

THE ENGINEERING EQUIPMENT AND MATERIALS USERS' ASSOCIATION

A Guide to the
Production Testing of Valves
for the Energy, Process and related Industries

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ENGINEERING EQUIPMENT AND MATERIALS USERS' ASSOCIATION

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Foreword

This Guide, developed by the EEMUA Piping Systems Technical Committee Valves section, is aimed at providing guidance to users, specifiers and inspectors with regard to production testing of ball, plug, gate, butterfly and globe valves designed to internationally recognised standards and intended for use in the energy, process and related industries.

It is a common assumption that valve test and product standards contain all that is required to ensure adequate performance, but this is not always the case. Standards committees dominated by manufacturers, and the difficulties involved in achieving universal agreement, often result in a 'lowest common denominator' which may not always fulfil the user's expectations, particularly for critical services.

For example, seat leak test pressures should ideally reflect the seating mechanism of the valve (i.e. whether it utilises externally applied force or differential pressure) and the differential pressure against which valves are required to seal in service, but often do not. Also, minimum required test times are often very short. Purchasers should consider the value of such short test times, when the time taken for conditions to stabilise might be several minutes.

Terminology

In this document, the words 'will' and 'should', when used in the context of actions or requirements of or by the purchaser or other parties, have specific meanings as follows:

- 'will' is used in connection with an action by the purchaser, or with an action or requirement normally expected of the manufacturer or supplier;
- 'should' indicates a recommendation; where a recommendation is of particular importance, phrases such as 'need to' are used.

1. Scope

This Guide sets out the recommended production tests to be applied to the following types of valves: ball, plug, gate, butterfly and globe. It does not apply to valves used exclusively for control purposes.

Tests of an optional nature are included. Tests outside the scope of this Guide include material sampling and non-destructive testing of valve materials to verify their physical properties, chemical composition and quality. Type approval tests, fire type tests and tests at high and low temperature, are also excluded.

2. Equipment, Facilities and Procedures for Pressure Testing

2.1 General Responsibilities for the Manufacturer

- 2.1.1 Testing will normally be carried out by the manufacturer who will be responsible for providing all the necessary facilities, labour and equipment required to perform the tests and inspections, and for overall safety in the preparation for and conduct of the test.
- 2.1.2 The manufacturer will need to be able to demonstrate to the satisfaction of the purchaser the adequacy of the methods and equipment used to carry out and monitor the test.
- 2.1.3 The manufacturer will normally be responsible for the safety and design of test equipment and for providing adequate safeguards for personnel in the areas of the test.

2.2 Equipment and Facilities: Particular Requirements

- 2.2.1 The valve needs to be adequately illuminated and accessible for inspection.
- 2.2.2 The test equipment and method of pressurising the valve need to ensure that all pressure containing parts of the valve are strength tested and it is not subjected to external constraint. Axial loads should, ideally, not be reduced by the method adopted to blank the ends (see Note 1 below). Where this is not practical or economical, in all cases a minimum of one valve of each unique size, material and rating should be tested. Approved methods of blanking valve ends for pressure sealing are:
 - blank flanges or covers for flanged end valves;
 - weld end caps with or without pups for weld end valves;
 - screwed plugs for threaded end valves.

Alternative pressure sealing methods may be used when agreed by the purchaser, but it is recommended that these be considered only where the validity of the valve design has been proven by prototype or sample testing with blank ends attached to the valve (see Note 2).

Note 1: When blank ends are attached to a valve, then maximum longitudinal tensile stresses are developed when the valve is internally pressurised. This assists in detecting cracks in the valve materials and weaknesses in bolted joints and other connecting parts. This is particularly important if valves have a body joint transverse to the pipe axis.

Note 2: A reduction in longitudinal stresses in the valve body can result from some alternative pressure sealing methods, e.g. clamping the valve ends in a press and internally sealing valve bores with 'floating bungs'. The ends of valve bores sealed by floating bungs are not subjected to the test pressure and may require supplementary non-destructive testing (NDT).

- 2.2.3 The test facilities need to permit complete (and demonstrable) isolation of the valve from the pressure source.

- 2.2.4 In order to ensure that the accuracy and sensitivity of volumetric measuring devices are adequate, their calibration needs to be performed with the same test fluid, at the same temperature, and to be within the same tolerances as required for the tests.
Note: Guidance on measurement and calibration systems can be found in ISO 10012.
- 2.2.5 The manufacturer should be required to have valid, uniquely identifiable calibration certificates available for, and traceable to, each item of measuring equipment used for testing, with calibration carried out in accordance with an approved quality standard.
- 2.2.6 The accuracy of pressure gauges used in testing should be in accordance with EN 837-1, Table 11, Class 1.6 or better. It is recommended that the gauges display the test pressure between 25% and 75% of full gauge pressure and have a minimum face diameter of 150 mm. The purchaser may agree the use of alternative devices to pressure gauges.
- 2.2.7 Safety relief devices need to be incorporated in the pressurising system in order to prevent overpressuring the valve and test equipment.
- 2.2.8 No valve undergoing pressure testing is to be subjected to any form of shock loading.
- 2.2.9 Temperature measuring devices are to be capable of indicating fluctuations of 1°C.
- 2.2.10 If testing with gas supplied from high pressure storage, the test arrangement needs to be such that the gas entering the valve does not lower the temperature to the extent that the validity of the test is affected.

2.3 Test Fluid

- 2.3.1 The preferred test fluid for hydrostatic tests is clean fresh water at ambient temperature (but see 2.3.2 below) containing a suitable corrosion inhibitor, or a non-corrosive liquid whose viscosity at ambient temperature is equal to or less than that of water, e.g. kerosene.
Note: Certain corrosion inhibitors may have the effect of reducing torque below that which would be required to operate the valve in service.
- 2.3.2 To avoid the risk of freezing when the test medium is water, the minimum temperature of the valve or ambient air during the test should not be less than 5°C. The water temperature should be held within the temperature range 7°C to 38°C during testing. Alternatively, up to 50% glycol (automotive antifreeze) may be added to the test water where the low temperature toughness of the valve shell material is not in doubt.
- 2.3.3 Consideration should be given to the use of a wetting agent in the test water.
- 2.3.4 If the test water is in contact with austenitic stainless steel, its maximum chloride content should be limited to a maximum of 50 ppm (mg/kg), i.e. demineralised or distilled water may need to be used in hard water areas.

If the purchaser can confirm that the maximum operating temperature of the valve will not be above 50°C, the maximum chloride content may be increased to not more than 200 ppm (mg/kg). The pH value of test water should be within the range 6.5 to 8.5.

- 2.3.5 After hydrostatic testing, valves should be fully drained. This is particularly important where austenitic stainless steels are present, to ensure freedom from chloride deposits.
- 2.3.6 If air is used for testing, it needs to be clean and oil-free. Bottled nitrogen is an acceptable alternative.

2.4 Witnessing and Test Reporting

- 2.4.1 The purchaser may wish to witness tests. In this regard he will need to specify his requirements to the manufacturer.
- 2.4.2 The results of each test should be recorded and authenticated by the signature of the manufacturer's inspector, and also by that of the purchaser's inspector where appropriate. A sample test record sheet is included in Appendix A for information.
- 2.4.3 For identification during testing, one end of the valve should be designated 'A' and the other end 'B', e.g. by reference to the nameplate. These designations should be recorded in the test report.

2.5 Removal and/or Refitting of Parts

- 2.5.1 The removal and refitting, during or after test, of any pressure-containing valve component, such as body vent or drain plugs and body cavity relief valves, may compromise acceptance of the hydrostatic shell test. It is recommended that a formal refitting procedure be agreed between the purchaser and manufacturer.
- 2.5.2 It is recommended that as a minimum the procedure ensure that:
 - the connections of all dismantled components, including male and female threads, are examined and verified to be compatible and in satisfactory condition;
 - the components originally fitted for the hydrostatic shell test are reused in the valve unless damaged or found incompatible, in which case new components need to be used and the test repeated;
 - secure engagement is achieved between threaded components;
 - if thread sealing tape is used and permitted by the purchaser, an excess of tape does not preclude secure thread engagement;
 - any seals and gaskets used are correctly fitted;
 - re-tightening of components is to the degree employed and shown to be effective in the previous hydrostatic shell test.

3. Types and Sequence of Tests

3.1 Recommended Test Requirements

- 3.1.1 The recommended test requirements for commodity valves and for those considered by the purchaser to be in critical service are contained in Table 1 (see Page 10). Considerations to be taken into account in determining criticality are: function, size, nature of fluid (gas, liquid), flammability, toxicity, temperature, pressure and consequence of failure, etc.

3.2 Information to be Provided by the Purchaser

- 3.2.1 Details of the information to be provided by the purchaser at the enquiry or purchase order stage are listed in Appendix B.

3.3 Test Sequence

- 3.3.1 When planning the test sequence for valves, care should be taken to minimise the number of steps required to fulfil the testing process. A proposed sequence is provided below. Note that some tests are not required for all valve types. Reference should be made to Table 1 (see Page 10).

The sequence of testing valves should be as follows unless otherwise agreed.

- a) antistatic test (see Chapter 8)
- b) hydrostatic shell test (see Chapter 4 Section 4.2)
- c) body cavity relief test (see Chapter 5)
- d) back seat test (globe and gate valves only) (see Chapter 9)
- e) disc strength test when conducted on an assembled valve (butterfly valves only) (see Chapter 10)
- f) high pressure hydrostatic seat test (see Chapter 6 Sections 6.3, 6.4, 6.5)
- g) operational/operating torque test (see Chapter 7)
- h) low pressure air shell test (see Chapter 4 Section 4.3)
- i) low pressure air seat test (see Chapter 6 Sections 6.6, 6.7, 6.8)
- j) high pressure gas seat test (see Chapter 6 Section 6.9).

Table 1 Recommended Valve Test Requirements

Nomenclature: Y = Test recommended N = Test not recommended
A = Test discretionary according to service conditions

TEST DESCRIPTION	COMMODITY VALVES					CRITICAL SERVICE VALVES				
	GATE ¹	GLOBE	BUT'FLY	PLUG	BALL	GATE ¹	GLOBE	BUT'FLY	PLUG	BALL
Antistatic (Chapter 8)	N	N	N	Y ²	Y ²	N	N	N	Y ²	Y ²
Hydrostatic Shell (liquid) (Section 4.2)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Shell Tightness (liquid) (Chapter 4)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Shell Tightness (LP gas) (Chapter 4)	N	N	N	N	N	A ³	A ³	A ³	A ³	A ³
Body Cavity Relief (Chapter 5)	Y ^{4,5}	N	N	Y ^{4,5}	Y ⁴	Y ^{4,5}	N	N	Y ^{4,5}	Y ⁴
Back Seat (liquid) (Chapter 9)	Y ⁴	Y ⁴	N	N	N	Y	Y	N	N	N
Disc Strength (liquid/gas) (Chapter 10)	N	N	N	N	N	N	N	Y ⁶	N	N
HP Seat (liquid) (Sections 6.3, 6.4, 6.5)	Y	Y	Y	Y	A ⁷	Y	Y	Y	Y	Y
HP Seat (gas) ⁸ (Sections 6.3, 6.4, 6.5)	N	N	N	N	N	A ^{3,4}	A ^{3,4}	A ^{3,4}	A ^{3,4}	A ^{3,4}
Operational (operability) (Chapter 7)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Torque/Force Measurement (Chapter 7)	N	N	N	N	N	Y ⁴	Y ⁴	Y ⁴	Y ⁴	Y ⁴
LP Seat (gas) (Sections 6.6, 6.7, 6.8)	A ³	A ³	A ³	A ³	Y	A ³	A ³	A ³	A ³	Y

Notes:

1 Wedge gate, expanding gate and slab gate.

2 Type test.

3 Gas service applications. Allowable leak rate for HP test should be agreed with manufacturer: will normally be several times LP rate.

4 Sample.

5 Only types which can lock liquid inside body cavity when in the closed position and which may subsequently be heated or could be exposed to fire.

6 'A' for sizes below DN 350 (14 in).

7 Strongly recommended where sealing force is mechanical, e.g. 'Orbit' type valves.

8 May be substituted for HP liquid seat test.