Process Valve Qualification Procedure

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Suggested revisions are invited and should be submitted to the Standards Department, API, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001, standards@api.org.

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1 Scope

This recommended practice (RP) provides recommendations for evaluation of a manufacturer's valve construction and quality management system for the purpose of determining a manufacturer's capability to provide new valves manufactured in accordance with the applicable standards listed in Section 2. Testing per this RP that does not have an established requirement in the applicable standard is for information only.

Qualification of valves under this RP is "manufacturing facility specific" and does not cover valves manufactured by other manufacturing facilities, whether owned by the same manufacturer or a third party.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies, except that new editions may be used on issue and shall become mandatory upon the effective date specified by the publisher or 12 months from the date of the revision (where no effective date is specified).

API RP 578, *Material Verification Program for New and Existing Alloy Piping Systems*

API 594, *Check Valves: Flanged, Lug, Wafer, and Butt-welding*

API 598, *Valve Inspection and Testing*

API 599, *Metal Plug Valves—Flanged, Threaded and Welding Ends*

API 600, *Bolted Bonnet Steel Gate Valves for Petroleum and Natural Gas Industries*

API 602, *Steel Gate, Globe and Check Valves for Sizes DN 100 and Smaller for the Petroleum and Natural Gas Industries*

API 603, *Corrosion-resistant, Bolted Bonnet Gate Valves—Flanged and Welding End*

API 607, *Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats*

API 608, *Metal Ball Valves—Flanged, Threaded, and Butt-welding Ends*

API 609, *Butterfly Valves: Double Flanged, Lug- and Wafer-type*

API 623, *Steel Globe Valves-Flanged and Butt-welding Ends, Bolted Bonnets*

API 624, *Type Testing of Rising Stem Valves Equipped with Flexible Graphite Packing for Fugitive Emissions*

API 641, *Type Testing of Quarter Turn Valves for Fugitive Emissions*

ASME B1.1 [1], *Unified Inch Screw Threads (UN & UNR Thread Form)*

ASME B16.5, *Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard*

[1] ASME International, 3 Park Avenue, New York, New York 10016-5990, www.asme.org.

ASME B16.10, *Face-to-Face and End-to-End Dimensions of Valves*

ASME B16.11, *Forged Fittings, Socket-Welding and Threaded*

ASME B16.25, *Buttwelding Ends*

ASME B16.34, *Valves—Flanged, Threaded, and Welding End*

ASME B18.2.2, *Square and Hex Nuts (Inch Series)*

ASME B31.3, *Process Piping*

ASTM A703 [2], *Standard Specification for Steel Castings, General Requirements for Pressure-containing Parts*

ASTM E340, *Standard Test Method for Macroetching Metals and Alloys*

ISO 9001 [3], *Quality Management Systems—Requirements*

ANSI/MSS SP-55 [4], *Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components—Visual Method for Evaluation of Surface Irregularities*

3 Terms and Definitions

For the purpose of this document the following terms and definitions apply.

3.1
acceptance criteria
Specified limits placed on the characteristics of an item, process, or service defined in codes, standards, or other manufacturer provided documents.

3.2
audit
A planned and documented activity performed to determine by investigation, examination, or evaluation of objective evidence the adequacy of and compliance with established procedures, instructions, drawings, and other applicable documents and the effectiveness of implementation.

3.3
break-to-open torque
The torque required to break (unseat) the valve closure element from its fully closed (seated) position, against the rated pressure differential.

3.4
casting method
For purposes of this document, casting method shall refer to either sand or investment casting method.

3.5
characteristic
Any property or attribute of an item, process, or service that is distinct, describable, and measurable.

[2] ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.
[3] International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, www.iso.org.
[4] Manufacturers Standardization Society of the Valve and Fittings Industry, Inc., 127 Park Street, NE, Vienna, Virginia 22180- 4602, www.mss-hq.org.

3.6
end-to-close torque
The torque required to close (seat) the valve closure element to its fully closed (seated) position, against the rated pressure differential.

3.7
manufacturer
The entity whose name or trademark appears on a valve.

3.8
manufacturing facility
Location of final assembly, inspection, and testing of the valve selected for evaluation.

3.9
nonconformance
Any item or action that does not meet the requirements of the standards listed in Section 2 or the manufacturer's specifications.

3.10
pressure-containing components
Any shell component (bodies, bonnets, covers, caps, or end pieces).

3.11
purchaser
A person, group, company, agency, corporation, or designated representative responsible for valve acceptance.

3.12
qualification facility
A testing facility that has no commercial relationship with the valve manufacturer, including ownership/part ownership or any other business relationship beyond testing to this RP or being an authorized modification facility for such manufacturer.

3.13
quality management system (QMS)
The planned and systematic actions necessary to provide confidence that a valve is manufactured in accordance with the requirements of the referenced API standard and manufacturer's specifications.

3.14
stem cylindricity
A condition of a surface of revolution in which all points of the surface are equidistant from a common axis.

3.15
stem run-out
The difference in diameters of a stem measured at intervals along its length when the stem is rotated 360º.

3.16
stem straightness
The condition in which the longitudinal elements of a stem or shaft are compared to a straight line.

3.17
supplier
An individual or organization that furnishes items in accordance with a procurement document. It is a term used to indicate any of the following: vendor, seller, contractor, subcontractor, or fabricator.

4 Manufacturer Quality Management System Evaluation

4.1 General

The manufacturer shall establish and maintain a quality management group that shall be responsible for establishing and maintaining a quality management system. The quality management system shall follow the principles of ISO 9001.

4.2 Record and Documentation Review

The manufacturer shall upon request make the following available:

a) quality manual;

b) organizational structure and functional responsibilities with levels of authority;

c) approved supplier list;

d) most recent supplier evaluation record;

e) inspection and test plan for purchased pressure containing components;

f) confirmation of sub-supplier quality management system following the principles of ISO 9001;

g) documents and records relating to special processes such as those used in welding, heat treatment, and nondestructive examination;

h) final product examination and testing documents;

i) test equipment list; and

j) traceability procedures of pressure containing components:

   1) certified mill test reports (CMTRs),

   2) certificates of compliance (CoCs).

4.3 Right of Access

The manufacturer's procurement documents shall require their suppliers to provide access to their plant facilities and records for inspection or audit by the manufacturer, their designated representative, or other parties authorized by the manufacturer.

4.4 Document Control

Documents supplied during valve qualification shall be identical copies of documents currently being used in the manufacturing process at the time of testing.

5 Valve Qualification

5.1 Data to be Provided by Manufacturer

5.1.1 General assembly drawings of one valve size of each design for each pressure class shall be available to the qualification facility. These drawings shall show: all applicable construction details, including stem-to-wedge, disk, ball, or plug connections; guides; bearings; stem seals; body joint; body joint gasket; seat(s); and seal(s). They shall also include descriptions of the construction materials for all of the parts, including fasteners. The manufacturer shall also identify the trim and sealing materials used.

5.1.2 Where welding, including casting repair, is performed by the manufacturer and/or the foundry on the valves being evaluated, the applicable welding procedures and weld procedure qualification shall be provided.

5.1.3 The manufacturer shall make available a tabulation of the foundries and forge shops from which castings or forgings used for bodies, bonnets, covers, and closure elements (e.g. wedges, disks, plugs, or balls) were obtained and the manufacturing facilities from which completed valves were obtained. The table shall include any special marking or coding used by the manufacturer to trace, distinguish, and identify component parts from different sources, including each manufacturing location and address.

5.1.4 For gate and globe valves, the manufacturer shall provide the recommended closure torques to adequately seat the valve at the maximum rated pressure for all sizes of valves being evaluated. For quarter-turn valves, the manufacturer shall provide break-to-open and end-to-close torques at the maximum rated pressure. For bidirectional valves, the manufacturer shall provide torque values for both directions.

5.1.5 The manufacturer shall provide written certification, signed by an officer or senior-level manager responsible for quality control for the manufacturing company, that states that the manufacturer's production valves, regardless of size, pressure class, or materials of construction, are equivalent to the valves involved in the qualification and comply with the applicable product standards.

5.1.6 The manufacturer shall identify the name and location of the facility where the valves undergo final assembly and testing for inclusion in the final report required by 5.5.

5.1.7 Manufacturing by a third party (private labeling), where the manufacturing facility does not fully own the name, trademark, or symbol on the valve, requires that the following additional information shall be documented in the final report prepared by the test facility:

a) owning entity of the trademark, valve design, casting patterns, or forging dies;

b) entity responsible for implementing the facility's QMS/quality control program; and

c) the business relationship between the manufacturing facility(s) and the trademark owner (valve supplier, joint venture, partial ownership, majority of controlling ownership).

A signed statement shall be included in the final report as required in 5.5.

5.2 Valve Qualification Facility

The manufacturer shall engage a qualification facility to perform the inspections, examinations, and tests described in this section. The facility(s) used shall be mutually agreeable to the purchaser and the manufacturer. The qualification facility staff responsible for testing shall include a degreed or licensed metallurgical engineer or mechanical engineer. The qualification facility may subcontract portions of these inspections, examinations, and tests as required; however, subcontracting back to the valve manufacturer is not permitted.

The qualification facility(s) shall be equipped and capable of performing or supervising the performance of nondestructive examination, physical tests, and chemical analyses on materials. The qualification facility staff shall be familiar with the applicable API valve standards and the codes, standards, and specifications referenced in those standards. The facility's proposed program shall cover the following:

a) qualifications of the personnel performing the inspections and tests;

b) test details and format used to present the results of the tests;

c) number, sizes, and types of valves examined (see Annex A); and

d) source of the test valves and test valves selection method.

5.3 Selection of Valves

5.3.1 In order to ensure that the test valves were not made specifically for the tests, a random sampling feature shall be incorporated into the program. The qualification facility personnel shall select the test valves randomly from the manufacturer's or distributor's stock. Alternatively, the purchaser may choose to select the valves to be tested.

5.3.2 Random sampling shall include selection from each material category to be qualified per Annex A. It is expected that the manufacturer shall have sufficient stock from which a random sampling of their valve products and shell materials to be qualified may be selected. A reduced number of valves from the recommended sample lot may be agreed upon by the purchaser and manufacturer. Selected valves shall be clearly identified. Once testing commences, testing shall be limited to the randomly selected sample lot with no substitutions.

5.3.3 Casting and forging materials qualification of shell components shall be in accordance with Annex A.

5.3.4 For nonstandard or built-to-order valves, these may be provided directly from the manufacturing facility to the qualification facility as agreed to by the purchaser. Quantity and specific test requirements are to be as agreed by the purchaser.

5.4 Required Examination and Testing

5.4.1 All of the pressure tests specified in API 598, including the optional high- or low-pressure closure tests, shall be performed on each valve. Subsequently, the valve shall be opened at the maximum rated differential pressure. After the pressure has been relieved, the seating surfaces shall be checked for damage. The double block and bleed test is required for valves identified by the manufacturer as being double block and bleed capable.

The torque is to be applied by a calibrated torque wrench either directly or through a gear operator to the center of the stem/shaft. If the torque recommended by the manufacturer should prove to be inadequate, the torque may be increased incrementally to a maximum of 1.25 times the recommended value until the seat leakage is within allowable limits. The required closure torques shall be measured and reported. During seat tests, external forces that affect seat leakage shall not be applied to the valve ends.

Prior to the start of the qualification testing, gate and globe valves shall be stroked full open and closed with the stem in the horizontal position with flow orientation in both the horizontal and vertical directions to confirm operability unless these positions are restricted by the manufacturer. Results and restrictions shall be noted on the report.

5.4.2 Dimensions and finishes in Annex D, Table D.1, shall be measured on each valve, as applicable, and reported with those specified in the applicable standards and the manufacturer's requirements.

5.4.3 All valve parts shall be visually examined to confirm compliance to applicable design standard and documented as listed in Annex D, Table D.2, as applicable.

5.4.4 After completion of required dimensional and visual examinations, paint and sealants shall be removed from the bodies, bonnets, and covers. Each of these valve pressure-containing components shall be visually examined to determine the following:

a) forgings or wrought materials are free from laps and seams; and

b) surface quality of castings, including the body, bonnet, and cover, is as specified in MSS SP-55.

After completing visual examination, a photograph of the disassembled valve parts, readable nameplate, and cast-in markings shall be made and conditions documented.

5.4.5 Material examinations listed in Table 1 shall be made on a minimum of five of the sample valves. The source of each body and bonnet (or cover) as well as each material category from each material source shall be sampled using a method that detects chemical composition. All detected elements are to be recorded (including all trace elements) using a method described in API RP 578. Chemical composition and hardness shall be nondestructively determined except that small samples may be removed from the body, bonnet, or cover in a manner that will not affect the integrity of the component (e.g. areas such as bosses, ribs, and flange perimeters) and all trace elements detected by the test method used shall be reported. In addition, casting weld repairs and other pressure-containing welds shall have chemical composition and hardness nondestructively determined.

Table 1—Material Examination Table

Tests	Pressure Containing Components	Seat Ring	Seal Weld	Stem	Yoke Nut and Back Seat[a]	Disk/Plug/ Ball	Body/ Bonnet Metallic Gasket	Bolts and Nuts[b]
Chemical composition	x	x[c]	—	x	x	x[a]	—	x
Tensile strength	x[d]	—	—	—	—	—	—	x[e]
Yield strength	x[d]	—	—	—	—	—	—	—
Elongation	x[d]	—	—	—	—	—	—	—
Reduction of area	x[d]	—	—	—	—	—	—	—
Hardness	x	x	—	x	x	x	x[f]	x
Dye penetrant	—	—	x[f,g]	—	—	—	—	—
Positive material identification (PMI)[h]	x	x	x[f]	x	x	x	x	x

KEY

x = required

— = not required

[a] These examinations apply to gate and globe valves only.

[b] A minimum of four bolts and nuts shall be randomly selected, representing all bolt sizes and material grades in the sample lots from tables in Annex A.

[c] If seating surfaces are welded, chemical analysis shall be made on both metals (weld metal and base metal). If the seating surfaces are applied in the form of thin plates welded to the disk, chemical analysis shall be made on the disk, the thin plates, the attachment welds, and all coatings and surface treatments.

[d] These test results may be taken from mill test reports except when physical testing is required per 5.4.12.

[e] Tensile strength shall be estimated using the measured hardness readings and the correlations (hardness to tensile strength) in ASTM A370.

[f] Applicable if testing can be performed without destruction of the valve.

[g] Magnetic particle may be done if requested.

[h] Refer to API RP 578 for PMI requirements.

5.4.6 Strength tests of the stem/shaft-to-closure element connection shall be performed on valves as indicated in Annex A, in accordance with the requirements of Annex B.

The manufacturer shall make a guide for sizing the required test fixtures by providing the calculated stem/shaft-to-closure element failure loads for the valves to be tested available to the qualification facility conducting the strength tests.

5.4.7 All pressure-retaining welds shall be completely radiographed in accordance with the requirements of ASME B31.3 using the acceptance criteria for normal fluid service conditions. Butt-welding end preparations, welds in fabricated wedges, and pressure-retaining welds that cannot be radiographed shall be examined in accordance with ASME B16.34 by either the magnetic particle or the liquid penetrant method.

5.4.8 All cast valves in the sample lot of each casting type (investment and sand) and material category per 5.3.3 shall have 100 % of the pressure-containing components examined by radiography. A minimum of three valve pressure-containing components shall be examined from each foundry source. The procedure shall be in accordance with ASME B16.34, Appendix I-1. The qualification facility shall report each type of discontinuity for each film, with sketches illustrating the locations of all films. Casting quality shall be determined and reported for each valve (body, bonnet, cover, or end piece). The suggested minimum acceptable casting radiographic results are given in Annex C.

5.4.9 Pressure-containing components shall be magnetic particle or dye penetrant examined with acceptance criteria in accordance with ASME B16.34 Appendix II or III.

5.4.10 For valves employing handwheels, four hand wheels out of the sample lot shall be subjected to a hammer test. Using normal force, the hammer (3 lb [1.5 kg] for valves NPS 4 [DN100] and smaller, 10 lb [5 kg] for valves NPS 6 [DN150] and larger) should strike the outer rim between the spokes at an angle perpendicular to the plane of the hand wheel and any damage reported.

5.4.11 Each test hand wheel shall be subjected to a torque test, applying three times the torque recommended by the manufacturer for closure. In applying the torque, the handwheel is removed from the valve and the center of the handwheel tightly secured in an appropriate fixture. Torque is applied to the outer rim of the hand wheel at the spoke junction using an attachment mounted to the wrench. Any damage shall be reported.

5.4.12 Mechanical testing and metallurgical examination shall be made on the pressure-containing components of two valves. For API 602, welded bonnet valves, a cross-sectional dissection shall be performed to analyze and verify the strength of the weld as well as the presence and type of any mechanical body/bonnet connection (threads). If additional alloys are included in the test lot, one chrome moly sample and/or one austenitic stainless steel sample shall also be examined. Mechanical testing shall include tensile, yield, elongation, and reduction of area. For carbon and low-alloy steels, tests shall also include hardness and charpy impact testing. Charpy impact test temperature shall be performed at the lowest valve temperature rating. Testing at other temperatures shall be agreed to by the purchaser. Microetch testing shall be conducted per ASTM A703 and shall include a 100× photomicrograph to assess the microstructure in accordance with ASTM E340. A wet-chemical, emission spectrometry, or equivalent analysis shall be made of these two samples and all elements, including trace elements, shall be noted. Duplex material shall have ferrite content verified and reported. Testing and examination results, as applicable, shall be compared to the appropriate ASTM standard and reported in the test report.

5.5 Documentation of Examination and Test Results

5.5.1 The qualification facility shall assemble all the data required by this section into a single document. The distribution of the test report shall be agreed to by the manufacturer and purchaser.

5.5.2 The test report shall be maintained for a minimum of seven years. A distribution log shall be maintained by the manufacturer for the purpose of notification of changes as specified in Section 6.

6 Post Qualification

6.1 For any given material group (Annex A), a change in any of the following items shall void the qualification for which this recommended practice was intended to qualify:

a) controlling ownership of the manufacturing facility;

b) location of the manufacturing facilities;

c) design change and/or a change to the manufacturing/fabrication method that may affect the performance of the valve or change the results of qualification testing in accordance with this RP.

6.2 Changes to a manufacturer's quality control procedures will not void the qualification of valves for which this RP was intended to qualify, provided that revisions do not reduce the scope of the manufacturer's previous inspection program and continue to meet the principles of ISO 9001 and/or API Q1.

6.3 Changes or additions of suppliers of pressure-containing components will not void the qualification, provided that the manufacturer qualifies the components in accordance with 5.3, 5.4.4, 5.4.5, 5.4.8, 5.4.9, and 5.4.12. Documentation of examination and test results shall be in accordance with 5.5 and shall be provided as an annex to the original test report.

6.4 Any change in valve stem packing will not void the qualification.

6.5 A revision of this RP is not intended to void any previous qualifications to RP 591. Likewise, a revision to the applicable API product standard is not intended to automatically void any previous qualifications to RP 591.

Annex A
(normative)

Selection Quantities for Examination and Test of Valves Made in Accordance with API Valve Standards

For each specified valve design, the minimum suggested sample lot is provided in Table A.2 through Table A.12.

For each NPS and class combination listed in the tables, the sample lot for each manufacturing plant location shall include at least three valves for each body and bonnet (or cover) source (foundry or forge shop), and three valves for each material category as defined in Table A.1.

Table A.1—Valve Selection Material Groups

Material Group	Description	Type	Typical ASTM Designation	
			Spec No.	Typical Grades
Group A	Carbon steels	Cast Cast Forged Forged	A216 A352 A105 A350	WCB WCC LCB LCC LC3 LF2 LF3
Group B	Low-alloy steels	Cast Forged	A217 A182	WC6 WC9 C5 C12 C12A F11 F22 F5 F9 F91
Group C	Austenitic	Cast Forged	A351 A182	CF8 CF3 CF8M CF3M CF8C CG8M F304 F304L F316 F316L F347 F347H F317
Group D	Duplex	Cast Forged	A995 A182	CD3MN F51 F53 F55
Group E	Corrosion-resistant alloys (CRA)	Cast Cast Forged	A494 A351 B462	M-35 CY40 CW6MC CW2M CW12MW CT15C CN7M N08020 Ni-Cr-Mo-Cu-Nb N10276 Ni-Mo-Cr
			B564	N04400 Ni-Cu N06600 Ni-Cr-Fe N06625 Ni-Cr-Mo-Nb N10276 Ni-Mo-Cr

NOTE Spec numbers and typical grades listed in Table A.1 are not all encompassing of all the ASTM designations available; they are only a representation of which specs apply to which material category.

For valve types not covered in this standard, the minimum suggested sample lot may be established by agreement between the manufacturer and end user.

Table A.2—Suggested Size and Class to be Tested for Each Type Check Valve (Single Plate, Dual Plate, Swing Type) Made in Accordance with API 594 or ASME B16.34

Nominal Pipe Size (NPS)	Class	Quantity (Each NPS)
4, 6, 16	150	1
3, 12	300	1

Table A.3—Suggested Size and Class to be Tested for Each Type Plug Valve (Lubricated, Non-lubricated, Elastomer Lined, Wedge Type) Made in Accordance with API 599

NPS	Class	Strength Test (NPS)[a]	Quantity (Each NPS)
4, 8	150	8	1
3	300	3	1
3, 6	600	—	1

[a] See Annex B for test details.

Table A.4—Suggested Size and Class to be Tested for Steel Gate Valves Made in Accordance with API 600[a]

NPS	Class	Strength Test (NPS) [b]	Quantity (Each NPS)
4, 12, 24	150	4, 12	1
3, 12	300	3, 12	1
3, 12	600	—	1

[a] Unless otherwise requested, all selected valves shall have flanged ends.
See Annex B for test details.

Table A.5—Suggested Size and Class to be Tested for Flanged Steel Gate Valves Made in Accordance with API 602

NPS	Class	Strength Test (NPS)[a]	Quantity (Each NPS)
3/4, 1	150	3/4	1
3/4, 1	300	3/4	1
1 1/2, 2	600	1 1/2	1
1, 2	1500	—	1

[a] Strength test required for only one valve for each material category. See Annex B for test details.

Table A.6—Suggested Size and Class to be Tested for Threaded/SW Steel Gate Valves Made in Accordance with API 602[a]

NPS	Class	Strength Test (NPS)[b]	Quantity (Each NPS)[c]
$^{1}/_{2}$, $1^{1}/_{2}$	800	$^{1}/_{2}$	3
$^{3}/_{4}$	800	$^{3}/_{4}$	6
1	800	1	4
$^{3}/_{4}$, 2	1500	$^{3}/_{4}$	3
1, $1^{1}/_{2}$	1500	1	4

[a] For manufacturers that make welded bonnet valves, one 800# and one 1500# welded bonnet valve shall be substituted for bolted bonnet valves in sample lot.

[b] Strength test required for only one valve for each material category. See Annex B for test details.

[c] For each NPS/Class combination, one valve shall be of socket weld construction, except that for $^{3}/_{4}$ NPS Class 800, two valves shall be of socket weld construction. The remaining valves shall be supplied with threaded ends.

Table A.7—Suggested Size, Class and Type to be Tested for Steel Globe and Check Valves Made in Accordance with API 602[a]

NPS	Class	Globe Quantity	Ball or Piston Check Quantity	Swing Check Quantity
$^{3}/_{4}$	800	2	1	1
1	800	1	—	—
1	1500	—	1	—
$1^{1}/_{2}$	1500	1	—	—

[a] Unless otherwise requested, valves shall be supplied with threaded ends.

Table A.8—Suggested Size and Class to be Tested for Steel Gate Valves Made in Accordance with API 603[a]

NPS	Class	Strength Test (NPS)[b]	Quantity (Each NPS)
4, 12, 24	150	4, 12	1
3, 12	300	3, 12	1
3, 12	600	—	1

[a] Unless otherwise requested, all selected valves shall have flanged ends.

[b] See Annex B for test details.

Table A.9—Suggested Size and Class to be Tested for Each Type Ball Valve (Floating Type: End Entry, Split Body, Three Piece and Top Entry; Trunnion Type: Split Body, Three Piece) Made in Accordance with API 608[a]

NPS	Class	Strength Test (NPS)[b]	Quantity (Each NPS)
4, 8	150	4	1
3, 6	300	6	1

[a] Metal-seated valves are not covered by this table.

[b] See Annex B for test details.

Table A.10—Suggested Size and Material Type to be Tested for Butterfly Valves (Materials per Table A.1, Ductile Iron, Grey Iron) Made in Accordance with API 609 (Category A)

NPS	Material	Quantity (Each NPS)
8, 12, 24	Materials per Table A.1	1
12, 24	Ductile Iron	1
12, 24	Grey Iron	1

Table A.11—Suggested Size and Class to be Tested for Each Type of Offset Butterfly Valve Design Made in Accordance with API 609 (Category B)

NPS	Class	Strength Test (NPS)[a]	Quantity (Each NPS)[b]
3, 12, 24	150	12	1
4, 12	300	12	1
3, 12	600	12	1

[a] See Annex B for test details.

[b] Selection shall include at least one flanged and one lug style design for each class.

Table A.12—Suggested Size and Class to be Tested for Steel Globe Valves Made in Accordance with ASME B16.34 or API 623[a]

NPS	Class	Quantity (Each NPS)
4, 6, 8	150	1
3, 6	300	1

[a] Unless otherwise requested, all selected valves shall have flanged ends.

Annex B
(normative)

Strength Tests for Stem/Shaft-to-closure Element Connections

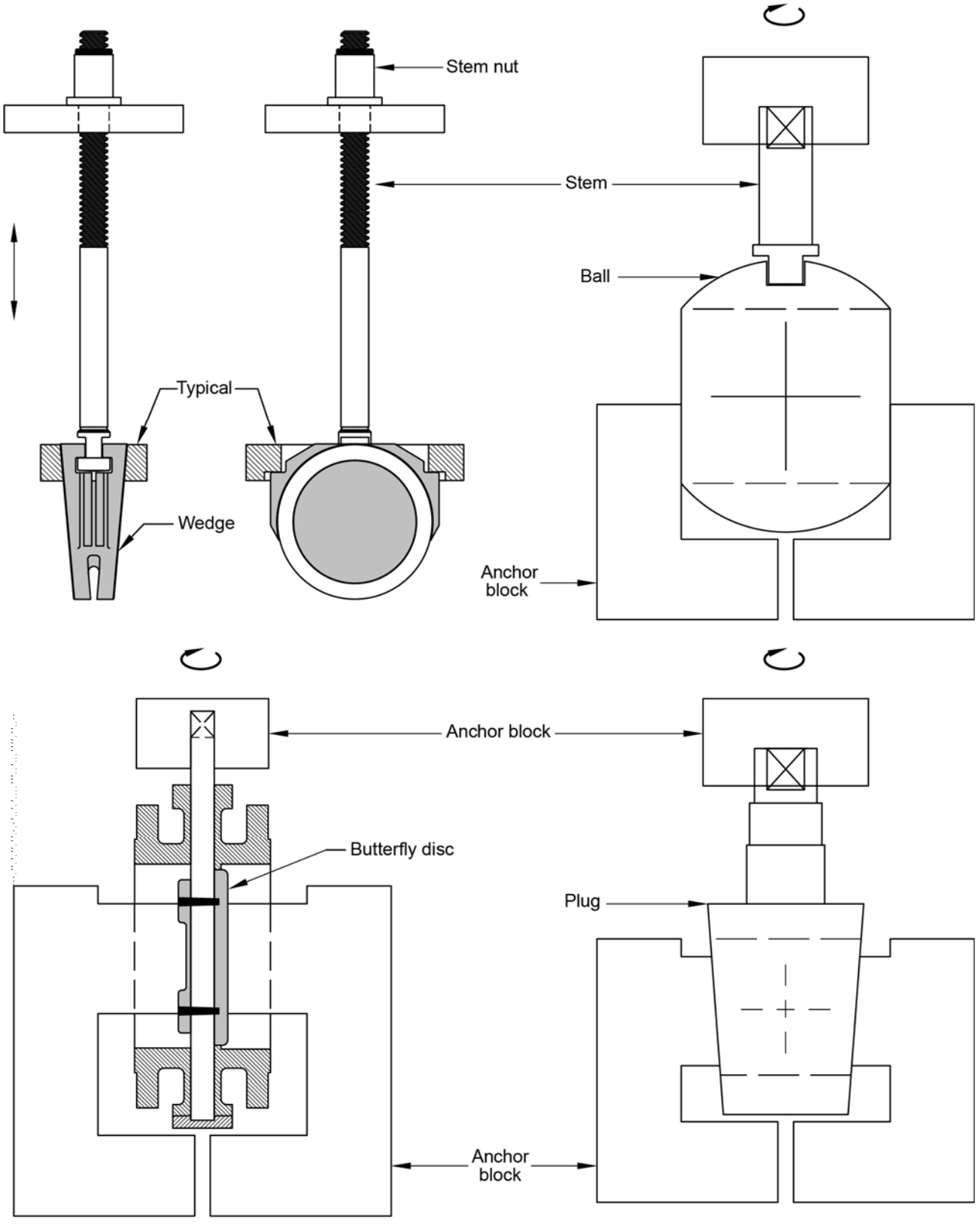
B.1 For steel gate valves, direct tensile loads shall be applied to wedge–stem stem nut assemblies to determine the location of the first point of failure and the magnitude of the loads at failure. The first point of failure (actual breakage of stem or disk) shall occur at a location that is outside the valve pressure boundary. Testing shall continue to determine the failure load of the stem-to-wedge connection and the results shall be reported.

B.2 For metal plug/ball valves and Category B butterfly valves, direct torsional loads shall be applied to stem-to-closure element assemblies to determine the location of the first point of failure (first permanent deformation of a drive train component) and the magnitude of the loads at failure as defined in the applicable API standards.

B.3 If any of the tested assemblies fail to meet the requirements of the first two paragraphs, all of the valves in the sample lot shall have the strength tests for stem/shaft-to-closure element connections performed and the results reported.

B.4 A dimensional analysis of the stem-to-closure element connection of all of the valve sizes for which approval is sought shall demonstrate that all of the connections are similarly proportioned to the tested stems and closure elements. If different product forms or different material mechanical properties are involved with untested valve sizes, additional stem-to-closure element tests shall be made to demonstrate the soundness of the other designs and/or materials.

B.5 Strength testing is potentially hazardous and it is essential that the safety of personnel be given prime consideration. The testing equipment shall be designed to apply the required tensile or torsional loads as applicable to all components. The test lab shall ensure that the test fixture does not misalign or introduce side loading that can influence the results of the strength test. Testing equipment shall not restrict or interfere with the movement of the wedge ears. Testing methods that involve welding to the closure element shall have nondestructive hardness testing performed before and after welding to ensure the stem connection characteristics of the closure element have not been altered. Machining or drilling of the closure element below the center line is allowed to provide a satisfactory surface for clamping. Torsional testing, as in Figure B.1, may be conducted in the original, as assembled valve.



NOTE Diagrams shown are only examples of allowed fixtures for strength testing.

Figure B.1—Torsional Testing

Annex C
(informative)

Suggested Minimum Acceptable Casting Radiographic Results for Wall Thickness <50 mm (2 in.)

Table C.1—Acceptable Casting Radiographic Results

Acceptable Comparative Discontinuity Type	Category	Plate ASTM E446
Gas	A	A3
Sand	B	B4
Shrink, Type 1	C	CA3
Shrink, Type 2	C	CB4
Shrink, Type 3	C	CC4
Shrink, Type 4	C	CD4
Hot Tears and Cracks	D and E	None
Inserts (Chills, Chaplets)	F	None

Annex D
(normative)

Examination and Testing Tables

Table D.1—Dimension and Finishes Table

Item #	Description	Gate	Globe	Check	Ball	Butterfly	Plug
External Dimensions and End Connections							
1	Face-to-face or end to end dimension (ASME B16.10)	x	x	x	x	x	x
2	Flange dimensions (ASME B16.5), including orientation of bolt holes	x	x	x	x	x	x
3	Facing finish, including number of grooves per in., of raised-face end flanges (ASME B16.5) and bonnet-joint flanges	x	x	x	x	x	x
4	Butt-welding end dimensions (ASME B16.25 or API 602, as applicable)	x	x	x	x	x	x
5	Center to top (closed and open position for rising stem valves)	x	x	x	x	x	x
6	Hand wheel diameter or lever length	x	x	—	x	x	x
7	Body, bonnet, cover, and end-piece thickness	x	x	x	x	x	x
8	Socket-weld ends and threaded ends (ASME B16.11)	x	x	x	x	—	x
9	Socket-weld end and threaded end dimension wall thickness per ASME B16.34	x	x	x	x	—	x
10	Type of the locking device and minimum pad lock shank diameter (if provided)	—	—	—	x	x	x
11	Lubricant fitting, size, and type	—	—	—	—	—	x
12	Lubrication fitting or plug material	x	x	x	x	x	x
13	Length of the disk guides on the disk	x	—	—	—	—	—
14	Verify pipe plug (pin retainer) is solid and same nominal chemical composition and material properties as the valve body	—	—	x	—	—	—
15	Position of closure element at time of delivery	x	x	x	x	x	x
16	Stem diameter at the extremities and midpoint of the packing contact area, stem surface finish over the packing contact area	x	x	—	x	x	x
17	Stem thread pitch, lead major diameter, and minor diameter	x	x	—	—	—	—
18	Stem cylindricity, run-out, and straightness	x	x	—	x	x	x
19	Stem projection (where applicable) per standard	x	x	—	—	—	—

Table D.1—Dimension and Finishes Table (Continued)

Item #	Description	Gate	Globe	Check	Ball	Butterfly	Plug
20	Stem thread engagement	x	—	—	—	—	—
21	Stuffing box dimensions and surface finish, gland follower dimensions, and remaining adjustment length	x	x	—	x	x	x
22	The clearance between the packing box bore (inside diameter) and the outside diameter of the gland	x	x	—	—	—	—
23	Packing gland, lantern ring, and spacer ring material	x	x	—	x	x	x
Fasteners							
24	Type of bolting threads (ASME B1.1 and B18.2.2)	x	x	x	x	x	x
25	Number and size of bonnet or cover bolts	x	x	x	x	—	x
Internal Components							
26	Wedge-wear travel	x	—	—	—	—	—
27	Gasket dimensions	x	x	x	x	—	x
28	Port opening (flow-way, bore, or seat ring inside diameters)	x	x	x	x	x	x
29	Backseat inside diameter and finish	x	x	—	—	—	—
30	Bonnet joint and end cap dimensions	x	x	x	x	—	x
31	Measure of electrical continuity per API standards	—	—	—	x	x	x
32	Surface finish of plug	—	—	—	—	—	x
33	Material of disk spring	—	—	x	—	—	—

KEY

x = required

— = not required

Table D.2—Visual Examinations

Item #	Description	Gate	Globe	Check	Ball	Butterfly	Plug
External Dimensions and End Connections							
1	Markings are as specified in ASME/ASTM and the applicable API valve standard and match corresponding mill test reports	x	x	x	x	x	x
2	Identification plate markings are as specified in the applicable API or ASME valve standard	x	x	x	x	x	x
3	Weld fabrication markings match applicable API standard and are marked on the identification plate, the extension, body, or bonnet as required	x	x	x	—	—	—
4	Warning label on end cover with instructions to remove disk blocking support prior to installation	—	—	x	—	—	—
5	Paint or coating type	x	x	x	x	x	x
6	Construction is as specified in the applicable API valve standard	x	x	x	x	x	x
7	Restrictions of temperature and pressure (e.g. those imposed by special soft seals or special trim materials) are marked on the valve identification plate	x	x	x	x	x	x
8	Hand wheel, gear operator, or lever operates clockwise to close when viewed from the outboard end of the stem, and that the hand wheel, gear operator, or lever is properly marked with an arrow and the word “open” to indicate the opening direction	x	x	—	x	x	x
9	Hand wheel or lever conditions, material, and method of fabrication (where applicable)	x	x	—	x	x	x
10	Method of attachment of the hand wheel nut (where applicable)	x	x	—	x	—	—
11	Valve fully opens to the applicable API specified limits	x	—	x	x	x	x
12	Number, location, and size of any tapped openings in pressure-containing parts	x	x	x	x	x	x
13	Body cavity test port	—	—	—	x	—	—
14	Type of end protection used in shipment	x	x	x	x	x	x
15	Verify lever, handwheels, and other operating mechanism can be removed and replaced without affecting the integrity of the stem seals, body seals, or stem retention means	—	—	—	x	x	x
16	Verify lever or manual gear operators cannot be assembled to the valve other than the correct configuration to indicate open and closed positions	—	—	—	x	x	x
17	Verify position stops are not integral with packing gland, gland flange, or gland bolting	—	—	—	x	x	x

Table D.2—Visual Examinations (Continued)

Item #	Description	Gate	Globe	Check	Ball	Butterfly	Plug
18	Are end flanges integral or welded by full penetration butt-welding? Are centering backing rings (used to facilitate welding) removed?	x	x	x	—	—	—
19	Body bonnet flange shape meets applicable API standard: Yes/No	x	—	x	—	—	—
20	Bonnet and body flange nut-bearing surfaces that require machining shall be machined parallel to the flange face	x	x	x	x	—	x
21	Welded bonnets meet the requirements of API 602	x	x	x	—	—	—
22	The yoke and stem nut assembly design permits stem nut removal while the valve is under pressure and backseated	x	x	—	—	—	—
23	The stem nut design allows for the removal of the handwheel while keeping the stem (and disk) in a fixed position	x	x	—	—	—	—
24	The yoke-to-stem nut-bearing surfaces are machined flat and parallel. A lubricating fitting is provided for the bearing surfaces.	x	x	—	—	—	—
25	When the stem nut is retained in the yoke by means of a threaded bushing, the bushing shall be secured in place using either a lock weld or a positive mechanical lock	x	x	—	—	—	—
26	Gland and gland flange made of one piece or two-piece design	x	x	—	—	—	—
27	Tapped blind hole for attachment of eyebolt or equivalent lifting device and thread type	—	—	x	—	—	—
28	Disk secured or supported during transport	—	—	x	—	—	—
29	Port pattern: short, regular, venturi, round-port full-bore	—	—	—	—	—	x
30	Method of adjustment for lubricated plug	—	—	—	—	—	x
31	Actuator mounting capability without removing pressure-containing components: Yes/No	—	—	—	x	—	x
32	Dimensional end flange face interruption that falls within the gasket seating area: Yes/No	—	—	x	x	x	—
33	Valve operability when stem is in horizontal position and flow is horizontal	x	x	—	—	—	—
34	Valve operability when stem is in horizontal position and flow is vertical	x	x	—	—	—	—
35	Plug design: lubricated or non-lubricated	—	—	—	—	—	x
	Fasteners						
36	Markings on the bolting for the body, bonnet, and cover joints are as specified in applicable ASTM specifications	x	x	x	x	x	x
37	Gland bolt and nut style: hinged eyebolts, headed bolts, stud bolts, or studs	x	x	—	—	—	—

Table D.2—Visual Examinations (Continued)

Item #	Description	Gate	Globe	Check	Ball	Butterfly	Plug
38	Fasteners that fall within the flange seating surface	—	—	x	x	x	—
39	Type of packing gland	x	x	—	x	x	x
40	Packing type and arrangement, size, and number of rings as well as the number of rings that could be added after the shell hydro-test	x	x	—	x	x	x
41	Presence of lubrication on the stem nut	x	x	—	—	—	—
42	Accessibility to adjustable packing without disassembly of the valve parts or operator parts	—	—	—	x	x	x
43	T-head is integral (without welding or weld buildup) with the stem	x	—	—	—	—	—
44	Type and direction of the stem threads	x	x	—	—	—	—
45	Blow-out proof stem or hinge pin design	—	—	x	x	x	x
	Internal Components						
46	Any disk nut on swing check valves is positively locked in place (single tack weld, lock washer, or lock nut not acceptable means in API 594)	—	—	x	—	—	—
47	Design of body-to-bonnet cover gasket or gaskets between pressure containing components (where applicable)	x	x	x	x	—	x
48	Type of closure element	x	x	x	x	x	x
49	Anti-static device	—	—	—	x	x	x
50	Conical backseat on bonnet	x	x	—	—	—	—
51	Conical or spherical seating face that seats against bonnet backseat	x	x	—	—	—	—
52	Is lubrication present in fitting?	x	x	—	—	—	—
53	Stem disk design: one piece or two piece	—	x	—	—	—	—
54	Radius of the stem at disk interface	—	x	—	—	—	—
55	Type of retention of disk/stem connection	—	x	—	—	—	—
56	Single-contact stop point to prevent the possibility of disk getting stuck in open position	—	—	x	—	—	—
57	Disk assembly design limits disk rotation to less than 360º	—	—	x	—	—	—
58	Lined plug type: fully lined or sleeve lined	—	—	—	—	—	x
59	Method of securing lining	—	—	—	—	—	x
60	Cavity vent: Yes/No	x	—	—	x	—	X
61	One-piece stem and plug: Yes/No	—	—	—	—	—	x
62	Method of attaching the seat ring to the body (where applicable)	x	x	x	—	x	—
63	Nothing other than light lubricant, having a viscosity no greater than kerosene, has been used on valve sealing surface, except for valves using lubricant as their primary sealing mechanism	x	x	x	x	x	—

Table D.2—Visual Examinations (Continued)

Item #	Description	Gate	Globe	Check	Ball	Butterfly	Plug
64	List of components secured by tack welding	x	x	x	x	x	x
65	When present, bonnet guides are in alignment with body guides	x	—	—	—	—	—
66	Disk guiding method	—	x	—	—	—	—
67	Verify that wedge/body guides do not protrude beyond the seat rings into the port area of the valve	x	—	—	—	—	—
68	Gap between disk and arm follows manufacturer's standard	—	—	x	—	—	—
69	Certification provided by the valve manufacturer confirms that the valves tested meet the emission requirements of API 624 or API 641 as dictated by product type (when required by standard)	x	x	—	x	x	x
70	Certification provided by the valve manufacturer confirms that the valves tested meet the fire testing requirements of API 607	—	—	—	x	x	x
71	Verify direct-mounted gear operators, actuators, and extension-mounted actuators are designed or provided with a means of preventing pressure buildup from stem seal, stem packing, or bonnet seal leakage	—	—	—	x	x	x

KEY

x = required

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