FOREWARD

The first edition of API Recommended Practice 591, “User Acceptance of Refinery Valves”, was published in December 1990. The recommended practice has three parts, “Section 1 - General”, “Section 2 – Guidelines for Quality Assurance Program”, and “Section 3 – Evaluation of Valves Manufactured to API Refining Department Valve Standards”

In the third edition, published in September 2003, the title was changed to “Process Valve Qualification Procedure.” Qualification of valves under this recommended practice was manufacturing facility specific and did not cover valves manufactured by other manufacturing facilities, whether owned by the same manufacturer or third party.

In the fourth edition, published in December 2008, this recommended practice clarified that, although fugitive emission testing was outside of the scope of this RP, a purchaser may request that the valve qualification procedure include fugitive emission testing per API 622, and that the testing results be included in the final test report.

In API RP 591 – 202X, the title of the document is changed to “Process Valve Evaluation Procedure”. An introduction section is added to describe the intent of the documentation as a snapshot of the manufacturing facility and its capabilities to produce new valves according to API standards. The previous sections relating to the quality program of the manufacturing facility and the section pertaining to the qualification of API RP 591 evaluation was moved from the main body to a new Annex providing purchaser guidance on qualification of the manufacturing facility. Furthermore, the evaluation section was reorganized to a more sequential format with the evaluations all tabulated accordingly.

INTRODUCTION

The current intent of this Recommended Practice is to evaluate a manufacturer's valve construction to determine their capability of proving valves manufactured in accordance with the applicable API standards. The evaluation program of API RP 591 provides a snapshot in time of the manufacture's products; considering manufacturers should be striving for improvement. The current structure of API RP 591 is a result of multiple revisions adding and modifying the scope and intent and valve type coverage of API RP 591.

Additionally, guidance on the evaluation of a manufacturer's quality assurance has been shifted to an informational Annex.

COMMENT FOR COMMENTER AND REVIEWER

The document and its contents have been re-organized and shifted, many paragraphs and information have been reformatted and potentially re-worded. The task force has to the best of our ability used red font to indicate any differences or additions in the intent or information and kept ~~red strike throughs~~ to show any information intentionally removed.

Process Valve Evaluation Procedure

1 Scope

This recommended practice (RP) provides recommendations for evaluation of a manufacturer's valve construction 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.

Evaluation 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 622, *Valve Packing for Fugitive Emissions*

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*

API Q1, *Quality Management System Requirements for Organizations Providing Products for the Petroleum and Natural Gas Industry*

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*

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 A751, *Standard Test Methods and Practices for Chemical Analysis of Steel Products*

ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM E3, *Standard Guide for Preparation of Metallographic Specimens*

ASTM E10, *Standard Test Method for Brinell Hardness of Metallic Materials*

ASTM E18, *Standard Test Methods for Rockwell Hardness of Metallic Materials*

ASTM E112, *Standard Test Methods for Determining Average Grain Size*

ASTM E340, Standard Practice for Macroetching Metals and Alloys

ASTM E446, Standard Reference Radiographs for Steel Castings Up to 2 in. (50.8mm) in Thickness

ASTM E562, Standard Test Method for Determining Volume Fraction by Systematic Manual Point Count

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, Definitions, and Abbreviations

3.1 Terms and Definitions

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

[1] ASME International, 3 Park Avenue, New York, New York 10016-5990, www.asme.org.
[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., 411 N Lee Street, Alexandria, Virginia 22314, www.mss-hq.org.

3.1.1
acceptance criteria
Specified limits placed on the characteristics of an item, process, or service defined in codes, standards, or other manufacturer provided documents.

3.1.2
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.

3.1.3
break-to-open torque
The torque required to break (unseat) the valve obturator from its fully closed (seated) position, against the rated (100%) seat pressure differential.

3.1.4
casting method
For purposes of this document, casting method shall refer to either sand or investment casting method.

3.1.5
characteristic
Any property or attribute of an item, process, or service that is distinct, describable, and measurable.

3.1.6
critical processes
Processes which dictate the resulting integrity of the principal shell components such as casting, forging, heat treatment, casting weld repairs.

3.1.7
critical supplier(s)
Material sourcing (foundry/Forgemaster/Mill) for principal shell components and critical process providers.

3.1.8
end-to-close torque
The torque required to close (seat) the valve obturator to its fully closed (seated) position, against the rated (100%) seat pressure differential.

3.1.9
manufacturer
The entity whose name or trademark appears on a valve.

3.1.10
manufacturing facility
Location of final assembly, inspection, and testing of the valve selected for evaluation.

3.1.11
nonconformance
Any item or action that does not meet the requirements of the referenced standards or the manufacturer's specifications.

3.1.12
obturator
Valve component that is positioned in the flow stream to permit flow or to obstruct flow, depending on its clousre

position. In a specific design, it may also be called a disc, wedge, plug, ball, gate diaphragm or other functionally similar expression.

3.1.13
positive material identification (PMI)
A verification performed to confirm that the material is consistent with what is specified. These tests may provide either qualitative or quantitative information that is sufficient to verify the major chemical composition(s) and are not intended as comprehensive chemical composition analysis of a material.

3.1.14
position seated valves
Valves which do not require active external assisting force on the obturator to achieve target seat tightness, instead the seal is achieved by proper positioning of the obturator

3.1.15
principal shell components
Valve bodies, bonnet, cover, caps, and end pieces. This does not include fasteners, trunnions, small blind flanges or small fittings.

3.1.16
pressure-containing weld
Any weld that is directly exposed to the media which may lead to release of media externally due to failure to function.

3.1.17
pressure-containing fastener
Any fastener that would lead to release of media externally due to failure to function.

3.1.18
pressure-retaining weld
Any weld that is not exposed directly to the media during standard operation which may lead to release of media due to failure to function.

3.1.19
purchaser
A person, group, company, agency, corporation, or designated representative responsible for valve acceptance.

3.1.20
testing 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.

3.1.21
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.

3.1.22
stem cylindricity
A condition of a surface of revolution in which all points of the surface are equidistant from a common axis.

3.1.23
stem run-out
The variation of radius from center-line of a stem as the stem is rotated 360º.

3.1.24
stem straightness
The condition in which the longitudinal elements of a stem or shaft are compared to a straight line.

3.1.25
supplier
An individual or organization that furnishes items or services to the manufacturing facility.

3.1.26
torqued seated valves
Valves which require active external assisting force on the obturator to achieve target seat tightness

3.2 Acronyms and Abbreviations

PT	*liquid penetrant examination*
MT	*magnetic particle examination*
RT	*radiography examination*
UT	*ultrasonic examination*

4 ~~Valve Qualification~~ Testing Facility

4.1 The manufacturer shall engage a testing facility to perform the evaluations described in this section. The facility(s) used shall be mutually agreeable to the purchaser and the manufacturer. The testing facility staff responsible for testing shall include a degreed or licensed metallurgical engineer or mechanical engineer.

4.2 The testing facility may subcontract portions of these inspections, examinations, and tests as required; however, subcontracting back to the valve manufacturer is not permitted.

4.3 The testing facility(s) shall be equipped and capable of performing or supervising the performance of nondestructive examination, physical tests, and chemical analyses on materials. All measuring equipment shall be calibrated. The testing facility staff shall be familiar with the applicable API valve standards and the codes, standards, and specifications referenced in those standards.

5 Selection of Valves

5.1 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 testing 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.

5.2 Random sampling shall include selection by principal shell component material group 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 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** Casting and forging materials qualification of shell components shall be in accordance with Annex A.~~

5.3 Nonstandard or built-to-order valves, may be provided directly from the manufacturing facility to the testing facility as agreed to by the purchaser. Quantity and specific test requirements are to be as agreed to by the purchaser.

6 Data to be Provided to the Testing Facility

6.1 Document Control

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

6.2 Manufacturer Information

6.2.1 Once the Annex A Sample Lot has been selected, the manufacturer shall make available a tabulation that indicates valve type, design standard, size, pressure class, bonnet connection type (e.g. welded, thread, bolted), and end connection type.

For each principal shell component and obturator, the tabulation shall show the material group, material grade, and the metal working process (casting vs forging). Additionally, any markings for traceability (heat number), special markings or coding that trace, distinguish, and identify each source for principal shell components, country of origin, and foundry designations, if utilized, shall be identified.

The tabulation shall include the names and address, and metal casting method(s) of each foundry and forgemaster for each principal shell component. In addition, the tabulation shall include the name and address of each manufacturing facility where valves undergo final assembly and testing.

6.2.2 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 Section 8.

6.2.3 Manufacturing by a third party (private labeling), where the manufacturing facility does not fully own the name, trademark, or symbol on the valve, the following additional information shall be documented in the final report prepared by the test facility. The manufacturer shall provide the following information in a signed statement:

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).

6.2.4 The manufacturer shall provide any current applicable QMS certificate, such as ISO 9001 or API Q1, if available

6.3 Valve Information

6.3.1 General assembly drawings of every valve submitted for testing shall be submitted to the testing 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 components, including fasteners. The manufacturer shall also identify the trim and sealing materials used.

6.3.2 The manufacturer shall provide certified mill test reports (CMTRs) of the principal shell components for all selected valves in the sample lot. For any principal shell component that do not have a CMTR, an appropriate certificate of compliance (CoCs) stating that the component meets the material requirements shall be provided.

6.3.3 For gate and globe valves, the manufacturer shall provide the recommended closure torques to adequately seat the valve at the maximum rated (100%) 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 (100%) differential pressure. For bidirectional valves, the manufacturer shall provide torque values for both directions.

6.3.4 The manufacturer shall provide any recommended operational instructions, including limitation to operating orientation.

6.3.5 The manufacturer shall provide any disassembly instruction that the evaluation facility needs to properly perform disassembly, including advising if special tools would be necessary.

6.3.6 The manufacturer shall note if the valve is double block and bleed capable

6.3.7 Where welding, including casting repair, is performed by the manufacturer and/or the foundry on the valves being evaluated, the applicable post-weld heat treatment, welding procedures, welding procedure qualification, and/or records shall be provided upon request.

6.3.8 The manufacturer shall provide any applicable type test certifications such as fire test to API 607, fugitive emission type test to API 624, or fugitive emission type test to API 641 for the selected valves. The applicable API 622 test certificate for graphitic packing shall also be provided.

6.4 Manufacturer Statement

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 evaluation and comply with the applicable product standards.

~~7.4.2 A signed statement shall be included in the final report as required in 5.5.~~

7 Required Examination and Testing

7.1 General

7.1.1 The following examination is written in a suggested order of operations to provide guidance in the sequence of inspection. The test lab may alter the sequence as necessary.

7.1.2 Additional design specific evaluations may be specified within each design specification., Refer to each API design standard's Annex. These evaluations are in addition to those specified within this RP.

7.1.3 See Annex C for required photographic records to be taken during evaluation process.

7.2 Pre-Disassembly Inspection

The selected valves per Annex B shall be inspected according to Annex D in the as-received condition.

7.3 Disassembly

The valve components shall be marked to help track part alignment and the valve disassembled with the least destructive method possible.

7.4 Post Disassembly Inspection

The selected valves per Annex B shall be disassembled and inspected according to Annex E

7.5 Non-destructive Testing

The selected valves per Annex B and their components shall be non-destructively evaluated according to Annex F

7.6 Destructive Testing

The selected valves per Annex B and their components shall be destructively evaluated according to Annex G and Annex H

8 Reporting

8.1 General

The testing facility shall combine all the information and documents collected in Section 6, the findings and photos from Section 7, and additional reporting requirements per Section 8 into a single document.

8.2 Summary Page

A summary page and/or table shall be made to summarize the results from the evaluation. Any corrective action or manufacturer's statement/corrective statement shall be noted. The revision of API RP 591 used shall be indicated on the report summary page.

8.3 Test Facility Information

The report shall include information about the test facility as follows:

- list of personnel performing the inspection and tests and their qualifications; and
- list of calibrated measuring devices used by the testing facility for the evaluation; and
- list of sub-contractors used by the testing facility for section 7.5 and section 7.6.

8.4 Valve Sampling Information

The report shall describe the method of valve sampling, including the following information:

- the source of the test valve and test valve selection method shall be described; and
- number, sizes, and types of valves examined (See Annex A).

8.5 Distribution

The distribution of this document shall be as agreed to by the manufacturer and purchaser. The test report shall be retained by the testing facility for a minimum of seven years. ~~A distribution log shall be maintained by the manufacturer for the purpose of notification of changes.~~

8.6 Corrective Action/Manufacture Statement

Any manufacturer provided corrective actions, statement, clarification, and/or additional testing conducted shall be included in the report.

9 Report Validity

9.1 General

For the purpose of this RP, the date of a previously conducted API RP 591 evaluation should not be the sole factor for determining report validity. The following sections are provided as a guideline of factors a purchaser may consider for determining the need for a full or partial re-evaluation of the manufacturing facility.

9.2 Management of Changes

9.2.1 Changes or additions of suppliers of principal shell components shall not invalidate the original evaluation. Additional evaluation may be required to amend a previously completed API RP 591 report. Suggested additional evaluation is shown in Table 1.

Table 1 – Recommend Evaluations for Management of Change

Recommended Evaluation	Foundry/Forgemaster change and/or additions	Manufacturer (assembly/testing) change and/or additions
Section 5	x	x
Section 6	x	x
Section 7.1	x	x
Section 7.2		x
Section 7.4		x
Section 7.5	x	
Section 7.6	x	

9.2.1 If change in valve stem packing affects the validity of any report(s) and certificate(s) submitted per para 6.3.8, the manufacture shall submit an updated type test report(s) and certificate(s) to the purchaser.

9.2.2 A revision of this RP is not intended to invalidate any previous qualifications or evaluations to API RP 591. Likewise, a revision to the applicable API product standard is not intended to automatically invalidate any previous qualifications or evaluations to API RP 591.

9.2.3 The manufacturer shall, upon purchaser request, provide a list of updated changes on items listed in Annex J.3.1 and J.3.2, as applicable to the aged API RP 591 report.

10 Valve Manufacturer Facility Qualification

The purchaser may additionally engage in evaluation of the valve manufacturer and their quality management system per Annex J in their process to qualify a manufacturer's facility and their valves.

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 testing sample lot is provided in Table A.2 through Table A.12.

Valve selections shall be applied for each material group as defined in Table A.1.

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) from each foundry/forgemaster location.

For valve types not covered in this standard, the minimum suggested valve selection may be established by agreement between the manufacturer and purchaser.

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 Forged	A494 A351 B462 B564	M-35 CY40 CW6MC CW2M CW12MW CT15C CN7M N08020 Ni-Cr-Mo-Cu-Nb N10276 Ni-Mo-Cr 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 group.

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 H 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.
[b] See Annex H 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 group. See Annex H 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 group. See Annex H 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 H 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 H 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 H 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)

Evaluation Sampling Rate

Table B.1, B.2, and B.3 provide the recommended sampling requirement for the evaluations as specified in the bodies and the Annexes of this standard. Any deviation to the below sampling shall be as agreed to by the purchaser.

Annex A Sample Lot refers to the sample lot of valves selected in Annex A for evaluation.

Annex B Selections is a subset of valves selected from the Annex A Sample Lot for additional NDE and destructive testing. A minimum of 5 valves shall be selected, with additional valves added as necessary to include each material group from each foundry/forgemaster for the Body and Bonnet/Cap.

Table B.1 Sampling Rate for Visual, Measurement, and Functional Examination

Section	Evaluation Item	Population	Sampling Rate
Annex D Pre-disassembly Evaluation			
D.1	Valve Markings/Identification	Annex A Sample Lot	100% of population
D.2	Valve Condition Inspection		
D.3	Valve Features		
D.4	Assembled Valve Dimensions		
D.5	Performance Testing		
D.6	Valve Inspection Post Testing		
D.7	Operator Inspection		
D.8	NDE in Assembled Condition		
D.9	API 602 Welded Bonnet Valve Cross Section		1 valve per material group
Annex E Post-disassembly Evaluation			
E.1	Disassembly Observations	Annex A Sample Lot	100% of population
E.2	Major Components		
E.3	Other Components		
E.4	Special Features		
E.5	Valve Design Specific Additional Evaluations		

Table B.2 Sampling Rate for Nondestructive Examination

Section	Evaluation Item	Population	Sampling Rate
Annex F Nondestructive Examinations			
F.1 Positive Material Identification (PMI)			
F.1.1	Principal Shell Components (Body, Bonnet/Cap, End Cap)	Annex B Selections	100% of population
F.1.2	Seat Rings		
F.1.3	Seal Welds		
F.1.4	Stems		
F.1.5	Yoke Nut, Bonnet Backseat/Backseat Bushing		
F.1.6	Disk/Plug/Ball		
F.1.7	Body-Bonnet Metallic Gasket		
F.1.8	Bolt	Annex B Sample Lot	Minimum of 4, covering all material grades and sizes
F.1.9	Nuts		
F.2 Manufacturer MTR Data			
F.2	MTR Data	Annex B Sample Lot	100% of population
F.3 Hardness Testing			
F.3.1	Principal Shell Components	Annex B Selections	100% of population
F.3.2	Seat Ring		
F.3.3	Stem		
F.3.4	Yoke Nut, Bonnet Backseat/Backseat Bushing		
F.3.5	Disk/Plug/Ball		
F.3.6	Body-Bonnet Metallic Gasket		
F.3.7	Pressure-Containing Bolt and Nuts	Annex A Sample Lot	Minimum of 4, all material grades and sizes
F.3.8	Casting weld repairs	Annex B Selections	100% of population
F.3.9	Other pressure-containing welds	Annex A Sample Lot	
F.4 Material Quality Evaluation			
F.4.1	Visual Examination of Principal Shell Components	Annex A Sample Lot	100% of population
F.4.2	RT of Principal Shell Components, Casting only		
F.4.3	RT of Pressure-Retaining Welds		
F.4.4	MT or PT of Principal Shell Components		
F.4.5	MT or PT of Buttweld Ends		
F.4.6	MT or PT of Welds in Fabricated Wedges		
F.4.7	MT or PT of Internal Seal Welds	Annex B Selections	100% of population

Table B.3 Sampling Rate for Destructive Examination

Section	Evaluation Item	Population	Sampling Rate
Annex G Destructive Examination			
G.1 Chemical Composition Examination			
G.1.1	Principal Shell Components	Annex H Selections	100% of population
G.1.2	Obturator		
G.1.3	Seat Ring		
G.1.4	Yoke Nuts/Stem Nut Retainer		
G.1.5	Stem/Shaft		
G.1.6	Packing Gland, Lantern Ring, and Spacer Ring		
G.1.7	Lubrication fittings and plugs		
G.1.8	Disc spring		
G.1.9	Pin-retainer Plug		
G.1.10	Backseat Bushing		
G.1.11	Pressure-Containing Bolt/Nuts	Annex A Sample Lot	Minimum of 4, all material grades and sizes
G.1.12	Casting weld repair	Annex H Selections	No minimum
G.1.13	Other pressure containing welds		
G.2 Mechanical Examination			
G.2.1	Principal Shell Components	Annex A Sample Lot	2 Valves, and 1 extra valve for each additional material group [a]
G.2.2	Ultimate Tensile Strength		
G.2.3	Yield Strength		
G.2.4	Elongation		
G.2.5	Reduction of Area		
G.2.6	Charpy Impact Testing	Annex A Sample Lot	2 Valves, and 1 extra valve for each additional material group
G.3 Metallurgical Examination			
G.3.1	Microstructure Evaluation	Annex A Sample Lot	2 Valves, and 1 extra valve for each additional material group
G.3.2	Grain-size Evaluation		
G.3.3	Ferrite Content		2 Valves
G.3.4	Cross-sectioning of component		2 Valves, and 1 extra valve for each additional material group
G.3.5	Aluminum Nitride Precipitation		
G.3.6	Weld Fusion		
G.3.7	Weld Heat Effected Zone		

[a] For valves where MTR data was not available for F.2, expand the testing quantity to a minimum of 5 valves and 1 extra valve for each additional material group

Table B.3 Sampling Rate for Destructive Examination (Continued)

Section	Evaluation Item	Population	Sampling Rate
G.4 Miscellaneous Testing			
G.4.1	Handwheel Torque Test	Annex A Sample Lot	4 Handwheels
G.4.2	Handwheel Impact Test		
G.4.3	Stem Strength Test		As specified in Annex A

Annex C
(normative)

Required Photographic Records

This section provides the minimum photographic record requirement for an API RP 591 report. Additionally, any damage observed during evaluation shall be photographed, including galling of parts.

C Required Photos

C.1 Pre-Disassembly (Annex D)

- As-received packaging condition, capturing product protection if so equipped
- Valves inside shipping crates/pallets
- As received valve and actuator assembly condition, after removal from container
- Completed valve before disassembly, front, back, top, all ends.
- Ends, after removal of protection, do not adjust valve obturator position from the shipped position.
- Gland, Gland Flange, stem seal area
- Nameplate, with text readable
- Markings, such as cast-in marking and stamped markings.
- Additional Tags

C.2 Post Disassembly (Annex E)

- A photograph of dissembled valve components per BOM from manufacturer
- Any markings on said components
- Any usage of grease heavier than kerosene
- Any extra components not included in BOM
- Stud and Nuts (Fasteners), both ends, showing markings.
- Photomicrograph of microstructure, 100x
- Macrophotograph of cross-section

C.3 NDE Photography (Annex F)

- Photos or Sketch of Radiograph locations

C.4 Miscellaneous Testing Photography (Annex G)

- Photos of Stem Testing, including result

Annex D
(normative)

Pre-Disassembly Evaluation

The selected valves shall be evaluated before disassembly. See Table D.1 through Table D.8. The valve and operator ~~readable~~ nameplate(s), ~~cast-in~~ markings ~~shall be made~~, and as received conditions shall be photographed, see Annex C for photographic record requirements.

For sampling rate, see Annex B.

Table D.1 – Pre-Disassembly, Markings and Conditions

#	Inspection Item	Requirements	600 Gate	623 Globe	594 Check	602 Gate	602 Globe	602 Check	603 Gate	608 Ball	609 Butterfly	599 Plug
Valve Markings/Identification												
D.1.1	Markings	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	x	x	x	x
D.1.2	Markings - fabrication weld	Weld fabrication markings match applicable API standard and are marked on the identification plate, the extension, body, or bonnet as required	x	x	x	x	x	x	x	x	x	x
D.1.3	Name plates	Identification plate markings are as specified in the applicable API or ASME valve standard	x	x	x	x	x	x	x	x	x	x
D.1.4	Name plate – PT restriction	Restriction 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	x	x	x	x
Valve Condition												
D.1.5	End protection	Type of end protection used in shipment	x	x	x	x	x	x	x	x	x	x
D.1.6	Closure position	Position of obturator at time of delivery	x	x	x	x	x	x	x	x	x	x
D.1.7	Warning label(s)	Warning label on end cover with instructions to remove disk blocking support prior to installation			x			x				
D.1.8	Disc support	Disk secured or supported during transport			x			x				

Table D.2 – Pre-Disassembly, Valve Features and Dimensions

#	Inspection Item	Requirements	600 Gate	623 Globe	594 Check	602 Gate	602 Globe	602 Check	603 Gate	608 Ball	609 Butterfly	599 Plug
Valve Features												
D.2.1	Stem lubrication	Presence of lubrication on the stem nut	x	x		x	x		x			
D.2.2	Stem projection	Stem projection (Where applicable) per standard	x	x		x	x		x			
D.2.3	Position stop	Verify position stops are not integral with packing gland, gland flange, or gland bolting								x	x	x
D.2.4	Flange face interruption	Dimensional end flange face interruption that falls within the gasket seating area: Yes/No			x					x	x	
D.2.5	Flange face interruption	Fasteners that fall within the flange seating surface: Yes/No			x					x	x	
D.2.6	Hinge plug seal weld	Verify Hinge plug is seal welded as applicable: Yes/No			x							
D.2.7	Packing adjustment	~~Accessibility to adjustable~~ Verify Packing is adjustable without disassembly of the valve components or operator components, as applicable: Yes/No/NA	x	x	x	x	x	x	x	x	x	x
D.2.8	Paint/coating	Record Paint or coating coverage and color, as applicable	x	x	x	x	x	x	x	x	x	x
D.2.9	Electrical continuity	Measure electrical continuity per API standards, as applicable: Pass/Fail								x	x	x
D.2.10	Test port	For API 608 Trunnion Ball Valves, verify existence of test port								x		
Assembled Valve Dimensions												
D.2.11	Valve assembly	Measure face-to-face or end to end dimension and verify against required dimension (e.g. ASME B16.10) ~~(ASME B16.10)~~	x	x	x	x	x	x	x	x	x	x
D.2.12	Valve assembly	Measure flange dimensions (ASME B16.5), including orientation of bolt holes	x	x	x	x	x	x	x	x	x	x
D.2.13	Valve assembly	Measure raised-face end flange facing finish, including number of grooves per inch, (ASME B16.5) ~~and bonnet joint flanges~~	x	x	x	x	x	x	x	x	x	x
D.2.14	Valve assembly	Measure external ring joint flange facing dimension meets standard (ASME B16.5), as applicable	x	x	x	x	x	x	x	x	x	x
D.2.15	Valve assembly	Measure butt-welding end dimensions (ASME B16.25 or API 602, as applicable)	x	x	x	x	x	x	x	x	x	x
D.2.16	Valve assembly	Measure Socket-weld ends and threaded ends (ASME B16.11)	x	x	x	x	x	x		x		x
D.2.17	Valve assembly	Measure Socket-weld end and threaded end dimension wall thickness per ASME B16.34	x	x	x	x	x	x		x		x

Table D.3 – Pre-Disassembly, Performance Testing

#	Inspection Item	Requirements	Gate	Globe	Check	Ball	Butterfly	Plug
D.3.1	Seat seal lubricant	Verify that 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	
D.3.2	Running torque[a]	Stroke valve fully open and closed and record the seating, unseating, and running torque with no pressure differential	x	x		x	x	x
D.3.3	Horizontal operation	Stroke full open and closed with the stem in the horizontal position with flow orientation in the horizontal directions to confirm operability unless these positions are restricted by the manufacturer.	x	x				
D.3.4	Horizontal operation	Stroke 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.	x	x				
D.3.5	Shell leak testing [d]	All shell pressure tests specified in API 598, shall be performed on each valve: Pass/Fail	x	x	x	x	x	x
D.3.6	Seat leak testing [abc] Seating torque [ab]	All seat pressure tests specified in API 598, both optional and required for high- or low-pressure seat testing, shall be performed on each valve. Pass/Fail For torque seated valves, the seating torque used during seat leak testing at (110%) rated seat pressure, shall be measured and recorded,	x	x	x	x	x	x
D.3.7	DBB testing [e]	If the valve is identified as Double Block and Bleed per API 598 definition, perform DBB testing per API 598: Pass/Fail	x			x		x
D.3.8	Opening torque [ab]	The torque required to open valve at maximum rated (100%) differential pressure shall be measured and recorded				x	x	x
D.3.9	Max dP opening	The valve shall be opened at the maximum rated (100%) differential pressure.	x	x		x	x	x

a Operate with a calibrated torque wrench either directly or through a gear operator to the center of the stem/shaft

b If the torque recommended by the manufacture should prove to be inadequate, the torque may be increase incrementally up to a maximum of 1.25 times the recommended value until seat leakage is within allowable limit

c For position seated valves valve, if any stop adjustment is necessary to achieve required leakage shall be documented.

d For valves equipped with adjustable packing, any adjustment to packing gland nut necessary to meet leakage test shall be documented.

e There are two variations of DBB testing, see API 598

Table D.4 – Pre-Disassembly, Post Pressure Test Inspection

#	Inspection Item	Requirements	API									
			600 Gate	623 Globe	594 Check	602 Gate	602 Globe	602 Check	603 Gate	608 Ball	609 Butterfly	599 Plug
D.4.1	Operational limit	Valve fully open to the applicable API specified limits	x			x		x	x	x	x	x
D.4.2	Parameter dimensions	Measure center to top (closed and open position for rising stem valves)	x	x	x	x	x	x	x	x	x	x
D.4.3	Bore clearance	Verify that wedge/body guides do not protrude beyond the seat rings into the port area of the valve	x			x			x			
D.4.4	Remaining packing adjustment	Measure remaining packing adjustment length	x	x		x	x		x	x	x	x

Table D.5 – Pre-Disassembly Evaluations, Operator Inspection

#	Inspection Item [ab]	Requirements	600 Gate	623 Globe	594 Check	602 Gate	602 Globe	602 Check	603 Gate	608 Ball	609 Butterfly	599 Plug
D.5.1	Locking devices	Type of the locking device and minimum pad lock shank diameter (if provided)								x	x	x
D.5.2	Operator marking	Verify hand wheel, gear operator, or lever operates clockwise to close when viewed from the outboard end of the stem, and that it is marked with an arrow and the word “open” to indicate the opening direction	x	x		x	x		x	x	x	x
D.5.3	Operator size	Measure handwheel diameter or lever length, as applicable.	x	x		x	x		x	x	x	x
D.5.4	Operator material	Hand wheel or lever conditions, material, and method of fabrication (where applicable)	x	x		x	x		x	x	x	x
D.5.5	Handwheel build	Inspect handwheel and verify proper design/build and that handwheel is free from burrs and sharp edges	x	x					x			
D.5.6	Handwheel nut	Method of attachment of the hand wheel nut (where applicable): Descriptive	x	x		x	x		x	*		
D.5.7	Handwheel “Hot” removal	Verify The stem nut design allows for the removal of the handwheel while keeping the stem (and disk) in a fixed position: True/False	x	x		x	x		x			
D.5.8	Operator “Hot” removal	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: True/False								x	x	x
D.5.9	Poke-yoke design	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

Table D.5 – Pre-Disassembly Evaluations, Operator Inspection (Continued)

#	Inspection Item [ab]	Requirements	600 Gate	623 Globe	594 Check	602 Gate	602 Globe	602 Check	603 Gate	608 Ball	609 Butterfly	599 Plug
D.5.10	Stem nut retainment method	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			x		x			
D.5.11	Stem nut “Hot” removal	Verify the yoke and stem nut assembly design permits stem nut removal while the valve is under pressure and backseated	x	x					x			
D.5.12	Actuator removal capability	Verify actuator mounting capability without removing Principal Shell Components: Yes/No								x		x
D.5.13	Operator pressure venting	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

a Certain inspection items here may require partial disassembly of the valve drive train.
b All welds which are removed or broken shall be documented and included in the list of components secured by tack welding. If full disassembly is necessary, perform the required inspection after disassembly.

Table D.6 – Pre-Disassembly, NDE in Assembled Condition

#	Inspection Item	Method	Acceptance Criteria
D.6.1	Pressure-containing welds	Radiographed in accordance with ASME B31.3	ASME B31.3 normal fluid service conditions.
D.6.2	External seal welds	Magnetic Particle or Dye Penetrant Tested in accordance with ASME B16.34 Appendix II and Appendix III	ASME B16.34 Appendix II and Appendix III

Table D.7 – Pre-Disassembly, API 602 Welded Bonnet Joint Evaluation

#	Item	Method and Requirement
D.7.1	Welded joint cross-section	Cross section of the valve to expose the welded joint for evaluation
D.7.2	Weld joint design	Visual Examination: Verify joint design type. Threaded and seal-welded vs full-strength weld. Identify any mechanical body/bonnet connection (thread)

Table D.8 – Pre-Disassembly, Design Specific Evaluations [a]

#	Inspection Item	Requirements
API 594 Additional Evaluations		
a	No additional evaluations	-
API 599 Additional Evaluations		
b	See API 599 Annex C	
API 600 Additional Evaluations		
c	No additional evaluations	-
API 602 Additional Evaluations		
d	No additional evaluations	-
API 603 Additional Evaluations		
e	No additional evaluations	-
API 608 Additional Evaluations		
f	No additional evaluations	-
API 609 Additional Evaluations		
g	No additional evaluations	-
API 623 Additional Evaluations		
h	No additional evaluations	-

a The evaluation requirements are only applicable to the relevant standard to which the valve is designed to, as applicable and indicated on the valve's name plate.

Annex E
(normative)

Post-Disassembly Evaluation

The disassembled valve components shall be evaluated. See Table E.1 through Table E.5.The valve and component ~~cast in~~ markings and welds which are removed or broken shall be photographed, and the conditions documented.See Annex C for additional photographic record requirements. Any additional welds shall be documented.

For sampling rate, see Annex B. The API 602 valve which is sectioned per Table D.7 shall not be subject to evaluation per Annex E if the relevant component or item were damaged or destroyed in the sectioning process

Table E.1 – Disassembly General Observations

#	Inspection Item	Requirements	API									
			600 Gate	623 Globe	594 Check	602 Gate	602 Globe	602 Check	603 Gate	608 Ball	609 Butterfly	599 Plug
E.1.1	Gasket condition	Photograph of the condition/location of all gaskets upon disassembly. Photo to show design type.	x	x	x	x	x	x	x	x	x	x
E.1.2	Bonnet guide	If Bonnet Guide is present, verify bonnet guide is in alignment with Body Guide	x			x			x			
E.1.3	Tack welded Components	A list of components secured by tack welding shall be maintained throughout the evaluation	x	x	x	x	x	x	x	x	x	x
E.1.4	Valve seating /sealing surfaces	All seating/sealing surfaces shall be inspected for damage	x	x	x	x	x	x	x	x	x	x

Note
Features or inspection points in table E.1 are items which require immediate or careful attention to during the moments of disassembly to properly observe or evaluate.

Table E.2 – Post-Disassembly, Principal Shell Components

#	Inspection Item	Requirements	API									
			600 Gate	623 Globe	594 Check	602 Gate	602 Globe	602 Check	603 Gate	608 Ball	609 Butterfly	599 Plug
~~E.2.1~~	~~Port pattern~~	~~Identify valve port to see if it's short, regular, venturi, round port full bore~~										~~x~~
E.2.1	Wall thickness	Measure Body, bonnet, cover, and end-piece wall thickness	x	x	x	x	x	x	x	x	x	x
E.2.2	Welded joint	Measure bonnet/cover weld deposit thickness for full-strength weld design on the sectioned component per D.9				x	x	x				
E.2.3	Bore ID	Measure Port opening (flow-way, bore, or seat ring inside diameters)	x	x	x	x	x	x	x	x	x	x
E.2.4	Flange facing	Verify facing finish of bonnet-joint flanges and end-cap flanges.	x	x	x	x	x	x	x	x	x	x
E.2.5	Bonnet, caps, end caps	Measure Bonnet joint and end cap dimensions	x	x	x	x	x	x	x	x	x	x
E.2.6	Welded end flange	Inspect End flanges to see if they are integral or welded. If welded, is it by full penetration butt-welding? Are centering backing rings (used to facilitate welding) removed?	x	x	x	x	x	x	x	x	x	x
E.2.7	Body/bonnet flange	Verify Body bonnet flange shape meets applicable API standard: Yes/No	x		x	x		x	x			
E.2.8	Flange nut bearing surfaces	Verify Flange nut-bearing surfaces meets applicable API standard	x	x	x	x	x	x	x	x		x
E.2.9	Stuffing box and packing gland	Measure Stuffing box dimensions , surface finish, and gland follower dimensions	x	x		x	x		x	x	x	x
E.2.10	Stuffing box and packing gland	Measure the clearance between the stuffing box bore (inside diameter) and the outside diameter of the packing gland	x	x		x	x		x	x	x	x
E.2.11	Bonnet yoke	Verify The yoke-to-stem nut-bearing surfaces are machined flat and parallel. and that a lubricating fitting is provided for the bearing surfaces.	x	x		x	x		x			
E.2.12	Backseat	Measure backseat inside diameter and finish	x	x		x	x		x			
E.2.13	Backseat	Verify backseat is conical	x	x		x	x		x			
E.2.14	Tapped and threaded holes	Document the number, location, and size of any tapped openings in Principal Shell Components	x	x	x	x	x	x	x	x	x	x
E.2.15	Tapped and threaded body holes	Measure thread engagement in tapped and threaded body holes and verify thread profile meets design code requirements			x						x	
E.2.16	Tapped hole for lifting valve	Verify Tapped blind hole for attachment of eyebolt or equivalent lifting device and thread type.			x							

Table E.3 – Post-Disassembly, Other Components

#	Inspection Item	Requirements	API									
			600 Gate	623 Globe	594 Check	602 Gate	602 Globe	602 Check	603 Gate	608 Ball	609 Butterfly	599 Plug
Fittings												
E.3.1	Lubrication fittings	Identify lubricant fitting, size, and type	x	x		x	x		x	x	x	x
E.3.2	Lubrication	Inspect ~~grease~~ fittings for presence of lubrication as applicable	x	x		x	x		x	x	x	x
Fasteners												
E.3.3	Pressure containing fasteners	Location, quantity, and size of pressure containing bolting.	x	x	x	x	x	x	x	x	x	x
E.3.4	Pressure containing fasteners	Verify thread profile meets design standard requirement (e.g. ASME B1.1 and B18.2.2)	x	x	x	x	x	x	x	x		x
E.3.5	Fasteners	Markings on the bolting for the body, bonnet, and cover joints are as specified in applicable ASTM specifications	x	x	x	x	x	x	x	x	x	x
Stem												
E.3.6	Stem	Measure 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	x	x	x
E.3.7	Stem	Measure straightness, stem run-out, and cylindricity	x	x		x	x		x	x	x	x
E.3.8	Stem thread	Measure thread pitch, major diameter, minor diameter	x	x		x	x		x			
E.3.9	Stem thread	Verify Stem thread type and resulting handwheel rotating direction meets standard requirements	x	x		x	x		x			
E.3.10	Stem/Stem Nut	Verify Stem and Stem Nut engagement is at least 1.5 times the stem diameter	x						x			
E.3.11	Stem	Verify T head is integral to stem	x			x			x			
E.3.12	Stem	Verify stem backseat seating surface is conical or spherical	x	x		x	x		x			

#	Inspection Item	Requirements	API									
			600 Gate	623 Globe	594 Check	602 Gate	602 Globe	602 Check	603 Gate	608 Ball	609 Butterfly	599 Plug
Stem Seal Elements												
E.3.13	Packing gland/gland flange	Record gland/gland Flange design type and if it's single or multi piece construction, as applicable.	x	x	x	x	x	x	x	x	x	x
E.3.14	Packing gland	Verify gland design meets standard requirements, as applicable	x	x	x	x	x	x	x	x	x	x
E.3.15	Packing gland/gland flange retaining fastener	Record and verify gland retaining fasteners style and design meets standard requirements: hinged eyebolts, headed bolts, stud bolts, or studs, as applicable	x	x	x	x	x	x	x	x	x	x
E.3.16	Packing	Record and verify packing type and arrangement, nominal width, and number of rings meets standard requirements ~~as well as the number of rings that could be added after the shell hydro test~~	x	x		x	x		x	x	x	x
Obturator												
E.3.17	Obturator	Identify obturator type	x	x	x	x	x	x	x	x	x	x
E.3.18	Disc guide	Identify and verify obturator guiding method meets standard requirement (e.g. hardfacing, type)	x	x								
E.3.19	Disc guide	Length of the disk guides on the disk	x									
E.3.20	Seat wear travel	Measure and verify seat wear travel meets minimum	x									
Seat												
E.3.21	Seat	Identify method of seat attachment to the body (Where applicable) Note: Welded in seats may be threaded and welded, this is confirmed later though valve cross-section	x	x	x	x	x	x	x		x	

Table E.4 – Post-Disassembly, Special Features

#	Inspection Item	Requirements	API									
			600 Gate	623 Globe	594 Check	602 Gate	602 Globe	602 Check	603 Gate	608 Ball	609 Butterfly	599 Plug
E.4.1	Blow-out proof design	Inspect and verify blow-out proof design is functional and meets standard requirements as applicable			x					x	x	x
E.4.2	Anti-static design	If applicable, test and verify electric continuity performance meets standard requirement.								x	x	x
E.4.3	Cavity venting	If equipped, verify presence of cavity venting mechanism. (e.g. drilled vent hole, vent valve, etc)	x			x			x	x		x

Table E.5 – Post-Disassembly, Design Specific Evaluations [a]

#	Inspection Item	Requirements
API 594 Additional Evaluations		
a	Disk contact point	Verify disk only contacts the body at a single point (Potential for valve to stuck open)
b	Disk nut attachment	Verify that any disk nut on valve is positively locked in place (single tack weld, lock washer, or lock nut not acceptable means in API 594)
c	Disk rotation design	Verify disk assembly design limits disk rotation to less than 360º
d	Disk-hinge arm	Verify gap exists between disc and hinge arm ~~per manufacture's standard~~
API 599 Additional Evaluations		
e	See API 599 Annex C	
API 600 Additional Evaluations		
f	No additional evaluations	-
API 602 Additional Evaluations		
g	No additional evaluations	-
API 603 Additional Evaluations		
h	No additional evaluations	-
API 608 Additional Evaluations		
i	No additional evaluations	-
API 609 Additional Evaluations		
j	No additional evaluations	-
API 623 Additional Evaluations		
a	Stem-disc design	Verify stem to disc contact surface is curved to allow contact through all disc misalignment
b	Stem-disc design	Identify stem-disc design, record if it's 1-piece type or 2-piece type
c	Stem-disc connection	Identify and record stem-disc retention method
d	Disc guide	Verify the obturator is body guided throughout its full range of travel

a The evaluation requirements are only applicable to the relevant standard to which the valve is designed to, as applicable and indicated on the valve's name plate.

Annex F
(normative)

Nondestructive Examinations

This section lists the Nondestructive Examinations (NDE) that shall be performed on the valve that are applicable. See Table F.1 through Table F.3. See Annex C for additional photographic record requirements.

For sampling rate, see Annex B. The API 602 valve which is sectioned per Table D.7 shall not be subject to evaluation per Annex F if the relevant component or item were damaged or destroyed in the sectioning process

Table F.1 – NDE, Positive Material Identification [ab]

#	Inspection Item [ab]	Note
F.1.1	Principal shell components	
F.1.2	Seat ring	
F.1.3	Seal weld	Only if able without destruction of valve
F.1.4	Stem	
F.1.5	Yoke nut, bonnet backseat/backseat bushing	Gate and Globe Valves Only
F.1.6	Disk/plug/ball	
F.1.7	Body-bonnet metallic gasket	
F.1.8	Bolt	Includes all bolting, pressure containing and non-pressure containing.
F.1.9	Nuts	Includes all nut, pressure containing and non-pressure containing.

a X-Ray Fluorescence and/or Optical Emission Spectrometry per agreed procedure

b X-Ray Fluorescence cannot detect levels of chemical elements that OES or Wet Chemistry can. It is used for quick material identification of known materials.

Table F.2 – NDE, Manufacturer MTR Data [a]

#	Inspection Item	Note
F.2.1	Principal shell components	Record Tensile Strength, Yield Strength, Elongation, Reduction of area and chemical composition from manufacture's MTR

a If MTR is not available, record unavailability on the report.

Table F.3 – NDE, Hardness Testing [a]

#	Inspection Item [a]	Note
F.3.1	Principal Shell Components	
F.3.2	Seat Ring	Does not include integral ring
F.3.3	Stem	
F.3.4	Yoke Nut, Bonnet Backseat/Backseat Bushing	Gate and Globe Valves Only
F.3.5	Disk/Plug/Ball	
F.3.6	Body-Bonnet Metallic Gasket	Applicable if testing can be performed without destruction of the valve.
F.3.7	Bolt and Nuts	Tensile strength shall be estimated using the measured hardness readings and the correlations (hardness to tensile strength) in ASTM A370.
F.3.8	Casting weld repairs	
F.3.9	Other pressure-containing welds	

a Hardness testing shall be conducted per ASTM E10 and/or ASTM E18

Table F.4 – NDE, Material Quality Evaluation

#	Inspection Item	Method	Acceptance
F.4.1	Principal Shell Components [a]	Visual Examination	Forgings/Wrought materials: Free from laps and seams Casting: MSS SP-55
F.4.2	Principal Shell Components, Casting [a]	RT per ASME B16.34, Appendix I-1.	Suggested maximum allowable defect given in Annex C
F.4.3	Pressure-retaining welds [ab]	RT per ASME B31.3	Acceptance criteria for ASME B31.3 normal fluid service conditions.
F.4.4	Principal Shell Components [a]	MT or PT in accordance with ASME B16.34 Appendix II and Appendix III 100% of accessible internal and external surfaces	ASME B16.34 Appendix II and Appendix III
F.4.5	Buttweld Ends	MT or PT in accordance with ASME B16.34 Appendix II and Appendix III	ASME B16.34 Appendix II and Appendix III
F.4.6	Welds in Fabricated Wedges [a]	MT or PT in accordance with ASME B16.34 Appendix II and Appendix III	ASME B16.34 Appendix II and Appendix III
F.4.7	Internal Seal Welds	MT or PT in accordance with ASME B16.34 Appendix II and Appendix III	ASME B16.34 Appendix II and Appendix III

[a] Paint, coatings, and sealants shall be removed from the components being evaluated.

[b] For welds which cannot be evaluated by RT, perform MT or PT according with ASME 16.34 Appendix II and Appendix III.

Annex G
(normative)

Destructive Examination

This section lists the Destructive Examinations (DE) that shall be performed on the valve and valve components that are applicable. See Table G.1 through Table G.5.Testing and examination results shall be compared to the appropriate ASTM standard, API product standard, and manufacturer's supplied MTR (See Table F.2) and report any differences in the test report. See Annex C for additional photographic record requirements.

For sampling rate, see Annex B. The API 602 valve which is sectioned per Table D.7 shall not be subject to evaluation per Annex G if the relevant component or item were damaged or destroyed in the sectioning process

Table G.1 – Destructive Examination, Chemical Composition [a]

#	Inspection Item [a]	Gate	Globe	Check	Ball	Butterfly	Plug
G.1.1	Principal Shell Components	x	x	x	x	x	x
G.1.2	Obturator	x	x	x	x	x	x
G.1.3	Seat Ring [b]	x	x	x	x	x	
G.1.4	Yoke Nuts/Stem Nut Retainer	x	x				
G.1.5	Stem/Shaft	x	x	x	x	x	x
G.1.6	Packing Gland, Lantern Ring, and Spacer Ring	x	x	x	x	x	x
G.1.7	Lubrication fittings and plugs	x	x	x	x	x	x
G.1.8	Disc spring			x			
G.1.9	Pin-retainer Plug			x			
G.1.10	Backseat Bushing	x	x				
G.1.11	Pressure-Containing Bolt/Nuts	x	x	x	x	x	x
G.1.12	Casting weld repair	x	x	x	x	x	x
G.1.13	Other pressure containing welds	x	x	x	x	x	x

[a] Chemical analysis shall be performed with Wet-chemical per ASTM A751 or Optical Emission Spectrometry technique and all elements, including trace elements, shall be noted in the report. X-ray Fluorescent Spectrometer (XRF) or Laser Induced Breakdown Spectroscopy (LIBS) shall not be allowed for the purpose of chemical analysis

[b] 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 weld, and all coatings and surface treatments.

Table G.2 – Destructive Examination, Mechanical Examination

#	Inspection Item	Method	Acceptance	Applicability
Principal Shell Components				
G.2.1	Ultimate Tensile Strength	ASTM A370	Relevant Material Standards	All Materials
G.2.2	Yield Strength			
G.2.3	Elongation			
G.2.4	Reduction of Area			
G.2.5	Charpy Impact Testing [a]	ASTM A370 [b]		Carbon Steel Low Alloy Steel
	Body;	1 set of samples from flange area and 1 set of samples from thickest non-flange area		
	Bonnet/Cap.	1 set of samples from flange area		

[a] Sub-sized test specimens may be used when full size specimens are not attainable, the largest possible sample size shall be used.
[b] Testing shall be done at lowest valve temperature rating, other temperatures shall be agreed to by the purchaser

Table G.3 – Destructive Examination, Metallurgical Examination

#	Inspection Item	Method	Applicability	Reporting
Microetch Evaluation of Principal Shell Components				
G.3.1	Microstructure Evaluation	Sample prep per ASTM E3 Etch per ASTM E407 Take photomicrograph @ 100x magnification Evaluation / analysis based on the type of material	All Materials	Submit photomicrograph and evaluation in report
G.3.2	Grain-size Evaluation	Sample prep per ASTM E3 Etch per ASTM E407 Evaluate to E112 @ 100x magnification	All Materials	
G.3.3	Ferrite Content	Sample prep per ASTM E3 Etch per ASTM E407 Take photomicrograph @ 500x magnification Evaluation / Analysis based on the type of material per ASTM E562	Duplex Stainless Steel	
Macroetch Evaluation of Principal Shell Components				
G.3.4	Cross-sectioning of component [a]	Cut valve across the body and bonnet Polish and etch per ASTM E340 Evaluate samples for welds	All Materials	Submit photo of cross section and assessment in report. Report if any welds were present
G.3.5	Aluminum Nitride Precipitation [b]	Macro-etch per ASTM E340 Evaluation per ASTM A703 Evaluate visually Assess the sample to determine the level of Intergranular Network structure per ASTM A703	Ferritic and Martensitic Stainless Steel	Submit assessment in report
G.3.6	Weld Fusion [c]	Macro-etch per ASTM E340 Evaluation visually	All Materials	Submit photo and finding in report
G.3.7	Weld Heat Effected Zone [c]	Macro-etch per ASTM E340 Evaluation visually	All Materials	Submit photo and finding in report

a Component shall be sectioned along the flow path. Any welded components (e.g. Seat Ring) shall be sectioned along with the main Principal Shell Components.

b Aluminum Nitride Precipitation (Aluminum nitride stringer) can form during the pouring process due to aluminum / aluminum oxide being added to the melt and/or pour too quickly thereafter. Aluminum nitride embrittlement can lead to casting failure.

c Applicable to any welds in the Principal Shell Components that are cross sectioned.

Table G.4 – Destructive Examination, Miscellaneous Testing

#	Inspection Item	Method	Applicability	Reporting
G.4.1	Handwheel Torque Test	Secure the center of the handwheel in an appropriate fixture. Apply three times the torque recommended by the manufacturer for closure to the outer rim at single point of contact.	All Materials [a]	Any damage shall be reported
G.4.2	Handwheel Impact 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 handwheel and any damage reported.	All Materials [a]	Any damage shall be reported
G.4.3	Stem Strength Test [b]	Evaluated per Annex H	All Materials	Any damage shall be reported

a Handwheels found on gearbox and/or actuators are not applicable to this test, manual operated valves only.

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

Table G.5 – Destructive Examination, Design Specific Evaluations [a]

#	Inspection Item	Requirements
	API 594 Additional Evaluations	
a	No additional evaluations	-
	API 599 Additional Evaluations	
b	See API 599 Annex C	
	API 600 Additional Evaluations	
c	No additional evaluations	-
	API 602 Additional Evaluations	
d	No additional evaluations	-
	API 603 Additional Evaluations	
e	No additional evaluations	-
	API 608 Additional Evaluations	
f	No additional evaluations	-
	API 609 Additional Evaluations	
g	No additional evaluations	-
	API 623 Additional Evaluations	
h	No additional evaluations	-

a The evaluation requirements are only applicable to the relevant standard to which the valve is designed to, as applicable and indicated on the valve's name plate.

Annex H
(normative)

Strength Tests for Stem/Shaft-to- Obturator Connections

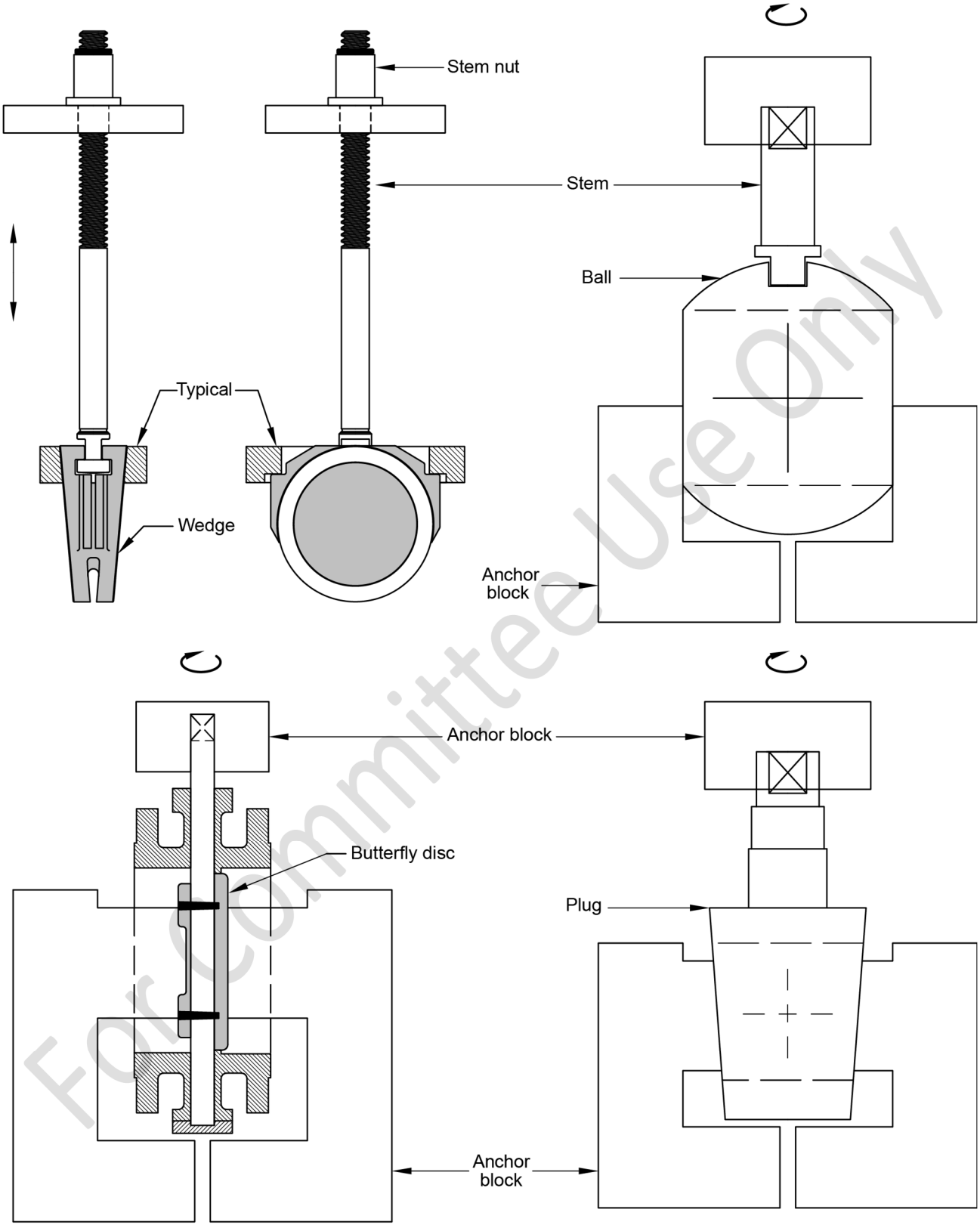
H.1 For steel gate valves, direct tensile loads shall be applied to wedge–stem stem nut assemblies to determine the location of the first point of failure and the magnitude of the loads at failure. The first point of failure (actual breakage of stem or disk) shall occur at a location that is outside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

H.2 For metal plug/ball valves and Category B butterfly valves, direct torsional loads shall be applied to stem-to-obturator 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.

H.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-obturator connections performed and the results reported.

H.4 A dimensional analysis of the stem-to-obturator 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 obturators. If different product forms or different material mechanical properties are involved with untested valve sizes, additional stem-to-obturator tests shall be made to demonstrate the soundness of the other designs and/or materials.

H.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 obturator shall have nondestructive hardness testing performed before and after welding to ensure the stem connection characteristics of the obturator have not been altered. Machining or drilling of the obturator below the center line is allowed to provide a satisfactory surface for clamping. Torsional testing, as in Figure H.1, may be conducted in the original, as assembled valve.



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

Figure H.1—Torsional Testing

Annex I
(informative)

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

Table I.1—Acceptable Casting Radiographic Results

Acceptable Comparative Discontinuity Type	Discontinuity 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 J
(informative)

Manufacturer Facility Qualification

J.1 Qualification Process

Manufacturer facility qualifications typically involve multiple steps of consideration by a purchaser. A usual component of a manufacture facility qualification process includes a physical review of a manufacturer's product, such as conducting an API RP 591 evaluation. Further to the physical product review, evaluations are often conducted on the manufacturer's QMS, facility, design and sourcing via on-site/off-site audit and document review to create objective evidence for the purchaser on the facility's capability to consistently produce said products.

This Annex provides guidance to the purchaser and manufacturer a non-exhaustive list of items and documentation which should be evaluated for both the initial and maintenance re-evaluation activities of a manufacturing facility.

J.2 Qualification Scope

Qualification of valves are commonly grouped by valve type, size, pressure class, and material group and tied to manufacturing facilities.

Manufacturing facilities are location specific and do not cover other facilities in different locations, whether owned by the same manufacturer or a third party.

J.3 Manufacturer Quality Management System Evaluation

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 or API Spec Q1.

J.3.1 General Record and QMS Documentation Review

Review of procedures and documentation provides an insight into the systems the manufacturer has set up and allows the purchaser to make an objective qualification of the manufacturer. The manufacturer shall upon request, submit or make available for review by the purchaser the following:

Facility Information

a) signed declaration stating the address of manufacturing facility and identifying the controlling ownership of the manufacturing facility and the relationship between the facility and the trademark owner;

b) QMS Certificate (ISO 9001 or API Q1), showing scope of QMS;

c) list of testing equipment;

d) tabulation of production scope of the manufacturing facility;

QMS Documentations

d) quality manual;

e) person/entity responsible for implementing the manufacturing facility's QMS/quality control program;

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

g) tabulated list of following procedures and their latest revision number;

1) supplier control procedures;
2) heat treatment procedure;
3) general welding procedures;
4) weld repair procedures;
5) post weld heat treatment procedures;
6) nondestructive examination procedures;
7) pressure testing procedures;
8) traceability procedure;
9) nonconformance product procedure;
10) preservation procedures;
11) final product examination and testing procedures;

h) list of applicable weld procedure specifications and procedure qualification records;

i) Inspection Test Plan (ITP) or Quality Plan (QP) for production;

j) ITP or QP for purchasing of principal shell components.

J.3.2 Supplier Management Review

Supplier management is essential for any manufacturing facility for the consistent production of valves to standards. The following documents shall upon request, be submitted or be made available for review by purchaser:

a) approved critical supplier list;

b) list of foundries and forgemasters for principal shell components and their locations;

c) document requiring critical suppliers to provide access to their facilities and records for inspection or audit by the manufacturer, their designated representative, or other parties authorized by the manufacturer;

d) tabulated list of latest evaluation of critical suppliers with latest date of evaluation;

e) most recent supplier evaluation record;

f) objective evidence confirming critical suppliers' quality management system follows the principles of ISO 9001.

J.4 Management of Change

J.4.1 A change in any of the following items may require re-evaluation of a qualified manufacturer's facility and may make an aged API RP 591 test report non-representative of current production:

a) controlling ownership of the manufacturing facility;

b) location of the manufacturing facility;

c) design change and/or a change to the manufacturing/fabrication method that may affect the performance of the valve or change the result of evaluation in accordance with API RP 591.

J.4.2 Changes to a manufacturer's quality control procedures shall not require re-evaluation of a manufacturer's facility, provided that the 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.

J.4.3 Changes or additions of suppliers of Principal Shell Components may require additional evaluation to amend a previously completed API RP 591 report. See Para 9.1

J.4.4 The manufacturer shall, upon request, provide a list of updated changes on items listed in J.3, and any documents which may be relevant to a related API RP 591 test report