Replacement of HANARO Seismic Monitoring System

Yun-Taek Im [a*], Seung-Gyu Doo [a], Min-Woo Lee [a], Byung-Hun Hwang [a], Jae-Ha Song [a], Kyung-Chul Kim [a]
Young-San Choi [a], and Jin-Won Shin [a]
[a] *Korea Atomic Energy Research Institute, 989-111 Daedeok-daero, Yuseong-gu, Daejeon 34057, Korea.*
HANARO Management Division.
[*] *Corresponding author: ytim@kaeri.re.kr*

1. Introduction

The HANARO seismic monitoring system has been in use for 20 years, and it monitors the seismic signals of the tri-axial accelerometer installed around the HANARO building and generates an alarm when exceeding the set value. The seismic monitoring system was replaced to reflect the regulatory agency guidelines as well as to solve an aging problem that was the discontinuation of spare parts. This paper shows the improvements in the seismic monitoring system to reflect the requirements from regulatory agencies.

2. Seismic Monitoring System

The seismic monitoring system used for 20 years had to be replaced due to the difficulty in supplying spare parts, and the system needed to be improved due to the inconsistency of the seismic signals from two seismic switches and the accelerometers. The research reactor, HANARO, is equipped with three tri-axial accelerometers and two seismic switches, and the seismic monitoring system processes signals of three accelerometers and seismic switches. Each tri-axial accelerometer is installed in the foundation, free-field, and the top of the reactor building, and measures acceleration signals during a seismic event. Two seismic switches installed on the ground of the reactor building are for earthquake alarm and earthquake occurrence respectively, generating a seismic trigger signal and an earthquake occurrence signal when the OBE is exceeded. The configuration of the seismic monitoring system is shown in Fig. 1(a).

However, the two seismic switches were installed on the ground of the reactor building for triggering seismic events, and the discrepancy between the ground signal and the free-field signal may occur. To solve this problem, the free-field accelerometer is used to monitor the seismic trigger and the occurrence of a seismic event instead of the seismic switch signals as shown in Fig. 1(b). Fig. 2 shows the replaced seismic monitoring system, and Table I shows the comparison table of before and after replacement. The set-point levels of seismic trigger and OBE are unchanged, however these are based on the free-field accelerometer after replacement.

2.1 Seismic Trigger

The seismic monitoring system is manufactured according to Reg. Guide 1.12, and signals of the accelerometers installed on the ground of the reactor building, the free-field, and the top of the reactor building are processed within the range of 0.2 to 50 Hz.

The seismic trigger uses the accelerometer signal in the free-field and satisfies the range from 0.001 to 0.02 g, and the seismic trigger levels of horizontal and vertical directions are 0.01g and 0.0067g, respectively [1, 2].

2.2 OBE Exceedance

● Maximum(Peak) Ground Acceleration

By following per under regulatory agency guidelines [3], maximum acceleration is determined by measuring the maximum ground motion of a free-field accelerometer to determine whether exceeding the OBE. In HANARO, the vertical and horizontal maximum ground accelerations of the free-field accelerometer are set to 0.1g and 0.067g, respectively. If the measured signal is exceeding the maximum ground acceleration, an OBE exceedance alarm is generated.

● OBE Spectrum

According to regulatory agency guidelines[3], the OBE response spectrum is exceeded if any one of the three components (two horizontal and one vertical) of the 5 % of critical damping response spectra generated using the free-field ground motion is larger than:

► The corresponding design response spectral acceleration, for frequencies between 2 to 10 Hz.

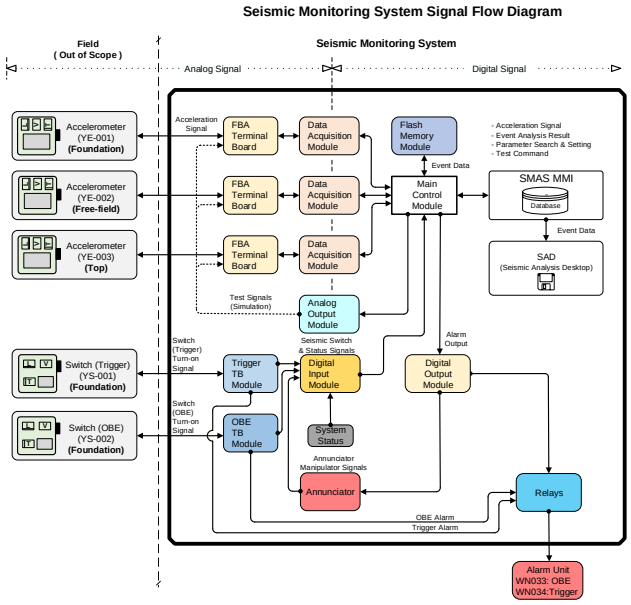
► The corresponding design response spectral velocity for frequencies between 1 and 2 Hz [3, 4].

3. Conclusions

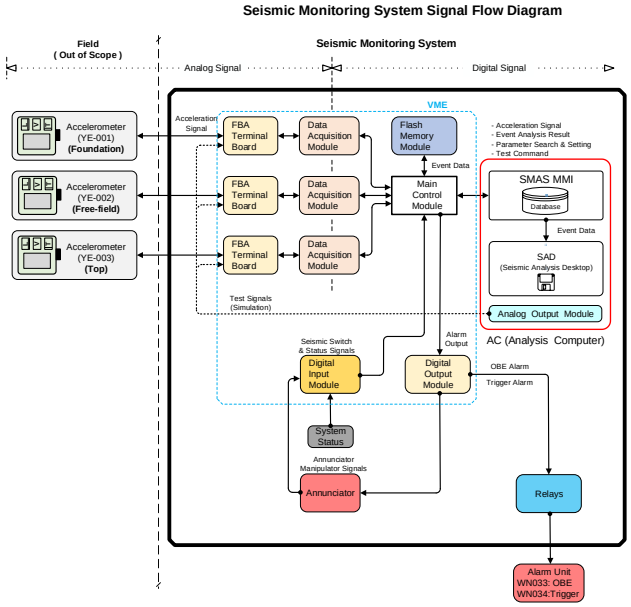
The seismic monitoring system of HANARO had been in use for 20 years, and there was a need for improvement due to aging. The functions of the seismic switches used previously were replaced by that of a free-field seismic accelerometer without changing set-points. And it was accordingly changed to determine whether the OBE was exceeded or not according to regulatory guidelines.

REFERENCES

[1] KINS/RG-N04.06 Rev. 2, 2017.
[2] Regulatory Guide 1.12, Nuclear Power Plant Instrumentation for Earthquakes, 1997.
[3] KINS/RG-N04.18 Rev. 2, 2017.
[4] Regulatory Guide 1.166, Pre-earthquake Planning and Immediate Nuclear Power Plant Operator Post-earthquake actions, 1997.



(a)



(b)

Fig. 1. Functional block diagram of the seismic monitoring system (a) before replacement (b) after replacement.

Fig. 2 The replaced seismic monitoring system in HANARO.

Table I: Before and After Comparison

{Accelerometer} [Switch] (Location)	Set-point	
	Before	**After**
{YE-001} (Foundation)	–	-
{YE-002} (Free-Field)	► OBE (FRS Spectrum)	► Trigger (H:0.01g / V:0.0067g) ► OBE (H:0.1g / V:0.067g) (FRS Spectrum)
{YE-003} (Top)	–	-
[YS-001] (Foundation)	► Trigger (H:0.01g / V:0.0067g)	(Removed)
[YS-002] (Foundation)	► OBE (H:0.1g / V:0.067g)	(Removed)