

## DP Series Diaphragm Valve Technical Report

### Scope

This technical report provides data on Swagelok® DP series diaphragm valves. The report covers:

- surface finish specifications
- inboard helium leak testing
- particle counting
- moisture analysis
- hydrocarbon analysis
- ionic cleanliness.

Particle counting, moisture and hydrocarbon analysis, and ionic cleanliness data show test results from valves cleaned with deionized (DI) water according to the techniques described in Swagelok *Ultrahigh Purity Process Specification (SC-01)*, MS-06-61.

### Surface Finish

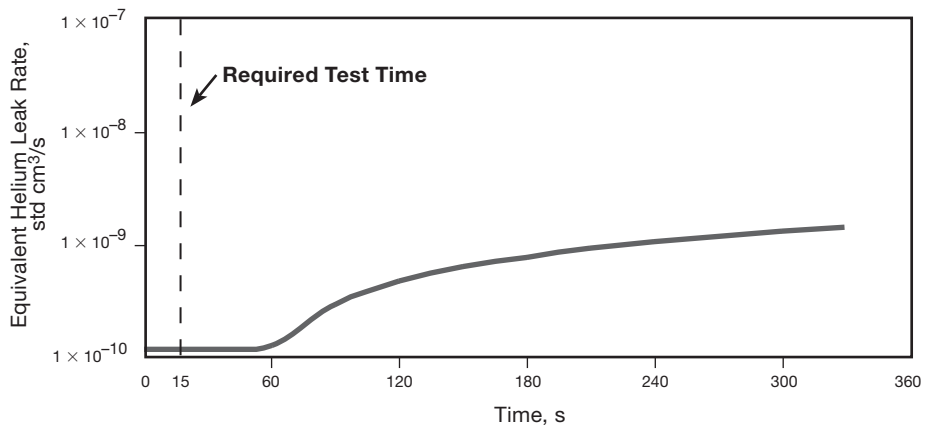
Statistical process control (SPC) allows Swagelok to provide consistent surface finishes, as described in Specification SC-01. The roughness average ( $R_a$ )

specification we have established for the wetted surfaces of DP series valves manufactured with a Swagelok P or P1 finish is 5  $\mu\text{in}$ . (0.13  $\mu\text{m}$ )  $R_a$  on average.

### Inboard Helium Leak Testing

SC-01 processed valves maintained a helium leak rate of less than  $1 \times 10^{-9}$  std  $\text{cm}^3/\text{s}$  at the seat for an average of 200 s, which exceeds the required test time of 15 s, in accordance with SEMI F1-96. This result indicates that the PCTFE seat design has a high resistance to permeation.

The DP series valves were assembled in a class 100 environment and tested to ASTM E498, Method A, at the rated pressure of the valve.

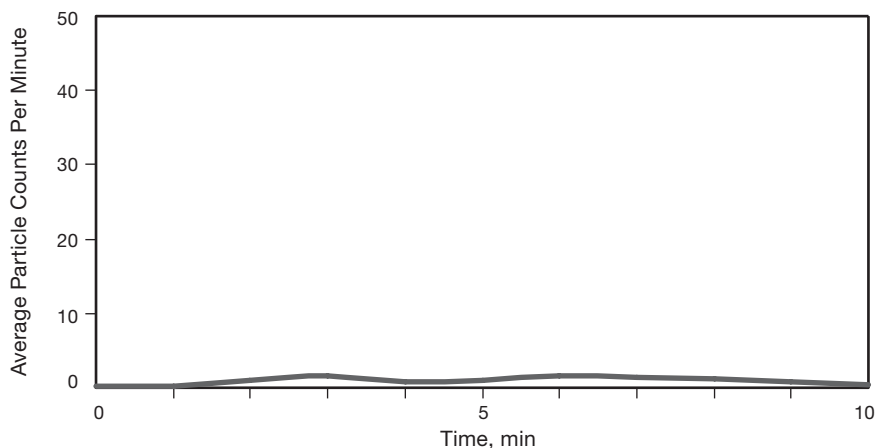


### Particle Counting

Static particle counts from SC-01 processed DP series valves are very low (less than 10 particles collected according to test parameters).

The DP series valves were tested in accordance with ASTM F1394:

- Class 100 cleanroom
- Class 100 laminar-flow bench
- 2.4 std  $\text{ft}^3/\text{min}$  flow rate
- Particles greater than 0.014  $\mu\text{m}$  in size detected. (Typical counters detect particles 0.020  $\mu\text{m}$  and greater in size.)



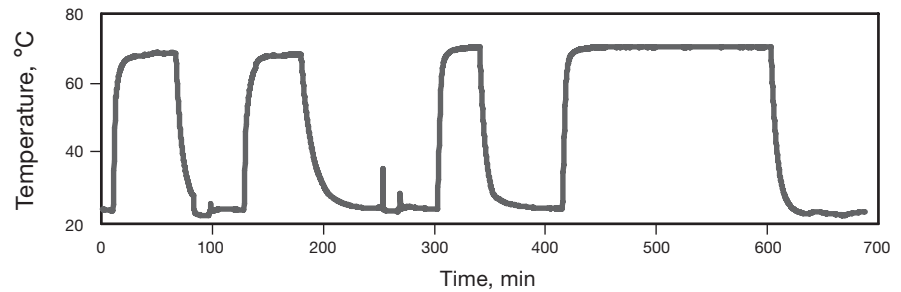
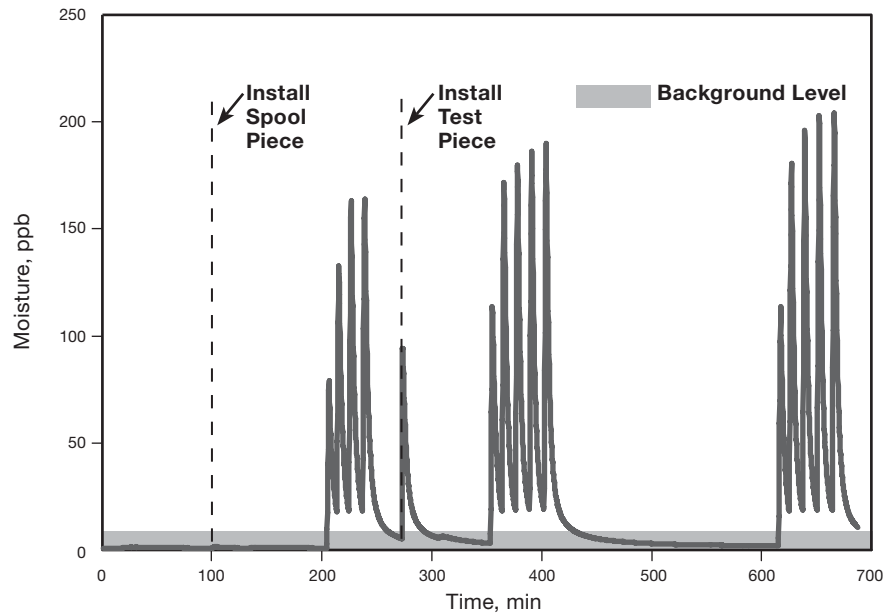
## Moisture Analysis

SC-01 processed valves recover to background levels from a 2 ppm moisture spike within 30 min, much faster than the 4 h recommended by SEMASPEC 95022734A-STD.

Three DP series valves were tested in accordance with SEMASPEC 90120397B-STD guidelines:

- The test gas was pure nitrogen.
- The flow rate was 1.28 std L/min at 30 psig (2 bar).

The lower graph shows the pattern of elevated temperatures that were applied to the valves during testing to enhance the moisture sensitivity of the system.

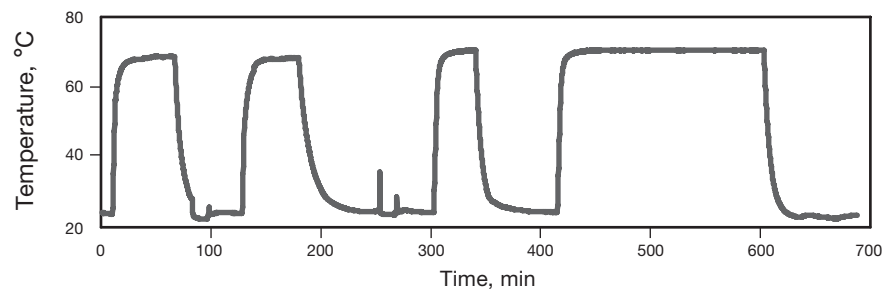
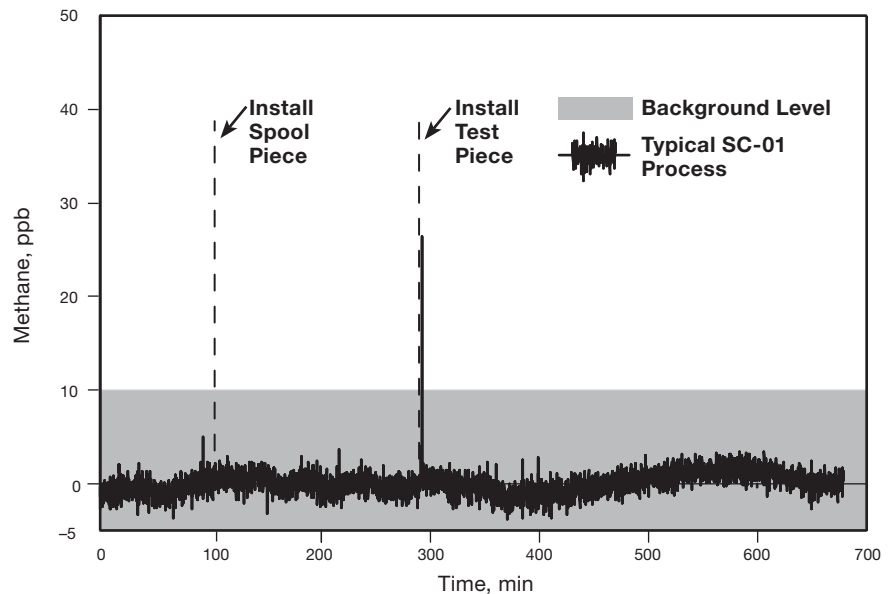


## Hydrocarbon Analysis

Hydrocarbon residues in SC-01 processed valves fall within the background level produced by the test instrument.

Hydrocarbon analyses of SC-01 processed products are conducted in accordance with SEMASPEC 90120396B-STD guidelines.

The lower graph shows the pattern of elevated temperatures that were applied to the valves during testing to drive off any hydrocarbon residues in the system.



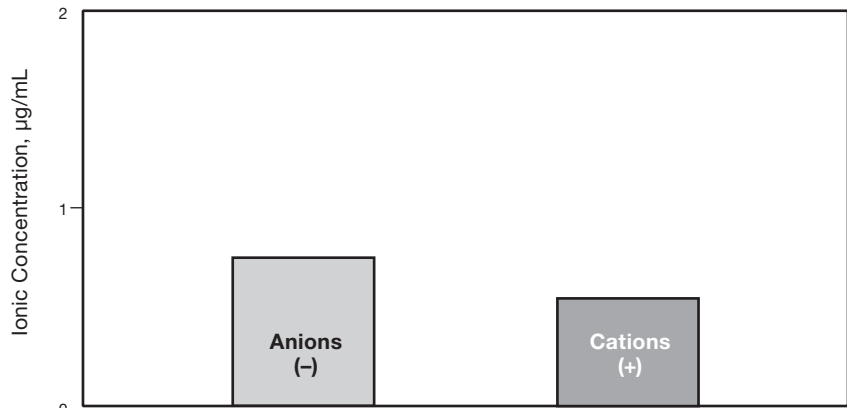
## Ionic Cleanliness

Residual ionic contamination is very low (less than 1 µg/mL for SC-01 processed valves).

The DP series valves were tested in accordance with ASTM F1374:

- Each valve was filled with deionized (DI) water.
- After 24 h, the sample was extracted and analyzed.

Anions (-)	Cations (+)
Fluoride	Lithium
Chloride	Sodium
Nitrate	Ammonium
Phosphate	Potassium
Sulfate	Magnesium
	Calcium



## Lab Cycle Testing

The DP series diaphragm valve was tested to determine an estimated cycle life of the diaphragms under severe laboratory conditions (table at right).

Both high- and low-pressure DP series pneumatically actuated valves with Elgiloy® diaphragms were tested. Valve cycle life was evaluated for leakage at regular intervals. Failure was defined as a helium leak rate greater than  $1 \times 10^{-9}$  std cm<sup>3</sup>/s for envelope (inboard) or seat leakage.

The tests predict the mean time to failure (MTTF) and the expected cycle life for 95 % of the valves.

These tests are not a guarantee of a minimum number of cycles in service. They indicate that in tests under these laboratory conditions the probability of early failure is low. Laboratory tests cannot duplicate the endless variety of actual operating conditions and cannot promise that the same results will be realized in service.

## Test Data

Model	High-Pressure	Low-Pressure	Low-Pressure
Mode of Actuation	Normally closed pneumatically actuated		
Quantity	10	10	20
Gas	Dry, filtered nitrogen		
Temperature °F (°C)	70 (20) ambient		
Inlet Pressure psig (bar)	3045 (210)	145 (9.9)	250 (17.2)
Outlet Pressure psig (bar)			
Actuator Pressure psig (bar)	100 (6.8)	70 (4.8)	70 (4.8)
Cycle Rate, cpm	30		
Mean Time to Failure (MTTF)	130 000 cycles	2 600 000 cycles	1 000 000 cycles
Expected Cycle Life for 95% of Valves	> 50 000 cycles	> 520 000 cycles	> 290 000 cycles

## **Referenced Documents**

### **ASTM Standards<sup>1</sup>**

- E498 Standard Test Method for Leaks Using the Mass Spectrometer Leak Detector or Residual Gas Analyzer in the Tracer Probe Mode
- F1374 Standard Test Method for Determination of Ionic/Organic Extractables of Internal Surfaces—IC/GC/FTIR for Gas Distribution Systems Components
- F1394 Standard Test Method for Determination of Particle Contribution from Gas Distribution System Valves

### **SEMATECH SEMASPECS<sup>2</sup>**

- 90120396B-STD Standard Test Method for Determination of Total Hydrocarbon Contribution by Gas Distribution Systems Components
- 90120397B-STD Standard Test Method for Determination of Moisture Contribution by Gas Distribution Systems Components
- 95022734A-STD Guide for High-Purity Systems in Semiconductor Manufacturing Equipment

### **SEMI Standard<sup>3</sup>**

- F1-96 Specification for Leak Integrity of High-Purity Gas Piping Systems and Components

### **Swagelok Specification**

*Ultra-high-Purity Process Specification (SC-01), MS-06-61*

1. American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428.
2. SEMATECH, Inc., 2706 Montopolis Dr., Austin, TX 78741.
3. Semiconductor Equipment and Materials International, 3801 Zanker Rd., San Jose, CA 95134.

#### **Safe Product Selection**

**When selecting products, 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.**