ERDMP for Cross Country Natural Gas Pipeline

By
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Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of methane, but commonly includes varying amounts of other higher hydrocarbons and a lesser percentage of carbon dioxide, nitrogen, and hydrogen sulphide.

- It is colourless, shapeless and odourless.

- Natural gas is an energy source often used as a fuel for heating, cooking, and electricity generation.

- It is also used as fuel for vehicles and as a chemical feedstock in the manufacture of plastics and other commercially important organic chemicals.
The rapid growth of business all over the world requires increasing hydrocarbon transport capacity.

With sophisticated technologies providing increased applications, pipelines are gaining advantage over other means of transport due to economic and safety considerations.

Pipeline System normally considered as “Safe Transportation Mode”.
India has a country wide network of approximate 15,000 KMs of gas pipelines.

*Source: MOPNG*
Disaster Management Legislations in India

- Factories Act 1948
- MSIHC Rules, 1989
- Chemical Accident (EPPR) Rules, 1996
- DM Act, 2005
- ERDMP Regulations, 2010
<table>
<thead>
<tr>
<th><strong>Factory Act 1948</strong></th>
<th><strong>MSIHC Rules, 1989</strong></th>
<th><strong>CA(EPPR)Rules,1996</strong></th>
<th><strong>DM Act, 2005</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Compulsory disclosure of information</td>
<td>Framed under EPA</td>
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<td>Establishment of National Disaster Management Authority</td>
</tr>
<tr>
<td>Dangers, health hazards, measures to overcome the same to Chief Inspector of Factories and Local authorities</td>
<td>More than 600 chemicals are identified to be hazardous and toxic</td>
<td>Constitution of Crisis Groups – Central, State, District &amp; Local Crisis Management Group</td>
<td>Lay down the policies on Disaster Management</td>
</tr>
<tr>
<td>Preparation of on-site Emergency Plan</td>
<td>Preparation of onsite emergency plan by industrial installation</td>
<td>Crisis Alert System</td>
<td>Enforcement and Implementation</td>
</tr>
<tr>
<td>Permissible Limits of exposure of Chemicals is prescribed – third schedule</td>
<td>Preparation of offsite emergency plan by Government</td>
<td>Information to Public</td>
<td></td>
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<td></td>
<td>Information to public liable to be affected</td>
<td></td>
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<tr>
<td></td>
<td>Responsibility of MAH Installations</td>
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</tbody>
</table>

Applicability:

- Hydrocarbon processing installations (Refinery, gas processing, LNG regasification installations etc.)
- Pipelines such as NG, Propane, Butane etc.
- Commercial Petroleum & Gas Storages facilities including
- LNG terminals
- Hydrocarbons gas bottling installations
- CGD networks
- Dispensing stations and petroleum retail outlets
- Transportation of petroleum product by road
Acceptable Risk

ALARP – As Low as reasonably Practical
IRPA (Individual Risk per Annum)

- **Intolerable**
  - $10^{-3}$/yr
  - Fundamental improvements needed. Only to be considered if there are no alternatives and people are well informed.

- **The ALARP or Tolerable region (Risk is tolerated only)**
  - $10^{-4}$/yr
  - Too high, significant effort required to improve.

- **Broadly Acceptable region (no need for detailed working to demonstrate ALARP)**
  - $10^{-5}$/yr
  - High, investigate alternatives.

- **Negligible, maintain normal precautions**
  - $10^{-8}$/yr
  - Low, consider cost-effective alternatives.
Disaster Management Approaches

Conventional Approach
- Rehabilitation
- Reconstruction
- Response

Modern Approach
- Planning
- Prevention
- Mitigation
- Preparedness

Hazards & Risks

Disaster
Classification of Emergencies - ERDMP

Onsite Emergency
- **Level I**
  - Manageable within site available resources
  - No impact outside the site
- **Level II**
  - Not manageable/ contained within site by available resources.
  - Potential to have effect beyond site location.
  - Mutual aid partners may be involved

Offsite Emergency
- **Level III**
  - Emergency with an off-site impact.
  - Control under District Admin management
  - Catastrophic and likely impact on human life, property and environment etc
<table>
<thead>
<tr>
<th>Pre Emergency</th>
<th>Emergency Mitigation</th>
<th>Emergency Preparedness</th>
<th>Emergency Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard Identification</td>
<td>Location Plans, Layouts &amp; Others</td>
<td>Emergency Drills</td>
<td>Emergency Organizations &amp; Responsibilities</td>
</tr>
<tr>
<td>Risk Analysis</td>
<td>Resource Mobilization</td>
<td>Training &amp; Awareness</td>
<td>Infrastructures</td>
</tr>
<tr>
<td>Causes of Disaster</td>
<td>Preventive Measures - Safety System</td>
<td>Mutual Aid</td>
<td>Recourses of Controlling Emergency</td>
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<td></td>
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<tr>
<td>Emergency Recovery</td>
<td></td>
<td></td>
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<tr>
<td>Information to Statutory Authorities</td>
<td></td>
<td>Incident Investigation</td>
<td></td>
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<tr>
<td>Salvage &amp; Recovery</td>
<td></td>
<td></td>
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<tr>
<td>Level-1 On site Emergency</td>
<td>1. Minor Natural Gas leakage through pinhole in pipeline (up to 20 mm).</td>
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<td>--------------------------</td>
<td>---------------------------------------------------------------------</td>
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<tr>
<td></td>
<td>2. Minor Natural Gas fire arising due to leakage through pinhole in pipeline (up to 20 mm).</td>
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<td></td>
<td>3. Leakage of Natural Gas due to failure of Instrument Tubing.</td>
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<td></td>
<td>4. Natural Gas fire due to leakage of Natural Gas due to failure of Instrument Tubing.</td>
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<tr>
<td></td>
<td>5. Minor Natural Gas leakage from PRS/Metering /Vent/Gasket Failure/Filter/Pig Launcher &amp; Receiver Barrel.</td>
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<tr>
<td></td>
<td>6. Minor Natural Gas fire arising out of gas leakage from the PRS/Metering/Vent /Gasket Failure/ Filter/Pig Launcher &amp; Receiver Barrel.</td>
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<tr>
<td></td>
<td>7. Pop off of Pressure Safety valve resulting in leakage of Natural Gas.</td>
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<td></td>
<td>8. Leakage of High Speed Diesel</td>
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<td></td>
<td>9. Fire due to spillage of high speed diesel etc.</td>
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</table>
| Level-2 On site Emergency | 1. Leakage of Natural Gas Leak from Aboveground/Underground pipelines through hole above 20 mm diameter & less than 50 mm diameter.  
2. Fire arising due to Natural Gas leakage through hole in pipeline hole above 20 mm diameter & less than 50 mm diameter. |
| --- | --- |
| Level-3 Off Site Emergency | 1. Leakage of Natural Gas Leak from Aboveground/Underground pipelines through 20% CSA of pipeline or full bore rupture.  
2. Fire arising due to Natural Gas leakage through 20% CSA of pipeline or full bore rupture. |
### Pre Emergency Planning: Calculation of Hazard Distances & Thermal Radiation

- **Example of estimated Failure Scenarios for Natural Gas Pipeline diameter 42” at line pressure 80 Kg/cm². (NR – Not Reached)**

<table>
<thead>
<tr>
<th>Location</th>
<th>Release of Gas (Kg/Sec)</th>
<th>Distances for different Thermal Radiation (KW/m²) intensity and 3D weather condition.</th>
<th>LFL distance (m) for 3D weather condition.</th>
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<tr>
<td></td>
<td></td>
<td>4.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Case 1 – 5 mm Diameter Hole (A/G)</td>
<td>0.29</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Case 1 – 5 mm Diameter Hole (U/G)</td>
<td></td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Case 2 – 20 mm Diameter Hole (A/G)</td>
<td>4.56</td>
<td>39</td>
<td>32</td>
</tr>
<tr>
<td>Case 2 – 20 mm Diameter Hole (U/G)</td>
<td></td>
<td>32</td>
<td>19</td>
</tr>
<tr>
<td>Case 3 – 50 mm Diameter Hole (A/G)</td>
<td>28.51</td>
<td>90</td>
<td>70</td>
</tr>
<tr>
<td>Case 3 – 50 mm Diameter Hole (U/G)</td>
<td></td>
<td>75</td>
<td>47</td>
</tr>
<tr>
<td>Case 4 – 20% CSA (U/G)</td>
<td>2519</td>
<td>577</td>
<td>390</td>
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- **Location of gas leakage and fire**
- 26 M distance of heat radiation of 37.5 KW/m²
- 32 M distance of heat radiation of 12.5 KW/m²
- 39 M distance of heat radiation of 4.5 KW/m²

<table>
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<tr>
<th>Radiation Level (KW/m²)</th>
<th>Observed Effect</th>
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<td>37.5</td>
<td>Sufficient to cause damage to process equipment</td>
</tr>
<tr>
<td>12.5</td>
<td>Minimum energy required for piloted ignition of wood, melting of plastic tubing</td>
</tr>
<tr>
<td>4</td>
<td>Sufficient to cause pain to personnel if unable to reach cover within 20s; however blistering of the skin (second degree burns) is likely; 0: lethality</td>
</tr>
</tbody>
</table>
Emergency Mitigation Measures - ERDMP

- Location Plan of the Installations indicating siting of the installation.
- Site Plan including layout of the installations indicating boundary walls, entry/exit gates, various facilities and location of various facilities.
- Layout of Fire Water Systems and Fire Fighting Equipment Details.
- Line block diagram of manufacturing process and process flow diagram (PFD).
- Internal and External Emergency contact numbers and addresses.
- Pipeline Route Map and Details of various facilities e.g. Sectionalizing Valves (SV), Intermediate pigging (IP) Stations, Radio repeater (RR) Stations etc.
- Addresses and Telephone Directory of Technical Support Services
- Security Threat Plan
- Safety Management System
Emergency Response Procedures & Measures - ERDMP

- **Emergency Shutdown of Pipelines.**
- **Detailed Action Plan on Scenarios, as identified in Risk Analysis.**
Disaster Management Plan – A Concern

- Lack of Disaster preparedness at all levels
- Encroachments
- Delayed Response due to Remote Locations
- Delayed Information
- Lack of Interface and Coordination

Huge Loss of Life and Property
Disaster Management Approach

- Robust Legal Framework
  - Focused Approach on Implementation of Safety Management System at Organizations
  - Shift from thrust on relief-centric approach to a pro-active assault on vulnerabilities through risk management measures
- Managing Encroachments
- Public Awareness and participation
- Strong initiatives from District/State Authorities
- Inbuilt Safety System, Redundancy and Technological Upgradation
Technological Up-gradation

**SCADA: Supervisory Control and Data Acquisition**
- Increase efficiency by Minimizing Fault Response Time
- Maximize Public Safety and Site Safety

**Distributed Control Room System**
- Maintain Real time data of all Pipeline Parameters, Supply and Operational Control of Facilities
- Instant leak detection with the help of Remote Terminal Units (RTUs)

**Remote Operated Shut Off Valve**
- To facilitate remote closure of valve from Control Room
- Rapid Closure of valve to Control Inventory in case of leakage

**Integrity Management System through software solution**
- Instant risk overview of Asset systems
- All Asset/Pipeline data saved in one central data management system
- Integration with existing GIS and ERP systems
THANK YOU
Causes of Natural Gas Pipeline Failure

- External Interference
- Corrosion
- Ground Movement
- Construction Defects
- Operation & Maintenance
- Others
### Statistics of Gas Pipeline Failure - EGIG

#### Primary Failure Cause Distribution (%)

- **Other and Unknown**: 6.6%
- **Ground Movement**: 4.8%
- **Hap tap made by error**: 7.4%
- **Construction...**: 16.7%
- **Corrosion**: 16.1%
- **External Interference**: 48.4%

#### Corrosion Distribution (%)

- **External**: 83%
- **Internal**: 13%
- **Unknown**: 4%

#### Incident Distribution on Detection

- **Public/Land Owner**: 41.3%
- **Patrol**: 7.5%
- **Contractor**: 17.5%
- **Company Staff**: 16.5%
- **Online Inspection**: 15.6%
- **Others**: 16.5%