Development of the Gross Containment Leakage Monitoring System Test Facilities for Wolsung unit 2, 3 and 4

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1. Introduction

The GCLMS(Gross Containment Leakage Monitoring System) test facility installed in Wolsung Unit 2, 3 and 4 is installed and operated in accordance with the requirements of the CNSC(Canadian Nuclear Safety Commission) Regulatory Document R-7, "Requirements for containment system for CANDU nuclear power plants" Code 3.12.2 "Status Monitoring Requirement"[1]. The GCLMS test, which detects a gross breach(allowing significant leakage) of containment integrity under normal power operations in the plant, is an in-service periodic test conducted only in Wolsung Units 2, 3 and 4. However the current testing facilities were manufactured more than 20 years ago, and due to failures caused by degradation and discontinuation of all parts, there were many difficulties in performing maintenance and in-service periodic test. Under the circumstances, the CRI(Central Research Institute) developed GCLMS test facilities, verified the performance of development test facilities through performance verification and field demonstration tests, and replaced existing facilities with development facilities. In this paper, introduce the developed W-GCLMST(Wolsung Gross Containment Leakage Monitoring System Test facilities) and verification results.

2. Development of W-GCLMST

2.1 Overview of GCLMS

The main purpose of the GCLMS will be to detect significant breaches of containment, occurring suddenly and not to evaluate or confirm the small changes in leakage which may occur over time. A "gross breach" is considered to be a localized, accidental impairment of containment integrity which appears suddenly, as opposed to gradual increase in the leakage rate due to normal aging of the structure. Typical causes include valves inadvertently left open or failure of containment isolation seals. The current test method used is a constant flow method. The test method is to verify integrity of the reactor building by varying the pressure of the reactor building from -1kPa(d) to 0kPa(d) and +1kPa(d) using air leakage for instrument after isolation of the reactor building[2].

2.2 Configuration of W-GCLMST

The developed Gross Containment Leakage Monitoring System Test Facilities for Wolsung unit 2, 3 and 4 consists of five major modules. These are the main computer for data collection and analysis, the Data Acquisition Unit(DMM : Digital Multi-Meter), the pressure transmitters(two differential pressure gauge and one barometer), the Ethernet hub and the Laptop for telemetry[3].

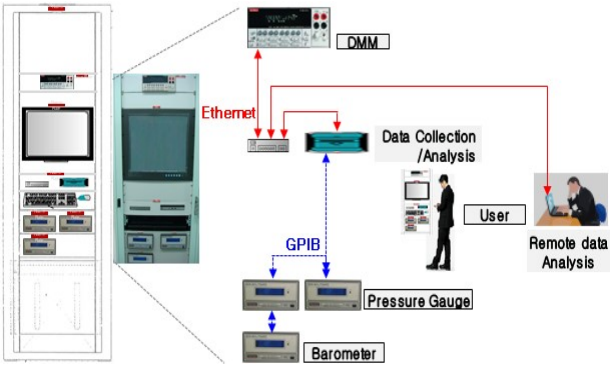

Fig. 1. Schematic diagram of W-GCLMST

The W-GCLMST software operates on the basis of the Windows 10, and all data, including the software and hardware environment settings for testing and data analysis, are managed using the database engine. The prototype software consists of three programs.

- Data Acquisition and Performing Test : User convenience functions such as acquiring data in real time during the periodic test of the GCLMS, storing data and testing data according to the test phase and creating graphs.
- Remote Data Analysis : Programs provide various offline analysis functions using user-specific programs added from improved prototypes, acquired data, and data stored in real-time from the acquisition and testing software remotely during testing to enable users to perform the desired analysis.
- Hardware Device Settings : Programs provide a function to manage information such as user programs for hardware maintenance, methods of communication with instruments for testing, setting up/change environment settings, and checking the status of development instruments.

2.3 Verification of W-GCLMS

To apply the developed test facility to the plant, it is very important to ensure reliability and objectivity for the performance of the development test facility. Therefore, visual inspection of the development prototype, initial performance test, electromagnetic compatibility test, comprehensive performance test, and finally, on-site demonstration test at the plant were performed. The performance verification results confirm that the development test facility meets all required performance verification criteria[4].

Fig. 2. Electromagnetic compatibility test (CE101, CE102, RE101, RE102)

Fig. 3. Comprehensive performance test On-site comparative verification & demonstration test

Fig. 4. Development facilities and performing in-service periodic test

2. 4 Differences and advantages in design between existing and new GCLMS test facility

The existing GCLMS test facility provided only basic data acquisition, calculation, storage, real-time acquisition and calculation value display functions on one computer based on HPIB and OS2, making it impossible for the tester to recalculate the test results or make real-time test decisions during the test.

Newly developed test facility changed their communication method to TCP/IP to improve their communication distance, enabling remote control and simultaneous access by multiple users. The moving average method applied from the beginning to the calculation of the data at the cumulative mean value eliminated the continuous effects of instantaneous noise. In addition, user convenience was increased, such as determining and eliminating anomalies for acquired data, recalculation of correction factor values, and displaying graphs of real-time test results.

3. Conclusions

Tests of the GCLMS of the reactor building in Wolsung Unit 2, 3 and 4 shall be carried out periodically during the operation of the plant, and this research task was carried out to replace and improve the discontinued test facilities that require continuous component supply and maintenance support for the facility. The prototype was completed in 2017 and the field demonstration test was conducted in April 2018, and the newly-developed test facilities for Wolsung Unit 2, 3 and 4 were successfully tested, developed, and applied in operation after replacement installation in June, July 2018 and May 2019. As a result, the government was able to secure alternative supply resources for discontinued test facilities.

REFERENCES

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