Development of Integrated Control and Data Acquisition System for Fuel Channel Inspection in Wolsong PHWR

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1. Introduction

A pressurized heavy water reactor (PHWR) designed to refuel in service produces the energy led by nuclear fission. Pressure tubes in pressurized heavy water reactor (PHWR) are inspected in accordance with the CSA N285.4, "Periodic Inspection of CANDU Nuclear Power Plant Components". Wolsong PHWR was required to inspect more pressure tubes by the requirement of the regulation for the safety operation.

Pressure tubes in Wolsong PHWR have inspected using AFCIS (AECL Fuel Channel Inspection System) developed by AECL in 2001. Due to the obsolescence AFCIS, KHNP developed CIMS (Channel Inspection and Measurement System) to increase the reliability of the inspection for pressure tubes in Wolsong PHWR. Field tests were performed to confirm the applicability of CIMS in Wolsong unit 3 and 4.

In this paper, ICADA (Integrated Control and Data Acquisition) system is presented in order to show the effectiveness of CIMS.

2. Development of ICADA for CIMS

2.1 Configuration of CIMS

The developed fuel channel inspection system (CIMS) consists of six major modules. These are the inspection head, the head delivery machine, the control panel racks, the interconnection cables, the NDE racks (CIMS-UT/ET) and ICADA racks.

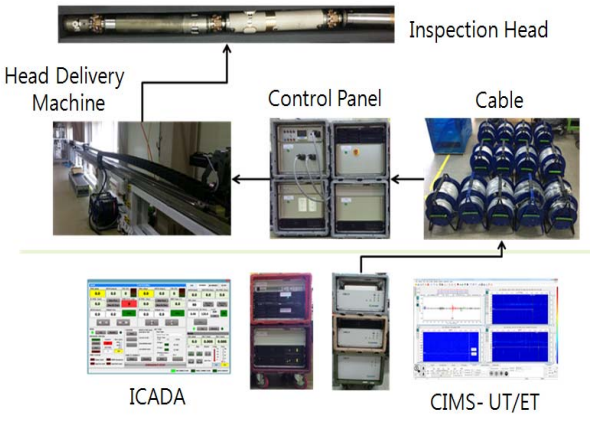

Fig. 1 Configuration of Channel Inspection & Measurement System (CIMS)

2.2 Design Requirements of ICADA

Design requirements of ICADA were established by comprehensively taking into considerations of the performance and the operation stability for the inspection system of pressure tubes, and findings of the commercial products.

In particular, the number of cables passed through the reactor building penetration was minimized to reduce the works for the installation and maintenance of CIMS. Figure 2 shows the block diagram of the ICADA.

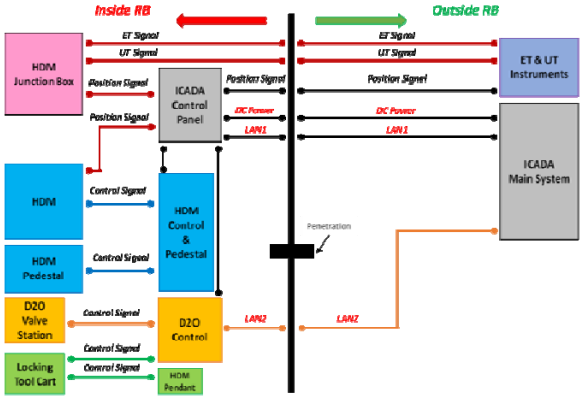

Fig. 2 Block Diagram of the integrated control and data acquisition system (ICADA)

2.2.1. Development of ICADA

The developed control panel racks are installed inside of the reactor building, and connected between modules of CIMS inside and outside of the reactor containment.

The function of the head delivery machine (HDM) is to insert and withdraw the inspection head from the inspected pressure tube of the reactor. The developed control panel racks was designed to control and monitor the movement of the HDM using ICADA software.

The functions of the developed control panel rack are as follows;

- HDM axial/rotary motors control
- HDM platform pedestals motors control
- HDM temperature (RTD) monitoring
- Locking pressure control and monitoring
- Valve station remote control
- Power supply with UPS

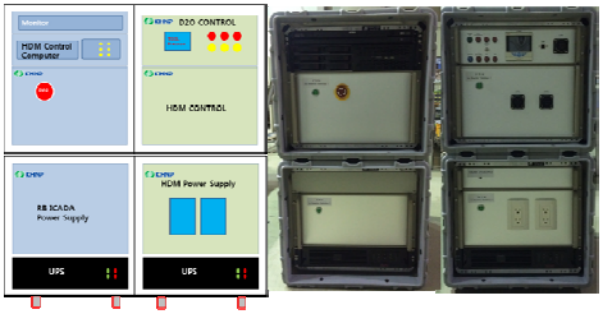

Fig. 3 Configuration of the Developed Control Panel Racks

2.2.2. ICADA SYSTEM

The ICADA rack is installed outside of the reactor containment building, and controls and monitors CIMS with the ICADA software to generate various test signals such as position signals of the inspection head. The position signals are used for firing the NDE equipment (CIMS-UT/ET) to acquire data of inspection.

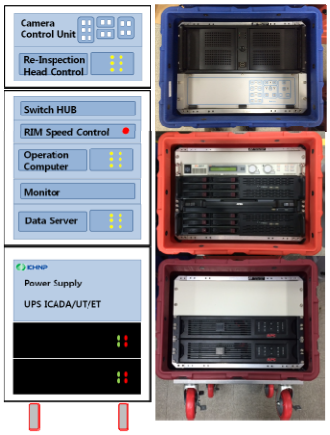

Fig. 4 Configuration of the Developed ICADA System

ICADA software is composed of four parts which are hardware interaction, data collection, data analysis, and hardware control and run on windows-based computers.

The functions of the ICADA software are as follows;

- Control panel racks control
  : HDM axial and rotational movement
- Monitoring ICADA system status
  : Database, Controller, Server
- Control Inspection Head
  : Rotating Module (RM) control
  : Camera Control Unit control and monitoring
  : Replicating module control
  : Release and retraction of probes
- Valve station control and monitoring
- HDM automatic and manual control
- Generating position signals
- Data acquisition of the length and deflection of tube
- Saving logs and data on computer
- Emergency stop
- Print and view the data of inspection

Fig. 5 ICADA Software User Interface

2.3. Verification of ICADA

The developed ICADA system was tested with HDM mock-up and applied to inspect two the pressure tubes each in Wolsong unit 3 and 4.

During the field application test, there were no errors to control and monitor CIMS to inspect the pressure tubes.

Fig. 6 HDM Mock-up and Installation in Reactor Building

3. Conclusions

As pressure tubes are ones of the most important components, they are required periodic and rigorous inspections to assess the reactor integrity as required for continuing operation based on the regulation. CIMS was developed to inspect pressure tubes during the in-service inspection in Wolsong PHWR.

In this paper, the development of ICADA is presented to confirm the applicability of CIMS during the field test in Wolsong unit 3 and 4. ICADA shows the performance and operation stability, and the effectiveness to inspect pressure tubes in Wolsong PHWR.

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