Pipeline Facilities Risk Management

Mike LaMont
November 30, 2016
CAUTION - ALLIGATORS
DO NOT FEED OR APPROACH
STAY AT A DISTANCE
VENOMOUS SNAKES
EXIST IN THIS PARK
Agenda

• What are “facilities”
• Regulatory drivers and objectives
• Overview of current risk modeling approaches
Facilities
Facilities
Complete IM Cycle (Line pipe)

HCAs

Repairs/P&MMs

Risk Analysis

Assessment
Stations are not directly mentioned in 49 CFR 192 Subpart O, but are included in gas integrity management FAQ-6:

**FAQ-6. Does the rule apply to more than line pipe? [11/03/2004]**

Yes. The continual evaluation, preventive and mitigative actions, and information analysis requirements of the rule apply to pipelines as defined in 49 CFR 192.3. This includes, but is not limited to, line pipe, valves and other appurtenances attached to line pipe, compressor units, metering stations, regulator stations, delivery stations, holders, and fabricated assemblies. The baseline integrity assessment and periodic re-assessment requirements apply only to line pipe including crossovers, bypass piping, etc.

The same thing goes with hazardous liquids. Stations are not directly mentioned in 195.452, but are included in liquid integrity management FAQ 2.1:
2.1 Does the rule apply to more than line pipe?

Yes. The continual evaluation and information analysis requirements of the rule apply to pipelines as defined in 49 CFR 195.2. This includes, but is not limited to, line pipe, valves and other appurtenances connected to line pipe, metering and delivery stations, pump stations, storage field facilities, and breakout tanks. The baseline integrity assessment and periodic re-assessment requirements apply only to line pipe.
Facility Risk

The chance of a negative outcome event occurring (likelihood) and the impact that negative outcome has (consequence)

Likelihood \times Consequence = Risk
Facility Risk

The chance of a negative outcome event occurring (likelihood) and the impact that negative outcome has (consequence)
Integrity Management (Facilities)
Facility Risk Modeling
Natural Gas Facilities – Risk Modeling
Hazardous Liquids Facilities – Risk Modeling
Facilities – Risk Modeling

• Risk modeling approaches are consistently inconsistent
  – Risk screening
  – Indexing/Semi-quantitative survey
  – Quantitative
Facilities – Risk Modeling

- Risk modeling approaches are consistently inconsistent
  - EPA
  - OSHA
  - DOT - PHMSA
Facility Consequence Screening
Facility Consequence Screening

Impact HCA?

<table>
<thead>
<tr>
<th>Asset Types</th>
<th>Product types</th>
</tr>
</thead>
<tbody>
<tr>
<td>SME Teams (based on common sense/local facility knowledge)</td>
<td></td>
</tr>
</tbody>
</table>

Consequences of Failure

SME Teams (based on common sense/local facility knowledge)
• Risk ranked facilities are subject to further review
Basic Screening
Basic Facility Screening

• SME Matrix
  – Safety
  – Environmental
  – Compliance
  – Operations
  – Cost
<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once per year</td>
<td>M</td>
</tr>
<tr>
<td>Once per 2 years</td>
<td>L</td>
</tr>
<tr>
<td>Once per 5 years</td>
<td>L</td>
</tr>
<tr>
<td>Once per 10 years</td>
<td>L</td>
</tr>
<tr>
<td>Once per 50 years</td>
<td>L</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hazard Exposure, No Injuries</th>
<th>First Aid</th>
<th>Recordable Injury</th>
<th>Lost Time</th>
<th>Fatality</th>
</tr>
</thead>
</table>

Safety and Health
## Environmental

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Consequence</th>
<th>Non-reportable</th>
<th>Reportable onsite</th>
<th>Reportable onsite</th>
<th>Limited offsite impact</th>
<th>Substantial offsite impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once per year</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Once per 2 years</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Once per 5 years</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Once per 10 years</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Once per 50 years</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Likelihood</td>
<td>Compliance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Procedure violation</td>
<td>Agency notification of non-compliance</td>
<td>Self identified and reported violation</td>
<td>Agency notice of violation</td>
<td>Serious agency notice of violation</td>
<td></td>
</tr>
<tr>
<td>Once per year</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>Once per 2 years</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>Once per 5 years</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>Once per 10 years</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>Once per 50 years</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td></td>
</tr>
</tbody>
</table>

Likelihood: L (Low), M (Medium), H (High)
# Operations Availability

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Consequence</th>
<th>1-6 hour shutdown</th>
<th>6-12 hour shutdown</th>
<th>12-24 hour shutdown</th>
<th>1-2 days shutdown</th>
<th>&gt; 2 days shutdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once per year</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Once per 2 years</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Once per 5 years</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Once per 10 years</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Once per 50 years</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Likelihood</td>
<td>Consequence</td>
<td>Consequence</td>
<td>Consequence</td>
<td>Consequence</td>
<td>Consequence</td>
<td>Consequence</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Once per year</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Once per 2 years</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Once per 5 years</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Once per 10 years</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Once per 50 years</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>&lt;$50 K</td>
<td>$50-250 K</td>
<td>$250K-$500K</td>
<td>$500K-$1MM</td>
<td>&gt; $1MM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Risk Ranked Facilities

- Risk ranked facilities are subject to further review
Hazardous Liquids
Facility Risk Screening
Facility Risk Screening

- General asset groupings
- Provides a total ROF score for the facility
- Drives limited P&MMs
Facility Assets

- Equipment/non-pipe
- Pipe
Facility Threat Categories

- Threats
  - Equipment/Non-pipe Malfunction or Failure
  - Pipe Corrosion
  - Pipe Outside force related failures
  - Operations
  - Other
Equipment/Non-pipe Malfunction or Failure

- Preventive maintenance program
- Routine inspections
- Secondary containment
- Valve releases
- Pump releases
- Automation
Pipe Corrosion

- External corrosion
  - External corrosion monitoring program
  - Cathodic protection systems
  - Soil/air interface
  - Historic releases caused by EC
Pipe Corrosion

- Internal corrosion
  - Internal corrosion monitoring program
  - Product type
  - Low flow/dead legs piping
  - Historic releases caused by IC
Pipe Corrosion

- Atmospheric corrosion
  - Facility proximity to coastal area
  - Previous atmospheric corrosion issues
  - Routine inspections
Pipe – Outside Force Related Failures

• Outside Force
  • Underground pipe markings?
  • Underground pipe mapped?
  • Excavations observed?
  • Historic OFD related failures?

• Natural Force Damage
  • Proximity to Gulf Coast, Southern Atlantic, Pacific Oceans?
  • Located in California or other earthquake prone areas?
  • Historic Natural Force Damage releases?
Pipe – Outside Force Related Failures

• Security
  • Facility access restricted/controlled?
  • Staffed by security personnel?
  • Facility staffed by operations personnel 24 hours a day/7 days a week?
  • Fencing, lighting, etc.?
Operations

• Operator error
  • Operator training program
  • Procedural audits
  • Technology/human interface studies
• Tank overfills
• Tank high level alarms
• Historic operator error releases
Other

- Recent acquisition?
- Historic failures due to other causes?
- Significant changes in operations?
Consequence of Failure

- High Consequence Areas
  - “Could affect” spill modeling
    Yes or No?
  - Weighting score based on HCA type (HPOP, OPOP, ECO, DW)
## Risk Scores

<table>
<thead>
<tr>
<th></th>
<th>Likelihood</th>
<th>Consequence</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equip/Non Pipe</td>
<td>Score</td>
<td>Score</td>
<td>Risk Score</td>
</tr>
<tr>
<td>Pipe Corrosion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OFD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## P&MMs

<table>
<thead>
<tr>
<th></th>
<th>Risk Score</th>
<th>P&amp;MM Considered</th>
<th>P&amp;MM Chosen?</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equip/Non Pipe</td>
<td>35</td>
<td>Increase valve inspect frequency</td>
<td>Yes</td>
<td>Operations</td>
</tr>
<tr>
<td>Pipe Corrosion</td>
<td>42</td>
<td>Dead leg program</td>
<td>Yes</td>
<td>Integrity</td>
</tr>
<tr>
<td>OFD</td>
<td>24</td>
<td>Additional bollards</td>
<td>Yes</td>
<td>Operations</td>
</tr>
<tr>
<td>Operations</td>
<td>12</td>
<td>Add alarm speaker outside control room</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>None</td>
<td>No</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Hazardous Liquids Asset Based Risk Screening
Asset Categories

Threats

- Corrosion
- WOF
- Incorrect Ops
- Equipment

Tanks

Manifolds

Station Pipe

Pumps
Consequence of Failure
Asset Risk Screening

• Threat driven by asset
• No facility comparisons (risk ranking)
Threat Common Factors

- **Corrosion**
  - CP, Product corrosivity

- **WOF**
  - Physical location, site security, activity level

- **Incorrect Ops**
  - Facility staffing during product movement, Operator training program, product movement procedure audits

- **Equipment**
  - Inspection frequency, preventive maintenance frequency
Asset Risk Screening – Tanks

- **Corrosion**
  - API Tank Inspections
  - Corrosion found
  - Corrosion tank failures

- **WOF**
  - WOF issues noted (inspection)
  - WOF tank failures

- **Incorrect Ops**
  - High level alarms
  - # of recent overfill incidents
  - Incorrect Ops tank failures

- **Equipment**
  - Most recent tank (API) inspection
  - Equipment related tank failures
Asset Risk Screening – Manifolds

- Corrosion
  - Atmospheric Inspections
  - Corrosion found
  - Corrosion failures
- WOF
  - WOF issues noted (inspection)
  - WOF failures
- Incorrect Ops
  - Level of automation
  - Incorrect Ops incidents
- Equipment
  - Most recent inspection
  - Equipment related incidents
Asset Risk Screening – Pumps

- Corrosion
  - Corrosion found
  - Corrosion failures
- WOF
  - WOF issues noted (inspection)
  - WOF failures

- Incorrect Ops
  - Incorrect Ops incidents

- Equipment
  - Most recent inspection
  - Equipment related incidents
Asset Risk Screening – Station Pipe

- Corrosion
  - Atmospheric corrosion inspections
  - Deadlegs
  - Corrosion found
  - Corrosion failures
- Incorrect Ops
  - Incorrect Ops failures
- WOF
  - Buried pipe locations
  - WOF issues noted (inspection)
  - WOF failures
- Equipment
  - Most recent inspection
  - Equipment related incidents
<table>
<thead>
<tr>
<th></th>
<th>Likelihood – by Threat</th>
<th>Consequence</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanks</td>
<td>Cor+EQ+WOF+IO = Score</td>
<td>Score</td>
<td>Risk Score</td>
</tr>
<tr>
<td>Manifolds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Station Pipe</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Asset Operational Dependability
Hazardous Liquids Facilities – Asset Dependability

- Asset risk screening
- Preventive maintenance program
Asset Dependability—Tanks

- Corrosion
  - External/Atmospheric Corrosion
    - Frequency of exposure to standing water
    - CP effectiveness
    - Current coating quality
    - Years since last external coating application
  - Internal Corrosion
    - Product Corrosivity
    - Corrosion inhibitors, coupons
    - Frequency of tank cleanouts

- Weather and Outside Force Damage
  - Outside Force Damage
    - Areas activity level
    - Number of OFD incidents resulting in releases
    - Number of OFD incidents without a release
    - Frequency of visual inspection
  - Security related damage
    - Level of facility security
    - Number of security related incidents
  - Natural Force Damage
    - Flood potential
    - Ground movement potential

- Operations
  - Operator error
    - Number of operator error tank overflow events
  - Documented procedures
  - Procedure implementation
  - Instrumentation
    - High level alarms
Asset Dependability—Equipment

- **Corrosion**
  - External/Atmospheric Corrosion
    - Frequency of exposure to standing water
    - CP effectiveness
    - Current coating quality
    - Years since last external coating application
  - Internal Corrosion
    - Product Corrosivity
    - Corrosion inhibitors, coupons

- **Operations**
  - Operator error
    - Number of operator error tank overflow events
    - Documented procedures
    - Procedure implementation

- **Equipment**
  - Malfunction/Failure
    - MOP greater than or less than 274 psi?
    - MOP exceedance in the past year?
    - Sufficient over pressure protection?

- **Outside Force Damage**
  - Areas activity level
  - Number of OFD incidents resulting in releases
  - Number of OFD incidents without a release
  - Frequency of visual inspection
Asset Dependability– Equipment

Other

– Instances of damage to equipment caused by “other causes”
– Releases resulting from “other causes”
Asset Dependability—Station Pipe

- Corrosion
  - External/Atmospheric Corrosion
    - Frequency of exposure to standing water
    - CP effectiveness
    - Current coating quality
    - Years since last external coating application
  - Internal Corrosion
    - Product Corrosivity
    - Corrosion inhibitors, coupons

- Equipment
  - Malfunction/Failure
    - MOP greater than or less than 274 psi?
    - MOP exceedance in the past year?
    - Sufficient over pressure protection?

- Outside Force Damage
  - Areas activity level
  - Number of OFD incidents resulting in releases
  - Number of OFD incidents without a release
  - Frequency of visual inspection
Asset Dependability – Station Pipe

- Operations
  - Operator error
    - Number of operator error tank overflow events
    - Documented procedures
    - Procedure implementation

- Other
  - Instances of damage to equipment caused by “other causes”
  - Releases resulting from “other causes”
# Risk Scores

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Consequence</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanks</td>
<td>Score</td>
<td>Score</td>
</tr>
<tr>
<td>Equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Station Pipe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Reliability Analysis

• Requires performance data
• Downtime trends
• Failure and maintenance history:
  – Individual equipment tracking
  – Trend by equipment model
Reliability Analysis

- Establish inspection and repair schedule
- Identify defective equipment models
- Develop systematic O&M approach
“Risk Tolerance”
Risk “Tolerance”

- Risk tolerance
- Piping circuits
- Tanks, etc.
- Risk reduction
- Inspection/maintenance

- API 353 “Managing Systems Integrity of Terminal and Tank Facilities – Managing the Risk of Liquid Petroleum Releases”
- API 1160 “Managing System Integrity for Hazardous Liquid Pipelines”
Threat Categories

• Threats
  • External corrosion
  • Internal corrosion
  • Third party

• Equipment
  • Natural Hazards
  • Incorrect Operations
External Corrosion

- Leak frequency
- Piping age
- Corrosion rate
- Pipe thickness
- Soil resistivity
- Cathodic protection
- Coating (Underground)
- Soil to Air Interface Number/Condition (Underground)
Internal Corrosion

- Leak frequency
- Pipe age
- Corrosion rate
- Pipe thickness
- Inspections
- Product type
- Flow conditions
- Pipe length
- Ethanol service

- API 353
- *Underground Piping Base Leak Frequency* = $5.0 \times 10^{-6}$ leaks per 100 ft-year
- *Baseline Underground Piping External Corrosion Rate* = 5 mpy
Third Party Damage

- Pipe location accuracy
- Pipe length
Equipment

- Leak frequency
- Number
Consequence of Failure

- Product type(s)
- Release volumes
- Potential impacts
  - Human
  - Ecological
  - Business
## Risk Scores

<table>
<thead>
<tr>
<th></th>
<th>Probability Score</th>
<th>Consequence</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very High</td>
<td>Score</td>
<td>Score</td>
<td><em>(Urgent Implementation of P&amp;MM or Assessment)</em></td>
</tr>
<tr>
<td>High</td>
<td>Score</td>
<td>Score</td>
<td><em>(Implement P&amp;MM or Assessment)</em></td>
</tr>
<tr>
<td>Moderate</td>
<td>Score</td>
<td>Score</td>
<td><em>(Implement P&amp;MM or Assessment)</em></td>
</tr>
<tr>
<td>Low</td>
<td>Score</td>
<td>Score</td>
<td><em>(Consider P&amp;MM or Assessment)</em></td>
</tr>
<tr>
<td>Very Low</td>
<td>Score</td>
<td>Score</td>
<td><em>(No Action)</em></td>
</tr>
</tbody>
</table>
Facilities – Risk Modeling Limitations

- Consequence analysis commonly incomplete
- Heavy SME input reliance
- Limited actionable results from screening models
- Models for different assets not always comparable
Conclusions

• Risk modeling approaches are consistently inconsistent
• Additional work on consequence analysis
• Continue to leverage other regulatory program risk efforts
• More robust models needed to drive action
Integrity Management (Facilities)
Thank You!

Mike LaMont

mike.lamont@ncintegrityplus.com

(936) 554-0839