NYSEARCH Modeling of Pipeline Interacting Threats

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Kiefner Original Risk Model

- Evaluates 9 primary threat interactions
  - Time dependent, independent and stable
- Quantifies consequence
  - Threat exposure, mitigation and resistance
- Utilizes operator specific data
  - Provides feedback mechanisms
- Incorporates SME and regulatory input
  - Valuable collaboration
  - New interacting threat risk model

New Kiefner IT Model Goals

- Identify interacting threats
  - Kiefner Failure Database
  - SMEs from NYSEARCH Funder Advisory Group
  - Industry papers, past experience
  - PHMSA 'Reportable Incidents Database'

- Develop rationale/technical support for selected interactions

- Develop method for quantifying interacting risks

- Modify software for calculating interacting risks

Defining Interacting Threats

$$P_{(Threat\ 1\ \&\ Threat\ 2)} > P_{Threat\ 1} + P_{Threat\ 2}$$

- 10% of DOT incident data analyzed - 2 or more interacting threats

- 16% of all interacting threat incidents- original Kiefner model interacting threats

  (SSC & EM/girth welds)

- 30 additional threat interactions identified- relative risk algorithms

  (9 and 21 threat matrices)

Algorithm Development

- Normalize coefficients

- Compare # failures due to threat interaction to # failures due to one threat
  - Driving threat
  - Variable threat (increased failure frequency)
  - More rapid degradation, increased stress or load, reduced tolerance to flaw or loading

$$R_{INTERACTING} = R_{PRIMARY} + \Sigma P_i * (R_{PRIMARY} + R_{VARIABLE})$$

P_i = increased likelihood of failure for a pair of threats

Threat Matrix Example

ORIGINAL SCORE		INTERACTION COMPONENT	INTERACTING SCORE
EC	115	42.77	157.77
IC	40	11	51
SCC	25	0	25
DP	40	0	40
DPS	135	0	135
DFW	10	0	10
DGW	60	0	60
CD	10	2.78	12.78
MCRE	5	9.04	14.04
TSBPC	5	0	5
GF	5	0	5
SPPF	5	0	5
IO	60	19.71	79.71
TP	295	9.08	304.08
PDP	50	7.05	57.05
V	5	0	5
EM	40	36.99	76.99
HRF	25	44.33	69.33
LIGHT	5	2.19	7.19
CW	5	0	5

TOTAL 940   **+**   **=**   **1124.94**

Threat Matrix Example (cont'd)

	ORIGINAL SCORE	INTERACTING SCORE	% CHANGE
EC	115	157.77	37%
IC	40	51	28%
SCC	25	25	0%
DP	40	40	0%
DPS	135	135	0%
DFW	10	10	0%
DGW	60	60	0%
CD	10	12.78	28%
MCRE	5	14.04	181%
TSBPC	5	5	0%
GF	5	5	0%
SPPF	5	5	0%
IO	60	79.71	33%
TP	295	304.08	3%
PDP	50	57.05	14%
V	5	5	0%
EM	40	76.99	92%
HRF	25	69.33	177%
LIGHT	5	7.19	44%
CW	5	5	0%

TOTAL 940   1124.94   **20%**

New Model Advantages

- Prior to implementation of IMP risk models, Operators:

  - Collected limited interactive threat data

    - Conducted independent system analysis on threat interactions

  - Experienced difficulty quantifying and integrating interactive threat risk scores into model

- Upon new Kiefner IT model implementation, IT risk scores are data quantified and easily integrated into an Operator's risk model

Operator Implementation

- Operators have two options for updating their risk models to include pipeline interacting threats:

- Updated NYSEARCH/Kiefner risk model (e.g. National Grid, National Fuel, Central Hudson)

- Interacting threats risk model incorporated into quantitative model (spreadsheet) (e.g. PG&E, Con Edison, Questar)

Operator Implementation Example
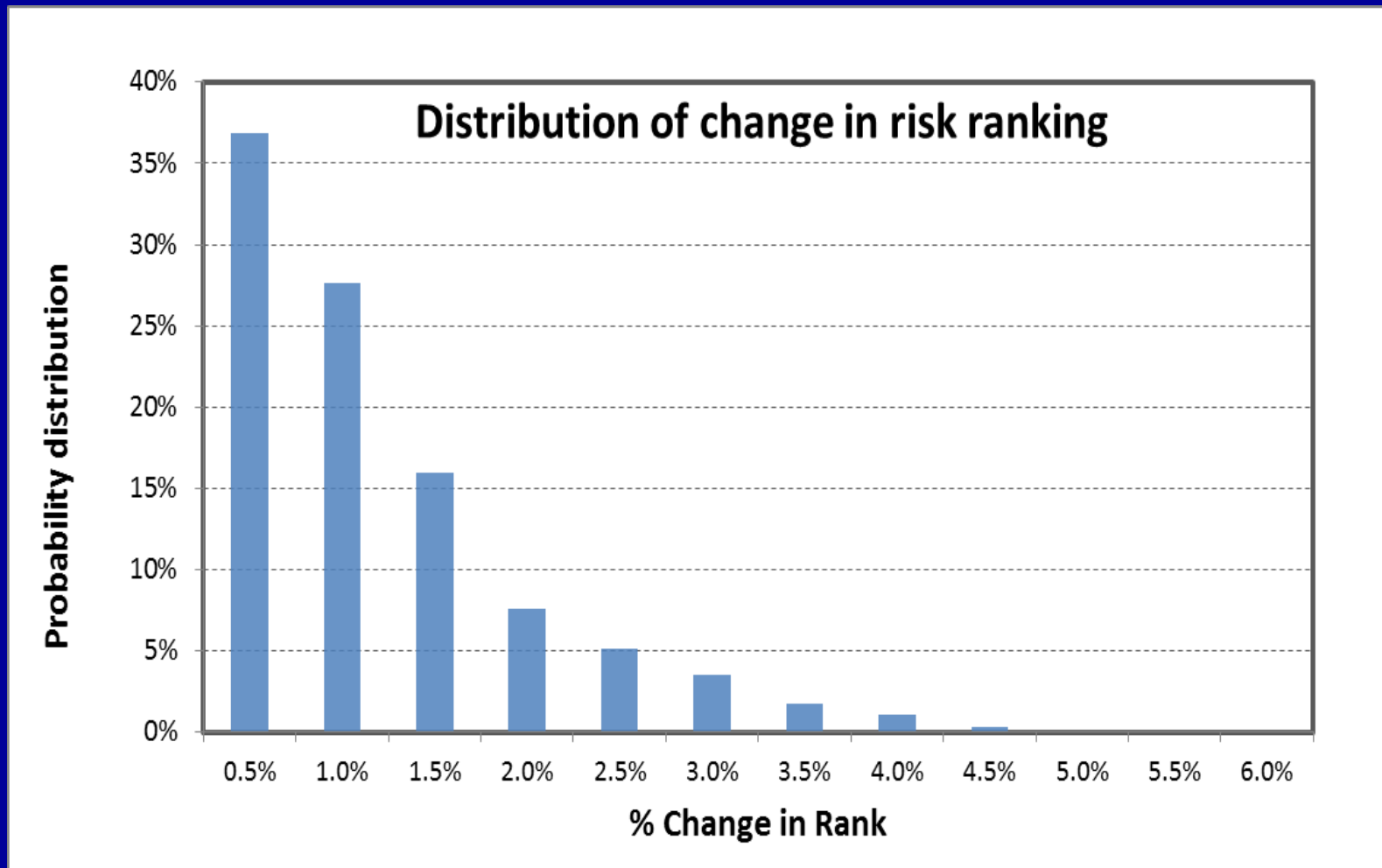
- One large operator's change in risk model segment risk ranking
- (≈27,000 segments)

Related Operator Activities

- Identify interactive threats in all root cause incident analysis

- Conduct periodic reviews of algorithm coefficients

  - based on operator experience

- Provide feedback for future model enhancement

THANK YOU

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