Emerging Risks - Process Safety Management (PSM) in Upstream (E&P) Industry

29th December, 2016
New Delhi
ONGC is the flagship National Oil Company of India, a ‘Maharatna’, with interests in E&P, Refining, LNG, Power, Petrochemicals & New sources of energy.
ONGC has in-house capability in entire facets of upstream Oil & Gas business.

- Seismic data Acquisition, Processing & Interpretation (API)
- Well drilling & Work-over operations
- Well testing & stimulation
- Production & Processing
- Reservoir Management
- Applied R&D and Training
- Engineering & Construction
- Transportation, etc.
E&P Infrastructure

Offshore Installation
- 248

Onshore Installation
- 250

Pipelines
- 24,300 Km

OSVs/ MSVs
- 15+49*

Well Stimulation Vessel
- 1+2*

Seismic Crews
- 18+3 (VSP)

Drilling Rigs
- 75+26*

Work-over Rigs
- 58+21*

Well Stimulation Units
- 129

Well Logging units
- 28+58*

Process Installations
- 13

Institutes / Centers of Excellence
- 11

Diversified Talent
- 33,605

* Charter-hired

As on 01.09.2015
Oil & Gas Upstream (E&P) Industry

- Complex, demanding technologies
- Hazardous conditions
- Potential for catastrophic consequences
• Categorized as High Risk Industry
➢ Need for High Reliability

Through
• Robust “Process Safety Management” (PSM) System
Emerging Risks:

• Risks associates with adoption of new technologies

• Competency of work force for handling risk oriented operations

• Ageing and maintenance of Equipments and structures (Asset Integrity Management)

• Work force Behaviour towards jobs (BBS)
ACCIDENTS don’t just happen…

“THEY ARE CAUSED!!!”
Case Study-1

Incident:
A fire incident took place at GGS, in the Heater Treater (HT) area. At the time of incident preparation work for regular servicing/periodic 6 monthly internal cleaning of HT-2 was being carried out through contractor. Two contractual workers lost their lives in the incident.
Case Study-1

Brief of Incident:

Regular servicing/periodic 6 monthly internal cleaning of HT-1 & HT-2 was going on through contractual workers. Job of servicing/internal cleaning of HT-1. HT-1 was put on operation.

On the incident day, HT-2 was isolated. After depressurizing of the vessel, closing of all valves and purging the vessel with produced water, opening of one of the manhole cover (manhole cover of third chamber) of HT-2 was started and completed by.

Thereafter, started opening second manhole cover (man hole cover of first chamber). At 1653 hrs fire was seen Resident Engineer.
Case Study-1

Brief of Incident:

The fire incident was reported to fire section, followed by information to senior officers. Fire-fighting by in-house facilities started. Shift crew started to close the valves to isolate hydrocarbon supply to HT’s. First fire tender arrived at the site followed by another 06 tenders from different installations. Other field persons were mobilized to close the wells connected to this GGS. Gas supply to installation was stopped from GCP immediately. All wells were closed. Fire extinguished after 4 hours. However, cooling of the area was continued in order to rule out re-ignition.

During search operations, two (2) charred bodies were found from the incident site in between HT-1 & HT-2 and closer to the second manhole of HT-2, by the Fire team. Bodies were taken away by Police.
Case Study-1

Causes of Incident:

Rich fuel/air mixture got into the fire chamber through air intake filter of HT-1 where a small explosion took place inside and fire broke the view glass (ordinary glass fitted). As the second manhole cover was being opened, it created ventilation for the hydrocarbon in the HT-2 which was not totally hydrocarbon free. The gas from the HT-2 acted as initial fuel for the fire.
Case Study-1

Causes of Incident:
Positive isolation of vessel was not carried out.

A sudden release of gas took place from the vessel due to release of trapped gas or vessel getting connected with flare header due to opening of failsafe PCV.

The workers were thrown aback and the hand tool being used hit the 1.5” fuel gas line of HT 1 close-by breaking it near the union. Breaking of this line provided a continuous source of fuel for fire to escalate.

One of three possible source of ignition was (a) Normal Hand Tools being used for opening of bolts (b) Use of cell-phone by one of the worker (c) synthetic clothing worn by workers.(d) Non adherence of SOPs/ISA
Case Study-1

Lessons Learnt:

• Strict implementation of work permit system;

• Job safety analysis to be carried out and attached with work permit;

• Tool box talk to be conducted every day prior to start of all critical jobs (despite being repetitive);

• Responsible personnel to supervise all the jobs carried out through contractual workers;

• SOPs & non-sparking tools to be made available at each site;

• Positive isolation of all pressure vessels before opening; use of non-sparking tools for jobs in such areas;
Case Study-1

Lessons Learnt:

• Use of fresh water for flushing and emptying out the vessel must be ensured, etc;

• Measurement of gas concentration and oxygen level (minimum 19.5%) before vessel entry.

• HAZOP study may be conducted and health check of installed equipment periodically

• Replacement of very old equipment;

• Sufficient numbers of Hydrocarbon & Oxygen detectors to be made available;

• Use of compressed air in place of servo gas for instrumentation.
Case Study-2

The rig was under dismantling. The draw-works and mast were lowered. The removal of the extension platform was part of the dismantling. During removal of platform, the two floor men and tool were on the platform and victim was under the platform.

After removal of all the four pins the platform fell down on individual Victim who got serious head injury, Tool pusher fell towards rotary table and got injury. One of the floor man fell into the cellar pit and got injury. Other floor man took a grip on the other support of supporting platform and did not have any injury. Victim was immediately attended by the rig medic and shifted to Hospital where he was declared brought dead.
The fatal platform
Pins locations in substructure & platform
Probable Causes

- Victim under the substructure either for fixing sling on the platform or waiting after taking out four pins. The floor men working on the substructure was not aware about victim presence under the substructure.

- The fall of platform was caused due to not securing of platform with the slings before taking out all the four pins connecting substructure with platform.

- The crew members were not completely aware about the dismantling procedure and their consequences about the operations.
Lessons Learnt:

Safety briefing should be given to crew members before commencing operations.

- The critical jobs like dismantling needs to be carried out under the supervision of tool pusher.

- More awareness towards safety are to be from mandatory trainings like mines vocational training, fire fighting training, first aid training, IWCF to all the crew members specially crew joined newly to the rig. The safety meetings needs to be carried out regularly by senior officers of ONGC and by M/S Contractor.
Lessons Learnt

Critical operations should be carried out by experienced crew members only.

- Approved copy of Safety Management System and Rig manual needs to be available at the rig and the tool pusher and drillers shall be aware about the requirements of safety for the operations.

- Anchoring should be ensured prior to taking out the pins. Proper coordination between the rig crew and crane operator during rig dismantling and rig building.
Lessons Learnt:

A dedicated Safety Officer, who has adequate field experience, needs to be deployed to disseminate information & to inculcate strict safety habits amongst crew members.

- The experience of crew members is vital for avoiding such type of incidents. The complete bio-data indicating qualification, experience, training attended for new crew members joining on the rig should be checked and approved by ONGC authorised person.

- Concept of reporting incidents including near miss should be developed, implemented and reported to ONGC on daily basis.
PSM-Definition

- "Process Safety" refers to the control of process hazards having the potential to cause major accidental loss.

- "Process Hazard" (or “Risk Source”) is the property of a dangerous inherent operational risk/substance or physical situation with the intrinsic potential to cause major accidental loss.

- Process safety management is the application of management systems to the identification, understanding and control of process hazards to prevent process-related injuries and incidents.
Ascribing Factors for PSM

- Organizations are operating in rapidly changing working environment.
- Introduction of complex major Hazard processes having the Potential for process safety Accidents.
- Limited understanding of the sources, causes, and consequences of major hazards and the frequency with which they occur.
- Increasing Incidence of Accidents viz. Fire, Explosion, Releases of Inflammable or toxic materials.
- Low frequency events but high consequences. These are Intolerable Risks.
Ascribing Factors for PSM

- High Level of Scrutiny by diverse stakeholders and low threshold of Acceptance of Failure.

- Impact on People, Environment, Asset, and Reputation.

- Large events have Impacts of global dimension on reputation, regulatory, and community relationship and ability to deliver in market place

- In hindsight the signs were clear, but generally fail to make the connections, draw the right conclusions, and follow-up to implement them

- It is essential to prevent and Manage Process Events in competent Manner
Challenges in PSM

- Low frequency nature of process events poses some challenges when implementing PSM.
- Assessing process risks properly as most people lack personal experience of process events.
- As process events have more complicated precursors, there is a need for more robust and sophisticated analysis tools to identify hazards and escalation factors.
Building Blocks of PSM

Design it right - Establish safe operating envelope

Operate it right

Maintain it Right

Knowledge

People

Competent, Motivated people

Management System

Process Integrity

Maintain the safe operating envelope

Operate within safe operating envelope

Develop and maintain knowledge
Concept of Process Safety – People, System and Equipment (PSE)

- **Man (People)**
- **Method (System)**
- **Machine (Equipment)**
- **Money**

PSE

Process Safety Management
Process Safety issues have always been under focus in Oil & Gas industry. To address these Process safety issues, very robust Process Safety management system needs to be in place to mitigate undesirable events as our industry is highly vulnerable to accidents.

ONGC has always been front runner in self regulation with proactive efforts to address the Process Safety issues.

ONGC is using the Process Safety Management System based on international standard API-RP-75 and OISD –GDN-206 and also within the ambit of ISO management platform. This System contains all the essential elements of a sound Process Safety Management System, customized to the specific needs of ONGC operations.

Process Safety Management System addresses the key aspects of Process safety, i.e. **People, System & Equipment** (PSE).

Assessment of PSE is essential for continual improvement.
<table>
<thead>
<tr>
<th>Element No.</th>
<th>Description of Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Leadership &amp; Organization</td>
</tr>
<tr>
<td>2.</td>
<td>HSE Information</td>
</tr>
<tr>
<td>3.</td>
<td>Hazard Analysis/Risk Assessment System</td>
</tr>
<tr>
<td>4.</td>
<td>Management of Change (MOC)</td>
</tr>
<tr>
<td>5.</td>
<td>Operating Procedure</td>
</tr>
<tr>
<td>6.</td>
<td>Safe Work Practices</td>
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<td>7.</td>
<td>Training</td>
</tr>
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<td>-------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>8.</td>
<td>Pre-Start Up Review</td>
</tr>
<tr>
<td>9.</td>
<td>Quality Assurance &amp; Equipment Safety Integrity (Asset Integrity Management)</td>
</tr>
<tr>
<td>10</td>
<td>Emergency Response &amp; Control</td>
</tr>
<tr>
<td>11</td>
<td>Incident Reporting, Investigation &amp; Analysis</td>
</tr>
<tr>
<td>12</td>
<td>HSE Audit Protocol</td>
</tr>
<tr>
<td>13</td>
<td>Records &amp; Documentation</td>
</tr>
<tr>
<td>14</td>
<td>Safety in Contract Management</td>
</tr>
</tbody>
</table>
New technology adopted is within ALARP.
The Process/Operational integrity depends on the quality of and balance between the following Process Safety Aspects:

**People:** The interaction of people with one another, with equipment and with systems.

**Systems:** Working methods, data collection & collation and Process Safety management systems.

**Equipment:** Hardware and technical integrity.

An efficient, safe and competitive asset operation needs to have the correct balance between these Process Safety Aspects for achieving continuous improvement.
Continual Improvement - PSE

- Continuous Improvement
- EQUIPMENT
- PEOPLE
- SYSTEMS
The Aspect "People" relates to Leadership commitment, Line Managers capability, workers suitability, competence, responsibility and accountability. This element is composed of four main aspects-

1. Structure and responsibility: Management structure, organization.
2. Human resources management: Job descriptions, hiring and placement, selection criteria and communication.
3. Training: It is an important aspect of Process Safety Management system to be addressed.
4. Competence: Competence requirement is essential for achieving efficiency.
### PSE- People

<table>
<thead>
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| **Leadership & Organization** | Corporate HSE Policy, HSE Vision & Mission, Purpose & Objective, Organization and Roles & Responsibilities | • HSE Policy signed by CEO  
• Defined Roles & Responsibilities of all Stakeholders  
• Loss Control Tour by Key Executives  
• Quarterly HSE Review by Director |
| **Process Safety Information**  | Statutory requirements, Applicable laws & Acts, Process equipment, Hazard analysis, electrical system, MSDS, Environment information and Occupational Health & hygiene | • Accident/ Incident/ Non-conformity Data  
• Process Equipment Related  
• Hazard Analysis  
• Operation and maintenance  
• Electrical Systems  
• Fire Protection and Safety Equipment  
• MSDS |
| **Training**       | Identification of training needs as per target groups for capacity build up          | • Exclusive Institute for Safety training (IPSHEM, Goa)  
• GT induction training  
• Safety Orientation training programme |
| **Contract Mngt.** | Elements of contractor safety management programme including bridging document    | • Organizing Contractor safety work shops  
• Ensuring MVT  
• Awareness programmes |
Safety Priority or Value?

Safety is a PRIORITY when working safely is a condition of employment, your boss insists you do it and you do what you are asked to do. It affects an individual’s behavior.

Safety is a VALUE when you work safely without being told to do so. It is at the center of who you are; it defines who you are and the way you work and live. It affects how you think.

Going from priority to value is a process. It takes time and effort on your part.
The key initiatives to address this Aspect-

1. To enhance visible management commitment.
2. Effective involvement of line management in HSE/Process Safety
3. Define Process Safety KPIs for all levels of management
4. Training programs for all personnel including contract employees.
5. Imparting leadership skills training to line management
6. Periodical launching of Safety awareness campaigns for all stakeholders
7. Drive for improving occupational health surveys for employees
The Aspect “Systems” relates to the capability to manage the operations in safe manner.

The system includes the following:
- Hazard Identification and Risk Assessment (HIRA)
- Operating Procedures
- Safe Work Practices
- Incident Reporting, Investigation & Analysis
- Audit Protocol
- Management of Change (MOC)
- Emergency Preparedness & Response.
- Quality management.

This Process Safety Management System needs to be in line with OHSAS:18001 & ISO: 9001 & ISO: 14001 standards.
# PSE- System

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| **Hazard Identification & Risk Assessment (HIRA)** | Hazard Identification (HAZID) Quantitative Risk Assessment (QRA), Process Hazard Analysis (PHA), and Determination of Risk magnitude for barrier analysis | • Carries out HAZOP studies & QRA  
• Compliance of Recommendations  
• Risk Register as per OHSAS & IS 17776  
• QHSE Certification by Third Party  
• Risk Based Audits |
| **Management of Change (MOC)**               | Covers the procedural requirements due to change in equipment/method/process/Men        | • Management of Change (MOC) document developed and validated by Petrofac  
• Safety critical system (By pass) methodology |
| **Operating Procedure**                      | Permit-To-Work (PTW), Simultaneous Operations (SIMOPS), Marine Procedure, Job Safety Analysis (JSA), Tool Box Talk (TBT), Guidelines on SOPs,, Taking over & handing over of charge procedure | • Developed SOPs, SIMOPS  
• Conducts JSA & TBT  
• Procedures developed for Non-standard/Non-routine jobs |
## PSE- System

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<td><strong>Safe Work Practices</strong></td>
<td>Welding &amp; cutting jobs, Chemical lab safety, Material handling, Helicopter safety, Working at height, Safety in using portable tools, Safety in hydrojetting, Pipe line safety, Motor vehicle operations etc.</td>
<td>• Dos &amp; Dont’s prepared for all Non-standard jobs as per JSA • Tool Box Talk is being conducted</td>
</tr>
<tr>
<td><strong>Pre-Start Up Review</strong></td>
<td>It ensures the missing links in the system after any change</td>
<td>• Documented procedure is being followed and ensured by competent authority as per MOC</td>
</tr>
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<td><strong>Emergency Response &amp; Control</strong></td>
<td>Guidelines for preparation of ERP &amp; DMP, mutual aid schemes, procedure for conducting mock drills and updating plan.</td>
<td>• Review &amp; update existing ERP &amp; DMP as per NDMA, MHA, MOPNG &amp; PNGRB guidelines • Conducts Mock drills for efficacy of plans</td>
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# PSE- System

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| Incident Reporting, Investigation & Analysis | Corporate guidelines on incident reporting as per statutory requirements, investigation methodology and subsequent analysis for avoiding reoccurrence of incidents | • Developed Incident reporting matrix based on MoPNG, MoEF, MHA PNGRB and PESO guidelines  
• DNV causation model is being used for incident investigation  
• Analysis is being done for lessons learnt  
• Safety Alerts are being circulated.  
• Case studies are being discussed in HSE review meetings |
| HSE Audit Protocol            | Audit & Inspection protocols for internal audits and inspections and External audits     | • Internal Safety Audits are being carried out as per approved check list according to Risk Matrix  
• Recommendations of ESA are being complied with effective monitoring mechanism |
The key initiatives to address this Aspect-

1. Development of Safety system for envisaged new areas
2. Effective implementation of P-D-C-A cycle (QHSE)
3. To establish leading and lagging indicators for operation
4. To update & develop SOPs for all equipment and process
5. Bridging document(s) for ONGC and contractors Safety-MS
6. Transformation of present manual PTW to Electronic
7. Incident reporting and root cause analysis investigations
8. Improved mechanism for Inspection and Monitoring
9. Effective hazardous waste management and disposal
10. Improve Effluent Management capability
This Aspect “Equipment” is composed of four main factors.

These four factors indicate management and demonstration of the equipment’s ability to perform with sustenance according with set objectives:

1. **Condition**: The current physical condition.
2. **Performance**: Conditions sufficient and acceptable to meet HSE, Operations and Financial targets.
3. **History**: Reason for current condition.
4. **Life Cycle Management**: How the conditions and due performance managed/improved for sustainable operations.
## PSE- Equipment

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| Quality Assurance & Equipment Safety Integrity (Asset Integrity Management) | Use of SAFE chart, Protection concept, assurance requirements and integrity of critical equipment | • Developed Inspection Reporting Requirements (IRR) document for effective inspection & maintenance  
• Audits are being carried out for Safety Critical Elements (SCE)  
• Adopting new methods like Bow Tie Technique for Asset Integrity Management |
| Records & Documentation                      | It covers the document control system based on ISO-9001                                 | • DOC is being followed with retrievable mechanism                               |
1. To use Best Available and Safest Technology (BAST) for designing of facilities
2. Ensuring reliability of safety critical equipment (SCE) by periodic testing / inspection etc.
3. Appropriate Safety Integrity Level (SIL)
4. Use of new methods like Bow Tie for risk management
5. Improved process automation for operations control
6. Accelerate structural integrity management program
7. Drive improvement in rotary and static equipment preventive maintenance systems (PMS)
8. Pipe line policy (Health & Integrity): including microbial induced corrosion (MIC)
Asset Integrity Management - Interface between PSE

- Deterioration
- System and hardware fixes; Written schemes, AIDA action closure, competency, alarm reduction, etc etc
- "Deep learning" Behavioural Changes needed

AI Initiatives

Sustained Performance 'Mindful Organisation'

Performance vs Time
It is required to define Safe Operating Limits (SOL) or ‘envelopes’.

Setting of range of each process variable under normal operating conditions

- There should be no undesired safety consequences as long process parameters are within the SOL
Managing Process Safety

- Identification of Critical Operating Parameters (COP)
- Define Never to Exceed Limit (NEL) of each COP
- Investigation of reasons for exceeding the NEL, howsoever, transient it may be.
- Ensuring suitable methods of control or safeguards in design for such occurrences.
Managing Process Safety

It is important that excursions beyond the SOL are identified / recorded even if they are transient in nature.

Root Cause Analysis of Such Excursions/Deviations to understand genesis.
Managing Process Safety

Defining of the SOE and COP-NEL, and ensuring that sufficient margin of safety is incorporated into the design of the process system.

This “Process Safety Buffer” consists of two parts:

- The “Troubleshoot Zone” within which the process can be controlled,
- The “Buffer Zone.”
Managing Process Safety

The top of this troubleshooting zone is the “Mandatory Action Point” at which ultimate safeguards (also known as “Never Deviate Action”), such as pressure relief valves operate;

Buffer zone ensures that the NEL is not exceeded in the time it takes for the Never Deviate action to have the desired effect.

Thus strategies viz. derating, replacement, revamp should be in place to manage process risks at acceptable level

i.e. As Low As Reasonably Practicable (ALARP)
To deliver competitive level of process safety performance we have to ensure assets are:

- **Designed** correctly
- **Operated** correctly
- **Maintained** correctly

And we need **Process Safety Management** system along with capable and competent workforce to prevent performance slippage.
Methods to monitor PSM Effectiveness

- Vulnerability assessment and risk based Inspections
- Periodic Audits
- Timely Compliance
- Action Tracking
- Management Reviews

Effective PSM
Holistic Risk Management

HSE + PSM Aspects = Holistic Risk Management

We design and build so that risks are As Low As Reasonably Practicable (ALARP)

Design Integrity

Technical Integrity

Integrity Leadership

Operating Integrity

We work within the operational barriers

We maintain the hardware barriers
Thank you all for rapt attention
PSE System Deliverables