PSV-6422 Deliverable Rev. A

REVISION	DATE	DESCRIPTION OF CHANGE
A	1/28/2026	Issued for Review

Relief Device Sizing Summary

Relief Device Tag : PSV-6422
P&ID Number : PID-001

Relief Device & Protected System Details

Manufacturer	-	Orifice Designation	**API J**
Model Number	-	API Orifice Area	**1.287 in²**
Serial Number	-	Relief Device Set Pressure (psig)	**150**
Valve Type	**CONVENTIONAL**		
		Nominal Pipe Size (NPS)	**2" x 3"**
New or Existing?	**EXISTING**		
Discharge Location	**FLARE**		
Ambient Pressure	**14.7**		

Protected System **Regeneration Water Flash Vessel (V-6422)**

MAWP (psig) **150** Criteria for MAWP **MAWP of V-6422**

Summary of Potential Relieving Scenarios

Credible?	Scenario	Required Relieving Flow (lb/hr)	Rated Relieving Flow (lb/hr)	Required Orifice Area (in²)	API Orifice Area (in²)
YES	1A Fire - Wetted	3,336	20,676	0.208	1.287
NO	1B Fire - Unwetted	-	-	-	-
YES	2A Blocked Outlet	17,555	14,126	1.599	1.287
Unknown	2B Overfilling	*Not Calculated*			
YES	3 CV Failure	824	15,783	0.067	1.287
NO	4 Hydraulic Expansion	-	-	-	-
Unknown	5 Loss of Cooling	*Not Calculated*			
Unknown	6 Abnormal Heat Input	*Not Calculated*			
Unknown	7 Exchanger Tube Rupture	*Not Calculated*			
Unknown	8 Compressor Equalization	*Not Calculated*			
Unknown	9 Power Failure	*Not Calculated*			
Unknown	10 Other	*Not Calculated*			

Design Scenario Summary

Design Scenario	**2A - Blocked Outlet - Vapor**	Required Orifice Area	**1.599 in²**
Relieving Fluid	**METHANE / ETHANE / PROPANE**	% Overpressure	**10%**

Existing Relief System Adequate?: **NO** **RELIEF VALVE UNDERSIZED** Recommended: K (1.838 in²)

Potential Relieving Scenario Descriptions

1A - Fire - Wetted Credible: YES

The Regeneration Water Flash Vessel (V-6422) contains liquid hydrocarbon that could generate vapor in the presence of external fire and, therefore, requires overpressure protection. The fire calculation was based on the vessel being 50% liquid full based on the normal liquid level. Vessel dimensions are from the U-1 form. Composition was taken from stream 11 from the provided H&MB.

1B - Fire - Unwetted Credible: NO

The system is not expected to be vapor full; therefore vapor fire is not considered. See 1A – Fire Wetted.

2A - Blocked Outlet Credible: YES

The feed to the system is relieved upstream at 800 psig by PSV-1447, which is greater than the MAWP of the system (150 psig) plus 10 % allowable overpressure; therefore, overpressure due to blocked outlet may occur.

2B - Overfilling Credible: Unknown

This scenario is not analyzed in this calculator. If applicable to your system, consult with a process engineer for proper evaluation.

3 - CV Failure Credible: YES

In the event PCV-6422A fails open, overpressure may occur. The maximum upstream pressure is 250 psig based on the set pressure of PSV-0989, which is greater than the MAWP of the system plus 10% allowable accumulation. Therefore, overpressure may occur in the event of a CV failure.

Additionally the PCV-6422A bypass was modeled as a 1” globe valve from the P&IDs.

4 - Hydraulic Expansion Credible: NO

The system is not expected to operate liquid-full or has a different applicable scenario.

5 - Loss of Cooling Credible: Unknown

This scenario is not analyzed in this calculator. If applicable to your system, consult with a process engineer for proper evaluation.

6 - Abnormal Heat Input Credible: Unknown

This scenario is not analyzed in this calculator. If applicable to your system, consult with a process engineer for proper evaluation.

7 - Exchanger Tube Rupture Credible: Unknown

This scenario is not analyzed in this calculator. If applicable to your system, consult with a process engineer for proper evaluation.

8 - Compressor Equalization Credible: Unknown

This scenario is not analyzed in this calculator. If applicable to your system, consult with a process engineer for proper evaluation.

9 - Power Failure Credible: Unknown

This scenario is not analyzed in this calculator. If applicable to your system, consult with a process engineer for proper evaluation.

10 - Other Credible: Unknown

This scenario is not analyzed in this calculator. If applicable to your system, consult with a process engineer for proper evaluation.

Calculation Details

1A - 1A - Fire-Wetted (Liquid Boil up)

Relief Device Sizing Summary

REQUIRED	
Relief Load:	**3,336 lb/hr**
Relief Area:	**0.208 in²**

RATED (J)	
Relief Load:	**20,676 lb/hr**
Relief Area:	**1.287 in²**

Sizing %: **16.1%**

Sizing Calculation

Operating Conditions (Inputs)

Normal Operating Pressure (Pn)	80 psig
Normal Operating Temperature (Tn)	125 °F

Vessel Details

Equipment Tag	V-6422
Orientation	Vertical
Head Type	2:1 ELLIPTICAL
Inner Diameter (ID)	24 in
Seam-to-Seam Length	6 ft
Height Above Grade	2 ft
Max Liquid Operating Level	50 %

Latent Heat Calculation

Ambient Pressure	14.7 psia
Relief Device Set Pressure	150 psig
Allowable Overpressure	21%
Absolute Relieving Pressure (P1)	196.2 psia
Relieving Temperature	47 °F

Required Relieving Rate Calculation	
Is the Vessel Insulated or Bare?	BARE
Environment Factor (F)	1.00
Wetted Surface Area (Aws)	23.2 ft²
Heat Absorption Constant (C1 or C2)	34,500
Total Heat Absorption (Q)	454,253 Btu/hr
Multi-Component Latent Heat	136 Btu/lb
Relief Load (W = Q/»)	3,336 lb/hr
Molecular Weight (M)	32.94 lb/lbmol
Compressibility Factor (Z)	1.0
Kd (Coefficient of Discharge)	0.975
Kb (Back Pressure Correction)	1.0
Required Orifice Area	0.2077 in²

Fluid Composition

Component	Mol %	MW (lb/lbmol)
Ethane	40.00	30.07
Propane	30.00	44.10
Isobutane	10.00	58.12
n-Butane	10.00	58.12
n-Pentane	10.00	72.15

Sizing Methodology

Fire Case (Wetted Surface) per API 521 Section 4.4.13.2:

Q = C• × F × A^0.82 where C• = 21,000 (adequate drainage) or 34,500 (inadequate)

W = Q / » (Relief load = Heat input / Latent heat)

A = W ×"(T×Z) / (C × Kd × P• × Kb ×"M) (API 520 vapor sizing equation)

2A - 2A - Blocked Outlet - Vapor

Relief Device Sizing Summary

REQUIRED	
Relief Load:	**17,555 lb/hr**
Relief Area:	**1.599 in²**

RATED (J)	
Relief Load:	**14,126 lb/hr**
Relief Area:	**1.287 in²**

Sizing %: **124.3% (Undersized!)**

Sizing Calculation

Operating Conditions (Inputs)	
Normal Operating Pressure (Pn)	80 psig
Normal Operating Temperature (Tn)	125 °F

Sizing Calculation	
Relief Device Set Pressure	150 psig
Allowable Overpressure	10%
Relieving Pressure (p1)	165.0 psig
Relieving Temperature (T1)	125 °F
Vapor Molecular Weight (M)	19.4
Specific Heat Ratio (k)	1.269
C Coefficient	344.0
Relieving Rate (Input)	17,555 lb/hr
Compressibility Factor (Z)	1.0
Kd (Coefficient of Discharge)	0.975
Kb (Back Pressure Correction)	1.0
Kc (Combination Correction)	1.0
Required Orifice Area	1.5994 in²

Fluid Composition

Component	Mol %	MW (lb/lbmol)
Methane	85.00	16.04
Ethane	7.00	30.07
Propane	3.00	44.10
n-Butane	2.00	58.12
CO2	2.00	44.01
Nitrogen	1.00	28.01

Sizing Methodology

Vapor Sizing per API 520 Section 5.6:

$$A = W \times \sqrt{(T \times Z)} / (C \times K_d \times P_1 \times K_b \times K_c \times \sqrt{M})$$

Where: Kd = 0.975 (vapor), Kb = 1.0 (atm discharge), Kc = 1.0 (no rupture disk), Z = 1.0

3 - 3 - CV Failure - Vapor

Relief Device Sizing Summary

REQUIRED	
Relief Load:	**824 lb/hr**
Relief Area:	**0.067 in²**

RATED (J)	
Relief Load:	**15,783 lb/hr**
Relief Area:	**1.287 in²**

Sizing %: **5.2%**

Sizing Calculation

Vapor Properties

Molecular Weight	24.18 lb/lbmol
Specific Gravity (Gg)	0.835
Specific Heat Ratio (k)	1.220
Ratio Factor (Fk)	0.871

Upstream & Downstream Properties

Maximum Operating Pressure (P1)	250 psig
Temperature (T1)	138 °F
Relief Device Set Pressure	150 psig
Allowable Overpressure	10%
Relieving Pressure (P2)	165.0 psig

Control Valve Specification

Valve Tag	PCV-6422A
Full-Open Valve Coefficient (Cv)	1.76
Pressure Drop Ratio Factor (XT)	0.569

Bypass Valve Information (Reference)

Valve Type	Globe Valve
Nominal Size	1"
Bypass Cv	9.79
Bypass Flow (q)	80,457 scfh
Bypass Mass Flow (W)	5,126 lb/hr

Used for Sizing	NO

Calculated Flow Through Failed Valve	
Mass Flow (W)	824 lb/hr
Compressibility Factor (Z)	0.95
C Coefficient	339.2
Kd (Coefficient of Discharge)	0.975
Kb (Back Pressure Correction)	1.0
Kc (Combination Correction)	1.0
Required Orifice Area	0.0672 in²

Fluid Composition

Component	Mol %	MW (lb/lbmol)
Methane	70.00	16.04
Ethane	12.00	30.07
Propane	8.00	44.10
Isobutane	3.00	58.12
n-Butane	3.00	58.12
Isopentane	1.00	72.15
n-Pentane	1.00	72.15
CO2	2.00	44.01

Sizing Methodology

Vapor Sizing per API 520 Section 5.6:

$$A = W \times \sqrt{(T \times Z) / (C \times K_d \times P_1 \times K_b \times K_c \times \sqrt{M})}$$

Where: Kd = 0.975 (vapor), Kb = 1.0 (atm discharge), Kc = 1.0 (no rupture disk), Z = 1.0

RELIEF DEVICE SIZING

REFERENCES & ATTACHMENTS

V-6422

REGENERATION WATER FLASH TANK

SIZE : 24" O.D. X 72" S/S
150 GALLON CAPACITY
MDMT: -20° F
MAWP:150 PSIG @ 150°F
MATL: CARBON STEEL

5

6114-A1-CS-2"

CAD-PID-0504
TK-6421

SET @ 20 PSIG

PAHH
PAH
PI 6422B
PAL

I

PIT 6422B

.75" B1H1 505005

PCV 6422B

2" B1A1 505006

2"x1"

2"x1"

1"

1"ET NO TRACE

.75" B1H1 505007

2" B1A1 505008

1" L1J1 505009

6081-A1-CS-2"

TO FLARE HEADER
CAD-PID-0510
6034-A1-CS-6"

6110-A1-CS-2"

SET @ 28 PSI

NO TRACE 1"ET

PCV 6422A

2" B1A1 505001

2"x0.5" 0.5"

2"x0.5"

2" B1A1 505004

.75" B1H1 505003

1" L1J1 505002

FR. FUEL GAS HDR.
CAD-PID-0501

6077-A1-CS-2"

1"x2"
SET @ 150 PSIG
PCV FAIUES

PSV 6422

2" B3A1 505040

CSO

.75" B1H1 505039

2"x1"

2" B3A1 505037

1" CSO B1A1 505038

CSO

1"ET NO TRACE

.75" B1H1 505031

2"

5

.5" B1H1 505035

CSO 1" 1" B1H1 505033

I 18

LAHH 6422

LSHH 6422

CSO 1" 1" B1H1 505034

.5" B1H1 505036

HS 6422

I 18

ZLC 6422

ZLO 6422

S

ZSC 6422

ZSO 6422

XV 6422

FR. REGENERATION SCRUBBER
297-223
V-1447

848-D2-CS-2"-1"H-HT

2" B1D1 505010

2"-600# F.C.

.75" B1D1 505011

2" B1D1 505012

2"-150#

CS SS

2"H

.75" B1H1 505025

LIT 6422

NOTE 1

LAH

LIC 6422

LAL

LALL 6422

I

CS SS

2" B1A1 505023

2" B1A1 505027

.5" B1H1 505029

LG 6422

3" DIA CHAMBER

2" B1A1 505024

CS SS

.75" B1H1 505026

2" B1A1 505028

.5" B1H1 505030

.5" B1H1 505015

PI 6422A

1" B1H1 505014

TI 6422 TAL

TIT 6422

2" B1A1 505013

1" B1H1 505041

1" B1H1 505042

.75" B1H1 505032

LY 6422

A/S

LCV 6422

2" B1A1 505016

2"x1" 1"-150# FC 2"x1"

2" B1A1 505019

2" C1A1 505020

2" B1A1 505022

6109-A2-CS-2"-1"H-HT

TO REGEN WATER STORAGE TANK
CAD-PID-0504
TK-6419

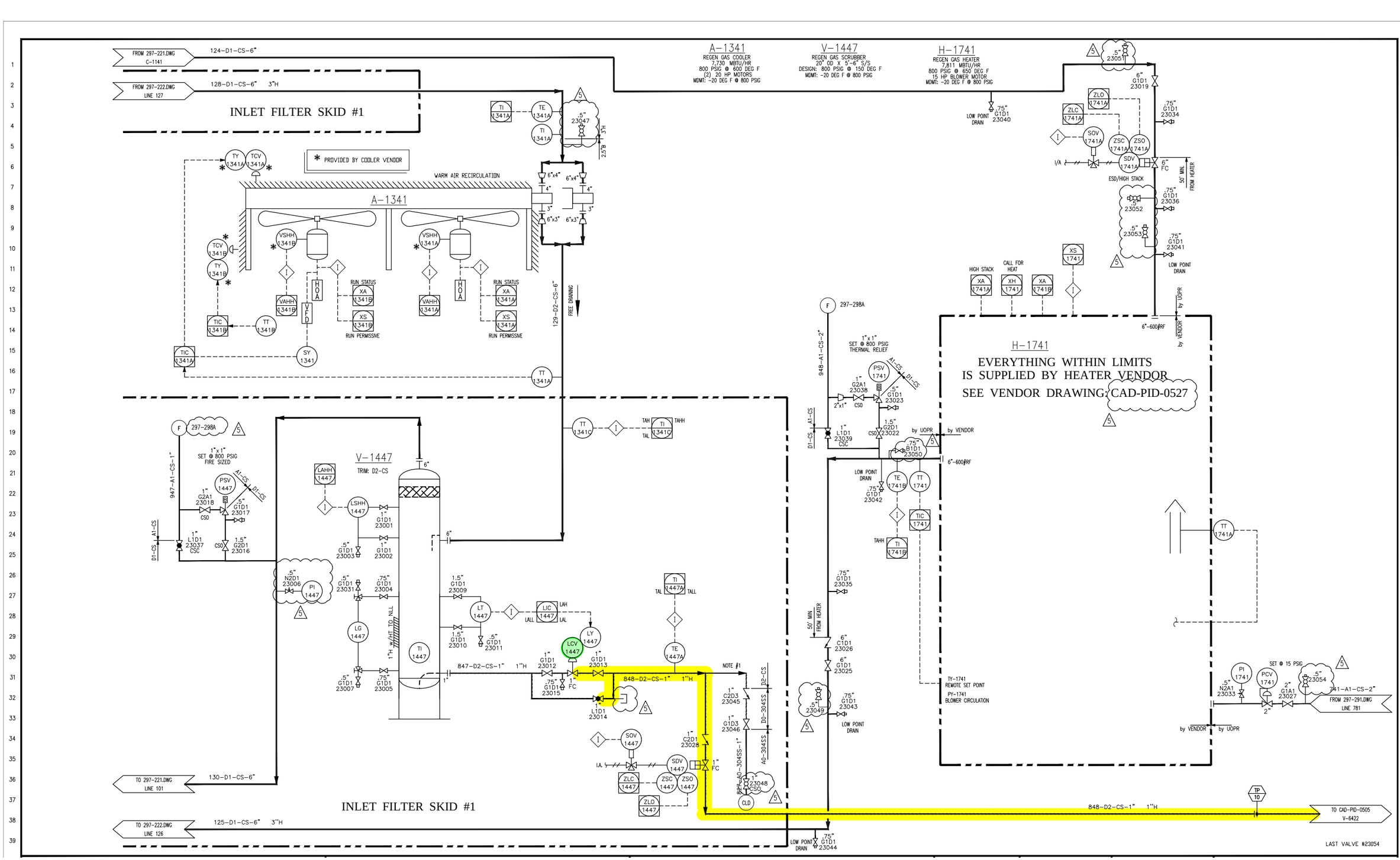
.75" B1H1 505017

.75" B1H1 505021

1" L1J1 505018 CSC

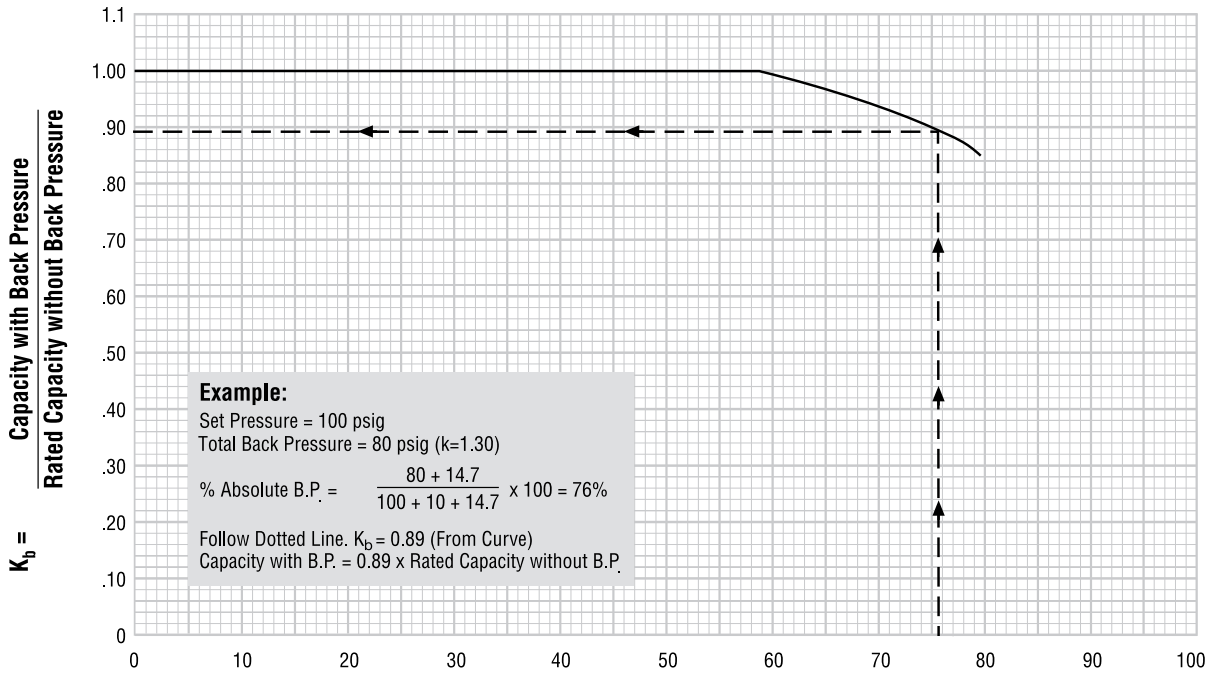
V-6422

LAST VALVE #505042


A-1341
REGEN GAS COOLER
7,730 MBTU/HR
800 PSIG @ 600 DEG F
(2) 20 HP MOTORS
MDMT: -20 DEG F @ 800 PSIG
V-1447
REGEN GAS SCRUBBER
20" OD X 5'-6" S/S
DESIGN: 800 PSIG @ 150 DEG F
MDMT: -20 DEG F @ 800 PSIG
H-1741
REGEN GAS HEATER
7,811 MBTU/HR
800 PSIG @ 650 DEG F
15 HP BLOWER MOTOR
MDMT: -20 DEG F @ 800 PSIG
FROM 297-221.DWG C-1141
124-D1-CS-6"
FROM 297-222.DWG LINE 127
128-D1-CS-6" 3"H
INLET FILTER SKID #1
* PROVIDED BY COOLER VENDOR
WARM AIR RECIRCULATION
A-1341
RUN PERMISSIVE
RUN PERMISSIVE
129-D2-CS-6"
FREE DRAINING
H-1741
EVERYTHING WITHIN LIMITS
IS SUPPLIED BY HEATER VENDOR
SEE VENDOR DRAWING: CAD-PID-0527
ESD/HIGH STACK
HIGH STACK
CALL FOR HEAT
LOW POINT DRAIN
LOW POINT DRAIN
50' MIN FROM HEATER
6"-600#RF
by VENDOR
by UOPR
947-A1-CS-1"
SET @ 800 PSIG FIRE SIZED
947-A1-CS-2"
SET @ 800 PSIG THERMAL RELIEF
V-1447
TRIM: D2-CS
1"H w/HT TO NLL
847-D2-CS-1" 1"H
848-D2-CS-1" 1"H
NOTE #1
D2-CS
D0-304SS
A0-304SS-1"
847-A0-304SS-1"
CLD
TY-1741 REMOTE SET POINT
PY-1741 BLOWER CIRCULATION
LOW POINT DRAIN
LOW POINT DRAIN
SET @ 15 PSIG
741-A1-CS-2"
FROM 297-291.DWG LINE 781
TO 297-221.DWG LINE 101
130-D1-CS-6"
TO 297-222.DWG LINE 126
125-D1-CS-6" 3"H
INLET FILTER SKID #1
848-D2-CS-1" 1"H
TO CAD-PID-0505 V-6422
LAST VALVE #23054

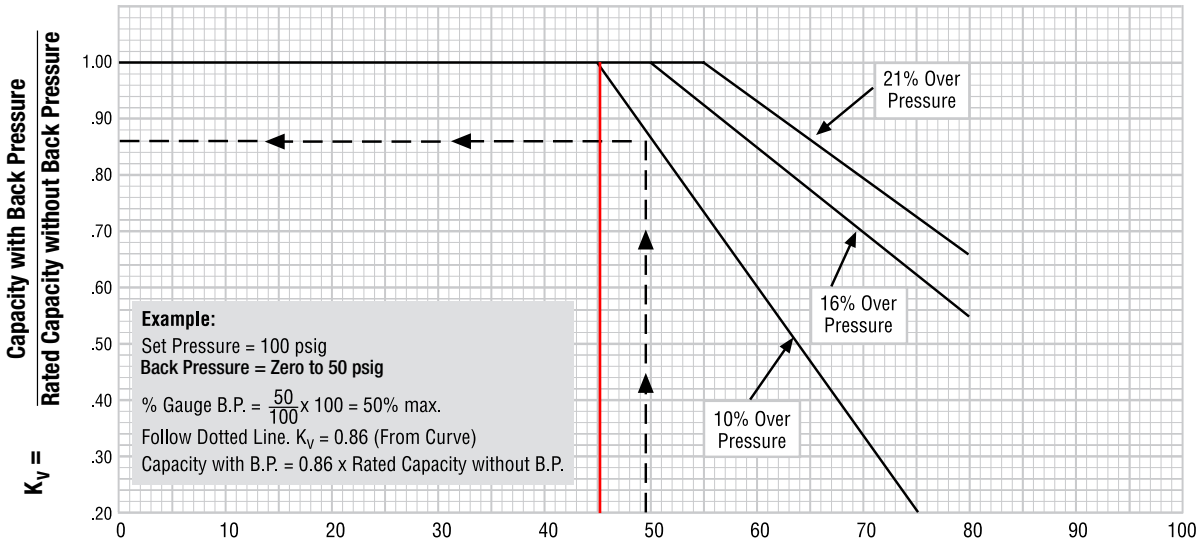
Sizing Factors for Vapors and Gases

Back Pressure Sizing Factor K_b



$$\% \text{ Absolute Back Pressure} = \frac{\text{Back Pressure, psia}}{\text{Set Pressure + Over Pressure, psia}} \text{ X } 100$$

Back Pressure Sizing Factor K_v BalanSeal Valves Only - Vapors and Gases



$$\% \text{ Gauge Back Pressure} = \frac{\text{Back Pressure, psig}}{\text{Set Pressure, psig}} \text{ X } 100$$

Micro-Form™ - Flow Up

Equal Percentage Characteristic

Valve Size	Port Diameter		Total Travel		Flow Coeffi-cient	Valve Opening—Percent of Total Travel											F_L[1]
	mm	Inches	mm	Inches		5	10	20	30	40	50	60	70	80	90	100	
1 Inch	6.4	0.25	19	0.75	C_v	0.0679	0.0858	0.122	0.167	0.231	0.325	0.458	0.646	0.905	1.25	1.76	0.96
					K_v	*0.0587*	*0.0742*	*0.106*	*0.144*	*0.200*	*0.281*	*0.396*	*0.559*	*0.783*	*1.08*	*1.52*	- - -
					X_T	0.705	0.623	0.620	0.631	0.585	0.565	0.578	0.569	0.555	0.588	0.569	- - -
	9.5	0.375	19	0.75	C_v	0.114	0.132	0.205	0.298	0.426	0.590	0.834	1.21	1.75	2.45	3.53	0.95
					K_v	*0.099*	*0.114*	*0.177*	*0.258*	*0.368*	*0.510*	*0.721*	*1.05*	*1.51*	*2.12*	*3.05*	- - -
					X_T	0.776	0.848	0.656	0.673	0.626	0.608	0.589	0.582	0.575	0.588	0.691	- - -
	12.7	0.5	19	0.75	C_v	0.185	0.235	0.357	0.523	0.752	1.07	1.50	2.13	3.05	4.30	5.87	0.96
					K_v	*0.160*	*0.203*	*0.309*	*0.452*	*0.650*	*0.926*	*1.30*	*1.84*	*2.64*	*3.72*	*5.08*	- - -
					X_T	0.718	0.674	0.640	0.596	0.575	0.592	0.593	0.568	0.569	0.599	0.755	- - -
	19.1	0.75	19	0.75	C_v	0.324	0.358	0.571	0.900	1.30	1.91	3.04	5.08	7.75	9.56	11.2	0.94
					K_v	*0.280*	*0.310*	*0.494*	*0.779*	*1.13*	*1.65*	*2.63*	*4.39*	*6.70*	*8.27*	*9.69*	- - -
					X_T	0.561	0.684	0.645	0.594	0.605	0.614	0.592	0.594	0.613	0.696	0.783	- - -
2 Inch	6.4	0.25	19	0.75	C_v	0.0679	0.0858	0.122	0.167	0.231	0.325	0.458	0.646	0.905	1.25	1.76	0.96
					K_v	*0.0587*	*0.0742*	*0.106*	*0.144*	*0.200*	*0.281*	*0.396*	*0.559*	*0.783*	*1.08*	*1.52*	- - -
					X_T	0.705	0.623	0.620	0.631	0.585	0.565	0.578	0.569	0.555	0.588	0.569	- - -
	9.5	0.375	19	0.75	C_v	0.114	0.132	0.205	0.298	0.426	0.590	0.834	1.21	1.75	2.45	3.53	0.95
					K_v	*0.099*	*0.114*	*0.177*	*0.258*	*0.368*	*0.510*	*0.721*	*1.05*	*1.51*	*2.12*	*3.05*	- - -
					X_T	0.776	0.848	0.656	0.673	0.626	0.608	0.589	0.582	0.575	0.588	0.691	- - -
	12.7	0.5	19	0.75	C_v	0.186	0.244	0.359	0.540	0.784	1.09	1.52	2.25	3.20	4.49	6.27	0.95
					K_v	*0.161*	*0.211*	*0.311*	*0.467*	*0.678*	*0.943*	*1.32*	*1.95*	*2.77*	*3.88*	*5.42*	- - -
					X_T	0.814	0.699	0.799	0.685	0.593	0.560	0.573	0.531	0.536	0.547	0.612	- - -
	19.1	0.75	19	0.75	C_v	0.305	0.367	0.583	0.892	1.31	2.02	3.14	5.18	8.01	10.6	13.4	0.92
					K_v	*0.264*	*0.317*	*0.504*	*0.772*	*1.13*	*1.75*	*2.72*	*4.48*	*6.93*	*9.17*	*11.6*	- - -
					X_T	0.697	0.513	0.477	0.481	0.478	0.447	0.400	0.432	0.465	0.512	0.640	- - -
	25.4	1	19	0.75	C_v	0.734	0.922	1.35	1.79	2.38	3.65	5.50	9.04	13.6	17.3	21.6	0.95
					K_v	*0.635*	*0.798*	*1.17*	*1.55*	*2.06*	*3.16*	*4.76*	*7.82*	*11.8*	*15.0*	*18.7*	- - -
					X_T	0.501	0.684	0.658	0.548	0.648	0.548	0.577	0.525	0.513	0.632	0.745	- - -
	31.8	1.25	19	0.75	C_v	1.08	1.22	1.65	2.26	3.24	5.14	8.90	15.2	22.6	26.9	33.2	0.94
					K_v	*0.934*	*1.06*	*1.43*	*1.96*	*2.80*	*4.45*	*7.70*	*13.1*	*19.5*	*23.3*	*28.7*	- - -
					X_T	0.587	0.686	0.636	0.638	0.649	0.520	0.706	0.687	0.680	0.767	0.761	- - -

1. At 100% travel.