

## Development of Safety Review Guide for the Periodic Safety Review of Reactor Vessel Internals

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### 1. Introduction

Aging management of the reactor vessel internals (RVIs) is one of the important issues for long-term operation of nuclear power plants (NPPs).

Safety review on the assessment and management of the RVI aging is conducted through the process of a periodic safety review (PSR). The regulatory body should check that reactor facilities sustain safety functions in light of degradation due to aging and that the operator of a nuclear power reactor establishes and implements management program to deal with degradation due to aging in order to guarantee the safety functions and the safety margin as a result of PSR.

KINS(Korea Institute of Nuclear Safety) has utilized safety review guides (SRG) which provide guidance to KINS staffs in performing safety reviews in order to assure the quality and uniformity of staff safety reviews.

The KINS SRGs for the continued operation of pressurized water reactors (PWRs) published in 2006 contain areas of review regarding aging management of RVIs in chapter 2 (III.2.15, Appendix 2.0.1)[1]. However unlike the SRGs for the continued operation, KINS has not officially published the SRGs for the PSR of PWRs, but published them as a form of the research report[2]. In addition to that, the report provides almost same review procedures for aging assessment and management of RVIs with the ones provided in the SRGs for the continued operation, it cannot provide review guidance specific to PSRs. Therefore, a PSR safety review guide should be developed for RVIs in PWRs.

In this study, a draft PSR safety review guide for reactor vessel internals in PWRs is developed and provided.

### 2. PSR Safety Review Guide for RVIs

In this section, structure and main contents of the PSR safety review guide for RVIs (PSR SRG-RIVs) are described.

#### 2.1 Structure of the Safety Review Guide

The structure of the PSR SRG-RIVs is determined based on the KINS safety review guides for PSR of CANDU reactors and standard review plan (SRP)[3]. The draft PSR SRG-RIVs is divided into six major

chapters and one appendix. Six chapters are (1) Areas of Review; (2) Acceptance Criteria; (3) Review Procedures; (4) Evaluation Findings; (5) Implementations; and (6) References. Of these, chapter 1 and 3 include following 4 sections for safety review in accordance with the Article 24 (1) of the Enforcement Regulation of the Nuclear Safety Act:

- A. Classification and selection of components subject to review
- B. Actual physical condition
- C. Degradation due to aging
- D. Use of experience of other NPPs and research findings

#### 2.2 Main contents of the Safety Review Guide

##### A. Classification and selection of RVI components

The applicant's classification and selection of RVI components are reviewed to ensure that all RVI components which perform a safety-related function or could affect an intended safety function when they are damaged.

##### B. Actual physical condition

The current regulations regarding to the details of a PSR, i.e. Article 37 of the Enforcement Decree and Article 24 of the Enforcement Regulation of the Nuclear Safety Act, are based on the 11 safety factors provided in the IAEA Safety Guide, 50-SG-O12[4]. However, IAEA revised the Safety Guide and increased safety factors from 11 to 14[5]. Considering this, the Nuclear Safety and Security Commission (NSSC) has recently launched revision process of those regulations for the purpose of safety enhancement of long-term operating NPPs as specified in the draft version of the 1<sup>st</sup> comprehensive nuclear safety plan.

Although the revision process is currently underway, two of 14 safety factors which are related to the plant are considered in the draft PSR SRG-RIVs. Those are as follows:

- Design(including documentation)
- Actual condition of structures, systems, and components(SSCs)

Reflecting the above two safety factors, review procedures for the section about the actual physical condition are developed including:

- The reviewer should review that all significant documentation relating to the original design basis has been obtained, securely stored and updated to

reflect all the modifications made to the RVIs and procedures since the plant's commissioning.

- If the data for representing the actual condition of RVIs is lacking, they should be generated or derived.
- In case it is difficult to determine the actual condition of the RVIs owing to layout or operating conditions that preclude a necessary inspection, the reviewer should identify those components and review their safety significance.

#### C. Degradation due to aging

Subparagraph 4 of Article 24 (1) in the Enforcement Regulation of the Nuclear Safety Act requires confirmation of whether degradation due to aging is being effectively controlled to maintain the required safety margin and whether an adequate aging management program (AMP) is in place. In particular, it requires the NPPs which conduct a PSR 20 years after the date of operating license to provide measures and programs to manage degradation due to aging of SSCs.

The assessment and management of aging is one of major elements of a PSR. In order to provide specific standard and guidance for the review of aging assessment, threshold values or screening criteria for the possible aging mechanisms in RVIs are provided in the appendix of the draft PSR SRG-RVIs. The threshold values and screening criteria are determined based on the recent research results from the regulatory bodies and the utilities[6, 7, 8]. If the threshold values or the screening criteria are exceeded for a RVI component, it is considered that the component is susceptible to the corresponding aging mechanism and the utility should provide an acceptable plan to perform evaluation for ensuring the integrity of the component or to monitor/mitigate/manage the aging mechanism. The licensee can utilize its own thresholds or screening criteria if they are justified as acceptable ones.

The reviewer should identify that the utility establishes an appropriate AMP for RVIs in the plant which conduct a PSR 20 years after the date of operating license. In the case of the utility who wishes to continue operating a nuclear power plant beyond the expiration of its design life(continued operation) the AMP for RVIs should also be established in accordance with the NSSC Notice No. 2012-35(Reactor.035). Therefore, the AMP for the operating NPPs should be differentiated from the AMP for the continued operation of NPPs. For this reason, it is specified in the draft PSR SRG-RVIs that the RVIs' AMP for the continued operation should be the enhanced program and be established in accordance with the NUREG-1800, 1801 and MRP-227-A.

#### D. Use of experience of other NPPs and research findings

The reviewer should determine whether there is adequate feedback of safety experience from other NPPs and of the findings of research related to RVIs.

### 2.3 Experts Review Results

The draft PSR SRG-RVIs was reviewed by 4 domestic experts in the fields of a PSR, RVIs, and component design and evaluation. Main items pointed out by the experts are as follows:

- Aging management should be started from the initial operation of NPPs in contrast to the subparagraph 4 (e) of Article 24 (1) in the Enforcement Regulation of the Nuclear Safety Act which requires a NPP to provide an AMP 20 years after the date of its operating license.
- Evaluation using thresholds and screening criteria for aging mechanisms are based on the MRP-227-A methodology which is a requirement for the enhanced RVIs' AMP for the continued operation. Therefore, those values should be applied only to RVIs in the plants for the continued operation.
- Technical standards for the continued operation such as NUREG-1800, 1801, and MRP-227-A should be incorporated as references, not the acceptance criteria for PSRs of operating NPPs.

Those will be considered for revision of the draft PSR SRG-RVIs.

### 3. Conclusions

In this paper, a draft PSR safety review guide for reactor vessel internals (PSR SRG-RVIs) in PWRs is introduced and main contents of the draft are provided. However, since the PSR safety review guides for areas other than RVIs in the pressurized water reactors (PWRs) are expected to be developed in the near future, the draft PSR SRG-RVIs should be revisited to be compatible with other PSR SRGs. In addition to that, future revision of the current regulations regarding the details of a PSR and expert's review results will also be incorporated in the draft.

### REFERENCES

- [1] KINS, Safety Review Guides for the Continued Operation of Pressurized Water Reactors, KINS/GE-N8, 2006
- [2] KINS, Development of Periodic Safety Review Guidelines, KINS/RR-139, 2002
- [3] KINS, Safety Review Guides for PSR of CANDU Reactors, KINS/GE-N9, 2007
- [4] IAEA, Periodic Nuclear Safety Review of Operational NPPs, IAEA Safety Series No. 50-SG-O12, 1994
- [5] IAEA, Periodic Safety Review of Nuclear Power Plants, IAEA Safety Standards Series, Safety Guide No. NS-G-2.10, 2003
- [6] EPRI, PWR Internals Material Aging Degradation Mechanism Screening and Threshold Values(Non-proprietary version for NRC), MRP-175, 2005
- [7] NRC, Degradation of LWR Core Internal Materials due to Neutron Irradiation, NUREG/CR-7027, 2010
- [8] KINS, Aging Mechanism and Operating Experience of Reactor Vessel Internals, KINS/RR-1009, 2013