Several considerations for National Human Resource Development in nuclear newcomer countries with the IAEA Milestones approach and Korea experience

HanSuk KO [a*]
[a] *Nuclear Training and Education Center, Korea Atomic Energy Research Institute*
hsko@kaeri.re.kr

*****Keywords : IAEA milestones approach, HRD

1. Introduction

The explosive growth of AI and the subsequent expansion of its ecosystem, encompassing AI data centers, semiconductor manufacturing and others, have catalyzed an unexpected growth in electricity demand. This booming demand for electricity has necessitated a fundamental re-evaluation of national electricity grids, as traditional forecasting models failed to account for the massive load profiles inherent to AI-driven industries. Consequently, as a strategic alternative, offering cost-competitiveness, carbon-free baseload and reliability. This trend is driving the expansion of more NPPs in nuclear power countries and as well as the newcomer countries which previously showed limited momentum to introduce their first NPP but now willing to host regional AI data hubs and secure their political and technological leadership, are introducing their first reactor projects.

For newcomer countries embarking on their first nuclear power program, the IAEA Milestones Approach provides a structured framework, identifying 19 distinct infrastructure issues across three developmental phases.[1]

The most core issue of this framework is Human Resource Development (HRD), designated as issue 10, which is the most demanding element in early years due to the extensive lead-time required to educate and train the competent staff with specialized knowledge, competence and skill. The successful supply of these competent and licensed staff is a prerequisite for the establishing all other infrastructure pillars, including legal frameworks, nuclear safety, safeguards and security.

From a distinct viewpoint of HRD in education, South Korea's National Human Resource Development (NHRD) is recognized as a benchmark for newcomer countries to consider its HRD in nuclear. By analyzing Korea's experience alongside the IAEA framework, this study identifies key considerations for HRD in newcomer countries.

This study examines the several considerations for HRD in newcomer countries with IAEA Milestone Approach and Korea experience. It also provides several lessons and learned for developing the national nuclear licensed personnel are capable of meeting the strict rules and regulations of the current nuclear industry.

2. IAEA milestones approach : HRD

Human Resource Development is intrinsically linked to the other 18 infrastructure issues within the IAEA framework. The nuclear sector is defined by its uncompromising demands for safety and security, necessitating a workforce that operates at the highest standards of performance. Historical data underscores this necessity, showing that approximately 80% of significant events in nuclear facilities stem from human error. Consequently, HRD planning for licensed personnel must commence during Phase 1 to accommodate the necessary training lead times. [1][2]

All individuals in the nuclear field are required to recognize the importance of safety, security and safeguards, to accept their responsibilities and to implement all activities under applicable regulations. Therefore HR covers the licensed staff and other staff in the organization.

To assist Member States, the IAEA utilizes the Nuclear Power Human Resources (NPHR) modeling tool. This tool simulates a program's progression—from initial planning and construction to operation and decommissioning—allowing planners to evaluate various staffing strategies and their impact on the national labor market. While Phase 1 requires only about 2% of the total program resources, the strategic decisions made during this early planning stage are vital for long-term success. All individuals in the nuclear field must recognize their responsibility toward safety and security regulations, encompassing both licensed and non-licensed organizational staff.[3]

3. National Human Resource Development in Korea

3.1 historical changes

Prior to 1998, South Korea utilized a top-down, export-oriented economic model, shifting its industrial focus from light industry to heavy chemical industries. This transition necessitated a significant expansion of vocational education to supply skilled labor. Following the 1997 Asian financial crisis, the nation adopted a tripartite approach involving government, business, and labor, eventually establishing the "Office of the Vice Prime Minister of Education and HRD" to coordinate stakeholder policies. [4]

Since 2001, Korea has actively experimented with NHRD policies to address labor market mismatches and the underutilization of youth and women. Key milestones include the HRD Basic Act (2001) and the first five-year NHRD Basic Plan. However, after 2008, a change in political leadership led to the removal of the Vice Prime Minister position and the fragmentation of NHRD activities across various ministries. Despite this, Korea successfully implemented the Best HRD award system (2005) and Meister Schools (2010), the latter of which significantly bolstered the employment rates of vocational graduates through industry-academia collaboration.

3.2 lessons and learned from the past

HS Oh(2002) pointed out Limitations in the National HRD Process of Korea are as follows. [5]

3.2.1. Imbalance in HRD by Age and Education Level

Excessive focus on college entrance exams contrasts with insufficient academic engagement at the university level (58% of Korean college students study less than 2 hours/week, compared to 13.3% in the US and 12% in Japan). Lack of capacity-building efforts for low-educated adults, who constitute over one-third of the economically active population.

3.2.2. Inefficiencies in the student selection system

Uniform egalitarianism in primary and secondary education leads to extreme competition for college admissions.

Corporate hiring practices still heavily rely on educational background rather than practical competencies.

3.2.3. Inadequate Mid-to-Long-Term Workforce Forecasting

Despite the shifting demand from low-skilled labor to knowledge-based workers, the workforce supply structure remains rigid, causing shortages in high-tech sectors (e.g., IT) and reliance on imported low-skilled labor.

4. Key Considerations for Nuclear Human Resource Development

The development of a competent nuclear workforce is a long-term undertaking requiring sustained political and financial commitment. For newcomer countries, sustainability depends on several systemic factors:

4.1 Strengthening the Educational Pipeline

A robust STEM foundation in primary and secondary education is essential. Universities must align research and degree programs with industry needs, while programs like the IAEA's Marie Sklodowska-Curie Fellowship and the Lise Meitner Programme are vital for supporting female nuclear professionals.

4.2 Knowledge Management and Performance Monitoring

To prevent the loss of expertise due to retirement, nations must implement systematic approaches to capture and transfer knowledge between generations. The "Systematic Approach to Training (SAT)" remains a key tool for maintaining workforce competency.

4.3 Leadership and Safety Culture

HR management must be rooted in a strong safety culture. Participation in the Integrated Management Systems (IMS) project can help unify safety, security, and quality assurance into a single framework. Senior management bears the responsibility for merit-based recruitment and international benchmarking to bridge competency gaps.

5. Conclusion

Implementing a nuclear power program through the IAEA Milestones Approach remains a major undertaking that demands meticulous planning and investment. As demonstrated by the Korean experience, newcomer countries can bridge the expertise gap through strategic international partnerships and a focused commitment to capacity building. By adopting a top-down planning model tailored to their specific political contexts and adhering to international safety standards, these newcomer countries can ensure their nuclear programs contribute meaningfully to energy security and global decarbonization for the next century. Ultimately, the engine of nuclear energy is not merely technical engineering, but a visionary commitment to human resource.

Although Korea's national HRD case cannot be directly applied to countries introducing nuclear power plants for the first time, it provides the following strategic implications. Firstly, strengthening the linkage between education and the labor market is necessary. Preemptive efforts are required to resolve youth unemployment by aligning educational outcomes with actual industry demands. Secondly, it is necessary to resolve information asymmetry. The information distribution system between the labor and education markets must be improved to ensure that national HRD data is widely accessible to employers. Thirdly, it is also necessary to improve demand-side HR practices. Workforce deployment practices must be reformed. Key measures include enhancing the professional status of women and expanding post-doctoral programs to fully utilize advanced-degree professionals.

REFERENCES

[1] IAEA Milestones Approach Developing the National Infrastructure for Nuclear Power, IAEA Nuclear Energy Series, No. NG-G-3.1(Rev.2), 2024
[2] Managing Human Performance to improve nuclear facility operation, IAEA Nuclear Energy Series, No. NG-T-2.7, 2013
[3] Nuclear Power Human Resource Model, IAEA training course series 73, 2021
[4] ES Cho, Gary N. McLean, "National human resource development revisited in the Republic of Korea" KEDI Journal of Educational Policy 14:1, pp. 25-46, 2017
[5] HS OH, " Exploring the National Human Resource Development Management Model and the Direction of HR Policy", Asian Journal of Education Vol 3, No. 2, pp.191-218, 2002(Korean)