Development of Remote Measuring Device 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 development of automatic remote measuring device such as design and fabrication and remote measuring program.

2. Design and fabrication of remote measuring device

2.1 Design

In previous research, we found out the best digital probe to remote measure for RVI modularization through the scale down model test [3]. 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. In conclusion, we feel sure that the gap between the CSB snubber and the reactor vessel can be measured by using of the remote measurement method.

We reviewed the reactor internal detail drawings and sequence of assemble and gap measuring for internal components. The CSB is assembled with 6 stabilizing lugs of reactor vessel and 2 shims per one lug are assembled as shown on Fig. 1. We have confidence that the sequence of remote measuring and arrangement of remote measuring device in reactor internal have not problem.

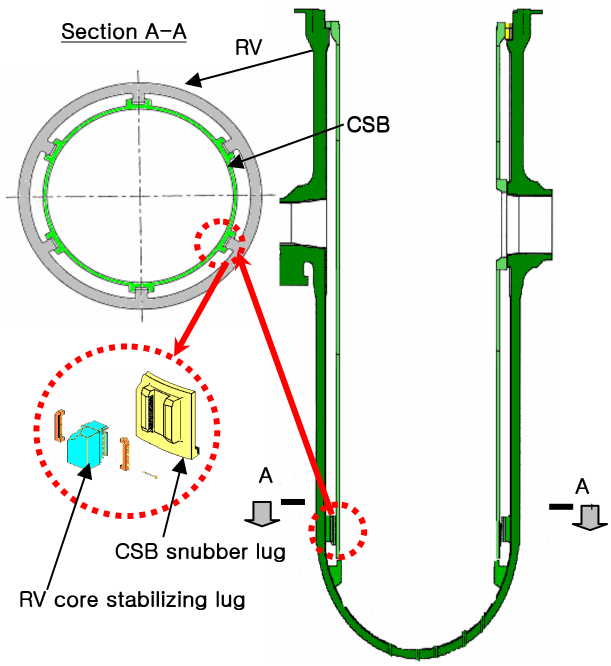

Fig. 1 Assembly parts between RV core stabilizing lug and CSB snubber lug

We designed the full scale device to remote measure the gap between the CSB snubber and the reactor vessel, the major characteristics of device are as below.

- The remote measuring device consists of digital probe system, pneumatic supply and control system, electric power system, remote control notebook and program.
- The quantity of digital probe make-up 72 sensors which are able to measure 72 points at once and size of the 12 shims can be calculated using the measurement data.
- The pneumatic system consists of air compressor, regulator and air hose.
- The channel box which is contained the digital probes, interface module and solenoid valve is designed 3 boxes. Each channel box contained 24 digital probes, interface modules and solenoid valves. These boxes are very easy to handle due to suitable weight and size.
- The 0-point adjustment jig and marking tool applied for remote measurement.
- All of the cable and air hose is easy to connection with channel box.

Fig. 2 shows the block diagram of the remote measuring device.

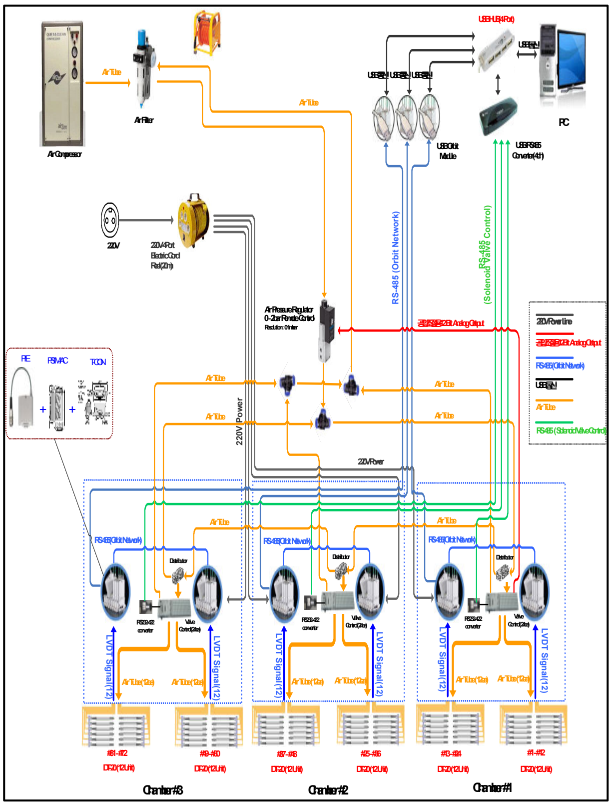

Fig. 2 The Block diagram of the remote measuring device

2.2 Fabrication

Fig. 3 shows the picture of remote measuring device that consists of 3 channel box, air compressor and notebook.

Fig. 3 The picture of the remote measuring device

The channel box can pack 24 digital probes and associated cables. These boxes are located on the bottom of lower support structure and the digital probes should be installed in the CSB before put in the reactor vessel. After installation of CSB in reactor vessel, the connection of channel box to the compressor and notebook can be done.

3. Development of remote measuring program

The automatic remote measuring program was developed to measure the gap automatically with measuring device. The program was integrated digital probe control program and pneumatic solenoid control program. The program language used the Microsoft visual C++ 6.0 and be able to install on the Pentium personnel computer.

This program can control the digital probes by all, group or by piece, and regulate the pressure of solenoid valve, and record the measurement data.

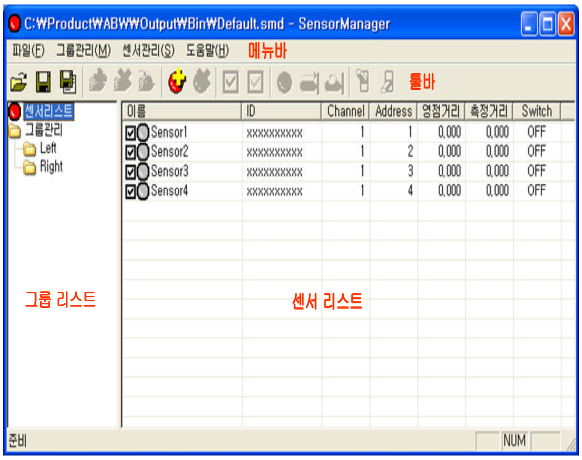

Fig. 4 The picture of the remote measuring program

4. Conclusion

The modularization of RVI is very important to achieve shortening of construction schedule. In previous study, we found out the best remote measurement technology for RVI modularize through the scale down model. The full scale remote measuring device was developed to measure the 72 points of gap between reactor vessel and CSB at once. The device consists of digital probe system, pneumatic supply and control system, electric power system, remote control notebook and program. We have succeed functional test of remote measuring device and program. In the next study, we will verify the remote measuring device and method using the mock-up of the reactor vessel and CSB.

REFERENCES

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