



CGA S-1.1—2022 PRESSURE RELIEF DEVICE STANDARDS—PART 1— CYLINDERS FOR COMPRESSED GASES

SIXTEENTH EDITION

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Work Item 22-025
Cylinder Valve Committee

NOTE—Technical changes from the previous edition are underlined.

NOTE—Appendix A (Informative) is for information only.

NOTE—Appendices B and C (Normative) are requirements.

FOREWORD

On April 16, 1981, the United States Department of Transportation promulgated new regulations to 49 CFR 173.34(d), which eliminated the need for pressure relief device approval by the Bureau of Explosives of the Association of American Railroads. It is the responsibility of the individual manufacturer or shipper to conduct his own flow and/or fire tests on new pressure relief device combinations to show compliance with CGA S-1.1 and CGA C-14 as applicable, and to retain test records of the compliance.

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1 Introduction

This standard represents the minimum requirements for pressure relief devices (PRDs) considered to be appropriate and adequate for use on cylinders with a water capacity less than or equal to 1000 lb (454 kg). Refer also to Title 49 of the U.S. *Code of Federal Regulations* (49 CFR), CSA B340, *Selection and use of cylinders, spheres, tubes, and other containers for the transportation of dangerous goods, Class 2*, and/or CSA B342, *Selection and use of UN pressure receptacles, multiple-element gas containers, and other pressure receptacles for the transport of dangerous goods, Class 2* [1, 2, 3].¹ This standard also applies to composite overwrapped pressure vessels (COPVs), DOT-3AX, DOT-3AAX, and DOT-3T cylinders with a water capacity greater than 1000 lb (454 kg) as well as United Nations (UN) pressure receptacles with a water capacity up to 3000 kg, and which comply with the design specifications and charging (filling) and maintenance regulations of the U.S. Department of Transportation (DOT) or the corresponding specifications and regulations of Transport Canada (TC) [1, 4].

When cylinders that conform to the specification requirements of DOT or TC but are used in services beyond the jurisdiction of any of these authorities, it is recommended that the state, provincial/territorial, city, and other local regulatory authorities over these cylinders be guided by this standard in determining PRD requirements provided that the cylinders are charged and maintained in accordance with DOT or TC regulations.

It is further recognized that there can be cylinders that are used in services beyond the jurisdiction of DOT or TC that do not conform to the specification requirements of either authority. The authority having jurisdiction (AHJ) over such cylinders should be guided by this standard in determining PRD requirements provided that such cylinders are considered by the authority as having a construction at least equal to the equivalent DOT or TC specification requirements and they are charged and maintained in accordance with DOT or TC requirements.

A number of states, provinces/territories, cities, and other local regulatory authorities have pressure vessel laws and regulations that include requirements for PRDs. This standard is prepared specifically for compressed gas cylinders, and the PRDs may not be acceptable unless special permission is obtained from the AHJ. For cylinders that come within the jurisdiction of state, provincial/territorial, and local regulatory authorities, the user should check for compliance with all such regulations.

For newly constructed cylinders that come within the jurisdiction of DOT or TC, PRDs shall comply with requirements of this standard. The intent of this standard is to minimize the number and optimize the types of approved PRDs specified for each specific gas. This standard does not prohibit the continued use of previously approved and installed devices unless stated otherwise in this standard, 49 CFR, CSA B340, and/or CSA B342 [1, 2, 3]. However, if a PRD is replaced, the new device shall meet the requirements of this standard.

It is the filler's responsibility to ensure that the PRD is correct.

2 Scope

This standard applies to the selection of PRDs for a single component compressed gas in cylinders. For selection of PRDs for compressed gas mixtures in cylinders, see CGA S-7, *Standard Method for Selecting Pressure Relief Devices for Compressed Gas Mixtures in Cylinders* [5].

This standard does not cover PRD requirements for CTC/DOT-4L and TC-4LM insulated cylinders containing cryogenic liquids, see CGA S-1.2, *Pressure Relief Device Standards—Part 2—Portable Containers for Compressed Gases* [6]. This standard does not cover PRD requirements for multi-unit tank car tanks (DOT106A/TC106A and DOT110A-W/TC110A), see 49 CFR 179.300-15 and CGSB 43.147, *Construction, Modification, Qualification, Maintenance, and Selection and Use of Means of Containment for the Handling, Offering for Transport, or Transporting of Dangerous Goods by Rail*, as appropriate [1, 7].

This standard includes tables that provide information pertaining to PRDs. Table 1 contains information on the different types of PRDs. Table 2 provides a list of gases and their PRD assignments. Table 3 contains temperature correction factors. Table 4 includes values for basic orifice factors flange taps for flow in ft³/minute.

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

For PRD standards for bulk transport containers and stationary storage containers, see CGA S-1.2 and CGA S-1.3, *Pressure Relief Device Standards—Part 3—Stationary Storage Containers for Compressed Gases* [6, 8].

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 Approach channel

Passage or passages through which fluid must pass from the cylinder to reach the operating parts of the PRD.

3.2.2 CG-10 activation time

Time for a CG-10 device to achieve its full rated flow capacity using a standardized activation test (see 7.8.1.5).

3.2.3 CG-10 design life

Time the CG-10 device is designed to provide operation, within its design specification, while in normal service and use.

3.2.4 CG-10 service life

Specific term to be applied to those devices (CG-10) that have been shown by special analysis or testing to demonstrate a fixed service life within its service (see 7.8.1.8 and 7.8.1.9).

3.2.5 Combination rupture disk/fusible plug device

Rupture disk in combination with a low temperature melting material intended to prevent bursting of the disk at its predetermined burst pressure unless the temperature is high enough to first cause yielding or melting of the fusible material.

3.2.6 Composite overwrapped pressure vessel (COPV)

Cylinder or tube structure full-wrapped or hoop-wrapped reinforced by continuous filaments held in a matrix with metallic or polymer liners.

3.2.7 Compressed gas

Material that is entirely gaseous at 20 °C (68 °F) at standard pressure of 101.3 kPa and which when packaged under pressure for transportation is entirely gaseous at –50 °C with a critical temperature less than or equal to –50 °C or partially liquid at temperatures above –50 °C.

NOTE—Also referred to as nonliquefied gas.

3.2.8 Cryogenic liquid

Liquefied gas having a boiling point lower than -130°F at 14.7 psia (-90°C at 101 kPa, abs).

3.2.9 Cylinders

Pressure vessels as described in 49 CFR 171.8 and applicable TC regulations (including DOT, TC, and UN pressure receptacles) [1, 4].

NOTE—Cylinder (when used) includes UN pressure receptacles or group of UN pressure receptacles that are an element of a MEGC that can be isolated.

3.2.10 Discharge channel

Passage or passages beyond the operating parts of the PRD through which fluid must pass to reach the atmosphere.

3.2.11 Flow capacity

For a PRD, the capacity in $\text{ft}^3/\text{minute}$ (m^3/minute) of free air discharged at the required flow rating pressure.

3.2.12 Flow rating pressure

Inlet static pressure at which the flow capacity of a PRD is measured for flow capacity rating purposes.

3.2.13 Free air

Air measured at a pressure of 14.696 psia at 60°F (101.325 kPa, abs at 15.6°C).²

3.2.14 Fusible plug device

Nonreclosing PRD designed to function by yielding or melting of a plug of fusible material within the specified temperature range (see Section 4).

3.2.15 Fusible trigger device

Nonreclosing PRD designed to function by activation of a trigger incorporating a fusible material that yields, melts, or is otherwise activated by heat.

NOTE—The trigger activates a mechanism that permits the release of gas.

3.2.16 Hazard zone A

Material with a toxicity LC_{50} less than or equal to 200 ppm.

3.2.17 Hazard zone B

Material with a toxicity LC_{50} greater than 200 ppm and less than or equal to 1000 ppm.

3.2.18 Hazard zone C

Material with a toxicity LC_{50} greater than 1000 ppm and less than or equal to 3000 ppm.

3.2.19 Hazard zone D

Material with a toxicity LC_{50} greater than 3000 ppm and less than or equal to 5000 ppm.

3.2.20 Lethal concentration fifty (LC_{50})

Concentration of a substance in air, exposure to which for a specified length of time is expected to cause the death of 50% of the entire defined experimental animal population.

3.2.21 Liquefied gas

Gas when packaged under pressure for transportation that is partially liquid at temperatures greater than -58°F (-50°C). A liquefied compressed gas is further categorized as follows:

- High pressure liquefied gas with a critical temperature between -58°F and 149°F (-50°C and 65°C); and
- Low pressure liquefied gas with a critical temperature greater than 149°F (65°C).

NOTE—Also referred to as liquefied compressed gas.

² kPa shall indicate gauge pressure unless otherwise noted as (kPa, abs) for absolute pressure or (kPa, differential) for differential pressure. All kPa values are rounded off per CGA P-11, *Guideline for Metric Practice in the Compressed Gas Industry* [9].

3.2.22 Metal hydride

Compound consisting of a metal alloy and hydrogen.

NOTE—As it pertains to this standard, these compounds are used in a metal hydride system where the hydrogen absorbs and desorbs from the metal alloy.

3.2.23 Metal hydride system

Group of components assembled as a package to contain metal-hydrogen compound(s) for which there exists an equilibrium condition where the metal alloy(s), hydrogen gas, and the metal-hydrogen compound(s) co-exist.

NOTE—Changes in pressure, temperature, and/or electrical potential shifts the equilibrium favoring the formation or decomposition of the metal-hydrogen compound(s) with respect to the metal alloy(s) and hydrogen gas.

3.2.24 Multiple-element gas container (MEGC)

Multi-modal assembly of UN cylinders, UN tubes, or UN bundles of cylinders interconnected by a manifold and assembled within a framework.

NOTE—Cylinder (when used) includes UN pressure receptacles or group of UN pressure receptacles that are an element of a MEGC that can be isolated.

3.2.25 Nonliquefied gas

See 3.2.7.

3.2.26 Pressure control valve

Device that vents only to maintain the operating pressure in the container under normal working conditions.

3.2.27 Pressure opening

Orifice in a PRD through which pressure is relieved.

NOTE—In a rupture disk device, this is the orifice against which the disk functions.

3.2.28 Pressure relief device (PRD)

Pressure 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 49 CFR 173.301(f)(1) or clause 4.3.2 of CSA B340 as adopted by 5.10(1) of the TC regulations [1, 2, 4].

NOTE—The term pressure relief device is synonymous with safety relief device as used by DOT or TC regulations [1, 2]. See Section 6 for further explanation of these devices.

3.2.29 Pressure relief valve

Type of PRD designed to relieve excessive pressure and to reclose and reseal to prevent further flow of gas or fluid from the container after resealing pressure is achieved.

3.2.30 Product containment device

Fail-safe device that actuates (closes) and stops the flow of lading from a tube if, in the event of an accident and/or rollover, the valve or combined valve/PRD assembly is sheared from the tube.

3.2.31 Projecting-type relief device

PRD in which the body of the device is extended to provide for exhaust ports that divert the exhaust fluid in a plane parallel to the longitudinal axis of the cylinder.

3.2.32 Rated burst pressure

Maximum pressure for which a rupture disk is designed to rupture at one specific temperature within the range of 60 °F to 160 °F (15.6 °C to 71.1 °C) when in contact with the pressure opening for which it was designed when tested as required in 7.3.

3.2.33 Reseating pressure

Value of decreasing pressure at which leakage ceases to appear through a water seal less than or equal to 4 in (102 mm) water column or other equivalent leakage detection method on the outlet of the pressure relief valve or pressure control valve after the device is subjected to the flow rating pressure.

NOTE—Also known as resealing pressure.

3.2.34 Room temperature

Any temperature within the range of 60 °F to 80 °F (15.6 °C to 26.7 °C).

3.2.35 Rupture disk

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

NOTE—Such disks, usually metal, are generally flat, preformed, reinforced, or grooved.

3.2.36 Rupture disk device

Nonreclosing PRD actuated by inlet static pressure.

3.2.37 Set pressure

Pressure at which a pressure relief valve is set to start-to-discharge (see 5.3.2).

3.2.38 Start-to-discharge pressure

Pressure at which the first bubble appears through a water seal of less than or equal to 4 in (102 mm) water column or other equivalent leakage detection method from the outlet of the pressure relief valve or pressure control valve (see 7.6).

3.2.39 Test pressure of the cylinder

Minimum pressure at which a cylinder shall be tested as prescribed in the specifications for compressed gas cylinders by DOT, TC, or UN.

3.2.40 Trailer tubes

DOT/TC/UN cylinders (over 12 ft [3.7 m] long) horizontally mounted to a chassis for over-the-road transportation.

3.2.40.1 Front end of a tube trailer

End used for attaching the tractor that would move the trailer.

3.2.40.2 Tubes

Cylinders over 12 ft (3.7 m) long.

3.2.40.3 Tubes, jumbo

Tubes with a diameter 18 in (45.7 cm) or greater.

3.2.40.4 Tubes, small

Tubes with a diameter less than 18 in (45.7 cm).

3.2.41 Tube module

Assembly, comprised of a tube bundle mounted within a structural frame that is designed to be mounted on a motor vehicle for highway transportation and is not necessarily designed for intermodal transportation, which would include ship and rail.

3.2.42 UN cylinder

Transportable UN pressure receptacle with a water capacity less than or equal to 150 L.

3.2.43 UN pressure receptacle

UN cylinder, UN tube, or an individual cylinder within a bundle of UN cylinders.

3.2.44 UN tube

Transportable UN pressure receptacle of seamless construction with a water capacity greater than 150 L but less than or equal to 3000 L.

3.2.45 Yield temperature

For a fusible plug, temperature at which the fusible material becomes sufficiently soft to extrude from its holder to permit the discharge of fluid when tested in accordance with 7.2.

4 Types of pressure relief devices

Types of PRDs are designated as follows.

4.1 Type CG-1

A Type CG-1 PRD is a rupture disk device (see 3.2.36) that functions by inlet static pressure actuating the rupture disk by bursting in tension or shear at a predetermined pressure to permit the discharge of fluid.

4.1.1 Limitations

Since this is a pressure operated device designed to release the entire contents of the container, there is no way to prevent the complete release of the contents, either as a result of normal functioning or premature rupture of the device.

4.2 Type CG-2

A Type CG-2 PRD is a fusible plug device using a fusible alloy with a yield temperature no greater than 170 °F (76.7 °C) or less than 157 °F (69.4 °C). Its nominal yield temperature is 165 °F (73.9 °C).

4.2.1 Limitations

Since this is a thermally operated device, it does not protect against overpressure from improper charging practices. This device releases the entire lading of the container when it functions and is limited to use on cylinders of 500 psi (34 bar) service pressure or less. This device may be used on higher service pressure cylinders provided that the developed pressure does not exceed 500 psi at 68 °F (34 bar at 20 °C) and the device type is mandated by this standard or TC regulations.

4.3 Type CG-3

A Type CG-3 PRD is a fusible plug device using a fusible alloy with a yield temperature no greater than 224 °F (106.7 °C) or less than 208 °F (97.8 °C). Its nominal yield temperature is 212 °F (100 °C).

4.3.1 Limitations

Same as for Type CG-2 (see 4.2.1).

4.4 Type CG-4

A Type CG-4 PRD is a combination rupture disk/fusible plug device using a fusible alloy with a yield temperature no greater than 170 °F (76.7 °C) or less than 157 °F (69.4 °C). Its nominal yield temperature is 165 °F (73.9 °C).

4.4.1 Limitations

Since this device is a combination device, it requires both excessive pressure and temperature to cause it to operate. A Type CG-4 PRD cannot function due to excessive pressure unless the fuse metal is melted out first. Such a combination device cannot prevent an improperly filled (overfilled) cylinder from rupturing due to hydrostatic pressure at room temperature or any temperature less than the melting temperature of the fusible metal, as will devices that contain only a rupture disk (CG-1). The complete release of the contents when this device functions cannot be prevented.

4.5 Type CG-5

A Type CG-5 PRD is a combination rupture disk/fusible plug device using a fusible alloy with a yield temperature no greater than 224 °F (106.7 °C) or less than 208 °F (97.8 °C). Its nominal yield temperature is 212 °F (100 °C).

4.5.1 Limitations

Same as for CG-4 (see 4.4.1).

4.6 Type CG-7

A Type CG-7 PRD is a pressure relief valve (see 3.2.29).

For more information on CG-7 PRDs used in propylene service, see Appendix A.

4.6.1 Limitations

This device is intended to limit (determined by the set pressure of this device) the maximum pressure in a container. This device does not protect against rupture of the container when the application of heat weakens the container to the point where its rupture pressure is less than the operating pressure of the device. It is limited to use on cylinders with service pressures no greater than 500 psi (34 bar).

For liquefied gases, pressure relief valve settings authorized for low pressure cylinders for a particular gas shall be used on high pressure (greater than 500 psi [34 bar] service pressure) cylinders for the same gas.

When in liquefied gas service, subsequent start-to-discharge and resealing/reseating pressure values can differ from the initial start-to-discharge and resealing/reseating pressure values set by the manufacturer.

4.7 Type CG-8

A Type CG-8 PRD is a rupture disk device followed by and in series with a pressure relief valve. The piping connecting the rupture disk and pressure relief valve shall be equipped with a sensing device to indicate pressure. This system shall be designed and constructed so the relieving capacity prescribed in 6.5 is achieved and the operation of the relief valve is not impeded.

4.7.1 Limitations

This device is a pressure actuated device. It is intended to maximize containment of the lading following release of temporary overpressure by resealing or reseating of the relief valve. Before release, it is less likely to exhibit leakage due to the hermetic seal of the rupture disk device. It is not intended for applications in which rapid opening is required due solely to extreme rise in surrounding temperature. It is not designed to protect the cylinder from rupture during exposure to a fire.

4.8 Type CG-9

A Type CG-9 PRD is a fusible plug for use at cylinder service pressures greater than 500 psi (34 bar) using a fusible alloy with a yield temperature no greater than 224 °F (106.7 °C) or less than 208 °F (97.8 °C). Its nominal yield temperature is 217 °F (102.7 °C).

4.8.1 Limitations

Since this is a thermally activated device, it does not protect against overpressure from improper charging practices. This device releases the entire lading of the container when it functions and is limited to use on cylinders with service pressures no greater than 6 000 psi (414 bar).

4.9 Type CG-10

A Type CG-10 PRD is a fusible trigger device with an activation time of less than 90 seconds at a fill pressure within the rated pressure range marked on the device, but no greater than 13 100 psi (903 bar). A CG-10 device shall be a fixed service life device with a design life of no less than 20 years.

4.9.1 Limitations

Since this is a thermally activated device, it does not protect against overpressure from improper charging practices. This device releases the entire lading of the container when it functions. It is limited to use on cylinders

whose service pressure is within the rated pressure range marked on the device, but no greater than 13 100 psi (903 bar).

4.10 Type CG-11

A Type CG-11 PRD is a pressure relief valve capable of actuating and reseating/resealing multiple times.

4.10.1 Limitations

This device is intended to limit (determined by the set pressure of this device) the maximum pressure in a container. A type CG-11 PRD does not protect against rupture of the container when the application of heat weakens the container to the point where its rupture pressure is less than the operating pressure of the device. The design life (a theoretical number expressed in years that the device is expected to perform its intended function) of the device shall be a minimum of 5 years. The device shall be removed from service upon the expiration of the design life, but no more than 10 years from the date of manufacture.

4.11 Type CG-12

A Type CG-12 PRD is a single PRD combining the general characteristics of a fusible trigger device and a pressure relief valve. The device can be either activated by temperature or actuated by pressure.

4.11.1 Limitations

The operation of the fusible trigger releases the entire lading of the container. It is limited to use on cylinders with service pressures that are within the rated pressure range marked on the device, but no greater than 13 100 psi (903 bar).

5 Application requirements for pressure relief devices

5.1 General

5.1.1 Applicable gas applications

Each cylinder charged with gas, unless excepted in 5.1.1.1, shall be equipped with one or more PRDs complying with the application assignments of Table 2 and the other requirements of this standard. Relief devices shall be verified for appropriateness for the cylinder and application at the time of installation. Relief devices shall be suitably checked for leaks before shipment. Cylinders that are found to be equipped with leaking or faulty relief devices shall not be shipped.

5.1.1.1 Hazard Zone A gases or liquids

PRDs for gases or liquids meeting the DOT definition of Hazard Zone A and other gases or liquids as designated by DOT or TC are prohibited.

5.1.2 Design, material, and location

The design, material, and location of PRDs shall be suitable for the intended service. Consideration shall be given in the design and application of PRDs to the effect of the resultant thrust when the device functions.

5.1.3 Devices at both ends of a cylinder or tube

When the devices are used at both ends of a cylinder or tube, the flow capacity of each device may be combined to meet the minimum flow capacity requirement. In no case shall the flow capacity at one end of the tube be less than 50%.

5.1.4 Device at one end of a cylinder or tube

When cylinders are required to be equipped with PRDs at one end only, the flow capacity of individual PRDs may be combined to meet the minimum flow capacity requirement. This provision is limited to CG-1 and CG-7 PRDs.

5.1.5 CG-9 in parallel with a CG-1 or CG-7 device

A CG-9 device, where authorized in Table 2, may be used in parallel with either a CG-1 device or CG-7 device. Where either of these combinations is used, the minimum required flow capacity shall be satisfied by the CG-1 or CG-7 device, whichever is the case.

5.1.6 CG-11 and CG-12 devices

When cylinders are required to be equipped with a CG-11 or CG-12 device, the minimum flow capacity requirement may be satisfied by using multiple CG-11 or multiple CG-12 devices in parallel.

5.1.7 Metal hydride systems with a CG-10 device

For metal hydride systems with a CG-10 device, a CG-11 device is also required whenever the thermodynamics of the metal hydride are such that the pressure in the cylinder exceeds the test pressure of the cylinder at a temperature less than the activation temperature of the CG-10 device. A CG-12 device may be used in place of the CG-10/CG-11 combination.

5.2 CG-1 rupture disk devices

When a rupture disk device is used as a PRD on a compressed gas cylinder, the rated burst pressure of the disk when tested at the specified design temperature within the range of 60 °F to 160 °F (15.6 °C to 71.1 °C) in accordance with 7.3 shall not exceed the minimum required test pressure of the cylinder with which the disk is used except as follows.

5.2.1 DOT-3E or TC-3EM cylinders

For DOT-3E or TC-3EM cylinders, the rated burst pressure of the disk shall not be greater than 4500 psi (310 bar).

5.2.2 DOT-39 and TC-39M cylinders

For DOT-39 and TC-39M cylinders, the burst pressure of the disk shall not be greater than 80% of the minimum required cylinder burst pressure and shall not be less than 105% of the cylinder test pressure.

5.2.3 Exceptions

Except as provided in 5.2.1 and 5.2.2, for rupture disks designed to have a rated burst pressure at a specified design temperature other than 70 °F (21.1 °C) and within the range of greater than 60 °F (15.6 °C) but not greater than 160 °F (71.1 °C), the rated burst pressure at 70 °F (21.1 °C) shall not be greater than 110% of the minimum required test pressure of the cylinder with which the disk is used.

Rupture disk device settings authorized for low pressure cylinders for a particular gas may be used on higher pressure cylinders for the same gas provided that the product fill density and pressurization level are the same as specified for the low pressure cylinder.

5.3 CG-7 pressure relief valves

5.3.1 Flow rating pressure

The flow rating pressure for pressure relief valves shall be the minimum test pressure of the intended low pressure cylinder (maximum 500 psi [34 bar] service pressure). For DOT-39 and TC-39M cylinders, the flow rating pressure for pressure relief valves shall be 80% of the minimum cylinder burst pressure.

A pressure relief valve can incorporate a fusible element to relieve the total contents at a predetermined temperature. Where both a pressure relief valve and a fusible element are allowed, the minimum required flow capacity shall be satisfied by the pressure relief valve.

5.3.2 Set pressure

Pressure relief valves shall have a start-to-discharge pressure no less than 75% or greater than 100% of the minimum test pressure of the cylinder except when such cylinder is used for propylene. The start-to-discharge pressure for propylene service shall not be less than 435 psi (30 bar) or 75% of the minimum test pressure of the cylinder, whichever is greater but no greater than 100% of the minimum test pressure of the cylinder.

For liquefied gases, pressure relief valve settings authorized for low pressure cylinders for a particular gas shall be used on high pressure (over 500 psi [34 bar] service pressure) cylinders for the same gas.

The blowdown (reseating) pressure for pressure relief valves shall be determined after the start-to-discharge pressure is established. The blowdown pressure shall not be less than the pressure in a normally charged cylinder at 130 °F (54.4 °C).

Pressure relief valves for DOT-39 and TC-39M cylinders shall have a start-to-discharge pressure not less than 105% of the cylinder test pressure or greater than 80% of the minimum required cylinder burst pressure. The reseating pressure, after the start-to-discharge pressure is determined, shall not be less than 80% of the cylinder test pressure.

5.4 CG-2, CG-3, and CG-9 fusible plug devices and CG-10 fusible trigger devices

5.4.1 CG-2 and CG-3 devices

CG-2 and CG-3 devices may be used on cylinders whose marked service pressures do not exceed 500 psi (34 bar). These devices may be used on higher service pressure cylinders provided that the product pressure is no greater than 500 psi at 68 °F (34 bar at 20 °C) and the device type is mandated by this standard or TC regulations.

5.4.2 CG-9 device

CG-9 devices may be used on cylinders whose marked service pressures do not exceed 6000 psi (414 bar).

5.4.3 CG-10 device

No CG-10 device is permitted to eject internal components outside the body of the device.

CG-10 devices shall only be installed into service where normal exposure temperatures range from -40 °F to 180 °F (-40 °C to 82 °C).

CG-10 devices are permitted to be used on cylinders whose marked service pressures do not exceed 13 100 psi (900 bar).

5.5 CG-8 rupture disk/pressure relief valves

A CG-8 device may be used in parallel with one or more rupture disk/fusible plug devices as auxiliary overpressure protection. The CG-8 device shall be sized in accordance with 6.5. The set pressure of this device is the greater of:

- rated burst pressure of the disk at 60 °F (15.6 °C); or
- set pressure of the relief valve (and shall be no less than 0.75 times the cylinder test pressure).

However, the set pressure shall not exceed the cylinder test pressure. The CG-8 system shall discharge within the control cabinet of the trailer or to a location that will not impinge on personnel.

The rupture disk portion of a rupture disk/pressure relief valve (CG-8) shall have a rated burst pressure between 0.75 and 1 times the cylinder test pressure at 60 °F (15.6 °C).

5.6 Piping of pressure relief devices

When fittings and piping are used on either the approach channel (upstream) or discharge channel (downstream) side or both sides of a PRD or PRDs, the fittings and piping shall be designed so the flow capacity of the PRD shall not be reduced below the capacity required for the cylinder on which the PRD assembly is installed or to the extent that the operation of the device could be impaired. Fittings, piping, and the method of attachment shall be designed to withstand normal handling and the pressures developed when the device or devices function. It is important to remember that PRD discharge piping contains pressure and written procedures shall be followed to ensure proper assembly and function. When elbows are used for the purpose to attach a vent line from the discharge channel of the PRD, they shall be installed, inspected, and maintained during service in accordance with the manufacturer's specifications.

A shutoff valve shall not be installed between the PRDs and the cylinder or in the discharge channel.

Discharge channels are manufactured of multiple parts and are not considered a separate component in themselves. Discharge channels may visually appear to be simple, can be often overlooked, and may not be actively used in normal operation; However, they can be one of the leading causes of failures, including unintended activations and possible delayed activation.

The design of PRD discharge piping shall, at a minimum, consider the following:

- Pipe and valve weight;
- Wind forces on vent stacks (where applicable);
- Direction of intended venting to ensure safety of personnel, property, and the environment;
- Reaction forces resulting from the flow through the PRD and discharge channels. For an equation that can be used to calculate thrust forces, see CGA G-5.5, *Standard for Hydrogen Vent Systems* [10];
- Prevention and/or removal of accumulated water, moisture, and debris (for example, sealed caps, spring loaded ball valves, drip legs, etc.). Water trapped in the discharge channel or the inlet of the PRD can freeze and damage components, can cause premature activation, and can even prevent activation;
- Loads, deformations, or impacts experienced during transportation and handling that can be different in magnitude and direction from loads experienced when the system is stationary;
- Backpressure that can develop during PRD discharge, particularly when multiple PRDs discharge into a common header;
- Range of service temperatures;
- Potential thermal expansion of piping; and
- Minimum rated burst pressure of the discharge channels that shall be equal or greater than the design pressure of the pressure receptacle.

Compression fittings on PRD piping should be double ferrule. All compression fittings shall be inspected for proper ferrule engagement per the manufacturer's instructions.

5.7 Relief devices for tubes mounted in tube trailers or modules

All trailers or modules with small or jumbo tubes carrying gases with an FTSC code fire potential of 2, 3, or 5 shall be equipped with vent lines pointing upwards and attached to relief devices on the tubes when these tubes are equipped with relief devices.

All trailer tubes (jumbo and small) that have relief devices shall have those devices either be "internal PRDs" or be protected from damage by an external structure or shield provided the structure or shield:

- is capable of withstanding a 2g impact load (twice the gross trailer weight) without any leakage from the relief device;