SAFETY CULTURE
During Decommissioning of Nuclear Power Reactors

BACKGROUND

In the United States, there are currently ten nuclear power reactors decommissioned with the NRC licenses terminated, and 20 nuclear power reactors in decommissioning status. Due to changing economic and political factors, it is possible that more reactors will be shut down in the future. Information on the decommissioning of nuclear facilities in the United States can be found on the NRC's Web page at https://www.nrc.gov/waste/decommissioning.html.

Internationally, nuclear power plants are also undergoing shutdown and decommissioning. The Fukushima Dai-ichi accident in March 2011 was a key event for nuclear power worldwide. In Japan, all nuclear plants in operation were shut down immediately after the accident, and most reactors have remained shut down. Schmitten (2016) believes that Japan's stricter safety regulations and a lengthy relicensing process to ensure compliance with the new regulations make it more difficult to operate small, older nuclear power plants. For this reason, Japanese utilities announced that these older reactors will now be decommissioned, bringing the total number of their reactors in decommissioning to 15. In Germany, 8 of the 17 operating reactors were permanently closed following Fukushima, and all of the country's nuclear power plants are currently planned to be shut down by 2022. Europe plans to decommission almost 150 of its nuclear power plants by 2030, which will account for nearly 69 percent of the total global number of expected nuclear power reactor closures.

As nuclear power reactors continue to enter decommissioning, the licensees face new and complex challenges, including regulatory, political, economic, technical, radiation, and nuclear waste issues and requirements. In addition, organizational and safety culture issues have been identified as particularly important during this phase, as evidenced by recent International Atomic Energy Agency (IAEA) reports and technical meetings, such as the IAEA report on "Human and Organizational Factors in Nuclear Safety in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant," issued 2014, and the 2015 IAEA Technical Meeting on "Safety Culture during the Transition from the Decision to Shut Down to the Decommissioning of Nuclear Facilities." In addition, safety culture during decommissioning has been the focus of numerous articles that highlight the importance of safety culture in the decommissioning phase of nuclear power plants:

- In 2002, Lekberg, from the Swedish Nuclear Power Inspectorate (SKI), reviewed safety culture issues during the decommissioning of nuclear power plants in Sweden. SKI identified key safety culture and organizational safety issues for decommissioning: obtaining and retaining staff competence, sustaining organizational memory, identifying key organizational functions and management skills that are critical during the transition from operations to decommissioning, sustaining organizational viability and accountability, sustaining motivation and trust in management, overseeing contractor work, decommissioning a multiunit site when one unit continues to operate, delaying dismantling of decommissioned nuclear power plants, establishing organizational processes and control systems to identify and address emerging as well as known safety issues, and determining and communicating the level of risk during decommissioning.

- In 2005, Slavcheva et al., from the ITER Consult and Pisa University, examined safety culture and organizational issues during the transition from operation to decommissioning and found that the pre-shutdown phase presents new challenges for safety culture. The authors identified key human and organizational challenges during the pre-shutdown phase: preservation of staff competence and morale, management and organizational capability, preservation of knowledge and corporate memory, preservation of safety culture, surveillance and permanent control to maintain an adequate level of nuclear and radiation safety, and development of appropriate solutions for new incoming issues such as the future of the site and the future of the workers.

- In 2015, Gotcheva et al., from the VTT Technical Research Centre of Finland, discussed safety culture issues that the licensee should prepare for in the different lifecycle phases, including decommissioning. The authors found that strategic decisions about the way the transition from operation to decommissioning occurs will directly influence the human resource strategy, as there will be increased pressure to reduce staff costs and numbers. Contractors are brought on site, and staff may lose their incentive to maintain motivation and dedication. Feelings of insecurity and uncertainty will result, and it is important that management maintain clear transparent communications during this time. Finally, the changing structure and physical layout of the plant as it is dismantled poses new challenges, such as different radiation hazards and contamination risks.

THE NRC'S SAFETY CULTURE POLICY STATEMENT AND DECOMMISSIONING

In 2011, the U.S. Nuclear Regulatory Commission (NRC) published the Safety Culture Policy Statement (SCPS), which sets forth the Commission's expectations that individuals and organizations establish and maintain a positive safety culture, and applies to all licensees, vendors, suppliers, and contractors. The SCPS applies to the licensees of nuclear power reactors in all lifecycle phases, including decommissioning. The SCPS is not a regulation. The organization can consider how to apply the SCPS to its regulated activities as part of its safety culture program. The NRC's SCPS, and additional information and educational tools, can be found on the NRC's safety culture Web site: https://www.nrc.gov/about-nrc/safety-culture/sc-policy-statement.html.

The SCPS defines nuclear safety culture as the core values and behaviors resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure the protection of people and the environment. The SCPS includes a list of nine traits further defining a positive safety culture. These traits describe patterns of thinking, feeling, and behaving that emphasize safety. These traits are leadership safety values and actions, problem identification and resolution, personal accountability, work processes, continuous learning, environment for raising concerns, effective safety communications, respectful work environment, and questioning attitude.

The decommissioning of nuclear power plants continues to be a challenge for many licensees. It is important to maintain a positive safety culture during this phase, as noted in the numerous studies and reports on this topic previously discussed. The SCPS reflects the NRC's emphasis on safety culture; therefore, it is important to gain an understanding of how the SCPS traits apply to decommissioning. While all of the SCPS traits are relevant to decommissioning, only six will be discussed here to show the importance of safety culture during this lifecycle phase. The behavioral examples of the traits listed below were selected and modified from NUREG-2165, "Safety Culture Common Language."

Leadership Safety Values and Actions

Decommissioning is a challenging task and may bring high levels of uncertainty and stress for the employees, which could result in lower levels of trust, commitment, job satisfaction, morale, and motivation. Because of this uncertainty, organizations may lose staff and resources, which may make it difficult to conduct necessary work or maintain safety. Leaders should ensure that information is available and transparent, and policies and practices are in place so the technical staff can

maintain their focus on safety. Identifying staff competencies needed for decommissioning and providing necessary training to staff, or recruiting and hiring new staff or contractors, are critical during this time.

The organization itself changes and new functions and structures are added to manage the new activities. The interface between the existing organization and the new structure and personnel should be clear. During this time, resources need to be sufficient to support the new demands on the organization and the decommissioning of the plant. Organizational structures and processes should be in place to ensure effective management and organizational viability during decommissioning. Finally, leaders should ensure that sufficient funds are available during all phases of decommissioning, including management of the decontamination, dismantling and removal of radioactive materials, waste, components and structures. The regulation in 10 CFR 50.75 establishes requirements for indicating to the NRC how a licensee will provide reasonable assurance that funds will be available for the decommissioning process. Without these funds in place, safety is challenged.

The following are examples of effective Leadership Safety Values and Actions:

- Leaders ensure that staffing levels are sufficient, personnel are qualified, and new contractors are trained; facilities are maintained and equipment and tools are available; resources are allocated for maintenance, equipment, and personnel to ensure safety during the process of decommissioning.

- Leaders develop and implement cost and schedule goals for decommissioning in a manner that reinforces the importance of safety, ensuring that corporate priorities align with safety priorities.

- Leaders use a systematic process for evaluating and implementing change so that safety remains the overriding priority, and unintended consequences are avoided.

Problem Identification and Resolution

The changing conditions of the plant can create new issues and challenges. These emergent safety issues should be identified and addressed in a timely manner, and the staff should be encouraged to continue to raise nuclear safety concerns. Frequent reports on plant status, and careful coordination and oversight of activities will contribute to overall plant safety. When improvement and maintenance of the plant are deferred or put on hold, a message may be sent that safety is a low priority. The postponement of routine maintenance activities, relocation of funds, and reduction in investments in equipment and plant improvements, may impact the safety culture of the plant.

- Individuals recognize deviations from standards and ensure that issues, problems, and degraded conditions are promptly reported and documented in the corrective action program.

- Issues are properly classified, prioritized, and evaluated according to their safety significance; root cause investigations are completed; issues are investigated thoroughly.

- Corrective actions are completed in a timely manner; deferrals of corrective actions are minimized.

Environment for Raising Concerns

Decommissioning results in many changes and challenges as the plant implements new work configurations and priorities. Staff may leave for other employment as contractors are hired to implement new work processes. The remaining staff members may begin to feel uncertain and insecure about their future. When staff members feel that their jobs are at risk, or if they lose trust in their management and commitment to their organization, they may become reluctant to engage in safety behaviors, such as raising nuclear safety concerns (Branch and Olson, 2011). However, with changes to the organization's structure, staffing, resources, and functions during decommissioning, challenges to plant safety can increase. Therefore, it is important that leadership continue to ensure that a safety-conscious work environment is maintained that encourages the staff to raise nuclear safety concerns without fear of negative consequences.

The following are examples of an effective Environment for Raising Concerns:

- Individuals feel free to raise nuclear safety concerns without fear of retribution; policies and procedures reinforce that individuals have the right and responsibility to raise nuclear safety concerns; all claims of retaliation are investigated and any necessary corrective actions are taken in a timely manner, including actions to mitigate any potential chilling effect.

- Leaders set and reinforce expectations for establishing and maintaining a safety-conscious work environment; leaders will respond in a respectful manner and provide timely feedback to the individuals raising concerns.

- Processes for raising concerns that are alternatives to the corrective action program and outside the influence of the management chain, such as reporting safety concerns directly to the NRC, are communicated and accessible to individuals.

Work Processes

Decommissioning requires new work activities and procedures. New staff and contractors are often hired and need to be trained, so that everyone knows and understands risks and safety behavior. Workers need to understand new radiation and contamination risks that result from the different conditions and physical layout of the plant. Because of new scenarios for potential accidents, hazard analysis and emergency response plans should be developed for the decommissioning phase. For example, the regulation in 10 CFR 50.54(q) is used when a licensee evaluates changes to its emergency plans during decommissioning. Further, safety should be understood by new staff and contractors. Adequate oversight and monitoring of contractors, subcontractors and other new staff are necessary to ensure that their activities address nuclear and radiation safety. Finally, the preservation of corporate memory, documents, drawings and records of the plant is important as duties are transferred to other organizations.

The following are examples of effective Work Processes:

- Work is effectively planned and executed by incorporating risk insights, job-site conditions, and coordination between different groups or job activities; personnel are aware of nuclear safety risks associated with the new work conditions and activities; work activities are coordinated to address conflicting or changing priorities.

- Individuals review procedures and instructions prior to work, manipulate equipment only when authorized or directed by approved procedures, and ensure that the status of work activities is properly documented.

- Procedures and work packages are complete, thorough, accurate, and current; components are labeled clearly, consistently, and accurately; activities are governed by comprehensive programs, processes, and procedures.

Effective Safety Communications

It is important during decommissioning that information is communicated effectively. Providing clear and frequent communication and information to employees on present and future situations, and possible challenges and outcomes, reduces uncertainty. Further, new work activities can create new radiation risks. Licensees should effectively communicate radiation and other risks during decommissioning.

The following are examples of Effective Safety Communication:

- Communications within work groups are timely and frequent; everyone has the information necessary to accomplish work activities safely and effectively; safety messages are integrated into daily activities and meetings.

- Leaders promptly communicate expected outcomes, potential problems, and planned contingencies; information on a wide range of issues is shared; reasons for resource allocations, organizational changes, and other decisions are communicated.

- Leaders encourage the free flow of information; individuals share information openly and candidly; leaders solicit feedback, listen to concerns, and communicate openly with all individuals.

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Questioning Attitude

If the organization does not handle the changing status of the plant proactively and openly, the staff may not transition well. Job uncertainty, and unclear goals and expectations, may affect worker motivation and negatively impact safety behaviors, such as asking questions and challenging assumptions (Branch and Olson, 2011). Without a clear path forward and understanding of their role and future, employees may lose the motivation to remain diligent on safety and maintain a questioning attitude.

The following are examples of effective Questioning Attitude:

- Individuals maintain a questioning attitude during pre-job briefings and job-site reviews to identify and resolve unexpected conditions; individuals stop work activities when confronted with an unexpected condition.

- Individuals challenge assumptions and ask questions to fully understand the bases of the management decision.

- Individuals avoid complacency and perform a thorough review of the work site and planned activity before work is performed; they verify procedure prerequisites rather than assume the prerequisites are met; contingency actions are discussed and understood during job planning and pre-job briefings.

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