Transactions of the Korean Nuclear Society Autumn Meeting
Gyeongju, Korea, October 29-30, 2009

Development and Site Acceptance Test of Integrated NIMS

Doo-Byung Yoon*, Jin-Ho Park, Young-Chul Choi, and Sung-Hwan Shin

Nuclear Technology Convergence Division, KAERI, 150 Duckjin-dong Yuseong-gu, Daejeon, 305-353, Korea
**Corresponding author: yoondb@kaeri.re.kr*

1. Introduction

The NIMS(NSSS Integrity Monitoring System) is an process monitoring/analysis system designed to provide an approach that includes areas of monitoring relevant to the integrity of the NSSS(Nuclear Steam Supply System). The NIMS consists of four monitoring systems: IVMS(Internal Vibration Monitoring System), LPMS (Loose Part Monitoring System), ALMS (Acoustic Leakage Monitoring System), and RCPVMS(Reactor Coolant Pump Vibration Monitoring System).

The IVMS is designed to monitor the vibration of the core support barrel and its associated components. The LPMS is designed to detect, localize, and estimate the loose parts within the primary pressure boundary of a reactor system. The ALMS monitors coolant leakage at potential leak regions. The RCPVMS monitors shaft orbit and shaft speed of the reactor coolant pumps.

The objective of this work is to develop the integrated NIMS which can perform on-line condition monitoring and integrated diagnosis of the pressure boundary components in NSSS(Nuclear Steam Supply System). In the following sections, the features of the integrated NIMS and the result of the SAT(Site Acceptance Test) will be described.

2. Development of Integrated NIMS

The Integrated NIMS(I-NIMS) was developed from 2006 to 2008. The prototype of the Integrated NIMS was manufactured in 2008.

Fig. 1 shows the schematic diagram of the Integrated NIMS.

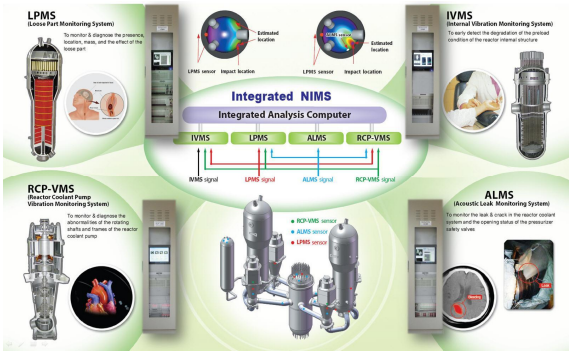

Fig. 1. Schematic diagram of the Integrated NIMS(NSSS Integrity Monitoring System)

Fig. 2 shows the schematic diagram of software for the Integrated NIMS. As shown in Fig. 2, the major feature of the integrated NIMS is that the integrated NIMS make full use of whole signals obtained from the field sensors for monitoring and diagnostics. Field sensors such as accelerometers, AE sensors, proximity probes, and ex-core neutron detectors have a common feature in that they can measure the vibration of the reactor structure, even though the measuring frequency ranges are different from each other. For example, the impact signal generated by a loose part can be detected not only by the accelerometers of LPMS, but also by the AE sensors of ALMS. Since the sensor locations of the LPMS are different from those of the ALMS, the ALMS sensors can be utilized as additional sensors for loose part monitoring and diagnosis. Therefore, by using an integrated signal acquisition, we can enhance the reliability and precision of the NIMS monitoring and diagnosis. As a result of this work, the integrated monitoring and diagnosis method of the I-NIMS were registered for patents [1,2].

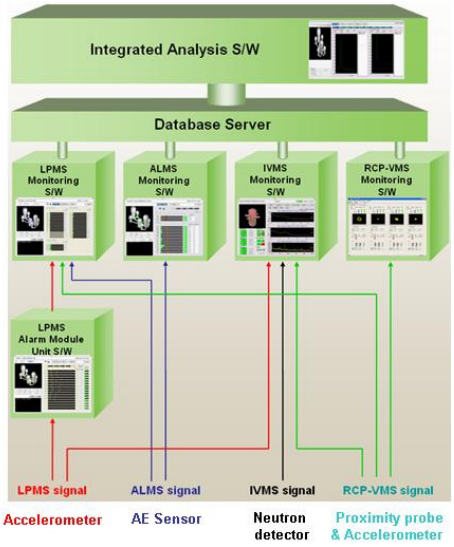

Fig. 2. Schematic diagram of software of the Integrated NIMS(NSSS Integrity Monitoring System)

The second feature of the integrated NIMS is that it is equipped with advanced analysis techniques that can remarkably improve the monitoring and diagnostic capability. For example, the new LPMS is equipped with a time-frequency analysis(smoothed Wigner-Ville distribution) function that can enhance the estimation capability for impact location[3,4]. Also, the I-NIMS is

equipped with advanced signal processing techniques such as the vibration mode separation algorithm, directional spectrum, etc.

Fig. 3 shows the prototype of hardware and software of the Integrated NIMS installed at the Yonggwang nuclear power plant unit 3.

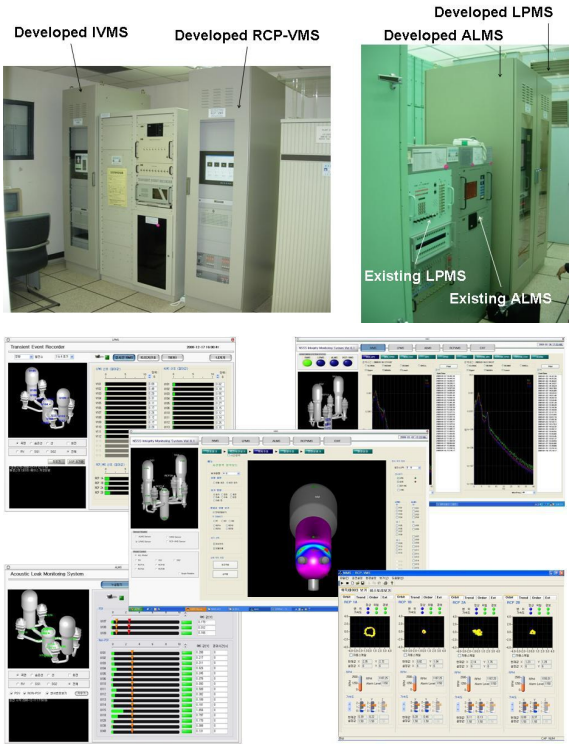

Fig. 3. Prototype of I-NIMS hardware/software installed at the Yonggwang nuclear power plant unit 3.

3. Site Acceptance Test of Integrated NIMS

In order to confirm the functional capability of the developed I-NIMS, a Site Acceptance Test was performed at the Yonggwang nuclear power plant unit 3. The functional capabilities of the hardware and software have been fully tested.

• Hardware Test
- In-place functional testing of the system hardware
- Triggering and alarming function of the systems
- Channel functioning of the AMU, SCM & DAM
- Data recording & transfer capability, etc.

• Software Test
- Real-time data display
- Signal analysis (Time-frequency analysis, Order analysis, FFT, etc.)
- Data management capability of the database program

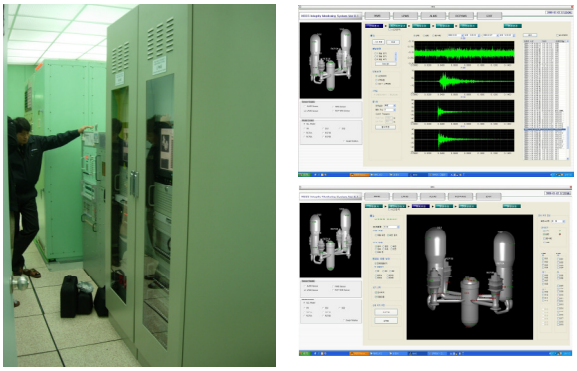

Fig. 4. Site Acceptance Test performed at Yonggwang nuclear power plant

The Site Acceptance Test in the Yonggwang nuclear power plant has been successfully completed. The I-NIMS is operating in the Yonggwang nuclear power plant unit 3 for monitoring and diagnosis of NSSS Integrity.

4. Conclusion

The Integrated NIMS(I-NIMS) have been newly developed by KAERI. The prototype of I-NIMS was manufactured at the end of 2008. In order to confirm the functional capability of the developed I-NIMS, a Site Acceptance Test was performed in Yonggwang NPP(unit 3). The developed I-NIMS is successfully operating in the Yonggwang NPP for monitoring the NSSS integrity. It is expected that the reliability and precision of the NSSS integrity monitoring and diagnosis could be enhanced by using the Integrated NIMS.

ACKNOWLEDGEMENTS

The authors acknowledge the financial support provided by the Ministry of Knowledge Economy of Korea.

REFERENCES

[1] J.-H. Park, D.-B. Yoon, Y.-C. Choi, I.-S. Koo et al., “Integrated Monitoring Method for Nuclear Device and System using the Same,” Patent Registration No. 0798006, 2008.
[2] D.-B. Yoon, J.-H. Park, and Y.-C. Choi, “Mass Estimation Method for Loose Parts of Nuclear Equipment and Estimation Device Using the Same,” Patent Registration No. 0798007, 2008.
[3] J.-H. Park et al., “Impact Source Localization on an Elastic Plate in a Noisy Environment,” Measurement Science & Technology Vol. 17, pp. 2757~2766, 2006.
[4] J.-H. Park et al., “An Impact Source Localization on a Spherical Shell by using Smoothed Wigner-Ville Distributions,” Key Engineering Materials Vols. 321~323, pp. 1274~1279, 2006.