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Digital Radiation Monitoring System for High-functioning Auto Radionuclide Analysis

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1. Introduction

The Digital Radiation Monitoring System, designed to protect the workers in the power plants and the public people from radiation emitting in the process of nuclear division in the nuclear power plants, gives warnings to the operating person on any failure in fuel or fuel cladding, primary/secondary leakage in the steam generator, and abnormal operation of the cooling system, chiller or gas processing system. Generally, the Digital Radiation Monitoring System which monitors radiation levels in certain areas, the Gas Radiation Monitoring System which monitors radiation levels in systems where gas and liquid pass through, and the System Radiation Monitoring System of the Liquid and Gas Radiation Monitoring System, In this study, the LCU(Local Control Unit) for the System Radiation Monitoring system, that enables real-time radiation monitoring and automatic radionuclide analysis to meet ICRP-60 proposals of the International Commission on Radiological Protection and to precisely monitor radiation, was designed, and the control algorithm and the applications, for smaller size of monitoring systems, compatibility with the operating system, real-time radiation monitoring and radionuclide analysis, was developed

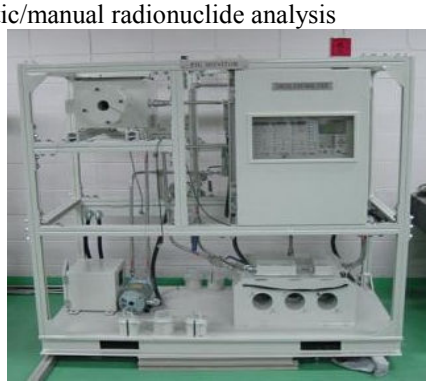
For 41 months of R&D period since May 2003, as part of the project for R&D in Electric Industry of the Ministry of Commerce, Industry & Energy, the System Radiation Monitoring System that allows automatic/manual radionuclide analysis and the Digital Radiation Monitoring System that utilizes national technology were developed, after a number of revisions and improvements, such as development of radiation metering algorithm and radionuclide analysis algorithm, circuit design and prototype development, and approval tests by nation's testing institutes.

2. Components of Digital Radiation Monitoring System

The recently developed Digital Radiation Monitornig System is divided into the PIG/PI Monitor which monitors gas system's gas radiation and the Liquid Monitor that monitors liquid system's liquid radiation within nuclear power plants. Each monitor consists of SKID and LCU. SKID is composed of Sampler including Detector, Purge, Valve, Pump, Flow Transmitter, Pressure Transmitter, and relevant pipes, while LCU includes Local Panel which receives signals from Detector and Transmitter and displays controlling, indicating and warning lamps.

2.1 PIG Monitor

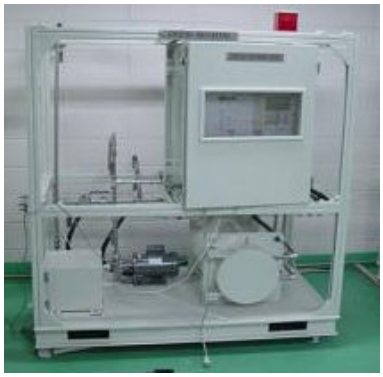
The PIG Monitor to monitor gas radiation meters β or γ of the gas in the duct or stack. It detects and measures β emitted from gas particles filtered through Moving Filter, while Iodine detects and measures Iodine γ from the gas filtered out at Particulate Filter before going to Sampler. LCU was designed and developed to implement monitoring and analysis at the same time, including radionuclide analysis module for automatic/manual radionuclide analysis



[Figure 1] Drawing of PIG Monitor

2.2 Liquid Monitor

The Liquid Monitor was designed to sample process-system liquid. It is equipped with Pump, Liquid Sampler, Flow Indicator and Inlet/Outlet Valve, in order to maintain a certain level of flow, while LCU controls Detector's signals and each monitor's operation and monitors the local conditions by sending displays, warings, alarms, lamps, radiaton levels and system status to Front Panel.

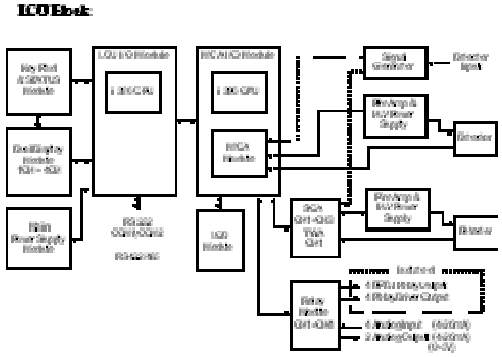


[Figure 2] Drawing of Liquid Monitor

3. Local Control Unit

3.1 LCU for High-functioning Auto Radionuclide Analysis

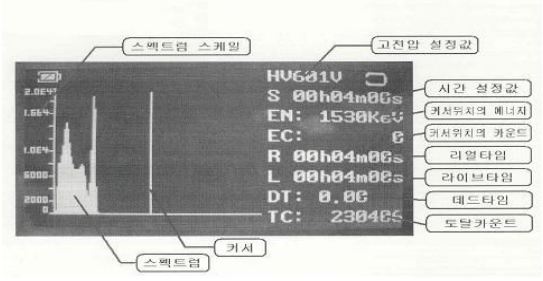
LCU, a metering controller for Digital Radiation Monitoring System, Composed of 12 electronic modules that implement each role, including the radionuclide analysis module, was designed for more precise measurement of radiation dosage and radionuclide analysis. It measure wave heights of electric pulses sent from the Detector, digitalises the values, displays radionuclide's radiation level, and seizes the actually-detected radionuclide, rather than merely measuring LCU's Particulate, Iodine or Gas Channel, through real-time data processing. It also automatically catches radionuclide corresponding to the radiation level metered along with a warning notice, and displays the metered radiation level real time.



[Figure 3] Drawing of LCU

3.2 Radiation Monitoring/Radionuclide Analysis Interlocking Algorithm

The Interlocking Algorithm for real-time precise radiation detection and radionuclide analysis was developed as a result of thorough V&V processes over the whole development period for higher reliability in monitoring, and diverse security I/O algorithms were optimized. In addition, the monitoring algorithm optimized through division of the 3-phase operation system including Local, Remote and Test was developed.



[Figure 4] Radionuclide Analysis

4. Conclusion

This study aims at improvements in the radiation monitoring system within existing nuclear power plants and development of new systems providing higher security in the power plant. As an effort for localization of the monitoring systems with better performance and functions, diverse data about monitoring systems within each power plant was collected and utilized to understand the PIG Monitor's structure, and relevant studies were analyzed to catch potential problems in recently-used radiation monitoring systems. Based on those results, the Local Control Unit which enables automatic radionuclide analysis, not a mere local control, in the radiation monitoring systems of each nuclear power plant was designed and developed, and parts of the radiation monitoring system that can be localized, such as Moving Particulate Sampler, Iodine Gas Sampler, Liquid Sampler and Check Source, were diminished in the size. The LCU of existing radiation monitoring systems, composed of Single Channel Analyzer, tended to give more warnings when ICRP-60 warning level proposed by the International Commission on Radiological Protection was applied, could not provide real-time measurement, and gave less precise measurement by not considering efficient spread factors for each radionuclide. In hope of addressing this problem, LCU was developed in connection with the automatic radionuclide analysis module in order to reinforce worker's convenience and precision in radiation measurement, and to comply with ICRP-60. Also, the developed system is expected to contribute to localization of key equipments in nuclear power plants, which enable radiation monitoring and automatic radionuclide analysis of the Digital Radiation Monitoring System manufactured abroad, after gaining higher reliability by passing diverse approval tests, including the environment test, electronic wave test and earthquake-resistance test by earthquake-resistance laboratory of the Korea Testing Laboratory and the Korea Electric Power Research Institute. In addition, it will bring huge effect corresponding to 40 billion won import through construction of power plants and substitution of equipments, and help in saving construction costs and reinforcing the capacity of national plants by providing 7 billion won costs necessary to maintenance and substitution for 7 years

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