A Study on Improvement of the Interface Control of NPP Construction and Operation Activities

Ku-Young Chung, Woo-Ho Lee, and Jae-Hun Lee
Quality Regulation Dep't., Korea Institute of Nuclear Safety,
k479cky@kins.re.kr; whlee@kins.re.kr ; jhlee@kins.re.kr

Abstract

Interface control activities during the nuclear power plant (NPP) construction and operation have been reviewed for enhancing the safety of NPP. The primary focus of the study is given on analysis of lessons learned from the recent significant events of Korean Standard Nuclear Power plant (KSNP), such as a series of break-off of thermal sleeves at YGN 5 & 6 and radioactivity leak at YGN 5, in respect of interface control. Based on the results of the analysis, this study recommends measures for the improvement of interface control among utility and technical supporting organizations (TSO), and suggests new regulatory systems, such as reporting of safety significant non-conformances, to effectively verify the adequacy of interface control activities during construction and operation of NPPs.

1. Introduction

Analyzing the lessons learned from the events of break-off of thermal sleeves at YGN 5 & 6 and radioactivity leak at YGN 5, it is concluded that insufficient interface control activities among participating organizations especially during design changing process cause the incidents which evoked a great resistance of the public, and the local residents. The effects of those incidents on plant personnel and environment were evaluated to be negligible. However the public demanded the regulator and utility to set up a joint investigation committee with local residents and a re-investigation by independent expert organization in foreign country. Although the re-investigation results by the German Oeko institute and TUEV turned out to be the same as those by KINS, the re-investigation itselt was a painful lesson to KINS that safety regulation cannot be kept its authority without the confidence of the public. In this regard, the interface control activities during construction and operation period were reviewed and analyzed to find out the potential issues and possible improvements of interface control activities for the utility and its technical supporting organizations as well as of the regulatory system.

2. Review of Incidents

2.1 A Series of Break-off of Thermal Sleeves

During the 1st periodic inspection of YGN 5 in April 2003, three of the four thermal sleeves were found stuck at the bottom of the reactor pressure vessel (RPV) and slightly damaged the base metal of RPV. In November 2003, four thermal sleeves of YGN 6 were also found dislocated, very similar to YGN 5, but no damage to the base metal of PRV.

The main cause of detachment was insufficient tie-up force between explosive expansion area of thermal sleeve and nozzle groove due to material change from Inconel-600 to Inconel-690 that has different material property. It was confirmed that the manufacturer performed explosive expansion process for Inconel-690 as the same way for Inconel-600 without the appropriate investigation of the effect of material change on the process with Nuclear Steam Supply System Design (SD) and utility did not confirm either the design change with the proper control activities such as quality assurance activities during design and manufacturing

2.2 Radioactivity Leak at YGN 5

In December 2003, isolation valves on the reactor coolant system (RCS) sampling line connected to the shutdown cooling system were found to be internally leaking at YGN5. Consequently, part of the demi-water system was contaminated by the leak of primary reactor coolant through the post accident sampling line and some contaminated water was released to the environment through the sewage disposal system.

The root cause of the incident was poor seating of first isolation valve and insufficient isolation capability of the valves in the downstream due to change of valve type from direct type to pilot type. It was confirmed that the utility purchased and installed different type valves without appropriate evaluation of design organization on the change of valve type.

3. Review of Interface Control Activities among Participating Organizations

With the analysis of the upper mentioned incident cases, it is identified that the design changes during construction and operation could induce unexpected incidents. Therefore they should be sufficiently reviewed and their potential weaknesses should be corrected properly by the participating organizations.

The participating organizations regarding construction and operation of NPP are SD, architecture engineering (AE), component design (CD), component manufacturing, turbine generator manufacturer (T/G), initial core design (ICD), construction company, and operating utility. (refer to Fig. 1)

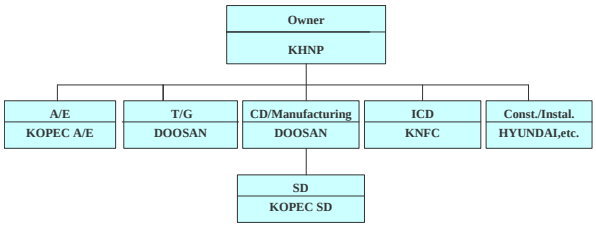

Fig. 1. Participating Organization for Shinkori 1,2 NPP Construction

The important interface activities for the construction described in project procedure manual are as follows;

- SD-CD interface : design requirements
- SD-AE interface : interface requirements
- SD-ICD interface : initial core design and accident analysis
- AE-T/G interface : manufacturing of secondary system
- AE-Construction : construction and installation

The interface activities for operation are controlled by Integrated Committee of Design Review to cope with the troubles occurred during operation.

4. Recommended Measures for utility and TSO

In order to improve the integrating function of utility on all interface activities, the recommended measures to be established and implemented are as follows;

- System for identification and management on major changes of design and manufacturing/ construction processes compare to previous unit including review results by TSO experts
- Feedback system to reflect the upper mentioned changes into operating procedures
- Management system for interface activities between SD and CD including intensified manufacturing inspection
- Improvement on current management system for interface activities during construction to make practical application of the experience of previous NPP construction activity.
- Improvement on procurement procedure, in case of design or item changes of safety related components, including the review and evaluation of suitability by the experts concerned.

5. Suggested New Regulatory Systems

5.1 Reporting System of Safety Related Non-conformances

Reducing the incidents due to the defects of major components embedded during design and manufacturing, it is necessary that the safety related non-conformances should be reported to the regulatory authority. Safety enhancement could be achieved through the direct confirmation of suitable evaluation and corrective measures for the reported non-conformance by the regulator

5.2 Improvement of Field Inspection during Design and Manufacturing

To verify the adequacy of the interface control activities among utility and TSO, it is necessary that the specific design documents and manufacturing processes descriptions should be submitted to the government to be reviewed and the manufacturing activities should be inspected by regulatory body.

6. Conclusion

It was discussed and suggested that the some measures for the improvement of interface control among utility and technical supporting organizations (TSO) as well as the new regulatory systems, for example reporting of safety significant non-conformances, are need to effectively confirm the interface control activities during construction and operation of NPPs for enhancing nuclear safety.

References

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