A Study on OBE Exceedance Criteria Using the CAV Concept for NPPs in Korea

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1. Introduction

NPPs in Korea have so far complied with the US Regulatory Guide 1.12 Rev.1 (1974) [1] for the seismic monitoring systems. However, researchers in Korea have been considering attempting to comply with Regulatory Guide 1.12 rev.2 (1997) [2] when implementing all future seismic monitoring systems. To comply with the new regulations, Operating Basis Earthquake (OBE) Exceedance Criteria applied with the Cumulative Absolute Velocity (CAV) has to be developed for local use.

The CAV was developed in the USA as one reasonable OBE exceedance criterion for NPPs; however, it has not been widely used outside the USA, not-withstanding its solid technical basis. It is, however, expected that the worldwide NPP construction boom will necessitate development and more frequent use of reasonable OBE exceedance criteria. As multi-units (four or more) are situated in one site in Korea, prevention of simultaneous shutdown of multi-unit caused by non damaging earthquakes is very important; otherwise, a serious economic loss could occur, and there could also be a great impact on the stability of the power grid that would arise due to the unnecessary shut down.

Actually, we have had the experience of observing a Peak Ground Acceleration (PGA)-value greater than 0.1g (the current OBE level for Korean NPPs) due to an M=4.8 earthquake (20th Jan. '07) that did not even cause any damage to the poorly-designed structures nearby. This experience gave a motivation to the KHNP should concern the needs of study on OBE exceedance criteria in view of application of the CAV to Korean seismic situation, which will be more practical.

The present paper is intended to show the intermediate result of the research on Operating Basis Earthquake (OBE) exceedance criteria in Korea.

2. The Concepts of CAV and OBE Exceedance Criteria

2.1. The Cumulative Absolute Velocity (CAV)[3]

The most challenging task in the operation of a seismic monitoring system for an NPP is determination of when and on what basis the power plant has to be shut down after an earthquake at the site. This issue has long been recognized and has finally been resolved at least in the U.S.A., by the publication of the Regulatory Guide 1.166 ('97) [3]. The essence of this regulatory guide is a focus on screening out the insignificant earthquakes by using the CAV, a new measure of ground-motion. The CAV measure includes a complementary concept for the earthquake ground-motion that exceeds the designed OBE, especially in the high frequency range above 10Hz.

The equation of the CAV is as follows.

$$CAV = \int_0^{tmax} |a(t)|d(t)$$

a(t) = acceleration time history (>0.025g),
tmax = duration of record

The CAV is an area which is enclosed by acceleration curves and a kind of velocity concept expressed as g·sec in its unit. It has characteristics of high sensitivity in a range of low frequency which has a big potential destructive energy, on the other hand, low sensitivity in a high frequency range which has weak destructive energy. Fig. 1 shows the illustration of the standard CAV calculation. The acceleration values above 0.025g during every one second are cumulated.

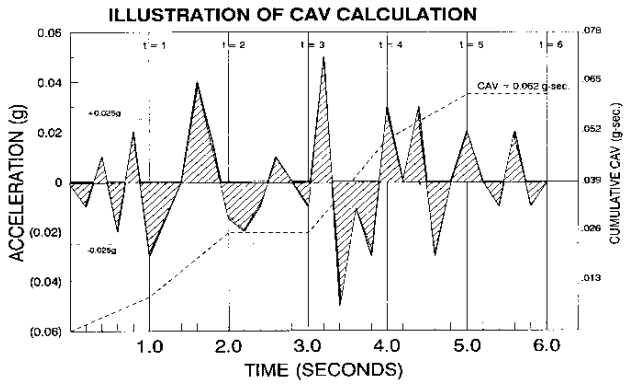

Fig. 1. The Concept of CAV and Illustration of CAV Calculation

2.2. The Operating Basis Earthquake (OBE) Exceedance Criteria

The level of the OBE should usually be fixed as 1/2 of the Safe Shutdown Earthquake (SSE=0.2g) level in

Korea. However the revised concept of the OBE criteria recommended by USNRC is as Figure 2 which includes the CAV concept.

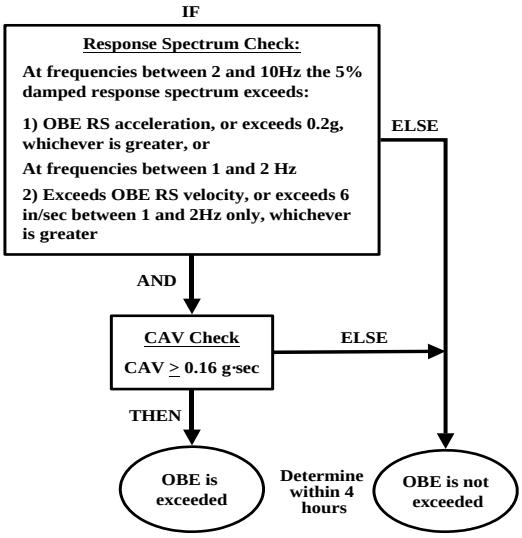

Fig. 2. Criteria for OBE Exceedance [3]

3. Method and Result

As an interim result of the project, we are able to suggest a preliminary value for the site-specific CAV OBE exceedance criteria for the Uljin NPP in Korea. This value was determined as a minimum CAV value for the MMI Ⅶ intensity based on the relation between the CAV and the seismic intensity. By definition, the MMI Ⅶ intensity is the ground-motion level that could cause a minor damage to a well-designed structure. Therefore no damage to the more rugged NPP structure, which is reinforced against earthquakes, is guaranteed if the minimum CAV value is used as a threshold of OBE exceedance criteria.

In deriving the CAV OBE exceedance criteria, it was necessary to generate a suite of simulated ground-motions for a range of earthquake magnitudes and calibrated distances to the site; it was also necessary to use an instrumental MMI intensity of FAS (Fourier Acceleration Spectra) MMI (Sokolov, '99) because there have been no strong ground-motion records or experienced intensity data from damaging earthquakes in Korea.

From the relation between the CAV values given for a specific NPP site (Uljin, UJA) and the values for the instrumental MMI intensity (FAS MMI), the CAV value of 0.13g·sec was determined at the minimum value of MMI 6.5, which is similar to the value of 0.165g·sec given in the U.S. NRC OBE exceedance criteria (Fig. 3).

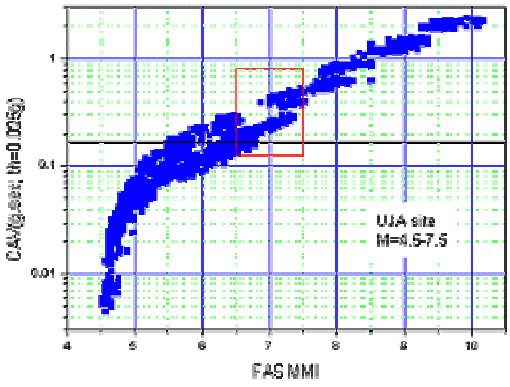

Fig. 3. Preliminary result of the relation between the CAV values specific to the Uljin site (UJA) and the instrumental MMI intensity (FAS MMI)

4. Conclusions

The interim result of this study on OBE exceedance criteria is that a CAV value of 0.13g·sec which is similar to the value of 0.165g·sec given by the U.S. NRC, was determined at the minimum value of MMI 6.5 as shown in Fig. 3. However since this result is based on the simulation, there still remains a margin of the CAV threshold value that must consider characteristics of the real strong ground-motion records. For future work, a calibration is planned for the CAV values that have been simulated from observation; this will be done by analyzing the world-wide strong ground-motion D/B. Also, data on the limited earthquake damage reported in Korea will be used to validate the simulated CAV values.

REFERENCES

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