Dynamic Risk

RISK MODEL WORK GROUP

Index Models and Applications
An Industry Perspective

June 15th, 2017

Technical Presentation #2

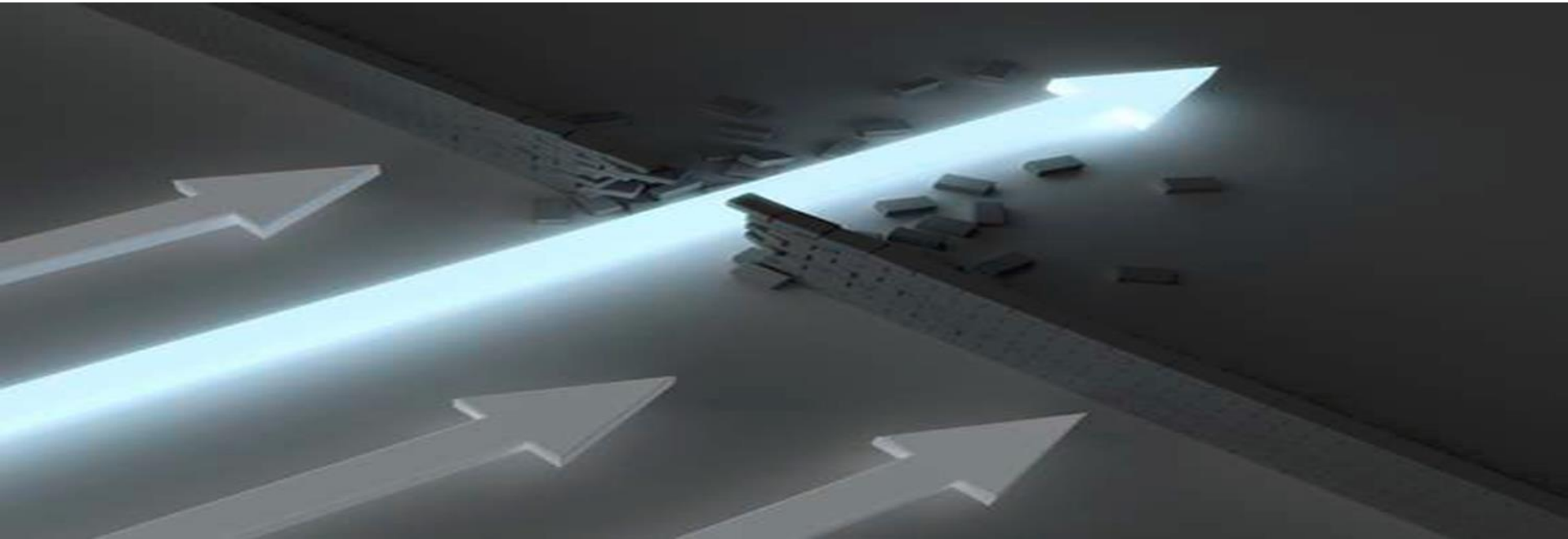
Index Models and Applications: Trevor MacFarlane (Dynamic Risk)

Content Considerations

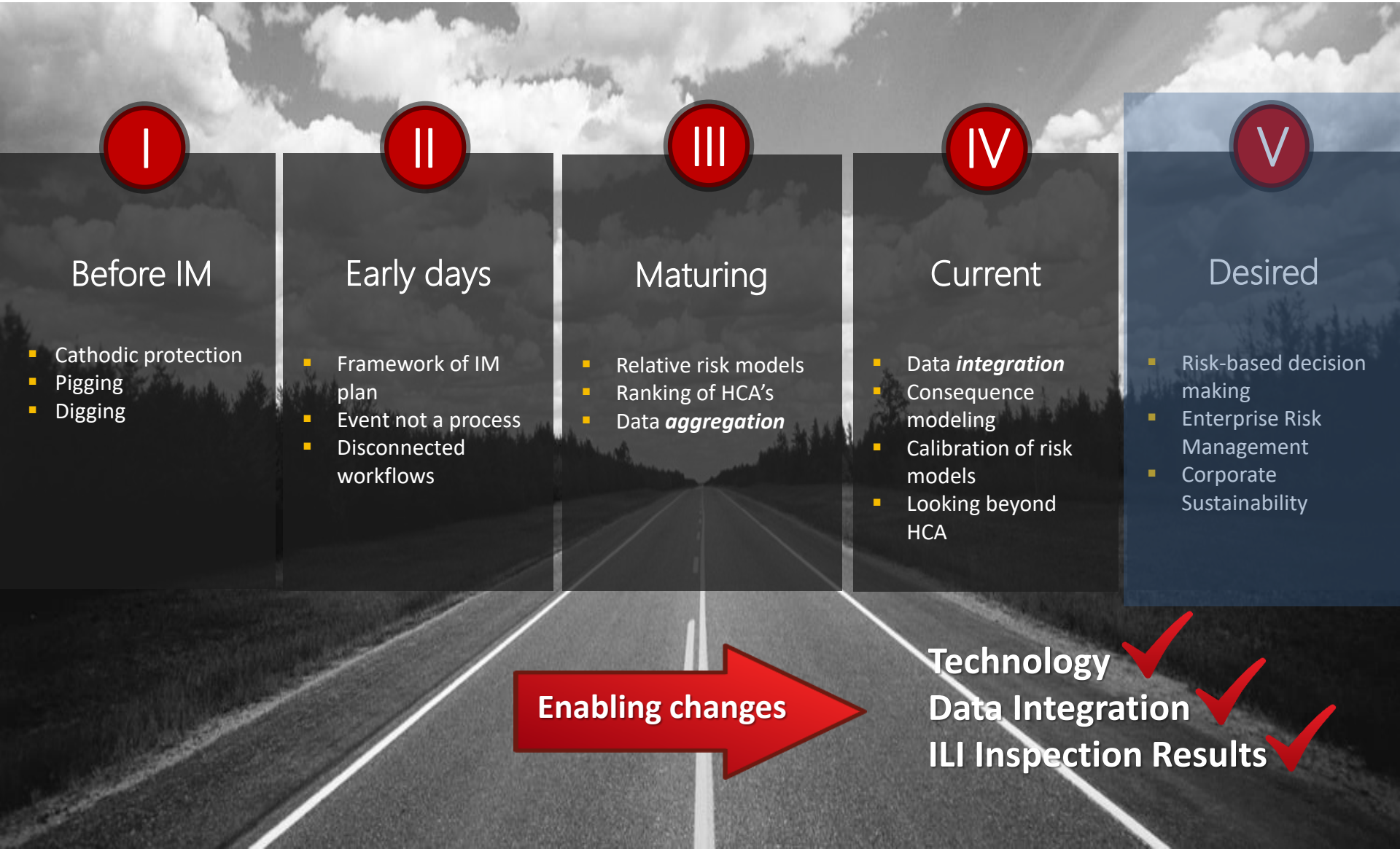
- Are we missing obvious reliability indicators using relative ranking models?
- How do we identify and optimize risk reduction activities?
- How to migrate a relative model to a quantitative model?
- How to use data to verify and identify improvement opportunities?
- Understanding the disconnect between past performance and future results.
- What do we do about low frequency, high impact events?

Key Take Aways

1. The evolution of risk analysis – what's changed?
2. A new definition of risk models – thinking beyond an Either / Or
3. The performance break-through



The evolution of pipeline safety



Risk Model - Objectives

- Identify highest risk pipeline segments.
- Highlight pipeline segments where the risk is changing.
- Calculate the benefit of risk mitigation activities (P&M measures).
- Identify gaps or concerns in data quality and completeness.
- Support decision making and program development.
- Improve system reliability.
- Eliminate high impact events.

Dynamic Risk

Risk Modeling is a continuum

- Small number of pure qualitative or pure quantitative risk models.
  - Most have some elements of both.
- Redefine our terms to include only:
  - Qualitative
  - Semi-quantitative
  - Quantitative

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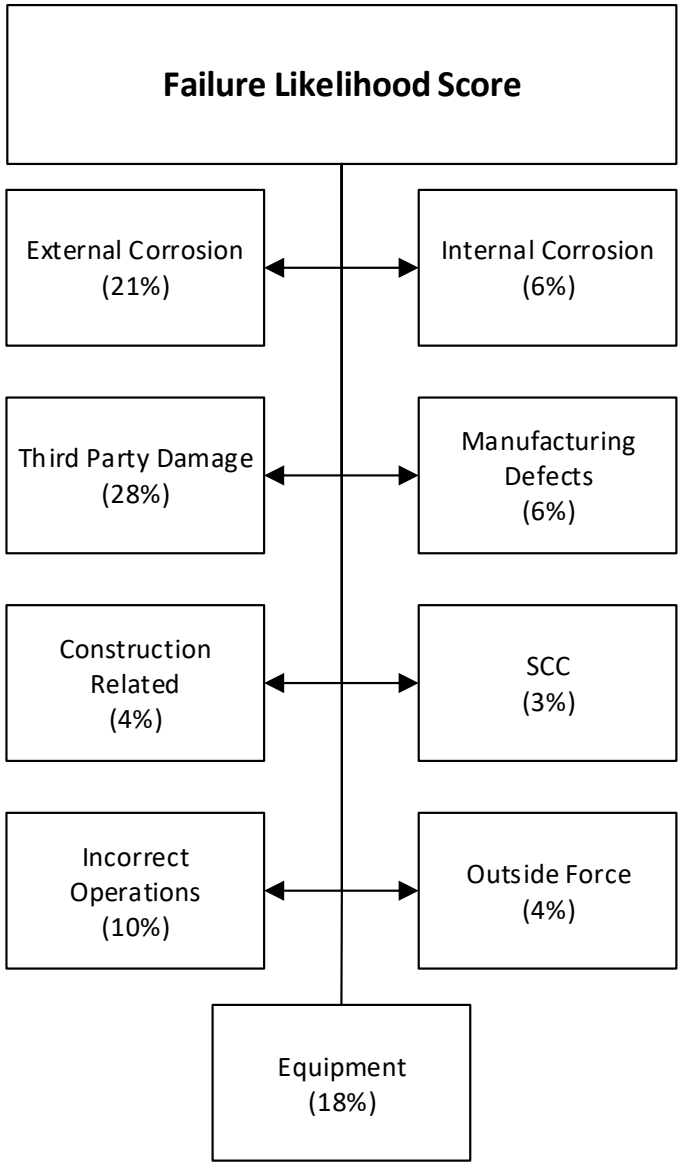
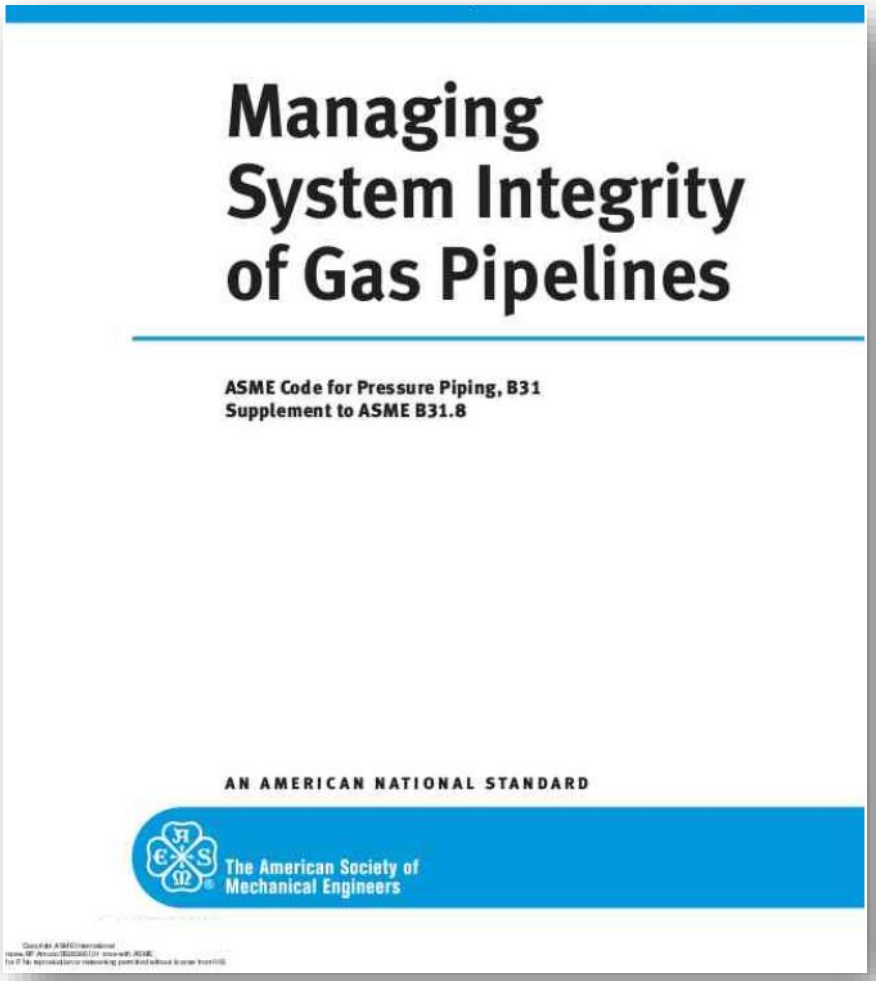
Qualitative Risk?





Dynamic Risk

External Corrosion - typical

$$S = M \times \left\{1 - \left[1 - \left(\frac{B}{10}\right)\right] \times \left[1 - \left(\frac{C_F}{10}\right)\right] \times \left[1 - \left(\frac{FH}{10}\right)\right]\right\} \times A_F$$

Where,

M	= Material Type Score (0 or 1);
S	= External Corrosion Score (0-10);
B	= Baseline Susceptibility Score (0-10);
C_F	= Stray Current / Interference Factor (0-10);
FH	= External Corrosion Failure History Score (0-10); and,
A_F	**= Integrity Assessment Mitigation Factor (1-10)**

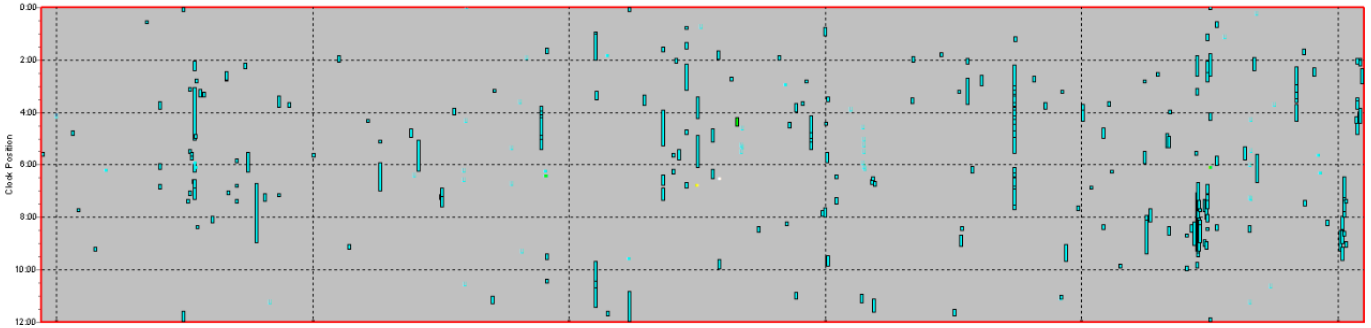
Baseline Susceptibility Score [B(0-10)]

The Baseline Susceptibility Score is determined on the basis of a number of weighted factors – each assigned a score from 0 to 10.

Variable	Factor	Fractional Weighting
Age	AF	0.20
Corrosion Allowance Factor	CAF	0.05
Coating System Type Score	MCT	0.30
CP Compliance Score	CP	0.20
Coating Condition Score	CC	0.20
Casings	CAS	0.05

Inspection Data!

10 mile pipeline – 122 anomalies, 2 digs, zero anomalies remaining below 1.39



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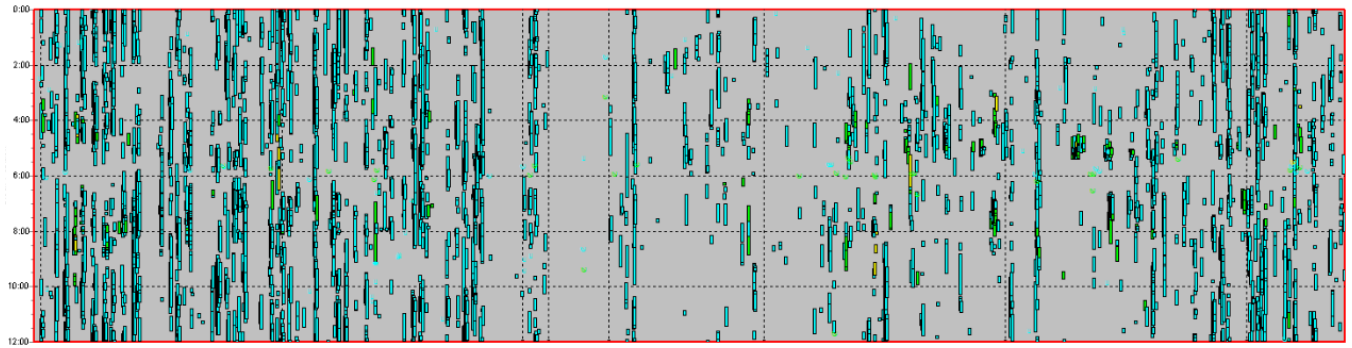
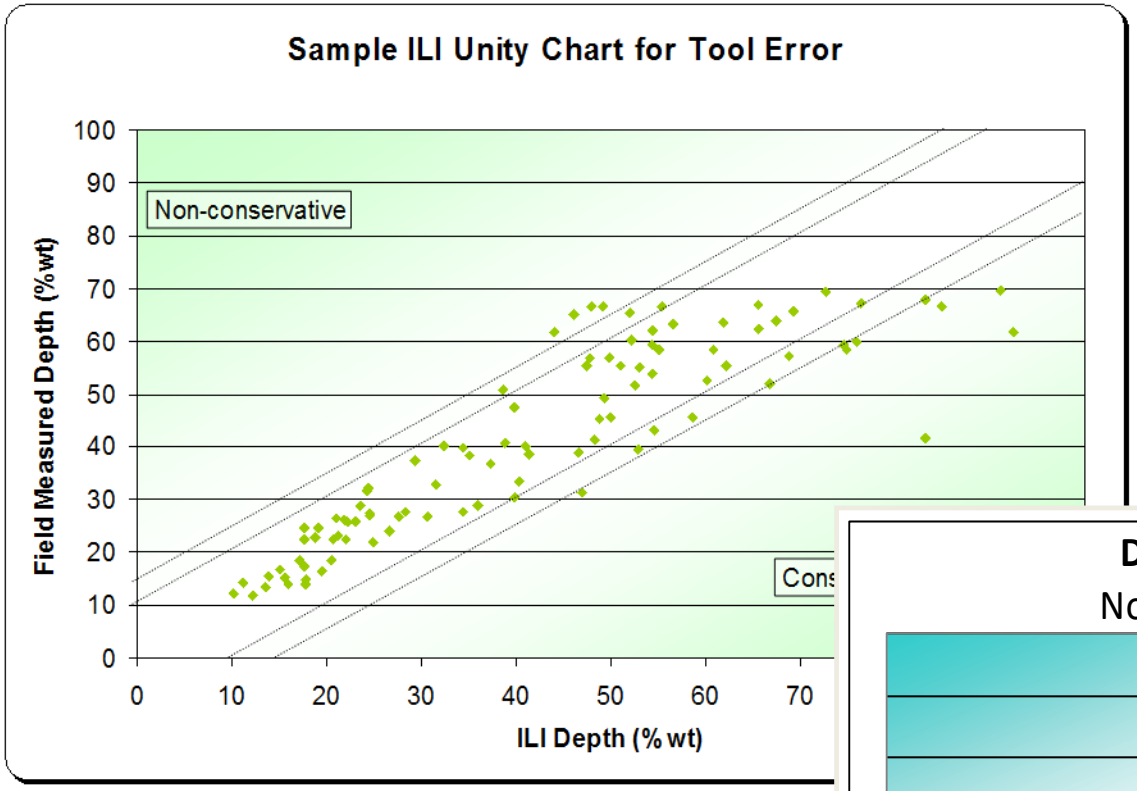
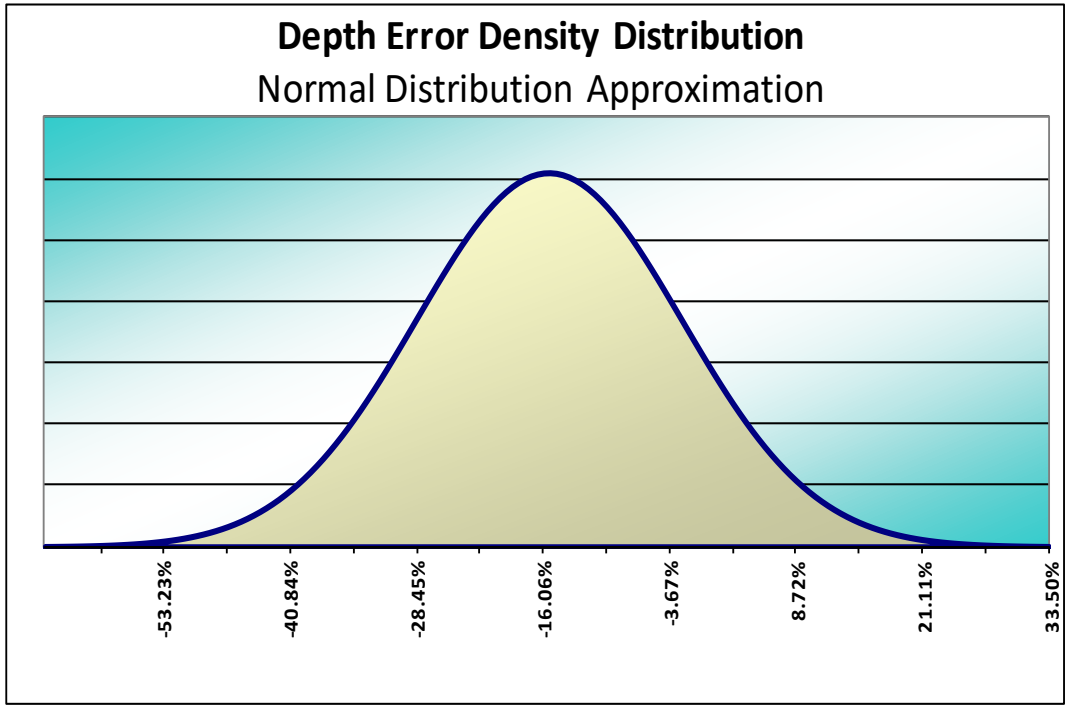
Not all inspected pipelines are equal…

10 mile pipeline – 7,274 anomalies, 7 digs, zero anomalies remaining below 1.39



External Corrosion – with ILI data





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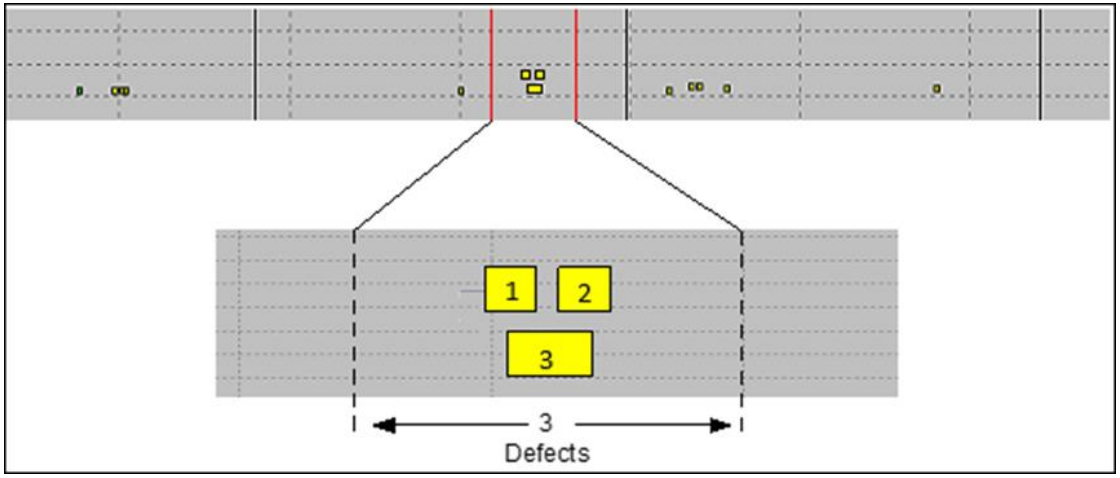
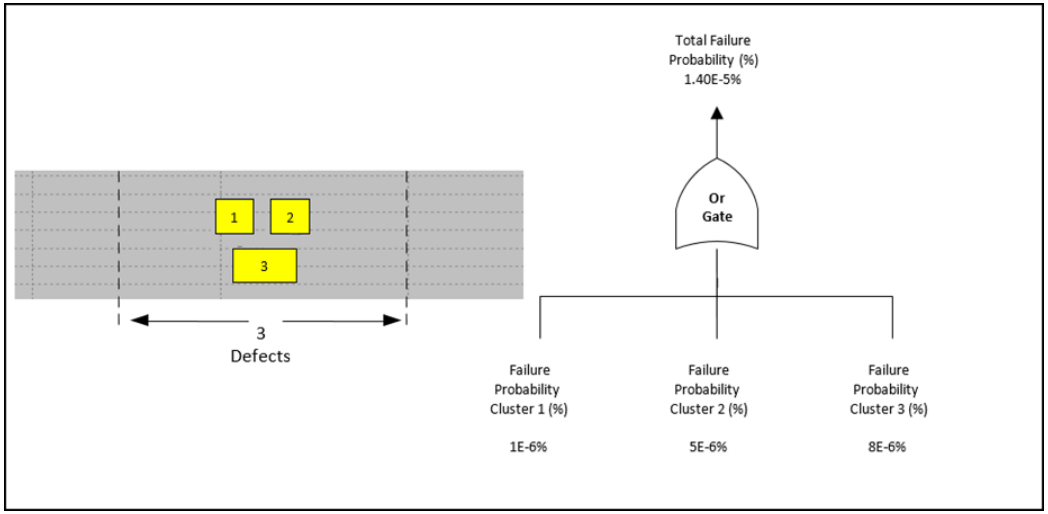




$$P_{Tot} = 1 - \left[\left(1 - P_{f,i}\right) \cdot \left(1 - P_{f,i+1}\right) \cdot \left(1 - P_{f,i+2}\right) \cdot \ldots \cdot \left(1 - P_{f,n}\right) \right]$$

External Interference

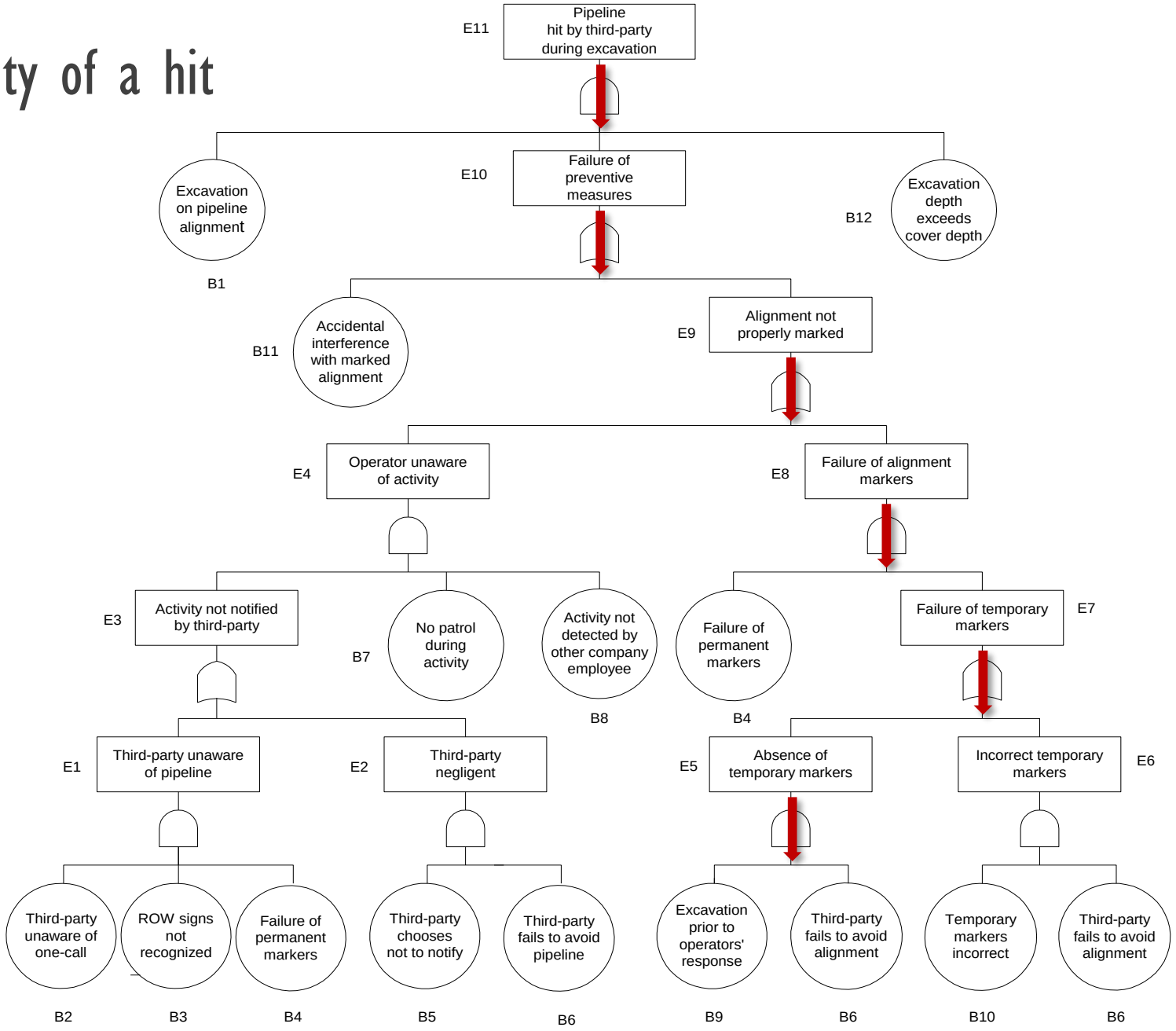
$$= \ Hit\ Susceptibility\ (\boldsymbol{H}) \ \times \ Failure\ Susceptibility\ (\boldsymbol{S_f})$$

Failure of a pipeline due to third party damage is the product of two independent factors:

- The susceptibility of the pipeline to incurring a hit by a third party ('H'); and,
- The susceptibility to failure of the pipeline, given a hit ('S_f').

External Interference

- Probability of a hit

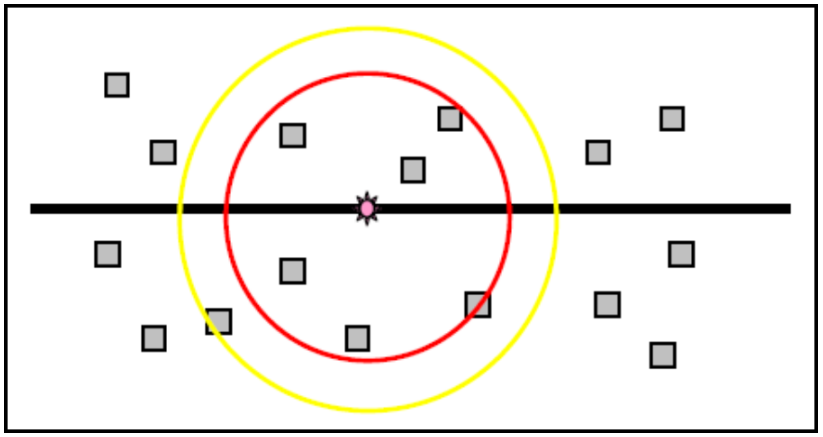


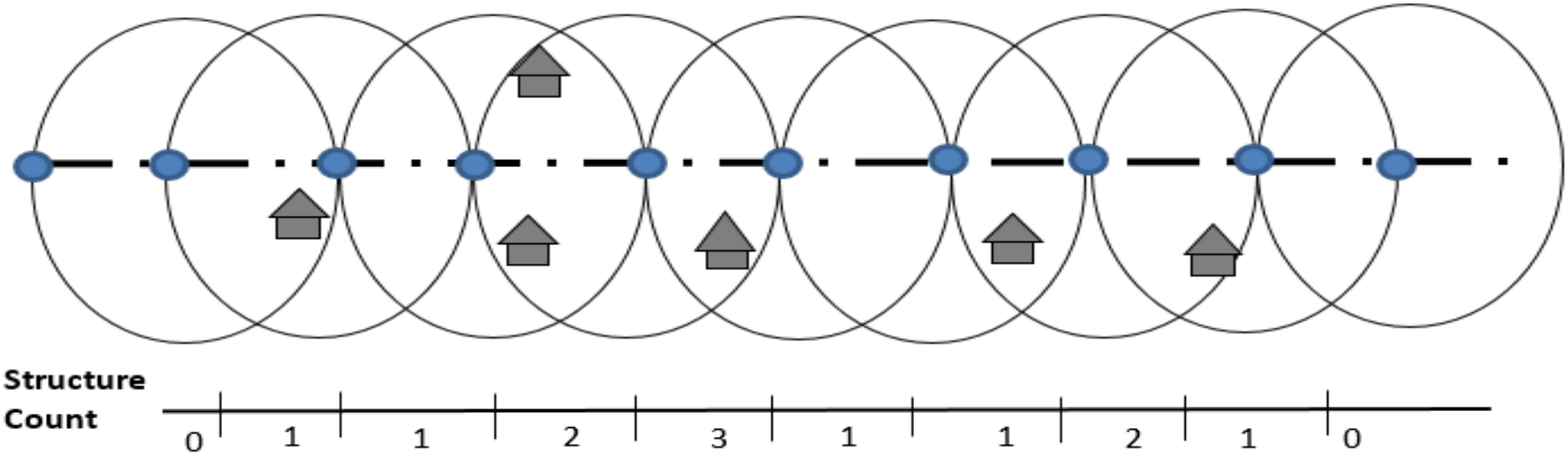
No	Event	Conditions	Probability
B1	Excavation on pipeline alignment (function of land use)	Commercial/Industrial	0.52
		High density residential	0.26
		Low density residential	0.36
		Agricultural	0.076
		Remote/Water Body	0.06
B2	Third-party unaware of one-call (function of method of communicating one-call system)	Advertising via direct mail-outs and promotion among contractors	0.24
		Above + Community meetings	0.10
		Community meetings only	0.50
B3	Right-of-way signs not recognized (function of placement frequency for signs)	Signs at selected crossings	0.23
		Signs at all crossings	0.19
		All crossings plus intermittently along route	0.17
B4	Failure of permanent markers (warning tape)	No buried markers	1.00
		With buried markers	0.10
B5	Third-party chooses not to notify (function of type of penalty for failure to advise of intent to excavate)	Voluntary	0.58
		Mandatory	0.33
		Mandatory plus civil penalty	0.14
		Right-of-way agreement	0.11
B6	Third-party fails to avoid pipeline	Default value	0.40
B7	ROW patrols fail to detect activity (function of patrol frequency)	Semi-daily patrols	0.13
		Daily patrols	0.30
		Bi-daily patrols	0.52
		Weekly patrols	0.80
		Biweekly patrols	0.90
		Monthly patrols	0.95
		Semi-annual patrols	0.99
		Annual patrols	0.996
		Default value	0.97
B8	Activity not detected by other employees	Response at the same day	0.02
B9	Excavation prior to operator's response (function of response time following advice of intent to excavate)	Response within two days	0.11
		Response within three days	0.20
		By company records	0.20
B10	Temporary mark incorrect (function of marking method)	By magnetic techniques	0.09
		By pipe locators/probe bars	0.01
		Provide route information	0.35
B11	Accidental interference with marked alignment (function of means of conveying information pertaining to location of pipeline during excavation by others)	Locate/mark	0.17
		Locate/mark/site supervision	0.03
		Pipe exposed by hand	0.06
		Cover depth <= 2.5 ft	0.42
B12	Excavation depth exceeding cover depth (function of depth of cover)	2.5 ft < Cover depth <= 3 ft	0.25
		3 ft < Cover depth <= 4 ft	0.08
		4 ft < Cover depth <= 5 ft	0.07
		Cover depth > 5 ft	0.06

Impact Frequency

Modeled Impact Frequency (hits/mile-yr)	Value of "F"
< 8.0E-4	1
≥ 8.0E-4 to < 1.3E-3	2
≥ 1.3E-3 to < 1.7E-3	3
≥ 1.7E-3 to < 2.2E-3	4
≥ 2.2E-3 to < 2.7E-3	5
≥ 2.7E-3 to < 3.1E-3	6
≥ 3.1E-3 to < 3.6E-3	7
≥ 3.6E-3 to < 4.1E-3	8
≥ 4.1E -3 to < 4.5E-3	9
≥ 4.5E-3	10

Consequence – Impact on Population





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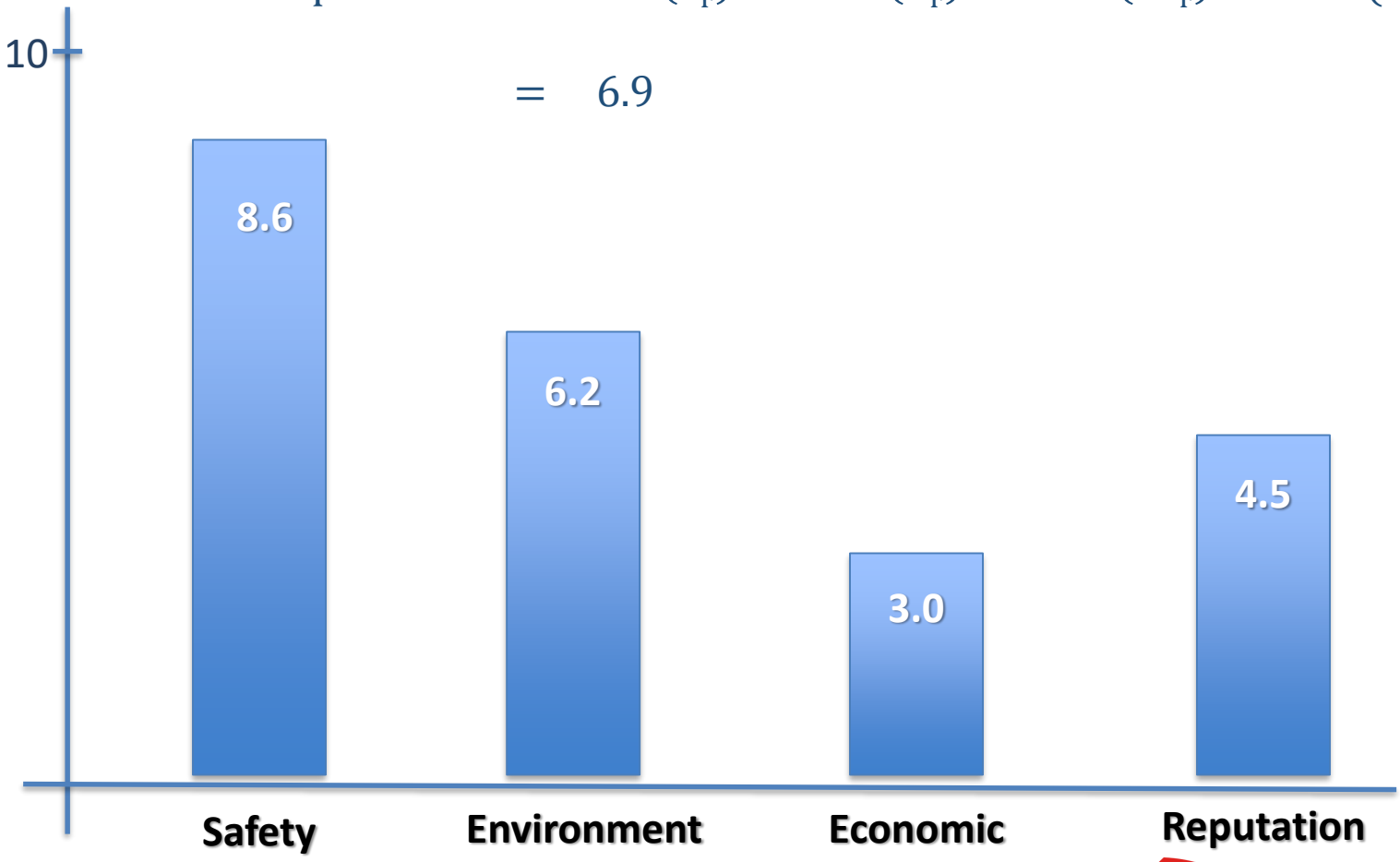
Impact Chart

		Negligible	Low	Medium	High	Extreme
		N	L	M	H	E
Health and Safety	Public / Employees	$0	$E3	$E4	$E5	$E6
		No HSE issues	Evacuation or Medical Aid or Near-Miss	Acute Injury	Severe Injury	Fatalities
Physical Damage / Economic Loss	Public / Commercial / Industrial	$E2	$E3	$E4	$E5	$E6
		No / Minor Damage	Light Property Damage	Moderate Property Damage	Heavy Property Damage	Severe Property Damage
	Service Disruption	$E2	$E3	$E4	$E5	$E6
		No service interruption	<1 day / No loss of contracted service	1-2 days / Loss of interruptible service	2-7 days / Loss of interruptible service	>1 week / Force Majeure
	Commodity Loss	$E2	$E3	$E4	$E5	$E6
		Controlled operating loss	Light losses (Leak/Rupture in low pressure, small dia. Line)	Moderate losses (Leak/Rupture in Intermediate Pressure, Small dia. Line)	Heavy losses (Rupture in HP, medium diameter line)	Ruptgure in HP large-diameter pipeline
	Company	$E2	$E3	$E4	$E5	$E6
		Minor Repair / Replacement	Material Repair or Replacement	Moderate Repair or Replacement	Loss of Major Infrastructure (readily accessible for repairs)	Loss of Major Infrastructure (difficult to access)
Environment	Emissions	$E1	$E2	$E3	$E4	$E5
		Low level emissions	Small / Minor emissions	Significant emissions	Heavy emissions	Very large emissions
	Rehabilitation	$E2	$E3	$E4	$E5	$E6
		No significant impact	Limited impact / Low Consequence Area	Moderate impact / Moderate Consequence Area	Heavy impact / High Consequence Area	Extreme impact / High Consequence Area
Regulatory	Regulatory Response	$E2	$E3	$E4	$E5	$E6
		No regulatory involvement	Informal meeting	Order to comply / Regulatory Audit	Review Practices / Loss of Influence on Policy	Line shut-down or pressure restriction
Corporate Image	Public Opinion	$E2	$E3	$E4	$E5	$E6
		No public record	Local coverage	Regional coverage	National coverage	Global coverage
	Government Relations	$E2	$E3	$E4	$E5	$E6
		No impact	Strained communications	Erosion of trust as a safe operator	Loss of influence on shaping policy / Lost lobby rights	Total breakdown of relationship

Impact Summary (Weighted)

$$\text{Impact Score} = 50\%\ (S_F) + 30\%\ (E_F) + 10\%\ (Ec_F) + 10\%\ (RF)$$

$$= \quad 6.9$$



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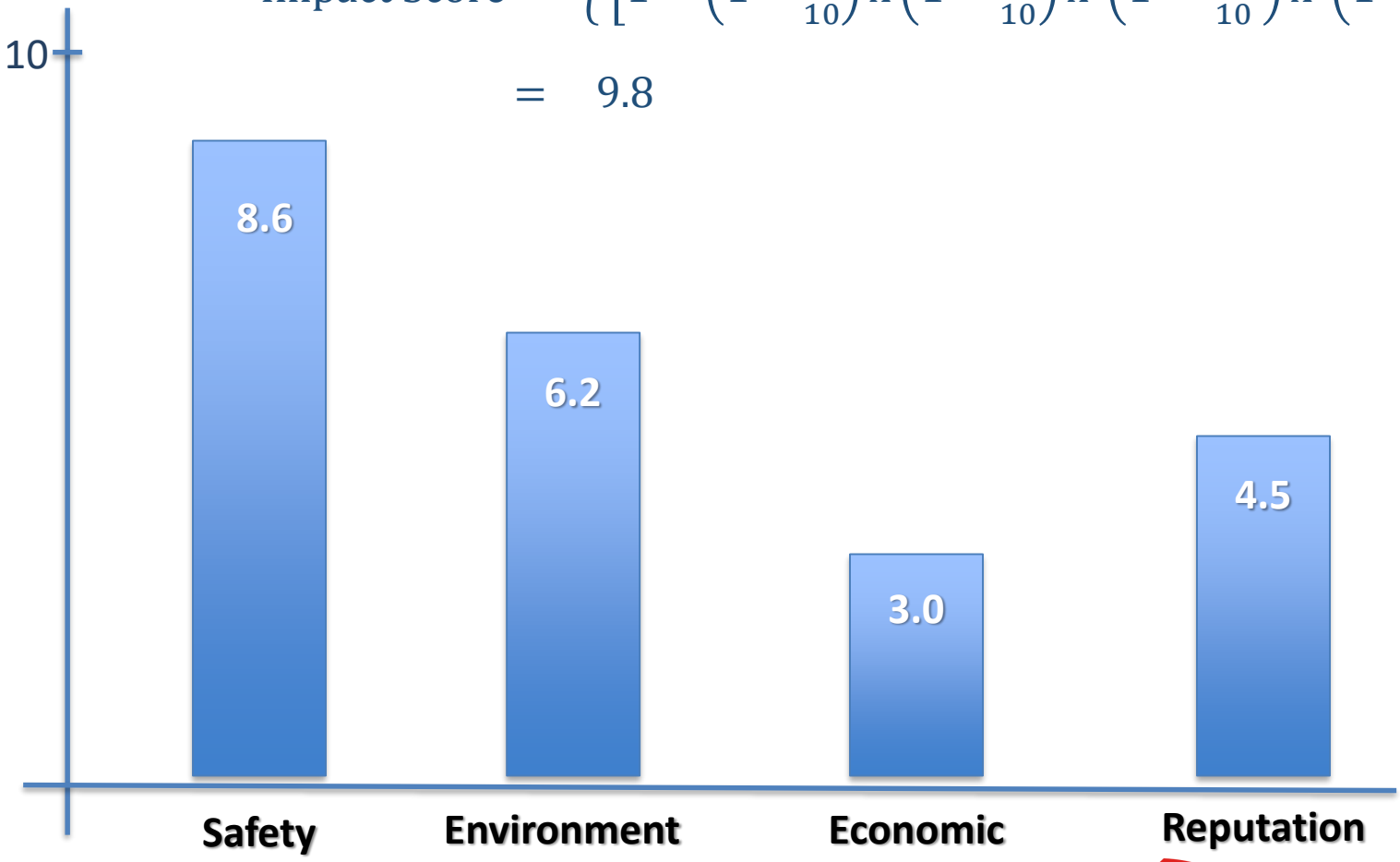
Impact Summary (Or Gate)

$$\text{Impact Score} = \left\{\left[1-\left(1-\frac{S_F}{10}\right)\text{x}\left(1-\frac{E_F}{10}\right)\text{x}\left(1-\frac{Ec_F}{10}\right)\text{x}\left(1-\frac{R_F}{10}\right)\right]\right\}$$

$$= 9.8$$



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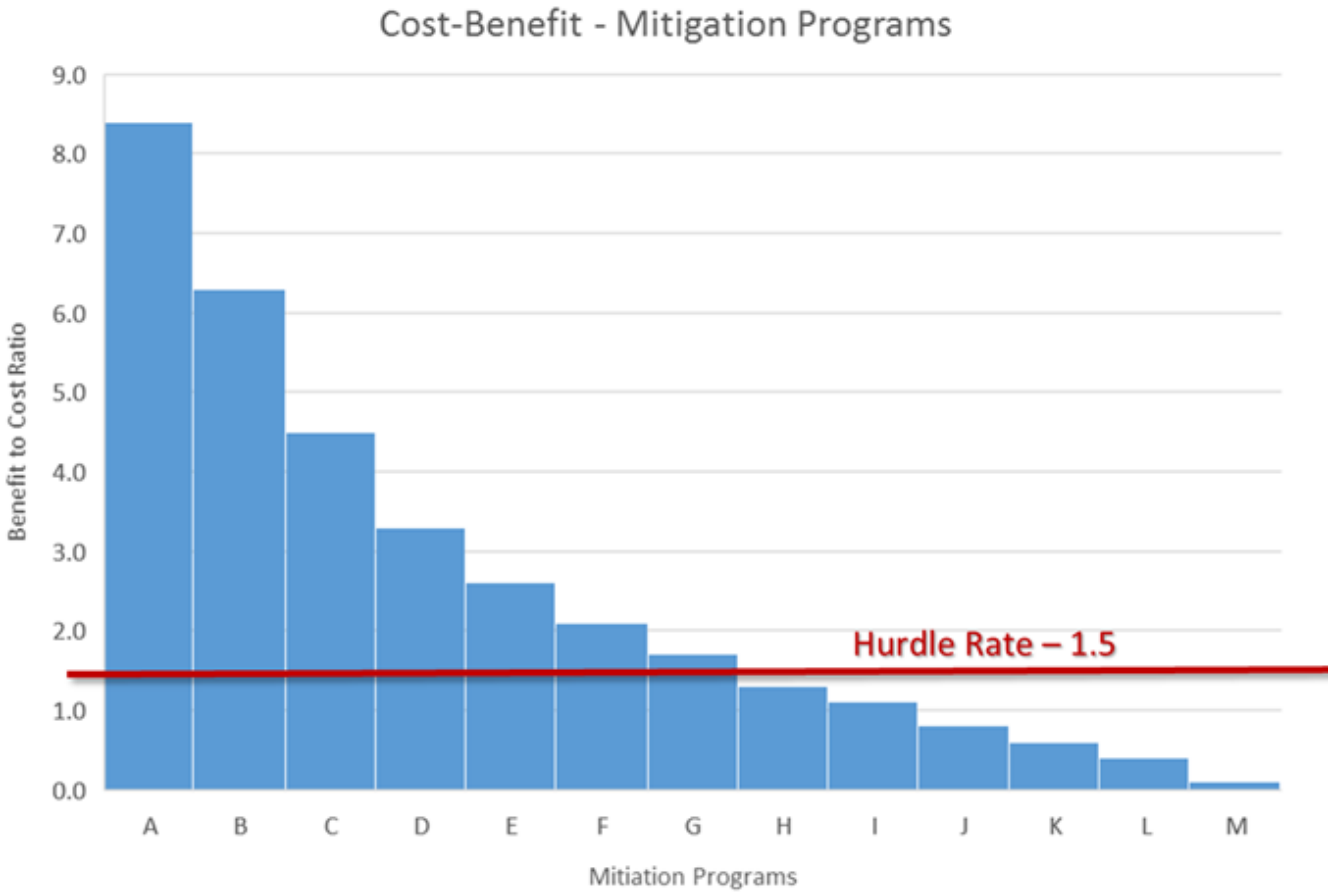
Risk Mitigation Benefit



Dynamic Risk

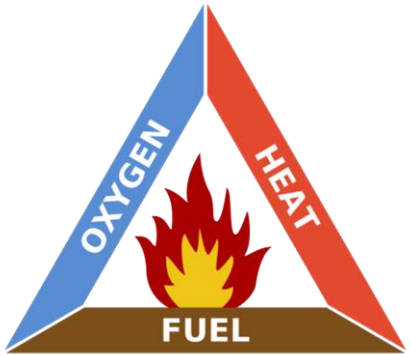
Risk Model – Why we do it?

- Identify highest risk pipeline segments.
- Highlight pipeline segments where the risk is changing.
- Calculate the benefit of risk mitigation activities (P&M measures).
- Identify gaps or concerns in data quality and completeness.
- Support decision making and program development.
- Improve system reliability.
- Eliminate high impact events.

Dynamic Risk

Low frequency, but high impact events

- Goal for the Industry, Regulators and Public
- Focus and identify locations of possible “high impact” events
- Ignore the likelihood of the event occurring (initially)
- What barriers or activities for that specific “high impact” event could be undertaken to eliminate that outcome
- Think Fire Triangle – eliminating just one, eliminates the outcome.



Dynamic Risk

Our Insight

- Dynamic Risk has developed and implemented risk analysis on more than 400,000 miles of pipeline in North America.
- We have designed and implemented 50+ company unique algorithms.
- We have used quantitative risk for all aspects of the pipeline life-cycle.
- Many of the these companies have reportable incident rates of less than ½ of the industry average.
- A number of these companies have virtually eliminated high impact events.

And there is no correlation between this result and the type of risk model they use!

Dynamic Risk

Performance Break-through

- There is a strong correlation with asset reliability performance and with this one activity:

Companies that use risk analysis to support IM planning and decision making consistently achieve the best reliability record.

Thank you for the opportunity to contribute to the RMWG.

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