

Flexible Graphite Packing System for Rising Stem Steel Valves - Design Requirements

Standard Practice
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This MSS Standard Practice was developed under the consensus of the MSS Technical Committee 308 and the MSS Coordinating Committee. The content of this Standard Practice is the result of the efforts of competent and concerned volunteers to provide an effective, clear, and non-exclusive specification that will benefit the industry as a whole. This MSS Standard Practice is intended as a basis for common practice by the manufacture, the user, and the general public. The existence of an MSS Standard Practice does not in itself preclude the manufacture, sale, or use of products not conforming to the Standard Practice. Mandatory conformance is established only by reference in a code, specification, sales contract, or public law, as applicable.

U.S. customary units in this SP are the standard; metric (SI) units are for reference only.

Unless otherwise specifically noted in this MSS SP, any standard referred to herein is identified by the date of issue that was applicable to the referenced standard(s) at the date of issue of this MSS SP. (See Annex A).

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FOREWORD

This Standard Practice was developed by a cooperative effort of representatives of valve and packing manufacturers. This Standard Practice is intended primarily to be an aid for the manufacture and procurement of packing systems with design features for rising-stem steel valves that utilize flexible graphite packing. However, this does not preclude the use of these system features for other types of packing systems since this Standard Practice represents the consensus input from a broad spectrum of industry applications.

This Standard Practice shall not be construed to be effective for all pressures and types of services expected of ASME B16.34 valves. Special service applications such as low fugitive emissions control or toxic fluid may require additional or different design measures that are outside the scope of this Standard Practice.

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FLEXIBLE GRAPHITE PACKING SYSTEM FOR RISING STEM STEEL VALVES - DESIGN REQUIREMENTS

1. **SCOPE** ⁽¹⁾

1.1 This Standard Practice establishes material and dimensional requirements for valve packing, packing chamber, packing gland, packing washer, bonnet, and stem as they relate to the total packing assembly.

1.2 This Standard Practice applies to standard, special, and limited Class 150 through Class 4500 (including intermediate classes) ASME B16.34 type steel gate, globe, and angle valves designed with rotating/rising and non-rotating/rising stems.

1.3 This Standard Practice applies to valves in which a flexible graphite packing assembly is used as the primary stem-sealing system.

1.4 This Standard Practice does not apply to valves that include a lantern ring as part of its packing system nor to bonnetless valves with split glands.

2. **DEFINITIONS**

2.1 See MSS SP-96 for definitions of terms used in this Standard Practice.

2.2 See Figure 5 for definitions of symbols used in this Standard Practice.

3. **PACKING ASSEMBLY**

3.1 The packing shall be composed of center and end rings or a cylinder of flexible graphite and end rings. A flexible graphite packing assembly that is

constructed with a braided carbon or braided graphite or metal-mesh that reinforces the flexible graphite may not require end rings. The end rings shall serve as wipers and anti-extrusion devices to keep the flexible graphite in the packing chamber during operation, including stroking, of the valve. Individual center rings may contain up to 2 splits per ring to facilitate valve packing installation. Braided end rings shall contain a maximum of 1 split per ring and molded end rings shall contain a maximum of 2 splits per ring. The end ring properties shall be designed to deter the extrusion and/or erosion of the center flexible graphite rings during valve operation.

Packing assemblies of flexible graphite without end rings may be used; however, the diametrical clearance specified in Table 1 and Table 2 shall be reduced to a maximum of 50% of that required for higher than Class 300 valves. The packing shall also be qualified to the requirements of MSS SP-121.

3.2 The packing assembly shall contain a dispersed passive corrosion-inhibitor, a dispersed embedded active corrosion-inhibitor, or a suitable combination of inhibitors, to minimize stem pitting caused by the galvanic corrosion phenomenon set up in a wet valve packing-chamber. Inhibitors in end rings are optional, unless otherwise specified by the purchaser.

3.3 The pre-installed density and dimensions of the flexible graphite packing shall be at the valve manufacturer's option. The final adjusted density and dimensions of the packing assembly shall be capable of sealing with no visible leakage when the valve is tested at a pressure equal to the valve's 100°F pressure rating at ambient conditions. The as-shipped remaining packing and packing gland adjustment (packing gland tight) shall be greater than 10% of the minimum depth of the packing chamber listed in Table 1 and Table 2.

NOTE: ⁽¹⁾

This Standard Practice is not intended to apply to valves developed for and predominantly used in instrument piping systems. (See MSS SP-99 and MSS SP-105)

3.4 The dimensional requirements of the packing assembly shall be per Table 1 and Table 2. The minimum width "W" and minimum depth "L" are listed.

3.5 Smaller packing widths ("W") and/or smaller depths ("L") may be used when qualified to the requirements of MSS SP-121. All other provisions of the Standard Practice shall apply.

4. **STEM**

4.1 The dimensional tolerances (bilateral or unilateral) shall be per Table 1 and Table 2. The stem finish shall be 32 Ra (microinch) (0.80 micrometers) or smoother. These stem characteristics shall apply in the area that contacts the packing during the full stroking of the valve. The stem diameter tolerance as shown in Table 1 and Table 2 applies to the stem diameter that contacts the packing I.D.

4.2 The stem diameter tolerance shall be such that the maximum diametrical clearance between the packing gland or follower I.D. ("B") and bonnet or packing washer ("C") as required in Table 1 and Table 2 is not exceeded.

4.3 The stem diameter that contacts the packing during the full stroking of the valve shall meet circularity, taper, and straightness requirements encompassed in a cylindricity tolerance of 0.003" (0.08mm) for 3" and smaller stems and 0.004" (0.10mm) for stems larger than 3" (see Figures 3 and 4).

4.4 The stem surface that contacts the packing during full stroking of the valve shall be free of scratches, pits, or voids deeper than 0.002" (0.05mm).

5. **PACKING GLAND**

5.1 The dimensional tolerances of the gland or follower I.D. and O.D. shall be such that the maximum diametrical clearance between the stem and gland or follower ("B") and packing chamber bore and gland or follower ("A") illustrated in Table 1 and Table 2 are not exceeded.

6. **PACKING CHAMBER**

6.1 The dimensional tolerance of the packing chamber shall be such that the maximum diametrical clearance between gland or follower and the packing chamber ("A") illustrated in Table 1 and Table 2 is not exceeded. The packing depth 4W or 5W illustrated in Table 1 and Table 2 refers to the equivalent of 4 or 5 square rings of packing which includes the top and bottom end rings. The packing chamber inside diameter surface finish shall be 125 Ra (microinch) (3.2 micrometers) or smoother, as illustrated in Figure 1 and Figure 2.

A chamfer or radius may be used at the entrance of the packing chamber.

6.2 The packing chamber bore shall meet squareness to the bonnet gasket surface or other appropriate datum surface encompassed in a perpendicularity tolerance of 0.006" (0.15mm) regardless of bore size, (see Figures 3 and 4).

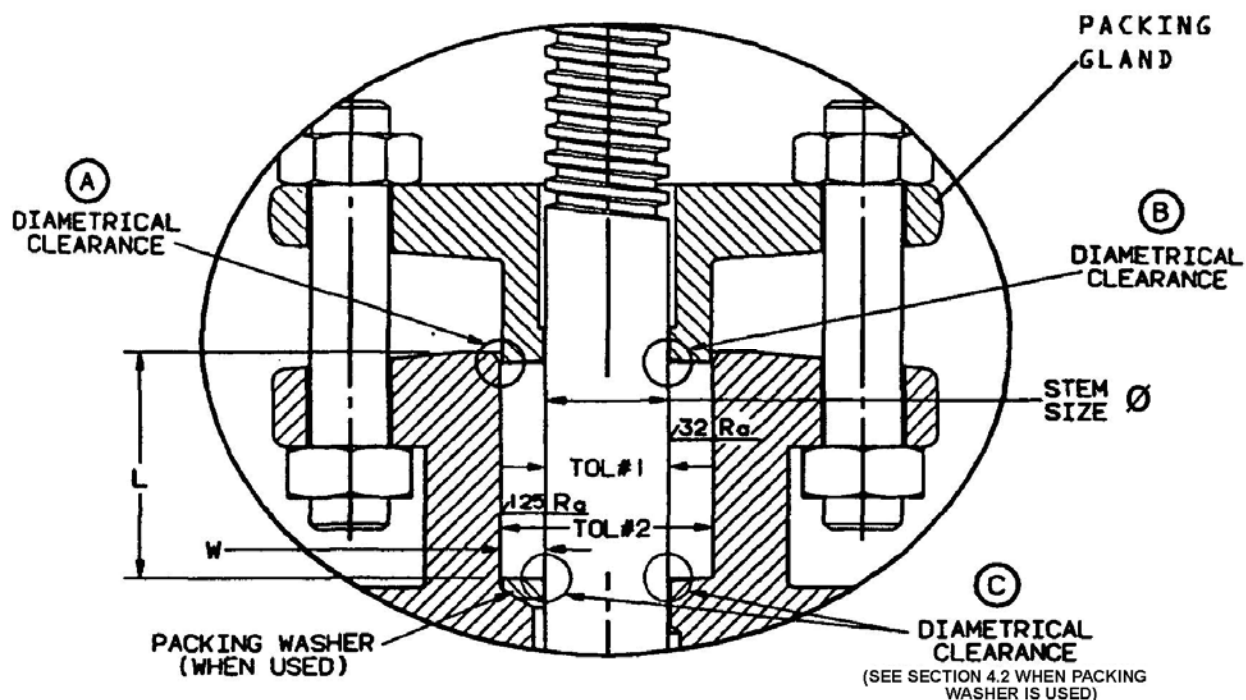
6.3 The packing chamber bore shall meet circularity, taper, and straightness requirements encompassed in a cylindricity tolerance of 0.006" (0.15mm), (see Figures 3 and 4).

6.4 The packing chamber bore and bonnet stem hole shall be concentric within a positional tolerance of $\varnothing 0.005$ " (0.13mm) as presented in Figures 3 and 4.

6.5 The packing chamber bore shall be free of scratches, pits, or voids deeper than 0.006" (0.015mm).

7. **PACKING WASHER OR VALVE BONNET**

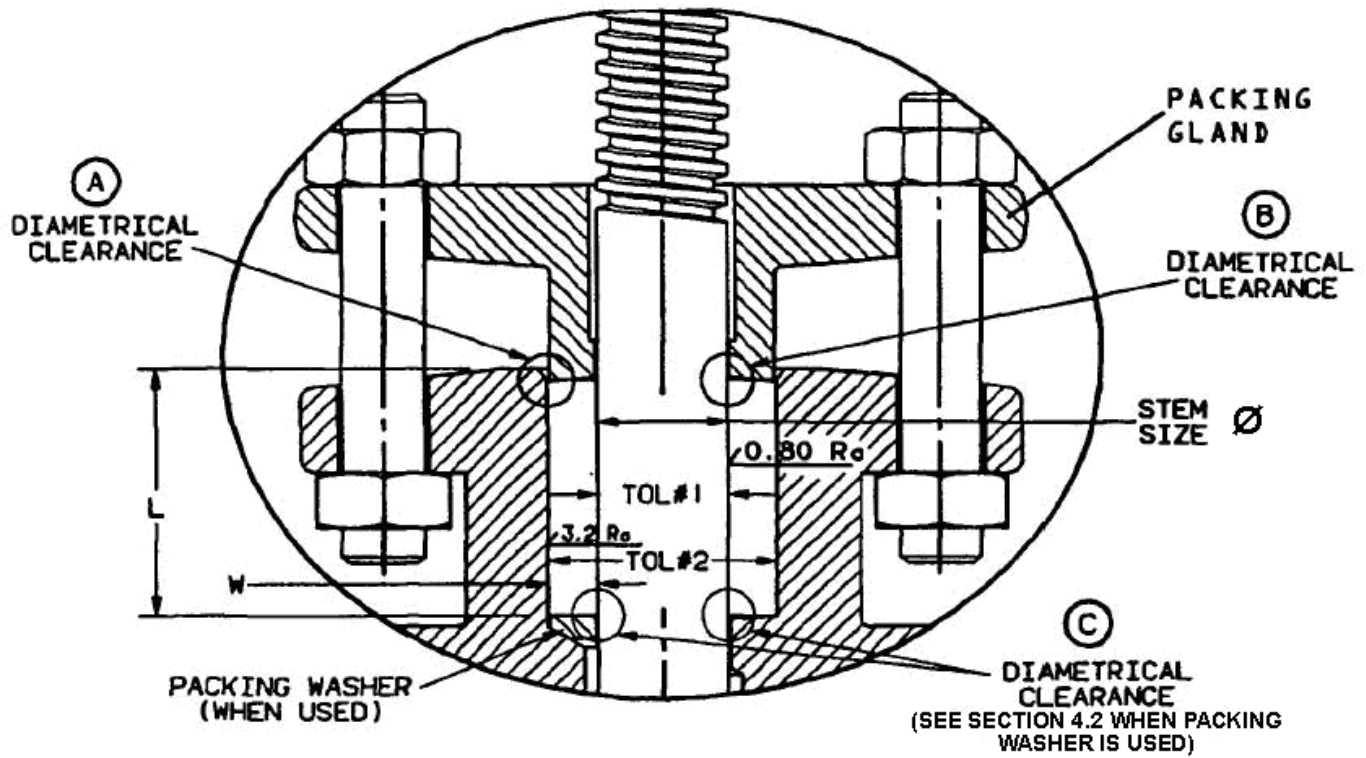
7.1 The tolerance on the valve bonnet or the packing washer, when a packing washer is used, shall be such that the maximum diametrical clearance between the stem and the bonnet or packing washer ("C"), illustrated in Table 1 and Table 2, is not exceeded.

FIGURE 1 Packing System Details (U.S. Units) (Illustrative Only)**TABLE 1 Packing System Details (U.S. Units)**

NOTE, DIMENSIONS ARE IN INCHES			WIDTH & DEPTH OF PACKING		DIAMETRICAL CLEARANCE - MAXIMUM		
STEM SIZE $\varnothing$	STEM DIAMETER TOL. #1 - MAXIMUM	PACKING CHAMBER I.D. TOL. #2 - MAXIMUM	W MINIMUM	L MINIMUM	(A) ⁽¹⁾	(B) ⁽¹⁾	(C) ⁽¹⁾
1/4" thru 1/2"	0.008	0.010	1/8	4W	.020	.040	.040
> 1/2" thru 11/16"	0.008	0.010	3/16	4W	.020	.040	.040
> 11/16" thru 1 1/4"	0.008	0.010	1/4	4W	.025	.050	.050
> 1 1/4" thru 2"	0.009	0.010	5/16	5W	.025	.050	.050
> 2" thru 3"	0.011	0.010	3/8	5W	.025	.050	.050
> 3" thru 3 1/2"	0.011	0.015	7/16	5W	.030	.065	.065
> 3 1/2" thru 4 1/4"	0.011	0.015	1/2	5W	.030	.065	.065
> 4 1/4" thru 5"	0.011	0.015	9/16	5W	.030	.065	.065
> 5" thru 7"	0.011	0.015	5/8	5W	.030	.065	.065

General Note: Dimensions are in inches

Note (1) The manufacturer may need to revise diametrical clearances for severe services and/or high pressure applications.

FIGURE 2 Packing System Details (Metric Units) (Illustrative Only)**TABLE 2 Packing System Details (Metric Units)**

NOTE : DIMENSIONS ARE IN MILLIMETERS			WIDTH & DEPTH OF PACKING		DIAMETRICAL CLEARANCE - MAXIMUM		
STEM SIZE Ø	STEM DIAMETER TOL. #1 - MAXIMUM	PACKING CHAMBER I.D. TOL. #2 - MAXIMUM	W MINIMUM	L MINIMUM	A ⁽¹⁾	B ⁽¹⁾	C ⁽¹⁾
6.4 thru 12.7	0.20	0.25	3.2	4W	0.51	1.02	1.02
> 12.7 thru 17.5	0.20	0.25	4.8	4W	0.51	1.02	1.02
> 17.5 thru 31.8	0.20	0.25	6.4	4W	0.64	1.27	1.27
> 31.8 thru 50.8	0.23	0.25	7.9	5W	0.64	1.27	1.27
> 50.8 thru 76.2	0.23	0.25	9.5	5W	0.64	1.27	1.27
> 76.2 thru 88.9	0.28	0.38	11.1	5W	0.76	1.65	1.65
> 88.9 thru 108.0	0.28	0.38	12.7	5W	0.76	1.65	1.65
> 108.0 thru 127.0	0.28	0.38	14.3	5W	0.76	1.65	1.65
> 127.0 thru 178.0	0.28	0.38	15.9	5W	0.76	1.65	1.65

General Note: Dimensions are in millimeters

Note (1) The manufacturer may need to revise diametrical clearances for severe services and/or high pressure applications.

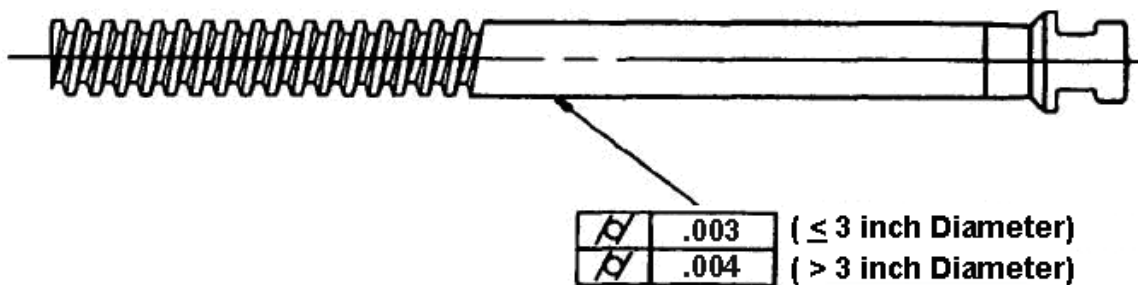
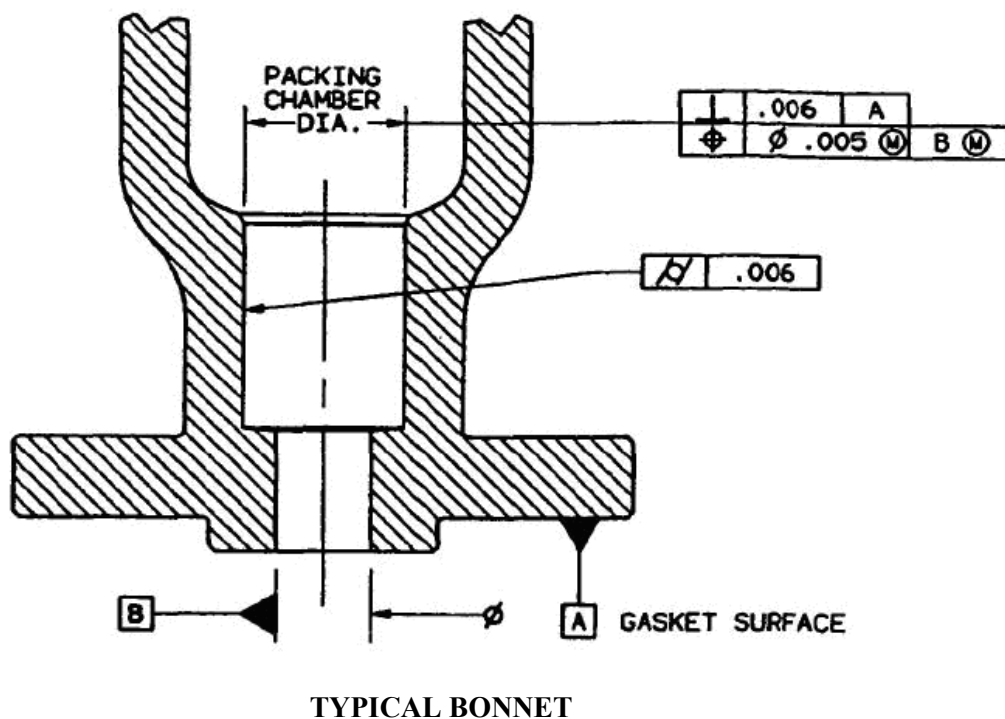


FIGURE 3 Stem/Bonnet Details (U.S. Units) (Illustrative Only)

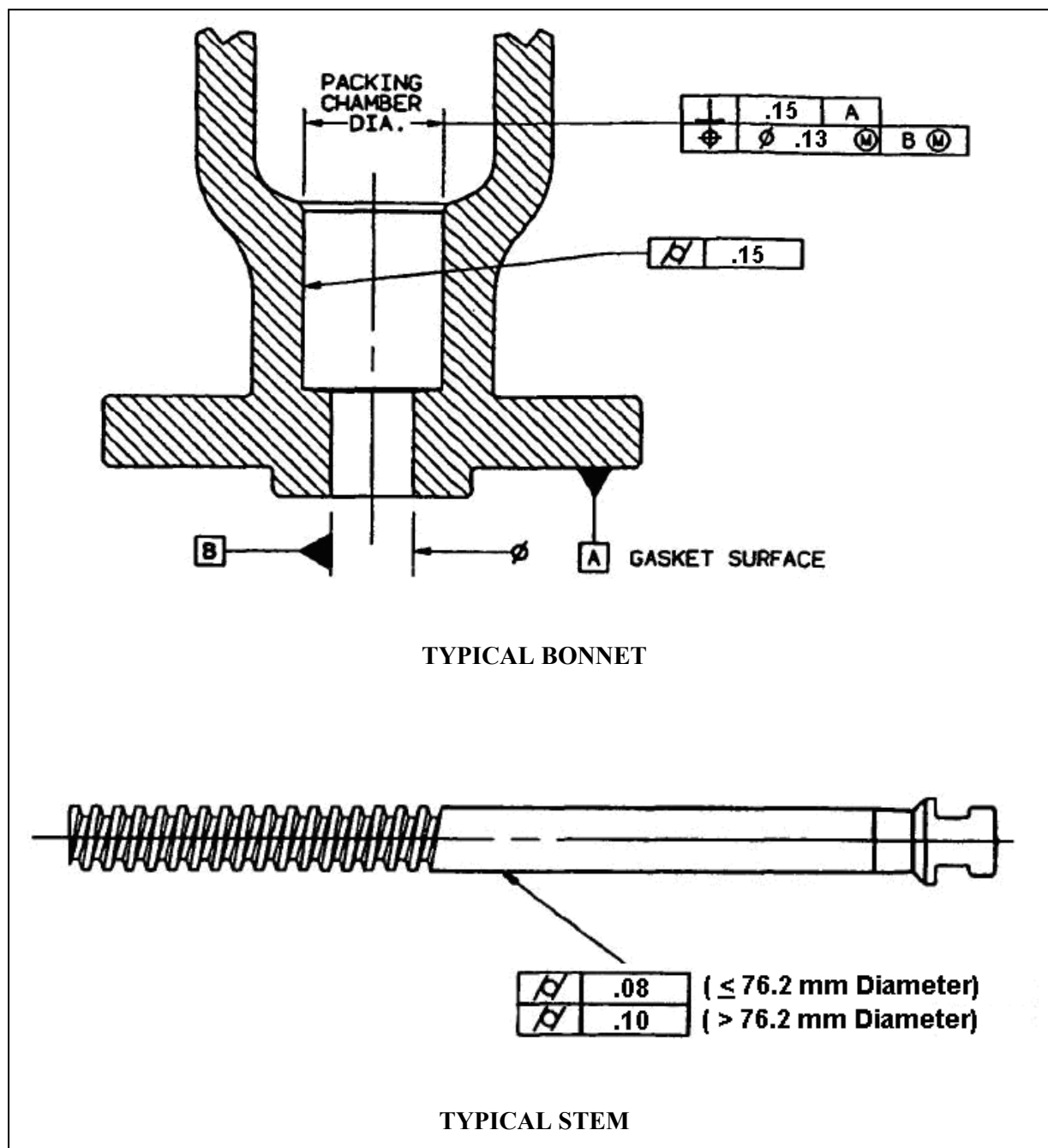
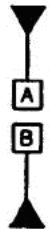


FIGURE 4 Stem/Bonnet Details (Metric Units) (Illustrative Only)



- **DATUM FEATURE**
DEF. A Datum Feature is used to designate a Datum Surface or Feature



- **CYLINDRICITY**
DEF. Cylindricity is a condition of a surface of revolution in which all points of the surface are equidistant from a common axis.



- **POSITION**
DEF. A Position Tolerance defines a zone within which the axis or center plane of a feature is permitted to vary from its theoretically exact position.



- **PERPENDICULARITY**
DEF. Perpendicularity is the condition of a surface, axis or line which is 90° from a Datum Plane Axis.



- **MAXIMUM MATERIAL CONDITION**
DEF. Maximum Material Condition is that condition where a feature of size contains the maximum amount of material within the stated limits of size. e.g., smallest hole, biggest shaft.

FIGURE 5 Geometric Symbols Definitions (Illustrative only)

ANNEX A

Referenced Standards and Applicable Dates

This Annex is an integral part of this Standard Practice and is placed after the main text for convenience.

Standard Name or Designation

ANSI/ ASME, ANSI, ASME/ANSI

B16.34 - 2004 Valves - Flanged, Threaded, and Welding End

MSS

SP-96-2001 Guidelines on Terminology for Valves and Fittings
SP-99-1994 (R 2005) Instrument Valves
SP-105-1996(R 2005) Instrument Valves for Code Applications
SP-121-1997(R 2002) Qualification Testing Methods for Stem Packing for Rising Stem Steel Valves

Publication of the following organizations appear in the above list:

ANSI American National Standards Institute, Inc.
25 West 43rd Street
New York, NY 10036

ASME ASME International
3 Park Avenue
New York, NY 10016-5990

MSS Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
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List of MSS Standard Practices (Price List Available Upon Request)

Number	
SP-6-2001	Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings
SP-9-2001	(R 05) Spot Facing for Bronze, Iron and Steel Flanges
SP-25-1998	Standard Marking System for Valves, Fittings, Flanges and Unions
SP-42-2004	Class 150 Corrosion Resistant Gate, Globe, Angle and Check Valves with Flanged and Butt Weld Ends
SP-43-1991	(R 01) Wrought Stainless Steel Butt-Welding Fittings
SP-44-2006	Steel Pipeline Flanges
SP-45-2003	Bypass and Drain Connections
SP-51-2003	Class 150LW Corrosion Resistant Flanges and Cast Flanged Fittings
SP-53-1999	(R 02) Quality Standard for Steel Castings and Forgings for Valves, Flanges and Fittings and Other Piping Components - Magnetic Particle Examination Method
SP-54-1999	(R 02) Quality Standard for Steel Castings for Valves, Flanges, and Fittings and Other Piping Components - Radiographic Examination Method
SP-55-2001	Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components - Visual Method for Evaluation of Surface Irregularities
SP-58-2002	Pipe Hangers and Supports - Materials, Design and Manufacture
SP-60-2004	Connecting Flange Joint Between Tapping Sleeves and Tapping Valves
SP-61-2003	Pressure Testing of Steel Valves
SP-65-2004	High Pressure Chemical Industry Flanges and Threaded Stubs for Use with Lens Gaskets
SP-67-2002a	Butterfly Valves
SP-68-1997	(R 04) High Pressure Butterfly Valves with Offset Design
SP-69-2003	Pipe Hangers and Supports - Selection and Application (ANSI/MSS Edition)
SP-70-2006	Gray Iron Gate Valves, Flanged and Threaded Ends
SP-71-2005	Gray Iron Swing Check Valves, Flanged and Threaded Ends
SP-72-1999	Ball Valves with Flanged or Butt-welding Ends for General Service
SP-73-2003	Brazing Joints for Copper and Copper Alloy Pressure Fittings
SP-75-2004	Specification for High Test Wrought Butt Welding Fittings
SP-77-1995	(R 00) Guidelines for Pipe Support Contractual Relationships
SP-78-2005a	Gray Iron Plug Valves, Flanged and Threaded Ends
SP-79-2004	Socket-Welding Reducer Inserts
SP-80-2003	Bronze Gate, Globe, Angle and Check Valves
SP-81-2006	Stainless Steel, Bonnetless, Flanged, Knife Gate Valves
SP-83-2006	Class 3000 Steel Pipe Unions, Socket-Welding and Threaded
SP-85-2002	Gray Iron Globe & Angle Valves, Flanged and Threaded Ends
SP-86-2002	Guidelines for Metric Data in Standards for Valves, Flanges, Fittings and Actuators
SP-88-1993	(R 01) Diaphragm Valves
SP-89-2003	Pipe Hangers and Supports - Fabrication and Installation Practices
SP-90-2000	Guidelines on Terminology for Pipe Hangers and Supports
SP-91-1992	(R 96) Guidelines for Manual Operation of Valves
SP-92-1999	MSS Valve User Guide
SP-93-1999	(R 04) Quality Standard for Steel Castings and Forgings for Valves, Flanges, and Fittings and Other Piping Components - Liquid Penetrant Examination Method
SP-94-1999	(R 04) Quality Std for Ferritic and Martensitic Steel Castings for Valves, Flanges, and Fittings and Other Piping Components - Ultrasonic Examination Method
SP-95-2006	Swage(d) Nipples and Bull Plugs
SP-96-2001	(R 05) Guidelines on Terminology for Valves and Fittings
SP-97-2006	Integrally Reinforced Forged Branch Outlet Fittings - Socket Welding, Threaded and Buttwelding Ends
SP-98-2001	(R 05) Protective Coatings for the Interior of Valves, Hydrants, and Fittings
SP-99-1994	(R 05) Instrument Valves
SP-100-2002	Qualification Requirements for Elastomer Diaphragms for Nuclear Service Diaphragm Valves
SP-101-1989	(R 01) Part-Turn Valve Actuator Attachment - Flange and Driving Component Dimensions and Performance Characteristics
SP-102-1989	(R 01) Multi-Turn Valve Actuator Attachment - Flange and Driving Component Dimensions and Performance Characteristics
SP-104-2003	Wrought Copper Solder Joint Pressure Fittings
SP-105-1996	(R 05) Instrument Valves for Code Applications
SP-106-2003	Cast Copper Alloy Flanges and Flanged Fittings, Class 125, 150 and 300
SP-108-2002	Resilient-Seated Cast-Iron Eccentric Plug Valves
SP-109-1997	(R 06) Welded Fabricated Copper Solder Joint Pressure Fittings
SP-110-1996	Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
SP-111-2001	(R 05) Gray-Iron and Ductile-Iron Tapping Sleeves
SP-112-1999	(R 04) Quality Standard for Evaluation of Cast Surface Finishes -Visual and Tactile Method. This SP must be sold with a 10-surface, three dimensional Cast Surface Comparator, which is a necessary part of the Standard. Additional Comparators may be sold separately.
SP-113-2001	Connecting Joint between Tapping Machines and Tapping Valves
SP-114-2001	Corrosion Resistant Pipe Fittings Threaded and Socket Welding, Class 150 and 1000
SP-115-2006	Excess Flow Valves 1 1/4 NPS and Smaller, for Fuel Gas Service
SP-116-2003	Service Line Valves and Fittings for Drinking Water Systems
SP-117-2006	Bellows Seals for Globe and Gate Valves
SP-118-2002	Compact Steel Globe & Check Valves - Flanged, Flangeless, Threaded & Welding Ends (Chemical & Petroleum Refinery Service)
SP-119-2003	Factory-Made Belled End Socket Welding Fittings
SP-120-2006	Flexible Graphite Packing System for Rising Stem Steel Valves (Design Requirements)
SP-121-2006	Qualification Testing Methods for Stem Packing for Rising Stem Steel Valves
SP-122-2005	Plastic Industrial Ball Valves
SP-123-1998	(R 06) Non-Ferrous Threaded and Solder-Joint Unions for Use With Copper Water Tube
SP-124-2001	Fabricated Tapping Sleeves
SP-125-2000	Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves
SP-126-2000	Steel In-Line Spring-Assisted Center Guided Check Valves
SP-127-2001	Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application
SP-128-2006	Ductile Iron Gate Valves
SP-129-2003	Copper-Nickel Socket-Welding Fittings and Unions
SP-130-2003	Bellows Seals for Instrument Valves
SP-131-2004	Metallic Manually Operated Gas Distribution Valves
SP-132-2004	Compression Packing Systems for Instrument Valves
SP-133-2005	Excess Flow Valves for Low Pressure Fuel Gas Appliances
SP-134-2006	Valves for Cryogenic Service Including Requirements for Body/Bonnet Extensions
SP-135-2006	High Pressure Steel Knife Gate Valves
(R-YEAR)	Indicates year standard reaffirmed without substantive changes

A large number of former MSS Practices have been approved by the ANSI or ANSI Standards, published by others. In order to maintain a single source of authoritative information, the MSS withdraws its Standard Practices in such cases.

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MSS/IHS SP