# Development of Safety Related Control Panels for Fuel Test Loop

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## 1. Introduction

FTL (Fuel Test Loop) is a test facility which could conduct fuel irradiation test at HANARO reactor [1]. The maximum 3 fuel pins can be tested in the IR1 irradiation hole of HANARO under the commercial power plant operating conditions. The safety related control panels are used for controlling of the safety related FTL process systems and shutdown the HANARO reactor against the abnormal operating conditions. In this paper, a design and manufacturing of the safety related control panels is introduced.

## 2. Development of Safety Related Control Panels

### *2.1 FTL control system*

The FTL is composed of an IPS (In-Pile test Section) and an OPS (Out Pile system). The IPS is to be loaded into the IR-1 position in the HANARO core. The IPS can accommodate up to 3 fuel pins and has instruments such as thermocouple, LVDT and SPND to measure the fuel performances during the test. The OPS contains pressurizer, cooler, pump, heater and purification system which are necessary to maintain the proper fluid conditions. The application fields of the FTL are as follows.

- · Nuclear fuel irradiation behavior test at the operating condition of the commercial power plant.
- · Fuel burn-up and mechanical integrity verification.
- · Irradiation data generation for the analysis model
- · Technical improvement of design and fabrication for the advanced fuel development.
- · Fuel rod irradiation test for performance verification.

The overall control system configuration is shown in Fig. 1. The FTL control system is divided into the safety related control system and the non-safety control system [2]. The safety control system is composed of the safety related control panels such as the protection panels, the safety control panels, and the safety indicator panel [3]. The non-safety control system composed of FTL control system and data acquisition. The FTL control system controls the process systems of FTL and the data acquisition system collects the signals from in-pile instruments such as thermocouple, LVDT and SPND to measure the fuel performances during the test.

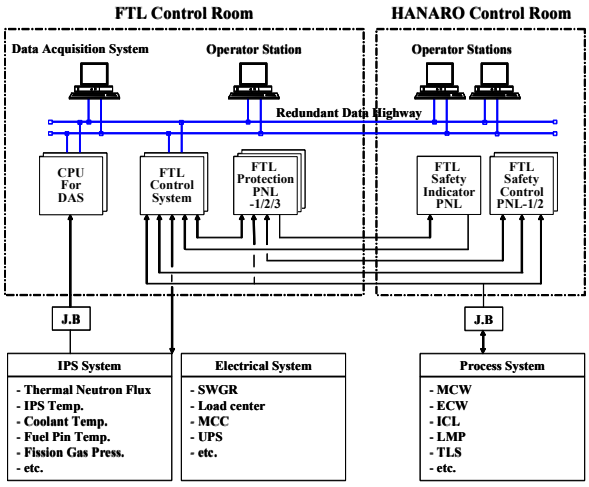


Fig. 1. Overall control system configuration.

### *2.2 Design of safety related control panels*

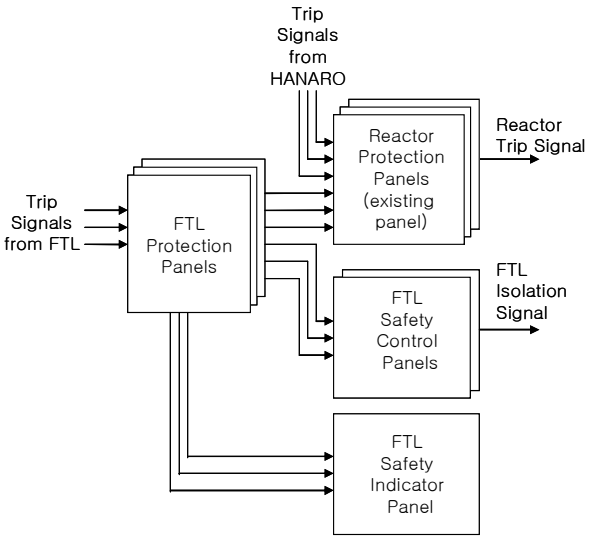


Fig. 2. Signal flow diagram of the safety related control panels.

The safety related control panels are clarified to Quality class “Q” and Seismic category “I”. The protection panels are installed in the FTL I&C Room located at the first floor of reactor hall. The safety control panels and the

safety indicator panel are installed in the HANARO control room. Fig. 2 shows the signal flow diagram of the safety related control panels. The safety related control panels were designed with following safety regulation of IEEE std-603 to ensure the system reliability.

- Single failure criterion
- Redundancy
- Independence
- Diversity
- Fail-safety design
- Manual initiation
- Channel checks
- Channel bypass
- Identification of protective action
- Interface with non safety related system
- Equipment qualification
- etc.

*2.3 Manufacturing of safety related control panels*

The safety related control panels were qualified by the IEEE std-323, Qualifying Class 1E equipment for nuclear power generating stations, and the IEEE std-344, Guide for seismic qualification of class 1E electric equipment for nuclear power generating stations.

The FTL protection panels composed of three channels receive signals from the corresponding field instruments, and generate the HANARO trip signal and the FTL shutdown signal if the measurement signal is exceeded the trip setpoint. The HANARO trip signals from the protection panels are interfaced with the corresponding channels of the HANARO RPS (Reactor Protection System) panels which generates the reactor trip signal. The HANARO RPS panels have the '2 out-of 3' local coincidence logic for reliability.

The main purpose of the safety control panels is to supply the emergency cooling water to remove the heat from test fuels after reactor shutdown. The safety control panels are composed of independent two panels, and have some manual switches and relays in each panel for controlling of safety related process systems. The safety control panels receive the trip signals from the protection panels when the transient excursions of the process condition from the IPS main cooling water occurred to unacceptable set point levels. The '2 out-of 3' concept is also applied to the safety control panels to satisfy the reliability of overall plant. If the any of above input signals come from the protection panels, The safety control panels automatically send the output command signals for safe cooling down the fuel temperature after HANARO shutdown.

The FTL safety indicator panel receives the following analog signals to supervise the vital process status in the HANARO control room together with the FTL control room. Fig. 3 shows the picture of FTL safety control panels and FTL indicator panel installed in HANARO control room.

Fig. 3. Picture of FTL safety control panels and FTL indicator panel.

## 3. Conclusion

A design and manufacturing of the safety related control panels for FTL was introduced. The panels were designed with the safety regulation of the IEEE std-603 and qualified by IEEE std-323 and IEEE std-344. This paper can be applied to the design and manufacturing of the safety related control panels in the nuclear facilities.

## 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.

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