



## Product Test Report

**PTR-5008**

Swagelok Company  
29500 Solon Road  
Solon, Ohio 44139 U.S.A.

Ver 01  
June 2022  
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### TITLE

Chloride Stress Corrosion Cracking (CSCC) Test of 316 Stainless Steel Swagelok® FK Medium-Pressure Fittings and Another Brand of 316 Stainless Steel Medium-Pressure Fittings while Pressurized to 15 000 psig (103.4 MPa)

### Swagelok Product Tested

Ordering Number	Tubing Material	Number of Fitting Ends Tested	Tubing Size x Wall in.	Tubing Hardness HRC
SS-4FK-6	Alloy 2507	8	1/4 x 0.049	24
SS-4FK-6	Alloy 2507	32	1/4 x 0.049	22
SS-6FK-6	Alloy 2507	8	3/8 x 0.065	26
SS-8FK-6	Alloy 2507	8	1/2 x 0.083	27
SS-8FK-6	Alloy 2507	32	1/2 x 0.083	26

### Another Brand Product Tested

Ordering Number	Tubing Material	Number of Fitting Ends Tested	Tubing Size x Wall in.	Tubing Hardness HRC
1/4 in. Straight	Alloy 2507	8	1/4 x 0.049	24
3/8 in. Straight	Alloy 2507	8	3/8 x 0.065	26
1/2 in. Straight	Alloy 2507	8	1/2 x 0.083	27

### PURPOSE

Assemblies of 316 stainless steel Swagelok FK medium-pressure fittings and another brand of 316 stainless steel medium-pressure fittings with annealed alloy 2507 tubing were tested under laboratory conditions to observe the effects of an environment that promotes Chloride Stress Corrosion Cracking (CSCC) of 316 stainless steel.



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### TEST CONDITIONS

Original test date: August 2018

The assemblies were exposed at 65°C (149°F) for 720 hours to alternating cycles of (a) salt spray (substitute ocean water per ASTM D1141) and (b) controlled humidity (60 to 70%) to encourage concentrating of chlorides in surface pits and crevices to accelerate CSCC of 316 SS. To evaluate risk of CSCC under assembly conditions with increased tensile stress in the female ported body, these conditions were included in the test:

- Initially tightened fitting assemblies
- Assemblies tightened one-eighth turn further to simulate multiple reassembled fittings

### TEST METHOD

1. Sample groups were prepared for each size from each manufacturer. Each sample assembly comprised two female ported barstock union fittings with the barstock body ends, each assembled to a 64 mm (2 1/2 in.) length of tubing.
2. Half of the 1/4 inch, 3/8 inch, and 1/2 inch size sample medium-pressure fittings were assembled according to manufacturer specified assembly instructions. For the Swagelok samples, that assembly method was nut tightening one turn past finger-tight (TPFT). For the other brand, that assembly method was nut tightening per the manufacturer's instructions. The other half of each size from each manufacturer was assembled one-eighth turn further to simulate its tightened condition after many reassemblies.
3. Each sample was pressurized with nitrogen to 15 000 psig (103.4 MPa) and monitored for leakage for 10 minutes prior to the CSCC test.
4. Samples were placed into a salt spray chamber (see **APPENDIX**) that utilized substitute ocean water per ASTM D1141.
5. Samples were pressurized with water to 15 000 psig (103.4 MPa) and held at that pressure throughout the CSCC test.
6. The chamber temperature was elevated to 65°C (149°F) and the following salt spray schedule, derived from SAE J2334 and ASTM B117, was initiated:
  - a. continuous salt spray maintained at 65°C for 24 hours
  - b. salt spray turned off, 60% to 70% relative humidity maintained at 65°C for 48 hours
  - c. repeat step a for 48 hours
  - d. repeat step b for 96 hours
  - e. repeat step a for 168 hours
  - f. repeat step b for 336 hours, for a schedule total of 720 hours (see **Figure 1**)
7. Upon completion of the 720 hours, the samples were removed and rinsed in de-ionized water.
8. Each sample was again pressurized with nitrogen to 15 000 psig (103.4 MPa) and monitored for leakage for 10 minutes.
9. The samples were then disassembled. The body components were examined by 100x optical microscope for presence of cracks extending from either end along the barstock surface.

**TEST RESULTS**

Description	Swagelok FK Medium-Pressure Fittings		Another Brand of Medium-Pressure Fittings	
	Manufacturer specified assembly	1/8 additional nut turn	Manufacturer specified assembly	1/8 additional nut turn
Number of fittings exhibiting leakage, pre- and post-salt spray nitrogen gas pressure tests	0 of 44	0 of 44	0 of 12	0 of 12
Number of fittings exhibiting leakage during 720 hours CSCC test	0 of 44	0 of 44	0 of 12	0 of 12
Number of fittings showing visible body cracks along the barstock surface (see <b>Figure 2</b> )	0 of 44	0 of 44	4 of 12 (33%)	3 of 12 (25%)

**Dual Cycle Humidity Test – at 65°C**



**Figure 1:** Cyclic humidity corrosion salt spray schedule



**Figure 2:** Examples of cracks on Another Brand's 316 SS fitting body

This test was performed to consider a specific set of conditions and should not be considered valid outside those conditions. Swagelok Company makes no representation or warranties regarding these selected conditions or the results attained. Laboratory tests cannot duplicate the variety of actual operating conditions. Test results are not offered as statistically significant. See the product catalog for technical data.

### SAFE PRODUCT SELECTION

When selecting a product, the total system design must be considered to ensure safe, trouble-free performance. Function, material compatibility, adequate ratings, proper installation, operation, and maintenance are the responsibilities of the system designer and user.

### Referenced Documents

ASTM D1141: *Standard Practice for the Preparation of Substitute Ocean Water*, ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428

ASTM E165-95: *Standard Test Method for Liquid Penetrant Examination*, ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428

ASTM B117-95: *Practice for Operating Salt Spray (Fog) Apparatus*, ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428

SAEJ2334: *Cosmetic Corrosion Lab Test*, SAE International, 400 Commonwealth Drive, Warrendale, PA 15096

### APPENDIX



**Figure 3:** Auto Technology Cyclic Corrosion Chamber



**Figure 4:** Pressurized FK Medium-Pressure Fittings in Cyclic Salt Spray Chamber