International Trends in Nuclear Safety Leadership and Future Tasks in Korea

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Keywords : Safety Leadership(Leadership for Safety), Safety Culture, Regulatory body

1. Introduction

The international nuclear community has long emphasized the importance of leadership in fostering organizational safety culture. In recent years, there has been increasing recognition of the need to strengthen safety leadership across nuclear regulatory bodies and the industry.

The IAEA defines "leadership for safety" as the use of an individual's capabilities and competences to give direction to individuals and groups and to influence their commitment to achieving the fundamental safety objective and to applying the fundamental safety principles, by means of shared goals, values and behavior [1], while the OECD/NEA describes leadership as a concept that is limited to senior management but can be demonstrated by individuals at any level of an organization, depending on their roles and responsibilities. It characterizes leadership as the ability of an individual or group of people to influence and guide followers [2]. Furthermore, WANO defines "nuclear leadership" as the behavior of an individual, irrespective of level, who takes the initiative to inspire by example, to coach, to influence and to shape behaviors of people in pursuit of nuclear excellence [3].

Despite these diverse definitions, a common thread is that leadership is not confined to executives or managers but constitutes a set of behavioral expectations applicable to individuals at all organizational levels. Accordingly, members of organizations in the nuclear sector are expected to understand and demonstrate safety leadership behaviors appropriate to their respective roles. This study reviews international trends in leadership enhancement initiatives and proposes future directions for implementation in Korea.

2. International trends in leadership enhancement initiatives

2.1. International Atomic Energy Agency (IAEA)

Effective leadership for safety is required by the IAEA Safety Standards to be established and sustained in organizations concerned with, and facilities and activities that give rise to, radiation risks, and to be demonstrated at the highest levels in an organization [1, 4]. The IAEA emphasizes the importance of leadership for safety not only under normal conditions but also during emergencies. In particular, the IAEA stipulates that leaders in emergency situations need to be aware of the situation, maintain control over the events that are under their influence, take effective actions with the available resources, and develop a response that will positively impact the course of the event. In this context, the following leadership competencies are identified as critical: situational awareness; decision-making, including strategic thinking; team management of emergency response teams; coordination; professionalism, integrity and honesty; and stress management [5].

The IAEA also introduces a Leadership Blueprint as a framework for developing effective leaders within the IAEA. It explains that leadership behaviors evolve continuously through a cyclical process — Leading Self, Leading through Relationships, Leading through Thinking, and Leading through Delivery — and provides specific behavioral guidance by distinguishing between desirable and undesirable behaviors [6]. In addition, the IAEA organizes the International School of Nuclear and Radiological Leadership for Safety, a short-term training program aimed at promoting leadership for safety worldwide. The program is based on the IAEA Safety Standards and incorporates relevant case studies.

2.2.Nuclear Energy Agency (NEA)

The NEA has established the Working Group on Leadership and Safety Culture (WGLSC) under the Committee on Nuclear Regulatory Activities (CNRA) to foster discussion and exchange of information and to consider practical approaches for sustaining effective leadership and a healthy safety culture within regulatory bodies.

The NEA proposes demonstrating leadership for safety at all levels as one of the key principles necessary to foster a sound safety culture in regulatory bodies [7]. Furthermore, it seeks to identify effective leadership characteristics and competencies and to illustrate how these characteristics and competencies manifest within regulatory bodies that maintain a strong safety culture through good practices. Accordingly, the NEA clarifies these leadership characteristics and competencies into the categories of intellectual, interpersonal, and influencing aspects, as follows [2]:

Intellectual aspects:

- Knowledge of the operation of the regulatory body;
- Identification of critical issues;

- Understanding of safety impact; and
- Technical competence.

Interpersonal aspects:
- Interpersonal competence and relationship management;
- Modelling safety leadership;
- Self- and social awareness; and
- Continuous learning.

Influencing aspects:
- Participatory and consultative approach;
- Reinforcement of expectations internally; and
- Reinforcement of expectations externally.

2.3.World Association of Nuclear Operators (WANO)

WANO defines organizational effectiveness as a function of effective leadership, a well-functioning management model (system), and a strong team of nuclear professionals [3]. In this framework, leadership is not merely a linking element but a multiplicative factor that enhances organizational effectiveness. It also identifies five attributes of nuclear leadership effectiveness, as described below, and proposes detailed behavioral guidance for their implementation.

LE.1 – Establish a vision of excellence that prioritizes nuclear safety
LE.2 – Engage the workforce
LE.3 – Create an environment of teamwork, trust and cooperation
LE.4 – Drive for sustainable results
LE.5 – Build leadership capability

2.4.United States Nuclear Regulatory Commission (NRC)

In 2018, the NRC developed the NRC Leadership Model to provide a roadmap for articulating how leadership can be demonstrated both individually and collectively in fulfilling the agency's mission [8]. The NRC Leadership Model explains that individual behaviors, demonstration of values, and practice of leadership form a foundation for agency programs and activities that enable the fulfillment of its mission and the achievement of its vision. It further emphasizes that successful leaders apply conscious, balanced effort across three core areas — processes, partnerships, and people. In addition, the model identifies multiple behaviors categorized under the acronym PREDICT and explains that the consistent practice of these behaviors creates a culture that supports innovation, inclusion, teamwork, and empowerment.

Participative Decision Making
Receptivity to New Ideas and Thinking
Empowerment and Shared Leadership
Diversity in Thought
Innovation and Risk Tolerance
Collaboration and **T**eamwork

The NRC promotes leadership development within the organization through level-specific training programs and a range of internal and external development initiatives. In addition to technical courses, the NRC also offers non-technical courses aimed at strengthening employees' leadership, communication, and cultural competencies.

3. Leadership enhancement initiatives at KINS

As discussed above, international organizations and major nuclear countries have developed and implemented their own leadership models and assessment programs to enhance nuclear leadership. Korea likewise recognizes the importance of leadership and the need for its further development and is pursing related initiatives.

In 2016, KINS established the draft KINS Safety Culture Principles, incorporating safety leadership as the first of its five core principles. The principles explicitly state that all employees are expected to exercise safety-first leadership in regulatory activities and present eight sub-attributes to operationalize the safety leadership principle. In the same year, KINS enacted a Safety Culture Management Procedure, under which safety leadership has been measured, evaluated, and improved within the broader framework of safety culture. Through periodic surveys and internal and external assessments, KINS has sought to enhance internal understanding of safety leadership and to ensure that behaviors reinforcing safety leadership are reflected in work attitudes and processes.

Subsequently, KINS reaffirmed the importance of safety leadership in fostering safety culture and promoting sound decision-making and incorporated leadership for safety and safety-first decision-making into the revised KINS Management System Manual. In 2024, KINS also launched a training course on understanding safety leadership to improve awareness among senior management and staff. The course addressed two main themes — regulatory leadership centered on safety and a nuclear safety leadership model — and is notable for moving beyond general leadership concepts to reflect the specific characteristics of nuclear safety and the role of a regulatory expert organization. Furthermore, KINS published and disseminated the official Korean translation of the NEA report on enhancing safety leadership. It also actively engaged in international cooperation by producing and sharing motion graphics videos summarizing the key content of the report in multiple language versions with overseas regulatory bodies.

4. Future Action Plans

In 2024, during the second Integrated Regulatory Review Service (IRRS) mission conducted by the IAEA, Korea received a recommendation concerning the development and implementation of a process for the

assessment of leadership for safety [9]. Accordingly, efforts are required to address this recommendation.

In response, the Nuclear Safety and Security Commission (NSSC) and KINS has jointly initiated a three-year plan to develop a safety leadership model and establish an associated assessment process. The plan is structed as follows:

Year 1: Review of domestic and international practices related to safety leadership models and assessment approaches

Year 2: Development of a draft safety leadership model and assessment methodology

Year 3: Establishment of a safety leadership assessment process and its integration into the management system

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