

CGA V-9 — 2024

9TH EDITION

COMPRESSED GAS ASSOCIATION STANDARD FOR COMPRESSED GAS CYLINDER VALVES

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Cylinder Valve Committee

NOTE—Technical changes from the previous edition are underlined.

NOTE—Appendices A, B, and C (Informative) are for information only.

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Contents	Page
1 Introduction.....	1
2 Scope	1
3 Definitions.....	2
4 Design considerations and requirements	8
4.1 Valve connection	8
4.2 Materials	9
4.3 Markings	11
4.4 Pressure relief devices	12
4.5 Specific valves.....	12
4.6 Other valve components/devices	13
4.7 Residual pressure valve fill adapters.....	14
5 Valve types and descriptions.....	14
5.1 Packed valves	14
5.2 Pressure seal valves	14
5.3 O-ring valves	15
5.4 Diaphragm valves.....	15
5.5 Post-type medical valves.....	15
5.6 Reverse seated valves	16
5.7 Remotely operated valves	16
5.8 Quick-release cylinder valves.....	16
5.9 Self-closing cylinder valves	17
5.10 Additional valve types.....	17
6 Valve qualification and documentation.....	18
6.1 General.....	18
6.2 Documentation	19
6.3 Valve qualification test procedure.....	19
7 Valve qualification tests.....	20
7.1 Performance and qualifying tests	20
7.2 Conditional qualifying tests.....	23
8 Production requirements	24
8.1 Materials	24
8.2 Cleaning	24
8.3 Testing of production valves.....	24
9 Maintenance.....	25
9.1 Inspection—General requirements.....	25
9.2 Inspection procedure	26
10 Cylinder valve protection caps	29
10.1 Introduction.....	29
10.2 General information	29
10.3 Cylinder valve protection cap design.....	29
10.4 Material selection.....	29
10.5 Testing.....	30
10.6 Markings	30
10.7 Valve protection other than cylinder valve protection caps	30
11 References	30
12 Additional references.....	32

Tables

Table 1—Sequence of tests for valve qualification 20

Table 2—Test pressures for tightness tests..... 22

Table 3—Production valve test pressures 25

Appendices

Appendix A—Valve selection guidelines (Informative)..... 33

Appendix B—Checklist of DOs and DO NOTs relative to valve use and abuse (Informative)..... 34

Appendix C—Compressed gas cylinder valve figures (Informative) 36

Appendices Figures

Figure C-1—Packed valve: Example 1 36

Figure C-2—Packed valve: Example 2 36

Figure C-3—Pressure seal valve 37

Figure C-4—O-ring valve 37

Figure C-5—Diaphragm packless valve..... 38

Figure C-6—Tied diaphragm valve 38

Figure C-7—Post-type medical valve..... 39

Figure C-8—Reverse seated valve 40

Figure C-9—Impact testing 40

1 Introduction

The Compressed Gas Association, Inc. (CGA) has long recognized the need to promote public safety in the use of cylinder valves. This standard defines factors that contribute to the safe design, manufacture, and use of cylinder valves for compressed gases.

Compressed gases supplied in cylinders are diverse in their chemical composition and properties. Some are oxidizers, some are flammables, some are inert, etc. Gases vary in degrees of corrosivity, toxicity, and pressure and exist not only in the pure state but also in a variety of mixtures. Thus, it is a primary safety requirement of the cylinder valve that it is designed and tested for its intended use.

2 Scope

This standard covers cylinder valve design, manufacture, and use including performance requirements such as operating temperature limits, pressure ranges, and flow capabilities. It also includes requirements such as materials, inlet and outlet connections, cleaning, qualification and production testing, maintenance, and reconditioning. This standard also includes guidelines and requirements for the design, material selection, testing, and marking of cylinder valve protection caps. Except as noted in the last paragraph of this section, this standard is intended for valves for compressed gases packaged in U.S. Department of Transportation (DOT) and Transport Canada (TC) cylinders.

This standard provides information on valve selection, valve use guidelines, and valve protection caps (see Appendix A, Appendix B, and Section 10, respectively).

This standard does not prejudice the continued use of valves in service or in inventory at a manufacturer's or user's site that were manufactured before the effective date of this standard provided the valves are identifiable to the original valve manufacturer and traceable to a manufacturing period. The identifying marks shall be permanent and visible on an installed valve.

The effective date of this standard is three years from the date of the publication of this edition, which was April 23, 2024. Valves manufactured on and after the effective date of this standard shall be in compliance with this standard.

This standard does not prohibit the use of valves that are Listed.

The following valves shall meet the requirements of ISO 10297, *Gas cylinders—Cylinder valves—Specification and type testing* as well as the additional requirements given in this standard [1]:¹

- cylinder valves intended to be fitted to refillable transportable gas cylinders;
- main valves (excluding ball valves) for cylinder bundles;
- cylinder valves or main valves with an integrated pressure regulator (VIPR) for nonmedical purposes;
- cylinder valves for pressure drums; and
- cylinder valves for tubes (excluding ball valves) not mounted to a chassis or framework.

The following valves shall meet the requirements of ISO 17879, *Gas Cylinders—Self closing cylinder valves—Specifications and type testing* as well as the applicable additional requirements given in this standard [2]:

- Self-closing cylinder valves intended to be fitted to refillable transportable gas cylinders; and
- Self-closing cylinder valves with a VIPR for nonmedical purposes.

¹ References are shown by bracketed numbers and are listed in order of appearance in the reference section.

The following valves shall meet the requirements of ISO 17871, *Gas Cylinders—Quick-release cylinder valves—Specifications and type testing* as well as the applicable additional requirements given in this standard [3]:

- Quick-release cylinder valves intended to be fitted to refillable transportable gas cylinders, pressure drums, and tubes; and
- Quick-release cylinder valves with a VIPR intended to be fitted to refillable transportable gas cylinders, pressure drums, and tubes.

This standard does not apply to:

- Cylinder valves used with nonrefillable cylinders (such as DOT-39, TC-39M, and nonrefillable cylinders manufactured under special permits or equivalency certificates);
- Cylinder valves used in DOT-2P and DOT-2Q (TC-2P and TC-2Q) cylinders;
- Cylinder with a VIPR used for medical purposes. See CGA E-18, *Standard for Medical Gas Valve Integrated Pressure Regulators* [4];
- Cylinder valves on DOT-4L (TC-4LM) cylinders;
- Cylinder valves in refrigerated liquid service; and
- Cylinder valves on DOT/TC/UN cylinders (tubes) that are mounted to a chassis or framework for road transportation.

3 Definitions

For the purpose of this standard, the following definitions apply.

3.1 Publication terminology

3.1.1 Shall

Indicates that the procedure is mandatory. It is used wherever the criterion for conformance to specific recommendations allows no deviation.

3.1.2 Should

Indicates that a procedure is recommended.

3.1.3 May

Indicates that the procedure is optional.

3.1.4 Will

Is used only to indicate the future, not a degree of requirement.

3.1.5 Can

Indicates a possibility or ability.

3.2 Technical definitions

3.2.1 Cylinder valve

Mechanical device attached to a compressed gas cylinder that permits flow in to or out of the cylinder when the device is in the open position and prevents flow when in the closed position.

3.2.2 Cylinder valve protection cap

Device fixed over a cylinder's valve during handling, transportation, and storage.

NOTE—It is attached to the cylinder by a threaded connection or other means and usually is removed to allow access to the cylinder valve.

3.2.3 General purpose valves

Valves used for industrial compressed gases.

3.2.4 Listed

Approved by an independent source to a relevant Underwriters Laboratories (UL) valve standard(s) that also performs periodic inspection of production.

3.2.5 Oxidizing gas service valve

Valves used for oxygen, oxygen-enriched gas mixtures (greater than 23.5% oxygen), or other highly oxidizing gases such as nitrous oxide.

NOTE—Valves used for air that has an oxygen concentration less than or equal to 23.5% by volume are not oxidizing gas service valves.

3.2.6 Quick-release valve

Valve with a valve operating mechanism designed for quick release of gas cylinder contents that is actuated by a valve operating device that can be activated by an activation device that might not be part of the quick release valve.

3.2.7 Self-closing cylinder valve

Valve with a normally closed valve operating mechanism that is actuated by a separate operating device that is not an integral part of the valve.

3.2.8 Special purpose valve

Valve that does not meet the flow coefficient (C_v) of the valves listed in 7.1.3.

3.2.9 Valve characteristics

3.2.9.1 Flow coefficient

Numeric constant (C_v) established through testing for each valve type and size.

NOTE— C_v can be used to calculate the maximum flow capacity of a valve in its full flow position.

3.2.9.2 Maximum service pressure

Maximum pressure at 70 °F (21.1 °C) at which the valve is designed to operate defined by the pressure rating of the outlet connection.

NOTE—The pressure could be higher than the maximum service pressure in actual use at temperatures greater than 70 °F (21.1 °C).

3.2.9.3 Opening pressure

Differential pressure between upstream and downstream pressures at which a RPD starts to open.

3.2.9.4 Pin-indexed

Nonthreaded type of connection to the valve outlet where noninterchangeability among connections is maintained by using a series of blind holes in the valve and matching pins in the connecting part.

3.2.9.5 Slow opening

Valve design that reduces pressure surges when the valve is opened quickly.

NOTE—Also known as controlled flow.

3.2.9.6 Tied diaphragm

Feature of a diaphragm-type design valve where the upper and lower stems are metallurgically bonded through the diaphragms so they move together and act as an integral unit assembly.

NOTE—See Figure C-6 in Appendix C.

3.2.9.7 Valve test pressure

1.2 times the maximum service pressure at 70 °F (21.1 °C) at which the valve is designed to operate defined by the pressure rating of the outlet connection.

3.2.10 Valve functions

3.2.10.1 Backseat

Fully opening the valve until the movement of the opening action is physically stopped by a valve component such as the packing, packing ring, bonnet, etc.

NOTE—In some designs, backseating acts as a secondary stem seal.

3.2.10.2 Closing off pressure

Differential pressure between upstream and downstream pressures at which a RPD closes.

NOTE—The closing off pressure can change as a function of the flow rate through the device.

3.2.10.3 Cracking

Act of slightly opening the valve to permit a very small amount of flow.

3.2.10.4 External leakage

Leakage to atmosphere when the valve is open and the outlet is sealed.

3.2.10.5 Full flow

Open position when maximum flow capacity is achieved.

3.2.10.6 Full open

Open position when the stem is backseated.

3.2.10.7 Internal leakage

Leakage across the valve seat when the valve is closed.

3.2.10.8 Shutoff

Position of the valve when the valve stem is in contact with the valve body seat; no flow condition of the valve.

NOTE—Also called closure.

3.2.11 Valve maintenance

3.2.11.1 Inspection

Procedure to determine if a valve is safe for further service.

3.2.11.2 Maintenance

Operations required to keep the valve in safe working condition, which can include inspection, cleaning, repair, or reconditioning.

3.2.11.3 Reconditioning

Operations required to restore a valve so it is safe for reuse.

3.2.11.4 Repair

Operations that include cleaning and are divided into major and minor repair.

3.2.11.5 Major repair

Operations associated with the replacement of valve components and accessories within the pressure boundary.

3.2.11.6 Minor repair

Operations involving the replacement of nonpressure retaining components when the valve is closed.

3.2.11.7 Scrapping

To render valves and components incapable of further use.

3.2.12 Valve parts

3.2.12.1 Backcheck device

Device that permits flow out of the valve but does not permit flow into the valve without special tooling to overcome the device.

3.2.12.2 Bonnet

Threaded valve component tightened onto or into the valve body to retain and compress the packing, diaphragm(s), or other sealing member(s).

NOTE—Also known as packing nut.

NOTE—See Figures C-2, C-3, C-4, C-5, C-7, and C-8 in Appendix C.

3.2.12.3 Diaphragm(s)

Formed, flexible disk(s) clamped between the valve bonnet and the ledge in the valve body in diaphragm-type valves that provide(s) a seal or pressure barrier between the wetted parts of the valve and the exterior.

NOTE—See Figures C-5 and C-6 in Appendix C.

3.2.12.4 Excess flow valve

Valve designed to close when the flow rate of fluid passing through it exceeds a prescribed flow rate as determined by pressure drop.

NOTE—An excess flow valve is used to prevent excessive flow out of a gas cylinder.

3.2.12.5 Flow restrictor

Device designed to limit the maximum flow through the valve outlet.

NOTE—See Figure C-5 in Appendix C.

3.2.12.6 Handwheel

Manually operated device attached to the valve stem used to open and close the valve.

NOTE—See Figures C-3, C-4, and C-5 in Appendix C.

3.2.12.7 Lower stem

Lower member of a two-piece stem actuated by the upper stem.

NOTE—Also known as a seat insert holder, seat plug, lower plug.

NOTE—See Figures C-3, C-4, C-5, and C-7 in Appendix C.

3.2.12.8 Outlet seal cap/plug

Cap or plug that serves as a protective covering for the valve outlet against contamination from external sources and serves as a pressure barrier to prevent leakage through the valve outlet.

NOTE—Also known as gas-tight outlet seal cap/plug.

NOTE—See Figure C-1 in Appendix C.

3.2.12.9 Outlet dust cap/plug

Cap or plug that only serves as a protective covering for the valve outlet to minimize contamination from external sources.

3.2.12.10 Packing

Nonmetallic material installed around the stem in a packed valve that when compressed creates a seal against leakage past the stem.

NOTE—Also known as packing gland.

NOTE—See Figures C-1, C-2, C-3, and C-7 in Appendix C.

3.2.12.11 Packing follower

Ring, usually metal, often installed on top of the packing in a packed-type valve so the packing nut is not torqued directly against the packing.

NOTE—Also known as a packing gland.

NOTE—See Figure C-1 in Appendix C.

3.2.12.12 Packing nut

See definition for bonnet.

3.2.12.13 Packing ring

Ring installed in a packed-type valve to provide a seat for the packing.

NOTE—Also known as a packing collar.

NOTE—See Figures C-1 and C-2 in Appendix C.

3.2.12.14 Pressure relief device (PRD)

Pressure-activated device and/or temperature-activated device used to prevent the pressure in a normally charged cylinder from rising above a predetermined maximum, thereby preventing rupture of the cylinder when subjected to a standard fire test as required by Title 49 of the U.S. *Code of Federal Regulations* (49 CFR) Part 173.301(f)(1) or Clause 4.3.2 of CSA B340, *Selection and use of cylinders, spheres, tubes and other containers for the transportation of dangerous goods, Class 2* as adopted by 5.10(1) of the *Transportation of Dangerous Goods* regulations [5, 6, 7].

NOTE—The term pressure relief device is synonymous with safety relief device as used by DOT or TC regulations. See Figures C-1, C-3, C-4, C-5, C-6, C-7, and C-8 in Appendix C.

3.2.12.15 Pressure relief nut

Rupture disk holder threaded onto the valve body that incorporates a precisely machined edge around a relief device discharge port against which the disk is designed to rupture.

NOTE—Also known as a cap.

3.2.12.16 Pressure relief plug

Rupture disk holder threaded into the valve body that retains a rupture disk in place and incorporates a precisely machined edge around a relief device discharge port against which the disk is designed to rupture.

3.2.12.17 Relief device gasket/washer

Seal ring located between the rupture disk and the relief device discharge port in the valve body.

3.2.12.18 Residual pressure device (RPD)

Device that is designed to prevent ingress of contaminants by maintaining a positive pressure within the cylinder relative to atmospheric by closing off its internal gas passages in the discharging direction.

3.2.12.19 Residual pressure valve (RPV)

Valve that incorporates an RPD.

3.2.12.20 Rupture disk

Operating part of a PRD that when installed in the device is designed to rupture at a predetermined pressure to permit the discharge of the cylinder contents.

3.2.12.21 Seat insert

Material contained in or on the lower stem (sometimes on a one-piece stem) usually made of a soft material to facilitate sealing against the valve body seat.

NOTE—See Figures C-3, C-4, C-5, C-6, C-7, and C-8 in Appendix C.

3.2.12.22 Tang

Member or extension projecting from either the lower end of an upper stem or the upper end of a lower stem, mechanically attached or integral to the stem, through which torque is transmitted in a two-piece stem.

NOTE—See Figure C-3 in Appendix C.

3.2.12.23 Thrust bearing

Disk-like part sometimes inserted between the upper stem and the metal diaphragms to reduce friction.

3.2.12.24 Upper stem

Upper member of a two-piece stem that when operated causes the lower stem to move.

NOTE—See Figures C-3, C-5, and C-7 in Appendix C.

3.2.12.25 Valve actuator

Manually or remotely operated device used to open and close the valve.

3.2.12.26 Valve body

Major portion of the valve (normally one piece) that contains the orifice, valve body seat, and inlet and outlet connections, and is machined to accept the component parts to create a valve assembly.

NOTE—See Figure C-2 in Appendix C.

3.2.12.27 Valve body seat

Sealing surface surrounding the orifice in the valve body.

NOTE—See Figure C-7 in Appendix C.

3.2.12.28 Valve inlet

Portion of the valve body that connects to the cylinder.

NOTE—See Figures C-1, C-2, C-3, C-4, C-5, C-7, and C-8 in Appendix C.

3.2.12.29 Valve outlet

Portion of the valve body through which product is introduced or discharged.

NOTE—See Figures C-2, C-3, C-4, C-6, C-7, and C-8 in Appendix C.

3.2.12.30 Valve stem, one-piece

Component that opens and closes the valve.

NOTE—Also known as a lower spindle or poppet.

NOTE—See Figures C-1 and C-2 in Appendix C.

3.2.12.31 Valve stem, two-piece

Components consisting of an upper stem and a lower stem that open and close the valve.

NOTE—See Figures C-3, C-4, and C-7 in Appendix C.

3.2.13 Visual inspection and examination

Evaluation with the unaided eye and without visual enhancements, for example, a magnifying tool.

4 Design considerations and requirements

Valves shall meet the requirements of ISO 10297, ISO 17871, or ISO 17879 (depending on the design) and the applicable additional requirements given in this standard [1, 2, 3].

4.1 Valve connection

4.1.1 Inlet connection

Valves are normally connected to the cylinder by means of a threaded valve inlet connection. These connections use either tapered or straight threads. These threads shall be in accordance with FED-STD-H28A, *Screw Thread Standards for Federal Services*, or other standards except where modified specifications are recognized as follows [8]. Design considerations for inlet connections follow:

- Modified national gas taper (NGT) threads such as with special thread root and crest forms are acceptable where enhanced sealing, extended valve life, or extended cylinder life can be achieved;
- Oversized valve threads such as chlorine 3/4"-14 NGT (CI) threads [(CI)-2 through (CI)-5] can be used to accommodate cylinder thread wear and extend the life of the cylinder;
- To accommodate valve or cylinder thread wear due to repeated removals and insertions, longer inlet thread length can be provided for valves as specified by The Chlorine Institute Pamphlet 17, *Packaging Plant Safety and Operational Guidelines* [9];
- Undersized threads are permitted where tinning or other metallurgically bonded coatings are applied to the inlet threads. Tinning or coating of threads to satisfy specification tolerances due to manufacturing errors is not permitted; and
- The valve inlet bore diameter and length shall comply with the requirements of CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*, or other standards [10].

4.1.2 Outlet connection

The means by which a valve is connected to the filling and utilization appliances is by one or more outlet connections. These outlet connections can have tapered threads, straight threads, or consist of a yoke connection where threads are not used. These connections should be in accordance with CGA V-1, or other standards or proprietary designs that have been qualified to a consensus industry standard (for example, CGA, ISO, UL) [10]. Design considerations for outlet connections follow:

- Outlet flow passages modified to incorporate filters, flow restrictors, flow-limiting devices, check valves, or other features are acceptable provided that:
 - The integrity of the joint and noninterchangeability are maintained
 - The mating connection manufactured in accordance with the dimensions given in the corresponding standard connects in a leak-tight manner with correct thread engagement;
- In the design of new threaded outlet connections, space for the incorporation of a flow-limiting device in the outlet should be considered; and
- Torque guidelines for sealing CGA outlet connections are found in Appendix II of CGA V-1, CGA V-17, *Guideline for Handling and Use of CGA 630/710 Series Ultra High Integrity Service Connections*, and CGA V-21, *Torque Guidelines for Sealing CGA Valve Outlet Connections* [10, 11, 12].

4.2 Materials

4.2.1 Requirements

Design requirements for materials are as follows:

- All metallic and nonmetallic material in contact with the gas shall be physically and chemically compatible with the products for which the valve is designed. Consideration shall be given to materials of valve components normally not in contact with the gas such as packings, O-rings, etc.;
- For corrosive service, compatible materials shall be used. Chlorine industrial valves use packings recommended by The Chlorine Institute [9]. Many other valves use polytetrafluoroethylene (PTFE) packing, commonly known as Teflon®;
- Alloys containing greater than 65% copper shall not be used with acetylene, vinyl chloride, vinyl methyl ether, and methylacetylene-type propadiene stabilized (MAPP) gases due to the possibility of the formation of explosive acetylides. For additional information regarding the formation of explosive acetylides in the presence of acetylene, see CGA G-1, *Acetylene* [13];
- Copper and its alloys shall not be used in gas-wetted areas with ammonia due to the susceptibility of these materials to stress corrosion cracking (SCC);
- Copper and its alloys shall not be used in gas-wetted areas with methylamine and methyl mercaptan due to corrosive attack;
- Nickel shall not be used in gas-wetted areas with carbon monoxide due to formation of nickel carbonyl;
- The potential for hydrogen embrittlement of nickel in gas-wetted areas shall be considered when using nickel in hydrogen service;
- Use caution anytime oxygen is used with stainless steel. In any application where stainless steel is used in oxygen systems, pressure, flow rates, cleanliness, and possible particle generation shall be considered in the design. In general, the higher the pressure and the higher the flow, the greater the chance of ignition of the stainless steel;
- Selection of materials for oxygen applications shall take into consideration the chance of ignition, especially with the advent of the high pressure connections where oxygen pressures as high as 4700 psi at 70 °F (32 400 kPa at 21.1 °C) can be reached;²
- For oxygen valve materials, the following shall be considered:
 - The valve design's susceptibility to ignition
 - A material's resistance to ignition in oxygen service
 - If used, lubricants shall be rated by the manufacturer for oxygen service pressure not less than the test pressure of the valve or qualified in accordance with ISO 10297 and ISO 17879 [1, 3]
 - Caution shall be used when selecting polymeric or elastomeric components such as O-rings in oxygen service. Nonmetallic materials such as polymers and elastomers can leach plasticizers that could react with oxygen. Polymers and elastomers vary greatly in chemical composition and curing processes and should be evaluated for use in their specific application
 - Nonmetallic materials such as plastics, elastomers, and lubricants are commonly used in high pressure oxygen supply systems. Of particular concern are materials in the flowing stream such as valve seats. Nonmetallic materials are used as seat materials due to their positive shutoff characteristics; however, they present a potential source of fuel that, once ignited, could produce toxic combustion by-products

² psi, bar, and kPa shall indicate gauge pressure unless otherwise noted as (psia; bar, abs; and kPa, abs) for absolute pressure or (psid; bar, dif; and kPa, dif) for differential pressure. All kPa values are rounded off per CGA P-11, *Guideline for Metric Practice in the Compressed Gas Industry* [14].

- Nonmetallic materials commonly used in medical oxygen cylinder valves can generate toxic by-products upon combustion/decomposition. Materials such as PTFE, polychlorotrifluoroethylene (PCTFE), and fluoroelastomers (FKM) can produce toxic chlorinated or fluorinated combustion/decomposition by-products. Some commonly used materials such as polyamide (nylon), polyetheretherketone (PEEK), and ethylene-propylene diene monomer (EPDM) generate less toxic combustion/decomposition by-products than the previously mentioned fluorinated compounds. However, these materials (for example, nylon, PEEK, and EPDM) have lower autoignition temperatures as established by standardized tests. Factors to consider when selecting nonmetallic materials for medical oxygen cylinder valves include:
 - Valve design's susceptibility to ignition
 - Material's resistance to ignition in oxygen service; and
- A material's potential toxic by-products, quantity of toxic by-products generated, and hazards if combustion/decomposition occurs. See CGA G-4.10, *Use of Nonmetallic Materials in High Pressure Oxygen Breathing Gas Applications*, for additional considerations in selecting nonmetallic materials [15].

It is imperative that the information contained in references such as those in the following list be taken into account by qualified technical personnel when designing, manufacturing, and assembling medical oxygen valves.

ASTM standard guides and practices:

- ASTM G63, *Standard Guide for Evaluating Nonmetallic Materials for Oxygen Service* [16];
- ASTM G88, *Standard Guide for Designing Systems for Oxygen Service* [17];
- ASTM G93, *Standard Guide for Cleanliness Levels and Cleaning Methods for Materials and Equipment Used in Oxygen-Enriched Environments* [18]; and
- ASTM G94, *Standard Guide for Evaluating Metals for Oxygen Service* [19].

ASTM test methods:

- ASTM G72, *Standard Test Method for Autogenous Ignition Temperature of Liquids and Solids in a High-Pressure Oxygen-Enriched Environment* [20];
- ASTM G74, *Standard Test Method for Ignition Sensitivity of Materials to Gaseous Fluid Impact* [21]; and
- ASTM G86, *Standard Test Method for Determining Ignition Sensitivity of Materials to Mechanical Impact in Ambient Liquid Oxygen and Pressurized Liquid and Gaseous Oxygen Environments* [22].

4.2.2 Recommendations and considerations

Design recommendations and considerations for materials are as follows:

- For noncorrosive service, brass is commonly used for the valve body, stem, and lower plug. The seat insert is usually a polyamide such as nylon and the packing is PTFE. If a separate tang is used between the stem and lower plug, it is usually made of stainless steel;
- Where metal diaphragms are used, the material(s) for the top and bottom diaphragms is selected for strength and corrosion resistance. Additional flexibility can be achieved by varying the thickness of the diaphragms, the number of diaphragms used, or modifying the materials of construction. For synthetic rubber diaphragm valves, the maximum use pressure is approximately 250 psi (1720 kPa);
- For medical valves, the body and bonnet are typically brass with bright copper, nickel, and chromium plating. The lower stem is typically brass;