Dynamic Risk

The Future of Pipeline Risk Management

RISK MODEL WORK GROUP

Technical Presentation #2

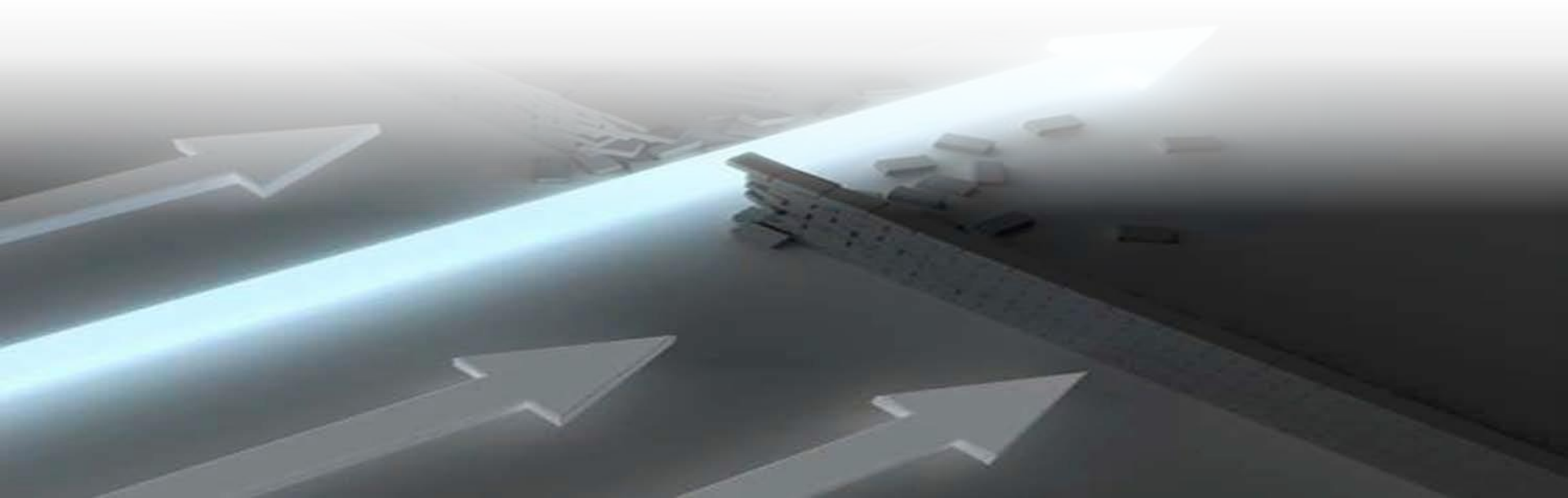
PRESENTER: TREVOR MACFARLANE,
PRESIDENT, DYNAMIC RISK

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 Takeaways

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

Dynamic Risk

I — Before IM

- Cathodic protection
- Pigging
- Digging

II — Early days

- Framework of IM plan
- Event not a process
- Disconnected workflows

III — Maturing

- Relative risk models
- Ranking of HCA's
- Data ***aggregation***

IV — Current

- Data ***integration***
- Consequence modeling
- Calibration of risk models
- Looking beyond HCA

V — Desired

- Risk-based decision making
- Enterprise Risk Management
- Corporate Sustainability

Enabling changes

Technology ✓
Data Integration ✓
ILI Inspection Results ✓

Risk Model - Objectives

Dynamic Risk

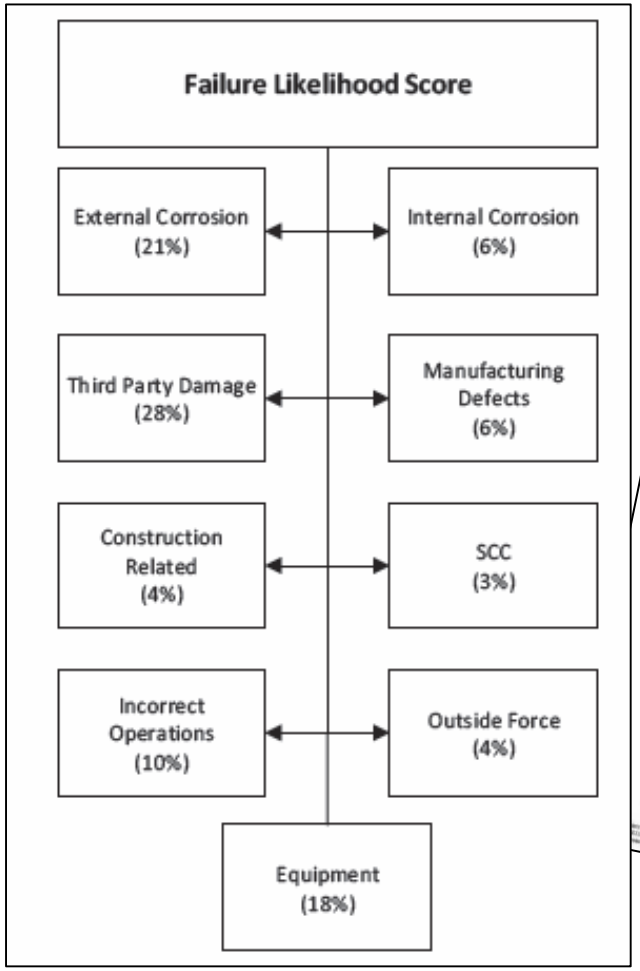
- Identify highest risk pipeline segments.
- Highlight pipeline segments where the risk is changing.
- Calculate the benefit of risk mitigation activities (P&M measures).
- Identify gaps or concerns in data quality and completeness.
- Support decision making and program development.
- Improve system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

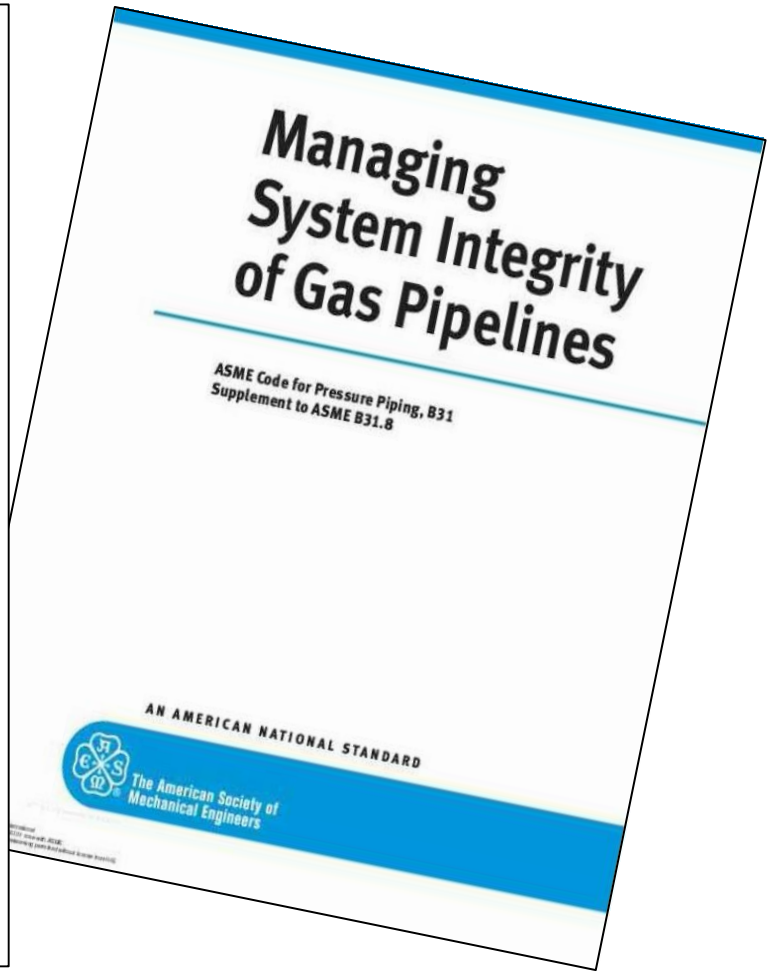
Risk Modeling is a Continuum

Dynamic Risk

- 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

Qualitative Risk?





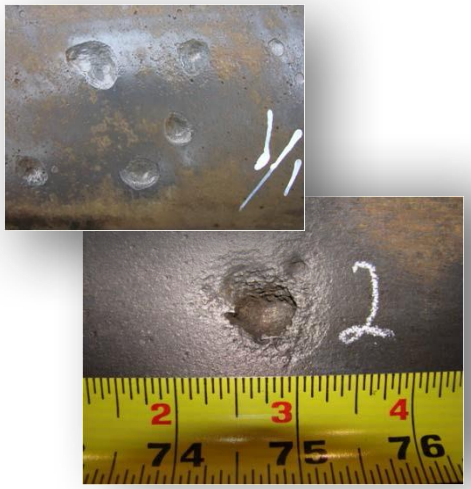
External Corrosion, Typical

Dynamic Risk

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

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)



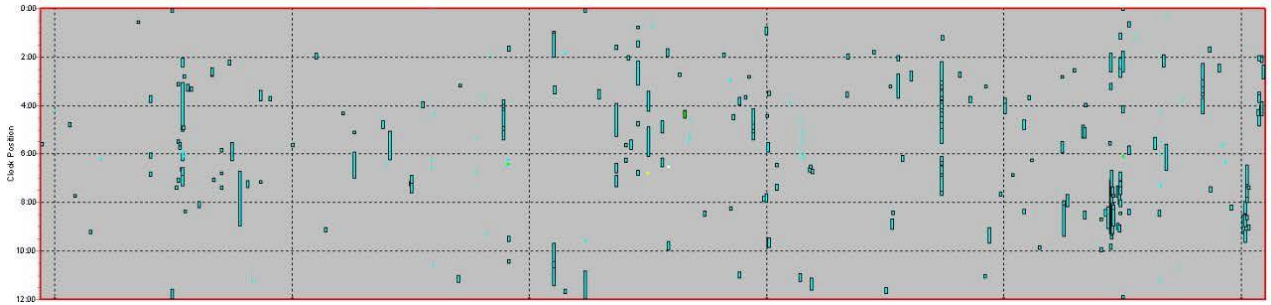
Baseline Susceptibility Score [B(0-10)]

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

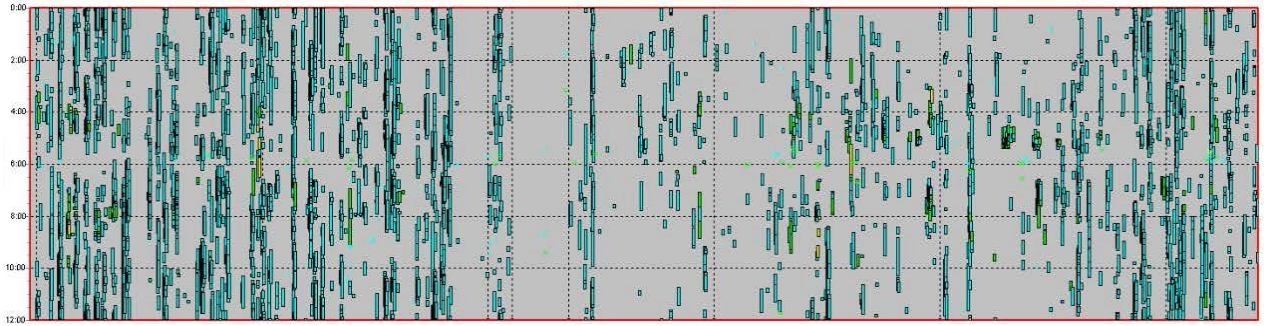
Inspection Data !

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

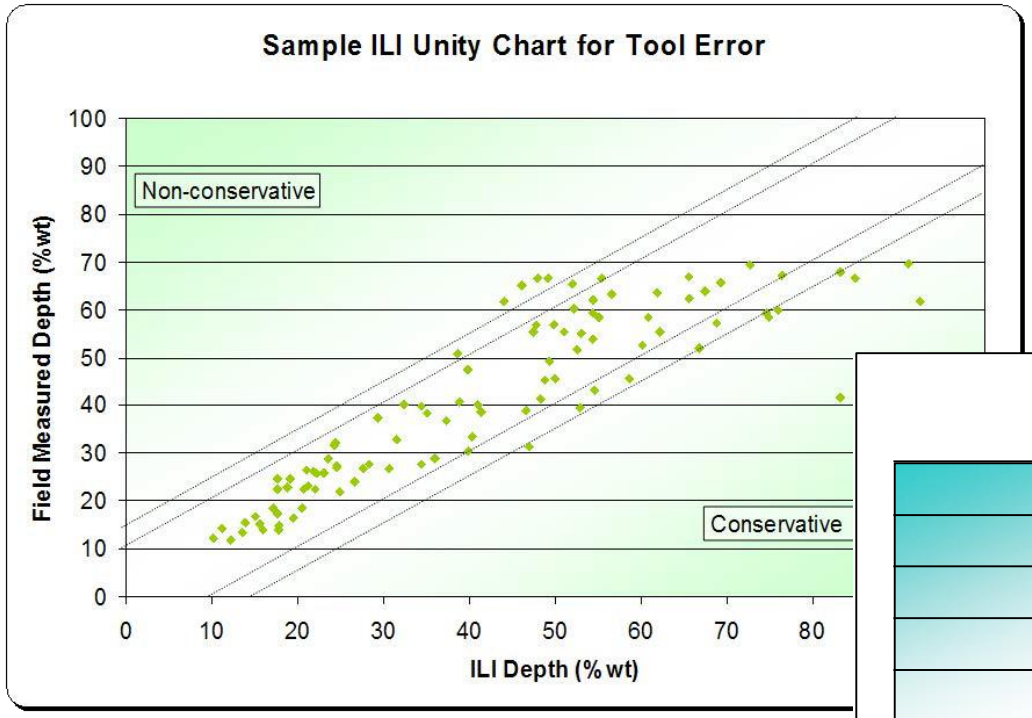


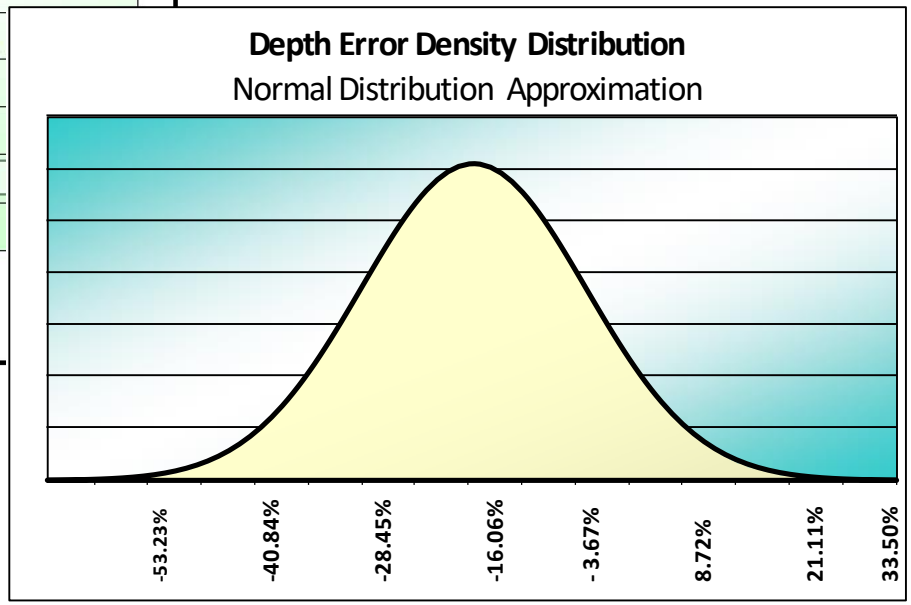
≠ **Not all inspected pipelines are equal…**

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



External Corrosion – with ILI data





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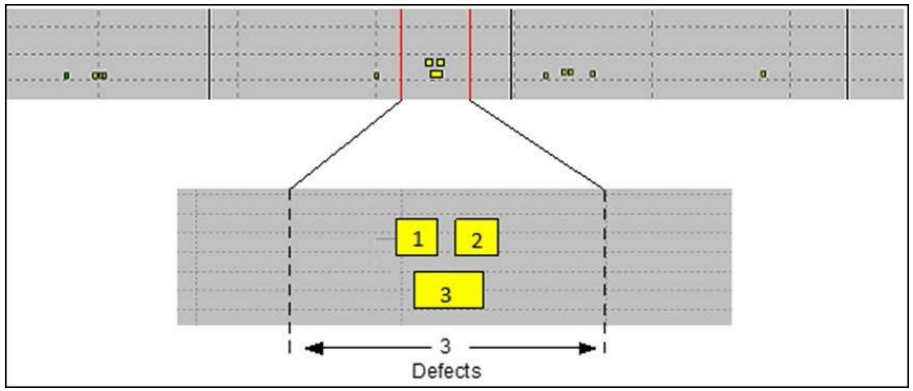
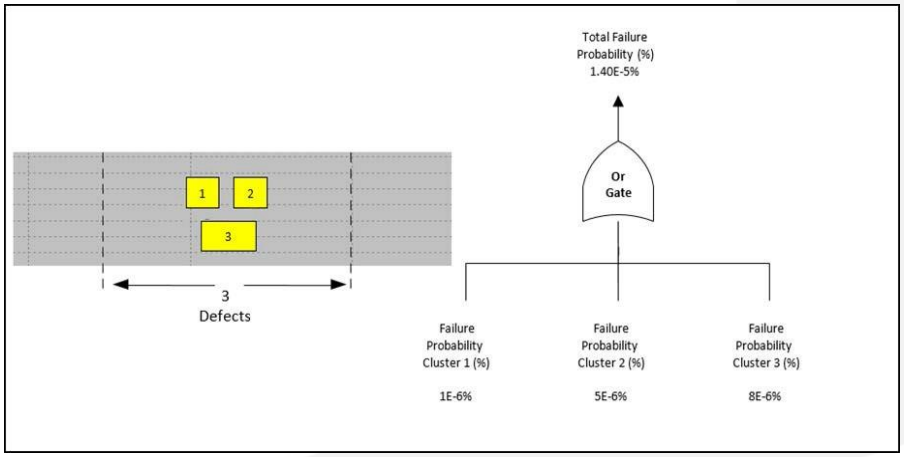




$$P_{Tot} = 1 - \left[\left(1 - P_{f,i}\right) \cdot \left(1 - P_{f,i+1}\right) \cdot \left(1 - P_{f,i+2}\right) \cdot \ldots \cdot \left(1 - P_{f,n}\right) \right]$$

External Interference

$$= \; Hit\ Susceptibility\ (\boldsymbol{H}) \times Failure\ Susceptibility\ (\boldsymbol{S_f}8$$

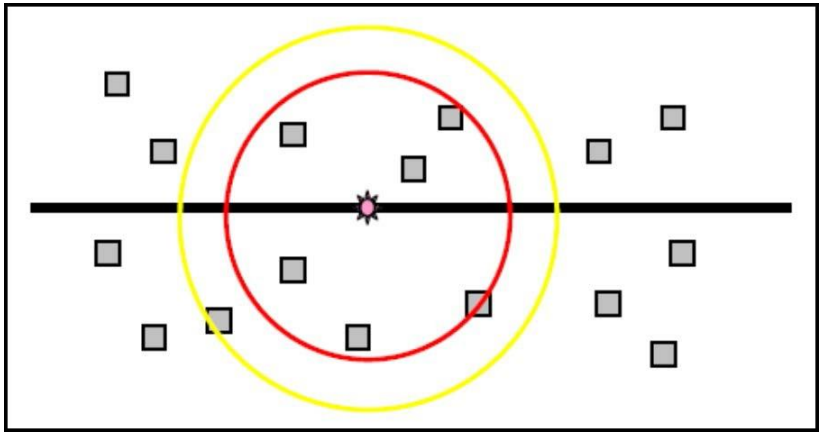
Failure of a pipeline due to third party damage is the product of two independent factors:

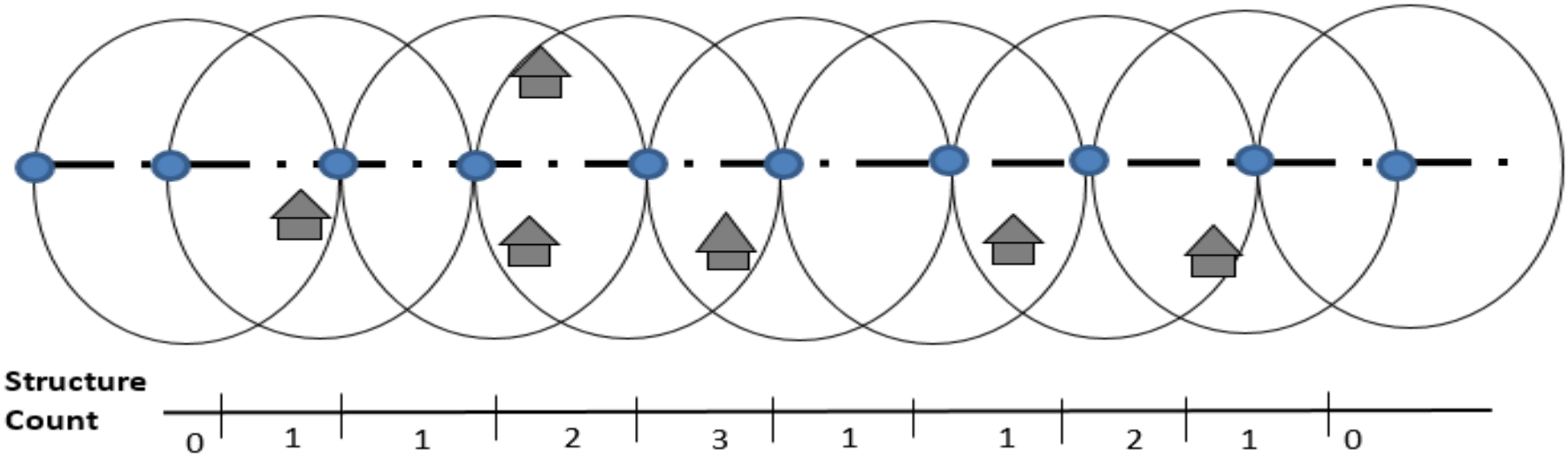
- The susceptibility of the pipeline to incurring a hit by a third party ('H'); and,
- The susceptibility to failure of the pipeline, given a hit ('S_f').

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



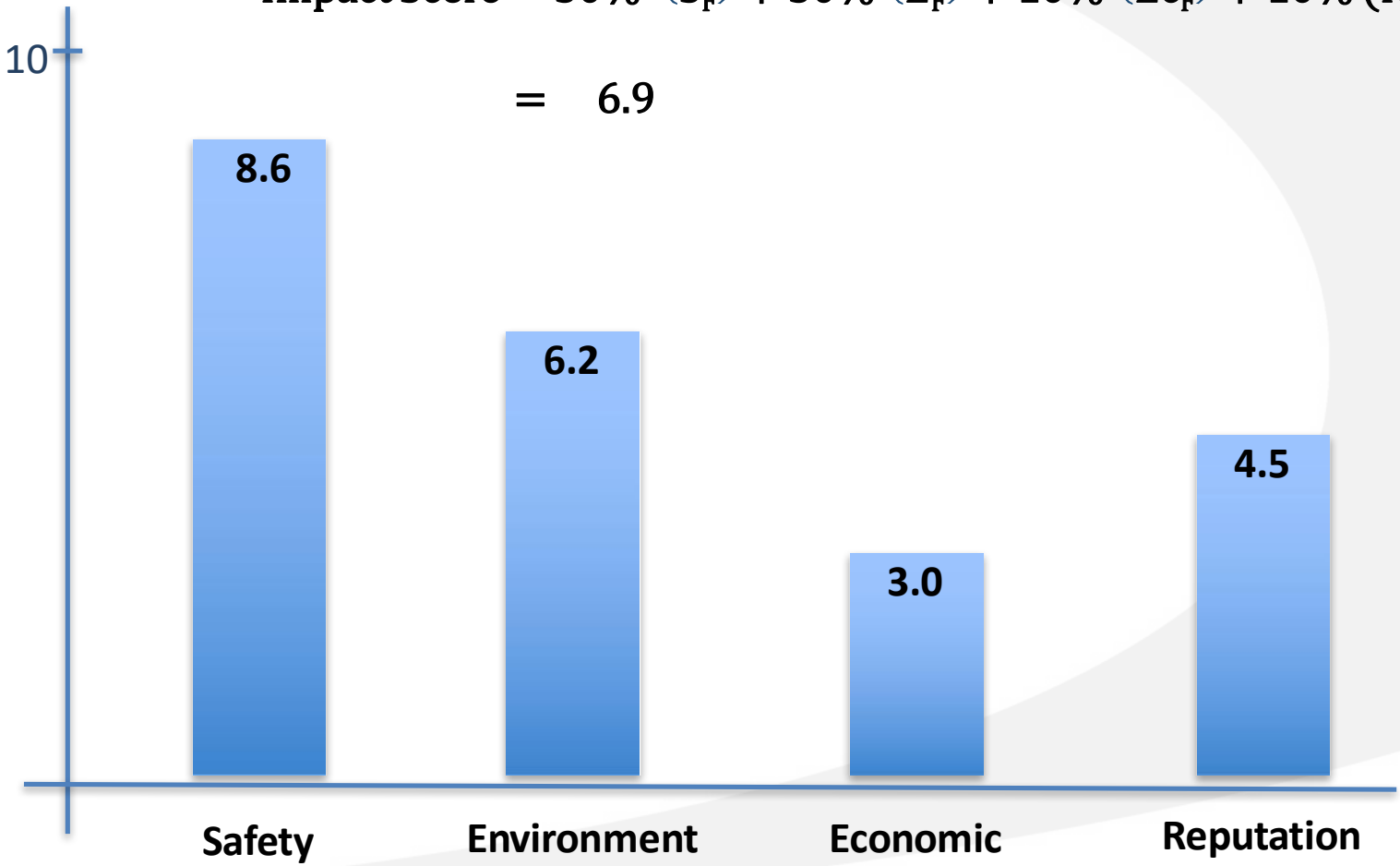


Impact Summary (Weighted)

Dynamic Risk

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

$$= 6.9$$

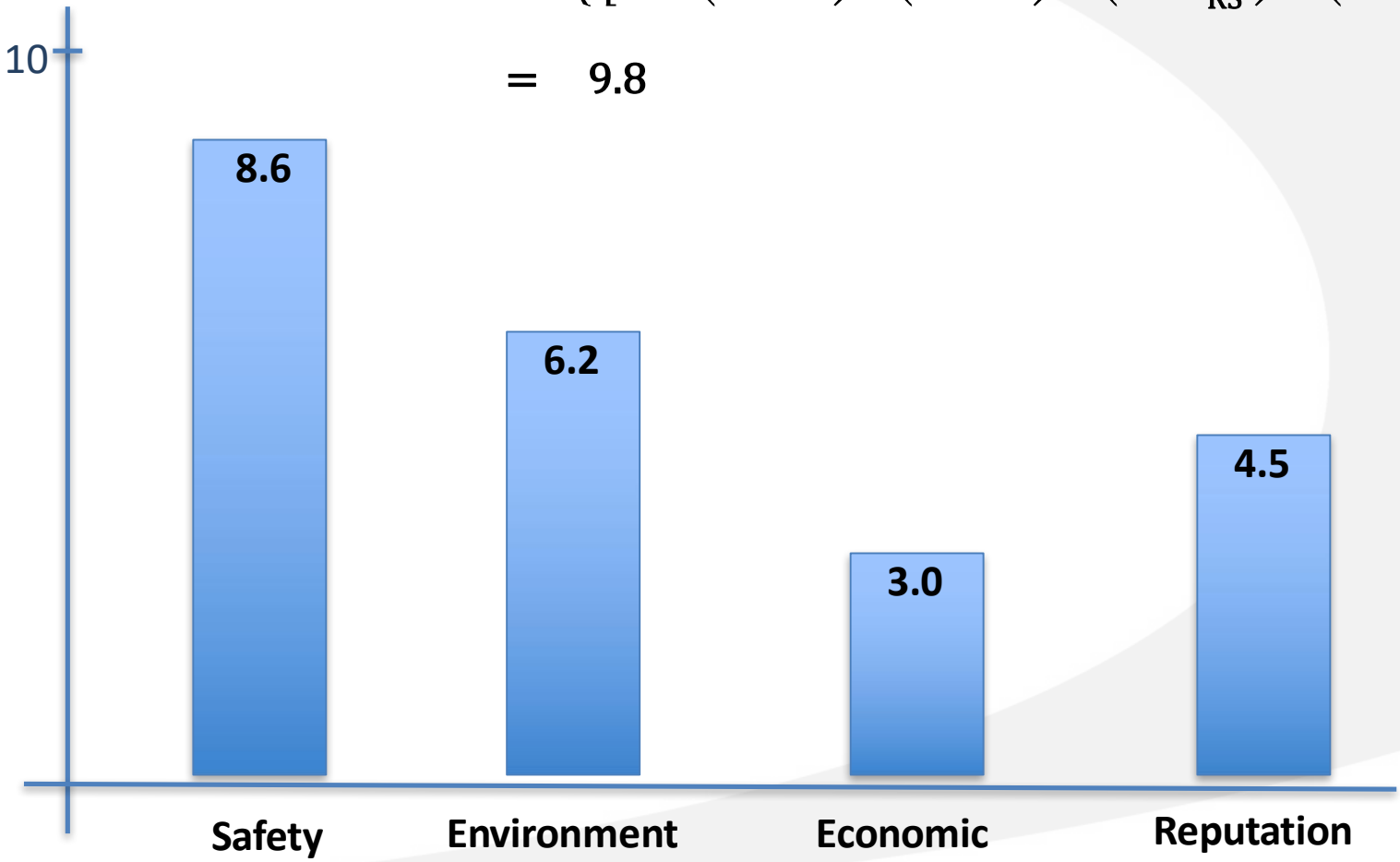


Impact Summary (Or Gate)

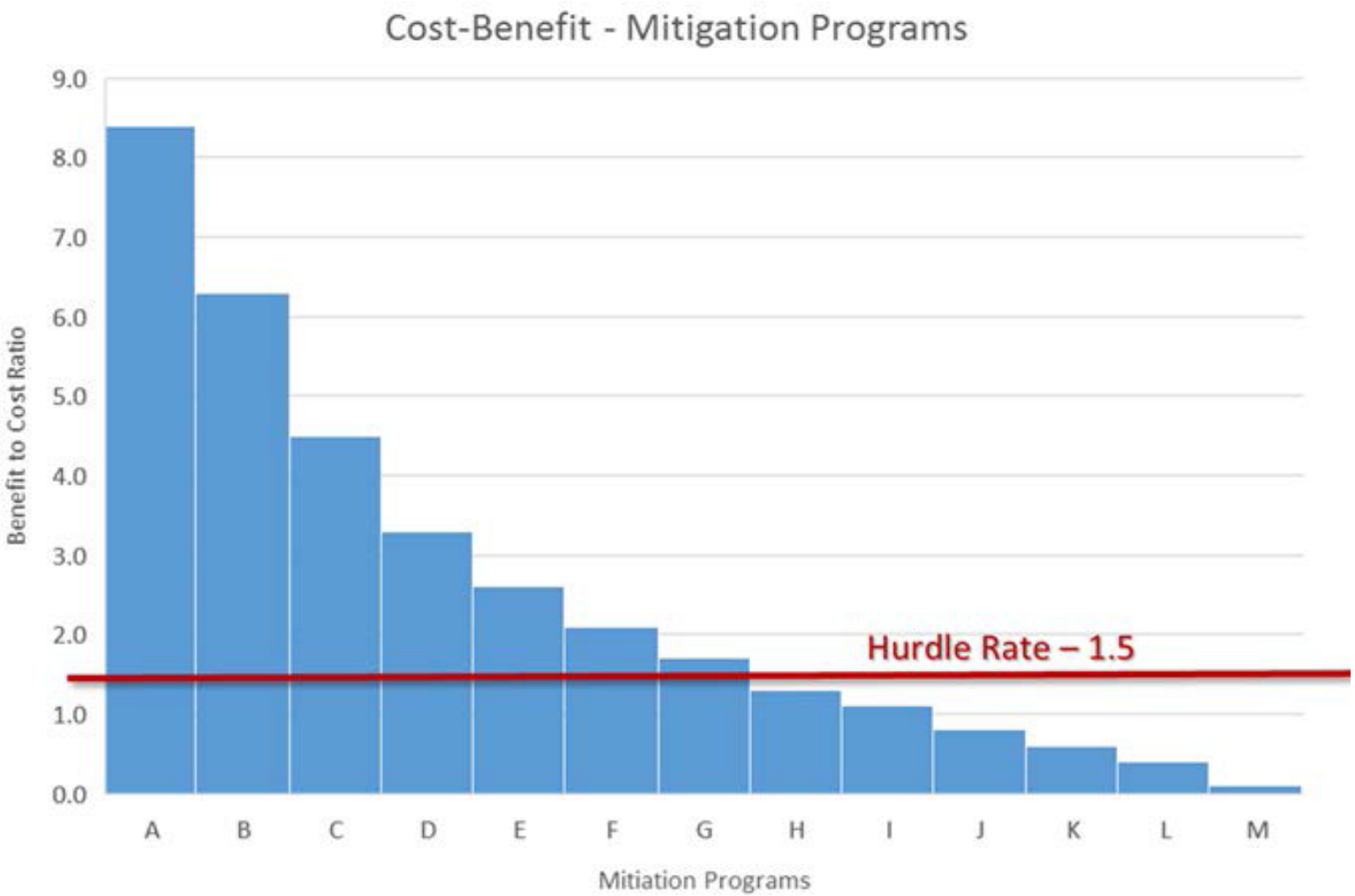
Dynamic Risk

$$\text{Impact Score} = \left\{\left[1-\left(1-\frac{P_Q}{RS}\right) x \left(1-\frac{U_Q}{RS}\right) x \left(1-\frac{UV_Q}{RS}\right) x \left(1-\frac{W_Q}{RS}\right)\right]\right\}$$

$$= 9.8$$



Risk Mitigation Benefit



Risk Model – Why we do it?

Dynamic Risk

- Identify highest risk pipeline segments.
- Highlight pipeline segments where the risk is changing.
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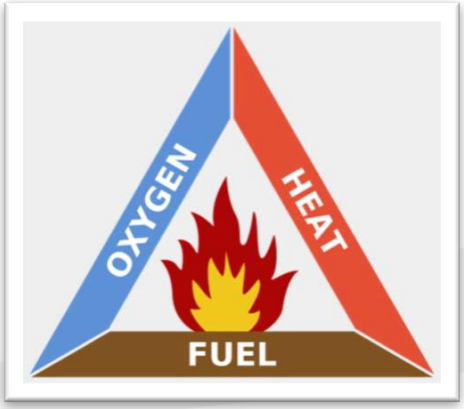
Low Frequency, but High Impact Events

Dynamic Risk

- 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.



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 strong correlation between this result and the type of risk model they use!

Performance Break-through

Dynamic Risk

- 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.

Dynamic Risk

To learn more about the future of pipeline risk management contact us at:

info@dynamicrisk.net