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Issue Management Risk Ranking Systems

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The Issue Management Risk Ranking System

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Abstract

Thousands of safety issues have been collected on-line at the Idaho National Engineering and Environmental Laboratory (INEEL) as part of the Issue Management Plan. However, there has been no established approach to prioritize collected and future issues. The authors developed a methodology, based on hazards assessment, to identify and risk rank over 5000 safety issues collected at INEEL. This approach required that it was easily applied and understandable for site adaptation and commensurate with the Integrated Safety Plan. High-risk issues were investigated and mitigative/preventive measures were suggested and ranked based on a cost-benefit scheme to provide risk-informed safety measures.

This methodology was consistent with other integrated safety management goals and tasks providing a site-wide risk informed decision tool to reduce hazardous conditions and focus resources on high-risk safety issues. As part of the issue management plan, this methodology was incorporated at the issue collection level and training was provided to management to better familiarize decision-makers with concepts of safety and risk.

This prioritization methodology and issue dissemination procedure will be discussed. Results of issue prioritization and training efforts will be summarized. Difficulties and advantages of the process will be reported. Development and incorporation of this process into INEELs lessons learned reporting and the site-wide integrated safety management program will be shown with an emphasis on establishing self reliance and ownership of safety issues.

Introduction

The Idaho National Engineering and Environmental Laboratory (INEEL) has established safety as a primary concern in its current and future work. In attempting to modify the workforce behavior to consciously care for personal safety and the safety of co-workers, several programs have been administered under the umbrella of the Integrated Safety Management (ISM) program. One of these programs is the Issue Management program that focuses on the collection and resolution of problems associated with unsafe conditions at the INEEL.

Unsafe conditions or concerns are reported into the ICARE system as issues by anyone providing work services to the laboratory. The ICARE system is maintained by an on-line computer based issue tracking and entering Intranet system available through standard worker access routes. These unsafe conditions or concerns reflect procedures, administrative controls, physical hazards, improper or inadequate safety barriers, or other issues that may result in a decrease in safety and, therefore, an increase in the risk of some adverse consequence to the site.

The nature of the issues collected was wide ranging due to the flexibility of the ICARE system and job diversity performed at INEEL. Although the collection of issues in the ICARE system was successful with more than 5000 records reported, the dissemination of issues based on the significance of each issue was non-standardized. This paper describes the methodology created to standardize the resolution and priority of issues and their significance based on a risk-informed approach. This methodology establishes the framework for the corrective actions and lessons learned program implementation.

Risk-Informed Methodology Development

Approach Requirements: Early in the issue dissemination process, it was recognized that all issues entered in the ICARE system had different levels of significance and that importance of an issue could be interpreted in various ways. The need for standardizing the prioritization process was evident. In addition, the results of this process needed to support and mold the corrective actions and lesson learned tasks slated to follow the dissemination process. Lastly, the approach needed to lend itself to some measurement of site safety performance, for current and predictive indicators of safety.

A risk-informed approach was suggested and adapted for the Issues Management program, because it could accomplish prioritization of issues and provide the basis for specific management strategies and technologies to increase safety. This methodology was consistent and paralleled the approach of the hazard assessment task being performed by the ISM initiative.

Issue Dissemination Process: The methodology developed to disseminate issues through a risk-informed prioritization and ranking scheme was adapted from military standards (ref. 1) and modified to more closely parallel hazard assessments performed at the INEEL (refs. 2-3). Dissemination of issues are accomplished by identifying potential hazardous conditions of the issues, causes of those conditions, the potential effects and consequences, the associated risk with the issues, and suggested mitigative measures to reduce high risk issues to a more reasonable level. This methodology supports the issue management objective of checking and tracking that system safety questions are considered, addressed, and resolved in a efficient manner.

Issue dissemination was accomplished using a systematic approach to identify hazardous conditions, causes, and consequences, risk, and mitigation. The general approach consisted of eleven steps:

1. Issue familiarization
2. Informal task analysis
3. Hazard identification
4. Scenario development
5. Cause identification
6. Consequence development
7. Preliminary Risk Assessment Code assignment
8. Identification of corrective measures
9. Final Risk Assessment Code assignment
10. Cost-benefit determination of corrective measures for high risk issues
11. Selection of cost-effective measures

These steps and the information collected during the dissemination process were collected and entered into a database. Each step is described in more detail below.

System Familiarization: Written information, such as concepts, specifications, drawings, procedures, and processes were collected. Issue analysts then discussed operations plant personnel directly involved in the issue, if required.

Informal Task Analysis: Task analysis involves the identification of tasks to be performed and component aspects of those tasks, such as who performs the task, what equipment/tools are needed, what are the controls and displays used, and what information is required as input and output of the system. For each issue, an informal task analysis was performed to identify required tasks and how the tasks would be performed.

Hazard Condition Identification: The informal task analysis was used as the basis for hazardous condition identification. These tasks were reviewed for six possible consequences affecting personnel, members of the public, the environment, environmental compliance, mission success, or public perception of the INEEL. Since looking at all potential hazards is a Herculean task, a generic hazard list was used to support this step. This generic list, as seen in Appendix A, was developed to reflect operational and situational hazards associated with the INEEL and may not be exhaustive for use in other facilities or operations.

Scenario Development: Scenario development reflects and documents an analyst's thought process in identifying the mechanisms in which the hazardous condition results in the specified consequence. The scenario includes the steps (in series) required for the outcome suggested, the likelihood of each step, and identifies any safety barriers in place that may partially mitigate the scenario. Scenario development and review is essential for issue dissemination justification and review.

Cause Identification: Cause identification is often an outcome of the scenario development. Causes, which could result in specific hazardous conditions, were identified. Each hazard condition may have multiple causes. For example, a storage container may come loose in transit because the securing strap broke (an equipment failure) or, an operator incorrectly secured the strap (a human action). The hazard causes focused on equipment failure, human actions, design inadequacies, or administrative controls (e.g., procedure errors or deficiencies). More detailed causes were identified if appropriate (e.g., equipment failure due to design). Although analysts attempted to identify the root cause of the hazard, often only the proximate cause, the obvious or immediate reason the hazardous condition has occurred, was known.

Consequence Identification: Consequences predicted from hazardous conditions were identified during this step in the PHA process. Hazardous conditions may cause multiple consequences. For example, following incorrect procedures using a piece of equipment may cause personnel injury as well as damage to the equipment. A dependency investigation was also initiated if the scenario development provided evidence that other systems or facilities affected (or that affect) by the hazard under consideration. Understanding the systems or facilities effected by a hazardous condition, aids in identifying a complete list of consequence areas to include in the dissemination of an issue.

There are six consequence areas that have been identified that cover INEEL safety and business concerns. They include: 1) injury to one or more members of the public, 2) personnel injury, 3) regulatory non-compliance, 4) mission interruption, 5) environmental damage, and 6) public perception.

Preliminary Risk Assessment Code (RAC): A preliminary RAC was assigned to each consequence resulting from a hazardous condition. These were based on the traditional definition of risk as a combination of frequency (of the hazardous condition leading to the specified consequence) and severity (of the consequence). Decisions for assigning a RAC for associated consequences were supported by the six risk matrices seen in Appendix B. The RACs were reviewed by a team of analysts for consistency.

Identification of Mitigative/Corrective Measures: High risk hazards (Category 1 or 2) were identified and scoped for measures that could reduce the risk of the hazard. The developed scenario provided understanding of the sequence of events that needed to occur for the hazardous condition to lead to the specified consequence. Only measures that reduced either the severity or the frequency of the RAC were considered.

Final RAC Assignment: Preliminary RACs were then reevaluated based on the associated corrective measures. Final RACs were modified by a reduction in severity and/or frequency of the consequence.

Cost-benefit Determination of Corrective Measures for High-Risk Issues: Each corrective measure was then analyzed for the effectiveness of the measure and the estimated cost to implement the measure. The effectiveness of the measure is an indication of the reduction of the RAC. The estimated cost of the measure is determined by historical site data estimates.

Selection of Cost/Effective Measures: Lastly, the most cost effective measures, based on the cost-benefit evaluation, are identified and suggested as potential improvement processes. This information will be used in site performance indicators to determine how successful this approach is in estimating and implementing corrective measures and reducing site risk to an acceptable level.

Information for these steps were entered into a hazard worksheet and then transferred to a hazards database.

Risk Matrices: The separation of consequences into six categories presented an interesting challenge in the issue dissemination process. The issue management team required a means of easily and understandably describing the consequence categories for reviewers and management less familiar with risk and hazard assessment techniques. In addition, these qualitative/semi-quantitative methods needed to reflect corporate and the Department of Energy (DOE) concerns. This approach deviates from some previous methods developed (Reference 4) and does not attempt to equate the significance of issues between consequences (e.g., two minor injuries is equivalent to a moderate public relations problem). Each consequence category is evaluated separately and on its own merit.

Communication of the risk matrices required a means of easily understanding and classifying an issue. This was accomplished by development of six (five by four) risk matrices that clearly show the frequency and the severity levels for each consequence category. These matrices can be seen in Appendix B and additional information on how these matrices are used can be found in Reference 5.

Results of Issue Prioritization

At the time this paper was written, the issue dissemination task was not finished. Issues that were considered to be significant were researched first to support site safety concerns. This included approximately 270 issues, which were identified as significant by a corrective action review board (CARB), prior to the issue management methodology development and review by the hazard analysis team. Therefore it should be noted that the subset of issues discussed in this section were biased toward higher-risk issues. Summaries of the results are presented below.

Each issue may result in risks in one or more consequence category. Therefore, the number of issues and the total number of counts across categories are not equal. Issues that contained high risk in any of the consequence categories were reevaluated as a risk-significant issue.

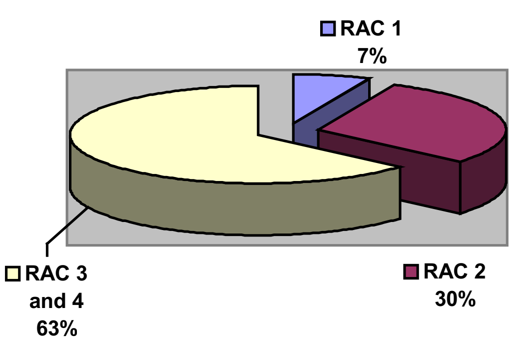
Risk Assessment Category Results: There were 18 issues that had a RAC of 1, which means that the issue posses an unacceptable level of risk and requires immediate corrective actions. Of these issues, all were considered high risk due to a personnel injury, mission interruption, or regulatory non-compliance concern. The majority (16) of issues fell into the personnel injury consequence category. Of these, 5 issues also had a RAC 1in another consequence area.

RAC 1 issues were diverse and included mostly site-wide process deficiencies. 9 issues focused on lock out tag out, one issue on fall protection, two issues on tank substances, fire suppression, and specific job hazards concerns. Material receipts inspection and radiological material classification concerns account for issues in the regulatory non-compliance consequence category.

80 issues were determined to be in the RAC 2 bin. These are issues that are undesirable and at a reduced priority level, but still require corrective actions to be taken. The remaining issues were designated as RAC 3 or RAC 4.

The following pie chart represents the RAC breakdown for the 270 issues that were originally identified as significant. The number of significant issues originally determined to be a significant concern were decreased by 63% when evaluated in a risk context. However, it should be noted that of the 4000 or so records not evaluated it is anticipated that some would fall into the risk significant category.

Figure 1- Breakdown of Significant Issues By Risk Assessment Code



Difficulties and Advantages of the process: The process of using a risk-informed approach to improve site safety, although not new in theory, was new in practice. The most difficult portion of the issue dissemination process was introducing a risk-informed approach to INEEL members not used to working in this new paradigm. The transition was made easier by groups of individuals at the INEEL well versed in the Nuclear Regulatory Commission's (NRC) push toward risk-informed analyses.

Scenario development and use of the risk-informed approach in performance indicators were perhaps the more difficult concepts to communicate. Original worksheets were reanalyzed to accommodate the appropriate scenarios. It was obvious from some procedures that some were cross cutting and affected the entire site, while others were very specific and reflected specific facility deficiencies. The database had to be modified to identify these type of considerations. Once these obstacles were overcome, the processing of the 270 significant events became much easier.

The next step in the issue management process is to use the information collected in issue dissemination to support a comprehensive and self-checking performance indicator program. Performance indicators, derived from the issue management hazards database, were more difficult to communicate to management. In fact, educating management that the end use of the issue dissemination process is not the prioritization of issues, but rather a comprehensive performance check and balance process has not been entirely successful to date.

Performance Indicators

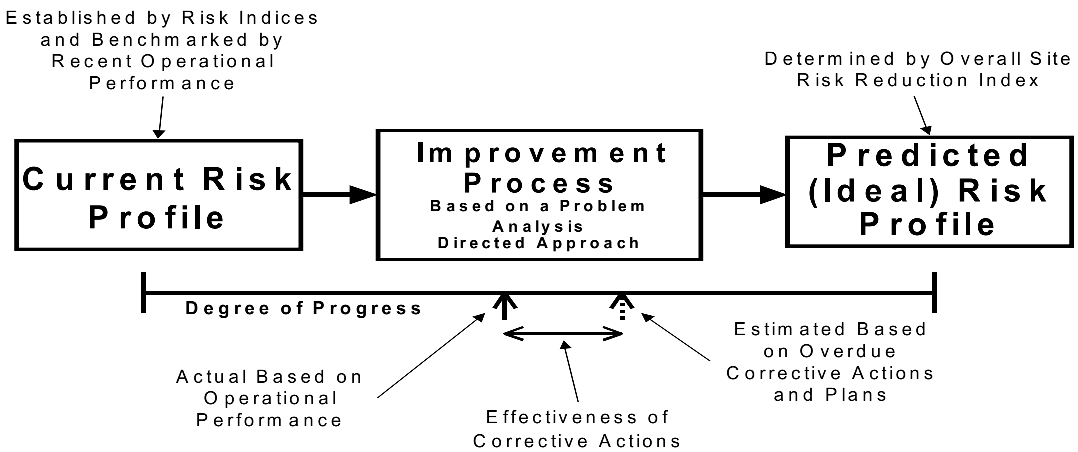
The objective of performance indicators is to ascertain how well INEEL is improving safety associated with the issue resolution process. In order to accomplish this objective, a simplified model of the general site risk reduction process from the ISM program has been developed. Next, metrics have been established to support programmatic decisions at each step in the process.

The approach for establishing performance indicator metrics for the ISM risk-reduction process focuses on four steps to provide a comprehensive picture of site/facility risk. These steps include: 1) establishing a baseline of performance; 2) grading the current risk state of the site/facility; 3) monitoring the issue resolution and subsequent effectiveness of the hazard improvement process; and, 4) developing and verifying predictive risk trends. The information to support each of these steps, except step one, will be available through the ISM hazard assessment database. These steps are depicted in Figure 3 and the supporting metrics are described in more detail in the following paragraphs.

Performance Indicator Metrics: There are six drafted performance indicator metrics that support the ISM risk-reduction process outlined in the previous paragraph. Three of these metrics are profiles that describe past (Operational Performance History Profile), present (Current Site/Facility Risk Profile), and predicted (Predicted Risk profile) risk by consequence category to the site or specific facilities. One qualitative metric (Improvement Process) provides insights into managing site/facility risk and two metrics measure the progress of corrective actions (Degree of Progress) and the effectiveness of the corrective actions and model accuracy. Each metric is described in the following paragraphs.

Operational Performance History Profile: The operational performance history profile is used to help benchmark and validate other portions of, and progress within, the Risk Reduction Process. The operational performance history profile is based on a collation of objective indicators specifically the number of: environmental violations, occurrence reports; and, Price Andersen Amendment Act (PAAA) reports. These values are collated, sorted, trended, and analyzed monthly for an empirical determination of the operational performance history. Additional data sources may be included in this analysis as they are identified or developed. This metric is then analyzed from a risk perspective to help establish and validate the current site/facility risk profile.

Figure 2 – Issues Resolution Process

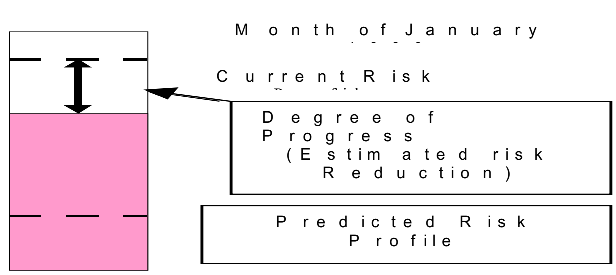


Current Site/Facility Risk Profile: In order to formula risk-informed decisions in the Risk Reduction Process and assess the level of risk reduction attained, the Current Risk Profile must be established. Risk assessment codes (RAC), which are based on hazard assessment process within ISM, are developed, to provide the unmitigated risk indices that comprise the Current Risk Profile. These preliminary RAC totals are broken down by consequence category, organization, and facility. This Current Risk Profile iu validated by comparison with the Operation Performance History on a quarterly basis, and can be updated, as future operational performance trends become apparent.

Predicted Risk Profile: The Predicted Risk Profile defines the level of site/facility risk that is predicted if specific improvements, which are often described in terms of safety barriers, are implemented. The Current Risk Profile is used as a basis for obtaining a more desirable (theoretical) risk profile. Similar to the Current Risk Profile, the Predicted Risk Profile is broken down by consequence category, organization, and facility. Differences between the current and predicted risk profiles performance indicators establish a measure of residual risk.

Improvement Process: The Improvement Process mentioned here is not a metric, but rather a method of providing information to aid in structuring the associated process in the ISM program. This information is extracted through the development of the predicted risk profile from the

Figure 3: Example of the Risk Reduction Progress Metric



current risk profile. The Improvement Process will be heavily dependent upon causal factors collected as part of the ISM process. High priority hazards (i.e., those hazards that contribute the greatest risk) or cross cutting causal trends would get special emphasis in developing strategies for the Improvement Process. This would identify the most efficient pathways for attaining the reduction of risk indicated by the Predicted Risk Profile.

Degree of Progress: Once implementation of the Improvement Process begins, it will be desirable to routinely assess the degree of progress toward reaching the level of risk reduction indicated by the Predicted Risk Profile. The most direct indicators for gauging the degree of progress within the Improvement Process, are measures of implementation (or non-implementation) of corrective action plans and the individual corrective actions. These corrective actions and plans are assumed to mitigate the root cause of past issues and therefore, affect future issues stemming from a similar cause. This, in turn, would reduce overall site/facility risk and prevent future safety problems. Measurement of the proportions of overdue corrective actions and plans is considered the most immediate indicator of the degree of completion of the Improvement Process.

Effectiveness of Corrective Actions and Hazard Assessment Accuracy: The independence of the operational historical data provides a means of benchmarking the current risk profile and establishing a connection between the effectiveness of the corrective actions and the accuracy of the hazard assessment. Measurement of the effectiveness of corrective actions and plans is accomplished by gauging the proximity of the risk of operational data relative to the of the Predicted Risk Profile (after a time step when the predicted risk profile becomes current) attained by the Improvement Process. This can best be ascertained by assessing the trends indicated by the routine updates to the operational performance profile. If this assessment indicates a significant difference between the estimated degree of progress towards the Predicted Risk Profile, deficiencies in the implemented corrective actions or inaccuracies in the Predicted Risk Profile are indicated. This assessment will be performed on a quarterly basis.

Conclusions

Development of a risk-ranking scheme for the INEEL was a challenging, but important step in supporting a risk informed safety culture. The growing influence and importance of safety at the national laboratories demands methods that can prioritize operational issues and establish guidelines for safe performance. Although this approach is new in theory it has not been formally accepted at the INEEL until recently.

The most significant preliminary results show that when using a risk-informed approach the number of significant events have been reduced by 65 percent. Obviously, there are substantial cost savings from not performing unnecessary corrective actions. Additional cost savings may be realized by applying corrective actions that target high-risk causes, as opposed to establishing a general corrective action program that may not be effective for some hazard scenarios.

There have been some difficulties in implementing this risk-informed approach. Although the overall impression of this scheme is positive, training was required for the analysts performing the ranking and prioritization of issues. Management also required assistance in understanding and implementing a risk-informed approach. Implementing the performance indicators will require a greater effort since it has been met with early confusion and is a more complex item. However, the authors believe that this approach will be successfully refined and implemented at the INEEL and would like to encourage other institutions toward a similar approach.

Appendix A: General Hazards List

I. Chemical Sources

Biological Agents
Construction
Corrosive Materials
Flammable Gases
Flammable Materials
Long-term Storage (decomposition)
Pesticide use
Radioactive Materials
Reactive Liquids
Volatile Flammable Liquids
Reactive Materials: Alkali metal & Corrosives
Oxygen Deficiency
Other
Material Handling Dangers
Material Transportation
Carcinogenic Materials
Low Visibility
Reactive Gases
Toxic Materials
Explosive materials
Pathogenic material (virus or bacteria)
General Hazardous Waste Materials

II. Cold Sources

Ice
Cryogenic materials
Other
Temperature extremes (low temp during activities)
Construction

III. Electrical Sources

Capacitors
Other High-Voltage Sources
Transformers
Static Electricity
Batteries
Exposed conductors
High Voltage (> 600 v)
Low Voltage (< 600 v)
Exposed Cables

IV. Environmental Sources

High Noise Levels
Construction
Excavation (unbreathable air)
Other
Inert and Low-Oxygen Atmospheres
Confined Space

V. Gravity Mass Sources

Construction

Excavation (cave-in)
Material Handling Dangers
Structural or Natural Phenomena
Other
Working at Heights
Slips, Trips, and Falls

VI. Heat Sources

Fire
Electrical
Chemical Reaction
Steam
Construction
Excavation (excessive heat from equipment)
Explosion
Friction
High Temperature
Material Transportation
Solar
Spontaneous Combustion
Temperature Extremes (during activities)
Other
Fire and Explosion
Hot Water

VII. Motion Sources

Belts
Excavation (heavy equipment)
Gears
Mass in Motion
Pinch Points
Construction
Material Handling Dangers

VIII. Administrative Programs

Operating Conditions
Program Deficiency
Regulatory Deficiency

Appendix B: Risk Assessment Category Risk Matrices

Table 1 - Risk Assessment Categorization for Site Personnel Injury

Hazard Likelihood Category (annualized)	Consequence Severity Category for Site Personnel Safety (Adverse health effects to a worker)			
	I Catastrophic (One or more deaths of a site worker	II Critical (Severe injuries or severe occupational illness, or permanent injury)	III Marginal (Minor Injuries or minor occupational illnesses requiring medical attention)	IV Negligible (minor injuries not requiring medical attention)
A—Frequent *	1	1	2	3
B—Probable *	1	1	2	3
C—Occasional *	1	2	3	4
D—Remote *	2	2	3	4
E—Improbable *	3	3	4	4

Table 2 - Risk Assessment Categorization for Public Injury

Hazard Likelihood Category (annualized)	Consequence Severity Category for Public Injury (Adverse health effects to a member of the public)			
	I Catastrophic (One or more deaths of a member of the public	II Critical (Severe injuries or severe occupational illness, or permanent injury)	III Marginal (Minor Injuries or minor occupational illnesses requiring medical attention)	IV Negligible (Minor injuries not requiring medical attention)
A—Frequent *	1	1	2	3
B—Probable *	1	1	2	3
C—Occasional *	1	2	3	4
D—Remote *	2	2	3	4
E—Improbable *	3	3	4	4

Table 3 - Risk Assessment Categorization for Environmental Damage

Hazard Likelihood Category (annualized)	Consequence Severity Category for Environmental Damage (Adverse health effects to the environment)			
	I Catastrophic (Severe acute or long-term damage to the ecosystem or environment)	II Critical (Loss of a majority of individuals within a species, or major disruption to the wild life in a localized area)	III Marginal (Damage to a small number of individuals in an population that results in a minor consequence to localized or regional ecosystems)	IV Negligible (minor acute effects on individuals in a population and ecosystem)
A—Frequent *	1	2	3	4
B—Probable *	1	2	4	4
C—Occasional *	1	2	4	4
D—Remote *	2	3	4	4
E—Improbable	3	4	4	4

Table 4 - Risk Assessment Categorization for Mission Interruption

Hazard Likelihood Category (annualized)	Consequence Severity Category for Mission Interruption (Conditions that effect mission unavailability)			
	I Catastrophic (Loss of investment, production, or opportunity to increase productivity greater than 5M/yr)	II Critical (Loss of investment, production, or opportunity to increase productivity between 1 and 5M/yr)	III Marginal (Loss of investment, production, or opportunity to increase productivity between 10,000 and 1M/yr)	IV Negligible (Loss of investment, production, or opportunity to increase productivity less than 10,000/yr
A—Frequent *	1	1	2	3
B—Probable *	1	1	2	3
C—Occasional *	1	2	3	4
D—Remote *	2	3	3	4
E—Improbable *	3	4	4	4

Table 5. Risk Assessment Categorization for Regulatory Noncompliance

Hazard Likelihood Category (annualized)	Consequence Severity Category for Regulatory Noncompliance (Conditions that effect regulatory compliance penalties)			
	I Catastrophic (Noncompliance with laws that result in penalties greater than 100k)	II Critical (Noncompliance with laws that result in penalties between 10k and 100k)	III Marginal (Noncompliance with laws that result in less than 10k in penalties)	IV Negligible (Noncompliance with laws that result in no significant penalties
A—Frequent *	1	1	2	2
B—Probable *	1	1	2	3
C—Occasional *	2	2	3	4
D—Remote *	2	3	3	4
E—Improbable *	3	4	4	4

Table 6 - Risk Assessment Categorization for Public Perception

Hazard Likelihood Category (annualized)	Consequence Severity Category for Public Perception (Reduction of public confidence about INEEL)			
	I Catastrophic (A condition or incident that causes national or international concern or attention)	II Critical (A condition or incident that causes state or regional concern or attention)	III Marginal (A condition or incident that causes local county or city concern or attention)	IV Negligible (A condition or incident that causes individual concern or attention)
A—Frequent *	1	1	2	3
B—Probable *	1	2	3	4
C—Occasional *	2	2	3	4
D—Remote *	3	3	4	4
E—Improbable *	4	4	4	4

***A—Frequent** (Consequences that occur one or more times a year) **B—Probable** (Consequences that are expected to occur .1 but less than 1 time annually)**C—Occasional** (Consequences that occur 0.01 but less than .1 times a year) **D—Remote** (Consequences that occur 0.001 to 0.01 times a year) **E—Improbable** (Consequences that occur below 0.001 times a year)

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