**Risk Modeling Work Group Agenda and Notes**

**Location of Meeting**: API Offices, 1800 West Loop South, Suite 1210, Houston, TX 77027

**Meeting Purpose**: Index Model Applications & Evolving to More Quantitative Models

**Date:** Thursday, June 15, 2017

**Attendees:** Participants listed at the end of this document.

**Meeting Action Items (identified by “\*\*” in the notes)** *None Identified*

1. Introductions / Safety Moment (Stuart Saulters; API / Steve Nanney; PHMSA)
	1. Introduction of Attendees, Safety Moment, Meeting Logistics and Timing

*Be cautious when doing home repairs – drilling (line of fire), etc. can be demonstrably hazardous (Stuart Saulters).*

* 1. Anticipated RMWG schedule

• *June 15, 2017 Index Model Meeting*

*o PHMSA internal full report draft comments by 7/21/17*

*• Draft report to RMWG by 8/4/17*

*o RMWG report comments due by 9/1/17*

*• Revise Document – final review late Sept.*

*• Final draft of the Risk Modeling Technical Guidance Document to PHMSA HQ for review by early 10/2017*

*• Public workshop – TBD – late Fall*

1. Technical Presentation #1: SME Input into Pipeline Risk Models (Chris McLaren; PHMSA)

*SME input is an aspect of most pipeline risk models*

*Complete and accurate records are not always available for every segment and some risk model inputs may not be obtainable from records*

*General guidelines discussed – SME qualifications, communication of what terms and nomenclature really mean, etc.*

*Process guidelines discussed – facilitated discussion important, rules for difference of opinion, etc.*

*Past RMWG technical presentations aspects of SME input summarized – Patev, Kendrick, Youngblood, Muhlbauer, Skow.*

*Conclusions:*

* *The need for SME-derived input to pipeline risk models is a virtual certainty – inevitable*
* *Be careful to have guidelines and a clearly defined process to obtain these inputs*

*Improve consistency over entire pipeline system and optimize future SME input from different personnel*

* *Detailed process descriptions will help reduce scatter/uncertainty in SME collected data*

*Team discussion:*

* *Encouraged a specific section on SME input in the technical guidelines documents.*
* *TCPL: Update SME input/results on annual basis; (because SME knowledge should and will change with time just as data changes with time); understand the limits of applicability of the SME input as it depends on the expert’s realm of experience (often specific to the system they are familiar with but should not be applied to other systems); check SME input with data and vice versa as both have limits of applicability and a limited framework in which it is relevant; work to get SME input results to converge in a reasonable manner (e.g., by regression against historical failure data trending).*
1. Technical Presentation #2: Index Models and Applications (Trevor MacFarlane and Patrick Vieth; Dynamic Risk)

*Using relative index models – Limitations and Strengths*

*Evolution of risk analysis – moving toward risk-based decision making, enterprise risk management, corporate sustainability. Have better technology/IT systems that facilitate data integration, have a lot of direct (e.g., ILI) inspection results. Overall objectives of risk models ultimately result in improved system reliability and elimination of high impact events.*

*New definition of risk models – Not either/or terminology, but more of a continuum. Suggest three terms – qualitative, semi-quantitative, quantitative. Most operators lie in the middle somewhere, with quantitative work sometimes behind a simple factor that gets applied in an index type of approach.*

*For example, B31.8S may have a general ILI inspection factor – might treat as a generic factor, but really is better to use the ILI data to better characterize the actual condition of the line (e.g., one segment may have a much higher density of below-threshold anomalies, vs. one that has a small number of below-threshold, anomalies; these should be treated differently in a risk model). This level of information can drive the simple factor entered into a B31.8S type of model.*

*Approach often uses OR logic to sum elements of risk, vs. weighting factors (that tend to minimize outliers). (With use of OR logic, the sum cannot be less than the single-highest factor).*

*Also showed event tree approach for external strike risk – enables impact on P&M measures, that can be expressed as a simple factor in a B31.8S type of approach.*

*This type of scoring, as applied to Index/relative models can help prioritize P&M measures via cost-benefit via “hurdle rate.”*

*Low frequency high consequence (LFHC) events: analogy of fire triangle (O2, heat, fuel) – assume have high consequence event, and ask “what would we do?” E.g., corrosive HL transport, need to prevent buildup of corrosion products as specific locations, so concentrate on that aspect to model/reduce risk.*

*The performance break-through – Noted they have observed no difference in selection of risk model approach vs. high impact pipeline release performance. Difference is that companies that actually use risk analysis to support IM planning and decision making achieve the best reliability record. This assumes a base-level of sophistication in the risk model (very simple risk models will have difficulty identifying true high-risk situations).*

*Team discussion:*

* *For event-tree approach, how assign probabilities? SME, other? Looked at TPD events and analyzed to get the assumed probabilities. SME input is valuable, but look for data first and then supplement with appropriate SME input.*

*Discussion pointed out that quantitative risk can be easier for site-specific applications, than for more generic system-wide applications.*

* *How treat information that is not available or readily applicable? Absence of information is an indicator of higher risk. Address by assigning a higher “risk” to those variables (know what you don’t know), which drivers risk profile and results in the gathering of better information.*
* *Management of Change and continuous improvement are important for a company to have successful management of risk – i.e., results in a culture of improvement and looking to reduce risk.*
* *Should not only question/qualify SME input, should also question/qualify industry/generic data to make sure is really applicable to the specific line segment being modeled.*
* *Critical, essential elements of any risk process include – leveraging actual ILI information, and looking at each threat category individually in addition to overall system risk (tends to get muted in index type of approaches). Why doing a particular risk analysis often drives the method.*
* *How incorporate inspection data for things not piggable? Approaches include proxy data sets for similar piping, looking at CP current levels, etc. Lack of information should be reflected in risk results. Look for statistically valid sample of limited data from system to help characterize.*
* *Overall (per Vieth) – underlying engine should be quantitative, but can be expressed as a more basic/simple factor to be used in a more qualitative type of model. Is essentially a semi-quantitative approach.*
1. Technical Presentation #3: Migration From Older Risk Analysis Methods to Quantitative Models (Kent Muhlbauer; WKM Consultancy)

*Quantitative models are more simple and easier to manage than non-quantitative models (noted that pipelinerisk.net is available as a free resource for risk practitioners).*

*Monetization of risk is necessary for decision makers vs. index type of numbers (much easier to understand and communicate risk results when there is a tangible basis).*

*Regulatory Standards – risk analysis is the centerpiece of IMP regulations.*

 *Is a current disconnect between IMP objectives vs. risk analysis techniques*

 *Summarized a set of suggested changes needed to B31.8S / API 1160*

 *PHMSA on record criticizing index models (but are currently allowed by guidance documents such as B31.8S)*

*Tools vs. models – Terminology is not consistent; instead suggest there are only two type of models: absolute results, relative results. Ingredients found in all valid risk models: probabilistic methods (scenarios, trees; statistics), and SME (input and validation). Tools are not risk analysis methods – tools are scenarios, event/fault trees, etc. What defines a risk analysis “method”? Must be able to pass the “map point” test – i.e., can analyst answer questions about the risk profile at any place someone can point to on a map? From this definition, one can derive a fairly short list of good (and “acceptable”) risk assessment approaches.*

*Risk analysis Is essentially a diagnostic tool – receiver operating characteristic (ROC) curve.*

*Best Practices –*

*CoF is now relatively robust. Consequences are generally better understood than likelihood, but must consider “most probable” in addition to “worst case” scenarios.*

*PoF: Operators should now evolve to a modernized approach versus index model approach. Stated “no defensible reason to use a relative risk assessment methodology.” Must really do a quantitative approach that can produce verifiable numbers. Note: This does not need to be overly complex.*

*Basic approach is to include exposure, mitigation, resistance (everything can be put into these three bins).*

* *Exposure: either time independent (events/mile-year) or degradation (mm/yr).*
* *Mitigation: estimating effectiveness of mitigation (multiple layers of swiss cheese analogy)*
* *Resistance: can estimate in various ways (simple or complex)*

 *Approach is similar to typical design methodologies, but decouples mitigation from exposure, and de-emphasizes details of underlying probability theory.*

*Data – Is a myth that QRA requires vast amounts of incident histories. Reality is that QRA requires no more data than other techniques. All RA approaches work better with better data. Statistics-centric modeling approaches have weaknesses.*

*Migrating from index models to something better (quantitative/probabilistic model) – six step process outlined. Stated there is no basis for the use of weightings in risk analysis approaches.*

*Team discussion:*

* *Discussion was not in complete agreement with the assertion that index models should no longer be used for pipeline risk modeling.*
1. Open Discussion Session #1 (Dane Spillers; PHMSA)
* *Simplistic qualitative oriented models are likely to stay in play to some extent (e.g., very small operators), but the benefit of moving to a more quantitative approach should be recognized.*
* *SME in an important aspect of risk modeling; need to pay attention and make this a quality level of input.*
* *External review of model by a third party SME can be a useful exercise.*
* *It may be that the SME function should ultimately be a “qualified” (or equivalent) task similar to other pipeline functions?*
* *Are RA results similar after translation from an index model to a quantitative model? Not necessarily, as the index models do not include the actual magnitude of risk driver differences, have non-algebraic logic that results in fundamentally different results, etc.*
* *Noted the technical guidance document should clearly outline the benefit of applying more quantitative approaches (help justify any increased resource level (or perception of increased level of resource)).*
* *Noted precursor analysis can be useful to help identify the unknown unknowns.*
* *If have index model score, how directly translate/compare to a quantitative score? WKM – cannot do, just recalculate the risk. Dynamic Risk – says have had success in looking at ranking of segments, but underlying risk engine allows more quantitative information to be in the model. TransCanada –says depends on purpose of risk assessment; if looking for information such as dominant threats on a specific location (so that the dominant threats can be mitigated) it is very difficult for an index model to technically achieve as it cannot compare between threats. Index scores are not comparable between threats but if PoF can be calculated in terms of a threat independent parameter such as failure rate it becomes threat independent and therefore comparable between threats, enabling the meaningful calculation of total probability of failure due to all threats.*
1. Technical Presentation #4: Index Models and Applications (Cindy Ansligner and Jarrett Compton; Vectren)

*[Noted presentation is for Vectren’s transmission model; have separate model for distribution.]*

*Use GeoFields products RiskFrame Modeler for risk, and RiskFrame HCA to evaluate Class and HCA locations.*

*Have five main defined goals for their risk process, but noted that risk analysis is a tool for the IM process, but is not the principal driver for the IM process.*

*Risk Model Review Process – do annual run of risk model and perform a plan/do/adjust/check process (culminates in 4th quarter annual review with SME’s and field personnel to verify algorithm and recommend improvements).*

*Risk model is a weighted relative index score approach – involves 119 inputs. [CoF includes population, business, and environment; weighted 10/7/1.]*

*Data fields of particular general company interest include single feed locations (particular issue in the winter; working to eliminate issue), current year install date, high occupancy locations, and line markers (TPD minimization).*

*LoF weightings stated as being based on the Vectren system, vs. generic industry data (also noted that they matched well with PHMSA industry 20-year incident cause data).*

*Account for assessments by reducing factor based on assessment results; is reduced/diminished over the time period since an assessment was performed.*

*RoF binned into six basic bands of risk level. These bands are show on GIS maps for company personnel to utilize.*

*Do sensitivity studies to see how any one factor affects the risk score – tornado diagram type of presentation to see most important factors.*

*Also do a model validation with specific operating area personnel to demonstrate areas of higher/lower relative risk as part of results validation.*

*Use scenarios to simulate effectiveness of specific assessments for individual line sections. Can also build other scenarios.*

*Do have areas of missing data – handled on an individual basis. Put in conservative values as a placeholder, but also doing physical work to fill in the gaps (e.g., pipe grade and wall thickness). For example, for documented test pressure: all HCA gaps remediated by end of 2016, all transmission gaps remediated by 2020. One of biggest current data gaps is seam type.*

*Lessons learned – RoF=LoF\*CoF over emphasizes the consequence portion; large number of risk segments makes prioritizing individual segments difficult; need to account for cost of remediation activities outside of the risk model for project prioritization.*

*Team discussion:*

* *Noted Vectren (like many others) has absolute values for cost, but only have relative risk comparisons (inherent aspect of weighted index model).*
* *Noted that the slide 8 LoF weightings drive results overall, but does not identify individual segment risk that happens to be different for segment-specific reason (inherent aspect/limitation of weighted index model).*
1. Technical Presentation #5: Data Quality for Index Models and Migration to Quantitative Models (Ernest Lever; GTI)

*Complexity science – “Number of words to describe something”; is closely related to information content. Complexity vs. scale should be considered when discussing risk modeling approaches.*

*Predicting the future – past is a poor indicator of the future; why? Real world “systems of systems” behavior can take a long time to see all interaction states; independent event interactions are not influenced by past events (i.e., the process has no memory) and it is challenging to predict these interactions for any specific time period.*

*Predicting the next outcome (developing distributions for risk models) – Need to identify possible system states. Can think of as a series of Bernoulli interactions, therefore can define a beta distribution from data. Can then apply Bayesian updating for field data. Typical application can be sampling to determine if a known defect is present (or extent of presence) in the overall population (e.g., hypergeometric sampling).*

*Incorporating Data Quality Metrics – For poorly understood system, data quality score is arrived at through an audit process. How extrapolate to the broader system as a whole? Is a risk tolerance issue for an organization to decide. Can then evaluate validity of available data. Can use Bayesian update techniques to update data to understand areas of higher uncertainty and then work to improve overall data quality over time. [Is analogous to six sigma approaches that identify the most important process/variable and optimize that.]*

*Subject Matter Expertise – various techniques available to elicit and combine. Noted that it is possible to construct hybrid Bayesian networks that compare the performance of competing expert models given different data.*

*Optimization – E.g., risk reduction activities. Noted that it is important to evaluate many diverse approaches and identify which approach is best for particular situations (situational awareness). Also important to update on a frequent basis to understand if overall risk is trending in the correct direction.*

*Team discussion:*

* *How make all this actionable? Is often as much a matter of how the risk analysis is handled by the overall risk management approach, as opposed the details of the particular modeling approach that is adopted.*
* *Industry unified approaches for risk analysis approaches would be useful.*
1. Exit De-briefing (Steve Nanney)
	1. Any needs from scribe for exit notes? *None identified.*
	2. Any group member comments on the conduct of the meeting and any improvements that could be implemented? *None identified.*

**Attachment 1 – Meeting Participants (\* indicates remote participant)**

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| Name | Organization |
| Ernest Lever | GTI |
| CJ Osman\* | INGAA |
| Chris Mclaren | PHMSA |
| Shahani Kariyawasam | TransCanada |
| Mark Hereth | P-PIC |
| Keith Leewis | Leewis & Associates (B31.8 & B31.8S) |
| Stuart Saulters | API |
| Mark Piazza | Colonial Pipeline |
| Jacob Steere\* | Consumers |
| Mark Clayton, Mark | CenterPoint Energy  |
| Steve Nanney | PHMSA |
| Erin Kurilla | AGA |
| Mohamed Elaoudiy | Phillips 66 |
| Charlie Childs\* | Kinder Morgan |
| Brandon Cavendish | Colonial Pipeline |
| Vincent Holohan\* | PHMSA |
| Mason Matthews\* | Athens Gas Utilities (APGA) |
| Dane Spillers | PHMSA |
| David Kuhtenia | Cycla |
| Pat Westrick\* | Marathon Pipeline |
| Steve Allen\* | URC of Indiana (NAPSR) |
| Robert Youngblood | INL |
| Patrick Vieth | Dynamic Risk |
| Kent Muhlbauer | WKM Consultancy |
| Cindy Ansligner | Vectren |
| Jarrett Compton | Vectren |
| Trevor MacFarlane | Dynamic Risk |