Reconditioning of Metallic Gate, Globe, and Check Valves

API RECOMMENDED PRACTICE 621
FIRST EDITION, MARCH 2001

American
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Institute

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Downstream Segment

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Reconditioning of Metallic Gate, Globe, and Check Valves

1 Scope

This Recommended Practice (RP) provides guidelines for reconditioning heavy wall (API 600 type) carbon steel, ferritic alloy (up to 9% Cr), stainless steel, and nickel alloy gate, globe, and check valves for ASME pressure classes 150, 300, 400, 600, 900, 1500, and 2500. Guidelines contained in this RP apply to flanged and butt weld cast or forged valves.

It is an expectation of this RP that a contractual agreement shall be established between the end user (Owner) and the valve reconditioning facility. The reconditioning facility may be OEM owned/operated, or directly associated and approved by the OEM. At the Owner's option, an independent facility may be used. The Owner shall determine that the facility selected for valve reconditioning has a documented and established working Quality Assurance Program. The Quality Assurance Program should include the essential elements described in Section 7 of API RP 591 or follow the principles of an appropriate standard from the ISO 9000 Series.

This RP does not cover reconditioning or re-manufacturing of used or surplus valves intended for resale. The only intent of this RP is to provide guidelines for refurbishing an Owner's valves for continued service in the Owner's facility. Valves reconditioned or re-manufactured to this RP may not meet API Standard requirements for new valves. The correct application of a valve reconditioned to this Practice remains the responsibility of the Owner.

2 References

Applicable requirements in the latest edition/revision of the following industry standards shall be considered an integral part of this RP.

API

591	*User Acceptance of Refinery Valves*
598	*Valve Inspection and Testing*
600	*Steel Gate Valves*—Flanged and Butt-Welding Ends

ASME[1]

B1.3M	*Screw Thread Gaging Systems for Dimensional Acceptability*
B1.5	*Acme Screw Thread*
B1.8	*Stub Acme Screw Threads*
B16.5	*Pipe Flanges and Flanged Fittings*
B16.10	*Face-to-Face and End-to-End Dimensions of Valves*
Boiler and Pressure Vessel Code	
Section V	*Nondestructive Examination*
Section IX	*Welding and Brazing Qualifications*

ASTM[2]

A193	*Specification for Alloy-Steel and Stainless Steel Bolting Material for High-Temperature Service*
A194	*Specification for Carbon and Alloy-Steel Nuts for Bolts in High-Pressure and High-Temperature Service*
A216	*Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service*
A217	*Specification for Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service*
A351	*Specification for Steel Castings, Austenitic, for High-Temperature Service*

MSS[3]

SP55	*Quality Standard for Steel Casting for Valves, Flanges, and Fittings and Other Piping Components (Visual Method)*

3 Owner Access

Owner shall have access to all reconditioning work, documentation, inspections, and test results at all times.

Access by the Owner shall be conducted in a manner that is not disruptive to the reconditioning work.

4 Owner Responsibilities

4.1 VALVE INFORMATION

Owner shall provide the reconditioner with the information necessary to determine the nature of any product that may have been contained in the valve cavity, packing, and/or gasket, and any known problems with the valve.

Any tag used shall be of a type and material that resists damage, fading, and inadvertent removal.

4.2 MATERIAL SAFETY DATA SHEET

A Material Safety Data Sheet (MSDS) shall be provided for each product that may have been contained in the valves sent for reconditioning.

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

[2]American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959.

[3]Manufacturers Standardization Society of the Valve Fittings Industry, Inc., 127 Park Street, N.E., Vienna, Virginia 22180.

4.3 PREPARATION FOR SHIPMENT TO RECONDITIONER

Valves to be shipped to the reconditioner shall:

a. Be in the open or partial open position.
b. Have all residual product drained and/or flushed out of the body.
c. Be decontaminated.
d. Have end flange gaskets removed.

5 Inspection, Identification, and Disassembly of Valves

5.1 GENERAL

Immediately upon receipt, valves shall be marked to identify the Owner.

Valves shall be visually inspected and classified as (1) valves capable of being reconditioned or (2) valves to be scrapped.

For valves that cannot be economically repaired, consideration shall be given to salvaging as many usable parts as possible for use only in valves of the same manufacturer, type, and material.

Scrapped valves and scrapped valve parts shall be disposed of in accordance with their Owner's instructions.

5.2 IDENTIFICATION NUMBER

Each valve shall be assigned a unique identification number that is traceable back to its Owner's shipping documentation or other pertinent information such as special instructions, records of previous reconditioning, etc.

Salvaged usable parts (excluding hand wheels) shall be identified as to the Owner, and the identification shall include the name of the valve manufacturer, the size, type, pressure class and trim of the valve and/or parts. The unique identification number shall start with an "R."

If a valve or salvaged usable part is to be stored for a period of time before entering the reconditioning process, the valve or salvaged useable part shall be stamped with its identification number as specified above. Alternatively, a tag with the number shall be attached to the valve or salvaged useable part. Tag shall be of a type and material that resists damage, fading, and inadvertent removal.

5.3 TRAVELER DOCUMENTS

An Owner-approved traveler document or electronic file shall be developed and maintained for each valve and shall reference the valve identification number.

Traveler information shall be accumulated through the reconditioning process, and shall constantly reflect the current status of repair, parts replaced, and work still to be performed. Traveler shall also reflect any dimensional changes as a result of the reconditioning process.

Unless otherwise specified, traveler information shall be archived by the reconditioner for a minimum of 10 years.

5.4 DISASSEMBLY AND CLEANING OF VALVES

Valves to be reconditioned shall be completely disassembled.

Old packing, gaskets, and bonnet bolting shall be removed and disposed of in accordance with owner's instructions and/or applicable regulations.

Tags from previous reconditioning shall be removed and the tag, or data from the tag, shall be placed in the reconditioned valve record document. OEM tags, if still attached to the valve, shall be removed.

Immediately after disassembly, the valve's identification number shall be metal stamped onto the valve's closure element, stem/shaft, seat rings if removed, and any other major part. Stamped markings shall remain on the individual valve components after the reconditioning process is completed and the valve is returned to the Owner.

a. Stamping shall be on non-functional surfaces and shall be made with low stress stamps.
b. If stamping is not practical, parts shall be tagged or electro-etched, except that all stems and closure elements for valves NPS 2 and larger shall be marked by stamping.

Unless a specific cleaning method is specified by the Owner, valve parts shall be thoroughly cleaned by any usual method, such as steam, chemical, sand/bead, or steel shot blasting. Finished surfaces that may be damaged during the cleaning process shall be protected.

Cleaning process shall remove all or nearly all paint, grease, rust, and product from both internal and external surfaces.

6 Repair of Valve Parts

6.1 GENERAL

6.1.1 Welding

Welding procedures and welders shall be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code.

Welding procedures shall be submitted to the Owner for approval.

Weld metal buildup and weld metal repairs, including any required post weld heat treatment, shall be performed in accordance with the approved procedures.

6.1.2 Non-Destructive Examination (NDE)

Welds, other than tack welds, shall be examined by the liquid penetrant method or by the non-destructive examination (NDE) method specified by the Owner.

NDE of parts and/or weld repairs shall be done in accordance with Owner-approved NDE procedures and acceptance criteria.

SNT-TC-1A Level II technicians certified for the procedures per ASME Section V shall evaluate NDE results.

6.1.3 Replacement Parts and Material

Sources of replacement parts shall be one or more of the following in preferential order:

a. Parts purchased from the original equipment manufacturer (OEM) or other OEM approved source.

b. Parts salvaged from scrapped valves from the same valve manufacturer and with matching identification.

c. Parts manufactured in the reconditioning facility, when approved by the Owner.

Material used to manufacture replacement parts in the reconditioning facility shall be as specified by the Owner.

a. If the Owner does not specify material, the material used (including heat treatment if applicable) shall be the material used by the original valve manufacturer, and shall comply with the requirements of the referenced standard.

b. Changes in material group, such as 13CR to austenitic stainless steel, require approval of the Owner.

c. Verification of the specific material used and its source shall be part of the required documentation.

6.2 INSPECTION OF VALVE PARTS

6.2.1 General

Valve parts shall be inspected to determine their acceptability for re-use and/or extent of required repair.

Criteria for acceptability and extent of repair shall be the component's ability to meet the Owner's expectation for continued service in his facility.

6.2.2 Threaded Parts

Threaded parts shall be visually inspected for gross defects, such as missing or incomplete threads, defective thread profile, torn or ruptured surfaces, and cracks.

Surface texture of threaded parts shall be evaluated by visual or tactile comparison with texture specimens or surface measurement equipment.

Visual inspection shall be made without magnification. Thread acceptability criteria shall be specified by the Owner in accordance with ASME B1.3M.

6.3 HANDWHEEL NUT

Handwheel nut shall be visually inspected for wear or corrosion of the threads or contact area.

If the handwheel nut is defective, it shall be repaired or replaced.

If the handwheel nut is locked into place with a setscrew or some other device, the locking mechanism shall be in place and fully functional.

6.4 HANDWHEEL

Handwheel shall be visually inspected for worn, bent, or broken spokes and rim.

Handwheel shall be inspected to verify proper engagement to the stem yoke nut. If the valve does not have a yoke nut, the handwheel shall be inspected to verify proper engagement to the stem.

A defective handwheel shall be repaired by the appropriate repair method for the defect: Bent spokes, hub, or rim may be straightened by pressing. Broken spokes or rim (if made of a weldable grade material) may be weld repaired.

If the defect(s) cannot be repaired, the handwheel shall be scrapped and replaced with one of similar size and material.

All parts of the handwheel and any repairs shall be free of burrs, metal splinters, and sharp metal edges.

6.5 YOKE

Yoke shall be visually inspected for defects and for proper alignment of the stem through the stem nut, packing chamber, back seat bushing, and wedge connection.

Defects shall be repaired by generally accepted repair procedures, such as welding and/or machining.

6.6 STEM NUT AND STEM NUT HOUSING

Stem nut and stem nut housing shall be visually inspected for corrosion, galling, or wear of bearing surfaces.

Defects shall be repaired by welding (if of a weldable material), machining and/or other appropriate methods. If the defects cannot be repaired, the nut/housing shall be replaced.

If a thrust bearing was used by the OEM in the design of the valve, the thrust bearing must be in place and free of excessive corrosion or wear. If necessary for smooth operation of the stem nut, the thrust bearing shall be replaced.

Internal threads of a tapped hole in the stem nut housing shall be visually inspected and defective threads shall be repaired and/or re-tapped.

Lubrication fittings shall be replaced.

If applicable, external threads on the stem nut shall be visually inspected for proper engagement to the handwheel nut.

Internal ACME threads of the stem nut shall be visually inspected for condition and proper engagement with the external threads of the stem in accordance with ASME B1.5 or B1.8.

6.7 STEM NUT RETAINER

If applicable, stem nut retainer shall be visually inspected for corrosion and wear. Threads shall be inspected for general condition and proper engagement to the valve bonnet or yoke.

Defective stem nut retainer shall be repaired by welding and/or machining. If defects cannot be repaired, stem nut retainer shall be replaced.

After assembly and before shipping, the stem nut retainer shall be tack welded, or otherwise locked, to the yoke.

6.8 PACKING GLAND FLANGE

Packing gland flange shall be visually inspected for corrosion, cracks, and/or straightness.

Defective flange shall be repaired or replaced.

6.9 PACKING GLAND

Packing gland shall be visually inspected for corrosion or wear and checked dimensionally for proper fit to the stuffing box and to the stem in accordance with OEM dimensions and tolerances. When OEM dimensions and tolerances are not available, the clearances specified in Figure 4 may be used, when approved by the Owner.

A damaged or broken packing gland shall be repaired or replaced.

6.10 BACK SEAT BUSHING

A back seat bushing's ability to seal against the opposing angle of the stem shall be determined by visually inspecting for corrosion, wear, and/or cracks. Sealing surface shall have a finish Ra of 32 μ inches or smoother.

A defective bushing shall be repaired with an Owner approved repair procedure or the bushing shall be replaced.

6.11 BODY AND BONNET

6.11.1 Bonnet Stuffing Box

The stuffing box shall be visually inspected for corrosion, wear, or scoring of the bore wall.

The stuffing box bore sealing area (the area of the stuffing box that contacts the packing) may have some pitting provided that the pitting does not extend for more than half the height of any individual compressed packing ring.

The stuffing box bore non-sealing area is not required to be inspected for surface finish.

A defective stuffing box shall be repaired by machining or welding and re-machining. Unless otherwise specified by the Owner, sleeving of the stuffing box is prohibited.

The stuffing box shall have a surface finish Ra of 125 μ in. or smoother, and its dimensions shall conform to API 600 Table 2. Under tolerance of the stuffing box bore from the nominal diameter listed in API 600 Table 2 is not allowed. However, an over tolerance as specified by the packing manufacturer, but not to exceed 2% of the stuffing box bore as listed in Table 2 of API 600 or 0.045 inches may be assumed, subject to Owner's approval.

6.11.2 Castings

Body and bonnet castings shall be visually inspected for defects in accordance with MSS SP-55.

Some pitting or areas of localized corrosion are allowed provided the requirements of Table 2 are met.

If deemed necessary, castings may be inspected with NDE (radiography or other method) to determine extent of defects.

Acceptability of WC6, WC9, LC2, LC3, C5, C12, and austenitic stainless casting metallurgy shall be verified by positive material identification (PMI) and by NDE as specified by the Owner.

Wall thickness of bonnet castings shall be measured at a minimum of two locations and wall thickness of body castings shall be measured at a minimum of three locations. Wall thickness shall be measured at additional locations if visual inspection identifies specific areas that require additional wall thickness verification.

a. Acceptable wall thickness shall conform to Table 1.

b. Location of measurements and thickness measured shall be recorded in the data file of each valve.

Unacceptable casting defects shall be removed and repaired. If the defect cannot be repaired, the casting shall be scrapped. For repairs:

a. Area of defect and areas of inadequate wall thickness shall be repaired by welding.

b. Weld metal surfaces shall be ground or machined to smoothness consistent with acceptable castings.

c. Postweld heat treatment is required for carbon steel casting weld repairs of a size and/or type described in ASTM A-216, Para.10.3.

Weld repairs on WC6, WC9, C5 and C12 castings shall be done in accordance with ASTM A-217, Par. 9.3. Owner shall specify NDE procedures to be used.

Weld repairs for all stainless steel castings shall be in accordance with ASTM A-351.

Nipples or pipe plugs screwed into tapped openings in the body, bonnet, or stuffing box shall be removed and the threads shall be inspected and repaired if necessary.

a. Replacement plugs shall be made from new bar stock. Bar stock material shall be equal or superior to that of the body material.

b. Unless otherwise specified, plugs shall be screwed and seal welded into place.

c. Unless otherwise specified, replacement nipples shall be made from material of equivalent chemical composition and strength as the body or bonnet material.

d. Replacement plugs or nipples shall be subject to applicable heat treatment.

6.11.3 Body-to-Bonnet Flanges and Gasket Surfaces

Body-to-bonnet flanges shall be inspected for corrosion and overall condition.

Unless otherwise specified by the Owner, the minimum flange thickness after machining, or any required weld repair and subsequent re-machining, shall not be less than .032" below the original thickness.

Defective surfaces around the flange bolt holes shall be repaired as necessary. Weld repairs shall be machined and/or ground and bolt holes shall be back spot faced to provide smooth nut bearing surfaces and unrestricted bolt holes.

Both body-to-bonnet gasket sealing surfaces shall be visually inspected for corrosion, wear, cuts, or scoring. Defects shall be repaired to achieve surface finish in accordance with OEM requirements. Alternatively, surface finish may be per Table 3, when approved by the Owner. Repairs to gasket sealing surfaces shall not alter the body-to-bonnet joint design dimensions that provide the inherent gasket compression control.

6.11.4 Body End Flanges, Gasket Surfaces, and Face-to-Face Dimensions

Face-to-face dimensions shall be checked for compliance with the following table:

Valve Size (NPS)	Face-to-face Dimension Allowable Variation from ASME B16.10 (inches)
1 to 14	± 0.120
16 and larger	± 0.187

Dimensional non-conformances shall be corrected by weld metal build up and/or machining.

Unless otherwise specified, gasket surface finish shall be a Ra of 125 μ in. to 250 μ in.

Defective surfaces around the bolt holes shall be repaired as necessary. Weld repairs shall be machined and/or ground and bolt holes shall be back spot faced to provide smooth nut bearing surfaces and unrestricted bolt holes. Back facing or spot facing shall not reduce the flange thickness below the minimum flange thickness requirements of ASME B16.5 or minimum flange thickness requirements as specified by the Owner.

Reduction of flange thickness below the minimum thickness requirements of ASME B16.5 is permitted when approved by the Owner.

6.12 BODY GUIDES

Body guides shall be visually inspected to verify that the wedge slides smoothly.

Body guides may be repaired by grinding or machining or by weld metal buildup and grinding or machining.

6.13 BODY SEAT RING(S)

Body seat rings shall be visually inspected for corrosion, wear or cuts, and for any apparent leakage between the seat ring and the valve body.

If the condition of the valve body and seat ring(s) permit, the seat ring(s) shall be repaired by machining or lapping of the sealing surface(s) to achieve chamfered edges and a flat surface approximately $^1/_{16}$" to $^1/_8$" wide with a Ra of 32 μ in. or smoother finish.

If the condition of the seat ring(s) requires more extensive repairs than specified above, one or more of the following repair procedures shall be used:

a. When approved by the Owner, the seat ring sealing surface may be replaced or repaired with a weld metal deposit of a material type appropriate for the required trim. The repaired seating surface shall meet the hardness minimum of API 600 Table 3. The Owner shall specify the need and extent of any required hardness testing of the seat ring sealing surfaces. If hardness testing is required, the procedure used shall be approved by the Owner.

b. Install new seat rings that meet the requirements of API 600 Table 3.

c. If leakage between the seat ring(s) and body is suspected, seal weld the seat rings into the body using an approved weld procedure compatible with both the body and seat ring base material. Unless otherwise specified, all non-welded seat rings, in ASME Class 600 and higher pressure class valves, shall be seal welded.

Use of bushings, shims, epoxy, glue, grease, or thread sealant between the body and seat rings is prohibited.

6.14 WEDGE GUIDES

Wedge guides shall be visually inspected for corrosion or wear.

Wedge guides shall also be physically checked to ensure proper fit to the body guides and guidance of the wedge into the seat rings.

Defects shall be repaired by weld buildup and/or machining, grinding, or milling.

6.15 WEDGE, GLOBE, DISC AND CLAPPER

Wedge, globe, disc or clapper (including the arm, hinge pin, and cap) assembly shall be visually inspected for corrosion, wear, or pitting.

Defective wedge, globe, disc or clapper shall be replaced, or shall be repaired by weld metal build up and/or machining, grinding and/or lapping after completion of repairs. Seating surface finish shall be a Ra of 32 μ in. or smoother.

Seating design for a wedge gate valve shall provide adequate seating both before and after the wear of the seating surfaces. When fully closed, the wedge seating surface shall provide an additional closing travel of not less than the following:

Valve Size (NPS)	Minimum Wear Travel (in.)
1 through 2	0.090
2 1/2 through 14	0.125
16 through 24	0.250

If the final fitting of a wedge to the seat rings results in an additional closing travel less than that specified in the table above, the wedge sealing surfaces may be built-up with weld metal to ensure an adequate distance from the area of seat ring contact and the edge of the wedge sealing surface.

Split wedge gate valves shall have all the weld metal build-up on the face of the wedge. Weld metal build-up on the backside of the wedge halves to compensate for wear or machining of the sealing surface of the wedge and seat rings is prohibited.

6.16 STEM

Stem shall be inspected for straightness and damage to the threads, backseat, and/or tee-head.

Portion of stem that slides through the packing shall be inspected for corrosion, pitting, wear, and taper.

Out-of-straightness of the entire length of the stem shall not exceed 0.001 in./in. (0.001 mm/mm).

Stem threads shall properly engage the internal threads of the stem nut in accordance with ASME Standard B1.5 and B1.8.

Stem backseat shall have a surface finish Ra of 32 μ in. or smoother and shall ensure proper seating against the sealing surface of the bonnet backseat.

Tee-head shall be inspected to verify proper engagement to the wedge.

Defective stems shall be replaced. Minimum stem diameter shall be in accordance with Table 1. Permitted under tolerance shall be per API 600 Table 1C.

When deemed repairable and subject to Owner approval, defective stem may be repaired with a qualified procedure appropriate for the type defect, including welding and/or machining. Stem weld repairs and weld qualification procedures shall conform to Appendix B.

Repaired stem shall be inspected with liquid penetrant examination or an alternative method when approved by the Owner. Stem packing area shall have:

a. No rejectable defects.

b. A surface finish Ra of 32 μ in. or smoother.

c. Maximum stem diameter under tolerance the lesser of: 150% of that given by API 600 Table 1C, or 1/32 in. below the manufacturer's original.

d. A maximum taper or cylindrical variation of 0.003 in. across the entire stem packing area.

6.17 BODY-TO-BONNET JOINT BOLTING

Unless otherwise specified, body-to-bonnet bolting shall be new ASTM A193 grade B7 bolts and ASTM A194 grade 2H nuts.

Bolting shall have readily visible marking imprinted into all bolts and nuts.

Special or other bolting requirements shall be in accordance with the Owner's engineering piping specification as supplied on the Owner's purchase order or as instructed by the Owner's representative.

6.18 PACKING GLAND EYE BOLTS

Packing eyebolts shall be visually inspected for corrosion or other damage. Damaged eyebolts shall be replaced.

Unless otherwise specified, nuts shall be replaced with ASTM A194 grade 2H nuts.

Special or other bolting requirements shall be in accordance with the Owner's engineering piping specification as supplied on the Owner's purchase order or as instructed by the Owner's representative.

6.19 PACKING

Unless otherwise specified, packing shall be a carbon and/or graphite packing ring arrangement, using an Owner approved Type A or Type E braided graphite filament for top and bottom rings and Type B flexible graphite die-formed endless inner rings, per Appendix A.

When specified, PTFE Vee Ring packing or lattice braid PTFE filament packing shall be per Appendix A. Special or other packing requirements shall be in accordance with Owner's engineering piping specification as supplied on Owner's purchase order, or as instructed by the Owner's representative.

Packing cross section shall be consistent with the final dimensions of the reconditioned stuffing box and stem.

6.20 BODY-TO-BONNET JOINT GASKET

Body-to-bonnet joint gasket shall conform to Table 3 unless special or other gasket material requirements are specified by the Owner.

7 Post-Repair Assembly

Before assembly of valve parts, internal surfaces (excluding body and bonnet gasket surfaces, seating surfaces, and stem) shall be coated with an Owner-approved rust preventative. Austenitic stainless steel materials are excluded from this requirement.

Gasket surfaces and seating surfaces may be lubricated with light oil not heavier than kerosene.

Stem threads shall be lubricated with an Owner-approved dry film lubricant. Lubricant shall be injected into the stem nut housing.

After testing, stem packing shall have a minimum of 30% of the packing gland available for field adjustment of the stem packing.

Body-to-bonnet joint bolting shall be tightened by a method and in a pattern, that achieves uniform compression and sealing of the gasket.

In the fully closed position, the end of the stem shall be flush with the top of the stem nut, as a minimum, and shall not exceed the maximum allowable projection above the stem nut permitted by API Std 600, as a maximum.

8 Pressure Test

Unless a more restrictive test is required by the Owner, pressure test of assembled valves shall be in accordance with API Std 598 and Appendix C of this recommended practice.

Additional testing shall be done at the request of the Owner as stated in the Owner's purchase order or as instructed by the Owner's representative.

Copy of the test results shall be included in the reconditioning work documentation.

9 Preparation for Shipment

Carbon steel and ferritic alloy steel valves shall be cleaned and externally coated with a general purpose aluminum or silver color paint.

Machined end flange gasket surfaces, butt weld ends, and stems shall be left completely paint free.

Machined and threaded surfaces (excluding stem threads) exposed to the atmosphere shall be coated with an Owner-approved rust preventative.

Valves shall have the end port openings covered and protected in accordance with API Std 600.

If specified, valves shall be secured in boxes or on wooden pallets for shipment.

Moving parts on valves shall be lubricated with an approved lubricant specific to the design and function of the part.

If special preparations, cleaning, or packaging are required prior to shipping, they shall be carried out in accordance with the Owner's instructions.

10 Tagging and Reconditioning Facility Identification

A stainless steel plate (valve tag) shall be permanently attached to the valve body or bonnet of each reconditioned valve. Attachment shall be per API Std 600 Par 3.15. Tag shall have the following metal-stamped or imprinted information:

a. Statement that valve has been reconditioned in accordance with API RP 621.
b. Name of reconditioning facility.
c. Date of reconditioning.
d. Size and type valve.
e. Body/bonnet material.
f. Stem material.
g. Body and gate seating surface material.
h. Packing material.
i. Gasket material.
j. Valve identification number, starting with the letter "R".
k. Valve pressure rating at 100°F, and pressure rating class number.
l. Any reduction in maximum pressure / temperature rating to reflect packing, bolting, and/or gasket material changes.

Tag shall have rounded corners.

Valves that are too small to have the tag directly attached shall have the tag attached to the valve body/bonnet with .035" (minimum) stainless steel wire.

If reconditioning included any special cleaning or other preparations for a specific service, an additional tag shall be wired to the valve identifying the special preparations performed.

Each reconditioned valve shall have the name of the reconditioning company and date of reconditioning (month and year) stamped on the valve, using $^{3}/_{8}$ to $^{1}/_{2}$-in. low stress characters. Stamping shall be located on a non-functional surface as follows:

a. For flanged valves, stamping shall be located on the outside diameter surface of a body or end flange.
b. For other valves, stamping shall be in the bonnet area.
c. For small valves where stamping per the above is not practical, the stamping method and location shall be approved by the Owner.

APPENDIX A—STEM PACKING

A.1 Scope

This Appendix covers requirements for materials, design, and installation for stem packing for valves being reconditioned in accordance with this Recommended Practice.

A.2 Types of Packing

Type A	Carbon or graphite wiper rings having a yarn property carbon assay of 95% minimum and with corrosion inhibitor applied at the time of manufacture.
Type B	Graphite die-formed rings made of 95% pure carbon graphite or better and with corrosion inhibitor. After die forming, the rings shall have a nominal density of 70-lbs/cu ft. (± 5 lbs/cu ft.)
Type C	PTFE Vee rings incorporating a heavy wall and heel section. A minimum of two pressure rings together with male and female adapters shall be used.
Type D	Lattice Braid continuous filament PTFE fiber treated with PTFE dispersion and an inert ingredient.
Type E	Flexible graphite foil wiper rings reinforced with braided Inconel filament.

A.3 Materials

Rings shall contain no asbestos.

Leachable chloride content of the rings shall be limited to 100 ppm maximum.

Total sulfur in the rings shall be 1000 ppm maximum.

Unless otherwise specified, packing shall contain no binders, lubricants, or other additives.

A.4 Spacers or Bushings

Spacers or bushings used to fill stuffing boxes of excessive depth on gate and globe valves shall:

a. Be compatible with the stem material.
b. Be made of carbon, or a material approved by the Owner, that is equivalent to the valve bonnet material or of a material with a greater corrosion and temperature resistance than the bonnet material, and with a hardness at least 50 HB different than the stem hardness. The use of carbon bushings shall be limited to packing chambers that have a flat bottom.
c. Conform with the dimensional clearances in Figure 4.

A.5 Lantern Rings

If a lantern ring is specified in the stuffing box for an external connection, it shall be aligned with the external connection or placed in accordance with the Owner's instructions.

Packing rings immediately above and immediately below the lantern shall be Type A wiper rings; or if Vee ring packing is used, a female adapter shall be immediately below and a male adapter shall be immediately above the lantern ring.

A.6 Flexible Graphite Packing for Block Valves

Refer to Figure 1.

A.7 PTFE Vee Ring Packing for Block Valves

Refer to Figure 2.

A.8 Lattice Braid PTFE Filament Packing for Block Valves

Refer to Figure 3.

APPENDIX B—WELD OVERLAY OF STEMS

B.1 Scope

This Appendix covers requirements for weld overlay of stems for valves being reconditioned in accordance with this Recommended Practice.

B.2 General

Weld overlay of stems shall be done by undercutting the defective stem packing area and rebuilding with a weld metal overlay. Undercutting shall be done by machining.

Reconditioner shall weld overlay only those stems for which a stem base material/ filler metal combination has been specifically qualified and approved.

Maximum allowable undercutting shall be to the thread root diameter.

Weld overlay is not allowed on stems with a diameter of 0.750 in. or smaller in the packing area.

After welding, the stem packing area shall be machined.

After machining, welded area shall be subjected to 100% dye penetrant examination. Examiner shall be SNT-TC-1A Level II qualified, as a minimum. No indications are allowed in the packing contact area.

Areas of defective weld may be repaired using this stem weld procedure provided the area of pitting or defective weld is undercut by machining and the entire area of undercut is welded in accordance with this procedure. Spot welding of individual defects or pits is prohibited.

Repair of stem T-head by weld build-up is not permitted.

All 300 series high carbon (C > 0.035) stainless steel stems shall be solution annealed after weld repair is completed.

B.3 Procedure Qualification and Sample Preparation

Weld procedures shall be qualified in accordance with Section IX of the ASME Code (QW-450 for weld metal build-up and corrosion resistant or hardfacing overlay).

Weld overlay by SMAW welding is prohibited.

A weld procedure shall be qualified for each stem material and filler metal combination to be used for repair.

Reconditioner shall provide to the Owner written notification of the stem material/filler metal combinations to be qualified.

Reconditioner shall prepare two samples from either 1.250 in. or 1.375 in. diameter API 600 valve stems for each stem material/filler metal combination to be qualified. Owner shall approve the samples before qualification of the procedure begins.

Owner shall be notified when the preparation of the samples will commence.

Reconditioner shall provide to the Owner a copy of the procedures to be qualified.

B.4 Laboratory Tests

One stem sample shall be subjected to a stem pull test in accordance with API Std 591 for each stem material and filler metal combination that is being qualified.

Except for a stem with a hard facing overlay, a $^3/_8$ in. wide specimen containing the overlay shall be taken from the center of the second sample stem longitudinally and a side bend test shall be performed in accordance with ASME Section IX, QW-453. Any sign of disbonding of the weld metal shall disqualify the repair procedure.

A specimen from the second stem sample shall be micro etched and photomicrographed to determine proper fusion.

A hardness profile shall be made across the centerline of the stem.

a. 410 stainless steel with a 410 stainless steel overlay:

   1. Unless otherwise specified, a hardness between 200 HB and 275 HB shall be maintained, both before and after welding.

   2. Hardness of the heat-affected zone shall be within 80 HB of the base metal hardness.

b. 300 series stainless steel with a 300 series stainless steel overlay:

   1. Hardness of the weld overlay shall be within 50 HB of the base metal hardness.

c. 410 stainless steel base with a corrosion resistant overlay.

   1. Post weld heat treatment is required.

   2. A maximum allowable reduction of hardness shall be a maximum of 30 HB.

   3. Unless otherwise specified, final base metal hardness shall be between 200 HB and 275 HB.

   4. After heat treatment hardness of the heat-affected zone shall be within 50 HB of the base metal.

   5. PMI shall be done on the weld overlay using an analyzer approved by the Owner.

   6. Chemical analyses shall be done for procedure qualifications and laboratory tests.

d. 300 series stainless steel base with a hard facing overlay:

   1. Postweld heat treatment is required.

   2. A maximum allowable reduction of hardness shall be a maximum of 30 HB.

   3. Unless otherwise specified, final base metal hardness shall be between 200 HB and 275 HB.

   4. After heat treatment, hardness of the heat-affected zone shall be within 50 HB of the base metal hardness.

APPENDIX C—TESTS

C.1 Scope

This Appendix covers requirements for testing of valves being reconditioned in accordance with this Recommended Practice.

C.2 General

Tests shall be conducted in a manner that verifies the pressure integrity of the valve body and the valve seat(s).

Unless a more restrictive test is specified, reconditioned valves shall be subjected to the following tests:

a. Shell and backseat test.
b. High pressure seat test of first side.
c. Low pressure air test of first side.
d. High pressure seat test of second side.
e. Low pressure air test of second side.

During seat testing for gate valves, the valve body cavity shall be pressurized by allowing the test medium to flow through the valve as the wedge is being closed down onto the seats.

Preferably, the seat test shall be performed with the valve stem in the horizontal position, the valve bore in the vertical position, and one side of the valve open.

If a valve must be tested with the stem in the vertical position, double flanging both sides of the valve and using a pipe stand is permitted for the high pressure seat tests. Double flanging both sides of the valve and using a bubbler is permitted for the low pressure air seat test when approved by the Owner.

Unless a more restrictive test is specified by the Owner, test pressures, test durations, test fluids, and leakage rates shall conform to API Std 598.

C.3 Test Equipment

Test equipment that may conceal or reduce disqualifying conditions from being easily detected shall not be used.

Gauges used for pressure tests shall have been calibrated to the National Bureau of Standards within the previous year and shall be functioning properly at the time of the test.

Equipment used for pressure tests shall not apply external forces that affect seat leakage. If an end-clamping test fixture is used, the reconditioner shall demonstrate that the fixture does not affect the seat-sealing capability of the valve being tested.

Handwheel wrenches shall be limited to a length of approximately twice the size (NPS) of the valve being tested. Extensions on the wrenches shall not be used.

Example: An 18 in. to 24 in. handwheel wrench may be used on an NPS 10 valve.

Hammers shall not be used on the valve body, flanges, or handwheel wrench to help seat the wedge.

Table 1—Minimum Thickness of Shell Wall and Minimum Diameter of Stem, in Inches

Valve Size	150#		300#		400#		600#		900#		1500#		2500#	
NPS	Shell Wall Thickness	Stem Diameter	Shell Wall Thickness	Stem Diameter	Shell Wall Thickness	Stem Diameter	Shell Wall Thickness	Stem Diameter	Shell Wall Thickness	Stem Diameter	Shell Wall Thickness	Stem Diameter	Shell Wall Thickness	Stem Diameter
1	0.20	0.62	0.20	0.62	–	–	0.27	0.62	–	–	0.45	0.75	0.53	0.75
1 1/2	0.20	0.68	0.25	0.75	–	–	0.31	0.75	–	–	0.53	0.87	0.69	0.87
2	0.28	0.75	0.32	0.75	–	–	0.38	0.75	–	–	0.69	1.00	0.82	1.00
2 1/2	0.32	0.75	0.38	0.75	–	–	0.41	0.87	–	–	0.82	1.12	0.94	1.12
3	0.35	0.87	0.41	0.87	–	–	0.44	1.00	0.69	1.12	0.88	1.25	1.12	1.25
4	0.38	1.00	0.44	1.00	0.44	1.12	0.57	1.12	0.78	1.25	1.07	1.37	1.35	1.37
6	0.41	1.12	0.57	1.25	0.60	1.37	0.69	1.50	0.97	1.62	1.38	1.75	1.85	1.87
8	0.44	1.25	0.63	1.37	0.69	1.50	0.88	1.62	1.13	1.87	1.76	2.12	2.38	2.37
10	0.50	1.37	0.69	1.50	0.78	1.75	1.01	1.87	1.32	2.12	2.13	2.50	2.60	2.87
12	0.57	1.50	0.75	1.62	0.88	1.87	1.13	2.00	1.54	2.25	2.51	2.75	3.35	3.25
14	0.60	1.62	0.82	1.75	1.00	1.87	1.26	2.25	1.69	2.37	2.63	3.00	–	–
16	0.63	1.75	0.88	1.87	1.07	2.00	1.38	2.37	1.94	2.50	3.01	3.00	–	–
18	0.66	1.87	0.94	2.00	1.13	2.25	1.51	2.50	2.13	3.00	3.38	–	–	–
20	0.69	2.00	1.00	2.12	1.25	2.50	1.63	2.75	2.38	–	3.76	–	–	–
24	0.75	2.25	1.13	2.50	1.38	2.75	1.88	3.00	2.79	–	4.38	–	–	–

Note:
1. The shell comprises the body and the bonnet.
2. For inspection purposes, the wall thickness of valve bodies and bonnets at the completion of reconditioning shall be no less than the minimum values shown in Table 1. When using this table, linear interpolation may be used for values intermediate to those not listed. The minimum thickness requirement for the body and bonnet is applicable only as measured from internal wetted surfaces. Minimum wall thickness shall not include liners, linings, or cartridges.

Table 2—Allowable Pitting and Localized Corrosion

Pitting or localized corrosion that reduces valve wall thickness below the minimum allowable wall thickness specified in Table 1 shall be acceptable if:

a. Maximum diameter of a circle that can enclose the pitting/corrosion conforms to the following table.

b. Minimum edge-to-edge distance between circles that enclose adjacent areas of pitting/corrosion conforms to the following table.

Wall thickness at location of pitting/corrosion is a minimum of 75% of the minimum wall thickness specified in Table 1.

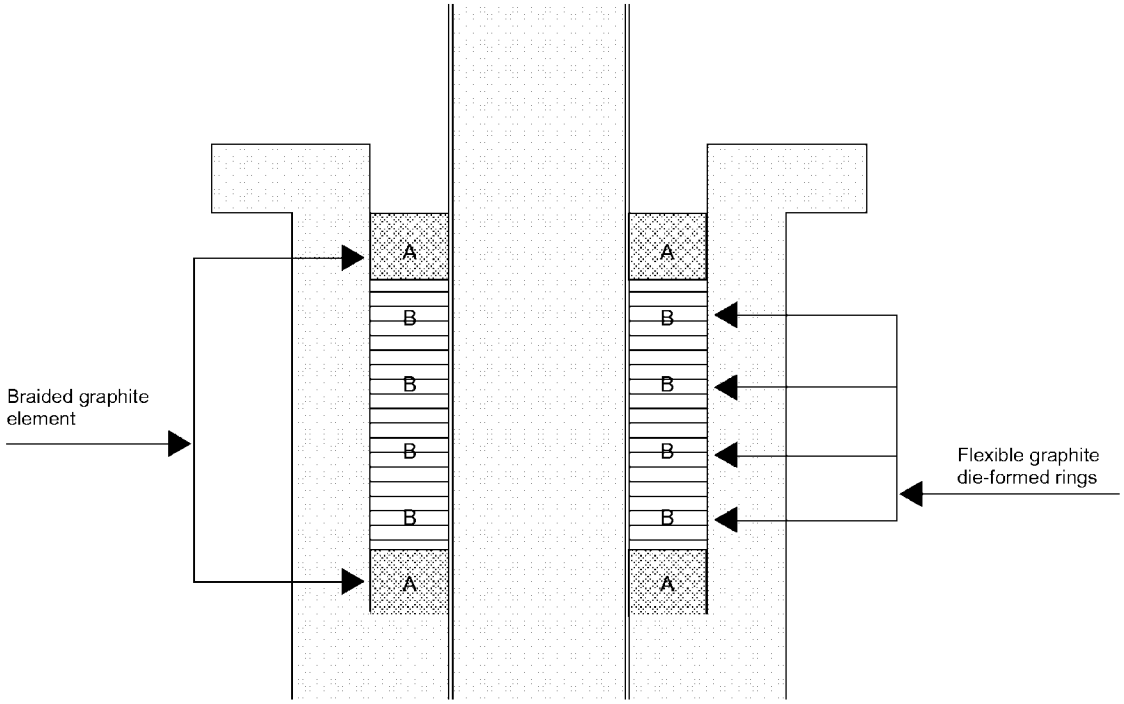
Valve Size (NPS)	Maximum Diameter of Circle that can Enclose Pitting/ Corrosion (inches)	Minimum Edge-to-Edge Distance Between Adjacent Enclosure Circles (inches)
1	0.15	0.75
1 1/2	0.18	0.90
2	0.23	1.15
2 1/2	0.25	1.25
3	0.28	1.40
4	0.35	1.75
6	0.45	2.25
8	0.55	2.75
10	0.64	3.20
12	0.74	3.70
14	0.87	4.25
16	0.93	4.65
18	1.02	5.10
20	1.11	5.55
24	1.30	6.50

Table 3—Gasket Material and Surface Finish

Material and surface finish of different gasket types shall conform to the following table:

Gasket Type	Material	Surface Finish
Flexible graphite with metal insert	Greater than 95% graphite, containing less than 100 ppm leachable chlorides, adhesively bonded to.002" minimum thickness flat or corrugated 304 or 316 SS metal reinforcing agent	125 to 250 µin.
Commercial grade PTFE with or without reinforcing fillers	Made of commercial PTFE suitable for temperatures up to 450°F. Glass or ceramic fillers may be used as reinforcing agents	125 to 250 µin.
Corrugated metal	Soft iron	Approx. 63 µin.
Spiral wound	Gasket metal winding of TP 304SS or TP 316L SS with filler material of PTFE or flexible graphite	125 to 250 µin.
Oval/rectangular ring	Soft iron	Ring Joint groove with a 32 to 63 µin. finish
Pressure seal gasket	Owner shall specify gasket material and any plating to be used.	Approx. 32 µin.

Note:
1 Flexible graphite with metal insert gaskets are suitable for use in Class 150 as per API Standard 600.
2. Owner may specify alternative materials to be used as reinforcing metals, wire, and windings and filler materials.



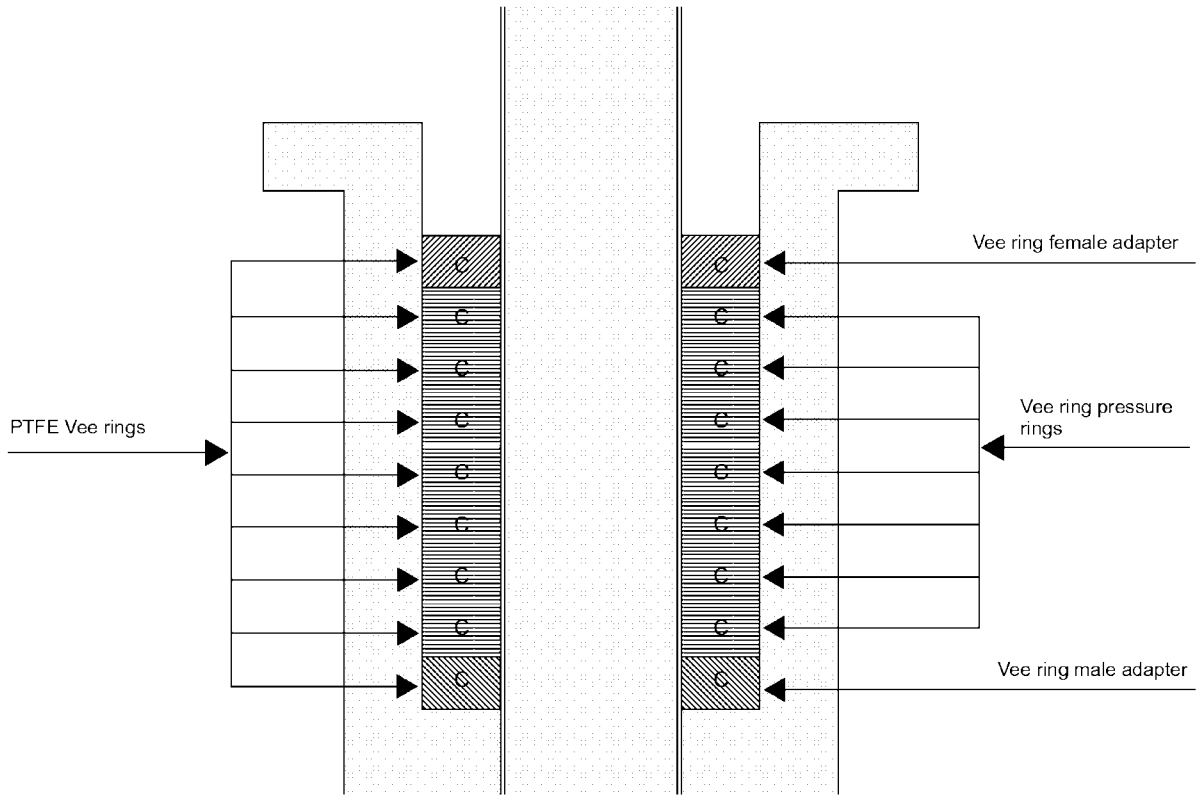
Notes:
1. There shall always be at least one Type A or Type E ring at the top and bottom of the stuffing box.

2. Depending on the depth of the stuffing box, a minimum of three and a maximum of four Type B rings shall be used. If necessary, a spacer may be used in the bottom of the stuffing box.

3. Pre-formed flexible graphite rings shall be installed as continuous rings over the end of the threads. Slipping cut rings of flexible graphite around the stem is not permitted.

4. Wrapping flexible graphite ribbon around the stem and using the packing gland and eyebolts to form the flexible graphite ring inside the stuffing box is not permitted.

Figure 1—Flexible Graphite Packing for Block Valves

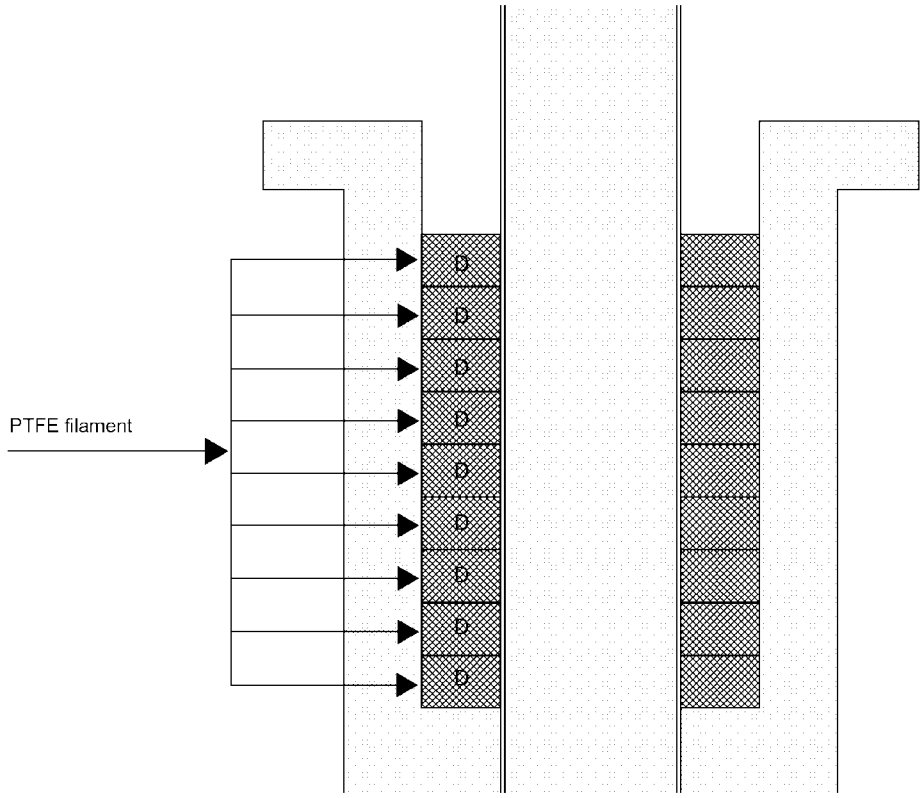


Notes:

1. A minimum of four rings shall be used (one male adapter; two pressure rings and one female adapter) unless the stuffing box is too large, in which case, pressure rings shall be increased to fill the remainder of the stuffing box.

2. Vee rings shall be installed as a continuous ring. Cutting of Vee rings is not permitted.

Figure 2—PTFE Vee Ring Packing for Block Valves



Note: Braided packing shall be scarf cut and individual rings shall be installed so that the cut in each ring is offset approximately 90° from the previous ring.

Figure 3—Lattice Braid PTFE Filament Packing for Block Valves

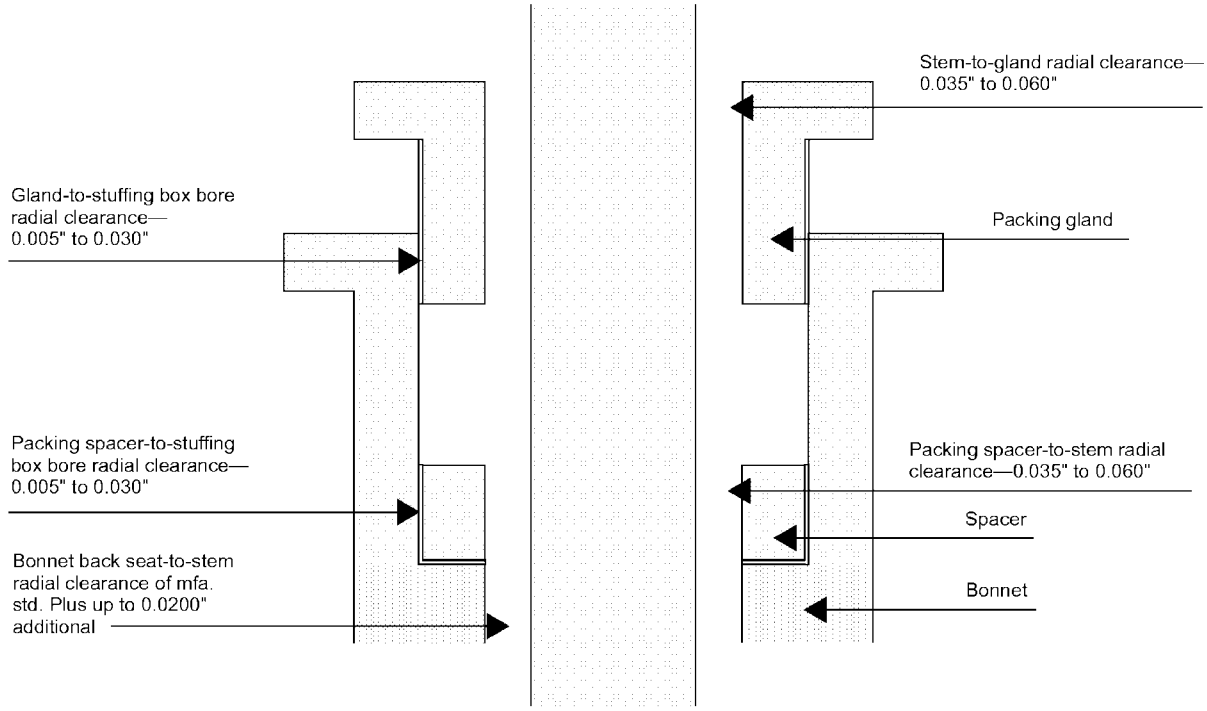


Figure 4—Stuffing Box Clearances

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