where
\[ A = \text{actual minimum discharge area through the valve at developed lift} \]
\[ P = \left(\text{set pressure} \times 1.10\right) + \text{atmospheric pressure, psia (kPa abs), or set pressure plus 3 psi (0.02 MPa)} + \text{atmospheric pressure, whichever is greater} \]
\[ P_d = \text{pressure at discharge from valve} \]
\[ w = \text{density of water at valve inlet conditions} \]
\[ W_t = \text{Theoretical Flow} \]

The average of the coefficients of discharge \( K_d \) of the tests shall be multiplied by 0.90 and the product shall be taken as the coefficient \( K \) of the design. The coefficient of the design shall not be greater than 0.878 (the product of 0.9 \times 0.975).

(b) If any of the experimentally determined coefficients fall outside of a range of \( \pm 5\% \) of the average coefficient, the unacceptable valves shall be replaced by two valves of the same size and set pressure. Following the testing of these valves, a new average coefficient shall be determined, excluding the replaced valve test results. If any individual coefficient is now outside of the \( \pm 5\% \) range, then the test shall be considered unsatisfactory and shall be cause for the ASME designated organization to refuse certification of the particular valve design.

NC-7744.3 Calculation of Certified Capacity.

(a) The certified capacity of all sizes and pressures of a given design for which the value of \( K \) has been established under the provisions of NC-7744.2 shall not exceed the value calculated by the theoretical equation above multiplied by the coefficient \( K \).

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

NC-7745 Single Valve Method

Where a single valve at a single pressure is to be capacity tested, the capacity rating may be based on three separate tests of the single valve at the specified set pressure. The certified capacity rating of the valve shall not exceed 90% of the average capacity established by the tests. Failure of the individual test capacities to fall within \( \pm 5\% \) of the average capacity may be cause for rejection of the test. The reason for the failure shall be determined and the test repeated.

Should additional valves of the same design be constructed at a later date, the results of the tests on the original valve may be included as applicable to the particular test method selected.

NC-7746 Laboratory Acceptance of Pressure Relieving Capacity Tests

Tests shall be conducted at a place where the testing facilities, methods, procedures, and Authorized Observer (person supervising the tests) meet the applicable requirements of ASME PTC 25-2001, Pressure Relief Devices. 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 Boiler and Pressure Vessel Committee on recommendation from a representative from an ASME designated organization. Acceptance of the testing facility is subject to review within each 5-year period. Capacity test data shall be submitted to the ASME designated organization for review and acceptance.

NC-7747 Proration of Capacity

(a) The capacity of a pressure relief valve applied to a system may be prorated to an overpressure greater than the overpressure for which the valve design is certified. This overpressure shall be within the allowable limits of the system.

(b) Depending on the method used for the initial capacity certification:

1. The prorated capacity shall be 90% of the average slope determined in NC-7743 multiplied by the prorated relieving pressure (psia); or
2. The prorated capacity shall be calculated using the appropriate equation from NC-7744.2 [where \( P \) is the prorated relieving pressure (psia) multiplied by the coefficient \( K \)].

NC-7748 Capacity Conversion

The rated pressure relieving capacity of pressure relief valves for liquids other than the liquids used for certification shall be determined by the method of conversion given in Appendix XVIII-1000. This conversion is not valid for liquid flashing valve operating conditions.

NC-7750 CAPACITY CERTIFICATION OF VACUUM RELIEF VALVES

NC-7751 General Requirements

NC-7751.1 Capacity Certification. Capacity certification procedures shall be as required in NC-7752 through NC-7755.

NC-7751.2 Test Media. Capacity certification tests for vacuum relief valves for air and gas service shall be conducted with dry steam, air, or gas. For steam test purposes the limits of 98% minimum quality and 20°F (10°C) maximum superheat shall apply. Capacity shall be corrected to dry saturated condition from these limits.

NC-7751.3 Test Method and Pressure. Capacity tests may be conducted by pressurizing the valve instead of using a vacuum, provided the inlet conditions of the valve...
(b) The coefficient shall not be applied to valves whose beta ratio (the ratio of valve throat and inlet diameter) lies outside the range of 0.15 to 0.75, unless tests have demonstrated that individual coefficients of discharge, \( K_d \), for valves of the extreme ends of a larger range is within ±5% of the average coefficient, \( K \). For designs where lift is used to determine the flow area, all valves shall have the same nominal lift-to-seat diameter ratio \( (L/D) \).

NC-7755 Laboratory Acceptance of Relieving Capacity Tests

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 25-2001, Pressure Relief Devices. 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 Boiler and Pressure Vessel Committee on recommendation from a representative from an ASME designated organization. Acceptance of the testing facility is subject to review within each 5-year period. Capacity test data shall be submitted to the ASME designated organization for review and acceptance.

NC-7760 Capacity Determination of Rupture Disk Devices

NC-7761 General Requirements

NC-7761.1 Test Media.

(a) Capacity tests of rupture disk devices for steam service shall be conducted with dry saturated steam. For test purposes, the limits of 98% minimum quality and 20°F (-10°C) maximum superheat shall apply. Capacity shall be corrected to the dry saturated condition from within these limits.

(b) Capacity tests for rupture disk devices for air and gas service shall be conducted with air, gas, or dry saturated steam.

NC-7761.2 Test Pressure.

(a) Capacity tests of rupture disk devices shall be conducted at a pressure not exceeding 110% of the stamped burst pressure.

(b) Capacity tests of rupture disk devices used at the inlet side of pressure relief valves shall be conducted at a pressure not exceeding 110% of the valve set pressure.

NC-7762 Capacity Determination of Rupture Disk Devices in Combination With Pressure Relief Valves

NC-7762.1 Capacity Determination Without Flow Test.

(a) The rated capacity of the combination of a pressure relief valve when installed with a rupture disk device at the inlet side of the valve shall not exceed 80% of the certified capacity of the valve. Alternatively, the capacity of such a combination shall be established in accordance with NC-7762.2.

(b) The rated capacity of the combination of a pressure relief valve when installed with a rupture disk device at the outlet of the valve shall be the certified capacity of the valve.

NC-7762.2 Capacity of Pressure Relief Valves in Combination With a Rupture Disk Device at the Inlet.

For each combination of pressure relief valve design and rupture disk device design, the Certificate Holder or the rupture disk device manufacturer shall have the capacity of the combination determined as prescribed in (a) and (b) below.

(a) The Certificate Holder or the rupture disk device manufacturer shall 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.

(b) Tests shall be performed in accordance with the requirements of (1) through (5) below. The rupture disk device and pressure relief valve combination to be tested shall be arranged to duplicate the combination assembly design.

1. The test shall be made using the minimum burst pressure of the rupture disk device design that is to be used in combination with the pressure relief valve design. The stamped bursting pressure shall be between 90% to 100% of the stamped set pressure of the valve.

2. The test procedure to be used shall be as follows:
   (a) The pressure relief valve by itself shall be tested for capacity without the rupture disk device at a pressure 10% above the valve set pressure.
   (b) The rupture disk device shall then be installed in front of the pressure relief valve and the disk burst to operate the valve. The capacity test shall be performed on the combination at 10% above the valve set pressure duplicating the test of (a) above.

3. The 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 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.

4. From the results of the tests, a Combination Capacity Factor shall be determined. The Combination Capacity Factor is the ratio of the average capacity which is determined by the combination tests to the capacity which is determined by the test of (2)(a) above. The Combination Capacity Factor shall be used as a multiplier to the certified capacity of the pressure relief valve in all sizes of the design, except when a different factor has been established for larger sizes and other pressures in accordance with NC-7762.3. The value of the Combination Capacity Factor
Factor shall not be greater than one. The Combination Capacity Factor shall apply only to combinations of the same design and manufacture of the pressure relief valve and the same design and manufacture of the rupture disk device as those tested.

(5) The test laboratory shall submit the test results to an ASME designated organization for acceptance of the Combination Capacity Factor.

**NC-7762.3 Optional Testing of Rupture Disk Devices and Pressure Relief Valves.**

(a) If desired, a Certificate Holder or a rupture disk manufacturer may conduct tests in the same manner as given in NC-7762.2 using the next two larger sizes of the same 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 approved, it may be used for all larger sizes of the combination, but the Factor shall not be greater than one.

(b) If desired, additional tests may be conducted at higher pressures in accordance with NC-7762.2 to establish a maximum Combination Capacity Factor to be used at all pressures higher than the highest tested, but the Factor shall not be greater than 1.

**NC-7763 Capacity of Rupture Disk Devices**

**NC-7763.1 Calculated Capacity.**

(a) The calculated capacity of a rupture disk device shall not exceed a value based on the applicable theoretical equation (Appendix XVIII) for the various media multiplied by a value for $K$ of 0.62. The area $A$ in the theoretical equation shall be the minimum net flow area existing after disk burst.

(b) 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.

**NC-7763.2 Tested Capacity.** A manufacturer may have the capacity of a given rupture disk device design approved for $K_D$ in general accordance with the procedures of NC-7730, as applicable.

**NC-7764 Laboratory Acceptance of Pressure Relieving Capacity Tests**

Tests shall be conducted at a place where the testing facilities, methods, procedures, and Authorized Observer (person supervising the tests) meet the applicable requirements of ASME PTC 25-2001, Pressure Relief Devices. 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 Boiler and Pressure Vessel Committee on recommendation of an ASME designee. Acceptance of the testing facility is subject to review within each 5 year period. Capacity test data shall be submitted to the ASME designee for review and acceptance.

**NC-7800 MARKING, STAMPING WITH CERTIFICATION MARK, AND DATA REPORTS**

**NC-7810 PRESSURE AND VACUUM RELIEF VALVES**

**NC-7811 Marking and Stamping with Certification Mark**

Each pressure relief valve shall be plainly marked by the Certificate Holder with the required data below in such a way that the marking will not be obliterated in service. The data shall be in characters not less than $\frac{3}{16}$ in. (2.5 mm) high. The marking shall be placed on the valve or on a nameplate securely fastened to the valve. The Certification Mark with NV Designator shall be stamped on the valve or nameplate, but the other required data may be stamped, etched, impressed, or cast. The marking shall include the following:

(a) name, or an acceptable abbreviation, of the Certificate Holder

(b) Certificate Holder's design or type number

(c) size ___ NPS (DN) of the valve inlet

(d) set pressure ___ psi (kPa)

(e) certified capacity and overpressure in percent or psi (kPa) in accordance with NC-7700

(1) Pressure Relief Valves

(-a) lb/hr (kg/hr) of saturated steam for valves certified on steam, or

(-b) scfm (standard cubic feet per minute) at 60°F (15°C) and 14.7 psia (101 kPa abs) of air for valves certified on air or gas, or

(-c) gal/min (m³/s) of water at 70°F (20°C) for valves certified on water

(2) Vacuum Relief Valves: scfh (standard cubic feet per hour) at 60°F (15°C) and 14.7 psi (101 kPa)

(f) applicable official Certification Mark, as shown in Table NCA-8100-1

In addition to the above, each pressure relief valve shall have a separate nameplate attached to the component that includes the marking requirements of NCA-8220 and NC-3593.2.

**NC-7812 Report Form for Pressure and Vacuum Relief Valves**

A Data Report Form NV-1 shall be filled out and signed by the Certificate Holder and signed by the Inspector for each pressure and vacuum relief valve stamped with the Certification Mark with NV Designator.
72 A **nonreclosing pressure relief device** is a pressure relief device designed to remain open after operation.
73 A **safety valve** is a pressure relief valve actuated by inlet static pressure and characterized by rapid opening or pop action.
74 A **safety relief valve** is a pressure relief valve characterized by rapid opening or pop action, or by opening generally proportional to the increase in pressure over the opening pressure.
75 A **relief valve** is a pressure relief valve actuated by inlet static pressure and having a gradual lift generally proportional to the increase in pressure over the opening pressure.
76 A **pilot-operated pressure relief valve** is a pressure relief valve in which the major relieving device is combined with and controlled by a self-actuated auxiliary pressure relief valve.
77 A **power-actuated pressure relief valve** is a pressure relief valve in which the major relieving device is combined with and controlled by a device requiring an external source of energy.
78 A **vacuum relief valve** is a pressure relief device designed to admit fluid to prevent an excessive internal vacuum; it is designed to reclose and prevent further flow of fluid after normal conditions have been restored.
79 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.
80 **Expected system pressure transient conditions** are those associated with normal system transient operation.
81 **Unexpected system excess pressure transient conditions** are those associated with unusual or abnormal system transients, but still considered to be within the design basis.
82 A pressure relief valve that has no protrusions in the bore and wherein the valve disk lifts to an extent sufficient for the minimum area, at any section at or below the body seat, to become the controlling orifice.
83 The specified disk temperature supplied to the rupture disk manufacturer shall be the temperature of the disk when the disk is expected to burst.
84 The **manufacturing design range** is a range of pressure within which the stamped burst pressure must fall. This range is included in the Design Specification and the Overpressure Protection Report.

85 A **lot of rupture disks** is those disks manufactured of material at one time, of the same size, thickness, type, heat, and manufacturing process including heat treatment.
86 Rupture disks will not burst at Design Pressure if back pressure builds up in the space between the two rupture disks. This will occur should leakage develop in the rupture disk due to corrosion or other causes.
87 Valve capacities are published in “Pressure Relief Device Certifications.” This publication may be obtained from the National Board of Boiler and Pressure Vessel Inspectors, 1055 Grupper Avenue, Columbus, OH 43229.
88 In lieu of marking all of the listed items on the flange or tab of each rupture disk, the marking may consist of a manufacturer’s coding number sufficient to identify each rupture disk with a certificate or tab that includes the required information and is supplied with each lot of rupture disks.