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Principles for Maintaining an Effective Technical Conscience

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INTRODUCTION

Principles for Maintaining an Effective Technical Conscience describes the attributes necessary to ensure ethical and effective technical support during the operation, maintenance, and modification of nuclear power plants. This document provides a set of attributes that should be applied to all levels of the organization, from senior corporate management to individual contributors at the sites, when technical issues and concerns are addressed. It is intended to provide a framework for discussion and communication of the importance of highly principled, thorough analyses, and reviews to ensure conformance with plant design requirements and emergency response strategy technical requirements when plant conditions, technical concerns, and proposed changes are evaluated.

The unique nature of nuclear technology is reflected in the requirements applied to nuclear power plant design and emergency response strategies. The design requirements are comprised of the plant design bases and the accepted industry codes and standards that form the foundation for the design bases. The plant design bases are the calculations, analyses, drawings, and specifications that describe the intended operational configuration of the plant. Design requirements also include applied factors to ensure an acceptable margin of safety in design and operating limits for all evaluated plant conditions. Emergency response strategies (FLEX, for example) provide added safety margin beyond the design bases in order to protect against fuel damage and loss of containment integrity.

As discussed in the principles, there exists a level of obligation and responsibility that must be strongly internalized at all levels of the organization and supported by station and corporate leaders. When technical reviews identify conditions or concerns that potentially reduce operating, design, or safety margins (such as unexpected boric acid deposits on carbon steel components, unusual indications of leakage in containment, or information that may alter assumptions for emergency response strategies), organizations with an effective technical conscience take action to thoroughly identify the cause, evaluate issue significance, and correct the condition and restore margins commensurate with its safety significance. Many important industry events were caused, in part, by insufficient technical reviews of plant conditions, technically incorrect plant design changes, or improper justification and acceptance of degraded or questionable conditions. Also contributing to events has been weak regard for technical considerations by individuals or organizations at large when making operational, maintenance, and technical decisions.

This document should be used in conjunction with other principles documents. For example, *Principles for a Strong Plant Operational Focus* ensure the appropriate balance of priorities for resolution of near-term operational issues and the appropriate level of technical review to support effective operational decisions. *Traits of a Healthy Nuclear Safety Culture*, including Addendum I and II, addresses the unique nature of nuclear technology and many of the engineering and technical behaviors necessary to support a healthy nuclear safety culture.

Because each plant and corporate organization has its own unique structure, the following clarifies how certain terms are used in this document. The term “engineering leader” refers to those personnel in the organization with engineering expertise who exercise leadership or managerial activities. The term “engineers” refers to personnel performing engineering functions that include tasks such as technical evaluation and review of plant conditions, test results, design, and temporary configuration changes, and technical interface with emergency response strategies. These personnel are entrusted and obligated to ensure these conditions, results, evaluations, and documents do not compromise the critical requirements of plant design, emergency response strategies, or margins to safety.

Definition of Technical Conscience:

The personal obligation leaders and individuals internalize and exercise to ensure plant operation, maintenance, and engineering activities are conducted in a manner consistent with plant design and emergency response strategy technical requirements, and that preserve operating, design, and safety margins.

The following principles are described in this document:

1. Senior leaders respect and reinforce the importance of technical considerations in decision-making.
2. Engineering leaders accept and exercise technical authority.
3. Engineers identify, communicate, and advocate resolution of technical concerns.
4. Engineers adhere to sound engineering principles and judgment.
5. Engineers challenge conditions and decisions when needed.

1. Senior leaders respect and reinforce the importance of technical considerations in decision-making.

Senior corporate and site leaders understand, respect, promote, and reinforce the importance of technical considerations to ensure decisions reflect the need to operate and maintain the plant within the requirements of plant design and emergency response strategies, and to ensure preservation of operating, design, and safety margins. Senior leaders understand the need to apply technical conservatism to decisions that affect nuclear safety, and ensure the appropriate balance between technical conservatism and business needs for matters that affect plant reliability. Consideration is given to clarify the bases for technical decisions which may be contentious. In all cases, leaders accept the responsibility to create a safe, positive environment for the identification and resolution of technical issues as part of the decision-making process.

Attributes:

- Senior leaders reinforce the expectation that engineers identify conditions that can degrade or call into question operating, design, and safety margins.
- Senior leaders encourage the sharing of diverse technical perspectives when making decisions. They create a safe environment to promote issue identification and delivery of quality technical products and decisions.
- Senior leaders recognize the need to obtain the perspectives of cognizant technical organizations in the decision-making process to ensure technical positions are fully understood.
- Senior leaders demonstrate personal responsibility to ensure the technical bases of proposed changes, evaluations, and decisions are thoroughly reviewed. Senior leaders challenge decisions and corrective actions that result in degraded operating, design, or safety margins.
- Senior leaders reinforce the engineering responsibility to own, understand, and maintain the bases of plant design and emergency response strategies. Senior leaders also reinforce expectation for the physical plant configuration and documents used to maintain the plant to accurately reflect design requirements, including prompt updates after implementation of approved configuration changes.
- Senior leaders invite challenges, listen, and use feedback to achieve optimum decisions.

2. Engineering leaders accept and exercise technical authority.

Engineering leaders recognize and accept their responsibility to address plant technical issues. They exercise a deep sense of personal obligation to uphold the requirements of plant design and emergency response strategies, and ensure appropriate operating, design, and safety margins are maintained.

Attributes:

- Engineering leaders ensure the organization understands and acknowledges that technical analyses and decisions are to be consistent with the requirements of plant design and emergency response strategies.
- Engineering leaders actively participate in issue management forums, such as key plant meetings, to ensure identification and evaluation of plant conditions and related decisions that can affect requirements of plant design or emergency response strategies, and reduce operating, design, or safety margins.
- Engineering leaders technically challenge analyses and recommendations to ensure the full range of potential consequences is clearly defined, understood, and communicated as part of final decision-making. Engineering leaders challenge the thoroughness of engineering judgment used as a basis for decisions and recommendations.
- Engineering leaders set high standards and reinforce expectations for thorough and complete technical reviews of conditions that potentially deviate from plant design requirements and emergency response strategies, or that could reduce operating, design, or safety margins. If necessary, independent third parties are contracted to ensure sufficient technical reviews are performed, especially for complex or first-of-a-kind designs.
- Engineering leaders ensure personnel who perform technical evaluations fully understand their responsibility and personal obligation to perform high-quality technical work. Engineering leaders emphasize the importance of using significant industry and job-related operating experience, and reinforce the responsibility of personnel to perform thorough, critical reviews of work performed by outside organizations.

3. Engineers identify, communicate, and advocate resolution of technical concerns.

Engineers identify trends and emerging technical issues, communicate concerns, advise management of potential consequences, and advocate the resolution of conditions that affect plant design requirements, technical aspects of emergency response strategies, or operating, design, or safety margins.

Attributes:

- Engineers routinely monitor plant conditions to identify and advocate the correction of design vulnerabilities, deviations from plant design requirements, degraded equipment conditions, or reductions in operating, design, or safety margins.
- Engineers ensure potential technical problems are understood, clearly defined, and promptly communicated for action. When needed, engineers obtain input from personnel with specialized knowledge, such as operations, maintenance, chemistry, radiation protection, emergency preparedness, or nondestructive examination.
- Engineers thoroughly evaluate and promptly communicate potential consequences and solutions for identified technical concerns. Methodical analysis, such as failure modes and effects, is used to ensure full understanding for potential consequences of the technical concern and the probabilities for undesired outcomes.
- Engineers ensure abnormal plant conditions or indications that cannot be readily explained are documented and evaluated to verify the conditions and indications do not challenge operational or design limits that protect plant safety and reliability.
- Engineers identify causes for abnormal plant conditions and advocate for solutions that support reliable equipment operation and operational excellence.
- Engineers ensure corrective action plans are developed and executed to restore margins or conformance to plant design requirements and emergency response strategies, in time frames commensurate with safety significance of an issue.
- When temporary solutions are required, engineers advocate timely implementation of permanent solutions.

4. Engineers adhere to sound engineering principles.

Engineers ensure high-quality products when they sign off as complete. Engineers develop technical products, recommendations, and decisions using facts, engineering practices, codes, standards, operating experience, and review/verification processes. The consequences and probabilities of undesired outcomes are thoroughly evaluated, documented, and communicated.

Attributes:

- Engineers use factual information from diverse sources to understand technical issues and provide technical products, recommendations, and decisions. This information is independently verified as part of the engineering review process.
- Technical products, recommendations, and decisions are carefully developed using approved and accepted codes, standards, and analytical tools. Design inputs, methodologies, and the bases for results are documented, independently verified, and formally communicated to appropriate stakeholders. Engineers systematically apply critical thinking, human performance techniques, and additional reviews to ensure high-quality products and to minimize the likelihood of errors and omissions.
- Assumptions and engineering judgment are fully documented and receive thorough independent verification to ensure they are appropriately conservative and consistent with approved codes and standards. Key assumptions and the use of engineering judgment are clearly communicated to decision-makers to ensure the limitations of the technical analyses are fully understood. When possible, assumptions are validated through physical examination, analysis, or testing.
- Engineers develop, maintain, and exercise their expert knowledge of plant operating limits, design requirements, industry codes and standards, and industry technical programs such as flow accelerated corrosion.
- Engineers recognize the limits of their technical expertise and clearly communicate to decision-makers when they are offering advice or opinions outside of their area of expertise. Engineers recognize that their signature represents professional endorsement of a quality product.

5. Engineers challenge conditions and decisions when needed.

Engineers are the guardians of plant design and licensing bases. They professionally challenge the technical bases of decisions that might compromise nuclear safety, plant design requirements, or emergency response strategies. In all decisions, engineers advocate actions to preserve and recover operating, design, and safety margins. Advocacy positions are formulated based on the best available technical facts, codes, standards, and analytical techniques. For decisions that affect plant reliability, engineers ensure decision-makers give appropriate priority to technical considerations, understand the potential consequences of considered options, and recognize the probabilities of undesired outcomes.

Attributes:

- Engineers demonstrate a deep personal commitment and obligation to ensure plant conditions and proposed changes are appropriately bounded by requirements of plant design and emergency response strategies, as well as applicable operating, design, and safety margins.
- Engineers communicate the technical bases for advocated positions, avoiding opinions and emotional arguments. Engineers clearly communicate to decision-makers the assumptions, judgments, analysis limitations, and potential consequences of advocated positions and the probabilities of undesired outcomes.
- Engineers display confidence and integrity when challenging conditions or decisions and advocating positions during the decision-making process. Engineers recognize the difficulty in communicating technical considerations and request feedback to ensure decision-makers fully understand those technical considerations that should strongly influence the decision.
- Engineers present technical considerations to decision-makers and insist on conservative decisions related to nuclear safety. They escalate concerns to appropriate levels of management. For decisions related to plant reliability, engineers understand and accept decisions based on facts and appropriate consideration for the potential risks to plant reliability. In all cases, engineers understand that risk-based decision-making may not result in selecting the most conservative option.

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