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ECONOMIC COMMISSION FOR EUROPE

International Electrotechnical Commission System
for Certification to Standards Relating to Equipment
for Use in Explosive Atmospheres (IECEx System)

The Importance to Correctly Assess the Flammable Hazards during Design and Operation

IECEx 2018
International Conference
Jakarta, Indonesia
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INTRODUCING

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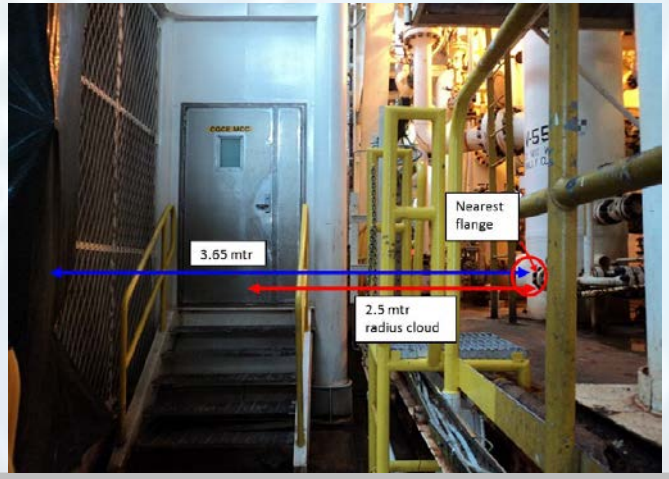
PETRONAS

Objectives

- To share past experiences on the importance of Hazardous Area Classification (HAC) assessment in defining the right hazards, right design, and the right selection of equipment in the explosive atmosphere.
- The need to control of Hazardous Area Classification in existing plant and infrastructure due to design change, upgrading and/or modification

#1 Modification done to the operation plant has not considered all risks during engineering and proper mitigation leading to..

- HAC not being updated to reflect the impact of the new installation of Fuel Gas Heater by Operation Group
- The latest fuel source that impact HAC is not communicated to Project Team resulting in improper design solution



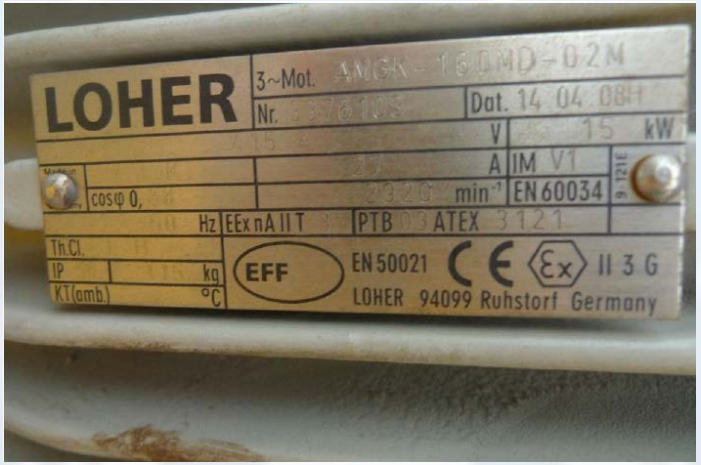
#2. Design consideration during engineering was based on worst case scenario leading to unoptimised solution:

- Inaccurate in performing HAC e.g Overdesign of battery room containing recombination type of battery

- The room was design based on worst case scenario i.e Vented Lead Acid batteries, resulting in unoptimised solution

#3. Incomplete hazardous area classification (HAC) drawings leading to wrong selection of equipment.

- HAC drawing was interpreted from top view only, resulting in Ex nA motor being selected instead of Ex de motor



#4. Generalisation of information leading to inaccuracies of area classification schedule

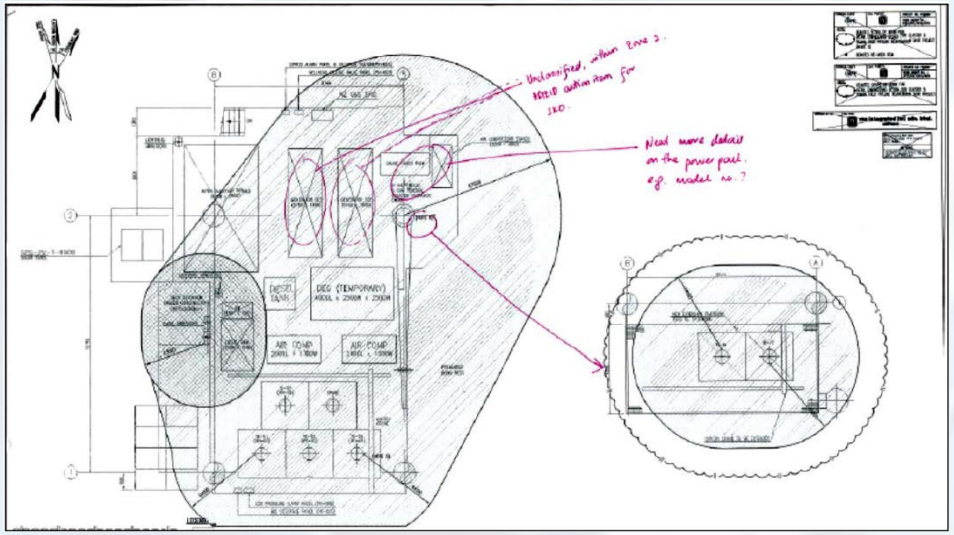
- Misinformation within area classification schedule (radius and temperature class)
  - AIT not accurate
  - Temperature class shall be decided based on individual equipment surface temperature

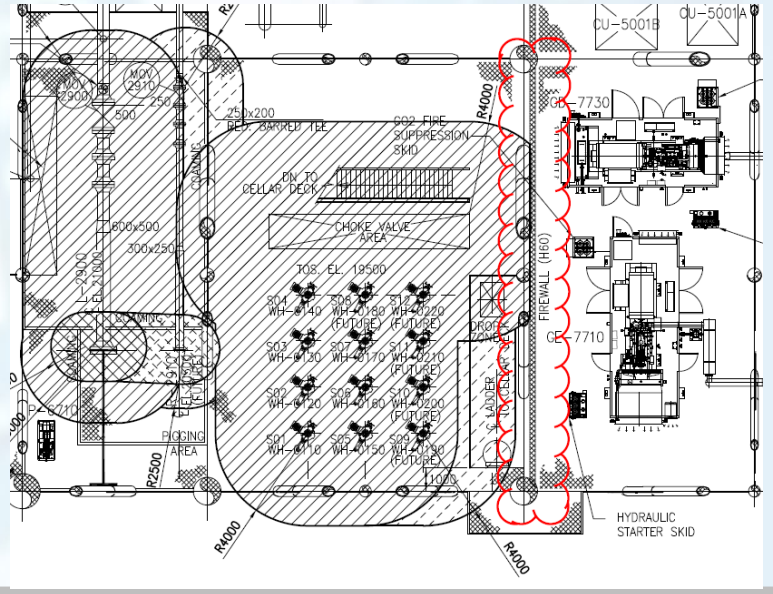
Notes:
1. Fluid Category defined based on Average Molecular Weight of HC within equipment. Guidance taken from Annex A and Annex C of IP15.
2. The Release Frequency Level for the whole plant is Level 1 with Secondary Grade of Release.

No.	Tag Number	Item Description	PFS/UFS No	Pressure, bar a	Gas Phase	Liquid Phase	AIT	Source of release	Level/Type of Ventilation	Gas Group ; Temp. Class	IP 15 Reference for R1	Hazard Radius (R1)		Hazard Radius (R2) at grade level (Table 5.8)	Remarks
					Fluid Category (Note 1)	Fluid Category	AIT	Source				Zone 1	Zone 2		
1	01R-1101	Central Livanov Gas Pig Receiver	001	91.5	G (i)	C	>200	Pig doors	Natural / Outdoor	IIA; T3		3	7.5	-	Area classification zone 2 of 7.5 m around valves & flanges
2	01R-1102	Gas Pig Receiver (Future)		95	G (i)	C	>200	Pig doors	Natural / Outdoor	IIA; T3		3	7.5	-	Area classification zone 2 of 7.5 m around valves & flanges
3	01R-1302	Condensate Pig Receiver (Future)					>200	Pig doors	Natural / Outdoor	IIA; T3		3	7.5	-	Area classification zone 2 of 7.5 m around valves & flanges
4	01R-1301	Central Livanov Condensate Pig Receiver	001	93	G (i)	C	>200	Pig doors	Natural / Outdoor	IIA; T3		3	7.5	-	Area classification zone 2 of 7.5 m around valves & flanges
5	01L-1101	Gas Pig Launcher	001	91.25	G (i)	C	>200	Pig doors	Natural / Outdoor	IIA; T3		3	7.5	-	Area classification zone 2 of 7.5 m around valves & flanges

#5. Overlook Operational requirement during design stage:

- No firewall was constructed to demarcate hazardous area contributed by wellhead.
- Non-hazardous area was not available to place temporary diesel generator, welding set and etc.





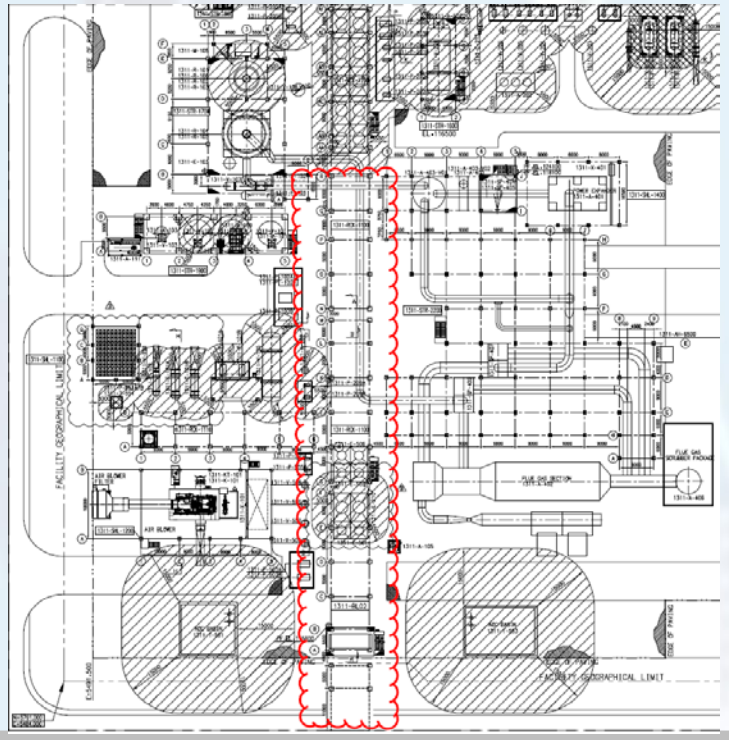
#6. Mismatch in application of Standards in performing Hazardous Area Classification

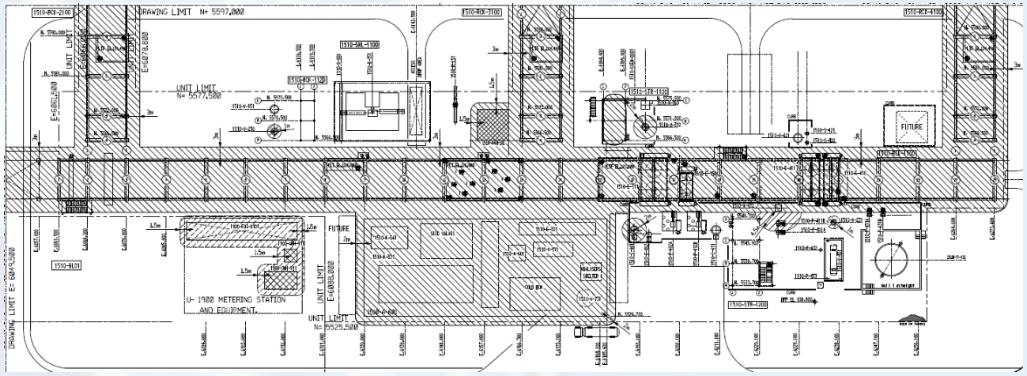
- Wrong reference used to perform HAC involving cryogenic facilities i.e IP Part 15 was used as reference. Clause 1.1 of Chapter 1 stated the exclusion of cryogenic facility for the applicability of the Code.

- HAC involving dust environment is not being assessed or performed i.e HAC was only done for gas sources

#7. Mismatch in application of Standards in performing Hazardous Area Classification

- IP part 15 exclusively used for HAC without cross reference with other standards where pipe rack is covered by API 505





Root Causes

- Competency gap in HAC and Ex related matter
- Lack of inter-discipline communication process during design stage in HAC assessment and Ex equipment selection requirement.
- HAC management guidelines was not fully adhered to.
- Management of Change (MOC) was not fully executed.

Implications

- Cost to install new Ex Equipment if over-design.
- Cost to replace non-compliance equipment if inaccurate design
- Production deferment for non-compliance installation.
- Operational impact i.e challenges to locate non-Ex equipment supply by contractor e.g temporary generator, welding sets

Resolutions

- Execute and fully comply to Ex Management system which includes:
  - Ex Training and Certification Scheme
  - Interdisciplinary communication and review process established
  - Appointment and Authorisation of Ex person
  - Management of Change (MOC)
    - Ex Situational Assessment
    - Ex Documentation

PETRONAS Technical Standards provides guidelines to ensure proper Hazardous Area Classification

- Hazardous Area Classification (Supplement/Amendment to International Standards)
  - IP -15
  - IEC 60079-10-1 and IEC 60079-10-2
  - API RP 500 and API RP 505
  - NFPA 497 and NFPA 499

PETRONAS Technical Standards provides guidelines to ensure proper management of Ex Equipment

1. Ex Electrical Equipment Inspection and Maintenance Guidelines (Ex IMG)
    - Standards and Guidelines
    - Personnel
    - Inspection
    - Maintenance
2. Ex Equipment Repair Guidelines (Ex ERG)
3. Ex Management Assessment Guidelines (Ex MAG)
4. Ex Equipment Selection Guidelines (ELECTRICAL) (Ex ESG-E)

Where does Hazardous Area and Ex Equipment positioned in the contact of Process Safety ?

INTRODUCING

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Major Accident that defines Process Safety

July 1988, Piper Alpha, 165 died

Sept 2005, Texas City, 15 died

Apr 2010, Macondo, 11 died

Major Accident Hazard Prevention

- Identify the asset's **Safety Critical Elements (SCE)**
- Prevent or limit consequences of **Major Accident Hazards (MAH)** as illustrated below:

Safety Critical Elements (hard safety barrier)

1. Structural Integrity
2. Process Containment
3. Ignition Control
4. Detection Systems
5. Protection Systems
6. Shutdown Systems
7. Emergency Responses
8. Lifesaving

Process Safety (soft safety barrier)

1. Proprietary & License Technology Assessment (PLTA)
2. Design Integrity (DI)
3. Mechanical Integrity (MI)
4. Ops Procedures (OP)
5. Pre-activity Safety Review (PASR)
6. Process Hazard Analysis (PHA)
7. Process Safety Information (PSI)
8. Management Of Change (MOC)

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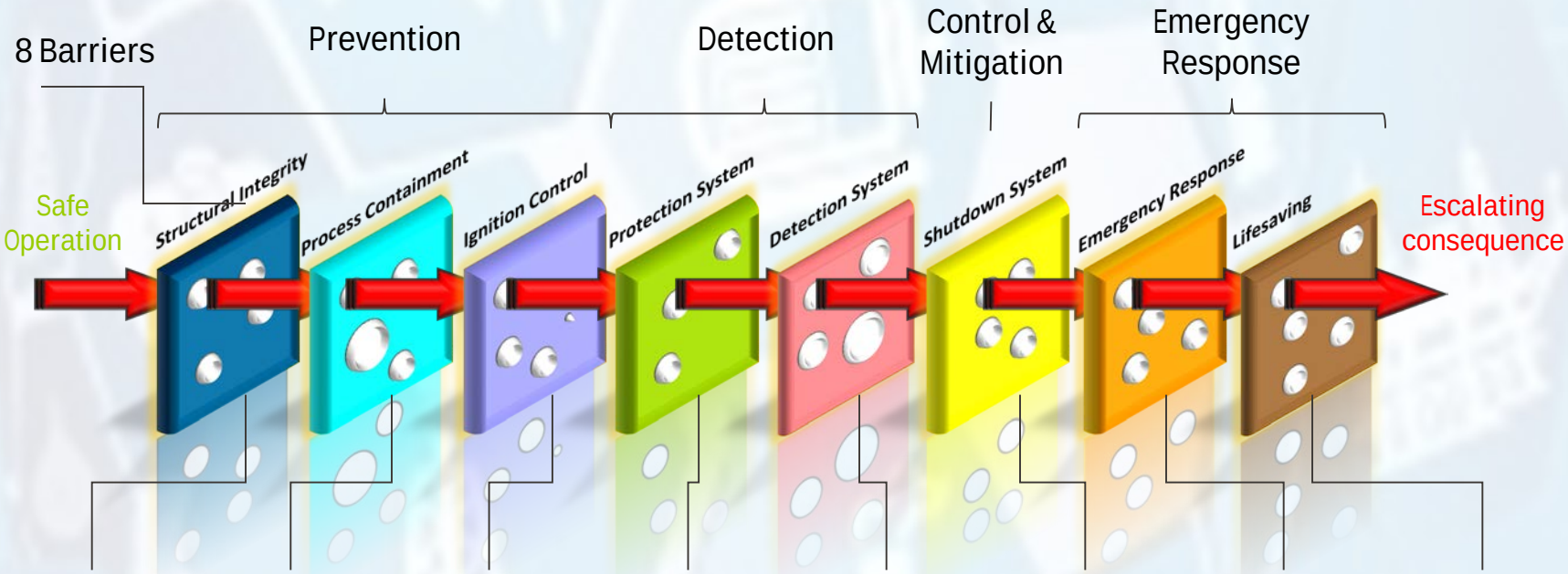
Safety Critical Element (SCE)

Hardware Barriers

Safety Critical Elements group*



- Ballast System
- Collision Avoidance
- Cranes
- Drilling System
- Mooring System
- Navigation Aids
- Onshore & Offshore Structures

- Fired Heaters
- Multi Cable Transits
- Heat Exchanger
- Helicopter Refuel
- Mechanical Handling
- Oil Water Control
- Open Drains
- Pipeline System
- Piping System
- Pressure Vessel
- Rotating Equipment
- Tank
- Tanker Loading
- Well Containment
- Wire Line Equipment

- **Hazardous Area**
- **Certified Ex Equipment**
- HVAC (process area)
- Earthing System
- Flare Tip Ignition
- Fuel Gas Purge System
- Miscellaneous Ignition Control
- Tank Inert System

- Chemical Injection
- Deluge System
- Fire/Explosion Protection
- FW Pumps
- FW Network
- Fire Fighting System
- Helideck Form
- Navigation Aids
- Power Management System
- Safeguarding Loops
- Sand Filter

- Security System (Access control, CCTV, Alarm / Detectors etc)
- Fire and Gas Detection System
- H_2O in Condensate (Gas dew point)

- Blowdown
- De-pressurisation System
- Drilling Well Control
- ESD
- HIPPS
- Relief Valves
- Shutoff Valves
- SSIV
- Well Isolation

- Communication System
- Emergency Power
- Emergency/ Escape Lighting
- Escape & Evacuation Routes
- Non-Fixed Fire Fighting Equipment
- Helicopter Facilities
- Process Control Alarm
- Temporary Refuge
- UPS

- Personal Survival Equipment
- Lifeboats
- Mutual Aid
- Rescue Facilities
- Tertiary Means of Escape

Intrumenttion | Electrical | Mech - Static | Civil | Mech - Rotary

*Typical SCE examples

HAC Assessment Methodology and Approach

This Key for a correct Area Classification; Fit for Purpose

- Common Fluid Categories; The application of IP Part 15 - Direct Example and Point Source Approach
- Dusts; The application of NFPA 499 – Recommended Practice for the Classification of Combustible Dusts and the application of IEC 60079, Part 10-2; Classification of Area – Combustible Dusts atmospheres – Direct Example Approach
- Cryogenic Flammable Material with release of >10mm, pressure >100BarA ; Consequence Modelling via dispersion study
- High Flash Point material eg; Lubricant. Verify mist formation via Consequence Modelling via dispersion study
- Pilot Plant & Lab Scale; The application of relaxation factors
- The application of Risk Assessment to assess the consequences of the ignition of an explosive atmosphere to determine the used of Ex equipment of a higher protection level (EPL) or lower EPL
- The use of Phast Software to perform Consequence Modelling

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GTS PSM Product Suites Services

FACILITY PROJECT LIFE CYCLE

Preliminary Design → Detailed Design / Construction / Commissioning → Operation / Periodic Review → Decommissioning

- Hazard Identification
- Hazard Assessment
- Consequence Assessment
- Risk Assessment
- Regulatory Requirement

PHA+ Design	QRA, FERA, EERA, ESSA, BRA, TRIA, SGIA, ALARP, Dropped Object Study, Ship Collision Study, Consequence Modelling, NFHA, 3D Consequence Modelling
PHA+ Risk	HAZID, HAZOP, LOPA, HER, Bow-Tie, Critical Activity Catalogue, Process Safety Aspects
PHA+ Regulatory	CIMAH, HSE CASE, FSDP, ERP
PHA+ Fire	AFP, PFP, EERDP, FSAR, Hydraulic Calculation, Firewater Demand Calculation, FERA, HAC
PHA+ Extra	

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Key milestones within PETRONAS, MEGA Projects & External Companies

OUR CLIENTS

External	Downstream		Upstream	MEGA Projects
SHELL	PP(T)SB	PC Ammonia SB	PCSB-PMO	SAMUR
SAMSUNG	PP(M)SB	PC LDPE SB	PCSB- SKO	PFLNG
CTCI	PDB	PC Ethylene SB	PCSB-SBO	SOGT
MHI	PEPI	PC Fertilizer K SB	PMU	PC GARRAF
TECHNIP	PLISB	PC Methanol SB	PCML	MNB
TECHICAS	PGB	PC MTBE SB	PCOSB-TO	RAPID
TTM	GDC	PC Polypropylene SB	PCSB-MO	PCP
JGC	PC Aromatics	PC Polyethylene SB	PCSB-VO	RGT
	PC ODG SB	ABF SB	MLNG	PDWT

KEY ACHIEVEMENTS

- PSM Implementation for PETRONAS Group Wide i.e. downstream & upstream
- PSM Audits for PETRONAS Group Wide with GHSED
- PHA, HAZOP, HER for PETRONAS Group Wide
- Zero Fire assessment & barrier management for PCSB-SKO & VCMSB
- PSM Training for PETRONAS Group Wide
- HAZOP Leader Certifications for PETRONAS Group Wide
- HAC Assessment & Review Workshop
- EERA Study for PCSB-SKO Temana
- Toxic Gas Dispersion for PCFKSB, PC LDPE SB
- Flare Radiation Study for PGB
- CRM for PCSB-SKO, PP(M)SB, PCMSB
- LOPA Study for PCSB-SBO Tembungo Field & PGB
- PRD Study for PETRONAS Group Wide
- QRA Study & HSE Case for PCSB-SKO, PCSB-SBO, PCSB-PMO, PCOSB-TO, PCML

- SHELL – HAZOP Facilitation for B11 and South Furious Facility.
- PC GARRAF – HAZOP & HAZID, Gas Dispersion Modelling Study, Flare (Toxic) Dispersion Study for Garraf Processing Plant. Garraf Light Oil Gas Pipeline HAZOP.
- SAMUR – Design Safety Review
- PFLNG –HAZOP input, review of various QRA & Safety Studies deliverables.
- SOGT – Facilitation of HAZOP for SOGT FEED by SAMSUNG Engineering.
- PCML – HSE Case Update including HER update, QRAs, MOPO etc.

HAC Assessment & Review Workshop

- Provide review and update during plant change/modification (Brownfield Project)
- Provide HAC Review Workshop (Greenfield Project)
- HAC review for Pilot Plant & Lab Scale

Thank you

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