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# Minimized Model Test to Develop Remote Measuring System for RVI Modularization

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## 1. Introduction

The construction duration of nuclear power plant is one of the most important factors to achieve high competitiveness. During the optimization of APR1400, it was suggested that the modularization of reactor vessel internals is one of a means to reduce the construction duration [1]. In general, Reactor Vessel Internals (RVI) consist of three components such as core support barrel (CSB), lower support structure (LSS)/core shroud (CS) and upper guide structure (UGS). It is complicated to assemble the RVI by conventional method and required much time about 8～10 months. For this reason, it is the critical path of construction schedule. To overcome the critical factor, the modularization of RVI is significantly required. In order to modularize the RVI, the gap between the CSB snubber lug and the reactor vessel lug must be measured by remote method outside reactor vessel and the digital probe of linear variable differential transformer (LVDT) to measure remotely was recommended [2]. In this paper, we will introduce the minimized model test such as design and fabrication of minimized model test equipment and test results of digital probe in various environments. We will develop automatic the remote measuring system of actual scale using the minimized model test results in the next step.

## 2. Design and fabrication of test equipment

### *2.1 Design*

The purpose of minimized model test is to confirm performance and application condition of digital probe. The performance of digital probe should be measure the gap of CSB snubber and reactor vessel that is the range 0.015 inch - 0.020inch. Therefore, the accuracy of measured length value should be micro mm unit.

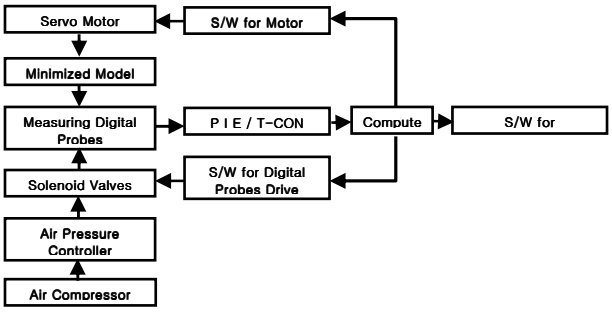


Fig. 1 Block diagram of minimized model test equipment

The equipment of model test was designed to take the condition of reactor vessel and internals into consideration such as narrow space and probe hole, to be light for easy handling by using the aluminum material. Digital probe connection jig is a threaded type to assemble the digital probe into CSB snubber.

Fig. 1 shows the block diagram of the minimized model test equipment. The servo motor makes the movement of the CSB snubber minimized model connected digital probe for up and down or front and rear. The air compressor makes driving of the digital probe and the obtained data is displayed on the computer through the interface module and network cable.

### *2.2 Fabrication*

Fig. 2 shows the picture of minimum model test equipment that consist of CSB snubber and reactor vessel lug model, 4 digital probes, air supply device, servo motor device, data interface module and notebook computer. The components of equipment were fabricated as below.

- The model pieces of CSB snubber and reactor vessel lug were machined to precise the surface and inside of the digital probe hole. The material is aluminum alloy.
- The digital probe connection jig of threaded type was fabricated.
- The commercial products such as the digital probe, the interface module, servo motor, I/O card and air compressor, etc were purchased.
- The calibration device was fabricated in order to adjust a zero point of sensor.
- The block gauge was used for test reliability of digital probe.

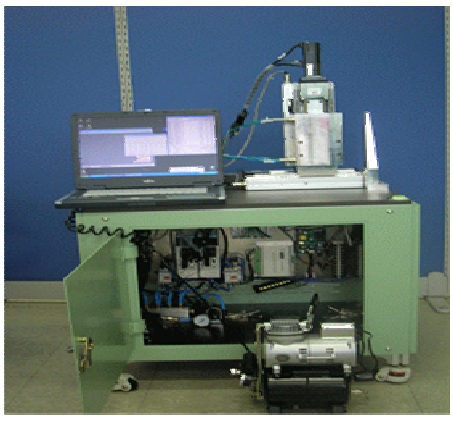

Fig. 2 Picture of minimized model test equipment

## 3. Test and Results

The tests were carried out repetitively to confirm reliability, consistency, accuracy and stability of digital probe and associated components for remote measurement. The test results were obtained as following figures.

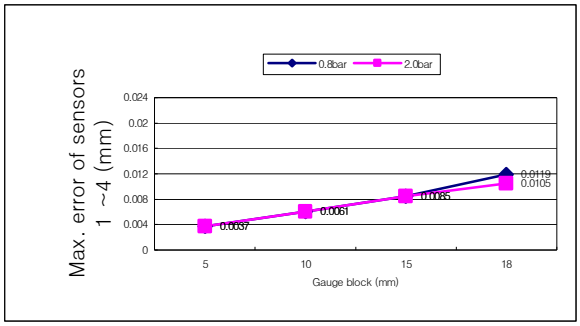


Fig. 3 Reliability test result of remote measuring digital probe

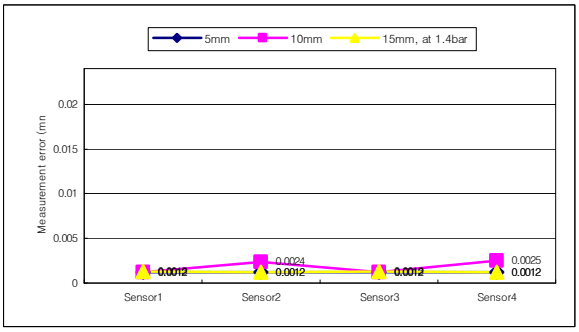


Fig. 4 Consistency test result of digital probe connection jig

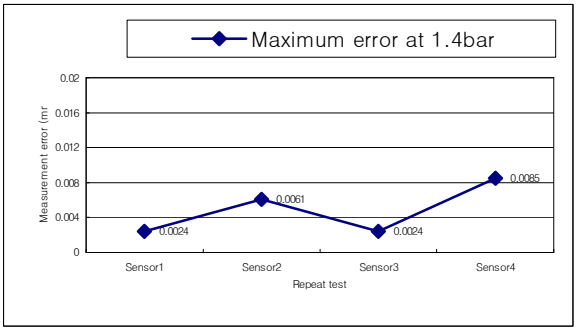


Fig. 5 Accuracy test result of zero point calibration device

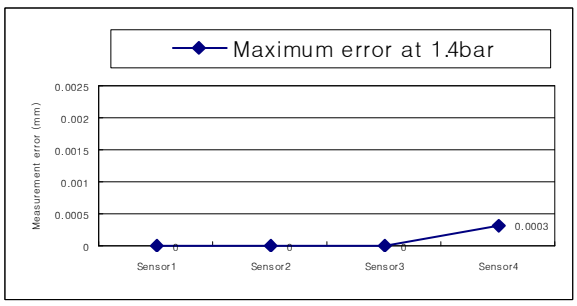


Fig. 6 Stability test result of the minimized model system at no disturbance

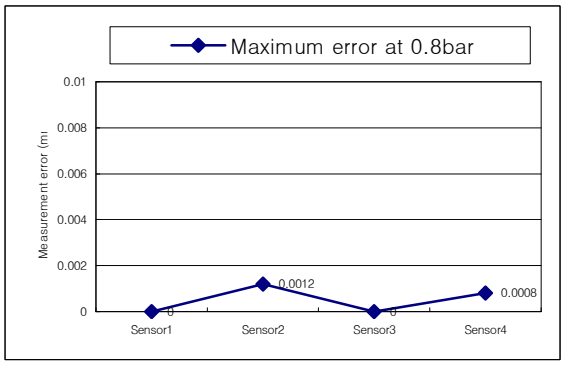


Fig. 7 Test result of the minimized model system at switching noise environment

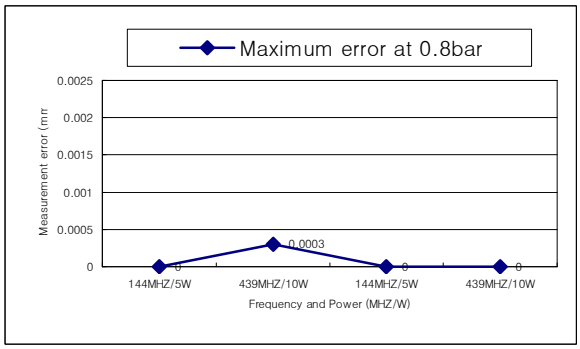


Fig. 8 Test result of the minimized model system at EMI environment

## 4. Conclusion

To confirm performance and application condition of digital probe for remote measurement of RVI gap, the minimized test model was fabricated and tests were accomplished in the various conditions.

As shown on the test results, the selected digital probe of LVDT type and the calibration device for the zero point adjustment and the other devices have a sufficient reliability and accuracy. And the digital probe connection jig has sufficient consistency. Network and system for remote measurement are very stable and no disturbance at EMI environment. The items which are required design change of reactor internal structure were surveyed through the fabrication and test process. In conclusion, the gap between the CSB snubber and the reactor vessel can be measured by using of the remote measurement method.

## REFERENCES

[1] ABB-CE, Support Work Agreement Work Order Delivery H-4, KEPCO, 1995.

[2]A Study on the Remote Measuring Scheme for Modularization, KNS 2006 Fall, Jae-Gon, Lee, Do-Young, Ko, Yong-Chul, Kang.