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**Principles for
Maintaining an
Effective Technical
Conscience**

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Introduction

Principles for Maintaining an Effective Technical Conscience establishes a set of principles to guide the reinforcement of desired behaviors to ensure ethical and effective technical support during the operation, maintenance and modification of nuclear power plants. Each principle is in italics followed by amplifying attributes to help clarify its intent. These attributes should be applied to all levels of the organization, from senior corporate executives to individual contributors, when technical issues and concerns are addressed. In part, insufficient technical reviews of plant conditions, technically incorrect plant design changes, or improper justification and acceptance of degraded or questionable conditions caused many important industry events. Also contributing to events has been a weak regard for technical considerations by individuals or organizations at large when making operational, maintenance and technical decisions.

While the intent of the original principles document was to establish a healthy technical conscience across all site organizations, many perceived the document as applicable only to engineers as opposed to all nuclear professionals. Broader nuclear professional understanding and internalization of technical conscience principles are needed to manage risk, address degraded conditions, and understand design and

license bases across the industry consistently. With ongoing changes to station organizations, shifting responsibilities, and attrition of experienced nuclear professionals, heavy reliance on traditional engineering organizations to serve as the sole technical back-stop may not be sustainable. Improved ownership and teamwork are required on the part of all nuclear professionals to act as a collective technical conscience for the station. The intent of this revision is to reinforce the obligations of all nuclear professionals to identify, communicate, and advocate for timely resolution of degraded conditions. This revision builds on the lessons in IER L1-14-20, *Integrated Risk – Healthy Technical Conscience*, and several other industry-shaping events. Additionally, the expectation is that all nuclear professionals seek out and respect technical input in decision-making, perform quality work, and challenge decisions when needed.

The unique nature of nuclear technology is reflected in the requirements applied to nuclear power plant design and beyond design basis 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 and long-term asset protection. 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 provide added safety margin beyond the design basis in order to protect against fuel damage and loss of containment integrity.

As discussed in the principles, a level of obligation and responsibility exists that must be strongly internalized at all levels of the organization and supported by all leaders and executives, including oversight organizations and safety review committees. Some conditions or concerns that potentially reduce operating, design or safety margins are unexpected boric acid deposits on carbon steel components, degraded chemistry conditions, unusual indications of leakage in containment, and instances that may alter assumptions for emergency response strategies. Organizations with an effective technical conscience thoroughly evaluate and correct the condition on a schedule commensurate with its safety and reliability significance. This revision reinforces the need for all nuclear professionals to own and internalize this obligation.

This document should be used in conjunction with other principles documents. For example, INPO 15-005, *Leadership and Team Effectiveness Attributes*, identifies the standards for effective leadership and

teams, including making effective decisions and appropriately managing risk. *Principles for a Strong Plant Operational Focus* (INPO 10-004) details 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* (INPO 12-012) and its accompanying addendums address the unique nature of nuclear technology and many of the engineering and technical behaviors necessary to support a healthy nuclear safety culture. *Principles for Excellence in Integrated Risk Management* (INPO 15-011) emphasizes consequence-biased decision-making and intolerance for unacceptable end-states. *Principles for Excellence in Corporate Performance* (INPO 17-004) provides a set of principles and attributes for the conduct of important aspects of corporate organizations.

Clarification of Terms Used in This Document

Because each plant and corporate organization has its own unique structure, the following clarifies how certain terms are used in this document:

- Engineer and technical staff—These terms include all personnel, regardless of their organizational assignment, who perform engineering and technical type functions at the station or who provide

technical products and services from corporate or vendor locations. Tasks include performing technical evaluations, monitoring and reviewing plant conditions, managing plant chemistry, analyzing test results, running diagnostics, troubleshooting, providing design changes, performing temporary configuration changes, and technically interfacing with beyond design basis emergency response strategies.

- **Engineering leader**—This term includes those personnel in the organization who have engineering expertise and exercise leadership or managerial activities, regardless of their department affiliation.
- **Nuclear professional**—This term includes all personnel who perform work at or who support the safe operation of the nuclear station. This includes individual contributors, managers and supplemental personnel who perform work at the station or who provide technical products and services from corporate and vendor locations.
- **Leader**—This term includes an individual who inspires, coaches and influences people to accomplish organizational goals while adhering to core values. For the purpose of this document, the term includes engineering managers, chemistry

managers, corporate functional area managers and so forth.

- Senior leaders—This term includes the senior leaders, plant managers and their direct reports who act in a leadership role to inspire, coach and influence people to accomplish organizational goals and pursue excellence.
- Corporate executives—This term refers to officers, including the site vice president, of the utility, corporation or operating company holding the operating or construction license for nuclear power plants.

Definition of Technical Conscience

Technical conscience is the personal obligation that nuclear professionals internalize and exercise to ensure plant activities are conducted in a manner that is consistent with plant design and licensing basis, that ensures high reliability; and that preserves operating, design, and safety margins.

The following principles are described in this document:

1. Senior leaders and corporate executives respect and reinforce the importance of technical considerations with a consequence-biased approach in decision-making.

2. Leaders accept, support and exercise their technical authority.
3. Engineers and technical staff identify, communicate and advocate timely resolution of technical concerns.
4. Engineers and technical staff adhere to sound principles and judgement to produce highquality products and decisions.
5. Nuclear professionals identify, question and advocate to resolve issues that may compromise nuclear safety or plant reliability.

Principle 1: Senior Leaders and Corporate Executives

Senior leaders and corporate executives respect and reinforce the importance of technical considerations with a consequence-biased approach in decision-making.

Senior site leaders and corporate executives ensure preservation of operation, design and safety margins. This is demonstrated by understanding, respecting, promoting and reinforcing the importance of technical considerations in decisions that reflect the need to operate and maintain the plant within the requirements of design, licensing basis, and beyond design basis emergency response strategies. Senior leaders understand the need to apply technical conservatism and consider potential worst-case outcomes in decisions that affect nuclear safety. Senior leaders also ensure the appropriate balance between technical conservatism, plant operating margins, and business needs for matters that affect plant reliability. In addition, senior leaders promote the culture for all nuclear professionals to identify and advocate for the resolution of important issues and to perform work in a high-quality manner.

Attributes

- Senior leaders and corporate executives recognize that sound decision-making is based on rigorous inclusion of technical considerations. They expect consideration of evaluation of alternatives and knowledge of pertinent operating experience and potential worst-case outcomes in a consequence-biased approach to decision-making.
- Senior leaders and corporate executives encourage the sharing of diverse technical perspectives; obtain perspectives of cognizant, functional organizations; and invite challenge and feedback to ensure technical positions are fully understood and to ensure safe and conservative decisions involving nuclear safety are achieved.
- Senior leaders and corporate executives 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 and corporate executives reinforce engineering responsibility to own, understand and maintain the design authority for the station in fulfilling licensing bases commitments.

- Senior leaders and corporate executives reinforce the expectation that the physical plant configuration and documents used to operate and maintain the plant reflect accurately design requirements, including prompt updates after implementation of approved configuration changes.
- Senior leaders and corporate executives promote a culture in which nuclear professionals exhibit a deep personal commitment to nuclear safety, reliability and long-term operation demonstrated through issue identification, questioning attitude, and advocacy to address degraded conditions.
- Senior leaders and corporate executives promote a culture in which all nuclear professionals understand how the quality of their work and adherence to fundamentals are important to ensure compliance with technical and design requirements.
- Senior leaders and corporate executives ensure that third parties are engaged and that critical oversight is applied to ensure sufficient technical reviews are performed to fully understand project technical risks. If necessary, independent third parties are contracted to ensure sufficient technical reviews are performed, especially for complex or first-of-a-kind designs, system lineups, inspections, and chemistry and radiological evolutions.

Principle 2: Technical Authority

Leaders accept, support and exercise their technical authority.

Engineering leaders recognize their unique role as the technical authority and exercise a deep sense of personal obligation to uphold their design and licensing basis technical authority. All leaders recognize and accept their ownership and authority to address plant technical issues, proactively communicate functional area experience and knowledge to resolve issues, and ensure high-quality technical products and decisions are developed.

Attributes

- Engineering leaders exercise a deep sense of personal obligation to uphold the requirements of plant design and licensing basis and to ensure appropriate operating, design and safety margins are maintained.
- Engineering leaders ensure the organization understands and acknowledges technical analyses; documentation and decisions are to be consistent with the requirements of plant design and licensing basis and with beyond-design-basis emergency response strategies.

- Engineering leaders reinforce expectations for engineers to exercise their unique role as guardians of plant design and licensing basis.
- Leaders recognize and accept responsibility to address plant technical issues.
- Leaders proactively participate and exert their authority, experience and technical knowledge gained through functional area assignments to ensure such are considered during evaluation of plant technical issues and related decisions.
- Leaders technically challenge analyses and recommendations to ensure the full range of potential consequences of failure are clearly defined, understood and communicated as part of final decision-making.
- Leaders set high standards and reinforce expectations for personnel to understand and fulfill their obligation to perform thorough and high-quality technical work, including using significant industry and job-related operating experience.
- Leaders create a safe and supportive environment that promotes issue identification and the delivery of quality technical products, services and decisions.

Principle 3: Timely Identification and Resolution

Engineers and technical staff identify, communicate and advocate timely resolution of technical concerns.

Engineers and technical staff apply their expert knowledge and skills to identify trends and emerging technical issues, communicate concerns, and advise management staff of potential consequences. Engineers advocate the timely resolution of conditions that affect requirements of plant design; licensing basis; beyond design basis emergency response strategies; and operating, design, or safety margins. A consequence-bias is maintained and worst-case outcomes are considered when addressing technical concerns.

Attributes

- Engineers and technical staff routinely monitor plant conditions to identify and advocate the timely correction of design vulnerabilities; deviations from plant design requirements; degraded equipment conditions; or reductions in operating, design, or safety margins.
- Engineers and technical staff ensure potential technical problems are understood, clearly defined, and promptly communicated for action.

- Engineers and technical staff thoroughly evaluate and promptly communicate potential consequences and solutions for identified technical concerns. Input from subject-matter experts and personnel with specialized knowledge — such as in operations, maintenance, engineering, chemistry, radiation protection, emergency preparedness or nondestructive examination — are used. Methodical evaluations or analyses are used to ensure full understanding of potential consequences of the technical concern and probabilities for undesired outcomes.
- Engineers and technical staff collaborate with other nuclear professionals to ensure abnormal plant conditions or indications that cannot be readily explained are documented, monitored, investigated and evaluated for causes and worst-case outcomes to verify that the conditions and indications do not challenge operational or design limits that protect plant safety and reliability.
- Engineers and technical staff ensure corrective action plans are developed and executed to restore margins or conformance to plant design and licensing requirements and operating, design or safety margins commensurate with the safety significance of an issue.

- Engineers and technical staff advocate for solutions that support safe and reliable plant operation. When temporary or bridging solutions are required, engineers advocate timely implementation of permanent solutions.

Principle 4: Quality

Engineers and technical staff adhere to sound principles and judgement to produce high-quality products and decisions.

Engineers and technical staff ensure that their products are of high quality from start to finish before signing them off as complete. They develop technical recommendations and decisions by using facts, codes, standards, operating experience, and review and verification processes.

Attributes

- Engineers and technical staff use factual information from diverse sources to understand technical issues and provide high-quality technical products, recommendations and decisions. This information is verified as part of the review process.
- Engineers and technical staff carefully develop and implement high-quality technical products, recommendations and decisions based upon approved procedures, codes, standards, analytical tools and operating experience.
- Engineers and technical staff recognize that systematically applying critical thinking, verification techniques, and additional reviews ensure

high-quality products and decisions to minimize the likelihood of errors and omissions. Technical inputs, methodologies, and the bases for engineering results are documented, independently verified, and formally communicated to appropriate stakeholders.

- Engineers and technical staff use assumptions and judgement that are fully documented, conservative, and consistent with approved codes and standards. Key assumptions and use of judgement are clearly communicated to decision makers to ensure that risks and the limits of technical analyses are fully understood. When possible, assumptions are validated through testing, physical examination or analysis.
- Engineers and technical staff recognize the limits of their technical expertise and clearly communicate to decision makers when offering advice or recommendations outside their area of expertise; they recognize their signature represents a professional endorsement of a quality product.
- Engineers and technical staff develop, maintain and exercise their expert knowledge of plant operating limits, design requirements, industry codes, standards and technical programs.

- Engineers and technical staff demonstrate a deep personal commitment and obligation to ensure plant conditions and proposed changes are appropriately bounded by requirements of plant design and licensing basis and preserve operating, design and safety margins.

Principle 5: Challenging Plant Conditions

Nuclear professionals identify, question and advocate to resolve issues that may compromise nuclear safety or plant reliability.

Nuclear professionals challenge plant conditions; technical bases of decisions; accuracy of technical information and specifications that may compromise nuclear safety; plant performance; and requirements of plant design, licensing basis, or beyond-design-basis emergency response strategies. All advocacy positions are formulated based on the best available facts, fundamentals, operating and functional area experience, and analytical techniques.

Attributes

- Nuclear professionals identify, document, advocate, and collaborate with engineers and technical staff to resolve degraded equipment conditions, questionable plant conditions, and inaccurate technical information or specifications.
- Nuclear professionals communicate the bases for advocated positions, avoiding opinions and emotional arguments. They clearly communicate to decision makers the assumptions, judgments,

analysis limitations, potential consequences of advocated positions, and the probabilities of undesired outcomes.

- Nuclear professionals display confidence and integrity when challenging conditions or decisions and when advocating positions during the decision-making process. They recognize the difficulty in communicating functional area and technical considerations and request feedback to ensure decision makers fully understand those considerations that should strongly influence the decision.
- Nuclear professionals proactively present technical considerations and functional expertise to decision makers, insist on conservative decisions related to nuclear safety, and, if needed, escalate concerns to appropriate members of management. They understand that decisions regarding plant reliability should be based on facts and appropriate consideration for potential risks and may not always result in selecting the most conservative option.

- Nuclear professionals demonstrate a commitment and obligation to ensure plant activities are conducted in a manner consistent with exacting specifications, approved procedures and design documents to ensure safety, equipment reliability, and compliance with plant design and licensing bases. Nuclear professionals recognize the limits of their expertise and, when needed, seek out subject-matter expert input to ensure that their actions do not compromise adherence to approved design documents.



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