EVALUATION OF SAFETY CULTURE IN WANO PRE-STARTUP REVIEWS

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ABSTRACT:

The requirements for performance of pre-startup reviews at new nuclear plants by the World Association of Nuclear Operators (WANO) are discussed. Specific emphasis is placed on the assessment of nuclear safety culture at sites nearing the end of construction activities and transitioning to the operational phase. A review of each of WANO's eight *Principles for a Strong Nuclear Safety Culture* is presented to give context to the attributes required to demonstrate a healthy safety culture. Finally, examples and emerging trends from recent WANO pre-startup reviews are discussed to provide perspective on current areas for improvement.

1. Introduction

Before initial criticality of each new nuclear power plant, WANO conducts a pre-startup review to ensure readiness for plant startup and subsequent safe and reliable operation of the unit. WANO, the World Association of Nuclear Operators, was formed in 1989 following the accident at Chernobyl. Its stated mission is "to maximise the safety and reliability of nuclear power plants worldwide by working together to assess, benchmark, and improve performance through mutual support, exchange of information and emulation of best practices." WANO has members in more than 30 countries operating a total of 440 nuclear units. Nuclear safety culture is a primary component of safe and reliable operation and, therefore, is a key part of any assessment of pre-startup readiness. This presentation will address WANO's method for conducting pre-start up reviews and, in particular, the eight principles and related attributes of nuclear safety culture that must be demonstrated. The eight principles were published by WANO in 2006 and have been adopted by member utilities worldwide:

1. Everyone is personally responsible for nuclear safety.
2. Leaders demonstrate commitment to safety.
3. Trust permeates the organisation.
4. Decision-making reflects safety first.
5. Nuclear technology is recognised as special and unique.
6. A questioning attitude is cultivated.
7. Organisational learning is embraced.
8. Nuclear safety undergoes constant examination.

WANO defines safety culture as "an organisation's values and behaviours--modelled by its leaders and internalised by its members--that serve to make nuclear safety the overriding priority." Implied in this definition is the notion that nuclear power plants are designed, built, and operated (and intended) to produce power in a safe, reliable, efficient manner; that the

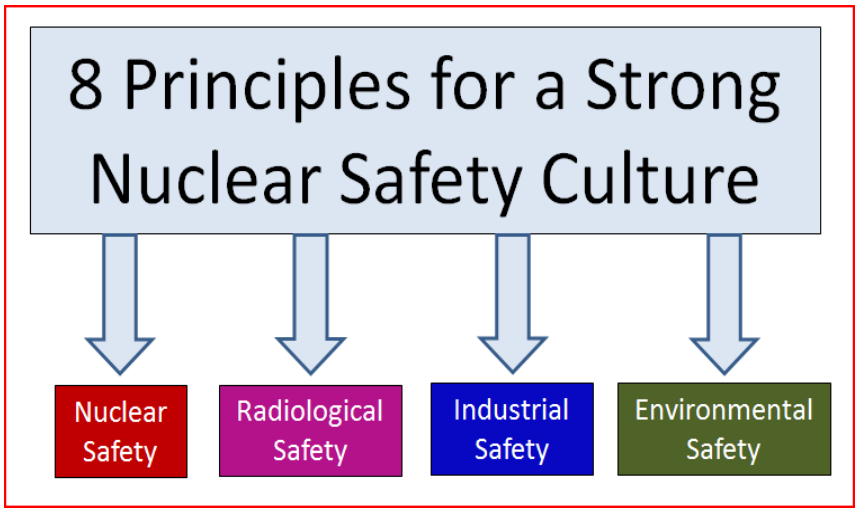
concept of safety culture applies to every employee in the nuclear organisation, from the board of directors to the individual contributor; that the focus is on nuclear safety, although the same principles apply to radiological safety, industrial safety, and environmental safety; and that nuclear safety is the first value adopted at a nuclear station and is never abandoned.[1] Three important themes related to nuclear safety culture in pre-startup reviews are clear:

- *Safety culture applies to every employee in the nuclear organization.*

  Nuclear safety is a collective responsibility; no one in the organisation is exempt from the obligation to ensure safety first. As stated by the IAEA, "The safety of the plant also depends critically on those who previously designed, constructed and commissioned it.[2]" Although WANO pre-startup reviews are not specifically evaluating plant design and construction, it is important to ensure the proper foundation for nuclear safety culture has been established from the beginning. For example, workers involved in areas such as staffing, training, quality assurance, operating experience, nuclear oversight and emergency planning have key roles in establishing the proper safety culture to support eventual operation of the facility.

- *The focus is on nuclear safety, although the same principles apply to radiological safety, industrial safety, and environmental safety.*

  Some utilities have adopted this view to demonstrate this alignment:



- *Nuclear safety is the first value adopted at a nuclear station and is never abandoned.*

  Nuclear safety culture must be assessed during the pre-operational phase, as it should be the first value adopted and should be evident from the very beginning of plant preparation for operation.

[1] WANO Guideline 2006-02, "Principles for a Strong Nuclear Safety Culture" January 2006, Limited Distribution
[2] IAEA Safety Culture Series No. 75-INSAG-4, 1991

2. Conduct of WANO Pre-Startup Reviews

2.1. Expectation and basis

After the Fukushima event, the WANO Governing Board commissioned a group of industry executives representing 14 companies from 12 different countries to propose recommendations regarding how the organisation should respond and how WANO could improve its programmes to more effectively fulfill its mission. While some pre-startup reviews had been conducted prior to Fukushima, one of the firm recommendations of the commission was to require the conduct of pre-startup reviews for all new nuclear power units. Additionally, a Memorandum of Understanding was signed in September between WANO and the IAEA to reflect increased cooperation between the two organisations following the Fukushima Daiichi accident. WANO Chairman Laurent Stricker stated, "As WANO was created by Chernobyl, so will it be changed forever by Fukushima."

2.2. Pre-startup review process

WANO pre-startup reviews are typically two weeks in duration, conducted by a team comprised of approximately 14 reviewers. The team consists of WANO employees and several industry peers representing nuclear stations affiliated with WANO regional centres located in Paris, Moscow, Atlanta or Tokyo. The WANO team leader conducts a pre-visit to the site several months before the pre-startup review to meet with senior management on the logistics of the review and to ensure a mutual understanding of the expected outcomes, scope, and schedule. Interviews with employees and a tour of the station are conducted during the pre-visit as well, providing valuable preliminary information as the team prepares for the review upon arrival.

Team members are assigned to review functional and cross-functional areas including operations, maintenance, chemistry, engineering, radiation protection, training, fire protection, emergency preparedness, organisation and administration, operating experience, plant status and configuration control, work management, and equipment performance and condition.

WANO pre-startup reviews differ from IAEA Pre-Operational Safety Review Team (pre-OSART) missions in several ways, but primarily in the conduct of crew performance observations in the control room simulator and in review of significant operating experience reports from the industry. Additionally, WANO pre-startup reviews are mandated for each new unit while IAEA pre-OSART missions are not.

3. Nuclear Safety Culture Principles

The health of the nuclear safety culture at the station is assessed through interviews with employees, data reviews and observations by the team. The eight *Principles for a Strong Nuclear Safety Culture*[3] are used as the basis for this phase of the review. It is important to see a strong foundation for nuclear safety culture before the plant begins operation. An effective

[3] WANO Guideline 2006-02, "Principles for a Strong Nuclear Safety Culture" January 2006, Limited Distribution

assessment must consider the actions already taken to establish the safety culture, as well as those actions necessary to ensure a healthy safety culture will be in place during the operational phase. Therefore, a forward-looking view is necessary during the pre-startup review to ensure proper implementation of these principles.

3.1. Principle #1: Everyone is personally responsible for nuclear safety.

Responsibility and authority for nuclear safety are well defined and clearly understood. Reporting relationships, positional authority, staffing, and financial resources support nuclear safety responsibilities. Corporate policies emphasise the overriding importance of nuclear safety.

WANO pre-startup review areas of emphasis in Principle #1:

It is important that all personnel understand the importance of adhering to nuclear safety standards and this level of understanding will be assessed during the pre-startup review. Through interviews and observation the team will determine if employees are following procedures and whether they are preparing to operate the plant according to the highest standards. The team will also assess whether the organisation demonstrates a healthy accountability for shortfalls in meeting standards and whether those shortfalls are identified and dispositioned through the corrective action programme.

3.2. Principle #2: Leaders demonstrate commitment to safety.

Executive and senior managers are the leading advocates of nuclear safety and demonstrate their commitment both in word and action. The nuclear safety message is communicated frequently and consistently, occasionally as a stand-alone theme. Leaders throughout the nuclear organisation set an example for safety.

WANO pre-startup review areas of emphasis in Principle #2:

As the construction phase of the project will be drawing to a close, the team will ensure rewards programmes and milestone goals reinforce the proper behaviours and do not emphasise schedule adherence over safety. Managers and supervisors should be providing appropriate oversight and coaching during significant field activities and safety-significant tests to support startup. Their leadership and reinforcement of standards should be visible in the field; and leaders should be personally involved in high-quality training, especially for a newly-established workforce that may have limited experience in an operating nuclear power plant. Selection and evaluation of managers and supervisors considers their ability to reinforce and communicate the principles of a strong nuclear safety culture.

3.3. Principle #3: Trust permeates the organisation.

A high level of trust is established in the organisation, fostered, in part, through timely and accurate communication. There is a free flow of information in which

issues are raised and addressed. Employees are informed of steps taken in response to their concerns.

WANO pre-startup review areas of emphasis in Principle #3:

A healthy safety culture, even during construction, allows personnel to raise nuclear safety concerns without fear of retribution. There must be a free flow of information at all levels of the organisation and important communication from management to the workforce must be timely and accurate if trust is to permeate the organisation. The pre-startup review team will also assess whether complete and accurate information is provided to oversight, audit, and regulatory organisations.

3.4. Principle #4: Decision-making reflects safety first.

Personnel are systematic and rigorous in making decisions that support safe, reliable plant operation. Operators are vested with the authority and understand the expectation, when faced with unexpected or uncertain conditions, to place the plant in a safe condition. Senior leaders support and reinforce conservative decisions.

WANO pre-startup review areas of emphasis in Principle #4:

The rigour applied to decision-making will be reviewed to ensure an emphasis on "prudent" choices, those consistent with a healthy nuclear safety culture, rather than "allowable" choices justified by limitations in schedule or budget. Senior leaders should support and reinforce conservative decisions and should require a rigorous approach to problem-solving. Operators are vested with the necessary authority to ensure decision-making reflects safety first.

3.5. Principle #5: Nuclear technology is recognised as special and unique.

The special characteristics of nuclear technology are taken into account in all decisions and actions. Reactivity control, continuity of core cooling, and integrity of fission product barriers are valued as essential, distinguishing attributes of the nuclear station work environment.

WANO pre-startup review areas of emphasis in Principle #5:

The special characteristics of nuclear technology are taken into account in all decisions and actions, regardless of the depth of a person's experience in the nuclear industry. For example, workers should understand foreign material exclusion is particularly important to protect fission product barriers, including the integrity of nuclear fuel. Plant activities are governed by comprehensive, high-quality procedures and processes. Equipment is properly maintained in all areas and systems and equipment turned over to operations are maintained consistent with the high standards required of an operating plant. An important aspect of the review is the transition from a "construction" culture to an "operating" culture. This aspect is one of the most important areas for WANO teams to evaluate the health of nuclear safety culture in a pre-startup plant.

3.6. Principle #6: A questioning attitude is cultivated.

Individuals demonstrate a questioning attitude by challenging assumptions, investigating anomalies, and considering potential adverse consequences of planned actions. This attitude is shaped by an understanding that accidents often result from a series of decisions and actions that reflect flaws in the shared assumptions, values and beliefs of the organisation. All employees are watchful for conditions or activities that can have an undesirable effect on plant safety.

WANO pre-startup review areas of emphasis in Principle #6:

Personnel do not proceed in the face of uncertainty and are not penalised for stopping an activity if they are unsure of the consequences of their actions. Workers realise their inappropriate actions during construction and testing contribute to latent problems that will become evident after the plant is on line, potentially impacting safe and reliable operation. For this reason workers are encouraged to identify conditions or behaviours that have the potential to degrade operating and design margins and are assured anomalies will be investigated thoroughly and properly.

3.7. Principle #7: Organizational learning is embraced.

Operating experience is highly valued, and the capacity to learn from experience is well developed. Training, self-assessments, corrective actions, and benchmarking are used to stimulate learning and improve performance.

WANO pre-startup review areas of emphasis in Principle #7:

Construction and operating experience is sought out and applied during construction and commissioning to prevent repeating lessons learned from previous industry events. A process is in place to obtain operating experience from the industry and to properly evaluate applicable items and establish effective corrective actions. Internal experience is also valued and acted upon to prevent repeat events; latent organisational weaknesses are identified and resolved to mitigate future events.

3.8. Principle #8: Nuclear safety undergoes constant examination.

Oversight is used to strengthen safety and improve performance. Nuclear safety is kept under constant scrutiny through a variety of monitoring techniques, some of which provide an independent "fresh look."

WANO pre-startup review areas of emphasis in Principle #8:

Independent oversight is valued, and sufficient and timely actions are taken to resolve identified concerns. Senior executives are periodically briefed on the results of oversight activities. Safety culture assessments are conducted and used as a basis for improvement, even in the pre-operational phase. A transition plan is in place to ensure

the oversight organisation is fully prepared to provide intrusive oversight of operating standards well before the first fuel load.

4. **Emerging Trends From Recently Completed WANO Pre-Startup Reviews** *(with reference to applicable nuclear safety culture principles, as appropriate)*

4.1. Insufficient emphasis on operator team-skills:

Primary focus is placed on the individual skills necessary to pass the license examination, without proper emphasis on the team skills necessary to operate the plant. For example, normal, abnormal, and emergency procedures are not adequately implemented; and shortfalls exist in crew communications and use of human error reduction techniques. In some cases, shift managers gave incorrect directions during simulated transients or stepped out of their oversight role, becoming too involved in the crew's direct actions. Often there is no conservative decision-making process in place. *(Reflects attributes of Principle 7: Organisational learning is embraced and Principle 4: Decision-making reflects safety first.)*

4.2. Weaknesses in safety system status control:

Often the station lacks a rigorous process to ensure the status of safety systems is maintained after turnover and that all system requirements are met prior to reactor mode changes. While workers demonstrated a tendency to follow the process if one is in place, they do not have an understanding of what could go wrong if they do not follow the process. An over-reliance on contract operators during the testing phase deprives station operators of valuable learning opportunities regarding systems they will soon be responsible to operate. *(Reflects attributes of Principle 5: Nuclear technology is recognised as special and unique.)*

4.3. Not learning from operating and construction experience:

Most sites have not captured lessons learned from lower-level events to identify developing station problems or causes before they contribute to an event. Additionally, the lack of timely evaluation of some significant operating experience and the late realisation of necessary actions have contributed to weaknesses in safety system status control, operational decision-making, identification of hazards affecting cooling water intake or off-site power supply, and prevention of unplanned radiological exposure. *(Reflects attributes of Principle 7: Organisational learning is embraced.)*

4.4. Ineffective use of training:

Some control room simulators do not adequately model some abnormal or emergency conditions or do not accurately reflect actual control room configuration. Additionally, training is often focused on technical knowledge and skills, with insufficient emphasis on error prevention techniques, communication, procedure use, and questioning attitude. On some occasions, training and

qualification were satisfactory for the crews assigned to the first operating unit but were not sufficient for the staff on subsequent units. *(Reflects attributes of Principle 5: Nuclear technology is recognised as special and unique and Principle 7: Organisational learning is embraced.)*

4.5. Status of fire protection systems:

Some sites had no methods in place to ensure the proper status of fire protection systems prior to core loading or subsequent reactor mode changes. The required status of fire protection active features (such as fire detection, fire pumps, valves, and dampers) or passive features (such as fire doors, pipe and cable penetrations, or cable coatings) could not be verified by approved and consistent methods. *(Reflects attributes of Principle 5: Nuclear technology is recognised as special and unique.)*

4.6. Emergency preparedness efforts focused on meeting minimum requirements:

Often the site's actions in emergency preparedness are focused on passing the required regulatory exercises before startup, without sufficient emphasis on mitigating the consequences of an accident. At many pre-startup sites, only one half of the organisation has ever participated in an emergency response drill; and often those who have drill experience have been exposed to the same drill scenario in each occurrence. *(Reflects attributes of Principle 7: Organisational learning is embraced and Principle 2: Leaders demonstrate a commitment to safety.)*

4.7. Senior managers have not placed emphasis on establishing a strong culture:

Management has not emphasised the importance of establishing a healthy reporting culture. Management standards and expectations are not effectively communicated to the workforce, and understanding and implementation of those standards is often not assessed. On some occasions, processes are put in place without adequate recognition of the limited nuclear experience of the workforce and the necessary training and communication that will be required to ensure effective implementation. Often, leaders assigned to the construction project in the early phases eventually become management leaders in the operating organisation; however, they do not recognise their operating standards are now out of line with the industry's best performers due to their prolonged absence from the requirements of an operating plant. *(Reflects attributes of Principle 2: Leaders demonstrate a commitment to safety and Principle 8: Nuclear safety undergoes constant examination.)*

4.8. The turn-key nature of some new plant projects contributes to deficiencies:

Insufficient oversight and involvement by station managers contributes to weaknesses in system turnover, particularly in readiness of procedures and proper closeout of open deficiencies. Additionally, installed systems in turn-key projects are not adequately protected from the harsh construction environment, resulting in

dirt and debris in critical systems. Station chemistry personnel are often not adequately integrated into startup activities to ensure proper system flushes and cleanliness inspections. *(Reflects attributes of Principle 8: Nuclear safety undergoes constant examination and Principle 5: Nuclear technology is recognised as special and unique.)*

5. Conclusion

WANO pre-startup reviews are required at all new nuclear power plants. These reviews cover all areas related to effective startup and operation of the new unit, and several emerging trends have been identified based on the conduct of numerous pre-startup reviews. Aspects of nuclear safety culture are applicable to many areas of the pre-startup review and are assessed to ensure the foundation for a healthy safety culture is in place. As stated in the WANO *Principles for a Strong Nuclear Safety Culture*, "nuclear safety is the first value adopted by a nuclear station and is never abandoned."

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