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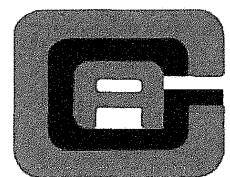
THE EXECUTIVE DIRECTOR
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WASHINGTON, D.C.

OBSOLETE

**CGA S-1.2—1980
(OBSOLETE)**

**PRESSURE RELIEF
DEVICE STANDARDS
PART 2—CARGO AND
PORTABLE TANKS FOR
COMPRESSED GASES**

FIFTH EDITION



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| Contents | Page |
|---|------|
| 1 Foreword | 1 |
| 2 Definitions..... | 1 |
| 3 Types of pressure relief devices..... | 3 |
| 4 Application requirements for pressure relief devices..... | 4 |
| 5 Design and construction requirements for pressure relief devices..... | 8 |
| 6 Tests of pressure relief devices..... | 11 |
| 7 Identification | 12 |
| 8 Maintenance requirements for pressure relief devices..... | 13 |
| 9 References | 13 |

Table

| | |
|---|----|
| Table 1—Values of G_i and G_u for minimum dot design pressure containers and commonly used flow rating pressures | 15 |
|---|----|

Figures

| | |
|---|----|
| Figure 1—Graph of A vs. $A^{0.82}$ | 17 |
| Figure 2—Constant C for gas or vapor related to ratio of specific heats ($k = C_p/C_v$) AT 60 °F and 14.7 psia. | 18 |

1 Foreword

This Part of the Pressure Relief Device Standards represents the minimum requirements recommended by the Compressed Gas Association, Inc. for pressure relief devices for use on cargo tanks and portable tanks for compressed gases having water capacity exceeding 1000 pounds and which comply with the specifications and charging and maintenance regulations of the Department of Transportation (DOT) or the corresponding portable tank specifications and regulations of the Canadian Transport Commissioners (CTC).

It is recognized that there are cargo and portable tanks that conform with the specification requirements of the DOT and portable tanks that conform with the specification requirements of the CTC which are used in services that are beyond the jurisdiction of either of these authorities. In such cases it is recommended that state, provincial, local or other authorities having jurisdiction over these containers be guided by Part 2 of these Standards in determining adequate pressure relief device requirements, provided that the cargo and portable tanks are charged with gas and maintained in accordance with the DOT or CTC Regulations that apply.

It is further recognized that there may be cargo and portable tanks which are used in services beyond the jurisdiction of the DOT or the CTC and which do not conform to the specification requirements of either authority. It is recommended that the authorities having jurisdiction over such cargo and portable tanks be guided by Part 2 of these Standards in determining pressure relief device requirements, provided that such cargo and portable tanks are considered by the authority as having a construction at least equal to the equivalent DOT or CTC specification requirements and further provided that the cargo and portable tanks shall be charged with gas and maintained in accordance with the DOT or CTC requirements that apply.

It is recommended that cargo and portable tanks fabricated after December 31, 1980 utilize pressure relief devices which meet the requirements of this edition of Pamphlet S-1 Part 2 of the CGA Pressure Relief Device Standards.

2 Definitions

For the purpose of this Standard the following terms are defined:

2.1

The term "Cargo Tank" means any container designed to be permanently attached to any motor vehicle or other highway vehicle and in which is to be transported any compressed gas. The term "cargo tank" shall not be construed to include any tank used solely for the purpose of supplying fuel for the propulsion of the vehicle or containers fabricated under specifications for cylinders.

2.2

The term "Portable Tank" means any container designed primarily to be temporarily attached to a motor vehicle, other vehicle, railroad car other than tank car, or marine vessel, and equipped with skids, mountings or accessories to facilitate handling of the container by mechanical means, in which is to be transported any compressed gas. The term "portable tank" shall not be construed to include any cargo tank, any tank car tank, or any tank of the DOT 106A and DOT 110A-W type.

2.3

A "Pressure Relief Device" is a device designed to open at a specified value of pressure. It may be a safety relief valve, a nonreclosing pressure relief device, or a nonreclosing pressure relief device in combination with a safety relief valve.

2.4

A "Safety Relief Valve" is a pressure relief device characterized by rapid opening pop action or by opening generally proportional to the increase in pressure over the opening pressure.

2.5

The "Set Pressure" of a safety relief valve is the pressure, marked on the valve and at which it is set to start-to-discharge.

2.6

The "Start-to-Discharge Pressure" of a safety relief valve is the pressure, measured at the valve inlet, at which there is a measurable lift, or at which discharge becomes continuous as determined by seeing, feeling or hearing.

2.7

The "Resealing Pressure" is the value of decreasing inlet static pressure at which no further leakage is detected after closing. The method of detection may be a specified water seal on the outlet or other means appropriate for the application.

2.8

The "Flow Capacity" is the relieving capacity of a pressure relief device determined at the flow rating pressure, expressed in cubic feet per minute of free air discharge.

2.9

The "Flow Rating Pressure" is the inlet static pressure at which the relieving capacity of a pressure relief device is determined for rating purposes.

2.10

"Free Air" or "Free Gas" is air or gas measured at a pressure of 14.7 pounds per square inch absolute and a temperature of 60 °F.

2.11

A "Non-Reclosing Pressure Relief Device" is a pressure relief device designed to remain open after operation. A manual resetting means may be provided.

2.11.1

A "Rupture Disk Device" is a nonreclosing pressure relief device actuated by inlet static pressure and designed to function by the bursting of a disk.

2.11.2

A "Breaking Pin Device" is a nonreclosing pressure relief device actuated by inlet static pressure and designed to function by the breakage of a load carrying section of a pin which supports a pressure containing member. It shall only be used in combination between a safety relief valve and the container.

2.11.3

A "Fusible Plug Device" is a nonreclosing device designed to function by the yielding or melting of a plug.

2.12

A "Combination Pressure Relief Device" is one of the following:

- (a) A breaking pin device in combination with a safety relief valve.
- (b) A rupture disk device in combination with a safety relief valve.

2.13

The "Code" as used in these Standards is defined as (1) Paragraph U-68, U-69, U-200 or U-201 of Section VIII of the Boiler and Pressure Vessel Code of the American Society of Mechanical Engineers, 1949 Edition; or (2) Section VIII Division 1 of the Boiler and Pressure Vessel Code of the American Society of Mechanical Engineers, 1950 edition through the current edition, including addenda; or (3) The Code for Unfired Pressure Vessels for Petroleum Liquids and Gases of the American Petroleum Institute and the American Society of Mechanical Engineers (API-ASME) *, 1951 Edition.

2.14

The term "DOT Design Pressure" as used in this Standard is identical to the term "maximum allowable working pressure" as used in the "Code" and is the maximum gage pressure at the top of the tank in its operating, position during normal operation.

Exception: For containers constructed in accordance with Paragraph U-68 or U-69 of Section VIII of the ASME Boiler and Pressure Vessel Code, 1949 Edition, the maximum allowable working pressure for the purpose of these standards is considered to be 125% of the design pressure as provided in 173.315 of DOT or CTC Regulations.

2.15

"DOT Regulations" as used in these Standards refers to Code of Federal Regulations, Title 49, Parts 100 to 199, Subchapters A, B and C. The following list provides a comparison of terms used in the DOT Regulations and in this Standard.

DOT Regulations

**Design Pressure
Safety Relief Device
Safety Relief Valve
Frangible Disk Device
(Not Used)
Fusible Plug

CGA S-1.2

**Design Pressure
Pressure Relief Device
Safety Relief Valve
Rupture Disk Device
Rupture Disk
Fusible Plug Device

NOTE: Terminology used in this Standard for pressure relief devices is consistent with ANSI B95.1-1977 where possible.

2.16

"CTC Regulations" as used in these Standards refers to Canadian Transport Commissioners, "Regulations for the Transportation of Dangerous Commodities by Rail."

3 Types of pressure relief devices

Types of pressure relief devices covered by this Part are as follows:

3.1 Safety relief valve**3.2**

Fusible Plug Device utilizing a fusible alloy with yield temperature not over 170 °F, nor less than 157 °F (165 °F nominal). See CGA Pamphlet S-1.1.

* The API-ASME Code, as a joint publication and interpretation service, was discontinued as of December 31, 1956.

** Identical to "Maximum Allowable Working Pressure" in Section VIII Division 1 of ASME Code.

3.3

Rupture disk device

3.4

Rupture Disk Device in combination with safety relief valve.

3.5

Breaking Pin Device in combination with safety relief valve.

4 Application requirements for pressure relief devices**4.1 General****4.1.1**

Each container shall be provided with one or more pressure relief devices which, unless otherwise specified, shall be safety relief valves of the spring-loaded type.

Safety relief valves shall meet the applicable requirements for design, materials, installation, set pressure tolerance, markings and certification of capacity of the current edition of one of the following standards:

- (a) "Safety Relief Valves for Anhydrous Ammonia and LP-Gas," UL 132 (Ref. 11).
- (b) ASME Section VIII Division 1, UG-125 through UG-136 (Ref. 12).
- (c) Appendix A of AAR Specifications for Tank Cars (Ref. 14).

Requirements for set pressure, flow capacity and overpressure are specified in Section 5 of this Standard.

4.1.2

Safety relief valves shall have a marked set pressure at the DOT design pressure of the container except as follows:

4.1.2.1

If an over-designed container is used, the marked set pressure of the safety relief valve may be between the minimum required DOT design pressure for the lading and the DOT design pressure of the container used.

4.1.2.2

For sulfur dioxide containers, a minimum marked set pressure of 120 and 110 psig is permitted for the 150 and 125 psig DOT design pressure containers, respectively. (See Table 1)

4.1.2.3

For carbon dioxide (refrigerated), nitrous oxide (refrigerated), and the gases listed in 4.1.10, there shall be no minimum marked set pressure.

4.1.2.4

For butadiene, inhibited, and liquefied petroleum gas containers, a minimum marked set pressure of 90% of the minimum DOT design pressure permitted for these loadings may be used. (See Table 1)

4.1.2.5

For containers constructed in accord with Paragraph U-68 or U-69 of the Code, 1949 Edition, the set pressure marked on the safety relief valve may be 125% of the original DOT design pressure of the container.

4.1.3

The design, material and location of pressure relief devices shall have been proved to be suitable for the intended service.

4.1.4

Pressure relief devices shall have direct communication with the vapor space of the container.

4.1.5

Any portion of liquid piping or hose which at any time may be closed at each end must be provided with a means for pressure relief to operate at a safe pressure.

4.1.6

The following additional restrictions apply to pressure relief devices on containers for carbon dioxide or nitrous oxide which are shipped in refrigerated and insulated containers:

4.1.6.1

The operating pressure in the container may be regulated by the use of one or more pressure controlling devices, which devices shall not be in lieu of the safety relief valve required in paragraph 4.1.1.

4.1.6.2

All pressure relief devices shall be so installed and located that the cooling effect of the contents will not prevent the effective operation of the device.

4.1.6.3

In addition to the safety relief valve required by paragraph 4.1.1 each container for carbon dioxide or nitrous oxide may be equipped with one or more rupture disk devices of suitable design with a stamped bursting pressure not exceeding two times the DOT design pressure of the container.

4.1.7

Subject to conditions of 173.315 (a) (1) of DOT Regulations for methyl chloride and sulfur dioxide optional portable tanks of 225 psig minimum DOT design pressure, one or more fusible plugs may be used in lieu of safety valves of the spring-loaded type. If the container is over 30 inches long a pressure relief device having the total required flow capacity must be provided at each end.

4.1.8

When storage containers for liquefied petroleum gas are permitted to be shipped in accordance with 173.315(j) of DOT regulations, they must be equipped with pressure relief devices in compliance with the requirements for safety relief devices on aboveground containers as specified in the current edition of National Fire Protection Association Pamphlet No. 58 "Standard For The Storage And Handling Of Liquefied Petroleum Gases."

4.1.9

When containers are filled by pumping equipment which has a discharge capacity in excess of the capacity of the container pressure relief devices, and which is capable of producing pressures in excess of the DOT design pressure of the container, precautions should be taken to prevent the development of pressures in the container in excess of 120% of its DOT design pressure. This may be done by providing a by-pass on the pump discharge, or by any other suitable method.

4.1.10

The following requirements apply to pressure relief devices on containers for liquefied methane, ethane, ethylene, carbon monoxide (see 4.1.10.1.2.2) and hydrogen, helium (refrigerated), and pressurized liquid oxygen, nitrogen, argon and neon.

4.1.10.1

The liquid container shall be protected by pressure relief devices consisting of one or more safety relief valves, and one or more rupture disk devices except as modified by 4.1.10.1.2.1, so installed that the devices remain at ambient temperature during normal container operation.

4.1.10.1.1

The marked set pressure of the safety relief valve shall not exceed the DOT design pressure of the container. The minimum capacity of the safety relief valve shall be sized to provide adequate venting capacity at 120% of the container DOT design pressure for operational emergency contingencies, except fire, but including loss of vacuum with insulation saturated with gaseous lading or air at atmospheric pressure, whichever provides the greater thermal conductance. The minimum required capacity of the safety relief valve for the loss of vacuum condition is

$$Qa = \frac{(130 - t)}{4(1200 - t)} G_i UA$$

where the value of U at the average temperature of the insulation may be used (alternatively the value of U at 100 °F may be used). For helium and hydrogen, the value of U must be chosen on the basis that the insulation space is filled with helium and hydrogen gas respectively at one atmosphere. (See Table 1 and 5.3.3 for nomenclature.)

4.1.10.1.2

The rupture disk device must have a stamped bursting pressure not to exceed 120% of the DOT design pressure at a coincident disk temperature not to exceed 800 F. In addition the room temperature rating for the lot of disks must be determined, and must be less than 150% of the DOT design pressure (plus 15 psi if vacuum insulation is used) of the container.

4.1.10.1.2.1

An alternate safety relief valve, with a marked set pressure not to exceed 110% of DOT design pressure may be used in lieu of the rupture disk device. Installation must provide for

- (a) Prevention of moisture accumulation at the seat by drainage away from that area.
- (b) Periodic drainage of the vent piping.
- (c) Avoidance of foreign material in the vent piping.

4.1.10.1.2.2

Rupture disk devices are not permitted on containers in liquefied carbon monoxide service.

4.1.10.1.3

The combined capacity of the pressure relief devices shall be adequate to relieve the vapor generated at 20% above the DOT design pressure when the container is exposed to fire or other unexpected source of external heat. This required flow capacity shall be determined in accordance with the provisions of 5.3.2, 5.3.3, or 5.3.4 when applicable.

4.1.10.1.3.1

When the flow capacity of the safety relief valve meets the requirements of 4.1.10.1.3, the supplemental pressure relief device meeting the requirements of 4.1.10.1.2 or 4.1.10.1.2.1 shall have a marked set pressure or stamped bursting pressure not exceeding

(a) For containers other than vacuum insulated

- (1) For safety relief valve in lieu of rupture disk device, the marked set pressure shall not exceed 136% of DOT design pressure.
- (2) For rupture disk device, the stamped bursting pressure at 70 °F shall not exceed 150% of DOT design pressure.

(b) For vacuum insulated containers:

- (1) For safety relief valve in lieu of rupture disk device, the marked set pressure shall not exceed 136% of (DOT design pressure + 15 psi).
- (2) For rupture disk device, the stamped bursting pressure at 70 °F shall not exceed 150% of (DOT design pressure + 15 psi).

4.1.10.2

The outer shell of vacuum insulated containers shall be protected with means for pressure relief as specified in 6(a) (13) of CGA-341, "Insulated Tank Truck Specification" (Ref. 10).

4.2 Piping of safety relief devices**4.2.1**

When fittings and piping are used on either the upstream or downstream side or both of a pressure relief device or devices, the passages shall be so designed that the flow capacity of the pressure relief device will not be reduced below the capacity required for the container on which the pressure relief device assembly is installed.

4.2.2

Pressure relief devices shall be arranged to discharge to the open air in such a manner as to prevent any impingement of escaping gas upon the container. Pressure relief devices shall be arranged to discharge upward except this is not required for carbon dioxide, nitrous oxide and pressurized liquid argon, nitrogen and oxygen.

4.2.3

No shutoff valves shall be installed between the pressure relief devices and the container except, in cases where two or more pressure relief devices are installed in the same container, a shut-off valve may be used where the arrangement of the shut-off valve or valves is such as always to insure full required capacity flow through at least one pressure relief device.

5 Design and construction requirements for pressure relief devices

5.1

The material, design and construction of a pressure relief device shall be such that there shall be no significant change in the functioning of the device and no serious corrosion or deterioration of the materials within the period between renewals, due to service conditions. The chemical and physical properties of the materials shall be uniform and suitable for the requirements of the part manufactured therefrom. Parts and components shall be suitably cleaned for the intended service.

5.2

Safety relief valves shall meet the applicable requirements for design, materials, installation, set pressure tolerance, markings and certification of flow capacity of one of the following standards

- (a) "Safety Relief Valves For Anhydrous Ammonia and LP-Gas," UL 132 (Ref. 11).
- (b) ASME Section VIII Division 1, UG-125 through UG-136 (Ref. 12).
- (c) Appendix A of AAR Specifications For Tank Cars (Ref. 14).

5.3

Pressure relief devices shall have a total flow capacity as calculated by the applicable formulas in 5.3.2 or 5.3.3. These formulas are based on the principle of relieving the vapor in the container generated at 120% of the DOT design pressure of the container.

5.3.1

The flow capacity of safety relief devices of each design and modification thereof shall be determined as required by the applicable Standard (see 5.2 and Section 6).

5.3.2

For liquefied compressed gases in uninsulated containers and in insulated containers not meeting the requirements of 5.3.4, the minimum required flow capacity of the pressure relief device(s) shall be calculated using the formula

$$Q_a = G_u A^{0.82}$$

Where

Q_a = Flow capacity in cubic feet per minute of free air.

G_u = Gas factor for uninsulated container obtained from Table 1 for the gas involved.

* A = Total outside surface area of the container in square feet.

NOTE: Graph of A vs. $A^{0.82}$ is shown in Figure 1.

5.3.3

For liquefied compressed gases in insulated containers where all materials comprising a representative sample of the insulation system remain completely in place when subjected to 1200 F, the U value shall

* When the surface area is not stamped on the name plate or when the marking is not legible, the area can be calculated by using one of the following formulas:

(1) Cylindrical container with hemispherical heads: Area = (overall length) X (outside diameter) X (3.1416).

(2) Cylindrical container with semi-ellipsoidal heads: Area = (overall length + .3 outside diameter) X (outside diameter) X (3.1416).

(3) Spherical container: Area = (outside diameter)² X (3.1416).

be as defined below and the minimum required flow capacity of the pressure relief device (s) shall be calculated using the formula

$$Q_a = GA^{0.82}$$

Where

U = Total thermal conductance of the container insulating material Btu/ (hr.ft².F) when saturated with gaseous lading or air at atmospheric pressure, whichever is greater. Value of U is determined at 100 °F except when 5.3.4.2 and 5.3.4.3 apply.

$$U = \left(\frac{\text{Thermal conductivity of insulation}}{\text{Thickness of insulation}} \right)$$

* A = Total outside surface area of the container in square feet.

G_i = Gas factor for insulated containers obtained from Table 1 for the gas involved.

Q_a = Flow capacity in cubic feet per minute of free air.

NOTE: Graph of A vs. $A^{0.82}$ is shown in Figure 1.

5.3.4

For liquefied compressed gases in insulated containers where any of the materials of a representative sample of the insulation system deteriorates when subjected to 1200 F, one of the following procedures shall be used to determine the minimum flow capacity requirement of the pressure relief device (s)

5.3.4.1

Use the formula for uninsulated containers in 5.32.

5.3.4.2

Determine the total thermal conductance (U) for a representative sample of the insulation system with a 1200 F external test environment. This value of U shall then be used in the formula in 5.3.3 to determine the minimum required flow capacity of the pressure relief device (s). The value of U shall be determined with the insulation saturated with gaseous lading or air at atmospheric pressure, whichever provides the greater thermal conductance.

5.3.4.3

If the insulation system is equipped with a jacket that remains in place during fire conditions, the thermal conductance U shall be determined with no insulation and a 1200 °F external test environment. The value of U shall be determined with gaseous lading or air at atmospheric pressure in the space between the jacket and container, whichever provides the greater thermal conductance. This value of U shall then be used in the formula in 5.3.3 to determine the minimum required flow capacity of the pressure relief device(s).

5.3.4.4

For insulated containers for pressurized oxygen, nitrogen and argon, the minimum required flow capacity of the pressure relief devices may be calculated using the formula of 5.3.3 provided the flow capacity of

* When the surface area is not stamped on the name plate or when the marking is not legible, the area can be calculated by using one of the following formulas:

(1) Cylindrical container with hemispherical heads: Area = (overall length) X (outside diameter) X (3.1416).

(2) Cylindrical container with semi-ellipsoidal heads: Area = (overall length + .3 outside diameter) X (outside diameter) X (3.1416).

(3) Spherical container: Area = (outside diameter)² X (3.1416).

the pressure relief devices shall not be less than 0.004 cu. ft./min. of free air per pound of water capacity of the container at a flow rating pressure of 25 psig. The value of U shall be determined at 100 F with insulation saturated with gaseous nitrogen at atmospheric pressure. (Requirements for the insulation and jacket material are specified in CGA-341, Reference 10).

5.3.5

Values are given in Table 1 for G_i (for insulated containers) and G_u (for uninsulated containers) for use in formulas $Q_a = G_i A^{0.82}$ and $Q_a = G_u A^{0.82}$. These values for G_i and G_u may be used in determining the required flow capacity at the flow rating pressure shown in Table 1, or below. Alternatively the G_i and G_u values may be calculated for the applicable flow rating pressure.

5.4 Safety relief valves

5.4.1

Safety relief valves shall be of the spring-loaded type. The inlet connection shall not be less than 3/4" nominal pipe size with physical dimensions for the wall thickness not less than those of Schedule 80 pipe (extra heavy), except that safety relief valves on insulated containers for the gases listed in 4.1.10 shall have an inlet connection not less than 1/2 inch nominal pipe size.

5.4.2

The minimum design pressures of containers required by the DOT and CTC for the various compressed gases are shown in Table 1.

5.4.3

Safety relief valves shall be designed so that the possibility of tampering will be minimized. If the pressure setting or adjustment is external, safety relief valves shall be provided with suitable means for sealing the adjustment.

5.4.4

If the design of a safety relief valve is such that liquid can collect on the discharge side, the valve shall be equipped with a drain at the lowest point where liquid can collect. Any discharge from the drain shall be directed to prevent impingement on the tank.

5.4.5

Seats or disks of cast iron shall not be used.

5.5 Rupture disk devices *

5.5.1

Where permitted in Section 4, a rupture disk device may be used as the sole pressure relief device on the container, or as a supplemental device, or in a combination device. Rupture disk devices shall meet the requirements of Section VIII Division 1 of the ASME Code (Reference 12).

* NOTE: It is recommended that the user closely review rupture disk characteristics for the expected operating conditions to prevent failure of the rupture disk due to fatigue or creep. (Consult with the rupture disk manufacturer.)

5.6 Rupture disk in combination with a safety relief valve

Where permitted in Section 4, a rupture disk device may be installed between a spring-loaded safety relief valve and the container provided such combination device meets the requirements of Section VIII Division 1 of the ASME Code (including UG-127 (a) (3) (b)).

5.6.1

The space between the rupture disk and the safety relief valve shall be provided with a tell-tale, try cock, needle valve or other suitable device to monitor or prevent accumulation of pressure. The device shall be open to the atmosphere during transportation except when prohibited by DOT or CTC.

NOTE: Users are warned that a rupture disk will not burst at its rated pressure if pressure builds up in the space between the disk and the safety relief valve which will occur should leakage develop in the disk due to corrosion or other cause.

5.7 Breaking pin devices

5.7.1

Breaking pin in combination with a safety relief valve. Where permitted in Section 4, a breaking pin device may be installed between a spring-loaded safety relief valve and the container provided such combination device meets the requirements of Section VIII Division 1 of the ASME Code (including UG-127 (b)).

5.7.1.1

The space between the breaking pin and the safety relief valve shall be provided with a tell-tale, try cock, needle valve or other suitable device to monitor or prevent accumulation of pressure. The device shall be open to the atmosphere during transportation except when prohibited by DOT or CTC.

NOTE: Users are warned that a breaking pin will not break at its rated pressure if back-pressure builds up in the space between the breaking pin and the safety relief valve.

5.7.2

Breaking Pin Devices shall not be used as single devices but only in combination with a safety relief valve.

5.8 Fusible plug devices

5.8.1

Where permitted in Section 4, fusible plug devices meeting the requirements of CGA S-1.1 may be used as a primary or supplemental device on containers.

6 Tests of pressure relief devices

6.1 Pressure tests of safety relief valves

6.1.1

Each safety relief valve shall be subject to an air or gas pressure test to determine the following:

6.1.1.1

That the start-to-discharge pressure setting is within tolerance of the set pressure marked on the valve as required by the applicable standard (see 5.2).

NOTE: In setting the valve, care must be taken that evidence of start-to-discharge is due to opening of the valve and not due to a defect.

6.1.1.2

That after the start-to-discharge pressure test, the resealing pressure is not less than 90% of the start-to-discharge pressure.

6.2 Flow capacity tests of safety relief valves

6.2.1

The flow capacity of each design and modification thereof of a spring-loaded safety relief valve shall be determined at the flow rating pressure as required by the applicable standard (see 5.2).

6.2.2

Methods of flow testing shall be as required by the applicable standard (see 5.2).

6.3 Tests of safety relief devices other than spring-loaded safety relief valves

6.3.1

When fusible plug devices are used to satisfy the requirements of these Standards, the flow capacity at a pressure of 120% of the DOT design pressure of the container may be determined by calculation if the capacity at some other pressure has been determined by actual flow tests conducted in accordance with CGA S-1.1 (Reference 7). All other test requirements of CGA S-1.1 shall apply.

6.3.2

When rupture disk devices or combination devices are used to satisfy the requirements of this Standard, the flow capacity at 120% of the DOT design pressure of the container shall be determined by the procedures of Section VIII Division 1 of the ASME Code.

6.4

Rejected Material may be reworked providing the material is subject to such additional tests as are required to insure compliance with all requirements of these Standards.

7 Identification

7.1

Safety relief valves shall be marked as required by the applicable Standard (see 5.2), and shall include:

- (a) Manufacturer's name or trademark and catalog number.
- (b) The year of manufacture. (c) The set pressure in psig.
- (d) The flow capacity in cubic feet per minute of free air.

7.2

Fusible plug devices shall be marked as required by CGA S-1.1. (Reference 7).

7.3

For pressure relief devices other than spring-loaded safety relief valves and fusible plug devices, the requirements of Section VIII Division 1 of the ASME Code shall apply.

7.3.1

For rupture disk devices the 70 F bursting pressure shall be included as information on rupture disks having a marked coincident temperature other than 70 °F (see 4.1.10.1.2).

8 Maintenance requirements for pressure relief devices

8.1

Care shall be exercised to avoid damage to pressure relief devices. Care shall also be exercised to avoid plugging by paint or other dirt accumulation of pressure relief device channels or other parts which could interfere with the functioning of the device.

8.2

Repair work on safety relief valves involving machining, grinding, welding or other alterations or modifications can be performed only by the valve manufacturer or by the shipper with the manufacturer's permission except:

If a trained specialist is available, the seating surfaces of metal-to-metal seat valves may be lapped. The flat gasket face on a valve body mounting surface, or the gasket tongue, may be machined to remove nicks and burrs. However the tolerances on the gasket tongue must not be exceeded.

8.3

Repair work on rupture disk holders involving machining, grinding, welding or other alterations or modifications can be performed only by the rupture disk holder manufacturer or by the shipper with the manufacturer's permission.

8.4

Only replacement parts or assemblies provided and properly identified by the manufacturer of the pressure relief device shall be used.

8.5 Routine checks when filling containers

8.5.1

Pressure relief devices periodically shall be examined externally for corrosion, damage, plugging of external pressure relief device channels, mechanical defects and leakage. Valves equipped with secondary resilient seals shall have the seals inspected periodically. If there is any doubt regarding the suitability of the pressure relief device for service the container shall not be filled until it is equipped with a suitable pressure relief device.

9 References

(1) Gas Measurement Committee Report No. 3, "Orifice Metering of Natural Gas." American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209. Reprinted with revisions, 1956.

(2) Code of Federal Regulations. Title 49, Transportation Parts 100 to 199. United States Government Printing Office, Washington, D.C. 20402.

(3) "How to Size Safety Relief Devices," F. J. Heller, Phillips Petroleum Company. 1954. (4) "Recommended Practice for the Manufacturer of Fusible Plugs," Pamphlet S-4. Compressed Gas Association, Inc., 500 Fifth Avenue. New York, New York 10036.

(5) CGA Pamphlet V-1, "American Standard - Canadian Standard Compressed Gas Cylinder Valve Outlet and Inlet Connections." Compressed Gas Association, Inc., 500 Fifth Avenue, New York, New York 10036.

(6) Canadian Transport Commissioners, "Regulations for the Transport of Dangerous Commodities by Rail." Available for nominal fee from the Supervisor of Government Publications, Department of Public Printing and Stationery, Ottawa, Canada.

- (7) "Pressure Relief Device Standards—Part 1—Cylinders for Compressed Gases," Pamphlet S-1.1, Compressed Gas Association, Inc., 500 Fifth Avenue, New York, N. Y. 10110.
- (8) "Pressure Relief Device Standards—Part 3—Compressed Gas Storage Containers," Pamphlet S-1.3. Compressed Gas Association, Inc., 500 Fifth Avenue, New York, N. Y. 10110.
- (9) Safety and Relief Valves, Performance Test Codes, PTC 25.3-1976. American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017.
- (10) Pamphlet CGA-341, "Insulated Tank Truck Specification," Compressed Gas Association, Inc., 500 Fifth Avenue, New York 10036.
- (11) UL 132 "Safety Relief Valves For Anhydrous Ammonia And LP-Gas." Underwriters Laboratories, Inc., 207 East Ohio Street, Chicago, Illinois 60611.
- (12) "ASME Boiler and Pressure Vessel Code Section VIII Division 1" American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017.
- (13) National Bureau Standards Monograph 111 "Technology of Liquid Helium." Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.
- (14) "Specifications For Tank Cars," Standard M-1002, The Association of American Railroads, 1920 L Street, N.W., Washington, D.C. 20036.

Table 1—Values of G_i and G_u for minimum dot design pressure containers and commonly used flow rating pressures (1)

| Gas | (5) Minimum recommended MAWP (psig) | Flow rating pressure (psig) | Value of G_i | Value of G_u |
|--|-------------------------------------|-----------------------------|----------------|----------------|
| Anhydrous ammonia | 265 | 318 | 2.80 | 22.1 |
| Anhydrous dimethylamine | 150 | 180 | 3.76 | 21.0 |
| Anhydrous monomethylamine | 150 | 180 | 3.55 | 29.4 |
| Anhydrous trimethylamine | 150 | 180 | 5.33 | 41.8 |
| Argon, pressurized liquid (2) | — | 100 | 10.2 | 59.0 |
| | — | 200 | 11.8 | 69.0 |
| | — | 300 | 13.8 | 82.0 |
| | — | 400 | 17.9 | 108.0 |
| Butadiene, inhibited | 100 | 120 | 4.17 | 35.8 |
| Carbon dioxide (refrigerated) (See 173.315) | 100 | 360 | 7.94 | 57.7 |
| | 100 | 390 | 6.46 | 47.4 |
| Carbon monoxide, liquefied (2) | — | 100 | 10.2 | 59.0 |
| | — | 200 | 11.8 | 69.0 |
| | — | 300 | 13.8 | 82.0 |
| Chlorine | 225 | 270 | 6.74 | 54.3 |
| Chlorodifluoroethane (R-142B) | 100 | 120 | 6.82 | 55.7 |
| Chlorodifluoromethane (R-22) | 250 | 300 | 7.92 | 64.0 |
| Dichlorodifluoromethane (R-12) | 150 | 180 | 8.94 | 72.0 |
| Dichlorodifluoromethane-difluoroethane mixture (R-500) | 250 | 300 | 8.75 | 71.9 |
| Dichlorodifluoromethane-dichlorotetrafluoroethane mixture (R-12/R-114 mixture) | 150 | 180 | 9.34 | 81.0 |
| Dichlorodifluoromethane-trichlorofluoromethane mixture (R-12/R-11 mixture) | 150 | 180 | 8.94 | 72.0 |
| Difluoroethane (R-152A) | 150 | 180 | 6.07 | 49.0 |
| Ethylene, liquefied | — | 100 | 5.42 | 36.8 |
| Helium (3) (4) | — | 200 | 52.5 | — |
| Hydrogen, liquefied (3) (4) | — | 50 | 8.6 | 45.8 |
| | — | 100 | 10.6 | 56.0 |
| | — | 140 | 14.5 (8) | 77.4 (8) |
| Liquefied petroleum gas | See 173.315 | 300 | 6.56 | 53.6 |
| Methyl chloride (6) | 150 | 180 | 4.96 | 40.4 |
| Methyl mercaptan | 100 | 120 | 6.05 | 51.2 |
| Neon, pressurized liquid (4) | — | 100 | 17.0 | 92.0 |
| | — | 200 | 20.8 | 113.4 |
| | — | 300 | 28.0 | 153.0 |
| Nitrogen, pressurized liquid | — | 100 | 10.2 | 59.0 |
| | — | 200 | 11.8 | 69.0 |
| | — | 300 | 13.8 | 82.0 |
| | — | 400 | 17.9 | 108.0 |
| Nitrous oxide (refrigerated) See 173.315 | 100 | 120 | 5.36 | 37.2 |
| | — | 420 | 6.20 | 46.0 |
| Oxygen, pressurized liquid (2) | — | 100 | 10.2 | 59.0 |
| | — | 200 | 11.8 | 69.0 |
| | — | 300 | 13.8 | 82.0 |
| | — | 400 | 17.9 | 108.8 |
| Sulfur dioxide (6) & (7) | 150 | 180 | 4.84 | 40.0 |
| Vinyl chloride | 150 | 180 | 5.61 | 46.8 |

NOTES

- (1) Flow rating pressure shall not exceed 120 % of DOT design pressure in determination of flow capacity.

When lower flow rating pressures than those shown are used, the values of G_i and G_u are on the safe side and may be used as shown or calculated as covered below. For higher flow rating pressures than shown, values of G_i and G_u must be calculated from the following formulas:

$$G_u = \frac{633,000}{LC} \sqrt{\frac{ZT}{M}} \quad \text{and} \quad G_i = \frac{73.4 \times (1200 - t)}{LC} \sqrt{\frac{ZT}{M}}$$

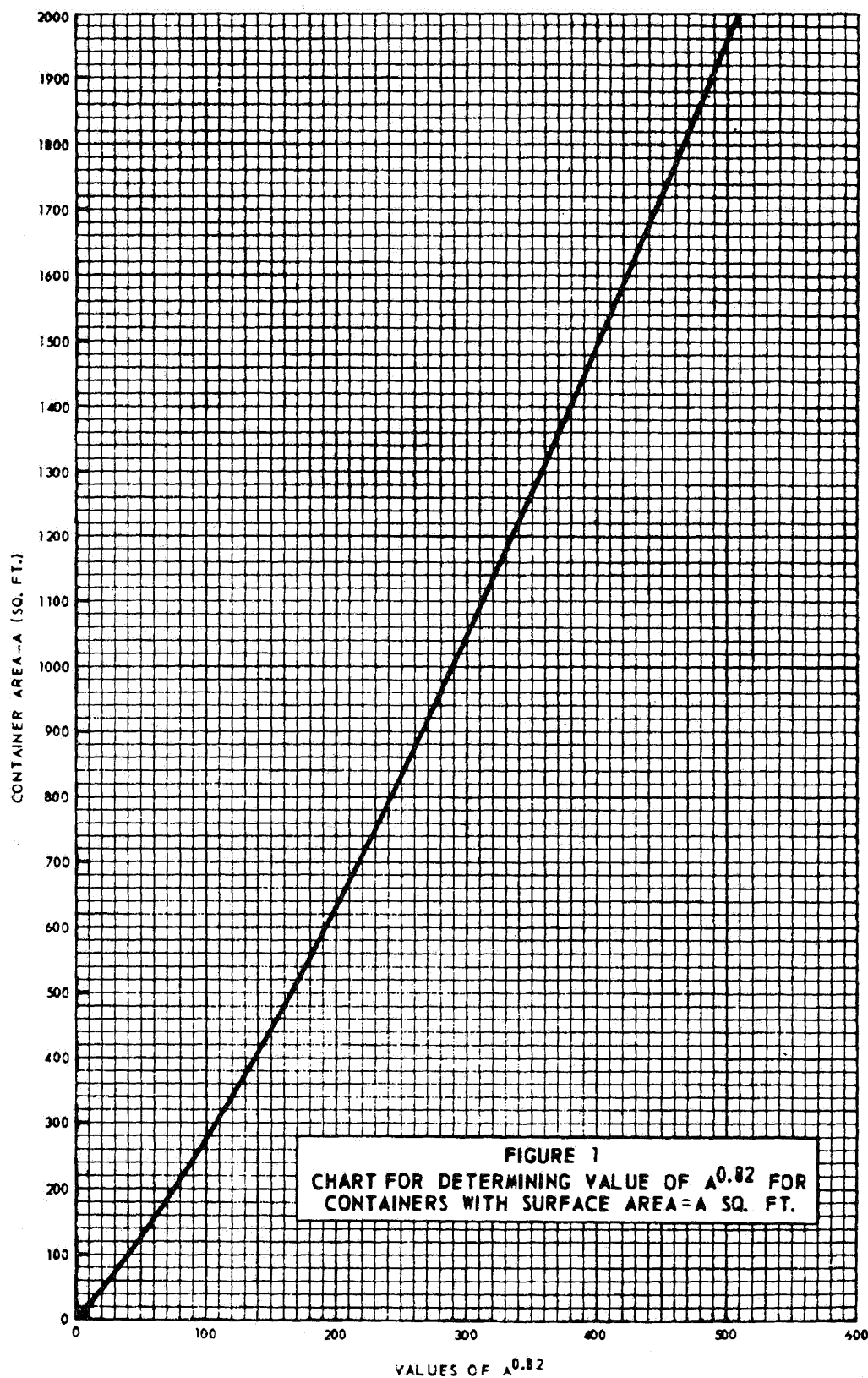
Where:

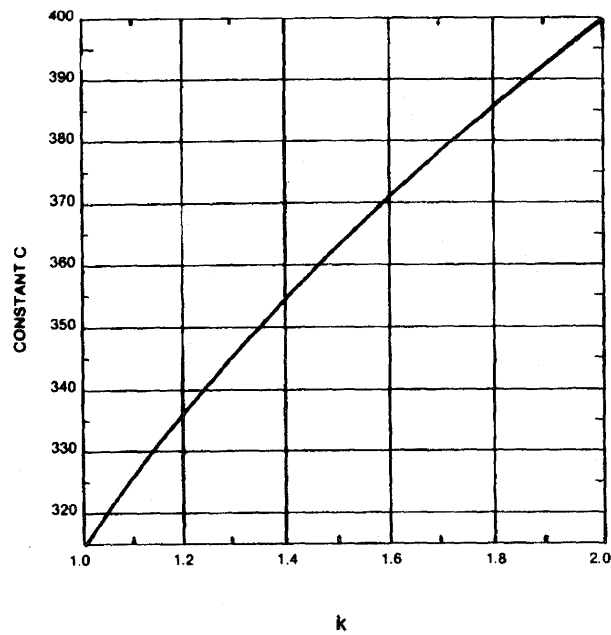
- L = Latent heat at flowing conditions in Btu per pound.
 C = Constant for gas or vapor related to ratio of specific heats ($k = C_p/C_v$) at 60 °F and 14.7 psia from Figure 2.
 Z = Compressibility factor at flowing conditions.
 T = Temperature in degrees R (Rankine) of gas at pressure at flowing conditions ($t + 460$).
 M = Molecular weight of gas.
 t = Temperature in degrees F (Fahrenheit) of gas at pressure at flowing conditions.

When compressibility factor "Z" is not known, 1.0 is a safe value of "Z" to use.

When gas constant "C" is not known, 315 is a safe value of "C" to use. For complete details concerning the basis and origin of these formulas, refer to Reference 3.

- (2) G_i and G_u values for carbon monoxide, oxygen and argon are based on nitrogen properties. For containers restricted to carbon monoxide only, oxygen only or to argon service only, G_i and G_u values may be calculated as above.
- (3) For determination of G_i for supercritical helium, see Appendix A of Chapter 6 of Reference 13. The same technique can be used for supercritical hydrogen.
- (4) Depending on specific insulation system used, it may be desirable to consider the effect of air condensation in sizing relief devices. See Chapter 6 of Reference 13.
- (5) Minimum design pressure recommended for non-insulated and non-refrigerated containers; a review of applicable DOT or CTC regulations is recommended. Marked set pressure of safety relief valve shall not exceed design pressure of container.
- (6) See 4.1.7.
- (7) For tanks over 1200 gallon water capacity, minimum DOT design pressure is 125 psig. See 4.1.2.2.
- (8) For the determination of G_i and G_u for supercritical hydrogen the same technique is used as for supercritical helium. See Appendix A of Chapter 6 of Reference 7. In the two-phase region between 140 psig and the critical pressure, when allowance is made for cold vapor that must remain in the container to maintain pressure, G_i and G_u values so obtained are less than those shown in Table 1 for 140 psig and above.





| k | CONSTANT C | k | CONSTANT C | k | CONSTANT C |
|------|------------|------|------------|------|------------|
| 1.00 | 315 | 1.26 | 343 | 1.52 | 366 |
| 1.02 | 318 | 1.28 | 345 | 1.54 | 368 |
| 1.04 | 320 | 1.30 | 347 | 1.56 | 369 |
| 1.06 | 322 | 1.32 | 349 | 1.58 | 371 |
| 1.08 | 324 | 1.34 | 351 | 1.60 | 372 |
| 1.10 | 327 | 1.36 | 352 | 1.62 | 374 |
| 1.12 | 329 | 1.38 | 354 | 1.64 | 376 |
| 1.14 | 331 | 1.40 | 356 | 1.66 | 377 |
| 1.16 | 333 | 1.42 | 358 | 1.68 | 379 |
| 1.18 | 335 | 1.44 | 359 | 1.70 | 380 |
| 1.20 | 337 | 1.46 | 361 | 2.00 | 400 |
| 1.22 | 339 | 1.48 | 363 | 2.20 | 412 |
| 1.24 | 341 | 1.50 | 364 | | |

Figure 2—Constant C for gas or vapor related to ratio of specific heats
($k = C_p/C_v$) AT 60 °F and 14.7 psia.

(Data from Figure UA-230, ASME Boiler and Pressure Vessel Code, Section VIII, Division 1).