Model Development for Proliferation Resistance Assessment

Yong Deok Lee, Kwang Seok Lee and Jung Won Lee
Korea Atomic Energy Research Institute, Yusung P.O. 105, Daejeon, 305-600, Korea
ydlee@kaeri.re.kr

1. Introduction

Nuclear fission reactors can offer the possibility of meeting the world's energy needs for next generation. If nuclear energy systems play a major role of world's energy supply, a future nuclear energy system must meet proliferation resistance requirement. Historically, the study of proliferation resistance was initiated at INFCE(International Nuclear Fuel Cycle Examination) of IAEA and NASAP(Non-proliferation Alternative Systems Assessment Program) of DOE from the 1970s. In 2000, INPRO(International Project on Innovative Nuclear Reactors and Fuel Cycles) program initiated by IAEA and GEN IN by the States proposed a proliferation resistance as a key component along with a sustainability, economics, safety and waste management. The evaluation of proliferation resistance and the application of the result to system are required in exporting or importing future nuclear energy systems. Therefore, the model development for evaluation of proliferation resistance was initiated as a long term R&D project.

Proliferation resistance analysis is intended to be performed from the earliest stages of the system design where initial flow diagrams and physical arrangement drawings are developed with safety analysis. The designer can introduce barriers that systematically make nuclear material diversion pathways less attractive. Eventually, the evaluation model and results will be used in the authorization and regulation of nuclear energy system.

2. Model Development for PR Assessment

The methodology for the proliferation resistance assessment has been developed. The assessment was classified into four different levels and integration of level results. The model consists of extrinsic measure which involves the status of national and institutional intension for proliferation resistance and intrinsic feature which represents the material itself property against proliferation. The model is based on INPRO user manual[1]. However, the total evaluation process is somewhat different and some parameters are newly added.

The process for the assessment of proliferation resistance is represented in Fig. 1. The extrinsic measure is first assessed for the state and institutional commitment and obligation using international agreement or arrangement. The extrinsic assessment shows the intension of the state and institution against the nuclear proliferation. Safeguards agreement between a nation and IAEA is one of the important international obligations. The intrinsic assessment shows the difficulty of material itself against nuclear material proliferation. In the intrinsic property, quality and quantity of nuclear material, material form and nuclear technology are involved. The quality involves the nuclear material composition, radiation field, heat generation and material type. The quantity involves nuclear mass and significant quantity(SQ). 1SQ is the required amount of making a nuclear explosive device. Therefore, the intrinsic assessment shows the nuclear system property against proliferation. The nuclear technology represents the status of enrichment and reprocessing facility and the fuel cycle option.

The nuclear material diversion faces the competition with facility safeguards system. Safeguards system for the facility plays a very important role against the diversion of nuclear materials. Nuclear material accountancy, containment and surveillance, detectability of nuclear material, facility information and inspections are involved in the safeguards barrier. In addition to the system assessment on the proliferation resistance, the process assessment of nuclear material in system is an another issue[2]. The process evaluation is considered in the two categories: process robustness assessment and probability evaluation based on the possible diversion of nuclear materials. The evaluation parameters and methodology for the process assessment needs further development. The integration of the assessment results for the system and process is an another issue to be

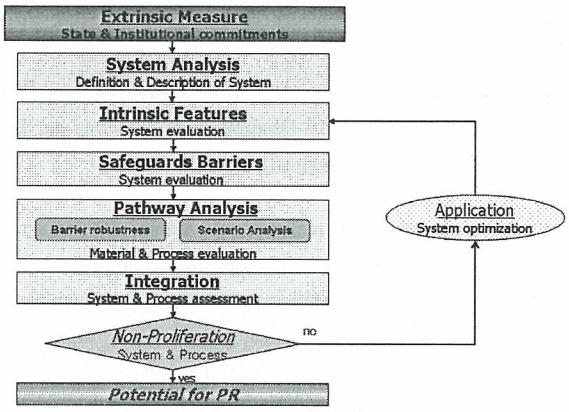

Fig. 1 Process of model assessment for proliferation resistance

resolved.

From the recent development[3], several evaluation parameters were added in the intrinsic and extrinsic measure. Rod, bundle and assembly for dimension of target in nuclear material form were newly added for the intrinsic feature. For the extrinsic measure, uranium mine, nuclear infrastructure, nuclear fuel fabrication facility, nuclear electric power capacity, nuclear power plant, storage for spent fuel and high level waste and nuclear R&D type were parameterized. The characteristic of the current model development is first to check the intension of the proliferation resistance of state and institution. Another feature is to assess the total system and the process in the system. However, the further development on the diversion scenario in each process is necessary.

3. Conclusion

Proliferation resistance is one of the goals for next generation nuclear energy system development. Therefore, the tool to assess the proliferation resistance is necessary to develop. The model development has been developed. The model was based on the INPRO methodology, but modified for better tool production. In the recent development, several evaluation parameters were newly added. The feature of current model is to assess the nuclear system and the individual process in the system. However, the model will be modified continuously to produce the better tool for evaluation of proliferation resistance.

REFERENCES

[1] International Atomic Eenergy Agency, INPRO Manual for the area of proliferation resistance IAEA-TECDOC-1575, (2007).

[2] Pacific Northwestern National Lab., Guidelines for the Performance of Nonproliferation Assessment PNNL-14294, (2003).

[3] Korea Atomic Energy Research Institute., Development of Proliferation Resistance Assessment Methodology Based on International Standard, (2009).