

Pipeline Facilities Risk Management

Mike LaMont
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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



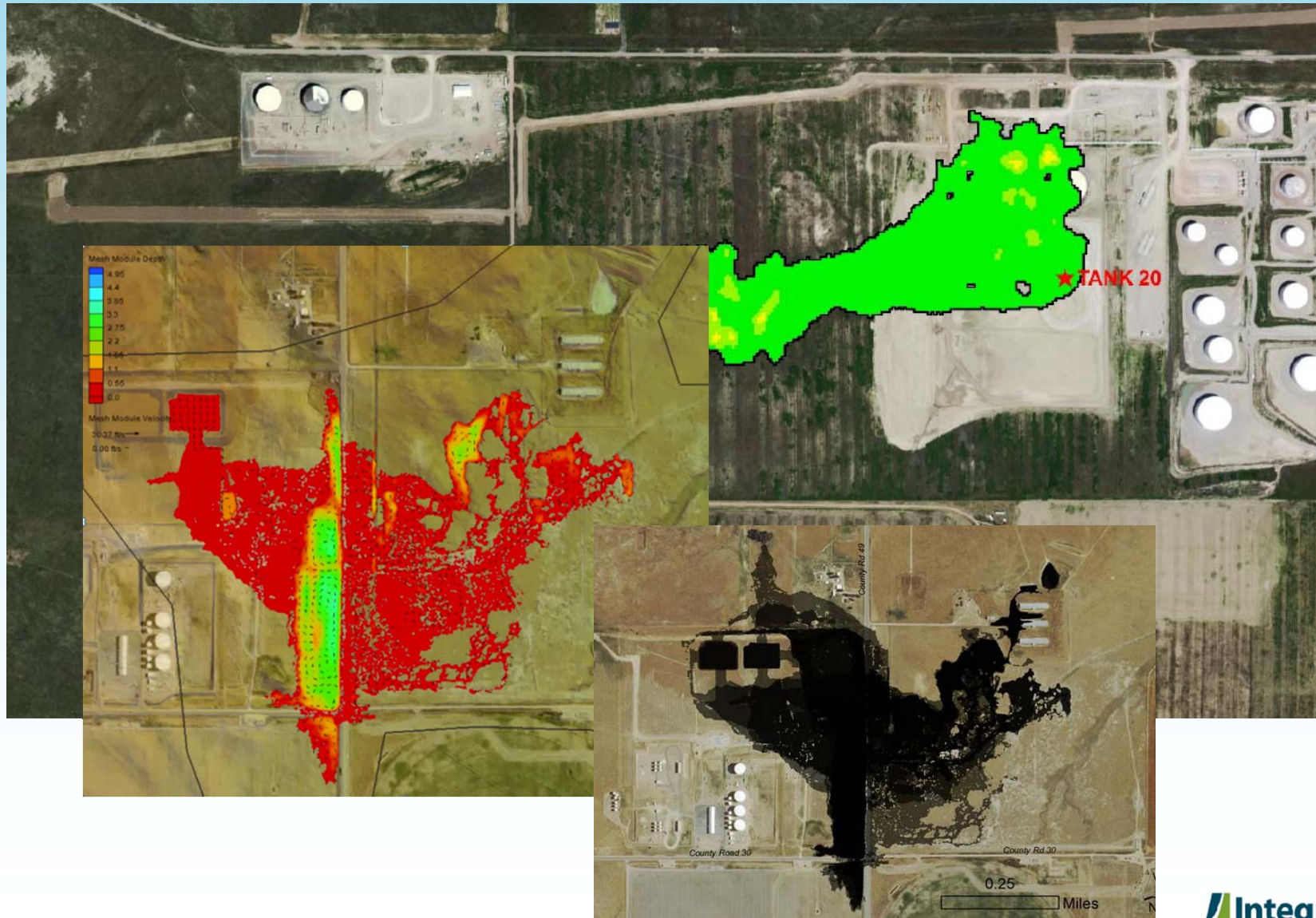
Facilities



Facilities

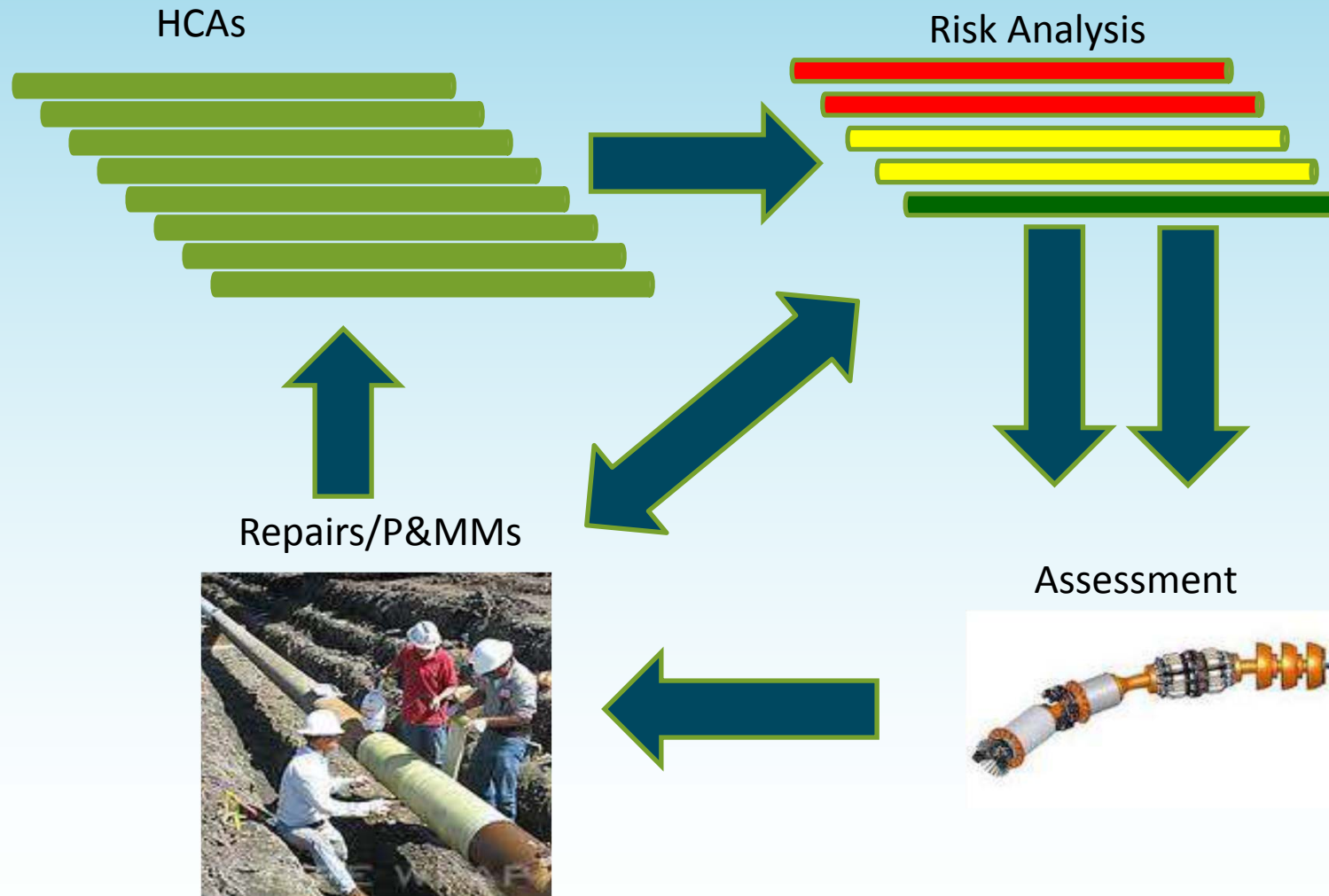


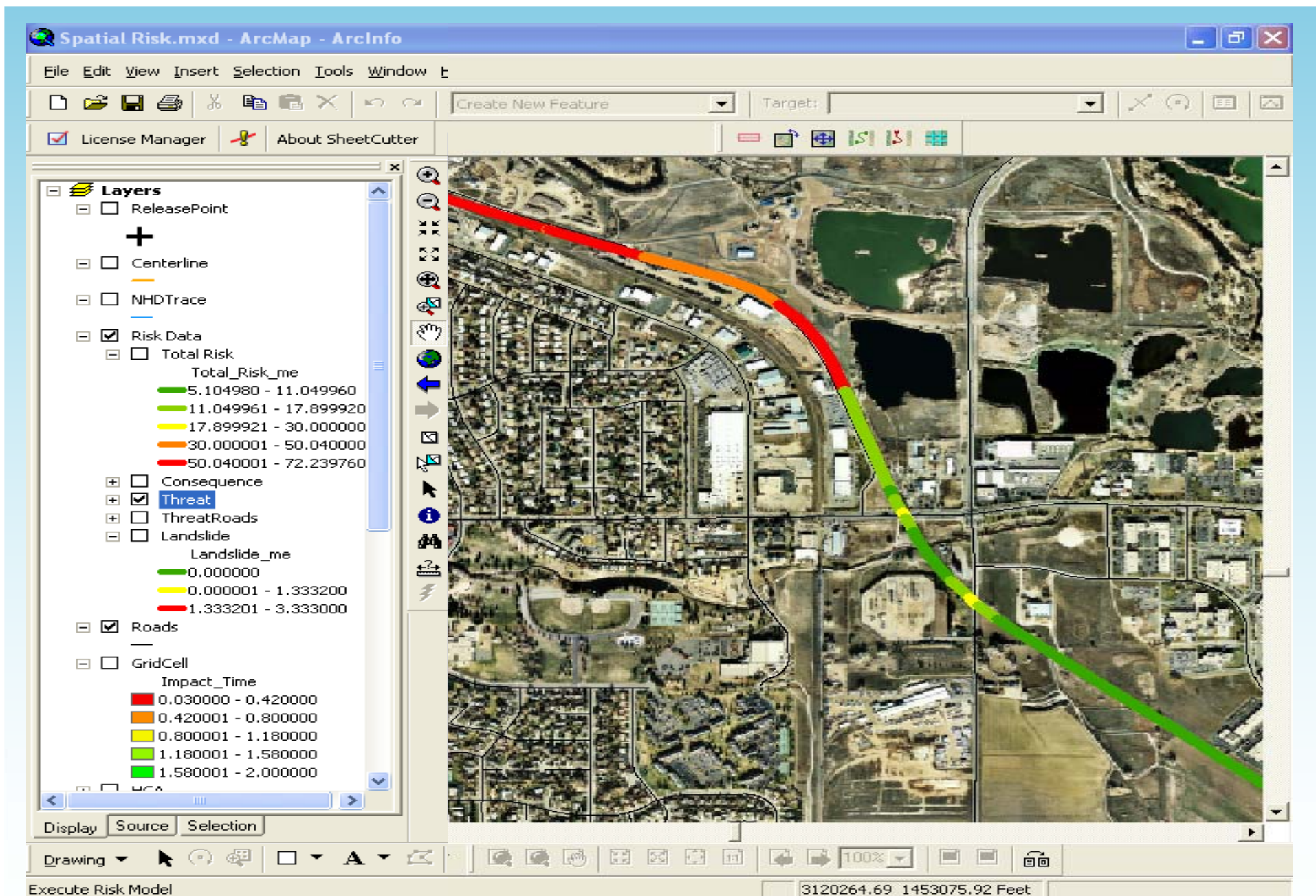
Facilities





Complete IM Cycle (Line pipe)





49 CFR 192 - Facilities

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:

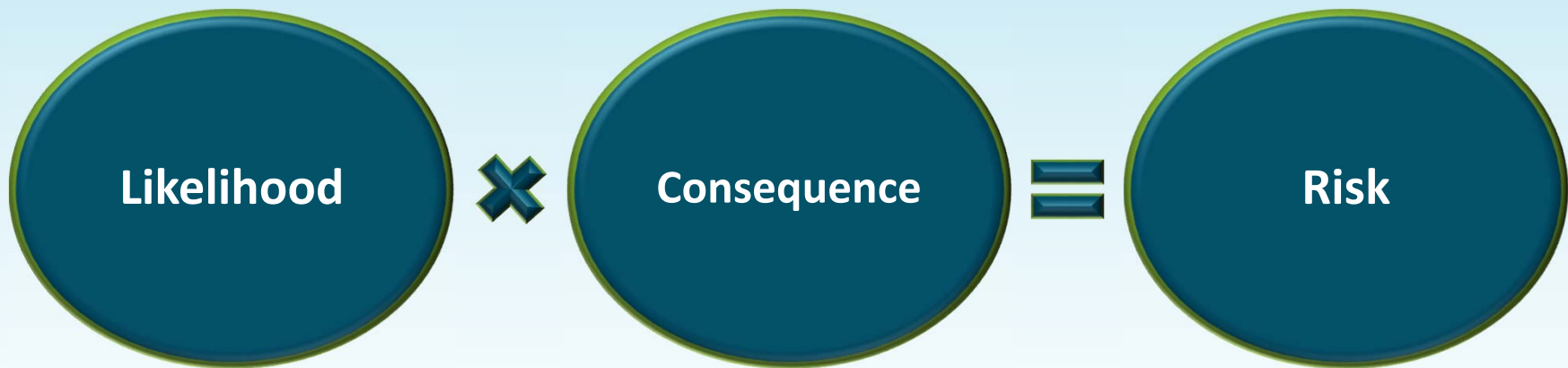
49 CFR 195 - Facilities

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)

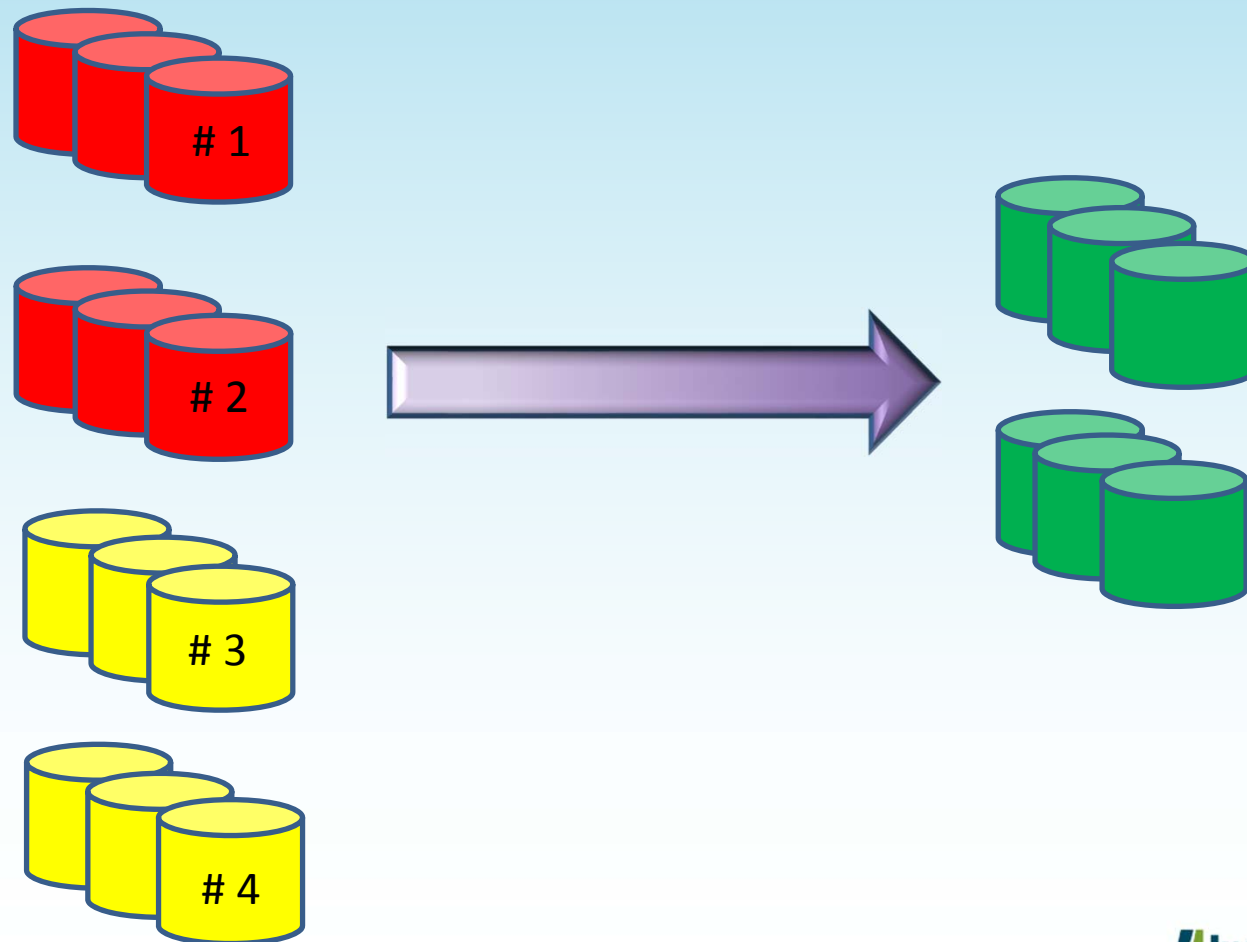


Facility Risk

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

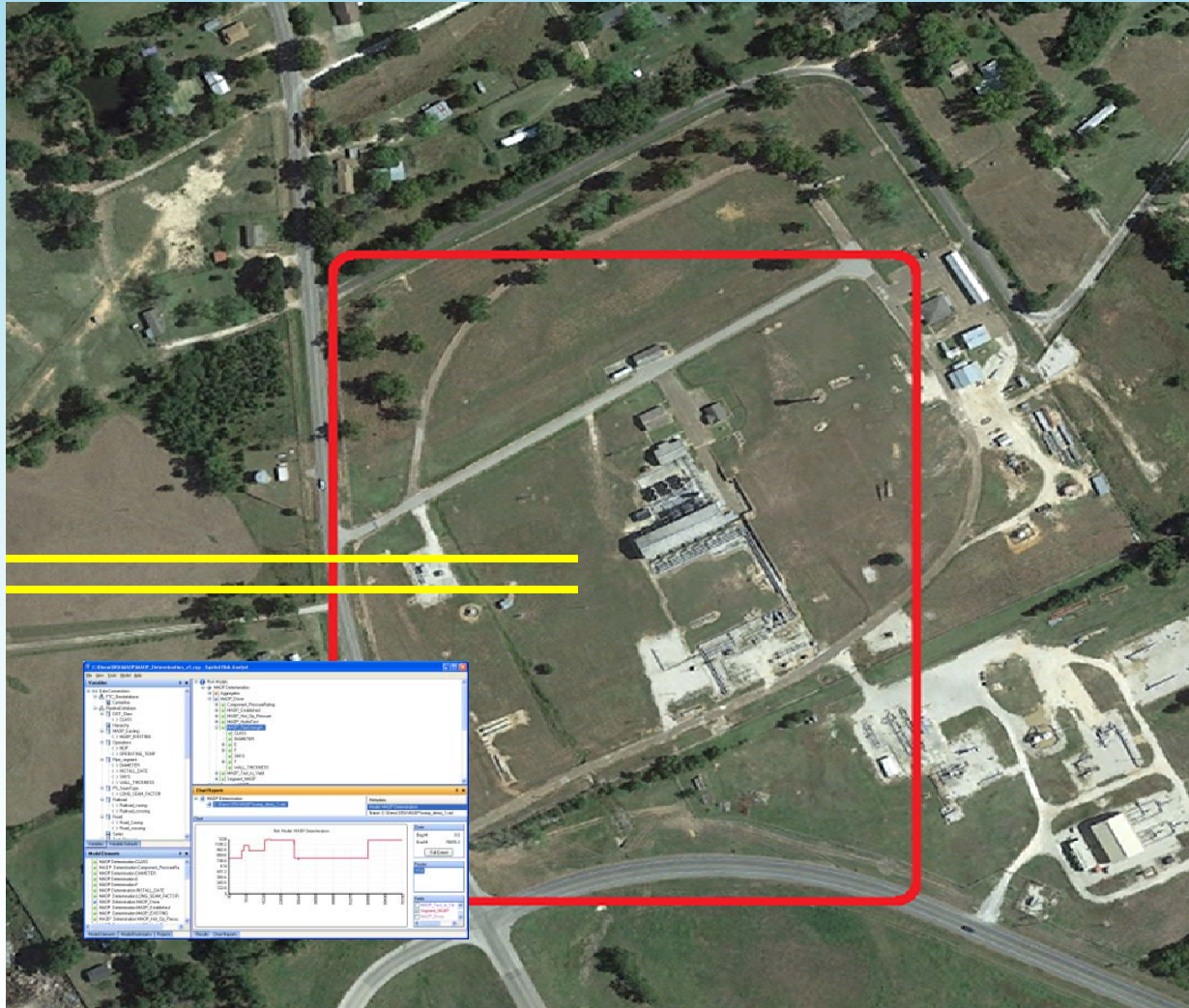


Integrity Management (Facilities)

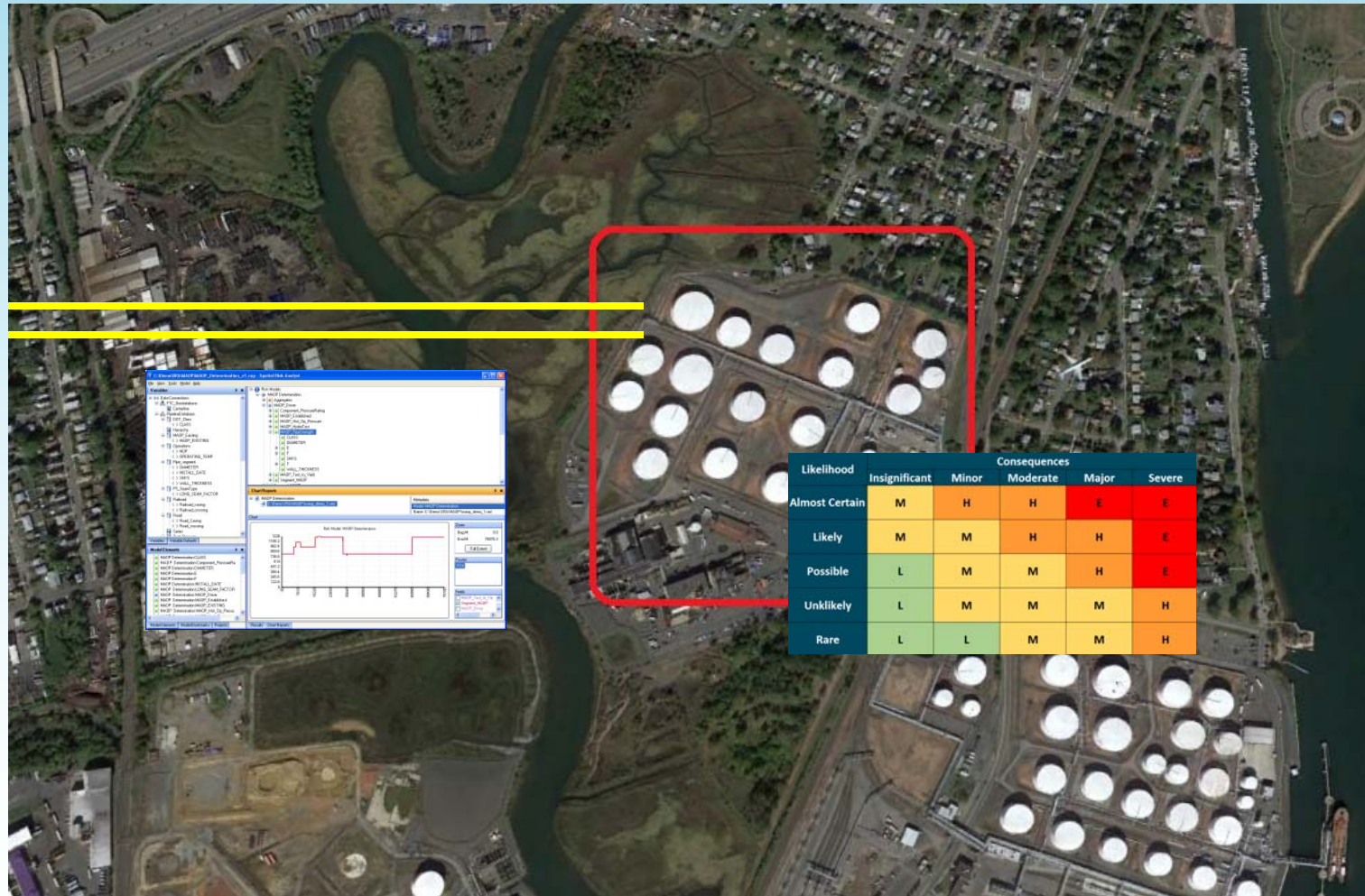


Facility Risk Modeling

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

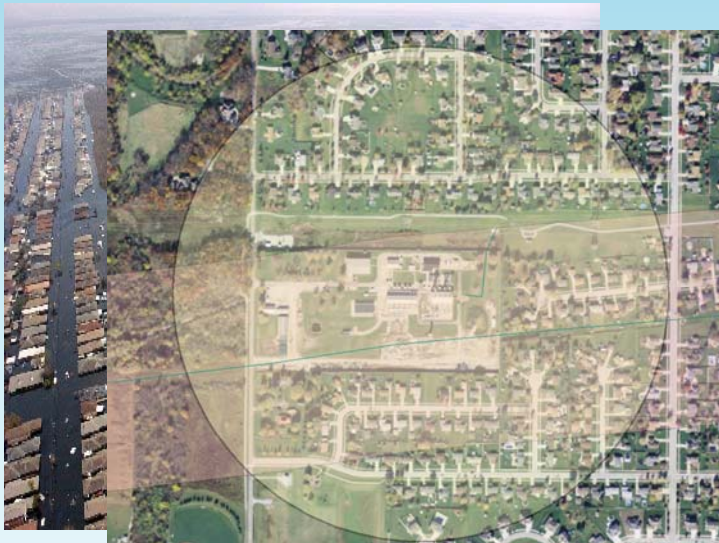
- Risk modeling approaches are consistently inconsistent
 - EPA
 - OSHA
 - DOT - PHMSA



Facility Consequence Screening

Facility Consequence Screening

Impact HCA?



Asset Types



| Consequences | | | | |
|---------------|-------|----------|-------|--------|
| Insignificant | Minor | Moderate | Major | Severe |
| M | H | H | E | E |
| M | M | H | H | E |
| L | M | M | H | E |
| L | M | M | M | H |
| L | L | M | M | H |

Product types

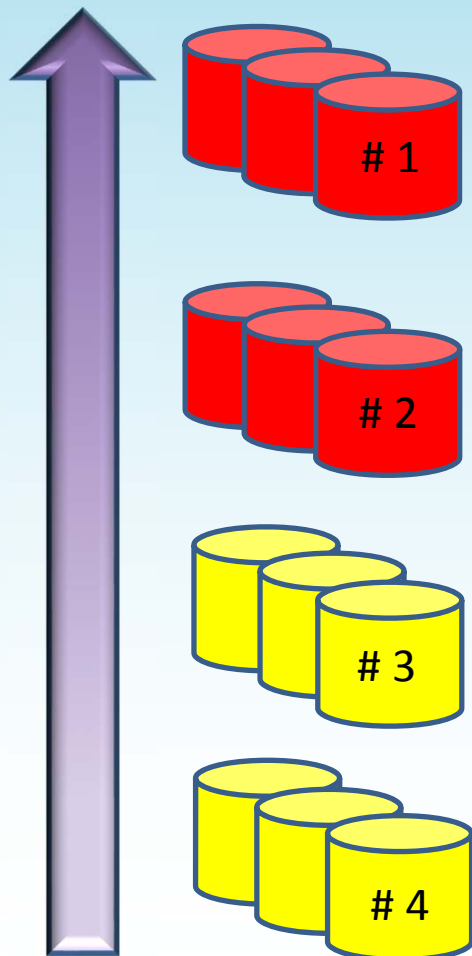


Consequences of Failure

SME Teams (based on common sense/local facility knowledge)

Facility Consequence Screening

Risk Ranked Facilities



- Risk ranked facilities are subject to further review

Basic Screening

Basic Facility Screening

- SME Matrix
 - Safety
 - Environmental
 - Compliance
 - Operations
 - Cost

Safety and Health

| Likelihood | Consequence | | | | |
|-------------------|---------------------------------|-----------|-------------------|-----------|----------|
| Once per year | M | H | H | H | H |
| Once per 2 years | L | M | H | H | H |
| Once per 5 years | L | M | M | H | H |
| Once per 10 years | L | L | M | H | H |
| Once per 50 years | L | L | L | M | H |
| | Hazard Exposure, No Injuries | First Aid | Recordable Injury | Lost Time | Fatality |

Environmental

| Likelihood | Consequence | | | | |
|-------------------|----------------|-------------------|-------------------|------------------------|-----------------------------|
| Once per year | M | H | H | H | H |
| Once per 2 years | L | M | H | H | H |
| Once per 5 years | L | M | M | H | H |
| Once per 10 years | L | L | M | H | H |
| Once per 50 years | L | L | L | M | H |
| | Non-reportable | Reportable onsite | Reportable onsite | Limited offsite impact | Substantial offsite impacts |

Compliance

| Likelihood | Consequence | | | | |
|-------------------|---------------------|---------------------------------------|--|----------------------------|------------------------------------|
| Once per year | M | H | H | H | H |
| Once per 2 years | L | M | H | H | H |
| Once per 5 years | L | M | M | H | H |
| Once per 10 years | L | L | M | H | H |
| Once per 50 years | L | L | L | M | H |
| | Procedure violation | Agency notification of non-compliance | Self identified and reported violation | Agency notice of violation | Serious agency notice of violation |

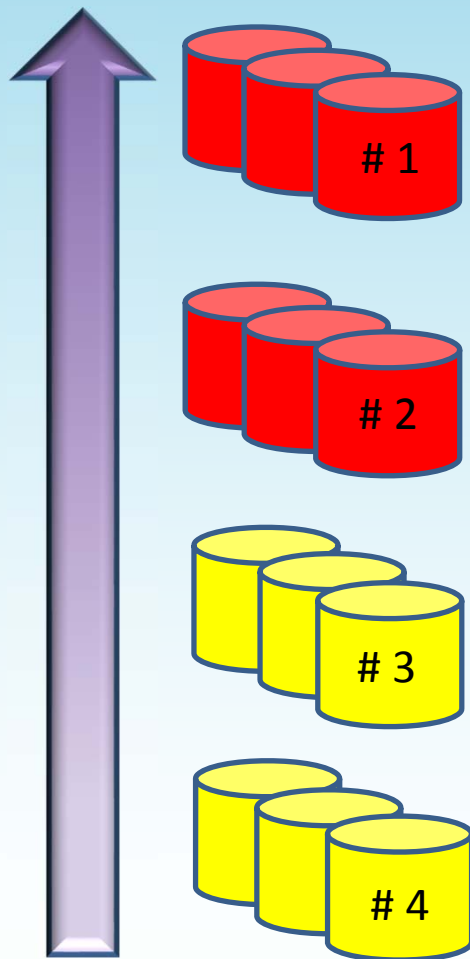
Operations Availability

| Likelihood | Consequence | | | | |
|-------------------|-------------------|--------------------|---------------------|-------------------|-------------------|
| Once per year | M | H | H | H | H |
| Once per 2 years | L | M | H | H | H |
| Once per 5 years | L | M | M | H | H |
| Once per 10 years | L | L | M | H | H |
| Once per 50 years | L | L | L | M | H |
| | 1-6 hour shutdown | 6-12 hour shutdown | 12-24 hour shutdown | 1-2 days shutdown | > 2 days shutdown |

Cost

| Likelihood | Consequence | | | | |
|-------------------|-------------|------------|---------------|--------------|---------|
| Once per year | M | H | H | H | H |
| Once per 2 years | L | M | H | H | H |
| Once per 5 years | L | M | M | H | H |
| Once per 10 years | L | L | M | H | H |
| Once per 50 years | L | L | L | M | H |
| | <\$50 K | \$50-250 K | \$250K-\$500K | \$500K-\$1MM | > \$1MM |

Risk Ranked Facilities



- Risk ranked facilities are subject to further review

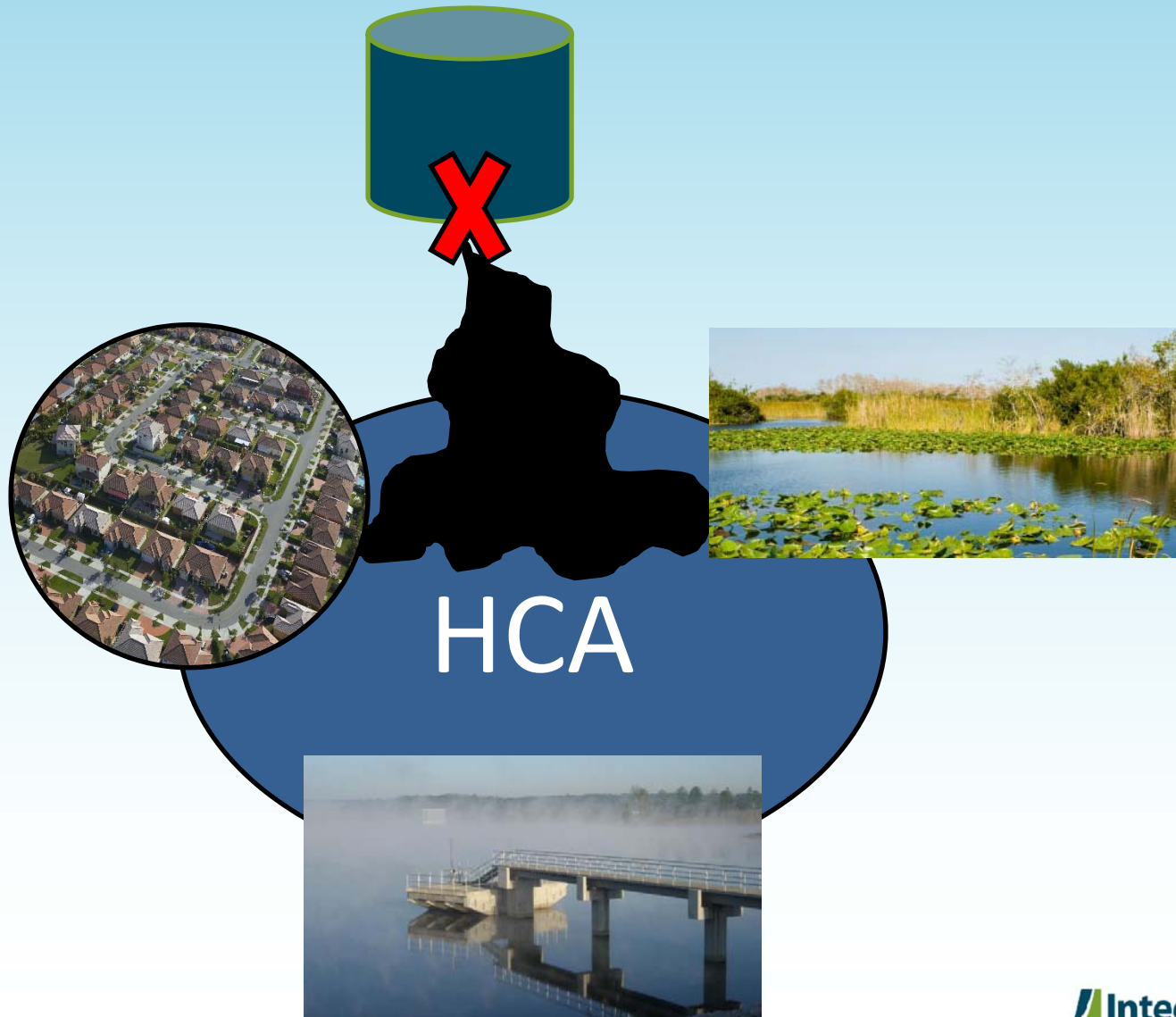
Hazardous Liquids Facility Risk Screening

Facility Risk Screening

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



Consequence of Failure



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

A close-up photograph of a metal pipe that is heavily corroded. The surface is covered in a thick, uneven layer of reddish-brown rust. The pipe is curved, and the background is blurred, showing more of the same rusted surface.

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



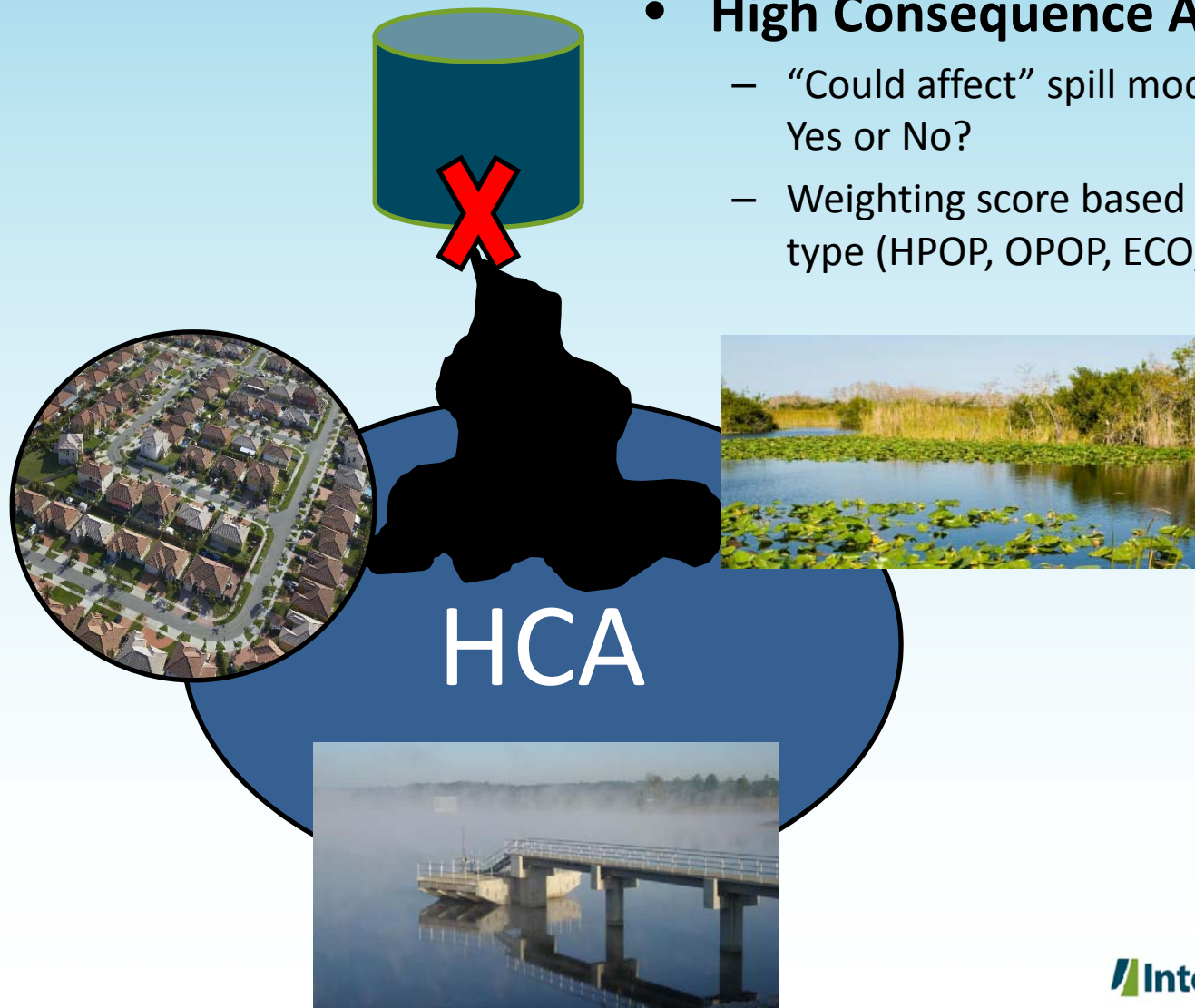
- Operator error
 - Operator training program
 - Procedural audits
 - Technology/human interface studies
 - Tank overfills
 - Tank high level alarms
 - Historic operator error releases

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

| | Likelihood | Consequence | Risk |
|----------------|------------|-------------|-------------------|
| Equip/Non Pipe | Score | Score | <i>Risk Score</i> |
| Pipe Corrosion | | | |
| OFD | | | |
| Operations | | | |
| Other | | | |

P&MMs

| | Risk Score | P&MM Considered | P&MM Chosen? | Responsibility |
|----------------|------------|--|--------------|----------------|
| Equip/Non Pipe | 35 | Increase valve inspect frequency | Yes | Operations |
| Pipe Corrosion | 42 | Dead leg program | Yes | Integrity |
| OFD | 24 | Additional bollards | Yes | Operations |
| Operations | 12 | Add alarm speaker outside control room | No | N/A |
| Other | 2 | None | No | N/A |



Hazardous Liquids Asset Based Risk Screening

Asset Categories

Threats

- Corrosion
- WOF
- Incorrect Ops
- Equipment



Tanks



Manifolds

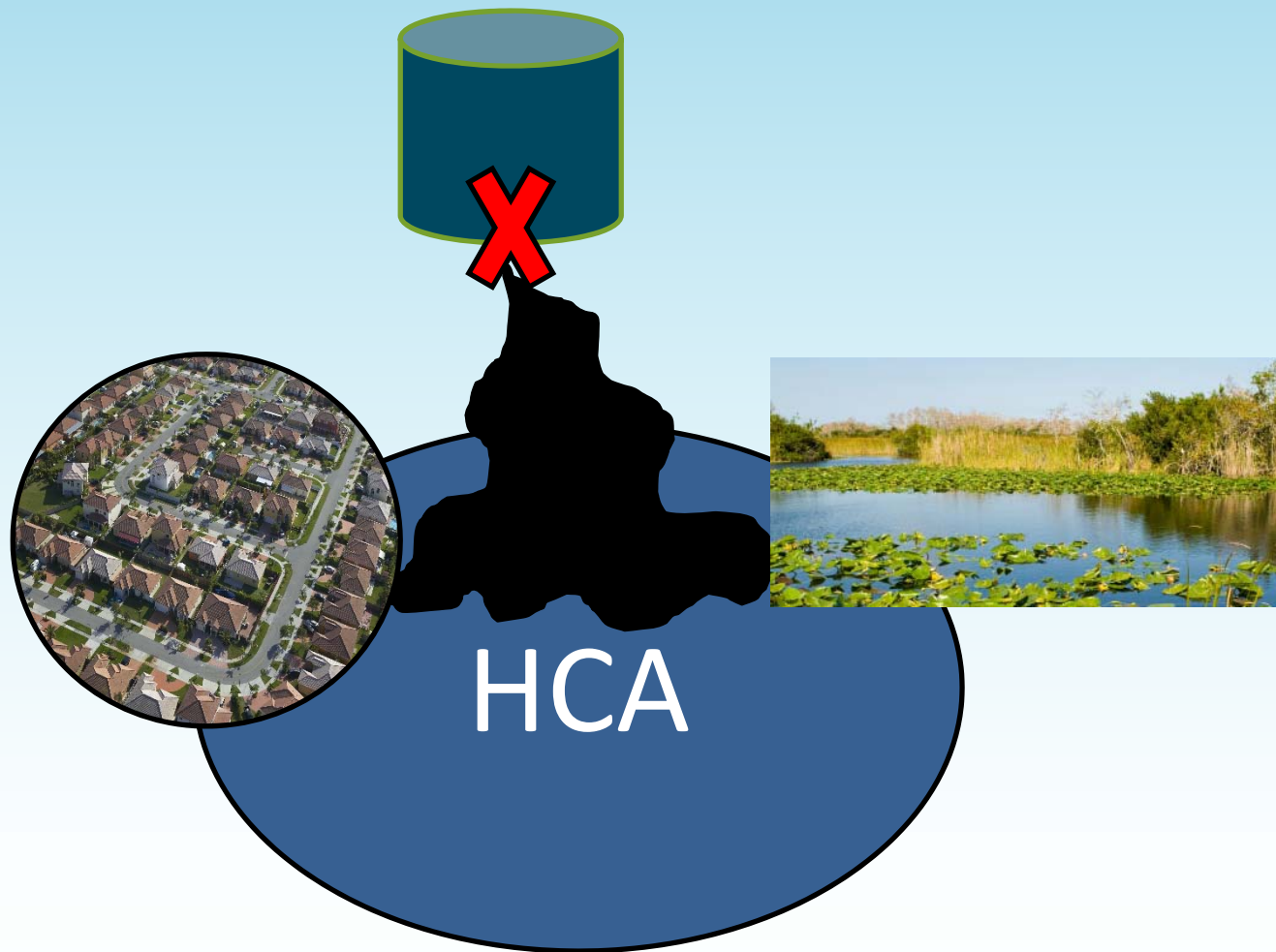


Station Pipe



Pumps

Consequence of Failure



Asset Risk Screening

- Threat driven by asset
- No facility comparisons (risk ranking)



Tanks



Manifolds



Pumps



Station Pipe



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



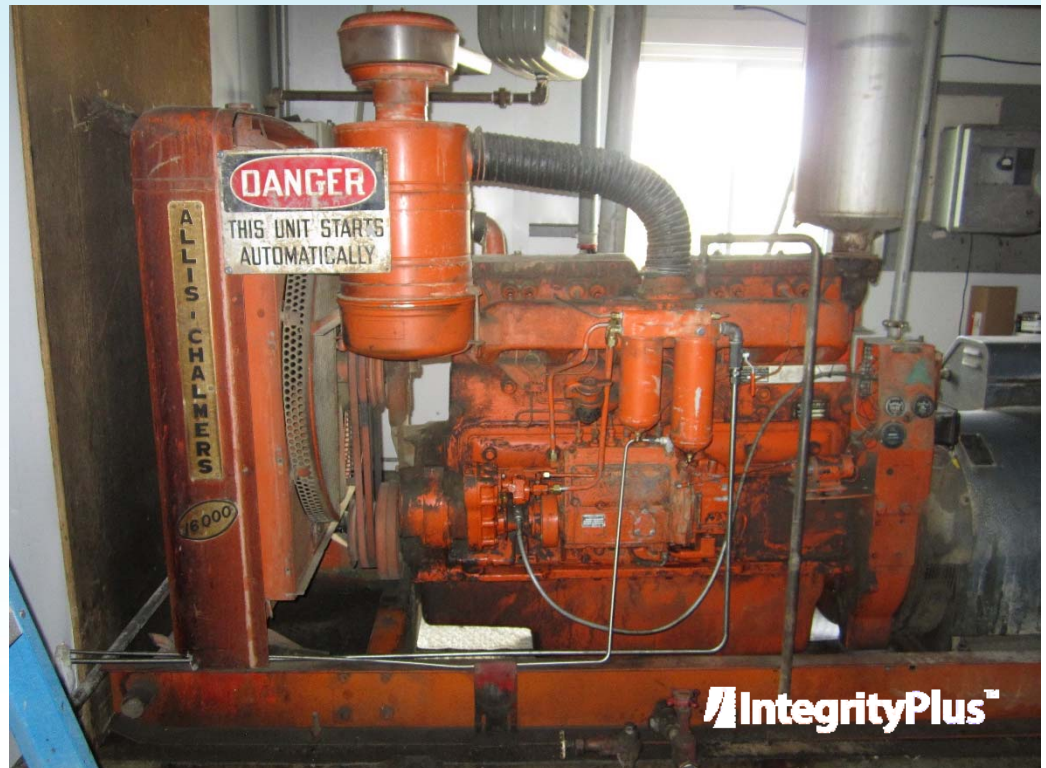
- Corrosion
 - Atmospheric Inspections
 - Corrosion found
 - Corrosion failures
- WOF
 - WOF issues noted (inspection)
 - WOF failures
- Incorrect Ops
 - Level of automation
 - Incorrect Ops incidents
- Equipment
 - Most recent inspection
 - Equipment related incidents

Asset Risk Screening – Pumps



- Incorrect Ops
 - Incorrect Ops incidents
- Equipment
 - Most recent inspection
 - Equipment related incidents

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



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

Risk Scores

| | Likelihood – by Threat | Consequence | Risk |
|--------------|------------------------|-------------|-------------------|
| Tanks | Cor+EQ+WOF+IO = Score | Score | <i>Risk Score</i> |
| Manifolds | | | |
| Pumps | | | |
| Station Pipe | | | |

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



- Outside Force Damage
 - Areas activity level
 - Number of OFD incidents resulting in releases
 - Number of OFD incidents without a release
 - Frequency of visual inspection
- 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?

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
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- Equipment
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 - 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

| | Likelihood | Consequence | Risk |
|--------------|------------|-------------|-------------------|
| Tanks | Score | Score | <i>Risk Score</i> |
| Equipment | | | |
| Station Pipe | | | |

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 = $5.0 * 10^{-6}$ leaks per 100 ft-year*
 - *Baseline Underground Piping External Corrosion Rate = 5 mpy*

Third Party Damage

- Pipe location accuracy
- Pipe length



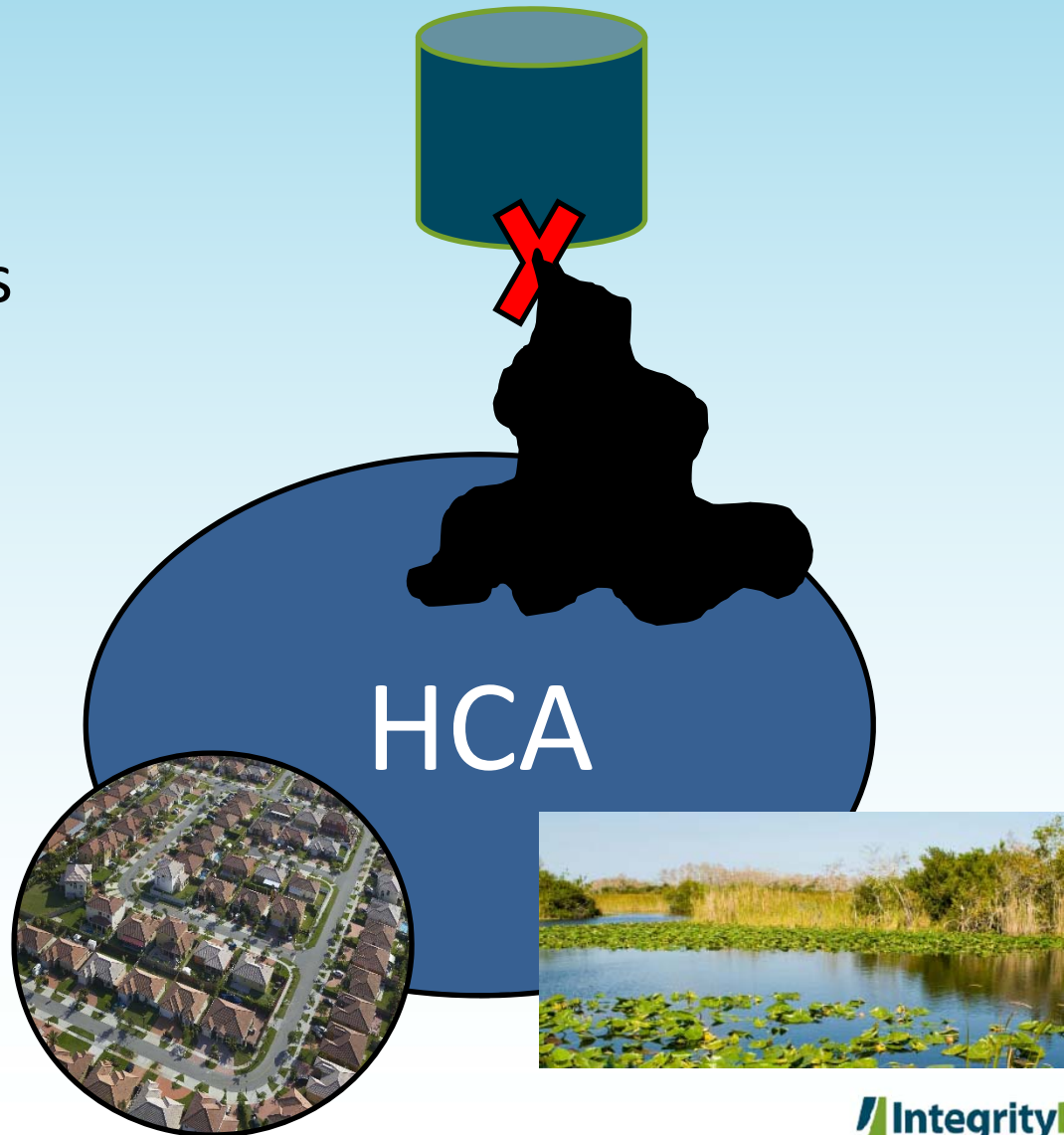
Equipment

- Leak frequency
- Number



Consequence of Failure

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



Risk Scores

| | Probability Score | Consequence | Score |
|-----------|-------------------|--------------|--|
| Very High | <i>Score</i> | <i>Score</i> | <i>(Urgent Implementation of P&MM or Assessment)</i> |
| High | <i>Score</i> | <i>Score</i> | <i>(Implement P&MM or Assessment)</i> |
| Moderate | <i>Score</i> | <i>Score</i> | <i>(Implement P&MM or Assessment)</i> |
| Low | <i>Score</i> | <i>Score</i> | <i>(Consider P&MM or Assessment)</i> |
| Very Low | <i>Score</i> | <i>Score</i> | <i>(No Action)</i> |

Facilities – Risk Modeling Limitations

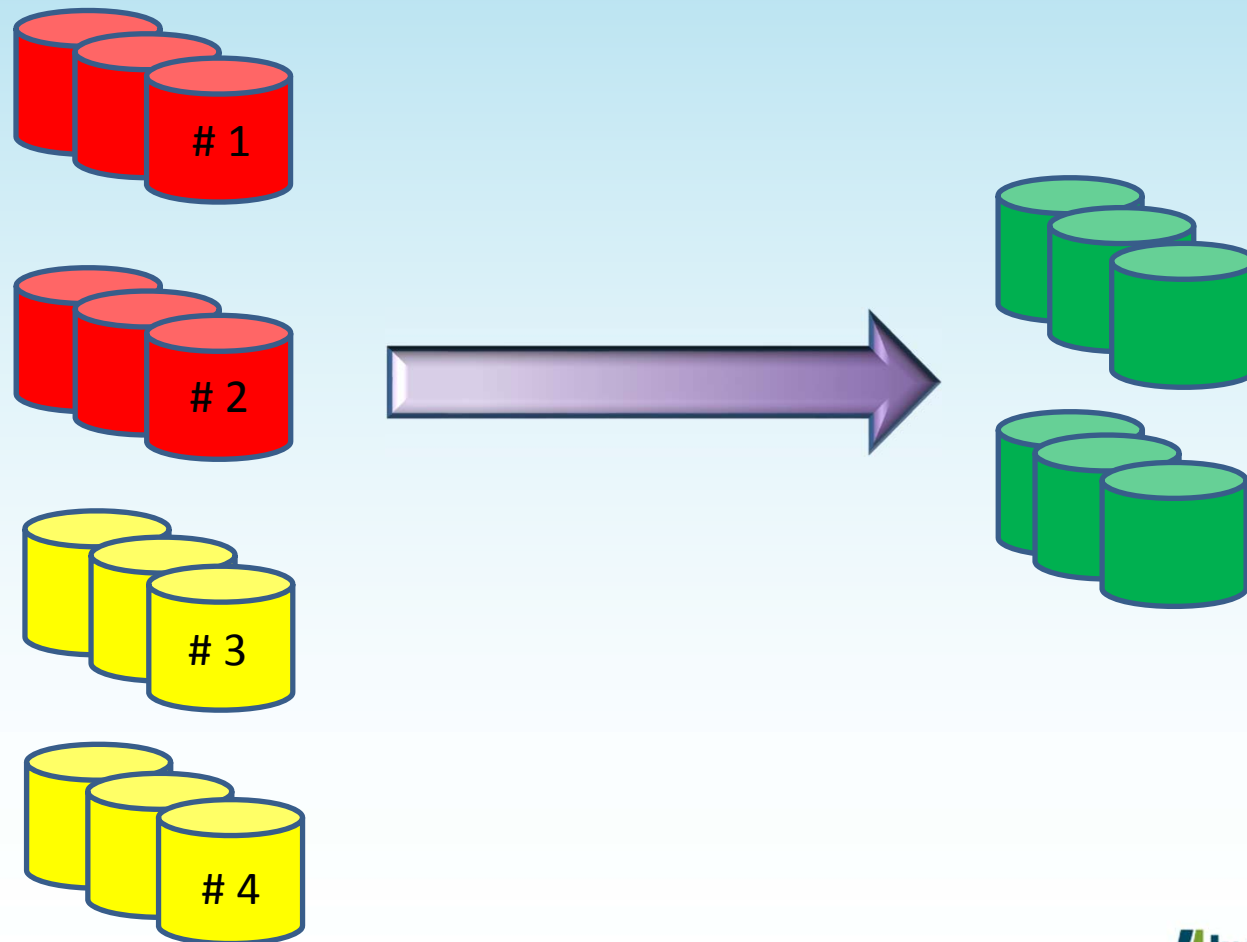
- Consequence analysis commonly incomplete
- Heavy SME input reliance
- Limited actionable results from screening models
- Models for different assets not always comparable



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)





Questions?



Thank You!

Mike LaMont

mike.lamont@ncintegrityplus.com

(936) 554-0839