

# Report of the Working Group on Safety in Indian Petroleum Sector

August 2023





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*Lastly, acknowledgments are due to each member of the Working Group for their objectivity of the purpose and sincerity of efforts to produce this report with the sole objective of making the Petroleum Industry safer for all.*

## REPORT OF THE WORKING GROUP ON SAFETY IN INDIAN PETROLEUM SECTOR

This has reference to Ministry of Petroleum and Natural Gas order number Expl-12031(11)/4/2022-EXPL-II-PNG (E-43727) dated 18th August 2022 constituting a Working Group to look into the whole gamut of safety framework and suggest necessary changes for petroleum sector in the country.

The report of the Working Group is enclosed herewith.



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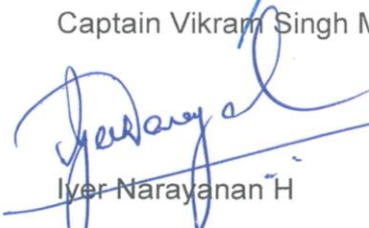


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# Report of the Working Group on Safety in Indian Petroleum Sector



## Executive Summary



## EXECUTIVE SUMMARY

### 1.0. Background

1.1. Ministry of Petroleum and Natural Gas (MoP&NG) vide ref. File No. Expl-12031(11)/4/2022-EXPL-II-PNG (E-43727) dated 18<sup>th</sup> August 2022 have constituted a Working Group to look into the whole gamut of safety framework and suggest necessary changes for petroleum sector in the country. The scope for the working group is stated as follows:

- i. **Review safety system followed by oil and gas industry and responses required in any emergency by the companies concerned considering the latest technological developments.**
- ii. **Identify gaps in extant laws including enforcement and accountability.**
- iii. **Recommend way forward to establish single safety regulator for petroleum sector.**

1.2. This report dwells on the observations and recommendations of the Working Group on the safety framework and the safety systems in Oil and Gas sector in India, key challenges, emergency preparedness and areas needing further strengthening. An effort has also been made to identify critical gaps related to safety in extant laws and amendments required, if any. The report further provides a road map to move towards a single safety regulator for Petroleum sector in India.

### 2.0. Methodology Followed

2.1. Considering the objective, scope and the time available for the study, Working Group invited major oil and gas organizations operating in India to present the safety systems currently followed by them, uniqueness, best practices, gaps and pain areas and new systems/ technologies/ ideas implemented by them for improvement of safety. To have an outside-in approach, inputs were invited from some of the international technology providers and knowledge resource organizations operating in this field. References were drawn from the observations and recommendations of high-level investigation committees for major incidents, root cause analysis of incidents that took place in last 5 years in Indian petroleum industry, observations made in Standing Committee on Petroleum and Natural Gas & in Safety Council meetings, observations during OISD external safety audits, organization audits, incident investigations etc. Reference was also drawn from recommendations in some of the panel reports of major incidents overseas and international standards and practices. Working Group made field visits to representative upstream and downstream installations to have inputs on the extant safety systems and their effectiveness in real time.

2.2. In addition to the inputs received from various organizations, the Working Group had the benefit of insights and vast first-hand experience of the individual members who were part of the Working Group in different areas of the oil and gas business. Deliberations were enriched further by inputs from other senior officers handling safety critical roles in respective organizations.

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### **3.0. Current Regulatory Mechanism**

- 3.1. Indian Oil and Gas Sector has two broad segments namely Upstream and Downstream/ Midstream. The upstream segment deals with exploration and production of crude oil and natural gas both onshore and offshore. The downstream & midstream segment deals with import, receipt, processing of crude oil to make refined petroleum products and receipt, storage, transportation, distribution, marketing of petroleum products & natural gas. Import and export of petroleum products including Liquefied Natural Gas (LNG) is also a part of the downstream/ midstream segment.
- 3.2. Safety in Indian Oil and Gas Sector is regulated under various Acts and rules/ regulations thereunder, main being - The Petroleum Act 1934, The Explosives Act 1884, The Mines Act 1952, Petroleum and Natural Gas Regulatory Board Act 2006, The Oilfield (Regulations and Development) Act 1948, The Factories Act 1948, The Disaster Management Act 2005 etc.
- 3.3. The main regulating authorities include Petroleum & Explosives Safety Organization (PESO), Director General of Mines Safety (DGMS), Petroleum and Natural gas Regulatory Board (PNGRB), Chief Inspectorate of Factories etc. Oil Industry Safety Directorate (OISD), a technical Directorate under the aegis of Ministry of Petroleum and Natural Gas coordinates the safety activities on behalf of Ministry of Petroleum & Natural Gas (MoPNG), assist the Safety Council, conduct safety audit of oil and gas installations/facilities, investigate accidents and publishes various technical and safety standards called OISD standards.

### **4.0. Deliberations and Recommendations**

- 4.1. After detail deliberations on various inputs, Working Group identified the following key focus areas to address some of the basic issues for overall improvement of safety in Indian Oil and Gas sector:
- Safety culture
  - Competency assurance of company employees
  - Safety management of outsourced and contracted out jobs
  - Management of safety barriers
  - Compliance to SOP (Standard Operating Procedures)
  - Adequate job supervision
  - Asset integrity management
  - Process Safety Management
  - Effectiveness of safety audits
  - Emergency preparedness and response management
  - Leveraging technology for safety
  - Emerging risks with increasing complexities in a transient business environment
  - Cyber security as a safety threat
  - Other domain specific issues needing attention

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4.2. Observations and deliberations of the Working Group are recorded in Section B and the recommendations are elaborated in Section C of the report. Some of the key recommendations are briefly given in the following paragraphs.

**4.3. Safety Culture**

4.3.1. All organisations in Oil and Gas Sector to carry out a formal assessment of the safety culture in their organisations, which should be benchmarked against an internationally accepted 'Safety Culture Maturity Model'.

4.3.2. Top leadership team including Board members to be given structured safety orientation to enlist their commitment to safety with emphasis on 'Visibly Felt Leadership'.

4.3.3. Each organisation to have a safety department at corporate level with the Head of Corporate Safety department reporting to the Head of the organisation either directly or through Head Corporate HSE.

4.3.4. Safety Performance Indicators comprising of both Leading and Lagging Indicators to be developed for monitoring safety performance and included in KPI/ KRA of key functionaries.

4.3.5. To make safety a habit, initiation to safety to start right from pre-school days with fun games and cartoon films. Public awareness on safety to be created through social media, movies, OTT inserts, and public campaigns about safety in daily life. To attract funding for this purpose, safety campaigns for public may be allowed as CSR budget of the companies.

**4.4. Competency Assurance of Company Employees**

4.4.1. A position based 'Three-Dimensional Competency Grid' including basic requirements, technical competencies and behavioural competencies to be developed for all positions to have a structured mechanism for tracking competency requirement, availability, interventions required and outcomes.

4.4.2. Orientation/ Training/ Retraining before taking over any role/assignment to be made compulsory and be made part of the HOTO (Handing over-Taking over) process.

4.4.3. Safety trainings to be an essential part of the operational trainings. Such trainings to focus on 'inherently safe operation' in addition to occupational safety and emergency response.

4.4.4. Organisations to develop specific competency criteria for posting personnel in HSE department.

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- 4.4.5. E&P installations (rigs and production installations), engaging workers above certain threshold number, to have a dedicated safety officer with required qualification/certification in upstream safety.
- 4.4.6. Domain specific training programs to have a judicious mix of classroom trainings, simulation-based trainings and field trainings as per job requirements including use of new age technologies like Augmented/Virtual Reality, 3D imaging, Training Simulators etc. to improve effectiveness of training.
- 4.4.7. OISD to accelerate its efforts in sharing knowledge with the industry on learnings from incidents. Industry may collaborate with OISD in developing videos/animations/ short films on incidents for this purpose.
- 4.5. **Safety Management of Outsourced and Contracted out Jobs**
  - 4.5.1. Tasks/ Works to be classified as extreme risk, high risk, medium risk and low risk. Outsourcing decisions to also consider the risk profile of the job in addition to other criteria.
  - 4.5.2. Complexity, risk profile and safety related requirements to be clearly depicted in tender documents, emphasized during pre-bid and kick-off meetings and included in final contract documents. In case of subcontracting, main contractor to own responsibility of the subcontractor/ agencies engaged by them.
  - 4.5.3. Organizations to develop a computer based 100 points safety rating system to monitor the safety performance of the contractors.
- 4.6. **Management of Safety Barriers**
  - 4.6.1. All organizations must define Board approved 'Life Saving Rules'. Violations to Life Saving Rules to be tracked as unsafe acts.
  - 4.6.2. Hazard Identification and Risk Assessment (HIRA) studies to be carried out for all existing facilities, if not already done, and to be repeated every 5 years after baseline HIRA. HIRA studies like HAZOP/HAZON/QRA to be part of the project implementation process for all new projects.
  - 4.6.3. All organizations to have documented 'Management of Change process (MoC) preferably in e-module. MoC process to be followed not only for hardware changes but also for changes in critical operating parameters /procedures, trip settings and prolonged bypassing of safety interlocks.
  - 4.6.4. Installations like Refineries, process plants, cross-country pipelines, offshore platforms to have well defined and documented 'Safe Operating Envelope' limits for operations. Any changes to Safe Operating Envelope Limits should follow the MoC process.

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- 4.6.5. Emergency Shutdown Systems (ESD) to be designed at initial stages of the project through HAZOP and SIL studies. Organizations also to have a system of Clear Function Test (CFT) and maintenance schedule for each component of ESD system.
- 4.6.6. Alarms rationalization exercise should be carried out, if not already done, to ensure effective and preferential attention of operator on important alarms.
- 4.6.7. Pre commissioning Safety Audit (PCSA) to be made compulsory before commissioning of any new/ revamped/ modified facilities.
- 4.6.8. Organizations to augment existing practices and procedures to cover reporting and investigation of Process Safety Events especially in refineries and process plants in line with API RP 754.
- 4.6.9. Unsafe Acts/ unsafe conditions should also be tracked in addition to near misses. Trend of near misses/ unsafe acts/ unsafe conditions to be analysed for any emerging pattern. Hi-Po near misses to be investigated with the same rigor as an incident.
- 4.7. **Compliance to Standard Operating Procedures (SOP)**
  - 4.7.1. Organizations to have an updated list of SOPs available vis a vis required. Required SOPs, if not available, should be developed in a time bound manner and existing SOPs reviewed/ reaffirmed at least once in 3 years.
  - 4.7.2. All SOPs should be verified in the field for actual compliance by surprise audits by independent internal teams at least once in a cycle of 3 years. Variation observed to be analysed to identify need for trainings or SOP updation.
  - 4.7.3. Frequent changes to SOPs should be avoided and any change to SOPs should be carried out only after thorough review. Changes to SOPs should also be checked for any consequent change requirement in other SOPs.
- 4.8. **Asset Integrity Management**
  - 4.8.1. Organisations to develop comprehensive asset integrity management program covering full life cycle of the assets including residual life assessment and replacement/ obsolescence policy for aged assets to ensure that assets are 'fit for purpose' throughout the lifecycle.
  - 4.8.2. Organisations to define Integrity Operating Windows (IOWs) for the critical assets that should be known to the operating staff and any change to IOW limits should follow MoC procedure. Short term or long-term vulnerabilities and safety risks related to operation of aged assets to be built in the operational risk metrics.

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### 4.9. Process Safety management

4.9.1. Refineries and Process plants to have focused program for Process Safety Management in line with PSM standards (CFR 1910.119) of OSHA or RBPS of CCPS. Recently revised OISD-GDN-206 may also be referred in this regard.

### 4.10. Effectiveness of Internal Safety Audits

4.10.1. Organizations to identify group of officers from different disciplines with right aptitude and job knowledge to develop large pool of internal safety auditors who should be trained on auditing skills and drawn for conducting internal safety audits by rotation. Competence should take precedence over availability while drawing officers for safety audits.

4.10.2. Field rounds of safety critical areas of the facility, dipstick checks on SOP compliance, random review of CCTV footages, surprise mock drills, check on status of previous audit findings to be essential parts of internal safety audits.

### 4.11. Resolution of Conflict on Audit Observations

4.11.1. All audit observations are to be tracked until a logical conclusion is reached. Sometimes the recommendations made in OISD external audits are not implementable due to practical difficulties like space constraints, litigations etc., especially in old locations. Acquiring new land or relocating the facilities is a time-consuming affair. At times organizations are not in agreement with the audit observations on technical grounds. The conflict remains unresolved and such recommendations remain open for a long time with no action. A methodology is suggested in the report to deal with such situations.

### 4.12. Emergency Preparedness and Response Management

4.12.1. Emergency Response Plans to be based on location specific quantitative/ qualitative risk assessments involving all possible emergencies.

4.12.2. Exception reports regarding the health of early detection & warning systems and critical emergency response systems to be reviewed by installation head and concerned safety person on a daily basis.

4.12.3. Mock drills to be conducted in odd hours also and should cover a variety of scenarios.

4.12.4. A mock drill debriefing session should be held immediately after the mock drill with all concerned. Observations during mock drills to be recorded & communicated to all concerned for corrective actions.

4.12.5. Communication protocols during emergencies should be unambiguous, duly authorized and known to the concerned with updated contact details.

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**4.13. Preparedness for specific Emergencies**

4.13.1. **Well Control in Upstream Operations** – Major E&P operators to have well-established crisis management teams. Other operators (not having own capability of crisis management) to have MoU with organizations having competency for blowout management.

4.13.2. **Emergency Response Centers** – Setting up of Emergency Response Centers as per recommendations of M B Lal Committee report, to be expedited.

4.13.3. **Regional Oil Spill Response Centre** – Ministry of Ports, Shipping and Waterways (MoPS&W) proposed setting up of Regional Oil Spill Response Centre (ROSRC) along Indian Coast line. Same to be expedited.

**4.14. Leveraging Technology for Enhanced Safety**

4.14.1. CCTV cameras with video analytics, cognitive capabilities, artificial intelligence to be extensively used for real time monitoring of unsafe acts, unsafe conditions and safety violations. Organizations to set up independent centralized monitoring and control centers to monitor and precipitate real time alerts.

4.14.2. IoT based techniques to be used to improve asset integrity, reliability, detection of process events, failure predictions etc.

4.14.3. Drones and robotics to be used for inspection and maintenance in inaccessible or hazardous areas wherever feasible.

4.14.4. Installation of PIDS (Pipeline Intrusion Detection System) with artificial intelligence to be encouraged at project stage itself to reduce safety incidents related to unauthorized tapping of cross-country pipelines.

4.14.5. Training Simulators, Digital twins, Virtual and Artificial Reality (VR/AR) to be deployed for improving training effectiveness and preparing the workforce both technically and temperamentally for handling real time emergencies.

**4.15. Emerging Risks due to Increasing Complexities in Transient Business Environment**

4.15.1. Increasing Complexities in Refineries due to new technologies and increased use of hydrogen needs more rigor in training of operating crew, adherence to SOPs, reliability of automated control & emergency shutdown systems and emergency preparedness.

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- 4.15.2. Additional HIRA study to be carried out for risks and hazards arising due to simultaneous operation of multiple fuels dispensing (MS/HSD/CNG/Auto LPG) along with EV charging at Retail outlets.
- 4.15.3. Suitable mechanism and protocol for testing of CNG cylinders on vehicles once in 3 years (as per IS 15975) to be instituted including penal provision for violations in the Motor Vehicle Act.
- 4.15.4. Recommendations of M B Lal Committee to have a 250-300 meter buffer zone around major Oil and Gas installations may be pursued for a logical conclusion to deal with population growth around major oil and gas installations.

### 4.16. Additional Sector Specific Areas Needing Attention

#### 4.16.1. Upstream Offshore Operations –

- a) Gaps in regulatory mechanism with respect to non-propelled vessels and Gaps in Petroleum & Natural Gas (Safety in Offshore Operations) Rules 2008 to be addressed.
- b) Fishing boats near offshore installations to be more closely regulated.
- c) The Offshore and Onshore oil and gas production site abandonment guidelines (SRG) dated 1<sup>st</sup> May 2018 to be reviewed and updated basis international standards.

#### 4.16.2. Cross country Pipelines

- a) **Population growth on Pipeline ROU** – If change in location class is perceived due to demographic changes along the ROU, QRA should be conducted once in 5 years and risk mitigation measures undertaken.
- b) **Geo Hazards (Wash outs/ Landslides)** – Pipeline operators should strive to adopt a Geological Hazard Risk Management program such as ISO 20074 from design stage.
- c) Joint Job Hazard analysis with civil administration to be carried out for existing hydrocarbon and CGD pipelines during city infrastructure upgrade projects.

#### 4.16.3. Other Specific Areas

- a) **Green Field Projects** – System to be implemented to report incidents, near misses, unsafe acts, unsafe conditions during construction. Internal inspections and safety audits should be carried out periodically. Pre commissioning safety audit (PCSA) to be compulsory for any new project.

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- b) **Ports/SPMS/Shipping Operations** – Ports having hydrocarbon operations to have adequate firefighting facilities, should follow mandatory OISD standards covered in Petroleum Rules and should carry out annual internal safety audits.
- c) **Oil and Gas installations operated by private/ JV operators** – Safety management system followed by private/ JV Operators should not be less stringent than suggested in applicable OISD standards. Major accidents should be reported to OISD. Organizations should carry out pre commissioning safety audits and annual internal safety audits.

**4.17. Cyber Security Risks**

4.17.1. In dealing with cyber security, threats to Operational technologies (OT) are most critical from safety point of view. To protect OT systems against cyber security risks-

- a) Organisations to carry out detailed system audit of complete IT/OT systems through agencies having expertise in this area and should have a process in place for periodic audits to identify new vulnerabilities.
- b) Organisations need to have comprehensive strategies for confronting known and unknown threats with a focus on mitigating the impact of breaches that have succeeded in evading security controls.
- c) In Oil and Gas Industry, traditionally different groups manage IT and OT systems. While OT systems are generally managed by specialised group associated with plant maintenance departments, IT systems are managed by the IT department. With the increasing convergence of IT and OT systems, ‘air gap’ and the exclusivity of attack points have vanished. It is therefore suggested that the organisation review the structure to consider centralised management of security administration for IT and OT systems with right skill set to have a holistic approach and response.



# SCOPE - 1



**Review of Safety System followed by Oil and Gas Industry and responses required in any emergency considering latest technological development**



# Section - 1 A

## Introduction and current safety systems & regulatory mechanism in Indian Oil and Gas Sector



## Report of the Working Group on Safety in Indian Petroleum Sector

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### 1.0 INTRODUCTION

#### 1.1. BACKGROUND

- 1.1.1. Standing Committee on Petroleum & Natural Gas submitted the thirteenth report on the subject 'Safety and Security of oil Installations of public sector oil companies - with specific reference to a western offshore mishap during cyclone Tauktae'. The Report was considered and adopted by the Standing Committee on Petroleum and Natural Gas on 04.04.2022.
- 1.1.2. The Committee, in its report, noted that the Oil and Natural Gas Industry handles highly inflammable hydrocarbons and processes them under high temperature and pressure. Any accident in Petroleum and Natural Gas Industry can cause serious outcomes like loss of lives, disruption of activities and huge destruction of economic value and also damage the local environment. Hence, the Committee observed that Safety in the petroleum sector is of utmost importance.
- 1.1.3. The Committee noted that many accidents happened in the oil and gas sector in the last several years including cyclone Tauktae, in May 2021, in which 86 lives were lost. Similarly, the oil well blowout of Oil India Limited in Baghjan, Assam in 2020, the GAIL pipeline blast at Andhra Pradesh in 2014 and the Jaipur incident of IOCL in 2009 etc., were some of the serious incidents in the petroleum industry in the country.
- 1.1.4. The Standing Committee in its report, amongst other recommendations, has recommended for constitution of a Working Group comprising industry professionals, legal experts, academics, etc. to look into the whole gamut of the safety framework and suggest necessary changes for the petroleum sector in the country.

#### 1.2. FORMATION OF WORKING GROUP

- 1.2.1. In pursuance of the recommendations contained in the Report of the High-Level Committee constituted to inquire into the sequence of events leading to the stranding of ONGC vessels in the Cyclone "Tauktae" and Thirteenth Report of the Standing Committee on Petroleum & Natural Gas on "Safety and Security of Oil Installations of Public Sector Oil Companies with specific reference to Western Offshore Mishap during Cyclone Tauktae", Ministry of Petroleum and Natural Gas (MoPNG) vide ref. File No. Expl-12031(11)/4/2022-EXPL-II-PNG (E-43727) dated 18<sup>th</sup> August 2022 (copy placed at Annexure 1.0), constituted a Working Group to look into the whole gamut of safety framework and suggest necessary changes for the petroleum sector in the country.

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1.2.2. The scope of the working group is stated in the above referred letter of MoPNG as follows:

- i. Review safety systems followed by the oil and gas industry and responses required in any emergency situation by the companies concerned considering the latest technological developments.
- ii. Identify gaps in extant laws including enforcement and accountability.
- iii. Recommend way forward to establish a single safety regulator for the petroleum sector.

1.2.3. The working group comprised the following members:

| S. No. | Sector             | Name (Sh.)                  | Designation & Organisation                         | Position             | Area of Operations     |
|--------|--------------------|-----------------------------|--|----------------------|------------------------|
| 1      | Industry           | M.K. Surana                 | CEO, RRPCL & Ex-C & MD, HPCL                       | Chairperson          | Downstream             |
| 2      |                    | T.K. Sengupta*              | Director, FIPI & Ex-Director, ONGC                 | Member               | Upstream               |
| 3      |                    | Arun Mittal                 | ED, OISD   | Member               | Common                 |
| 4      |                    | Badal Roy                   | Chief Safety Advisor, DGH & Ex. ED, ONGC           | Member               | Upstream               |
| 5      |                    | Anuj Jain                   | ED – LPG & Pipeline, HPCL                          | Member               | Downstream (Pipeline)  |
| 6      |                    | C Mathavan*                 | ED – Asset Manager, ONGC, Mumbai High Asset        | Member               | Upstream (offshore)    |
| 7      |                    | Ranjan Mehrotra             | ED (HSE) – Corporate Office, IOCL                  | Member               | Downstream (Marketing) |
| 8      |                    | Goutom Chakraborty*         | ED – CGD & Renewable, GAIL                         | Member               | Midstream (CGD)        |
| 9      |                    | Ajay Dixit                  | ED – Chief HSE, ONGC                               | Member               | Upstream               |
| 10     |                    | Rajiv Kacker                | ED – Projects, IOCL                                | Member               | Downstream (Refinery)  |
| 11     |                    | Sanjeev Raina               | CGM – Corporate HSSE, BPCL                         | Member               | Downstream (Marketing) |
| 12     |                    | S.C. Gupta*                 | Head – Technical, PNGRB                            | Member               | Common                 |
| 13     |                    | Pratim Sarma*               | Director – P & E, OISD                             | Member – Coordinator | Downstream (Refinery)  |
| 14     | Shipping           | Captain Vikram Singh Manhas | Nautical Surveyor cum DDG (Technical), DG Shipping | Member               | Shipping               |
| 15     | Industry - Private | Y.K. Lodha                  | Head – Group, S & OR, RIL                          | Member               | Downstream (Refinery)  |
| 16     |                    | Brennan S Punnappully*      | Cairn Oil & Gas, Vedanta Limited                   | Member               | Upstream               |

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|    |          |                                  |   |        |            |
|----|----------|----------------------------------|---|--------|------------|
| 17 | Legal    | Iyer Narayanan<br>H              | ED – Legal, HPCL                                | Member | Downstream |
| 18 |          | Amit Jindal                      | HOD – Legal, DGH                                | Member | Upstream   |
| 19 | Academic | Moreshwar<br>Kudkilwar           | Dy. Fire Advisor,<br>O/o DG (FS, CD & HG)       | Member | -          |
| 20 |          | Gagan<br>Upadhyay<br>(Alternate) | Asst. Director - NFSC,<br>Nagpur                | Member | -          |
| 21 |          | Prof. Keka Ojha                  | Dept. of Petroleum Engg.<br>IIT, (ISM), Dhanbad | Member | -          |
| 22 |          | Prof. G.D. Yadav<br>(Padmashree) | Institute of Chemical Tech,<br>Mumbai.          | Member | -          |

*\* Since the formation of working group, Sh. C Mathavan and Sh. S C Gupta have been redesignated; Sh. Goutam Chakraborty has been deputed to subsidiary of GAIL; Sh. Pratim Sarma and Sh. T K Sengupta have completed their tenure in the respective organization and Sh. Brennan S Punnapully has separated from Cairn, Vedanta. All these members were actively involved in the deliberations of the working group till the completion of the report.*

1.2.4. This report dwells on the observations of the Working Group on the safety framework and the safety systems in the petroleum sector in India, key challenges, emergency situations and recommendations. An effort has also been made to identify critical gaps related to safety in extant laws including enforcement, accountability and amendments required, if any. The report further provides a possible road map to move towards a single regulator.

**1.3. METHODOLOGY ADOPTED**

1.3.1. Considering the objective, scope and time available for the study, the Working Group invited the major oil and gas organisations, operating in India, to present the safety systems currently followed by them, uniqueness, best practices, gaps and pain areas and new systems/ technologies/ ideas implemented by them for improvement of safety. To have an outside-in approach, inputs were invited from some of the international technology providers and knowledge resource organisations operating in this field. References were drawn from the observations and recommendations of high-level investigation committees for major incidents, root cause analysis of incidents that took place in the last 5 years in the Indian petroleum industry, observations made in Standing Committee & Safety Council meetings, observations during OISD external safety audits, organization audits, incident investigations etc. as provided by OISD. Reference was also drawn from recommendations in some of the panel reports of major incidents overseas and international standards. The Working Group made field visits to representative upstream and downstream installations to have inputs on the extant safety systems and their effectiveness in real time. All the inputs so gathered were deliberated in detail in domain specific focus groups followed by discussions in the full Working Group meetings to identify critical focus areas and finalise the recommendations.

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1.3.2. The Working Group received presentations from the following major oil and gas companies (in the public and private sectors) operating in the Upstream, Midstream and Downstream sectors in India.

- a) **Companies engaged in Exploration and Production business** – M/s Oil and Natural Gas Corporation Ltd (ONGC), M/s Oil India Ltd, M/s Cairn Energy Ltd (Vedanta), M/s Reliance Industries Ltd (Upstream)
- b) **Companies engaged in Refining and Marketing business**- M/s Indian Oil Corporation Ltd (IOCL), M/s Bharat Petroleum Corporation Ltd (BPCL), M/s Hindustan Petroleum Corporation Ltd (HPCL), M/s Reliance Industries Ltd (Downstream), M/s Nayara Energy Ltd
- c) **Companies engaged in LNG and Natural Gas business** – M/s GAIL (India) Ltd, M/s Petronet LNG Ltd, M/s Shell India Ltd, M/s Indraprastha Gas Ltd (IGL)
- d) **Companies engaged in Engineering and Project Management Consulting business** – M/s Engineers India Ltd

1.3.3. Presentations were received from the following international consulting and knowledge resource organisations on current trends, international best practices and benchmarking for safety:

- a) **M/s DSS+ (Dupont)**
- b) **M/s DNV**

1.3.4. Presentations were received from the following international organisations on the application of new age technologies for safety improvements:

- a) **M/s Honeywell**
- b) **M/s Accenture**
- c) **M/s Tata Consulting Engineers Ltd. (TCE) & M/s Falck Fire Consulting Limited, UK on Emergency Response Centre (ERC)**

1.3.5. In addition to the above, presentations were also received from:

- a) **Advisor (Env) IPA, representing MoPS&W on Regional Oil Spill Response Centre (ROSRC)**
- b) **Audit Team Leader/OISD on Organisational audit outcome**
- c) **OISD on extant safety management system, current regulations & regulators, major onsite accidents with root cause analysis for last five years, HSE issues, gaps in extant laws. OISD also briefed the Working Group about the proposal in 2013 to set up the 'Petroleum & Natural Gas Industry Safety Board' (PNGISB) which was not proceeded with after detailed deliberations in the Group of Secretaries of the concerned ministries.**
- d) **OISD / GAIL on safety issues related to the use of Hydrogen.**

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1.3.6. Working Group made field visits to -

- a) **BPCL's Mumbai Refinery and its AR/VR learning centre at Refinery**
- b) **ONGC's Mumbai High offshore platform in Western Offshore**
- c) **A representative charter rig operating for ONGC in the Western Offshore area.**
- d) **Vehicle & Air Traffic Monitoring System (VATMS) at the Mumbai office of ONGC.**

1.3.7. Brainstorming sessions were held in two major groups - one focused on upstream and the other on downstream/midstream, which was followed by a series of deliberations in meetings of the full working group held through physical and virtual modes.

1.3.8. In addition to the presentations and the inputs received from the various organisations, the Working Group had the benefit of insights and vast first-hand experience of the individual members who were part of the Working Group in different areas of the oil and gas business. Deliberations were further enriched by inputs of other senior officers handling safety critical roles in respective organisations.

### 1.4. COVERAGE

1.4.1. Working group has reviewed the extant safety systems pertaining to the following areas:

#### a) Upstream

- i. Exploration & Production (E&P) - Onshore
- ii. Exploration & Production (E&P) – Offshore covering Process Complex, Platform, Rigs, Vessels, Helicopters
- iii. Offshore Pipelines

#### b) Midstream and Downstream

- i. Refineries and associated Petrochemical complex
- ii. Crude Oil receipt facilities & SPM (Single Point Mooring)
- iii. Gas Processing Plants
- iv. Marketing Installations covering POL (Petroleum, Oil and Lubricants) Terminals/ Depots, LPG Bottling Plants , Aviation Fuelling Stations (AFS), Import Facilities for petroleum products, Lube Blending Plants
- v. Cross country pipelines for POL, LPG, Natural Gas, Crude oil
- vi. Retail Fuel Stations
- vii. POL and LPG transportation by road, rail, ships
- viii. LNG Terminals
- ix. City Gas Distribution
- x. Storage Caverns for Crude and LPG
- xi. EV Charging
- xii. Use of Hydrogen

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### 1.5. LIMITATION AND QUALIFICATION

- 1.5.1. The scope of the working group was focused on safety and therefore the report does not deal with any environmental or general location security issues unless the same has a safety angle.
- 1.5.2. Petroleum industry handles material, which is inflammable and has inherent associated risks. However, the degree of complexity, criticality, risk probability and impact vary across different segments of the business. Hence, even similar solutions may have varying implementation intensity across different segments.
- 1.5.3. Wherever any Act, Rules or Regulation is mentioned in the report, it would interalia include the subsequent amendments thereof.
- 1.5.4. For upstream operations or common user facilities with unincorporated JV structure, the company entrusted with the responsibility of operation/ maintenance of the facility (generally called 'Operator') will be discharging the primary responsibilities related to safety aspects of the installation/ location unless specifically defined otherwise.
- 1.5.5. The mandate of the working group was an overall review of safety systems in the Indian Petroleum industry and not an investigation of any particular incident or safety audit of a particular organization. Considering the objective, time available for the review and the vastness of the subject, the group has relied on dipstick checks, inputs from the organisations, enquiries made, investigation reports of past incidents, observations during OISD external audits, the experience of the working group members & other officers of the organisations and the field visit to representative locations, to identify critical issues. It is clarified that though the Working Group has made field visits to representative locations to understand the issues and the effectiveness of the safety systems, these were not intended to carry out safety audits of the visited locations/organisations.
- 1.5.6. It is well appreciated and recognized that the organisations, employees and the management have all the intentions not to have any safety related incidents or violations. Organisations do take efforts to institute systems, install hardware, establish protocols and Standard Operating Procedures (SOPs), impart training and try to instill safety discipline. However, incidents do happen. The purpose of any such industry Working Group is to review and identify areas that can bring further improvements. It is, therefore, possible that areas for improvement get more prominence in the report than the areas of existing strengths. It is not to undermine the efforts already being put in by individual organisations for the improvement of safety.

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- 1.5.7. Though the observations are made with specific inputs and after detailed deliberations, the report generally avoids naming any organization, unless absolutely necessary for the context, in the spirit of the deliberations and objective of the review.
- 1.5.8. Safety invariably has a human angle and therefore a constantly evolving process. Every new incident may challenge the comprehensiveness of the earlier reviews. While this report makes a sincere effort to contribute towards making the industry safer, it may also suffer the same deficiency in future.
- 1.5.9. Oil and Gas Installations in India have evolved and grown over a period of time through various brownfield and green field expansions/ revamps and have different vintage in terms of technology and plant age profile. It leads to varying degrees of vulnerabilities as far as asset integrity is concerned. Working Group is inclined to believe that all oil and gas organisations are inherently obliged to take necessary timely actions to ensure the asset integrity of the systems and the associated hardware irrespective of the date of original installation, by timely interventions for repairs, replacements and upgrades depending on the segmental needs.
- 1.5.10. This report is a review report and is not to be construed as a certification report by any agency or organization for any legal or evidence purposes.

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**2.0 CURRENT SAFETY SYSTEMS AND REGULATORY MECHANISM**

**2.1. OIL AND GAS INFRASTRUCTURE IN INDIA<sup>1</sup>**

- 2.1.1. Over the years Indian Oil and Gas sector has seen multifold growth fueled by economic development, consumption growth, refining capabilities and availability of skilled manpower. India is the third largest consumer of petroleum products, the third largest importer of crude oil and the fourth largest importer of LNG in the world.
- 2.1.2. As of 01.06.2023, India has 23 operating refineries with an installed capacity of 253.9 MMTPA (5.02 mbpd). Out of this, 19 refineries with an installed capacity of 154.4 MMTPA are under the public sector and the remaining 4 refineries with an installed capacity of 99.5 MMTPA are under the private sector/ Joint ventures. Further additional refining capacity will be added in the near future in view of greenfield and brownfield expansion projects currently under implementation by various companies.
- 2.1.3. The cross-country pipeline network in India comprises 10,420 km (147.9 MMTPA capacity) of crude oil pipelines and 22,618 km (140.6 MMTPA capacity) of product pipelines. Common career natural gas pipeline network comprises 21,921 km of operational pipelines and a further 12,002 km of pipelines under construction.
- 2.1.4. There are 16 Gas processing plants and 6 LNG (Liquefied Natural Gas) gasification terminals. The current installed capacity of LNG terminals is 42.7 MMTPA.
- 2.1.5. Marketing infrastructure includes 310 POL terminals and depots, 283 Aviation Fuel stations, 87,093 Retail Outlets. There are 4,952 stations with CNG/LNG facilities and 8,853 stations with EV charging facilities as of 01.06.2023.
- 2.1.6. Marketing infrastructure also includes 208 LPG Bottling plants of PSUs (22,225 TMTA capacity) and 25,392 LPG Distributors of PSUs with 31.5 crore active domestic LPG consumers. In addition, there are certain private bottlers, who works for Oil Marketing Companies as of 01.06.2023.
- 2.1.7. The refineries currently in operation in India along with the location map are placed in Annexure 2.1 and Annexure 2.2. The pipeline map of India is placed in Annexure 2.3.
- 2.1.8. In the upstream sector, there are a total of 336 installations in offshore areas and 609 installations in onshore areas. During 2022-23, domestic production in India included 29.2 MMT (0.59 mbpd) of crude oil including condensate and 34,450 MMSCM of natural gas. Total consumption of petroleum products in 2022-23 was 222.3 MMT and of natural gas was 60,311 MMSCM. India imported 232.6 MMT of crude oil and 26,647 MMSCM of LNG to meet its requirements.

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<sup>1</sup> Source: PPAC Snapshot of India's Oil and Gas Data Monthly Ready Reckoner, May 2023

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### 2.2. HYDROCARBON BUSINESS PROCESS FLOW

- 2.2.1. Crude oil/ Natural Gas is produced by drilling the oil/ gas reservoirs, onshore as well as offshore, thousands of meters below the surface of the earth or below the seabed with the help of Rigs. Oil/ gas produced from wells is fed to Crude Oil or Natural Gas pipelines from processing stations for further use. Oil produced from oil wells domestically or imported from other countries through Large Crude Carriers is transported to refineries through subsea and onland pipelines. At refineries, the crude oil is converted into various petroleum products through a series of complex processes operating at varying temperatures and pressures including in the presence of catalysts/ chemicals.
- 2.2.2. Various petroleum products produced at refineries are transported across the length and breadth of the country through a multimodal transport system, which includes cross country pipelines, ships, rail wagons and tank trucks.
- 2.2.3. Transportation fuels (Petrol and Diesel) transported from refineries to terminals/ depots are then delivered to a network of Retail Fuel Stations for fueling consumers vehicles.
- 2.2.4. LPG from refineries, processing plants or imported through large gas carriers is transported to LPG bottling plants by cross country pipelines, rail wagons or tank trucks. At bottling plants, LPG is bottled in LPG cylinders. LPG Cylinders are delivered to various end consumers through a network of LPG distributors.
- 2.2.5. Oil installations carry a large inventory of hydrocarbons in the form of crude oil, intermediate products and finished petroleum products. Each stage of production, processing, storage and transportation of petroleum products has its own safety challenges and are required to be dealt with through a combination of inbuilt design features and controls, advance automation, operational discipline, standard operating procedures, trained human resources, forewarning devices, logic controllers, emergency shutdown systems and emergency response mechanisms.

### 2.3. ACTS/ RULES/ REGULATIONS CURRENTLY APPLICABLE TO THE OIL AND GAS INDUSTRY IN INDIA

- 2.3.1. Various acts, rules and regulations generally applicable to the petroleum sector in India include the following:
  - a) **The Petroleum Act, 1934** - *An Act to consolidate and amend the law relating to the import, transport, storage, production, refining and blending of petroleum. The Petroleum Rules, 2002 and Calcium Carbide Rules, 1987 are the rules under the Act applicable to the oil & gas industry.*
  - b) **The Explosives Act, 1884** - *An Act to regulate the manufacture, possession, use, sale, transport, import and export of Explosives.*

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*The Explosives Rules, 2008; Static and Mobile Pressure Vessels (unfired) Rules, 2016; Gas Cylinders Rules, 2016 and Ammonium Nitrate Rules, 2012 are the rules under the Act applicable to the oil & gas industry.*

- c) **The Factories Act, 1948** - *An Act to consolidate and amend the law regulating labour and safety in factories. This Act is applicable to the entire oil & gas sector, except that portion of upstream sector, which is covered under the Mines Act 1952.*

*Factory Rules of respective States regulate oil & gas installations regarding labour and safety (except upstream)*

- d) **The Mines Act, 1952** - *An Act to amend and consolidate the law relating to the regulation of labour and safety in mines. This Act is applicable to the upstream sector (onshore).*

*Mines Rules, 1955; Oil Mines Regulations, 2017 and Mines Vocational Training Rules, 1966 are the rules & regulations applicable to upstream (onshore) installations.*

- e) **The Oilfields (Regulation and Development) Act, 1948** - *An Act to provide for the regulation of oilfields and for the development of mineral oil resources.*

*The Petroleum and Natural Gas (Safety in Offshore Operations) Rules, 2008 is the rule under the Act covering the safety of offshore upstream operations.*

- f) **Petroleum and Minerals Pipeline (Acquisition of Right of User in Land) Act, 1962** - *An Act to provide for the acquisition of the right of user in land for laying pipelines for the transport of petroleum and minerals and for matters connected therewith.*

- g) **Petroleum and Natural Gas Regulatory Board Act, 2006** – *An Act to provide for the establishment of the Petroleum and Natural Gas Regulatory Board to regulate the refining, processing, storage, transportation, distribution, marketing and sale of petroleum, petroleum products and natural gas excluding production of crude oil and natural gas so as to protect the interests of consumers and entities.*

*Regulations applicable under this act include The Petroleum and Natural Gas Regulatory Board (Code of Practices for Emergency Response and Disaster Management Plan (ERDMP)) Regulations, 2010 and various Technical Standards and Specifications including Safety Standards (T4S) under the Act covering safety in midstream & downstream sector (list of T4S regulations placed at Annexure 2.4).*

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- h) The Electricity Act, 2003** - An Act to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity and generally for taking measures conducive to development of electricity industry, promoting competition therein, protecting interest of consumers and supply of electricity to all areas, rationalisation of electricity tariff, ensuring transparent policies regarding subsidies, promotion of efficient and environmentally benign policies, constitution of Central Electricity Authority, Regulatory Commissions and establishment of Appellate Tribunal and for matters connected therewith or incidental thereto.

*The Central Electricity Authority (Measures Relating to Safety & Electricity Supply) Regulations, 2023 and The Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Electric Plants and Electric Lines) Regulations, 2011 are the regulations under the Act on electrical safety.*

- i) The Disaster Management Act, 2005** - An Act to provide for the effective management of disasters and for matters connected therewith or incident thereto.

*National Policy on Disaster Management (NPDM) 2009 was formulated as an institutional framework under this Act with the objective of ensuring an efficient and effective mechanism for identification, assessment, prevention, preparedness and resilience at all levels for disaster risks.*

- j) The Environment (Protection) Act, 1986** – An act to provide for the protection and improvement of the environment and for the matters connected therewith.

*Rules applicable to Oil and Gas Industry under this act include:*

- i. The Manufacture, Storage & Import of Hazardous Chemical Rules 1989*
- ii. The Chemical Accidents (Emergency Planning, Preparedness & Response) Rules 1996*
- iii. Environment (Protection Second Amendment Rules) 2002 for DG Set*
- iv. The Noise Pollution (Regulation & Control) Rules 2000*
- v. Hazardous and Other Waste (Management and Transboundary Movement) Rules 2016*
- vi. The Bio Medical Waste Management Rules, 2016*
- vii. The Battery (Management and Handling) Rules 2022*
- viii. The E Waste (Management and Handling) Rules, 2022*
- ix. The Plastic Waste Management Rules 2016*
- x. Construction and Demolition Waste Management Rules 2016*
- xi. Solid Waste Management Rules, 2016*
- xii. Notification on Coastal Regulation Zone 2019*

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**k) The Air (Prevention & Control of Pollution) Act 1981**

*The Air (Prevention & Control of Pollution) Act 1981 - An Act to provide for the prevention, control and abatement of air pollution, for the establishment, with a view to carrying out the aforesaid purposes, of Boards, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith.*

- i. National Ambient Air Quality Standards Notification November 2009*
- ii. Modified Directions under the Air (Prevention & Control of Pollution) Act, as may be issued from time to time.*

**l) The Water (Prevention & Control of Pollution) Act 1974**

*An Act to provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water, for the establishment, with a view to carrying out the purposes aforesaid, of Boards for the prevention and control of water pollution, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith.*

- i. Modified Directions under the Water (Prevention & Control of Pollution) Act, as may be issued from time to time.*

**m) The Motor Vehicles Act, 1988 - An Act to consolidate and amend the law relating to motor vehicles.**

*The Motor Vehicles (Driving) Regulations 2017, Central Motor Vehicle Rules 1989 and Motor Vehicles Rules of respective States are applicable rules under this act.*

**n) The Indian Boiler Act 1923 and The Indian Boilers Regulations 1950**

*The Indian Boilers Act, 1923 was enacted with the objective to provide mainly for the safety of life and property of persons from the danger of explosions of steam boilers and for achieving uniformity in registration and inspection during operation and maintenance of boilers in India. Provision under Indian Boiler Act are applicable to Oil & Gas Industry also wherever boilers or steam is used.*

**o) Other Applicable Acts/ Rules/ Regulations/ Code/ Notification - In addition to the above, other acts which are relevant to safety in the Oil and Gas Industry include:**

- i. The Inflammable Substances Act, 1952*
- ii. Aircraft Act 1934 & Aircraft Rules, 1937*
- iii. UAS (Unmanned Aircraft system) Rules/ Drone Rules, 2021*
- iv. Forest Conservation Act, 1980 and Forest (Conservation) Rules, 2022*
- v. Wildlife Protection Act, 1972*
- vi. Forest Rights Act, 2006*

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- vii. *Merchant Shipping Act 1958*
  - viii. *Public Liability Insurance Act 1991 and the Public Liability Insurance Rules, 1991*
  - ix. *Employees' State Insurance Act, 1948*
  - x. *Contract Labour (Regulation & Abolition) Act, 1970*
  - xi. *The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996*
  - xii. *Shop and Establishment Acts of the respective states*
  - xiii. *Energy Conservation Act, 2001*
  - xiv. *National Building Code, 2016*
- p) **OISD Standards** – OISD so far has published 118 Standards (including recommended practices and guideline) covering various safety aspects of the Oil and Gas Business. Out of these, 6 standards are included in Petroleum Rules 2002, 2 standards in Gas Cylinder Rules 2016, 1 standard in Static and Mobile Pressure Vessels (Unfired) Rules 2016, 16 standards in Oil Mines Regulations 2017 and 5 standards in the PNGRB Regulations and take a statutory nature. However, oil and gas companies in India generally follow the standards published by OISD. The list of OISD standards is placed in Annexure 2.5.

2.3.2. **'The Occupational Safety, Health and Working Conditions Code, 2020'** - A new Act called *'The Occupational Safety, Health and Working Conditions Code, 2020'* was notified on 29th September 2020. This code envisages repealing 13 extant Acts including the Factory Act 1948 and the Mines Act 1952 related to safety in the oil and gas industry. It shall come into force on such date as the Central Government may, by notification appoint; and different dates may be appointed for different provisions of this code and any reference in any such provision to the commencement of this code shall be construed as a reference to the coming into force of that provision. Presently, Rules under this Act are in the draft stage.

## **2.4. MAJOR REGULATING AUTHORITIES**

2.4.1. Presently, the critical aspect of managing safety in the Petroleum & Natural Gas Industry of India is overseen by a number of authorities of various statures - both statutory and administrative, operating simultaneously in framing safety regulations and implementation thereof. Major agencies involved in regulating the safety framework for Oil and Gas sector in India include the following:

### **a) Petroleum & Explosives Safety Organization (PESO)**

The Petroleum and Explosives Safety Organization (PESO), formerly known as the Department of Explosives, was established on 05/09/1898, and works as a nodal agency for regulating the safety of hazardous substances such as explosives, compressed gas and petroleum. PESO's major work is to administer the responsibilities delegated under the Explosives Act 1884 and Petroleum Act 1934 and the Rules made thereunder related to the manufacture, import, export,

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transport, possession, sale and use of Explosives, Petroleum products and Compressed Gases. The administrative ministry for PESO is the Department for Promotion of Industry and Internal Trade (DPIIT) under the Ministry of Commerce and Industry.

### **b) Directorate General of Mines Safety (DGMS)**

DGMS is the regulatory agency under the Ministry of Labour and Employment in matters pertaining to occupational safety, health and welfare of persons employed in oil mines under the Mines Act, 1952 and the Rules and Regulations framed there under. Apart from administering the Mines Act and the subordinate legislation there under, DGMS also administers the Indian Electricity Act in the upstream (onshore) sector. The organization has its headquarters at Dhanbad (Jharkhand) and is headed by the Director General of Mines Safety.

### **c) Petroleum and Natural Gas Regulatory Board (PNGRB)**

The Petroleum and Natural Gas Regulatory Board (PNGRB) was constituted under The Petroleum and Natural Gas Regulatory Board Act, 2006 (No. 19 of 2006) notified via Gazette Notification dated 31<sup>st</sup> March 2006. It was established to protect the interests of consumers and entities engaged in specified activities relating to petroleum, petroleum products and natural gas and to promote competitive markets and for matters connected therewith or incidental thereto.

Further, the Board has also been mandated to regulate the refining, processing, storage, transportation, distribution, marketing and sale of petroleum, petroleum products and natural gas excluding the production of crude oil and natural gas so as to ensure uninterrupted and adequate supply of petroleum, petroleum products and natural gas in all parts of the country. PNGRB has also published Technical Standards and Specifications including Safety Standards (T4S) which are applicable to Oil and Gas Industry.

### **d) Oil Industry Safety Directorate (OISD)**

The Oil Industry Safety Directorate (OISD), a technical directorate under the aegis of MoPNG, was formed in 1986 by a resolution of the Government with an objective to formulate and standardize procedures and guidelines in the areas of design, operation and maintenance as also the creation of new safety standards. It also coordinates the implementation of a series of self-regulatory measures aimed at enhancing the safety of the Oil and Gas Industry in India. OISD is manned by a group of technical experts drawn from the Oil & Gas industry in the area of design, operation, maintenance, inspection, safety, environment etc. So far, OISD has published 118 standards covering various sectors of the Oil and Gas business.

Petroleum & Natural Gas (Safety in Offshore Operations) Rules, 2008 were notified in the Gazette of India to regulate safety in offshore oil and gas exploration, drilling, production and related activities; and OISD was designated as Competent Authority to exercise the powers and functions as stipulated in these rules, 2008 vide Gazette notification issued in June' 2008. Under the provisions of these Rules, OISD accords consent for the operation of E&P offshore installations.

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### **e) Safety Council**

To ensure proper implementation of various aspects of safety in the oil & gas industry, the Government of India, vide Resolution No. R-13013/4/84-OR-1 dated 10<sup>th</sup> January 1986 set up a Safety Council at the apex, under the administrative control of the Ministry of Petroleum & Natural Gas (MoPNG).

Safety Council is headed by Secretary MoPNG as Chairman & includes members comprising Additional Secretaries, Joint Secretaries, Chief Executives of all Public Sector Undertakings, at least two Chief Executives from Private/ JV Companies on rotational basis, Statutory bodies such as Chief Controller of Explosives, Director General of Mines Safety, Adviser (Fire), Secretary Central Electricity Board and Director General of Factory Advice Service and Labour Institutes. Executive Director-OISD acts as the member secretary of the Safety Council and assists the Safety Council.

To review the Safety performance of the Industry, the Safety Council meets at least once in a year and the last meeting of the council i.e., the 40<sup>th</sup> Safety Council meeting was held on 30<sup>th</sup> June 2023.

### **f) Inspectorate of Factories**

States have a Chief Inspector of Factories to look after the implementation of provisions of the Factories Act, 1948. The Chief Inspector of Factories, who is also called Director of Factories or Director of Industrial Safety & Health (DISH) in some States, is assisted by Inspectors of Factories. Primarily their responsibility and authority, as stipulated under the Act, is to see that the occupational health interests of the labour employed in the industrial sector are not jeopardised. Provisions of the Factories Act are applicable to Oil and gas Sector (except upstream) like any other industrial sector employing labour.

### **g) Inspectorate of Boilers (IBR)**

Under the provisions of Indian Boilers Regulations 1950, the Inspector of Boiler has overall responsibility and authority, in states and Union Territories to oversee safe installation, operation and testing of high-pressure boilers in the industries. Provision of the Indian Boiler Act, 1923 and Regulation thereunder are applicable to Oil and Gas Industry wherever boilers are installed, or steam is used.

### **h) Central Electricity Authority (CEA)**

The agency looks after the enforcement of directions and procedures as per the provisions of the CEA Regulations. Provisions of the Indian Electricity Act, 2003 and Regulations thereunder are applicable to Oil and Gas Industry, wherever electrical systems are installed.

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### i) Central and State Pollution Control Boards

Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) have a responsibility to look after the implementation of regulations in respect of the prevention, control and abatement of environmental pollution. These Boards have been empowered to oversee compliance with the Rules pertaining to the import of hazardous and toxic chemicals, which includes hydrocarbon. Approval of SPCB is required for setting up new facilities and starting operations of the same. They also regularly monitor the emissions in the air, effluent discharge from the installations and storage/movement of hazardous waste/ materials.

### j) Other Agencies

Apart from the above, the offshore vessels are required to have all applicable certificates and licenses. In addition, there are other agencies whose approval/ NOC is required for construction and operation of Oil and Gas facilities. For example:

- Specified Period License (SPL) from the Director General of Shipping (DGS) for foreign flag vessels including rigs and barges for operation in offshore.
- Approval of Director General of Civil Aviation (DGCA) for helicopter services in offshore and for elevated structures like flares, tall columns/vessels etc.
- Approval of State Maritime Boards for construction and operation of jetties/ SPM and other marine facilities
- NOC from District Collector for setting up of Refinery/ POL depots/terminals/ LPG bottling plants /Retail Outlets etc.
- NOC from Gram Panchayat/ Urban local body for setting up LPG cylinder godowns etc.
- Environment Clearance from the Ministry of Environment, Forest and Climate Change (MoEFCC) for Category 'A' Projects and from State Environment Impact Assessment Authority (SEIAA) for Category 'B' Projects as per the requirements/ Schedule of EIA notification S.O. 1533 dt. 14<sup>th</sup> September 2006.
- Clearance from Forest Department, Coastal Zone Management Authority, Railways, Highways Authorities, Archaeological Department, Wildlife Department, Fisheries Department and Defence establishments etc, wherever required.

2.4.2. Ministry of Petroleum and Natural Gas (MoPNG) also regularly monitors and reviews various safety issues in the Oil & gas Sector and directs the Oil and Gas companies from time to time to take suitable measures to ensure the safety of these vital installations. Necessary changes in statutes, rules and regulations are made from time to time so that the legislations enforcing these measures are in tune with the business requirements and are strengthened to enhance the level of safety in the Oil and Gas Industry.

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2.5. REGULATORY FRAMEWORK FOR DIFFERENT SEGMENTS OF THE OIL AND GAS INDUSTRY IN INDIA

2.5.1. The regulatory framework as applicable currently to various segments of the Oil and Gas business is given in Table 2.1 below and further elaborated in the subsequent paras:

Table 2.1 Summary of Regulatory Mechanism in the Indian Oil and Gas Industry

| Industry Segment Category                           | Industry Segment   | Concerned Ministry   | Concerned Acts                                    | Concerned Rules/ Regulations   | Statutory Authority   |
|---|--|--|---|--|---|
| Upstream Sector<br>Exploration and Production (E&P) | Onshore  | Ministry of Labor & Employment   | Mines Act, 1952                                   | Mines Rules 1955, Oil Mines Regulations 2017, Mines Vocational Training Rules 1966   | Directorate General of Mines Safety (DGMS)                                      |
| Exploration and Production (E&P)                    | Offshore   | Ministry of Petroleum & Natural Gas  | Oil fields (Regulation and Development) Act, 1948 | Petroleum & Natural Gas (Safety in Offshore Operations) Rules, 2008                  | Oil Industry Safety Directorate (OISD)- Competent Authority                     |
| Downstream and Mid-Stream Sector                    | a) Refining of Crude Oil (Refineries)  | Department for Promotion of Industry and Internal Trade (DPIIT), Ministry of Commerce & Industry | Petroleum Act, 1934                               | Petroleum Rules, 2002<br>Explosive Rules 2008  | Petroleum & Explosive safety organisation (PESO)                                |
|   | b) Processing of Natural Gas (Gas Processing Plants)   |  | Explosives Act, 1884                              | Static and Mobile Pressure Vessels (Unfired) Rules, 2016<br>Gas Cylinder Rules, 2016 |   |
|   | c) Storage and transportation of crude oil, petroleum products, natural gas and LNG (POL Terminals/ POL Depots /Cross Country Pipelines / LPG Bottling Plants/ AFSs/ LNG | Ministry of Labor & Employment   | Factories Act 1948                                | Factories Rules promulgated by the respective  | Chief Inspector of Factories or Director of Factories or Director of Industrial |

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|   |  |  |  |  |
|---|--|--|--|--|
| Terminals, Crude & LPG Caverns etc.)<br><br>d) Marketing of petroleum products, Natural Gas and LNG (Retail –Outlets, LPG cylinder warehouses/ /CNG & LNG Stations etc.)<br><br>e) Manufacturing of Lubricating Oils, Greases and Specialties |  |  | State Govts under this act   | Safety & Health (as may be named in the respective States) |
|   | Ministry of Petroleum & Natural Gas    | Petroleum & Natural Gas Regulatory Board Act, 2006 | PNGRB safety Regulations including various Technical Standards and Specifications including Safety Standards (T4S) | Petroleum & Natural Gas Regulatory Board (PNGRB)           |
|   | Ministry of Power                      | Electricity Act 2003                               | CEA Regulations 2023   | Central Electricity Authority (CEA)                        |
|   | DPIIT, Ministry of Commerce & Industry | Indian Boiler Act 1923                             | The Indian Boiler Regulations 1950   | Chief Inspectorate of Boilers                              |

In addition to the above -

1. *OISD, a technical directorate under MoPNG, carries out safety audits and accident investigations for oil and gas installations and also develops safety standards that are generally followed by the Indian Oil and Gas Industry*
2. *Other Statutory Authorities like Central Pollution Control Board (CPCB) and various State Pollution Control Boards (SPCBs) have the responsibility to look after the implementation of regulations in respect of prevention, control and abatement of environmental pollution thru respective Acts.*

2.5.2. The regulatory mechanism as applied to various segments of the Oil and Gas Industry is further elaborated below:

**a) Onshore Exploration, Development and Production**

Upstream activities in India are carried out under the Oilfields (Regulation and Development) Act 1948.

Under this act definition of ‘Mine’ include any excavation for the purpose of searching for or obtaining (mineral oils) and includes oil wells. By definition, mineral oils also include natural gas and petroleum. Consequently, the safety of oilfield operations in India is governed by the Mines Act 1952 which is an act to amend and consolidate the law relating to regulations of labour and safety in mines.

Oil Mines Regulations 1984 was superseded by Oil Mines Regulations 2017 by the Directorate General of Mines Safety (DGMS) in the exercise of powers conferred by the Mines Act, 1952 to deal with matters for the prevention of possible dangers in onshore oil mines in India. The statutory authority for the same is DGMS which is under the Ministry of Labour and Employment.

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In addition to the above, certain specific activities and facilities also come under the purview of other regulators like the Petroleum and Explosive Safety Organisation (PESO), Atomic Energy Regulatory Board (AERB) etc.

### **b) Offshore Exploration, Development and Production**

The jurisdiction of Mines Act 1952 and consequently Oil Mines Regulation 2017 is limited to activities within the Indian Territory. Hence, till June 2008, there were no clearly defined safety regulations for the Offshore Upstream Petroleum operations.

Ministry of Petroleum and Natural Gas, in June 2008, through a Gazette notification under the Oilfields (Regulation and Development) Act 1948 notified the Petroleum and Natural Gas (Safety in offshore operations) Rules 2008 for regulating safety in upstream offshore petroleum activities and designated Oil Industries Safety Directorate (OISD) as the competent authority to exercise powers and functions as stipulated in the said rules.

The scope of the above rule includes offshore installations, plants, associated pipelines, cables, and other equipment for petroleum activities, but does not include supply and support vessels or ships that transport petroleum in bulk, which are covered under shipping laws.

Operators involved in offshore upstream hydrocarbon operations have to obtain consent for operation for their facilities from OISD before the commencement of operation.

The Offshore mobile facilities like floating and jack-up rigs which are within the scope of Petroleum and Natural Gas (Safety in offshore operations) Rules 2008 have also to obtain clearance from the Indian Navy operating in Indian waters. In addition, in case of any foreign flag vessel it has to obtain Specified Period License (SPL) from the Directorate General of Shipping for operating in Indian waters.

### **c) Refineries**

In accordance with Petroleum Rules 2002, approval of the Chief Controller of Explosives is required for project report with specifications and plans showing the general arrangements of tanks, stills, furnaces, electrical installations, pump houses, arrangement for drainage, treatment and disposal of effluents, arrangement for fighting the fire, fencing gates and all plants and buildings at the place where it is proposed to refine, crack, reform or blend petroleum (refinery).

The refinery operations and facilities are regulated by the rules as defined under Petroleum Rules 2002 and amendments thereof. Other statutory rules such as Static and Mobile Pressure Vessel Rules 2016 and Explosive Rules prepared under Explosives Act 1884 are applicable depending on the type of facilities and products handled.

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OISD-STD-118 lays down minimum requirements within the plant boundary for petroleum refineries. OISD-STD-116 lays down requirements for Fire Protection Facilities for Petroleum Refineries and Oil/ Gas Processing Plants. Facility/equipment specific requirements are laid down in various other OISD Standards/Guidelines/ Recommended Practices.

In addition to the above, the operations and facilities at refineries are also governed by the Factory Act 1948; Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2023; Motor Vehicles Act 1988 with the Motor Vehicles (Driving) Regulations, 2017, Boiler Act 1923 and Indian Boiler Regulations, 1950. In addition, there are various environmental acts and rules governing this sector.

**d) POL Terminals/ Depots:**

License is obtained from the Chief Controller of Explosives under Petroleum Rules 2002 for storage of petroleum products. The operations and facilities at these installations are regulated by the rules as defined under Petroleum Rules 2002 and amendments thereof. The site layout and construction of the installation require to be approved by PESO.

PNGRB (Technical Standards and Specifications including Safety Standards for Petroleum Installations) Regulations, 2020 cover safety in design, material and equipment, piping system components and fabrication, installation and testing, commissioning, corrosion control, operation and maintenance and safety of Petroleum Installations.

OISD-STD-244 lays down the minimum safety requirements in design, layout, automation, storage, loading/ unloading operation, inspection & maintenance, fire protection, training, emergency planning & response and safety audit systems of Petroleum Depots, Terminals, and standalone Crude Oil Storage Terminals (COT).

The operations and facilities at POL Terminals/ Depots are also governed by the Factory Act 1948; Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2023; Motor Vehicles Act 1988 with the Motor Vehicles (Driving) Regulations, 2017. In addition, there are various environmental Acts and Rules governing this sector. NOC from District Collector is also obtained for new locations.

**e) LPG Bottling Plants:**

License is obtained from the Chief Controller of Explosives under Static and Mobile Pressure Vessel Rules, 2016 for storage of LPG. License is obtained for filling of LPG in cylinders and storage of LPG in cylinders from the Chief Controller of Explosives in line with Gas Cylinder Rules, 2016. The site layout and construction of the LPG bottling plant are required to be approved by PESO.

PNGRB (Technical Standards and Specifications including Safety Standards for LPG Storage, Handling and Bottling Facilities) Regulations, 2019 cover the minimum requirements for engineering and safety considerations in layout, design, storage,

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LPG tank trucks, pipelines, bulk handling, operating procedures, bottling operations, maintenance, inspection, safety management system, fire protection facilities, competence assurance, emergency management plan, gas monitoring system of LPG storage, handling and bottling facilities.

OISD-STD-144/ OISD-GDN-169 (as applicable) lay down the minimum safety requirements on design, layout, storage, loading/ unloading, operation, inspection & maintenance, fire protection, emergency planning and safety audit systems of LPG Installations. OISD-STD-150 lays down the design and safety requirements for liquified petroleum gas mounded storage facility.

The operations and facilities at LPG Bottling Plants are also governed by the Factory Act 1948; Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2023; Motor Vehicles Act 1988 with the Motor Vehicles (Driving) Regulations, 2017. In addition, there are various environmental acts and rules governing this sector. NOC from District Collector is also obtained for new locations.

### **f) Aviation Fuelling Stations:**

License is obtained from the Chief Controller of Explosives for storage of Aviation Fuel at stations and refuelling of aircraft from the Chief Controller of Explosives in line with Petroleum Rules, 2002. The site layout and construction of Aviation Fuel Stations and Refuellers are required to be approved by PESO.

OISD-STD-235 lay down the minimum safety requirements on design, layout, storage, loading / unloading, operation, inspection & maintenance, fire protection, emergency planning and safety audit systems of Aviation fuelling Stations.

The operations and facilities of Aviation Fuelling Stations are also governed by the Factory Act 1948; Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2023; Motor Vehicles Act 1988 with the Motor Vehicles (Driving) Regulations, 2017. In addition, Aviation Fuelling Stations are governed by the statutory authority DGCA (Director General of Civil Aviation) under CAR (Civil Aviation Requirements) series subsequently there are various environmental Acts and Rules governing this sector. NOC from District Collector is also obtained for new locations.

### **g) Retail Fuel Stations:**

License is obtained from the Chief Controller of Explosives under Petroleum Rules 2002 for storage of petroleum products. The site layout and construction of the retail outlet require to be approved by PESO. NOC from District Magistrate/ District Collector is also obtained before starting operations at the Retail Outlet.

PNGRB (Technical Standards and Specifications including Safety Standards for dispensing of Automotive Fuels) Regulations, 2018 cover the minimum requirements for engineering and safety considerations in layout, design, operating procedures, maintenance, inspection, safety equipment, electrical power distribution system, automation, competence assurance, emergency management plan, customer safety and awareness at retail outlets dispensing.

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OISD-STD-225 lays down the minimum requirements in for design, operation, inspection, maintenance, training, and consumer safety at Petroleum Retail Outlets (PRO).

In addition to the above, the operations and facilities at Retail Outlet are also governed by Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2023; Motor Vehicles Act 1988 with the Motor Vehicles (Driving) Regulations, 2017.

### **h) POL and LPG transportation by road, rail, and ships:**

For POL product transportation, every tank vehicle used for the transport of petroleum, in bulk onland shall be built, tested and maintained in accordance with the requirements laid down in the Petroleum Rules 2002 and be of a type approved in writing by the Chief Controller of Explosives.

OISD-RP-157 covers recommended practices on safety procedures in the entire transportation of petroleum products including loading / unloading operations for road and rail transportation.

Statutory requirements during transportation are covered under the Motor Vehicles Act 1988 with Motor Vehicles (Driving) Regulations, 2017.

OISD-STD-159 covers basic requirements of safety in design/ fabrication of vessels with material specifications, fittings and mountings, for transportation of LPG conforming to IS: 4576 (latest) in bulk by road tank trucks. Additionally, transportation of LPG in bulk is also regulated through the Static and Mobile Pressure Vessels (unfired) Rules, 2016.

For bulk LPG transportation, the vessel should be fabricated by the party approved by statutory authorities according to design as per the SMPV Rules 2016 and IS: 2825 (latest) or equivalent as approved by statutory authorities.

LPG/ POL products are also transported in tank wagons by the Railways. These wagons are designed by Directorate Research Design and Standards Organization (RDSO).

For construction and equipment of ships carrying liquified gases in bulk, IGC Code is follow.

### **i) Cross country pipelines:**

Under the Petroleum and Natural Gas Regulatory Board (PNGRB) Act 2006, PNGRB grants authorization to the entities for laying pipelines for petroleum, petroleum products and natural gas as per the definition given in the PNGRB Act.

In accordance with Petroleum Rules 2002, approval of the Chief Controller of Explosives is required for the route of the pipeline, and of the design, construction and working. The pipeline operations and facilities are regulated by the rules as defined under Petroleum Rules 2002 (latest amendments).

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PNGRB (Technical Standards and Specifications including Safety Standards for Petroleum and Petroleum Products Pipelines) Regulations, 2016 also cover pipeline design, materials and equipment, piping system components and fabrication, installation, testing, corrosion control, operation and maintenance and safety of petroleum and petroleum products pipelines.

OISD standards (141, 188, 214 & 226) cover minimum requirements for pipeline design, corrosion control, materials, equipment, welding, assembly installation, laying, inspection during construction, testing, commissioning, operation, inspection, maintenance, modification, abandonment and safety aspects of cross-country pipelines.

In addition to the above, hydrocarbon pipeline and their associated facilities are covered under various other regulations like the Petroleum and Mineral Pipelines (Acquisition of Right of Users in Land) Act, 1962; Factory Act 1948; Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2023; National Highway Act, 1956; Railway Act, 1989; Forest Conservation Act 1980 and Rules 1981; Public Liability Insurance Act and Rules 1991. In addition, there are various environmental acts and rules governing this sector.

**j) City Gas Distribution (CGD):**

Under the Petroleum and Natural Gas Regulatory Board (PNGRB) Act 2006, PNGRB grants authorization to the entities for developing a City Gas Distribution (CGD) network (including the PNG network) in a specified Geographical Area (GA) of the country. CGD sector has four distinct segments namely Auto, Domestic, and Commercial. "Compressed Natural Gas" (CNG) is predominantly used as auto-fuel and "Piped Natural Gas" (PNG) is used in domestic, commercial and Industrial segments".

The city gas distribution network is generally laid through the permission of authorities, however in a few cases requirement of Right of Use (ROU) may be there for the laying of pipelines, all such cases are treated as natural gas pipelines and accordingly the regulatory requirements for safety are dealt.

**k) LNG/ LCNG Facilities:**

Petroleum and Natural Gas Regulatory Board (Technical Standards and Specifications including Safety Standards for Liquefied Natural Gas Facilities) Regulations, 2016 lay down minimum requirements of layout within the plant boundary for unloading/ loading, storage, regasification, transfer & handling and tank truck loading facilities for LNG facilities. These regulations cover safety in the design and operational aspects of process systems, storage tanks, regasification facilities, ship shore interlock, berthing conditions for the ship, and receiving facilities including jetty and port. Any entity intending to set up LNG facilities, or terminal has to submit its detailed plan including design considerations conforming to these Regulations to PESCO for their approval prior to seeking registration with the Board.

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Static and Mobile Pressure Vessels (Unfired) Rules, 2016 were amended in 2018 to include Auto LNG/ LCNG dispensing stations. Auto LNG dispensing stations are those premises meant for storing and dispensing auto LNG as automotive fuel to motor vehicles. To store and dispense auto-LNG in auto-LNG or LCNG dispensing stations as automotive fuel to motor vehicles and/or store LNG in connection with LCNG dispensing, approval from PESO for installation and maintenance is required.

Central Motor Vehicle Rules, 1989 was amended in 2017 to include LNG as an automotive fuel. Tankers for LNG transportation through road need license under SMPV (U) Rules. Additionally, a license for storage of LNG needs to be obtained under SMPV (U) Rules, 2016 by the consignee/ LNG receiver. Amendments were published under the SMPV (Amendment) Act, 2018 towards the specifications of LNG storage vessels, piping, fitting & valves and safety standards.

The 2018 Amendment to Gas Cylinder Rules, 2016 included Auto LNG (LNG meant for automotive fuel) under its regulatory framework. The Amendment rules were extended to the storage of LNG in cylinders, its possession, import and transport. The Amendment rules also mention the specifications, and quality standards of a cryogenic cylinder.

Under Static and Mobile Pressure Vessels (Amendment) Rules, 2021 provisions were incorporated to allow the transportation of cryogenic compressed gases such as Oxygen, Argon, Nitrogen, LNG etc. through ISO containers in domestic areas.

OISD-STD-194 lay down the minimum safety requirements for unloading, storage and regasification of Liquefied Natural Gas (LNG) & OISD-STD-245 is about the standard on safety for LNG bunkering facilities at ports for large ships, coastal shipping and inland water transport (IWT) terminals.

International Gas Carrier (IGC) Code provides standards for the safe transport of liquefied gases through maritime transport routes to minimize risks to ships, crew and the environment.

The operations and facilities at LNG Terminals are also governed by the Factory Act 1948; Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2023; Motor Vehicles Act 1988 with *the Motor Vehicles (Driving) Regulations, 2017*. In addition, there are various environmental Acts and Rules governing this sector.

### I) Caverns (Crude/ LPG):

Construction of the cavern, storage of petroleum in the cavern and all associated facilities require specific approval from concerned authorities. Various acts and regulations inter alia applicable are Petroleum Act 1934, Explosives Act 1884, Factory Act 1948, Indian Electricity Act 2003; Petroleum and Natural Gas

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Regulatory Board (Technical Standards and Specifications including Safety Standards for LPG Storage, Handling and Bottling Facilities) Regulations 2019; Manufacture Storage and Import of Hazardous Chemicals Rules-1989; Applicable Coastal Regulatory Zone regulations; apart from environmental acts.

OISD has revised its standard OISD-STD-230 on 'Unlined Underground Rock Cavern Storage for Petroleum & Liquefied Petroleum Gas' in 2021.

### m) **EV charging stations:**

Applicable regulatory requirements for EV Charging stations include CEA (Central Electricity Authority) Notification dated 08.06.2023 for additional safety requirements for electric vehicle charging station; Ministry of Power revised consolidated Guidelines and Standards dated 14.01.2022 on charging infrastructure for electric vehicles; PNGRB Notification 2022 for setting up of EV charging and battery swap facility at ROs.

### n) **Hydrogen:**

Gas Cylinder Rules are followed for the purpose of PESO License for Storage and Dispensing of Hydrogen procured from within India and are manufactured as per Gas Cylinder Rules. For storage in Bullets, SMPV Rule 2016 is applicable under Explosive Act 1984.

The gas tubes procured from abroad should be comply with NFPA/ ASME standards and are required to obtain PESO approval.

## 2.6. CURRENT SAFETY SYSTEMS

2.6.1. Oil & Gas industry, by nature, is required to strive for highest standards of safety. However, safety system deployed depends on the segment, size and type of the installation. Many of the Indian Oil and Gas Companies have established Safety Management System based on ISO 45001:2018, which specifies requirements for occupational health and safety (OH&S) management system. The Safety Management System in major oil & gas installations comprises of many aspects, which include design and construction of facilities at inception, commissioning/ operations/ start-up/ shutdown of installations, change management, standard operating procedures (SOPs), asset integrity management, safety warning systems, emergency shutdown systems (ESD), Fire detection and suppression systems, training, hazard identification & analysis, planning for emergencies & preparedness for response, incident investigation, near miss reporting, safety audits, mock drills etc as per applicability. Some of the measures being taken under various aspects are as follows:

a) **Design aspects** - In order to make installations inherently safe following measures are taken by the companies:

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- Careful selection of technologies with due consideration of safety aspects related to the operation and maintenance of facilities and handling of feed material, products & intermediate streams, effluents, emissions, chemicals & catalysts involved in the process.
  - Design of installations as per relevant national and international codes and standards.
  - Incorporation of safety related engineering and administrative controls at the design stage. It includes the provision of process safety equipment, instrumentation, safety interlocks, pressure relieving and control devices, suitable seals/ gaskets & other leak prevention measures, emergency shutdown systems, fail safe mode for equipment and instruments, material selection, corrosion/ erosion prevention measures, blast proof control rooms, flare design considering multiple emergency scenarios, fire-fighting facilities, automatic sprinklers, hydrocarbon/ smoke/ flame sensors etc.
  - Hazard and Operability (HAZOP) study, Quantitative Risk Assessment (QRA) and Safety Integrity Level (SIL) study at inception stage of projects.
  - Adhering to inter distances between plants/ facilities and equipment based on regulatory requirement, QRA and OISD standards.
  - 3-D computer modelling of the plant including stage-wise review and walk-through review of computer models from operability and safety point of view during the design and plant construction stage.
  - Incorporation of best engineering practices in line with the American Society of Mechanical Engineers (ASME), American Petroleum Institute (API), Deutsche Institute Fur Normung (DIN), National Fire Prevention Association (NFPA), Bureau of Indian Standards (BIS), OISD Standards etc.
- b) Construction aspects** - During construction of the facilities, as a part of project execution, the following measures are taken:
- Pre-qualification criteria defined in tenders to ensure the selection of qualified and experienced project execution agencies and equipment suppliers or floating enquiries to vendors/ contractors pre-registered through a defined process and meeting necessary technical qualification requirements.
  - Stage-wise inspection and testing of material, equipment and construction activities including the use of advance technologies for the same.
  - Stage-wise checks by licensors and third-party inspection agencies
  - Meticulous planning for loading, unloading, transportation and erection of heavy equipment.

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- Testing of tools/ tackles/ lifting equipment and certification by authorised agencies.
  - Use of highly skilled workforce for specialised activities
  - Job Safety Analysis (JSA) for critical activities
  - Work permit system for job authorisation
  - Safety stewards for on-the-job safety watch
  - Toolbox meetings and safety induction trainings for contract workforce
  - Safety and operability check by multi-disciplinary internal teams before start of commissioning activities including functionality checks for critical equipment and safety devices.
  - Pre-commissioning safety audit by internal/ OISD team
  - Pressure test, leak test, trip and safety interlock checks and emergency shutdown system simulation during the pre-commissioning stage
- c) Operations aspects** - After commissioning of the facilities, during operation and maintenance, the following safety measures are incorporated:
- Documented manuals and Standard Operating Procedures (SOP) entailing operation, maintenance, safe start-up, shutdown and emergency handling of the facilities.
  - Laid down Maintenance & Inspection (M&I) procedures to ensure asset integrity for safe & reliable operations including periodic asset replacement/ upgrade plans to take care of obsolescence & incorporation of new technologies in addition to wear and tear.
  - Continuous process plants are subjected to major Maintenance and Inspection, once in 3-5 years, which is generally called 'Plant Turnaround'. Pipelines and pressure vessels are subjected to hydro test at a defined periodicity. Tankages also have a defined cycle in which these are subjected to major inspection and repairs.
  - Adhering to the safe operating envelope as per the design of the plant including alarm and trip limits
  - Identification, maintenance and monitoring of Safety Critical Equipment
  - Establishing an Emergency Response & Disaster Management Plan (ERDMP)
  - Hazard Identification and Job Safety Analysis (JSA) for critical activities and non-routine jobs
  - Ensuring an effective Work Permit System
  - Conducting periodic Safety Audits for gap assessment and mitigation

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- Periodic Safety Audit by the OISD team/ third party agencies
  - Conduct periodic onsite and offsite mock drills to check the effectiveness of ERDMP and the readiness of the emergency response system.
  - Safety Committee Meetings, Management Review Meetings and plant level safety committee meetings including participation of workers' representatives.
- d) Management of Change** – Any change to the installed hardware (unless it is a part of routine changeover or identical replacement) or change in operating parameters beyond the safe operating envelope or change in operating philosophy needs a structured mechanism for effecting the changes to avoid any unintended outcomes. Most companies have implemented formal process for the Management of Change (MoC) which include:
- Careful analysis of the need and objective of the intended change
  - Design checks and modifications if so, required for the intended change with proper documentation.
  - Review and approval of different departments for the proposed change
  - HAZOP study of the system, where change is intended, by a multidisciplinary team.
  - Formal approval mechanism for authorising the change.
  - Updation of all documentation/ drawings/ manuals for the changes and reissue of the same by competent authorities. Maintaining version control of change documents.
  - Retraining of the connected workforce for the changed system
  - Approval/ information to any regulating/ statutory authorities, if so required
- e) Competency Building** – A competent and skilled workforce is essential to ensure safe operations. All the organisations are taking measures for training and skilling their workforce. Organisations either have their own training facilities or take outside help. Measures taken for competency building include:
- Induction training and on the job training
  - Training by process licensors, technology providers, original equipment manufacturers (OEMs) and subject matter experts
  - Hand holding by senior staff and periodic refresher training.
  - Operation and emergency handling manuals and operating instructions

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- Peer group learnings through technical conferences, seminars, participation in industry groups and task-based industry working groups/ activity committees.
  - Safety and firefighting training including live fire training.
  - Operations and emergency handling training through training simulators
  - Mock drills and safety audits
  - Learnings from investigation reports and analysis of past incidents in the company and in the industry
- f) **Early Warning Systems** – Installations are provided with early warning systems to initiate timely actions for avoidance of untoward incidents. It includes the provision of:
- Process Alarms & annunciators provided in DCS / SCADA control room.
  - Hydrocarbon sensors, flame, smoke and H<sub>2</sub>S leak detectors with indications in control rooms and Fire & Safety control rooms.
  - Corrosion coupons installed in equipment.
  - Thermal scanning of refractory lined vessels / electrical devices
  - Online vibration monitoring systems for rotary equipment.
  - CCTV Cameras in the plant with visibility in control rooms
  - Online flare monitoring
  - Online inspection and health monitoring of equipment
  - Continuous monitoring of process parameters through DCS
  - Fire alarms, and manual call points are provided at various locations within the plant.
- g) **Data logging and documentation control**
- Defined critical operational parameters are continuously recorded in DCS and are backed up in historiographer servers. The events can be traced back in time, using the data so available.
  - Critical events/ activities during a shift and important instructions are logged in daily shift logbooks. Continuous process plants follow man-to-man relieving and shift handing over - taking over the system.
  - Any trip bypass is logged including alternative risk mitigation measures taken. Some companies follow authorisation and escalation matrix depending on the severity and time for which the trip is bypassed.

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- Operation manual, Emergency Response and Disaster Management Plans (ERDMP), Standard Operating Procedures etc. are duly authorised by designated persons and any change to the same need to follow an approval mechanism.
- Incidents are logged and investigated. Most of the companies are now using online systems for incident and near miss reporting.
- History cards are maintained for critical equipment recording health status, work carried out, modification done if any and observations during major overhauls which help to plan for future repairs, replacements and risk assessments. It also sometimes helps in incident investigations to assess whether any modifications/ equipment failure has led to the incident.
- Records of mock drills to assess the effectiveness and response of emergency response systems and corrections if required.

### **h) Additional safety measures in cross-country pipelines**

- Patrolling of the pipeline through line walkers (security personnel).
- SCADA (Supervisory Control and Data Acquisition) system for online monitoring of operational parameters.
- Optical Fibre Cable (OFC) based dedicated telecommunication system for effective and quick communication between the stations/ sectionalizing valve (SV) stations/ cathodic protection stations.
- Monitoring of Repeater-cum-Cathodic Protection Stations through Close Circuit Television (CCTV) based surveillance system.
- Security surveillance system, where the pipeline locations are vulnerable from a pilferage point of view.
- Application software-based Leak Detection System (LDS) in liquid pipelines.

### **i) Additional safety measures in Offshore locations**

- Design of Offshore platforms is based on the standards/ codes like API-RP-2A-WSD (Construction of Platforms), API-RP-14 C (Safety system of offshore Production Facilities) & D (Subsurface Safety Systems), SOLAS (Safety of Life at Sea), NFPA (National Fire Protection Association), 100 Years weather criteria etc.
- Offshore rigs/ installations/ vessels follow international guidelines related to MODU (Mobile Offshore Drilling Unit), SOLAS (Safety of Life at Sea) & IMO (International Maritime Organization).
- For helicopter operations, DGCA's (Directorate General of Civil Aviation) regulations are followed.

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- All Offshore Installations/ Rigs obtain 'Consent for operation' from the Oil Industry Safety Directorate (OISD) after a critical examination of all safety requirements as per Petroleum and Natural Gas (Safety in Offshore Operations) Rules 2008.
  - Audit by a third party for fit-for-purpose certification of topside facilities.
  - Class Certification Audits for MODUs and vessels
  - Survival at Sea and Helicopter Under Water Escape Training (HUET)
  - Selection, installation and testing of well control equipment during Drilling and Workover operations as per the recommended practices on Well Control specified in OISD-RP-174 of OISD.
- j) Additional Good Practices** – Additional measures implemented by some organisations include:
- Defining 'Life Saving Rules' for the location/organisation
  - Task observation
  - Periodic review of the effectiveness of SOPs in real life situations by appointed observers and analysing the deviations for necessary advice to concerned or updation of SOPs if so needed.
  - Installation specific risk registers identifying the hazard associated with the critical operational activities and site-specific safe work practices to mitigate the hazards.
  - Defining criticality factor or vulnerability factor for the jobs on predetermined criteria, which automatically escalates the supervision level required.
  - Meetings to deliberate on 'What Can Go Wrong' for critical jobs and take proactive remediation measures.
  - Safety Induction training as a prerequisite before the issue of entry passes to the contract workforce.
  - Field rounds/ inspection at regular intervals by senior management apart from regular inspection by operating personnel.
  - Safety workshops involving senior project management team of the Owner, Project Management Consultant (PMC) and major contractors at the start of the project to have a common commitment to safety.
  - Standardization of Safety Critical Equipment (SCE)
  - Educating the community in the vicinity regarding the facilities, associated hazards and actions required in case of any untoward incidents.
  - OFC (Optic Fibre Cable) based Pipeline Intrusion Detection System (PIDS)/ acoustic sensor-based leak detection system.
  - Pipelines mapping through Geographic Information System (GIS)

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### 2.7. EMERGENCY PREPAREDNESS

**2.7.1.** In view of the hazardous nature of the operation, Oil and Gas installations must be in a state of high alert and readiness for handling emergencies all the time. Depending on the type of installation, measures taken to handle emergencies at oil and gas installations include the following:

- a) Installations are equipped with hydrocarbon detectors, smoke & flame detectors, H<sub>2</sub>S detectors, Manual Call Points (MCP), CCTV cameras etc. at various locations within the installation with indications/ alarms/ display in Fire & Safety control room and main control room for early warning and response.
- b) Refineries and big installation have fire station within the premise, which is manned round the clock by a crew trained for firefighting. Additionally, security and operating staff are also trained in firefighting.
- c) Installations are provided with fire sirens, which are tested regularly. Plant communication systems and all call facilities on specific channels of walkie-talkies are also used for emergency alarms to ensure that all plant personnel are aware of emergency conditions.
- d) Fire protection systems include fixed equipment like fire hydrants, fire monitors, deluge, sprinklers etc. and mobile firefighting equipment like fire trucks, foam tenders, mobile fire water monitors and foam pourers, dry chemical powder skids etc.
- e) Installations are provided with suitably designed firewater network. The firewater header is always charged and in case of emergency, header pressure is maintained through a series of firewater pumps, which include a combination of electric motor driven and diesel driven pumps to ensure the availability of firewater even in a power outage situation. Firewater pumps are regularly tested for readiness and auto cut-in systems.
- f) At specified locations in plants, firefighting equipment like fire hose reels, dry powder chemical extinguishers, sand buckets etc. are provided.
- g) Installations have mutual aid arrangements with nearby industries and fire brigade to augment the resources in case of need.
- h) Installations are also equipped with advance firefighting/ protection gadgets like High-Volume Long-Range Monitors (HVLRM), Medium Expansion Foam Generators (MEFG), remotely operated shutoff valves (ROSOV) etc., as per requirements and guidelines.
- i) Adequate quantity of foam and dry chemical powder extinguishers are maintained at installations.

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- j) Tall columns, LPG vessels, storage tanks etc. are provided with automatic sprinklers.
- k) Floating roof tanks are provided with automatic rim seal fire detection and protection system.
- l) Installations have an Emergency Shutdown Device (ESD) which gets activated automatically when certain process parameters are breached. ESD can also be activated manually in case of emergency leading to shutdown of the operations in part or in full.
- m) Control rooms are of blast proof construction. Control rooms, rack rooms housing marshalling cabinets and critical enclosed spaces like turbine generator rooms etc. are provided with clean agent flooding system to extinguish fire.
- n) Firefighting system, fire extinguishers, sensors, detectors, alarm systems, call points etc. are regularly checked and tested for readiness in all conditions.
- o) Regular firefighting training is provided to employees and contract workforce including live fire training.
- p) In midstream & downstream, Emergency Response and Disaster Management Plans (ERDMP) for the location are approved at appropriate level. ERDMPs are periodically reviewed and certified by third party agencies approved by PNGRB. Disaster Management Plan is also submitted to the Chief Inspector of Factories and District Collector. Onsite and Offsite Mock drills are conducted periodically to test the effectiveness of the emergency response systems as per ERDMP.
- q) The organisation structure for an emergency and the communication protocol etc. are defined in ERDMPs and get activated as soon as an emergency is declared by the designated person.
- r) Refineries and major installations have an onsite dispensary with trained medical staff and ambulances to provide immediate medical assistance.
- s) Operating staff is given first aid training. First aid boxes are provided at various locations within the plant.
- t) Any emergency related to cross country pipeline or with any tanker/ truck is handled with the help of fire-fighting assistance from local administration and nearby terminal/ oil installation, some of which are also provided with emergency response vehicles.
- u) Installations also maintain a designated Disaster Management Control Room suitably located and equipped with an updated set of various engineering and emergency response documents. Contact details of the agencies/ persons required to be informed in an emergency are also maintained in the Emergency and Disaster Management Control Room.

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### 2.7.2. Emergency Preparedness for Offshore:

Offshore process platforms are provided with:

- a) Fire detection system: Comprising of Thermal, Smoke detection system, Gas Detection System (HC, H<sub>2</sub>S), Fusible plug loops etc.
- b) Emergency Shut Down (ESD): ESD system is actuated automatically when critical process limits are breached. ESD can also be manually actuated. ESD system provides a mean to initiate process shut down of a platform when an abnormal condition is detected.
- c) Fire Shut Down (FSD) System: A fire shut down (FSD) occurs when Fire or Heat is sensed by detectors in the Fire and Gas detection system. This can also be manually activated. Upon FSD, the process system shuts down, all Shutdown valves and wells close, an inventory of hydrocarbon is blown down to flare and fire suppression system is activated.
- d) Fire water system: Deluge, Sprinklers on Auto and Fire Hydrants, Foam water Hose reels and Monitors for manual firefighting, Dry chemical skids
- e) Flooding system: Clean agents like FM200, and Novec 1230 are used in enclosed spaces like Turbine enclosure, Control Rooms etc.
- f) The platform paging/ communication system is utilized for emergency alarms to ensure that platform personnel are aware of emergency conditions that might arise.
- g) Lifesaving and evacuation equipment are available which are inspected and maintained as per documented schedules.
- h) All operators are required to maintain Tier-I (to handle up to 700 tons of oil spill) oil spill response facility on-board Multi Support Vessels (MSVs) to cover the entire operational area.
- i) Major PSU E&P operators have dedicated teams called Crisis Management Team (CMT) to control emergency scenarios related to blowout/ uncontrolled flow of formation fluid from oil & gas wells and tackle related emergencies.

### 2.8. CURRENT USE OF LATEST TECHNOLOGIES IN THE INDUSTRY

2.8.1. Oil and Gas Industry is making continuous efforts to leverage new technologies for the improvement of safety in its operations. Some of the efforts by some of the companies to leverage new age technologies include:

- a) Use of Artificial Intelligence (AI), Augmented Reality (AR) and Virtual Reality (VR) based software for training.
- b) Use of training simulators and digital twins for operator's training and emergency simulations

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- c) Use of video analytics for identifying unsafe acts/conditions and behavioural patterns
- d) Use of drones for inspection of unapproachable locations like flare tips, stacks, pipelines etc.
- e) Use of artificial intelligence enabled drone-based surveillance system for monitoring of activities across the locations. This has not only helped in identifying the unsafe acts/ conditions, but also proved its use in supervising the workers in unsafe/ high elevations.
- f) Use of robots for safer and faster turnaround maintenance and cleaning of hazardous storage tanks without man entry.
- g) Use of robotic systems for hazardous and time-consuming high-pressure industrial washing (for ex. - washing and cleaning of heat exchangers), hydro jetting activities etc.
- h) Application of radiotracer techniques for leak detection (for example identification of heat exchanger leaks).
- i) Ultrasonic technology based continuous, real-time monitoring of pipeline health and integrity (detecting corrosion as well as corrosion rates) to prevent potential leak hazards.
- j) Use of AI-based predictive and preventive maintenance practices to take proactive measures.

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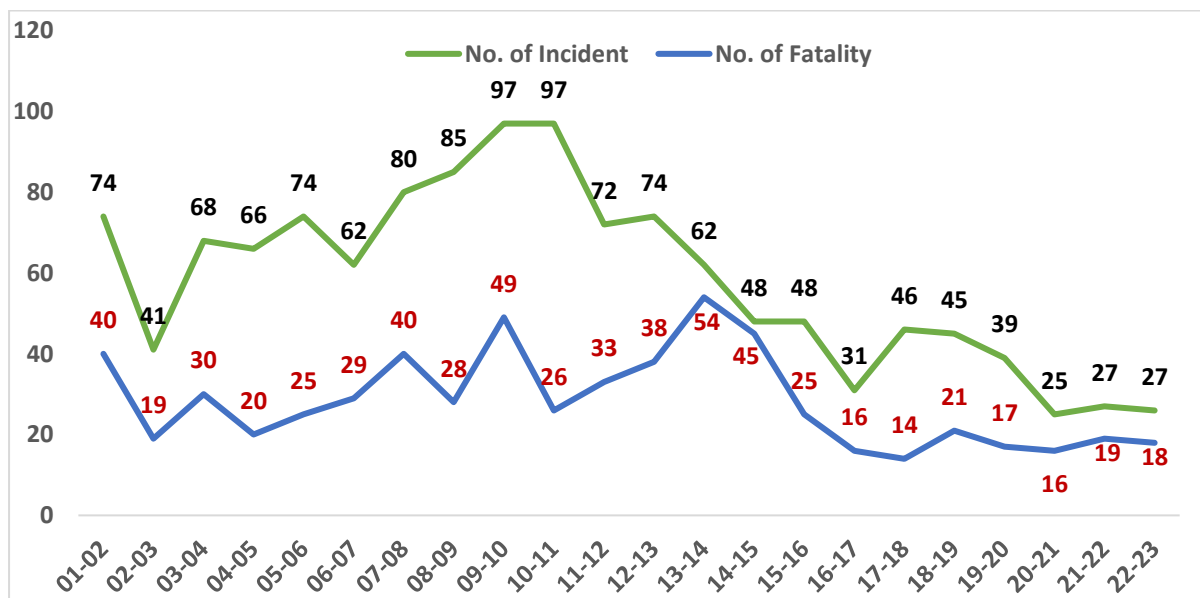
### 3.0 HISTORICAL TRENDS OF SAFETY INCIDENTS IN INDIAN OIL & GAS INDUSTRY

#### 3.1. ONSITE INCIDENTS IN OIL AND GAS INSTALLATIONS

3.1.1. Exploration, production, transportation, storage, processing and refining of oil and gas are complex processes and carries inherent risk. A high level of automation coupled with a man-machine interface poses additional risks. A conscious introspection based on past incidents and efforts to avoid recurrence is therefore essential.

3.1.2. Number of incidents have been reported in Oil and Gas Industry, including a few major fires/ explosions in refineries, oil well blowout in upstream installation, explosion/ fire in major pipeline, fire/ explosion in oil marketing terminals and in LPG bottling plants, sinking of marine vessels while working for offshore upstream installation, helicopter accidents while on service for offshore upstream installations etc. Many of these incidents had multiple casualties.

3.1.3. Historical trend of major onsite incidents and fatalities in the last two decades (April 2001 - March 2023) in the Indian Oil and Gas Industry is placed in Fig 3.1.1.



**Fig 3.1.1 -Trend of major onsite incidents in the Indian Oil and Gas Industry in the last two decades**

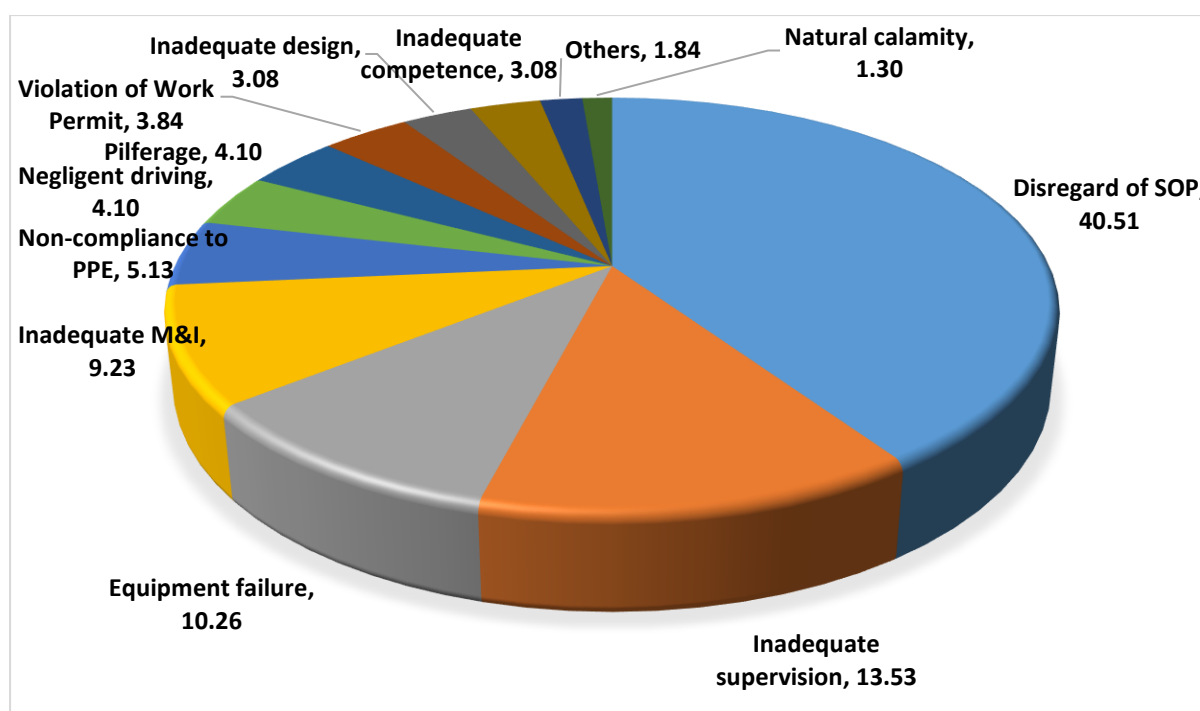
*(Does not include accidents in Retail Outlet, CGD, Offshore vessel, Helicopter and private marketing installations)*

*(Source: OISD database)*

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3.1.4. It is positive to note that there has been a sharp decline in the numbers of major accidents and fatalities over the last decade. However, it is also concerning that 91 fatalities were recorded in 164 incidents in the last 5 years (April 2018 to March 2023).

3.1.5. An analysis of the major onsite incidents in the last 5 years (April 2018 to March 2023) in the Indian Oil and Gas Industry and the major factors responsible for these incidents (in %) is given in Fig 3.1.2.



**Fig 3.1.2 - Analysis of major onsite incidents in the last five years**

(Source: OISD database)

3.1.6. From the analysis, the primary cause of accidents (40.5%) was observed to be disregard/ non-adherence to Standard Operating Procedures followed by inadequate supervision (13.53%), equipment failures (10.26%), inadequate maintenance & inspection (9.23%). These four factors alone contributed to 73.53 % of the total incidents. Hence, foolproof mechanism for adherence to SOP, effective supervision and proper upkeep of the facilities are the key areas for improving HSE performance.

3.1.7. Substantial amount of work in the Oil and Gas Industry is carried out through contracts. Hence, competency and management of the contract workforce is an important factor in ensuring overall safety at work.

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3.2. OFF-LOCATION ACCIDENTS INVOLVING TRANSPORTATION OF PETROLEUM PRODUCTS:

3.2.1. The working group also reviewed off-location incidents involving the transportation of petroleum products (LPG, MS and HSD) of PSU oil marketing companies for the last twenty years. Historical trend on offsite incidents and fatalities of the last two decades is placed in Fig 3.1.3.

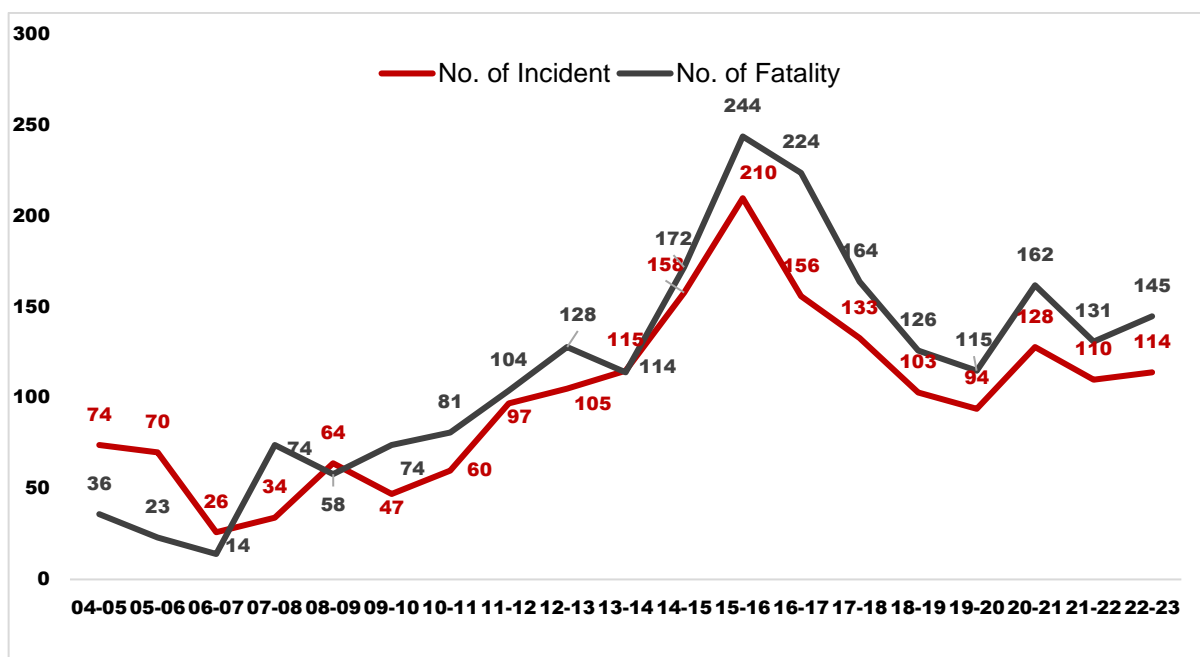


Fig 3.1.3 - Offsite incidents involving road transportation of MS, HSD, and LPG in the last twenty years. The data pertains to PSU OMC's LPG and POL tank trucks only (Source: OISD database)

3.2.2. Root cause analysis of these accidents reveals that 35% of the transport related incidents happened due to negligent driving of the TT crew, 14% due to equipment failure and the remaining 51% due to other reasons (mainly negligent driving of other drivers on road, bad condition of road/ potholes, stray animals on road etc.).

3.2.3. Industry has a focused on number of measures to improve road safety like monitoring through a Vehicle Tracking System (VTS), simulator-based training, defensive driver training, Journey Risk Management (JRM), inspection of trucks/ tankers as per checklist before entering the installation, medical check-up of truck crew etc. However, still there are areas for further improvement.

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#### **4.0 MAJOR RECOMMENDATIONS OF PREVIOUS HIGH-LEVEL COMMITTEES AND STATUS OF IMPLEMENTATION**

##### **4.1 SOME HIGH-LEVEL COMMITTEES APPOINTED BY MOPNG**

The status of implementation on recommendations of some of the high-level committees appointed by the Ministry of Petroleum and Natural Gas, in the last two decades, to enquire into specific incidents, is as follows:

##### **4.1.1. M.B Lal Committee for fire/ explosion incident at a POL Terminal in Jaipur, Rajasthan.**

A fire/ explosion accident occurred in the POL (Petroleum, Oil & Lubricants) terminal at Sitapura (Sanganer), Jaipur, Rajasthan on 29<sup>th</sup> October 2009. The incident caused the death of 11 people and injuries to 45 people. The entire installation was destroyed and buildings in the immediate neighbourhood also suffered damages.

A seven-member enquiry committee constituted by MoPNG under the Chairmanship of Shri M.B. Lal, submitted its report with 118 recommendations.

Out of the total 118 recommendations, 113 recommendations were reported to have been complied with by the oil and gas industry and the balance 5 recommendations, which are policy matter are detailed below:

1. OISD can be developed as an autonomous body independent from the public sector oil and gas companies and free to develop its cadre of safety professionals with no affiliations to any company.
2. Government may consider regulating by an Act, the planning and use pattern of land around major petroleum and petrochemical high hazard installations and plants which will make it mandatory to institute a process of consultation between the major industries and the land planning authorities (both state and local).
3. The Petroleum Rules 2002 may be suitably amended for a buffer safety zone around the petroleum installations.
4. To deploy the services of CISF for security responsibility. It would be desirable to get a complete study done from the security angle from a competent agency like CISF or others and take appropriate steps for ensuring security.
5. An Emergency Response Centre equipped with advance firefighting equipment viz; fire tenders & trained manpower shall be considered on cost sharing basis or outsourcing basis.

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### **4.1.2. High Level Committee for blowout incident at Baghjan, Tinsukia district, Assam.**

An incident of uncontrolled flow of gas and condensate occurred in well BGN#5 in Tinsukia district of upper Assam on 27<sup>th</sup> May 2020 and caught fire on 9<sup>th</sup> June 2020. Blow out control operation was completed in 172 days i.e., on 15<sup>th</sup> Nov 2020 and three employees lost their lives during the course of handling the blowout.

The Ministry of Petroleum and Natural Gas constituted a three-member Committee to inquire into the incident headed by DG-DGH.

In compliance with the NGT order, another high-level committee consisting of five members was constituted by MoPNG, headed by Secretary MoPNG. The committee submitted its report with 41 recommendations. Some of the major recommendations of the High-Level Committee are:

- Organizations should develop comprehensive manuals for workover, drilling, production, pipeline operations etc. covering all operations in detail, which shall act as the guiding document covering all operations.
- Chief of HSE at the Corporate level, headed by a senior level officer should directly report to CMD.
- All operators including small & medium and major contractors should establish a dedicated HSE group, manned by HSE specialists of required strength based on organisational activities.
- Organizations should carry out gap analysis w.r.t. training requirements and impart training accordingly.
- Organizations should develop a strong Crisis Management Team/ enter into MoU with the established organization(s).
- Disaster Management Plan (DMP) of Districts and organizations should be reviewed and suitably revised in view of this incident.
- Implement an IT-enabled system to ensure the availability of real-time information on critical operational parameters.
- Establish a system of surveillance of installations (including rigs) through CCTV.
- Carry out a survey to assess safety culture periodically and implement recommendations.

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### 4.1.3. High Level Committee for incident related to cyclone Tauktae at Western Offshore, Mumbai.

Several vessels on contract (directly or through its contractors) with more than 700 people on-board were stranded in western offshore areas during cyclone “Tauktae” on 17<sup>th</sup> May 2021. The stranding, drifting and subsequent events have led to the loss of 86 persons. Out of the 86 deceased persons, 75 were on board Barge P-305 and 11 on Tug Varaprada.

To inquire into the sequence of events leading to the stranding of vessels in the cyclone “Tauktae”, a three-member High-Level Committee (HLC) was constituted by MoPNG headed by the Director General of Shipping. The committee submitted its report to the Ministry with 54 recommendations under 21 heads. Some of the major recommendations of the High-Level Committee are:

- Provision of operational ocean observing instruments on offshore platforms and installations to improve the predictive capability on weather forecasting of IMD and INCOIS.
- Adequate number of AHTs for non-propelled barges and ETV.
- A uniform policy for hiring of marine spread for the entire company.
- To verify that the training courses undergone by all individuals are standard courses from accredited institutes.
- ONGC should get accreditation for the survival at sea training being provided at its institute at Goa.
- The accommodation barges shall carry 10% excess of the required life raft capacity for training purpose.
- Servicing of the lifesaving appliances is recorded on CCTV.
- All accommodation barges need to have lifeboat(s) and life-rafts complying with applicable SPS/ MODU Code.
- Immersion suits as per applicable SPS/ MODU Code.
- To follow OISD guidelines regarding the useful life of Life Saving Appliances. The age of the life raft may be limited to a maximum of 10 years.
- VATMS system of ONGC to be utilised for enhanced coordination with other agencies and for taking preventive actions.

**4.2** OISD is monitoring the compliance status of HLC recommendations of Baghjan and Tauktae on a quarterly basis and verifying the same during the external safety audits of the companies. The ATR of the recommendations are also being reviewed at MoPNG and discussed during the Safety Council meetings.

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**5.0 GLOBAL TRENDS IN OIL AND GAS SAFETY**

**5.1** Marsh Q1 2022: 27<sup>th</sup> edition of 100 largest losses in the hydrocarbon industry (1974-2021) depicts a business segment wise breakdown of the incidents as follows:

| Segment                    | % contribution |
|----------------------------|----------------|
| Refining                   | 39%            |
| Petrochemicals             | 26%            |
| Upstream                   | 24%            |
| Gas Processing Terminals   | 6%             |
| Terminals and Distribution | 5%             |

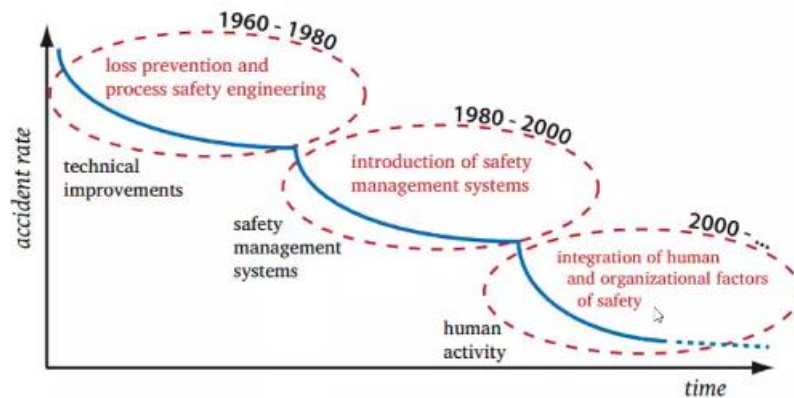
Out of the above, 32% were due to explosion, 24% for mechanical failures and 13% due to natural catastrophes.

**5.2** History of incidents globally suggests that 100% success in being able to avoid the recurrence of similar incidents is yet to be achieved. The major challenges in applying the learning of past incidents to avoid the recurrence of similar incidents and ensuring that the risk mitigation barriers remain robust are discussed in the 26<sup>th</sup> edition of Marsh 100 largest losses in the hydrocarbon industry, published in March 2020. Four major challenges in applying learning the past incidents to avoid the recurrence of similar incidents, as stated in the report, remain relevant in future as well and are reiterated below:

- **Distance** - Regulation following a major incident is often enforced locally rather than globally, and consequently only, or at least mostly, affects local awareness. At the same time, parties can be affected by closeness bias that is — feeling unconsciously less affected by events a long way away.
- **Culture** - Fear of litigation and blame prevents open reporting of incidents, and learnings within organizations. In some cultures, difficulty challenging upwards can also prevent improvements from being implemented.
- **Tunnel vision** - Not realizing the wider relevance of lessons. “Silo thinking” can cause companies to imagine that an incident happening in a different type of facility from their own does not provide applicable learnings.
- **Time** - Lessons were initially learned, but have since been forgotten, or the solutions implemented were insufficiently sustained. This can be attributed to the departure of experienced people, loss of corporate memory, the evolution of risk for an ageing plant, or even simple complacency.

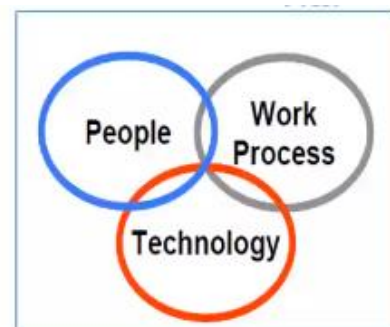
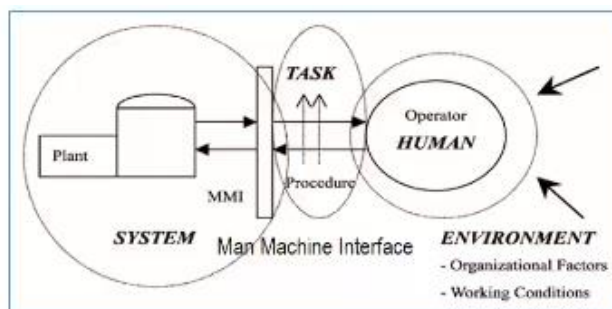
**5.3** Over a period of time, safety programs have traversed a long distance from being largely focused on technical improvements and loss prevention to more holistic Safety Management Systems including integration of human and organisational factors.

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5.4 An integrated approach to safety includes:

- An integrated look at the plant, machineries and system technology
- Work process and practices that make use of and maintain this technology.
- The people and their collective abilities under the constraints of organisational factors and working conditions that interacts with machines/ plant/ systems by defined tasks and procedures.



5.5 The Baker panel, constituted after the Texas City BP Refinery accident in March 2005, to look into the Safety Management System at US refineries of BP has laid great emphasis on Process Safety Management in their recommendations. Root cause analysis of various accidents over a period is also suggesting clear drivers for a strong focus on Process Safety Management in Oil and Gas Industry in addition to occupational safety.

Risk vulnerabilities have many dimensions. Not all hazards are caused by the same factors or involve the same degree of potential damage. Personal or occupational safety hazards give rise to incidents—such as slips, falls, vehicle accidents etc. —that primarily affect one individual worker or few workers for each occurrence. Process safety hazards can give rise to major accidents involving the release of potentially dangerous materials, the release of energy (such as fires and explosions), or both. Process safety incidents can have catastrophic effects and can result in multiple injuries and fatalities, as well as substantial economic, property, and environmental damage. Process safety incidents can affect workers inside the installation and members of the public who reside nearby. Process safety in an Oil and Gas Installation involves the prevention of leak, spill, equipment malfunction, over-pressure, excessive

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temperature, corrosion, metal fatigue, and other similar conditions. Process safety programs focus on the design and engineering of facilities, hazard assessment, management of change, inspection, testing, and maintenance of equipment, effective alarms, effective process control, procedures, training of personnel, and human factors.

- 5.6 Organization culture, leadership role, cascading of ownership, safety benchmarking and continual improvement loop in safety performance are getting increasing prominence in Safety Management Programs. Safety related KPIs are shifting from lagging indicators to a judicious combination of leading and lagging indicators.
- 5.7 With increasing complexities, external standards represent only minimum expectations and the sites scoring high on safety performance demonstrate commitment rather than just compliance through the development and application of their own standards.
- 5.8 Other emerging trends, influencing Safety programs in Oil and Gas Industry include:
- a) **Managing the talent life cycle** - Bridging the talent gap created due to retirements, retrenchments, increasing shift towards contracting and outsourcing, flight of talent to rising knowledge industry and other new energy industries, competition within the industry due to shortage of specialists etc. To manage this challenge, organisations are increasingly focusing on identifying safety critical positions, defining minimum competency requirements for each role and personnel change management.
  - b) **Increasing role of technology in driving safety performance** – Important technology pieces being explored and deployed rapidly in safety management processes include automated workflows, integrated dashboards for live and accurate data, use of artificial intelligence (AI) in identifying weaknesses in design and operational controls, using drones, smart stations, digital twins, artificial intelligence, robots, reality technology etc. to drive safety and operational efficiencies, using Augmented and Virtual Reality models (AR/ VR), Simulators etc. for facilitating learning.
  - c) **Shift to risk-based approach instead of task based** - Organisations are adopting integrated organization for safety and risk management. Risk based approach includes identifying key risks and their impact potential, gaps in risk controls and underlying management systems, risk oversight and continuous improvement.
  - d) **Emerging risks in new business context** - New forms of energy and continuously evolving new business models are throwing up new risks, which need to be addressed. For example, new businesses like green hydrogen, a high-level of outsourcing and the increasing role of partnerships in the oil and gas business are a few such challenges.
  - e) **Cyber Security threats** – Enhanced automation, connectivity, the internet of Things, AI and a multitude of use specific generic softwares residing at different layers of automation cause additional vulnerabilities from safety point of view.

# Section - 1 B

# Deliberations and Observations



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**6.0 OBSERVATIONS & DELIBERATIONS**

Oil and Gas Industry continues to make efforts to implement better processes, upgrade the hardware and adopt improved operating procedures to make the industry safer. Over a period, various acts have been enacted and rules/regulations put in place by the concerned authorities to ensure discipline and compliance to minimum required safety standards. Major incidents are investigated in detail and recommendations are monitored for implementation by various agencies which do provide useful learnings and help in bringing further improvements. However, the goal of having an accident-free industry still eludes. Every major incident brings back the focus on the adequacy of the extant safety systems and on new measures to avoid recurrence of the similar incidents.

**6.1. HISTORY OF INDUSTRIAL INCIDENTS BRINGS FORTH FOLLOWING IMPORTANT LESSONS:**

- An incident occurs when the last of the safety barriers, in the series, falls. Before the occurrence of the incident, a number of safety barriers, which could have stopped the incident, might have fallen, but either gone unnoticed or due cognisance was not taken in time. In all likelihood, this might have happened over a period of time.
- Deviation from a standard procedure, which appears to cause an incident, might not have happened for the first time. Even the most experienced crew may overlook basics under overconfidence. In earlier instances, when similar deviations were taken, the incident might not have occurred either due to other safety barriers playing a role or due to pure luck. But luck may not come to the rescue always.
- There may be different types of incidents with a variety of immediate causes but there is a strong likelihood of a human angle to most of the incidents at some stage in the root. This might manifest in different manners in different situations and may not be limited to the first line or immediate workforce only.
- Humans can make mistakes. Different persons may respond to the same situation differently. Even the response of the same person to the same situation may differ at different points in time depending on other personal, contextual or environmental factors. Training and standard operating procedures help in reducing errors and bring consistency of response by humans.
- Complex events even with a high degree of vulnerability can be carried out safely with a good amount of planning, supervision and oversight while even routine activities may lead to an incident if handled without due care.
- Visually felt leadership has great significance. Therefore, the orientation of senior management to safety is critical.

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- Perception may differ from reality. Hence, eyes and ears on the ground are important as far as safety is concerned.
- Technology can help immensely in improving safety but human judgement at critical moments is unavoidable and is extremely important.
- Only installation of safety related Hardware/automation does not ensure safety unless the same is backed with proper management processes and control to achieve desired outcomes.

### 6.2. KEY FOCUS AREAS FOR OVERALL IMPROVEMENT OF SAFETY

The working group, after a lot of deliberations, identified the following key focus areas to address some of the basic issues for overall improvement of safety in the Indian Petroleum Sector:

- Safety culture
- Competency assurance of company employees
- Safety management of outsourced and contracted out jobs
- Management of safety barriers
- Compliance with SOP (Standard Operating Procedures)
- Adequate job supervision
- Asset Integrity Management
- Process Safety Management
- Effectiveness of Safety audits
- Emergency preparedness and response management
- Leveraging technology for enhanced safety
- Emerging risks due to increasing complexities in a transient business environment
- Cyber security risks
- Other domain specific issues needing attention

Further details on each of the above focus areas are given in subsequent paragraphs below.

### 6.3. SAFETY CULTURE

6.3.1. Culture is traditionally defined as a “shared set of beliefs, norms and practices communicated through a common language”. In the absence of a healthy safety culture, even the best safety management practices will be largely ineffective in ensuring and sustaining good safety performance.

6.3.2. Building a healthy safety culture in an organisation needs the involvement and empowerment of all – management, supervisors, workers and even contractors. It is also observed that if the safety values are not consistently and constantly shared at all levels of management and among all employees, any gains that result from declaring Safety a ‘priority’ are likely to be short-lived.

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- 6.3.3. The safety culture of an organisation evolves over the time in response to various events, including changes in leadership and its management systems. The safety culture of an organisation therefore may also be viewed as reflecting prior events or prior defining periods in the history of the organisation such as ownership changes, reorganisations, financial difficulties, technological changes and management changes. Some of these prior events or defining periods may be common to similar organisations in the same industry or in similar situations. Others may be unique to a particular organisation. Local conditions and factors also affect safety cultures at a particular site.
- 6.3.4. Additionally, commercial considerations, including cost control and production, play a role in defining the safety culture of an organization. All organizations that produce goods and services not only face limitations on resources, including financial resource, but also must effectively manage the tension that exists between the operational demands relating to the production and those relating to safety.
- 6.3.5. What an organization believes is the appropriate balance between safety and production considerations, and how it organizes itself to accomplish this balance, serves in part to define the organization's safety culture. Risk awareness, consistency in compliance with rules and procedures, degree of tolerance for deviations and transparency in reporting, ownership of mistakes, seriousness in learning from past mistakes, meticulousness in safety audits, and management response to failures, all serve to define an organisation's safety culture.
- 6.3.6. Five essential elements of a positive safety culture are Shared Values, Leadership involvement, Two Way Communication, Continuous Learning and Accountability.
- 6.3.7. In order to develop a sustainable safety culture, it is essential to have a realistic assessment of the current state, and major factors influencing the same and plan for monitoring and constant improvement.
- 6.3.8. **Safety Culture Assessment**
- 6.3.8.1. Over the last two decades, there has been a steady growth in the use of maturity models to assess safety culture across a wide range of industries. Many organisations in Oil & Gas industry have also been striving to enhance their safety performance by using the maturity model as an assessment as well as an improvement tool.
- 6.3.8.2. Prevalent safety maturity models benchmark the organisations on a 4 or 5-point scale. The underline theme is that the safety performance of an organisation improves as it moves from Reactive (lagging) mode to Proactive (leading) mode. Organisations also move to a higher level of safety maturity, as they are increasingly informed and have increasing trust levels.
- 6.3.8.3. Various maturity models are in use, which sometimes use different terminologies. Two of the more commonly used safety maturity models, which are based on the DuPont Bradley Curve, which is a 4-point scale, and the Hudson Maturity Model, which is a 5-point scale, are described below. There may be more variants in use, but basic principles are likely to be similar.

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6.3.8.4. dss+ (DuPont)/ Bradley curve as given in Fig 6.1 below depicts four stages of safety maturity in an organisation namely (i) Reactive (ii) Dependent (iii) Independent and (iv) Interdependent.

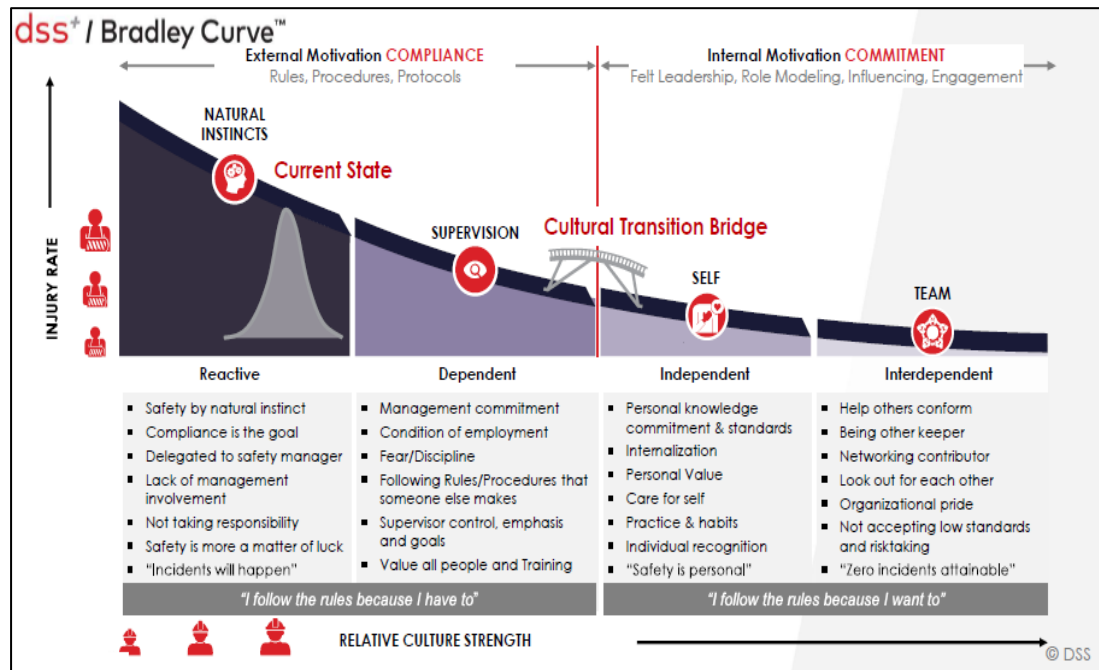


Fig 6.1: dss+ (DuPont)/ Bradley Curve for Safety Culture

6.3.8.5. Another commonly used model is the Hudson model for safety culture maturity as given in Fig 6.2 which classifies the safety culture of an organisation into 5 stages namely (i) Pathological (ii) Reactive (iii) Calculative (iv) Proactive and (v) Generative.

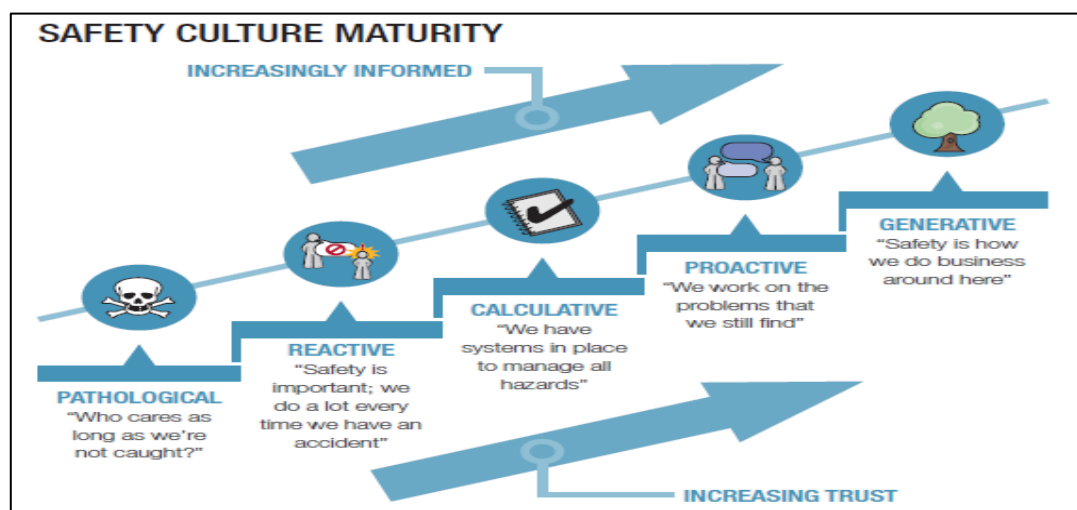


Fig 6.2: Hudson model for Safety Culture Maturity

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- 6.3.8.6. Many of the organizations in the Indian Petroleum Industry have conducted safety culture/ perception surveys either in-house or through third party agencies, in past. Some of them have used their own parameters and some have used parameters as defined in international benchmark maturity models. However, there is no defined interval or frequency for conducting such surveys on a regular and periodical basis to analyse the continual improvement in safety performance. Some of the perception surveys were conducted involving the representation mainly from management employees through questionnaires/ interviews and ignoring the views/ feedback from staff/ non-management and other stakeholders (Contractor/ Business partner/ Contract workmen). Also in some cases, findings of external surveys are at wide variance to in-house surveys.
- 6.3.8.7. For some organisations who have conducted the safety culture assessments using standard methodologies, the current maturity ranking has been observed to be in the range of 2 to 3 on the above models, which indicates 'Dependent' or 'Calculative' stage, and organisations have to work in order to graduate to the next stages of safety culture maturity.
- 6.3.9. Leadership Commitment to Safety Values**
- 6.3.9.1. The commitment to safety and the active engagement of leaders at all levels is critical to the development and continual improvement of the organization's safety culture. Their actions set the direction, expectations, and acceptable behaviours of the workforce and influence all aspects of the organization's culture. The maturity of the safety culture and level of organizational engagement is directly related to leadership commitment.
- 6.3.9.2. For the purpose of safety, leadership includes all who have a leadership role within the organization, regardless of title. While different levels of leadership have different responsibilities and different levels of influence over the safety culture, all levels of leadership have an obligation to build a sense of shared purpose and trust among team members.
- 6.3.9.3. Visible leadership commitment and engagement are vital pieces in creating and maintaining a robust safety culture. This visible commitment and engagement manifests in many different ways like leadership site engagements, resource allocation, prioritization, communication, policies, actions, response to an emergency situation / perceived risk and in everyday behaviour. A growing trend is to move a step further from 'visible' leadership to 'felt' leadership.
- 6.3.9.4. Leadership needs to articulate a clear message on the importance of safety, match that message with both the policies and the actions, clearly define expectations, set correct safety performance indicators and strengthen accountability at all levels.
- 6.3.9.5. In most organisations, leadership teams understand and are articulate about the importance of safety. However, policies and actions on the ground may not consistently match the intent and the expectation of the outcomes. In some organisations, safety is viewed more from the prism of compliance and avoidance of negative outcomes of an incident rather than a proactive trust building exercise among the stakeholders.

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6.3.9.6. In order to enlist leadership commitment to safety values proper safety orientation of the top leadership team is a must, which may need structured interventions.

### 6.3.10. Organization Structure

6.3.10.1. All organizations have dedicated Safety functions. The construct and the reporting structure of the safety function, however, varies from organization to organization depending on the business segment and the organization's philosophy.

6.3.10.2. Generally, at Head Quarter level, safety is a subgroup within Corporate HSE Department with the Head - Corporate HSE reporting to CMD/ CEO. In some organizations, the Head - Corporate HSE reports to a director level person.

6.3.10.3. Apart from corporate HSE, further safety organization is embedded in respective functions/Strategic Business Units/operating locations. The embedded safety function generally has administrative reporting to the line function but also has a dotted line relationship with the Corporate HSE. Corporate HSE provides necessary guidance and inputs to embedded safety functionaries in the performance of their role.

### 6.3.11. Monitoring Safety Performance (Leading and Lagging Indicators)

6.3.11.1. In order to monitor safety performance, most organizations have incorporated targets related to safety management as a part of Key Performance Indicators (KPIs) which have been cascaded down to SBUs (Strategic Business Units), departments as well as individuals in the annual appraisal system. These Safety Performance indicators can be broadly divided into two categories – lagging (reactive) indicators and leading (proactive) indicators.

6.3.11.2. Lagging indicators help in reactive monitoring and are suitable for examining the current level of occupational safety retrospectively and in comparison, with other companies. These indicators are based on data gathered regarding safety incidents and outcomes – events that have occurred and cannot be reversed. Some of the lagging indicators being followed by the organizations are:

- Incident/ Accident analysis
- Fatality accident rate (FAR)
- Lost time injury frequency rate (LTIF)
- Process safety events
- Severity of injuries and fatalities
- Road accident during transportation of petroleum products

6.3.11.3. Reactive monitoring based on the lagging indicators help organisations to identify and correct deficiencies in response to specific incidents or trends. By very nature, lagging indicators suffer from the disadvantage that they suggest corrective actions after the occurrence of an incident or event.

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6.3.11.4. Well recognised and generally accepted lagging indicators exist for personal safety but not for process safety because process safety accidents occur infrequently and are often unrelated to each other in their causal factors. Past process safety events may have limited value in predicting future process related events. Therefore, for preventing process safety related events, organisations need to develop leading indicators.

6.3.11.5. Leading indicators focus on risk control processes and provide a future outlook. Unlike lagging indicators, they do not focus on past events but instead concentrate on measures that can be implemented or existing conditions that can be amended in an effort to prevent future safety incidents. Active monitoring evaluates the present state of a facility through the routine and systematic inspection and testing of work systems, premises, plant and equipment, safety related systems etc. Leading indicators play a vital role in preventing accidents as well as strengthening the safety culture in the workplace and are referred to as “preventive indicators”. Some leading safety indicators being followed by the oil & gas industry are:

- Internal & External safety audit management
- Number of equipment inspected as per the schedule
- Timely turn-around of the facilities
- Management safety inspection
- Safety Training
- Mock Drills
- Implementation & certification of ISO 9001, ISO 14001, ISO 45001 etc.
- Reporting of Unsafe Acts & Unsafe Conditions
- Deliberations in Management review meetings and Safety Committee Meetings
- Suggestion schemes
- Recognition & reward schemes

6.3.11.6. It may be noted that lead indicators also may not always predict failure. For example, equipment may fail despite timely inspection. Hence, a judicious mix of carefully chosen leading and lagging indicators is to be used to monitor safety performance.

6.3.11.7. Most organizations are following some form of leading and lagging indicators and have implemented systems to monitor them. However, currently lagging indicators dominate performance metrics. Loss time injuries and fatality rates are the most commonly used indicators for measuring safety performance. Specific, measurable and outcome focused leading indicators are still evolving.

6.3.11.8. Many organisations have developed an in-house HSE Index to monitor safety performance. It does help in relative improvement on a time scale. However, there is no commonly adopted HSE Index framework among organisations to have peer comparison. Also, the elements or the measurement standards considered to derive at the HSE index, if not carefully chosen, may not be comprehensive or reflective of the true state of affairs. It may sometimes mislead or give a false notion of comfort to the management.

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6.3.11.9. Some of the organizations do benchmarking & monitoring of various HSE parameters through e-module like SAP. However, the effectiveness of such monitoring is yet to be established.

### **6.3.12. Specific Initiatives by Different Organisations to Improve Safety Culture**

Some of the specific initiatives taken by different organisations in the Indian Petroleum Sector to improve safety culture are listed below and can be considered for implementation across:

- Safety champion scheme to enhance the engagement and ownership among the employees for safety.
- Reward, recognition & penalty schemes for employees and other stakeholder/ business partners.
- Authority to stop work on observing any deviation from the standard operating procedure or as considered to be of imminent danger.
- Specific theme-based programs throughout the month to make employees and contract workforce aware of activity related hazards, risks & controls.
- Online reporting of accidents, near miss incidents, unsafe acts and unsafe conditions through a dedicated portal developed for the purpose. However, access to contractual workers is still an issue.
- Animated safety video for learnings from past incidents on major incidents.
- Use of a driving simulator for imparting training on road safety along with adopting the system to generate real time alerts for unsafe driving based on facial recognition technology.
- Implementing a psychological safety concept to achieve the goal of zero incident/ accident. Psychological safety is the environment where everyone feels safe and responsible to speak up openly with the belief that we can always improve, everyone can grow their ability and learn from unsafe acts/ unsafe conditions/ mistakes to make a safe and accident-free working environment.
- Safety inspection/ tour by Senior Management and follow-up for liquidation of action items.
- AI (Artificial Intelligence) based safety surveillance system to detect and report unsafe acts and unsafe conditions in the field.

### **6.3.13. Safety Budget**

6.3.13.1. Past budget constraints, leading to future safety incidents are not uncommon in the international history of accidents. Hence, every organisation necessarily needs to have a specific safety budget. Equally important is to have an objective and clear definition of what will constitute a safety budget.

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6.3.13.2. Most of the organisations have specific HSE budget, which is generally need based or program based. However, the clear bifurcation of the budget into the three heads of HSE namely Health, Environment and Safety is sometimes not available. It creates the possibility of the safety budget getting used on other heads within HSE resulting in a potential compromise on safety. It becomes even more important with increasing corporate sensitivity and focus on environment related items and the growing importance of ESG ratings in treasury management of the companies. It is, therefore, necessary to specifically identify safety budget and utilise it only for safety related items.

6.3.13.3. The safety budget of an organisation may depend on a number of factors like size, complexity, geographic spread, compliance requirements, vintage of the plant and machinery, specific initiatives, past efforts, resource availability, risk perception, surrounding areas, new expansion/ revamp plans, safety culture, management commitment to safety etc. However, the safety budget, which can be an important leading safety performance indicator, is not benchmarked. Even in cost estimates for major projects, an exclusive budget for safety items or emergency preparedness is not mentioned as a separate head.

6.3.13.4. It may be worthwhile to monitor safety expenditure per unit of production or as a percentage of the total cost of the project and compared in the peer group.

6.3.13.5. It is also preferable to sub-classify the safety budget into major heads like

- Routine or Specific
- Replacement or Addition
- Maintenance or Improvement
- Corrective, Preventive or Predictive
- Safety Promotion, Safety Training and Safety studies
- Firefighting and Emergency Readiness etc.

### **6.4. COMPETENCY ASSURANCE OF COMPANY EMPLOYEES**

6.4.1 All major Oil and Gas Companies have some sort of formal/ informal competency assurance programs to assess competency required, available, gaps and interventions. The structure, depth and intensity of implementation of the competency assurance program however varies from organization to organization depending on the line of business, size of the organization, company's HR (Human Resources) policies, resource availability and involvement of the senior management in competency assurance programs.

6.4.2 A robust competency assurance program necessarily needs to have a clear definition of competency requirements for each position, periodic assessment of the competencies of available employees, competency gap identification at the organization and at an individual level and structured interventions to bridge the gaps both organizationally and individually. It is to be further supported by periodic

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reassessment to identify new/ residual competency gaps and continuous efforts to bridge the same through refresher programs or new interventions. Technological changes and new business processes throw up new skill requirements necessitating continuous upgradation of competency of available manpower/ hiring new skill sets.

6.4.3 Following observations are recorded with respect to competency assurance for company employees related to safety. The competency assurance for the extended workforce engaged by contractors is dealt with in a separate section of the report dealing with contract management.

### 6.4.4 **Competency Assessment**

6.4.4.1 Organisations have job descriptions, qualifications and experience/ grade requirement metrics for various positions basis which recruitment/ placements take place. However, very few organisations have a structured mechanism for mapping the competency requirement at the organizational and individual level for each position/ band of positions.

6.4.4.2 Some organisations have implemented a system of assessing the competencies of individual employees through 'Competency Assessment Centres'. However, very few organisations have a robust mechanism for placements of individual employees considering the competency requirements of specific positions/ groups of positions.

6.4.4.3 Many times, officers are drawn from their regular work, to be part of teams to carry out specialized tasks related to safety like HIRA (Hazard Identification and Risk Assessment), QRA (Quantitative Risk Analysis), Multi-disciplinary safety audits etc. with no formal training on these tasks. It affects the quality of the output of these studies/ audits and the overall safety performance.

6.4.4.4 Not all organisations have a structured mechanism of training/ retraining/ refresher programs as a mandatory part of the competency assurance program.

6.4.4.5 Competency requirements for the organisation/ individuals need periodic reassessment to identify and bridge residual/ new competency gaps especially considering changing business needs and technological advancements.

6.4.4.6 Structure/ contents of retraining/ refresher programs needs periodic review and updation to cater to changing business needs, and technological advancements and to incorporate learnings from past incidents.

6.4.4.7 While major oil and gas companies have online records of training provided to their employees, the correlation of training records of an individual to positional competency requirements is generally not available.

### 6.4.5 **Training Content and Training Effectiveness**

6.4.5.1 All major organisations have been subjecting their employees to various training programs during the course of their employment. Major organisations either have their own training facilities for imparting functional, behavioural and managerial training or use the services of professional bodies/ specialized training institutes/ academic institutions for the same. Some organisations have also entered into arrangements with leading educational institutes/ professional bodies for tailor

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- made programs depending on their needs. However, in spite of the intent and the efforts, further strengthening is needed in the structure, content and delivery of the training/ skill upgradation/ competency development programs. Fast changes in technologies, increased complexity in operations, higher mobility of the younger workforce, preference for white-collar jobs and increased job opportunities for skilled manpower within India and abroad are only making the imperative stronger.
- 6.4.5.2 Companies have a system in place for providing overall induction training/ orientation to the newly recruited officers. Job specific/ location specific inputs/ training is also generally provided on the initial postings. However, the intensity of job specific/ location specific knowledge dissipation gets diluted in subsequent postings when an existing employee gets transferred to a new location/ new department or takes up a new role in the organization. Orientation and retraining with specific knowledge dissipation for new assignments/ location/ departments needs to be a mandatory part of the transition and Handing Over -Taking Over (HOTO) process for all assignments.
- 6.4.5.3 The balance between functional, behavioural and management training as per the requirement of different positions in the hierarchy needs a review to ensure that focus on technical and safety training is not compromised especially at junior and lower middle management levels.
- 6.4.5.4 Companies do have a system of employees projecting their training needs either as a part of the performance appraisal system or separately. However, gaps have been observed in the alignment of training provided vis a vis training needs of individuals.
- 6.4.5.5 Safety is an essential part of operational management. Domain training while including known emergency situations and desired responses, it does not necessarily develop safety orientation, which may help in the inherently safe performance of the functional assignment. Current safety training is mostly focused on 'occupational safety' and 'process safety' orientation is yet to get the required impetus.
- 6.4.5.6 Based on the experience and learning from incidents, the oil industry has been consistently upgrading its processes, technologies and protocols to make the operations increasingly safer and limit the impact of any untoward incident. However, the complexities and the number of variables involved in operations coupled with hazards associated with the material handled, time available to respond and man/ machine interface in a dynamically changing environment generates the probabilities of unprecedented, unexpected and unintended situations in real time operations. Operating staff is to be proactively prepared technically and temperamentally to respond to such unexpected situations. The training, therefore, needs to have a combination of classroom training, simulation training and field training in real life for building confidence and adequate response in case of emergency situations. It needs infrastructure and facilities like operation training simulators (OTS) for simulating process events and emergency situations, facilities for training for fighting live fires in different situations, working in enclosed spaces, working at heights, sea survival training for offshore operations and regular mock drills for different possible scenarios. However, not all the organisations have

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the infrastructure for conducting such training. Even in organisations that have operation training simulators, the full potential of the same is yet to be harnessed.

- 6.4.5.7 Films/ video clips of real-life safety incidents or animations wherever available are being used in safety training. However, the systematic collection of the footage from real life incidents and producing training content is not yet institutionalized in India.
- 6.4.5.8 Training effectiveness, especially in the area of safety, can be vastly improved by using modern techniques and training tools like 3D images, augmented/ virtual reality, interactive applications etc. Recently some organisations have deployed Virtual reality techniques as a training medium, however use-cases are few and in the initial stages. It needs expeditious propagation. It is emphasized here that computer-based training modules can only be an aid but not an alternative to physical training programs. Over-reliance on computer-based training can sometimes lead to inadequate preparedness to deal with real time emergencies.
- 6.4.5.9 It is observed that the metrics for judging training performance are generally output based rather than outcome based and are judged basis training man-days or training hours spent rather than the competency upgrade achieved and the effectiveness of the same on the job. The process of follow-up assessments post training after some time to check the effectiveness of the training on the actual job is not much prevalent. It also needs alignment and more intense engagement between functional departments and the HR department on the objective and desired outcome of a particular training program right from the conceptualization stage.
- 6.4.5.10 In some organizations, training is not a part of the Key Performance Indicators (KPI)/ Key Responsibility Areas (KRA) of the individual employees. Even in organisations where Learning and Growth is an essential part of Balance Score Card Metrics used for performance appraisals, the effectiveness of the same gets diminished if the same is not outcome based.
- 6.4.5.11 Instances have also been reported wherein the quality of the external agencies/ faculty deployed for specialized training was not up to the mark. Organizations have quoted the need to select parties on L1 bid basis and purchase guidelines being restrictive of using QCBS (Quality and Cost Based Selection) methodology for this purpose as a reason. However, different companies have different practices regarding the selection of training agencies depending on the needs and the area of training. Any procedural impediments in ensuring the deployment of the right agencies for imparting specialized training related to safety needs to be addressed by the management of the organisations concerned.

**6.4.6 Industry Engagement, Knowledge / Information Sharing & Peer Learning**

- 6.4.6.1 It has been highlighted that the industry hesitates in sharing their experiences or incidences proactively so that similar incidents may be prevented in other places. In developed economies, publishing well-documented case studies on major safety

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incidents is a common practice. In India, companies hesitate to do the same mainly due to fear of out of context selective use of the information, negative public response, media glare, loss of reputation, harassment from interest groups/ unscrupulous elements and long drawn litigations.

6.4.6.2 There are only limited professional forums for candid discussion on common issues, lessons learnt from major incidents, best practices, innovation & new initiatives among the industry members related to safety.

6.4.6.3 Medium and small upstream operators do not have the necessary infrastructure & facilities for providing training. Utilization of training facilities across the industry members is also not a generally prevalent practice.

**6.4.7 Qualification / Certification of Safety Officers**

6.4.7.1 As per the Factory Act and Rule thereunder, safety officer(s) are required to be appointed as per the applicable norms for any manufacturing process or operation involving any risk of bodily injury, poisoning or disease, or any other hazard to health. The qualification and requirement of the safety officer as per Factory Rule varies from state to state.

6.4.7.2 As per the Factory Act and Rule thereunder, the safety officer should possess a recognized degree in any branch of engineering or technology and should have practical experience of working in a supervisory capacity for a period not less than two years. In addition, he should also possess a degree or diploma in industrial safety recognized by the Central Government.

6.4.7.3 Additionally, in some states, safety officers should have adequate knowledge of the language spoken by the majority of the workers in the region in which the factory is situated.

6.4.7.4 In upstream, as per OMR 2017, a safety officer is appointed to assist the manager of the mine. The safety officer appointed shall hold a degree or diploma in engineering; or degree in science; or a degree in industrial safety from an educational institution recognised by the Central Government or a post-graduate diploma in industrial safety from a Regional Labour Institute and has experience in the management or supervision of operations in oil mines for a period of not less than eight years in case of diploma in engineering and degree in science; and five years in other cases.

6.4.7.5 As such in E&P installations (Rigs and Production Installations), there is no specific statutory requirement to appoint a dedicated safety officer. Current practice in E&P companies is to assign the safety officer's job additionally to Assistant Installation Manager. As there is no specific requirement of a degree or diploma in industrial safety recognized by the Central Government for the safety officer in OMR 2017, in E&P installations safety officer are generally not having said degree/ diploma.

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**6.5. SAFETY MANAGEMENT OF OUTSOURCED & CONTRACTED OUT JOBS**

- 6.5.1 A significant part of the work in the oil & gas industry is carried out through outsourcing. The outsourcing has continued to increase significantly in the last few years and the trend is expected to continue.
- 6.5.2 Outsourcing may include only services or may include the supply of equipment/ material and/or engineering also. EPC contracts on an LSTK basis in major projects and outsourcing of operation and maintenance of facilities in entirety through contracts is also very common. This could involve the deployment of outsourced manpower either directly or through contracting agencies.
- 6.5.3 Fundamentally, there is no issue with outsourcing or contracting out a part or whole of a job as far as the right agency and competent resources are deployed with proper supervision. Rather at times, it is unavoidable or desirable. However, the risk of incident increases significantly if the work is executed through an agency, which is not competent or experienced to carry out similar types of jobs. Additional risks get induced, in case of inadequate planning and communication, inadequate monitoring and supervision, a new working environment with unknown hazards, complexity of work and lack of clearly defined roles & responsibilities. Quality of resources deployed by the contractor at the site including man, machine & supervision and safety orientation of the top management of the contracting agency towards safety are very critical elements.
- 6.5.4 Incident data of the last decade suggests vulnerability among the contractual workmen in the oil & gas industry, which shows that the contractor safety management needs a fresh review to strengthen the system further.
- 6.5.5 Primarily, it is the responsibility of the company (designated operator in case of upstream) to ensure robust and effective safety management for all outsourced work. The company needs to ensure that the safety management system, standards and expectations from the contractors are the same as those applicable to the company and its employees.
- 6.5.6 Safety management of outsourced works needs to be incorporated/ ensured through the entire lifecycle of the contracted work starting from the planning stage, continuing through the tendering process, pre-qualification, formal contract, bridging document, induction of workforce, execution of the work, close-out and rating of the contractor after completion of the work. The following observations are made in this regard:
- 6.5.7 **Criteria for Outsourcing Decision**
- 6.5.7.1 Variations are observed in the type of jobs being outsourced within the industry. Even within the same organisation, variations have been observed from location to location regarding the practices followed. Consideration of the safety angle in the decision-making process for outsourcing is not explicit. Organisations also do not

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seem to have structured metrics to decide on the jobs that can be outsourced. It is desirable to define the criteria to be followed for outsourcing the decision of a job, in which safety should also be an important criterion. The criteria can be revised depending on the needs from time to time through appropriate approvals.

### 6.5.8 Classification of Contracts Depending on Risks Involved

6.5.8.1 There are varieties of works being outsourced in the oil & gas industry. It may include major project works on a turnkey or conventional basis, turnaround maintenance of plants/ facilities, charter hire of rigs or vessels, operation and maintenance of complete facilities like depots/ terminals/ LPG bottling plants, transportation of petroleum products and other highly specialised services. It may also include services like large equipment transportation through road and sea routes, heavy lifts for equipment installation, replacement or refurbishment, regular maintenance or routine cleaning, electrical systems of different voltage ratings, cleaning of tankages etc. All of the above represent works demanding differing levels of skills, commitment and resources and have varying levels of associated risks. Risk dimensions will also vary depending on the situation under which the job is being carried out like - in a running plant or shutdown plant, under brownfield conditions or green field conditions, emergency job or a planned job, in good weather conditions or bad weather conditions, standalone job or with other concurrent jobs, at ground level or at height, in open space or enclosed space etc. The level of supervision & oversight possible from the company side at a particular location and time may also have a bearing.

6.5.8.2 It is observed that safety risks associated with the jobs are not given due consideration by many organizations while selecting the agencies for floating tenders or finalising the tender document. It is desired that companies carry out a risk assessment of the works during the planning stage and classify the work as per their associated risks on a four-point scale such as extreme, high, moderate and low risk. Suitable criteria may accordingly be included in the tender enquiries. A visible risk rating of the job will help in better focus on specific safety elements of the jobs based on the requirements.

### 6.5.9 Incorporating Safety Requirements in Tender Documents

6.5.9.1 One of the key reasons for not being able to hold the contracting agency accountable or enforce the safety requirements effectively is ambiguity/ deficiency in the contract documents regarding safety requirements, safety performance expectations, contractors' obligations, deterrents and accountability/ responsibility metrics.

Depending on the type and complexity of the job, tender documents should include, safety related requirements, which may include:

- Clear expectations related to managing the work safely, safety performance, training etc.
- Company's safety policies, procedures
- Roles and responsibilities of the contractor's key personnel (including their management teams) related to safety

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- Communication protocol between the Company, the contractor and their subcontractors
- Essential Processes for eliminating or reducing risks like work permits, PPE requirements, induction training, toolbox meetings, scaffolding standards, barricades, site housekeeping, day start and day end processes, heavy lifts processes, enclosed space entries, gas tests and hot work permissions, special requirements, concurrent job risks etc.
- Procedures for handling policy and procedural non-compliance, including contract termination and blacklisting/ holiday listing for future jobs.
- Procedure for handling changes to processes, procedures or control
- Safety culture etc.

6.5.9.2 Though some elements of safety requirements are incorporated in the tender document, others need to be included depending on the risk category and complexity of the job. It may be preferable to have a vetted standard safety requirement document applicable to all jobs and a second attachment (if so required) specifying requirements applicable to the particular job.

### 6.5.10 Contractor Selection

6.5.10.1 Generally, a contractor is selected through a process of competitive bidding on a limited or public tender basis unless services are of specialised or proprietary nature. Technically acceptable L1 bidder is generally the selected contractor. Either contractors to whom the tender is floated are out of a prequalified list or prequalification criteria are specified in the tender document. In some cases, Quality and Cost Based Sourcing (QCBS) methods are adopted if so required.

6.5.10.2 Safety criteria are generally not included in the prequalification criteria or while selecting the potential bidders for floating tenders. It is desirable that past safety performance of the contractor on similar types of jobs and the company's orientation to safety is also checked while selecting of the contractors. Companies can adopt suitable mechanisms for the same. A point system with suitable weightage for past safety performance judged through fatalities, loss time incidents, reported deviations, compensation paid, penalties charged, litigations etc. can be devised. Some weightages can also be given to the company's safety policies, practices, training system etc.

### 6.5.11 Bridging Document for Safety Management

6.5.11.1 Most of the major companies prefer their safety policies and procedures to be uniformly followed by the contractors. However, some of the major national/international contracting agencies prefer to follow their own safety systems, as their workers are well conversant and trained with the same. In such cases, there is a need for a bridging document between the company's and contractor's safety management document to clearly depict the actions required where the contractor's system is at deviation to the one followed by the company or where the contractor's document is ambiguous or silent.

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- 6.5.11.2 Practice of bridging documents is more prevalent in the upstream sector for major contracts. However, variations are observed in the contents of the bridging documents. The RACI chart (responsible, accountable, consult, inform) which depicts the responsibility metrics is not found in some bridging documents. Emergency response with clear guidelines, which should be a part of the bridging document, is also sometimes missed. In some cases, the HSE management system of the contractor is passed on as the bridging document, while in some, HSE clauses of the contract are assumed as the bridging document.
- 6.5.11.3 Wherever required, a properly drafted unambiguous bridging document between Company/ operator and the contractor is essential to avoid any confusion or lack of ownership.
- 6.5.11.4 Downstream companies mostly have been insisting on their own safety management systems to be followed by the contractors as a part of the contract. Sometimes in major projects, these systems are defined by the PMC in consultation with the Company to be uniformly followed by all the contractors.
- 6.5.12 Emphasis on Safety in Pre-bid Meeting and Kick-off Meeting**
- 6.5.12.1 Pre bid meeting is held after floating tender and before bid submission to clarify any technical or commercial doubts to the prospective bidders. Kick off meeting is held after the award of the job and is used as an opportunity for the contractor to become familiar with the location, facility, personnel, and other work information.
- 6.5.12.2 In both these meetings while technical, commercial and scope related aspects get discussed, the company's expectations on safety are generally not emphasised unless the job needs any specific precautions.
- 6.5.12.3 Pre bid meeting can be very effectively used to highlight the safety related expectations and the requirements of the company. It will help in contractor properly assimilate the safety requirements of the company, clarify his doubts and submit a bid considering the same. Similarly, a kick-off meeting is an important bridging step in working together to prevent incidents and resolve any safety issues.
- 6.5.13 Contract Workmen Training and Skill Development**
- 6.5.13.1 With a significant amount of work in the companies being undertaken through contracts, it is necessary that the workforce deployed possesses an adequate level of competence for undertaking the assigned work. The tendency of contractors to deploy inadequately trained workmen on the job has been observed to be an important contributor to many safety incidents. There are institutes providing training and certification for specific skills including ITIs, Skill Development Institutes (SDIs)/ Hydrocarbon Sector Skill Council (HSSC) and more are being set up/ upgraded. Major contractors also have their own facilities to train their workers. This is in addition to workers skilling themselves through on the job learning by assisting skilled workers. However, ensuring that workers get deployed on the job only as per their competence and skill has been an area of concern in view of heterogeneous demography, uneven employment opportunities, mismatch in skill set available vis

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a vis requirement, lack of emphasis on vocational skills in schools and colleges and lack of insistence by the executing agencies to demand quality resources.

6.5.13.2 As far as safety is concerned, a worker's general safety behaviour, knowledge about his tasks and related tasks including safety aspects, awareness of associated risks and actions required in emergencies are important. Companies generally achieve this through safety induction programs, toolbox talks, periodic training and refresher training, and safety audits.

6.5.13.3 Induction to the contractual workforce at a new place is very important to familiarize them with the location, facilities, specific hazards, procedures, emergency management etc. This is being carried out in general, however the content coverage is sometimes not adequate and, in some cases, evidence of such training in the form of record is not maintained.

6.5.13.4 Contractual workforce is sometimes rotated/ assigned different nature of jobs, basis the needs and requirements of the installation. Gap analysis (along with commensurate action) with respect to the competency/ induction requirement for the newly assigned job is often missed out.

6.5.13.5 In upstream, emergency/ survival training like firefighting, first aid, well control, survival at sea & HUET for offshore have found mention in some of the contract documents. These are generally provided through third party agencies who also provide certification.

6.5.13.6 Recent HLC (High Level Committee) reports for some incidents in the upstream sector, not only highlighted the gaps in the competency of the contractor's workforce, but also brought out gaps in the authenticity of certificates as well as weakness in the verification process of the training certificates by contractor & operator. As per the HLC report, the veracity of certain training certificates and the institutes issuing them were not completely reliable. Some training certificates were found to have been issued by institutes not accredited for imparting the said training.

6.5.13.7 It is therefore, necessary that safety training be conducted either by the company or through agencies after verifying their credentials and certification thoroughly verified.

### 6.5.14 **Safety Performance Monitoring and Safety Rating**

6.5.14.1 There is no uniformity in measuring the safety performance of the contractor during and after the execution of the contract. It differs from organisation to organisation. Differences are also noticed between different units of the same organisation.

6.5.14.2 Very few companies have a structured safety performance monitoring of the contractor. Some organisations incorporate a checklist in the contract, developed on certain safety parameters, for periodic evaluation of safety performance as a routine procedure. However, the effectiveness of such monitoring is not ensured.

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6.5.14.3 Fatalities and loss time incidents normally get reported, but other small incidents sometimes escape reporting.

6.5.14.4 A well-structured, transparent and objective safety performance rating system for contractors is therefore recommended to create motivation in the contractor to maintain a high safety performance level and help in the selection of a competent agency.

6.5.14.5 The safety rating should take into consideration the job safety performance of the contractor as well as the company's safety policies, practices and training methodologies. The safety ratings should also be shared with the contractors.

### 6.5.15 Incentive Schemes/ Penalty Clauses for Safety Violations

6.5.15.1 Downstream companies generally have clauses imposing financial penalties for safety violations in the contracts. However, the penalties have not been sufficient to cause enough deterrent against safety violations. Upstream companies do not seem to have such penalty clauses in their contracts.

6.5.15.2 Very few organisations have incentive scheme in contracts, which values HSE performance.

6.5.15.3 It is recommended to have suitable financial penalties in all contracts for safety violations. An incentive scheme can be considered after a robust reporting mechanism for all safety violations is in place and safeguards are built up to ensure that the incentive scheme does not motivate the contractor to suppress the reporting of safety incidents.

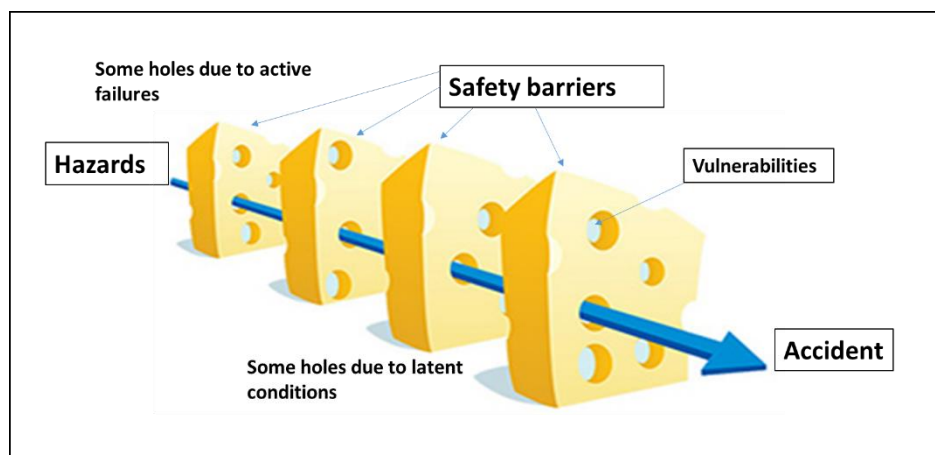
## 6.6. MANAGEMENT OF SAFETY BARRIERS

6.6.1 A safety barrier is anything that is purposefully put in place to eliminate or reduce the risk of an undesirable event. Safety barriers may also be put to delay the occurrence of an event to give time to respond, limit the duration or reduce the impact. Any system may include multiple safety barriers implemented through various means like inherently safe design, standard operating procedures (SOPs), management of change process, warning system, emergency response system etc. These will broadly pertain to Plant, Process and People.

6.6.2 Safety Barriers can be represented using the "Swiss Cheese" model developed by James Reason and Dante Orlandella. It likens safety barriers to multiple slices of Swiss cheese, stacked side by side.

6.6.3 The Swiss cheese model focuses on the active and latent failures that are represented as 'holes' in the barriers and the potential for this 'hole' to be breached. The potential for a major accident increases when these holes line up, because in such a situation, any deviation will push through all the barriers and result in a bigger incident.

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**Fig 6.3: Swiss Cheese Model for Safety Barriers**

- 6.6.4 Hazard identification and risk management should identify suitable barriers (Slices of cheese) with minimising potential breach areas ensuring that potential breaches in one layer do not align with another. In other words, a problem will not lead to a major incident because at least one barrier will prevent the problem from propagating further.
- 6.6.5 Some of the important safety barriers being used in the oil & gas industry and the observations related to the Indian Oil and Gas Industry are given below:
- 6.6.6 **Inherent Safety in Design**
- 6.6.6.1 Inherent safety during design is the first and most effective safety barrier. Various national and international codes and standards like ASTM, API, ANSI, DIN, IS, OISD etc. as applicable are followed with appropriate factor of safety in design. Hazard and Operability Study (HAZOP), Quantitative Risk Analysis (QRA), and Safety Integrity Level (SIL) studies are carried out to identify risks and take necessary mitigation measures. Fail-safe modes for various equipment and instrumentations are defined. Pressure relieving devices, expansion loops, safety interlocks, emergency shutdown devices, flare system, cathodic protection, earthing grid etc. are some of the elements introduced at the design stage for the safety of the system.
- 6.6.6.2 During construction, various equipment, material, and system is subjected to quality assurance and functionality checks to ensure conformity to the design. Trips, alarms and Emergency Shutdown Systems are tested for functionality before commissioning.
- 6.6.6.3 Pre-commissioning Safety audits (PCSA) is also conducted before commissioning of the new/revamped facilities after mechanical completion and before start of commissioning of the new facilities. For major projects in PSU Oil companies, PCSA is carried out through the OISD team.

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6.6.6.4 In some cases, the metallurgy of certain components in the field was found to be at variation to design intent. To take care of the same, positive metal identification techniques are being deployed after installation to avoid mix up especially where multiple metallurgies are in use in the same plant. Space limitation in existing facilities poses challenges in drawing layouts meeting all standards for new brownfield expansions/ revamps and needs engineering ingenuity to successfully carry out such projects.

### 6.6.7 Hazard Identification and Risk Assessment (HIRA)

6.6.7.1 HIRA is a collective term that encompasses all activities involved in identifying hazards and evaluating risk at facilities, throughout their life cycle, to make certain that risks to the workforce, the public or the environment are consistently controlled within the organization's risk tolerance. HIRA encompasses the entire spectrum of risk analysis, from qualitative to quantitative. HIRA is also used as a tool for identifying operability concerns and opportunities for continuous improvement.

6.6.7.2 Indian Oil and Gas Industry has HIRA processes in place. However, the general understanding and the seriousness of HIRA are less than satisfactory in some organisations. Gaps are observed during audits regarding the review and updation of the HIRA report (Risk Register) at the desired frequency or after significant events. In some organisations, concerns are also raised on the comprehensiveness of the risk assessment for all probable hazards and the composition of teams performing HIRA, which necessarily need to include people with expertise in respective areas like technology, engineering, process operations, instrumentation & control etc.

6.6.7.3 Hazard and operability study (HAZOP) and Quantitative Risk Analysis (QRA) are specialised HIRA studies required for the process industry. While HAZOP and QRA is mostly done by the industry at the project stage, gaps have been observed at periodic review and updation at a specified frequency. In some cases, HAZOP recommendations are not fully implemented in a time bound manner. Gaps have also been observed in terms of the identified hazard and the effectiveness of the recommended mitigation measures.

6.6.7.4 Job safety analysis (JSA) is a structured tool that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the worker, the task, the tools, and the work environment. Ideally, the safeguards are supposed to be in place against identified hazards to ensure the job is executed safely. JSA is generally carried out before a non-routine operation (mostly controlled by a work permit), which is explicitly not covered in HIRA. Gaps have been observed in the rigour with which the JSA is carried out and sometimes have been observed to miss the critical job specific hazards.

### 6.6.8 Management of Change (MOC)

6.6.8.1 Management of change (MOC) is an important element under the Safety management system of an organisation. It is a systematic approach towards any hardware or software changes to be undertaken in the existing system, so that all associated hazards of the proposed change are identified and effective control/mitigation measures are put in place including revision of documents, SOP etc.

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6.6.8.2 All major organisations have established well defined MOC systems. However, gaps have been observed in certain aspects of MOC implementation such as the implementation of some schemes/ changes in the field without approved MOC, HAZOP not being done for all MOCs, P&ID and operating manual not being updated after MOC implementation etc. MOC compliance for change in safe operating envelope/ trip settings of equipment/ prolonged bypassing of safety interlocks is found to be low in many organisations.

### 6.6.9 Life Saving Rules

6.6.9.1 Lifesaving Rules set out clear and simple “do’s” and “don’ts” covering activities with the highest potential safety risk. They draw attention to the activities most likely to lead to a fatality and the life-saving actions, which an individual must follow as mitigation measures to protect themselves. Lifesaving rules require absolute compliance from every person in the workforce (employee or contractual workmen) all the time as any violation could result in a fatality or major process safety event.

6.6.9.2 Such rules exist in major Indian oil & gas organisations with the names like Lifesaving Rules, Lifesaving Cardinal Rules, HSE Rules, Loss Control Rules etc. The general awareness about such rules, however, is observed to be lesser than desired particularly among the workers and contract workmen. The mechanism to implement these rules and to observe deviations is also observed to be generally weak.

### 6.6.10 Work Permit System

6.6.10.1 Working in hydrocarbon processing/ handling installation presents a special risk. In order to ensure safe working conditions and to carry out the work safely, the work permit system is followed in the oil & gas industry. In general, Indian oil & gas companies follow a work permit system in line with OISD-STD-105. Training is also provided regularly on the work permit system. Many companies have implemented e-work permit systems.

6.6.10.2 However, cases have been observed where some of the entries as required in the work permits are either not made or not made properly (for example: LEL reading missing in the hot work permit, oxygen data missing in confined space work permit etc.). Deviations in the effective implementation of electrical lock-out tag-out system have been found in many installations. Cases have also been observed during audits where jobs were started or were in progress without valid work permits. Specific and unambiguous mention of precautions required due to other concurrent jobs in progress has also been found missing in some cases.

6.6.10.3 Instances have been observed where toolbox talk/ meetings are found to be not adequately covering hazards associated with the job and mitigation measures identified through JSA.

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### 6.6.11 Mapping and Monitoring of Safety Critical Equipment (SCE)

6.6.11.1 Safety critical equipment are those equipment or system which are essential for the overall safe operation of the plant or the processes at any installation and needs to be in healthy condition at all times. Identification of safety critical equipment is therefore a critical process in any type of industry. Largely, installations are having a list of safety critical equipment and they are well mapped in the maintenance plan.

6.6.11.2 However, few organisations have not identified a list of safety critical equipment with their maintenance/ calibration/ testing plan. In some cases, Safety Critical Equipment have been identified but gaps were found in their health assessment for example - the pressure safety valve is overdue for scheduled maintenance & inspection/ testing.

### 6.6.12 Safe Operating Envelope

6.6.12.1 Safe operating envelope is a defined band of values for various operating parameters which if not breached will keep the plant operation within safe limits. Safe operating envelope limits are not supposed to be breached. In very special circumstances if a limit is required to be breached, the same is to be done only with proper risk evaluation and authorisation. Generally, the safe operating envelope limits are defined in DCS or SCADA systems as alarms before trips and are connected to annunciators to give warnings in case these limits are being approached. These limits may become extremely critical in start-up, shutdown and unsteady state operations. A formal documented Safe Operating Envelope eliminates or reduces the chances of judgemental errors and extraneous pressures influencing operations. Safe Operating Envelope may also include parameters, which are not available in DCS and are field monitored.

6.6.12.2 The operating crew generally have a safe operating envelope in their mind, adopted by them as a part of the operating manual, SOPs, supervisor's instruction, training or experience but very few organisations have a robust formal well-documented management process for the same.

6.6.12.3 In addition to Safe Operating Envelope, of late focus is also placed on Integrity Operating Windows (IOWs). Integrity Operating Windows has established limits for process parameters that affect the mechanical integrity of fixed equipment and piping. When operating parameters deviate from these limits, degradation is more likely to occur. IOWs should be considered as a subset of a larger group of unit operating parameters. If unit operations are kept within these limits, degradation should be predictable; however, this does not necessarily mean a low rate of damage. For example - breaching a pressure limit may cause the rupture of a pressure vessel and will be part of the safe operating envelope while consistently operated at higher than specified velocity may cause faster erosion of the piping system and will be a part of IOW.

6.6.12.4 In the Indian Oil and Gas Industry, the safe operating envelope is generally defined and followed by the Operations department. Asset Integrity Management is generally handled independently by Inspection and Maintenance department.

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Consciousness about the Integrity of Operating Windows among the operating crew is low.

### 6.6.13 Emergency Shutdown (ESD) System and Alarm Management

6.6.13.1 Emergency Shutdown (ESD) systems are specialized control systems to protect personnel, plant and the environment in case the process goes beyond the control regime or safe operating envelope. ESD is a vital layer of protection for providing safe operations and is designed to minimize the consequences of an emergency situation, such as overflowing, escape of hazardous materials, outbreak of fire etc. by taking the system to safe shutdown.

6.6.13.2 Emergency shutdown can be activated either through a pre-programmed logic controller or manually. ESD can be triggered manually from the field or from the control room. Oil & gas installations have different levels of ESD systems like unit shut down, process shut down, fire and gas shut down and total shut down. ESD is a part of plant design.

6.6.13.3 Similarly, an alarm management system is to alert the operator about abnormal operating situations in any process plant. The purpose of an alarm system is to direct the operator's attention towards plant conditions requiring timely assessment or action to safeguard the unit.

6.6.13.4 Oil & gas installations, in general, have robust ESD and alarm management systems. However, gaps have been observed during audits with respect to the location of ESD switches in the field for accessibility and availability in emergency, periodic checks on the integrity of ESD at specified frequencies and record keeping of the same.

6.6.13.5 It is also observed that judicious alarm rationalisation has not been carried out by many organisations. As a result, too many alarms are observed in the system including faulty/ superfluous alarms. A large number of alarms affect the span of attention of the operator with the possibility of even important alarms not getting due attention. Cases have also been observed where alarm values were found changed without following any deviation approval or MOC (management of change) process.

### 6.6.14 Trip Bypass Management

6.6.14.1 Process plants are designed with systems to trip the equipment or the plant automatically to either protect the equipment/ the plant or to prevent any unintended consequence or safety event in case certain parameters go out of control regime. Trips are not supposed to be bypassed in normal circumstances. In case of any such requirement, there is supposed to be a robust and well-defined trip override authorisation procedure along with alternative control measures in place to safeguard the system. Operations with trips bypassed/ overridden are to be carried out only with due approvals as per trip bypass policy/ procedure. For each trip bypass, a record is to be maintained including the start and end time of override. No long-term override (as defined in the override procedure) is permitted unless a proper MOC is in place. Trip overrides are supposed to be recorded in the daily shift log and communicated during shift handover.

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6.6.15 Oil & gas installations have a well-defined trip override procedure. Alternative control measures required in case of the need for any trip override are also documented. However, cases have been observed of Trip bypass/ settings changes without approval from the competent authority or without alternative mechanisms in place. Cases of some trips under bypass for prolonged durations are also observed.

### 6.6.16 Reporting Process Safety Event (PSE), Near-Miss, Unsafe Act & Unsafe Condition

6.6.16.1 A Process Safety Event can be defined as an unplanned or uncontrolled loss of primary containment (LOPC) of any material including non-toxic and non-flammable materials (e.g., steam, hot condensate, nitrogen, compressed CO<sub>2</sub> etc.) from a process, or an undesired event or condition that under slightly different circumstances could have resulted in a loss of primary containment of a material. Process safety events represent incidents with greater consequences due to weaknesses in the barriers. When used in conjunction with lower tier indicators, it can provide a company with an assessment of its process safety performance and will give early leads in identifying key process safety failures, which may otherwise lead to major process safety incidents.

6.6.16.2 Currently only a few organisations are mapping Process Safety Events, as it is not a mandatory requirement by any statute as well as OISD standard at present. OISD recently revised standard on Safety Management System OISD-GDN-206, has defined and touched upon the Process Safety Events.

6.6.16.3 As far as personal safety incidents are concerned, Oil & Gas installations largely have a robust system of reporting incidents & near misses. Most companies have also shifted to e-module for the same.

6.6.16.4 Reporting of unsafe acts & unsafe conditions is also being done in some organizations. However, it is observed that many unsafe acts/ conditions noticed during OISD audits have not been captured in the system otherwise. Participation by the contractual workforce is observed to be low in such reporting. In many organisations, unsafe acts & conditions are reported as near misses. Investigation of even high potential near misses are not observed to be as rigorous as an actual incident to facilitate proactive corrective actions.

### 6.6.17 Risk and Vulnerability Index:

6.6.17.1 Vulnerability index is a process of indexing the risks based on their severity, potential consequence and their supervision control levels. If a job has a high vulnerability index, then supervision from higher management personnel is required i.e., supervision escalation metrics are defined based on the vulnerability index.

6.6.17.2 The concept of vulnerability index is new and has been adopted by a few organisations under varying names.

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**6.7. COMPLIANCE WITH STANDARD OPERATING PROCEDURES (SOP)**

- 6.7.1 Standard Operating Procedure (SOP) is a set of detailed written instructions to achieve uniformity in the performance of a specific function/ task. These documents contain instructions or steps on how to execute a task and serve as a tool to ensure that activities are performed properly following operational, quality, environmental and safety requirements. SOPs help in better planning on the jobs, reduce dependency on the individuals performing the task for the expected outcome, eliminates or reduces chances of errors/ misses and makes traceability easier.
- 6.7.2 In the Oil and Gas Industry, SOPs are available for different situations like start-up operation, normal operation, simultaneous operation, maintenance & inspection, normal shutdown, emergency operation, emergency shut down etc. SOPs are also made for specialised tasks. Organisations maintain their own activity-based SOPs defining how a process needs to be carried out including responsibilities, tools, methods, measurements, precautions etc. Work instructions/ Do's & Don'ts are derived from SOPs for communication to operating crew and display at workplace.
- 6.7.3 SOPs are developed by respective Subject Matter Experts (SMEs). For specialised equipment/ licensed units, inputs of licensors/ original equipment manufacturers are incorporated in the SOPs. SOPs are maintained either as Procedure manual/ Operation manual/ Maintenance manual etc. or separately and are generally approved/ authorised.
- 6.7.4 Review or revision frequency of SOP generally varies from 1 year to 5 years or even more. However, if the installation has undergone any incident, major revamp, modification in systems/ equipment/ process on account of engineering changes, policy changes or government regulation, revision is taken up early. No consistency in revision frequency has been observed amongst companies.
- 6.7.5 SOPs are currently being approved within the organization at different levels ranging from top management to Plant/ Installation in-charge or functional in-charge and vary amongst companies. Control or process of authentication of Contractor's SOP for hired services also varies amongst companies.
- 6.7.6 Training and awareness of SOP is imparted to the operating crew through regular training programs. Some companies also have training simulators for operations.
- 6.7.7 Root cause analysis of various incidents that took place in the Indian petroleum industry in the last five years revealed that 41% of the accidents are caused due to disregard of SOPs (refer 40<sup>th</sup> Safety Council Meeting). This highlights a gap in SOP compliance and is an important area for improvement.
- 6.7.8 Some of the gaps (not necessarily at all installation/ organisation) related to SOP implementation, as emerged from the deliberations in the working group or OISD audit reports include:

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- SOPs not available for some of the critical activities or some of the scenarios.
- Ambiguity, lack of clarity or inconsistency in available SOPs
- Inadequate understanding of the SOPs.
- Revisions to SOPs not communicated or percolated to the work force.
- SOPs did not appropriately address the safety considerations in the specified task.
- SOPs not reviewed/ revised after plant modifications/ revamp/ incident etc. as per MOC (Management of Change) procedure.
- SOPs not reviewed/ revised at the stipulated frequency or learnings from past incidents not incorporated.
- Ineffective document control resulting in multiple/ outdated versions of SOP in circulation leading to errors.
- Lack of clarity in Roles & Responsibilities and escalation metrics in SOPs.
- Deviations in actual working from the SOPs.
- Overconfidence of the operating crew or short cuts taken disregarding the SOPs
- Lack of awareness or necessary management controls to ensure SOP compliance without deviations.

### **6.8. ADEQUATE JOB SUPERVISION**

6.8.1 Inadequate supervision has been found to be the root cause of 13.53% of the total accidents in the Indian Petroleum Industry in the last 5 years. Inadequate supervision may be a result of a number of reasons, some related to the person concerned and some related to the environment in which he/ she is operating. Individual reasons may include lack of competence, application of mind, commitment to safety or clarity on the work processes and associated hazards. External reasons may include overload, multiple simultaneously running tasks with overlapping responsibilities, inadequate management processes, lack of SOPs, lack of adequate resources, organization culture etc. Non-operational priorities in the organization may also sometimes lead to dilution in the focus on the main job and lack of supervision.

6.8.2 To improve job supervision, a focus on organization culture, competency assurance of employees involved in supervisory roles, well laid down SOPs and inclusion of safety performance indicators in the KPIs is required. Each of these subjects is specifically dealt with in respective paragraphs in the report. In addition, clarity on Responsibility and Accountability metrics helps in ensuring adequate job supervision.

### **6.9. ASSET INTEGRITY MANAGEMENT**

6.9.1. Various equipment and hardware are procured and installed following national and international standards. All companies have elaborate maintenance and inspection processes for the upkeep of the plant and facilities. Companies are also using maintenance management modules in SAP or specialised packages like Maximo.

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- 6.9.2. However, equipment failure and inadequate maintenance & inspection is observed to be the root cause of 19% of the safety incidents in Indian Oil and Gas Companies in the last 5 years.
- 6.9.3. Inability to release the equipment for regular maintenance in view of production pressures, delayed turnaround cycles, quality issues in workmanship, non-availability of genuine spare parts at the required time, and short cuts and improper analysis of failures are some of the reasons. Maintenance staff gets over occupied by breakdown and emergency jobs causing preventive maintenance to take a back seat generating a vicious cycle. High corrosion rate in coastal locations and painting quality has also been an area of concern.
- 6.9.4. Many of the installations including offshore process platforms and cross-country pipelines have crossed their design life. The problems get compounded in the offshore and coastal areas due to hostile weather and corrosive atmosphere. Many organizations have put 'Asset Integrity Management' in place including residual life assessment and replacement/ obsolescence policy of aged equipment. However, a holistic approach to the issue is still a work in progress.
- 6.9.5. Ignoring the ageing of assets while continuing the use of the same without proper maintenance/ replacement may lead to failure of equipment, loss of containment, loss of efficacy, loss of reliability etc. Sometimes it may result in safety incidents/ accidents or even disasters.
- 6.9.6. Companies are trying to employ the latest inspection and maintenance techniques, which facilitate on the run inspection and maintenance. Risk based maintenance and residual life assessment techniques are increasingly becoming popular. Some companies are also implementing pilot projects using new age technologies like IoT, analytics and machine learning for predictive maintenance and trouble shooting. Comprehensive Asset Integrity Management Program covering the full life cycle of the asset right from design/ procurement to replacement/ retirement including well defined Integrity Operating Windows (IOWs) is the way forward.

### **6.10. PROCESS SAFETY MANAGEMENT**

- 6.10.1. Petroleum Industry deals with flammable materials in liquid or gaseous forms at varying pressures and temperatures. Process Safety Management deals with preventing or minimizing the consequences of unexpected release of toxic, reactive or flammable liquids and gases.
- 6.10.2. The objective of process safety management (PSM) is to ensure that potential hazards are identified and mitigation measures are in place to prevent unwanted release of energy or hazardous materials into locations that could expose employees and others to serious harm.

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- 6.10.3. Process Safety Management adopts an integrated approach, in which people, plant and systems all inter-relate:
- Plant and equipment - of an appropriate design standard/ integrity and adequately maintained.
  - Systems/ Procedures – fit for purpose and practicable.
  - People – adequately competent and work within a positive cultural framework that encourages safe behaviour and a belief that any injury, harm or damage can be avoided.
- 6.10.4. OSHA standard on Process Safety Management has 14 elements and CCPS, and RBPS model proposes 20 element model, both models offer a robust mechanism for strengthening and improving the process safety culture across the operating locations.
- 6.10.5. The OSHA standard 14 elements are as follows:
- i. Process Safety Information
  - ii. Process Hazard Analysis
  - iii. Operating Procedures and safe practices
  - iv. Hot Work Permit
  - v. Emergency Preparedness and Response
  - vi. Mechanical Integrity
  - vii. Pre-Startup Safety Review
  - viii. Training
  - ix. Management of Change
  - x. Incident investigation
  - xi. Contractors
  - xii. Compliance Audits
  - xiii. Employees involvement
  - xiv. Trade Secrets
- 6.10.6. The 20 Elements of Risk-Based Process Safety (CCPS RBPS) listed under four functional block heads are as follows:
- a. Foundational Block: Commit to Process Safety
    - i. Process safety culture
    - ii. Compliance with standards
    - iii. Process safety competency
    - iv. Workforce involvement
    - v. Stakeholder outreach
  - b. Foundational Block: Understand Hazards and Risks
    - vi. Process knowledge management
    - vii. Hazard identification and risk analysis (HIRA)

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- c. Foundational Block: Manage Risk
    - viii. Operating procedures
    - ix. Safe work practices
    - x. Asset integrity and reliability
    - xi. Contractor management
    - xii. Training and performance assurance
    - xiii. Management of change
    - xiv. Operational readiness
    - xv. Conduct of operations
    - xvi. Emergency management
  - d. Foundational Block: Learn from Experience
    - xvii. Incident investigation
    - xviii. Measurements and metrics
    - xix. Auditing
    - xx. Management review and continuous improvement
- 6.10.7. Most of the above processes are in vogue in the Indian Oil and Gas Sector in some or the other form as independent processes. Some companies have now implemented PSM in an integrated manner. However, the required rigour in the implementation and control of each of these elements is yet to emerge.
- 6.10.8. PSM as a concept and the elements defined therein are quite useful and Oil and Gas companies need to adopt the same in a manner such that the field presence of the operating staff does not get compromised due to additional paperwork required.

### 6.11. EFFECTIVENESS OF SAFETY AUDITS

- 6.11.1. Safety audit is a systematic, independent and documented review to verify conformance with prescribed standards. It helps in the identification of vulnerable areas, risks & hazards and opportunities for improvement. It gives an idea about the effectiveness of the implementation of the Safety Management System in an organisation/ location and the achievement of its objectives. Safety audits also act as a feedback mechanism for the management regarding the status and effectiveness of various elements of the Safety Management System in the organisation and draw focus on the areas of improvement.
- 6.11.2. Following types of Safety audits are being conducted at various installations/ locations of the Indian oil and gas industry:

#### a) Internal Safety Audit

An internal safety audit is conducted by the location/ organisation itself. In most of the organisations, this audit is conducted on yearly basis through multidisciplinary team consisting of experienced officers from various disciplines viz. operation, maintenance, inspection and safety as per the requirement of OISD-STD-145 adopting OISD checklist. In addition, some organizations have a system of safety inspection by senior management also.

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### **b) External Safety Audit (ESA)**

External Safety Audit (ESA) is conducted by OISD by a multidisciplinary team of officers drawn from OISD and other companies in the Oil and Gas industry as per the requirement of OISD-STD-145 adopting OISD checklist. Between two consecutive OISD external safety audits, a surprise safety audit (SSA) may also be conducted for major locations.

### **c) Third Party Safety Audits**

Installations covered under PNGRB Act and Factories Act also conduct a third-party safety audit through agencies authorised by respective regulatory agencies.

Some organisations also carry out specific safety audits through third party expert agencies.

- 6.11.3. An effective internal safety audit with timely follow-up on compliance, strengthen the company's safety system and culture. However, the gap is observed in the quality and effectiveness of many of the internal safety audits during subsequent external audits and incident investigations. Gaps have been observed related to selection of the audit team, the methodology adopted for the audit and monitoring of implementation status.

#### **a) Selection of audit team:**

An internal audit is supposed to be conducted by a multidisciplinary team comprising officers knowledgeable in the concerned areas. In some cases, team composition was found to be not representative of all required functions. On some occasions, auditors are selected based on availability instead of competency, compromising the quality of the audit and defeating the purpose. Many auditors are not trained for safety audits and lack auditing skills.

#### **b) Methodology of safety audit:**

In some audits, coverage of the audit in terms of facilities & systems was found inadequate, while in some instances, the audit checklist was not comprehensive enough to satisfy audit requirements. In some internal audits, the time provided to auditors was not sufficient to cover the entire scope of the audit.

#### **c) Monitoring of implementation status:**

It is acknowledged that all organisations have intent and also make reasonable efforts for the timely closure of internal as well as external audit findings. However, as presented in the 40<sup>th</sup> Safety Council meeting, there are more than 700 OISD recommendations pending compliance for more than two years. This shows the scope for improvement in the current practice of monitoring compliance with audit recommendations.

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6.11.4. Implementation of a few recommendations given in the OISD safety audit is reported to be infeasible by the organization concerned especially at old pre-OISD constructed locations. Issues have been observed related to inter distances between facilities, tank dyke capacity, the road around facilities, tank truck parking area, re-routing of tank's pipelines inside a dyke enclosure which cross other tank areas, two-row arrangement of tanks in a dyke enclosure etc. Closing such installations/ facilities without an alternate arrangement will disrupt supplies to the market. Availability and acquisition of new land for resiting of the installations/ facilities is a time-consuming affair. Organizations are facing difficulties in the closure of such long pending safety audit recommendations.

### **6.12. EMERGENCY PREPAREDNESS AND RESPONSE MANAGEMENT**

6.12.1. Emergency preparedness and response management is a critical component of the safety management system. The objective of emergency response management is to mitigate the adverse effects of incidents through effective risk assessment, emergency preparedness and mitigation & response measures.

6.12.2. At every stage of operation in the oil & gas industry, be it exploration, production, refining, transportation, storage, distribution and end usage, there are inherent and associated risks which if not mitigated or properly handled, can lead to unintended consequences. Various systems and safety barriers are therefore, incorporated to eliminate or reduce the possibility of the occurrence of incidents. Emergency preparedness and response management is the last system to mitigate/ reduce the impact in case all other safety barriers are breached and an incident has occurred or is about to occur.

6.12.3. Most common possible emergency in Oil and Gas Industry is fire or explosion. During the last five years i.e., from April 2018 to Mar 2023, the Indian oil and gas industry has recorded 45 major incidents of fire and explosion involving 38 fatalities.

6.12.4. The other major risks having a greater impact on society & environment in terms of life and property are BLEVE (Boiling liquid expanding vapour explosion), Blowout, pipeline rupture in populated areas, major oil spills (especially in offshore) etc.

6.12.5. Various emergency response measures provided in the Indian Oil and Gas Industry and observations related to the same are as follows:

#### **6.12.6. Quantitative Risk Assessment (QRA)**

All major installations carry out scientific studies like QRA (Quantitative Risk Assessment) to identify the risk profile using specialised software. QRA simulates the probable events, and their likely impact, and identifies the most vulnerable systems and risk contours which help in preparing suitable mitigation measures.

#### **6.12.7. Emergency Response and Disaster Management Plans (ERDMP)**

6.12.7.1. Oil and Gas Industry has well defined onsite and offsite Emergency Response Plan (ERP)/ Disaster Management Plan (DMP)/ Emergency Response & Disaster Management Plan (ERDMP) in line with statutory requirements and MoPNG DMP

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guidelines. The organisation, roles & responsibilities and command structure during an emergency are also defined in the ERDMP document. These plans are reviewed and updated at stipulated frequency or in case of any major changes/revamp.

6.12.7.2. ERDMPs need further refinement to ensure coverage of all possible emergency scenarios. ERDMPs need to be reviewed and updated after major accidents or at stipulated frequency. Regular updation of contact details of designated persons and emergency services specified in ERDMPs is essential for use in emergencies.

### 6.12.8. Early Detection and Warning Systems

6.12.8.1. Installations have various early detection and warning systems like fire sirens, smoke and flame detectors, Hydrocarbon leak detectors, H<sub>2</sub>S detectors etc. installed at critical locations in the installations. These detectors have indications/annunciators in Operation Control Room and Fire and Safety Control Room. There are also manual call points (break glass system) at various locations in the plants with indications at fire and safety control rooms.

### 6.12.9. Emergency shutdown systems

6.12.9.1. Process plants are equipped with emergency shutdown systems that trigger a system/ unit shutdown either through a predetermined system logic or manually in case the system breaches the safe operating envelope to either avoid the incident or reduce the impact of an incident.

6.12.9.2. Cross-country pipelines have remote operated sectionalising valves to isolate part of the affected line so that leakage of flammable liquids can be contained which otherwise can cause or feed a fire increasing the impact manifold.

### 6.12.10. Fire Fighting System

6.12.10.1. Firefighting systems at the installations are designed in line with the relevant OISD standards, which have been made mandatory due to inclusion in Petroleum Rules 2002 and Oil Mines Regulations 2017.

6.12.10.2. Fire water system is always kept in charged condition and maintained at a specified pressure. Fire pumps are regularly tested including an auto cut-in mechanism. Automatic sprinklers are provided on tall columns, hydrocarbon storage vessels and tankages. A flooding system (clean agent) is provided in the control rooms. Floating roof tanks are provided with a rim seal protection system. Remote operated long-range firewater monitors are also provided at critical locations in process plants. Adequate quantity of foam, and dry chemical powder extinguishers are also maintained.

6.12.10.3. Major installations have their own well-equipped fire station with fire trucks, foam generators etc. Fire stations are manned round the clock by a trained firefighting crew. Big locations also have Occupational Health Management Centre within the premise, which is manned by qualified doctors, and nursing staff as a first level response in case of medical emergency. Locations also have tie up with multi-

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speciality hospitals in the vicinity. Smaller locations depend on the Area Fire Department and firefighting facilities of other neighbouring locations.

6.12.10.4. Operating staff is provided with specific training on emergencies and firefighting including live fire training. There are mutual aid arrangements with neighbouring industries to pool up resources in case of major fires. Regular mock drills are carried out to check the readiness and effectiveness of the firefighting system and records are maintained. During external audits, emergency preparedness is generally verified through a review of records and by conducting surprise mock drills.

6.12.10.5. While companies make efforts to keep the firefighting system in order all the time, it's maintenance and upkeep need further improvement. During audits and mock drills, instances of leakages in fire hydrants/ fire water lines, fire pumps not developing requisite pressure or not cutting in as desired, fire monitors not able to cover the target area, sprinklers/ foam pourers found choked etc. have been noticed. In some places deficiencies concerning availability of firewater storage as per standards and timely replenishment of foam have also been noticed.

### 6.12.11. **Mock Drills**

6.12.11.1. Mock drill is a tool to validate the effectiveness & readiness of various elements of emergency response systems and to identify the gaps for improvements. All installations conduct mock drills as per periodicity defined as per regulatory/ OISD standard requirements and maintain records. In case of offsite mock drills district administration, mutual aid members, and fire brigade also participate.

6.12.11.2. While mock drills are carried out regularly, many a times they tend to test similar scenarios repeatedly in various mock drills rather than covering different possible scenarios. Gaps were also observed with respect to the need to conduct mock drills at odd hours, drills involving mutual aid partners, frequency of offsite mock drills etc.

### 6.12.12. **Preparedness for Specific Emergencies**

#### 6.12.12.1. **Well control in upstream operation**

6.12.12.1.1. During drilling and workover operations, the flow of formation fluid into the wellbore is considered as kick. If not controlled, a kick may result in a blowout, which is an uncontrolled flow of formation fluid from the wellbore and may endanger the safety of personnel, equipment and the environment.

6.12.12.1.2. Primary well control is maintained by hydrostatic pressure in the wellbore by mud/ brine (well fluid) at least equal to the formation pressure to prevent the flow of formation fluid.

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- 6.12.12.1.3. In case of kick, assembly of well control equipment including blowout preventers, spools, valves, and nipples connected to the top of the casing head is used to control the well and bring the situation under control.
- 6.12.12.1.4. Well control equipment is tested periodically as per API/ OISD standards. The key personnel undergo certified courses (IWCF/ IADC) in well control. BOP drills are carried out to check preparedness and take remedial measures.
- 6.12.12.1.5. ONGC seems to have well established Crisis Management Team (CMT) equipped to handle blowouts. OIL India also is in the process of strengthening its CMT as per recommendations of the High-Level Committee post Baghjan incident. However, medium & small operators who are active in the E&P space do not have similar team and equipment to handle well control crisis.
- 6.12.12.1.6. One of the recommendations of HLC was “Organizations should develop a strong Crisis Management Team well equipped and trained to handle blowouts and/ or enter into MoU with the established organization(s) in blowout management for enhancing preparedness in case of a blowout”. As per the information available, still such MoUs are not in place with the established organization(s) in blowout management.
- 6.12.12.1.7. The gaps are also observed related to the healthiness of well control equipment (inspection/ re-certification, function & pressure tests, control unit etc.) and the competency of key personnel in well control.
- 6.12.12.2. **Oil Spill**
- 6.12.12.2.1. Oil spill, especially in offshore, can have a significant impact on the environment and human health, and requires a specific response and control measures viz., containment, monitoring, recovery, treatment and disposal. While it is very critical for upstream offshore operations, to some extent it is also applicable to downstream with respect to SPM operations, subsea pipelines and for crude receipts and product dispatches through ships.
- 6.12.12.2.2. India became one of the few countries that adopted the International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC) immediately after it was adopted by the International Maritime Organisation (IMO) in 1990. As per the National Oil Spill Disaster Contingency Plan (NOS-DCP), the Indian Coast Guard is the national authority to coordinate the response to oil spills in India’s maritime zones.
- 6.12.12.2.3. The NOS-DCP divides India’s maritime zones into three regions: West, East, and Andaman & Nicobar Islands, which are further divided into 11 districts. Each of the three regions has a designated Regional Commander who is responsible for combating oil spills under the Regional Oil Spill Disaster Contingency Plan (ROS-DCP). Every region has a Response Centre, manned by qualified personnel and a well-stocked inventory of equipment. Apart from the response centres, a number of other resource agencies under the NOS-DCP coordinate with the Coast Guard to combat oil spills.

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6.12.12.2.4. The oil handling agencies (OHA) are required to develop an oil spill contingency plan (OSCP) indicating the strategies for prevention and control of oil spills for Tier 1, 2 & 3 type spills in accordance with NOS-DCP. Mapping environmental sensitivities is an integral part of the contingency plan.

|   |  |
|---|--|
| Tier 1 Oil Spill (up to 700 Tons)       | Small spills, usually at specific installations and sites e.g. SBMs, harbours  |
| Tier 2 Oil Spill (700 - 10000 Tons)     | Medium level spills requiring more equipment and support than that available at the local site   |
| Tier 3 Oil Spill (more than 10000 Tons) | Large spills beyond the response capability of the country. Global responses are necessary due to the scale, impact and complexity of the spill. |

6.12.12.2.5. Internationally also, oil spills are categorized into three tiers, but the quantity of spills is not defined. It depends on the response level required.

6.12.12.2.6. OHAs are required to maintain minimum inventory w.r.t Pollution Response Equipment, PPE, Vessel and IMO trained manpower as per risk category in accordance with the requirements of NOS-DCP.

6.12.12.2.7. Presently, there is no Oil Spill Response Organization available in India, which can provide a Tier 3 response in case of any eventuality. Some organisations like ONGC have a membership with OSRL, UK for the Tier-3 oil spill response. M/s OSRL holds a Tier-3 stockpile and provides response training, and other services. The membership provides access to OSRL equipment and personnel in Singapore and in the United Kingdom.

6.12.12.2.8. Indian Coast Guard (ICG) and OISD are conducting Joint Inspection of Tier-1 Pollution Response Capabilities of OHAs.

6.12.12.2.9. The gaps observed are mainly regarding the availability of minimum inventory requirement as per NOS-DCP, which was enhanced substantially in 2018. Due to the shortage in the availability of inventory, the OSCP of OHAs not getting approval from Indian Coast Guard.

6.12.12.2.10. During the Joint Inspection of ICG with OISD, it is observed that OHAs and Ports operating in the same vicinity (Paradip, Kochi, Kandla) have successfully demonstrated Oil Spill Response preparedness with shared pollution response inventory. However, the same is yet to be accepted by ICG.

**6.12.12.3. Cyclones**

6.12.12.3.1. Western and eastern offshore are important areas of E&P activities and such activities would only increase in volume and value in the times to come. The presence and movement of various kinds of vessels in the western and eastern offshore/ coastal areas would therefore need a robust system of monitoring vessels once a cyclone warning is issued.

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6.12.12.3.2. The operators and contractors in offshore depend on the cyclone forecast of IMD and some other service providers. DG Shipping has issued SOP to be followed in case of cyclones, which is followed by E&P operators working in offshore. This is monitored by Government through OISD, and DGS facilitates resolving any safety matter when brought to its notice, by coordinating amongst various concerned agencies and authorities.

6.12.12.3.3. Communication of instructions to various contracting and subcontracting agencies, command structure, responsibility metrics and positive confirmation of actions taken in case of cyclonic situations has been under critical review in one of the recent incidents during cyclone Tauktae and needs strengthening. The Emergency Response Plan of Operators and the contractors have been observed to be inadequate in addressing operation and emergency actions for barges in the event of an approaching cyclone.

6.12.12.3.4. SOPs for major on land installations like refineries, terminals etc. in case of cyclone warnings/ high wind conditions are in place. It includes precautions like not keeping the storage tanks empty, lowering the high masts, lowering crane booms, no rigging operations, securing loose items in plants etc. including taking precautionary shutdown or reducing throughput.

**6.12.13. Additional measures being pursued to improve Emergency Preparedness and Response**

6.12.13.1. In Order to further improve emergency preparedness and response, the following additional measures are being pursued by the Indian Oil and Gas Industry:

**6.12.13.2. Setting up Emergency Response Centre (ERC)**

6.12.13.2.1. One of the recommendations of the M B Lal Committee, which investigated the IOCL Jaipur Fire Incident, was about setting up Emergency Response Centre (ERC) at critical locations in India that can handle major oil fires in a zone with specialization and expertise available with them. For setting up of pilot ERCs, six locations namely Jaipur, Vizag, Manmad, Hazira, Dibiyapur and Jorhat (newly added) have been identified. The industry members participating in the ERC project are ONGC, IOCL, BPCL, HPCL, GAIL and OIL (recently added). Bharat Petroleum Corporation Limited is coordinating the effort for ERC on behalf of MoPNG & the Industry.

6.12.13.2.2. There were delays in establishing the actual requirements and specifications for setting up a pilot ERC initially. However, now Detailed Feasibility Report (DFR) has been completed in phase-I and further actions are to be initiated expeditiously.

**6.12.13.3. Regional Oil Spill Response Centre (ROSRC)**

6.12.13.3.1. Presently, there are no oil spill response organizations along the Indian coastline, which is prevalent in other coastal countries of the world. For any Tier-III response, India is dependent on International Oil Spill Response Organizations

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which are located outside India and involve substantial mobilization time due to long distance and statutory & custom clearance processes.

- 6.12.13.3.2. System of Industry lead oil spill response co-operatives is prevalent in neighbouring countries For Ex. Oil Industry Environmental Safety Group Association (IESG), Thailand, Petroleum Industry of Malaysia Mutual Aid Group (PIMMAG), Malaysia, Australian Marine Oil Spill Centre (AMOSOC), Australia.
- 6.12.13.3.3. A proposal for the formation of a Regional Oil Spill Response Centre (ROSRC) along the Indian coastline is under consideration by the Ministry of Ports, Shipping & Waterways. A Committee in this regard has been constituted under the chairmanship of the Joint Secretary (Ports). The broad Terms of Reference of the Committee includes assessing the need for setting up ROSRC, its Roles & Responsibilities, locations, facilities required to be maintained, roles of ports, oil handling companies & state authorities and suggested mode of funding/ financial model of operation of ROSRC. The committee has taken the inputs of various stakeholders including E&P operators in the East and West coast of India.

### 6.13. LEVERAGING TECHNOLOGY FOR ENHANCED SAFETY

- 6.13.1. New age technologies are growing at a rapid pace and are finding new applications every day. The oil and gas industry, which traditionally has been quite advanced in automation and the use of sophisticated technologies in its operation, is further leveraging these technologies focusing on efficient operations and improved safety.
- 6.13.2. Some of the new age technologies which are helping in an overall improvement in safety management include:
  - 6.13.3. **Use of CCTV and Drones**
    - 6.13.3.1. Oil & gas installations have good coverage of CCTV cameras with live monitoring. Basically, CCTV were installed for security surveillance and operational requirements at installations to monitor specific areas.
    - 6.13.3.2. Some organisations have started leveraging CCTV for better safety management by monitoring of activities like hot work, work at height, process abnormality, use of personal protective equipment (PPE) by people in hazardous/ licensed areas, safety behaviour of people in the field etc. It is helping in timely identification of unsafe conditions and acts.
    - 6.13.3.3. While CCTV cameras are generally fixed and have limitations in terms of coverage and mobility, drones provide flexibility for deployment on a need basis. Some of the organisations have successfully deployed drones for the inspection of flare tips, storage tanks, surveillance of cross-country pipelines etc. Drones can also be used at facilities like offshore platforms and well sites for surveillance, inspection and maintenance. Drones can be used to identify unsafe acts and conditions, detect leaks, locate spills, corrosion, hot spots etc. Drones can also be very useful at large project construction sites to identify unsafe conditions **and act for further strengthening the Safety Management System.**

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- 6.13.3.4. Drones have some limitations with respect to flight lengths and pose some safety risks like the possibility of a spark from the battery in a hydrocarbon environment, the danger of hitting other plant facilities in case of mis-manoeuve or misjudgement. The use of drones in licensed areas is to be a controlled activity as it can also pose security threats from unscrupulous elements.
- 6.13.4. **Analytics and Centralized Safety Monitoring System**
- 6.13.4.1. Availability of a vast pool of real time data from CCTV coverage is being used to generate real time safety alerts and warnings using analytics, Artificial Intelligence (AI) and Machine Learning (ML) software.
- 6.13.4.2. Few organizations have set-up independent centralized monitoring and control centres to monitor and precipitate real time corrective action including rapid response in case of a developing hazardous situation or an unsafe act.
- 6.13.4.3. Few organizations have also started pilot projects using AI, based on CCTV monitoring to capture unsafe acts and conditions and to study behavioural patterns, which can be used to develop necessary interventions for overall safety improvement. Moreover, policies regarding further action after identification of unsafe conditions and acts (other than taking corrective action), is a work in progress.
- 6.13.5. **Pipeline Intrusion Detection Systems (PIDS)**
- 6.13.5.1. Traditional leak detection system (LDS) which has been implemented in all cross-country pipelines has the limitation of coming to know about the leak after the leak has already started. A substantial time gap can be there from the time of noticing the leak and reaching the emergency response team to the site. This intervening time gap poses substantial safety risk and can make subsequent emergency handling operation more difficult and complicated.
- 6.13.5.2. In the last few years, the industry is implementing some new techniques like fibre optic based 'Pipeline Intrusion Detection System (PIDS)', which alerts the operator, the moment any activity like excavation etc. is carried out in the neighbourhood of the pipeline. This system has also been found very effective in preventing incidences of product pilferage from pipelines.
- 6.13.5.3. PIDS is a fast-evolving system and accuracy depends based on signature analysis. Some organisations have done pilots using a combination of PIDs, AI and Drones to bring more precision to the analysis.
- 6.13.5.4. Presently use of PIDS is not mandatory and is being deployed by organisations of their own free will, in pilferage prone areas.
- 6.13.6. **IoT and Analytics**
- 6.13.6.1. Industry 4.0 involves adapting the 'Internet of Things' (IoT) by using Smart Sensors, Digitization, Cloud, Digital Twin, Advance Analytics, Virtual Reality (VR) etc. IoT has enormous potential to be used in the Indian oil and gas industry to

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substantially improve operational efficiency, reliability, asset integrity, failure predictions and safety performance. It can help the oil and gas industry in improving working conditions, monitor environmental conditions, data collection, streamlining operation, increasing productivity, generating real time alerts and can help in limiting unsafe acts and exposure to hazardous situations thereby reducing employees' risks.

6.13.6.2. Some organizations have started using IoT based techniques for remote maintenance thus ensuring the safety of workers by helping them move away from potentially hazardous workspaces. It also facilitates expert help in emergencies from remote. Robotic tank cleaning, flare tip inspection, and remote troubleshooting by OEMs on critical equipment are few such examples.

### 6.13.7. Use of Technologies in Safety Training

6.13.7.1. Training Simulators, Digital Twins and Virtual/ Augmented Reality technologies have been successfully used to bring vast improvement in training effectiveness and preparedness of the operating crew to handle emergencies. Simulators and digital twins can simulate the process emergencies in almost real environment and help in preparing the operator for a desired response. VR/AR can give a feel to be in a real situation like a live fire or an enclosed space or in an operating plant without being actually there. Apart from imparting technical training, these technologies can also help in preparing the crew, mentally and temperamentally for emergency situations. This area is fast evolving.

## 6.14. EMERGING RISKS DUE TO INCREASING COMPLEXITIES IN A TRANSIENT BUSINESS ENVIRONMENT

6.14.1. There are continuous efforts in the oil and gas Industry to find new sources of energy, extract more value from each hydrocarbon molecule, adopt more efficient processes and transit to more environmentally friendly products and processes. Continuous efforts are also being made to offer multiple low carbon energy options and superior customer experience.

6.14.2. In the above efforts, some additional risks are getting introduced in the Oil and Gas space. Some of these risks are already visible and others may surface in future.

6.14.3. Some of such future risks which need attention include:

### 6.14.4. Increasing Complexities in Refining Operation

6.14.4.1. Need for better value realisation in refining processes from each molecule of crude oil processed, the compulsion to make products that are environmentally friendly and the increasing integration of petrochemical units with refineries, have necessitated the introduction of complex technologies in the Refinery complexes. Many of these technologies operate under hydrogen environment at much higher temperature and pressure conditions than what were prevalent earlier in refineries.

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- 6.14.4.2. Use of catalysts in refineries has increased multifold due to the above processes. Multiple types of catalysts in different processes need special types of catalyst handling, loading and unloading processes some of which are carried out only by expert agencies under an inert environment. Operationally also it introduces a new set of contingencies during unit upsets/ shutdowns and start-ups.
- 6.14.4.3. Use of Hydrogen in refineries has increased multi fold, post implementation of BS IV and BS VI specifications for transportation fuels. It will increase further with the introduction of sophisticated bottom of the barrel upgradation technologies.
- 6.14.4.4. High complexities, increased use of hydrogen, high temperature/ high pressure operations, catalyst handling etc. have increased safety risks in refining operations which are managed with the help of detailed SOPs, advance automation, system controls, emergency shutdown systems and emergency preparedness.
- 6.14.5. **Use of Hydrogen as Transport Fuel**
- 6.14.5.1. Push for the use of green hydrogen as a sustainable transport fuel for the future will bring hydrogen into the public environment, which was otherwise restricted to the confined industrial environment. With the advent of hydrogen as a fuel, a completely new hydrogen infra system will get created. The components of new hydrogen infra would include electrolyser modules for hydrogen production, storage of liquid and gaseous hydrogen, loading and unloading of hydrogen tankers, road transport of high-pressure hydrogen tube trailers (up to 700 bar), cryogenic liquid hydrogen transport, hydrogen dispensing stations, hydrogen compressors, pure hydrogen pipeline, handling of pure oxygen, repurposing of existing natural gas network for injection of hydrogen etc.
- 6.14.5.2. Hydrogen is a highly flammable gas and leaks generate a serious risk of fire. It has a very low ignition energy and is combustible over a wide range of concentrations from 4% to 74.2%. A small spark is sufficient to ignite hydrogen in the air, if it is not handled properly. Hydrogen is colourless, odourless, tasteless, and generally undetectable by the human senses. Natural gas, LPG and propane are also odourless, but a sulphur-containing (Mercaptan) odorant is added to these gases so that a leak can be detected. However, similar comfort is not available for hydrogen because currently there is no known odorant that can be added to hydrogen that is light enough to diffuse at the same rate as hydrogen.
- 6.14.5.3. Hydrogen is one of the lightest elements on earth, so when a leak occurs, the gas rapidly disperses upwards. This makes ignition less likely, but hydrogen ignites and burns more easily than petrol or diesel. In fact, even a small spark of static electricity is enough to set off an explosion when hydrogen is available. Hydrogen flame is also invisible, so it is hard to pinpoint where the actual 'fire' is, but it generates a low radiant heat due to the absence of carbon and tends to burn out quickly.
- 6.14.5.4. Hydrogen is usually stored and transported in liquefied hydrogen tanks and hence it must be cooled down dramatically. If hydrogen escape from its tank and met

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skin, it can cause severe frostbite or even the loss of extremities and even break metal equipment. Hydrogen has a boiling temperature of only 20° Kelvin or -435° F. This causes the fuel to boil off very quickly when spilled, creating only a narrow window for ignition. Inspection and dealing with metallurgical failure aspects related to hydrogen containing equipment are specialised subjects.

6.14.5.5. It is, therefore, emphasised that each system, subsystem and component of hydrogen infrastructure will require an understanding of its unique safety related properties & related phenomena and the knowledge of acceptable engineering approaches to control the hazards & risks associated with the use of hydrogen. It is to be done taking into account the surrounding environment in which the system will be ultimately operating, concurrent risks and the level of awareness and understanding that can be created amongst the connected people operating or using this system at a large scale.

### 6.14.6. **Concurrent Safe State Hazards with Multiple Fuel Choices at Retail Outlets**

6.14.6.1. New energy alternatives and business paradigms to offer one stop solution for all energy needs of a customer have introduced the risk of 'concurrent safe state hazards' at fuel stations. A situation of 'concurrent safe state hazard' arises when each of the systems in itself is safe when seen in isolation but together they pose a new safety threat. Some of such risks may also arise due to the neighbourhood and the ecosystem in which the oil and gas business operates or will operate.

6.14.6.2. Traditionally Retail outlets handled only dispensing of MS and HSD. With the advent of CNG (Compressed Natural Gas) and Electric Vehicles (EVs), the existing retail outlets are being expanded/ revamped to include multiple forms of energy dispensing in a single place. While traditionally, the cardinal principle had been to keep the source of ignition and hydrocarbons away from each other, integration of EV charging stations along with CNG/ MS/ HSD dispensing at retail outlets has brought potential ignition sources and hydrocarbon sources in close proximity.

6.14.6.3. Fire is the main hazard when it comes to EV charging stations. The most common cause for such fire is the insufficient rating/ improperly maintained electrical wiring and power supplies within the building or structure where the charger is installed. Malfunctions can occur in the transfer of electricity between charging stations and vehicles resulting in fire if proper controls are not in place. Cases of batteries installed into EV vehicles exploding or catching fire have also been noticed.

6.14.6.4. Energy storage stations (ESS) will be necessary to supplement the direct grid electrical supply and accommodate a large demand for EV charging. The primary risk of these systems is damage or overheating from an internal fault that could cause a fire.

6.14.6.5. While each of the systems in itself may be safe or with manageable risks, but together may pose more severe safety risks.

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**6.14.7. Hydro testing of On-board CNG Cylinders and Monitoring**

6.14.7.1. In Petrol and Diesel Vehicles, the fuel in the fuel tanks of the vehicles is at atmospheric pressure. In CNG (Compressed Natural Gas) vehicles, CNG is filled in pressurised cylinders on the vehicles. Presently Indian standards are available to guide the manufacturing, inspection and testing of CNG cylinders for automobile vehicles. However, a mechanism to monitor the authenticity and validity of the hydro test certificate of onboard CNG cylinders is not available. In view of the increasing use of CNG vehicles, lack of testing infrastructure and lack of adequate monitoring mechanism, the possibility of CNG cylinders, which have not been hydro tested as per schedule, being in vehicles on the road, cannot be ruled out which poses a safety risk.

**6.14.8. LNG Transportation through Tankers**

6.14.8.1. LNG is transported in cryogenic condition (stored at -160 degree celsius) in road transport through Tank Lorries. The tankers are specially designed to carry cryogenic liquid. These tanks are double-walled vacuum insulated & can contain LNG in liquid form over a long period of time. Because of vacuum insulation, boil-off gas generation is negligible and can take care of minor generation of boil-off gas. These tanks are protected by safety valves, which take care of the over-pressurization of tanks.

6.14.8.2. Safety standards for LNG facilities are already defined in Petroleum and Natural Gas Regulatory Board (Technical Standards and Specifications including Safety Standards for Liquefied Natural Gas Facilities) Regulations, 2018 and OISD-STD-194 (revised edition 2016).

**6.14.9. Increased Automation and Advance Process Controls**

6.14.9.1. Oil Industry generally had a higher degree of embedded automation compared to many other industries, which is getting further impetus due to integration with new edge technologies like Advance Process Controls, Digital Twins, Artificial intelligence (AI), Internet of things (IoT), Machine Learning (ML) etc. Simultaneously, process technologies involved in Oil and Gas industry are becoming increasingly more complex with enhanced risk profiles.

6.14.9.2. Generally, advancement in technologies and automation comes laden with promises of less dependency on human skills, precise operations and safe work environment. However, it also inherently poses additional risks like cyber security threats, consequences of system malfunctions, over dependence on machine solutions etc.

6.14.9.3. It is also highlighted that earlier, the plant control software like DCS/ SCADA etc. was used to be dedicated software of proprietary nature. Restricted accessibility of these software is used to guard against any compromise by unscrupulous elements. IoT and Increased integration with commonly used business software for further processing & analytics with new user interfaces has removed the 'Air Gap' and introduces additional vulnerabilities.

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6.14.9.4. Increasing dependence on automation, complexities in the system and mutual interdependency of the system, need an enhanced level of asset integrity management to ensure that system malfunctions are avoided. To address this issue higher Safety Integrity Levels (SIL) are being used in the oil and gas industry. SIL is a measure of safety system performance in terms of the probability of failure on demand. SIL 4 offers the highest safety assurance.

### 6.14.10. **Thickly Populated Surroundings Near Major Oil Installations**

6.14.10.1. Oil installation/ refineries are normally constructed quite away from the city limits and residential areas; however, invariably over a period of short time, installations get surrounded by vendor shops as well as residential complexes. As of date, there is no rule/ statute, which restricts or controls such habitation. The thick population in the vicinity greatly increases the safety and security risks to the installation and the people working therein. High-rise buildings in the vicinity of such installations pose additional security and safety threats. In case of a thick population in the vicinity, the impact of any untoward incident in the installation increases multi fold in terms of risk to life and property. Emergency handling, evacuation in case of exigencies, movement of emergency services, firefighting etc. also becomes very difficult.

6.14.10.2. This issue has also been highlighted in the M B Lal Committee report, post Jaipur fire incident in 2009 and the requirement of a buffer zone was recommended as per quantitative risk assessment. Action on the above recommendation is still pending. The recommendation of the M B Lal Committee report in this regard is quoted below for ready reference:

Quote:

*“The Petroleum Rules 2002 which regulates the Safety in Petroleum Installations do not specify any distances to be kept clear or unoccupied beyond the boundaries of the Installation. The Committee has studied the vapour cloud dispersion models in this incident and is of the opinion that a distance of 250 to 300 meters from the likely point of ignition is necessary to be kept clear. The Committee recommends that the Petroleum Rules 2002 may be suitably amended for a buffer safety zone around the Petroleum Installations.”*

Unquote:

### 6.14.11. **Changing Climate Conditions Challenging Erstwhile Design Criteria**

6.14.10.1 Various facilities in an Oil and Gas installation are designed taking into account geo hazard criteria like seismic, wind etc. for the zone in which the facilities are installed with adequate factor of safety as per relevant standards. However due to climate changes, there are changes to seismic zones and encountered wind speeds. Higher intensity of cyclones and tsunamis have also been observed in coastal areas. Concentrated intense rainfall and cloudbursts at specific locations caused flood like situations.

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6.14.10.2 Hence, there is a need for systematic review and validation of the said criteria for future designs. Risk assessment also needs to be carried out for existing facilities to develop appropriate mitigation/ emergency response plans in case of such situations.

**6.15. ADDITIONAL SECTOR SPECIFIC AREAS NEEDING ATTENTION - UPSTREAM OFFSHORE OPERATIONS**

6.15.1. Some additional sector specific issues pertaining to upstream offshore operations, which need attention include:

**6.15.2. Gaps in Regulatory Mechanism with respect to Non-Propelled Vessels**

- a) The non-propelled vessels are still governed under the Coasting Vessels Act, 1838 which only provides for the registration of the vessels, but has no provisions for administration, regulation, survey, certification, licence and penalty.
- b) The non-propelled vessels are not required to have their towing plan approved while taking special passengers on board to the offshore areas or during evacuation.

**6.15.3. Gaps in Petroleum & Natural Gas (Safety in Offshore Operations) Rules 2008**

6.15.3.1. Oil Industry Safety Directorate (OISD) designated as Competent Authority manages offshore safety under Petroleum & Natural Gas (Safety in Offshore Operations) Rules, 2008. The Directorate, under the provisions of these Rules, accords 'consent for operation' of offshore fixed (process platforms and unmanned platforms) and mobile installations (Rigs/ FPSO/ MOPU).

6.15.3.2. However, the Petroleum & Natural Gas (Safety in Offshore Operations) Rules 2008 and the consent process does not cover the following areas/ operations:

- a) The exploration and stimulation vessels are not offered for 'Consent to operate', as currently these are not covered under the ambit of rules. Looking into safety aspects and prevalent practices in other countries, there is a need to bring them into the ambit of rules.
- b) There is no provision for the requirement of consent for offshore trunk pipelines, as the pipeline is not considered a separate installation. The current provision in the rule covers pipelines in general and they are considered in association with installation. Trunk pipelines are big size pipelines carrying large quantities of oil & gas from offshore to onshore and are not associated with any particular installation.

6.15.3.3. The rules are based on goal setting approach, which is quite different from prevalent rules & regulations applicable in onland operations. There is no reference to OISD standards, though OISD standards have been referred in many of the rules & regulations applicable to onland operations. With many new operators now operational in offshore, the current goal setting approach needs a review.

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6.15.3.4. To safeguard the exploitation of workers and also to ensure safe operations, there are rules & regulations applicable to onland operations regarding maximum hours of duty. However, there is no such provision for maximum duty at offshore.

### 6.15.4. Safety Management of offshore vessels

6.15.4.1. Operators in offshore hire vessels through contracts. Safety Management of offshore vessels is typically addressed through the Maritime regulatory framework for the construction, certification and licensing of vessels. The Safety Management System of the operator and contractor and between contractor and vessel owner is aligned through contract and Bridging document.

Some organisations have well established procedures for hiring vessels in terms of the vintage of the vessel, safety requirements, competence etc. However, in some cases, clear safety requirements, including vintage of the vessel, roles and responsibilities, competence etc. are not clearly defined in the contract/ bridging document. The gap is more visible in the case of sub-contracting.

6.15.4.2. Many of the operators and contractors are also not aware of Indian rules and OISD standards, more so in foreign operated rigs and vessels.

### 6.15.5. Safety Zone

6.15.5.1. As per international laws as well as P&NG (Safety in offshore operations) Rules 2008, the safety zone of an offshore installation extends from the seabed to a maximum of five hundred meters above the highest point of the facility in the vertical plane and horizontally extends five hundred meters out from its extremities, where it may be located at any time. No unauthorised vessel (including aircraft) shall enter, pass, stay or operate in the safety zone, which has not been granted permission by the operator.

6.15.5.2. However, there are regular violations of the safety zone by fishing vessels and sometimes by drifting Merchant vessels as the shipping line passes through the ODA in western offshore. These are a source of high risk for the hydrocarbon bearing offshore installations.

### 6.15.6. Air Logistics

6.15.6.1. Aviation operations at offshore with relation to the petroleum industry comprises of operation of helicopters mainly for transportation of personnel from shore to offshore installations and infield transfer of operational personnel. All helicopters operating in offshore for such work are chartered from national and international helicopter operators.

6.15.6.2. Petroleum companies chartering and operating helicopters for their operations have the responsibility to ensure the selection of helicopter operators including suitable helicopters, provision of suitable operational infrastructure & safety equipment and optimisation of their operations for minimising the risk and ensuring safety of helicopter operations.

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6.15.6.3. Operators have developed an aviation usage policy to provide safe and efficient use of helicopters to support company operations. However, in view of some recent helicopter accidents, this area needs attention.

**6.15.7. Offshore Pipelines**

6.15.7.1. There is a very large network of pipelines in the offshore fields, which transport oil and gas within the fields and from the offshore fields to on land plants. The following issues are noted with respect to offshore pipelines:

- a) Although all the pipelines transporting crude oil and gas within the offshore fields and those transporting crude oil and gas from offshore fields to shore based facilities come under the purview of P&NG (Safety in offshore) Rules 2008, OISD does not issue separate 'consent to operate' for pipelines. For the pipelines which transport crude oil and gas from offshore to land based facilities, for the portion of the lines on land (after the landfall point to the land-based facility), approval from PESO is required for their operation. Thus, dual approval is required for the operation of the different sections of the pipeline from different regulators. Since there is no separate consent to operate for these lines in the offshore portion, obtaining approval from PESO for the on-land portion is a challenge for the operators.
- b) There is a need for carrying out regular health checks of these pipelines to ensure preventive actions before their failure. A large length of offshore pipelines is not compatible with intelligent pigging, which is the traditional system of health checks of the lines.

**6.15.8. Abandonment/ Decommissioning/ Site Restoration**

6.15.8.1. With the ageing of E&P fields, some of the producing fields have ceased production or are on the end of a declining production curve, requiring abandonment/ decommissioning/ site restoration. MoPNG has issued 'Offshore and onshore oil and gas production site abandonment guidelines (popularly known as SRG guidelines) through a Gazette notification dated 1<sup>st</sup> May 2018.

6.15.8.2. With a number of fields likely to be de-commissioned in the near future, further relook at SRG guidelines may be required, including safety aspects based on the experience of some of the fields already in the process of decommissioning and abandonment.

**6.16. ADDITIONAL SECTOR SPECIFIC AREAS NEEDING ATTENTION - CROSS COUNTRY PIPELINES**

6.16.1. Some additional sector specific issues pertaining to cross country pipelines, which need attention include:

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**6.16.2. Population Growth on/ near Pipeline ROU (Right of Use)**

6.16.2.1. Pipeline route is selected, as far as possible, away from dwellings and residential areas. Right of Use (ROU) acquisition, to lay the pipelines, is done under the Petroleum and Minerals Pipelines (Acquisition of Right of User in Land) Act, 1962 popularly known as the P&MP Act 1962. While pipeline operators try to keep ROU free from encroachment through line patrolling, still over a period of time, encroachment in such notified area is not a very uncommon phenomenon. The pipeline operator is supposed to have regular line patrolling to detect and prevent any encroachment at the start itself. However, once ROU is encroached, removal of encroachment is a herculean task for the pipeline operator.

6.16.2.2. Such encroachment may cause damage to the pipeline and may become a safety hazard for the local people. Encroachments also cause hindrances in maintenance and rescue operations in case of emergencies. Many cases have been noticed where such structures are used as a cover for pilferages by tapping high-pressure hydrocarbon pipelines in operation, which also cause grave safety hazards.

6.16.2.3. Though there are penal provisions against damage to pipelines and police cases are also registered whenever such cases are noticed, the same has not worked as an effective deterrent. Also, such penal provisions do not cover violations in terms of encroachment of ROU by construction of permanent structures, drilling of borewells, planting of deep-rooted trees etc.

**6.16.3. Location Class Factor for Pipelines**

6.16.3.1. Regulations for gas transmission pipelines establish pipe strength requirements based on population density near the pipeline. Locations along gas pipelines are divided into classes from 1 (rural) to 4 (densely populated) and are based upon the number of buildings or dwellings for human occupancy.

6.16.3.2. With the increase in the population in the inhabitable areas through which pipelines are passing or where the area may get inhabited in future; there is a chance of change in 'location class' over a period of time and a reassessment of location class may be necessary.

6.16.3.3. In some cases, pipelines may come under transport corridors, major Govt. projects or development by local authorities. In such cases, regular inspection & maintenance of pipelines and emergency response may be a challenge.

**6.16.4. Geo-hazards (Washouts, Landslides etc.)**

6.16.4.1. Due to climate changes, instances of concentrated intense rainfall in isolated locations are increasing, causing flooding and sometimes change in the path of the rivers. It increases the risk of exposure and washout of pipelines laid under such rivers/ canals. Landslides especially for the pipelines laid in hilly and ghat sections may cause physical damage to the pipelines and can create safety hazards to nearby populations.

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**6.16.5. AC/ DC Interference of Power Lines with Cross Country Pipelines**

6.16.5.1. With the vast development in the power sector, AC/ DC interference due to power lines, metro/ other railways have been observed to adversely impact the integrity of cross-country hydrocarbon pipelines. In addition, the presence of other pipelines of different age/ coating material/ cathodic protection systems in the same ROU corridor or nearby high-tension cable corridors also causes electrical interference. It may impact the effectiveness of corrosion resistance measures provided for the pipelines.

**6.16.6. Transportation of High Vapour Pressure Hydrocarbon Liquid through Pipelines**

6.16.6.1. Presently, there is no separate guidelines/ safety standard for the design of high vapour pressure hydrocarbon liquids like C2, and C3 in cryogenic condition (transported as liquid at very low temperature in pipeline but are gaseous at ambient temperature and atmospheric pressure conditions). Already pipelines to transport Ethane, Propane and Butane in cryogenic conditions are in operation by different operators.

**6.16.7. Hydrogen (H<sub>2</sub>) Transportation through Pipelines**

6.16.7.1. With the increased focus on green hydrogen generation and its use in industry and as domestic fuel, entities are conducting pilot studies for blending Hydrogen with Natural Gas in the pipeline network. The impact of hydrogen on the material properties of existing pipelines for natural gas is also under study.

However, the present regulations do not address the safety aspects of Hydrogen blending in existing NG pipeline systems.

**6.16.8. Need for updated geographical information and coordination for CGD/ hydrocarbon pipelines through common utility corridors.**

6.16.8.1. There is a growing trend of creating utility corridors in cities, societies and along national highways. Lack of coordination between different agencies especially in the case of city gas distribution (CGD) and hydrocarbon pipelines passing through urban areas can pose a safety risk.

6.16.8.2. Presently system of having updated geographical information of pipelines (trunk/ city gas) or other utilities e.g., water, drain, optical fibre cable etc. in the city area is not very strong. In such conditions, new operators can cause damage to existing facilities during construction/ maintenance work due to unawareness of the route of other existing facilities. The availability of information on various utilities in the same corridor is also necessary during the handling of emergencies.

**6.16.9. Vulnerability of CGD / Hydrocarbon Pipelines during City Infra Upgrades**

6.16.9.1. In view of rapid urbanisation and augmentation of public infrastructure in almost all parts of the country, a lot of construction activities are in progress. Many cities are also getting underground metros and bypasses. Multiple utility services are

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being routed or relocated through common corridors. Lack of information on existing facilities or lack of coordination between different agencies especially in the case of city gas distribution (CGD) and hydrocarbon pipelines passing through urban areas can pose safety risk. Section of cross-country pipelines which are laid above ground along the roads/ bridges/ supported structures) are also vulnerable during the widening of roads, bridges, and laying metro/monorail lines and need due care and coordination.

### 6.17. CYBER SECURITY RISKS

- 6.17.1. In Oil and Gas Industry, technologies can be broadly classified into two categories –Operational Technologies (OT) and Information Technologies (IT).
- 6.17.2. OT focuses on the management and control of physical devices existing and operating in the real world that monitors and controls processes and production activities. It focuses on data and communication and includes the infrastructure and processes required to create, process, store, secure and exchange all forms of electronic data.
- 6.17.3. From safety point of view, Cyber security of OT- the systems that control equipment, machinery, and mechanical processes in factories, power plants, the energy grid, and other critical infrastructure – is very critical. An attack on OT can have severe consequences, ranging from disruption or outages of critical services to catastrophic threats to human life and property.
- 6.17.4. A typical IT/ OT architecture of an Oil and Gas company is illustrated in the following figure 6.4.

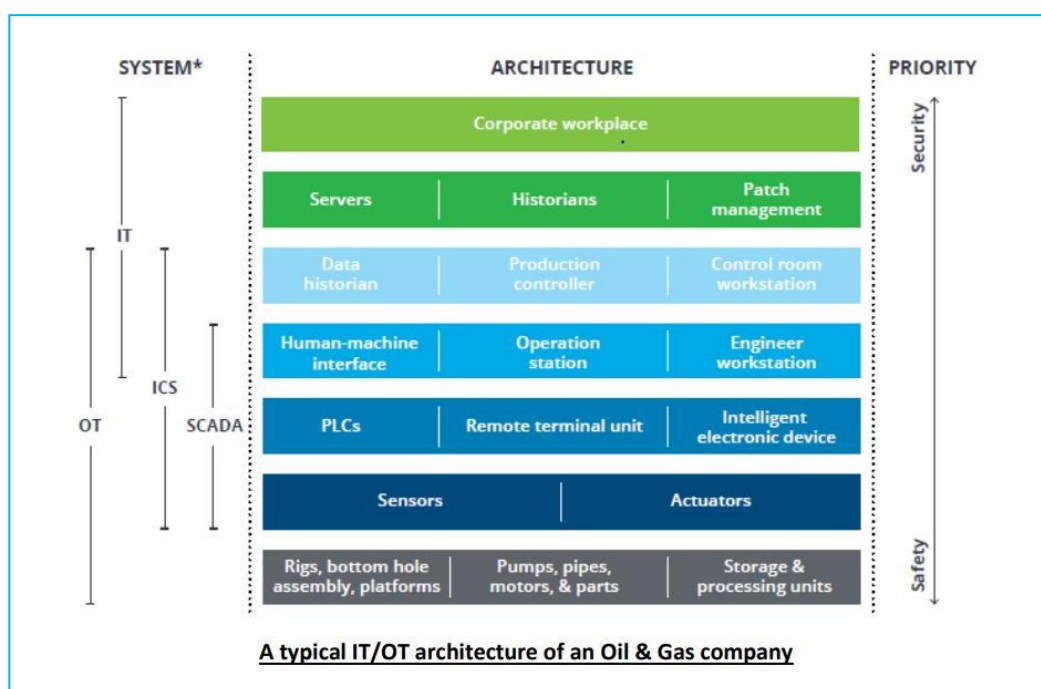


Fig 6.4: A typical IT/OT architecture of an oil and Gas Industry

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- 6.17.5. OT has traditionally relied on hardware and software developed specifically for industrial needs. As a result, OT and IT infrastructures have been separate entities historically, both physically and from a management standpoint. OT has not traditionally been networked technology - meaning connected to a larger network over the internet. Devices for monitoring or adjustment with computer resources generally used closed proprietary protocols and programmable logic controllers rather than technologies that afford full computer control. The systems involved often relied on 'air gapping' for security.
- 6.17.6. With increasing automation, advancement of digital transformation initiatives and the Internet of Things (IoT), the majority of the OT devices are connected either to the internet or through an enterprise server. In a connected world with remote operations and integration of business processes across functions, there is increased convergence of OT and IT networks. The 'air gap' that once insulated OT systems from bad actors has all but disappeared and OT has become a bigger target for cybercriminals. The motives can be many, ranging from ransom to sabotage.
- 6.17.7. Cyber criminals are also becoming increasingly more sophisticated and adept at exploiting OT vulnerabilities. Supervisory control and data acquisition (SCADA) and industrial control systems (ICS) remain their primary targets. OT systems are particularly vulnerable to advanced threats, largely due to:
- a) Prevalence of legacy systems from disparate vendors using a mix of proprietary protocols.
  - b) Infrequent updating compared to IT
  - c) Cyber-attacks in the OT environment can go undetected for a long time.
  - d) Fragmented Ownership - IT and OT were developed with distinct missions, thus cyber ownership and responsibility are fragmented across the organization.
  - e) Early stages in OT Cyber maturity - OT cybersecurity program activities have not yet been planned or deployed or they have been planned and defined but only partially deployed.
  - f) Lack of hardened end points and encryption of data when in motion.
  - g) Lack of segmentation
  - h) Irregular patch management
  - i) Latency concerns – Firewalls could introduce unacceptable latency into time critical ICS (Industrial Control Systems) systems.
  - j) Tasks intended to secure OT infrastructure are not completed.
- 6.17.8. IT/ OT convergence has the following important implications from a safety and security point of view:
- a) **Expanded attack surface:** Connecting the OT and IT infrastructures exposes each to attacks from the other's endpoints. Relatively insecure OT devices such as valves, pumps, sensors, electronic locks, thermostats, and robots now are potential entry points to the IT infrastructure. In the other direction, cyber

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attackers can target critical utilities, such as the electrical grid and transportation systems, using the mobile network as an entry point.

- b) **Increased complexity:** OT network environments are complex, with hundreds of devices to monitor and secure, usually from a mix of vendors. This complexity exacerbates the challenges surrounding visibility and personnel, as each device stores its own data and has specific security configuration needs and requirements.
- c) **Advanced threat landscape:** Connecting OT to the internet exposes the OT infrastructure to a range of legacy malware that is easily caught by signature-based IT security solutions but may still be effective on insecure industrial devices. Cybercriminals often test old malware by attacking a small number of machines, and then use the successful exploits to mount large-scale attacks.

6.17.9. Organisations, therefore, need to have comprehensive strategies for confronting known and unknown threats, with a focus on mitigating the impact of breaches that have succeeded in evading security controls. Such strategies need to incorporate solutions that enable visibility, restrict access with precision and automation, detect and contain live breaches, thwart lateral movement and minimize the attack surface within the OT network.

# Section - 1 C

## Recommendations



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**7.0 RECOMMENDATIONS FOR THE OVERALL IMPROVEMENT OF SAFETY IN INDIAN PETROLEUM SECTOR**

The working group had detailed deliberations on the inputs received from various organisations, domain experts from the industry/ academia, regulators and knowledge organisations, study of the current safety management systems followed by various organisations, root cause analysis of accidents that occurred in the Indian petroleum sector in last five years, observations and recommendations made by various committees investigating major incidents, first-hand experience of Working Group members and key personnel handling safety critical roles in the organisations and global trends in safety management.

Based on the above, the Working Group wishes to make the following recommendations for the overall improvement of safety in the Indian Petroleum Sector. Working Group acknowledges that some of the recommendations mentioned in this report are already in vogue in some organisations. However, re-mention of the same in this report indicates the importance of the item for overall safety management, prompt for those who are yet to implement and a chance to revisit for possible improvements for those who have already implemented.

**7.1. SAFETY CULTURE**

**7.1.1. Benchmarking of Organisations' Safety Culture against Safety Culture Maturity Model**

7.1.1.1. All Organizations in Oil and Gas Sector are to carry out a formal assessment of the safety culture in their organisation on an immediate basis. A formal Safety Perception Survey involving all stakeholders to be a necessary part of the above study.

7.1.1.2. Major organisations, employing more than 500 people, should consider carrying out the above safety culture assessment through a reputed third-party agency and benchmarked against an internationally accepted Safety Culture Maturity Model. A formal Safety Perception Survey involving all stakeholders to be a necessary part of the above study.

7.1.1.3. Different companies may be at different levels of safety maturity currently. Based on the findings, Organisations to develop a time bound road map for improvement clearly identifying short term and long-term action items. Findings of the study and the action plan to be presented to the respective Boards of the Companies.

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7.1.1.4. First study to be completed by the organisations within two years of this report, which should be repeated periodically at least once in five years. Organisations that have completed such study through a reputed third-party external agency in the last 3 years need not do it again immediately, if they so desire, but should closely monitor the implementation of the recommendations and repeat the study after completion of 5 years from the first study.

7.1.1.5. OISD to include the availability of such study reports and improvement roadmap as a checkpoint in their audits. OISD to also carry out dipstick checks on ground realities during their safety audits. However, organizations may choose to keep the findings of such study reports confidential and present them only to their respective Board.

**7.1.2. Safety Orientation of Top Management to Enlist Leadership Commitment**

7.1.2.1. In order to ensure that safety is viewed in the organisation as a proactive trust building exercise with the stakeholders and not viewed only from the prism of compliance and avoidance of negative outcomes of an incident, leadership commitment to safety values is essential. To enlist the commitment of leadership teams to safety, it is recommended that top leadership teams including Board level be given structured safety orientation. It will help in clear articulation of expectations and ensuring that the intent matches the policies and actions on the ground.

**7.1.3. Organisation Structure**

7.1.3.1. Safety is an integral part of the overall operations management and therefore it is necessary that there is a proper functional relationship between line functions and safety departments at various levels of the organization.

7.1.3.2. Organizations should have a corporate department, dedicatedly looking after safety, with its Head either directly reporting to the head of the organization (Chief Executive Officer/ MD/ CMD) or through Head-Corporate HSE. Functions of Corporate Safety should include organisational safety culture assessments, monitoring of external and internal safety audit recommendations, corporate wide theme driven safety initiatives, information dissipation, overall coordination, issuing necessary policy guidelines related to safety and any other responsibility related to safety which the management of the concerned organization may decide.

7.1.3.3. Each Strategic Business Unit, which has asset-facing operations, should have a safety function. Head-Safety in SBU should be reporting to the concerned SBU Head either directly or through the Head HSE of the concerned SBU. Each operating location having asset facing operations should have a designated safety officer reportable to the Location in-Charge.

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- 7.1.3.4. All safety functions embedded in locations and SBUs to have a direct (administrative) reporting relationship to concerned functions and a dotted line relationship with Corporate Safety.
- 7.1.4. **Leadership Orientation towards 'Visibly Felt Leadership'**
- 7.1.4.1. Leadership teams to be oriented to provide "Visibly Felt Leadership" as far as safety is concerned. Periodic field rounds/ safety tours by Senior Management to be made compulsory and to be included in the individual's targets. Records to be maintained of such safety tours along with observations. Senior management should set the right examples and should be extra meticulous in adhering to safety rules themselves.
- 7.1.4.2. Safety should have no differentiation among people depending on their status, level in the hierarchy or engagement terms. The rigour and focus of the implementation of safety rules should be the same for all. The safety department/ officers should be empowered for the same through executive orders.
- 7.1.4.3. Leadership to actively involve in safety campaigns and encourage innovative ways to keep safety always in focus. Awareness drives, safety competitions, experience sharing, visual displays, animation, films, innovative ways to motivate the workforce to identify and report unsafe acts and unsafe conditions etc. are a few such ways.
- 7.1.5. **Development of Safety Performance Indicators (Set of Leading and Lagging Indicators)**
- 7.1.5.1. A set of safety performance indicators comprising of a combination of leading and lagging indicators to be framed for monitoring the safety performance of the SBUs, locations and the organisation as a whole.
- 7.1.5.2. Safety Performance indicators to be included in KPIs/ KRAs (Key Performance Indicators/ Key Result Areas) of key functionaries and included in performance management metrics. Measurement metrics to be objective, specific and outcome based to ensure accountability and effectiveness.
- 7.1.6. **Allocation and Monitoring of Safety Budget**
- 7.1.6.1. Safety Budget to be separately and specifically allocated and monitored. If it is a part of the overall HSE budget, then the budget for the three elements of HSE i.e., Health, Safety and Environment to be separately identified and approved. The safety budget may be further sub-classified as per respective organization guidelines. However, the suggested major headings are as follows:

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- Routine or Specific
- Maintenance, Replacement or Improvement
- Corrective, Preventive or Predictive
- Safety Promotion, Safety Training, Safety studies or Safety audits
- Firefighting and Emergency Preparedness

7.1.6.2. Safety budget proposals to clearly specify the purpose and expected outcomes. In case of non-approval of a safety budget proposal, reasons should be recorded for such non-approvals with alternate mitigation measures, if so required.

### 7.1.7. **Development of Inherent National Safety Culture**

7.1.7.1. In order to have a wide pervading inherent national safety culture, it is necessary that the same be not restricted to only industrial set ups and includes safety in personal and public life as well. It would need the safety orientation of the public at large and from early stages in life.

### 7.1.7.2. **Safety Training in Schools, Colleges & Vocational Training Institutes**

- a) Children are the best learners and if they are taught safety aspects in the school, they are likely to develop it as a habit facilitating the development of a good safety culture.
- b) Curriculum may start with home safety and road safety at the pre-primary and primary level and slowly incorporate fire safety, emergency response, and hazard identification at the senior school level. The methods and content can be made more relevant/ interesting depending on the age profile and education level as the child climbs up the education ladder. In nursery schools, safety orientation may be included in the form of fun games, group exercises, visual demonstrations, cartoon films etc. that may include simple subjects like climbing up/ down ladders, handling sharp objects, hot substances, getting in and out of vehicles, crossing roads etc. These are practised compulsorily in many countries.
- c) At the undergraduate level, the course on safety may be clubbed with the environmental course.
- d) While learning the trade in Vocational Education and Training (VET), also called Career and Technical Education (CTE), safety should be interwoven in the course module itself.

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- e) If any approval from Education Boards/ UGC or AICTE is required for inclusion of a compulsory course in schools or colleges or VET, the same may be facilitated through concerned ministries. More intense and specialised courses on safety may also be included as electives as per New Education Policy (NEP).
- f) Engineering courses to include process safety management as a subject in the curriculum, if not already there. MoPNG may facilitate the process by taking up with the concerned Ministry.

### 7.1.7.3. Safety Education for General Public

- a) One of the most effective ways to propagate safety messages to the general public is through the use of social media, television and OTT interludes, cinemas, displays at public places etc. in an interesting manner. Intelligent use of humour and day-to-day life situations can attract necessary interest in safety messages.
- b) Safety contents can be developed for the general public on common subjects of daily relevance like safety at home, traffic safety, using elevators & escalators, and safety related to public transport – trains, aeroplanes, metros, buses, taxis etc.
- c) Localisation of the content depending on the social background and language used may be necessary in a country like India with multi-culture and heterogeneous demography.
- d) Safety may be included as a part of themes for the CSR (Corporate Social Responsibility) Budget by the corporates to attract funding for the development and propagation of safety content for the public in a professional manner.

## 7.2. COMPETENCY ASSURANCE OF COMPANY EMPLOYEES

### 7.2.1. Position requirement based Three-Dimensional Competency Grid

- 7.2.1.1. Organisations to develop a three-dimensional competency requirement grid for each position in the organisation identifying:
  - a) **Basic requirement** – Qualification, area and number of years of relevant experience, specific certification required if any, minimum medical fitness requirements, if any
  - b) **Technical Competency/ Domain Expertise Framework** – Technical/ Domain related functional knowledge areas necessary for the role and the level of expertise required like - basic, intermediate or proficient.
  - c) **Behavioural traits/ Behavioural Competency Framework** – As required for the role.

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While the above grids can be developed for all positions in the organisation, it should necessarily be done for safety critical roles. Safety critical roles include all functional roles having safety requirements and are not restricted to only roles in safety departments. Organisations that already have a technical competency framework may review/ update the framework and bring the necessary focus on implementation.

- 7.2.1.2. Employees operating the positions are to be assessed against the competency requirement and suitable interventions are to be devised to bridge the competency gaps. Interventions to bridge the competency gaps may be developed keeping in view both the present and the future requirements at the individual and organisational level. The assessment process should be objective, clearly defined, documented, and communicated. The assessment process should be independent of the performance appraisal process.
- 7.2.1.3. A structured mechanism of training, retraining/ refresher programs, and periodic reassessment to identify and bridge residual/ competency gaps to be a mandatory part of the competency assurance program.
- 7.2.1.4. Competency grids are to be periodically reviewed and updated at least once in 5 years or as may be required to take care of new business requirements, technological developments and new business processes.
- 7.2.2. **Rebalancing Training Mix – Functional v/s Behavioural & Management Trainings**
  - 7.2.2.1. Organisations to review the balance between functional/ technical, behavioural and managerial training as per the requirement of different positions in the hierarchy to ensure that focus on technical/ functional training is not compromised at junior and lower middle management levels.
  - 7.2.2.2. It is suggested that for asset facing and O&M related workforce, technical/ functional training time should comprise of about 70 % of the total time consumed by individuals on training and competency development. The percentage of managerial and behavioural training may increase, at higher levels in the hierarchy.
  - 7.2.2.3. Safety training is to be an essential part of the operational training, which in addition to occupational safety and emergency response should also focus on inherently safe operation.
- 7.2.3. **Compulsory Orientation/ Training/ Retraining before Taking over any Role/ Assignment**
  - 7.2.3.1. Orientation, training and retraining with specific knowledge assimilation for new assignment/ reassignment to any location/ department to be a mandatory part of the transition and Handing Over -Taking Over (HOTO) process for all assignments.

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- 7.2.3.2. Organization to develop role specific list of mandatory domain specific training that a person needs to undergo before the commencement of duty in his/ her role and place of duty.
- 7.2.3.3. Organisations to develop specific competence criteria for posting personnel in the HSE department based on the requirement for the function. Placements in the HSE department at various levels from Corporate to installation level should fulfil this criterion. In case of a competency gap, necessary interventions including certifications/ training should be provided in a time bound manner.
- 7.2.4. **Qualification/ Certification of Safety Officers**
- 7.2.4.1. Variations are observed in qualifications and mandatory requirements for designated safety officers in different states as per applicable Factories Rules. It is suggested that Factories Departments may consider bringing uniformity in the same. In that case, Factories Departments can approve a common list of the institutes on a national basis from where a degree and diploma in industrial safety will be acceptable as a qualification for safety officers.
- 7.2.4.2. Oil Industry has a reasonable number of experienced officers with proficiency in safety related matters. To create a larger pool of designated safety officers and to give further impetus to overall safety management, Factories Departments may consider recognizing them as designated safety officers based on necessary evaluation through online tests. Necessary amendment in Factories Rules may be considered, if so required.
- 7.2.4.3. MoPNG may suitably take up with the concerned Ministry for necessary amendment in the Factories Act/ Rules thereunder.
- 7.2.4.4. For E&P installations (rigs and production installations) as of date, the designated safety officer is not mandated in the Mines Act/ Regulations thereunder. It is recommended that E&P installations engaging more than 20 workers, should have a designated officer dedicated to safety. A designated safety officer needs to have specified minimum qualification/ certification in upstream safety. For small installations, engaging less than 20 workers, Assistant Installation Manager can continue to hold the responsibility of designated safety officer in addition to his own at Installations, as per the present practice.
- 7.2.5. **Innovation in Training Content and Delivery**
- 7.2.5.1. Domain specific training programs to have a judicious mix of classroom training, simulation-based training and field training as per job requirements.

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- 7.2.5.2. Training content to use videos, animations, illustrations, photographs, vectors, images etc. for visual impact, easy understanding and longer retainage.
- 7.2.5.3. Organisations to develop a repository of subject specific short duration online training modules, which people can access from anywhere.
- 7.2.5.4. Organisations should work towards using new age technologies like Virtual Reality, 3D imaging, and Training Simulators to improve the effectiveness of training.
- 7.2.5.5. All training programs, whether online or physical, need to have post training evaluation and follow up assessment to judge on the job effectiveness of the training interventions.
- 7.2.6. **Quality of Mandatory/ Specialised Training done through External Agencies**
  - 7.2.6.1. Companies to verify that the mandatory training courses undergone by individuals are standard courses, undertaken through national or international accredited agencies. A robust system to verify the authenticity of the agency, course completed and the certificates issued by them to be instituted. QR code or such methods to ensure the authenticity of training certificates to be encouraged.
  - 7.2.6.2. Procedural issues, if any, hindering the selection of competent agencies for mandatory/ specialised training to be addressed by the management of the concerned organisations.
  - 7.2.6.3. An internal process to monitor the validity of the mandatory training and generate advance notice through the Enterprise Resource Planning (ERP) system for the expiry of the same may be implemented for ensuring the continued validity of the mandatory certifications.
- 7.2.7. **Knowledge Sharing and Industry Collaboration**
  - 7.2.7.1. Companies having similar processes and operations, using similar equipment & systems and requiring similar knowledge & skill sets to have frequent interactions to share their experiences and work together to develop a common knowledge base. It will help in enhancing industry wide competence. This will also help small and medium companies with limited resources and experience to utilize the overall industry knowledge and enhance the competence of their employees.
  - 7.2.7.2. OISD to accelerate its efforts in sharing knowledge with the industry on learnings from incidents. The industry may also collaborate with OISD in developing videos/ animations/ short films on incidents. It will propagate the learnings more effectively and help in preventing the recurrence of similar incidents.

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- 7.2.7.3. OISD to accelerate structured training for internal safety auditors, to enhance the quality of internal safety audits of the companies on a reasonable charge basis.
- 7.2.7.4. Major organisations may also explore the possibility of providing training to other organisations in their facilities on a chargeable basis.

**7.3. SAFETY MANAGEMENT OF OUTSOURCED AND CONTRACTED-OUT-JOBS**

**7.3.1. Risk Based Classification of Tasks/ Works**

- 7.3.1.1. The organizations to carry out a risk assessment of the tasks/ works during the planning stage and classify the work as per their associated risks on a 4-point scale as - Extreme, high, moderate and low risk. Where simultaneous activities are likely to be carried out, additional risk assessment to be undertaken for the total scope.
- 7.3.1.2. It is desirable that organisations have criteria to decide outsourcing decisions. The decision to outsource a job should also consider the risk profile of the job in addition to other criteria.
- 7.3.1.3. For routine and repetitive jobs, risk-profiling exercise can be carried out on one time basis and reviewed periodically, at least once in 5 years. Basis the experience, the job risk category can be revised as required. In case of any incident, the risk category should be reviewed, and revised or reaffirmed as a standard process. Objectivity and consistency are to be ensured while defining the risk category of the jobs.
- 7.3.1.4. While registering contractors in the master vendor list, the risk profile for the works for which the contractor is registered should also be kept on record.

**7.3.2. Incorporation of Safety Requirements in Tender and Contract Documents**

- 7.3.2.1. The organization is to ensure that the safety management system, standards and expectations from the outsourced agencies/ contractors are the same as those applicable to the company and its employees.
- 7.3.2.2. Depending on the type, complexity and risk profile of the job, necessary safety related requirements are to be clearly specified in the tender document.
- 7.3.2.3. Tender document to clearly depict the expectations from the contractor related to safety performance including the type of safety precautions, PPE (Personal protective equipment) required, roles & responsibilities of the contractor's key personnel, minimum competency criteria and mandatory training/ certification required for the people to be deployed on the job, essential processes to reduce the risks, communication protocols, legal obligations etc.

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- 7.3.2.4. Since the day-to-day supervision of the contract workforce is done by the supervisor of the contractor, it is imperative that they are well versed in matters of safety related to the contract. Hence, in the tender document, special emphasis must be given to the minimum competency criteria and mandatory training/ certification required for the contractor supervisors.
- 7.3.2.5. Organisations to develop a standard vetted document depicting safety requirements for each category of risk profile which will generally apply to all jobs in a relevant risk category. Additional safety requirements, if any, for a particular job or at a particular location may be included as a separate annexure to it.
- 7.3.2.6. For extreme risk and high-risk category jobs, necessary safety criteria may be included in the prequalification criteria to ensure the selection of competent contractors capable of delivering the expected safety performance. Past safety performance on similar types of jobs and the company's orientation to safety may be checked while selecting the contractor. Organisations may adopt suitable mechanisms for the same, including a well-defined safety rating system.
- 7.3.2.7. Financial penalties for safety violations, which can act as a reasonable deterrent to be necessarily included in all contracts.
- 7.3.2.8. Company's expectations and requirements related to safety should be specifically explained during pre-bid meetings & kick-off meetings and should be a part of final contract documents.
- 7.3.2.9. The organization to have corporate guidelines for standardization of bridging documents for bridging the gap between their own safety management system and that of the contractor, wherever required. RACI chart (Responsibility, Accountability, Consulting & Informing) as per the guidelines and Emergency response system with clear guidelines should be an essential part of such bridging documents.
- 7.3.2.10. Wherever subcontracting is allowed, the main contractor to own complete responsibility for the safety performance of the subcontractors/ agencies hired by him and the same should be clearly stated in the contract documents.
- 7.3.3. Safety Training for Contract Workforce**
- 7.3.3.1. As a policy, companies must undertake safety induction training for all contracted workforce once they report to the workplace to familiarize them with the site-specific hazards, procedures etc. Job specific safety training, and refresher training should also be carried out for the contracted workforce as per requirements. Evidence of such training should be kept on record such as photographs/ video evidence.

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- 7.3.3.2. Contractor should ensure that the workforce undergoes mandatory training courses as specified in the contract before the commencement of their duty. A system is to be put in place by the organizations to verify the evidence of such training.
- 7.3.3.3. Short video films in local languages on safety related subjects to be developed by the organizations and to be played in common areas like canteen, restrooms, entry gates etc. Organizations should share such videos among themselves, OISD to facilitate the same.
- 7.3.4. **Safety Performance Monitoring & Safety Rating for Contractors in High-Risk Jobs**
- 7.3.4.1. Safety performance of the contractor should be reviewed at periodic intervals (as per contract/ guidelines) to ensure that the safety requirements, as agreed upon, are met and the contractor receives regular feedback on his safety performance.
- 7.3.4.2. Any change in the job risk profile during the currency of the job due to any change in the task, work practice or environment should be identified, discussed and necessary actions/ precautions taken.
- 7.3.4.3. Organisations should develop a structured, transparent and objective safety performance rating system taking into consideration:-
- a) On the job safety performance of the contractor judged through recorded parameters like number of fatalities, loss time incidents, reported deviations, monetary compensation paid, penalties charged, litigations etc.
  - b) Contractor's orientation to safety judged by their safety policies, practices, training methodologies, their safety organisation structure, and number/ qualification/ experience of the safety supervisors intended to be deployed on the job etc.
- 7.3.4.4. A 100-point system with a weightage of 80% for (a) and 20% for (b) above is recommended. Appropriate weighted average method for points received over multiple jobs to be devised to have contractor's rating at any point in time. Safety performance on recent jobs may be given higher weightage than older jobs.
- 7.3.4.5. To avoid any bias, the safety rating is to be automatically derived from a computerised system as per the defined logic/ algorithm based on field data captured from authentic sources and should be available online. Suitable administrative mechanism to be put in place to ensure first hand factual reporting of safety related violations by the concerned in real time. Reasonable deterrents should be instituted to ensure that the process is followed in letter and spirit.

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7.3.4.6. It is suggested that a safety rating system may be started immediately to start collecting data. Once reasonable data points are available in the system, safety ratings can be used for the selection, holiday listing and blacklisting of the contractors.

### **7.4. MANAGEMENT OF SAFETY BARRIERS**

7.4.1. Oil and Gas industry invariably implements a number of safety barriers across the lifecycle from plant design, construction and operation stages up to the retirement of the assets, to minimise or eliminate any incident. Multiple processes are in place for the incorporation and sustenance of the safety barriers depending on the type of barrier and the stage of implementation. The following suggestions are made for further improvement and effectiveness of the measures.

#### **7.4.2. Life Saving Rules**

7.4.2.1. All organisations must define Life Saving Rules. Life-Saving Rules are not intended to address all risks and hazards in the oil and gas industry; they are meant to draw attention to the activities most likely to lead to a fatality, and the life-saving actions over which an individual has control. The Rules are not intended to replace company management systems, policies, safety-training programmes, operating procedures, or work instructions, and in fact rely on this framework being in place.

7.4.2.2. IOGP (The International Association of Oil and Gas Producers) Life Saving Rules report 459 issued in August 2018 came out with simplified nine Life-Saving Rules as given below, established through rigorous data analysis:

- a) Bypassing Safety Controls: Obtain authorization before overriding or disabling safety controls
- b) Confined Space: Obtain authorization before entering a confined space
- c) Driving: Follow safe driving rules
- d) Energy Isolation: Verify isolation and zero energy before work begins
- e) Hot Work: Control flammables and ignition sources
- f) Line of Fire: Keep yourself and others out of the line of fire
- g) Safe Mechanical Lifting: Plan lifting operations and control the area
- h) Work Authorisation: Work with a valid permit when required
- i) Working at Height: Protect yourself against a fall when working at height

Companies may choose to adopt these rules or frame their own rules depending on their own experience.

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- 7.4.2.3. The Life-Saving Rules must be explained as part of the induction process, reiterated during significant safety meetings and displayed with high visibility at relevant work locations to prompt self-review before undertaking an activity. Every employee and contractual worker should be made aware of these rules.
- 7.4.2.4. Organisations to put in place a monitoring mechanism to ensure that rules are followed and violations of these Rules are captured and reported as Unsafe acts/ Unsafe conditions.
- 7.4.3. **Inherent Safety in Design**
- 7.4.3.1. Organisations to strive to make the designs inherently safe to the extent possible. Compliance with national and international standards, appropriate safety margins, thorough inspections during fabrication and construction, HAZOP, QRA and SIL studies, 3D walk through models, proper designs of safety critical devices, trip and interlock settings, emergency shutdown systems, fail safe modes of various instrumentation & equipment, loop checking, pre commissioning safety audits, flare system design etc. are some of the critical areas to look into.
- 7.4.4. **Hazard Identification and Risk Assessment (HIRA)**
- 7.4.4.1. The hazards associated with all aspects of the installation should be identified by a multi-disciplinary team. The hazard identification process should be dynamic and ongoing to ensure that any new hazard is identified throughout different phases of the project (such as planning, design, construction, commissioning, operation including start-up and shutdown, maintenance etc.). This step is critical in the context of risk management since an overlooked hazard (hence, risk) cannot be further assessed and controlled. Qualitative, Semi-quantitative or Quantitative risk assessment (QRA), as applicable to be used to determine the level of risk including consequences and probabilities of occurrence.
- 7.4.4.2. Organisations should establish a risk matrix, applicable throughout the organisation, for carrying out qualitative risk analysis.
- 7.4.4.3. The HIRA of existing facilities should be performed as soon as possible, if already not done. The HIRA should be reviewed and updated/ revalidated every 5 years after baseline HIRA. In case of a major incident occurrence or any major modifications in the facility that may deem the earlier HIRA invalid, the installation should carry out HIRA/ HAZOP study and QRA again as per requirement.
- 7.4.4.4. Awareness should be spread about the identification of hazards throughout the organisation. Installation personnel should be aware of the HIRA report (Risk Register) and about significant hazards along with controls.

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- 7.4.4.5. To ensure the quality of Hazard and Operability study (HAZOP) and Quantitative Risk Analysis (QRA), services of professional agencies may be utilised wherever required. It should be the responsibility of the Installation to ensure the correctness of the input data used for the HAZOP and QRA studies. HAZOP & QRA report should be verified by Installation for correctness of information and consistency in terms of study and recommendation before approving it. The cause-effect relationship should be carefully checked while approving recommendations to ensure the effectiveness of the suggested mitigation measures.
- 7.4.4.6. Report once approved by the appropriate authority in the company/ Installation, should be acted upon for implementation of the recommendations. Suitable monitoring and escalation mechanism to be put in place to ensure the time bound implementation of the recommendations.
- 7.4.5. **Management of Change (MOC)**
- 7.4.5.1. Most of the organisations have some form of MOC system; however, certain grey areas exist in its implementation. To make the system more robust, the following is recommended:
- a) All organisations must have a documented approved MOC process in place.
  - b) Process Organisations should implement an e-module of the MOC system, which is easy to monitor. It will ensure that the system is not bypassed in any situation and there is a trail at each stage of MOC review and approval. E-system can also generate alerts in case of delay in approval, delay in implementation etc. OISD-STD-178 may also be referred to in this regard.
  - c) MOC system should be implemented not only for hardware changes but also for making changes in critical operating parameters/ procedures, trip settings and prolonged bypassing of safety interlocks.
  - d) Organisations should ensure the effectiveness of the process for identifying new/ consequent hazards introduced due to change and the required mitigation measures.
  - e) Audit of the MOC system should be carried out at least annually (can be integrated with the internal audit) to identify exceptions where modifications have been carried out without MOC or deviation has been taken to the stipulated process. Effectiveness of MOC procedure, timely completion and closure of MOC requests, updation of P&IDs and other documentation, manuals, standard operating procedures etc. as required may also be checked and concerned people are impressed upon to adhere to the MOC process.

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### 7.4.6. Work Permit System

7.4.6.1. Most of the organisations have a structured Work Permit System. However, certain grey areas exist in its implementation. To make the system more robust, the following is recommended:

- a) Organisations should implement an e-module of the Work Permit system, which is easy to monitor, in line with the OISD-STD-105. It is preferable to have an online geographical depiction of the hot work permits on a location map for easy identification of concurrent jobs in progress in a specified zone at any point in time.
- b) Any work in the licensed area of the installation, other than operation related activities by the operating crew, should be covered under a work permit system of the organizations.
- c) Responsibility metrics should be clear between the permit issuer and the permit receiver.
- d) Job Safety Analysis (JSA) to be carried out for all critical tasks/ jobs by a multi-disciplinary team comprising of representatives from Operation, Maintenance/ Projects and Safety. JSA should be relevant for the task/ job under execution, should explicitly cover all hazards related to the task/ job and clearly identify mitigation measures required.
- e) Organizations to ensure that toolbox talk adequately covers the hazards involved in the job as identified in JSA, and specific safety precautions to be followed.
- f) Persons responsible for the safety function at the location should be aware of the work permits issued during the day and they should be carrying out field checks depending on the criticality and risk profile of the job. Deviations observed, if any, should be reported and corrected immediately. Safety persons should be empowered to stop job in case of safety deviations/ violation of work permit instructions.
- g) Audit of the Work Permit system should be carried out (can be integrated with the internal safety audit) to check the effectiveness of the Work Permit system, deviations observed during field checks by the safety department, gas test, linkage with JSA, permit extensions, closure, concurrent job permits etc.

### 7.4.7. Risk and Vulnerability Index

7.4.7.1. Different jobs have different risk profiles. Vulnerability for the same or similar jobs may vary depending on the circumstances under which the job is executed and the supervision available. Vulnerability index is a process of indexing the jobs based on their severity, potential consequence, circumstances under which the job is being

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carried out and the supervision control levels. If a job has a high vulnerability index, then supervision/ oversight from higher management personnel is required in addition to supervision by the concerned supervisor.

7.4.7.2. In organisations where Vulnerability Index is implemented, it is a part of the work permit system and depending on the vulnerability index, it becomes necessary for the senior person, as per the defined escalation metrics, to visit the site and keep track of the job during the day.

7.4.7.3. Vulnerability index is comparatively a new concept, however as per organizations, that have implemented it (in whatever name), found it an effective tool for monitoring & control of critical tasks with higher risks. Organisations should consider adopting such an index for further enhancements in the monitoring of critical tasks.

### 7.4.8. Mapping and Monitoring of Safety Critical Equipment (SCE)

7.4.8.1. All the organizations to identify list of safety critical equipment. The status of safety critical equipment is to be regularly monitored to ensure their availability all the time. Exception reports for non-availability of safety critical equipment should be available to designated persons and alternate risk mitigation plans should be in place.

7.4.8.2. While planning any jobs with high-risk profiles, availability of the relevant safety critical equipment should be ensured.

7.4.8.3. It is recommended to map Safety Critical Equipment along with their maintenance and calibration/ testing schedule (as applicable) in the e-module for better monitoring. Alerts should get generated to the concerned in case of deviation from the schedule.

7.4.8.4. In case of any deferral/ bypass, a well-defined deferral/ bypass management system with due risks evaluation, alternate controls and appropriate approval to be followed.

7.4.8.5. Availability of safety critical equipment in good health should be essentially checked during the internal safety audit. History of downtime of safety critical equipment, when the same were not available to perform the intended function, should also be reviewed during audits.

### 7.4.9. Safe Operating Envelope

7.4.9.1. Installations like refineries, process plants, cross-country pipelines, offshore platforms etc. to have an approved documented management process for defining and managing parameters and limits of the safe operating envelope for plant operations.

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- 7.4.9.2. Any changes to Safe Operating Envelope limits should follow MOC Process.
- 7.4.9.3. Escalation and authorisation metrics to bypass any parameter of Safe Operating Envelope should be well defined and known to the operating crew.
- 7.4.9.4. Training to operating crew should include the logic, importance and emergency response for the parameters forming part of the Safe Operating Envelope. Training Simulators may be useful in training the operating crew on the importance and response involving these parameters.
- 7.4.9.5. Any process event involving a breach of the Safe Operating Envelope should be recorded, thoroughly investigated and necessary remedial measures implemented.
- 7.4.10. Emergency Shutdown Device (ESD) and Alarm Management**
- 7.4.10.1. Emergency Shutdown (ESD) systems are to be well designed from the initial stages of a project through HAZOP and SIL studies. The organizations should have a system for clear function tests (CFTs) and maintenance schedules for each component of the ESD system, which shall have to be adhered and audited.
- 7.4.10.2. ESD switches are to be strategically located and the integrity of ESD is to be checked at the stipulated frequency as defined by the organization. Training on ESD to be an essential part of training for the connected persons.
- 7.4.10.3. Alarm Management is one of the important pillars of LOPA (Layers of Protection Analysis). Organisations to carry out alarm rationalisation exercises to ensure effective and preferential attention of the operator on important alarms. Regular audits on alarm management are to be carried out by the organizations for control measures. Trends on repeated alarms, spurious alarms, non-functional elements, alarms on bypass etc. should be analysed and corrective/ preventive actions taken.
- 7.4.11. Trip Bypass Management**
- 7.4.11.1. Generally, the trips are always to be kept in line when the plant is in operation. However, organisations need to have a well-documented trip bypass process to take care of situations where continuing plant operation is inevitable even with trip bypass. Such a process should include approval hierarchy and alternate controls to be in place during the period a trip is under temporary bypass mode.
- 7.4.11.2. The organizations to develop a system for regular review of the trip bypass management system and ensure that no critical equipment/ system/ trip/ interlock is bypassed or the trip values changed without approval from the competent authority or management of change process and without written alternate mitigation measures.

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7.4.11.3. The approval mechanism should escalate telescopically with increasing period of time for which a trip is under bypass. Approval should be obtained in real time. Any interlock which continues to be in bypass mode for a longer period as specified in OISD-GDN-206, must be reviewed critically for further course of action with requisite MOC. Additional mitigation measures, if required should be in place.

### 7.4.12. Pre-Commissioning Safety Audit (PCSA)

7.4.12.1. Pre-commissioning Safety Audit (PCSA) before commissioning of any new/ revamped/ modified facilities is an important step in ensuring inherent safety and must be carried out without fail with a specific checklist for different business units, operations etc.

### 7.4.13. Reporting Process Safety Events (PSE), Unsafe Acts and Unsafe Conditions

7.4.13.1. Organisations to augment existing practices and procedures to cover reporting and investigation of Process safety events, especially in Refineries, and process plants in line with API RP 754 preferably through e modules.

7.4.13.2. The organizations to augment existing practices and procedures to cover reporting of near misses, unsafe acts and unsafe conditions under separate headings preferably through e modules.

7.4.13.3. Contractual workforce should also be encouraged to report near misses, unsafe acts and unsafe conditions. A suitable mechanism to facilitate the same may be developed keeping in view the practicability and the sustainability of the same.

7.4.13.4. Awareness programme on reporting of near misses, unsafe acts, and unsafe conditions for the workforce to be conducted periodically. Innovating ways to be devised to encourage reporting of near misses, unsafe acts, and unsafe situations including suitable reward mechanisms for reporting.

7.4.13.5. All reported near misses are to be investigated for identifying the root causes. Analysis is to be used to generate themes and trends, which can then be used to identify focus areas for improvement in overall safety risk management at the facilities/ installations. High potential near misses are to be investigated with the same rigour as an actual incident.

7.4.13.6. All the reported unsafe acts and unsafe conditions should be rectified, and findings should be shared with all concerned. Further analysis is to be carried out to identify any pattern to take suitable remedial measures.

7.4.13.7. Trends of near misses and unsafe acts/ unsafe conditions are to be presented and discussed in safety committee meetings.

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**7.5. COMPLIANCE WITH STANDARD OPERATING PROCEDURES (SOP)**

**7.5.1. Updation of SOPs**

7.5.1.1. Organization to prepare a duly approved list of activities covering all cross-sections of work for which Standard Operating Procedures (SOP) are required to be maintained.

7.5.1.2. Based on the list, written Standard operating procedures are to be developed and established, if not already available, by subject matter experts (SMEs) keeping in view, statutory requirements and OISD standards.

7.5.1.3. Organizations to define the process for creation, review, approval and authorisation of SOPs including version control, issue, update, publish and recall.

7.5.1.4. SOPs to be reviewed and updated/ reaffirmed at least once in 3 years. However, SOPs are to be necessarily reviewed and updated/ reaffirmed as required in the following situations:

- Modification/ revamping of the installation
- Introduction and/ or deletion of facilities/ equipment/ procedure/ technology etc.
- Change in Process Safety Information
- Change in operation/ operating conditions
- Changes in applicable statutory, regulatory, and OISD standard
- In case of any incident/accident

7.5.1.5. In case of outsourced/ contracted services, SOPs (of organization or contractor) that will prevail should be controlled through bridging document before the start of the assignment.

7.5.1.6. Frequent changes to SOPs should be avoided unless absolutely necessary. Changes to SOP should be carried out only after thorough analysis.

**7.5.2. Ensuring Compliance Effectiveness of SOPs**

7.5.2.1. Latest approved version of SOPs with a version number to be made available online with proper access control. SOPs should be easily accessible to authorised persons.

7.5.2.2. Concerned persons are to be made aware and trained on the SOPs relevant to them. Periodic refresher programs are also to be conducted.

7.5.2.3. Any changes incorporated in SOPs are to be immediately communicated to the concerned including online availability.

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- 7.5.2.4. No deviation to SOPs should generally be taken. In case of extreme necessities, the same is to be done only with proper authorisation. Escalation and approval metrics for authorising any deviation to be defined in SOP itself.
- 7.5.2.5. Adherence to SOPs in the field is to be ensured through periodic assurance and audits including surprise checks.
- 7.5.2.6. In order to ensure compliance with SOPs, all SOPs should be verified in the field on actual jobs in real life situations at least once in a cycle of 3 years through surprise audit by independent internal teams.
- 7.5.2.7. Variation from the SOP observed on the actual job to be recorded and analysed to identify any need for updating SOPs or retrain the persons concerned. Variation across units/ locations, if any, should also be analysed for this purpose.
- 7.5.2.8. Changes to any SOP are to be also checked for any consequent impacts or changes required in other SOPs.

**7.6. ASSET INTEGRITY MANAGEMENT**

- 7.6.1. Organisations to develop comprehensive asset integrity management program covering the full lifecycle of the assets right from design/ procurement to replacement/ retirement.
- 7.6.2. Organisations to define Integrity Operating windows (IOWs) for the critical assets which should be known to the operating staff and breaching the Integrity Operating Window limits should follow MoC procedure.
  - 7.6.2.1. Proper mechanism to be put in place to ensure adherence to preventive/ predictive maintenance and inspection schedules and turnaround cycles. Delayed inspection or missed preventive/ predictive maintenance schedule cycle is to be monitored as one of the leading indicators under safety performance criteria.
  - 7.6.2.2. Asset integrity management program to include residual life assessment and replacement/ obsolescence policy for aged assets to ensure that integrity of all assets, equipment and facilities are fit for purpose throughout the lifecycle of the operation.
- 7.6.3. Risk based maintenance and advance techniques, facilitating online inspection and maintenance may be utilised wherever feasible and acceptable.
  - 7.6.3.1. Short term or long-term vulnerabilities and safety risks related to the operation of aged assets are to be built into the operational risk monitoring.

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### **7.7. PROCESS SAFETY MANAGEMENT**

- 7.7.1. Refineries and process plants should have a focussed program for Process Safety Management.
- 7.7.2. OISD may develop Process Safety Management Standards for Indian Oil and Gas Production/ Refining/ Processing facilities on the lines of 14 elements of PSM standards (CFR 1910.119) of OSHA (Occupational Safety and Health Administration) of the US Labor Department or 20 elements Risk Based Process Safety (RBPS) system developed by CCPS (Centre for Chemical Process Safety) of American Institute of Chemical Engineers (AIChE).
- 7.7.3. OISD has recently revised OISD-GDN-206 (Guidelines for Safety Management System). The same may also be referred to in this regard.

### **7.8. EFFECTIVENESS OF INTERNAL SAFETY AUDITS**

#### **7.8.1. Internal Safety Audit Team**

- 7.8.1.1. The organization to identify a group of officers from different disciplines with the right aptitude and job knowledge to develop a pool of personnel for internal safety audits. These people are to be provided with the necessary training in auditing skills (For ex. ISO 45001 lead auditor course or equivalent). Multidisciplinary internal audit teams are to be drawn out of this pool.
- 7.8.1.2. The people selected in the audit group should normally be part of their normal functions performing their normal duties and drawn only for specific audits for a short duration to ensure that audit team members are in touch with ground realities and updated in their knowledge base. It would need a large pool of people to be trained with periodic replenishment as the people may grow in the hierarchy or may get different assignments and may not be available for audits beyond a level.
- 7.8.1.3. The composition and size of the internal safety audit team may vary depending on the facilities, type of installations and areas to be audited.

- 7.8.1.4. Competence should take precedence over availability when choosing audit teams.

#### **7.8.2. Internal Safety Audit Methodology**

- 7.8.2.1. In order to have consistency, companies to prepare a company specific documented process for internal safety audit of its facilities. Guidelines of OISD-STD-145 can be followed for this purpose.

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- 7.8.2.2. Scope of the safety audit should cover all activities and facilities in the installation. Companies with multi location operations should ensure coverage of all locations in a cycle.
- 7.8.2.3. All organizations are to have an internal safety audit of all facilities of a location at least once in a year. A safety audit of one location should be completed in a single stretch to ensure focus and the least disturbance to the normal working of the location.
- 7.8.2.4. Checklist based audit is preferred for inclusiveness and verification of all applicable requirements. Checklists should be periodically updated to include new requirements emanating from changes in regulatory requirements, revision of standards, recommendations from accident investigations etc. However, the checklist should be a facilitating tool and should not make the audit a mechanical activity of ticking off the checkboxes. Audit to be based on observations on the ground and interaction with the people at various levels on the job.
- 7.8.2.5. Audit process to have an element of surprise. Field rounds of all safety critical areas of the facility, dipstick checks on SOP compliance, random review of CCTV footings, surprise mock drills, and status on findings of previous audits should be an essential part of the audit.
- 7.8.2.6. The findings and conclusions of the audit should be provided to the management and auditee in the form of a report within the stipulated timeframe. Objective evidence should be included to establish the audit finding. Reference of regulation/OISD standard to be provided wherever applicable for clarity and awareness.
- 7.8.3. **Compliance Monitoring for Audit Observations/ Recommendations**
- 7.8.3.1. After an audit report is received, the auditee should develop a time bound action plan for the liquidation of the audit findings.
- 7.8.3.2. Companies to have a review and monitoring system for time bound liquidation of the audit findings. It is recommended to use an online system for tracking audit findings until closure.
- 7.8.3.3. Auditee should submit monthly/ quarterly compliance in the portal with submission of details of actions taken attaching objective evidence, wherever applicable (until closure of all findings). Management should decide the authority, who will review the compliance and close audit finding in the portal.

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7.8.3.4. Status of long pending audit recommendations to be presented to the Committee of Functional Directors on a quarterly basis and to the Board of Directors on six monthly basis with age analysis of the recommendations.

**7.8.4. Resolution of Conflict**

7.8.4.1. While detailed audit reports may follow, audit observations should be discussed by the auditor with the auditee at the end of the audit itself. Any unresolved disagreements between Auditee and Auditor on audit findings or recommendations should be recorded at the end of the audit, to be handled as per the process. The audit Procedure should lay down the methodology for recording of unresolved disagreements between the auditor and auditee.

7.8.4.2. It has been observed that sometimes the recommendations made in the OISD external audits are not implementable due to practical difficulties like space constraints, litigations etc. especially at old locations. Acquiring new land or relocating the facilities is a time-consuming affair if it is so recommended. At times, the concerned organisation is not in agreement with the audit recommendations on technical grounds and the conflict remains unresolved inspite of discussions with OISD. Currently there is no mechanism to deal with such situations. As a result, such recommendations continue to remain open without action for a long time.

7.8.4.3. In case of conflict between the findings in the OISD audit and the view of the concerned company or genuine difficulties in the implementation of the audit recommendation, the following procedure is suggested:

- a) Concerned functional head should inform the Head of Corporate HSE regarding the non-acceptance of the audit recommendation with reasons.
- b) A multidisciplinary internal team headed by senior level officers in HSE Department should review the proposal and carry out a risk analysis. QRA may also be carried out wherever required.
- c) The audit recommendations, finding of the multidisciplinary team and risk analysis are to be presented to a committee, chaired by the concerned functional director with the Head of Corporate HSE and the head of the concerned SBU as the essential members.
- d) Committee as mentioned in (c) above after its review, if decides to implement the audit recommendations, the same should be taken up for implementation. However, if this committee, after an objective review decides not to go ahead with the implementation of the recommendations, partly or fully, the reasons for the same should be recorded with proper risk analysis and alternate mitigation measures.

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- e) All such recommendations made in OISD external audit which the company decides not to implement, due to whatever reasons, should be reported to the Board through Safety Committee/ Risk Management Committee.
- f) OISD to be intimated of the decision about non-implementing of particular recommendations along with detailed reasoning, risk analysis, alternate mitigation measures being implemented and the Board agenda/ minutes recording this item.
- g) Once the Board of the company has taken note of the non-implementation of the recommendation with all necessary details, OISD should consider it as a closure of the recommendation assuming that the respective organisation at the appropriate level has taken a call regarding the risks involved.

### **7.9. EMERGENCY PREPAREDNESS AND RESPONSE MANAGEMENT**

7.9.1. In order to further enhance emergency preparedness and response mechanism, the following is recommended.

#### **7.9.2. Emergency Response & Disaster Management Plan (ERP/ DMP/ ERDMP)**

7.9.2.1. Emergency response plan (ERP/ DMP/ ERDMP) shall be based on location specific qualitative/ quantitative risk assessments covering all possible emergencies. It should also cover emergencies arising due to events in the vicinity of the location outside the boundary of installation like pipeline leakage, transportation of POL products, chemicals etc. as per prevailing regulatory requirements and OISD Standards.

7.9.2.2. ERDMPs are to be periodically reviewed and updated as per prevailing regulatory requirements and OISD Standard.

7.9.2.3. Contact details of the designated persons and emergency services in the emergency response plan are to be updated/ reaffirmed at least once a quarter. A suitable monitoring mechanism is to be put in place for the same.

#### **7.9.3. Early Detection, Warning and Emergency Shutdown Systems**

7.9.3.1. Exception reports regarding the healthiness of the early detection and warning systems should be reviewed by the installation head and safety department on a daily basis. The same should also be sent to the concerned functional and safety department. Any non-functional items should be brought back to a healthy condition in a time bound manner and alternate mechanisms to be put in place to reduce/ mitigate the risks in the meantime.

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**7.9.4. Fire Fighting Systems**

7.9.4.1. Firefighting system to be kept in a healthy condition at all times. Maintenance and upkeep of the firefighting system are to be dealt with the same importance as the main plant system. Inspection, and regular maintenance of firefighting system viz. FAFPE, fire pumps, fire water tanks, fire hydrant lines, hydrants, monitors, hose boxes, sprinkler systems, foam systems etc. to be carried out in line with the rules, regulations and OISD standards including functionality checks.

7.9.4.2. Onsite and Offsite mock drills as defined in the rules, regulations and OISD standards are to be conducted at all locations as per the defined frequency. Mock drills to cover all possible scenarios. Mock drills are to be also conducted at odd hours. Off-site mock drill to include mutual aid partners and district administration.

7.9.4.3. Specific observers are to be appointed to cover various aspects of the mock drill. The debriefing session should be held immediately after the mock drill including observers to understand the gaps and corrective actions required. The lessons learnt should be recorded and communicated to the concerned internal and external stakeholders for corrective action.

**7.9.5. Preparedness for Specific Emergencies**

**7.9.5.1. Well Control in Upstream Operations**

- a) The healthiness of well control equipment such as five yearly major inspection/recertification, regular function & pressure tests and competency of key personnel in well control to be ensured by the concerned E&P operators in line with rules and OISD standards.
- b) Weekly BOP drills to be carried out as per OISD standards covering all possible scenarios.
- c) Major E&P operators should have well established Crisis Management Team (CMT) equipped for handling blowouts. Other operators (not having their own capability of crisis management) should have MoU with organizations having competency in blowout management.

**7.9.5.2. Oil Spills:**

- a) The oil handling agencies (OHA) including E&P offshore operators should develop an oil spill contingency plan (OSCP) indicating the strategies for the prevention and control of oil spill in accordance with the National Oil Spill Disaster Contingency Plan (NOS-DCP).

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- b) OHAs to maintain minimum inventory w.r.t Pollution Response Equipment, PPE, Vessel and IMO trained manpower as per risk category in accordance with the requirements of NOS-DCP for Tier-1 oil spill response.

**7.9.5.3. Cyclones**

- a) To improve the predictive capability of IMD and INCOIS for offshore platforms and installations, it is recommended (in line with HLC recommendation) that:
  - i. The density of operational ocean observing instruments with real-time data transmission needs to be increased, especially near offshore installations.
  - ii. Data exchange between offshore industries and forecasting agencies
  - iii. Creation of a Decision Support System and SOPs to provide actionable disaster management instructions for the Indian offshore industry.
- b) In every cyclone warning, the organizations should follow MoPNG DMP and organizations own guidelines on specific safety precautions. In addition, offshore should also follow SOP issued by Directorate General Shipping.

**7.9.6. Additional Measures for Emergency Preparedness and Response**

**7.9.6.1. Setting up Emergency Response Centre (ERC)**

One of the recommendations of the M B Lal Committee, which investigated the IOCL Jaipur Fire Incident, was about setting up Emergency Response Centre (ERC) at critical locations in India that can handle major oil fires with expertise. Oil & gas PSU organisations are in the process of establishing Pilot ERCs at selected six locations. Industry members participating in the ERC project to speed up the process and complete the same in a time bound manner.

**7.9.6.2. Regional Oil Spill Response Centre (ROSRC)**

The Ministry of Ports, Shipping & Waterways proposed setting up of Regional Oil Spill Response Centre (ROSRC) along the Indian coastline. MoPNG should take up the matter with MoPS&W to expedite the process of setting up of ROSRC.

**7.10. LEVERAGING TECHNOLOGY FOR ENHANCED SAFETY**

- 7.10.1. Technology is growing at a fast pace and for enhanced productivity and safety, it is imperative to embrace the latest developments like Digitization, Artificial Intelligence (AI), Internet of Things (IoT), Advance Analytics, Machine Learning,

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Virtual & Augmented Reality (VR), Robotics, Drone etc. The area is fast evolving with increasing use cases in the industry. In this regard some of the following areas where the use of technology has been already demonstrated for enhancing safety, can be easily adopted across the industry:

- a) CCTV cameras are used extensively in the oil and gas industries to monitor security and specific areas of operations. CCTV system to be further augmented and leveraged for real time monitoring of safety violations, unsafe acts and unsafe conditions.
- b) High-risk activities should be monitored through CCTV. In case, fixed CCTV is not having coverage of such areas, the use of portable CCTV camera (appropriate for the area classification) connected through Wi-Fi can be explored.
- c) Organisations to set up independent centralised monitoring and control centres to monitor and precipitate real time alerts and corrective actions including rapid response in case of developing hazardous situation.
- d) Centralised monitoring should further be leveraged with the use of new age technologies like video analytics, cognitive capabilities, artificial intelligence and machine learning to detect patterns, unsafe behaviours etc.
- e) Companies should explore IoT based techniques to substantially improve asset integrity, reliability, detection of process safety events, failure predictions, enhancing safety performance etc. IoT and robotics can also be used for maintenance works in hazardous conditions like maintenance and cleaning of crude and product storage tanks etc. for ensuring the safety of workers.
- f) Possibility of usage of drones in the well site, offshore platform, and cross-country pipelines (especially in areas where day/ night patrolling is not feasible) may be explored for monitoring critical activities. Drones can also be used for the inspection of inaccessible areas like flare tips etc. However, collateral safety and control aspects related to the use of drones should be kept in view while using in installations and hazardous areas.
- g) CCTV and drone based feed can be used very effectively for managing safety at large project construction sites.
- h) Use of detection technologies like PIDS (Pipeline Intrusion Detection System) to be encouraged for cross-country pipelines at the project stage itself to reduce safety incidents related to unauthorised tapping of liquid and gaseous hydrocarbon pipelines. Oil Industry to also work to improve the detection accuracy of such systems.

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- i) Training Simulators, Digital Twins, and Virtual/ Augmented Reality techniques should be compulsorily deployed by the industry for improving training effectiveness and preparing the workforce both technically and temperamentally for handling real time emergencies.

**7.11. EMERGING RISKS DUE TO INCREASING COMPLEXITIES IN THE TRANSIENT BUSINESS ENVIRONMENT**

**7.11.1. Increasing Complexities in Refining Operations**

7.11.1.1. New complex technologies may have different operating & control philosophies compared to traditional technologies and may give lesser time to respond. Hence, preparing the operating crew both technically and temperamentally for the same is critical. Continuous engagement with the licensors until the level of expertise is reached, rigorous training of the operating crew, adherence to SOPs, reliability of automated controls and emergency shutdown systems and emergency preparedness are the key areas to mitigate the risks. Emergency simulation and response are to be an important part of the operator's training. Online Training Simulators should be configured for the same.

7.11.1.2. Need for fresh QRA studies on a totality basis to be assessed by the organisations in view of the above.

7.11.1.3. Organisations should carry out specific drive to decongest the facilities by removing old and redundant facilities within the plant area if any.

7.11.1.4. For carrying out any maintenance/ project/ hook-up jobs in running or partially shut down units, JSA should be a must and more intense.

7.11.1.5. Unit Turnaround philosophies are to be reviewed from a safety point of view also in case of staggered turnarounds with the shutdown of some of the units or some parts of the units. Additional precautions like water curtains, stand-by fire trucks, positive isolations, portable hydrocarbon sensors, portable smoke/ flame detectors, dedicated turnaround area coordinator from operations etc. may be deployed as needed.

**7.11.2. Use of Hydrogen as Transport Fuel**

7.11.2.1. With the onset of the hydrogen economy in energy and other related sectors, there will be a paradigm shift in the way the new form of energy will be handled. It is envisaged that many new business entities will venture into the field of hydrogen with little or no exposure to hydrogen handling. Therefore, there will be challenges related to a lack of safety awareness and heightened risks of accidents involving hydrogen due to its wide range of flammability, low ignition energy, and explosive nature.

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7.11.2.2. With regard to safety aspects, the following recommendation are made:

- a) Development and adoption of comprehensive safety standards on design & layout, construction, operations maintenance and inspection of facilities used for storage, transportation and dispensing of hydrogen as a transport fuel.
- b) Development and adoption of necessary legislation covering the safety aspects in the entire value chain of hydrogen including consent/ license/ NOC and regulatory body to oversee implementation of the legislation.
- c) Creation of test facilities/ labs for testing equipment, systems , subsystems used in the hydrogen value chain.
- d) R&D collaboration with reputed institutions for developing methods and materials for the detection of hydrogen leaks and hydrogen fires.
- e) Development of expertise on safety aspects of hydrogen covering the areas of hydrogen safety, standards, certification and integrated project management. Necessary business specific training programs may be developed for the same.

**7.11.3. Multiple Fuel Choices at Retail Outlet**

7.11.3.1. Traditionally, Retail Outlets handled only MS/ HSD dispensing facilities. In some of them Auto LPG and CNG dispensing facilities were added. Now EV charging facilities are installed in many Retail Outlets and in future Hydrogen blended CNG, Hydrogen and LNG dispensing facilities may also get added. Additional risks arise when multiple facilities located in the same area are operational concurrently.

7.11.3.2. It is recommended that organizations should carry out detailed HIRA study on a representative case basis for additional hazards and risks arising because of the addition of new fuels/ EV charging stations in existing Retail Outlets and concurrent operations. However, additional risks, if any in Retail Outlets located in congested areas are also to be reviewed. All necessary measures emerging as a result of the HIRA study should be implemented in a time bound manner.

7.11.3.3. Presently Oil Marketing Companies (OMCs) have prepared Emergency Response & Disaster Management Plan (ERDMP) for Retail Outlet (RO) models under various combinations such as MS, HSD, CNG, and Auto LPG. It is recommended that ERDMPs be revised to include new emergency scenarios with the addition of new fuels/ EV charging at existing retail outlets, and concurrent operations.

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7.11.3.4. Safety aspects related to EV charging are yet evolving. However, basis the experience so far, the following is suggested with respect to EV charging facilities at Retail Outlets:

- a) EV charging stations shall follow the rules/ regulations including T4S regulations of PNGRB on setting up of EV charging and battery swap facility at Retail Outlets.
- b) The EVs charging stations shall be equipped with a protective device/ ESD against the uncontrolled reverse power flow from the vehicle. In operator assisted EV charging stations, the EV charging operator shall be appropriately trained and the EV charging operator shall be equipped with proper PPEs.
- c) The electric vehicle shall preferably be in a drive out position and parked at a retail outlet in a distinctly earmarked place where it can manoeuvre out without hindering other vehicles, which come and exit for refuelling of petroleum products.
- d) Battery charging/ swapping facility should preferably be in a corner along the boundary of the service station without hindrance to existing facilities of the service station and vehicular movement. The place shall be clearly demarcated keeping in mind the minimum requirements as follows:
  - The equipment layout shall conform to the safety distance requirements from hazardous facilities as per rules, and regulations.
  - The battery charging/ battery swapping facility and EV parking area shall be in a non-hazardous area.
  - The layout shall have suitable accessibility to emergency exit/ rescue.
  - A CCTV camera should be provided for close monitoring of the EV charging area and battery swapping station facilities with minimum retention as per guidelines.
  - Appropriate firefighting facilities shall be provided at the battery charging/ swapping station. Fire detection, alarm and control systems shall be provided as per relevant Standards.

### 7.11.4. Hydrotesting of CNG Cylinders

7.11.4.1. The hydrotest details of CNG cylinders may be linked to the online portal of the Ministry of Transport like mParivahan. **Ministry of Road Transport and Highways may take suitable action for implementation.** Non-availability of valid hydrotest certificate for CNG cylinders (once in 03 years as specified in IS 15975) in the vehicles should attract financial penalty under Central Motor Vehicle Act.

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7.11.4.2. A RFID/ Bar Code/ QR code-based system may be developed for cylinder testing. Display of these codes on the vehicle cylinder may be made mandatory. The updated data can be accessed online through these codes to check the validity of hydrotest during the gas filling of the cylinders. The industry may develop suitable mechanisms and protocols in consultation with testing agencies and cylinder manufacturers.

7.11.4.3. Adequate cylinder testing facilities to be developed in the country for the above. MoPNG may take up with the concerned Ministry.

**7.11.5. LNG Transportation through Tankers**

7.11.5.1. OISD may develop a new standard dealing with the design and safety of LNG transportation through tankers.

**7.11.6. Increased Automation and Advance Process Controls:**

7.11.6.1. Organization should develop competency framework guidelines in terms of knowledge, skills, abilities and experience required by a person to successfully handle the operation and maintenance of increased automation and related complexities. The competence gap of the assigned workforce should be regularly bridged and reviewed to keep pace with the rapid changes in evolving technologies and IoT.

7.11.6.2. With increased reliance on automation, the organization to have an increased level of reliability of the automation systems. SIL (Safety Integrity Level) study should be carried out and facilities should comply with the requirement of chosen SIL level. Asset Integrity Management should have a proper replacement and obsolescence plan in view of new developments.

7.11.6.3. Maintenance and inspection procedures shall be strictly followed by the organization as per the laid down standard operating procedures and maintenance schedule.

7.11.6.4. Organisations to have adequate protection against cyber security threats. (Please also refer to Section C - Para 7.17 on Cyber Security in this report)

**7.11.7. Thickly Populated Surroundings Near Major Oil Installations**

7.11.7.1. This issue has also been highlighted in the M B Lal Committee report post Jaipur fire incident in 2009 and the requirement of the buffer zone of 250 to 300 m from the likely point of ignition was recommended as per quantitative risk assessment. No significant progress has been achieved so far in maintaining sterilized zones around installations.

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7.11.7.2. Older installations are already having thickly populated areas in the vicinity which have come up over a period of time after the commissioning of the facilities. Construction of multi-storey buildings, private societies, illegal structures, shops etc. around the new installations which came up, after the above recommendations were made by the M B Lal Committee, is also not uncommon.

7.11.7.3. This working group is of the view that matter may be suitably pursued for a logical conclusion.

**7.11.8. Changing Climate Conditions challenging erstwhile Design Criteria**

7.11.8.1. Design of plants and facilities is carried out considering codes and criteria related to wind speeds, earthquake zones, cyclones, rainfall etc. Of late, in view of changed climatic conditions different patterns have been observed challenging the erstwhile criteria. In order to better prepare for such eventualities, it is recommended that:

- a) Design of new facilities should consider the revised inputs available with adequate factors of safety if the installations are located in areas prone to such calamities.
- b) Existing facilities may also be reviewed if any additional measures are required.

**7.12. ADDITIONAL SECTOR SPECIFIC AREAS NEEDING ATTENTION – UPSTREAM OFFSHORE OPERATIONS**

**7.12.1. Gaps in Regulatory Mechanism with respect to Non-Propelled Vessels**

7.12.1.1. All seagoing vessels irrespective of their tonnage or means of propulsion or area of operation to be registered under the Merchant Shipping Act, so as to ensure safety, security and pollution prevention aspects.

7.12.1.2. All foreign flag vessels chartered by Indian entities for coastal operation/ trade should be required to have a license from the Director General of Shipping, Govt. of India.

7.12.1.3. Registration of vessels is to be valid for a given time period, and same to be revalidated in accordance with the procedure.

7.12.1.4. Following provisions should also be incorporated in **Merchant Shipping Act**:

- Provisions to deal with marine incidents by ships.
- Provisions to deal with abandoned vessels, insurance and financial security.

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- Provisions for control measures for vessels, dealing with defaulting ship-owners, and detention of un-seaworthy vessels.
- Provisions for safety and security management for vessels and port facilities.
- Provisions for empowering the nodal search and rescue agencies.
- Provisions to deal with flagless vessels.

7.12.1.5. For all accommodation barges on the Indian coast, the International Management Code for Safe Operation of Ships and for Pollution Prevention (ISM Code) to be made mandatory.

7.12.1.6. All accommodation barges deployed in Indian EEZ need to necessarily have lifeboat(s) and life rafts complying with applicable SPS Code or MODU Code. E&P operators to ensure the same through adequate contractual provisions without any exemption. Any leeway available under codes regarding the same should not be used to bypass this requirement.

7.12.1.7. E&P operators should follow relevant OISD guidelines including regarding the useful life of Life Saving Appliances. The age of the life raft may be limited to a maximum of 10 years for all Indian vessels and Foreign Flag vessels operating on a long-term basis on Indian EEZ.

7.12.1.8. E&P operators and contractors to monitor the timely servicing of all the Life-Saving Appliances through accredited serving agencies and videograph the procedure.

7.12.1.9. It is understood that MoPS&W is pursuing changes in the Merchant Shipping Act to incorporate recommendations of the HLC set up after Tauktae Incident.

**7.12.2. Gaps in Petroleum & Natural Gas (Safety in Offshore Operations) Rules 2008**

7.12.2.1. Petroleum & Natural Gas (Safety in Offshore Operations) Rules 2008 is the only rule governing safety in offshore operational areas. There is a need to review and revise it with the experience gained in the last 15 years of its implementation and to incorporate new requirements, wherever felt necessary. Following areas needs to be considered:

- a) The exploration and stimulation vessels to be brought into the ambit of rules.
- b) Trunk pipelines are to be considered separately for issuing consent to operate.
- c) References to OISD standards to be mentioned in the rules to bring requirements of standards in the ambit of rules.

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- d) Rules should either state or require offshore operators to establish offshore stay policy approved by Board for regular employees as well as contractor's employees to ensure their sound health both physically and psychologically.

**7.12.3. Safety Management of Offshore Vessels**

7.12.3.1. The operator and contractor to comply with the HSE requirements detailed in the contract and bridging document. Contract/ bridging documents should clearly define the vintage of vessels, roles and responsibilities, competence requirements etc.

7.12.3.2. The operator and contractor to comply with the requirements of all applicable statutes like Petroleum & Natural Gas (Safety in Offshore Operations) Rules 2008, Merchant Shipping Act 1958 apart from all applicable International Conventions such as International Convention of Safety of Life at Sea (SOLAS), International Convention for the Prevention of Pollution from Ships (MARPOL) etc. and applicable OISD standards.

7.12.3.3. Operator and contractor to ensure that all the personnel being deployed at offshore undergo training as per OISD-STD-176. Some of the mandatory trainings are as follows:

- a) Survival at Sea (SAS - accredited by DGS/ OPITO)
- b) Helicopter Under Water Escape Training (HUET) (OPITO accredited training, reqd. if going by helicopter)
- c) Elementary first aid
- d) Firefighting
- e) Coxswain boat handling (Lifeboat Captain)
- f) Helicopter Landing Assistance/ Officer (for HLA/ HLO)
- g) Oil Spill Response training (IMO level-1 equivalent)
- h) Fast Rescue Craft (FRC) training for a mobile installation
- i) Major Emergency Management Initial Response (MEMIR)
- j) Operation & maintenance of offshore cranes certified as per API-RP 2D (For Crane operators)
- k) Well control for Key drilling personnel on rigs (IADC/ IWCF accredited training)

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**7.12.4. Safety zone**

7.12.4.1. Fishing boats in the offshore development area (ODA) in the vicinity of offshore facilities need to be more closely regulated. Indian Coast Guard may be provided with the authority for such regulation.

7.12.4.2. Any drifting/ rogue vessel inside ODA, which pose threat to the offshore installations should be communicated to the Indian Coast Guard/ Indian Navy. A suitable authority for necessary protocol may be established with concerned Ministry for handling such issue.

**7.12.5. Air Logistics**

7.12.5.1. The operators need to develop a Safety Management System for aviation operations addressing inter alia the following:

- a) Ensuring compliance with legal requirements.
- b) Selection of contractors, suitable helicopters and appropriate size of the fleet.
- c) Optimisation of operations for minimising risk.
- d) Identification of key personnel for handling of contracts & operations and defining their roles and responsibilities.
- e) Provision of appropriate infrastructure like heliports, helipads, communication facilities etc. complying with regulations.
- f) Provision of Helicopter Health Usage and Monitoring System (HUMS)
- g) Provision of personal safety equipment like life jackets, rebreathers, Personal Locator Transmitters etc.
- h) Pre-flight inspections
- i) Risk assessment and mitigation
- j) Incident Management
- k) Training and briefing requirements for passengers.
- l) Medical and Emergency Evacuation
- m) Night operations
- n) Search and Rescue
- o) Emergency response

7.12.5.2. International standards and guidelines available for developing the Safety Management System like the Aircraft Management Guidelines (latest version) of the

**Report of the Working Group on Safety in Indian Petroleum Sector**

International Association of Oil & Gas Producers (IOGP) may be referred for the development of the same.

**7.12.6. Offshore Pipelines**

7.12.6.1. Offshore Pipelines are to be considered as separate installations and an internal safety audit system should be institutionalized for them with criteria and frequency as defined in OISD-STD-145.

7.12.6.2. Operators may consider the use of modern systems like the Magnetic Tomography Method (MTM) etc. for health checks of non-piggable pipelines.

7.12.6.3. The operators to ensure that all new offshore lines laid in future are made suitable for intelligent pigging so that regular health checks of the lines can be carried out and preventive measures, where needed, can be undertaken.

**7.12.7. Abandonment/ Decommissioning/ Site Restoration:**

7.12.7.1. SRG guidelines (Offshore and onshore oil and gas production site abandonment guidelines) dated 1<sup>st</sup> May 2018 issued by MoPNG through Gazette notification may be revisited and aligned with major developments and changes brought into international standards.

**7.13. ADDITIONAL SECTOR SPECIFIC AREAS NEEDING ATTENTION – CROSS COUNTRY PIPELINES**

**7.13.1. Population Growth on Pipeline ROU/ ROW**

7.13.1.1. Organization (pipeline operator) to notify Government revenue authority regarding pipeline ROU/ ROW acquired under 3(1)/ 6(1) notification and ensure entry of the same in form 7/12 or equivalent registers applicable to the concerned state. This will prevent permission by the revenue authority for the construction of permanent property in ROU/ ROW though it can be used for agricultural purposes. Whenever land property is sold to a third party/ agency, pipeline demarcation shall be made available in 7/12 form or equivalent registers of land revenue record, so that the new landowner is also bound to use the land for agricultural purpose only.

7.13.1.2. Whenever pipeline ROU/ROW is witnessing population growth, pilferage preventive mechanisms like PIDS, DCVG survey to ascertain any foreign tapping on the pipelines etc. may be instituted, apart from intensifying pipeline patrolling in day and night period.

7.13.1.3. If a change in location class is perceived due to demographic changes along the existing pipeline route, a Quantitative Risk assessment (QRA) should be carried out once in 5 years considering the actual population and permanent settlements.

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Necessary risk mitigation measures should be undertaken accordingly. In such situations monitoring and ensuring pipeline integrity will be critical. Suitable techniques including PIDS, LTS, STS, DCVG, Cathodic protection, physical line patrolling etc. may be used to facilitate the same.

### 7.13.2. **Geo-hazards (Washouts, Landslides etc.)**

7.13.2.1. Pipeline operators should strive to adopt a Geological Hazard Risk Management program such as ISO 20074 from the design stage.

7.13.2.2. Adopting horizontal directional drilling method at the appropriate depth and proactive monitoring & mitigation program may be helpful.

### 7.13.3. **AC/DC Interference of Power Transmission Lines with Cross Country Pipelines**

7.13.3.1. It should be obligatory for pipeline operators to conduct interference surveys and take mitigation measures in existing pipelines. A study on interference in upcoming pipeline projects should be carried out during the design phase itself.

### 7.13.4. **Transportation of High Vapour Pressure Liquid Hydrocarbons through Pipelines**

7.13.4.1. Considering different hazard potentials of high vapour pressure pipelines like C2, and C3 in cryogenic condition, OISD may develop separate standard/ guidelines to cover design, construction & commissioning, operations & maintenance, safety instrumentation and firefighting requirement for high vapour pressure liquid hydrocarbon pipelines.

### 7.13.5. **Hydrogen (H<sub>2</sub>) Transportation through Pipelines**

7.13.5.1. There is a need to develop specific codes/ standards for hydrogen pipelines in India, which should cover its design, construction, operation, maintenance, and safety.

7.13.5.2. Necessary Act for transportation of hydrogen through pipeline, similar to The Petroleum and Minerals Pipelines (Acquisition of Right of User in Land) Act, 1962 needs to be developed.

### 7.13.6. **Geographic Information System (GIS) & coordination for CGD/ Hydrocarbon Pipelines through Common Utility Corridors**

7.13.6.1. It is recommended to have a robust mechanism for keeping updated geographical information of pipelines and other utilities with a common notified nodal agency. It will help in avoiding incidents due to damage to existing pipelines when a new user takes up the job in an existing corridor/ ROW.

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**7.13.7. Vulnerability of CGD/Hydrocarbon Pipelines during City Infrastructure Upgrade**

7.13.7.1. Agencies and contractors are to be sensitised about the existence of CGD/ Hydrocarbon lines while construction of metro/ train lines, road/ bridge construction/ widening, and creation of utility corridor jobs. A Job Hazard analysis is to be carried out jointly by the concerned oil/gas company and the project executing authorities. Precautions required should be recorded and monitored by the concerned project executing authority. Oil companies may also make periodic checks and advise their observations to the project executing authorities to ensure compliance.

**7.14. OTHER SPECIFIC AREAS NEEDING ATTENTION**

**7.14.1. Green-field Projects Construction**

7.14.1.1. To enhance safety during the construction of green field refineries/ petrochemical plants/ O&G installations/ cross country pipelines etc., it is recommended that:

- a) Major accidents should be reported to the regulators and OISD.
- b) System should be implemented to report Incidents, near misses, unsafe acts and unsafe conditions, as is the practice with operating O&G installations.
- c) Internal inspections and audits should be carried out to ensure compliance with the safety requirements and records maintained.
- d) PCSA (pre commissioning safety audits) of the facilities to be carried out before commissioning.
- e) Companies may also take OISD help to carry out sample audits during the construction phase.

**7.14.2. Port/ SPMs/ Shipping Operations for Crude & Products including Jetty Pipelines**

7.14.2.1. Handling of hydrocarbon products at Ports (at SPM, Jetty, pipeline transfer & storage) is expanding at a fast pace. Major ports have been audited by OISD as per the request from the Ministry of Ports, Shipping and Waterways. Based on audit findings, it is recommended that:

- a) All Ports handling Hydrocarbons should have firefighting facilities installed as per OISD-STD-156, which is a mandatory standard as per the Petroleum Rules 2002.
- b) All Oil & Gas entities operating in ports (including Private) should design and operate their facilities (storage and pipeline) as per OISD standards OISD-STD-118 (Layouts in oil & gas installations), OISD-STD-117 (Fire Protection facilities in Oil & Gas installations), OISD-STD-105 (Work Permit system), OISD-STD-141

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(Design, construction requirements for cross country pipelines), which are mandatory standards as per Petroleum Rules 2002.

- c) All Ports handling Hydrocarbons should carry out an annual internal safety audit covering all related facilities including storage and pipeline.
- d) All upcoming hydrocarbon facilities in ports including private ports and involving private entities should carry out PCSA (pre commissioning safety audits) of their projects before commissioning.

**7.14.3. Oil & Gas Installations/ Pipelines operated by Private/ JV Operators**

7.14.3.1. With the increase in the participation of private/ joint venture operators in the oil & gas industry, it is recommended that even for Oil & Gas Installations/ Pipelines operated by Private/ JV Operators –

- a) Safety Management System followed is not less stringent than suggested in the applicable OISD standards.
- b) Major accidents should be reported to OISD as per the Disaster Management Plan (latest) of MoPNG.
- c) Organisations should have a system to report incidents, near misses, unsafe acts and unsafe conditions.
- d) Organisations to conduct internal inspections and audits to ensure compliance with the safety requirements and records maintained.
- e) All oil & gas installations should carry out PCSA (pre commissioning safety audits) of their projects before commissioning.

**7.14.4. No fly zone for Low Flying Objects (drones) for category A vital oil and gas installations:**

7.14.4.1. It is envisaged that drones shall be used more & more in the oil & gas industry for real-time surveillance of assets and pipelines, emergency response, visual inspection and maintenance. However, drones present an emerging threat to the security of installations. Drones can be configured to carry IEDs, biological or chemical agents, conduct surveillance etc. Drone threat also exists to disrupt unsecured Wi-Fi networks & unencrypted wireless communications.

7.14.4.2. It is recommended that:

- a) The oil and gas industry should get their vital installations and sensitive areas declared as NO DRONE ZONE areas.
- b) “No Drone zone” should be displayed at prominent places on the perimeter walls of the vital installations and sensitive areas.

**Report of the Working Group on Safety in Indian Petroleum Sector**

- c) In case of any sighting of a drone/ UAV at installation, the same should be immediately informed to the local police.
- d) Use of drone at vital installations for surveillance or inspection of assets should be done with prior permission from District/ local authorities and security agencies in line with rules issued by the Ministry of Civil Aviation, Government of India.
- e) Organization to arrange training/ guidance session with NSG and BPR&D, MHA on anti-drone equipment, technology, and measures.

**7.14.5. Safety related to the use of EVs in Refineries/ O&G installations.**

- 7.14.5.1. With the proliferation of electric vehicles, which are environmentally friendly, questions were raised by the industry regarding the use of electric vehicles in refineries/ O&G installations.
- 7.14.5.2. Working Group is of the opinion that EV vehicles should not be allowed in the licensed area of the petroleum installations unless a full risk assessment is done, and necessary approval is obtained from the competent authority.

**7.15. CYBER SECURITY RISKS**

- 7.15.1. Organisations need to have comprehensive strategies for confronting known and unknown threats with a focus on mitigating the impact of breaches that have succeeded in evading security controls. Such strategies need to incorporate solutions that enable visibility, restrict access with precision and automation, detect and contain live breaches, thwart lateral movements and minimize the attack surface.
- 7.15.2. The solutions will depend on the size & geographical spread of the organisation, type and nature of interface with the outside environment, number and vintage of technology solutions in operation, technology architecture set up and the controls/ monitoring mechanism already in place.
- 7.15.3. Following suggestions are made in this regard:
  - 7.15.3.1. Organisations to conduct a detailed system audit of complete IT/ OT systems, through agencies having expertise in the security of IT & OT systems and chart out a time bound program for implementation of mitigation measures as required.
  - 7.15.3.2. Organisation to have a process in place for periodic system audit to identify new threats and vulnerabilities and implement mitigation measures.
  - 7.15.3.3. Organisations to put in place process and protocols to identify threats as early as possible and response mechanisms to limit the impact in case security is breached.

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7.15.3.4. In dealing with cyber security threats to OT systems, which is most critical from safety point of view, the following basic practices may be useful:

- a) **Identification, classification and prioritisation of assets** – A security team cannot protect assets it cannot see. This results in a critical security gap for many organizations. The first step in improving OT security posture is to have an up-to-date inventory of devices and applications running on a network. Also, an undated information on users authorised to use each/ set of applications should be known to identify unintended users.
- b) **Segmentation of the Network** - It is one of the most effective architectural concepts for protecting OT environments. The idea is to divide the network into a series of functional segments or “zones” (which may include sub-zones or microsegments) and make each zone accessible only by authorized devices, applications, and users. A firewall defines and enforces the zones, and it also defines conduits, which are channels that enable essential data and applications to cross from one zone to another. This architectural model of zones and conduits greatly reduces the risk of intrusion. It also limits the potential impact of a breach by restricting an attacker’s ability to move in an “east-west” or lateral direction. Users or devices authorized for a specific activity in a specific zone are limited to operating within that zone.
- c) **Controlling Access by Users and Devices**- Devices, users, and applications need to be authenticated before they can access OT network segments. Secure authentication is critical. Two factor authentication is recommended.  
  
Process for access authorisation and authentication should be in place. Generally, access even for query/ report modes should be restricted only to the extent required for the assigned jobs. All staff with operational or administrative access to process control systems should be appropriately screened.  
  
In case of change/ separation of personnel or change in roles, access rights to a prior person should be disabled or modified immediately.
- d) **Monitoring and Analysis of Traffic for Threats and Vulnerabilities** - Once firewalls divide an OT network into zones, segments, and conduits, it is important to monitor and analyse network traffic to detect known and unknown threats.
- e) **Centralised Security Management** - Traditionally, OT environments have not contained wireless connections. In many cases, however, organizations are deploying sensors and other devices in their OT environments and connecting

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them wirelessly. This increases the digital attack surface. Wireless access points (APs), as well as network switches, are attractive targets for cyberattacks. Both need security by design, administered from one central interface, instead of being protected by add-on point security solutions managed through multiple interfaces. Centralized security management not only reduces risk but also improves visibility and minimizes administration time for security and operations teams.

In Oil and Gas Industry, traditionally IT and OT systems are managed by different groups. While OT systems are managed by specialised group associated with plant maintenance departments, IT systems are managed by the IT department. With the increasing convergence of IT and OT systems 'air gap' and the exclusivity of attack points have vanished. It is therefore suggested that the organisation review the structure to consider centralised management of security administration for IT and OT systems to have a holistic approach and response.

**f) Basic Hygiene -**

- i. Change default passwords immediately after installation of databases or programs
- ii. Database access logs should be retained
- iii. Configure idle and active session timeouts
- iv. Restrict the use of external devices like USB, disc drives etc.
- v. Disable e-mail and internet access from Process control systems
- vi. Anti-virus should be installed on all machines and updated with the latest pattern files. Users should not have access to disable antivirus scanning from his/ her device.
- vii. In case of outsourced service is used for data centre management or process control system maintenance, the antecedent of the people deployed should be verified and their activities monitored.
- viii. CCTV and access control should be provided in data centres, marshalling rack rooms, and control panel rooms to monitor unauthorised entry/ movements.
- ix. Logs should be maintained for critical system activities/ setup changes/ database accesses etc. to have an audit trail.

**g) Guidance may also be drawn from relevant ISO standards including ISO 27001 and ISO 27032 in this regard.**

# SCOPE - 2



**Identification of  
gaps in extant  
laws including  
enforcement  
and  
accountability**



# SCOPE - 3



**Way forward  
to establish a  
Single Safety  
Regulator for  
the Petroleum  
Sector in India**



# **ANNEXURES**

Report of the Working Group on Safety in Indian Petroleum Sector

Annexure 1.0

Office Order dated 18<sup>th</sup> August 2022 for Constitution of the Working Group on Safety

File No. Expl-12031(11)/4/2022-EXPL-II-PNG (E-43727)

GOVERNMENT OF INDIA  
MINISTRY OF PETROLEUM & NATURAL GAS  
(EXPLORATION DIVISION)

\*\*\*\*\*

Shastri Bhawan, New Delhi  
Dated 18<sup>th</sup> August, 2022

ORDER

**Subject: Constitution of Working Group to look into the whole gamut of safety framework and suggest necessary changes for petroleum sector in the country.**

In pursuance of the recommendations contained in the Report of the High Level Committee constituted to inquire into the sequence of events leading to the stranding of ONGC vessels in the Cyclone "Tauktae" and Thirteenth Report of the Standing Committee on Petroleum & Natural Gas on "Safety and Security of Oil Installations of Public Sector Oil Companies with specific reference to Western Offshore Mishap during Cyclone Tauktae", it has been decided to constitute the following Working Group :-

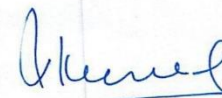
| Sector       | Name (Sh.)                | Designation and Organisation                  | Position              | Area of Operations     |
|--------------|---------------------------|---|-----------------------|------------------------|
| Industry     | M K Surana                | CEO, RRPCL and Ex-CMD, HPCL                   | Chairperson           | Downstream             |
|              | T K Sengupta              | Director FIPI and Ex-Director, ONGC           | Member                | Upstream               |
|              | Arun Mittal               | ED OISD                                       | Member                | Common                 |
|              | Badal Roy                 | Chief Safety Advisor, DGH & Ex-ED, ONGC       | Member                | Upstream               |
|              | Anuj Jain                 | ED-LPG & Pipeline, HPCL                       | Member                | Downstream (Pipeline)  |
|              | C Mathavan                | ED-Asset Manager, ONGC Mumbai High Asset      | Member                | Upstream (Offshore)    |
|              | Ranjan Mehrotra           | ED-Corporate HSE, IOCL                        | Member                | Downstream (Marketing) |
|              | Goutom Chakraborty        | ED-CGD & Renewable, GAIL                      | Member                | Midstream (CGD)        |
|              | Ajay Dixit                | ED-Chief HSE, ONGC                            | Member                | Upstream               |
|              | Rajiv Kacker              | ED-Projects, IOCL                             | Member                | Downstream (Refinery)  |
|              | Sanjeev Raina             | CGM-Corporate HSE, BPCL                       | Member                | Downstream (Marketing) |
|              | S C Gupta                 | Head Technical, PNGRB                         | Member                | Common                 |
| Pratim Sarma | Director-P&E, OISD        | Member Coordinator                            | Downstream (Refinery) |                        |
| Shipping     | Capt. Vikram Singh Manhas | Nautical Surveyor cum DDG(Tech.), DG Shipping | Member                | Shipping               |

(Confidential)

## Report of the Working Group on Safety in Indian Petroleum Sector

|                    |                             |  |        |                       |
|--------------------|-----------------------------|--|--------|-----------------------|
| Industry (Private) | Y K Lodha                   | Head-Group S&OR, RIL                         | Member | Downstream (Refinery) |
|                    | Brennan S Punnappully       | Cairn Oil & Gas, Vedanta Limited             | Member | Upstream              |
| Legal              | Iyer Narayanan H            | ED-Legal, HPCL                               | Member | Downstream            |
|                    | Amit Jindal                 | HoD Legal DGH                                | Member | Upstream              |
| Academic           | Moreshwar Kudkilwar         | Deputy Fire Advisor, O/o DG (FS,CD & HG)     | Member | --                    |
|                    | Gagan Upadhyay (Alternate)  | Assistant Director, NFSC, Nagpur             |        |                       |
|                    | Prof Keka Ojha              | Deptt. Of Petroleum Engg. IIT (ISM), Dhanbad | Member | --                    |
|                    | Prof G D Yadav (Padmashree) | Institute of Chemical Technology, Mumbai     | Member | --                    |

2. OISD may service the Working Group. Scope of the working group is to:
  - i. Review safety system followed by oil and gas industry and responses required in any emergency situation by the companies concerned considering the latest technological developments
  - ii. Identify gaps in extant laws including enforcement and accountability
  - iii. Recommend way forward to establish single safety regulator for petroleum sector
  - iv. The working group will submit draft report by 31.12.2022.
3. This issues with the approval of Secretary, PNG.



(R K Kureel)  
Director (E-II)  
Tel. 011-23381029

To

All Committee members

Copy for information to:

1. PPS to Secretary (PNG)
2. PPS to JS(R&E)

Report of the Working Group on Safety in Indian Petroleum Sector

Annexure 2.1

**List of Refineries in India & installed capacity as of 01.06.2023**

| S. No                | NAME OF THE OIL COMPANY                                   | STATE          | LOCATION & YEAR OF REFINERY | CAPACIT (MMTPA) |
|----------------------|---|----------------|-----------------------------|-----------------|
| 1                    | INDIAN OIL CORPORATION LIMITED (IOCL)                     | BIHAR          | BARAUNI (1964)              | 6.0             |
| 2                    |   | GUJARAT        | KOYALI (1965)               | 13.7            |
| 3                    |   | WEST BENGAL    | HALDIA (1975)               | 8.0             |
| 4                    |   | UTTAR PRADESH  | MATHURA (1982)              | 8.0             |
| 5                    |   | HARYANA        | PANIPAT (1998)              | 15.0            |
| 6                    |   | ASSAM          | GUWAHATI (1962)             | 1.0             |
| 7                    |   | ASSAM          | DIGBOI (1901)               | 0.65            |
| 8                    |   | ASSAM          | BONGAIGAON (1979)           | 2.70            |
| 9                    |   | ODISHA         | PARADIP (2016)              | 15.0            |
| <b>IOCL TOTAL</b>    |   |                |                             | <b>70.1</b>     |
| 10                   | HINDUSTAN PETROLEUM CORPORATION LIMITED (HPCL)            | MAHARASTRA     | MUMBAI (1954)               | 9.5             |
| 11                   |   | ANDHRA PRADESH | VISAKH (1957)               | 11.0            |
| 12                   | HPCL-HINDUSTAN MITTAL ENERGY LIMITED (HMEL) (JV)          | PUNJAB         | BATHINDA (2012)             | 11.3            |
| <b>HPCL-TOTAL</b>    |   |                |                             | <b>31.8</b>     |
| 13                   | BHARAT PETROLEUM CORPORATION LIMITED (BPCL)               | MAHARASTRA     | MUMBAI (1955)               | 12.0            |
| 14                   |   | KERALA         | KOCHI (1966)                | 15.5            |
| 15                   | BPCL-BHARAT OMAN REFINERIES LIMITED (BORL)                | MADHYA PRADESH | BINA (2011)                 | 7.8             |
| <b>BPCL-TOTAL</b>    |   |                |                             | <b>35.3</b>     |
| 16                   | CHENNAI PETROLEUM CORPORATION LIMITED (CPCL)              | TAMIL NADU     | MANALI (1969)               | 10.5            |
| 17                   |   | TAMIL NADU     | CAUVERY BASIN (1993)        | 0.0             |
| <b>CPCL-TOTAL</b>    |   |                |                             | <b>10.5</b>     |
| 18                   | NUMALIGARH REFINERIES LIMITED (NRL)                       | ASSAM          | NUMALIGARH (1999)           | 3.0             |
| <b>NRL-TOTAL</b>     |   |                |                             | <b>3.0</b>      |
| 19                   | OIL & NATURAL GAS CORPORATION LIMITED (ONGC)              | ANDHRA PRADESH | TATIPAKA (2001)             | 0.07            |
| 20                   | ONGC-MANGALORE REFINERIES & PETROCHEMICALS LIMITED (MRPL) | KARNATAKA      | MANGALORE (1996)            | 15.0            |
| <b>ONGC TOTAL</b>    |   |                |                             | <b>15.1</b>     |
| <b>PSU/ JV TOTAL</b> |   |                |                             | <b>163.1</b>    |
| 21                   | RELIANCE INDUSTRIES LIMITED (RIL)                         | GUJARAT        | JAMNAGAR (DTA) (1999)       | 33.0            |
| 22                   |   | GUJARAT        | JAMNAGAR (SEZ) (2008)       | 35.2            |
| <b>RIL TOTAL</b>     |   |                |                             | <b>68.2</b>     |
| 23                   | NAYARA ENERGY LIMITED (NEL)                               | GUJARAT        | VADINAR (2006)              | 20.0            |
| <b>NEL TOTAL</b>     |   |                |                             | <b>20.0</b>     |
| <b>PVT TOTAL</b>     |   |                |                             | <b>88.2</b>     |
| <b>ALL INDIA</b>     |   |                |                             | <b>253.9</b>    |

Source: PPAC Snapshot of India's Oil and Gas Data Monthly Ready Reckoner, May 2023

Annexure 2.2

**Map of Refineries in India**



Source: PPAC Snapshot of India's Oil and Gas Ready Reckoner

**Oil and Gas pipelines in India**



Source: PPAC Snapshot of India's Oil and Gas Data Monthly Ready Reckoner, May 2023

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Annexure 2.4

**List of PNGRB T4S Regulations**

| T4S Regulation   | Description  |
|--|--|
| ERDMP Regulations  | Petroleum and Natural Gas Regulatory Board (Codes of Practices for Emergency Response and Disaster Management Plan)  |
| LNG T4S Regulations  | Petroleum and Natural Gas Regulatory Board (Technical Standards and Specifications including Safety Standards for Liquefied Natural Gas Facilities) Regulations, 2018                      |
| Retail Outlets T4S Regulations                                 | Petroleum and Natural Gas Regulatory Board (Technical Standards and Specifications including Safety Standards for Retail Outlets dispensing Petroleum, Auto LPG and CNG) Regulations, 2018 |
| LPG T4S Regulations  | Petroleum and Natural Gas Regulatory Board (Technical Standards and Specifications including Safety, Safety Standards for LPG Storage, Handling and Bottling Facilities) Regulations, 2019 |
| Petroleum Installation T4S Regulations                         | Petroleum and Natural Gas Regulatory Board (Technical Standards and Specifications including Safety Standards for Petroleum Installations) Regulations, 2020                               |
| Petroleum Refineries and Gas Processing Plants T4S Regulations | Petroleum and Natural Gas Regulatory Board (Technical Standards and Specifications including Safety Standards for Petroleum Refineries and Gas Processing Plants) Regulations, 2023.       |
| CGD T4S Regulations  | Petroleum and Natural Gas Regulatory Board (Technical Standards and Specifications including Safety Standards for City or Local Natural Gas Distribution Networks)                         |
| NGPL T4S Regulations   | Petroleum and Natural Gas Regulatory Board (Technical Standards and Specifications including Safety Standards for Natural Gas Pipelines) Regulations, 2009                                 |
| PPPL T4S Regulations   | Petroleum and Natural Gas Regulatory Board (Technical Standards and Specifications including Safety Standards for Petroleum and Petroleum Products Pipelines) Regulations, 2016            |

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Annexure 2.5

List of OISD Standards

| Sr. No. | OISD Standard/<br>GDN/RP No | Standard Name   |
|---------|-----------------------------|---|
| 1       | OISD-STD-105                | Work Permit System – <b>Revised standard approved in 40<sup>th</sup> SCM</b>  |
| 2       | OISD-STD-106                | Pressure Relief & Disposal System   |
| 3       | OISD-STD-108                | Oil Storage and Handling – <b>Revised standard approved in 40<sup>th</sup> SCM</b>  |
| 4       | OISD-STD-109                | Process Design and Operating Philosophies on Blow Down & sewer system   |
| 5       | OISD-RP-110                 | Recommended Practices on Static Electricity   |
| 6       | OISD-STD-111                | Process Design & Operating Philosophies on Fired Process Furnace  |
| 7       | OISD-STD-112                | Safe Handling of Air Hydrocarbon Mixtures & Pyrophoric Substances   |
| 8       | OISD-STD-113                | Classification of Area for Electrical Installations at Hydrocarbon Processing & Handling Facilities                                 |
| 9       | OISD-STD-114                | Safe Handling of Hazardous Chemicals  |
| 10      | OISD-GDN-115                | Guidelines on firefighting equipment and appliances in petroleum industry – <b>Revised standard approved in 40<sup>th</sup> SCM</b> |
| 11      | OISD-STD-116                | Fire protection facilities for petroleum refineries and oil/ gas processing plants – <b>Under Revision</b>                          |
| 12      | OISD-STD-117                | Fire protection facilities for petroleum depots, terminals, pipeline installations & lube oil installations – <b>Under Revision</b> |
| 13      | OISD-STD-118                | Layouts for oil and gas installations – <b>Under Revision</b>   |
| 14      | OISD-STD-119 <sup>2</sup>   | Selection, Operation and Maintenance of Pumps   |
| 15      | OISD-STD-120 <sup>2</sup>   | Selection, Operation and Maintenance of Compressors   |
| 16      | OISD-STD-121 <sup>2</sup>   | Selection, Operation Inspection & Maintenance of Steam & Gas Turbines   |
| 17      | OISD-RP-122 <sup>2</sup>    | Selection, Operation and Maintenance of Fans, Blowers, Gear Boxes, Agitators & Mixers   |
| 18      | OISD-RP-123 <sup>2</sup>    | Selection, Operation and Maintenance of Rotary Equipment Components   |
| 19      | OISD-RP-124 <sup>2</sup>    | Predictive Maintenance Practices  |

<sup>2</sup> New Standard (OISD-STD-240) is under development merging the OISD STD/ RP from 119 to 127

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| Sr. No. | OISD Standard/<br>GDN/RP No | Standard Name  |
|---------|-----------------------------|--|
| 20      | OISD-STD-125 <sup>2</sup>   | Inspection & Maintenance of Mechanical Seals   |
| 21      | OISD-RP-126 <sup>2</sup>    | Specific practices for installations and maintenance of Rotating Equipment   |
| 22      | OISD-STD-127 <sup>2</sup>   | Selection, Operation, Inspection & Maintenance of Diesel Engines   |
| 23      | OISD-STD-128                | Inspection of unfired pressure vessels – <b>Under Revision</b>   |
| 24      | OISD-STD-129                | Inspection of storage tanks – <b>Revised standard approved in 40<sup>th</sup> SCM</b>                                      |
| 25      | OISD-STD-130                | Inspection of piping systems – <b>Under Revision</b>   |
| 26      | OISD-STD-131                | Inspection of Boilers  |
| 27      | OISD-STD-132                | Inspection of Pressure Relieving devices   |
| 28      | OISD-STD-133                | Inspection of Fired Heaters  |
| 29      | OISD-STD-134                | Inspection of Heat Exchangers  |
| 30      | OISD-STD-135                | Inspection of Loading & Unloading hoses for Petroleum Products   |
| 31      | OISD-STD-137                | Inspection of Electrical Equipment   |
| 32      | OISD-STD-139                | Design, Construction, Inspection & Maintenance of Offshore Pipelines and Facilities & Requirements Of Deep Water Pipelines |
| 33      | OISD-STD-140                | Inspection of jetty pipelines  |
| 34      | OISD-STD-141                | Design, construction and inspection requirements for cross country liquid hydrocarbon pipelines – <b>Under Revision</b>    |
| 35      | OISD-STD-142                | Inspection of firefighting equipments and systems – <b>Revised standard approved in 40<sup>th</sup> SCM</b>                |
| 36      | OISD-STD-144                | Liquefied Petroleum Gas (LPG) Installations – <b>Under Revision</b>  |
| 37      | OISD-STD-145                | Internal Safety Audits   |
| 38      | OISD-RP-146                 | Preservation of idle electrical equipment – <b>Revised standard approved in 40<sup>th</sup> SCM</b>                        |
| 39      | OISD-RP-147                 | Inspection & safe practices during electrical installations – <b>Revised standard approved in 40<sup>th</sup> SCM</b>      |
| 40      | OISD-RP-148                 | Inspection & safe practices during overhauling electrical equipment – <b>Under Revision</b>                                |

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| Sr. No. | OISD Standard/<br>GDN/RP No | Standard Name   |
|---------|-----------------------------|---|
| 41      | OISD-RP-149                 | Design aspects for safety in electrical systems   |
| 42      | OISD-STD-150                | Design and Safety Requirements For Liquefied Petroleum Gas Mounded Storage Facility   |
| 43      | OISD-STD-151                | Safety in Design, Fabrication and Fittings Propane Tank Trucks  |
| 44      | OISD-STD-152                | Safety instrumentation for process system in hydrocarbon industry – <b>Under Revision</b>                                       |
| 45      | OISD-STD-153                | Maintenance & inspection of safety instrumentation in hydrocarbon industry  |
| 46      | OISD-STD-154                | Safety aspects in functional training – <b>Under Revision</b>   |
| 47      | OISD-STD-155                | Personal protective equipments  |
| 48      | OISD-STD-156                | Fire Protection Facilities for Ports Handling Hydrocarbons  |
| 49      | OISD-RP-157                 | Safety in Transportation of Bulk Petroleum Products (Rail and Road)   |
| 50      | OISD-RP-158                 | Recommended Practices on Storage and Handling of Bulk Liquefied Petroleum Gas - <b>Under Revision</b>                           |
| 51      | OISD-STD-159                | LPG Tank Trucks - Requirements of Safety on Design/Fabrication & Fittings   |
| 52      | OISD-GDN-161                | LPG Tank Truck Incidents Rescue & Relief Operations   |
| 53      | OISD-STD-162                | Safety in installation and maintenance of LPG Cylinders Manifold  |
| 54      | OISD-STD-163                | Safety of control room in hydrocarbon industry – <b>Under Revision</b>  |
| 55      | OISD-STD-164                | Fire Proofing of Steel Supporting Structures in Oil & Gas Industry  |
| 56      | OISD-GDN-165                | Guidelines for rescue & relief operations for POL tank truck accident – <b>Revised standard approved in 40<sup>th</sup> SCM</b> |
| 57      | OISD-GDN-166                | Guidelines for Occupational Health Monitoring in Oil and Gas Industry   |
| 58      | OISD-RP-167                 | POL Tank lorry Design & Safety  |
| 59      | OISD-GDN-169                | OISD Guidelines on Small LPG Bottling Plants (Design and Fire Protection facilities) - <b>Under Revision</b>                    |
| 60      | OISD-STD-170                | Inspection, Maintenance, Repairs & Rehabilitation of Foundations & Structures   |
| 61      | OISD-STD-171                | Preservation of Idle Static & Rotary Mechanical Equipment   |

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| Sr. No. | OISD Standard/<br>GDN/RP No | Standard Name   |
|---------|-----------------------------|---|
| 62      | OISD-STD-173                | Fire Prevention and Protection System for Electrical Installations  |
| 63      | OISD-RP-174                 | Well Control – <b>Under Revision</b>  |
| 64      | OISD-STD-175                | Cementing Operations  |
| 65      | OISD-STD-176                | HSE training for E&P personnel – <b>Revised standard approved in 40<sup>th</sup> SCM</b>                                  |
| 66      | OISD-STD-177                | Inspection and Maintenance of Insulation Systems  |
| 67      | OISD-STD-178                | Management of Change – <b>Revised standard approved in 40<sup>th</sup> SCM</b>  |
| 68      | OISD-STD-179                | Safety Requirements On Compression, Storage, Handling & Refueling Of Natural Gas (CNG) For Use In Automotive Sector.      |
| 69      | OISD-GDN-180                | Lightning Protection  |
| 70      | OISD-STD-181                | Geophysical Operations – <b>Under Revision</b>  |
| 71      | OISD-GDN-182                | Safe Practices for Workover and Well Stimulation Operations   |
| 72      | OISD-STD-183                | Standard on Logging Operations  |
| 73      | OISD-STD-184                | Standard on life saving appliances – <b>Under Revision</b>  |
| 74      | OISD-STD-185                | Wire Line Operations  |
| 75      | OISD-GDN-186                | Simultaneous Operations in E&P Industry – <b>Revised standard approved in 40<sup>th</sup> SCM</b>                         |
| 76      | OISD-STD-187                | Care and use of wire rope – <b>Revised standard approved in 40<sup>th</sup> SCM</b>                                       |
| 77      | OISD-STD-188                | Corrosion Monitoring and Control Of Offshore & Onshore Pipelines  |
| 78      | OISD-STD-189                | Standard on firefighting equipment for Drilling Rigs, Work Over Rigs and Production Installations – <b>Under Revision</b> |
| 79      | OISD-STD-190                | Safety in derrick floor operations (Onshore and Offshore Drilling Rigs ) – <b>Under Revision</b>                          |
| 80      | OISD-STD-191                | Oil Field Explosive Safety  |
| 81      | OISD-GDN-192                | Safety Practices during Construction  |
| 82      | OISD-GDN-193 <sup>3</sup>   | Guidelines for gas lift operations & maintenance – <b>Under Revision</b>  |

<sup>3</sup> OISD-STD-231 is being merged with OISD-GDN-193

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| Sr. No. | OISD Standard/ GDN/RP No  | Standard Name  |
|---------|---------------------------|--|
| 83      | OISD-STD-194              | Unloading, storage and regasification of Liquefied Natural Gas (LNG) – <b>Under Revision</b>                           |
| 84      | OISD-STD-195              | Safety in Design, Operation, Inspection and Maintenance of Hydrocarbon Gas Compressor Stations and Terminals           |
| 85      | OISD-GDN-196              | Guidelines for Seeking Environmental Clearance of Development Projects in Petroleum Industry                           |
| 86      | OISD-GDN-197              | Guidelines for Environmental Impact Assessment   |
| 87      | OISD-GDN-200              | Guidelines for preparation of oil spill response contingency plan – <b>Under Revision</b>                              |
| 88      | OISD-RP-201 <sup>4</sup>  | Environment Management in oil & gas industry – <b>Under Revision</b>   |
| 89      | OISD-GDN-202 <sup>5</sup> | Field inspection of Drilling & Work-over Rig Mast, Substructure & Rig equipment – <b>Under Revision</b>                |
| 90      | OISD-GDN-203              | Operation, Maintenance & Inspection Of Hoisting Equipment  |
| 91      | OISD-RP-205               | Recommended Practices for Crane Operation, Maintenance & Testing (for Upstream)  |
| 92      | OISD-GDN-206              | Guidelines on Safety Management System in petroleum industry – <b>Revised standard approved in 40<sup>th</sup> SCM</b> |
| 93      | OISD-GDN-207              | Contractor Safety  |
| 94      | OISD-STD-210              | Storage, handling and refueling of LPG for automotive use – <b>Revised standard approved in 40<sup>th</sup> SCM</b>    |
| 95      | OISD-GDN-211              | Safety in Petroleum Laboratories   |
| 96      | OISD-STD-214              | Cross Country LPG pipelines – <b>Under Revision</b>  |
| 97      | OISD-STD-216              | Electrical safety in Onshore & Offshore Drilling & Workover Rigs – <b>Under Revision</b>                               |
| 98      | OISD-GDN-218              | Guidelines for Safe Rig- Up & Rig- Down of Drilling and Work-Over Rigs – <b>Under Revision</b>                         |
| 99      | OISD-GDN-219              | Guidelines on Field Inspection, Handling & Testing of Casing Pipe & Tubing   |
| 100     | OISD-GDN-224              | Monitoring & control of volatile organic compounds emission – <b>Revised standard approved in 40<sup>th</sup> SCM</b>  |

<sup>4</sup> OISD-GDN-196 and 197 is being merged with OISD-RP-201

<sup>5</sup> OISD-GDN-203 is being merged with OISD-GDN-202

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| Sr. No. | OISD Standard/ GDN/RP No  | Standard Name  |
|---------|---------------------------|--|
| 101     | OISD-STD-225              | Storage, Handling & Dispensing at Petroleum Retail Outlets   |
| 102     | OISD-STD-226              | Natural Gas transmission pipelines and City Gas Distribution networks – <b>Under Revision</b>  |
| 103     | OISD-STD-227 <sup>6</sup> | Emergency response and preparedness in oil & gas industry – <b>Revised standard approved in 40<sup>th</sup> SCM</b>                          |
| 104     | OISD-GDN-228              | Selection, Training & Placement of Fire Operators in Hydrocarbon & Petrochemical Industry  |
| 105     | OISD-STD-230              | Unlined Underground Rock Cavern Storage for Petroleum & Liquefied Petroleum Gas  |
| 106     | OISD-STD-231              | Sucker Rod Pumping Units   |
| 107     | OISD-GDN-232              | Identification of hazards and control measures in E&P industry   |
| 108     | OISD-GDN-233              | Guidelines on inspection of Non-piggable pipelines.  |
| 109     | OISD-STD-234              | Electrical Safety in Onshore Production Installations in E&P Sector  |
| 110     | OISD-STD-235              | Storage, handling, refuelling and firefighting at aviation fuelling stations – <b>Under Revision</b>   |
| 111     | OISD-STD-236              | Design, Layout, Operation & Maintenance of Refrigerated LPG Storage  |
| 112     | OISD-STD-237              | Layout, Design consideration, Safety, Operation and Maintenance of Lube/ Grease manufacturing and filling plants                             |
| 113     | OISD-RP-238               | Well Integrity   |
| 114     | OISD-GDN-239              | Guidelines On Annular Casing Pressure Management For Onshore Wells   |
| 115     | OISD-RP-242               | Drilling and Testing of HPHT Wells   |
| 116     | OISD-RP-243               | Recommended Practices on Coal based Methane (CBM) operations   |
| 117     | OISD-STD-244              | Storage and handling of petroleum products at depots and terminals including standalone crude oil storage facilities – <b>Under Revision</b> |
| 118     | OISD-STD-245              | Standard on safety for LNG bunkering facilities at ports for large ships, coastal shipping and inland water transport (IWT) terminals        |

<sup>6</sup> OISD GDN-168 and 204 is being merged with OISD-STD-227

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**New Standard under development**

| Sr. No. | OISD Standard/<br>GDN/RP No | Standard Name  |
|---------|-----------------------------|--|
| 1       | OISD-STD-100                | Definition, Abbreviation and Unit used in OISD Standards |
| 2       | OISD-STD-241                | Hydrogen Safety  |

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## ABBREVIATION

|        |  |
|--------|--|
| AC/DC  | Alternating Current/ Direct Current        |
| AERB   | Atomic Energy Regulatory Board             |
| AFS    | Aviation Fuelling Station                  |
| AHT    | Anchor Handling Tug                        |
| AI     | Artificial Intelligence                    |
| AIChE  | American Institute of Chemical Engineers   |
| AICTE  | All India Council for Technical Education  |
| AMOSC  | Australian Marine Oil Spill Centre         |
| ANSI   | American National Standards Institute      |
| AP     | Access Point                               |
| API    | American Petroleum Institute               |
| AR     | Augmented Reality                          |
| ASME   | American Society of Mechanical Engineers   |
| ASTM   | American Society for Testing and Materials |
| ATR    | Action Taken Report                        |
| BLEVE  | Boiling Liquid Expanding Vapour Explosion  |
| BIS    | Bureau of Indian Standards                 |
| BPCL   | Bharat Petroleum Corporation Limited       |
| BPR&D  | Bureau of Police Research and Development  |
| BS     | Bharat Stage                               |
| C2, C3 | Ethane and Propane                         |
| CAR    | Civil Aviation Requirements                |
| CCPS   | Center for Chemical Process Safety         |
| CCTV   | Close Circuit Television                   |
| CEA    | Central Electricity Authority              |

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|                 |  |
|-----------------|--|
| CEO             | Chief Executive Officer  |
| CFT             | Clear Function Test  |
| CGD             | City Gas Distribution  |
| CISF            | Central Industrial Security Force                                  |
| CMD             | Chairman and Managing Director                                     |
| CMT             | Crisis Management Team   |
| CNG             | Compressed Natural Gas   |
| CO <sub>2</sub> | Carbon Dioxide   |
| COT             | Crude Oil Terminal   |
| CPCB            | Central Pollution Control Board                                    |
| CSR             | Corporate Social Responsibility                                    |
| CTE             | Career and Technical Education                                     |
| DCS             | Distributed Control System   |
| DCVG            | Direct Current Voltage Gradient                                    |
| DDG             | Deputy Director General  |
| DG              | Director General   |
| DGCA            | Directorate General of Civil Aviation                              |
| DG Set          | Diesel Generator Set   |
| DG (FS, CD, HG) | Directorate General (Fire Services, Civil Defence and Home Guards) |
| DGH             | Directorate General of Hydrocarbons                                |
| DGMS            | Directorate General of Mines Safety                                |
| DGS             | Directorate General of Shipping                                    |
| DIN             | Deutsche Institute Fur Normung                                     |
| DISH            | Director of Industrial Safety and Health                           |
| DMP             | Disaster Management Plan   |
| DPIIT           | Department for Promotion of Industry and Internal Trade            |
| DNV             | Det Norske Veritas   |

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|                  |   |
|------------------|---|
| DSS+             | Dupont Sustainable Solutions                    |
| E&P              | Exploration and Production                      |
| ED               | Executive Director                              |
| EEZ              | Exclusive Economic Zone                         |
| EPC              | Engineering, Procurement and Construction       |
| ERDMP            | Emergency Response and Disaster Management Plan |
| ERC              | Emergency Response Centre                       |
| ERP              | Emergency Response Plan                         |
| ERP              | Enterprise Resource Planning                    |
| ESA              | External Safety Audit                           |
| ESD              | Emergency Shutdown Device                       |
| ESG              | Environmental, Social and Governance            |
| ESS              | Energy Storage Stations                         |
| ETV              | Emergency Towing Vessel                         |
| EV               | Electric Vehicle                                |
| E-Waste          | Electronic Waste                                |
| FAR              | Fatality Accident Rate                          |
| FIPI             | Federation of Indian Petroleum Industry         |
| FPSO             | Floating Production Storage and Offloading      |
| FRC              | Fast Rescue Craft                               |
| FSD              | Fire Shut Down                                  |
| GAIL             | GAIL (India) Limited                            |
| GDN              | Guidelines                                      |
| GIS              | Geographic Information System                   |
| H <sub>2</sub>   | Hydrogen  |
| H <sub>2</sub> S | Hydrogen Sulfide                                |
| HAZOP            | Hazard and Operability                          |

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|           |   |
|-----------|---|
| HC        | Hydro Carbon  |
| HDPE      | High Density Polyethylene                               |
| HIRA      | Hazard Identification and Risk Assessment               |
| HLA       | Helicopter Loading Assistance                           |
| HLC       | High Level Committee                                    |
| HLO       | Helicopter Loading Officer                              |
| HPCL      | Hindustan Petroleum Corporation Limited                 |
| HOTO      | Handing Over-Taking Over                                |
| HSD       | High Speed Diesel                                       |
| HSE       | Health, Environment and Safety                          |
| HUET      | Helicopter Under Water Escape Training                  |
| HVLRM     | High-Volume Long-Range Monitor                          |
| IADC      | International Association of Drilling Contractors       |
| IBR       | Indian Boiler Regulation                                |
| ICG       | Indian Coast Guard                                      |
| ICS       | Industrial Control System                               |
| IED       | Improvised Explosive Drone                              |
| IESG      | Industry Environment Safety Group                       |
| IGC       | International Gas Carrier                               |
| IIT (ISM) | Indian Institute of Technology (Indian School of Mines) |
| IMD       | Indian Meteorological Department                        |
| IMO       | International Maritime Organization                     |
| INCOIS    | Indian National Centre for Ocean Information Services   |
| IOCL      | Indian Oil Corporation Limited                          |
| IOW       | Integrity Operating Windows                             |
| IOGP      | International Association of Oil and Gas Producers      |
| IoT       | Internet of Things                                      |

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|       |  |
|-------|--|
| ISM   | International Safety Management                |
| ISO   | International Organization for Standardization |
| IT    | Information Technologies                       |
| IWCF  | International Well Control Forum               |
| IWT   | Inland Water Transport                         |
| JRM   | Journey Risk Management                        |
| JSA   | Job Safety Analysis                            |
| JV    | Joint Venture                                  |
| KPI   | Key Performance Indicators                     |
| KRA   | Key Responsibility Area                        |
| L1    | Lowest One                                     |
| LCNG  | Liquid to Compressed Natural Gas               |
| LDS   | Leak Detection System                          |
| LEL   | Lower Explosive Limit                          |
| LNG   | Liquified Natural Gas                          |
| LOPA  | Layers of Protection Analysis                  |
| LOPC  | Loss of Primary Containment                    |
| LPG   | Liquified Petroleum Gas                        |
| LSTK  | Lump Sum Turnkey                               |
| LTIF  | Lost Time Injury Frequency                     |
| LTS   | Long Term Survival                             |
| M&I   | Maintenance and Inspection                     |
| mbpd  | Million Barrels Per Day                        |
| MCP   | Manual Call Point                              |
| MDPE  | Medium Density Polyethylene                    |
| MEFG  | Medium Expansion Foam Generator                |
| MEMIR | Major Emergency Management Initial Response    |

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|         |  |
|---------|--|
| MHA     | Ministry of Home Affairs                           |
| ML      | Machine Learning                                   |
| MMT     | Million Metric Tonnes                              |
| MMSCM   | Million Metric Standard Cubic Meters               |
| MMTPA   | Million Metric Tonnes Per Annum                    |
| MOC     | Management of Change                               |
| MODU    | Mobile Offshore Drilling Unit                      |
| MoEFCC  | Ministry of Environment, Forest and Climate Change |
| MoPS&W  | Ministry of Ports, Shipping and Waterways          |
| MoU     | Memorandum of Understanding                        |
| MS      | Motor Spirit                                       |
| MSV     | Multi Support Vessel                               |
| NEP     | New Education Policy                               |
| NFPA    | National Fire Prevention Association               |
| NFSC    | National Fire Service College                      |
| NGT     | National Green Tribunal                            |
| NOC     | No Objection Certificate                           |
| NOS-DCP | National Oil Spill Disaster Contingency Plan       |
| NPDM    | National Policy on Disaster Management             |
| NSG     | National Security Guard                            |
| O&G     | Oil and Gas  |
| O&M     | Operations and Maintenance                         |
| ODA     | Offshore Development Area                          |
| OEM     | Original Equipment Manufacturers                   |
| OFC     | Optical Fibre Cable                                |
| OHA     | Oil Handling Agencies                              |
| OH&S    | Occupational Health and Safety                     |

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|        |   |
|--------|---|
| OIL    | Oil India Limited                                     |
| OISD   | Oil Industry Safety Directorate                       |
| OMC    | Oil Marketing Companies                               |
| OMR    | Oil Mines Regulations                                 |
| ONGC   | Oil and Natural Gas Corporation Limited               |
| OPITO  | Offshore Petroleum Industry Training Organization     |
| OPRC   | Oil Pollution Preparedness, Response and Co-operation |
| OSCP   | Oil Spill Contingency Plan                            |
| OSHA   | Occupational Safety and Health Administration         |
| OSRL   | Oil Spill Response Limited                            |
| OT     | Operational Technologies                              |
| OTS    | Operation Training Simulator                          |
| OTT    | Over the Top  |
| PCSA   | Pre-Commissioning Safety Audit                        |
| P&E    | Process and Engineering                               |
| P&ID   | Piping and Instrumentation Diagram                    |
| P&NG   | Petroleum and Natural Gas                             |
| PESO   | Petroleum and Explosives Safety Organization          |
| PIDS   | Pipeline Intrusion Detection System                   |
| PIMMAG | Petroleum Industry of Malaysia Mutual Aid Group       |
| PMC    | Project Management Consultant                         |
| PNG    | Piped Natural Gas                                     |
| PNGISB | Petroleum and Natural Gas Industry Safety Board       |
| PNGRB  | Petroleum and Natural Gas Regulatory Board            |
| POL    | Petroleum, Oil and Lubricants                         |
| PPE    | Personal Protective Equipment                         |
| PSE    | Process Safety Events                                 |

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|         |   |
|---------|---|
| PSM     | Process Safety Management                     |
| PSU     | Public Sector Undertaking                     |
| QCBS    | Quality and Cost Based Selection              |
| QR      | Quick Response                                |
| QRA     | Quantitative Risk Assessment                  |
| RACI    | Responsible, Accountable, Consult, Inform     |
| RBPS    | Risk Based Process Safety                     |
| RDSO    | Research Design and Standards Organization    |
| RFID    | Radio Frequency Identification                |
| RIL     | Reliance Industries Limited                   |
| RO      | Retail Outlet                                 |
| ROS-DCP | Regional Oil Spill Disaster Contingency Plan  |
| ROSOV   | Remotely Operated Shutoff Valves              |
| ROSRC   | Regional Oil Spill Response Centre            |
| RoU     | Right of Use                                  |
| RP      | Recommended Practices                         |
| RRPCL   | Ratnagiri Refinery and Petrochemical Limited  |
| S&OR    | Safety and Operational Risk                   |
| SAP     | System, Applications and Products             |
| SAS     | Survival at Sea                               |
| SBM     | Single Buoy Mooring                           |
| SBU     | Strategic Business Unit                       |
| SCADA   | Supervisory Control and Data Acquisition      |
| SCE     | Safety Critical Equipment                     |
| SCM     | Safety Council Meeting                        |
| SDI     | Skill Development Institute                   |
| SEIAA   | State Environment Impact Assessment Authority |

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| SIL      | Safety Integrity Level  |
| SME      | Subject Matter Experts  |
| SMPV (U) | Static and Mobile Pressure Vessels (Unfired)                      |
| SOLAS    | Safety of Life at Sea   |
| SOP      | Standard Operating Procedures                                     |
| SPCB     | State Pollution Control Board                                     |
| SPL      | Specified Period License  |
| SPM      | Single Point Mooring  |
| SPS      | Special Purpose Ship  |
| SRG      | Site Restoration Guidelines                                       |
| SSA      | Surprise Safety Audit   |
| STD      | Standard  |
| STS      | Short Term Survival   |
| SV       | Sectionalizing Valve  |
| T4S      | Technical Standards and Specifications including Safety Standards |
| TMTPA    | Thousand Metric Tonnes Per Annum                                  |
| TT       | Tank Truck  |
| UAV      | Unmanned Aerial Vehicle   |
| UAS      | Unmanned Aircraft System  |
| UGC      | University Grants Commission                                      |
| USB      | Universal Serial Bus  |
| VATMS    | Vessel and Air Traffic Management System                          |
| VET      | Vocational Education and Training                                 |
| VR       | Virtual Reality   |
| VTS      | Vehicle Tracking System   |
| Wi-Fi    | Wireless Fidelity   |
| WSD      | Working Stress Design   |

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## **REFERENCES**

1. Presentations and submissions made to the Working Group by various organizations operating in the Oil and Gas Sector in India (both in public sector and private sector) in upstream, midstream and downstream segment regarding safety systems followed in the respective Organizations, gaps and pain areas and suggested improvements.
2. Presentations made to the Working Group by M/s dss+ and M/s DNV on international best practices on safety management.
3. Presentations made to the Working Group by M/s Accenture on leveraging new age technologies for Safety Management.
4. Presentations made to the Working Group by M/s Tata Consulting Engineers Ltd. (TCE) & Falck Fire Consulting Limited, UK on Emergency Response Centre.
5. Presentations made to the Working Group by Advisor (Env.) IPA, representing MoPS&W on Regional Oil Spill Response Centre (ROSRC).
6. Data base of OISD regarding root cause analysis of accidents in Indian Oil and Gas Industry in last five years.
7. OISD standards, IOGP guidelines, API standards, OSHA, CCPS and ISO standards to the extent referred in the report.
8. Recommendations of the High-Level Committee constituted to inquire into the sequence of events leading to stranding of ONGC vessels in Cyclone 'Tauktae' in May 2021.
9. Recommendations of the High-Level Committee after Baghjan - 5 well blowout incident at Oil India in Assam in May 2020.
10. Recommendations of the M B Lal Committee after the fire incident at IOCL Terminal in Jaipur in October 2009.
11. OISD audit reports, OISD accident investigation reports and Safety Council minutes.
12. Following reports of the Parliamentary Standing Committee on Petroleum and Natural Gas dealing with the subject of Safety in Oil and Gas Sector
  - a. Recommendation No. 3, in Report No. 12 (15<sup>th</sup> Lok Sabha)- Need for Single Agency to Enforce Safety (May 2012)
  - b. Recommendation No. 3, in Report No. 17 (15<sup>th</sup> Lok Sabha)- Need for Single Agency to Enforce Safety (May 2013)
  - c. Recommendation No. 10, in Report No. 24 (16<sup>th</sup> Lok Sabha) – Formation of a unified Safety Board (July 2018)

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- d. Recommendation No. 5 in Report No. 13 (17<sup>th</sup> Lok Sabha)- Need for Single Safety Agency for Petroleum Sector (April 2022)
  - e. Recommendation no 8 in Report No. 19 (17<sup>th</sup> Lok Sabha) - Need for Single Agency to Enforce Safety (March 2023)
13. PPAC reports as available on their web site regarding statistics on Indian Petroleum Sector.
  14. January 2007 Report of the BP US Refineries independent safety review panel (Baker Panel Report) after BP Texas City Refinery process accident in January 2005.
  15. 27<sup>th</sup> edition of Marsh Report Q1 2022 on 100 largest losses in the Hydrocarbon industry (1974-2021).
  16. Swiss Cheese accident causation model originally proposed by James Reason in 2000.
  17. Dupont Bradley Curve, originally developed by Mr. Berlin Bradley, an employee of Dupont in 1995.
  18. Hudson safety culture maturity model originally developed by Prof. Patric Hudson in 2001.

**END OF REPORT**