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*Content Based*
*Chemical Engineering*

# Relief Valve(s) - Conventional Steam, Liquid, & Gas/Vapor Relief

**BASIS:** Sizing Relief Valves; based on "Alternate Sizing Method for Relief Valves" - ASME Pressure Vessel Code, Sec. VIII, Div.I, App.XI. Calculations for overpressure and viscosity correction factors are from fitted equations.

**NOTES:** Always begin a new case by retrieving the original file. Direct entry of data in cells that originally contain table lookups could cause functions to be lost, or incorrect calculations. I format cells requiring entry colored **RED**; calculated values are black.

## · Relief Valve - Steam

1.) Enter the identification at [C4].
2.) Enter the required flow of steam at [E6].
3.) Enter set pressure at [E7].
4.) Enter valve's discharge back-pressure [E8]. Assure the specific volume is correct for the lower discharge relieving pressure, many discharge lines are undersized due to this detail.
5.) Enter the percent over pressure at [E9].
6.) The temperature for saturated steam is looked up from the steam tables and shown at [E10]. If a "super-heated" value is necessary manually enter this temperature at [E10].
7.) The "super-heat" sizing factor is looked up from the tables, based on the entered press/temp relationship.
8.) The "NAPIER" sizing factor is calculated and shown at [E12].
9.) The "absolute relieving pressure" is calculated and shown at [E13].
10.) Required area "A" is calculated and shown at [F16]. After selecting a valve that provides this minimum area, enter its MAXIMUM rate at [E21]. The valve's percent utilization is shown at [D22] for its maximum capacity to allow more effective change control decision making.
11.) Also calculated and shown at [G29] is the valve's reaction forces required for stress analysis.

## · Relief Valve - Liquid

1.) Enter the identification at [C4].
2.) Enter fluid name at [C5], use [=], then go to liquid table. eg. [=A88] is "WATER", or directly enter if not in the table.
3.) Enter the required flow at [D7], in mass units the equivalent volumetric flow will show at [G7].
4.) If the liquid [C5], is in the liquid table, a representative specific gravity will show at [D9], otherwise directly directly enter it at [D9]. Check that the sp. gr. value is appropriate for the particular application. The same conditions apply for the viscosity located at [G9].
5.) Enter the required set-pressure at [E11].
6.) Enter valve's discharge back-pressure [E12].
7.) Enter the percent over pressure at [E13].
8.) The overpressure sizing factor will be calculated and shown at [E14].
9.) The specific gravity sizing factor will be calculated and shown at [E15].
10.) The viscosity correction factor will be calculated and shown at [E16].
11.) Required area "A" is calculated and shown at [G20]. After selecting a valve that provides this minimum are enter this valve's MAXIMUM rate at [E25]. The valve's percent utilization is shown at [D26] for its maximun capacity to allow more effective change control decision making.
12.) Enter the relief valve discharge nozzle nominal size at [G29]. This valve's reaction forces are calculated and

## · Relief Valve - Gas/Vapor

1.) Enter the identification at [C4].
2.) Enter fluid name at [C5], use [=], then go to fluid table. eg. [=A62] is "METHYL ALCOHOL", or directly ente
Enter the gas temperature at [D8].
3.) The gas molecular weight will be looked up and reflected at [D9], if in the table, otherwise enter directly.
4.) Enter set pressure at [F10].
5.) Enter valve's discharge back-pressure at [F11].
6.) Enter the percent over pressure at [F21].
Data for cells [F13:F16] is calculated if the gas is in the tables, if not enter directly in the appropriate cell.
Manual entry will over-write the built-in lookup functions; DO NOT SAVE THE FILE WITH THE SAME NAME.
7.) Required area "A" is calculated and shown at [F19]. After selecting a valve that provides this minimum area enter this valve's MAXIMUM rate at [E24]. The valve's percent utilization is shown at [D25] for its maximun capacity to allow more effective change control decision making.
8.) Also calculated and shown at [G32] is the valve's reaction forces required for stress analysis.

***Print out using direct EXCEL commands.***



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4/24/2004

# Relief Valve - Conventional Steam Relief - Find Area

**SERVICE:** Yankee Dryer Protection; PSV-616046

| | | |
|---|---|---|
| Steam Flow Rate : | 21300 | lb/hr |
| Set Pressure : | 100 | psig |
| Back Pressure : | 0 | psig |
| Over Pressure : | 10 | % |
| Steam Temperature : | 337.88 | °F |
| Super Heat Factor : | 1.00 | Ksh |
| Napier Correction Factor : | 1.00 | Kn |
| Absolute Relieving Pressure : | 124.7 | P, psia |

$$A := \frac{W_s}{49 \cdot P \cdot K_{sh} \cdot K_n} = 3.486 \text{ sq in}$$

**SELECTION:**

- Valve MAXIMUM Capacity: 23600 lb/hr
- This Valve will be @ 90.3% of its design capacity.
- Reaction forces, for this maximum discharge rate are ……

$$F := \frac{\left[ W \cdot \sqrt{\frac{(k \cdot T)}{(k+1) \cdot M_w}} \right]}{366} = 322.58 \text{ lbs.}$$

4/24/2004

# Relief Valve - Conventional Steam Relief - Find Area

**SERVICE:** Yankee Dryer Protection; PSV-616046

| | | |
|---|---|---|
| Steam Flow Rate : | 2.6837549 | kg/sec |
| Set Pressure : | 379211.65 | Pa |
| Back Pressure : | 32405.359 | Pa |
| Over Pressure : | 3 | % |
| Steam Temperature : | 287.07 | °K |
| Super Heat Factor : | 1.00 | Ksh |
| Absolute Relieving Pressure : | 458535.83 | Pa..abs |

$$A := \frac{720 \cdot W_s}{P \cdot K_{sh}} = 0.004214 \text{ sq. meter}$$

**SELECTION:**

- Valve MAXIMUM Capacity: 2.9734534 kg/sec
- This Valve will be @ 90.3% of its design capacity.
- Reaction forces, for this maximum discharge rate are ……

$$F_R := 129 \cdot W \cdot \sqrt{\frac{(k \cdot T)}{(k+1) \cdot MW}} = 1038.86 \text{ newton}$$

4/24/2004

# Relief Valve - Convential Liquid ASME Code, Find Area

**VALVE:** Seal Water System Protection; 6G-091
**SERVICE:** WATER

| | | | | | |
|---|---|---|---|---|---|
| Liquid Flow Rate : | 120000 | lb/hr | vol, VL : | 240 | gpm |
| Temperature : | 70 | ºF | temp, abs : | 530 | ºR |
| Specific Gravity : | 1.000 | | viscosity, μ | 0.974224 | cps |

| | | |
|---|---|---|
| Set Pressure : | 180 | psig |
| Back Pressure : | 0 | psig |
| % Overpressure : | 10 | % |
| Overpressure Sizing Factor : | 0.6 | Kp |
| Specific Gravity Sizing Factor : | 1.00 | Kg |
| Viscosity Correction Factor : | 1.00 | Ku |

$$A := \frac{V_L}{24.3 \cdot K_p \cdot K_g \cdot K_u \cdot \sqrt{(1.25 \cdot P_1) - P_2}} = 1.097 \text{ in}^2$$

**SELECTION:**

- Valve MAXIMUM Capacity 295 gpm.
- This Valve will be @ 81.4% of its design capacity.
- Reaction forces, for this maximum discharge rate are .....

Relief Valve Discharge Dia. = 2.067 inches

$$F_R := \frac{\left(0.00176 \cdot SG \cdot GPM^2\right)}{D^2} = 35.85 \text{ lbs.}$$

# Relief Valve - Convential Liquid ASME Code, Find Area

**VALVE:** Seal Water System Protection; 6G-091
**SERVICE:** WATER

| | | | | | |
|---|---|---|---|---|---|
| Liquid Flow Rate : | 15.119746 | kg/sec | vol, VL : | 0.015119746 | $m^3$/sec |
| Temperature : | 21.111111 | ºC | temp, abs : | 294.261111 | ºK |
| Specific Gravity : | 1.000 | | viscosity, μ | 9.74224E-07 | $m^2$/sec |

| | | |
|---|---|---|
| Set Pressure : | 1241056.3 | Pa |
| Back Pressure : | 0 | Pa |
| % Overpressure : | 10 | % |
| Overpressure Sizing Factor : | 0.6 | Kp |
| Specific Gravity Sizing Factor : | 1.000 | Kg |
| Viscosity Correction Factor : | 1.000 | Ku |

$$A := \frac{34.9 \cdot V_L}{K_p \cdot K_g \cdot K_u \cdot \sqrt{(1.25 \cdot P_1) - P_2}} = 0.000706103 \text{ meter}^2$$

**SELECTION:**

- Valve MAXIMUM Capacity : 0.0186116 $m^3$/sec
- This Valve will be @ 81.2% of its design capacity.
- Reaction forces, for this maximum discharge rate are .....

Relief Valve Discharge Dia. = 0.05248 meter

$$F_R := \frac{(1268 \cdot SG \cdot V_L^2)}{D^2} = 159.477491 \text{ newton}$$

4/24/2004

# Relief Valve - Vapors and Gases LB/HR, Find Area

**VALVE:** TEST
**SERVICE:** HYDROGEN BROMIDE

| | | | | | |
|---|---|---|---|---|---|
| Gas Flow Rate : | 91600 | lb/hr | Vol, $V_G$ : | 7287.4 | scfm |
| Temperature : | 282.2 | °F | Temp, abs : | 742.2 | °R |
| Gas Molecular Weight : | 80.92 | MW | Spec Heat : | 1.42 | Ratio |

| | | |
|---|---|---|
| Set Pressure : | 100 | psig |
| Back Pressure : | 0 | psig |
| Over Pressure : | 10 | % |
| Molecular Weight Sizing Factor : | 8.9956 | Km |
| Temperature Sizing Factor : | 0.8370 | Kt |
| Specific Heat Sizing Factor : | 1.1359 | Kc |
| Absolute Relieving Pressure : | 124.70 | psia |

$$A := \frac{W}{(13.2 \cdot P \cdot K_m \cdot K_t \cdot K_c)} = 6.506534 \quad in^2$$

**SELECTION:**

- Valve MAXIMUM Capacity 100000 lb/hr
- This Valve will be @ 91.6% of its design capacity.
- Reaction forces, for this maximum discharge rate are .....

$$F := \frac{W \cdot \sqrt{\frac{k \cdot T}{(k+1) \cdot M_W}}}{366} = 633.85 \quad lbs.$$

4/24/2004

# Relief Valve - Vapors and Gases LB/HR, Find Area

**VALVE:** TEST
**SERVICE:** HYDROGEN BROMIDE

| | | | | | |
|---|---|---|---|---|---|
| Gas Flow Rate : | 11.541406 | kg/sec | Vol, $V_G$ : | 40325.4 | $Nm^3/sec$ |
| Temperature : | 139 | °C | Temp, abs : | 412.15 | ºK |
| Gas Molecular Weight : | 80.92 | MW | Spec Heat : | 1.42 | Ratio |

| | | |
|---|---|---|
| Set Pressure : | 689475.73 | Pa |
| Back Pressure : | 0 | Pa |
| Over Pressure : | 10 | % |
| Molecular Weight Sizing Factor : | 8.9956 | Km |
| Temperature Sizing Factor : | 0.8374 | Kt |
| Specific Heat Sizing Factor : | 1.1359 | Kc |
| Absolute Relieving Pressure : | 859748.30 | Pa |

$$A := \frac{2670 \cdot W}{\left(P \cdot K_m \cdot K_t \cdot K_c\right)} = 0.004189 \quad meter^2$$

**SELECTION:**

- Valve MAXIMUM Capacity 12.599788 kg/sec
- This Valve will be @ 91.6% of its design capacity.
- Reaction forces, for this maximum discharge rate are .....

$$F_R := 129 \cdot W \cdot \sqrt{\frac{(k \cdot T)}{(k+1) \cdot MW}} = 2809.89 \quad newton$$

**REQUISITION NO.:** _____ **DEVICE NO.:** _____

**INSTRUMENT TAG NO:** _____

| PLANT | PROJECT | APPROVAL | # REQ'D | SUPPLIER |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

ITEM: **RELIEF VALVE** DATE: _____

VENDORS DATA REQ'D: **CAPACITY CERTIFICATION** FLOWSHEET: _____

DESIGN BASIS: **(CONFIDENTIAL INFORMATION NOT FOR USE ON INQUIRY OR P.O.)**
Protects the downstream low pressure steam users from excess pressure, resulting from the high pressure steam supply.

• **SPECIFICATION** •

SUGGESTED VENDORS: **TELEDYNE FARRIS**

VENDOR DESIGNATION: **26PC10S-170/SP**

TYPE OF VALVE: **SAFETY RELIEF VALVE**

NOZZLE DESIGNATION: **"P" - (6.38" Orifice Area)**

PRESS./TEMP. RATING: **185 psig/450 deg.F.**

• **MATERIALS OF CONSTRUCTION** •

- BODY: **SA-216 GR. WCB**
- BONNET: **SA-216 GR. WCB**
- SPRING: **CARBON STEEL**

OPEN OR ENCLOSED SPRING: **OPEN**

LIFTING GEAR: **OPEN LEVER**

SET PRESSURE: **65 PSIG**

• **FLUID OR CHARACTERISTICS OF FLUID USED** •

**SATURATED STEAM - NORM. 50 PSIG. - 298 DEG. F.**

CAPACITY REQUIRED: **19325 LB/HR, MAX = 26960**

% OVER PRESSURE: **10%**

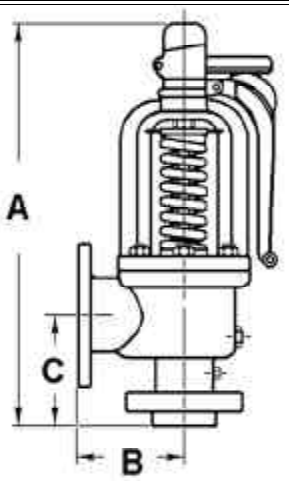
BACK PRESSURE: **0 PSIG**

• **SPECIAL REQUIREMENTS** •

**1.) SP = Special O Ring Seat = Ethylene Propylene**
**2.)**
**3.)**

**WHEN SUBMITTING BID, SUPPLY TYPE & DIMENSIONAL INFO AS REQUIRED IN THE BOX.**

**FILL IN DIMENSIONS**




**DIMENSIONS**

| | | |
|---|---|---|
| **A =** | **31** | **inches** |
| **B =** | **9** | **inches** |
| **C =** | **7-1/8** | **inches** |
| **Weight =** | **190** | **lbs.** |

**CONNECTIONS**

| | SIZE | DESCRIPTION |
|---|---|---|
| **INLET:** | **4** | **150# RF** |
| **OUTLET:** | **6** | **150# RF** |

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