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Implementing an Analytical Model for Distribution Integrity Analysis -

Project and Process Overview

2011 ESRI International User Conference

July 12, 2011

Distribution Integrity Analysis
Presentation Abstract

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To comply with the recently enacted Distribution Integrity Management regulation, MichCon is in the process of implementing an analytical risk model that executes within the ArcGIS environment. This session will provide an overview of the implemented Distribution Integrity Risk Model, along with a discussion of the key project tasks and decision factors encountered during the model configuration effort. Topics to be covered include -

- *Cataloging and evaluating data for inclusion in the risk models,*
- *Establishing a strategy for system segmentation and evaluation,*
- *Reviewing and analyzing risk model results.*

Agenda

- MichCon System Overview
- Solution Requirements
- Solution Overview
- DIMP Risk Assessment Model
- Project Implementation
  - Key Tasks and Activities
  - Risk Model Data Review Process
  - Risk Groups and System Segmentation
  - Results Analysis
  - Next Steps
- Lessons Learned
- Future Plans

Distribution Integrity Analysis
MichCon System Overview

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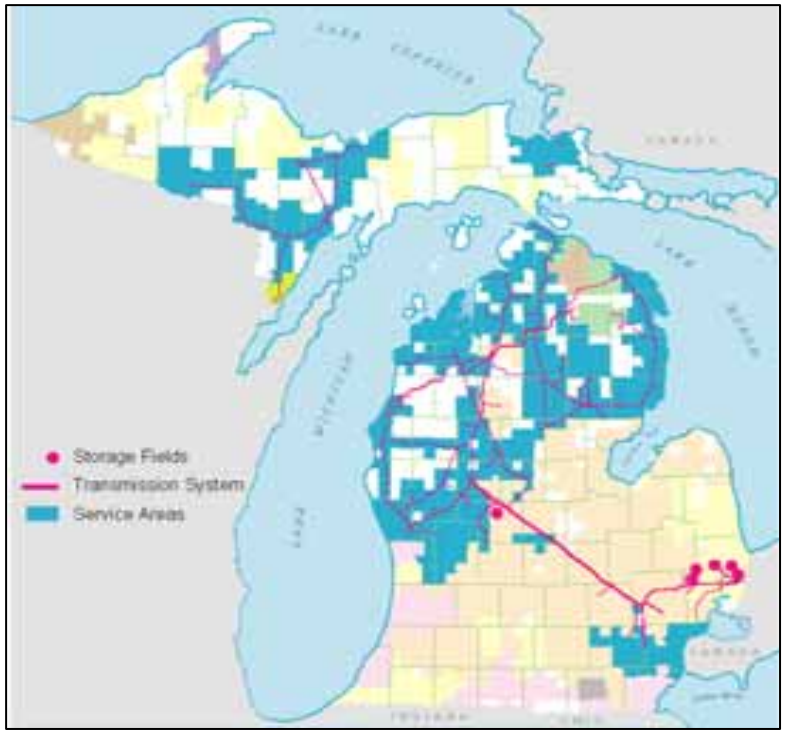
- Areas Served (approx. 1.2 Million Customers)
  - Southeastern Michigan
  - Grand Rapids
  - Muskegon
  - Northern Michigan



Distribution Integrity Analysis
MichCon System Overview

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- **18,645 Miles of Distribution Main**
  - 14,528 Miles (78%) Protected (PE Plastic & Coated Steel w/ Cathodic Protection)
  - 4,117 Miles (22%) Unprotected (Cast/Wrought Iron, Bare Steel, Coated Steel w/o Cathodic Protection)

- **1,190,478 Services**
  - 960,536 (81%) Protected (PE Plastic, Coated Steel w/ Cathodic Protection, Copper)
  - 229,942 (19%) Unprotected (Cast/Wrought Iron, Bare Steel, Coated Steel w/o Cathodic Protection)

Distribution Integrity Management - Regulation Overview

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MichCon's DIMP Plan:

- Demonstrates an understanding of our distribution system
- Addresses Significant threats to our distribution pipelines
- **Evaluates and prioritizes risks to our distribution pipelines**
- Identifies and implements actions to mitigate risks
- Measures performance and effectiveness of our DIMP program
- Periodically evaluates and improves plan
- Provides annual report on measures to Regulators
- Provides for 10 year retention of records demonstrating compliance with rule

Significant Threats include:

- Excavation Damage
- Natural Forces
- Material/Welds
- Other Outside Force Damage
- Other
- Incorrect Operations
- Corrosion
- Equipment Failure

MichCon Requirements / Expectations

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- Need Risk Model to meet DIMP requirements.
- Magnitude of main and services segments precluded implementation of manual risk calculation methods
- Well established ESRI GIS containing mains and services. Take advantage of investment.
- Repeatable process and solution.
- Ability to extract and integrate data from other systems to use as part of the risk analysis.
- Extensible solution to incorporate additional / improved data over time.

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Full Range of Engineering Services

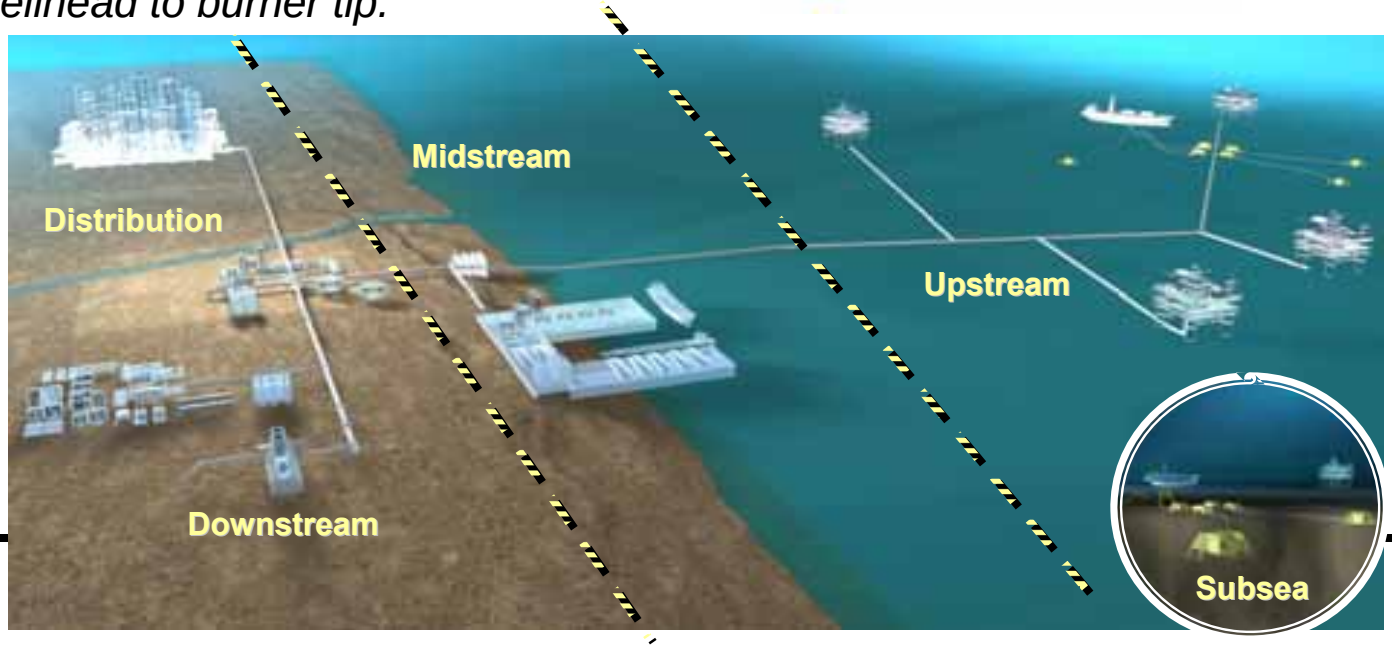
- Technical Assurance
- Engineering and Consulting
- Marine Consulting and Operations
- Project Execution

Software Products and Services

- Heritage Stoner Software and Advantica
- Planning, Operations, and Integrity Management Software
- Providing software and modeling services to MichCon since early1980's

esri Partner Network Silver

… From wellhead to burner tip.



Solution Overview

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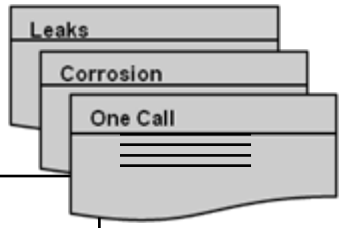
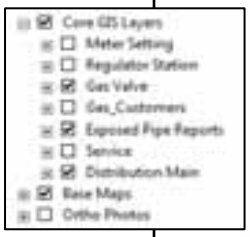
MichCon Subject Matter Experts

External System Integration



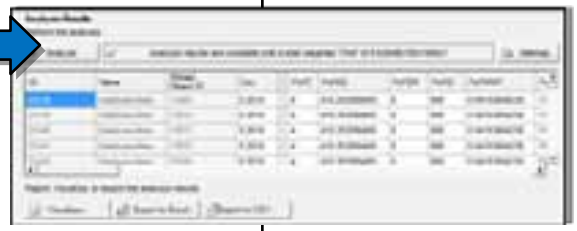
MichCon GIS and Assets



UPTIME INTEGRITY MANAGEMENT

DRAM Risk Model Configured for MichCon Local Conditions

$$\int(x) = \sum (a * b) ** z$$

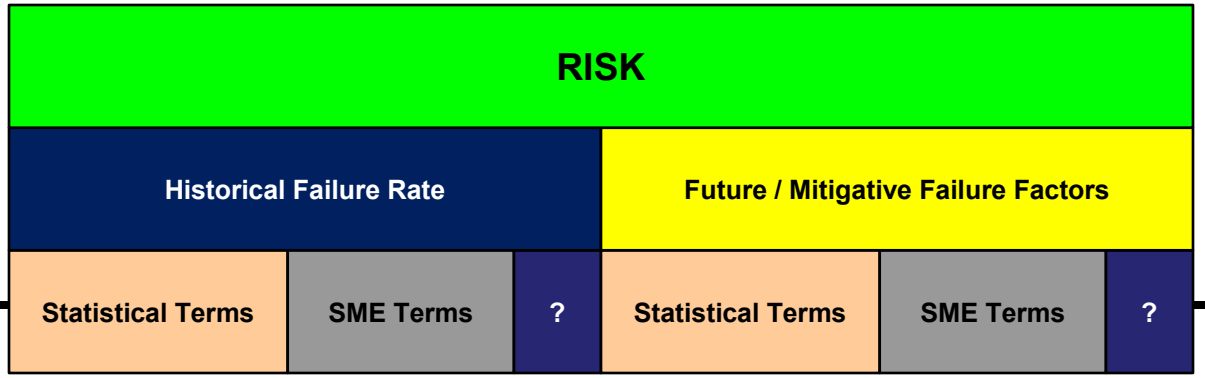


Model Results

DRAM Risk Models

- Developed in partnership with the Gas Technology Institute (GTI) and sponsored by Operations Technology Development NFP (OTD) and several leading U.S. distribution companies
- 16 Models to Address threats for prioritized combinations of …
  - Material Type (steel, cast iron, plastic), and
  - Asset Type (mains, services, meter sets, regulator stations).
- Utilizes both Statistical Analysis-based and SME-based factors. Over 100 factors considered across all models.
- [(Probability of Failure)*(Gas Ingress)*(Gas Ignition)*(Consequence)] * (SME)

- Model Format



Sample Model Factors – Excavation Damage

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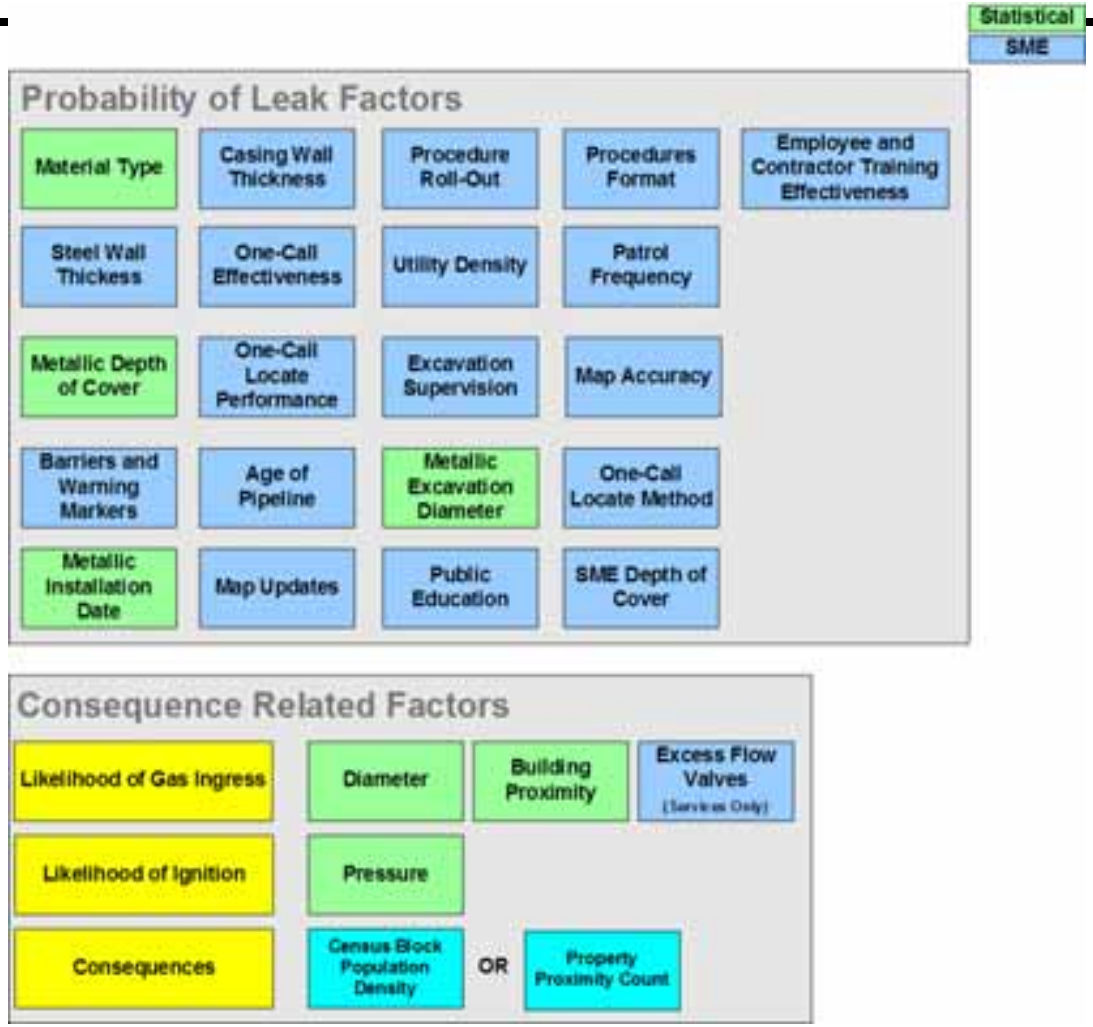

Sample Formulas and Factor Weighting

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Installation Date Weighting
X Diameter Weighting
X Depth of Cover Weighting
X Material Type Weighting

= *Probability of Failure*

Factor	Levels	Weighting
Installation Date	≤1939	0.005282
	≥1940	0.014403
Diameter	≤ 3”	0.031820
	>3” – 7”	2.008382
	>7”	0.120656
Depth of Cover	0 – 3 ft	2.760667
	> 3ft	0.632237
Material Type	Steel	1.0
	Cast Iron	1.127

Consequence related factors.

Gas Ingress Diameter weighting
X Gas Ingress Proximity weighting
X Gas Ignition Pressure weighting

= *Probability of Incident*

Factor	Levels	Weighting
Gas Ingress Diameter	≤ 5”	0.11
	> 5”	.163
Gas Ingress Proximity	0 – 5 ft	.314
	15 – 30 ft	.389
	30 – 100 ft	.194
	100+ ft	0.0
Gas Ignition Pressure	LP (<1 psi)	.004365
	MP (≥1 psi)	.072724

Spatial Factor

Excavation Damage – Sample SME Factors

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Factor	Levels	Weighting	Source
Barriers and Warning Markers	Reinforced Concrete Slab and Warning Tape or Marker Balls	0.032	GL Reports
	½ inch Steel Plate and Warning Tape or Marker Balls	0.032	
	Reinforced Concrete Slab	0.19	
	Warning Tape or Marker Balls	0.59	
	None	1.0	
One-Call Effectiveness	Limited. 4.91 or more hits/1000 tickets	1.3	Industry Statistics
	Average. From 3.61 to 4.91 hits/1000 tickets	1	
	Comprehensive. 3.61 or less hits/1000 tickets	0.75	
One-Call Locate Performance	All of the locates within the past three months were done within the minimum time mandated by regulatory oversight.	1.0	SME
	Some of the locates within the past three months were NOT done within the minimum time mandated by regulatory oversight.	1.5	

Implementing the Solution at MichCon - Project Plan Overview

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- Data and Gap Analysis
  - Data Review Workshop. Identified data currently available v. Risk Model Factors
  - Gap Analysis. Prioritize external data for inclusion in the model based on ease of access, influence on the models, versus using an SME approach for certain factors
  - Determined integration strategy
- Configuration of the Risk Model
  - Connecting Risk Model to MichCon's GIS Datamodel
  - Developed necessary interfaces for external data
  - Collected SME questionnaire results
  - Establish Risk Groups. Segment system into different regions
- Execution and Deployment
  - Model execution, QA and validation
  - Training Integrity Engineers. Correlation to DIMP Plan.
  - Model results analysis.

Data and Gap Analysis Process

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- Model Factor Data was cataloged for its availability and system used to maintain information
  - Access databases, Maximo, Third Party Applications
- Local Subject Matter Experts provided input as to quality, consistency and relevance of data in various regions
  - Key driver was to ensure consistency of model results for comparative analysis across the regions
- MichCon Gas Distribution Geodatabase model required minimal changes as many factors already accommodated

Data Preparation and Integration

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- Most data already in Esri
- Extract, Translate and Load Process established for the following key systems
  - Corrosion
  - Leak History
  - One Calls
  - Excavation Damage
  - Training information for excavators and first responders
- New data layers created for the imported data
- Minimal scrubbing of data from external systems – used ‘as-is’

Establishing Risk Groups – System Segmentation

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- Used existing station boundaries as Risk Groups
  - Basis for internal budgeting and operations
  - Same areas used for leak and corrosion surveys
  - Areas are geographically disparate, allows for regional comparison
  - Risk Mitigation Plans addressed on regional basis
- Software will allow for further breakdown for future analysis
  - By material types, geographical sub-areas, etc.

Final Plans to meet August 2, 2011 DIMP Implementation

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- Finish risk analysis
- Develop mitigation plans and cost estimates
- Review mitigation plans with operations to obtain buy-in and develop implementation schedule

Risk Assessment Results

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- Report and screen shots to be provided at presentation

Lessons Learned

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- Performance
  - Volumetric Issues.
    - Tuning of the model. Data segmentation
- Data Review / Consolidation Effort
  - Process was more intensive than originally planned
  - Large group of SME not efficient.
  - Generalist were effective in moderating smaller, focused SME groups to obtain specific information.
- Testing and Model Verification Time took longer than expected
  - Smaller ‘pilot area’ may have been more efficient to verify and better understand model. I.e. Model verification on smaller section up front.

Future Plans

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- Sensitivity Analysis
  - Rerun model scenarios with varied factor values and weightings
- Establish extended models to replace manual risk calculations for mains renewal programs
- Extend Models to Address additional threat and asset combinations
- Consideration of ‘Interactive Threats’