

Status of a Periodic Safety Review of HANARO

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Abstract. The first Periodic Safety Review (PSR) for HANARO¹ is now being conducted to meet the mandatory requirements in accordance with the National Nuclear Safety Act, which was amended to impose PSR on the research and training reactors in Korea. The set of documents of the HANARO periodic safety review including all safety significant findings is supposed to be submitted to the regulatory body by the end of 2018. HANARO has been operating over 20 years for the radioisotope production, material irradiation, neutron transmutation doping, neutron activation analysis, and neutron beam utilization. Periodic inspections and In-service inspections have been fulfilled to ensure the safe operation of the facility and also a special safety review after the Fukushima Daiichi Accident was done to check if the facility could be in safe conditions by natural or external events such as an earthquake, flooding, loss of offsite electric power, station blackout, etc. But the whole comprehensive safety review for the reactor facility had not been performed before. Hence the ongoing periodic safety review will provide the first opportunity to obtain an overall view of the actual plant safety and the quality of the safety documentation, and to determine reasonable and practical modifications to ensure and improve the safety. In this paper, the implementation status of HANARO periodic safety review will be presented.

1. Introduction

Korea has a lot of experience in conducting periodic safety review for nuclear power plants since the first PSR for Gori-1 reactor performed in May 2000 ~ Nov. 2002. All nuclear power plants in Korea are undertaking PSR every 10 years in order to meet the National Law. The 11 safety factors have been assessed for PSR of power reactors until the National Nuclear Safety Acts was amended in Nov. 2014. The amendment mainly describes that the 14 safety factors should be applied in conducting PSR and research reactors also should undertake PSR according to the law. At present, the research reactors in Korea consist of HANARO (30MWt), a research reactor at the Korea Atomic Energy Research Institute (KAERI), and SGN 201(0.1Wt), a training reactor at Kyung Hee University. Two research reactors have been designated as those that should submit PSR report to the regulatory body until the end of 2018. This will be the first PSR for research reactors in Korea. Therefore, the operating organizations should be well prepared to complete the PSR in a timely manner.

As the operating organization, KAERI started the PSR project by establishing a project management team and acquiring budget from the government in 2015. A time schedule was developed in order to complete the PSR satisfying all of the requirements by the due date. KAERI made contracts with two domestic engineering companies to perform a review of safety factors and a global assessment. But the safety factors such as emergency planning and radiological impact on the environment were planned to be reviewed by the Nuclear Emergency and Environmental Protection Division in KAERI. The review of each safety factors is being carried out now and outcomes from the review will be summarized, which will be followed by the global assessment. And then an integrated implementation plan of safety improvements will be made, which includes safety significance and prioritization.

¹ Hi-flux Advanced Neutron Application Reactor

Finally the summary report and integrated implementation plan will be submitted to the regulatory body by the end of 2018.

2. Preparation of the PSR project

2.1 Establishment of the project management team

To undertake the PSR, the first thing to do is to establish an appropriate project management team. However, many of the engineers and researchers who worked in the design & construction stage are no longer available since they retired a long time ago. The remainders have been assigned to other projects such as constructing a new research reactor in Korea and refurbishing research reactors in other countries. Considering available human resources in our organization, a Task Force Team has been set up for managing this project, whose members are mainly the staffs of HANARO Management Division. External companies and another division in KAERI will perform the review of safety factors and the global assessment, while TFT members will offer input documents, review the safety review report and the global assessment report, and prepare the implementation plan for safety improvement. The primary tasks of the project management team are summarized as follows:

- Project planning
- Budget planning
- Time scheduling
- Preparation of the basis document for PSR
- Preparation of specifications for making contracts with engineering companies for a review of safety factors and a global assessment
- Gathering input documents for the review of safety factors and offering to engineering companies
- Review of the safety factor review report made by engineering companies
- Review of the global assessment report
- Preparation of the integrated implementation plan of safety improvements
- Submission of the PSR documentation to the regulatory body, which includes the summary report covering review of each safety factor, the global assessment report, and integrated implementation plan

Quality assurance team is also involved in the project to prepare a quality assurance plan that defines the requirements for the preparation and verification of the PSR documentation. The quality assurance plan ensures that all reviewers use the same input data to maintain consistency across all areas of the review.










2.2 Establishment of budget

The project management team estimated the overall budget for the PSR project in consideration of the scope of the review, the schedule, the human resources available in the organization, and the amount of payment to contractors. Some domestic engineering companies, which have a lot of experience in undertaking a PSR for a nuclear power reactor, consulted us about an expected expense for PSR project. However, research reactors have the different operating objectives, organization, SSCs, safety classification, documentation, activities, and procedures from those of nuclear power reactors. While estimating the project budget, a lot of different characteristics between HANARO and other nuclear power reactors

in Korea were taken into account. The project manager submitted a final proposal to the senior & executive management for the required budget and got the approval from the government in 2015.

2.3 Time Schedule

The project management team established a time schedule including major milestones and cut-off dates. The time schedule should take into account that the review of safety factors is an iterative process and should allow time for interfaces between the various safety factors. So we've allocated enough time for the review of safety factors and the review of safety factor review report considering the whole schedule. The master schedule for HANARO PSR project is as follows.

	2015	2016	2017	2018	2019	2020
1	Establishment of a project management team, detail plan of the review, and preparation of budget  Jun. 30, 2015					
2	Preparation of PSR basis document Understanding between the KAERI and the Regulatory body on the PSR  Jun. 30, 2016					
3	Preparation of Technical Specifications for Safety Factor Review Tendering process for contracts  Jun. 30, 2016					
4	Search and Retrieval of PSR input data such as design documents, construction drawings, analysis report and input/output data  Sep. 30, 2016					
5	Review of 14 safety factors - Review by contractors - Review by internal staff Preparation of Global Assessment Report  Jun. 30, 2018					
6	Preparation of final PSR report including summaries from the safety reports, global assessment report and integrated implementation plan  Dec. 15, 2018					
7	Submission of the final PSR report and summary report to the regulatory body  Dec. 31, 2018					
8	Assessment of PSR reports submitted and preparation of assessment reports Approval by the regulatory body (End of the PSR)  Dec. 31, 2019					
9	Execution of the integrated implementation plan 					

3. PSR Implementation

3.1 PSR basis document

The IAEA Specific Safety Guide No. SSG-25[1] recommends that a basis document should be produced during the initial stage of the PSR, which includes the following contents:

- The scope and objectives of the PSR including the current national and international standards and codes to be used
- Project plan consisting of organization of the project, project & quality management, and a process to ensure consistency between the safety factors
- The plant licensing basis at the time of initiation of the PSR
- A description of the systematic review approach
- Process for identifying, categorizing, prioritizing, and resolving negative findings
- Major milestones, including cut-off dates, methodology of the PSR, the safety factors to be reviewed, the structure of the documentation including a deliverable list and the applicable national and international standards, codes and practices.
- The methodology & document structure of the global assessment
- Guidance to prepare the integrated implementation plan
- A plan for communicating and gaining relevant approval from the regulatory body
- Systematic method to record outputs from the PSR

KAERI has developed a PSR basis document in collaboration with an engineering company since the project began. The basis document identifies the scope and objectives, national regulations, codes and standards, safety factors, a list of SSCs, and methodology of the PSR. All of the contents the IAEA guide suggests are not included in the document due to the lack of experience in the conduct of PSR for research reactors. However it is expected to be supplemented as the review process is going on even though ideally, it should be completed in the initial phase.

3.2 Review of the safety factors

Eleven safety factors of the PSR were enforced for a power reactor before the amendment of the National Nuclear Safety Act in Korea. The revised law calls for 14 (fourteen) safety factors to be reviewed for both power reactors and research reactors. New safety factors introduced into the revised law are the plant design, hazard analysis and probabilistic safety assessment. This is to meet the international trend and the recommendations made during the 48th IAEA General Conference held on 20-24 September 2004. The safety factors listed in the revised law are consistent with those of IAEA SSG-25[1].

- i. Safety factors relating to the plant*
 - (1) Plant design;
 - (2) Actual condition of the structures, systems and components (SSCs) important to safety;
 - (3) Equipment qualification;
 - (4) Ageing.
- ii. Safety factors relating to safety analysis*
 - (5) Deterministic safety analysis;
 - (6) Probabilistic safety assessment;
 - (7) Hazard analysis.
- iii. Safety factors relating to performance and feedback of experience*
 - (8) Safety performance
 - (9) Use of experience from other plants and research findings.
- iv. Safety factors relating to management*
 - (10) Organization, the management system and safety culture;
 - (11) Procedures;

- (12) Human factors;
- (13) Emergency planning.
- v. *Safety factors relating to the environment*
 - (14) Radiological impact on the environment.

When we apply these safety factors to a research reactor, we have to consider the Graded Approach. In general, safety class I, II & III are applied to the power reactors [2] whereas only safety class III is applied to our research reactor. The Graded Approach should be considered for a research reactor so as not to apply a severe code & standards for power reactors to the PSR of the research reactor.

In order to perform the review of safety factors, KAERI made contracts with two domestic engineering companies, KEPCO E&C and FNC Technology, which have plenty of experiences in PSR for nuclear power reactors. The companies are reviewing the 12 safety factors except emergency planning and radiological impact on the environment, which are being reviewed internally by the Nuclear Emergency and Environmental Protection Division in KAERI. We are expecting the first draft of safety review report to be prepared in Dec. 2017 in accordance with the time schedule.

3.3 Global assessment and integrated implementation plan for safety improvements

An analysis of the interfaces between the various safety factors will be carried out after finishing the review of separate safety factors. Considering all the findings from the each safety factor review and what safety improvements are reasonable and practicable, a global assessment report will be prepared by the project management team and the companies. An integrated implementation plan of proposed safety improvements will be made, which includes safety significance and prioritization. The integrated implementation plan and summary report will be submitted to the regulatory body by the end of 2018.

4. Conclusions

The first PSR project for HANARO commenced in 2015 after operating 20 years since it reached first criticality. According to the amendment to the National Nuclear Safety Act in 2014, research reactors as well as nuclear power reactors in Korea became to mandatorily perform the PSR for 14 safety factors every 10 years. KAERI made the project management team and established the budget to conduct PSR project successfully. The time schedule was set up to complete the PSR satisfying all the requirements by the due date. KAERI has developed the PSR basis document for the conduct of the PSR, which includes the scope, major milestones, codes and standards, safety factors, a list of SSCs, and methodology of PSR. The review of 12 safety factors is being performed by two domestic engineering companies according to the contracts, while emergency planning and radiological impact on the environment are being reviewed by an internal division of KAERI. The first draft of safety review report is expected to be completed in Dec. 2017.

5. References

- [1] INTERNATIONAL ATOMIC ENERGY AGENCY, Periodic Safety Review for Nuclear Power Plants, Specific Safety Guide No. SSG-25
- [2] American Nuclear Society, Nuclear Safety Criteria for the design of Stationary Pressurized Water Reactor Plants, ANSI/ANS-51.1-1983(R1988:W1998)