



# **NATURAL GAS PIPELINES**

**“Safety and Risk Management in highly populated areas**

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roduction



***Natural Gas is environment friendly and safe to handle***



***Produces up to 65 percent fewer emissions than coal &  
25 percent fewer emissions than oil.***



***Natural Gas is highly inflammable & explosive in nature***

***If not handled with care***

***Has great potential to cause devastation***

Contents



**HOW SAFE IS SAFE**

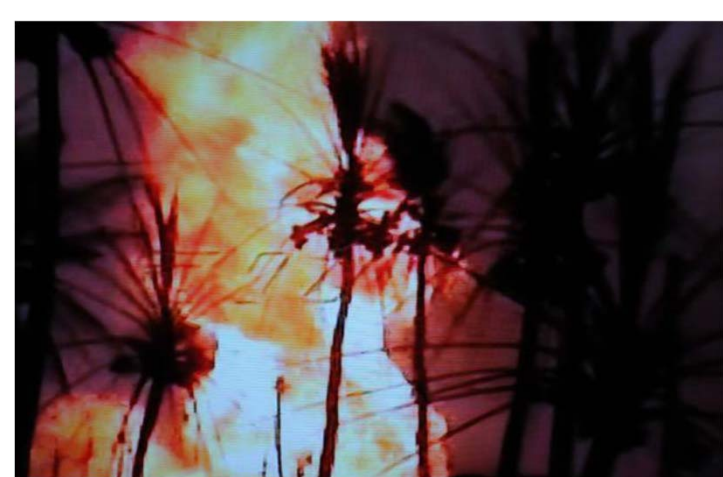
**PIPELINE THREATS**

**HIGH CONSEQUENCE AREAS (HCA) & CLASS LOCATION**

**CASE STUDY - CONSEQUENCE ANALYSIS OF GAS RELEASES**

**PREVENTIVE & REMEDIAL OPTIONS TO ENHANCE PIPELINE SAFETY**

# MASSIVE EXPLOSION AT GAIL PIPELINE IN ANDHRA PRADESH KILLS 21 AND SEVERAL INJURED- 2014





# TAIWAN GAS BLASTS KILLS 25 - 2014



# Can such incidents be prevented?

*What we learn from history is that we usually don't learn from history-Warren Buffet*

How safe is safe?



Can we eliminate risk?

Or is question: “What is tolerable risk?”

- ✓ Internal targets set?
- ✓ Government policy?
- ✓ Regulatory decision?
- ✓ Community concern?

There may be no *single* answer to question of “How Safe is Safe?”

But there *are* approaches to improve understanding and communicate risk

Why safe is safe?



Risk and safety is all in the eye of beholder

- ✓ We all know there is no such thing as zero risk, but we want assurance that we are safe

Risk communications with all stakeholders must be interactive

Each party should commit to:

- ✓ Increasing knowledge and understanding
- ✓ Enhancing trust and credibility
- ✓ Resolving conflict related to ROU, land use , encroachments etc.



## Risk – from community perspective



Public definition of risk

$$\text{Risk} = \text{Hazard}^* \times \text{Concern}^{**}$$

\*Hazard may be actual or perceived

\*\* Concern may be over safety, environment, fairness, property value, lack of information, lack of trust

Risk is higher if the harm to people, asset, environment or reputation is high or there is a concern among the stakeholders over safety

## Ask – technical answer



As seen by operators & regulators:

$$\text{Risk} = \text{Probability} \times \text{Consequence}$$

Risk may be decreased by reducing either likelihood OR the consequence of failure OR both.

Consequence:

- ✓ Safety of public and workers
- ✓ Environmental impact
- ✓ Upsets and reliability in service
- ✓ Costs and liability

# Types of pipeline threats



Time-Dependent Threats  
(threats tending to grow over time)

External Corrosion  
Internal Corrosion  
Stress Corrosion  
Cracking

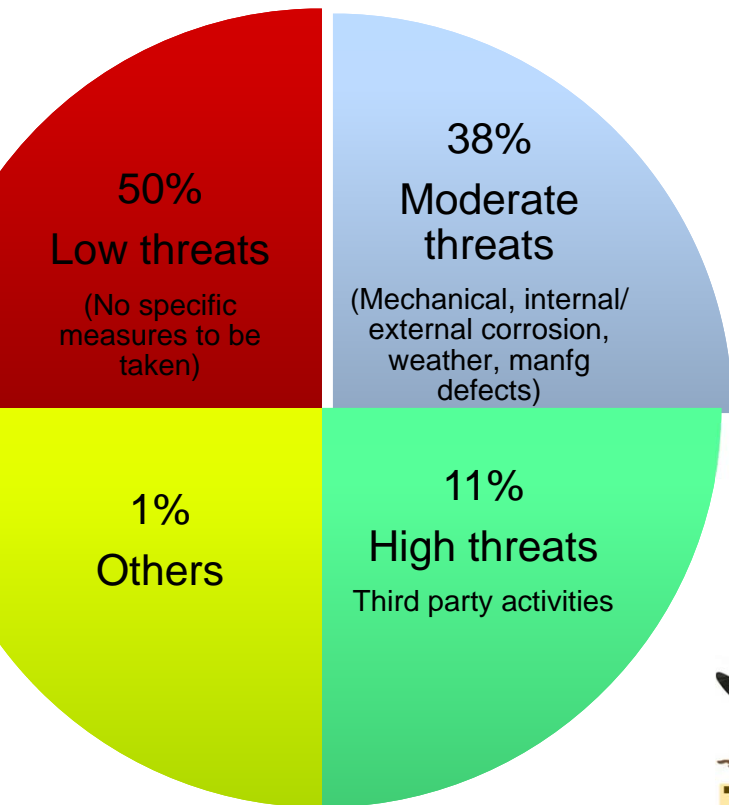
Resident Threats (threats that do not grow over time; instead they tend to act when influenced by another condition or failure mechanism)

- Manufacturing
- Fabrication/Construction
- Equipment

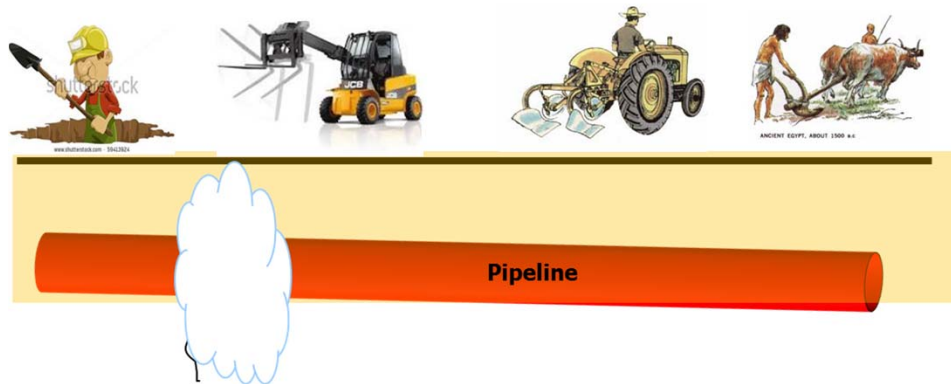
Time-Independent Threats  
(not influenced by time)

- Human Error
- Excavation Damage
- Earth Movement, Outside Force or Weather

# Types of pipeline threats



## Third party damage



***Pipelines traverse mostly through public areas.***

***Is it still possible to manage risks at vulnerable locations?***



## High Consequence Areas (HCA) as defined by our Organisation



Critical areas/locations near to pipeline where an incident or an accident has the maximum potential to cause damage to life & property.

- ✓ All class 3 & 4 locations as per ASME B31.8
- ✓ All areas vulnerable to illegal & third party activities
- ✓ Facilities like hospitals, temples, schools near pipeline.
- ✓ Crossings location, construction of roads/bridges/dams near pipeline
- ✓ Any other location, which in the opinion of Area Manager, has a high risk of damage or failure to pipeline

## Location Class based on population



PER SECTION 840.22 AND 840.3 OF ASME B 31.8,

Class I location, one mile section, has less than 10 dwellings,

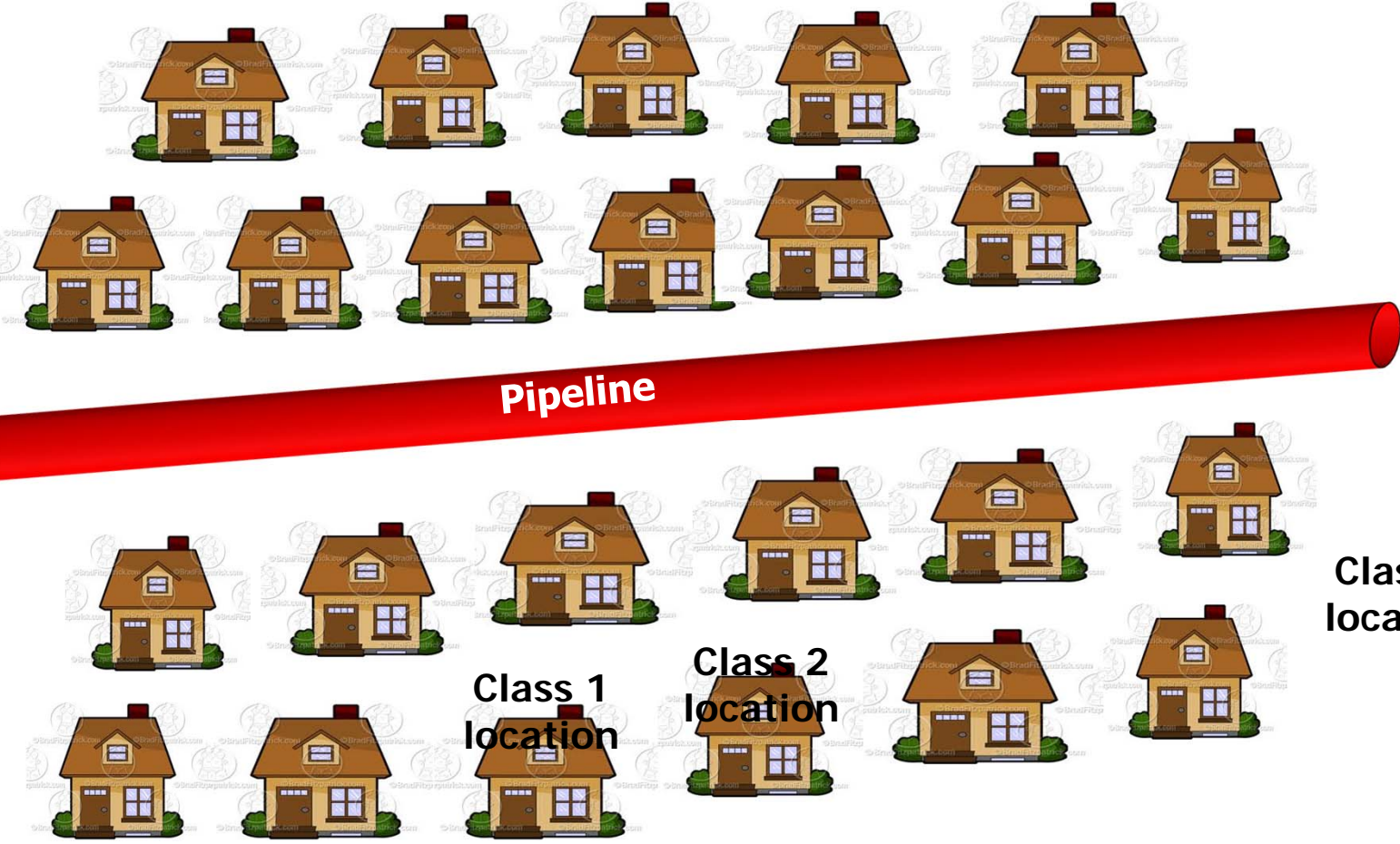
Class-II has more than 10 and less than 46 no of dwelling/ buildings,

Class III locations has more than 46 no of building

Class IV location has multi-Storey building intended for human

occupancy in the vicinity of 01 mile section.

# Big Problem ! Urbanization leading to change in class location



# Criteria for analysis



Terrain surrounding the pipeline segment

Elevation profile

Characteristics of the product transported

Amount of product that could be released

Possibility of a spillage into a farm field in case of oil transportation

Physical support of the pipeline segment

Exposure of the pipeline to operating pressure exceeding established maximum operating pressure

# Consequence Analysis – a case study



As identified for this portion of a Natural Gas pipeline based on following criteria:

Case-1 : Full bore rupture of 12inch tapping at supply side of 16inch pipeline – Area perceived to be vulnerable

Case-2 : Leak equivalent to 20% of flow area of 16inch line near an industrial area – High number of dwellings in the vicinity

Case-3 : Leak equivalent to 20% of flow area of 16inch line in area between industrial area and consumption point - Farmland available and prone to Third party activities

Case-4 : Leak equivalent to 20% of flow area of 16inch line from insulated flange near skid within the premises of consumer – High potential of domino effect within site in case of gas leak

Consequence modelling software used for analysing the cases (DNV PHAST 6.7)



# Consequence Analysis – a case study (contd.)



## Assumptions:

Long pipeline model used with leak rate considered representing rate between 0-20s of leak initiation to replicate initial rate of release

Isolation of gas supply considered at source at 1800s from leak initiation based on available detection and isolation system

Pressurised gas release of Methane modelled for release at given pressure and temperature conditions with leak sizes including credible and worst cases.

Models run for 1.5F (night) and 5D (day) replicating worst weather conditions

Vertical release considered for leak orientation in case of buried portions considering that there is accidental/ uncontrolled excavation leading to the release due to external impact for e.g., third party damage (case 2&3)

Horizontal release for above ground portions to replicate more severe impact scenarios (case 1&4)

# Consequence Analysis – a case study (contd.)



## Result summary:

Results of all possible consequences, i.e. flash fire, jet fire and explosion have been analysed

Most probable consequence for this release is flash fire if there is a delayed ignition and chances for a jet fire if an immediate ignition occurs.

For cases 2&3 there are less chances of explosion for this material due to one of the reasons

- supplied flammable mass is low (<1 MT)
- release in open fields with less congestion
- the gas rises up immediately being a vertical release and methane being a light gas.

For cases 1&4 there are possibilities of explosion if the LFL or 0.5 LFL flammable cloud encounters congested areas (such as industrial equipment & populated areas) and finds an ignition source as the supplied flammable mass is significant and the rising cloud travels close to ground for about 150-200m before rising upward

# ential Impacts



**sequences related to pipeline failures could be**

Leak / Fire / Explosion

Loss of National & Private property

Environmental damage: Atmosphere, water bodies (surface and sub-soil) and soil, Gas Clouds, etc.

Interruption of feedstock supply to Refineries / manufacturing units, evacuation of finished products and supply to consumption centers



# Remedial Options



## Use results are used for

Annual risk assessment of all the threats by multi-disciplinary team

Emergency response and control planning reviewed based on risk assessment

Strengthening administrative controls for condition monitoring

Focused efforts on surveillance across pipeline

## Are there any more remedial options to manage risk where location class has changed since commissioning?

**De-rate the pipe section** to MAOP applicable to that class location

**Strengthen the pipe i.e.** increase MAOP to original value

- Increase the existing pipe wall thickness

- Cut & replace with higher thickness/ higher SMYS pipe

- Re-test the pipe section to establish higher MAOP

**Based on risk assessment, take suitable measures to mitigate risks to acceptable limits.** Use integrity assessment methods prescribed by codes , develop & follow performance plan for risk mitigation



## Safety measures taken in areas earmarked for development



**PATROLLING-** Increase patrolling, when construction is in progress and area included in vulnerable location.

**PUBLIC AWARENESS PROGRAMS-** Arrange Necessary Awareness Program for land owners

**BARRICADING-** Barricading of ROU when construction work in progress

**BOUNDARY WALL CROSSING THE PIPELINE -** The design of boundary wall should be as per Standard RGTIL design to ensure the load will not come directly on the pipeline. Drawing is to be given to developer for construction of Boundary wall.

**CONCRETE SLAB-** Concrete slab is suggested for location where there is change in the class due to increased population and for vehicular movement above the pipeline.

**INSTALL ADDITIONAL WARNING MARKERS** for proposed/internal roads and at Boundary

**INSTALL ADDITIONAL BOUNDARY MARKERS** at every 10 m of interval in the Block.

# Planning a new pipeline



## Early planning and dialogue with community

- Panchayats
- Farm Owners/ Farmers
- Landowners, etc.

## Fact finding

- Route alternative considerations
- Review route with landowner, adjusting as possible

## Trustworthy dialogue

- Knowledgeable, trained company representatives
- Commitment by all to reach solutions

## Mitigate Risks

- Design and routing carefully planned
- Special construction practices
- Additional safeguards near some areas may require consideration of:
  - Thicker wall pipe under rivers
  - Supplemental patrols or inspections
  - Warning tape to warn excavators
  - Route deviations

# Regulations



**PMP Act 1962 & PNGRB Act 2006 are stringent laws & lays down punishments for willful damage, theft, pilferages & sabotage to petroleum & natural gas pipelines**

Section 15 & 16 of the PMP Act 1962 recently amended provides for imprisonment & fine from 6 months & upto max of 10 years for willful obstruction of work, damage to pipeline, pilferage or disruption in supplies depending on severity of the offence.

With intent to commit sabotage or with knowledge that such an act may cause death of any person, the punishment is rigorous imprisonment from 10 years to life & even death penalty

PNGRB Act 2006 provides for punishment to every person/entity who willfully removes, destroys, or damages any pipeline with imprisonment which may extend to 3 years or with fine which may extend to Rs 25 crores or with both,

"Oil Industry Safety Directorate", evaluates the Safety performance of oil & gas industry members every year and the best performers are awarded trophies by the Hon'ble Minister of Petroleum & Natural Gas.



## Public awareness & relations programs



Public Awareness programs(PAP) conducted monthly to create an awareness among the people.

During PAP, requests from local Sarpanch & authorities taken regarding the social needs of the villages

Social Welfare scheme initiated through Reliance Foundation(RF).

Survey being carried out



## Protection at populated areas- Installation of concrete slabs

Shallow depth observed at certain locations

As a protective measure against any third party damages and undue stresses transferred to the pipeline, 100 mm thick RCC slabs placed on top of the pipe over a 200 mm thick sand bedding.

These slabs could be hand carried by a set of 4 people.

This enabled the protection work without causing much disturbance to the top soil.





**THE CHALLENGE IS NOT TO ELIMINATE RISKS  
BUT TO IDENTIFY & MANAGE THEM APPROPRIATELY  
FOR SAFE & RELIABLE OPERATION OF PIPELINES**

