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Design of Instrumentation and Control System for ALTAS

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1. Introduction

The ATLAS(Advanced Thermal-hydraulic Test Loop for Accident Simulation) facility, which is a 1/2-height, 1/288-volume scaled and full-pressure test facility, has recently been constructed under the thermal-hydraulic integral effect test program by KAERI(Korea Atomic Energy Research Institute). [1] The ATLAS consists of a reactor vessel and a core simulator, two steam generators, a pressurizer, four main coolant pumps, the related reactor coolant system (RCS) piping, safety injection systems, and secondary system and auxiliary systems. Figure 1 shows the overview schematic display of HMI implemented in the ATLAS. This paper introduces the instrumentation and control system of the ATLAS facility. The operation procedure, control logics and transient test scenarios have been developed to use the analysis result analyzed by a multi-dimensional best-estimate thermal hydraulic code MARS 3.0. [2]

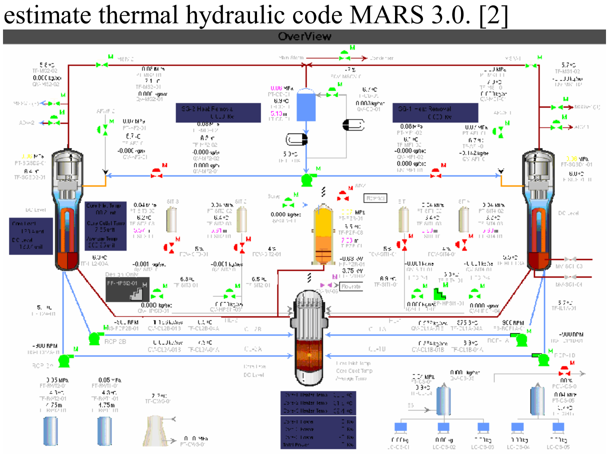

Figure 1 The Overview Schematic Display of ATLAS.

2. Configuration of Control Station

I&C system of the ATLAS is established with the hybrid distributed control system (DCS) supplied by RTP corp. The distributed system consists of HMI and Monitoring Server system, Control and Interlock Protection system, Data Acquisition, Storage and Retrieval system, Network system and Emergency Shutdown Panel. [3] Figure 2 shows a picture of the configuration of ATLAS Control Stations. The input/output modules are distributed in 10 cabinets and they are controlled by two CPUs. The raw signals from field are processed or converted to engineering units (EU) in the system server and the processed IO signals are controlled through HMI (Human Machine Interface) system by operators.


Figure 2 Configuration of ATLAS Control Stations.

3. Design of Measurement

For the measurement of the thermal hydraulic phenomena in the ALTAS facility, almost 2,000 instrumentations, such as 951 thermocouples, 404 analog input channels for pressure transmitters, differential pressure transmitters, flow meters, balances and power meters, 110 analog output channels for operation of pumps and heaters, etc are installed in ATLAS components. Among them, some special instrumentations including related measurement method were developed for the measurements of mass flow rates in the primary piping and break system. Table 1 represents the configuration of input and output channels. [4]

Table 1 Configuration of input and output channels.

항 목		모듈 수량	모듈당 채널수	공급 채널수
Analog Input	T/C	125	8	1,000
	전압/전류 입력	62	8	496
Analog Output		16	8	128
Digital	Input	22	16	352
	Output	13	16	208
Serial		4	8	32
합 계		238	-	2,216

4. Design of Control Station and HMI

The ARIDES software on a LINUX platform is provided by BNF Technology Inc. for HMI and control. In addition to almost 2,000 input and output channels, about 1500 logically derived IO signals are processed at 10Hz in ARIDES software. The Human-Machine-Interface (HMI) consists of 43 processing windows corresponding to fluid systems. Figure 3 shows the configuration of ATLAS Operator Stations, Server and Control Cabinets. There is an emergency control system in ATLAS for preventing the major hardware, pumps and heaters from failure in case of emergency. The emergency control system get running software protection by control logics and manual protection on the emergency panel. The monitoring system can display the real time trend or historical data of the selected IO signals on LCD monitors in a graphical form. The data logging system can be started or stopped by operator and the logging frequency can be selected among 0.5, 1, 2, 10Hz. The raw values as well as EU converted values are saved in the data logging system for processing and analyzing test data.

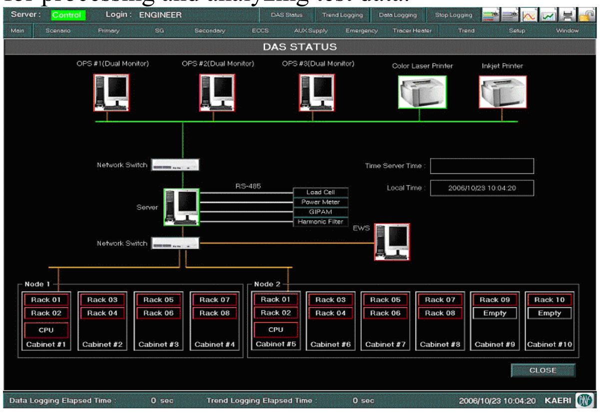

Figure 3 Configuration of Operator Stations and Control Cabinets.

5. Design of Control Logic

All control devices can be controlled by manual, auto, sequence, group, and table control methods. The control logics are distributed in the two RTP CPU, the system server and HMI. The control logics which directly control or protect the field control devices are installed in the RTP CPU. The sequence, group, and table control logics is applied for simulation of behavior of the major accident scenario of the APR1400/OPR1000. Figure 4 shows a display for control of analog output and table. Figure 5 shows data flow for scenario control. Flexible control logics which control and monitor sequential operation of the control devices are installed at the system server. They are based on the standard C++ program syntax and can be easily customized depending on user request. Flexibility is for implementation of the major accident scenario simulations of the APR1400/OPR1000 with the ATLAS facility. A little of control logics which are needed for communication between the system server (or RTP CPU) and the HMI are also installed at the HMI.

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[4] B.J.Yun, K.H.Kang, B.D.Kim,W.P.Baek, “Overall Instrumentations for the ATLAS Integral Effect Test Program”, *Transactions of the Korean Nuclear Society Autumn Meeting Busan, Korea, October 27-28, 2005*

Figure 4 Display for Control of Analog and Table

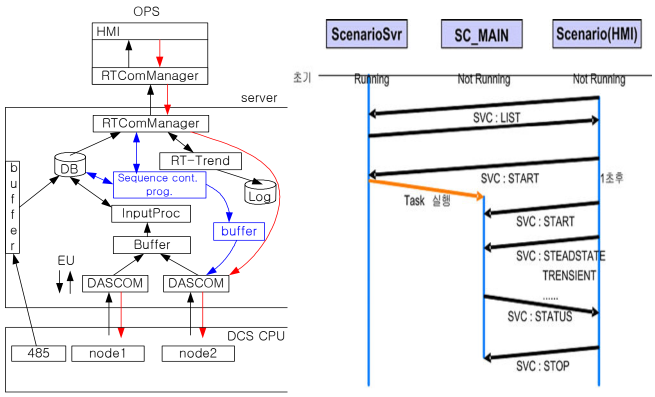

Figure 5 Data Flow for Scenario Control.