Lessons Learned In PL Risk Assessment
Historical (Informal) Risk Mgmt

ADVANTAGES:

• simple/intuitive
• consensus is often sought
• utilizes experience and engr judgment
• successful
Historical (Informal) Risk Mgmt

REASONS TO CHANGE:

• more at stake from mistakes
• inefficiencies/subjectivities
• lack of consistency
• need to consider complicated factors
Risk Management Objectives

Reduce risks

Reduce costs

Increase understanding
  – decision support tool
  – resource allocation tool
Risk Management Process

I. Perform a risk assessment
   assign values to all conditions and activities

II. Establish Risk Targets
   benchmarking

III. Allocate Resources Accordingly
Pipeline XYZ, having conditions...
A
B
.
.
...and operated as...
D
E
.
.
...has a risk of failure of _____
The Role of Statistics

*Probably the single best decision support available*

Problems:

- Historical data usefulness in current situation
- Small amount of data in rare-event situations
Traffic Impact Event
## Simple Matrix

<table>
<thead>
<tr>
<th>Probability</th>
<th>Low</th>
<th>Med</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td><strong>Med</strong></td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Consequence</th>
<th>Low</th>
<th>Med</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>Med</td>
<td>4</td>
<td>5</td>
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</tr>
<tr>
<td>High</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>
PRA Event Sequence

High MV Vehicle on Road

Vehicle leaves road

Vehicle hits barrier

Barrier yields

Vehicle hits pipe

Pipe ruptures

%Probability

%Probability

%Probability

%Probability

%Probability

likelihood
PRA Factor Analysis

- Speed/mass
- Angle of impact
- Barrier materials/geometry
- Distance/soil type to barrier
- Barrier defects/strength
- Prob barrier yield
Index Analysis

- Most important factors
- Relative contribution to risk picture

Index Model
Indexing Analysis

traffic volume/type 30%
barrier type 40%
distance from roadway 30%
Review of 10 Indexing Models

Failure categories covered

- Op Err
- Design
- Corr
- 3rd Party

Models
Number of Probability Factors Considered

- 60
- 56
- 29
- 14
- 11
- 8
- 4
- 4
- 3

Models

Prob Factors

0 10 20 30 40 50 60
Favorite Prob Factors

Coating type/condition
Age
Wall Thickness
Hydrotest
Leak Hist
CP Hist
Some Other Common Prob Factors

SCC
Pressure
Diameter
Soil Condition
Joint Type
More Exotic Prob Factors

Transition Temp
Op Training
Drug Testing
Goodwill Factor
Public Education
Manufacture Plant
Sabotage Hist
Repair Access
Mining Activity
Cycles
AC Power
Number of Consequence Factors Considered

Conseq Factors

Models

0 2 4 6 8 10

Conseq Factors
Most Common Conseq Factors

Class location (or equivalent)
Security of Thruput
A Very Simple Model

Pipeline Index  =  C  +  W  +  A  +  Cl  +  S

where

C = Coating
W = Wall Thickness
A = Age
Cl = Class location
S = Security of Throughput
Issues in risk modeling

sources of information
cost/benefit of the analysis
“objectivity”
reproducible results
defensible
Lessons Learned

1. Work from general to specific
2. Think 'organic'
3. Avoid complexity
4. Use computers wisely
5. Build the program as you would build a new pipeline
6. Study your results
I. Work from general to specific
II. Think “organic”
risk results, resource allocation model, presentations, etc

HAZOPS, FMEA, Event/fault trees, etc

pipe specs, inspection data, statistics, etc
III. Avoid complexity
IV. Use computers wisely
V. Build the program as you would build a new pipeline
Project Phases

- Conceptualize
- Route selection
- Design
- Material procurement
- Construction
- Commissioning
- Project completion files
Picking a PL Risk Assessment Approach
Balancing

Identifying an exhaustive list of contributing factors

vs

Choosing the critical few to incorporate in a model

(comprehensive vs complex vs simple)
Balancing

"Hard" data and engineering judgement

(how to incorporate widely-held beliefs which do not have supporting statistical data)
Balancing Uncertainty vs Statistics

(how much reliance to place on predictive power of limited data)
Balancing

Flexibility

vs

Situation-specific model

(ability to use same model for variety of products, geographical locations, facility types, etc)
Sectioning

A

B

C

Metropolis

swamp
The Ideal Risk Model

simple/easily understandable
comprehensive
accurate predictor
expandable
cheap
Risk Assessment Program
Costs (initial)

Study A: 200 miles of pipeline and 8 stations in 5 months
Study B: 700 miles of pipeline and 20 stations per month
Project Completion

- documenting all aspects
- assigning responsibilities
- measuring improvement
- re-visiting processes
- management of change

(see DOT documentation, “Admin Elements”)

Lessons Learned

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5. Build the program as you would build a new pipeline
6. Study your results
VI. Study your results
Resource Allocation Modeling
## Management Options

<table>
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<tr>
<th>Resource Allocation Choice</th>
<th>Cost Impact</th>
<th>Risk Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase Public Education</td>
<td>+ $4000</td>
<td>- 0.8%</td>
</tr>
<tr>
<td>Perform Close Interval Survey</td>
<td>+ $11000</td>
<td>- 2.6%</td>
</tr>
<tr>
<td>Reduce Air Patrol</td>
<td>- $7600</td>
<td>+ 1.1%</td>
</tr>
<tr>
<td>Perform Hydrostatic Test</td>
<td>+ $67000</td>
<td>- 8.2%</td>
</tr>
</tbody>
</table>
Conclusions

• RA/RM should be cost effective

• Few roadmaps to follow

• Manage as any large project

• Risk Management is a valuable tool
If you don’t have a number,

you don’t have a fact,

you have an opinion.