DETERMINATION OF CERTIFIED RELIEVING CAPACITIES

1.0 GENERAL

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

1.2 For the slope or flow factor method – calculate using the slope or flow factor given.

1.3 Valves certified by the single valve method or three valve average have the certified capacity listed.

2.0 SAFETY VALVES FOR POWER BOILERS (Section I):

2.1 Coefficient Method Formula:

For nozzle…….. W = (51.5 APK)

For flat seat (low lift)……. W = (51.5π DLPK)

For 45º 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

A = actual discharge area through the valve at developed life, 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 of lbs. per hour per psia.

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

2.3 For superheated conditions the capacity shall be calculated by multiplying the capacity as determined in 2.1 or 2.2 by the appropriate K_{sh} factor found in Section I table PG-68.7.

2.4. For pressures over 1500 psig and up to 3200 psig the capacity shall be calculated by multiplying the capacity as determined in 2.1 or 2.2 by the following only if the correction factor is greater than 1.0:

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

2.5 For pressures over 3200 psig the capacity shall be calculated by multiplying the capacity as determined in 2.1 or 2.2 by the appropriate K_{sc} factor found in Section I table PG-69.2.3.

3.0 SAFETY VALVES FOR NUCLEAR VESSELS (Section III):

3.1 Coefficient Method Formula:

Steam:

For nozzle…….. W = (51.5 APK)

For flat seat (low lift)……. W = (51.5π DLPK)

For 45º seat……W = (51.5π DLPK) (.707)

For steam at pressures over 1500 psi and up to 3200 psi the valve 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 @ 60ºF and 14.7, psia
For Gas……... W = CAPK √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 stream)

P_d = pressure at discharge from valve, psia

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

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

3.2 Slope Method Formula:

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

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

W = slope x [(set pressure + 3 psi or 10%, whichever is greater) + 14.7, psia], (For air, gas, or steam over than main stream)

For Liquid (water):

$W = F \times \sqrt{(P - P_d)}$ 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.

3.3 Values less than 15 psig and Vacuum Relief Valves:

Consult ASME Code Section III subsections NC, ND, or NE for applicable capacity equations.

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

4.1 Coefficient Method Formula:

For nozzle…….. W = (51.5 APK)

For flat seat…….. W = (51.5π DLPK)

For 45º seat…….. W = (51.5π DLPK) (.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 x (set pressure + 10% + 14.7, psia)

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

5.1 Coefficient Method Formula:

For Steam:

For nozzle…….…… W = (51.5 APK)

For flat seat……..…W = (51.5π DLPK)

For 45º seat……..…. W = (51.5π DLPK) (.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 @ 60ºF 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 psia or 10%, whichever is greater) + 14.7, psia

- OR –

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

Pd = pressure at discharge from valve, psia

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

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

5.2 Slope Method Formula:

The values of slope given have units of 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):

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

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 Resistance method are not marked with a relieving capacity value. The certified flow resistance (K_{rg}, K_{rl}, K_{rgl}) 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. The flow resistance subscripts “g,” “l,” or “gl” indicate that the device has been certified for gas (k_{rg}), liquid (K_{rl}), or both gases and liquids (K_{rgl}). 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 can be determined from the equations found in 5.1 above using the minimum net flow area (MNFA) marked on the nameplate and an assumed coefficient of discharge equal to 0.62.