

14th Chemical Process Safety Sharing (CPSS)

Consequence Assessment of Ship Tanker Fire and Explosion at Jetty during transferring

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Agenda



Introduction

Objectives

Swiss Cheese Model for Fire Incident

PHAST Simulation Utilization

Summary



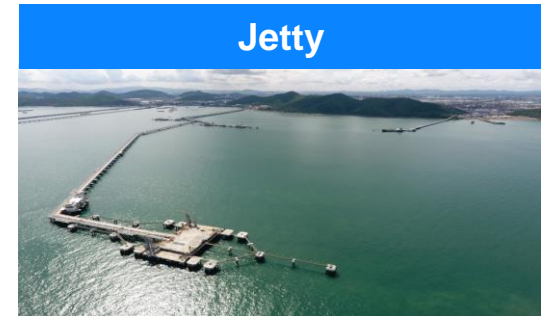
Introduction



- The oil transportation by ship tanker is high risk activities due to containing large flammable quantity.
- It can lead to catastrophic incidents e.g. fires and explosions resulting in multiple fatalities, major asset damage, environmental impact, etc.
- There are many incidents related to ship tanker explosion in Thailand as shown in Table 1.

Table 1: Historical incidents related to Ship tanker during 2022-2023 in Thailand

Date	Incidents (Location)	Causes	Impact people	
			No. of Fatality	No. of Injury
04 th Mar 22	Ship explosion (At Samut Prakan)	Performing hot work on ship tanker.	8	4
27 th Mar 22	Fire on Ship (At Samut Prakan)	Sparks from the chafing anchor chain ignited flammable gases	1	1
17 th Jan 23	Ship explosion (At Samut Songkhram)	Performing hot work on ship tanker.	1	3



Jetty



Ship tanker at Jetty



Ship explosion (At Samut Prakan)



Introduction (cont.)



- **Other Impacts**

- 1. People Impacts**

- a. Loss of life: e.g. crew, passengers, and coastal communities.
- b. Physical and psychological impact: Long-term effect for survivors (Impact to quality of life).

- 2. Environmental Impacts**

- a. Marine pollution: Oil spills and toxic substances can harm marine eco-systems.
- b. Coastal damage: Destruction of fishing grounds and sightseeing.

- 3. Economic Impacts**

- a. Asset damage and expense: Ship tanker, compensation, fire fighting expense, cleanup, recovery activities, etc.
- b. Indirect Cost : Lost revenue from tourism, economic disruption, etc.

- 4. Reputation Impacts**

- a. Affect to reputation of the responsible party, resulting in impact in their trust and business opportunities.





1. To evaluate the consequence how impact to people/asset
2. To define the safety distance/zone after incident happens for emergency response plan



Swiss Cheese Model for Fire Incident



1 Engineering safety design

- Plot Plan, Site Layout, Equipment arrangement
- Basic Process Control System (BPCS), Critical Alarm, Critical Check Valve.
- Material and Equipment selection : Piping, Process Vessel
- Pressure Relief Valve (PRV), Pressure Vacuum Valve (PVV)



Ship Tanker Hydrocarbons

3 Operation

- Operating Procedure : Normal, Abnormal and Emergency
- PTW & Positive Isolation Procedure
- Shift Handover
- Operation Training Simulator

5 Detection & Protection System

- Fire & Gas detection system
- Passive fire : Fireproofing & Coating
- Active Fire : Firewater system, Deluge system, fixed foam system, fire suppression system

2 Inspection & Maintenance

- Site Safety Inspection and Audit (Daily & Monthly)
- Inspection, Testing and Preventive Maintenance Plan (Daily & Yearly)
- Major Turnaround (MTA)
- Risk Based Inspection Program & predictive Analysis

4 Process Safety Culture

- STOP & Denial Work Authority
- Process Safety Fundamental (PSF)
- GEMBA Walk
- Learning From Incident

6 Emergency Response & Crisis Management

- Emergency & Crisis Management Procedure & Plan
- Business continuity Management & Plan
- Medical emergency Procedure
- Emergency & Crisis Communication System
- Integrated Emergency and Crisis Management Centers
- Professional ERT
- Consequence Modelling (PHAST DNV)
- ERT Functional Competency Framework
- Fire, Rescue, HAZMAR Training
- Firefighting equipment readiness
- Emergency drills (Table top / Field)
- Mutual aid & MOU

LOPC Event

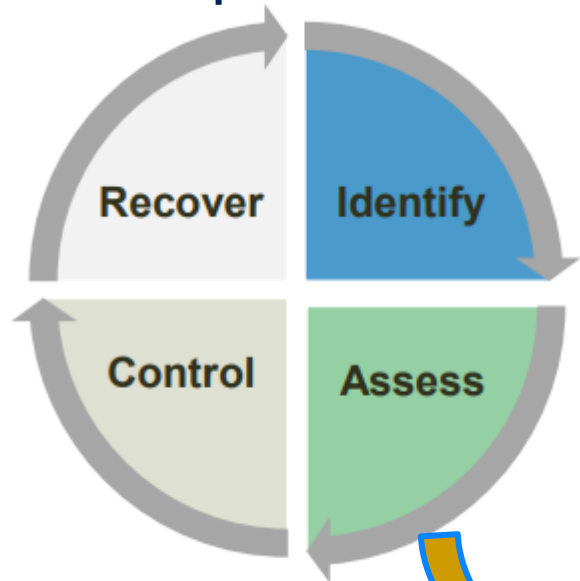
Fire Incident

PHAST Simulation Utilization



- The PHAST program is a **globally adopted solution** for modelling consequence and being used in diverse industries, including oil and gas, petrochemical or liquefied natural gas (LNG).
- The PHAST program ensures a **standardized** understanding among all participants."

4 main steps for risk assessment



Consequence Modelling by PHAST DNV



Input data

Processing

Output data

- Accurate
- Avg from historical data
- Reference standard

- Simulate by using PHAST

- Interpret the PHAST result
- Apply to Emergency Response Plan (Pre-Incident Plan : PIP)



A. Input data into PHAST model

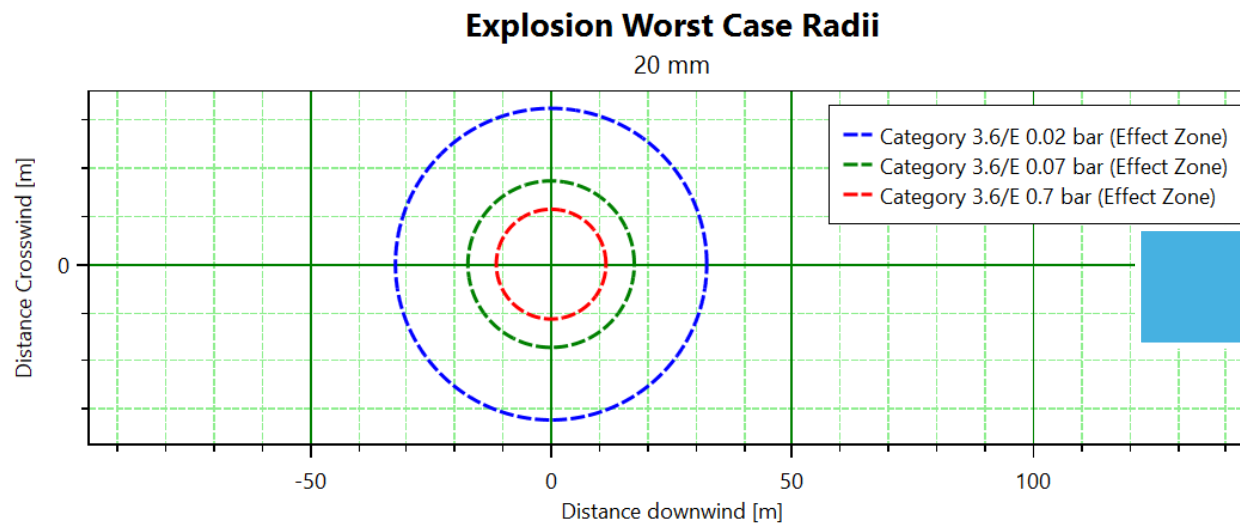


Scenario study from risk assessment		Loading arm was failure then fire and explosion at ship tanker.
Input data in PHAST DNV		Remark
A. Equipment and Operating Condition		
Equipment name	Ship tanker	
Volume	30,000 m ³	Ref. Local data
Pressure	1 barg	Ref. Local data
Temperature	41 °C	Ref. Local data
Leak Hole Size	20 mm	Ref. Local data
Material	Kerosene	Ref. Local data
B. Weather Condition		
Scenario type	Leak	
Wind Speed	3.61 m/s	Average historical data in 10 yrs.
Wind direction	NE and SE	Same as above.
Pasquill Stability	E	Analysis from Local wind stability.
C. Concerned impact Level		
Explosion	Level 1: 0.02 barg Level 2: 0.07 barg Level 3: 0.7 barg	Define safe distance Partial damage building Total destruction of buildings
Pool Fire	Level 1: 4.73 kW/m ² Level 2: 8 kW/m ² Level 3: 37.5 kW/m ²	Need shielding/clothing protection Need cooling asset equipment Fixed firefighting systems would be required

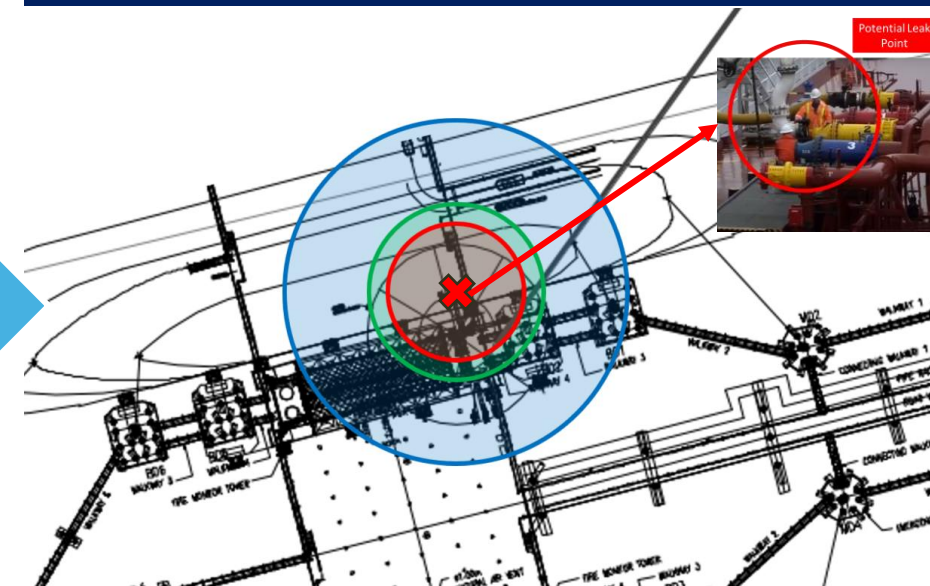
B. PHAST result utilization



Output from Consequence Modelling Program



Apply to actual layout

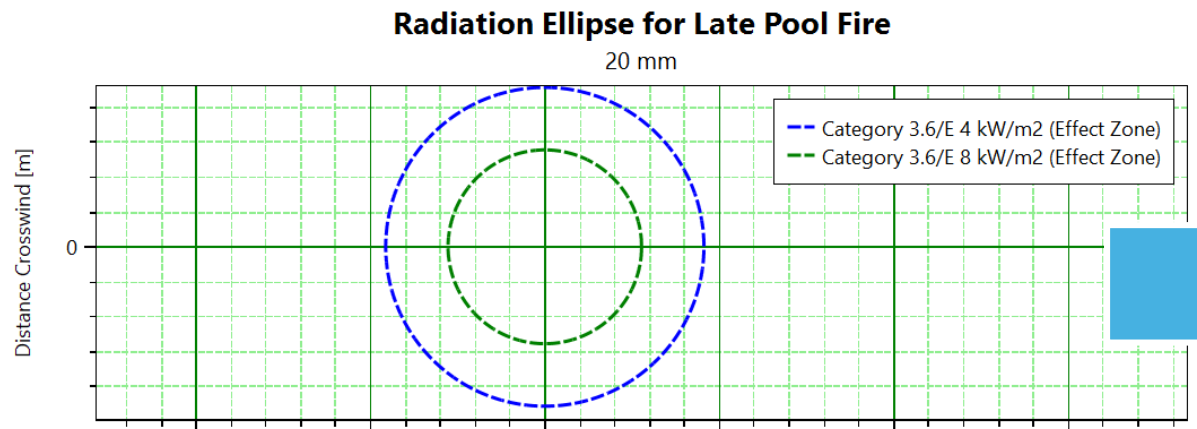


Pressure (barg)	Description	Distance (m)	Applying to actual distance
0.02	Safe distance	32	Define Safe Distance
0.07	Partial damage building	17	Do not entry
0.7	Total destruction of buildings	11	Do not entry 100% Probability of fatality inside or in unprotected structures

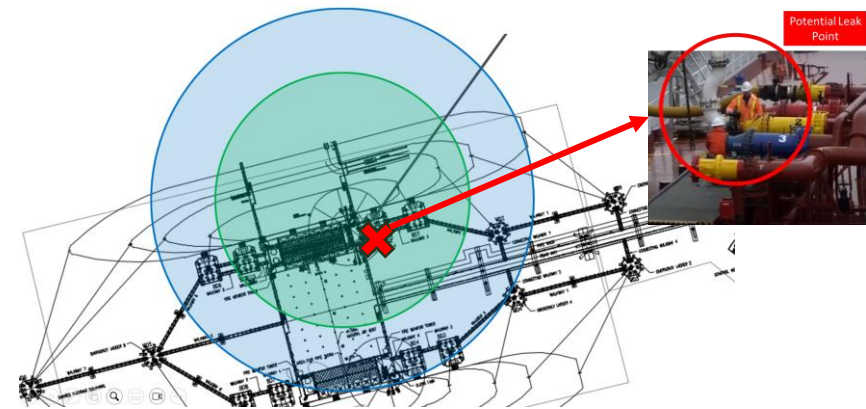
B. PHAST result utilization (cont.)



Output from Consequence Modelling Program



Apply to actual layout



Thermal Radiation Intensity (kW/m ²)	Description	Distance (m)	Applying to actual distance
4.73	Glass ruined ,Damage to people	91	<ol style="list-style-type: none"> Define Hot Zone for need shielding or clothing protection. Define Command Post (CP) and Staging Area in out of Hot Zone.
8	Plastic melting ,Damage to asset	55	Need cooling asset / equipment
37.5	Probable total destruction of buildings; heavy machine tools (7000 lb) moved and badly damaged.	N/A	Fixed firefighting systems would be required.



B. PHAST result utilization (cont.)



- Apply the PHAST result to develop emergency plans (**Pre-Incident Plan : PIP**) and exercise plans.
- The PIP objective is to help emergency responders to effectively plan for practice and manage emergencies with the available resources in the first one hour of an event to prevent escalation.
- These events are required the Emergency Response Team and equipment to handle the activities.
- Emergency exercise to ensure plan to evacuate people, instruct people, activate fire protection system and mobilize emergency response team.

B. PHAST result utilization (cont.)



Pre-Incident Plan Development



Thai Oil Group Pre-Incident Plan

Fire - Jetty 7 (Jet A1)

Originating Company	Thai Oil Public Company Ltd.
Department	QMOS
Document Number	JET-002
Revision Number	01
Pre-Incident Plan Level	Level 2
Issue Date	01/07/2024
Revision Date	01/01/2029
Reviewer	Occupational Health, Safety and Fire Manager

Controlled Document, Copy No: 01

REVISION HISTORY				
Ver.	Change Description	Date	Prepared/Reviewed by	Approved by
00	New Document	26/03/2020	HWLD-Dolchai, QMOS-Jirayus/QMOS-Narong	QMOS manager
01	New Form	29/11/2020	QMOS-Narong, Kamonchai	QMOS manager
02	New material	01/07/2024	QMOS-Kamonchai	QMOS Manager

Key

1. Identify possible cause and consequence to release HC
2. Identify product properties and document related
3. **Simulate to identify surrounding exposure and escalation**
4. **Analyze Hot Zone & Cooling Zone**
5. Develop Fire Fighting Plot plan

	Business Unit: Thai Oil Refinery	Incident Specific location: Jetty 7	PIP Scenario: Pool Fire	PIP Number : PIP-L2-FIR-TOP-D-MOV-JETTY7-01
Scenario Description			Consequence Modelling / Exclusion Zones / Hot Zones	
During discharge Jet A-1 to Tanker. Leaked at flange and got pool fire. Hot zone is estimated to be 91 meters from the source.				
Product Properties		Supporting Documents		
Material Handling	Kerosene	Fire water Systems	R111602-03900-HS-PID-0001, 2, 3	
Flashpoint (°C)	38 -52 °C	Drainage Layout	03900-PI-PL0-001	
Explosive Limits (LEL)	0.7-5.0 %	Electrical/Instrumentation	R1116025(B)-03900-EL-LAY-0006-009-rev0	
Auto Ignition Temperature	210 °C	Operations Procedures/ESD	MMLD-QWI-4010	
Toxicity	Kerosene	Detection System	R111602-03900-HS-PID-0001	
Surrounding Exposure / Escalation Potential				
Potential Risk Area	Threat / Consequences	Timeline for Escalation		
Loading Arm	Asset damage	Immediate at ignition		
Stationary Fire Monitor	Asset damage	Immediate at ignition		
Additional Information				
<ul style="list-style-type: none"> • The temperature for failure can be assumed to be. • Structural steel 538 °C. • Pressurised vessels 250 °C - 300 °C. • Cabling 100 °C - 150 °C. • Emergency personnel operating at Jetty 8 are required to wear self-contained breathing apparatus (SCBA) when positioned downwind. 				
			Plot plan	

B. PHAST result utilization (cont.)



Pre-Incident Plan Development

Key

- Task Actions shall be provided with 3 dimension as ERT response, Owner Area (Action in MCB), Other Area (Outside unit)
 - Emergency Response Team (ERT)** - Focus on Emergency & Rescue Response on Site
 - Owner Area** - Action from ASM, Panel man, LTR, etc. The action related with process condition shall be done in the early stage (activate water spray from MCB, Depressuring, Safe shutdown – Refer to abnormal procedure)
 - Impact to/from other area** – Communication is the key to inform upstream / downstream unit

Emergency Response / Production Units Actions					
ERT response		Production units response			
Task	Action by	Owner area		Others area	
		Task	Action by	Task	Action by
1. ปฏิบัติตาม PIP L1 Fire Process unit 0.1 to 10 bar 50mm hole					
2. ตรวจสอบ Spray water ที่ Loading arm ว่าทำงานหรือไม่ ถ้าไม่ทำงานให้ทำการเปิดจาก Control room	Loading master/Jetty crew	1. ทำการหยุดเชื้อเพลิงโดยการกด ESD no. 1 Block 39-UZ-1210 trip Stop load BZ P-7608/P-7610 (TPX) At. 1. Jetty Control 39-HZA-644 2. Jetty Shelter 39-HZA 759 3. Ship Shore Link 39-HZA-704	Loading master/Jetty crew	1. Inform TPX # 36102	Panel man Loading master
3. กรณีที่เกิดเป็น Pool fire ให้ทำการฉีด Foam โดย Remote monitor หัวใดหัวหนึ่งของท่า 8 กรณีที่ฉีดไม่พอ ให้ทำการหยุด spray water	Loading master/Jetty crew	2. ทำการ Isolate valve ที่ Safe location Platform 39-UZV-1203 (TSOV) Automatic Trip From ESD-1 Active	Loading master/Jetty crew	2. ทำการแจ้งเรือให้ทราบและทำการช่วยเหลือตัวของคนแผนฉุกเฉินของเรือ	Loading master
4. การเปิด Remote monitor อีกหัวของท่า 8 ทำการ cooling จุดที่ยังหล่อเย็นไม่ทั่วถึง	Loading master/Jetty crew	3. ในกรณีที่เรายังใช้งาน อุปกรณ์ดับเพลิงที่เป็นแบบ Automatic ทั้งหมดแล้ว ในส่วนที่เป็น อุปกรณ์ดับเพลิงประจำท่าที่ใช้งานได้โดยทีมงาน Jetty Crew และ Loading Master .ช่วยในการควบคุมเพลิงและระงับเหตุตามความเหมาะสมอีกทาง ให้พิจารณาตามสถานการณ์	Loading master/Jetty crew	3. ทำการแจ้ง MMLR	ASM/Panel man

Fire/Safety equipment Requirements					
Qty	Description	Location	Qty	Description	Location
2	1000 gpm Remote Water/Foam monitors on Jetty	Hot Zone	2	Fire water Nozzle from Hose cabinets	Hot Zone
1	1 x 3 % AR-AFFF Foam concentrate 8000 litres	Hot Zone	1	Foam cart on Jetty	Hot Zone
4	2 ½" Fire hose from Hose cabinets	Hot Zone	4	SCBA	CR Jetty 7,8
4	1 ½" fire hose from Hose cabinets	Hot Zone	2	Wheel extinguisher	Hot Zone



B. PHAST result utilization (cont.)



Pre-Incident Plan Deployment

- Once the Pre-Incident Plan is completed, the **Area Owner** should have a final check to ensure all data is correct and send the registration to Section responsibility.
- The **Area Owner** sets an exercise schedule.
Note: It is recommended where possible to conduct a Table-top exercise for new plans before a full deployment exercise.
- Each Pre-incident plans should be exercised at least once every six months by all shifts. Table top exercise (desk top review) should be discussed within team when team's available.
- The recommendation shall be recorded and followed as monthly basis.

PMS: KPI #12: Dry run "Abnormal case" 4 subjects/year & "Emergency case" 2 Subjects/year

Process Area	Abnormal case				Emergency case	
	01	02	03	04	01	02
TOC-1	K-8701AB Trip	K-402 Trip	U-700 Power fail	H-101 Major tube leak	P-214A/B Leak	R-8702
TOC-2	H-1301 Fuel failure Prolong	P-1507 Reboiler Feed Pump Failure	Reformer F-9411 Tube Rupture	V-2119 Liquid Overflow Protection	PIP-L2-FIRE-TOP-A-TOC2-C-01501	PIP-L2-FIRE-TOP-A-TOC2-H-01101
TOC-3	F-2201 Major Tube Rupture	HMU-1 Power Failure	P-2501 Failure	K-9202 Failure	C-2552 Sight glass Leak	C-2201 Bottom flange Leak
TOC-4	NHT-3 loss recycle gas Unit 2600	F-2101 Major tube leak Unit 2100	Power failure Unit 2700	Loss of recycle gas Unit 9700	E-9720 flange leaking and fire	P-2110AB flange leaking and fire
TOC-5	Temperature run away	K-9504 Trip	HVU-3 Crash S/D	F-9502 Major Tube rupture	S-2255B Leak and got fire	C-9519 Sight glass leak & got fire
UTILITY	B-101 or B-4011 Tube rupture	RFO. Total loss and use stand by fuel oil	Back start all process (Utility, SPP, EE)	NG total supply loss TP / MU RFG/SPP B12 (UTILITY, SPP)	Pre fire plan for "E-4203	Pre fire plan MCB1 (UTILITY, SPP)
SPP	U-8500 Gen Shedding SUB-81	P-84605A or B HHP BFW block-2 failure	BACK START ALL PROCESS (UTILITY, SPP, EE)	NG total supply loss TP / MU RFG/SPP B12 (UTILITY, SPP)	Pre fire plan PIP L2 TOP SPP G-85055	Pre fire plan MCB1 (UTILITY, SPP)
OIL MOVEMENT	Ethyl Mercaptan leak at V-3504	A-3906 Benzene jetty VRU activated carbon hot spot	T-3085 storage tank leak	LPG sphere flange leak and jet fire potential BLEVE at T3509	Power failure and consequence to T-3094 overflow and fire	MLA X-3942B broken BZ loading ESD-2 ERC not close and fire
LORRY (TOP)	T-3656 (E-100) overflow while top up from LLTE tank	Gantry-11 GH-95 loading hose leak during loading	P-3651A/B (UG-91) leak at D/C flange while running	Gantry-5 truck loading GH-91 overflow (Meter overrun)	Gantry-9 (UG-91) air eliminator passing to pit and fire	Gantry-12 (UG-95) vent valve at loading arm passing to pit and fire
LORRY (SUL)	T-3655 (LAB) overflow during top up (ATG fall)	Sulphur loading arm broken and leak during loading	LAB flexibag truck tear and pouring to ground	LAB ISO tank leak at connecting valve	LAB leak at discharge of loading pump P-3655A/B and fire	C10+ leak at discharge of transfer pump P-3632A/B and fire
LORRY (TLB)	500SN flexibag leak during loading and spill to environment	150SW loading arm leak during loading	500SN ISO tank hit structure and leak	150BS flexibag truck tear and pouring to ground	Bitumen truck overflow spill to driver	Electric wire of bitumen truck burn and fire
OFFSITE	32MOV166 Flange leak	T-3078 Tank Over fill	P-3251B Pump fire	T-3089 Lightning rim fire	T-13018 Lightning rim fire	H2S release from stack odor abatement
TLB	HFU Loss off Hydrogen supply	200L-E-122 & 400L-E-212 Loss of LR	100L-P-101 LR feed pump fail	Total steam failure	200L-V-102 Propane drum got fire case	400L-V-403 propane drum got fire case.
TPX	Loss of FD F-7201 & F-7101	Total Power Failure	Loss of P-7004A/B	Loss of P-7509A/B	A, V-7103, B, C, V-7405	
LABIX	1. Total Power Failure	2. Loss of P-58901A/B	3. Loss of P-58901A/B	4. Loss of K-63801	A, P-58505A (PIP L2), B, C, V-58204 (PIP L2), D,	

OPERATION PRACTICE PLAN 2023

Program	Dec22	Jan23	Feb23	Mar23	Apr23	May23	Jun23	Jul23	Aug23	Sep23	Oct23	Nov23	Dec23
1. Abnormal Case Dry Run	SHR A	SHR B	SHR C	SHR D									
2. Emergency Case Dry Run	SHR A	SHR B	SHR C	SHR D									
Area Learning workshop / HOK													
First Line Team													
Main LABIX Case of Pre fire Plan													
TPX Emergency Exercise (QMOS)													
Aspect Review													
1. s (every 2 months)													
2. CS/CSO yearly check													
Competency (DS, 10, 11)													

Abnormal & Emergency Cases

Case No.	Description	Frequency	Responsible
1	LOSS OF LEAD SOLVENT CIRCULATION WORK INSTRUCTION	Monthly	Area Owner
2	NORMAL SHUTDOWN SULFOLANE UNIT (U-100) WORK INSTRUCTION	Monthly	Area Owner
3	NORMAL OPERATION TO INTERNAL CIRCULATION UNIT 100	Monthly	Area Owner



Summary



Swiss Cheese Model for Fire Incident

- Users consider to use Prevention and Mitigation Barrier according to the suitability of each location or equipment.

PHAST Simulation & Result Utilization

1. Data input is required to be accurate and referenced from standards. The statistical data for local area (e.g. weather) will be used for data representative.
2. PHAST Result utilization
 - a) Define **safety distance/zones** for explosions and other related consequence
e.g. Assembly Point, Command Post, Staging Area for fire-trucks, foam transport vehicles, auxiliary vehicles at safety distance, Hot Zone of 4.73 kw/m^2 to be clothing protection requirement, Cooling Zone of $8\text{-}37.5 \text{ kw/m}^2$ to be applied for asset by mobile firefighting (e.g. portable monitor).
 - b) Develop **Pre-Incident Plan** and deploy to all concerned party.
 - The Area Owner should develop PIP with related party concern.
 - Task Actions shall be provided with 3 dimension as ERT response, Owner Area (Action in MCB), Other Area (Outside unit)
 - Table-top exercise (desk top review) and Emergency filed exercise shall be planned in routine. The recommendation shall be documented and gap closure.



Thank you for your attention

Q&A

