

# 2007 PMHSA R&D FORUM

*Defect Remediation / Repair / Mitigation  
Liquids and Gas Transmission Pipelines*

# Cause of Incidents

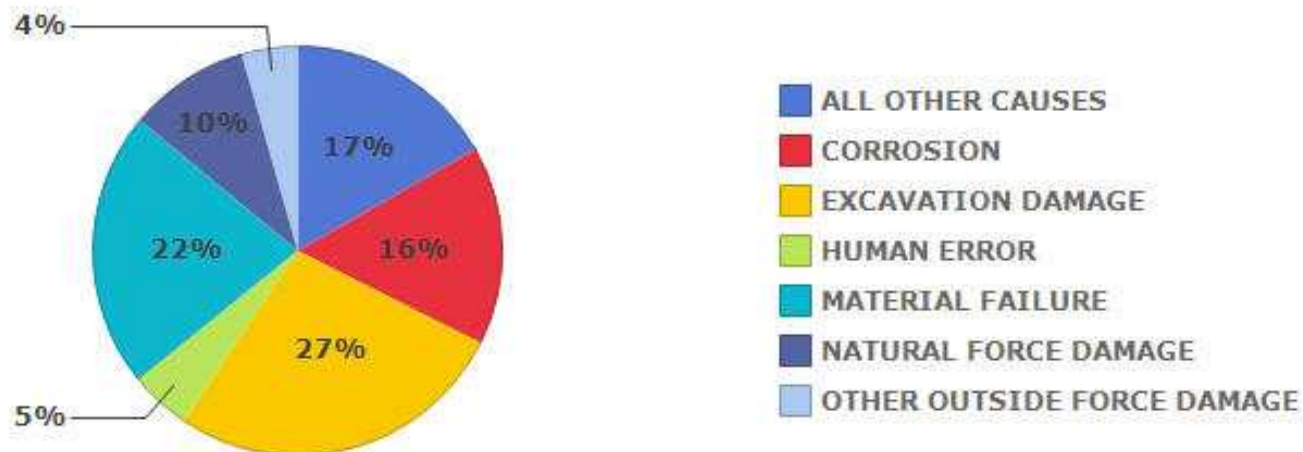
All Pipeline Systems | Hazardous Liquid | Gas Transmission | Gas Gathering | Gas Distribution

## Nationwide All Pipeline Systems: Significant Incident Details : 2003

Cause	Number of Incidents	% total Incidents	Fatalities	Injuries	Property Damage (B) (C)	% of Property Damage
ALL OTHER CAUSES	49	17%	7	16	\$15,761,780	13%
CORROSION	46	16%	0	0	\$31,944,403	26%
EXCAVATION DAMAGE	79	27%	5	36	\$19,921,378	16%
HUMAN ERROR	14	5%	0	6	\$888,982	1%
MATERIAL FAILURE	64	22%	0	5	\$39,706,197	32%
NATURAL FORCE DAMAGE	28	10%	0	5	\$8,420,674	7%
OTHER OUTSIDE FORCE DAMAGE	13	4%	0	3	\$8,588,252	7%
<b>Totals</b>	<b>293</b>	<b>100%</b>	<b>12</b>	<b>71</b>	<b>\$125,231,666</b>	<b>100%</b>

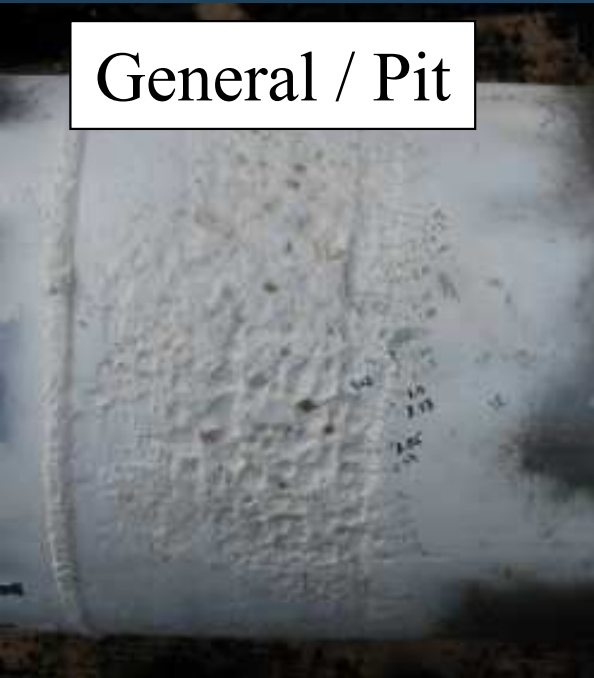
### Failure Cause Breakdown

#### Nationwide All Pipeline Systems Failure Causes 2003

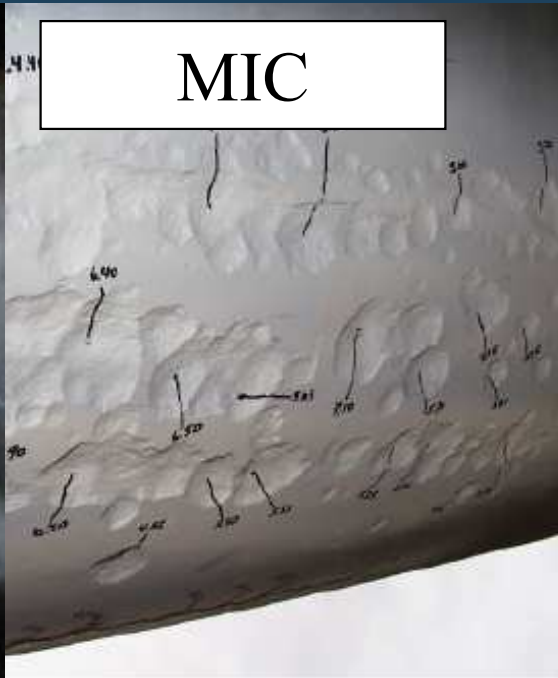


# External Corrosion

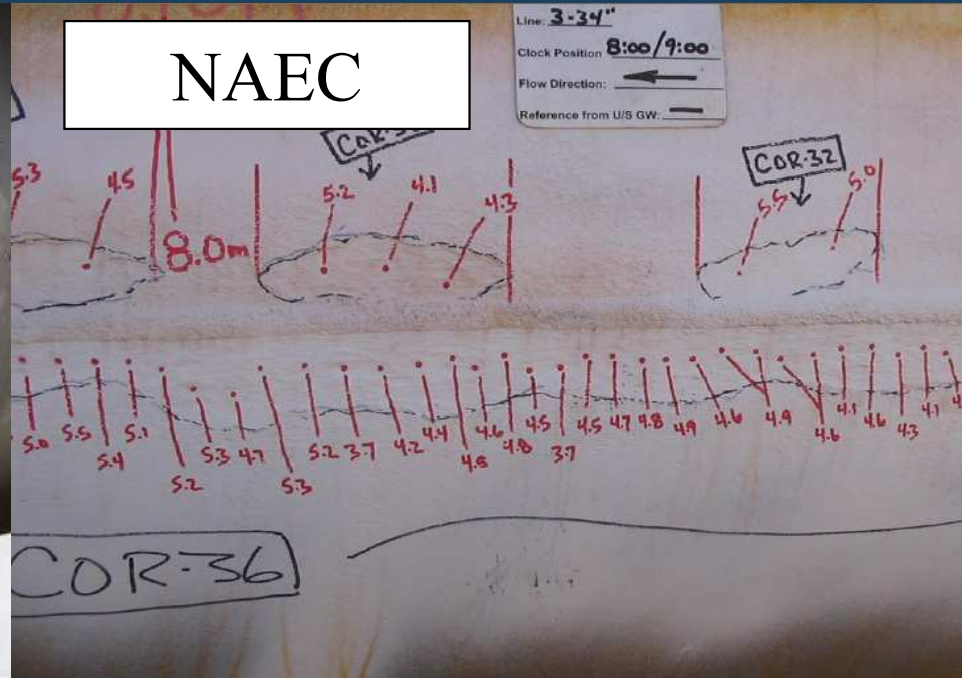
General / Pit



MIC



NAEC



Selective Seam



AC / DC



# General Corrosion - Mitigation

- **Sleeve**
  - Pressure Containing
  - Reinforcement
- **Re-coat**
- **Pipe replacement**
- **Grinding – Selective Seam?**

# Internal Corrosion

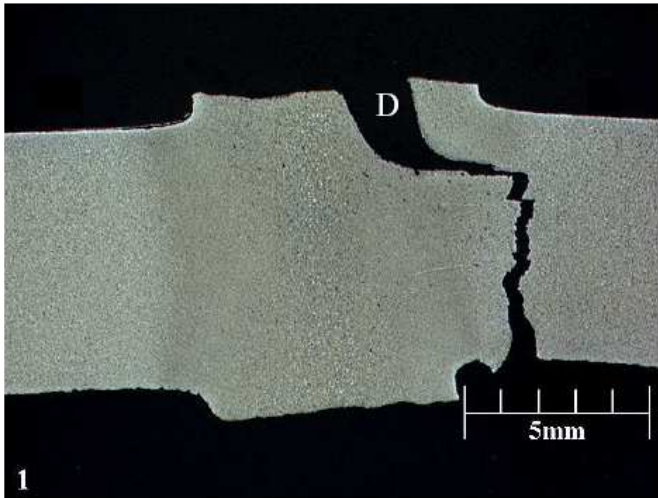
- **“Internal pipe corrosion is a threat wherever corrodents such as water, bacteria and solids cannot be specifically prevented from entering a pipeline”**



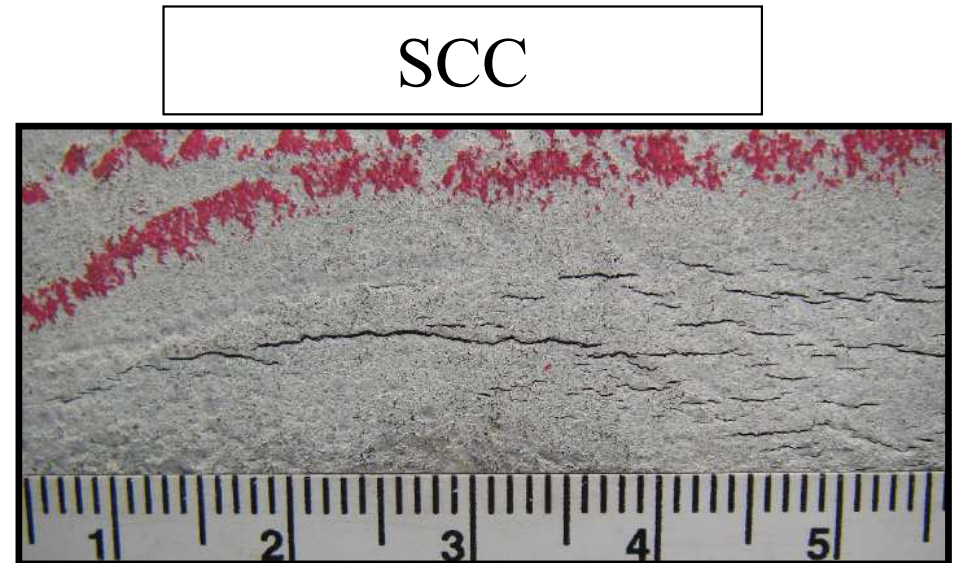
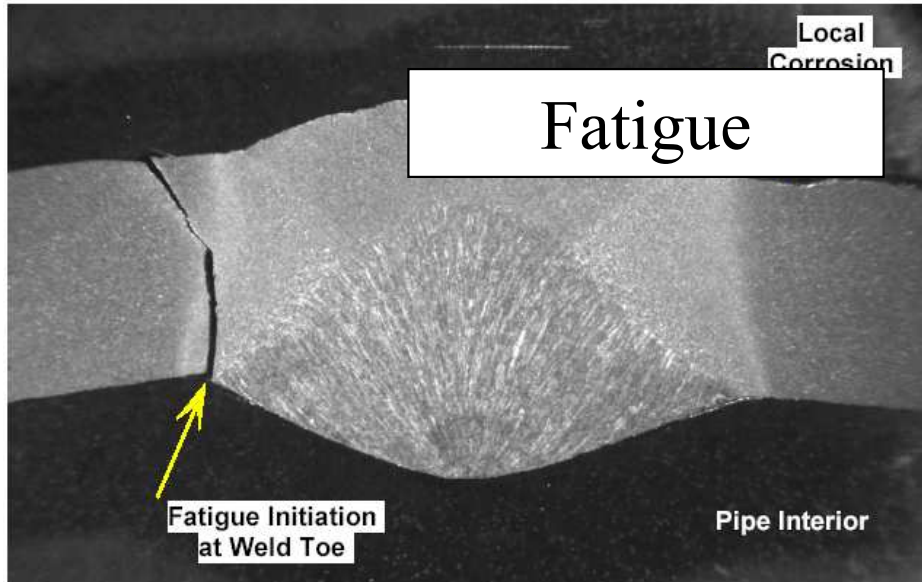
# Internal Corrosion - Mitigation

- **Sleeve**
  - Pressure Containing
- **Pipe replacement**
- **Cleaning Programs**
- **Corrosion Inhibitor**

# Cracking (Materials)



Manufacturing  
Defects

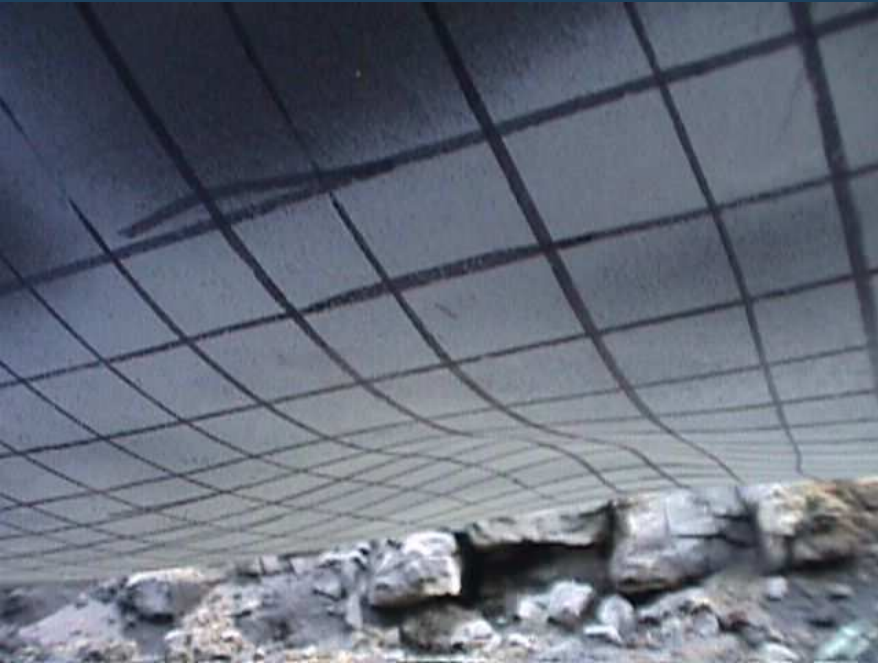


# Cracking - Mitigation

- **Sleeve**
  - Pressure Containing
- **Pipe replacement**
- **Grinding Repairs – External Cracks**



# Dents



# Dents

## Pipeline DENT

Susceptibility usually worsened by:

- 1) Stress concentrators: notch, gouge, crack, pit, groove, scratch, arc burn, defect, inclusion, etc.
- 2) Metal loss (corrosion)
- 3) Variable or cyclical loading

Typical Failure:    **DENT + CRACK**

# Buckles and Wrinkles

- **Repair of pipeline wrinkle at historical wrinkle location**



# Natural Forces

## Buckling / Wrinkles

- **Likelihood**
  - wherever large ground movements can occur
  - thaw subsidence, frost heave
  - unstable slopes
  - differential settlements
  - seismic areas

# Materials (other)

- **Welding defects**
- **Girth weld cracks**
- **Manufacturing defects**
- **Repair sleeves**
- **Fittings**

# Complex Features

- **Dents with**
  - Gouges
  - Metal Loss
  - Cracking
- **Metal loss with**
  - Cracking
  - SCC

# Questions

- **Do we have the repair tools we need?**
- **Do we have the tools to assess fitness for purpose?**
- **Do we have the tools to understand safe working limits...**
  - To continue operating?
  - To safely excavate and work on the pipeline?