Hybrid Control System for the ATLAS Facility

Seok CHO, Dong-Jin Euh, Bok-duk Kim, Ki-Yong Choi, *Hyun-Sik Park, Yeon-Sik Kim, Won-Pil Baek*
Korea Atomic Energy Research Institute, (150-1 Deokjin-dong) 1045 Daedeokdaero, Yuseong, Daejeon, 305-353, Korea, Tel:+82-42-868-2719, Fax:+82-42-868-8362, Email:scho@kaeri.re.kr

1. Introduction

A thermal-hydraulic integral effect test (IET) loop, advanced thermal-hydraulic test loop for accident simulation (ATLAS), has been constructed in the Korea Atomic Energy Research Institute (KAERI) [1]. For the data acquisition and control system, hybrid control system (HCS) was adopted to enhance the integrated performance of demanding process control application for acquiring of experimental data [2].

The whole feature of the data acquisition and control system consists of 1 set of the HCS for head-ware connection, 1 server station for signal processing schemes, 1 engineering work station (EWS) for control logics, and 3 operator interface station (OPS) for human-machine interface. The total number of signals for the data acquisition and the system control of the atlas facility is up to about 2010 channels, which are distributed in 16 chasses which are installed in 10 cabinets. The main focus of this paper is to present the technical configuration of the HCS of the atlas facility.

2. Configuration of the HCS

As a data acquisition and control system, the ATLAS facility adopted RTP 2300 HCS specifically designed for demanding process control applications. Hybrid design of the present system provides both the high-speed scanning features of a Programmable Logic Controller (PLC) while simultaneously supporting the complex control algorithms found in a Distributed Control System (DCS) [3]. Fig. 1 shows the H/W configuration of HCS [4].

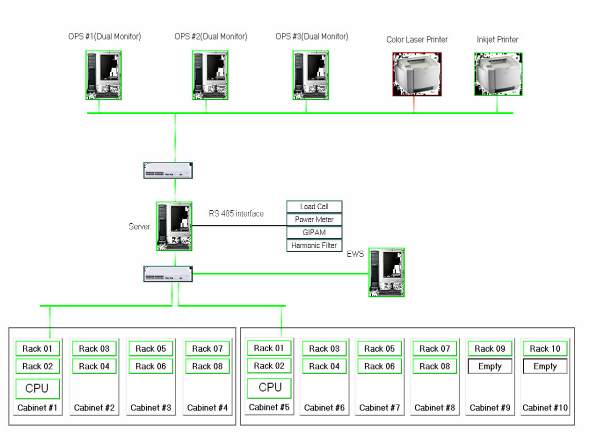

Fig. 1 Schematics of the Hybrid Control System of ATLAS facility

Two Intel-architecture embedded controllers, which include two redundant I/O communication channels that provide a secure high-speed Ethernet interface for a data transfer between the embedded controller and the common communication cards in the I/O chasses, are installed and divide the whole system into two parts such as target node-I and target node-II for the load-distribution as shown in Fig. 1.

All in-and-out signals of the embedded controller have been manipulated by the Server, which executes three main independent processes called 'DasComm', 'InputProcess', and 'RtCommManager'. DasComm receives data periodically at a interval of a maximum of 100 ms (10 Hz) and these data are updated to the common and shared buffer called DASBUFFER, which has the latest data received from the controllers of the HCS. InputProcess reads the DASBUFFER every second and sends the data to the database. RtCommManager provides the interfacial connection between the server program and the 3 Operator Stations (OPS).

Functional signal of the ATLAS facility consists of a measurement-based analog input signal and a control-based in-out signal such as an AO, DO, DI, and SR signal. The number of measurement-based analog input signals is up to 1,236 at present. The control-based in-out signal is assigned for an individual control of working devices such as pumps, valves, and heaters and for a monitoring of the status including alarm and fault signals of the related devices.

3. Human Machine Interface (HMI)

For the Human-Machine Interface (HMI), 3 OPSs and an EWS are connected to the HCS and located in the control room of the ATLAS facility. Moreover, these stations including the Server station are inter-connected with each other to enhance the operating performance of the HMI system.

The primary function of the EWS is to download new or modified control logic to each CPU of two target nodes. Other function is to serve as a data transfer station for the Engineering Simulator, the objective of which is to compare the measured principle parameters with the calculated corresponding results of the MARS code. The other function of the EWS is to acquire GIPAM and GIMAC data by an RS485 serial communication protocol. The GIPAM and GIMAC signals are for an observation of the status of the main power control station and VCB (Vacuum Circuit Break) and ACB (Air Circuit Break).

The operating S/W of the HMI is ARIDES-PO of BNF technologies Co. based on LINUX Fedora 4 OS. The HMI display consists of 49 graphic displays and is categorized into 10 groups. Figure 2 shows one of the examples of the HMI display. The HMI display not only includes a graphic display of the system but also a data trend display. In the data trend display mode, the operator can choose a maximum of 10 parameters for a trend group and the maximum number of a trend group is up to 50. There are two kinds of trend groups such as a Real-Time-Trend for the real time data display of the selected parameters and HDSR for the previous long-term history display. For a loop test, sensor calibration and instrument status check, separate graphic displays are provided in the HMI display program.

For a control of working devices such as pump, valve, and heater in the facility, specifically designed pop-up consoles are adopted. By using these types of consoles, operators can control the working devices precisely and identify the status of the respective devices. The control mode and reference signals can be selected on the console.

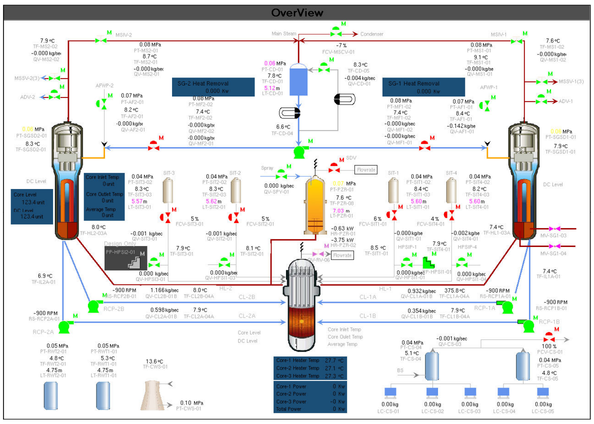

Fig. 2 Overview display as one of the HMI graphic displays of ATLAS

4. Signal processing Scheme

The measurement data of ATLAS has been categorized into three groups such as first-, second-, and third-order variables as shown in Fig. 3, which shows the signal processing scheme for the measurement-based AI signal. The first-order variable is that the EU (engineering unit) value can be calculated by using a linear fitting equation with the reference of density. To calculate the EU value of the second-order variable, a simple equation has to be used with density calculated from the steam table. Finally, the third-order variable has complicated and several-stage calculation logic. In the instrumentation of ATLAS, only the BDFT falls under this order of variables.

In the present system, the measurement input signals are transferred as mA and they must be converted to usable engineering units. Different equations must be used depending on the type of instruments and the location of the instrument. The number of experimental data files is up to 21 including “NPA_display” file for a comparison of the MARS’ results.

5. Conclusions

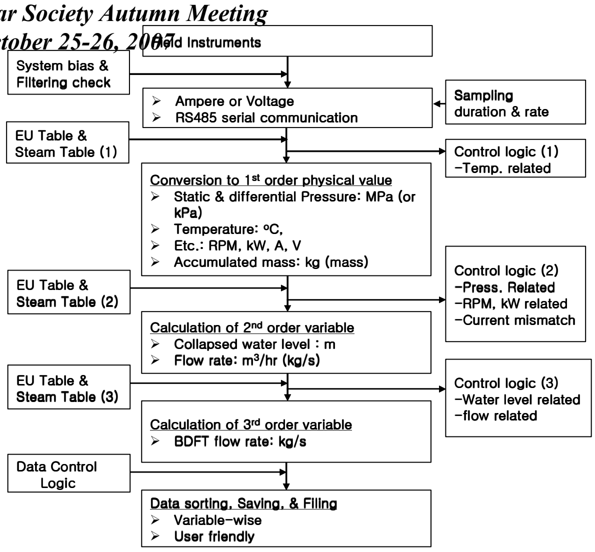

Fig. 3 Schematic diagram of signal processing

Descriptions of the data acquisition-control system and instrumentation of the ATLAS facility have been presented in this paper. To enhance the system’s performance for a process control and data acquisition, the Hybrid Control System (HCS) was selected as the data acquisition and control system. The whole feature of the data acquisition and control system consists of 1 set of the HCS, 1 Server Station for the signal processing schemes, 1 Engineering Work Station (EWS), and 3 Operator Interface stations (OPS) for a Human-Machine Interface (HMI).

From the experience obtained from several preliminary tests, the data acquisition and control system will be further updated in the near future to make it more effective than its present status.

REFERENCES

1. W.-P. Baek, C.-H. Song, B.-J. Yun, T.-S. Kwon, S.-K. Moon, S.-J. Lee, “KAERI integral effect test program and the ATLAS design,” *Nuclear Tech.*, ***152***, pp. 183~195, 2005.

2. B.-J. Yun, et al., “Instrumentation and Measurement method for the ATLAS test facility,” Technical report, KAERI/TR-3336/2007, 2007.

3. RTP Co. “RTP technical manuals – User guide,” 1995

4. S. Cho, et al., “Description on the signal processing system of ATLAS facility,” Technical Report, KAERI/TR-3334/2007, 2007.