Contractor:	PROJECT	MKP Methanol Project			Owner :
TIANCHEN CORP.CHINA	UNIT	General Technical	PHASE	As Built Drawing	شرکت کیمیای پارس خاورمیانه Middle East Kimiaye Pars Co.
	DOC. Title	Calculation Sheet for Pressure Safety Valve			
	Owner No.	MKP-11-AS-9000-IN-CAL-009			
	Contractor No.	MKP-11-AS-9000-PS84-CAL-009			
Licensor:	TOPSOE No.	N/A		Rev. : Z01	Page : 1 of 17

CALCULATION SHEET
FOR
PRESSURE SAFETY VALVE

Z01	30.04.2020	As Built	Xu Yekun	Xu Hang	Liu Shengkai	
0	10.01.2017	Final Issue	Xu Yekun	Xu Hang	Shi Jing	
B	20.12.2016	Issued for Review	Xu Yekun	Xu Hang	Shi Jing	
A	08.11.2016	Issued for Review	Xu Yekun	Xu Hang	Shi Jing	
REV.	DATE	PURPOSE OF ISSUE	PREPARE	CHECK	REVIEW	APPROVE

Contractor:	PROJECT	MKP Methanol Project			Owner :
TIANCHEN CORP.CHINA	UNIT	General Technical	PHASE	As Built Drawing	شرکت کیمیای پارس خاورمیانه Middle East Kimiaye Pars Co.
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Licensor:	TOPSOE No.	N/A		Rev. : Z01	Page : 2 of 17

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Item NO.	PSV-1008 PSV-1009	P&ID NO.	1000-PID-002
Case	Inadvertent opening of PV-1006		
Equation	Ws=3171.3(Cv1-Cv2)Ph(Gg/T)^0.5		

Parameter	Unit	Value
No flow and no venting, since the upstream pressure is only 52barg, while the setting pressure of PSV-1008/1009 is 55barg. TOPSOE designed this PSV in the condition that gas station was not exist. So minimum size PSV*(1D2)* will be choosen.		

Remark: PSV-1009 is spare PSV.

Item NO.	PSV-1013 PSV-1014	P&ID NO.	1000-PID-002
Case	Inadvertent opening of PV-1011		
Equation	-		

Parameter	Unit	Value
Rated Cv value(Provided by vendor)		44
Venting required (Provided by vendor)	Nm3/h	37400
Venting required(Provided by TOPSOE)	Nm3/h	37000
Venting required (Ws)	kg/h	27950

Remark: The venting required is decided by the structure of PV-1011. So TCC provided the venting condition to control valve vendor to calculated the flowrate passing through PV-1011 under venting condition. It is a little bigger than TOPSOE's value. So vendor's value is adopted.

Item NO.	PSV-1015	P&ID NO.	1000-PID-002
Case	Fire- unwetted surface		
Equation	Ws=2.722*(Tw-T)^1.25*A*（M*P)^0.5/T^1.1506		

Parameter	Unit	Value
F'		560.47
Wall temperature (Tw)	℃	593.00
Venting temperature (T)	℃	87.00
Exposed area (A)	m2	16.18
Molecular weight (M)	g/mol	16.74
Venting pressure (P)	bara	53.00
Venting required (Ws)	kg/h	3602.31

Remark:

Item NO.	PSV-1031	P&ID NO.	1000-PID-003
Case	Fire- unwetted surface		
Equation	Ws=182*C*A*(M*P*100/(T+273.15))^0.5		

Parameter	Unit	Value
F'		69.84
Coefficient C		0.025
Operating temperature (T)	℃	380.00
Exposed area (A)	m2	74.41
Molecular weight (M)	g/mol	16.54
Operating pressure (P)	bara	49.80
Venting required (Ws)	kg/h	3824.06

Remark: According to API-521, F' is smaller than 182, then F' is set at 182 during calculation.

Item NO.	PSV-1038	P&ID NO.	1000-PID-003
Case	Fire- unwetted surface		
Equation	Ws=182*C*A*(M*P*100/(T+273.15))^0.5		

Parameter	Unit	Value
F'		69.84
Coefficient C		0.025
Venting temperature (T)	℃	375.00
Exposed area (A)	m2	43.96
Molecular weight (M)	g/mol	16.54
Venting pressure (P)	bara	49.30
Venting required (Ws)	kg/h	2256.58

Remark: According to API-521, F' is smaller than 182, then F' is set at 182 during calculation.

Item NO.	PSV-1043	P&ID NO.	1000-PID-003
Case	Fire- unwetted surface		
Equation	Ws=182*C*A*(M*P*100/(T+273.15))^0.5		

Parameter	Unit	Value
F'		69.84
Coefficient C		0.025
Operating temperature (T)	℃	375.00
Exposed area (A)	m2	43.96
Molecular weight (M)	g/mol	16.54
Operating pressure (P)	bara	49.30
Venting required (Ws)	kg/h	2256.58

Remark: According to API-521, F' is smaller than 182, then F' is set at 182 during calculation.

Item NO.	PSV-2019	P&ID NO.	2000-PID-001
Case	Non-explosive liquified gas drum without insulation, fire case		
Equation	Ws=2.55*10^5•F•Ar^0.82/q		

Parameter	Unit	Value
Environment factor (F)	1	1.00
Heated area (Ar)	m2	8.57
Letent heat @venting condition (q)	kJ/kg	1600.00
Venting required (Ws)	kg/h	928.02

Remark:

Item NO.	PSV-2121 PSV-2122	P&ID NO.	2000-PID-005
Case	Outlets valve abnormally closed		
Equation	Total incoming steam and vapor plus that generated therein at relieving conditions		

Parameter	Unit	Value
Venting required (Ws)	kg/h	27180.00

Remark: Rated operation of FT-2002: 27180kg/h; The value will be confirmed by ITT.

Item NO.	PSV-2171 PSV-2172	P&ID NO.	2000-PID-006
Case	Outlets valve abnormally closed		
Equation	Total incoming steam and vapor plus that generated therein at relieving conditions		

Parameter	Unit	Value
Venting required (Ws)	kg/h	48000.00

Remark: Rated operation of FT-2001:48000kg/h; The value will be confirmed by ITT.

Item NO.	PSV-2354~60	P&ID NO.	2000-PID-012
Case	Outlets valve abnormally closed		
Equation	Total incoming steam and vapor plus that generated therein at relieving conditions		

Parameter	Unit	Value
Venting required (Ws)	kg/h	83693.13

Remark: The total capacity is 502159kg/h (Normal capacity is 456508 considering 1.1 times) which is shared by PSV-2354, PSV-2355, PSV-2356, PSV-2357, PSV-2358, PSV-2359; PSV-2360 is spare and its capacity is the same as PSV-2354~59.

Item NO.	PSV-2354~60	P&ID NO.	2000-PID-012
Case	Heat exchange E 2020 tube rupture (Liquid)		
Equation	Ws=min{1.68•ρ•d^2•(△P/ρ)^0.5,F}		

Parameter	Unit	Value
Heat exchange tube inner diameter (d)	mm	48.26
Liquid density (ρ)	kg/m3	683.00
Differential pressure of high pressure side and low side (△P)	bar	74.70
Flow rate @high pressure side (F)	kg/h	64721.50
Venting required (Ws)	kg/h	883801
Final Venting required (Ws)	kg/h	64721.50

Remark: Just for the fluid at high pressure side is liquid phase. Camparing the normal flow rate for high pressure side (388329kg/h) and the calculation value (5302806kg/h), and choose the smaller value as the final venting required;The value is shared by six (PSV-2354~59), and PSV-2360 is spare and its capacity is the same as PSV-2354~59.

Item NO.	PSV-2365	P&ID NO.	2000-PID-012
Case	Outlets valve abnormally closed		
Equation	Superheater minimum flow protection.		

Parameter	Unit	Value
Venting required (Ws)	kg/h	110000.00

Remark: Superheater minimum flow protection.

Item NO.	PSV-2376~80	P&ID NO.	2000-PID-013
Case	Outlets valve abnormally closed		
Equation	Total incoming steam and vapor plus that generated therein at relieving conditions		

Parameter	Unit	Value
Environment factor (F)	1	1.00
Heated area (Ar)	m2	8.57
Letent heat @venting condition (q)	kJ/kg	1600.00
Venting required (Ws)	kg/h	107500.00

Remark: The total capacity is 430000kg/h (Normal capacity is 388329 considering 1.1 times) which is shared by PSV-2376, PSV-2377, PSV-2378, and PSV-2379; PSV-2380 is spare and its capacity is the same as PSV-2376~79.

Item NO.	PSV-2458	P&ID NO.	2000-PID-015
Case	Heat exchange E 2025 tube rupture (Gas)		
Equation	Ws=2.463*d^2*(ΔP*ρV/10)^0.5		

Parameter	Unit	Value
Tube inner diameter (d)	mm	22.10
Gas density (ρV)	kg/m3	9.09
Differential pressure of high pressure side and low side (△P)	bar	20.30
Venting required (Ws) in E2025 shell side	kg/h	5167.48

Remark: Just for the fluid at high pressure side is gas phase. Choose the bigger value as Ws after comparing the value in datasheet of HTAS (13200Nm3/h or 7107kg/h) with the calculation.

Item NO.	PSV-2494	P&ID NO.	2000-PID-016
Case	Heat exchange E 2027 tube rupture (Gas)		
Equation	Ws=2.463*d^2*(ΔP*ρV/10)^0.5		

Parameter	Unit	Value
Tube inner diameter (d)	mm	15.75
Gas density (ρV)	kg/m3	10.7
Differential pressure of high pressure side and low side (△P)	bar	22.70
Venting required (Ws) in E2027 shell side	kg/h	3011.14

Remark: Just for the fluid at high pressure side is gas phase. Choose the bigger value as Ws after comparing the value in datasheet of HTAS (6000Nm3/h or 3011kg/h) with the

Item NO.	PSV-2546 PSV-2555	P&ID NO.	2000-PID-017
Case	Inadvertent opening of PCV-2545		
Equation	-		

Parameter	Unit	Value
Venting required (Provided by vendor)	Nm3/h	2900.00
Venting required(Provided by TOPSOE)	Nm3/h	1350.00
Venting required (Ws)	kg/h	3625.00

Remark: The venting required is decided by the structure of PCV-2545. So TCC provided the venting condition to control valve vendor to calculated the flowrate passing through PCV-2545 under venting condition. It is bigger than TOPSOE's value. So vendor's value is adopted.PSV-2555 is spare.

Item NO.	PSV-2604 PSV-2605	P&ID NO.	2000-PID-019
Case	Inadvertent opening of PV-2608		
Equation	-		

Parameter	Unit	Value
Rated Cv value(Provided by vendor)		6.50
Venting required (Provided by vendor)	Nm3/h	6350.00
Venting required(Provided by TOPSOE)	Nm3/h	9500.00
Venting required (Ws)	kg/h	3973.88

Remark: The venting required is decided by the structure of PV-2608. So TCC provided the venting condition to control valve vendor to calculated the flowrate passing through PV-2608 under venting condition. It is smaller than TOPSOE's value. So TOPSOE's value is adopted.

Item NO.	PSV-2581	P&ID NO.	2000-PID-018
Case	Outlets valve abnormally closed		
Equation	Total incoming steam and vapor plus that generated therein at relieving conditions		

Parameter	Unit	Value
Venting required (Ws)	kg/h	39000.00

Remark: The rated capacity is 31200Nm3/h or 39000kg/h. The capacity will be confirmed by C2001 vendor.

Item NO.	PSV-3047, PSV-3048, PSV-3057	P&ID NO.	3000-PID-002
Case	The outlet valve closing, the maximum steam production of D3003（Blocked outlet）		
Equation	Ws=H/q		

Parameter	Unit	Value
Venting required (Ws)	kg/h	281464

Remark:

Item NO.	PSV-3143, PSV-3146, PSV-3149	P&ID NO.	3000-PID-005
Case	Heat exchange (E3003 1/2/3) tube rupture		
Equation	Ws=2.463*d^2*(ΔP*ρV/10)^0.5		

Parameter	Unit	Value
Tube inner diameter (d)	mm	22.1
Gas density (ρV)	kg/m3	35.1
Differential pressure of high pressure side and low side (△P)	bar	81.20
Venting required (Ws)	Nm3/h	*45175*
Venting required (Ws)	kg/h	20309

Remark:

Item NO.	PSV-3163	P&ID NO.	3000-PID-006
Case	Gas vessel with unwetted area, external fire (Open pool fire)		
Equation	Ws=2.722*(Tw-T)^1.25*A*（M*P)^0.5/T^1.1506		

Parameter	Unit	Value
F'		295
Wall temperature (Tw)	℃	593
Venting temperature (T)	℃	229
Exposed area (A)	m2	113
molecular weight (M)	g/mol	11.60
Venting pressure (P)	bara	120.80
Venting required (Ws)	kg/h	*14269*

Remark:

Item NO.	PSV-3173, PSV-3174	P&ID NO.	3000-PID-006
Case	Gas pipe, inlet valve FV-3169 unnormally open, high pressure gas flow into low pressure equiment		
Equation	-		

Parameter	Unit	Value
Rated Cv value(Provided by vendor)		72.0
Venting required (Provided by vendor)	Nm3/h	107000
Venting required(Provided by TOPSOE)	Nm3/h	100000
Venting required (Ws)	kg/h	44758

Remark: The venting required is decided by the structure of FV-3169. So TCC provided the venting condition to control valve vendor to calculated the flowrate passing through FV-3169 under venting condition. It is a little bigger than TOPSOE's value. So vendor's value is adopted.

Item NO.	PSV-3196, PSV-3197, PSV-3206	P&ID NO.	3000-PID-007
Case	Gas pipe, inlet valve LV-3161 A/B unnormally open, high pressure gas flow into low pressure		
Equation	Preliminarily calculated by Sinet		

Parameter	Unit	Value
Venting required (Ws)	Nm3/h	125000

Item NO.	RD-3001	P&ID NO.	3000-PID-021
Case	Heat exchange (E3012) tube rupture		
Equation	Ws=2.463*d^2*(ΔP*ρV/10)^0.5		

Parameter	Unit	Value
Tube inner diameter (d)	mm	15.75
Gas density (ρV)	kg/m3	10.8
Differential pressure of high pressure side and low side (△P)	bar	19.80
Venting required (Ws)	Nm3/h	17961
Venting required (Ws)	kg/h	2825

Item NO.	RD-3002	P&ID NO.	3000-PID-021	Item NO.	RD-3003	P&ID NO.	3000-PID-021
Case	Heat exchange (E3013) tube rupture			Case	Heat exchange (E3014) tube rupture		
Equation	Ws=2.463*d^2*(ΔP*ρV/10)^0.5			Equation	Ws=2.463*d^2*(ΔP*ρV/10)^0.5		
Parameter		Unit	Value	Parameter		Unit	Value
Tube inner diameter (d)		mm	15.8	Tube inner diameter (d)		mm	15.8
Gas density (ρV)		kg/m3	35.4	Gas density (ρV)		kg/m3	20.9
Differential pressure of high pressure side and low side (△P)		bar	79.00	Differential pressure of high pressure side and low side (△P)		bar	42.50
Venting required (Ws)		Nm3/h	24426	Venting required (Ws)		Nm3/h	11652
Venting required (Ws)		kg/h	10217	Venting required (Ws)		kg/h	5795
Remark:							

Item NO.		P&ID NO.		Item NO.		P&ID NO.	
Case				Case			
Equation				Equation			
Parameter		Unit	Value	Parameter		Unit	Value

Item NO.		P&ID NO.		Item NO.		P&ID NO.	
Case				Case			
Equation				Equation			
Parameter		Unit	Value	Parameter		Unit	Value

Item NO.	PSV-4001	P&ID NO.	4000-PID-001	Item NO.		P&ID NO.	
Case	Hydraulic expansion in the pipe that are blocked in while they are filled with liquid at near-ambient temperatures and are heated by direct solar radiation.			Case			
Equation	API 521 section 4.4.12.1 causes c）			Equation			

Parameter	Unit	Value	Parameter	Unit	Value
Cubic expansion coefficient, αv	1/℃	0.00145			
Radiation surface of pipe，S	m^2	215			
Solar radiation，Φ （Based on solar constant, 1376W）	W	296309			
Relative density referred to water, d		0.766			
Specific heat capacity, c	J/kg K	2695			
Venting required (Ws)	kg/h	567			
Remark:					

Item NO.	PSV-1015	P&ID NO.	1000-PID-002	Item NO.	PSV-1031	P&ID NO.	1000-PID-003
Case				Case			
Equation				Equation			

Parameter	Unit	Value	Parameter	Unit	Value
Remark:			Remark:		

Item NO.		P&ID NO.		Item NO.		P&ID NO.	
Case				Case			
Equation				Equation			

Parameter	Unit	Value	Parameter	Unit	Value
Remark:			Remark:		

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Item NO.	PSV-5058,5059,5060,5061	P&ID NO.	5000-PID-002
Case	Reflux Failure		
Equation	Equal to the amount into condenser		
Venting required (Ws)	1. The overall relieve amout of the T5001 overhead is equal to the amount into condenser AE5004 which is 112490kg/h, and the MW is 29.92, thus the overall amount is around 84217 Nm3/h. 2. This overall amount is shared by 3 PSVs which are PSV-5058,5058 and 5060. And one PSV-5061 is a spare one.		
Remark:			

Item NO.	PSV-5058, 5059, 5060, 5061	P&ID NO.	5000-PID-002
Case	Heat exchange (E5024 1/2) tube rupture		
Equation	Ws=2.463*d^2*(ΔP*ρV/10)^0.5		
Parameter		Unit	Value
Tube inner diameter (d)		mm	28.45
Gas density (ρV)		kg/m3	9.50
Differential pressure of high pressure side and low side (△P)		bar	20.74
Venting required (Ws) in E5024 1/2 shell side		kg/h	8847
Venting required (Ws) in E5024 1/2 shell side		m3/h	4795
Venting required (Ws) in T5001 top		kg/h	21641
Remark: E5024 1/2 tube side relief density is 1.845 kg/m3 which is using to calculate E5024 1/2 shell side real volumetric			

Item NO.	PSV-5058,5059,5060,5061	P&ID NO.	5000-PID-002
Case	Heat exchange (E5001) tube rupture		
Equation	Ws=2.463*d^2*(ΔP*ρV/10)^0.5		
Parameter		Unit	Value
Tube inner diameter (d)		mm	27.53
Gas density (ρV)		kg/m3	3.37
Differential pressure of high pressure side and low side (△P)		bar	2.44
Venting required (Ws) in E5001 shell side		kg/h	1693
Venting required (Ws) in E5001 shell side		m3/h	674
Venting required (Ws) in T5001 top		kg/h	3044
Remark: E5001 tube side relief density is 2.51kg/m3 which is using to calculate E5001 shell side real volumetric rate. E5001 tube rupture case only consider steam pressure accidently increased to the none			

Item NO.	PSV-5058, 5059, 5060, 5061	P&ID NO.	5000-PID-002
Case	Non-explosive liquified gas with insulation, fire case		
Equation	Ws=255000•Ar^0.82/q*λ*(904-t)/66570/δ		
Parameter		Unit	Value
Heat conductivity of insulation layer (λ)		W/m•K	0.25
Heated area (Ar)		m2	144.75
Letent heat @venting condition (q)		kJ/kg	1219.23
Insulation thickness (δ)		m	0.06
Saturated Temperature @venting pressure (t)		℃	122.38
Venting required (Ws)		kg/h	604.88
Remark: The wetted surface which is heated area in equation included: The high-high level in column part , the overall shell side liquid level in reboilers(E5024 1/2) flow to column bottom part, and all column trays fluid flow to column bottom part.			

Item NO.	PSV-5085	P&ID NO.	5000-PID-003
Case	Hydraulic Expansion		
Equation	m=q*(d*1000)*3600, where q=α_v*Φ/(1000*d*c)		
Parameter		Unit	Value
Cubic expansion coefficient ($\alpha_{v)}$		1/℃	0.00044
Total heat transfer rate (Φ)		MW	3.5100
Relative density to water (d)		N/A	0.989
Specific heat capicity of trapped fluid (c)		kJ/kg•K	4.18
Expansion volume amount (q)		m^3/s	0.00037
Expansion mass amount (m)		kg/h	1329.79
Remark: Total heat transfer rate use heat exchanger data sheet duty. Relative density and specific heat capicity is based on fluid on hot side temperature condition.			

Item NO.	PSV-5108	P&ID NO.	5000-PID-004
Case	Hydraulic Expansion		
Equation	m=q*(d*1000)*3600, where q=α_v*Φ/(1000*d*c)		
Parameter		Unit	Value
Cubic expansion coefficient ($\alpha_{v)}$		1/℃	0.00044
Total heat transfer rate (Φ)		MW	0.3000
Relative density to water (d)		N/A	0.989
Specific heat capicity of trapped fluid (c)		kJ/kg•K	4.18
Expansion volume amount (q)		m^3/s	0.00003
Expansion mass amount (m)		kg/h	113.68
Remark: Total heat transfer rate use heat exchanger data sheet duty. Relative density and specific heat capicity is based on fluid on hot side temperature condition.			

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Item NO.	PSV-5073	P&ID NO.	5000-PID-003
Case	Non-explosive liquified gas with insulation, fire case		
Equation	Ws=255000•Ar^0.82/q*λ*(904-t)/66570/δ		

Parameter	Unit	Value
Heat conductivity of insulation layer (λ)	W/m•K	0.25
Heated area (Ar)	m2	12.13
Letent heat @venting condition (q)	kJ/kg	2023.42
Insulation thickness (δ)	m	0.06
Saturated Temperature @venting pressure (t)	℃	190.00
Venting required (Ws)	kg/h	43.59

Remark:

Item NO.	PSV-5179,5180	P&ID NO.	5000-PID-006
Case	Heat exchange (E5002 1/2/3/4) tube rupture		
Equation	Ws=2.463*d^2*(ΔP*ρV/10)^0.5		

Parameter	Unit	Value
Tube inner diameter (d)	mm	21.18
Gas density (ρV)	kg/m3	7.35
Differential pressure of high pressure side and low side (△P)	bar	1.71
Venting required (Ws) in E5002 shell side	kg/h	1239
Venting required (Ws) in E5002 shell side	m3/h	226
Venting required (Ws) in T5002 top	kg/h	1086

Remark: E5002 tube side relief density is 5.493kg/m3 which is using to calculate E5002 shell side real volumetric rate. E5002 tube rupture case only consider steam pressure accidently increased near to the T5003 PSV relief pressure.

Item NO.	PSV-5220	P&ID NO.	5000-PID-008
Case	Hydraulic Expansion		
Equation	m=q*(d*1000)*3600, where q=α_v*Φ/(1000*d*c)		

Parameter	Unit	Value
Cubic expansion coefficient (α_v)	1/℃	0.00044
Total heat transfer rate (Φ)	MW	1.6000
Relative density to water (d)	N/A	0.956
Specific heat capicity of trapped fluid (c)	kJ/kg•K	4.18
Expansion volume amount (q)	m^3/s	0.00018
Expansion mass amount (m)	kg/h	606.32

Remark: Total heat transfer rate use heat exchanger data sheet duty.
Relative density and specific heat capicity is based on fluid on hot side temperature condition.

Item NO.	PSV-5179,5180	P&ID NO.	5000-PID-006
Case	Reflux Failure		
Equation	Equal to the amount into condenser		

Venting required (Ws)	1. The overall relieve amout of the T5002 overhead is equal to the amount into condenser AE5005 which is 418559kg/h, and the MW is 29.08, thus the overall amount is around 332411 Nm3/h. 2. TCC has consulted Topsoe about why reflux failure condition is not used for PSV sizing, and Topsoe reply is: Reflux failure was also considered but due to higher pressure no additional gas phase needs to be relieved.

Remark: Topsoe reply please check 30% model review Topsoe reply document.

Item NO.	PSV-5179,5180	P&ID NO.	5000-PID-006
Case	Non-explosive liquified gas with insulation, fire case		
Equation	Ws=255000•Ar^0.82/q*λ*(904-t)/66570/δ		

Parameter	Unit	Value
Heat conductivity of insulation layer (λ)	W/m•K	0.25
Heated area (Ar)	m2	600.28
Letent heat @venting condition (q)	kJ/kg	1204.13
Insulation thickness (δ)	m	0.06
Saturated Temperature @venting pressure (t)	℃	121.00
Venting required (Ws)	kg/h	1969.65

Remark: Normal calculation is, the wetted surface which is heated area in equation included: The high-high level in column part , the overall shell side liquid level in reboilers(E5002 1/2/3/4) flow to column bottom part, and all column trays fluid flow to column bottom part. **However, this liquid level is higher than 7.6m, thus use 7.6m to calculate wetted surface directly. The result relieve rate is around 578 Nm3/h.**

Item NO.	PSV-5444	P&ID NO.	5000-PID-009
Case	Hydraulic Expansion		
Equation	m=q*(d*1000)*3600, where q=α_v*Φ/(1000*d*c)		

Parameter	Unit	Value
Cubic expansion coefficient (α_v)	1/℃	0.00044
Total heat transfer rate (Φ)	MW	0.1600
Relative density to water (d)	N/A	0.989
Specific heat capicity of trapped fluid (c)	kJ/kg•K	4.18
Expansion volume amount (q)	m^3/s	0.00002
Expansion mass amount (m)	kg/h	60.63

Remark: Total heat transfer rate use heat exchanger data sheet duty.
Relative density and specific heat capicity is based on fluid on hot side temperature condition.

Item NO.	PSV-5308	P&ID NO.	5000-PID-011
Case	Hydraulic Expansion		
Equation	m=q*(d*1000)*3600, where q=α_v*Φ/(1000*d*c)		

Parameter	Unit	Value
Cubic expansion coefficient ($\alpha_{v)}$	1/℃	0.00044
Total heat transfer rate (Φ)	MW	15.7000
Relative density to water (d)	N/A	0.989
Specific heat capicity of trapped fluid (c)	kJ/kg•K	4.18
Expansion volume amount (q)	m^3/s	0.00167
Expansion mass amount (m)	kg/h	5949.47

Remark: Total heat transfer rate use heat exchanger data sheet duty. Relative density and specific heat capicity is based on fluid on hot side temperature condition.

Item NO.	PSV-5250,5251,5261	P&ID NO.	5000-PID-012
Case	Heat exchange (E5003 1/2) tube rupture		
Equation	Ws=2.463*d^2*(ΔP*ρV/10)^0.5		

Parameter	Unit	Value
Tube inner diameter (d)	mm	14.83
Gas density (ρV)	kg/m3	3.99
Differential pressure of high pressure side and low side (△P)	bar	0.50
Venting required (Ws) in E5003 1/2 shell side	kg/h	242
Venting required (Ws) in E5003 1/2 shell side	m3/h	65
Venting required (Ws) in T5003 top	kg/h	389

Remark: E5003 tube side relief density is 3.738kg/m3 which is using to calculate E5003 shell side real volumetric rate.

Item NO.	PSV-5250,5251,5261	P&ID NO.	5000-PID-010
Case	Heat exchange (E5023) tube rupture		
Equation	Ws=2.463*d^2*(ΔP*ρV/10)^0.5		

Parameter	Unit	Value
Tube inner diameter (d)	mm	22.10
Gas density (ρV)	kg/m3	9.74
Differential pressure of high pressure side and low side (△P)	bar	18.84
Venting required (Ws) in E5023 shell side	kg/h	5153
Venting required (Ws) in E5023 shell side	m3/h	1768
Venting required (Ws) in T5003 top	kg/h	10617

Remark: E5023 tube side relief density is 2.914kg/m3 which is using to calculate E5023 shell side real volumetric rate.

Item NO.	PSV-5250,5251,5261	P&ID NO.	5000-PID-010
Case	Reflux Failure		
Equation	Equal to the amount into condenser		

Venting required (Ws)	1. The overall relieve amout of the T5003 overhead is equal to the amount into condenser E5002 1/2/3/4 which is 440751kg/h, and the MW is 32.04, thus the overall amount is around 308333 Nm3/h. However, normally we think maybe just one reboiler of E5002 1/2/3/4 will fail to cause reflux failure, thus the amount should be 77084 Nm3/h. 2. This amount is shared by 2 PSVs which are PSV-5250 and 5251. And one PSV-5161 is a spare one.

Remark:

Item NO.	PSV-5250,5251,5261	P&ID NO.	5000-PID-010
Case	Non-explosive liquified gas with insulation, fire case		
Equation	Ws=255000•Ar^0.82/q*λ*(904-t)/66570/δ		

Parameter	Unit	Value
Heat conductivity of insulation layer (λ)	W/m•K	0.25
Heated area (Ar)	m2	454.28
Letent heat @venting condition (q)	kJ/kg	1327.02
Insulation thickness (δ)	m	0.06
Saturated Temperature @venting pressure (t)	℃	147.38
Venting required (Ws)	kg/h	1374.22

Remark: Normal calculation is, the wetted surface which is heated area in equation included: The high-high level in column part , the overall shell side liquid level in reboilers(E5003 1/2&E5023) flow to column bottom part, and all column trays fluid flow to column bottom part. **However, this liquid level is higher than 7.6m, thus use 7.6m to calculate wetted surface directly. The result relieve rate is around 460 Nm3/h.**

Item NO.	PSV-5339	P&ID NO.	5000-PID-012
Case	Hydraulic Expansion		
Equation	m=q*(d*1000)*3600, where q=α_v*Φ/(1000*d*c)		

Parameter	Unit	Value
Cubic expansion coefficient ($\alpha_{v)}$	1/℃	0.00044
Total heat transfer rate (Φ)	MW	3.6000
Relative density to water (d)	N/A	0.989
Specific heat capicity of trapped fluid (c)	kJ/kg•K	4.18
Expansion volume amount (q)	m^3/s	0.00038
Expansion mass amount (m)	kg/h	1364.21

Remark: Total heat transfer rate use heat exchanger data sheet duty.
Relative density and specific heat capicity is based on fluid on hot side temperature condition.

Contractor:	PROJECT	MKP Methanol Project			Owner :
TIANCHEN CORP.CHINA	UNIT	General Technical	PHASE	As Built Drawing	Middle East Kimiaye Pars Co.
	DOC. Title	Calculation Sheet for Pressure Safety Valve			
	Owner NO.	MKP-11-AS-9000-IN-CAL-009			
	Contractor NO.	MKP-11-AS-9000-PS84-CAL-009			
Licensor:	TOPSOE NO.	N/A			Rev. :Z01 Page: 12 of 17

Item NO.	**PSV-5370**	**P&ID NO.**	**5000-PID-013**
Case	Hydraulic Expansion		
Equation	m=q*(d*1000)*3600, where q=α_v*Φ/(1000*d*c)		

Parameter	Unit	Value
Cubic expansion coefficient ($\alpha_{v)}$	1/℃	0.00044
Total heat transfer rate (Φ)	MW	0.1600
Relative density to water (d)	N/A	0.989
Specific heat capicity of trapped fluid (c)	kJ/kg•K	4.18
Expansion volume amount (q)	m^3/s	0.00002
Expansion mass amount (m)	kg/h	60.63

Remark: Total heat transfer rate use heat exchanger data sheet duty.
Relative density and specific heat capicity is based on fluid on hot side temperature condition.

Item NO.	**PSV-5384,5386**	**P&ID NO.**	**5000-PID-014**
Case	Non-explosive liquified gas drum without insulation, fire case		
Equation	V=Ws/MW*22.414, where Ws=255000•F•Ar^0.82/q		

Parameter	Unit	Value
Environment factor (F)	1	1.00
Heated area (Ar)	m2	72.39
Letent heat @venting condition (q)	kJ/kg	832.60
Venting required (Ws)	kg/h	10257.08
Molar Weight(MW)	kg/kmol	32.00
Venting required (V)	Nm3/h	7184.44

Remark: Topsoe has updated X5001 data sheet thus the length of equipment is longer which caused the relieve capacity is higher than PDP PSV data sheet.

Item NO.		**P&ID NO.**	
Case			
Equation			

Remark:

Item NO.		**P&ID NO.**	
Case			
Equation			

Remark:

Item NO.		**P&ID NO.**	
Case			
Equation			

Remark:

Item NO.		**P&ID NO.**	
Case			
Equation			

Remark:

Item NO.	PSV-6021 PSV-6022	P&ID NO.	6000-PID-002

Case 1	Inadvertent opening of FV-6031			Case 2	Inadvertent opening of FV-5367		
Equation				Equation			
Parameter		Unit	Value	Parameter		Unit	Value
At relieving conditions there is almost no flow, so minimum size PSV(1D2) is choosen				At relieving conditions there is almost no flow, so minimum size PSV(1D2) is choosen			
Remark: PSV-6021 is spare PSV.							

Item NO.	PSV-6027	P&ID NO.	6000-PID-002	Item NO.	PSV-6053	P&ID NO.	6000-PID-003
Case	Fire- wetted surface			Case	Fire- wetted surface		
Equation	Ws=255000•Ar^0.82/q			Equation	Ws=255000•Ar^0.82/q		
Parameter		Unit	Value	Parameter		Unit	Value
Heated area (Ar)		m2	19.58	Heated area (Ar)		m2	60.05
Letent heat @venting condition (q)		kJ/kg	1601.87	Letent heat @venting condition (q)		kJ/kg	1500.83
Venting required (Ws)		kg/h	1824.73	Venting required (Ws)		kg/h	4881.91
Remark: It is smaller than TOPSOE's value. So TOPSOE's value(2560 kg/h) is adopted.				Remark:			

Item NO.	PSV-6085	P&ID NO.	6000-PID-004	Item NO.		P&ID NO.	
Case	Hydraulic expansion			Case			
Equation				Equation			
Parameter		Unit	Value	Parameter		Unit	Value
For liquid hydraulic expansion case, at relieving conditions the relieving flow rate is very very small, so minimum size PSV(3/4 D 1) is choosen.							
Remark:				Remark:			

Contractor:	PROJECT	MKP Methanol Project			Owner :
TIANCHEN CORP.CHINA	UNIT	General Technical	PHASE	As Built Drawing	
	DOC. Title	Calculation Sheet for Pressure Safety Valve			
	Owner NO.	MKP-11-AS-9000-IN-CAL-009			
	Contractor NO.	MKP-11-AS-9000-PS84-CAL-009			
Licensor:	TOPSOE NO.	N/A			Rev. :Z01 Page: 14 of 17

Item NO.	**PSV-7010 PSV-7011 PSV-7012**	**P&ID NO.**	**7000-PID-006**
Case	Gas pipe, inlet valve unnormally open, high pressure gas flow into low pressure equiment		
Equation	Ws=Ws(Maximum Upstream Steam)+Ws(Maximum Upstream BFW)-Ws(Normal Downstream Steam)		

Parameter	Unit	Value
Maximum Upstream Steam Flow	kg/h	388258
Maximum Upstream BFW Flow(TV7002)	kg/h	38015
Maximum Upstream BFW Flow(TV7003)	kg/h	38015
Maximum Upstream BFW Flow(TV7004)	kg/h	3801
Normal Downstream Steam	kg/h	147347
Venting required (Ws)	kg/h	320742

Remark:
（1） The Maximum Upstream Steam Flow is in EOR-LEAN case and the Maximum Upstream BFW Flow is decided by TV7002/03/04 provided by vendor,Normal Downstream Steam is decided by FT7001AB FT2001 FT2002 FT0500-1/2
（2）320742 is split by PSV-7010/7011
（3）The capacity of PSV provided by topsoe is 254500kg/h and the capacity will be chosen as 254500kg/h

Item NO.	**PSV-7023 PSV-7024**	**P&ID NO.**	**7000-PID-007**
Case	Gas pipe, inlet valve unnormally open, high pressure gas flow into low pressure equiment		
Equation	Ws=Ws(Maximum Upstream Steam)+Ws(Maximum Upstream BFW)-Ws(Normal Downstream Steam)		

Parameter	Unit	Value
Maximum Upstream Steam Flow	kg/h	282156
Maximum Upstream BFW Flow(TV7026)	kg/h	1182
Maximum Upstream BFW Flow(TV7027)	kg/h	1182
Normal Downstream Steam	kg/h	78254
Venting required (Ws)	kg/h	206266

Remark:
（1）The Maximum Upstream Steam Flow is decided by PV7025 A/B provided by vendor and the Maximum Upstream BFW Flow is decided by TV7026/27 provided by vendor,Normal Downstream Steam is for export.
（2）The capacity of PSV provided by topsoe is 267300kg/h and the capacity will be chosen as 267300kg/h

Item NO.	**PSV-7036 PSV-7037**	**P&ID NO.**	**7000-PID-008**
Case	Gas pipe, inlet valve unnormally open, high pressure gas flow into low pressure equiment		
Equation			

Parameter	Unit	Value
Venting required (Ws)	kg/h	0

Remark:
（1）No flow at relieving condition so min. size PSV choosen

Item NO.	**PSV-7057 PSV-7058 PSV-7059 PSV-7060 PSV-7061**	**P&ID NO.**	**7000-PID-009**
Case	Gas pipe, inlet valve unnormally open, high pressure gas flow into low pressure equiment		
Equation	Ws=Ws(Maximum Upstream Steam)+Ws(Maximum Upstream BFW)-Ws(Normal Downstream Steam)		

Parameter	Unit	Value
Maximum Upstream Steam Flow	kg/h	240911
Maximum Upstream BFW Flow(TV7052)	kg/h	17377
Maximum Upstream BFW Flow(TV7053)	kg/h	17377
Venting required (Ws)	kg/h	275665

Remark:
（1）The Maximum Upstream Steam Flow is in EOR-RICH case and the Maximum Upstream BFW Flow is decided by TV7052/53 provided by vendor
（2）275665 is split by PSV-7057/7058/7059/7060
（3）The capacity of PSV provided by topsoe is 320250kg/h and the capacity will be chosen as 320250kg/h

Contractor:	PROJECT	MKP Methanol Project			Owner :	
TIANCHEN CORP.CHINA	UNIT	General Technical	PHASE	As Built Drawing		
	DOC. Title	Calculation Sheet for Pressure Safety Valve				
	Owner NO.	MKP-11-AS-9000-IN-CAL-009				
	Contractor NO.	MKP-11-AS-9000-PS84-CAL-009				
Licensor:	TOPSOE NO.	N/A			Rev. :Z01	Page: 15 of 17

Item NO.	**PSV-7095 PSV-7096 PSV-7097**	**P&ID NO.**	**7000-PID-012**
Case	Valve unnormally closed		
Rated Cv value(Provided by vendor)			1050
Venting required (Provided by vendor)		Nm3/h	51000
Venting required(Provided by TOPSOE)		Nm3/h	64000
Venting required (Ws)		kg/h	32000

Remark:（1） The venting required is decided by the structure of PV-7094. So TCC provided the venting condition to control valve vendor to calculated the flowrate passing through PV-7094 under venting condition.
（2）The capacity of PSV provided by topsoe is 64000kg/h and the capacity will be chosen as 64000kg/h
(3）64000 is split by PSV-7095/7096,7097 is spare

Item NO.	**PSV-7132 PSV-7134 PSV-7136 PSV-7137**	**P&ID NO.**	**7000-PID-013**
Case	Valve unnormally closed		
Equation	Ws=Ws(Maximum Upstream Steam)		
Parameter		Unit	Value
Maximum Upstream Steam Flow		kg/h	28130
Venting required (Ws)		kg/h	28130

Remark:
（1）The capacity of PSV will be confirmed by FT7001A/B vendor

Item NO.	**PSV-7130 PSV-7131 PSV-7135**	**P&ID NO.**	**7000-PID-013**
Case 12			
Equation	Ws=Wsmax-Wsnor		
Parameter		Unit	Value
Venting required (Ws)		kg/h	28200

Remark:
（1）The capacity of PSV will be chosen as 10% of P 7001.

Item NO.	**PSV-7142 PSV-7143**	**P&ID NO.**	**7000-PID-014**
Case 12	Control Vavle failure		
Equation	Ws=Wsmax-Wsnor		
Parameter		Unit	Value
Wsmax=		kg/h	279000
Wsnor=		kg/h	24000.00
Venting required (Ws)		kg/h	255000

Remark:
（1）The capacity of PSV provided by topsoe is 255000kg/h and the capacity will be chosen as 255000kg/h

Contractor:	PROJECT	MKP Methanol Project			Owner :
TIANCHEN CORP.CHINA	UNIT	General Technical	PHASE	As Built Drawing	
	DOC. Title	Calculation Sheet for Pressure Safety Valve			
	Owner NO.	MKP-11-AS-9000-IN-CAL-009			
	Contractor NO.	MKP-11-AS-9000-PS84-CAL-009			
Licensor:	TOPSOE NO.	N/A			Rev. : Z01 Page: 16 of 17

Item NO.	**PSV-7253 PSV-7254**	**P&ID NO.**	**7000-PID-026**
Case	Valve unnormally closed / Blocked outlet		
Equation	Ws=H/q		

Parameter	Unit	Value
Heat input (H)	kJ/h	5132755.00
Letent heat @venting condition (q)	kJ/kg	2038.00
Venting required (Ws)	kg/h	2518.53

Remark: According to TOPSOE, the vapor mass rate is 3700 kg/h.

Item NO.		**P&ID NO.**	
Case			
Equation			

Parameter	Unit	Value

Remark:

Item NO.	**PSV-7256**	**P&ID NO.**	**7000-PID-026**
Case	Hydraulic expansion		
Equation			

For liquid hydraulic expansion case, at relieving conditions the relieving flow rate is very small, so minimum size PSV is choosen.

Remark: According to TOPSOE, the liquid mass rate is 190 kg/h. The calculated relief orifice area is 2 mm^2, while the choosed orifice area is the minimum size of 71 mm^2

Item NO.		**P&ID NO.**	
Case			
Equation			

Parameter	Unit	Value

Remark:

Item NO.		**P&ID NO.**	
Case			
Equation			

Parameter	Unit	Value

Remark:

Contractor:	PROJECT	MKP Methanol Project			Owner :	
TIANCHEN CORP.CHINA	UNIT	General Technical	PHASE	As Built Drawing		
	DOC. Title	Calculation Sheet for Pressure Safety Valve				
	Owner NO.	MKP-11-AS-9000-IN-CAL-009				
	Contractor NO.	MKP-11-AS-9000-PS84-CAL-009				
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Item NO.	**PSV-0532A PSV-0532B**	**P&ID NO.**	**0500-PID-002 0500-PID-003**	**Item NO.**		**P&ID NO.**	
Case	Valve unnormally closed			Case			
Equation	Ws=Ws(Maximum Upstream Steam)			Equation			
Parameter		Unit	Value	Parameter		Unit	Value
Maximum Upstream Steam Flow		kg/h	16210				
Venting required (Ws)		kg/h	16210				
Remark:				Remark:			

Item NO.		**P&ID NO.**		**Item NO.**		**P&ID NO.**	
Case				Case			
Equation				Equation			
Parameter		Unit	Value	Parameter		Unit	Value
Remark:				Remark:			

Item NO.		**P&ID NO.**		**Item NO.**		**P&ID NO.**	
Case				Case			
Equation				Equation			
Parameter		Unit	Value	Parameter		Unit	Value
Remark:				Remark:			