Introduction

- The rapid growth of business all over the India requires increasing hydrocarbon transport capacity.

- A pipeline is actually a system of equipment designed to allow material to flow continuously or intermittently from one location to another.

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

- Hydrocarbons are highly flammable substance, transported through cross country pipelines at high pressure often close to centres of high population or through areas of high environmental sensitivity.
Pipeline Incidents
Incident Statistics

Significant Incidents

Root Cause Analysis

PHSMA Root Cause Analysis (2010-2018)
- Natural Force Damage: 8%
- Material/Weld/Equipment Failure: 37%
- Excavation Damage: 14%
- Incorrect Operations: 6%
- Other Factors: 8%
- All Other Causes: 4%

Reference: PHSMA Significant Incidents

NG Root Cause Analysis (2010-2017)
- Natural Force Damage: 17%
- Corrosion: 25%
- Excavation Damage: 33%
- Material/Weld/Equipment Failure: 17%
- Incorrect Operations: 8%
- Other Outside Factors: 0%
- All Other Causes: 0%

Reference: PHSMA Significant Incidents
Codes and Standards

- **ASME B 31.8S : Managing System Integrity of Gas Pipelines.**

  *This Code is specifically designed to provide the operator with the information necessary to develop and implement an effective integrity management program utilizing proven industry practices and processes.*

- **PNGRB (Integrity Management System for Natural Gas Pipelines), Regulations 2012**

- **PNGRB (Integrity Management System for City Gas Distribution Network), Regulations 2013**

- **PNGRB (Integrity Management System for Petroleum Product and Petroleum Product Pipelines), Regulations - Draft**
Integrity Management System

• Evaluate the risk associated with Cross Country Pipelines and effectively allocate resources for prevention, detection and mitigation activities;

• Improve the safety of so as to protect the personnel, Public, Environment and Property;

• Have streamlined and effective operations to minimize the probability of gas pipeline failure.
Integrity Management Tools

- Inline Inspection
- Cathodic Protection
- Surveillance
- Hydrotest
- Direct Assessment & Evaluations
- Thickness Assessment and Periodic Reviews
- Pipeline Equipment Health Monitoring
- Review of Existing Pipeline Class Locations
IMS Components

- Integrity Management Plan
- Performance Plan
- Communication Plan
- Management of Change
- Quality Control Plan

- Internal Data Gathering, Review & Integration
- Threat Identification
- Consequence & Impact Analysis
- Risk Assessment
- Integrity Assessment
- Mitigation & Response
- Update, Review & Integrate

- Identifying and maintaining the documents required
- Defining roles and responsibilities
- Reviewing of Integrity Management Plan
- Training and awareness
- Periodic internal Audit
- Documentation of corrective actions taken or required to be taken to improve the integrity management plan or quality plan.
Pipeline Threats

- **Time-Dependent**
  - External corrosion
  - Internal corrosion
  - Stress corrosion cracking
  - Manufacturing-related defects
  - Welding/fabrication related
  - Equipment
  - Third party/mechanical damage
  - Incorrect operational procedure
  - Weather-related and outside force
  - **Defective Pipe Seam**
  - **Defective Pipe**
  - **Defective pipe girth weld**
  - **Defective fabrication weld**
  - **Wrinkle bend or buckle**
  - **Stripped threads /broken pipe/coupling failure**
  - **Gasket O-ring failure**
  - **Control/relief equipment malfunction**
  - **Seal pump packing failure**
  - **Miscellaneous**
  - **Damage inflicted by first, second or third party (instantaneous/immediate failure)**
  - **Previously damaged pipe (delayed failure mode)**
  - **Vandalism**

- **Time-Independent**
  - **Weather related**
  - **Lightening**
  - **Heavy Rains or Floods**
  - **Earth Movements**

Besides the above, certain other threats may be applicable based upon the land pattern: i. Creek area effects, ii. Muddy land effects & iii. River bed movements
Risk Assessment Methodology

1. Initial Data Gathering/Review
2. Threat Identification
   - All threats evaluated
     - YES
     - NO
3. Consequence & Impact Analysis
4. Risk Assessment & Evaluation
5. Integrity Assessment
   - Whether Mitigation and Responses Required
     - YES
     - NO
6. Review of Integrity Management System
7. Data Updation & Integration
8. Mitigation & Response
Risk Assessment

• *Pipeline sections may be prioritized for integrity assessment based on severity of composite risk due to all threats.*

• The composite risk value for particular pipeline section is product of relative likelihood of failure and consequences altogether due to all applicable threats. Risk priority shall be established for pipeline sections observed with high risk to organize the integrity assessment.

• The risk may simply be categorized as high, medium, low (or 1, 2, 3) or larger range, to differentiate the priorities among various sections.
Risk Assessment

The risk assessment is continuous and repetitive process. System wide risk assessment shall be carried out at least every year by pipeline operators incorporating and updating the recently captured data in risk model such as:

a) Increase in Operating Pressure, average temperature/dew point of gas, water content in gas beyond acceptable limits.

b) Changes in Right of Use conditions like development of encroachments, increase in third party activities/ population density, major washouts.

c) Pipeline Leak/rupture history.

d) Addition of new /expansion of the existing railway/road/waterway crossings.

e) Changes to pipeline cathodic protection levels due to external interference problems.

f) Any other issues which may affect the integrity of pipeline.

g) The results of previous integrity assessments.
Performance Measurement

Performance measures serve as a tool for evaluating the success of the pipeline Integrity Management System. The performance measures have been developed as a method to gauge the extent to which the pipeline Integrity Management System goals have been met.

<table>
<thead>
<tr>
<th>Goals</th>
<th>Performance Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>To maintain pipeline Pipe-to-Soil Potential (PSP) within acceptable limits</td>
<td>PSP Level</td>
</tr>
<tr>
<td>Execution of In-line Inspection pigging</td>
<td>As applicable</td>
</tr>
<tr>
<td>Leakage and ruptures</td>
<td>Number</td>
</tr>
<tr>
<td>Development, Training and Awareness programmes</td>
<td>Number of training and awareness programmes conducted in a year</td>
</tr>
<tr>
<td>No Right of Use encroachments</td>
<td>Number of encroachments</td>
</tr>
</tbody>
</table>
Performance Measurement

In addition to the above performance measures, the pipeline Integrity System Monitoring Report includes the following:

- Patrolling Inspected vs. Planned.
- Key Integrity issues such as encroachments, restoration, constructional deficiencies, mitigation plan and any operational issues.
- The number of Integrity Management System required activities completed.
- The number of defects found requiring repair or mitigation.
- The number of leaks reported.

For performance measures relating to damage events, the following points are documented in the Operator’s Damage Prevention Report:

- The number of third party damage events and near misses.
- The number of pipeline hits by third parties due to lack of notification.
- Aerial surveillance and patrolling reports.
Management of Change

Prior to implementation of any changes to pipeline system, a systematic process shall be adopted to ensure that prospective changes (such as design, operation, or maintenance) are evaluated for their potential risk impacts to pipeline integrity including impact on environment. All natural gas pipeline operators shall define a management of change plan in integrity management programme to at least address the following:

a) Reason for Changes  
b) Authority to approve changes  
c) Analysis of implications (threat and risk analysis)  
d) Documentation  
e) Communication of changes to affected parties
Future Challenges

Challenges in Pipelines

- Aging of Pipelines
- Societal Awareness on Pipelines
- Urbanization nearby Pipelines
- Third Party Damage
- Encroachments
- Absence of Nodal Agency
- Land Acquisition
The integrity of Natural Gas Pipeline System is achieved through continuous efforts at all stages to ensure that pipeline is designed, commissioned, operated and maintained as per stipulated codes, standards and guidelines.

Thanks