**Scope**

This technical report provides data on Swagelok® BN series bellows valves. The report covers:

- P surface finish specifications
- static particle counting
- moisture analysis
- hydrocarbon analysis
- ionic cleanliness
- lab cycle test data.

Moisture and hydrocarbon analysis data show test results from valves cleaned with deionized (DI) water in accordance with Swagelok Ultrahigh Purity Process Specification (SC-01), MS-06-61. Particle counting data contrast test results from valves cleaned in accordance with SC-01 and with Swagelok Photovoltaic Process Specification (SC-06), MS-06-64. Ionic cleanliness data for SC-01 and SC-06 processed valves are comparable.

**Surface Finish**

Statistical process control (SPC) allows Swagelok to provide consistent surface finishes, as described in SC-01. The surface finish distribution at right illustrates the roughness average ($R_a$) specifications we have established for the wetted surfaces of BN series valves manufactured with the P finish:

- Surface roughness is 8 µin. (0.20 µm) $R_a$ on average
- Surface roughness will not exceed 15 µin. (0.38 µm) $R_a$.

**Particle Counting**

Static particle counts from SC-01 and SC-06 processed BN series valves are very low.

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

- Class 100 cleanroom
- Class 100 laminar-flow bench
- 2.4 std ft$^3$/min flow rate
- Particles greater than 0.014 µm in size detected.
**Moisture Analysis**

SC-01 processed valves dry down very quickly to the background level produced by the test instrument. The valves also recover quickly following the introduction of moisture spikes.

**Hydrocarbon Analysis**

Test results for hydrocarbon residues in SC-01 processed valves fall entirely within the background level produced by the test instrument.

**Ionic Cleanliness**

Residual ionic contamination is very low (less than 1 µg/mL for SC-01 and SC-06 processed valves).

The BN 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.

<table>
<thead>
<tr>
<th>Anions (−)</th>
<th>Cations (+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluoride</td>
<td>Lithium</td>
</tr>
<tr>
<td>Chloride</td>
<td>Sodium</td>
</tr>
<tr>
<td>Nitrate</td>
<td>Ammonium</td>
</tr>
<tr>
<td>Phosphate</td>
<td>Potassium</td>
</tr>
<tr>
<td>Sulfate</td>
<td>Magnesium</td>
</tr>
<tr>
<td></td>
<td>Calcium</td>
</tr>
</tbody>
</table>
**Lab Cycle Testing**

The BN series valve was tested to determine an estimated cycle life of the bellows under a set of controlled laboratory conditions (table at right).

Standard BN series pneumatically actuated valves with 321 SS bellows were tested. Valve cycle life was evaluated for leakage to atmosphere at regular intervals. Failure was defined as loss of internal static pressure during cycling or detection of an inboard helium leak rate greater than $4 \times 10^{-9}$ std cm$^3$/s.

All 30 test valves passed internal static pressure and inboard leakage test requirements for 4.7 million cycles. Ten of the same valves were tested to 12.2 million cycles. No valves failed; tests were stopped at predetermined levels.

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**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>30 pneumatically actuated valves</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas</strong></td>
<td>Dry, filtered nitrogen</td>
</tr>
<tr>
<td><strong>Temperature, °F (°C)</strong></td>
<td>70 (20)</td>
</tr>
<tr>
<td><strong>Constant Static Pressure, psig (bar)</strong></td>
<td>100 (6.8)</td>
</tr>
<tr>
<td><strong>Actuator Pressure, psig (bar)</strong></td>
<td>80 (5.5)</td>
</tr>
<tr>
<td><strong>Cycle Rate, cpm</strong></td>
<td>30</td>
</tr>
</tbody>
</table>

**Referenced Documents**

- **ASTM Standards**
  - F1394 Standard Test Method for Determination of Particle Contribution from Gas Distribution System Valves

- **Swagelok Specifications**
  - Photovoltaic Process Specification (SC-06), MS-06-64
  - Ultrahigh-Purity Process Specification (SC-01), MS-06-61

1. American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428.

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**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.