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TB Series Ball Valve

TECHNICAL REPORT

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SSP INTRODUCTION

Since its inception in 1926, SSP has exhibited an expertise in the precision machining of tight tolerance, high quality fitting components. In fact, SSP's historical reputation for product quality, service and performance is recognized across the country and around the world.

In 1986, SSP relocated to its 25-acre property in Twinsburg, Ohio Southeast of Cleveland in North America's manufacturing heartland. Within its modern 165,000 square foot manufacturing facility, SSP has developed the internal ability to control its manufacturing variables as much or more than any other fittings' manufacturer. SSP designs and produces its own specialty cutting tools to proprietary standards with a 5 axis CNC tool and cutter grinder, high speed 4 axis CNC machining centers and ultra precise EDM's to allow manufacturing to the most stringent dimensional tolerances and surface finishes. Additionally, SSP's tool making capability supports an internal hot, closed-die forging operation. SSP plans, controls and performs its own metal forging operations on all elbows, tees and crosses manufactured into SSP fittings, connectors and adapters. Indeed, SSP's production capacity is among the largest single-site facilities in the entire industry with the capability to allow one-of-a kind, "specials" machining on single spindle CNC's to high volume production on multi-spindle automatics.

Furthermore, SSP's ISO9001 Quality System Certification and Registration by DNV assures conformance to the highest levels of quality. The substantial investment of time and funds to obtain and maintain such status has paid dividends for SSP and its customers in efficiencies in process and supply.

1.0 INTRODUCTION

This document's purpose is to report, in a published format for public review, a representative sampling of the TB Series Ball Valves' actual performance results from the Design Plan's Validation Tests. The performance results are measured against the Design Team's Approved Acceptance Criteria, which are based on meeting or exceeding the published and/or test-based performance of equivalent products from Swagelok and Parker. A positive testing performance of the products in the Validation Tests was required to complete the final element of the design cycle and provide for the Design Released of the TB Series Ball Valve product family.

1.1 SCOPE

Scope: Performance testing of the TB Series Ball Valve – This test report documents the results of the performance testing for the SSP TB Series Ball Valve. The samples were tested for hydrostatic proof and burst strength, leakage test at ambient, leakage test at low temp, leakage test at high temp, a continuous operations test, and a torque actuation test. The cold working pressure rating of this product is 6,000 psig.

1.2 REFERENCES

- SSP No. QM06, "SSP Tech Center Laboratory Quality Manual"
- ISO 17025, "General Requirements for the Competence of Testing and Calibration Laboratories"
- ISO 9001:2008, "Quality Management Systems – Requirements"
- ANSI/NCSL Z540-1, "Calibration Laboratories and Measuring and Test Equipment, General Requirements"
- ASTM F1387-99, "Standard Specification for Performance of Piping and Tubing Mechanically Attached Fittings"
- ISO 10012-1, "Quality Assurance Requirements for Measuring Equipment"
- MIL-STD-45662A, "Calibration System Requirements"
- SSP No. IP11, "Interchange Test"

1.3 TEST SPECIMEN DESCRIPTION

This test report will document all of the testing involved in the validation of the design for TB Series Ball Valve. While many of the validation tests performed on this ball valve were conducted in a similar manner to the functional testing described in ISO 15500, this validation testing was not meant to be an exact duplicate of the type approval testing outlined in those documents and certain key details of this validation testing program may vary from these testing standards. All test samples were built in accordance with the TB Series Ball Valve Assembly document. Reference document number **EAS – 002, "83 – 83X Ball Valve Assembly Specification".** The competitive sample valves were Swagelok part number, SS-83XPS4 which had ¼" tube fitting outlet ports. The competitive samples were purchased new and were tested as received without alteration or adjustment.

All samples for this test, both SSP and competitor, were made from 316 grade stainless steel.

Sample #	Heat Code (s)	
83X (Three way)		
1	Body – N/A	Endscrews – EMX
2	Body – N/A	Endscrews – N/A
3	Body – N/A	Endscrews – N/A
4	Body – N/A	Endscrews – N/A
5	Body – N/A	Endscrews – N/A
6	Body – N/A	Endscrews – N/A
10	Body – N/A	Endscrews – EMX
11	Body – N/A	Endscrews – N/A
12	Body – N/A	Endscrews – N/A
1[*1]	Body – N/A	Endscrews – BSN
2[*1]	Body – N/A	Endscrews – BSN
3[*1]	Body – N/A	Endscrews – BSN
S1 (competitor sample 3-way)	Body – SHP	Endscrews – TCW
S2 (competitor sample 3-way)	Body – SHP	Endscrews – TCW

[*1] – samples from ITR - 940

1.4 SUMMARY

No detectable seat leakage or shell leakage was observed from any of the ball valve test samples at any point during the leakage portions of the validation testing. Hydrostatic and burst test results were well in excess of the minimum acceptable requirements. No shell leakage was observed from any of the SSP 83X samples during the continued operation portion of the testing. Seat leakage was detected from two of the eight individual seats in the SSP 83X sample population during the continued operation portion of the testing, but it was comparable to seat leakage observed from the leading competitor valve samples up to 10,000 cycles and significantly lower than the leading competitor valves beyond 10,000 cycles. The SSP 83X three way ball valve is now considered to be adequately validated for use.

2.0 TEST PROCEDURES AND RESULTS

2.1: HYDROSTATIC STRENGTH AND BURST TESTING

Purpose: Each sample was tested for hydrostatic proof and burst testing. Each test sample was individually plumbed into a hydrostatic burst-test stand. The procedure for the hydrostatic proof and burst test is outlined below.

Test Procedure: Each test sample was prepared with one side port capped off and the bottom port plugged. The open side port was plumbed to be the inlet pressure. The handle was turned to be in the open position for this port. This allowed for complete pressurization of the internal cavities. Hydrostatic (water) pressure was applied to the inlet port of each of the test samples at ambient temperature. The samples were pressurized and tested independently. The pressure was slowly increased until a minimum of 14,504 psig was reached and then held for three minutes. During this time, each sample was visually examined for leakage (water droplets) of deformation. The hydrostatic pressure was then increased to the point where the integrity of the shell seal was lost. This pressure was then recorded as the “Burst Pressure” for the test sample.

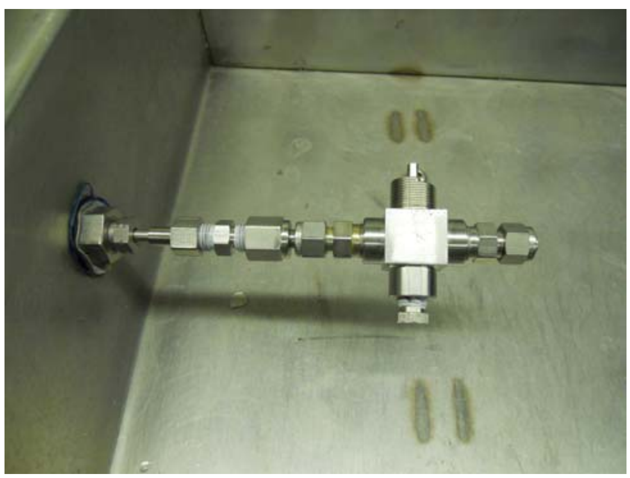


Figure 2.1.1 Hydrostatic Proof and Burst Setup

Acceptance Criteria: This test result met or exceeded the established Design Team's Acceptance Criteria for this product. The primary acceptance criteria for this test is similar to those documented in ISO 15500-2 and ISO 15500-4, were applicable. The acceptance criterion for the hydrostatic portion of the validation testing is to withstand a minimum internal pressure of 14,504 psig (1000 bar) for a three minute time period without any signs of leakage or deformation. The acceptance criterion for the burst test portion of the validation test is to withstand a minimum internal pressure of 4 times the full rated pressure of the valve (4 x 6000 psig = 24,000 psig minimum) without significant loss of containment.

SSP TB Series Ball Valve Validation Testing: Hydrostatic Proof and Burst			
Sample Number	Hydrostatic Strength Test @ 14504 psig	Burst Pressure Actual (psig)	Failure Mode
4	Pass	30,550	Endscrew seal leakage
5	Pass	29,832	Endscrew seal leakage
6	Pass	28,570	Endscrew seal leakage

Test Date : 8/05/11

2.2: LEAKAGE TEST (AMBIENT)

Purpose: Samples were tested for seat and shell leakage at both high and low pressures at three different temperatures: ambient, low temp, and high temp. The procedure for leakage testing at ambient temperature is outlined below.

Test Procedure: The valves were prepared for testing by plugging the bottom port and positioning the stems so that the orifices of the balls were facing the valve ports labeled "side B". The port labeled "side A" was then plumbed to be the inlet pressure. The valve was then submerged in water at ambient (room) temperature. A pressure of 75 psig was applied to the valve. The samples were visually examined for seat and shell leakage (bubble formation) for two minutes. The pressure was then increased to 6000 psig and the samples were visually examined for seat and shell leakage (bubble formation) for two minutes. Pressure was released from the valve. Next, the test samples' stems were actuated so that the orifices of the balls were facing the valve ports labeled "side A" and all of the previous steps repeated. This procedure ensures that both seats and all shell seals of each sample valve are tested for leak-tight performance.

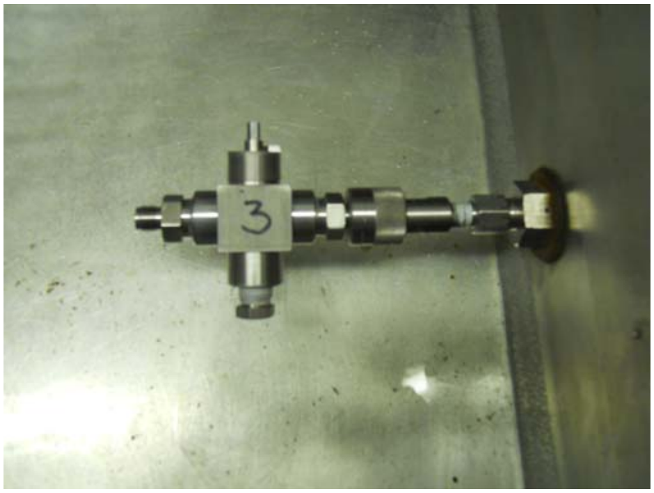


Figure 2.2.1 Leak Test for ambient Temp

Acceptance Criteria: In every case all 83X Ball Valve test results met or exceeded the established Design Team's Acceptance Criteria for these products. The primary acceptance criteria for all validation testing are similar to those documented in ISO 15500-2 and ISO 15500-4, where applicable. The acceptance criterion for all internal and external leakage tests is a maximum leakage rate of less than 20 cm^3/hr.

SSP TB Series Ball Valve Leakage Test - Seat and Shell Leakage at Ambient Temp.						
Sample no.	Port side	Seat Leakage @ Ambient (75 psig)	Shell Leakage @ Ambient (75 psig)	Seat Leakage @ Ambient (6 ksig)	Shell Leakage @ Ambient (6 ksig)	Sample configuration used
1	A	0	0	0	0	L83XPD4 - 316
	B	0	0	0	0	
2	A	0	0	0	0	L83XPD4 - 316
	B	0	0	0	0	
3	A	0	0	0	0	L83XPD4 - 316
	B	0	0	0	0	
10	A	0	0	0	0	L83XKD4-316
	B	0	0	0	0	
11	A	0	0	0	0	L83XKD4-316
	B	0	0	0	0	
12	A	0	0	0	0	L83XKD4-316
	B	0	0	0	0	

Test Dates : 1/17/12 & 2/2/12

2.3: LEAKAGE TEST (LOW TEMP)

Purpose: Samples were tested for seat and shell leakage at both high and low pressures at three different temperatures: ambient, low temp, and high temp. The procedure for leakage testing at low temperature is outlined below.

Test Procedure: For the Low temperature portion of the leakage test, the valves were prepared for testing by plugging the bottom port. The position of the stem was turned so that the orifice of the ball was facing the valve ports labeled "side B". The sample valves were submerged in a water/ethylene glycol mixture at -32°F and allowed to soak for a minimum of four hours. After soaking at temperature, 75 psig of air pressure was applied to the valve ports labeled side "A" of each test sample. The samples were visually examined for seat and shell leakage (air bubbles) for two minutes. The pressure was then increased to 6000 psig and the samples were visually examined for seat and shell leakage for two minutes. Next, pressure was released and the test samples' stems were actuated so that the orifices of the balls were facing the valve ports labeled side "A" and all of the steps above were repeated. This procedure ensures that both seats and shell seals of each sample valve are tested for leak-tight performance.

Leak Test set up for Low Temp Test

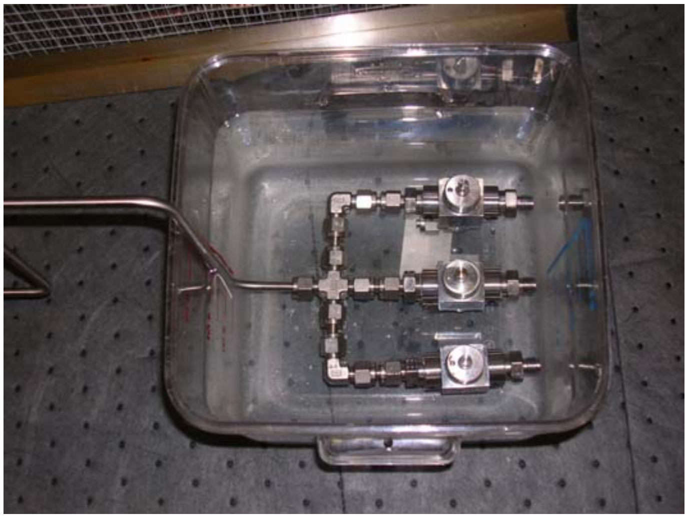


Figure 2.3.1 Leak Test for Low Temp Test

Acceptance Criteria: In every case all 83X Ball Valve test results met or exceeded the established Design Team's Acceptance Criteria for these products. The primary acceptance criteria for all validation testing are similar to those documented in ISO 15500-2 and ISO 15500-4, where applicable. The acceptance criterion for all internal and external leakage tests is a maximum leakage rate of less than 20 cm^3/hr under temperature conditions.

SSP TB Series Ball Valve Leakage Test - Seat and Shell Leakage at -32°F.						
Sample no.	Port side	Seat Leakage @ -32°F (75 psig)	Shell Leakage @ -32°F (75 psig)	Seat Leakage @ -32°F (6 ksig)	Shell Leakage @ -32°F (6 ksig)	Sample configuration used
1	A	0	0	0	0	L83XPD4 - 316
	B	0	0	0	0	
2	A	0	0	0	0	L83XPD4 - 316
	B	0	0	0	0	
3	A	0	0	0	0	L83XPD4 - 316
	B	0	0	0	0	
10	A	0	0	0	0	L83XKD4 - 316
	B	0	0	0	0	
11	A	0	0	0	0	L83XKD4 - 316
	B	0	0	0	0	
12	A	0	0	0	0	L83XKD4 - 316
	B	0	0	0	0	

Test Dates : 1/18/12 & 2/2/12

2.4: LEAKAGE TEST (HIGH TEMP)

Purpose: Samples were tested for seat and shell leakage at both high and low pressures at three different temperatures: ambient, low temp, and high temp. The procedure for leakage testing at high temperature is outlined below.

Test Procedure: For the high temperature portion of the leakage test, the valve samples were prepared for testing by plugging the bottom port and positioning the stems so that the orifices of the balls were facing the valve port labeled side “B”. The sample valves were then placed in an oven at 200°F and allowed to soak for a minimum of four hours. After soaking at temperature, the valves were removed from the oven and transferred into a 200°F water bath. Here, 75 psig of air pressure was applied to the valve ports labeled side “A” of each test sample. The samples were visually examined for seat and shell leakage (air bubbles) for two minutes. The pressure was then increased to 6000 psig and the samples were visually examined for seat and shell leakage for two minutes. Next, pressure was released and the test samples’ stems were actuated so that the orifices of the balls were facing the valve ports labeled side “A” and all of the steps above were repeated. This procedure ensures that both seats and shell seals of each sample valve are tested for leak-tight performance.

Figure 2.4.1 Leak Test set up for High Temp Test

Figure 2.4.2 Leak Test set up for High Temp Test

Acceptance Criteria: In every case all 83X Ball Valve test results met or exceeded the established Design Team's Acceptance Criteria for these products. The primary acceptance criteria for all validation testing are similar to those documented in ISO 15500-2 and ISO 15500-4, where applicable. The acceptance criterion for all internal and external leakage tests is a maximum leakage rate of less than 20 cm^3/hr under temperature conditions.

SSP TB Series Ball Valve Leakage Test - Seat and Shell Leakage at 185°F.						
Sample no.	Port side	Seat Leakage @ 185°F (75 psig)	Shell Leakage @ 185°F (75 psig)	Seat Leakage @ 185°F (6 ksig)	Shell Leakage @ 185°F (6 ksig)	Sample configuration used
1	A	0	0	0	0	L83XPD4 - 316
	B	0	0	0	0	
2	A	0	0	0	0	L83XPD4 - 316
	B	0	0	0	0	
3	A	0	0	0	0	L83XPD4 - 316
	B	0	0	0	0	
10	A	0	0	0	0	L83XKD4 - 316
	B	0	0	0	0	
11	A	0	0	X	0	L83XKD4 - 316
	B	0	0	0	0	
12	A	0	0	0	0	L83XKD4 - 316
	B	0	0	0	0	

Test Dates : 1/19/12 & 2/3/12

2.5: CONTINUOUS OPERATION TEST

Purpose: Samples were tested for seal durability over an increased number of cycles. Sample valves were mounted, in parallel, in the continued operation test cycle rig and cycled 20,000 times. Leak tests were performed at regular intervals. Performance of SSP Ball valves were compared to the performance of a competitor Ball valve of similar design (Swagelok® 83X Series). The SSP valve part number used in the continuous operation test was L83XPD4-316.

Test Procedure: Four SSP samples and 2 samples from a leading competitor were initially tested for leak tight sealing at room temperature at 1000 psig and 6000 psig. The samples were then prepared for testing by attaching a length of pipe stub to the bottom port of each valve. The port labeled side "A" of each valve was connected to a high pressure, compressed air supply regulated to approximately 3600 psig. The port labeled side "B" of each valve was connected to a flexible hose exhausting to atmospheric pressure (0 psig). The test valves were mounted to pneumatically operated 180° - turn actuators. One complete cycle consisted of the following steps:

1) Actuating the valve such that the ball orifice is facing side "A", thus filling the pipe-stub attached to the bottom port of each valve with 3600 psig compressed air.
2) Static in this position for 15 second.
3) Actuating the valve such that the ball orifice is facing side "B", thus exhausting the trapped volume from the pipe stub down to atmospheric pressure.
4) Static in this position for 15 seconds, then return to step 1.

This cycling procedure ensures that both valve seats are fully loaded during each cycle of the test. The valves were disconnected from the cycle rig and tested for seat and shell leakage every 2,500 cycles. The samples were cycled until either 20,000 cycles were completed or until gross leakage was observed, whichever occurred first. For the analysis of the data generated from this test, each seat was treated as a separate datum point giving a total of eight SSP data points (along with four Swagelok® data points).

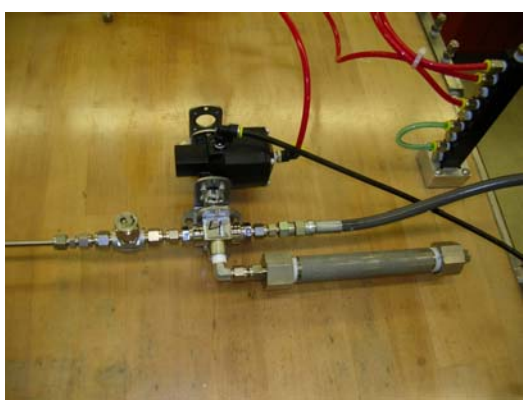
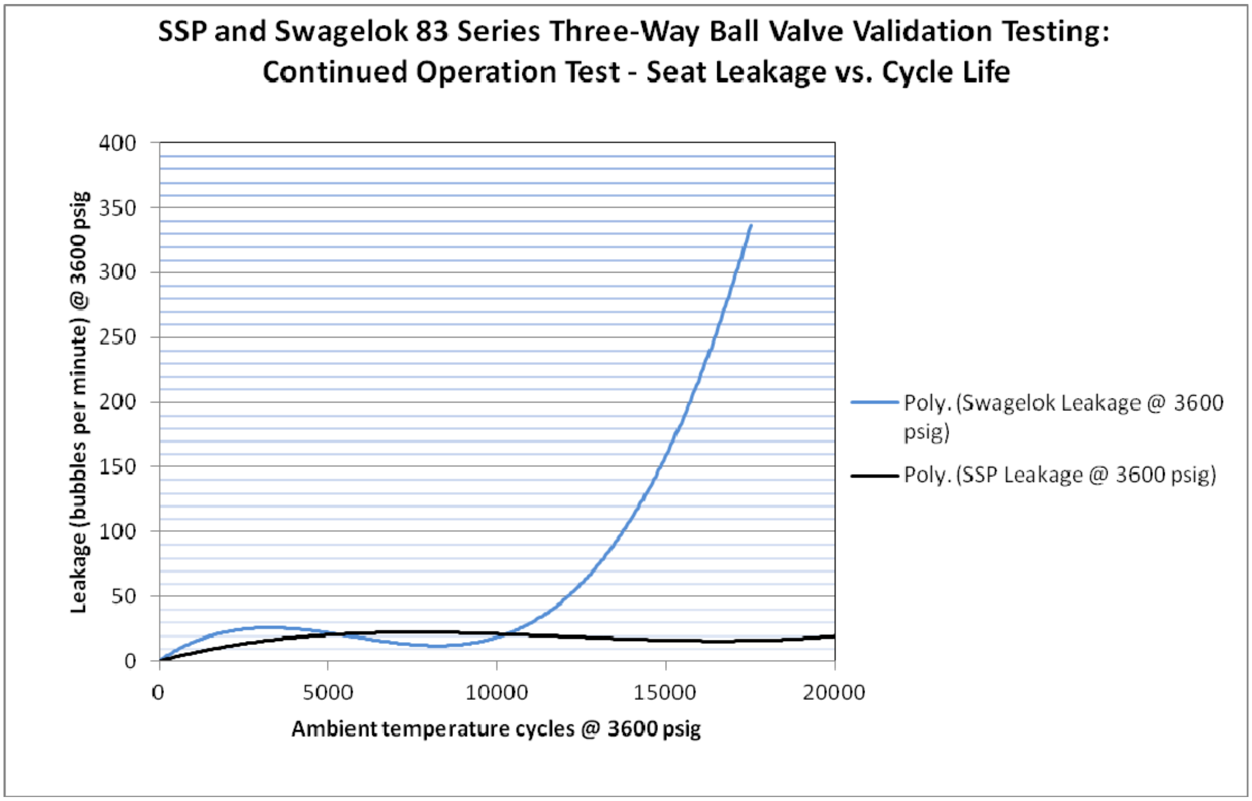


Figure 2.5.1 Continuous Operation Test Setup

Acceptance Criteria: In every case all 83X Ball Valve test results met or exceeded the established Design Team's Acceptance Criteria for these products. The acceptance criterion for the continued operation portion of the test is performance equal to or better than, the leading competitor (Swagelok 83X Series) in terms of seat and shell leakage vs. cycle life.



2.6: TORQUE TEST

Purpose: Samples were tested for necessary torque required to actuate the SSP TB Series Ball Valve. Most samples used for recording Torque Values were used in other portions of the Validation Testing. Measurements were taken at different points in the testing procedure to record a varying set of torque values across a wide range of usages. The material listed in this section is mostly for consideration in choosing adequate components for use in automated systems.

Test Procedure: Sample valves were held in either a bench top vice or testing mount to check for torque values. Once the sample valve was secure, a torque wrench was applied to the valve handle by way of a handle socket. Pressure was applied to the torque wrench to actuate the handle. This was done three times for each handle and the values recorded for opening and closing of the valves.

Torque test set up

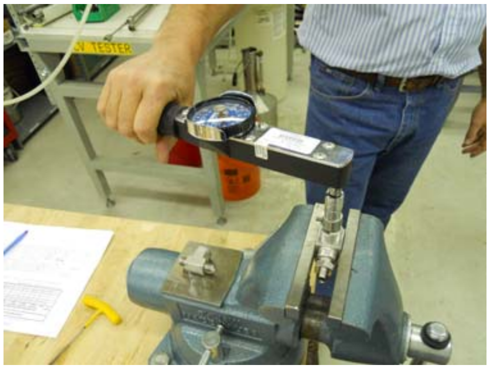


Figure 2.6.1 Torque Test Setup

Acceptance Criteria: In every case all 83X Ball Valve test results met or exceeded the established Design Team's Acceptance Criteria for these products. The primary acceptance criteria for all validation testing are similar to those documented in ISO 5211, where applicable. The acceptance criterion for the torque test is that when completely opening and closing of the valve shall require no greater torque than 32 Nm or 283 lbf * in to comply with the F04 design requirements.

SSP TB Series Ball Valve Torque Test.					
Sample no.	actuation	Torque - initial trial	Torque - second trial	Torque - third trial	Test condition
1	to open	28 in*lbs	15 in*lbs	14.5 in*lbs	performed at the completion of the leak test
	to close	17 in*lbs	16 in*lbs	13.5 in*lbs	
2	to open	30 in*lbs	18.5 in*lbs	18 in*lbs	performed at the completion of the leak test
	to close	15 in*lbs	16 in*lbs	15 in*lbs	
3	to open	28.5 in*lbs	18.5 in*lbs	17 in*lbs	performed at the completion of the leak test
	to close	16.5 in*lbs	15.5 in*lbs	15 in*lbs	
10	to open	12 in*lbs	11 in*lbs	11 in*lbs	performed before leak test
	to close	10 in*lbs	9 in*lbs	9 in*lbs	
11	to open	13 in*lbs	13 in*lbs	15 in*lbs	performed before leak test
	to close	10 in*lbs	15 in*lbs	15 in*lbs	
12	to open	15 in*lbs	14 in*lbs	15 in*lbs	performed before leak test
	to close	13 in*lbs	11 in*lbs	16 in*lbs	

Test Dates : 1/20/12 & 2/2/12

3.0: TEST EQUIPMENT AND INSTRUMENTATION

Calibration and Standardization:

1. Description: Torque Wrench
   Range: 0 – 30 in – lbs.
   ID #: 33 - 1010974
   Calibration Date: 09/26/11 Due: 09/26/12

2. Description: Gas Pressure Transducer
   Range: 0 – 10,000 psig
   ID #: 74466
   Calibration Date: 01/24/11 Due: 01/24/12

3. Description: Gas Pressure Gage
   Range: 0 – 10,000 psig
   ID #: 67176
   Calibration Date: 01/24/11 Due: 01/24/12

4. Description: Hydrostatic Pressure Gage
   Range: 0 – 60,000 psig
   ID #: 096221 – 1
   Calibration Date: 02/10/11 Due: 02/10/12

5. Description: Microprocessor Thermometer
   Range: -328°F to 662°F
   ID #: 1016704
   Calibration Date: 09/19/11 Due: 09/19/12

6. Description: Gas Pressure Gage
   Range: 0 – 10,000 psig
   ID #: 67176
   Calibration Date: 02/04/09 Due: 02/4/10

7. Description: Gas Pressure Transducer
   Range: 0 – 10,000 psig
   ID #: 74466
   Calibration Date: 02/04/09 Due: 02/04/10

8. Description: Burst Stand Pressure Gage
   Range: 0 to 80000 psig
   ID #: 8428
   Calibration Date: 05/02/09 Due: 05/02/10

9. Description: Microprocessor Thermometer
   Range: -328°F to 662°F
   ID #: 1016704
   Calibration Date: 09/17/08 Due: 09/17/09

4.0: QUALITY ASSURANCE PROGRAM

The preceding lists the major Validation Tests that were performed, and the sections which follow describe the tests and outline specific results. All products manufactured at SSP are to approved and controlled engineering documentation, to established process and quality procedures at every stage of manufacture, with fully calibrated quality and process instrumentation, using only certified and traceable materials. Tested products were selected randomly from documented normal production runs. Before and after test samples were retained for reference. All tubing used in testing meets applicable ASTM specifications, and has approved material and chemical certifications.

All SSP tests conducted on products are with laboratory equipment and instrumentation in current calibration in an ISO 17025 accredited laboratory. Trained personnel conducted tests by following approved, written test procedures. All test results were subjected to thorough engineering review and approval before internal publication.

ASTM Material Standards		
Standard	**Material Shape**	**Description**
A 182	Forged Fittings, Parts	Standard Specification for Forged or Rolled Alloy – Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
A 276	Bars	Standard Specification for Stainless Steel Bars and Shapes
A 479	Bar, Shapes	Standard Specification for Stainless Steel Bars and Shapes for use in Boilers and other Pressure Vessels
B 16	Bar, Shapes	Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for use in Screw Machines
B 124	Bar, Shapes	Standard Specification for Copper and Copper Alloy Forging Rod, Bar and Shapes
B 453	Bar, Shapes	Standard Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Rod
A 179	Tube	Standard Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes
A 213	Tube	Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater and Heat-Exchanger Tubes
A 249	Tube	Standard Specification for Welded Austenitic Steel Boiler, Superheater, Heat-Exchanger, and Condenser Tubes
A 269	Tubing	Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
B 68	Tube	Standard Specification for Copper Tube, Bright Annealed
B 75	Tube	Standard Specification for Seamless Copper Tube
B 88	Tube	Standard Specification for Seamless Copper Water Tube

Table 4.0.0

Applicable Codes and Standards	
Section	**Test Description**
ANSI/ASME B 31.1	Power Piping Code
ANSI/ASME B 31.3	Process Piping Code
ANSI/ASME BPV Section VIII	Boiler & Pressure Vessel Code
ISO 7257	Aircraft – Hydraulic tubing joints and fittings – Rotary flexure test

Table 4.0.1

5.0: ATTACHMENTS

A. MATERIAL CERTS

B. EQUIPMENT

Validation Test Equipment		
Section	**Test Description**	**Test Equipment Description**
3.1	Initial Makeup Test	1016702 Torque Wrench
3.2	Hydrostatic Burst Pressure Test	1279 Ashcroft Pressure Gage
		L-400 Maximator Liquid Pump
3.3	Hydraulic Impulse Pressure Test	PDCR 911 Druck Pressure Transducer
		451279 SSL 02B Ashcroft Pressure Gage
3.4	Repeated Remake Test	DLE 15-75 Maximator Air Booster Pump
		L-400 Maximator Liquid Pump
3.5	Tension Force Test	FI-90 Force Indicator
		31910 Load Cell
		DTM Dillon Tensile Tester
3.6	Vibration Stress/Endurance Test	42-05000W160S SC Hydraulic Engineering
		Booster Pump
		2100 Strain Gage Conditioner System.
		The Measurements Group
3.7	Intermix Assurance Test	DLE 15-75 Maximator Air Booster Pump
		L-400 Maximator Liquid Pump
3.8	Interchange Assurance Test	DLE 15-75 Maximator Air Booster Pump
		L-400 Maximator Liquid Pump
3.9	Gas Pressure Leak Test	HP 224 McDaniels Pressure Gage
		DLE 15-75 Maximator Air Booster Pump
3.10	Thermal Cycle, Thermal Shock Test	3210 Applied Test Systems Split Furnace
		XT16 Athena Temperature Controller
		MS-40 Veeco Helium Leak Detector
3.11	Vacuum Test	MS-40 Veeco Helium Leak Detector
3.12	Low Temperature (Cryogenic) Helium Leak Test	MS-40 Veeco Helium Leak Detector
		Type K TC Thermocouple

Table 5.0.D.0

C. REVISIONS

SSP Document Number: ILDTR120214