Bellows Requirements for Balanced Pressure Relief and Safety Valves

1. Purpose
This specification sets forth the requirements for design, fabrication and testing of metallic bellows to be used in Balanced type Pressure Relief and Safety Valve.

2. Materials
The following materials are permissible to manufacture the bellows.

Bellows material chart

Material Type	Typical Specification
304 STAINLESS	ASTM 240/ASTM A312
304L STAINLESS	ASTM 240/ASTM A312
316 STAINLESS	ASTM 240/ASTM A312
316L STAINLESS	ASTM 240/ASTM A312
321 STAINLESS	ASTM 240/ASTM A312
347 STAINLESS	ASTM A240/ASTM A312
ALLOY 600	ASTM B 167/ASTM B168
ALLOY 625	ASTM B 443
ALLOY 718	ASTM B 670
ALLOY 400	ASTM B 127/ASTM B165
ALLOY C22	ASTM B 575/ASTM B622
ALLOY C276	ASTM B 575/ASTM B622

3. Scope
This specification specifies type testing, examination, and acceptability for the purpose of manufacturing bellows to be used in balanced safety valve.
Safety valves include Relief Valves (for liquid); Safety Valves (for gas and vapor) and Safety and Relief Valves (for liquid, gas and vapor).

4. General Requirements
4.1. The bellows are the expandable metal parts that act as a seal preventing the fluid from discharge piping be in contact with the disc and seat of the valve.
A bellows assembly includes the bellows and related end fittings attached to the bellows by welding.

4.2. Each bellows assembly design and each bellows material shall be qualified by type testing.
Type testing includes both ambient temperature and high-temperature testing.
The ambient temperature tests shall be carried out at a pressure at least equal to the rated valve pressure for 100 °F (38 °C).
The high-temperature tests shall be carried out at a pressure at least equal to the rated valve pressure for the maximum temperature for which the bellows is designated.

4.3. A successful qualification requires that three bellows assemblies of the same design and material be type tested at ambient conditions and three more be tested at the high temperature conditions, and that all six meet the qualification acceptance requirements.
The six bellows assemblies for testing shall be randomly selected from a regular bellows assembly production lot.

5. Test Procedure
5.1. Pretest Examination

5.1.1. The bellows assemblies to be tested shall be cleaned.

5.1.2. The unrestrained (free) height of each bellows shall be measured and recorded along with the compressed and extended heights for which the qualification applies.
The compressed and extended ratios shall be the ones recorded in the test report.

5.1.3. All bellows assembly welds shall be examined using a liquid dye penetrant.
Any indication of a crack or any weld defect shall be cause for rejection.

5.2. Pressure Test
5.2.1. Each bellows assembly shall be pressure tested.

5.2.2. The pressure test fluid shall be water containing less than 50 ppm of chlorides.

5.2.3. For the pressure test, the bellows shall be positioned at its compressed design height corresponding to the valve full open position.
Positioning may be either in a valve assembly or in a test fixture duplicating the intended valve assembly.

5.2.4. The test fluid pressure shall be applied in the same direction (externally or internally) for which the bellows assembly is to be qualified.

5.2.5. The test fluid pressure shall be not less than 1.5 times the rated pressure of the valve at 100 °F (38 °C).

5.2.6. The minimum pressure test duration shall be five minutes.

5.2.7. Any pressure decreasing or visually detectable leakage over the test duration shall be cause for rejection.

5.3. Cycle Test
5.3.1. Each bellows assembly shall be cycle tested.

5.3.2. For the cycle test, the bellows assembly shall be installed in either a completely assembled valve or a test fixture that simulates the intended bellows valve installation and incorporates its maximum possible extension and compression.

5.3.3. The frequency of cycling shall not exceed one cycle per second.

5.3.4. One complete cycle is defined as movement of the bellows from the design compressed position to the design extended position and return to the compressed position corresponding to the valve open-closed-open positions.

5.3.5. The ambient cycle test cycling shall be carried out at ambient temperature and with the bellows subjected to a water pressure, as a minimum, equal to the 100°F (38°C) intended valve pressure rating.
The high-temperature cycle test shall be carried out at a temperature at least the maximum bellows assembly rated temperature, and with the bellows subjected to a pressure, as a minimum, equal to the intended valve pressure rating at the test temperature.
The test fluid for the high temperature test may be liquid or gas, at the manufacturer's option.

5.3.6. Water containing less than 50 ppm of chlorides shall be used.

5.3.7. The minimum number of test cycles required for qualification for each bellows assembly shall be 2000.

5.4. Post Test Examination
5.4.1. Upon completion of the cycle test, repeat the liquid dye penetrant examination. Any indication of a crack or any weld defect shall be cause for rejection.

6. Acceptability
Acceptance of the bellows assembly design and construction shall be based on all six assemblies meeting the qualification test requirements.

7. Test Report
A test report shall be prepared and be available at the valve manufacturer's facility for review upon purchaser request.

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