g]$
= 1321.6 psi {*Ibid.*}

Allowable Design Stresses (Appendix 24, para. 24-8 Table 24-8)

S_{OH} = allowable design stress of hub material, operating
= 16700 psi {ASME BPVC Section II Part D, A182 316L at 212°F}

S_{AH} = allowable design stress of hub material, assembly
= 16700 psi {*Ibid.* at ambient}

$S_{1o, allow}$ = maximum allowable value of S_{1o}
= 1.5 S_{OH}
= 25050 psi
$S_{1a, allow}$ = maximum allowable value of S_{1a}
= 1.5 S_{AH}
= 25050 psi

$S_{2, allow}$ = maximum allowable value of S_2
= S_{OH}
= 16700 psi

$S_{3o, allow}$ = maximum allowable value of S_{3o}
= 0.8 S_{OH}
= 13360 psi
$S_{3a, allow}$ = maximum allowable value of S_{3a}
= 0.8 S_{AH}
= 13360 psi

$S_{4o, allow}$ = maximum allowable value of S_{4o}
= 0.8 S_{OH}
= 13360 psi
$S_{4a, allow}$ = maximum allowable value of S_{4a}
= 0.8 S_{AH}
= 13360 psi

$S_{9o, allow}$ = maximum allowable value of S_{9o}
= 1.6 S_{OH}
= 26720 psi
$S_{9a, allow}$ = maximum allowable value of S_{9a}
= 1.6 S_{AH}
= 26720 psi

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Case Validation:

S_{1o}	<	$S_{1o,\ allow}$	
124.8	<	25050	**YES**
S_{1a}	<	$S_{1a,\ allow}$	
250.3	<	25050	**YES**
S_2	<	$S_{2,\ allow}$	
1433	<	16700	**YES**
S_{3o}	<	$S_{3o,\ allow}$	
718	<	13360	**YES**
S_{3a}	<	$S_{3a,\ allow}$	
718	<	13360	**YES**
S_{4o}	<	$S_{4o,\ allow}$	
5.5	<	13360	**YES**
S_{4a}	<	$S_{4a,\ allow}$	
52.3	<	13360	**YES**
S_{9o}	<	$S_{9o,\ allow}$	
1322	<	26720	**YES**
S_{9a}	<	$S_{9a,\ allow}$	
1322	<	26720	**YES**

Therefore, the ¾" clamp end is sufficient for the pressure indicated per Appendix 24 of ASME BPVC, Section VIII, Division 1.

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Section 4
Witnessed Burst Test Calculations

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4 Witnessed Burst Test Calculations

4.1 Burst Test Overview

ASME B31.3 paragraph 304.7.2 permits burst testing of unlisted assemblies. With reference to the Ashcroft pressure switches, the primary focus of this ASME Section VIII, Div. 1, UG-101 (a)(2)(b) *tests based on bursting of the part* is to determine the burst pressure (and subsequent MAWP under para. UG-101) of the unlisted piston/housing/spring/back-up-ring assemblies, whose combined strength cannot be computed with a satisfactory assurance of accuracy.

Burst tests were witnessed by an ASME National Board Authorized Inspector, whose valid commission number is written on each witnessed burst test report.

The piston head has been demonstrated above to be designed to resist the operating force exerted on it by the internal pressure by calculation with reference to ASME materials used.

The mode of failure was noted during the witnessed burst test reports, and in all cases the A-Series pressure switch components did not fail. All burst tests were stopped due to seal loss at the thread due to the unusually high pressures.

Please see UG-101 witnessed burst-test results in Appendix A. The parts were hydrostatically tested in the presence of a National Board certified Authorized Inspector until burst per ASME BPVC Section VIII, UG-101(m), and the burst pressure and mode of failure duly noted.

4.2 Burst Test Analysis

The pressure switches included in this design registration were grouped together depending upon the mode of construction or operation of the unlisted assemblies. The following table, referencing drawings 50C411 & 50C412, details the groupings and hence the qualified parts for a given burst-test unit.

Table 4.2 Analytical Groupings of Pressure Switches

Pressure Switches	Rated Pressure (psi)
BV-2	2,000
BV-1	200
BV-3	7,500
S-2	200

4.3 Maximum Allowable Working Pressure Calculations

The following assumptions apply to the hydrostatic test calculations:

1) The material and geometry of the assembly burst-tested is representative of a regular production unit. The tested unit was assembled by a method performed the same as for regular production units, which are controlled via a recognized quality system.
2) The tested unit is representative of the weakest assembly of the representative configuration tested. Each tested unit is representative of a variant assembly or assemblies and is burst with thinnest wall and subject to maximum process pressure.

The maximum allowable working pressures for the unlisted assemblies are calculated as follows:

$P = (B/4)*E*(S_\mu / S_{\mu r})$ {ASME Section VIII, UG-101 (m)(2)(a)}

where:

P = Calculated MAWP at room temperature

B = Burst test pressure

E = Efficiency of weld joint

S_μ = Specified minimum tensile strength at room temperature

$S_{\mu r}$ = Maximum actual tensile strength at room temperature from heat lot

MAWP at design temperature for each material in use was calculated as follows:

$P_0 = P * (S / S_2)$ {*Ibid.* UG-101 (k)}

where:

P_0 = Maximum allowable working pressure at design temperature

P = From above

S = Maximum allowable stress value at design temperature

S_2 = Maximum allowable stress value at test temperature

The following calculation shows that the parts tested are constructed to pressure ratings consistent with ASME BPVC Section VIII, UG–101. **Table 4.3** provides tabular calculations for all burst-tested units. Each test was done for worst case pressure and material conditions. The example below is for test number 1 per **Table 4.3** below.

Model tested: BV-1
Qualifying Switches: BV-1 per Drawings 50C411 & 50C412.

B = 12000 psi
E = 0.7
S_μ = 70 ksi {ASME 31.3 table A-1, Type 316L, A240/A358}
$S_{\mu r}$ = 512 MPa = 74.2 ksi {Appendix A}
P = $(B/4)*E*(S_\mu / S_{\mu r})$ {ASME Section VIII, UG-101 (m)(2)(a)}
= (12000/4) * 0.7 * 0.942
= 1978 psi

Check at ambient:

Rated Pressure	<	P	?
200 psi	<	1689 psi	**Yes. Therefore o.k.**

S = 16700 psi {*Ibid.* @ 212°F}
S_2 = 16700 psi {ASME 31.3 table A-1, Type 316L, A240/A358}
P_0 = P * (S / S_2) { UG-101 (k)}
= 1978 psi

Check at design temperature 212°F:

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Rated Pressure	<	P_0	?
200 psi	<	1978 psi	**Yes. Therefore o.k.**

Therefore, by inspection, the representative burst-tested configurations, as well as configurations qualified by those tested, were designed in compliance to ASME B31.3 – 2010.

5. Conclusion

With reference to the foregoing calculations and burst test results, the pressure switches evaluated in this report have been demonstrated to be designed per the applicable sections of ASME B31.3-2010.

The Scope of registration is summarized in Table 2.3 of Section 2.3.

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Table 4.3 Witnessed Burst Test Results

Test No.	Ashcroft Part	Design Pressure (DP) psi	Burst Pressure psi	E	S_u	S_{uavg}	S_u/S_{uavg}	MAWP (UG-101 (m)(2)) psi @ ambient	S	S_2	MAWP @ 212 °F (UG-101 (k))	DP < MAWP?
1	BV-1	200	12000	0.7	70	74.3	0.94213	1978	16700	16700	1978	Yes
2	BV-2	2000	49000	1	70	74.3	0.94213	11541	16700	16700	11541	Yes
3	BV-3	7500	56000	1	70	74.3	0.94213	13190	16700	16700	13190	Yes
4	S-2	200	12000	0.7	70	74.3	0.94213	1978	16700	16700	1978	Yes

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Appendix A
ASME BPVC Section VIII, Div. 1, UG-101
Witnessed Burst-Test Results

Ashcroft Witnessed Burst Test Report No. _____

Product Part No.: BU-2 (FIELD ADJUSTABLE)

Product description: PISTON ASSEMACY FOR A-SERIES SWITCH 20000 PSI

Project Identification: Ashcroft A-Series Pressure Switch watertight and explosion proof

Fitting Description: See diagram

Test Rig Pressure Gauge	
Manufacturer:	ASHCROFT
Serial Number:	A: 0777 B: 0302 C: 0632
Gauge Range:	A: 7500psi B: 30000 psi C: 8000 Psi
Calibration Date:	A: 2/16/2011 B: 5/17/11 C: 8/8/11
Attach calibration certificate to witnessed test report	

TEST TEMPERATURE: 70.7 F

TEST DATE: 8/11/2011

TIME: 10:23

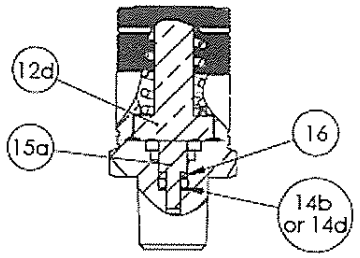
Material Certification References: _____

Material Certification $S_{\mu avg}$ _____

Ashcroft Witnessed Burst Test Report No. _____

Factory Set

BV-2
500-2000 psi

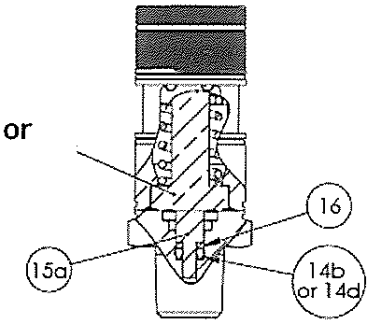


BV-2 PISTON ASSEMBLY				
Item	Qty	Part No	Description	Material
12d	1	344A184-03	UPPER PISTON	BRASS
15a	1	344A185-01	LOWER PISTON	316L
16	1	122A189-02	BACK-UP RING	TEFLON
SELECT O-RING BASED ON "SEAL" CODE ORDERED				
14b	1	185A106-95	O-RING (FOR "B" SEAL)	BUNA
14d	1	185A106-98	O-RING (FOR "V" SEAL)	VITON

Field Adjustable

BV-2
500-2000 psi

or



BV-2 PISTON ASSEMBLY				
Item	Qty	Part No	Description	Material
12a	1	344A184-04	UPPER PISTON	BRASS
15a	1	344A185-01	LOWER PISTON	316L
16	1	122A189-02	BACK-UP RING	TEFLON
SELECT O-RING BASED ON "SEAL" CODE ORDERED				
14b	1	185A106-95	O-RING (FOR "B" SEAL)	BUNA
14d	1	185A106 98	O-RING (FOR "V" SEAL)	VITON

Notes:

1. Factory Set and Field Adjustable units interchangeable for purpose of pressure seal test.
2. Seal materials of similar durometer are assumed equivalent, and are limited and limit design temperature. Note o-ring material tested.

Representative Test Sample Diagram to be threaded into test apparatus

Rated Design pressure of proprietary sensor seal assembly: 2000 psi
Minimum required burst target value: 9000 psi.
Do not stop test at 9000 psi. Test burst sample to failure, noting mode of failure.

Ashcroft Witnessed Burst Test Report No. _____

Burst Test Recorded Results

	Column 1 Pressure (psig)	Column 2 Hold time (minutes)	Column 3 Clock time	Column 4 Comments
	1000	~~30~~ .5	Initialization pressure	Initialization pressure
	1214	.5	10:23	
	~~1400~~ 1412	.5		
A	1621	.5		
	1815	.5		
	2018	.5		NO LEAK, NO BURST
	4500	.5	10:29	NO LEAK, NO BURST
B	9000	.5		NO LEAK, NO BURST
	30000	.5		NO LEAK, NO BURST
C	49000	—		FAILURE @ OF TEFLON NO BURST, NO LEAK IN UNIT

Column 1 Pressure (psig)	Column 2 Hold time (minutes)	Column 3 Clock time	Column 4 Comments

* "PASS" and "FAIL" are defined above.

At what pressure did the sample FAIL or the test discontinued?:

49000 PSI

GENERAL OBSERVATIONS / COMMENTS / MODE OF FAILURE:

TEFLON TAPE FAILED @ THREAD, NOT THE ACTUAL PRODUCT

Therefore, the maximum pressure observed is confirmed to be

49000 psi and the test is accepted.

Ashcroft Witnessed Burst Test Report No. _____

The undersigned have witnessed the burst test pass pressure above and verified that the above MAWP is permissible per the burst result recorded in this witnessed burst test report:

Test Performed by:	**National Board Authorized Inspector:**
Name: NANCY LASELL Signature: Nancy Lasell Organization: **Ashcroft Inc** 250 East Main Street, Stratford, CT, 06614 Test Date: 8/11/11	Authorized Name: Dennis Poulos Signature: Dennis Poulos Organization: HSBCT NB Commission expiry: NB#12054A 12/31/11 Date : 8/11/11

A facsimile of the National Board Authorized Inspector Commission is to be provided along with the witnessed burst test report.

Ashcroft Witnessed Burst Test Report No. _____

Ashcroft Witnessed Burst Test Report No. _____

Product Part No.: BV-1 (FIELD ADJUSTABLE)

Product description: O-RING PISTON A-SERIES SWITCH 2000 PSI

Project Identification: Ashcroft A-Series Pressure Switch watertight and explosion proof

Fitting Description: See diagram

Test Rig Pressure Gauge	
Manufacturer: ASHCROFT	
Serial Number: A: 0277	B: 0225
Gauge Range: A: 7500 PSI	B: 30 000
Calibration Date: A: 2/16/11	B: 3/21/11
Attach calibration certificate to witnessed test report	

TEST TEMPERATURE: 68.1 °F

TEST DATE: 8/11/11

TIME: 11:30 AM

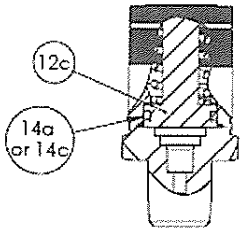
Material Certification References: _____

Material Certification $S_{\mu avg}$ _____

Ashcroft Witnessed Burst Test Report No. _____

Factory Set

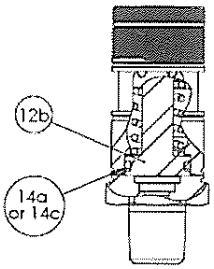
BV-1
100-200 psi



or

Field Adjustable

BV-1
100-200 psi



BV-1 PISTON ASSEMBLY				
Item	Qty	Part No	Description	Material
12c	1	344A164-01	UPPER PISTON	316L
SELECT O-RING BASED ON "SEAL" CODE ORDERED				
14a	1	185A106-96	O-RING (FOR "B" SEAL)	BUNA
14c	1	185A106-99	O-RING (FOR "V" SEAL)	VITON

BV-1 PISTON ASSEMBLY				
Item	Qty	Part No	Description	Material
12b	1	344A164-02	UPPER PISTON	316L
SELECT O-RING BASED ON "SEAL" CODE ORDERED				
14a	1	185A106-96	O-RING (FOR "B" SEAL)	BUNA
14c	1	185A106-99	O-RING (FOR "V" SEAL)	VITON

Notes:

1. Factory Set and Field Adjustable units interchangeable for purpose of pressure seal test.
2. Seal materials of similar durometer are assumed equivalent, and are limited and limit design temperature. Note o-ring material tested.

Representative Test Sample Diagram to be threaded into test apparatus

Rated Design pressure of proprietary sensor seal assembly: 200 psi
Minimum required burst target value: 900 psi.
Do not stop test at 900 psi. Test burst sample to failure, noting mode of failure.

Ashcroft Witnessed Burst Test Report No. _____

Burst Test Recorded Results

	Column 1 Pressure (psig)	Column 2 Hold time (minutes)	Column 3 Clock time	Column 4 Comments
	120	.5	Initialization pressure	Initialization pressure
	128	.5	11:20 AM	
A	148	.5		
	165	.5		
	189	.5		
	210	.5		
	461	.5		
	979	.5		NO BURST
B	1200			BURST

Column 1 Pressure (psig)	Column 2 Hold time (minutes)	Column 3 Clock time	Column 4 Comments

* "PASS" and "FAIL" are defined above.

At what pressure did the sample FAIL or the test discontinued?:

12 000 PSI

GENERAL OBSERVATIONS / COMMENTS / MODE OF FAILURE:

HOUSING WELD SEPARATED

Therefore, the maximum pressure observed is confirmed to be

12000 PSI and the test is accepted.

Ashcroft Witnessed Burst Test Report No. _____

The undersigned have witnessed the burst test pass pressure above and verified that the above MAWP is permissible per the burst result recorded in this witnessed burst test report:

Test Performed by:	**National Board Authorized Inspector:**
Name: NANCY LASELL Signature: Nancy Lasell Organization: **Ashcroft Inc** 250 East Main Street, Stratford, CT, 06614 Test Date: 8/11/11	Authorized Name: Dennis Poulos Signature: Dennis Poulos Organization: HSBCT NB Commission expiry: NB# 12054A exp: 12/31/11 Date : 8/11/11

A facsimile of the National Board Authorized Inspector Commission is to be provided along with the witnessed burst test report.

Ashcroft Witnessed Burst Test Report No. _____

Ashcroft Witnessed Burst Test Report No. _____

Product Part No.: BV-3 (FIELD ADJUSTABLE)

Product description: PISTON A-SERIES SWITCH 7500PSI

Project Identification: Ashcroft A-Series Pressure Switch watertight and explosion proof

Fitting Description: See diagram

Test Rig Pressure Gauge		
Manufacturer: ASHCROFT		
Serial Number:		
A: 0777	B: 0302	C: 0832
Gauge Range:		
A: 7500PSI	B: 30,000PSI	C: 30,000 PSI
Calibration Date:		
A: 2/16/11	B: 5/17/11	C: 8/8/11
Attach calibration certificate to witnessed test report		

TEST TEMPERATURE: 68.1°F

TEST DATE: 8/11/11

TIME: 11:15 AM

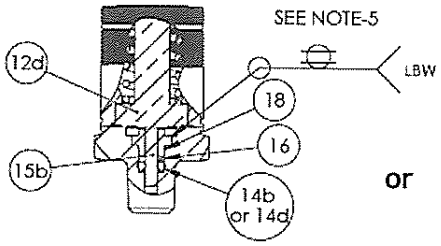
Material Certification References: _____

Material Certification $S_{\mu avg}$ _____

Ashcroft Witnessed Burst Test Report No. _____

Factory Set

BV-3
5000-7500 psi

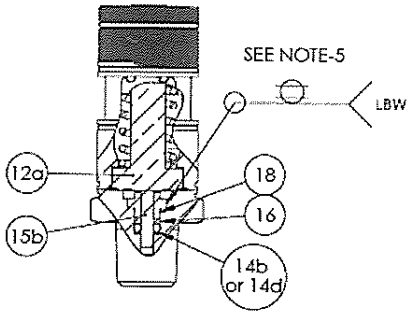


BV-3 PISTON ASSEMBLY				
Item	Qty	Part No	Description	Material
12d	1	344A184-03	UPPER PISTON	BRASS
15b	1	344A186-01	LOWER PISTON	316L
16	1	122A189-02	BACK-UP RING	TEFLON
17	1	471A186-01	STOP	316L
SELECT O RING BASED ON "SEAL" CODE ORDERED				
14b	1	185A106-95	O-RING (FOR "B" SEAL)	BUNA
14d	1	185A106-98	O-RING (FOR "V" SEAL)	VITON

or

Field Adjustable

BV-3
5000-7500 psi



BV-3 PISTON ASSEMBLY				
Item	Qty	Part No	Description	Material
12a	1	344A184-04	UPPER PISTON	BRASS
15b	1	344A186-01	LOWER PISTON	316L
16	1	122A189-02	BACK-UP RING	TEFLON
18	1	471A186-01	STOP	316L
SELECT O-RING BASED ON "SEAL" CODE ORDERED				
14b	1	185A106-95	O-RING (FOR "B" SEAL)	BUNA
14d	1	185A106-98	O-RING (FOR "V" SEAL)	VITON

Notes:

1. Factory Set and Field Adjustable units interchangeable for purpose of pressure seal test.
2. Seal materials of similar durometer are assumed equivalent, and are limited and limit design temperature. Note o-ring material tested.

Representative Test Sample Diagram to be threaded into test apparatus

Rated Design pressure of proprietary sensor seal assembly: 7500 psi
Minimum required burst target value: 33,750 psi.
Do not stop test at 33,750 psi. Test burst sample to failure, noting mode of failure.

Ashcroft Witnessed Burst Test Report No. _____

Burst Test Recorded Results

	Column 1 Pressure (psig)	Column 2 Hold time (minutes)	Column 3 Clock time	Column 4 Comments
			Initialization pressure	Initialization pressure
A	3750	.5		
A	4500	.5	10:50 AM	
A	5272	.5		
A	6091	.5		
A	6777	.5		
A	7559			
B	16250	.5	11:00 AM	NO BURST
C	35,000	.5	11:05 AM	NO BURST
C	56,000			NO BURST

Column 1 Pressure (psig)	Column 2 Hold time (minutes)	Column 3 Clock time	Column 4 Comments

* "PASS" and "FAIL" are defined above.

At what pressure did the sample FAIL or the test discontinued?:

56000 PSI

GENERAL OBSERVATIONS / COMMENTS / MODE OF FAILURE:

NO FAILURE. PUMP COULD NOT GO HIGHER.

Therefore, the maximum pressure observed is confirmed to be

56000 PSI and the test is accepted.

Ashcroft Witnessed Burst Test Report No. _____

The undersigned have witnessed the burst test pass pressure above and verified that the above MAWP is permissible per the burst result recorded in this witnessed burst test report:

Test Performed by:	**National Board Authorized Inspector:**
Name: NANCY LASELL	Authorized Name: Dennis Paulos
Signature: Nancy Lasell	Signature: Dennis Paulos
Organization: **Ashcroft Inc** 250 East Main Street, Stratford, CT, 06614	Organization: HSBCT
	NB Commission expiry: NB#12054A exp: 12/31/11
Test Date: 8/11/11	Date : 8/11/11

A facsimile of the National Board Authorized Inspector Commission is to be provided along with the witnessed burst test report.

Ashcroft Witnessed Burst Test Report No. _____

Ashcroft Witnessed Burst Test Report No. _____

Product Part No.: S-2 (FACTORY SET)

Product description: PISTON ASSEMBLY (DIAPHRAGM)
A-SERIES SWITCH 200PSI

Project Identification: Ashcroft A-Series Pressure Switch watertight and explosion proof

Fitting Description: See diagram

Test Rig Pressure Gauge		
Manufacturer:	ASHCROFT	
Serial Number:	A: 0777	B: 0225
Gauge Range:	A: 7500 psi	B: 30000
Calibration Date:	A: 2/16/11	B: 3/21/11
Attach calibration certificate to witnessed test report		

TEST TEMPERATURE: 70.7°F

TEST DATE: 8/11/11

TIME: 11:57

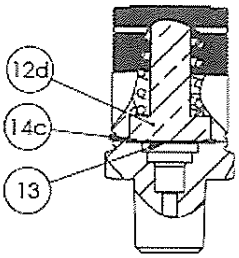
Material Certification References: _____

Material Certification $S_{\mu avg}$ _____

Ashcroft Witnessed Burst Test Report No. _____

Factory Set

S-2
30-200 psi

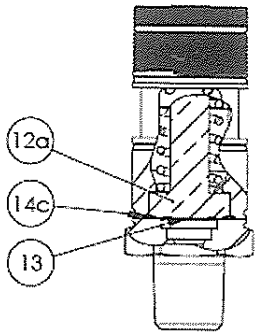


S-2 PISTON ASSEMBLY				
Item	Qty	Part No	Description	Material
12d	1	344A184-03	UPPER PISTON	BRASS
13	1	171A227-01	DIAPHRAGM	316L

or

Field Adjustable

S-2
30-200 psi



S-2 PISTON ASSEMBLY				
Item	Qty	Part No	Description	Material
12a	1	344A184-04	UPPER PISTON	ALUM.
13	1	171A227-01	DIAPHRAGM	316L
14c		286A163-01	BACK-UP RING	SILICONE

Notes:

1. Factory Set and Field Adjustable units interchangeable for purpose of pressure seal test.
2. Seal materials of similar durometer are assumed equivalent, and are limited and limit design temperature. Note o-ring material tested.

Representative Test Sample Diagram to be threaded into test apparatus

Rated Design pressure of proprietary sensor seal assembly: 200 psi
Minimum required burst target value: 900 psi.
Do not stop test at 900 psi. Test burst sample to failure, noting mode of failure.

Ashcroft Witnessed Burst Test Report No. _____

Burst Test Recorded Results

Column 1 Pressure (psig)	Column 2 Hold time (minutes)	Column 3 Clock time	Column 4 Comments
115	.5	Initialization pressure	Initialization pressure
126	.5	11:50AM	
145	.5		
169	.5		
188	.5		
218	.5		
460	.5		
933	.5		No Burst
12000		12:17	Burst

Column 1 Pressure (psig)	Column 2 Hold time (minutes)	Column 3 Clock time	Column 4 Comments

* "PASS" and "FAIL" are defined above.

At what pressure did the sample FAIL or the test discontinued?:

12000 PSI

GENERAL OBSERVATIONS / COMMENTS / MODE OF FAILURE:

WELD AT HOUSING SEPARATED

Therefore, the maximum pressure observed is confirmed to be

12000 PSI and the test is accepted.

Ashcroft Witnessed Burst Test Report No. _____

The undersigned have witnessed the burst test pass pressure above and verified that the above MAWP is permissible per the burst result recorded in this witnessed burst test report:

Test Performed by:	**National Board Authorized Inspector:**
Name: NANCY LASELL Signature: Nancy Lasell Organization: **Ashcroft Inc** 250 East Main Street, Stratford, CT, 06614 Test Date: 8/11/11	Authorized Name: Dennis Poulos Signature: Dennis Poulos Organization: HSBCT NB Commission expiry: NB# 12054A, exp: 12/31/11 Date : 8/11/11

A facsimile of the National Board Authorized Inspector Commission is to be provided along with the witnessed burst test report.

Ashcroft Witnessed Burst Test Report No. _____

Lloyd's Register

Current issue date:	27 February 2020	Original approval(s):
Expiry date:	31 January 2021	ISO 9001 - 11 January 1994
Certificate identity number:	10268598	

Certificate of Approval

This is to certify that the Management System of:

Ashcroft, Inc.

250 East Main Street, Stratford, CT, 06614, United States

has been approved by Lloyd's Register to the following standards:

ISO 9001:2015

Approval number(s): ISO 9001 – 0011501

The scope of this approval is applicable to:

Design and Manufacture of Pressure and Temperature Calibration and Measurement Equipment. Distribution of Pressure and Temperature Measurement Equipment Sourced Globally.

Cliff Muckleroy

Area Operations Manager Americas

Issued by: Lloyd's Register Quality Assurance, Inc.

for and on behalf of: Lloyd's Register Quality Assurance Limited

ANAB ACCREDITED ISO/IEC 17021 MANAGEMENT SYSTEMS CERTIFICATION BODY

Lloyd's Register

Phil Reed,
250 East Main Street, Stratford, CT, 06614,
United States

Lloyd's Register Quality Assurance Inc.
1330 Enclave Parkway Suite 200
Houston, Texas 77077
United States

T +1 866-971-5772
www.lr.org

3 December 2020

To whom it may concern

Re: Confirmation that the certificate validity has been extended for a period of up to six months from the expiry date.

I am writing regarding your request for the certificate renewal assessment to be postponed, based on IAF ID3: 2011 Management of Extraordinary Events or Circumstances Affecting ABs, CBs, and Certified Organizations).

Based on the information available from your organization's management system, we have determined that your management system certification validity can be extended for a maximum of six months.

However, as soon as the effects of Covid-19 have subsided, it will be necessary to undertake a certificate renewal assessment as soon as possible. If the recertification is successfully completed during the six-month extension period, an updated certificate will be issued.

The date of issuance of the new certificate will be the date of completion of our technical review, which will be conducted after the completion of the renewal assessment. The expiry date will be three years from the expiry date of the current certificate.

It should be noted that IAF ID3 requirements are that if the renewal assessment (including technical review) is not completed during the extension validity period of 6 months, the certificate will be suspended, and an assessment based on the initial assessment duration will be required to reinstate the certificate.

Organization name: Ashcroft, Inc.
Address: 250 East Main Street, Stratford, CT, 06614, United States
Client No.: UQA0100118
Assessment standard: ISO 9001:2015
Scope of approval: Design and Manufacture of Pressure and Temperature Calibration and Measurement Equipment. Distribution of Pressure and Temperature Measurement Equipment Sourced Globally.
Certificate number: 10268598
Expiry date of current certificate: 31 January 2021
End of extension validity period: 31 July 2021

Yours sincerely,

Cliff Muckleroy
Area Operations Manager Americas