A LOS ASISTENTES A LOS CURSOS

Las autoridades de la Facultad de Ingeniería, por conducto del Jefe de la División de Educación Continua, otorgan una constancia de asistencia a quienes cumplan con los requisitos establecidos para cada curso.

El control de asistencia se llevará a cabo a través de la persona que le entregó el material didáctico y será registrada por las autoridades de la División, con el fin de entregarle constancia a los alumnos que cumplan como mínimo el 80% de asistencia.

Recomendamos a los asistentes recojan su constancia en la fecha que se les señale al término del evento. La DECFI solo las retendrá por el periodo de un año, pasado este tiempo no se hará responsable de este documento.

Se recomienda a los alumnos participar activamente con sus ideas y experiencias , pues los cursos que ofrece la División están planeados para que los profesores expongan una tesis, pero sobre todo, para que coordinen las opiniones de todos los interesados, constituyendo verdaderos seminarios.

Es muy importante que todos los asistentes llenen y entreguen su solicitud de inscripción al inicio del curso, información que servirá para integrar un directorio de asistentes.

Con el objeto de mejorar los servicios que la División de Educación Continua ofrece, al final del curso deberán requisitar y entregar la evaluación a través de un cuestionario diseñado para emitir juicios anónimos.

Se recomienda llenar dicha evaluación conforme los profesores impartan sus clases, a efecto de llenar en la última sesión las evaluaciones y con esto sean más fehacientes sus apreciaciones.

Atentamente
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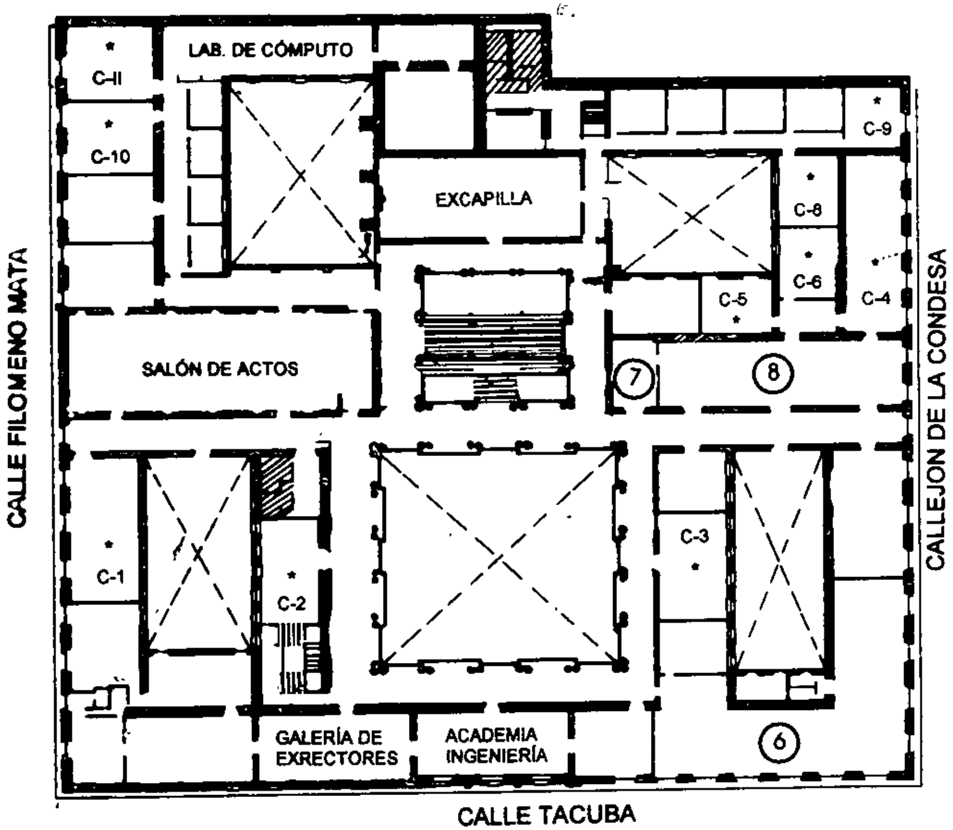

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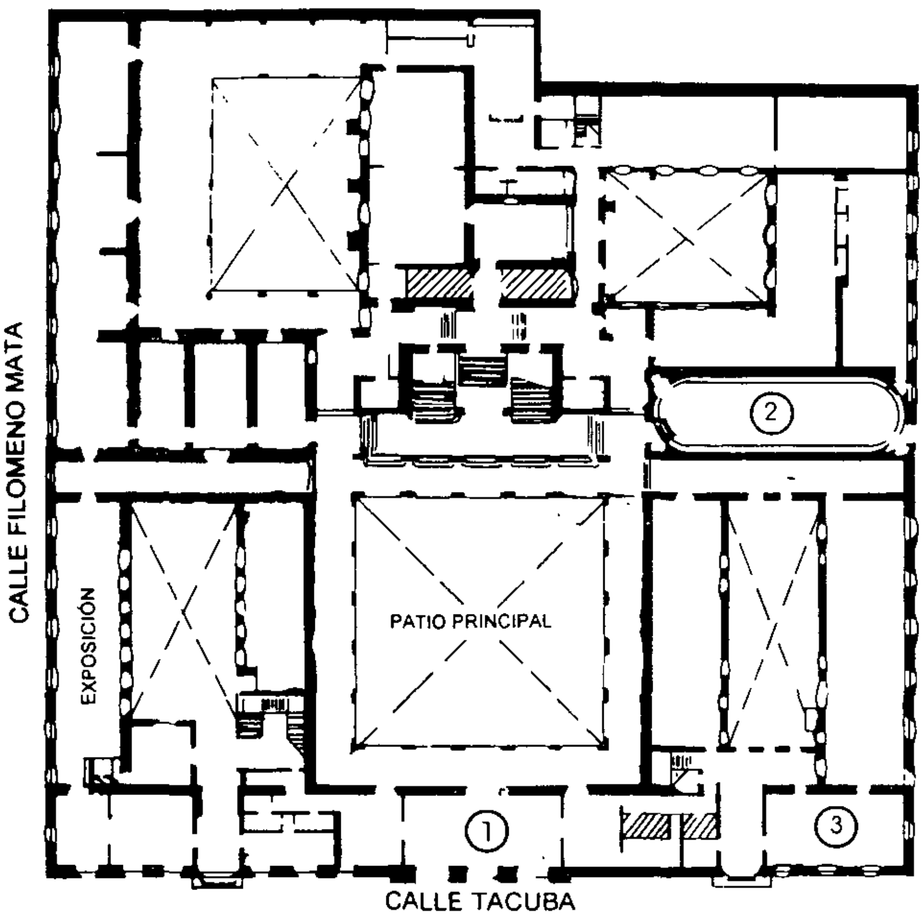

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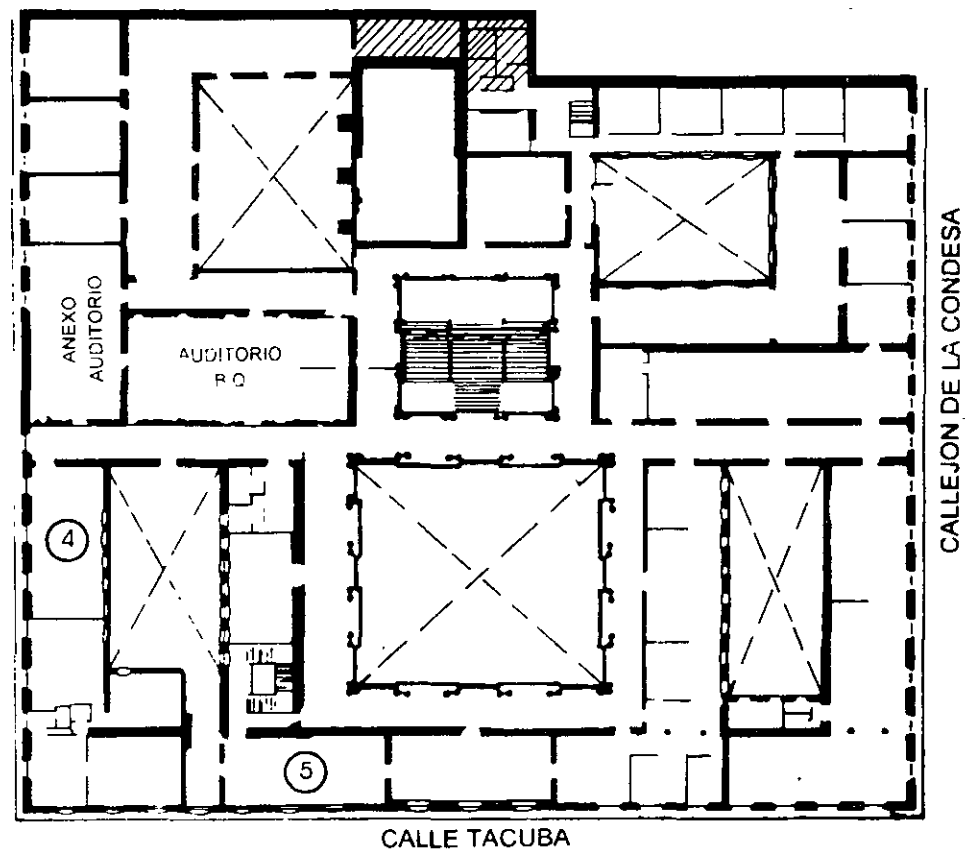

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DIVISIÓN DE EDUCACIÓN CONTINUA

División de Educación Continua, Facultad de Ingeniería, UNAM.

CURSOS ABIERTOS

DIPLOMADO DE RECIPIENTES A PRESIÓN

MÓDULO IV

DISPOSITIVOS DE ALIVIO A PRESIÓN CONFORME A LA SECCIÓN VIII, DIV. 1 DEL CÓDIGO ASME CA 254

TEMA

APUNTES GENERALES

INGENIERIA MECANICA

EXPOSITOR: ING. ORLANDO R. RIVERA MENDOZA
DEL 28 DE MAYO AL 01 DE JUNIO DE 2007
PALACIO DE MINERÍA

Palacio de Minería, Calle de Tacuba No 5, Primer piso, Delegación Cuauhtémoc, CP 06000, Centro Histórico, México D F., APDO Postal M-2285 ■ Tels: 5521 4021 al 24, 5623 2910 y 5623.2971 ■ Fax: 5510 0573

UNIVERSIDAD NACIONAL AUTONOMA DE MÉXICO
FACULTAD DE INGENIERIA
DIVISIÓN DE EDUCACIÓN CONTINUA

CURSO / MODULO

DISPOSITIVOS DE ALIVIO DE PRESION

CONFORME A SECCION VIII, DIV.1 DEL CODIGO ASME

Instructor : Ing. Orlando R. Rivera
Duración Total: 20 Horas
Lunes a Viernes de 17:00 a 21:00 Horas

PRESSURE RELIEF DEVICES

(c) the Manufacturer's written Quality Control System includes procedures to control the development, distribution, and retention of the Partial Data Reports.

(4) For guidance in preparing Partial Data Reports, see Appendix W.

(d) This Division, in paragraphs such as UW-2, UF-1, UF-32(b), UB-1, UB-22, UCS-66, UNF-56, UHA-51, UCL-27, and UHT-6, establishes special requirements to qualify a vessel for certain "special services." (Paragraphs, such as UW-2, prohibit certain types of construction or materials in some special services.) The special services to which special requirements are applicable are classified as follows:

(1) lethal service [for example, see UW-2(a)];

04 (2) services below certain temperatures (for example, see UW-2(b), UCS-65, UHA-51, and UHT-6);

(3) unfired steam boiler [for example, see UW-2(c)];

(4) direct firing [for example, see UW-2(d)].

When a vessel is intended for such special services, the special service and the paragraphs of special requirements complied with shall be indicated on the Data Reports.

(e) For sample forms and guidance in their preparation, see Appendix W.

PRESSURE RELIEF DEVICES

04 UG-125 GENERAL

(a) All pressure vessels within the Scope of this Division, irrespective of size or pressure, shall be provided with pressure relief devices in accordance with the requirements of UG-125 through UG-137. It is the responsibility of the user to ensure that the required pressure relief devices are properly installed prior to initial operation. These pressure relief devices need not be supplied by the vessel Manufacturer. Unless otherwise defined in this Division, the definitions relating to pressure relief devices in Section 2 of ASME PTC 25 shall apply.

(b) An unfired steam boiler, as defined in U-1(g), shall be equipped with pressure relief devices required by Section I insofar as they are applicable to the service of the particular installation.

(c) All pressure vessels other than unfired steam boilers shall be protected by a pressure relief device that shall prevent the pressure from rising more than 10% or 3 psi (20 kPa), whichever is greater, above the maximum allowable working pressure except as permitted in (1) and (2) below. (See UG-134 for pressure settings.)

(1) When multiple pressure relief devices are provided and set in accordance with UG-134(a), they shall prevent the pressure from rising more than 16% or 4 psi (30 kPa), whichever is greater, above the maximum allowable working pressure.

(2) Where an additional hazard can be created by exposure of a pressure vessel to fire or other unexpected sources of external heat, supplemental pressure relief devices shall be installed to protect against excessive pressure. Such supplemental pressure relief devices shall be capable of preventing the pressure from rising more than 21% above the maximum allowable working pressure. [For additional information, see Appendix M, M-14(a)]. The same pressure relief devices may be used to satisfy the capacity requirements of (c) or (c)(1) above and this paragraph provided the pressure setting requirements of UG-134(a) are met.

(3) Pressure relief devices, intended primarily for protection against exposure of a pressure vessel to fire or other unexpected sources of external heat installed on vessels having no permanent supply connection and used for storage at ambient temperatures of nonrefrigerated liquefied compressed gases,[41] are excluded from the requirements of (c)(1) and (c)(2) above, provided:

(a) the pressure relief devices are capable of preventing the pressure from rising more than 20% above the maximum allowable working pressure of the vessels;

(b) the set pressure marked on these devices shall not exceed the maximum allowable working pressure of the vessels;

(c) the vessels have sufficient ullage to avoid a liquid full condition;

(d) the maximum allowable working pressure of the vessels on which these pressure relief devices are installed is greater than the vapor pressure of the stored liquefied compressed gas at the maximum anticipated temperature[42] that the gas will reach under atmospheric conditions; and

(e) pressure relief valves used to satisfy these provisions also comply with the requirements of UG-129(a)(5), UG-131(c)(2), and UG-134(d)(2).

(d) Pressure relief devices shall be constructed, located, and installed so that they are readily accessible for inspection, replacement, and repair and so that they cannot be readily rendered inoperative (see Appendix M), and should be selected on the basis of their intended service.

[41] For the purpose of these rules, gases are considered to be substances having a vapor pressure greater than 40 psia (300 kPa absolute) at 100°F (40°C).

[42] Normally this temperature should not be less than 115°F (45°C).

(e) Pressure relief valves or nonreclosing pressure relief devices[43] may be used to protect against overpressure. Nonreclosing pressure relief devices may be used either alone or, if applicable, in combination with pressure relief valves on vessels.

NOTE Use of nonreclosing pressure relief devices of some types may be advisable on vessels containing substances that may render a pressure relief valve inoperative, where a loss of valuable material by leakage should be avoided, or where contamination of the atmosphere by leakage of noxious fluids must be avoided. The use of rupture disk devices may also be advisable when very rapid rates of pressure rise may be encountered.

(f) Vessels that are to operate completely filled with liquid shall be equipped with pressure relief devices designed for liquid service, unless otherwise protected against overpressure.

(g) The pressure relief devices required in (a) above need not be installed directly on a pressure vessel when either of the following conditions apply:

(1) the source of pressure is external to the vessel and is under such positive control that the pressure in the vessel cannot exceed the maximum allowable working pressure at the operating temperature except as permitted in (c) above (see UG-98), or under the conditions set forth in Appendix M.

(2) there are no intervening stop valves between the vessel and the pressure relief device or devices except as permitted under UG-135(d).

NOTE Pressure reducing valves and similar mechanical or electrical control instruments, except for pilot operated pressure relief valves as permitted in UG-126(b), are not considered as sufficiently positive in action to prevent excess pressures from being developed.

(h) Pressure relief valves for steam service shall meet the requirements of UG-131(b).

UG-126 PRESSURE RELIEF VALVES[44]

(a) Safety, safety relief, and relief valves shall be of the direct spring loaded type.

(b) Pilot operated pressure relief valves may be used, provided that the pilot is self-actuated and the main valve will open automatically at not over the set pressure and will discharge its full rated capacity if some essential part of the pilot should fail.

(c) The spring in a pressure relief valve shall not be set for any pressure more than 5% above or below that for which the valve is marked, unless the setting is within the spring design range established by the valve Manufacturer or is determined to be acceptable to the Manufacturer. The initial adjustment shall be performed by the Manufacturer, his authorized representative, or an Assembler, and a valve data tag shall be provided that identifies the set pressure capacity and date. The valve shall be sealed with a seal identifying the Manufacturer, his authorized representative, or the Assembler performing the adjustment.

(d) The set pressure tolerances, plus or minus, of pressure relief valves shall not exceed 2 psi (15 kPa) for pressures up to and including 70 psi (500 kPa) and 3% for pressures above 70 psi (500 kPa).

UG-127 NONRECLOSING PRESSURE RELIEF DEVICES

(a) Rupture Disk Devices[45]

(1) General Every rupture disk shall have a marked burst pressure established by rules of UG-137(d)(3) within a manufacturing design range[46] at a specified disk temperature[47] and shall be marked with a lot[48] number. The burst pressure tolerance at the specified disk temperature shall not exceed ±2 psi (±15 kPa) for marked burst pressure up to and including 40 psi (300 kPa) and ±5% for marked burst pressure above 40 psi (300 kPa).

[43] A *pressure relief valve* is a pressure relief device which is designed to reclose and prevent the further flow of fluid after normal conditions have been restored. A *nonreclosing pressure relief device* is a pressure relief device designed to remain open after operation.

[44] A *safety valve* is a pressure relief valve actuated by inlet static pressure and characterized by rapid opening or pop action. A *relief valve* is a pressure relief valve actuated by inlet static pressure which opens in proportion to the increase in pressure over the opening pressure. A *safety relief valve* is a pressure relief valve characterized by rapid opening or pop action, or by opening in proportion to the increase in pressure over the opening pressure, depending on application. A *pilot operated pressure relief valve* is a pressure relief valve in which the major relieving device is combined with and is controlled by a self-actuated auxiliary pressure relief valve.

[45] A *rupture disk device* is a nonreclosing pressure relief device actuated by inlet static pressure and designed to function by the bursting of a pressure containing disk. A *rupture disk* is the pressure containing and pressure sensitive element of a rupture disk device. Rupture disks may be designed in several configurations, such as plain flat, prebulged, or reverse buckling. A *rupture disk holder* is the structure which encloses and clamps the rupture disk in position.

[46] The *manufacturing design range* is a range of pressure within which the marked burst pressure must fall to be acceptable for a particular requirement as agreed upon between the rupture disk Manufacturer and the user or his agent. The manufacturing design range must be evaluated in conjuction with the specified burst pressure to ensure that the marked burst pressure of the rupture disk will always be within applicable limits of UG-134. Users are cautioned that certain types of rupture disks have manufacturing ranges that can result in a marked burst pressure greater than the specified burst pressure.

[47] The specified disk temperature supplied to the rupture disk Manufacturer shall be the temperature of the disk when the disk is expected to burst.

[48] A *lot of rupture disks* is those disks manufactured of a material at the same time, of the same size, thickness, type, heat, and manufacturing process including heat treatment.

(2) Relieving Capacity The rated flow capacity of a pressure relief system which uses a rupture disk device as the sole relief device shall be determined by a value calculated under the requirements of (a) using a coefficient of discharge or (b) using flow resistances below.

(a) When the rupture disk device discharges directly to atmosphere and

(1) is installed within eight pipe diameters from the vessel nozzle entry; and

(2) with a length of discharge pipe not greater than five pipe diameters from the rupture disk device; and

(3) the nominal diameters of the inlet and discharge piping are equal to or greater than the stamped NPS designator of the device, the calculated relieving capacity of a pressure relief system shall not exceed a value based on the applicable theoretical flow equation [see UG-131(e)(2) and Appendix 11] for the various media multiplied by a coefficient of discharge K equal to 0.62. The area A in the theoretical flow equation shall be the minimum net flow area[49] as specified by the rupture disk device Manufacturer.

(b) The calculated capacity of any pressure relief system may be determined by analyzing the total system resistance to flow. This analysis shall take into consideration the flow resistance of the rupture disk device, piping and piping components including the exit nozzle on the vessels, elbows, tees, reducers, and valves. The calculation shall be made using accepted engineering practices for determining fluid flow through piping systems. This calculated relieving capacity shall be multiplied by a factor of 0.90 or less to allow for uncertainties inherent with this method. The certified flow resistance[50] K_R for the rupture disk device, expressed as the velocity head loss, shall be determined in accordance with UG-131(k) through (r).

(3) Application of Rupture Disks

(a) A rupture disk device may be used as the sole pressure relieving device on a vessel.

NOTE When rupture disk devices are used, it is recommended that the design pressure of the vessel be sufficiently above the intended operating pressure to provide sufficient margin between operating pressure and rupture disk bursting pressure to prevent premature failure of the rupture disk due to fatigue or creep

Application of rupture disk devices to liquid service should be carefully evaluated to assure that the design of the rupture disk device and the dynamic energy of the system on which it is installed will result in sufficient opening of the rupture disk

(b) A rupture disk device may be installed between a pressure relief valve[51] and the vessel provided:

(1) the combination of the pressure relief valve and the rupture disk device is ample in capacity to meet the requirements of UG-133(a) and (b);

(2) the marked capacity of a pressure relief valve (nozzle type) when installed with a rupture disk device between the inlet of the valve and the vessel shall be multiplied by a factor of 0.90 of the rated relieving capacity of the valve alone, or alternatively, the capacity of such a combination shall be established in accordance with (3) below;

(3) the capacity of the combination of the rupture disk device and the pressure relief valve may be established in accordance with the appropriate paragraphs of UG-132;

(4) the space between a rupture disk device and a pressure relief valve shall be provided with a pressure gage, a try cock, free vent, or suitable telltale indicator. This arrangement permits detection of disk rupture or leakage.[52]

(5) the opening[49] provided through the rupture disk, after burst, is sufficient to permit a flow equal to the capacity of the valve [(2) and (3) above], and there is no chance of interference with proper functioning of the valve; but in no case shall this area be less than the area of the inlet of the valve unless the capacity and functioning of the specific combination of rupture disk device and pressure relief valve have been established by test in accordance with UG-132

(c) A rupture disk device may be installed on the outlet side[53] of a pressure relief valve which is opened by direct action of the pressure in the vessel provided:

(1) the pressure relief valve will not fail to open at its proper pressure setting regardless of any back pressure that can accumulate between the pressure relief valve disk and the rupture disk. The space between the pressure relief valve disk and the rupture disk shall be

[49] The *minimum net flow area* is the calculated net area after a complete burst of the disk with appropriate allowance for any structural members which may reduce the net flow area through the rupture disk device The net flow area for sizing purposes shall not exceed the nominal pipe size area of the rupture disk device

[50] The *certified flow resistance* K_R is a dimensionless factor used to calculate the velocity head loss that results from the presence of a rupture disk device in a pressure relief system

[51] Use of a rupture disk device in combination with a pressure relief valve shall be carefully evaluated to ensure that the media being handled and the valve operational characteristics will result in opening of the valve coincident with the bursting of the rupture disk

[52] Users are warned that a rupture disk will not burst at its design pressure if back pressure builds up in the space between the disk and the pressure relief valve which will occur should leakage develop in the rupture disk due to corrosion or other cause

[53] This use of a rupture disk device in series with the pressure relief valve is permitted to minimize the loss by leakage through the valve of valuable or of noxious or otherwise hazardous materials, and where a rupture disk alone or disk located on the inlet side of the valve is impracticable, or to prevent corrosive gases from a common discharge line from reaching the valve internals.

vented or drained to prevent accumulation of pressure, or suitable means shall be provided to ensure that an accumulation of pressure does not affect the proper operation of the pressure relief valve.[54]

(2) the pressure relief valve is ample in capacity to meet the requirements of UG-125(c);

(3) the marked burst pressure of the rupture disk at the specified disk temperature plus any pressure in the outlet piping shall not exceed the design pressure of the outlet portion of the pressure relief valve and any pipe or fitting between the valve and the rupture disk device. However, in no case shall the marked burst pressure of the rupture disk at the specified disk temperature plus any pressure in the outlet piping exceed the maximum allowable working pressure of the vessel or the set pressure of the pressure relief valve.

(4) the opening provided through the rupture disk device after breakage is sufficient to permit a flow equal to the rated capacity of the attached pressure relief valve without exceeding the allowable overpressure;

(5) any piping beyond the rupture disk cannot be obstructed by the rupture disk or fragment;

(6) the system is designed to consider the adverse effects of any leakage through the pressure relief valve or through the outlet side rupture disk device, to ensure system performance and reliability.[55]

(7) the bonnet of a balancing bellows or diaphragm type pressure relief valve shall be vented to prevent accumulation of pressure in the bonnet.

(b) Breaking Pin Device[56]

(1) Breaking pin devices shall not be used as single devices but only in combination between the pressure relief valve and the vessel.

(2) The space between a breaking pin device and a pressure relief valve shall be provided with a pressure gage, a try cock, a free vent, or suitable telltale indicator. This arrangement permits detection of breaking pin device operation or leakage.

(3) Each breaking pin device shall have a rated pressure and temperature at which the pin will break. The breaking pin shall be identified to a lot number and shall be guaranteed by the Manufacturer to break when the rated pressure, within the following tolerances, is applied to the device:

Rated Pressure, psi (kPa)		Tolerance, Plus or Minus, psi (kPa)
Min	Max	
30 (200)	150 (1 000)	5 (35)
150 (1 000)	275 (1 900)	10 (70)
275 (1 900)	375 (2 600)	15 (100)

(4) The rated pressure of the breaking pin plus the tolerance in psi shall not exceed 105% of the maximum allowable working pressure of the vessel to which it is applied.

(5) The rated pressure at the specified temperature[57] shall be verified by breaking two or more sample breaking pins from each lot of the same material and the same size as those to be used. The lot size shall not exceed 25. The test shall be made in a device of the same form and pressure dimensions as that in which the breaking pin is to be used.

(c) Spring Loaded Nonreclosing Pressure Relief Device

(1) A spring loaded nonreclosing pressure relief device, pressure actuated by means which permit the spring loaded portion of the device to open at the specified set pressure and remain open until manually reset, may be used provided the design of the spring loaded nonreclosing device is such that if the actuating means fail, the device will achieve full opening at or below its set pressure. Such a device may not be used in combination with any other pressure relief device. The tolerance on opening point shall not exceed ±5%.

(2) The calculated capacity rating of a spring loaded nonreclosing pressure relief device shall not exceed a value based on the applicable theoretical formula (see UG-131) for the various media, multiplied by: K = coefficient = 0.62.

The area A (square inches) in the theoretical formula shall be the flow area through the minimum opening of the spring loaded nonreclosing pressure relief device.

(3) In lieu of the method of capacity rating in (2) above, a Manufacturer may have the capacity of a spring loaded nonreclosing pressure relief device design certified in general accordance with the procedures of UG-131, as applicable.

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[54] Users are warned that many types of pressure relief valves will not open at the set pressure if pressure builds up in the space between the pressure relief valve disk and the rupture disk device. A specially designed pressure relief valve such as a diaphragm valve, pilot operated valve, or a valve equipped with a balancing bellows above the disk may be required.

[55] Some adverse effects resulting from leakage may include obstructing the flow path, corrosion of pressure relief valve components, and undesirable bursts of the outlet side rupture disk.

[56] 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. A *breaking pin* is the load-carrying element of a breaking pin device. A *breaking pin housing* is the structure which encloses the breaking pin mechanism. The material of the housing shall be listed in Section II and be permitted for use in this Division.

[57] The specified temperature supplied to the breaking pin manufacturer shall be the temperature of the breaking pin when an emergency condition exists and the pin is expected to break.

UG-128 LIQUID PRESSURE RELIEF VALVES

Any liquid pressure relief valve used shall be at least NPS ½ (DN 15).

UG-129 MARKING

(a) Safety, Safety Relief, Relief, Liquid Pressure Relief, and Pilot Operated Pressure Relief Valves Each safety, safety relief, relief, liquid pressure relief, and pilot operated pressure relief valve NPS ½ (DN 15) and larger shall be plainly marked by the Manufacturer or Assembler with the required data in such a way that the marking will not be obliterated in service. The marking may be placed on the valve or on a plate or plates that satisfy the requirements of UG-119:

(1) the name, or an acceptable abbreviation, of the Manufacturer and the Assembler;

(2) Manufacturer's design or type number;

(3) NPS size ______ (the nominal pipe size of the valve inlet);

(4) set pressure ______ psi (kPa), and, if applicable per UG-136(d)(4), cold differential test pressure ______ psi (kPa);

(5) certified capacity (as applicable):

(a) lb/hr of saturated steam at an overpressure of 10% or 3 psi (20 kPa), whichever is greater for valves certified on steam complying with UG-131(b); or

(b) gal/min of water at 70°F (20°C) at an overpressure of 10% or 3 psi (20 kPa), whichever is greater for valves certified on water; or

(c) SCFM [standard cubic feet per minute at 60°F and 14.7 psia (20°C and 101 kPa)], or lb/min, of air at an overpressure of 10% or 3 psi (20 kPa), whichever is greater. Valves that are capacity certified in accordance with UG-131(c)(2) shall be marked "at 20% overpressure."

(d) In addition to one of the fluids specified above, the Manufacturer may indicate the capacity in other fluids (see Appendix 11).

(6) year built, or alternatively, a coding may be marked on the valve such that the valve Manufacturer or Assembler can identify the year the valve was assembled or tested;

(7) ASME Symbol as shown in Fig. UG-129.1. The pilot of a pilot operated pressure relief valve shall be plainly marked by the Manufacturer or Assembler showing the name of the Manufacturer, the Manufacturer's design or type number, the set pressure in pounds per square inch, and the year built, or alternatively, a coding that the Manufacturer can use to identify the year built.

FIG. UG-129.1 OFFICIAL SYMBOL FOR STAMP TO DENOTE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS' STANDARD FOR PRESSURE RELIEF VALVES

On valves smaller than NPS ½ (DN 15), the markings may be made on a metal tag attached by wire or adhesive meeting the requirements of UG-119 or other means suitable for the service conditions.

(b) Safety and safety relief valves certified for a steam discharging capacity under the provisions of Section I and bearing the official Code Symbol Stamp of Section I for safety valves may be used on pressure vessels. The rated capacity in terms of other fluids shall be determined by the method of conversion given in Appendix 11. [See UG-131(h).]

(c) Pressure Relief Valves in Combination With Rupture Disk Devices Pressure relief valves in combination with rupture disk devices shall be marked with the capacity as established in accordance with UG-127(a)(3)(b)(2) (using 0.90 factor) or the combination capacity factor established by test in accordance with UG-132(a) or (b), in addition to the marking of UG-129(a) and (f) below. The marking may be placed on the pressure relief valve or rupture disk device or on a plate or plates that satisfy the requirements of UG-119. The marking shall include the following:

(1) name of Manufacturer of valve;

(2) design or type number of valve;

(3) name of Manufacturer of rupture disk device;

(4) design or type number of rupture disk device;

(5) capacity or combination capacity factor;

(6) name of organization responsible for this marking. This shall be either the vessel user, vessel Manufacturer, rupture disk Manufacturer, or pressure relief valve Manufacturer.

(d) Pressure Relief Valves in Combination With Breaking Pin Devices Pressure relief valves in combination with breaking pin devices shall be marked in accordance with (a) above. In addition, the rated pressure shall be marked on the breaking pin and the breaking pin housing.

(e) Rupture Disk Devices. Every rupture disk shall be plainly marked by the Manufacturer in such a way that the marking will not be obliterated in service. The rupture disk marking may be placed on the flange of the disk or

FIG. UG-129.2 OFFICIAL SYMBOL FOR STAMP TO DENOTE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS' STANDARD FOR RUPTURE DISK DEVICES

on a metal tab that satisfies the requirements of UG-119. The marking shall include the following:

(1) the name or identifying trademark of the Manufacturer;

(2) Manufacturer's design or type number;

(3) lot number;

(4) disk material;

(5) size ________ [NPS (DN) of rupture disk holder];

(6) marked burst pressure ________ psi (kPa);

(7) specified disk temperature ________ °F (°C);

(8) minimum net flow area ________ sq in. (sq mm);

(9) certified flow resistance (as applicable):

(a) K_{RG} ________ for rupture disk certified on air or gases; or

(b) K_{RL} ________ for rupture disk certified on liquid; or

(c) K_{RGL} ________ for rupture disk certified on air or gases, and liquid;

(10) ASME symbol as shown in Fig. UG-129.2;

(11) year built, or alternatively, a coding may be marked on the rupture disk such that the rupture disk device Manufacturer can identify the year the rupture disk device was assembled and tested.

Items (1), (2), and (5) above and flow direction shall also be marked on the rupture disk holder.

(f) Spring Loaded Nonreclosing Pressure Relief Devices Spring loaded nonreclosing pressure relief devices shall be marked in accordance with (a) above except that the Code Symbol Stamp is to be applied only when the capacity has been established and certified in accordance with UG-127(c)(3) and all other requirements of UG-130 have been met.

UG-130 CODE SYMBOL STAMP

Each pressure relief device[58] to which the Code Symbol (see Figs. UG-129.1 and UG-129.2) will be applied shall have been fabricated or assembled by a Manufacturer or Assembler holding a valid Certificate of Authorization (UG-117) and capacity certified in accordance with the requirements of this Division. A Certified Individual (*CI*) shall provide oversight as required by UG-117(a). Each use of the Code Symbol shall also be documented on a Certificate of Conformance Form UV-1 or UD-1, as appropriate.

[58] Vacuum relief devices are not covered by Code Symbol Stamp requirements

UG-131 CERTIFICATION OF CAPACITY OF PRESSURE RELIEF DEVICES

(a) Before the Code Symbol is applied to any pressure relief device, the device Manufacturers shall have the capacity of their devices certified in accordance with the provisions of these paragraphs. For pressure relief valves, (b) through (j) below apply and for rupture disk devices, (k) through (r) below apply except where noted.

(b)(1) Capacity certification tests for pressure relief valves for compressible fluids shall be conducted on dry saturated steam, or air, or gas. When dry saturated steam is used, the limits for test purposes shall be 98% minimum quality and 20°F (10°C) maximum superheat. Correction from within these limits may be made to the dry saturated condition. Pressure relief valves for steam service may be rated as above, but at least one valve of each series shall be tested on steam to demonstrate the steam capacity and performance.

(2) Capacity certification tests for pressure relief valves for incompressible fluids shall be conducted on water at a temperature between 40°F (5°C) and 125°F (4°C and 50°C).

(c)(1) Capacity certification tests shall be conducted at a pressure which does not exceed the pressure for which the pressure relief valve is set to operate by more than 10% or 3 psi (20 kPa), whichever is greater, except as provided in (c)(2) below. Minimum pressure for capacity certification tests shall be at least 3 psi (20 kPa) above set pressure. The reseating pressure shall be noted and recorded.

(2) Capacity certification tests of pressure relief valves for use in accordance with UG-125(c)(3) may be conducted at a pressure not to exceed 120% of the stamped set pressure of the valve.

(3)(a) Pressure relief valves for compressible fluids having an adjustable blowdown construction shall be adjusted prior to testing so that the blowdown does not exceed 5% of the set pressure or 3 psi (20 kPa), whichever is greater.

(b) The blowdown of pressure relief valves for incompressible fluids and pressure relief valves for compressible fluids having nonadjustable blowdown shall be noted and recorded.

(4) Capacity certification of pilot operated pressure relief valves may be based on tests without the pilot valves installed, provided prior to capacity tests it has been demonstrated by test to the satisfaction of the Authorized Observer that the pilot valve will cause the main valve to open fully at a pressure which does not exceed the set pressure by more than 10% or 3 psi (20 kPa), whichever is greater, and that the pilot valve in combination with the main valve will meet all the requirements of this Division.

(d)(1) A capacity certification test is required on a set of three valves for each combination of size, design, and pressure setting. The stamped capacity rating for each combination of design, size, and test pressure shall not exceed 90% of the average capacity of the three valves tested. The capacity for each set of three valves shall fall within a range of ±5% of the average capacity. Failure to meet this requirement shall be cause to refuse certification of that particular pressure relief valve design.

• *(2)* If a Manufacturer wishes to apply the Code Symbol to a design of pressure relief valves, four valves of each combination of pipe size and orifice size shall be tested. These four valves shall be set at pressures which cover the approximate range of pressures for which the valve will be used or covering the range available at the certified test facility that shall conduct the tests. The capacities based on these four tests shall be as follows.

(a) For compressible fluids, the slope W/P of the actual measured capacity versus the flow pressure for each test point shall be calculated and averaged:

$$\text{slope} = \frac{W}{P} = \frac{\text{measured capacity}}{\text{absolute flow pressure, psia}}$$

All values derived from the testing must fall within ±5% of the average value:

$$\text{minimum slope} = 0.95 \times \text{average slope}$$

$$\text{maximum slope} = 1.05 \times \text{average slope}$$

If the values derived from the testing do not fall between the minimum and maximum slope values, the Authorized Observer shall require that additional valves be tested at the rate of two for each valve beyond the maximum and minimum values with a limit of four additional valves.

The relieving capacity to be stamped on the valve shall not exceed 90% of the average slope times the absolute accumulation pressure:

$$\text{rated slope} = 0.90 \times \text{average slope}$$

(U.S. Customary Units)

$$\text{stamped capacity} \leq \text{rated slope } (1.10 \times \text{set pressure} + 14.7) \text{ or } (\text{set pressure} + 3 \text{ psi} + 14.7), \text{ whichever is greater}$$

(SI Units)

$$\text{stamped capacity} \leq \text{rated slope } (1.10 \times \text{set pressure} + 100 \text{ kPa}) \text{ or } (\text{set pressure} + 20 \text{ kPa} + 101 \text{ kPa}), \text{ whichever is greater}$$

For valves certified in accordance with (c)(2) above

(U.S. Customary Units)

$$\text{stamped capacity} \leq \text{rated slope } (1.20 \times \text{set pressure} + 14.7 \text{ or } (\text{set pressure} + 3 \text{ psi} + 14.7), \text{ whichever is greater}$$

(SI Units)

$$\text{stamped capacity} \leq \text{rated slope } (1.20 \times \text{set pressure} + 100 \text{ kPa}) \text{ or } (\text{set pressure} + 20 \text{ kPa} + 101 \text{ kPa}), \text{ whichever is greater}$$

(b) For incompressible fluids, the capacities shall be plotted on log-log paper against the differential (inlet minus discharge pressure) test pressure and a straight line drawn through these four points. If the four points do not establish a straight line, two additional valves shall be tested for each unsatisfactory point, with a limit of two unsatisfactory points. Any point that departs from the straight line by more than 5% should be considered an unsatisfactory point. The relieving capacity shall be determined from this line. The certified capacity shall not exceed 90% of the capacity taken from the line.

(e) Instead of individual capacity certification as provided in (d) above, a coefficient of discharge K may be established for a specific pressure relief valve design according to the following procedure.

(1) For each design, the pressure relief valve Manufacturer shall submit for test at least three valves for each of three different sizes (a total of nine valves) together with detailed drawings showing the valve construction. Each valve of a given size shall be set at a different pressure.

(2) Tests shall be made on each pressure relief valve to determine its capacity-lift, popping and blow-down pressures, and actual capacity in terms of the fluid used in the test. A coefficient K_D shall be established for each test run as follows:

$$K_D = \frac{\text{actual flow}}{\text{theoretical flow}} = \text{coefficient of discharge}$$

where actual flow is determined quantitatively by test, and theoretical flow is calculated by the appropriate formula which follows:

For tests with dry saturated steam,

$$W_T = 51.5AP$$

NOTE: For dry saturated steam pressures over 1500 psig (10.9 MPa gage) and up to 3200 psig (22.1 MPa gage), the value of W_T, calculated by the above equation, shall be corrected by being multiplied by the following factors, which shall be used only if it is 1.0 or greater

(U.S. Customary Units)

$$\left(\frac{0.1906P - 1000}{0.2292P - 1061}\right)$$

(SI Units)

$$\left(\frac{27.6P - 1\,000}{33.2P - 1\,001}\right)$$

For tests with air,

$$W_T = 356AP\sqrt{\frac{M}{T}}$$

For tests with natural gas,

$$W_T = CAP\sqrt{\frac{M}{ZT}}$$

For tests with water,

$$W_T = 2407A\sqrt{(P - P_d)w}$$

where

- W_T = theoretical flow
- A = actual discharge area through the valve at developed lift, sq in.
- P = (set pressure × 1.10) plus atmospheric pressure, psia, or set pressure plus 3 psi (20 kPa) plus atmospheric pressure, whichever is greater
- P_d = pressure at discharge from valve
- M = molecular weight
- T = absolute temperature at inlet, °F + 460°F (273°C)
- C = constant for gas or vapor based on the ratio of specific heats
  $k = c_p/c_v$ (see Fig. 11-1)
- Z = compressibility factor corresponding to P and T
- w = specific weight of water at valve inlet conditions

The average of the coefficients K_D of the nine tests required shall be multiplied by 0.90, and this product shall be taken as the coefficient K of that design. The coefficient of the design shall not be greater than 0.878 (the product of 0.9 × 0.975).

NOTE: All experimentally determined coefficients K_D shall fall within a range of ±5% of the average K_D found. Failure to meet this requirement shall be cause to refuse certification of that particular valve design.

To convert lb/hr of water to gal/min of water, multiply the capacity in lb/hr by 1/500.

(3) The official relieving capacity of all sizes and pressures of a given design, for which K has been established under the provisions of (e)(2) above, that are manufactured subsequently shall not exceed the value calculated by the appropriate formula in (e)(2) above multiplied by the coefficient K (see Appendix 11).

(4) The coefficient shall not be applied to valves whose beta ratio (ratio of valve throat to inlet diameter) lies outside the range of 0.15 to 0.75, unless tests have demonstrated that the individual coefficient of discharge K_D for valves at the extreme ends of a larger range is within ±5% of the average coefficient K. For designs where the lift is used to determine the flow area, all valves shall have the same nominal lift-to-seat diameter ratio (L/D).

(f) Tests shall be conducted at a place where the testing facilities, methods, procedures, and person supervising the tests (Authorized Observer) meet the applicable requirements of ASME PTC 25. The tests shall be made under the supervision of and certified by an Authorized Observer. The testing facilities, methods, procedures, and qualifications of the Authorized Observer shall be subject to the acceptance of the ASME on recommendation of a representative from an ASME designated organization. Acceptance of the testing facility is subject to review within each 5 year period.

(g) Capacity test data reports for each valve model, type, and size, signed by the Manufacturer and the Authorized Observer witnessing the tests shall be submitted to the ASME designated organization for review and acceptance.[59] Where changes are made in the design, capacity certification tests shall be repeated.

(h) For absolute pressures up to 1500 psia (10 MPa absolute), it is permissible to rate safety valves under PG-69.1.2 of Section I with capacity ratings at a flow pressure of 103% of the set pressure, for use on pressure vessels, without further test. In such instances, the capacity rating of the valve may be increased to allow for the flow pressure permitted in (c)(1) and (c)(3) above, namely, 110% of the set pressure, by the multiplier,

[59] Valve capacities and rupture disk device flow resistances are published in "Pressure Relief Device Certifications." This publication may be obtained from the National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Avenue, Columbus, Ohio 43229.

(U.S. Customary Units)

$$\frac{1.10p + 14.7}{1.03p + 14.7}$$

(SI Units)

$$\frac{1.10p + 100}{1.03p + 100}$$

where

p = set pressure, psig (kPa gage)

Such valves shall be marked in accordance with UG-129. This multiplier shall not be used as a divisor to transform test ratings from a higher to a lower flow.

For steam pressures above 1500 psig (10.3 MPa gage), the above multiplier is not applicable. For pressure relief valves with relieving pressures between 1500 psig (10.9 MPa gage) and 3200 psig (22.1 MPa gage), the capacity shall be determined by using the equation for steam and the correction factor for high pressure steam in (e)(2) above with the permitted absolute relieving pressure (for Customary units, $1.10p + 14.7$; for SI units, $1.10p + 101$) and the coefficient K for that valve design.

(i) Rating of nozzle type pressure relief valves, i.e., coefficient K_D, greater than 0.90 and nozzle construction, for saturated water shall be according to 11-2.

(j) When changes are made in the design of a pressure relief valve in such a manner as to affect the flow path, lift, or performance characteristics of the valve, new tests in accordance with this Division shall be performed.

(k) The certified flow resistance K_R of the rupture disk device used in UG-127(a)(2) shall be either $K_R = 2.4$, or as determined in accordance with (l) through (r) below.

(l) Flow resistance certification tests for rupture disk for air or gas service K_{RG} shall be burst and flow tested with air or gas. Flow resistance certification tests for liquid service K_{RL} shall be burst tested with water and flow tested with air or gas. Rupture disk for air or gas and liquid service K_{RGL} may be certified with air or gas as above, but at least one rupture disk of the number required under (o) below for each size of each series shall be burst tested with water and flow tested with air or gas to demonstrate the liquid service flow resistance.

(m) Flow resistance certification tests shall be conducted at a rupture disk device inlet pressure which does not exceed 110% of the device set pressure.

(n)(1) The flow resistance for rupture disk devices tested with nonpressure containing disk items, such as seals, support rings, and vacuum supports, is applicable for the same rupture device design without seals, support rings, or vacuum supports.

(2) A change in material for rupture disks and their nonpressure containing disk items, such as seals, support rings, and vacuum supports, is not considered a design change and does not require retesting.

(3) Additional linings, coatings, or platings may be used for the same design of rupture disk devices provided:

(a) the certificate holder has performed a verification burst test of rupture disks with the additional linings, coatings, or platings and has documented that the addition of these materials does not affect the rupture disk opening configuration; and

(b) such verification tests shall be conducted with rupture disks of the smallest size and minimum burst pressure for which the certified flow resistance with additional materials is to be used.

(o) Flow resistance certification of rupture disk devices shall be determined by one of the following methods.

(1) One Size Method

(a) For each rupture disk device design, three rupture disks from the same lot shall be individually burst and flow tested in accordance with (p) below. The burst pressure shall be the minimum of the rupture disk device design of the size tested.

(b) The certified flow resistance K_R determined in (p) below shall apply only to the rupture disk design of the size tested.

(c) When additional rupture disks of the same design are constructed at a later date, the test results on the original rupture disks may be included as applicable in the three size method described in (o)(2) below.

(2) Three Size Method

(a) This method of flow resistance certification may be used for a rupture disk device design of three or more sizes. The burst pressure shall be the minimum of the rupture disk device design for each of the sizes submitted for test.

(b) For each rupture disk device design, three rupture disks from the same lot shall be burst and flow tested in accordance with (p) below for each of three different sizes of the same design.

(c) The certified flow resistance K_R shall apply to all sizes and pressures of the design of the rupture disk device tested.

(p) A certified flow resistance K_R may be established for a specific rupture disk device design according to the following procedure.

(1) For each design, the rupture disk Manufacturer shall submit for test the required rupture disk devices in accordance with (o) above together with the cross section drawings showing the rupture disk device design.

(2) Tests shall be made on each rupture disk device to determine its burst pressure and flow resistance at a facility which meets the requirements of (f) above.

(3) Calculate an average flow resistance using the individual flow resistances determined in (p)(2) above. All individual flow resistances shall fall within the average flow resistance by an acceptance band of plus or minus three times the average of the absolute values of the deviations of the individual flow resistances from the average flow resistance. Any individual flow resistance that falls outside of this band shall be replaced on a two for one basis. A new average flow resistance shall be computed and the individual flow resistances evaluated as stated above.

(4) The certified flow resistance K_R for a rupture disk design shall not be less than zero and shall not be less than the sum of the average flow resistance plus three times the average of the absolute values of the deviations of individual flow resistances from the average flow resistance.

(q) Flow resistance test data reports for each rupture disk device design, signed by the Manufacturer and the Authorized Observer witnessing the tests, shall be submitted to the ASME designated organization for review and acceptance.[59]

(r) When changes are made in the design of a rupture disk device which affect the flow path or burst performance characteristics of the device, new tests in accordance with this Division shall be performed.

UG-132 CERTIFICATION OF CAPACITY OF PRESSURE RELIEF VALVES IN COMBINATION WITH NONRECLOSING PRESSURE RELIEF DEVICES

(a) Capacity of Pressure Relief Valves in Combination With a Rupture Disk Device at the Inlet

(1) For each combination of pressure relief valve design and rupture disk device design, the pressure relief valve Manufacturer or the rupture disk device Manufacturer may have the capacity of the combination certified as prescribed in (3) and (4) below.

(2) Capacity certification tests shall be conducted on saturated steam, air, or natural gas. When saturated steam is used, corrections for moisture content of the steam shall be made.

(3) The pressure relief valve Manufacturer or the rupture disk device Manufacturer may submit for tests the smallest rupture disk device size with the equivalent size of pressure relief valve that is intended to be used as a combination device. The pressure relief valve to be tested shall have the largest orifice used in the particular inlet size.

(4) Tests may be performed in accordance with the following subparagraphs. The rupture disk device and pressure relief valve combination to be tested shall be arranged to duplicate the combination assembly design.

(a) The test shall embody the minimum burst pressure of the rupture disk device design which is to be used in combination with the pressure relief valve design. The marked burst pressure shall be between 90% and 100% of the marked set pressure of the valve.

(b) The test procedure to be used shall be as follows.

The pressure relief valve (one valve) shall be tested for capacity as an individual valve, without the rupture disk device at a pressure 10% or 3 psi (20 kPa), whichever is greater, above the valve set pressure.

The rupture disk device shall then be installed at the inlet of the pressure relief valve and the disk burst to operate the valve. The capacity test shall be performed on the combination at 10% or 3 psi (20 kPa), whichever is greater, above the valve set pressure duplicating the individual pressure relief valve capacity test.

(c) Tests shall be repeated with two additional rupture disks of the same nominal rating for a total of three rupture disks to be tested with the single pressure valve. The results of the test capacity shall fall within a range of 10% of the average capacity of the three tests. Failure to meet this requirement shall be cause to require retest for determination of cause of the discrepancies.

(d) From the results of the tests, a Combination Capacity Factor shall be determined. The Combination Capacity Factor is the ratio of the average capacity determined by the combination tests to the capacity determined on the individual valve.

The Combination Capacity Factor shall be used as a multiplier to make appropriate changes in the ASME rated relieving capacity of the pressure relief valve in all sizes of the design. The value of the Combination Capacity Factor shall not be greater than one. The Combination Capacity Factor shall apply only to combinations of the same design of pressure relief valve and the same design of rupture disk device as those tested.

(e) The test laboratory shall submit the test results to the ASME designated organization for acceptance of the Combination Capacity Factor.[60]

(b) Optional Testing of Rupture Disk Devices and Pressure Relief Valves

(1) If desired, a valve Manufacturer or a rupture disk Manufacturer may conduct tests in the same manner as outlined in (a)(4)(c) and (a)(4)(d) above using the next

[60] The *set pressure* is the value of increasing inlet static pressure at which a pressure relief device displays one of the operational characteristics as defined by opening pressure, popping pressure, start-to-leak pressure, burst pressure, or breaking pressure. (The applicable operating characteristic for a specific device design is specified by the device Manufacturer.)

two larger sizes of the design of rupture disk device and pressure relief valve to determine a Combination Capacity Factor applicable to larger sizes. If a greater Combination Capacity Factor is established and can be certified, it may be used for all larger sizes of the combination, but shall not be greater than one.

(2) If desired, additional tests may be conducted at higher pressures in accordance with (a)(4)(c) and (a)(4)(d) above to establish a maximum Combination Capacity Factor to be used at all pressures higher than the highest tested, but shall not be greater than one.

(c) Capacity of Breaking Pin Devices in Combination With Pressure Relief Valves

(1) Breaking pin devices in combination with pressure relief valves shall be capacity tested in compliance with UG-131(d) or UG-131(e) as a combination.

(2) Capacity certification and Code Symbol stamping shall be based on the capacity established in accordance with these paragraphs.

UG-133 DETERMINATION OF PRESSURE RELIEVING REQUIREMENTS

(a) Except as permitted in (b) below, the aggregate capacity of the pressure relief devices connected to any vessel or system of vessels for the release of a liquid, air, steam, or other vapor shall be sufficient to carry off the maximum quantity that can be generated or supplied to the attached equipment without permitting a rise in pressure within the vessel of more than 16% above the maximum allowable working pressure when the pressure relief devices are blowing.

(b) Pressure relief devices as permitted in UG-125(c)(2), as protection against excessive pressure caused by exposure to fire or other sources of external heat, shall have a relieving capacity sufficient to prevent the pressure from rising more than 21% above the maximum allowable working pressure of the vessel when all pressure relief devices are blowing.

(c) Vessels connected together by a system of adequate piping not containing valves which can isolate any vessel may be considered as one unit in figuring the required relieving capacity of pressure relief devices to be furnished.

(d) Heat exchangers and similar vessels shall be protected with a pressure relief device of sufficient capacity to avoid overpressure in case of an internal failure.

(e) The official rated capacity, or the certified flow resistance and minimum net flow area, of a pressure relief device shall be that which is stamped on the device and guaranteed by the Manufacturer.

(f) The rated pressure relieving capacity of a pressure relief valve for other than steam or air shall be determined by the method of conversion given in Appendix 11.

(g) To prorate the relieving capacity at any relieving pressure greater than $1.10p$, as permitted under UG-125, a multiplier may be applied to the official relieving capacity of a pressure relief device as follows:

(U.S. Customary Units)

$$\frac{P + 14.7}{1.10p + 14.7}$$

(SI Units)

$$\frac{P + 101}{1.10p + 101}$$

where

P = relieving pressure, psig (kPa gage)
p = set pressure, psig (kPa gage)

For steam pressures above 1,500 psig (10.3 MPa gage), the above multiplier is not applicable. For steam valves with relieving pressures greater than 1,500 psig (10 MPa gage) and less than or equal to 3,200 psig (22.1 MPa gage), the capacity at relieving pressures greater than $1.10p$ shall be determined using the equation for steam and the correction factor for high pressure steam in UG-131(e)(2) with the permitted absolute relieving pressure and the coefficient K for that valve design.

UG-134 PRESSURE SETTING OF PRESSURE RELIEF DEVICES

(a) When a single pressure relief device is used, the set pressure[60] marked on the device shall not exceed the maximum allowable working pressure of the vessel. When the required capacity is provided in more than one pressure relief device, only one pressure relief device need be set at or below the maximum allowable working pressure, and the additional pressure relief devices may be set to open at higher pressures but in no case at a pressure higher than 105% of the maximum allowable working pressure, except as provided in (b) below.

(b) For pressure relief devices permitted in UG-125(c)(2) as protection against excessive pressure caused by exposure to fire or other sources of external heat, the device marked set pressure shall not exceed 110% of the maximum allowable working pressure of the vessel. If such a pressure relief device is used to meet the requirements of both UG-125(c) and UG-125(c)(2), the device marked set pressure shall not be over the maximum allowable working pressure.

(c) The pressure relief device set pressure shall include the effects of static head and constant back pressure.

(d)(1) The set pressure tolerance for pressure relief valves shall not exceed ±2 psi (15 kPa) for pressures up to and including 70 psi (500 kPa) and ±3% for pressures above 70 psi (500 kPa), except as covered in (d)(2) below.

(2) The set pressure tolerance of pressure relief valves which comply with UG-125(c)(3) shall be within −0%, +10%.

(e) The burst pressure tolerance for rupture disk devices at the specified disk temperature shall not exceed ±2 psi (15 kPa) of marked burst pressure up to 40 psi (300 kPa) and ±5% of marked burst pressure 40 psi (300 kPa) and over.

UG-135 INSTALLATION

(a) Pressure relief devices intended for use in compressible fluid service shall be connected to the vessel in the vapor space above any contained liquid or to piping connected to the vapor space in the vessel which is to be protected. Pressure relief devices intended for use in liquid service shall be connected below the normal liquid level.

(b)(1) The opening through all pipe, fittings, and nonreclosing pressure relief devices (if installed) between a pressure vessel and its pressure relief valve shall have at least the area of the pressure relief valve inlet. The characteristics of this upstream system shall be such that the pressure drop will not reduce the relieving capacity below that required or adversely affect the proper operation of the pressure relief valve.

(2) The opening in the vessel wall shall be designed to provide unobstructed flow between the vessel and its pressure relief device (see Appendix M).[61]

(c) When two or more required pressure relief devices are placed on one connection, the inlet internal cross-sectional area of this connection shall be either sized to avoid restricting flow to the pressure relief devices or made at least equal to the combined inlet areas of the safety devices connected to it. The flow characteristics of the upstream system shall satisfy the requirements of (b) above. (See Appendix M.)

(d) There shall be no intervening stop valves between the vessel and its pressure relief device or devices, or between the pressure relief device or devices and the point of discharge, except:

(1) when these stop valves are so constructed or positively controlled that the closing of the maximum number of block valves possible at one time will not reduce the pressure relieving capacity provided by the unaffected pressure relief devices below the required relieving capacity; or

(2) under conditions set forth in Appendix M.

(e) The pressure relief devices on all vessels shall be so installed that their proper functioning will not be hindered by the nature of the vessel's contents.

(f) Discharge lines from pressure relief devices shall be designed to facilitate drainage or shall be fitted with drains to prevent liquid from lodging in the discharge side of the pressure relief device, and such lines shall lead to a safe place of discharge. The size of the discharge lines shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the pressure relief devices below that required to properly protect the vessel, or adversely affect the proper operation of the pressure relief devices. [See UG-136(a)(8) and Appendix M.]

UG-136 MINIMUM REQUIREMENTS FOR PRESSURE RELIEF VALVES

UG-136(a) Mechanical Requirements

UG-136(a)(1) The design shall incorporate guiding arrangements necessary to ensure consistent operation and tightness.

UG-136(a)(2) The spring shall be designed so that the full lift spring compression shall be no greater than 80% of the nominal solid deflection. The permanent set of the spring (defined as the difference between the free height and height measured 10 min after the spring has been compressed solid three additional times after presetting at room temperature) shall not exceed 0.5% of the free height.

UG-136(a)(3) Each pressure relief valve on air, water over 140°F (60°C), or steam service shall have a substantial lifting device which when activated will release the seating force on the disk when the pressure relief valve is subjected to a pressure of at least 75% of the set pressure of the valve. Pilot operated pressure relief valves used on these services shall be provided with either a lifting device as described above or means for connecting and applying pressure to the pilot adequate to verify that the moving parts critical to proper operation are free to move.

UG-136(a)(4) The seat of a pressure relief valve shall be fastened to the body of the pressure relief valve in such a way that there is no possibility of the seat lifting.

[61] Users are warned that the proper operation of various rupture disk devices depends upon following the Manufacturer's installation instructions closely with regard to the flow direction marked on the device. Some device designs will burst at pressures much greater than their marked burst pressure when installed with the process pressure on the vent side of the device.

UG-136(a)(5) In the design of the body of the pressure relief valve, consideration shall be given to minimizing the effects of deposits.

UG-136(a)(6) Pressure relief valves having screwed inlet or outlet connections shall be provided with wrenching surfaces to allow for normal installation without damaging operating parts.

UG-136(a)(7) Means shall be provided in the design of all pressure relief valves for use under this Division for sealing all initial adjustments which can be made without disassembly of the valve. Seals shall be installed by the Manufacturer or Assembler at the time of initial adjustment. Seals shall be installed in a manner to prevent changing the adjustment without breaking the seal. For pressure relief valves larger than NPS $\frac{1}{2}$ (DN 15), the seal shall serve as a means of identifying the Manufacturer or Assembler making the initial adjustment.

UG-136(a)(8) If the design of a pressure relief valve is such that liquid can collect on the discharge side of the disk, except as permitted in (a)(9) below, the valve shall be equipped with a drain at the lowest point where liquid can collect (for installation, see UG-135).

UG-136(a)(9) Pressure relief valves that cannot be equipped with a drain as required in (a)(8) above because of design or application may be used provided:

(a) the pressure relief valves are used only on gas service where there is neither liquid discharged from the valve nor liquid formed by condensation on the discharge side of the valve; and

(b) the pressure relief valves are provided with a cover or discharge piping per UG-135(f) to prevent liquid or other contaminant from entering the discharge side of the valve; and

(c) the pressure relief valve is marked FOR GAS SERVICE ONLY in addition to the requirements of UG-129.

UG-136(a)(10) For pressure relief valves of the diaphragm type, the space above the diaphragm shall be vented to prevent a buildup of pressure above the diaphragm. Pressure relief valves of the diaphragm type shall be designed so that failure or deterioration of the diaphragm material will not impair the ability of the valve to relieve at the rated capacity.

UG-136(b) Material Selections

UG-136(b)(1) Cast iron seats and disks are not permitted.

UG-136(b)(2) Adjacent sliding surfaces such as guides and disks or disk holders shall both be of corrosion resistant material. Springs of corrosion resistant material or having a corrosion resistant coating are required. The seats and disks of pressure relief valves shall be of suitable material to resist corrosion by the fluid to be contained.

NOTE The degree of corrosion resistance, appropriate to the intended service, shall be a matter of agreement between the manufacturer and the purchaser

UG-136(b)(3) Materials used in bodies and bonnets or yokes shall be listed in Section II and this Division. Carbon and low alloy steel bodies, bonnets, yokes and bolting (UG-20) subject to in-service temperatures colder than −20°F (−30°C) shall meet the requirements of UCS-66, unless exempted by the following.

(a) The coincident ratio defined in Fig. UCS-66.1 is 0.35 or less.

(b) The material(s) is exempted from impact testing per Fig. UCS-66.

UG-136(b)(4) Materials used in nozzles, disks, and other parts contained within the external structure of the pressure relief valves shall be one of the following categories:

(a) listed in Section II;

(b) listed in ASTM specifications;

(c) controlled by the Manufacturer of the pressure relief valve by a specification ensuring control of chemical and physical properties and quality at least equivalent to ASTM standards.

UG-136(c) Inspection of Manufacturing and/or Assembly of Pressure Relief Valves

UG-136(c)(1) A Manufacturer or Assembler shall demonstrate to the satisfaction of a representative from an ASME designated organization that his manufacturing, production, and testing facilities and quality control procedures will insure close agreement between the performance of random production samples and the performance of those valves submitted for Capacity Certification.

UG-136(c)(2) Manufacturing, assembly, inspection, and test operations including capacity are subject to inspections at any time by a representative from an ASME designated organization

UG-136(c)(3) A Manufacturer or Assembler may be granted permission to apply the UV Code Symbol to production pressure relief valves capacity certified in accordance with UG-131 provided the following tests are successfully completed. This permission shall expire on the fifth anniversary of the date it is initially granted. The permission may be extended for 5 year periods if the following tests are successfully repeated within the 6-month period before expiration.

(a) Two sample production pressure relief valves of a size and capacity within the capability of an ASME accepted laboratory shall be selected by a representative from an ASME designated organization.

(b) Operational and capacity tests shall be conducted in the presence of a representative from an ASME designated organization at an ASME accepted laboratory.

The pressure relief valve Manufacturer or Assembler shall be notified of the time of the test and may have representatives present to witness the test. Pressure relief valves having an adjustable blowdown construction shall be adjusted by the Manufacturer or Assembler following successful testing for operation but prior to flow testing so that the blowdown does not exceed 7% of the set pressure or 3 psi (20 kPa), whichever is greater. This adjustment may be made on the flow test facility.

(c) Should any pressure relief valve fail to relieve at or above its certified capacity or should it fail to meet performance requirements of this Division, the test shall be repeated at the rate of two replacement pressure relief valves, selected in accordance with (c)(3)(a) above, for each pressure relief valve that failed.

(d) Failure of any of the replacement pressure relief valves to meet the capacity or the performance requirements of this Division shall be cause for revocation within 60 days of the authorization to use the Code Symbol on that particular type of pressure relief valve. During this period, the Manufacturer or Assembler shall demonstrate the cause of such deficiency and the action taken to guard against future occurrence, and the requirements of (c)(3) above shall apply.

UG-136(c)(4) Use of the Code Symbol Stamp by an Assembler indicates the use of original, unmodified parts in strict accordance with the instructions of the Manufacturer of the pressure relief valve.

(a) An assembler may transfer original and unmodified pressure relief parts produced by the Manufacturer to other Assemblers provided the following conditions are met:

(1) both Assemblers have been granted permission to apply the V or UV Code Symbol to the specific valve type in which the parts are to be used;

(2) the Quality Control System of the Assembler receiving the pressure relief valve parts shall define the controls for the procurement and acceptance of those parts; and

(3) the pressure relief valve parts are appropriately packaged, marked, or sealed by the Manufacturer to ensure that the parts are:

(a) produced by the Manufacturer; and

(b) the parts are original and unmodified.

(b) However, an Assembler may convert original finished parts by machining to another finished part for a specific application under the following conditions:

(1) Conversions shall be specified by the Manufacturer. Drawings and/or written instructions used for part conversion shall be obtained from the Manufacturer and shall include a drawing or description of the converted part before and after machining.

(2) The Assembler's quality control system, as accepted by a representative from an ASME designated organization, must describe in detail the conversion of original parts, provisions for inspection and acceptance, personnel training, and control of current Manufacturer's drawings and/or written instructions.

(3) The Assembler must document each use of a converted part and that the part was used in strict accordance with the instructions of the Manufacturer.

(4) The Assembler must demonstrate to the Manufacturer the ability to perform each type of conversion. The Manufacturer shall document all authorizations granted to perform part conversions. The Manufacturer and Assembler shall maintain a file of such authorizations.

(5) At least annually a review shall be performed by the Manufacturer of an Assembler's system and machining capabilities. The Manufacturer shall document the results of these reviews. A copy of this documentation shall be kept on file by the Assembler. The review results shall be made available to a representative from an ASME designated organization.

UG-136(c)(5) In addition to the requirements of UG-129, the marking shall include the name of the Manufacturer and the final Assembler. The Code Symbol Stamp shall be that of the final Assembler.

NOTE: Within the requirements of UG-136(c) and (d): A *Manufacturer* is defined as a person or organization who is completely responsible for design, material selection, capacity certification, manufacture of all component parts, assembly, testing, sealing, and shipping of pressure relief valves certified under this Division. An *Assembler* is defined as a person or organization who purchases or receives from a Manufacturer or another Assembler the necessary component parts or pressure relief valves and assembles, adjusts, tests, seals, and ships pressure relief valves certified under this Division, at a geographical location other than and using facilities other than those used by the Manufacturer. An Assembler may be organizationally independent of a Manufacturer or may be wholly or partly owned by a Manufacturer.

UG-136(d) Production Testing by Manufacturers and Assemblers

UG-136(d)(1) Each pressure relief valve to which the Code Symbol Stamp is to be applied shall be subjected to the following tests by the Manufacturer or Assembler. A Manufacturer or Assembler shall have a documented program for the application, calibration, and maintenance of gages and instruments used during these tests.

UG-136(d)(2) The primary pressure parts of each pressure relief valve exceeding NPS 1 (DN 25) inlet size or 300 psi (2100 MPa) set pressure where the materials used are either cast or welded shall be tested at a pressure of at least 1.5 times the design pressure of the parts. These tests shall be conducted after all machining operations on the parts have been completed. There shall be no visible sign of leakage.

UG-136(d)(3) The secondary pressure zone of each closed bonnet pressure relief valve exceeding NPS 1 (DN 25) inlet size when such pressure relief valves are designed for discharge to a closed system shall be tested with air or other gas at a pressure of at least 30 psi (200 kPa). There shall be no visible sign of leakage.

UG-136(d)(4) Each pressure relief valve shall be tested to demonstrate its popping or set pressure. Pressure relief valves marked for steam service or having special internal parts for steam service shall be tested with steam, except that pressure relief valves beyond the capability of the production steam test facility either because of size or set pressure may be tested on air. Necessary corrections for differentials in popping pressure between steam and air shall be established by the Manufacturer and applied to the popping point on air. Pressure relief valves marked for gas or vapor may be tested with air. Pressure relief valves marked for liquid service shall be tested with water or other suitable liquid. When a valve is adjusted to correct for service conditions of superimposed back pressure, temperature, or the differential in popping pressure between steam and air, the actual test pressure (cold differential test pressure) shall be marked on the valve per UG-129. Test fixtures and test drums where applicable shall be of adequate size and capacity to ensure that pressure relief valve action is consistent with the stamped set pressure within the tolerances required by UG-134(d).

04 *UG-136(d)(5)* After completion of the tests required by (d)(4) above, a seat tightness test shall be conducted. Unless otherwise designated by a Manufacturer's published pressure relief valve specification or another specification agreed to by the user, the seat tightness test and acceptance criteria shall be in accordance with API 527.

UG-136(d)(6) Testing time on steam pressure relief valves shall be sufficient, depending on size and design, to insure that test results are repeatable and representative of field performance.

UG-136(e) Design Requirements At the time of the submission of pressure relief valves for capacity certification, or testing in accordance with (c)(3) above, the ASME designated organization has the authority to review the design for conformity with the requirements of UG-136(a) and UG-136(b) and to reject or require modification of designs which do not conform, prior to capacity testing.

UG-136(f) Welding and Other Requirements All welding, brazing, heat treatment, and nondestructive examination used in the construction of bodies, bonnets, and yokes shall be performed in accordance with the applicable requirements of this Division.

UG-137 MINIMUM REQUIREMENTS FOR RUPTURE DISK DEVICES

UG-137(a) Mechanical Requirements

UG-137(a)(1) The design shall incorporate arrangements necessary to ensure consistent operation and tightness.

UG-137(a)(2) Rupture disk devices having threaded inlet or outlet connections shall be designed to allow for normal installation without damaging the rupture disk.

UG-137(b) Material Selections

UG-137(b)(1) The rupture disk material is not required to conform to a material specification listed in ASME Section II. The rupture disk material shall be controlled by the Manufacturer of the rupture disk device by a specification ensuring the control of material properties.

UG-137(b)(2) Materials used in rupture disk holders shall be listed in Section II and this Division. Carbon and low alloy steel holders and bolting (UG-20) subject to in-service temperatures colder than −20°F (−30°C) shall meet the requirements of UCS-66, unless exempted by the following.

(*a*) The coincident ratio defined in Fig. UCS-66.1 is 0.40 or less.

(*b*) The material(s) is exempted from impact testing per Fig. UCS-66.

UG-137(b)(3) Materials used in other parts contained within the external structure of the rupture disk holder shall be one of the following categories:

(*a*) listed in Section II; or

(*b*) listed in ASTM specifications; or

(*c*) controlled by the Manufacturer of the rupture disk device by a specification insuring control of chemical and physical properties and quality at least equivalent to ASTM standards.

UG-137(c) Inspection of Manufacturing of Rupture Disk Devices

UG-137(c)(1) A Manufacturer shall demonstrate to the satisfaction of a representative of an ASME designated organization that its manufacturing, production, and testing facilities and quality control procedures will insure close agreement between the performance of random production samples and the performance of those devices submitted for Certification.

UG-137(c)(2) Manufacturing, assembly, inspection, and test operations are subject to inspections at any time by an ASME designee.

UG-137(c)(3) A Manufacturer may be granted permission to apply the UD Code Symbol to production rupture disk devices certified in accordance with UG-131 provided the following tests are successfully completed.

This permission shall expire on the fifth anniversary of the date it is initially granted. The permission may be extended for five year periods if the following tests are successfully repeated within the 6 month period before expiration.

(a) Two production sample rupture disk devices of a size and capacity within the capability of an ASME accepted laboratory shall be selected by a representative of an ASME designated organization.

(b) Burst and flow testing shall be conducted in the presence of a representative of an ASME designated organization at a place which meets the requirements of UG-131(f). The device Manufacturer shall be notified of the time of the test and may have representatives present to witness the test.

(c) Should any device fail to meet or exceed the performance requirements (burst pressure, minimum net flow area, and flow resistance) of UG-127, the test shall be repeated at the rate of two replacement devices, selected and tested in accordance with (c)(3)(a) and (c)(3)(b) above for each device that failed.

(d) Failure of any of the replacement devices to meet the performance requirements of this Division shall be cause for revocation within 60 days of the authorization to use the Code Symbol on that particular type of rupture disk device design. During this period, the Manufacturer shall demonstrate the cause of such deficiency and the action taken to guard against future occurrence, and the requirements of (c)(3) above shall apply.

UG-137(d) Production Testing by Manufacturers

UG-137(d)(1) Each rupture disk device to which the Code Symbol Stamp is to be applied shall be subjected to the following tests by the Manufacturer. The Manufacturer shall have a documented program for the application, calibration, and maintenance of gages and instruments used during these tests.

UG-137(d)(2) The pressure parts of each rupture disk holder exceeding NPS 1 (DN 25) inlet size or 300 psi (2 100 kPa) design pressure where the materials used are either cast or welded shall be tested at a pressure of at least 1.5 times the design pressure of the parts. These tests shall be conducted after all machining operations on the parts have been completed but prior to installation of the rupture disk. There shall be no visible sign of leakage.

UG-137(d)(3) Each lot of rupture disks shall be tested in accordance with one of the following methods. All tests of disks for a given lot shall be made in a holder of the same form and pressure area dimensions as that being used in service. Sample rupture disks, selected from each lot of rupture disks, shall be made from the same material and of the same size as those to be used in service. Test results shall be applicable only to rupture disks used in disk holders supplied by the rupture disk Manufacturer.

(a) At least two sample rupture disks from each lot of rupture disks shall be burst at the specified disk temperature. The marked burst pressure shall be determined so that the sample rupture disk burst pressures are within the burst pressure tolerance specified by UG-127(a)(1).

(b) At least four sample rupture disks, but not less than 5% from each lot of rupture disks, shall be burst at four different temperatures distributed over the applicable temperature range for which the disks will be used. This data shall be used to establish a smooth curve of burst pressure versus temperature for the lot of disks. The burst pressure for each data point shall not deviate from the curve more than the burst pressure tolerance specified in UG-127(a)(1).

The value for the marked burst pressure shall be derived from the curve for a specified temperature.

(c) For prebulged solid metal disks or graphite disks only, at least four sample rupture disks using one size of disk from each lot of material shall be burst at four different temperatures, distributed over the applicable temperature range for which this material will be used. These data shall be used to establish a smooth curve of percent change of burst pressure versus temperature for the lot of material. The acceptance criteria of smooth curve shall be as in (d)(3)(b) above.

At least two disks from each lot of disks, made from this lot of material and of the same size as those to be used, shall be burst at the ambient temperature to establish the room temperature rating of the lot of disks. The percent change shall be used to establish the marked burst pressure at the specified disk temperature for the lot of disks

UG-137(e) Design Requirements At the time of the inspection in accordance with (c)(3) above, a representative from an ASME designated organization has the authority to review the design for conformity with the requirements of UG-137(a) and UG-137(b) and to reject or require modification of designs which to not conform, prior to capacity testing.

UG-137(f) Welding and Other Requirements All welding, brazing, heat treatment, and nondestructive examination used in the construction of rupture disk holders and pressure parts shall be performed in accordance with the applicable requirements of this Division.

CAPACITY CONVERSIONS FOR SAFETY VALVES

MANDATORY APPENDIX 11
CAPACITY CONVERSIONS FOR SAFETY VALVES

11-1

The capacity of a safety or relief valve in terms of a gas or vapor other than the medium for which the valve was officially rated shall be determined by application of the following formulas:[1]

For steam,

$$W_s = C_N KAP$$

where:

C_N = 51.5 for U.S. Customary calculations
C_N = 5.25 for SI calculations

For air,

$$W_a = CKAP\sqrt{\frac{M}{T}}$$

(U.S. Customary Units)

C = 356
M = 28.97 mol. wt.
T = 520 when W_a is the rated capacity

(SI Units)

C = 27.03
M = 28.97 mol. wt.
T = 293 when W_a is the rated capacity

For any gas or vapor,

$$W = CKAP\sqrt{\frac{M}{T}}$$

where

W_s = rated capacity, lb/hr (kg/h) of steam
W_a = rated capacity, converted to lb/hr (kg/h) of air at 60°F (20°C), inlet temperature
W = flow of any gas or vapor, lb/hr
C = constant for gas or vapor which is function of the ratio of specific heats, $k = c_p/c_v$ (see Fig. 11-1)
K = coefficient of discharge [see UG-131(d) and (e)]
A = actual discharge area of the safety valve, sq in. (sq mm)
P = (set pressure × 1.10) plus atmospheric pressure, psia (MPa_{abs})
M = molecular weight
T = absolute temperature at inlet [(°F + 460) (K)]

These formulas may also be used when the required flow of any gas or vapor is known and it is necessary to compute the rated capacity of steam or air.

Molecular weights of some of the common gases and vapors are given in Table 11-1.

For hydrocarbon vapors, where the actual value of k is not known, the conservative value, $k = 1.001$ has been commonly used and the formula becomes

$$W = CKAP\sqrt{\frac{M}{T}}$$

where

C = 315, for U.S. Customary Calculations
C = 23.95, for SI Calculations

When desired, as in the case of light hydrocarbons, the compressibility factor Z may be included in the formulas for gases and vapors as follows:

$$W = CKAP\sqrt{\frac{M}{ZT}}$$

Example 1

GIVEN: A safety valve bears a certified capacity rating of 3020 lb/hr of steam for a pressure setting of 200 psi.

PROBLEM: What is the relieving capacity of that valve in terms of air at 100°F for the same pressure setting?

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[1] Knowing the official rating capacity of a safety valve which is stamped on the valve, it is possible to determine the overall value of KA in either of the following formulas in cases where the value of these individual terms is not known:

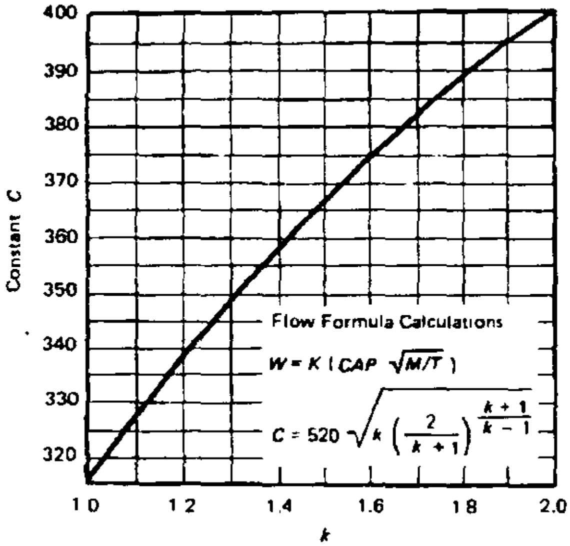
Official Rating in Steam

$$KA = \frac{W_s}{51.5P}$$

Official Rating in Air

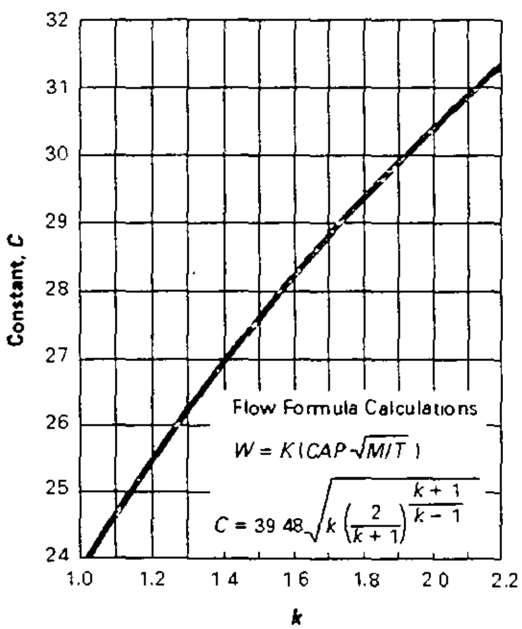
$$KA = \frac{W_a}{CP}\sqrt{\frac{T}{M}}$$

This value for KA is then substituted in the above formulas to determine the capacity of the safety valve in terms of the new gas or vapor.



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	...	...

FIG. 11-1 CONSTANT C FOR GAS OR VAPOR RELATED TO RATIO OF SPECIFIC HEATS ($k = c_p/c_v$)



k	Constant C	k	Constant C	k	Constant C
1.001	23.95	1.26	26.05	1.52	27.80
1.02	24.12	1.28	26.20	1.54	27.93
1.04	24.30	1.30	26.34	1.56	28.05
1.06	24.47	1.32	26.49	1.58	28.17
1.08	24.64	1.34	26.63	1.60	28.29
1.10	24.81	1.36	26.76	1.62	28.40
1.12	24.97	1.38	26.90	1.64	28.52
1.14	25.13	1.40	27.03	1.66	28.63
1.16	25.29	1.42	27.17	1.68	28.74
1.18	25.45	1.44	27.30	1.70	28.86
1.20	25.60	1.46	27.43	2.00	30.39
1.22	25.76	1.48	27.55	2.20	31.29
1.24	25.91	1.50	27.68	...	...

FIG. 11-1M CONSTANT C FOR GAS OR VAPOR RELATED TO RATIO OF SPECIFIC HEATS ($k = c_p/c_v$)

TABLE 11-1
MOLECULAR WEIGHTS OF GASES AND VAPORS

Air	28.97	Freon 22	86.48
Acetylene	26.04	Freon 114	170.90
Ammonia	17.03	Hydrogen	2.02
Butane	58.12	Hydrogen Sulfide	34.08
Carbon Dioxide	44.01	Methane	16.04
Chlorine	70.91	Methyl Chloride	50.48
Ethane	30.07	Nitrogen	28.02
Ethylene	28.05	Oxygen	32.00
Freon 11	137.371	Propane	44.09
Freon 12	120.9	Sulfur Dioxide	64.06

SOLUTION:

For steam

$$W_s = 51.5KAP$$

$$3020 = 51.5KAP$$

$$KAP = \frac{3020}{51.5} = 58.5$$

For air

$$W_a = CKAP\sqrt{\frac{M}{T}}$$

$$= 356\ KAP\sqrt{\frac{28.97}{460 + 100}}$$

$$= (356)(58.5)\sqrt{\frac{28.97}{560}}$$

$$= 4750 \text{ lb/hr}$$

Example 2

GIVEN: It is required to relieve 5000 lb/hr of propane from a pressure vessel through a safety valve set to relieve at a pressure of P_s, psi, and with an inlet temperature at 125°F.

PROBLEM: What total capacity in pounds of steam per hour in safety valves must be furnished?

SOLUTION:

For propane,

$$W = CKAP\sqrt{\frac{M}{T}}$$

The value of C is not definitely known. Use the conservative value, $C = 315$.

$$5000 = 315\ KAP\sqrt{\frac{44.09}{460 + 125}}$$

$$KAP = 57.7$$

For steam,

$$W_s = 51.5\ KAP = (51.5)(57.7)$$

$$= 2970 \text{ lb/hr set to relieve at } P_s, \text{ psi}$$

Example 3

GIVEN: It is required to relieve 1000 lb/hr of ammonia from a pressure vessel at 150°F.

PROBLEM: What is the required total capacity in pounds of steam per hour at the same pressure setting?

SOLUTION:

For ammonia,

$$W = CKAP\sqrt{\frac{M}{T}}$$

Manufacturer and user agree to use $k = 1.33$; from Fig. 11-1, $C = 350$.

$$1000 = 350\ KAP\sqrt{\frac{17.03}{460 + 150}}$$

$$KAP = 17.10$$

For steam,

$$W_s = 51.5\ KAP = 51.5 \times 17.10$$

$$= 880 \text{ lb/hr}$$

Example 4

GIVEN: A safety valve bearing a certified rating of 10,000 cu ft/min of air at 60°F and 14.7 psia (atmospheric pressure).

PROBLEM: What is the flow capacity of this safety valve in pounds of saturated steam per hour for the same pressure setting?

SOLUTION:

For air: Weight of dry air at 60°F and 14.7 psia is 0.0766 lb/cu ft.

$$W_a = 10{,}000 \times 0.0766 \times 60 = 45{,}960 \text{ lb/hr}$$

$$45{,}960 = 356\ KAP\sqrt{\frac{28.97}{460 + 60}}$$

$$KAP = 546$$

For steam,

$$W_s = 51.5\ KAP = (51.5)(546)$$

$$= 28{,}200 \text{ lb/hr}$$

NOTE: Before converting the capacity of a safety valve from any gas to steam, the requirements of UG-131(b) must be met.

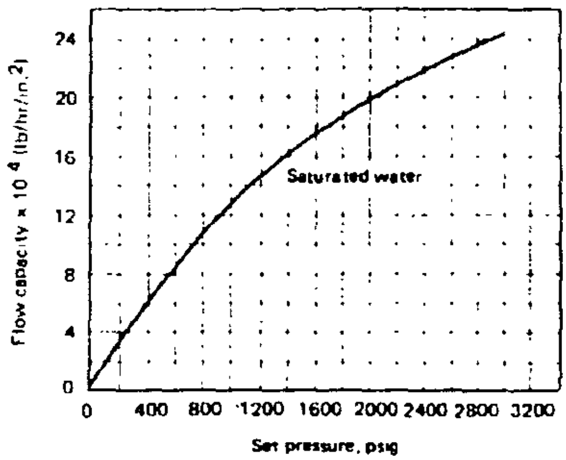


FIG. 11-2 FLOW CAPACITY CURVE FOR RATING NOZZLE TYPE SAFETY VALVES ON SATURATED WATER (BASED ON 10% OVERPRESSURE)

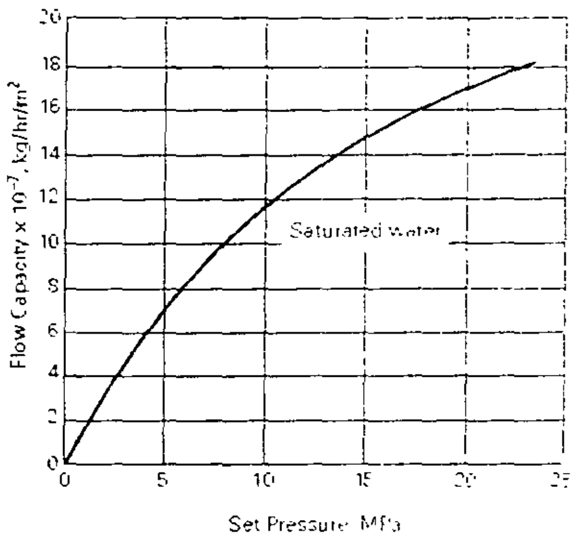


FIG. 11-2M FLOW CAPACITY CURVE FOR RATING NOZZLE TYPE SAFETY VALVES ON SATURATED WATER (BASED ON 10% OVERPRESSURE)

11-2

(a) Since it is realized that the saturated water capacity is configuration sensitive, the following applies only to those safety valves that have a nozzle type construction (throat to inlet diameter ratio of 0.25 to 0.80 with a continuously contoured change and have exhibited a coefficient K_D in excess of 0.90). No saturated water rating shall apply to other types of construction.

NOTE The manufacturer, user, and Inspector are all cautioned that for the following rating to apply, the valve shall be continuously subjected to saturated water. If, after initial relief the flow media changes to quality steam, the valve shall be rated as per dry saturated steam. Valves installed on vessels or lines containing steam–water mixture shall be rated on dry saturated steam.

(b) To determine the saturated water capacity of a valve currently rated under UG-131 and meeting the requirements of (a) above, refer to Fig. 11-2. Enter the graph at the set pressure of the valve, move vertically upward to the saturated water line and read horizontally the relieving capacity. This capacity is the theoretical, isentropic value arrived at by assuming equilibrium flow and calculated values for the critical pressure ratio.

DETERMINATION
OF
CERTIFIED RELIEVING CAPACITIES

DETERMINATION OF CERTIFIED RELIEVING CAPACITIES

1.0 GENERAL

To determine the relieving capacity which should appear on a valve set between the maximum and minimum listed set pressures:

1.1 For the coefficient method - use the formula as applicable for the Code section and the coefficient and area given for the particular design of valve.

1.2 For the slope method - calculate using the slope given

Listed below are the equations used to calculate pressure relief valve capacities that were certified by the coefficient or slope methods.

2.0 SAFETY VALVES FOR POWER BOILERS (Section I):

2.1 Coefficient Method Formula.

for nozzle.................. $W = (51.5\ APK)$

for flat seat................. $W = (51.5\pi\ DLPK)$

for 45° seat. .... $W = (51.5\pi\ DLPK)\ (.707)$

For steam at pressures over 1500 psi and up to 3200 psi the value W of the certified relieving capacity shall be multiplied by:

$$\frac{0.1906P - 1000}{0.2292P - 1061}$$

Where W = rated capacity, pounds dry saturated steam per hour

A = actual discharge area through the valve at developed lift, square inches

D = seat diameter, inches

K = certified coefficient

L = lift, inches

P = (stamped set pressure + 2 psi or 3%, whichever is greater) + 14.7, psia

2.2 Slope Method Formula:

The values of slope given have units lbs per hour per psia.

W = slope x (stamped set pressure + 2 psi or 3%, whichever is greater + 14.7, psia)

3.0 SAFETY VALVES FOR NUCLEAR VESSELS (Section III):

3 1 Coefficient Method Formula:

Steam:

for nozzle..................W = (51.5 APK)

for flat seat................W = (51.5π DLPK)

for 45° seat......... .....W = (51.5π DLPK) (.707)

For steam at pressures over 1500 psi and up to 3200 psi the value W of the certified relieving capacity shall be multiplied by

$$\frac{0.1906P - 1000}{0.2292P - 1061}$$

Where W = rated capacity, pounds dry saturated steam per hour

For Air:. .... W = 18.331APK @ 60°F and 14.7, psia

For Gas................W = CAPK $\sqrt{M/T}$

For liquid (water) ..W = 4 814AK $\sqrt{w(P-P_d)}$

Where W = rated capacity, lbs/hr (dry saturated steam), SCFM (air), lbs/hr (gas or vapor), GPM (water)

A = actual discharge area through the valve at developed lift, square inches

C = constant for gas or vapor based on the ratio of specific heats C_p/C_v

D = seat diameter, inches

K = certified coefficient

L = lift, inches

M = molecular weight

P = (stamped set pressure + 3%) + 14.7, psia (for Class 1, 2 and 3 main

-OR-

P = (stamped set pressure + 2 5 psi or 10%, whichever is greater) + 14.7, psia (For air, gas, or steam valves other than main steam)

P_d = pressure at discharge from valve, psia

T = absolute temperature at inlet, °R (degrees Fahrenheit + 460)

w = 62.3058 lbs/ft^3, specific weight of water @ 70°F

3.2 Slope Method Formula:

The values of slope given have the units SCFM or lbs. per hour per psia.

W =slope x (set pressure + 3% + 14.7, psia), (for Class 1, 2 and 3 main stream valves)

W = slope x [(set pressure + 2.5 psi or 10%, whichever is greater) + 14.7, psia], (For air, gas, or steam other than main steam)

For Liquid (water).

$W = F \sqrt{(P - P_d)}$ where F = flow factor

The flow factor is a rating number for liquid service determined by a test. It is equal to the capacity in gallons per minute divided by the square root of the differential flowing pressure. It is equivalent to the "slope" for an air or steam valve.

4.0 SAFETY AND SAFETY RELIEF VALVES FOR HEATING BOILERS (Section IV).

4.1 Coefficient Method Formula.

for nozzle .... W = (51.5APK)

for flat seat................. W = (51.5πDLPK)

for 45° seat............... W = (51.5πDLPK) (.707)

Where W = rated capacity, pounds dry saturated steam per hour

A = actual discharge area through the valve at developed lift, square inches

D = seat diameter, inches

K = certified coefficient

L = lift, inches

P = (15 + 33.3%) + 14.7, psia = 34.7, psia for 15 psi steam safety valves

-OR-

P = (stamped set pressure + 10%) + 14.7, psia for safety relief valves for hot water boilers

4.2 Slope Method Formula:

The values of slope given have the units of BTUs per hour per psia or lbs per hour per psia

W = slope (set pressure + 10% + 14.7, psia)

5.0 SAFETY VALVES FOR PRESSURE VESSELS (Section VIII, Divisions 1 & 2)

5.1 Coefficient Method Formula:

For Steam:

for nozzle.................W = (51.5 APK)

for flat seat.................W = (51.5πDLPK)

for 45° seat...............W = (51.5πDLPK) (.707)

For steam at pressures over 1500 psi and up to 3000 psi the value W of the certified relieving capacity shall be multiplied by.

$$\frac{0.1906P - 1000}{0.2292P - 1061}$$

For Air: W = 18.331APK @ 60°F and 14.7, psia

For Gas or Vapor: $W = CKAP \sqrt{M/T}$

For Liquid (water): $W = 4.814AK \sqrt{w(P - P_d)}$

Where W = rated capacity, lbs/hr (dry saturated steam), SCFM (air), lbs/hr (gas or vapor), GPM (water)

A = nozzle throat area, square inches

C = constant for gas or vapor based on ratio of specific heats C_p/C_v

D = seat diameter, inches

K = certified coefficient

L = lift, inches

M = molecular weight

P = (stamped set pressure + 3 psi or 10%, whichever is greater) + 14.7, psia

-OR-

P = (stamped set pressure + 20%) + 14.7, psia for test per UG - 131(c)(2)

P_d = pressure at discharge from valve, psia

T = absolute temperature at inlet, °R (degrees Fahrenheit + 460)

w = 62.3058 lbs/ft^3, specific weight @ 70°F

5.2 Slope Method Formula:

The values of slope given have the units SCFM or lbs. per hour per psia.

W = slope x [(set pressure + 10%) + 14.7, psia

-OR-

W = slope x [(stamped set pressure + 20%) + 14.7, psia for test per UG-131(c)(2)

For Liquid (water) $W = F \times \sqrt{(P - Pd)}$

Where F = flow factor

The flow factor is a rating number for liquid service determined by a test It is equal to the capacity in gallons per minute divided by the square root of the differential flowing pressure It is equivalent to the "slope" for an air or steam valve.

5.3 Flow Resistance (Non-reclosing devices)

Device designs certified by the Flow Resistant method are not marked with a relieving capacity value The certified flow resistance appears on the nameplate and is to be used when determining total flow resistance of the pressure relief system and the flowing capacity it will relieve through the use of accepted engineering practices. Unless otherwise noted, the pressure drop across a certified non-reclosing device shall be calculated using dimensions for standard pipe (STD).

For pressure relief systems discharging directly to atmosphere which includes a non-reclosing device installed within 8 pipe diameters of the vessel nozzle and having a discharge pipe no longer than 5 pipe diameters, system capacity is determined from the equations found in 5.1 above using the minimum net flow area marked on the nameplate and an assumed coefficient of discharge equal to 0.62.

UNIVERSIDAD NACIONAL AUTONOMA DE MÉXICO
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DATOS DEL INSTRUCTOR

ING. ORLANDO R. RIVERA

Tel. / Fax: (55) 5776-6524 ; E-mail: orlanriver@hotmail.com

Es Ingeniero Mecánico Titulado egresado de la Escuela Superior de Ingeniería Mecánica y Eléctrica del Instituto Politécnico Nacional. Cuenta con una experiencia profesional de más de 20 años en diseño, fabricación, inspección, prueba, certificación, montaje y reparación de calderas, recipientes a presión, sistemas de tubería y componentes nucleares. Ha calificado ante el Gobierno de Texas, Ohio, Pennsylvania y The National Board of Boiler and Pressure Vessel inspectors de Norte America como Inspector Autorizado, Supervisor de Inspectores Autorizados e Inspector Nuclear Autorizado de ASME.
Ha sido asesor de más de 40 empresas en México, Colombia, Venezuela, Brasil y Argentina en Sistemas y Certificaciones de ASME y National Board.
Ha impartido el Diplomado de Ingeniería de Calderas y Recipientes a Presión en la División de Educación Continua de la Facultad de Ingeniería de la Universidad Nacional Autónoma de México, y ha presentado ponencias en Talleres Internacionales de Capacitación en Calderas, Recipientes a Presión y Temas Afines de la Asociación Mexicana de Ingenieros Mecánicos y Electricistas, A.C. (AMIME). Actualmente es Presidente del Comité de Calderas y Recipientes a Presión de AMIME y Consultor de varias compañías nacionales e internacionales.

2004.