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# **Excellence in Integrated Risk Management**

**The elements, attributes, and behaviors that  
exemplify excellence in integrated risk  
management**

Revision 1

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## INTRODUCTION

This document provides guidance to nuclear managers to address the broad aspects of integrated risk management present in the operation of commercial nuclear facilities. Key elements of integrated risk management are identified, as well as important attributes of each element. Behaviors that illustrate effective integrated risk management are also described. Information in this document is intended to inform programs, processes, and procedures that are used to assess, mitigate, and manage integrated risk. The desired long-term outcome of this effort is to reduce the number of significant and noteworthy events that threaten safe and reliable plant operation. This document does not define specific programmatic requirements of integrated risk management. The information herein is intended to further anchor behaviors and actions related to risk management as defined in selected INPO and industry documents listed in Appendix D.

The five sequential elements of integrated risk management described in this document are as follows:

1. **Identify the Potential Risks:** Implement methods to identify conditions and activities that individually and collectively have the potential to result in adverse outcomes.
2. **Assess the Risk:** Analyze, quantify, and qualify the likelihood of adverse outcomes.
3. **Minimize or Mitigate the Risk:** Develop strategies, define roles and responsibilities, and identify tools to prevent unnecessary risk or to mitigate residual risk.
4. **Implement Risk Management Strategies:** Implement activities necessary to control, execute, and monitor risk management strategies.
5. **Learn and Adapt:** Periodically evaluate risk management strategies to identify and implement improvements to minimize risk.

Appendix A identifies the behaviors on four levels of a typical organizational hierarchy (individuals, supervisors/managers, senior managers, and corporate) that support integrated risk management.

Appendix B includes the organizational contributors for effective integrated risk management.

Appendix C contains the warning flags for integrated risk management. These warning flags can be used to determine if weaknesses in risk management practices are prominent within an organization or during stressful periods. They can also be used in situational or organizational self-assessments.

Appendix D contains references used in the development of this document that are drawn from within the nuclear industry as well as external industries.

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## BACKGROUND

Risk has traditionally been described in terms of the likelihood and consequence associated with an adverse outcome. In the context of this document, the term *risk* applies to a wide spectrum of possible adverse outcomes, with nuclear safety being the overriding priority. Other risks include operational consequences (inadvertent plant trip), adverse effects on personnel (injury), equipment damage, financial loss, adverse regulatory implications, and damaged community relations. Taking this spectrum of risk into consideration, integrated risk management is defined in this document as follows:

*Integrated risk management is the integrated set of behaviors and processes used to identify, reduce, and manage the inherent risks associated with commercial nuclear plant operation. It encompasses nuclear (highest priority), radiological, personnel, environmental, and business risks, both internal and external to the nuclear organization.*

An underlying theme in several 2010 significant industry events was that individuals at all levels either did not recognize operational risk or inappropriately accepted the risk without sufficiently engaging others in the decision-making process. Risk management weaknesses included insufficient risk recognition, inappropriate decision-making, and inadequate risk mitigation activities. INPO SOER 10-2, *Engaged, Thinking Organizations*, described these significant events but did not define an integrated approach to assessing risk. Probabilistic risk assessments are sometimes viewed as providing an integrated assessment; however, they primarily focus on fuel damage and radiological release, without addressing other broad, unacceptable consequences that need to be considered in an integrated risk management process.

To clarify the scope and focus of integrated risk management, an industry expert panel was convened to identify the attributes of an integrated risk assessment process, including the measuring, monitoring, and mitigation of all types of risk. Members of the expert panel represented a broad cross-section of the nuclear power industry and provided a wide range of perspectives on the basic elements, attributes, and behaviors that exemplify excellence in integrated risk management. The expert panel analyzed INPO plant evaluation areas for improvement related to risk management and reviewed existing risk models both in the nuclear industry and in other industries. The panel developed an integrated risk management framework that identified the five sequential elements of risk management described in this document.

Many of the references used in developing this document, included in Appendix D, provide valuable principle-based guidance and insight regarding risk management. However, a key reference that provides integrated process-based implementation guidance for the work management process, which is fundamental to managing risk, is AP-928, *Work Management Process Description*. This guidance can be used as a benchmark for assessing the adequacy of risk considerations in work management.

The following descriptions are intended to help clarify the terms frequently used when discussing risk management. They are neither all-inclusive nor precise. They are intended to enhance understanding and communication rather than to prescribe specific parameters or guidelines. Each INPO member will likely have its own guidance, trigger points, processes, and actions; but all should be aligned with these concepts.

**Risk:** a product of the probability and the potential consequences associated with the threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities and that may be avoided through preemptive action

- When assessing the magnitude of risk associated with the probability and consequence of a given threat, an important lesson learned from the 2011 Fukushima event, as described in IER L1-13-10, *Nuclear Accident at the Fukushima Daiichi Nuclear Power Station*, warrants careful consideration: If the potential consequence of an event is unacceptably catastrophic, regardless of the improbability of occurrence, tolerating or accommodating the risk without implementing compensatory actions commensurate with the potential safety impact is equally unacceptable.

**Nuclear Risk:** the potential for core damage or significant release of radioactivity because of an inability to maintain the integrity of the fission product barriers designed to protect the health and safety of the plant staff and the public—This risk may result from failure to properly control or cool the reactor core or fuel in storage, or it may result from equipment configurations that decrease defense-in-depth, such as limited functionality of key safety systems or components. The probability of consequences associated with this risk may sometimes be expressed in terms of core damage frequency (CDF) or large early release frequency (LERF). Factors to consider in managing nuclear risk include, but are not limited to, the following:

- **configuration risk** – the risk posed by the plant, considering the alignment and condition of plant systems, structures, and components— This risk is managed by maintaining sufficient important safety system/equipment redundancy and diversity in a functional state—as discussed in AP-928—accounting for hazards posed by random failure, fire, flood, wind, or seismic events.
- **reactivity risk** – the risk of a reactivity excursion or event— This risk is managed by controlling evolutions that affect reactivity and fuel movement.

**Radiological Risk:** the potential for detrimental health effects caused by internal or external dose or contamination, or the impact on the environment as a direct consequence of exposure to radiation or radioactive material—This includes the potential for unplanned exposure, exposure beyond administrative limits, encounters with hot particles, and exposure to an unplanned airborne environment.

**Personnel (Industrial Safety) Risk:** the potential for injury or death because of industrial hazards other than radiation

**Environmental Risk:** the potential threat of adverse effects on living organisms and the environment caused by effluents, emissions, wastes, resource depletion, and so forth arising from an organization's activities

**Operational Risk:** the potential for an undesirable consequence involving a plant transient, reactor scram/turbine trip, component damage, loss of safety system diversity or redundancy, exceeding technical specification allowed out-of-service times, or exceeding cumulative equipment unavailability or reliability goals

**Generation Risk:** the potential for lost generation, including outage extensions, critical long lead time equipment failures, and operational risks that incur generation loss

**Business Risk:** the potential for an unacceptable consequence for the business, such as loss of public, regulatory, shareholder, or financial industry confidence, significant budget overruns that could impact corporate support of the plant, or financial impacts associated with generation risk

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## 1. IDENTIFY THE POTENTIAL RISKS

**Element: Implement methods to identify conditions and activities that individually and collectively have the potential to result in adverse outcomes.**

### Attributes

- Methods exist that promote the recognition of potential risk conditions and activities.
  - Formal methods identify risk to critical safety functions, safe and stable plant operations, radiological safety, industrial safety, and other desired end states.
  - Processes, such as the corrective action program or work management, are used to screen priorities for potential risk.
  - Quickly degrading plant systems or conditions that affect risk are promptly recognized, communicated horizontally and vertically, and addressed with urgency commensurate with the potential or actual consequences.
  - Formal processes identify when a station is outside the assumed risk boundary conditions.
- Personnel at all levels are engaged in identifying risk conditions and activities and in elevating the responses to these conditions.
  - Personnel have the appropriate knowledge and experience to identify potential sources of risk associated with their roles and responsibilities.
  - Personnel understand their responsibilities and authorities for communicating and elevating the responses to risk conditions.
  - Personnel behaviors demonstrate a bias for identifying risk-adverse conditions versus proving why risk does not exist.
  - Personnel have a mind-set that unnecessary risk is not acceptable.
- The integrated risk significance of aggregate plant conditions is collectively reviewed and assessed on a periodic basis, probing for risk that may not be fully understood.
  - Backlogs are periodically reviewed to identify gradual declines or long-standing problems that could affect integrated risk.
  - Repetitive and long-standing problems that introduce increased risks are not tolerated, and potential adverse outcomes are recognized.
  - Integrated trending processes proactively identify potential emerging risks.

## 2. ASSESS THE RISK

**Element: Analyze, quantify, and qualify the likelihood of adverse outcomes.**

**Attributes**

- Analyze a full range of possible risks, outcomes, and consequences (operational, radiological, environmental, regulatory, personnel safety, and financial).
  - Risk assessments, both probabilistic and deterministic, are performed in a systematic manner in accordance with applicable methods, processes, and standards.
  - The human element is considered as part of the risk assessment (for example, worker qualification, experience, procedure clarity, work environment, error-likely situations, and fatigue are evaluated).
  - An operating experience review is included in the risk assessment as appropriate for the risk level.
  - Inherent design vulnerabilities are understood, assessed, and reviewed based on the most up-to-date methods and data to identify potential adverse consequences. In particular, it is important to understand in great detail events of low or uncertain probability if the consequences could be significant.
- Quantify the risk identified.
  - A graded approach is used to quantify and analyze the risk identified. An appropriate level of assessment rigor is applied for the potential consequences involved. As described in IER L1-13-10, due consideration is given to an important lesson learned from the 2011 Fukushima event: If the potential consequence of an event is unacceptably catastrophic, regardless of the improbability of occurrence, tolerating or accommodating the risk without implementing compensatory actions commensurate with the potential safety impact is equally unacceptable.
  - Degraded plant conditions are quantified and fully understood as part of the risk assessment.
  - Risk assessments quantify the key factors that would be candidates for risk mitigation.
- Qualify the risk identified.
  - Assumptions and uncertainties related to risk assessment are clearly identified and validated.
  - Assumed margins are validated to ensure they are sufficient for the expected range of conditions. Equipment with negative margin is modified to improve margin.
  - The risk assessment receives appropriate cross-functional review and challenge.

### 3. MINIMIZE OR MITIGATE THE RISK

**Element: Develop strategies, define roles and responsibilities, and identify tools to prevent unnecessary risk or to mitigate residual risk.**

#### Attributes

- Personnel develop strategies to minimize or mitigate risk based on the results and insights from the risk assessment.
  - Actions to minimize or mitigate risk are prioritized based on risk probability and adverse outcomes.
  - Strategies are in place to reevaluate an activity if the risk is high or increased. No risk is accepted without a commensurate benefit to the safety of a mission.
  - Contingencies and alternate approaches are developed and assigned for probable unexpected outcomes. In particular, contingency plans should be made for residual risk associated with well-beyond-design-basis events that are not completely mitigated by plant design features or operating procedures.
  - A graded approach is used to determine additional management actions to address the integrated risk inherent in work activities.
  - Exposure time to risk is minimized, provided this does not unduly stress the task and introduce additional risk.
- Roles and responsibilities are clearly defined for risk mitigation strategies.
  - Organizational leaders have clear roles in implementation strategies.
  - Appropriate levels of the organization are empowered to make risk decisions.
  - Personnel understand approval authority levels defined for accepting risk based on risk significance.
  - Personnel who are directly affected by selected risk controls are involved in the risk decision-making process.
  - Stop work authority and veto authority are identified.
  - Strategies are reviewed cross-functionally as needed.
- Organizational tools are used in strategies to minimize and mitigate risk.
  - Tools such as training, exercises, procedure changes, work planning, engineering controls, increased oversight, administrative controls, and contingencies are defined to minimize and manage the integrated risk inherent in work activities.
  - Engineering controls to minimize or mitigate risk are preferred over operator actions.

#### 4. IMPLEMENT RISK MANAGEMENT STRATEGIES

**Element: Implement activities necessary to control, execute, and monitor risk management strategies.**

##### Attributes

- Administrative controls are used to implement risk management strategies.
  - Corporate policies and practices support integrated risk management implementation.
  - Risk management practices are deployed, with some barriers being in place continuously.
  - Prioritization processes heavily weight the elimination of nuclear safety/plant reliability vulnerabilities.
  - Work management practices are in place to maintain low backlogs for equipment or process control deficiencies that can create risk.
  - Modifications and design changes are considered to reduce risk.
  - Protected equipment processes are in place for risk-significant components.
- Risk management strategies are executed as planned.
  - Communication methods establish awareness and understanding of risk management strategy implementation performance.
  - Risks and assumed boundary conditions are reviewed during prejob briefings.
  - Risk management contingencies are implemented for risk increases that result when key equipment is taken out of service.
- Methods are established (such as observations, performance indicators, and oversight) to monitor risk management strategy implementation.
  - Management and internal and external oversight groups are scheduled to review and observe risk management strategy implementation to ensure appropriate behaviors and actions are implemented and are effective.
  - Supervisors monitor strategies and execution.
  - Acceptance or normalization of unnecessary risk is identified and corrected.
  - Changes to risk management strategies are assessed, reviewed, and communicated appropriately.

## 5. LEARN AND ADAPT

**Element: Periodically evaluate risk management strategies to identify and implement improvements to minimize risk.**

### Attributes

- Periodically evaluate risk management performance.
  - Self-assessments, independent assessments, and in-field observations of risk management activities are performed to provide feedback on effectiveness.
  - Operating experience and benchmarking are used in evaluating risk management.
    - External risk management operating experience is reviewed, internalized, and applied.
    - Station operating experience on risk management is shared with the industry.
    - Risk management strategies and implementation are benchmarked.
  - Changes in risk profiles are reviewed during postjob briefings.
- Risk management lessons learned are identified.
  - Lessons learned are identified in processes and are analyzed both when risk management strategies are effective and should be replicated and when they are not implemented correctly or an event occurs.
  - Increases in the level of risk or normalization of risk are identified and evaluated against established risk management standards.
  - Corrective actions are identified to resolve risk management shortfalls.
- Risk management improvements are implemented.
  - Corporate decisions, planning, and oversight strategies are adapted and are focused based on lessons learned with risk management.
  - Risk model and risk assessment changes are incorporated into the risk management process.
  - Risk assumptions are updated and risk assessments are revalidated based on the feedback obtained.
  - Training is used to improve risk management performance.
  - Knowledge transfer programs are adjusted to reflect risk management learning.

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## APPENDIX A

### BEHAVIORS

The following behaviors are representative of effective integrated risk management elements and attributes. These behaviors are listed for four organizational levels—individuals, supervisors/managers, senior managers, and corporate executives—for each element of integrated risk management. Additional behaviors are also described for integrated risk management governance. This appendix contains representative behavior examples of each attribute; it is not designed to be an inclusive list.

#### **Identify the Potential Risks**

**Element:** Implement methods to identify conditions and activities that individually and collectively have the potential to result in adverse outcomes.

#### **Individual Behaviors**

- Identify risk during job planning and preparation, questioning and evaluating unexpected or changing conditions.
- Take personal responsibility to challenge the risk involved in both routine and infrequently performed activities and to identify risk contingencies to minimize/mitigate identified risks. Recognize error traps, such as an individual being qualified but not proficient.
- When in doubt or when conditions that affect risk change, stop and involve others in the discussion. Challenge peers on potential risk activities.
- Maintain an awareness of plant status, protected equipment, and the risk associated with various plant configurations. Establish risk significance at the component level with approved methods.
- Track and trend degraded conditions. Study, understand, and trend corrective action cause codes and event codes for risk-significant equipment.
- Maintain an awareness of personal risks relative to fatigue, skills, and knowledge.
- Report problems at a low threshold, and encourage different perspectives on the risk involved in activities. Document adverse risk conditions in the corrective action program.

#### **Supervisor/Manager Behaviors**

- Actively seek to identify risk-significant conditions and behaviors, using established processes such as the corrective action program, system health monitoring, the observation program, prejob and postjob briefings, work management, scheduled management reviews, job safety analyses, and probabilistic safety assessment outputs.

- Encourage problem reporting regardless of personal perception of risk (allow the organization to see risk that individuals close to the job recognize).
- Communicate, reinforce, actively listen to, and reward the identification of risk- significant problems, conditions, and behaviors.
- Provide line oversight for proper implementation of risk management standards and expectations. Personally observe risk-significant activities, from planning through execution and critique. Periodically perform parallel observations with other managers/supervisors to verify the effectiveness of training and knowledge.
- Reinforce standards for excellence in equipment reliability, being intolerant of failures and recognizing the risk significance of equipment reliability problems.
- Recognize when risk-significant conditions need escalation or cross-functional input.
- Shield workers from undue schedule or production pressure.
- Provide training to personnel on risk concepts, methods to identify sources of risk, methods to establish risk significance, and recognition of changing conditions that increase risk.
- Task assignment considers the risk that may be inherent in infrequently performed tests or evolutions.

### **Senior Manager Behaviors**

- Communicate the vision and values for potential risk condition identification.
- Provide appropriate resources to support risk management.
- Promote rewards and recognition for risk identification.
- Promote a positive safety culture relative to risk identification. Minimize production pressure.
- Establish or maintain oversight of the collective risk identification. Observe and participate with workers in the field to reinforce expectations and to visually observe important problems.
- Ensure workers understand their responsibilities to identify risk.
- Accurately identify the risk impact of budget decisions.

### **Corporate Behaviors**

- Personally observe the station, people, and processes in the field. For example, visit the control room, work control center, maintenance shops, and the outage control center to obtain worker perspective on risk management. Ask workers what help they need to identify and manage risks.

- Validate sufficient quantification of risk through final problem resolution.
- Clearly and frequently communicate risk management focus, as well as unacceptable risk end states.
- Communicate new areas of risk identified by outside industry groups, regulators, or vendors to appropriate station personnel.
- Provide oversight of corporate initiatives on integrated risk management with other key stakeholders.
- Provide governance to ensure station and fleet risk recognition processes meet industry excellence standards.
- Monitor what managers are paying attention to, as well as management organizational capacity to identify risk.
- Monitor the messages the nuclear organization hears from corporate on the importance of identifying and managing risk.
- Promote a positive safety culture, and recognize the adverse impact of production focus.
- Identify and minimize integrated risk when making budget decisions that could affect plant execution of long-range plans.

## **Assess the Risk**

**Element:** Analyze, quantify, and qualify the likelihood of adverse outcomes.

### **Individual Behaviors**

- Assess what can go wrong, considering likelihood and consequences (not just the worst case).
- Use relevant operating experience during job preparation and performance.
- Perform a postjob analysis after critical work. Determine if the risk assessment was accurate or if additional actions should be incorporated in future work activities.
- Ensure risk tools and methodologies (including the probabilistic risk assessment) are structured to ensure comprehensive results.
- Know what decisions are within the personal span of control.
- Evaluate and maintain safety margins.
- Ensure risk from scheduled work is consistent and appropriate with station goals.
- Ensure understanding and agreement with all risk management assumptions. Challenge personal assumptions on important job activity conditions.
- Ensure risk models reflect as-built and as-operated plant conditions.
- Ensure probabilistic risk assessment model maintenance and update requirements are implemented and incorporated into daily and outage risk assessment tools.

### **Supervisor/Manager Behaviors**

- Actively participate in challenge boards and cross-functional evaluations of risk.
- Test when unsure of actual risk, seeking the true cause for unknown conditions.
- Review, challenge, and communicate assumptions in risk assessments.
- Communicate risk assessment conclusions and risk contributors.
- Ensure risk assessment procedures and tools are applied appropriately.
- Align needed resources, and seek additional resources if needed for risk analysis.
- Ensure appropriate operating experience (both internal and external) is used for the risk involved.
- Know what decisions are within each person's span of control.
- Verify that trained and qualified individuals participate in risk assessments.

### **Senior Manager Behaviors**

- Demonstrate a risk-adverse bias, and guard against group think.
- Provide resources for risk assessment functions with appropriate knowledge and skill.
- Establish an appropriate balance between risk and production.
- Verify that operating experience is embedded in risk assessment.
- Ensure the work management process includes risk assessment behaviors.
- Independently oversee and monitor risk assessment practices. Participate in risk assessment when the level of risk is high.
- Conduct risk-ranking of budget items, including modifications, to identify high-risk items. Clearly communicate the risk significance of unfunded work to corporate leaders.
- Ensure risk models are validated and are incorporated into station processes and procedures.

### **Corporate Behaviors**

- Maintain oversight on the risk analysis decisions that are made, and ensure risk analyses are robust and of high quality.
- Engage corporate subject-matter experts in risk assessments.
- Integrate the understanding and assessment of activities that introduce risk.
- Employ techniques to test risk perceptions or the risk willingness of employees and leaders.
- Communicate risk implications of budget decisions, and evaluate the risk implications of activities eliminated or added by budget decisions.
- Challenge the organization regarding the use of operating experience in risk assessments.
- Maintain a sufficient level of independence during risk assessment activities.

## **Minimize or Mitigate the Risk**

**Element:** Develop strategies, define roles and responsibilities, and identify tools to prevent unnecessary risk and to mitigate residual risk.

### **Individual Behaviors**

- Ensure risk management strategies exist and are understood for planned work (all individuals associated with work, not just line workers).
- Ensure individuals directly involved in activities have input on the strategies and understand the relative risk involved.
- Review strategies to ensure defense-in-depth.
- Engage in the development of contingency plans, including actions, tools, support needed, owners, and communication strategies.
- Identify critical steps and decision points in strategies.
- Identify required support, procedures, and tools for strategies.
- Independently verify important barriers, assumptions, and mitigating actions in strategies.
- Seek understanding of risk management strategy decisions (for example, if a design change is not approved, the engineer who advocated the change needs to understand why).

### **Supervisor/Manager Behaviors**

- Correct or modify behaviors that can result in increased risk during strategy development.
- Ensure risk strategy concepts are incorporated into all program-level procedures, as appropriate.
- Ensure contingency plans are developed to mitigate unanticipated risks (protected equipment, tagging, and communication plans).
- Ensure the risk strategy includes an evaluation of the human element (qualification, fatigue, proficiency, just-in-time training, and so forth).
- Periodically verify that risk assumptions still apply during risk strategy development.
- Challenge the robustness of barriers established in risk management strategies.
- Ensure risk mitigation plans and strategies are commensurate with the level of risk (including action prioritization, material and personnel staging, and exit or abort strategies).
- Ensure the risk accepted is commensurate with the benefit to safety.
- Ensure the timing of strategy actions are risk appropriate (potentially defer or reschedule to a lower-risk time as appropriate).

- Ensure that long-term equipment problems and operator workarounds and burdens are appropriate for the relative risk incurred.
- Establish clear roles and responsibilities for risk strategies (ensure decision-making strategies are commensurate with the risk involved).
- Verify that methods established to mitigate risk are practical. Strive to understand what message workers take from organizational decisions—for example, budget decisions—as they affect priority and risk perceptions.

### **Senior Manager Behaviors**

- Maintain strategy decision-making at the appropriate level commensurate with the risk.
- Respect challenges from station personnel on risk decision-making, and foster an open environment.
- Verify that operator burdens and operator workarounds are minimized in strategies.
- Challenge the risk management strategies presented. Accept no unnecessary risk, and accept necessary risks only when benefits have been demonstrated.
- Establish clear expectations. Ensure clear *stop* or *exit* criteria are established.
- Communicate the basis for risk management decisions.
- Ensure resources and organizational capacities are sufficient to allow effective risk management and maintain vertical communication.
- Ensure programs and processes are established to minimize integrated risk in strategy development.

### **Corporate Behaviors**

- Encourage the use of programs and processes to facilitate risk decision-making in risk management strategies; for example, staffing the outage control center or forming high-intensity teams.
- Encourage and verify strong relationships between corporate employers and site employees, and ensure the corporate support staff has nuclear knowledge to assist in risk management strategy development.
- Validate the rigor and timeliness of interim margin management actions and issue closure plans.

## **Implement Risk Management Strategies**

**Element:** Implement activities necessary to control, execute, and monitor risk management strategies.

### **Individual Behaviors**

- Use human performance tools to appropriately consider and engage in the work or activity being performed.
- Elevate and communicate issues when plans or conditions change or are not as expected.
- Question whether emergent risks for an activity are within risk management strategies. Stop work and place the plant in a safe condition if potentially outside of plans or assumptions.
- Know critical steps and contingencies in implementing risk management strategies.
- Perform activities per station standards and expectations (procedure use and adherence standards, protected equipment processes, and so forth).

### **Supervisor/Manager Behaviors**

- Ensure personnel monitor both planned and actual (as occurred) risk.
- Communicate risk mitigation strategies and individual roles and responsibilities associated with integrated risk management plans.
- Observe, monitor, and reinforce risk mitigation actions, and identify and correct barriers and behaviors that could result in adverse outcomes.
  - Verify personnel understand and comply with exit strategies and contingencies. Ensure management decision-makers are known and effective.
  - Ensure supervisors stay in role while executing risk mitigation strategies.
- Validate important barriers, inputs, and assumptions while implementing risk management strategies.
- Escalate decision-making when conditions differ from plans or assumptions.
- Stop implementation if appropriate behaviors are not exhibited.
- Identify resource shortfalls that affect risk.

### **Senior Manager Behaviors**

- Ensure a monitoring plan is in place (performance indicators, reports, walkdowns, and so forth) for risk management strategies.
- Ensure that deviations do not become normalized; that is, personnel do not become more risk tolerant over time.



- Verify the engagement of all personnel through surveys, visual observations, discussions with workers in the field, and so forth.
- Modify station practices to make integrated risk management visible.
- Communicate and explain the rationale behind risk-based decisions made and any changes thereafter.

### **Corporate Behaviors**

- Verify that integrated risk management principles and strategies are understood and are implemented as designed.
- Ensure appropriate risk tools are being used that meet executive expectations.
- Challenge site validation of vendor products or performance when evaluating risk, to eliminate challenges with overreliance on vendors.
- Perform periodic aggregate impact reviews of degraded conditions that can affect risk.

## **Learn and Adapt**

**Element:** Periodically evaluate risk management strategies to identify and implement improvements to minimize risk.

### **Individual Behaviors**

- Seek and understand feedback on personal risk management performance. Actively participate in postjob debriefings, and recommend any needed improvements.
- Document any lessons learned in the corrective action program. Develop lessons learned, training, and process revisions based on corrective action program input on risk management.
- Advance risk management lessons learned to peers.
- Develop operating experience on risk-significant equipment and on changing behaviors.
- Participate in improvement initiatives such as benchmarking and self-assessments.
- Be accountable for own actions, and identify own shortcomings that may create undue risk.
- Identify suggestions and resource needs for reducing risk for routine job functions.

### **Supervisor/Manager Behaviors**

- Revise processes and procedures to address identified shortfalls that increase the likelihood of error.
- Establish training to address gaps from execution (as identified in the corrective action program, operating experience, self-assessments, and benchmarking).
- Communicate both positive and negative experiences to the industry, station, and fleet.
- Recommend changes or additions to long-range plans based on lessons learned and emergent conditions.
- Support the self-assessment of integrated risk management.
- Actively solicit feedback on the effectiveness of risk identification, mitigation, and management measures following risk-significant activities.
- Ensure that training committees consider risk insights in the systematic approach to training process.

### **Senior Manager Behaviors**

- Update station programs, processes, procedures, and long-range plans based on lessons learned.

- Verify the effectiveness of changes made to risk management policies, practices, methods, and tools.
- Promptly identify and reinforce lessons learned when operation is outside integrated risk management guidelines.
- Endorse and ensure the use of operating experience, self-assessments, and benchmarking for risk management activities. Share and communicate lessons learned from these activities.
- Provide resources for training processes to incorporate and reinforce risk management. Teach or lead training on integrated risk management.
- Maintain an open atmosphere for the critique of risk.
- Assess and take ownership for missed opportunities and inappropriate risk management decisions.
- Communicate challenges to risk management.
- Participate in corporate reviews of risk management.

### **Corporate Behaviors**

- Demand and use robust line and independent information to verify that risk management is implemented effectively.
- Verify that self-assessments, audits, and challenges are performed on risk management processes, programs, and activities.
- Review previous long-range plans and commitments, and evaluate risk management decisions.
- Ensure formal evaluations are performed as warranted for low margin operating conditions.
- Validate the assessment of organizational performance when causal analysis is performed for risk-adverse conditions, and ensure associated corrective actions are robust and timely.
- Provide timely coaching on standards and expectations when risk management shortfalls are identified. Ensure station risk management lessons learned are distributed and internalized at a fleet level as appropriate.

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## APPENDIX B

### ORGANIZATIONAL CHARACTERISTICS FOR EFFECTIVE INTEGRATED RISK MANAGEMENT

Principles, policies, practices, oversight, and training are established and maintained to ensure that a comprehensive risk management strategy is in place over the life cycle of the nuclear asset.

- A set of principles is defined for integrated risk management.
  - The application of risk tools is considered as part of core business.
  - Integrated risk management processes are preemptive and preventive.
  - Risk gradients or levels are established and defined in accordance with established processes.
  - The integrated risk management processes prescribe methods to determine acceptable levels of risk.
  - Expectations are established that every individual is responsible for identifying potential risks during his or her work and for responding as required. These expectations are clearly communicated and periodically reinforced.
  - The importance of managing defenses, conservative decision-making, a questioning attitude, and the use of operating experience, as these relate to integrated risk management, is clearly communicated.
  - Risk management is used as a decision-making tool to systematically help identify risks and benefits and to determine the best course of action for any given situation.
- Corporate policies and practices support integrated risk management.
  - A corporate policy is in place that establishes a governance model for integrated risk management.
  - The corporate board of directors periodically reviews the framework for managing integrated risk.
  - Corporate exposure and margins are assessed for risk and are considered as part of the integrated risk management process.
  - Roles and responsibilities are clearly established for the various aspects of integrated risk management.
  - Levels of authority for decision-making are defined and applied using a graded approach commensurate with the level of potential risk.
  - Requirements for management and independent oversight are described as part of the integrated risk process.

- The risk management process is integrated with other key processes, such as long- range planning, on-line work management, equipment health, margin management, design modification, and fleet priorities, as applicable.
  - Effective thresholds or triggers are established in processes to ensure appropriate levels of oversight for risk-based decisions.
  - A comprehensive risk assessment model is in place and is maintained current with industry standards. The model reflects as-designed, as-built, and as-operated conditions.
  - Tools provided to personnel are current with the risk assessment model and are user friendly.
  - Methods used to determine fleet and station priorities are integrated with the risk management process.
  - Acceptable and unacceptable risk states are defined, and unacceptable outcomes are clearly identified.
  - Risk terms are clearly defined and communicated through a common language.
  - Processes and procedures include requirements for risk considerations and implementation criteria and support consistent application of risk tools.
  - Incentives and rewards are established to show value in risk identification and management.
- Leadership practices support integrated risk management.
    - Senior corporate executives endorse and support stations by providing sufficient resources.
    - Senior managers are committed to the application of risk tools as part of core business.
    - Leaders reinforce appropriate risk behaviors and value the independent challenge of risk decisions.
    - A positive safety culture is developed and maintained.
    - Managers are responsible for the routine application of an integrated risk model at every level of activity.
    - Aggregate risk is evaluated, and actions are taken to manage cumulative risk.
    - Decisions to accept risk are made at the appropriate level.
    - Resources are provided to increase the margin to unacceptable risk conditions.
    - Risk management is used to determine how people and equipment are most efficiently used.
    - Risk awareness is promoted through visible means, such as posters and schedules, throughout the site.

- Periodic leadership assessments are performed to check the understanding of risk management concepts.
- Oversight ensures that integrated risk management performance is assessed appropriately.
  - Integrated risk management governance oversight and executive and support functions are periodically reviewed.
  - Key performance metrics are established to objectively monitor integrated risk management performance.
- Training supports effective integrated risk management.
  - All workers have the appropriate knowledge and experience to identify potential risk.
  - Select personnel have the appropriate level of knowledge and skill to assess risk.
  - Training is provided to appropriate populations such that risk management actions and behaviors can be implemented effectively.
  - Training and knowledge transfer programs reflect lessons learned obtained from the *learn and adapt* element of integrated risk management.

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## APPENDIX C

### INTEGRATED RISK MANAGEMENT WARNING FLAGS

The following warning flags are provided to help individuals and managers identify potentially adverse conditions within their organizations that could affect integrated risk management. These warning flags are grouped by defenses that are relied on to minimize risk-related events. Managers are encouraged to reflect on these warning flags and use them to stimulate discussion in a variety of management forums. These warning flags can be used as the basis for conducting situational or organizational self-assessments.

#### Individual Performance

- Individuals or groups exhibit self-imposed production pressure.
- Work activities are considered routine.
- Individuals are quick to make risk judgments without taking the time to fully understand the situation.
- Past success without adverse outcomes becomes the basis for continuing at-risk behaviors or practices.
- Personnel take pride in their ability to work through or with levels of risk that could have been mitigated or eliminated.
- Risk is not communicated effectively up the organization. Individuals assume that the next level of supervision knows or understands the risk involved or that there are insufficient resources to manage the risk.
- Problem reporting is not transparent. Individuals are not willing to say conditions were too risky.

#### Leadership Performance

- Delegation is lacking, with a few individuals relied on to make major decisions.
- Leadership is physically or mentally separated from the reactor and/or the plant and is insufficiently aware of current conditions and attitudes.
- Personnel in the organization do not understand the truth about risk management at the working level.
- Performance indicators are used to justify existing risk management strategies and performance levels.
- The reasons for changes made at the station that can impact risk are not clearly communicated to station personnel.

### Organizational Performance

- Personnel in the organization tend to engage in consensus thinking (group think), without an effective devil's advocate and without counterview points encouraged.
- A corporate or station appetite for changes or improvements distracts personnel from the core business of operating the reactor safely.
- Personnel overly defer to managers and perceived experts at every level of the organization.
- Risk activities are not assigned clear owners.

### Program or Process

- Risk and reliability analysis does not have a defined organizational structure or established application to nuclear power plant operations.
- The organization assumes that risk management is healthy because a program or process was established (complacency exists).
- Risk management processes are overrelied on, instead of personal ownership and accountability for managing risk.
- Risk management processes are inefficient or cumbersome ("more" is often not better).

## APPENDIX D

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