A Study on Seismicity Parameters and a Logic Tree in the PSHA for a NPP Safety

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1. Introduction

Recent study on the sensitivity of seismicity parameters [1] showed that the Gutenberg-Richter (G-R) parameter was the most sensitive one. This study was based on the PSHA (Probabilistic Seismic Hazard Analysis) for Shinuljin Nuclear Units 1&2 performed in 2008. This paper summarizes the review results of the input values provided by expert panels and suggests a logic tree for calculating the G-R parameter values to reduce the uncertainty in the PSHA for Korean NPPs.

2. Review of PSHA Input Data Provided by Expert Panels for Shinuljin Units 1&2

2.1 Seismic Source Map

The tectonic structure of the Korean Peninsula widely differs from experts. Figure 1 shows four seismic source maps (best estimate and alternative) for Shinuljin Units 1&2 site. These maps were subjectively developed by expert teams, each consisted of one geologist and one seismologist. The geological structure is a major factor for determining the seismic source, in general. However, it is noted that some sources in a map have very weak bases which seismically differentiate a source from a adjacent one.

2.2 Magnitude and Epicenter

There are several historical earthquake catalogs with a time span of about 2000 years. Expert panels mainly used the KIGAM (Korea Inst. of Geosci. and Mineral Res.) and and Kiewha Lee¡s catalog for historical earthquakes and the KMA (Korea Meteo. Admin.) catalog for instrumental earthquakes. As the historical earthquake catalogs indicate the MM intensity only, experts converted the MM inten-sity to a magnitude to obtain the seismicity parameters. Experts used different equations of different origins, i.e., western US, central US, Europe, China, Korea for the conversion from an intensity to a magnitude. Recently, a direct conversion criterion [2] from a damage record to a magnitude was suggested to reduce the uncertainty of the magnitude in the historical earthquake catalog.

Regarding the epicenter of the historical earthquake, experts used Kiewha Lee¡s catalog whose uncertainties are large as was discussed by Seo [2]. So, the earthquake recurrence rate which depends on the earthquake counts in a source could be influenced by uncertain epicenters.

2.3 Completeness of Earthquake Catalog

Each expert team used different earthquake catalog, magnitude and period of a catalog for calculating the G-R parameter. In case of the historical earthquake catalog, events with magnitude greater than 4.5 and a period of 13-1904 or 1500-1750 or 1392-1904 were used. For the case of the instrumental earthquake catalog, events between 1978 and 2008 with magnitude greater than 2.5 or 3.0 or 3.3 were used. Some expert team used both catalogs with similar magnitude and period, as described above. The base of these experts¡ selection was that those magnitudes and periods were relatively complete. It should be noted that the density of the population or earthquake monitoring station is a measure of the completeness.

The G-R values provided by expert teams show wide variation compared with the KEPRI result [3] which was obtained by using similar catalog and periods with the completeness evaluated. This means that the completeness analysis should be considered together as an important factor in the PSHA.

2.4 G-R Value and Its Correction within a Source

The best estimate recurrence rate of an earthquake with a magnitude greater than 5.0 varies from 0.001 (minimum) to 0.085 (maximum) depending on the seismic sources shown in Figure 1. The G-R-a values converted from the above recurrence rates are 4.32 and 6.25, respectively. Also, the best estimate G-R-b values provided by expert teams are 0.43 (minimum) to 0.99 (maximum). The minimum G-R-a and -b values correspond to a zone with very small population density due to mountainous area which covers approximately 70% of the Korean Peninsula. Both G-R-a and -b values show wide variation.

The G-R parameter is very sensitive to the sample size. So, the suitability of the value or the seismic source zone should be reviewed, if the G-R parameter was determined from a very limited number of data in a geologically divided seismic source zone. In some cases, it may be necessary to use either the whole catalog or a spatial smoothing method, when we calculate the G-R parameter for an individual source.

2.5 Logic Tree

It has been the common practice to use a logic tree by considering the above-mentioned uncertain parameters in the PSHA. However, the logic tree has only been used to process the weighted parameters input by experts.

A logic tree needs to be developed by experts to reduce the uncertainty in the input parameters, especially in Korea. Figure 2 shows a suggested logic tree by taking into account the factors described in Section 2.

3. Conclusion

Factors which are related with a determination of the Gutenberg-Richter parameter in the PSHA for Shinuljjn Units 1&2 are reviewed. It¡s necessary to consider the completeness of the earthquake catalog and to correct the Gutenberg-Richter value if it is determined from a very limited number of data. A logic tree needs to be developed by experts to reduce the uncertainty in the input para-meters.

ACKNOWLEDGEMENT

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REFERENCES

[1] J.M. Seo et al.,¡A study on the Sensitivity of the Gutenberg-Richter Parameter Value on the Seismic Hazard in Korea,¡ EESK Conference, 2009. 3.
[2] J.M. Seo ,¡Re-evaluation of the Historical Earthquakes through Test on Ancient Structural Models and Analysis of Recent Earthquakes,¡ EESK Conference Proceedings, 2008. 3.
[3] KEPRI, Improvement of Uncertainty in Probabilistic Seismic Hazard Analysis, TR.96NJ21.J1999.72, Feb. 1999.

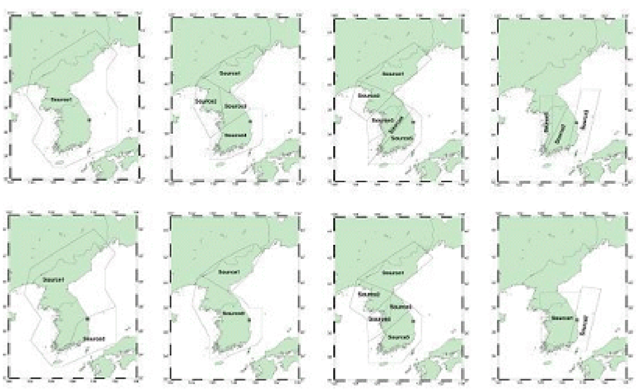

Figure 1. Seismic source maps (best estimate and alternative) provided by 4 expert teams for Shinuljin 1&2 PSHA.

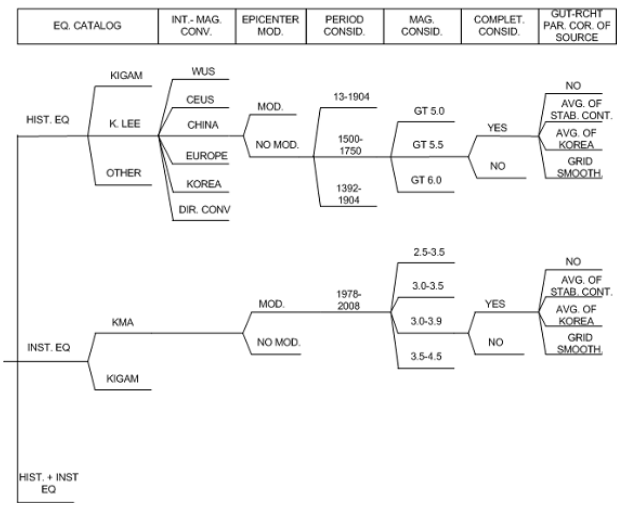

Figure 2. An example of logic tree proposed to determine the seismicity parameters in the PSHA in Korea