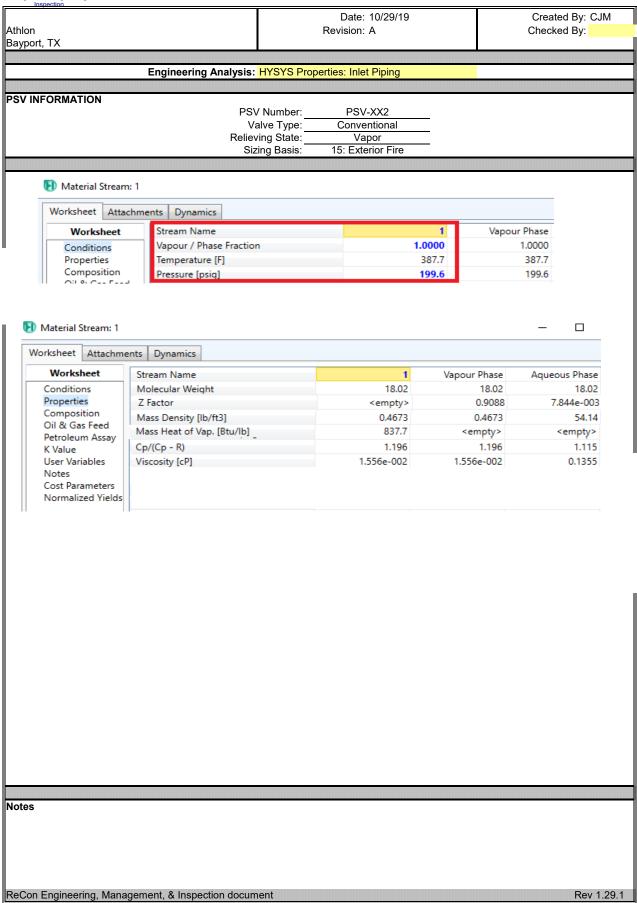


thlon	Date: 10/29/19 Revision: A	Created By: CJM
ayport, TX	Revision. A	Checked By: 0
Eiro Cooo Ovifi	on Calculation Vanor Polinf	
Fire Case Orin	ce Calculation - Vapor Relief	
SV INFORMATION		
PSV Number: Vessel Item #	PSV-XX2 E-778 Shell Side	<u> </u>
Vessel Description:	E-778 Shell	_
Flow Sheet Reference #:	SK-19282010-001 Rev.A	<u></u>
Relieving State:	Vapor	
Sizing Basis:	15: Exterior Fire	
IPUTS		
Flowrate, W (lb/hr) =	1836.2	
Relieving Temperature, T (deg F) =	387.7	
Ratio of Specific Heats, k =	1.20	k+1
Coefficient of the ratio of specific heats ⁽¹⁾ , $\mathbf{C} =$	336.8	$C = 520\sqrt{k\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}$
Compressibility Factor, Z =	0.9088	(k+1)
Molecular Weight, M =	18.02	
Ratio of P_2/P_1 , $\mathbf{r} =$	0.0721	<u>(k-1)</u>
Coefficient of Subcritical Flow ⁽²⁾ , $\mathbf{F_2}$ =	0.1683	$F_{2} = \sqrt{\left(\frac{k}{k-1}\right)(r)^{\frac{2}{k}}} \left \frac{1 - r^{\frac{(k-1)}{k}}}{1 - r} \right $
Critical Flow Pressure Ratio ⁽³⁾ , P _{cf} / P ₁ =	0.565	$ \sqrt{(k-1)^{(r)}}$ $1-r$
- · · · · · · · · · · · · · · · · · · ·	165	N L J
Set Pressure, P (psig) =	•	<u> </u>
PSV Type (conv, pilot, bellows) =	Conventional	
Back Pressure, P2 (psig) =	0.75	/ =1 0 for conventional
Back Pressure Correction Factor, $\mathbf{K}_{b} =$	1.0	K _b =1.0 for conventional
Manufacturer Coefficient of Discharge ⁽⁵⁾ , $\mathbf{K_d}$ =	0.8	
Combination Correction Factor for Rupture Disks, \mathbf{K}_{c} =	1	Kc=1.0 if rupture disk not installed, else 0. if MFG not available
ALCULATIONS:		
Upstream Relieving Pressure: P ₁ (psig) =	199.65	Set pressure + 21% allowable overpressur
Critical Flow Area Calculation ⁽²⁾ , A =	0.208	in ²
		$A = \frac{W}{CK_d P_1 K_b K_c} \sqrt{\frac{TZ}{M}}$
Sub-critical Flow Area Calculation ⁽⁴⁾ , A =	Critical Flow	$A = \frac{W}{735*F_2K_dK_c} \sqrt{\frac{ZT}{MP_1(P_1 - P_2)}}$
Available Orifice Area, $\mathbf{A_v}$ =	0.221	in²
Valve Maximum Flowrate = W * (Av / A)	1952.3	lbs/hr
OTES		
Valve Maximum Flowrate = W * (Av / A) OTES	1952.3	lbs/hr
EFERENCES API RP 520, 7th Edition, "Coefficient C" Equation taken from F	igure 32, pg. 44	
API RP 520, 7th Edition, "Sizing for Critical Flow" Equation 3.2	2, pg. 42	
API RP 520, 7th Edition, "Critical Flow Pressure Ratio" Equation API RP 520, 7th Edition, "Sizing for Subcritical Flow: Gas or V. API RP 520, 7th Edition, "Sizing for Critical Flow" pg. 42	on 3.1, pg. 41 apor" Equation 3.5, pg. 45	







Engineering Analysis: HYSYS Properties: Outlet Piping	on			Date: 10/29/19 Revision: A		Created By: CJM Checked By:
PSV Number:						, ,
PSV Number:						
PSV Number:		Engineering	ع Analysis: HYSYS Prop	perties: Outlet Piping		
PSV Number:	INFORMATION					
Naterial Stream: 1 Worksheet	IN OKUMATEL		PSV Number:	PSV-XX2		
Relieving State: Vapor Sizing Basis: 15: Exterior Fire Worksheet Attachments Dynamics Vapour Phase Conditions Properties Composition Vapour Phase Fraction 1.0000 1.0			Valve Type:		_	
Worksheet Attachments Dynamics Uspour Phase			Relieving State:	Vapor	_	
Worksheet				15: Exterior Fire		
Worksheet Attachments Dynamics Stream Name 1 Vapour Phase Vapour / Phase Fraction 1.0000 1.00						
Worksheet Attachments Dynamics Stream Name 1 Vapour Phase Vapour / Phase Fraction 1.0000 1.00						
Worksheet Attachments Dynamics Stream Name 1 Vapour Phase Vapour / Phase Fraction 1.0000 1.00						
Worksheet Stream Name 1 Vapour Phase Vapour / Phase Fraction 1.0000 1.	Material Str	ream: 1				
Worksheet Stream Name 1 Vapour Phase Vapour / Phase Fraction 1.0000 1.	Worksheet	Attachments Dyna	mics			
Vapour / Phase Fraction 1,0000 1,					1 Vano	Dhase
Properties Composition Pressure [psig]						
Material Stream: 1						
Worksheet Attachments Dynamics Worksheet Conditions Properties Composition Oil & Gas Feed Petroleum Assay K Value Office Potential Stream: 1 Worksheet Attachments Dynamics Stream Name 1 Vapour Phase Aqueous Phase Molecular Weight 18.02						
Worksheet	000.00	r . Pressure	[psig]		0.0000	0.0000
Worksheet						
Worksheet						
Worksheet						
Worksheet Stream Name 1 Vapour Phase Aqueous Phase Conditions Properties Molecular Weight 18.02	Material Stream	: 1				_ 🗆
Worksheet Stream Name 1 Vapour Phase Aqueous Phase Conditions Properties Molecular Weight 18.02						
Molecular Weight 18.02 1						
Properties Composition Oil & Gas Feed Petroleum Assay K Value Z Factor Cempty 0.9846 6.142e-00 6.1	Worksheet					Aqueous Phase
Composition Oil & Gas Feed Petroleum Assay K Value Mass Density [lb/ft3] 3.730e-002 3.730e-002 59,8 Cp/(Cp - R) 1.294 1.294 1.12 Viscosity [cP] 1.203e-002 1.203e-002 0.2796			ght			18.02
Oil & Gas Feed Petroleum Assay K Value Cp/(Cp - R) 1.294 1.294 1.12 Viscosity [cP] 1.203e-002 1.203e-002 0.2796						6.142e-004
Petroleum Assay K Value Cp/(cp = N)			[lb/ft3]			59.80
K Value Viscosity [cP] 1.203e-002 1.203e-002 0.2790		Cp/(Cp - K)				1.123
		Viscosity [cP]		1.203e-002	1.203e-002	0.2790
5						
	s					



		Date: 10/29/19	Created By: CJM
Athlon		Revision: A	Checked By: 0
ayport, TX			•
Fire Case R	elief Requirement Calc	ulation for Vessels - Inadquate	Drainage/Fire Fighting Equipment
SV INFORMATION			
	PSV Number:	PSV-XX2	<u>-</u>
	Vessel Item #	E-778 Shell Side	_
	sel Description:	E-778 Shell	<u>-</u>
	et Reference #:	SK-19282010-001 Rev.A	-
I	Relieving State:	Vapor	
	Sizing Basis:	15: Exterior Fire	
NPUTS			Spherical Vessel Code:
Vessel Orientation =	V	H = Horizontal, V = Vertical, S	•
Number of Ends(Heads) =	<u>1</u>	Number of Ends (Heads) expo	
Type of Ends =	E	F = Flat, H = Hemispherical, E	= Elliptical
D =	1.96 ft	Vessel diameter	
HLL =	16.00 ft	High liquid level	
L =	16.00 ft	Length of vessel, T/T (1)	
H =		Vessel elevation	
F =	1.00	Environmental factor ⁽²⁾	
Latent Heat of Vap., $\lambda = $	837.7 btu/lb	From process simulation calcul	ations (at relieving conditions)
ALCULATIONS			
0.1	ft ²		11/ IB ABI 504
Spherical Vessel, A _{Sws} =		Total Wetted Area of a Spheric	cal Vessel Per API 521
Spherical Vessel, A _{Sws} =	ft ²	Total Wetted Area of a Spheric	cal Vessel Per API 2000
E _{vertical} =	16.0 ft	Effective liquid level (up to 25 f	t from the flame source)
Vertical Vessel, A _{vws} =	ft ²	(3)Total Wetted Area of a Vertic	•
Vertical Vessel, A _{vws} =	ft ²		al Vessel with HEMISPHERICAL Ends
Vertical Vessel, A _{vws} =	102.6 ft ²	Total Wetted Area of a Vertic	al Vessel with ELLIPTICAL Ends
E _{horizontal} =	ft	Effective liquid level (up to 25 f	t from the flame source)
F _{wp} =			
Horizontal Vessel, A _{Hws} =	ft ²	(3)Total Wetted Area of a Horizo	ontal Vessel with FLAT Ends
	ft ²		ontal Vessel with HEMISPHERICAL Ends
Horizontal Vessel, A _{Hws} =			
Horizontal Vessel, A _{Hws} =	ft ²	℃ Γotal Wetted Area of a Horiz	ontal Vessel with ELLIPTICAL Ends
A _{ws} =	103 ft²	Total wetted surface area	
VV-3			
0 -	1,538,219 Btu/hr	Total heat absorption (input) to	the wetted surface ⁽⁴⁾ $Q = 34,500 * F * A_{ws}^{-0.82}$
Q	1,550,218 DIU/NI	i otal neat absorption (input) to	$Q = 34,300^{\circ} F + A_{ws}$
		Demoired Delief Deta (-0/1)	
10/ -	1 836 lh/hr		
W =	1,836 lb/hr	Required Relief Rate (=Q/λ)	
W =	1,836 lb/hr	Required Relief Rate (=Q/\(\lambda\)	
	1,836 lb/hr	Required Relief Rate (=Q/A)	
	1,836 lb/hr	Required Relief Rate (=Q/A)	
	1,836 lb/hr	Required Relief Rate (=Q/n)	
	1,836_ lb/hr	Required Relief Rate (=Q/A)	
	1,836_ lb/hr	Required Relief Rate (=Q/n)	
	<u>1,836</u> lb/hr	Required Relief Rate (=Q/A)	
	1,836_ lb/hr	Required Relief Rate (=Q/n)	
	1,836_ lb/hr	Required Relief Rate (=Q/A)	
IOTES	1,836_ lb/hr	Required Relief Rate (=Q/A)	
REFERENCES			
IOTES REFERENCES This spreadsheets calculates	s the wetted area for a H	HORIZONTAL or VERTICAL ves	sel.
EFERENCES This spreadsheets calculates API STD 521, 5th edition, Ta	s the wetted area for a Hable 6 "Environmental Fa	HORIZONTAL or VERTICAL ves	
EFERENCES This spreadsheets calculates API STD 521, 5th edition, Ta	s the wetted area for a Hable 6 "Environmental Fa	HORIZONTAL or VERTICAL ves	sel. Valve Databook, Valve Sizing Section.
EFERENCES This spreadsheets calculates API STD 521, 5th edition, Ta Wetted Surface Area Calcul	s the wetted area for a Fable 6 "Environmental Fa	HORIZONTAL or VERTICAL ves actor", pg. 41 VS22 in the Consolidated Relief	Valve Databook, Valve Sizing Section.
EFERENCES This spreadsheets calculates API STD 521, 5th edition, Ta Wetted Surface Area Calcul API STD 521, 5th edition, "F	s the wetted area for a Hable 6 "Environmental Fations taken from page Valeat Absorption to Liquid	HORIZONTAL or VERTICAL vest actor", pg. 41 VS22 in the Consolidated Relief Is", Equation 6, pg. 40 (without a	Valve Databook, Valve Sizing Section. dequate draining and firefighting equipment)
EFERENCES This spreadsheets calculated API STD 521, 5th edition, Tall Wetted Surface Area Calculated API STD 521, 5th edition, "In the control of the contro	s the wetted area for a Hable 6 "Environmental Fations taken from page Valeat Absorption to Liquid	HORIZONTAL or VERTICAL vest actor", pg. 41 VS22 in the Consolidated Relief Is", Equation 6, pg. 40 (without a	Valve Databook, Valve Sizing Section.
EFERENCES This spreadsheets calculates API STD 521, 5th edition, Ta Wetted Surface Area Calcul API STD 521, 5th edition, "F	s the wetted area for a Hable 6 "Environmental Fations taken from page Velat Absorption to Liquidations taken from page 4	HORIZONTAL or VERTICAL vest actor", pg. 41 VS22 in the Consolidated Relief Is", Equation 6, pg. 40 (without a 439 in the Pressure Vessel Hand	Valve Databook, Valve Sizing Section. dequate draining and firefighting equipment)



		Date:	10/29/19		Created By	r: CJM
Athlon		Revision:			Checked By	
Bayport, TX		Relief Valve No.:	PSV-XX2			
		INLET PIPING	CALCIII ATI	ONS		
nlet Piping Segments		INCE! FIFING	CALCULATI	ONS		
Sizing Basis:	Pipe Size (n	ominal diameter) =	2.00	inches		
1: Closed Outlet on		side Diameter, d =		inches		
/essels		Pipe Spec =				
		Pipe Schedule =				
	(5)Moody	Friction Factor, f =		-		
	ouj			_		
	Total Length o	f Straight Pipe, L =	2.0 ft			
		gth of 90° Elbows =		# Elbows=		$L_{eq}/d = 30$
(1) _E	quivalent Length of 90° Lon			# Elbows=		L _{eq} /d = 20
		gth of 45° Elbows =		# Elbows=		L _{eq} /d = 16
	(1)Equivalent Length			# Tees=		$L_{eq}/d = 60$
	(1)Equivalent Length			# Tees=		L _{eq} /d = 20
	, ,	gth of Gate Valve=		# Valves=		$L_{eq}/d = 8$
		ngth of Ball Valve =		# Valves=		$L_{eq}/d = 3$
	(4)Equivalent Length	•		- K-factor=		•
	(1)Equivalent Length			-	1	Crane pg. A-29
	, ,	ength of Reducer =		(6)	4.15	Reduced id = 1.048
	Equivalent Le	ength of Enlarger =		(6)K-factor=		Enlarged id =
Other Fitting:		Equivalent Length=		# Fittings=		⁽⁸⁾ Cv =
Other Fitting:		Equivalent Length=		# Fittings=		L _{eq} /d =
Total	Equivalent Length of Valves	and Fittings, L _{eq} =	43.9 ft	as 2 in. pipe)	
	·					
nlet Piping Stream Prop	erties					
Relief Rate of Liquid of	or Vap Valve Capacity, W =	1,952	lb/hr			
	Set Pressure =		psig			
	Inlet Piping Temperature =	387.7		847.7	°R	
	Molecular Weight =	18.02	lb/lbmol			
	Density in Inlet Line =		lb/ft ³			
(7)5	Viscosity in Inlet Line =	0.02	• •		* 0000 \	
"Reynolds	Number (Re) in Inlet Line =	397,074.89	(Laminar flow oc	curs when Re	≥ 2000.)	
nlet Line Pressure Drop	Calculation					
					(0)	
Total Equivalent Len	gth (valves & fittings), L _{eq} =	43.9	ft	For valves ar	nd fittings ⁽²⁾ :	
	Friction Factor, f =	0.019	-		$\int L$	W^2
				$\Delta P_{psi} = 0.00$	0000336-	$\frac{1}{2}$
	al Straight Pipe Length, L =	2.0	_ft		,	~~
	Factor (straight pipe), f =	0.019	-	For valves ar		•
Ins	side Diameter of Piping, d =	1.939	in_	$\Delta P_{psi} = 0.0$	0000336 ^{fl}	LW^2
				$\Delta I_{psi} - 0.0$	0000330— L	$\overline{d^5}$
Inlet Piping, To	otal Pressure Drop, ΔP_{psi} =	0.87		Note: Resista	nce coefficie	nt K =
ΔP _{psi} , I	Percent of Set Pressure =	0.53	% ^(a)		$f \tau *(L_{eq}/D) f$	or valves and fittings
					f*(L/D) for st	raight pipe
NOTES						
	Part II, Sect. 4.2.2, inlet pipir	na is not to exceed	a pressure drop of	of 3% of the se	et pressure.	
The current inlet piping i						
) "Posistanos Cos	fficients for Valve	c and Eittings"	nogos A 26	thru A 20
REFERENCES	ts" Technical Dapor No. 440	, incorplance C00	cure Drep Coloub	ations" article (Payes A-20 Cheresources	S.com
¹⁾ Crane Co., "Flow of Fluid	ds" Technical Paper No. 410	ns in Pineline Pres			5. 101 000 ui 000	
¹⁾ Crane Co., "Flow of Fluic ²⁾ Phil Leckner, "Equivalen	t Length of Valves and Fittin	gs in Pipeline Pres	n Straight Pipe" n	g. 3-2. Ea. 3-5	i	
¹⁾ Crane Co., "Flow of Fluic ²⁾ Phil Leckner, "Equivalen ³⁾ Crane Co., "Flow of Fluic	t Length of Valves and Fittin ds" Technical Paper No. 410	igs in Pipeline Pres), "Pressure Drop i	n Straight Pipe" p	g. 3-2, Eq. 3-5 e 13 and Table	i e 14	
⁽¹⁾ Crane Co., "Flow of Fluic ⁽²⁾ Phil Leckner, "Equivalen ⁽³⁾ Crane Co., "Flow of Fluic ⁽⁴⁾ API STD 521, 5th editior	t Length of Valves and Fittin	ngs in Pipeline Pres D, "Pressure Drop in e fittings and reduce	n Straight Pipe" p ers", pg. 110 Tabl	e 13 and Table	e 14	orrect Friction Factor, f.
Orane Co., "Flow of Fluic Phil Leckner, "Equivalen" Crane Co., "Flow of Fluic API STD 521, 5th edition This calculation is valid f	t Length of Valves and Fittir ds" Technical Paper No. 410 n, "Typical K-factors for pipe for steel pipe, for all other pi nd 2-11.	ngs in Pipeline Pres D, "Pressure Drop in Fittings and reduce pe material see Cra	n Straight Pipe" pers", pg. 110 Tabl ane pg. A-26 or p	e 13 and Table g. A-23, to det	e 14 ermine the co	
Crane Co., "Flow of Fluic Phil Leckner, "Equivalen" Crane Co., "Flow of Fluic API STD 521, 5th edition This calculation is valid for Crane Co., page A-26 are	t Length of Valves and Fittinds" Technical Paper No. 410 n, "Typical K-factors for pipe for steel pipe, for all other pind 2-11. ds" Technical Paper No. 410	igs in Pipeline Pres), "Pressure Drop in fittings and reduce pe material see Cro), pages 1-6 thru 1-	n Straight Pipe" p ers", pg. 110 Tabl ane pg. A-26 or p -7. Friction factor	e 13 and Table g. A-23, to det for straight pi	e 14 ermine the co pe in laminar	flow is equal to 64/Re.
Crane Co., "Flow of Fluic Phil Leckner, "Equivalen" Crane Co., "Flow of Fluic API STD 521, 5th edition This calculation is valid for Crane Co., page A-26 are	t Length of Valves and Fittir ds" Technical Paper No. 410 n, "Typical K-factors for pipe for steel pipe, for all other pi nd 2-11.	ngs in Pipeline Pres), "Pressure Drop in fittings and reduce pe material see Cro), pages 1-6 thru 1- nical Paper No. 410	n Straight Pipe" pers", pg. 110 Tablane pg. A-26 or pers. 7. Friction factor 0 (08/11 Reprint)	e 13 and Table g. A-23, to det for straight pip equations 2-1	e 14 ermine the co pe in laminar	flow is equal to 64/Re.
Crane Co., "Flow of Fluic Phil Leckner, "Equivalen" Crane Co., "Flow of Fluic API STD 521, 5th edition This calculation is valid f Crane Co., page A-26 al	t Length of Valves and Fittinds" Technical Paper No. 410 n, "Typical K-factors for pipe for steel pipe, for all other pind 2-11. ds" Technical Paper No. 410	ngs in Pipeline Pres), "Pressure Drop in fittings and reduce pe material see Cro), pages 1-6 thru 1- nical Paper No. 410	n Straight Pipe" p ers", pg. 110 Tabl ane pg. A-26 or p -7. Friction factor	e 13 and Table g. A-23, to det for straight pip equations 2-1	e 14 ermine the co pe in laminar	flow is equal to 64/Re.



		Date:	10/29/19		Created By: CJM
hlon		Revision:			Checked By:
ayport, TX		Relief Valve No.:	PSV-XX2		
	OU	TLET PIPING C	ALCULATION	S	
utlet Piping Segments					
Sizing Basis:	Pipe Size (n	ominal diameter) =	2.00	inches	
1: Closed Outlet on Vessels	Pipe In	side Diameter, d =	2.000	inches	
		Pipe Spec =	CS		
		Pipe Schedule =	Sch 40		
	(5)Moody	Friction Factor, f =	0.019	_	
	Total Length of	f Straight Pipe, L =	3.0 ft		
		th of 90° Elbows =	5.0 ft		$L_{eq}/d = 30$
	(1)Equivalent Length of 90° Lone			# Elbows=	L _{eq} /d = 20
		th of 45° Elbows =		# Elbows=	L _{eq} /d = 16
	(1)Equivalent Length			# Tees=	$L_{eq}/d = 60$
	(1)Equivalent Length	of Thru Flow Tee =		# Tees=	$L_{eq}/d = 20$
	⁽¹⁾ Equivalent Len	gth of Gate Valve=		# Valves=	$L_{eq}/d = 8$
	⁽¹⁾ Equivalent Len	ngth of Ball Valve =		# Valves=	$L_{eq}/d = 3$
	⁽⁴⁾ Equivalent Length			K-factor=	
		ngth of Exit Loss =		K-factor=	Crane pg. A-29
	•	ength of Reducer =		(6)K-factor=	Reduced id =
Other Fitting	Equivalent Le	ength of Enlarger = Equivalent Length=		(6)K-factor=	Enlarged id =
Other Fitting:		Equivalent Length=		# Fittings= # Fittings=	L _{eq} /d =
	Total Equivalent Length of Valves		5 O ff	as 2 in. pipe	Eeq/u -
	Total Equivalent Length of Valves	and rittings, Leq -	3.0 10	as 2 III. pipe	
Outlet Piping Stream Properties					
Relief Rate of	Liquid or Vap Valve Capacity, W =	1,952			
	Relief Valve Set Pressure =	165			
	^(c) Header Pressure, P _H = Outlet Piping Temperature, T =	14.70 672		212.00	psig oc
Ratio of Spec	cific Heats at Outlet Conditions, k =	1.3		212.00	•
	Gas Compressibility Factor, Z =	0.98		M= 1.702-	$(10^{-5}) \left(\frac{W}{n_1 d^{-2}} \right) \left(\frac{ZT}{M} \right)^{0.5}$
	Sas Relative Molecular Weight, M =	18.0	lb/lbmol	$Ma_2 = 1.7023$	$\left(\frac{10}{p_{H}d_{H}^{2}}\right)\left(\frac{1}{M}\right)$
	Mach Number at Pipe Outlet, Ma ₂ =	0.493			
Se	et Outlet Line Outlet Pressure, P _o =	14.70	psia	If Ma $_2$ < 1.0, P	$_{o}$ = P_{H} ; however, if Ma $_{2}$ > 1.0, set P_{o} = P_{crit}
	Liquid Danaity in Outlet Line a		u (600	nM	
Vanor A	Liquid Density in Outlet Line, $\rho_L = \frac{1}{2}$ verage Density in Outlet Line, $\rho_V = \frac{1}{2}$	0.08	lb/ft3	$\rho_V = \frac{pM}{ZTR}$	
vapor	Viscosity in Outlet Line =	0.012		ZIK	
⁽⁸⁾ Rey	nolds Number (Re) in Outlet Line =		(Laminar flow oc	curs when Re ≤	2000.)
Outlet Line Pressure Drop Calcula		7.05	noio	Critical absolute	o procesure: not Ma. =1.0 (conic flow): if the
·	Critical absolute pressure, P _{crit} =	7.25	•		e pressure: set Ma ₂ =1.0 (sonic flow); if the
·	Critical absolute pressure, P_{crit} = t Length (valves and fittings), L_{eq} =	5.0	•	critical pressure	e is less than the pipe outlet pressure then
·	Critical absolute pressure, \mathbf{P}_{crit} = t Length (valves and fittings), \mathbf{L}_{eq} = Moody Friction Factor, \mathbf{f} =	5.0 0.019	ft	critical pressure the flow is subs	e is less than the pipe outlet pressure then conic.
·	Critical absolute pressure, P_{crit} = t Length (valves and fittings), L_{eq} =	5.0	ft in	critical pressure the flow is subs	e is less than the pipe outlet pressure then conic.
·	Critical absolute pressure, \mathbf{P}_{crit} = t Length (valves and fittings), \mathbf{L}_{eq} = Moody Friction Factor, \mathbf{f} = Line Diameter, \mathbf{d} =	5.0 0.019 2.00	ft in	critical pressure the flow is subs	e is less than the pipe outlet pressure then
Total Equivalen	Critical absolute pressure, $\mathbf{P}_{crit} =$ t Length (valves and fittings), $\mathbf{L}_{eq} =$ Moody Friction Factor, $\mathbf{f} =$ Line Diameter, $\mathbf{d} =$ Total Straight Pipe Length, $\mathbf{L} =$	5.0 0.019 2.00 3.0	ft in ft	critical pressure the flow is subs $P_{crit} = 1.702x10$	is less than the pipe outlet pressure then conic. $ ^{5} \left(\frac{W}{d^{2}}\right) \left(\frac{Z \cdot T}{M}\right)^{a \cdot 5} $
Total Equivalen	Critical absolute pressure, $\mathbf{P}_{\text{crit}} = t$ Length (valves and fittings), $\mathbf{L}_{\text{eq}} = t$ Length (valves and fittings), $\mathbf{L}_{\text{eq}} = t$ Line Diameter, $\mathbf{d} = t$ Total Straight Pipe Length, $\mathbf{L} = t$ Friction Factor (straight pipe), $\mathbf{f} = t$ Diameter of Piping at Header, $\mathbf{d}_{\text{H}} = t$ ve Design Backpressure Allowed =	5.0 0.019 2.00 3.0 0.019	ft in ft	critical pressure the flow is subs	is less than the pipe outlet pressure then conic. $ ^{5} \left(\frac{W}{d^{2}}\right) \left(\frac{Z \cdot T}{M}\right)^{a \cdot 5} $
Total Equivalen Inside Val	Critical absolute pressure, $\mathbf{P}_{\text{crit}} = t$ Length (valves and fittings), $\mathbf{L}_{\text{eq}} = t$ Length (valves and fittings), $\mathbf{L}_{\text{eq}} = t$ Long Triction Factor, $\mathbf{f} = t$ Line Diameter, $\mathbf{d} = t$ Total Straight Pipe Length, $\mathbf{L} = t$ Friction Factor (straight pipe), $\mathbf{f} = t$ Diameter of Piping at Header, $\mathbf{d}_{\text{H}} = t$ Ve Design Backpressure Allowed Max Back Pressure Allowed, $\mathbf{P}_{\text{B}} = t$	5.0 0.019 2.00 3.0 0.019 2.000 21% 49.40	ft in ft in psia	critical pressure the flow is subs $P_{\rm crit} = 1.702 {\rm x} 10$ $P_{AVG} = \frac{P_o + 1}{2}$	is less than the pipe outlet pressure then conic. $e^{s}\left(\frac{W}{d^2}\right)\left(\frac{Z\cdot T}{M}\right)^{0.5}$ $P_{\underline{B}}$
Total Equivalen Inside Val	Critical absolute pressure, $\mathbf{P}_{\text{crit}} = t$ Length (valves and fittings), $\mathbf{L}_{\text{eq}} = t$ Length (valves and fittings), $\mathbf{L}_{\text{eq}} = t$ Line Diameter, $\mathbf{d} = t$ Total Straight Pipe Length, $\mathbf{L} = t$ Friction Factor (straight pipe), $\mathbf{f} = t$ Diameter of Piping at Header, $\mathbf{d}_{\text{H}} = t$ ve Design Backpressure Allowed =	5.0 0.019 2.00 3.0 0.019 2.000 21% 49.40	ft in ft in	critical pressure the flow is subs $P_{\rm crit} = 1.702 {\rm x} 10$ $P_{AVG} = \frac{P_o + 1}{2}$	is less than the pipe outlet pressure then conic. $e^{s}\left(\frac{W}{d^2}\right)\left(\frac{Z\cdot T}{M}\right)^{0.5}$ $P_{\underline{B}}$
Total Equivalen Inside Val Outlet Line Avg	Critical absolute pressure, P _{crit} = t Length (valves and fittings), L _{eq} = Moody Friction Factor, f = Line Diameter, d = Total Straight Pipe Length, L = Friction Factor (straight pipe), f = Diameter of Piping at Header, d _H = ve Design Backpressure Allowed Max Back Pressure Allowed, P _B = I. Press. at Max BP Allowed, P _{AVG} =	5.0 0.019 2.00 3.0 0.019 2.000 21% 49.40 32.05	ft in ft in psia psia ^(b)	critical pressure the flow is subs $P_{crit} = 1.702x10$	is less than the pipe outlet pressure then conic. $e^{s}\left(\frac{W}{d^2}\right)\left(\frac{Z\cdot T}{M}\right)^{0.5}$ $P_{\underline{B}}$
Total Equivalen Inside Vali Outlet Line Avg	Critical absolute pressure, \mathbf{P}_{crit} = t Length (valves and fittings), \mathbf{L}_{eq} = Moody Friction Factor, \mathbf{f} = Line Diameter, \mathbf{d} = Total Straight Pipe Length, \mathbf{L} = Friction Factor (straight pipe), \mathbf{f} = Diameter of Piping at Header, \mathbf{d}_{H} = ve Design Backpressure Allowed = Max Back Pressure Allowed, \mathbf{P}_{B} = 1, Press. at Max BP Allowed, \mathbf{P}_{AVG} = utlet Piping Pressure Drop, $\Delta\mathbf{P}_{\text{psi}}$ = utlet Piping Pressure Drop, $\Delta\mathbf{P}_{\text{psi}}$ =	5.0 0.019 2.00 3.0 0.019 2.000 219% 49.40 32.05	ft in ft in psia psia psia psi	critical pressure the flow is substantial $P_{crit}=1.702x10$ $P_{AVG}=\frac{P_o+.}{2}$ $\Delta P_{psi}=0.0000$	is less than the pipe outlet pressure then ionic. $\frac{w}{d^2} \left(\frac{Z \cdot T}{M}\right)^{as}$ $\frac{P_B}{d^2} = \frac{fLW^2}{\rho d^5}$
Total Equivalen Inside Valv Outlet Line Avg (3)Or	Critical absolute pressure, $\mathbf{P}_{\text{crit}} = $ t Length (valves and fittings), $\mathbf{L}_{\text{eq}} = $ Moody Friction Factor, $\mathbf{f} = $ Line Diameter, $\mathbf{d} = $ Total Straight Pipe Length, $\mathbf{L} = $ Friction Factor (straight pipe), $\mathbf{f} = $ Diameter of Piping at Header, $\mathbf{d}_{\text{H}} = $ ve Design Backpressure Allowed = Max Back Pressure Allowed, $\mathbf{P}_{\text{B}} = $ 1. Press. at Max BP Allowed, $\mathbf{P}_{\text{AVG}} = $ utlet Piping Pressure Drop, $\Delta \mathbf{P}_{\text{psi}} = $ Outlet Piping Back Pressure, $\Delta \mathbf{P}_{\text{C}} = $	5.0 0.019 2.00 3.0 0.019 2.000 21% 49.40 32.05 0.75	ft in ft in psia psia psia psi psi psi	critical pressure the flow is substantial $P_{crit}=1.702x10$ $P_{AVG}=\frac{P_o+.}{2}$ $\Delta P_{psi}=0.0000$	is less than the pipe outlet pressure then conic. $e^{s}\left(\frac{W}{d^2}\right)\left(\frac{Z\cdot T}{M}\right)^{0.5}$ $P_{\underline{B}}$
Total Equivalen Inside Valv Outlet Line Avg (3)Or	Critical absolute pressure, \mathbf{P}_{crit} = t Length (valves and fittings), \mathbf{L}_{eq} = Moody Friction Factor, \mathbf{f} = Line Diameter, \mathbf{d} = Total Straight Pipe Length, \mathbf{L} = Friction Factor (straight pipe), \mathbf{f} = Diameter of Piping at Header, \mathbf{d}_{H} = ve Design Backpressure Allowed = Max Back Pressure Allowed, \mathbf{P}_{B} = 1, Press. at Max BP Allowed, \mathbf{P}_{AVG} = utlet Piping Pressure Drop, $\Delta\mathbf{P}_{\text{psi}}$ = utlet Piping Pressure Drop, $\Delta\mathbf{P}_{\text{psi}}$ =	5.0 0.019 2.00 3.0 0.019 2.000 219% 49.40 32.05	ft in ft in psia psia psia psi psi psi	critical pressure the flow is subs $P_{crit} = 1.702 \text{x} 10$ $P_{AVG} = \frac{P_o + 1}{2}$ $\Delta P_{psi} = 0.000$ $BP_c = \Delta P$	is less than the pipe outlet pressure then ionic. $\frac{d}{d^2}\left(\frac{Z \cdot T}{M}\right)^{as}$ $\frac{d}{d^2}\left(\frac{Z \cdot T}{M}\right)^{as}$ $\frac{d}{d^2}\left(\frac{DW^2}{M}\right)^{as}$ $\frac{d}{d^3}\left(\frac{DW^2}{DM^3}\right)^{as}$ $\frac{d}{d^3}\left(\frac{DW^2}{DM^3}\right)^{as}$ $\frac{d}{d^3}\left(\frac{DW^2}{DM^3}\right)^{as}$
Total Equivalen Inside Val Outlet Line Avg (3)Ol Calculated (Pressure	Critical absolute pressure, P_{crit} = t Length (valves and fittings), L_{eq} = Moody Friction Factor, f = Line Diameter, d = Total Straight Pipe Length, L = Friction Factor (straight pipe), f = Diameter of Piping at Header, d_{H} = ve Design Backpressure Allowed = Max Back Pressure Allowed, P_{B} = 1, Press. at Max BP Allowed, P_{AVG} = utilet Piping Pressure Drop, ΔP_{psi} = Outlet Piping Back Pressure, BP_{C} = 1 Prop, Percent of Set Pressure = for Atmospheric Relief Valves, F =	5.0 0.019 2.00 3.0 0.019 2.000 21% 49.40 32.05 0.75	ft in ft psia psia (b) psi psi psi gsig (a)	critical pressure the flow is subs $P_{crit} = 1.702 \text{x} 10$ $P_{AVG} = \frac{P_o + 1}{2}$ $\Delta P_{psi} = 0.000$ $BP_c = \Delta P$	is less than the pipe outlet pressure then ionic. $\frac{d}{d^2}\left(\frac{Z \cdot T}{M}\right)^{as}$ $\frac{d}{d^2}\left(\frac{Z \cdot T}{M}\right)^{as}$ $\frac{d}{d^2}\left(\frac{DW^2}{M}\right)^{as}$ $\frac{d}{d^2}\left(\frac{DW^2}{M}\right)^{as}$ $\frac{d}{d^2}\left(\frac{DW^2}{M}\right)^{as}$ $\frac{d}{d^2}\left(\frac{DW^2}{M}\right)^{as}$ $\frac{d}{d^2}\left(\frac{DW^2}{M}\right)^{as}$
Total Equivalen Inside Val Outlet Line Avg (3)Ot Calculated Pressure (7)Reaction Force f (Reaction force calculation is no	Critical absolute pressure, \mathbf{P}_{crit} = t Length (valves and fittings), \mathbf{L}_{aq} = Moody Friction Factor, \mathbf{f} = Line Diameter, \mathbf{d} = Total Straight Pipe Length, \mathbf{L} = Friction Factor (straight pipe), \mathbf{f} = Diameter of Piging at Header, \mathbf{d}_{H^-} veve Design Backpressure Allowed = Max Back Pressure Allowed, \mathbf{P}_{B^-} Press. at Max BP Allowed, \mathbf{P}_{AVG} = utilet Piping Pressure Drop, $\Delta \mathbf{P}_{psi}$ = Outlet Piping Back Pressure, \mathbf{BP}_{C^-} = Drop, Percent of Set Pressure = for Atmospheric Relief Valves, \mathbf{F} = at applicable for non atmospheric	5.0 0.019 2.00 3.0 0.019 2.000 21% 49.40 32.05 0.75 0.75	ft in ft psia psia (b) psi psi psi gsig (a)	critical pressure the flow is subs $P_{crit} = 1.702 \text{x} 10$ $P_{AVG} = \frac{P_o + 1}{2}$ $\Delta P_{psi} = 0.000$ $BP_c = \Delta P$	is less than the pipe outlet pressure then ionic. $\frac{w}{d^2} \left(\frac{Z \cdot T}{M}\right)^{as}$ $\frac{P_B}{d^2} = \frac{fLW^2}{\rho d^5}$
Total Equivalen Inside Val Outlet Line Avg (3)Ol Calculated (Pressure	Critical absolute pressure, \mathbf{P}_{crit} = t Length (valves and fittings), \mathbf{L}_{aq} = Moody Friction Factor, \mathbf{f} = Line Diameter, \mathbf{d} = Total Straight Pipe Length, \mathbf{L} = Friction Factor (straight pipe), \mathbf{f} = Diameter of Piging at Header, \mathbf{d}_{H^-} veve Design Backpressure Allowed = Max Back Pressure Allowed, \mathbf{P}_{B^-} Press. at Max BP Allowed, \mathbf{P}_{AVG} = utilet Piping Pressure Drop, $\Delta \mathbf{P}_{psi}$ = Outlet Piping Back Pressure, \mathbf{BP}_{C^-} = Drop, Percent of Set Pressure = for Atmospheric Relief Valves, \mathbf{F} = at applicable for non atmospheric	5.0 0.019 2.00 3.0 0.019 2.000 21% 49.40 32.05 0.75 0.75	ft in ft psia psia (b) psi psi psi gsig (a)	critical pressure the flow is subs $P_{crit} = 1.702 \text{x} 10$ $P_{AVG} = \frac{P_o + 1}{2}$ $\Delta P_{psi} = 0.000$ $BP_c = \Delta P$	is less than the pipe outlet pressure then ionic. $\frac{d}{d^2}\left(\frac{Z \cdot T}{M}\right)^{as}$ $\frac{d}{d^2}\left(\frac{Z \cdot T}{M}\right)^{as}$ $\frac{d}{d^2}\left(\frac{DW^2}{M}\right)^{as}$ $\frac{d}{d^3}\left(\frac{d^3}{d^3}\right)^{as}$ $\frac{d}{d^3}\left($
Total Equivalen Inside Valv Outlet Line Avg (3)Or Calculated t Pressure (7)Reaction Force f (Reaction force calculation is no relief de	Critical absolute pressure, \mathbf{P}_{crit} = t Length (valves and fittings), \mathbf{L}_{aq} = Moody Friction Factor, \mathbf{f} = Line Diameter, \mathbf{d} = Total Straight Pipe Length, \mathbf{L} = Friction Factor (straight pipe), \mathbf{f} = Diameter of Piging at Header, \mathbf{d}_{H^-} veve Design Backpressure Allowed = Max Back Pressure Allowed, \mathbf{P}_{B^-} Press. at Max BP Allowed, \mathbf{P}_{AVG} = utilet Piping Pressure Drop, $\Delta \mathbf{P}_{psi}$ = Outlet Piping Back Pressure, \mathbf{BP}_{C^-} = Drop, Percent of Set Pressure = for Atmospheric Relief Valves, \mathbf{F} = to applicable for non atmospheric	5.0 0.019 2.00 3.0 0.019 2.000 21% 49.40 32.05 0.75 0.75	ft in ft psia psia (b) psi psi psi gsig (a)	critical pressure the flow is subs $P_{crit} = 1.702 \text{x} 10$ $P_{AVG} = \frac{P_o + 1}{2}$ $\Delta P_{psi} = 0.000$ $BP_c = \Delta P$	is less than the pipe outlet pressure then ionic. $\frac{d}{d^2}\left(\frac{Z \cdot T}{M}\right)^{as}$ $\frac{d}{d^2}\left(\frac{Z \cdot T}{M}\right)^{as}$ $\frac{d}{d^2}\left(\frac{DW^2}{M}\right)^{as}$ $\frac{d}{d^3}\left(\frac{d^3}{d^3}\right)^{as}$ $\frac{d}{d^3}\left($
Total Equivalen Inside Val Outlet Line Avg (3)O Calculated (Pressure (7)Reaction Force f (Reaction force calculation is no relief de	Critical absolute pressure, \mathbf{P}_{crit} = t Length (valves and fittings), \mathbf{L}_{aq} = Moody Friction Factor, \mathbf{f} = Line Diameter, \mathbf{d} = Total Straight Pipe Length, \mathbf{L} = Friction Factor (straight pipe), \mathbf{f} = Diameter of Piging at Header, \mathbf{d}_{H^-} veve Design Backpressure Allowed = Max Back Pressure Allowed, \mathbf{P}_{B^-} Press. at Max BP Allowed, \mathbf{P}_{AVG} = utilet Piping Pressure Drop, $\Delta \mathbf{P}_{psi}$ = Outlet Piping Back Pressure, \mathbf{BP}_{C^-} = Drop, Percent of Set Pressure = for Atmospheric Relief Valves, \mathbf{F} = to applicable for non atmospheric	5.0 0.019 2.00 3.0 0.019 2.000 21% 49.40 32.05 0.75 0.45% 26.82	ft in ft in psia psia (b) psi psig (a)	critical pressure the flow is subs $P_{crit} = 1.702 \text{x} 10$ $P_{AVG} = \frac{P_o + \frac{1}{2}}{2}$ $\Delta P_{psi} = 0.000$ $BP_c = \Delta P$ $F = \frac{W}{366} \sqrt{\frac{1}{(k)}}$	is less than the pipe outlet pressure then ionic. $\frac{d}{d^2}\left(\frac{U \cdot T}{M}\right)^{as}$

Pln calculating multiple pipe segments, i.e., changes in diameter, the header pressure in the second segment should be equal to the "Calculated Outlet Piping Back Pressure", BPc, in the first segment.

REFERENCES

- ¹⁾ Crane Co., "Flow of Fluids" Technical Paper No. 410, "Resistance Coefficients for Valves and Fittings" pages A-26 thru A-30
- ²⁾API STD 521, 5th edition, "Design of relief device discharging piping", pg. 105 Equation #28: Isothermal outlet Mach number
- ³⁾ Crane Co., "Flow of Fluids" Technical Paper No. 410, "Pressure Drop in Straight Pipe" pg. 3-2, Eq. 3-5
- API STD 521, 5th edition, "Typical K-factors for pipe fittings and reducers", pg. 110 Table 13 and Table 14
- 5) This calculation is valid for steel pipe, for all other pipe material see Crane pg. A-26 or pg. A-23, to determine the correct Friction Factor, f.
- ³⁾ Crane Co., page A-26 and 2-11.
- 7) This calculation should be used as a reference only, a competent mechanical engineer should determine the required support design. API RP 520 Part II, 5th edition, Determining Reaction Forces" Section 4.4.1.1 for any gas, vapor, or steam discharging to the atmosphere.
- Drane Co., "Flow of Fluids" Technical Paper No. 410, pages 1-6 thru 1-7. Friction factor for straight pipe in laminar flow is equal to 64/Re.
- ⁹⁾ Cv converted to L_{ed}/d by combining Crane Co. Technical Paper No. 410 (08/11 Reprint) equations 2-11 and 2-4 as follows:

 $\frac{L_{eq}}{D} = 890.4256 \frac{d^4}{f * Cv^2}$

ReCon Engineering, Management, & Inspection document



Date: 10/29/19 Created By: CJM Revision: A Checked By: 0 Athlon Bayport, TX Fire Case Relief Requirement Calculation for Vessels - Adequate Drainage & Fire Fighting Equipment PSV INFORMATION **PSV Number:** PSV-XX2 E-778 Shell Side Vessel Item # Vessel Description: E-778 Shell Flow Sheet Reference #: SK-19282010-001 Rev.A Relieving State: Vapor 15: Exterior Fire Sizing Basis: INPUTS Spherical Vessel Code: Vessel Orientation = H = Horizontal, V = Vertical, S = Spherical Number of Ends(Heads) = Number of Ends (Heads) exposed to the Fire. Type of Ends = F = Flat, H = Hemispherical, E = Elliptical 1.96 ft D = Vessel diameter HLL = 16.00 ft High liquid level Length of vessel, T/T $^{\left(1\right)}$ L= 16.00 ft Vessel elevation Environmental factor⁽²⁾ F= 1.00 Latent Heat of Vap., λ = 851 btu/lb From process simulation calculations (at relieving conditions) CALCULATIONS Spherical Vessel, A_{Sws} = ____ ft² Total Wetted Area of a Spherical Vessel Per API 521 Spherical Vessel, A_{Sws} = Total Wetted Area of a Spherical Vessel Per API 2000 Effective liquid level (up to 25 ft from the flame source) 16.0 ft ⁽³⁾Total Wetted Area of a Vertical Vessel with FLAT Ends Vertical Vessel, A_{Vws} = ft² (3)Total Wetted Area of a Vertical Vessel with HEMISPHERICAL Ends Vertical Vessel, A_{Vws} = ft² ft² (5) Total Wetted Area of a Vertical Vessel with ELLIPTICAL Ends Vertical Vessel, A_{Vws} = 102.6 E_{horizontal} = ft Effective liquid level (up to 25 ft from the flame source) ⁽³⁾Total Wetted Area of a Horizontal Vessel with FLAT Ends Horizontal Vessel, A_{Hws} = ft² (3)Total Wetted Area of a Horizontal Vessel with HEMISPHERICAL Ends Horizontal Vessel, A_{Hws} = Horizontal Vessel, A_{Hws} = (5)Total Wetted Area of a Horizontal Vessel with ELLIPTICAL Ends ft² $A_{ws} = 103 \text{ ft}^2$ Total wetted surface area $Q = 21,000*F*A_{ws}^{0.82}$ Total heat absorption (input) to the wetted surface⁽⁴⁾ Q = <u>936,307</u> Btu/hr W = 1,100 lb/hr Required Relief Rate (=Q/λ) NOTES (1) This spreadsheets calculates the wetted area for a HORIZONTAL or VERTICAL vessel. ⁽²⁾ API STD 521, 5th edition, Table 6 "Environmental Factor", pg. 41 Wetted Surface Area Calculations taken from page VS22 in the Consolidated Relief Valve Databook, Valve Sizing Section. 4) API STD 521, 5th edition, "Heat Absorption to Liquids", Equation 6, pg. 40 (with adequate draining and firefighting equipment) ^[5] Wetted Surface Area Calculations taken from page 439 in the Pressure Vessel Handbook, 13th Ed. By Eugene F. Megyesy. ReCon Engineering, Management, & Inspection document Rev 1.29.1





Athlon Date: 10/29/2019 Checked By: 0
Bayport, TX Revision: A

Fire Case Relief Requirement Calculation - Vapor Expansion

PSV CALCULATION SHEET

PSV Number: PSV-XX2
Vessel Item # E-778 Shell Side
Vessel Description: E-778 Shell
Flow Sheet Reference #: SK-19282010-001 Rev.A

Relieving State: Vapor Sizing Basis: Fire

INPUTS

Vessel Orientation =	V		H = Horizontal, V = Vertical, S = Spherical
Number of Ends(Heads) =	1		Number of Ends (Heads) exposed to the Fire.
Type of Ends =	Е		F = Flat, H = Hemispherical, E = Elliptical
D =	1.96	ft	Vessel diameter
L=	16.00	ft	Length of vessel, T/T ⁽¹⁾
H =	5.00	ft	Vessel elevation
MW =	18.02		Molecular weight of the gas
P _n =	0	psig	Normal operating gas pressure
T _n =	70	°F	Normal operating gas temperature
T _w =	1100	°F	Max. vessel wall temp (Assume 1100 °F for Carbon Steel Vessel)
Set Pressure =	0	psig	
	21	%	Allowable overpressure (fire case)

CALCULATIONS

m = 44.7 mais Names I amounting on a basis to massage	
p _n =14.7_psia Normal operating gas absolute pressure	
p ₁ = 14.7 psia Upstream relieving pressure (set pressure + allowable overpressure +atm. pres	sure)
$T_n = {530}$ R Normal operating gas absolute temperature	
T _w = 1560 °R Recommended maximum vessel wall temperature	
$T_1 = {}$ 530 $^{\circ}$ R Gas absolute temperature, at the upstream relieving pressure T1 =(P1 / P $_{\eta}$) *	Τη
A' = 102.6 ft² Exposed surface area of the vessel	
q _m = 1,005.2 lb/hr Relief Load Vapor ⁽²⁾	

 $q_m = 0.1406\sqrt{M * p_1} \frac{A'(T_w - T_1)^{1.25}}{T_1^{1.1506}}$

NOTES

REFERENCES

- (1) This spreadsheets calculates the wetted area for a HORIZONTAL or VERTICAL vessel.
- (2) API STD 521, 5th edition, "Heat Absorption Equations for Vessels", Equation 12, pg. 43. This calculation is used to determine the required relief rate for vapor expansion during a fire.

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Rev 1.29.1



PSV Number P&ID	PSV-XX2		Date: 10/29/19 Revision: A					Created By: CJM Checked By: 0				
	PSV-XX2			D. II.	· D	•						
	PSV-XX2			Reliei	Requirements	Summary						
	P3V-XX2				D	-44-d F-	!			ı		
IIP&II)		. ^	1	Causin na a nat #		otected Eq			MAWP			
Set Pressure			-	Equipment # Equipment Description E-778 Shell S E-778 Shell			psig @	1	°F			
Manufacturer			-	E-116 SHEILS		E-110 S	orieli		103			°F
Model #			•							psig @ psig @		°F
Orifice	E									psig @		°F
Area		Multivalve								psig w		<u>'</u>
Style	Conventional	Manavarvo										<u></u>
Ctylo	Conventional		Relief	R	equired Relief		Capacity	Inlet Pres	sure Loss	Outlet Pr	essure Loss	Mitigation
	Relief Condition		Description		Volume (gpm)	Area (in ²)	(lb/hr)	(psi)	(%)	(psi)	(%)	required
01: Closed Out			2 ccciipticii	1,100	voidino (gpin)	7 ti Ga (iii)	34,798	0.87	0.53%	0.75	\ /	roquirou
02: Cooling-wa				.,			2 1,1 2 2		0.00%	• • • • • • • • • • • • • • • • • • • •	0.00%	
03: Top-tower	Reflux Failure								0.00%		0.00%	
	n Reflux Failure								0.00%		0.00%	
05: Lean-oil Fa	ailure to Absorber								0.00%		0.00%	
06: Accumulation of Noncondensables									0.00%		0.00%	
07: Entrance of Highly Volatile Material									0.00%		0.00%	
08: Overfilling Storage or Surge Vessel								0.00%		0.00%		
	09: Failure of Automatic Control								0.00%		0.00%	
	Heat or Vapor Input								0.00%		0.00%	
11: Split Excha									0.00%		0.00%	
12: Internal Ex									0.00%		0.00%	
	13: Chemical Reaction								0.00%		0.00%	
14: Hydraulic E									0.00%		0.00%	
15: Exterior Fir									0.00%		0.00%	
	ure (steam, electric, air,	or other)							0.00%		0.00%	
	t Valve Operation								0.00%		0.00%	
18: Other	18: Other								0.00%		0.00%	
									0.00%		0.00%	
									0.00% 0.00%		0.00% 0.00%	
									0.00 %		0.00%	
NOTES												
	eering, Management, & Ir		- a.u.m. o.u.t									Rev 1.29.1



Date: 10/29/19 Created By: CJM Athlon Revision: A Checked By: 0 Bayport, TX Orifice Calculation - Liquid Relief PSV INFORMATION PSV Number: PSV-XX2 Vessel Item # E-778 Shell Side Vessel Description: E-778 Shell Flow Sheet Reference #: SK-19282010-001 Rev.A Relieving State: Liquid 01: Closed Outlet on Vessels Sizing Basis: INPUT DATA 2.53_gpm Flowrate, Q = 1100.2 lbs/hr 165.0 psig Set Pressure, P_s = Allowable Overpressure = 21 % Relieving Pressure, P_R = 199.7 psig Back Pressure P_B= psig 0.87 Specific Gravity at oper temp, G = 0.1355 cP Viscosity, μ = 54.22690209 lb/ft3 Density, ρ = Manufacturer Coefficient of Discharge⁽¹⁾, $\mathbf{K_d} =$ 0.65 Default K_d=0.65 certified, Kd=0.62 for non-certified $R = \frac{Q(2800 \times G)}{}$ Reynolds Number⁽²⁾, **R** = 96.635 1.000 If back pressure is atm., $\rm K_w$ =1 otherwise see API 520, Fig 31. Capacity Correction Factor due to Back Pressure⁽³⁾, $\mathbf{K_w}$ = $K_{v} = \left(0.9935 + \frac{2.878}{R^{0.5}} + \frac{342.75}{R^{1.5}}\right)^{-1.0}$ Capacity Correction Factor due to Viscosity⁽⁴⁾, $\mathbf{K_v} =$ 0.997 Combination Correction Factor for Rupture Disks $^{(5)}$, $\mathbf{K_c}$ = 1.0 K_c =1.0 if rupture disk not installed, else 0.9, if MFG not available Correction Factor due to Overpressure⁽⁶⁾, \mathbf{K}_{p} = 0.6 At 25%, $K_p = 1.0$; at 10% $K_p = 0.6$ CALCULATED RESULTS PSV Liquid Capacity Certification Required? Y or N = $A_{cert} = \frac{Q}{38K_d K_w K_c K_v} \sqrt{\frac{G}{p_1 - p_2}}$ $0.007 in^2$ Required Orifice Area for a Liquid Certified Relief Valve (7), Acert = $A_{non-cert} = \frac{Q}{38K_d K_w K_c K_v K_p} \frac{G}{1.25p - p_b}$ N/A in² Required Orifice Area for a *Non-Certified* Liquid Relief Valve ⁽⁸⁾, **A**_{non-cert} = Available Orifice Area, A_v = 0.221 in² Relief Valve Maximum Flow Rate = Q (A_v / A) = 80 gpm Relief Valve Maximum Mass Flowrate = 34,798 lb/hr NOTES REFERENCES ⁽¹⁾API RP 520, 7th Edition, "Rated Coefficient of Discharge, K_d" pg. 52 (certified) and pg. 54 (non-certified) API RP 520, 7th Edition, "Sizing for Liquid Relief", Equation 3.10, pg. 53 API RP 520, 7th Edition, "Capacity Correction Factor due to Backpressure", pg. 52; Figure 31, pg. 38 API RP 520, 7th Edition, "Capacity Correction Factor due to Viscosity", pg.52; Figure 36, pg. 54 API RP 520, 7th Edition, "Capacity Correction Factor for Rupture Disks", pg.52 API RP 520, 7th Edition, "Capacity Correction Factor due to Overpressure", Figure 37, pg.55 API RP 520, 7th Edition, "Sizing for Liquid Relief: Pressure Relief Valves Requiring Capacity Certification", Equation 3.9, pg. 52 API RP 520, 7th Edition, "Sizing for Liquid Relief: Pressure Relief Valves Not Requiring Capacity Certification", Equation 3.12, pg. 54 Rev 1.29.1 ReCon Engineering, Management, & Inspection document