

Nayara Energy perspective on PSM implementation



27th February 2023

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Nayara Energy Limited



Nayara Energy Executive Summary



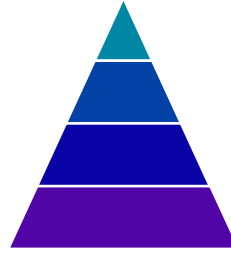
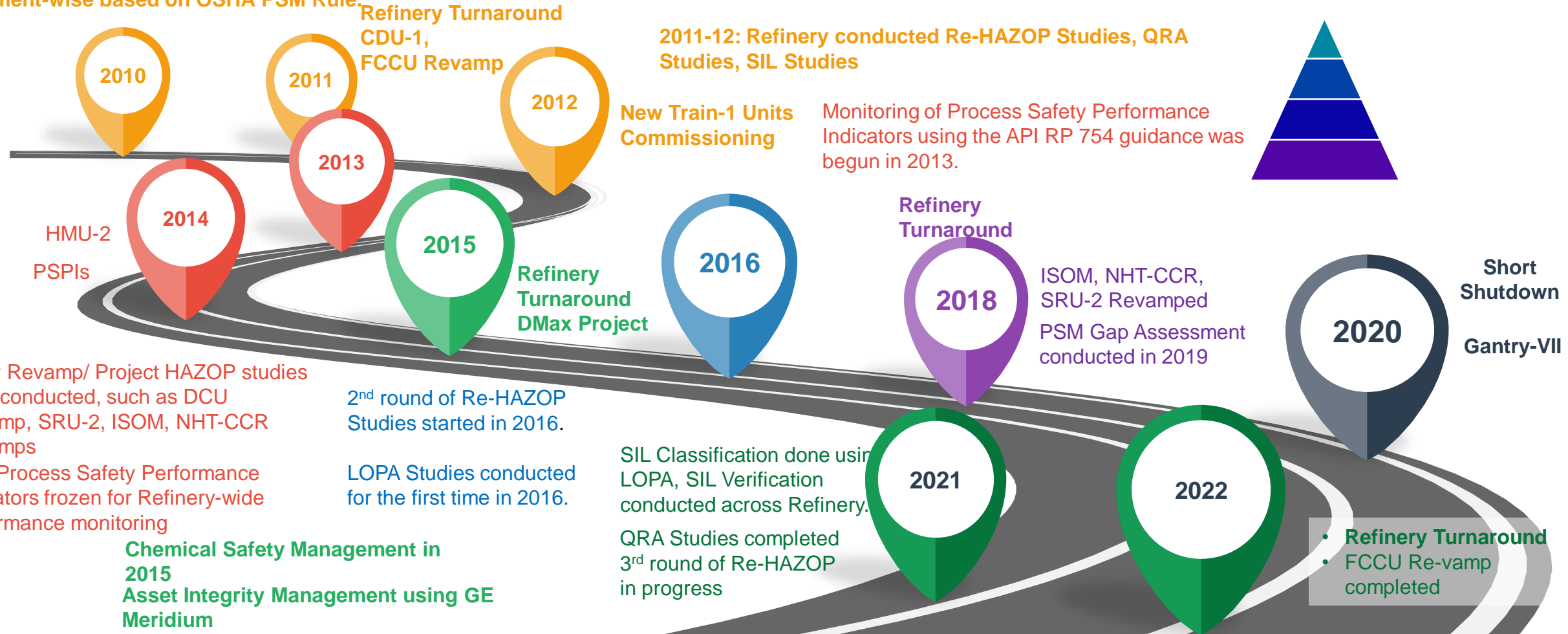
- Vadinar refinery started commercial production in 2008 (10.5 MMTPA) and transformed to a complex, modern large refinery in 2012 (20 MMTPA).
- India's second largest single location modern and complex refinery with Nelson Complexity Index of 11.8.
- Fully integrated with captive infrastructure for crude receipt, product movement with sufficient steam/power and utility generation. Strategic advantage of being a coastal refinery.
- We aim to build one of the largest integrated petrochemicals complexes in the world. With our Phase 1 of the petrochemical expansion project underway Nayara Energy is setting up a 450 KTPA capacity Polypropylene plant, a new Propylene recovery unit along with upgrades to the existing FCC and LPG Treatment Units.
- Safe, reliable, consistent and efficient Refinery operation in terms of capacity utilisation, energy efficiency, Opex etc.
- The Refinery Management Systems certified in accordance with ISO 14001:2015, ISO 9001:2015 & ISO 45001:2018.

PSM Implementation Journey

★ All unit HAZOP Studies were done for Base Refinery prior to construction (project started around 1996)

Safety Management System was established. PSM was implemented element-wise based on OSHA PSM Rule.

The Refinery started monitoring Process Safety Performance using the **Leading & Lagging Indicator Metrics** espoused by the Center for Chemical Process Safety (CCPS) of the American Institute of Chemical Engineers (AIChE) in 2010-11





PSM Elements

- The primary intent of PSM implementation in the refinery has been the “Proactive identification, evaluation & prevention of loss of primary containment” of toxic, reactive, flammable or explosive chemicals from a process.
- PSM elements provides a systematic approach towards achieving these ends, resting on the three pillars of integrity:
 - Operational integrity,
 - Plant integrity and
 - Design integrity.

Knowledge and Operational Control

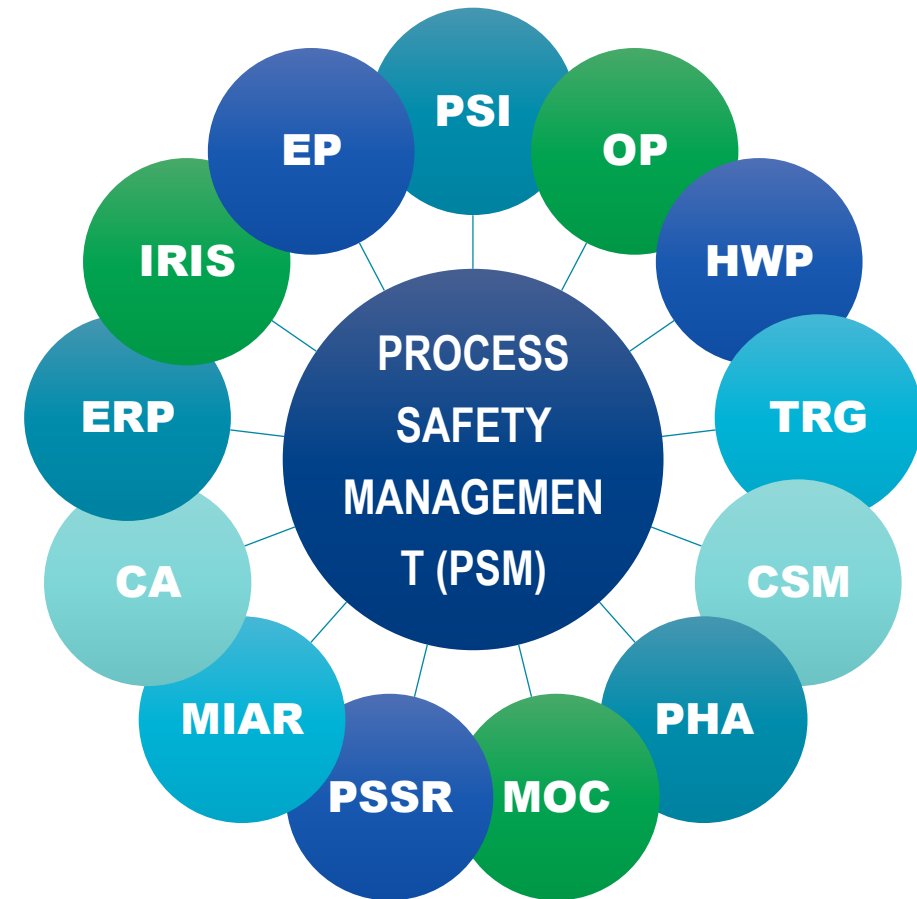
1. Process Safety Information (PSI)
2. Operating Procedures (OP)
3. Hot Work Permit (HWP)
4. Training (TRG)
5. Contractor Safety Management (CSM)

Incidents & Learnings

11. Emergency Response and Planning (ERP)
12. Incident Investigation (II)
13. Employee Participation (EP)

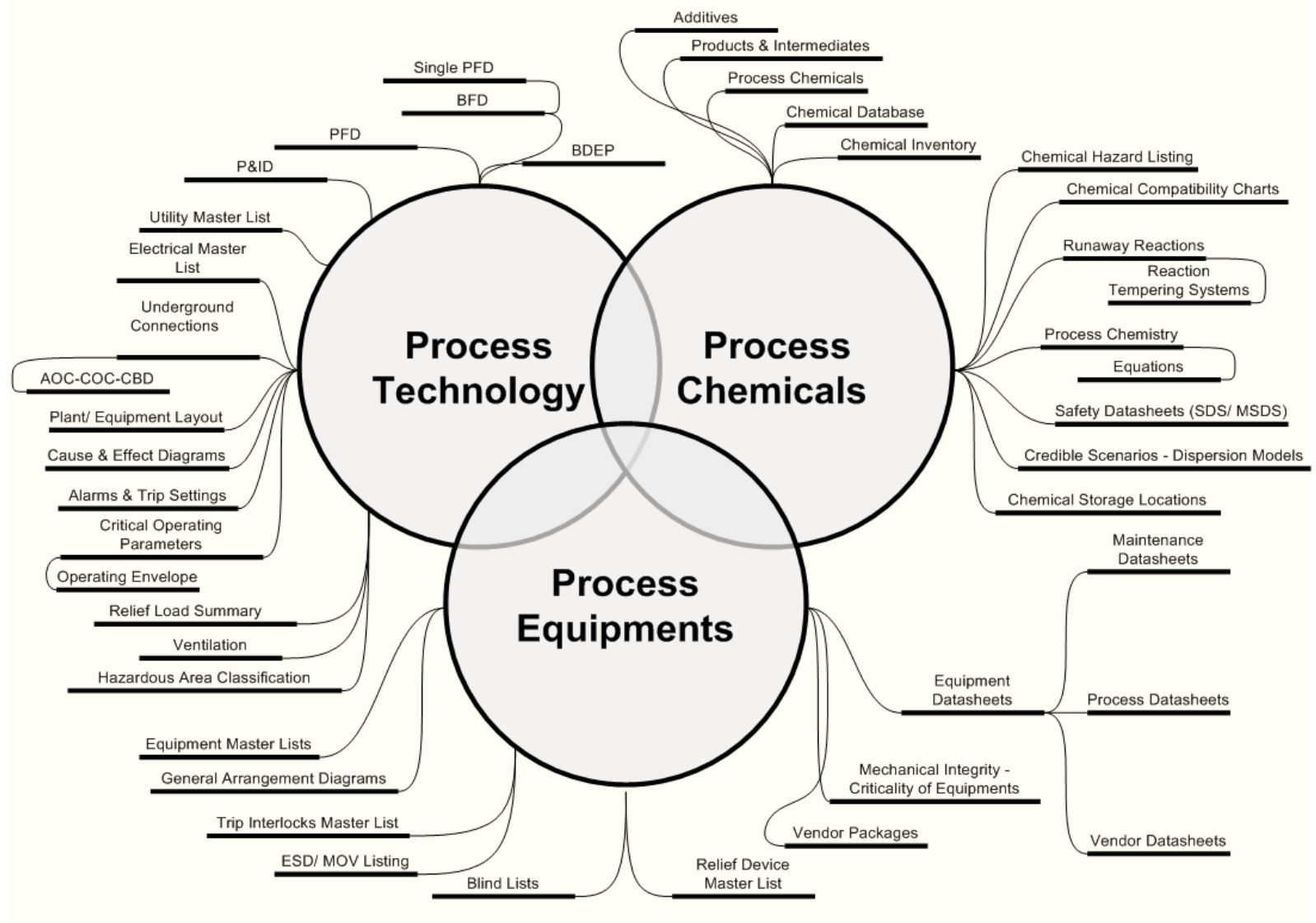
Hazard Identification and Control

6. Process Hazard Analysis (PHA)
7. Management of Change (MOC)
8. Pre-startup Safety Review (PSSR)
9. Mechanical Integrity (MI)
10. Compliance Audits (CA)



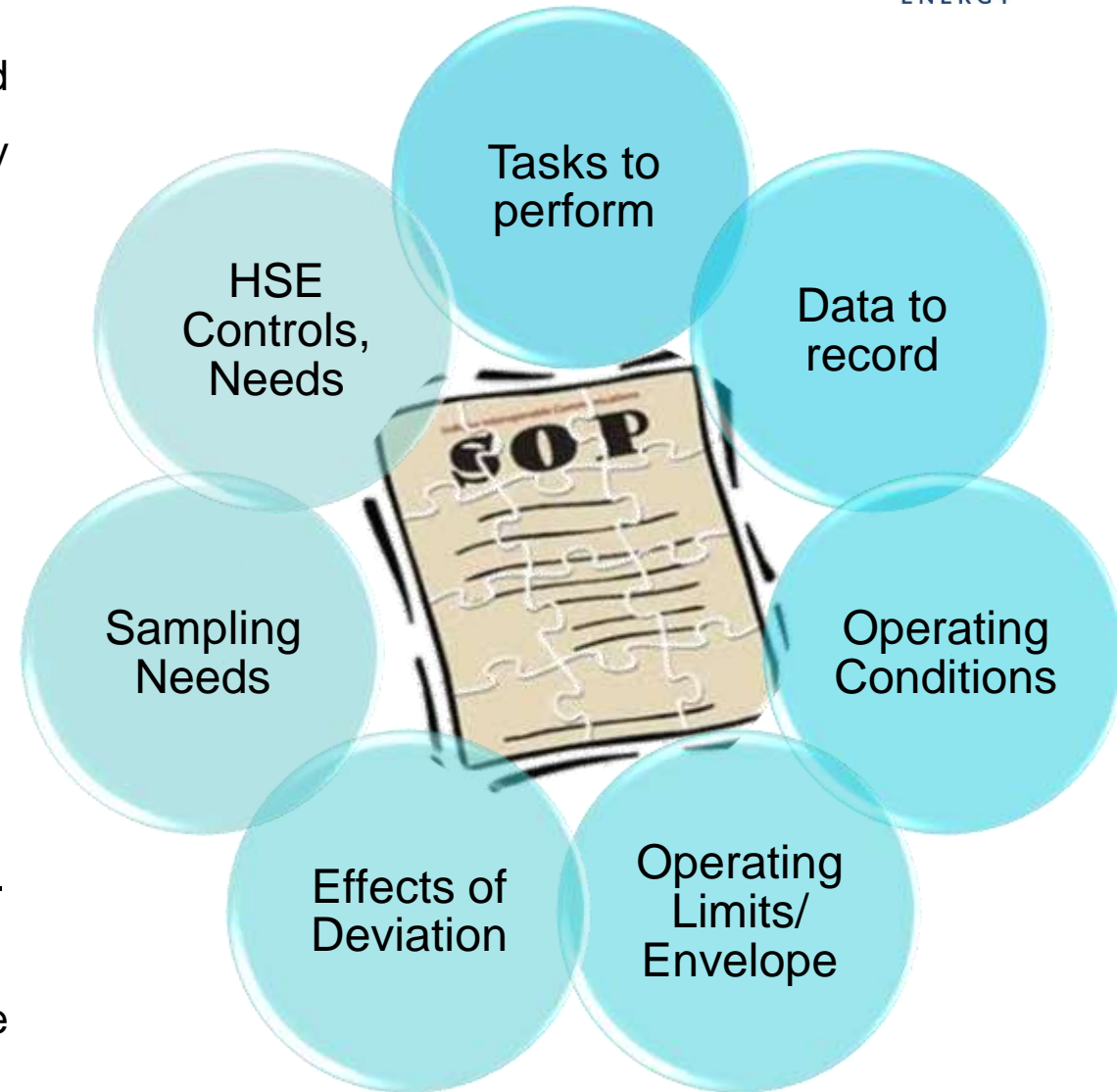
Process Safety Information (PSI)

- The compilation and continual updating of Process Safety Information (PSI) is key to ensuring the continued safety of any process industry including the refinery.
- As required by standards (OISD GDN-206[10], OSHA, etc.), employers must complete a compilation of written Process Safety Information before conducting any process hazard analysis.
- The complete and updated Process Safety Information has been made accessible to all employees through a Portal.



Operating Procedures (OP)

- To provide clear instructions for safely conducting activities involved in a particular process we have developed and we are regularly updating/ revising various Procedures.
- The Procedures utilized are divided into
 - **Management Procedures** (applicable to the whole Refinery),
 - **Standard Operating Procedures** (SOPs) (applicable to specific Units),
 - **Standard Maintenance Practices** (SMPs) applicable to Maintenance Activities
- **Developed more than 3500 SOPs** which are specific to the units.
- **Available to the employees through a common** web based **Portal**.
- Training of concerned employees in the field.
- A Competency Test is conducted along with Interviews with the respective Area Managers, prior to deployment of Officers.



Hot Work Permit (HWP)

- The Work Permit System based on OISD STD-105 as made mandatory by Rule 171 (1) of the Petroleum Rules, 2002, makes it a requirement to obtain permits for conducting Hot Work anywhere inside the Refinery Complex.
- Primary focus in the Refinery, where there may be a lot of flammable/ explosive materials is on Ignition Control. This is ensured by monitoring and regulating the Hot Work Permits issued.
- As per OSHA PSM Rule requirements, the Hot Work Permit in the Refinery documents the Fire Prevention and Protection Measures undertaken prior to a Hot Job.
- Every **such Job is treated as critical in the Refinery and Task-based Risk Assessment** (TBRA/ JSA) with relevant **higher level Authorizations** are required.
- A **Hot Work Permit Registration Portal has also been developed** and maintained by the Fire Department to monitor Hot Jobs in progress.
- **Compliance** to Hot Work Permit is **monitored as a Process Safety Performance Indicator**.



Training (TRG)

- Training Guidelines have been created based on OSHA Guidelines and OISD STD-154, for Mandatory Trainings to be held in the Refinery.
- Every person (visitor, employee, or contractor) is provided with a Safety Induction before entering the Refinery Complex.
- The Employees undergo a **mandatory fresher training** as per contents mentioned in OISD -154 consisting of various Health, Safety, Environment and Fire Modules that include training on:
 - Process Safety Management,
 - Incident Reporting & Investigation,
 - Toxic Gas Awareness (H₂S),
 - Work Permit System, and
 - Hazardous Area Classification
- Mandatory Work permit training in line with OISD-105 requirement for all Issuers, Receivers and Approvers.
- **Refresher** training is conducted for both above subjects at **2 years & 3 years interval** respectively.
- **These mandatory safety trainings are followed by online validation through a portal.**
- Apart from mandatory trainings, trainings on various elements of PSM such as PHA, Incident Investigations etc. are also conducted as per defined schedule.



Contractor Safety Management (CSM)

- The Contractor Management Procedure in the refinery drafted on the basis of OISD GDN-207, covers various aspects of Contractor Management **including Pre-Selection, Selection, Evaluation, Performance Monitoring, and Performance Review** of the Contractors.
- The Contractors are evaluated based on their past performances (including HSEF) prior to selection using a **Pre-Qualification Questionnaire having 60%** compliance as minimum requirement apart from their technical competencies in a **2 layered selection** process.
- Contractor **Kick-off meeting is conducted before mobilization** to communicate HSEF requirements.
- All selected **contractors are assessed by a competent 3rd party based on their respective trade** and competency.
- All contractor undergo **mandatory training programs as defined in the procedure before deployment** to the working location.
- **Monthly performance evaluation** carried out for monitoring of compliance by the contractors.
- **Monthly Contractor Safety committee meetings** are held with site in-charges to ensure a 2 way communication between contractors and senior members from Nayara Energy.
- Periodic **contractor safety audits are conducted** to monitor on field HSEF performance of the contractors.
- Contractor **safety performance is reviewed** during renewal of the contract.



Process Hazard Analysis (PHA)

- Nayara Energy has conducted extensive Process Hazard Analysis in the form of HAZOPs covering the existing Base Refinery Units in 2008-2009, then the Expansion units in 2011.
- **Every Change brought into the Refinery** follows the Management of Change (MOC) Procedure that **encompasses PHA for ensuring that the Change does not bring in uncontrollable** new hazards into the equation.
- **All recommendations of any** PHA are tracked through the portal for Refinery-wide PHA, which is one of Process Safety performance Indicators.
- **HAZOP Studies are also repeated every 5 years** for all the Refinery units (whole unit HAZOP) for revalidation of the Process Hazard Analysis (PHA).
- The Refinery has **completed 2 full cycles of Re-HAZOP Studies till date.** The 3rd Re-HAZOP study of the Refinery started in 2021.
- QRA studies are now included as part of PHA revalidation programs in the Refinery complex. The last cycle of the studies was conducted in 2020 and completed in March 2022.
- The Refinery has conducted SIL Classification and Verification studies for its Safety Instrumented Functions (SIFs).



Management of Change (MOC)

- To ensure that any changes don't introduce new hazards without control or override the existing controls, Nayara Energy has created and implemented the Management of Change (MOC) Procedure.
- The Procedure has been drafted based on OISD GDN-178, OISD STD-206, the OSHA PSM Rule, and the CCPS Guidelines for the Management of Change of Process Safety.
- This procedure manages **soft changes, temporary as well as emergency** changes
- The **Change Management starts with the conceptualization** of an idea and **scheme generation**. The idea generated is presented on the Online Portal for further evaluation followed by **costing & scheduling and in-principal approval**.
- Any such changes may be to prevent incidents, improve utilisation and optimisation of facilities, reduce downtime, or reduce risk to the personnel.
- **The proposal** is then **evaluated** for **detailed engineering** and **for determining any Process Hazards** involved (PHA) **through checklists, HAZID and HAZOP** as required.
- Based on **PHA study & detail engineering management approval** is obtained.
- MOC is executed considering all above aspects and PSSR is conducted subsequently.



Pre-Startup Safety Review (PSSR)

- The Pre-Start-up Safety Review is conducted prior to commissioning of any new Unit or modified sections of a Unit.
- The Refinery has developed a **22 PSSR Checklists** based on OSHA PSM Rule, UK HSE Guidelines, OISD GDN-145 and OISD GDN-206 to conduct the PSSR.
- The objective to conduct PSSR is
 - The Construction & Equipment are in accordance with Design Specifications for new facilities
 - Safety, Operating, Maintenance, and Emergency Procedures are in place and are adequate
 - For changes, MOC procedure is followed and all HAZOP recommendations have been implemented before start-up.
 - Training of each employee involved in operating a process has been completed.
- **PSSR after shutdown** are conducted as per defined matrix using a **unit start-up checklist** in line with OISD requirement.
- PSSRs are planned in **two levels** (Level1 & Level2) to ensure its objective.
- For the PSSR, a multi-disciplinary team (consisting of experienced personnel) checks and forms a Punch List to be cleared prior to commissioning of the Section/ Unit. For **level 1 PSSR** cross Functional team from **Senior Management participates.**
- The deviations identified are **prioritized in A,B, & C categories.** All **A category points are rectified** before start up.
- An Online **PSSR Tracking System is used in the Refinery to track** the completion of the Punch Points thus generated.



Mechanical Integrity (MI)

- The OSHA PSM Rule and OISD GDN-206 require a Mechanical Integrity program in place to ensure that equipment are designed, installed and operate as intended without chances of failure. For this purpose, a Mechanical Integrity & Asset Reliability (MIAR) program is in place at the Refinery.
- Nayara Energy has devised a **Risk Based Inspection strategy** for equipment for all disciplines based on criticality i.e. (Non critical, Semi critical, Critical & Super critical).
- The criticality is determined using the RAM (Risk Assessment Matrix).
- **Based on the criticality frequency of the Inspection** program will be finalized.
- **Deficiencies** observed during Inspection program is **analysed** to update **inspection frequencies**.
- **Reliability Centred Maintenance (RCM)** is identified as approach **to identify reliability improvement**.
- RCM is **conducted to identify Reliability Improvement Plans & Maintenance Tasks** for an asset based on its operating context, past failure history and failure modes.
- **> 3500 equipment** has been **covered under RCM study** which has **benefitted in Reliability Improvement, Optimization of Resources, Integrated Asset Performance Management.**



Compliance Audits (CA)

- Based on the various OISD, OSHA, other Statutory Rules & Regulations being followed, the Refinery conducts Audits regularly to monitor the implementation and need for any change, and when there are any amendments made to existing standards or based on International Best Practices found.
- Internal Safety Audits are conducted through internal cross functional team.
 - Bi-Monthly **Cross Functional Safety Audit** in each unit which involves PSM aspects as per defined checklists.
 - **Contractor Safety Audit**- once in four months.
 - **Internal Process Safety Audits** as part of OISD requirements.
 - Other Specific audits such as **Specific area Audits, SOP Audits, Relief system visual Inspection, Small bore piping Audit, Fire Proofing Audit** etc. is carried out.
- External Safety Audits have been performed by reputed auditors/ service providers.
- All the Audit Recommendations are tracked through the Safety Portal for implementation.



Emergency Response & Planning (ERP)

- The Refinery has incorporated many statutory rules and guidelines for the formation and implementation of Emergency Response Plans, viz.
 - Factories Act 1948: Schedule 1, Section 41B
 - Petroleum & Natural Gas Regulatory Board (PNGRB) Emergency Response Regulations (2010)
 - OISD GDN-168
 - Manufacture, Storage and Import of Hazardous Chemicals (MSIHC) Rules, 1989: Rule 14
- The Refinery has classified the **On-site Emergencies into 3 levels.**
- An Emergency Response and Disaster Management Plan (ERDMP) has been implemented in the Refinery. **Separate training sessions are also held in addition to mandatory fire fighting training.**
- Emergency **scenarios** are defined from **QRA studies** conducted, based on that **Pre Incident Planning is carried out.**
- In accordance with the framework of the OSEMP, Nayara Energy conducts periodic mock-drills as per yearly schedules. Frequency is as suggested in the PNGRB Rules. Total 18 mock drills are planned in calendar year.
- The actions based on the recommendations are also tracked in the Safety Portal.
- Site has trained **level 1 rescuers** round the clock in all shifts in addition to **Fire fighting team and Auxiliary fire squad.**
- **Auxiliary Fire squad** consists of > 90 **trained personnel from operations** department from different units.
- **Blast call system** developed for immediate information to **key personnel** in case of any turn out initiated.



Incident Investigation (II)

- The Incident Reporting and Investigation System was developed based on various Statutory Requirements, viz
 - Gujarat Factory Rules, 1963: Rule 68J (4), 103, Chapter IX, Schedule XIX
 - Factory Act, 1947: Sections 88, 88A
 - Petroleum Rules, 2002: Chapter XI
 - Workmen Compensation Act;
- As per procedure Incidents are reported within 24 hours of the occurrence.
- Multi-Disciplinary **cross functional Investigation teams are then formed** with senior management involvement and the investigation is completed as per defined investigation matrix.
- **Categorization** of Near miss and Incident based on the **Impact** on People-Environment-Asset-Reputation (PEAR) in terms of **Minor, Significant, Critical and Major**.
- In case of any Loss of Containment, Spill Release Matrix is utilized to categorize the incident severity based on API 754.
- The Investigation is performed using any of the methods including **Fault Tree Analysis** and the **5 Whys Method** by a team trained in techniques of Incident investigation and Root cause Analysis.
- The **learnings are derived after each investigation and shared with** other **Area Managers** for **horizontal deployment of applicable learnings**.

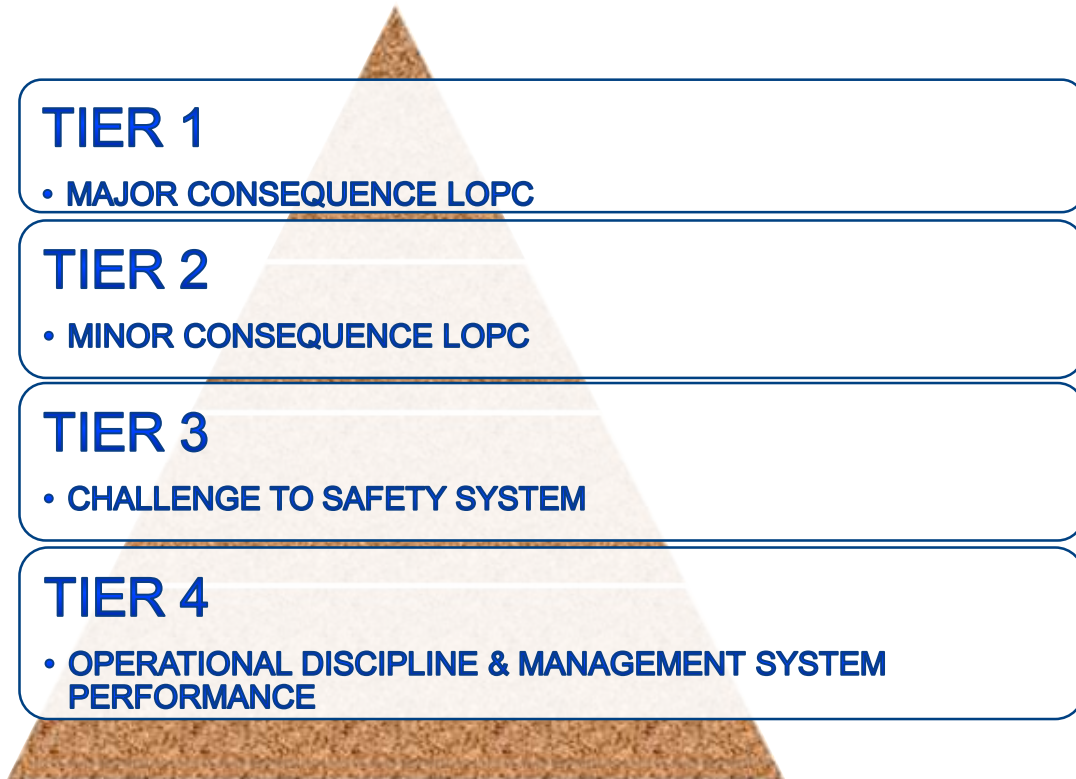


Employee Participation (EP)



- At Nayara, the employees are engaged in various activities providing feedback to the Management Procedures, Standard Operating Procedures (SOPs), Management of Change Process, Process Hazard Analysis(including HAZOP), Incident Investigation (Fault Tree Analysis, What If, 5 Whys, etc.), Pre-Start-up Safety Review, etc.
- Nayara Energy has defined dedicated procedure for Employee Participation.
- To ensure **structured employee participation 4 tier committees** are formed
 - **Area Safety Committee** – Headed by Area Manager and participated by Engineers and Contractor supervisors
 - **Contractor Safety Committee** - Headed by Maintenance Head and participated by Engineers & Contractor Site In-charges.
 - **Management Safety Committee** - Headed by Head of Refinery and participated by HODs, Area Managers and Maintenance Heads.
 - **Apex Committee** - Headed by Head of Refinery and participated by Leadership team and HODs.
- On 1st of every month **HSEF time out** is conducted **led by Senior Management and participated by employees and contractors** to communicate details of **Promotional activities, Incident learnings and seek feedback.**
- As part of employee participation **reporting of Unsafe conditions/ near misses** is encouraged by the management
- Schemes like **Safety Champions (Individual)** and **Best of Best (Area wise)** have been introduced.

Monitoring Process Safety Performance



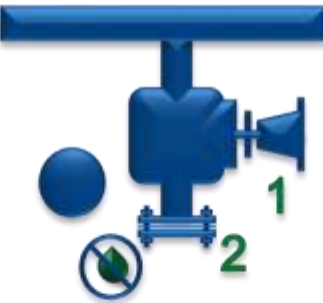
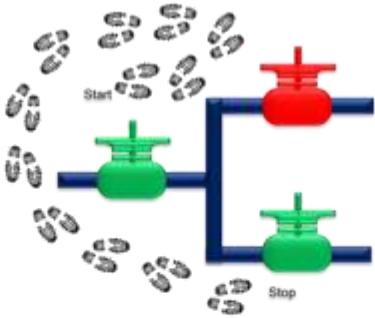
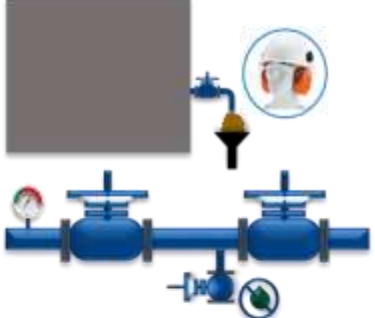
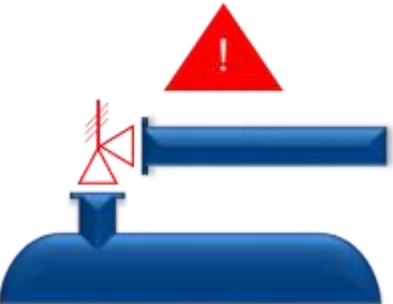
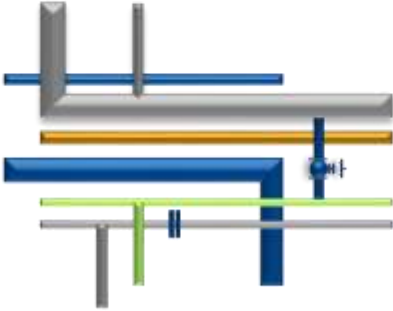


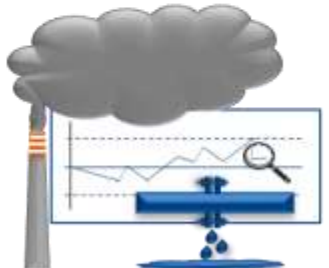


- PSM Department monitors status of
 - Process Safety Events (Tier 1, Tier 2 and Process Near misses daily.
 - Safety critical systems, interlocks and OLS clamps, F&G systems weekly
 - Relief device monitoring and status of Mock drills is carried out monthly.
 - Supercritical Equipment inspection & Fire fighting system inspection monthly.
 - Visual monitoring of relief devices quarterly.
 - Chemical database monitoring annually.

TIER 1: MAJOR CONSEQUENCE LOPC	
.....	
TIER 2: MINOR CONSEQUENCE LOPC	
.....	
TIER 3: CHALLENGE TO SAFETY SYSTEM	
Defeated Safety Critical System/interlocks	...
Defect in Relief devices	...
Defeated Fire Systems	...
Online Leak sealing	...
TIER 4: OPERATIONAL DISCIPLINE & MANAGEMENT SYSTEM PERFORMANCE	
ERP Drills (Actual Vs Planned)	... %
Super-Critical Equipment Inspections	... %
Hot Work Permit Compliance	... %
Process Near Miss Approved	...
Operating range excursions	...

Nayara's Process Safety Fundamentals

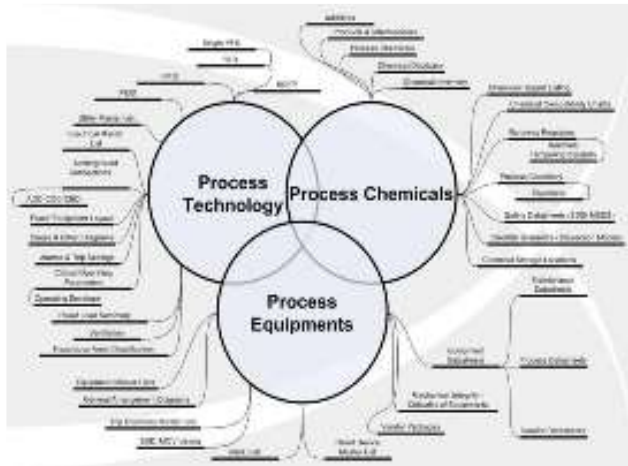
Safe Operational Principles to Avoid Process Safety Incidents

 <p>Operate within Safe Limits Don't bypass Trip Interlocks</p>	 <p>Respect Process Hazards Keep out of Line of Fire</p>	 <p>Maintain Safe Isolation - Dual Isolations & Leak Tightness</p>	 <p>Verify Line-up - Don't proceed without field clearance</p>	 <p>Empty, De-energize before Line Break & Draining</p>
 <p>Report Deficiencies in Safety Critical Equipment</p>	 <p>Recognize and Manage Changes to Plant and Personnel</p>	 <p>Follow up-to-date Procedures Stop if the unexpected occurs</p>	 <p>Maintain Risk Control Systems as per Design Intent</p>	 <p>Report & Analyze Process Safety Events – Near Miss/ Incident</p>

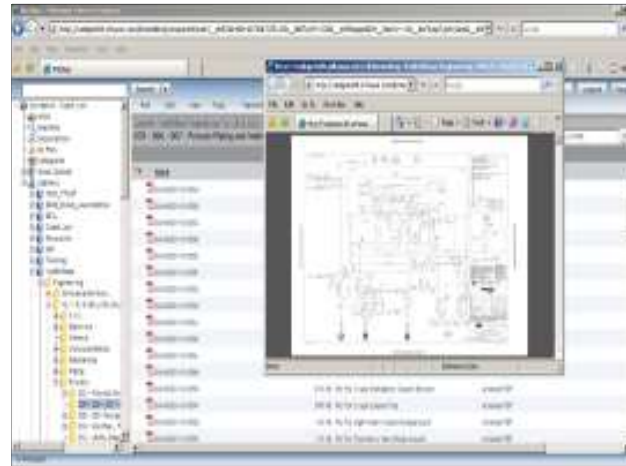
The intent of the PSFs is to **emphasize some critical front-line tasks and behaviors** that need to be fully understood and supported by all operational leaders to enable successful process safety performance. ²¹

Developing Online Systems

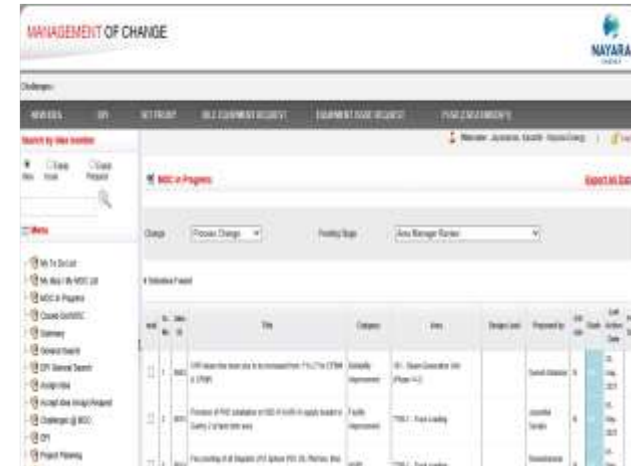
Process Safety Information



Engineering Documentum (Webtop)



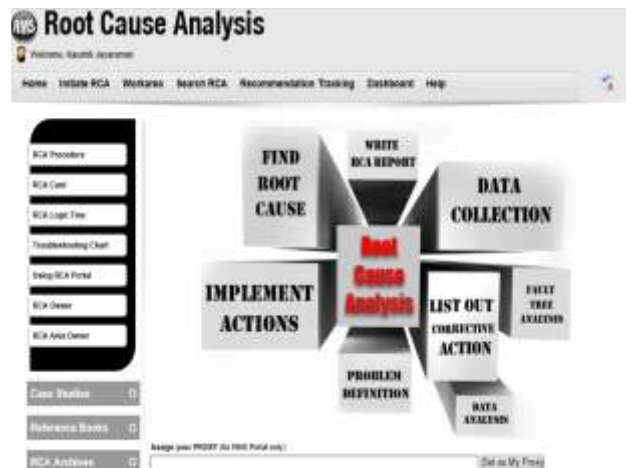
Management of Change



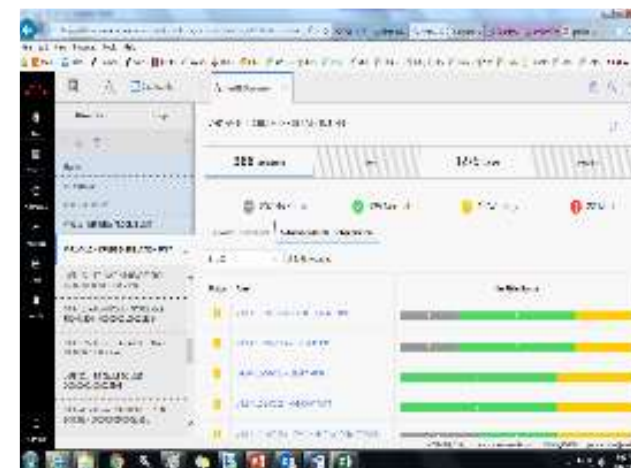
HAZOP, PSSR – Action Tracking



Root Cause Analysis Portal



Asset Performance Monitoring – GE Meridium



Journey continues....

Its not something new. It has been designed in!

The Process Safety Perception Survey was launched in Nov-Dec' 2020 with a focused on the Organizational Culture/ Operational Discipline aspects.

Tank Overfill Protection, Lightning Protection, Facility Siting and Inter-spacing distances,...

Periodic monitoring of Process Safety Performance Indicators (Leading & Lagging)

Refinery fully audited for PSM Implementation based on OSHA PSM & CCPS RBPS systems by renowned international Third Party in 2019.



Vadinar refinery becomes India's first to install RGAs to make Crude, Product & Intermediate storage floating roof tanks lightning proof

PSM in Projects
Process Hazard Analysis (PHA) methods like HAZID, HAZOP, SIL, QRA, P&ID and Model Reviews are conducted from Conceptual Stage

PSM Implementation Highlights



- No major Process Incidents (Tier 1) since 2014.
- More than 75% reduction in Minor Process events Incidents in last 5 years.
- Number of Trip Interlocks bypassed brought down to zero.
- > 98% compliance with Inspection, Testing, and Preventive Maintenance (ITPM) Plans for Super-critical Equipment.
- 3 cycles of periodic PHA (HAZOP) completed with No overdue Process hazard Analysis Actions.
- SIL Assessment & Verification for entire refinery is completed.
- Development of 12 Process Safety Management procedures as part of continual improvement.
- Revalidation of HAZOP leaders & Investigation Team Leaders.
- Conducting PSM Gap Assessment every 5 years through External consultants.
- Achieved more than 5000 Man-hours of PSM training in CY-2022.
- Development of PSM Center of Excellence in collaboration with IIT Delhi & M/s. Gexcon.

Actions to achieve Process Safety Excellence



- Develop In-house capabilities to carry out various Risk Management studies, using software like PHAST Risk, ExSILentia, Bow tie Software, Detect 3D for enhanced Risk Management.
- Develop digitization solution for up to date monitoring of Process Safety Performance Indicators. Viz: Interlock bypass monitoring, On-line clamp status monitoring etc.
- Improve features of existing web based platforms by incorporating analytics for up to date Management Information system.
- Complete F&G mapping of the facilities across the refinery.
- Develop in-house capabilities by creating a pool of personnel, competent to carry out Risk Assessment and Root Cause Analysis by conducting periodic training and workshops.
- Enhanced focus on imparting awareness tenets of Operating Discipline.
- Conduct Process Safety perception survey creating a robust Process Safety Culture.
- Strengthening Process Safety Performance indicators and existing procedures as part of the continual improvement and adopting best practices followed at other refineries.
- Develop interactive training e-modules for Process Safety Elements.

Thank You

