The Current Status and Prospects of INPRO and GIF Proliferation Resistance Evaluation Methodology

Ji-song Jeong[a,b], Ho-Dong Kim[a,*], and Seung-kyu Ahn[a]
[a] Korea Atomic Energy Research Institute, 111, Daedeok-daero 989beon-gil, Yuseong-gu, Daejeon, Republic of Korea
[b] University of Science & Technology, 217 Gajeong-Ro, Yuseong-gu, Daejeon, Republic of Korea
[*]khd@kaeri.re.kr

1. Introduction

INPRO (International Project on innovative Nuclear Reactors and Fuel Cycles) is an international cooperation project which aims to ensure that nuclear energy is available to contribute to meeting the energy needs of the 21st century in a sustainable manner. GIF (Generation Ⅳ International Forum) is an international cooperation for development of next generation reactor. Both of them are representative projects that developing Proliferation Resistance (PR) evaluation methodology. The evaluation methodology to quantify the PR on a nuclear system is being developed. However, each nuclear system has so many different processes and characteristics that it is difficult to evaluate PR quantitatively and qualitatively. The evaluation methodology which can evaluate safeguardability will be drawn through the development of various methodologies. They were refined over the years through several case studies. Also, Korea actively participates in GIF and INPRO for development of PR evaluation methodology. This paper reviews the current status and prospects of INPRO and GEN-Ⅳ 's PR methodology.

2. Framework of INPRO and GIF Proliferation Resistance Evaluation Methodology

2.1 INPRO PREM

The INPRO Nuclear Proliferation Resistance Evaluation Methodology (PREM) has been developed through numerous IAEA reports. The Evaluation Methodology was divided into basic principle (BP), user requirement (UR), indicator in consideration of international, regional, trends, and technical achievements. BP has included the necessary conditions for satisfying PR over the full life cycle of the future Nuclear Energy System (NES), and UR has identified the items required to satisfy BP. Finally, criteria and indicators for evaluating PR are defined.

2.2 GIF PREM

In GEN Ⅳ, all possible strategies for proliferation are classified as concealed diversion, overt diversion, concealed facility misuse, overt facility misuse and independent clandestine facility use. The Evaluation Methodology is divided into a challenge, a system response to a challenge, and outcomes. Specially, in the evaluation of GEN Ⅳ, scenarios for diversion methodology are set up in the system to evaluate PR of each scenario. Evaluation of PR is highly critical for GEN Ⅳ methodology.

3. Current Status of INPRO and GIF PREM

3.1 Current Status of INPRO PREM and the Related Activities ROK Has Done

INPRO was initiated for purpose of jointly considering the international actions required to achieve the desired innovations in nuclear reactors and fuel cycles. Korea has participated in several INPRO collaborative projects such as RISC, PRADA, PROSA and so on. Especially, PROSA (Proliferation Resistance and Safeguardability Assessment) process has been applied to a SFR Fuel Manufacturing Facility (SFMF) by KAERI. The case study demonstrated that the proposed PROSA process is simpler to perform than the original INPRO methodology and can be applied from the early stage of design showing the relationship of PR assessment to the Safeguards-by-Design process. The ROK is currently making a Technical Document related to PROSA SFMF.

3.2 Current Status of GIF PREM and the Related Activities ROK Has Done

KAERI has contributed to development of the PRPPEM by taking a leading role in GIF Proliferation Resistance and Physical Protection Working Group (PRPPWG). The ROK is actively participating in GIF PRPPWG and planning to increase the effectiveness by sharing the results of nuclear nonproliferation studies. The PRPP Methodology was applied to evaluate a proliferation resistance for a Pyro-processing facility design. The study identified new metrics and a pathway analysis algorithm based on GIF PRPP measures and analysis approach. KAERI used Reference Engineering-scale Pyro-processing Facility (REPF) model in this study. KAERI recently translated "Evaluation Methodology for Proliferation Resistance and Physical Protection of Gen.Ⅳ Nuclear Energy Systems – Revision 6", which is a technical report by GIF PRPPWG in 2011, into Korean. Also, "System White Papers : PR&PP of the Six Generation Ⅳ Nuclear Energy Systems" is now under revision by GIF PRPPWG.

4. The Prospects and Outlook

The ROK is continuing its nonproliferation research such as the development of PR evaluation methodology in an international initiatives like GIF and INPRO. Nuclear technology needs international cooperation in order to minimize the risks, could be occurred during a long-term investment. Therefore, we have to grasp the constant changes in the international joint study and try to keep participating in it actively.

5. Conclusion

By applying an evaluation system from the initial stage of design of the NES, problems on proliferation threat can be solved early and nuclear system design that reflecting PR can be realized. The INPRO and GEN Ⅳ Proliferation Resistance Evaluation Methodologies will be used as an assessment tool to evaluate PR for future NES. These activities will shed light on PR advancements of the current system designs.

REFERENCES

[1] Generation IV International Forum (GIF), "A Technology Roadmap for Generation IV Nuclear Energy Systems." Tech. rep, (2002).

[2] Generation IV International Forum (GIF) PRPP Working Group, "Evaluation Methodology for Proliferation Resistance and Physical Protection of Generation IV Nuclear Energy Systems — Revision 6." Tech. rep, (2011).

[3] S.K. Ahn et al., "A Proliferation Resistance Evaluation for a Pyroprocessing Facility Design", INMM 55th Annual Meeting (2014)