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SSP CNG Plus™

SSP DUOLOK® FITTINGS

ON 1.000” x 0.120 MW 316SS TUBING

ENGINEERING 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.

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.

In 2010, SSP's Technical Center Laboratory was certified by A2LA to be compliant with the requirements of ISO/IEC 17025:2005 (A2LA Certificate No. 3030.01). This certification assures that results developed by SSP's Technical Center Laboratory meet the same standard of accuracy, independence and integrity as other certified third-party commercial laboratories. The scope of SSP's accreditation includes the following test methods:

Impulse Testing (ASTM F1387, A5)
Pneumatic Proof Test (ASTM F1387, A3)
Hydrostatic Proof Test (ASTM F1387, A4)
Flexural Fatigue Test (ASTM F1387, A6)
Tensile Test (ASTM F1387, A7)
Hydrostatic Burst Test (ASTM F1387, A8)
Rotary Flex Test (ASTM F1387, A10)
Hardness – Rockwell C, B & N (ASTM E18)
Hardness – Vickers (ASTM E384)

For CNG Plus projects, SSP partners with contractors from bid preparation through the transfer of the station to the owner. Construction services have been created to help the contractor prepare a submittal and become certified. SSP provides all the tools and materials required to complete the job quickly, including preconstruction services to simplify material planning and teach new, time-saving assembly techniques. SSP stands beside the costumer through project sign-off and acceptance by the owner with material test report documentation and releases.

1.0 INTRODUCTION

This document summarizes the findings observed when testing a sampling of SSP Duolok® tube fittings on 1.000" x 0.120 MW 316SS tubing. The products were evaluated for assembly torque, gas leak, and hydrostatic burst test. The performance results are measured against the Design Team's Approved Acceptance Criteria.

1.1 SCOPE

Scope: This test report documents the results of performance testing for the 1" SSP Duolok Tube Fittings on 0.120" minimum wall 316 stainless steel straight tubing.

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"

1.3 TEST SPECIMEN DESCRIPTION

This technical report lists the validation tests that were performed, and the sections which follow describe the test and outline specific results. All products are manufactured at SSP 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 material. Test products were selected randomly from normal production runs. Before and after test samples were retained for reference. All tubing used in testing meets ASTM specifications.

All product testing was conducted in SSP's ISO 17025 accredited Technical Center Laboratory with laboratory equipment and instrumentation in current calibration. Trained personnel conducted tests by following approved, written test procedures. All test results were subjected to thorough engineering review and approval before internal publication.

1.4 SUMMARY

In every case, all SSP test results met or exceeded the established Design Team's Acceptance Criteria for these products.

2.0 TEST PROCEDURES AND RESULTS

The following sections describe the tests performed and summarize the results of each. For full results and data, see Section 5.0.A Test Data.

2.1: INITIAL MAKE-UP TORQUE TEST

Purpose: Test determines the torque necessary for the initial assembly of tube, fitting body, back ferrule, front ferrule, and nut assembled together per standard assembly instructions.

Test Procedure: The tube fitting assembly is assembled with body and components to a "finger-tight" position. The nut is then tightened to the manufacturer's recommended number of turns for initial make-up. The torque required to achieve this initial make-up is recorded after every ¼ turn of the nut.

Figure 2.1.1 Initial Make-up Assembly Components

Figure 2.1.2 Initial Make-up Torque Test Equipment

Results:

Average Initial Make-up Torque At Each Quarter Turn					
Tubing	**.25 Turns**	**.50 Turns**	**.75 Turns**	**1 Turn**	**1.25 Turns**
1.000" x 0.120 MW 316SS	10 ft·lb	35 ft·lb	69 ft·lb	115 ft·lb	171 ft·lb

Table 2.1.1 Initial Make-Up Results

2.2: GAS LEAK TEST

Purpose: Test determines if the tube fitting assembly has adequate gas pressure retaining capability, based on the ANSI / ASME B 31.3 maximum allowable working pressure of the tubing.

Test Procedure: The tube fitting assembly is pressurized under water with air in regular pressure increments to the maximum allowable working pressure of the tubing. This pressure is held for a minimum of five minutes.

Figure 2.2.1 Gas Leak Test Equipment

Figure 2.2.2 Gas Leak Test Configuration

Acceptance Criteria: The tube fitting assembly is to sustain a test pressure of the ANSI / ASME maximum allowable working pressure of the tubing without any indication of a leak.

Results:

Tubing	Working Pressure	Number of Leaks
1.000" x 0.120 MW 316SS	5,300 psi	0

Table 2.2.1 Gas Leak Test Results

2.3: HYDROSTATIC BURST TEST

Purpose: Test determines if the tube fitting assembly has adequate pressure-retaining capability, based on the ANSI / ASME B 31.3 maximum allowable working pressure of the tubing.

Test Procedure: The tube fitting assembly is hydrostatically pressurized in regular pressure increments which increase until tube burst is attained. The maximum pressure, in PSIG, at which the tube bursts or tubing pushes out of the fitting is recorded.

Figure 2.3.1 Burst Test Equipment

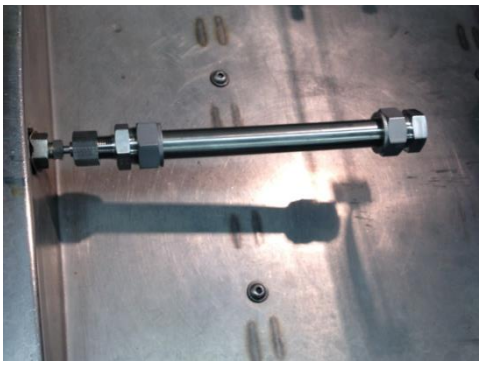

Figure 2.3.2 Burst Test Configuration

Acceptance Criteria: The tube fitting assembly is to sustain a hydrostatic pressure, without observed leakage, exceeding a minimum of 4 times the ANSI / ASME maximum allowable working pressure of the tubing. ***Preferred* (Pass):** Failure is to be by burst above 4 times working pressure, not by push out from the fitting. ***Acceptable* (Accept):** Failure greater than 3.5 times working pressure.

Results:

Hydrostatic Burst Test					
Tubing	**Working Pressure**	**4x Working Pressure**	**Average Failure Pressure**	**Failure Type**	**Pass/Fail**
1.000" x 0.120 MW 316SS	5,300 psi	21,200 psi	20,264 psi	Burst	Accept

Table 2.3.1 Hydrostatic Bust Test Results

3.0: TEST EQUIPMENT AND INSTRUMENTATION

Calibration and Standardization:

1. Description: Torque Wrench
   Range: 0 – 250 ft·lb
   ID #: 819682
   Calibration Date: 12/16/2013 Due Date: 12/16/2014

2. Description: 10,000 psi digital gage
   Range: 0 – 10,000 psi
   ID #: 67176
   Calibration Date: 09/12/2013 Due Date: 09/12/2014

3. Description: 10,000 psi transducer
   Range: 0 – 10,000 psi
   ID #: 74466
   Calibration Date: 09/12/2013 Due Date: 09/12/2014

4. Description: 72,000 psi digital gage
   Range: 0 – 72,000 psi
   ID #: 096221-1
   Calibration Date: 06/10/2013 Due Date: 06/10/2014

5. Description: 72,000 psi transducer
   Range: 0 – 72,000 psi
   ID #: 096221
   Calibration Date: 06/10/2013 Due Date: 06/10/2014

4.0: QUALITY ASSURANCE PROGRAM

The preceding lists the major Validation Tests that were performed, 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.

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 4.0.1, ASTM Material Standards

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 4.0.2, Applicable Codes and Standards

5.0: ATTACHMENTS

A. TEST DATA

1" X .120 min wall straight tubing (Duolok)

Sample No.	Initial Makeup Torque, ft-lb					Gas Leak Test							
	Revolutions (Hand tight)					Test Press.	Time	A.C. Leak	Pass Fail	Test Press.	Time	A.C. Leak	Pass Fail
#	0.25	0.5	0.75	1.00	1.25	Psig	Minute	Leak / None	P / F	Psig	Minute	Leak / None	P / F
1	10	30	55	90	125	3,600	1	None	P	5,500	5	None	P
2	10	35	85	160	250	3,600	1	None	P	5,500	5	None	P
3	10	25	55	80	120	3,600	1	None	P	5,500	5	None	P
4	10	30	60	100	145	3,600	1	None	P	5,500	5	None	P
5	10	45	85	160	215	3,600	1	None	P	5,500	5	None	P
6	10	35	65	93	145	3,600	1	None	P	5,500	5	None	P
7	10	35	70	105	150	3,600	1	None	P	5,500	5	None	P
8	10	45	83	157	255	3,600	1	None	P	5,500	5	None	P
9	10	40	73	112	155	3,600	1	None	P	5,500	5	None	P
10	10	33	63	90	145	3,600	1	None	P	5,500	5	None	P
AVG	10	35	69	115	171								

Sample No.	Initial Makeup Torque, ft-lb					Burst Test		
	Revolutions (Snug)					Actual Burst	Fail Type	Pass Fail
#	0.25	0.5	0.75	1.00	1.25	psig	n/a	P / F
1	25	60	105	155	200	20,079	burst	A
2	30	60	105	140	180			
3	25	60	105	135	195	20,081	burst	A
4	30	65	105	190	255			
5	32	65	130	188	275	20,330	burst	A
6	30	60	93	143	195			
7	40	68	100	155	180	20,455	burst	A
8	34	65	113	150	185			
9	35	60	95	140	185	20,375	burst	A
10	35	65	110	145	225			

B. EQUIPMENT

Validation Test Equipment	
Test Description	**Test Equipment Description**
Hydrostatic Burst Pressure Test	1279 Ashcroft Pressure Gage
	DLE 15-75 Maximator Booster Pump
Gas Leak Test	L-400 Maximator® Liquid Pump
	HP 224 McDaniel Pressure Gage

Table 5.0.B.1

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