

Safety Evaluation for the Impact of Storm Surges on Nuclear Facilities considering the Climate Change

Seung Gyu Hyun*, Sobeom Jin

Korea Institute of Nuclear Safety, 62Gwahak-ro, Yuseong-gu, Daejeon, 305-338

*Corresponding author: mgodo@kins.re.kr

1. Introduction

Twenty one units of Nuclear Power Plants(hereinafter NPPs) are operating and five units are under construction in Korea. In particular, Kori unit 1 has been operating for over 30 years. All of the interior NPPs are located in coastal areas and use the sea water for the cooling system. Therefore, the change of sea level seem to affect the safety of NPPs in case of a flood(Hyun et al., 2009).

The IPCC 4th Report(2007) showed that the climate change induced by the high CO₂ effluent scenario results in rise of the sea level (+ 26 to 59 cm), increase in wind strength and more increase of typhoon intensity in the period between 2090 and 2099 and the rate of global mean sea level rise was up to 1.8 ± 0.5 mm/yr from 1961 to 2003.

Kang et al.(2005) reported that the rise rate of sea level was 5.4 ± 0.3 mm/yr at the entire East Sea and was 6.6 ± 0.4 mm/yr for the southern part of East Sea from 1992 to 2002. These results are approximately four times greater than the results of the IPCC 4th Report.

The IAEA recommends that some safety margin related with climate change should be taken into consideration in the design basis flood for constructing new NPPs considering the entire plant lifetime and for periodic safety reviewing of operating NPPs referring to the interval between two consecutive reviews(2003).

This paper, therefore, summarized the current regulatory activities related with the safety assessment of the impact of storm surge on the NPPs with climate change.

2. Regulatory requirements for the safety of NPPs in flood with climate change

Notices of the NSSC (Nuclear Safety and Security Commission) and Safety Review Guideline (Korea Institute of Nuclear Safety, 2010) do not describe a direct requirement over climate change. But, the safety evaluation on the flood for newly constructed NPPs shall be carried out considering the entire lifetime of a plant.

Article 24 "Details of Periodic Safety Review" in the Enforcement Rule of Atomic Energy Safety Act for operating NPPs requires applications of the existing analysis methods, safety standards and knowledge over the characteristics of natural phenomena. The natural

phenomena for the consideration as listed in the article include meteorological conditions like typhoons and floods. The article also describes upon the verification of sustained adequacy of an existing safety analysis, considering the condition of reactor facilities at the time of review thereof and the condition during the 10 years after review base day, and using current analysis methods, safety standards and knowledge.

3. Safety evaluation over climate change

The licensee used the probable maximum typhoon for evaluating the flooding impact on the site and the safety related structures, systems and components of a nuclear facility. This typhoon is built by increasing 10% of typhoon intensity to the historically strongest typhoon. This condition is matched to the recommendation of the IAEA(2003) that refers to the IPCC 3rd(2001) reporting that the intensity of typhoon will be increased to 10% in the end of the 21st Century.

Based on the previous assumption, the safety evaluations for the impact of storm surge on the safety of NPPs are given;

3.1 Life extension of Kori Unit 1 (2007)

On behalf of the safety review for the operation lifetime extension of Kori Unit 1, in operation for 30 years since April 29, 1978, the licensee included the results of the safety analysis for the reactor with respect to climate change in the application, as follows.

In evaluating any potential hazards to the safety-related facilities due to the effects of probable maximum surge, the licensee adopted the recommendation of the IAEA Safety Guide Ns-G-3.5 (2003) and added the expected sea level rise after 10 years to the probable maximum sea level. The reevaluated results for the flood hazard induced by surge indicated that all safety related facilities are safety.

3.2 Yonggwang Units 3 & 4 PSR(Periodic Safety Review, 2007)

Even though the sea level rise and storm surge are taken into account by referring the IPCC 4th report, the reevaluation results for the coastal flood indicated that some of the safety-related structures of the units may not have been damaged by the storm surge.

3.3 Uljin Units 1 & 2 PSR (2008) and Units 3 & 4 PSR (2010)

The reevaluation results for the coastal flood at Uljin units 1, 2, 3 & 4 showed that the probability of the maximum storm surge due to rise in the sea level and increase in wind speed by the typhoons will be low until the next safety evaluation in 2018 and 2020.

3.4 Shin Kori Units 1&2 Operating License(2010)

The probable maximum sea level caused by the probable maximum typhoon and rise of sea level may not be higher than the site level during the entire lifetime(40 years) of NPPs.

3.5 Shin Kori Units 3&4 Construction Permit (2008)

The probable maximum sea level induced by storm surge may be lower than the base level of site when implementing the IAEA recommendation for evaluating the flood hazard in considering the predicted value (0.059m) in the IPCC 4th Report.

4. Summary

Climate change has been known to be the main reason for the rise in the global sea level and the increasing typhoon occurrences and intensities. Coastal flood due to climate change needs to be considered for construction and operation of NPPs.

Nevertheless, the variation of climatic characteristics and sea level at the NPP sites should be monitored continuously and the safety of NPP sites should be checked on a regular basis since the inherent uncertainties in the analytical methods and climate change itself is great.

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