Transactions of the Korean Nuclear Society Autumn Meeting
PyeongChang, Korea, October 30-31, 2008

Review for Improvement of Seismic Monitoring System in Korea for ALARA

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1. Introduction

Seismic monitoring system in nuclear power plant in Korea has been installed in compliance with US Regulatory Guide 1.12 Rev.1(1974)[1] in 11 nuclear reactor units among 20, including the first plant, Kori unit 1. This regulation informs to place a time-history accelerometer, a peak accelerometer, a response spectrum recorder and a seismic switch on the locations indicating the best response from the structure. It includes pertinent location on the seismic category I equipment or piping. However this fact makes sometimes maintenance being difficult and problematic, because of a number of instruments and types. ALARA (As Low As Reasonably Achievable) is also difficult to maintain due to inappropriate location of the instrumentation.

To enhance its maintenance and for ALARA maintaining, regulatory guide 1.12 has been revised in 1997(rev.2)[2]. The revised regulation deleted the requirement for seismic category I equipment or piping. Instead, ALARA is more emphasized. It requires only tri-axial time-history accelerometer on six different positions including containment foundation as seismic instrumentation.

Thus inventory on seismic monitoring instrumentation referred to its position, number and panel system have been performed throughout the whole nuclear power plants. Most of the plants apart from Wolsung and Kori unit #1 have to modify the design of seismic instrumentation to comply with the revised regulatory. In most plants, an accelerometer is placed on the support of steam generator being hardly maintainable ALARA.

The present paper is to show the result of the measurement of radiation dose rate around the steam generator and is to insist the need to maintain ALARA.

2. Methods and Results

2.1. Seismic monitoring system in NPP

Inventory on seismic monitoring instrumentation referred to its position, number and panel system have been performed throughout the whole nuclear power plants. Most of the plants apart from Wolsung and Kori unit #1 have to be modified to comply with the revised regulatory.

Table 1 shows only time-history accelerometers which are placed in NPP. Time-history accelerometer is main key instrument which is demanded to install in the revised version 2. Instruments are of three models in Korea NPP.

Table 1. Time-accelerometer of NPP

Power Plant	model	number	remark
Kori #1	FBA-3	5	Replaced in 2007 from SSA-320
Kori #2	FBA-3	3	Kinemetrics
Kori #3&4	FBA-3	7	Kinemetrics
Younggwang #1&2	FBA-3	7	Kinemetrics
Younggwang # 3&4	FBA-3	5	Kinemetrics
Younggwang # 5&6	FBA-3	5	Kinemetrics
Ulchin #1&2	FBA-3	4	Kinemetrics
Ulchin #3&4	FBA-3	5	Kinemetrics
Ulchin #5&6	AC-23	7	GeoSIG
Wolsung #1	AC-23	5	GeoSIG
Wolsung #2	SSA-320	5	Terra

Time-history accelerometers with its dynamic range in power plants meet requirement of the revised regulation (more than 1,000:1).

2.2. Measurement of radiation dose around steam generator

The data, of which gamma-ray exposure around the steam generator was measured, is given by Younggwang units 3&4. The gamma ray dose rate was 360mSv/h, which is very high compared to 20mSv/y of radiation worker's dose limit. Even there is no enough space to install a shielding material to protect from radiation exposure on an accelerometer in most of the plant. Therefore average neutron energies and fluxes were measured to analyze the expected radiation damage of the accelerometer from it. They were 0.182MeV and 1.478×10^4 n/cm^{2}s in 1997, and 0.05MeV and 1.42×10^5 n/cm^{2}s in 2006 respectively as table 2. It was concluded that there will be no radiation damage caused by radiation exposure; nevertheless, the effect on worker still cannot be disregarded.

Table 2. Neutron dose rate of S/G of Younggwang NPP

NPP	Position	Flux	Average energy	Measured date
Y #4	S/G 100'	1.478x10^4 n/cm^2 s	***0.182 Mev***	1997.11
Y #2	S/G 100'	***1.42x10^5 n/cm^2 s***	0.05 Mev	2006.9

2.3. Case Study from oversea NPP and Korea NPP plan

For reference and to verify, some of nuclear power plants such as Palo Verde and San Onofre units 2&3 in USA complying with the new regulatory version were reviewed. It is confirmed that there is only 6 time-history accelerometers and none in the area of steam generator. New power plants under construction in Korea planned to comply with the new regulatory version.

3. Conclusions

Current seismic instrumentation in most plants needs to be removed in large number of instruments such as seismic switch, peak accelerometer, response spectrum recorder and trigger switch to comply with the new regulatory version, with remaining only time-history accelerometer. All the time-history accelerometer placed on the support of steam generator have to be also moved to the place easily accessible and maintainable ALARA. The new location will be surely obtainable the pertinent seismic acceleration data. The right position of additional instrumentation will be offered in its data in the future paper.

REFERENCES

[1] Regulatory Guide 1.12 “Nuclear Power Plant Instrumentation for Earthquakes (Rev. 1)”, 1974
[2] Regulatory Guide 1.12 “Nuclear Power Plant Instrumentation for Earthquakes (Rev. 2)” March, 1997
[3] US EPR FSAR
[4] US Palo Verde NPP FSAR, 2005
[5] US San Onofre #2&3 FSAR
[6] Korea APR 1400 SSAR
[7] Korea Shinkori #3&4 PSAR
[8] Korea Shinkori #1&2 PSAR