Transactions of the Korean Nuclear Society Spring Meeting
Chuncheon, Korea, May 25-26 2006

Control System for Cold Neutron Source

Sung Ho Ahn, Kye Hong Lee, Young Ki Kim, Hark Rho Kim
Development of Systems for Cold Neutron Source, Korea Atomic Energy Research Institute,
150 Deokjin-dong, Yuseong-gu, Daejeon 305-353, Korea,
shahn2@kaeri.re.kr

1. Introduction

The Cold Neutron Source (CNS), installed in the vertical hole of the reflector tank at the HANARO, is the facility in which thermal neutrons pass through liquid hydrogen at 20 K then are modulated down to cold neutron in the range of 0.1 and 10 meV. The control system of the CNS performs the control and monitoring functions for the CNS process systems as well as the shutdown function for the HANARO and the CNS main components. The normal operation of the CNS is performed in Operator Work Station (OWS) located at the reactor control room. The startup and shutdown operations are performed in the CNS instrumentation room. The OWS installed in the reactor control room are used for the integral operation of all facilities in the reactor as well as CNS facility.

2. Control System

The control system for CNS consists of a main control system, a shutdown panel system including shutdown related instruments, a helium refrigerator control system, field instruments system, and Radiation Monitoring System (RMS). The design classification of I&C system is given by Table 1. And the overall control system configuration is given by Figure 1.

Table 1. Design classification of control system.

System	Safety	Quality	Seismic
Main control system	NNS	T	Non
Shutdown control system (including shutdown related instruments)	NNS	T	Non
Helium refrigerator control system	NNS	S	Non
Field instruments	NNS	S	Non
Radiation monitoring system	NNS	S	Non

There are three operation modes for the CNS: (1) Shutdown, (2) Start-up, and (3) Normal operation. The control system has two system control modes: (1) Manual and (2) Auto. And there will be two permission modes: (1) Local and (2) Remote modes. Operation is performed in two locations, the reactor control room, the CNS instrumentation room in the reactor hall. The shutdown and start-up operation are done at the CNS instrumentation room via Manual-mode while the normal operation is done at the reactor control room via Auto-mode. There are several control systems to control the utilization facilities and reactor itself in the HANARO reactor. The OWS installed in the reactor control room are used for the integral operation of all facilities in the reactor as well as CNS facility. The main control system should communicate with the operator workstation in the reactor control room by using of same communication protocol.

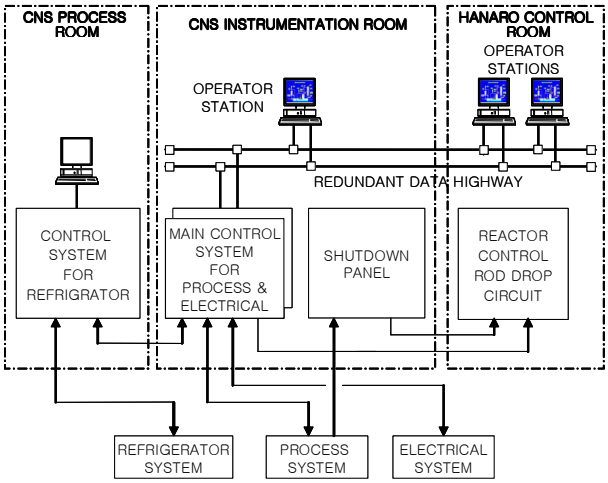

Figure 1. Overall configuration of control system.

2.1 Main Control System

The main control system uses a digitalized computer control system, which control and monitor all field signals from the various systems like the helium refrigerator system, the hydrogen moderator system, the vacuum system, the gas blanket system, the exhaust ventilation system, etc. The main control system has a shut down function which shut down the reactor and the CNS main components in case of some abnormal conditions in order to protect components or systems of CNS facility. .The control and monitoring system is the nuclear non-safety system and does not effect to the reactor safety in case of system failure. Most of the control functions are accomplished by the digitalized main control system by an automatic control mode. Manual mode is also provided for operational flexibility.

The main control system shall be a digitalized computer and have a powerful network function with other controllers. The main control computer system shall be duplicated for improving the operation reliability. While one control computer is operating, the other one shall be on hot standby mode. When a failure is detected in the operating server, all functions are transferred to the hot standby system. All the controllers and the Human Man Interface (HMI) systems are connected together by a redundant network system to constitute an integrated system. To support monitoring and data acquisition, data sever system is connected to the control network. Data sever system collects and saves the data and offers the retrieving function for trending and for servicing the internet application. Any computers can monitor the process and use saved data by the person who have permission to access. An active control selection function for the operator workstations should be equipped for preventing the duplicate control.

2.2 Shutdown Panel System

The shutdown panel system is to shut down the reactor in case of some abnormal conditions. The shutdown panel is composed of the relay devices and the trip units, which compare measured signals with setpoints and generate the reactor trip signals. The reactor shutdown signals are generated in both the shutdown panel and the main control computer system in order to have diversity in shutdown function. The measurement sensors and the transmitters are composed of the independent triple redundancy devices in the shutdown system. The shutdown logics in shutdown panel and the main control computer system are composed by 2 out of 3 coincidence logic in order to improve the reliability of the protective function. Figure 2 shows the logic for HANARO shutdown. The reactor trip signals caused by CNS facility are connected to the dropping device of the control absorber rod belonged to the HANARO Reactor Regulating System (RRS), which is classified the non-safety system. The state of the shutdown function is maintained until the operator recovers it manually.

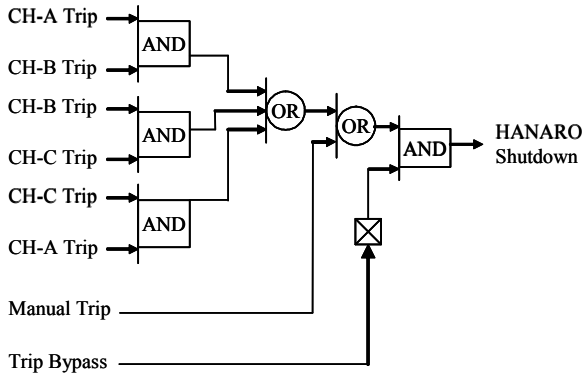

Figure 2. HANARO shutdown logic.

2.3 Helium Refrigerator Control System

An independent digital control system shall be provided for the control and monitoring of the helium refrigerator system by a refrigerator supplier. The main control system should communicate with the refrigerator control system by using of same communication protocol.

2.4 RMS System

The CNS RMS system measures and monitors the radiation of the cold neutron experimental building. The RMS system will be composed of the gamma detector (4ea), the neutron detector (2ea), the alarm unit, the local display unit, the digitalized RMS control computer, and the radiation monitoring software, etc. The CNS RMS is the nuclear non-safety system and does not effect to the reactor safety in case of system failure. However, the RMS server shall be duplicated for improving the operation reliability. While one RMS control computer is operating, the other one shall be on the hot standby mode. When a failure is detected in the operating server, all functions are transferred to the hot standby server. The RMS computer system is installed in the health physics room located in the cold neutron experimental building.

3. Conclusions

The control system for CNS consists of a main control system, a shutdown panel system including shutdown related instruments, a helium refrigerator control system, field instruments system, and RMS system. The CNS control system performs a control and monitoring function for the CNS process systems as well as a shutdown function for the HANARO and the CNS main components.

Acknowledgement

This research has been carried out as a part of the nuclear R&D program funded by the Ministry of Science and Technology in Korea.

REFERENCES

[1] S. H. Ahn, et al., “Instrumentation and control system design for cold neutron source in HANARO,” pp. 621-622, HANARO 2005, Daejeon, Korea, 2005.
[2] H. S. Jung, et al., “Basic design requirements for systems and facilities of HANARO cold neutron source,” KAERI/TR-2993/2005, 2005.
[3] B. S. Kim, et al., “Fundamental Design of systems and facilities for cold neutron source in the HANARO,” KAERI/TR-3126/2006, 2006.