

Commissioning and Operation Scheme of the HANARO FTL

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1. Introduction

According to the increasing demand for irradiation tests to develop new fuels, a 3-Pin FTL(Fuel Test Loop for 3 pin test fuel) facility has been installed to conduct in-core fuel performance tests at operating conditions in HANARO(Fig. 1). KAERI is performing the pre-operation to confirm the functional and performance requirements of the systems. The operation schemes and the procedures are developing to operate this facility in HANARO.

2. Commissioning and Functional Tests

The commissioning and testing of the loop is split into different categories as follows :

- manufacturing testing : tests performed by the manufacturer of equipment.
- component testing : tests performed on site to check the proper mounting of an equipment.
- instrumentation testing : tests performed on the instrumentation thermocouples, pressure and differential pressure transmitters including the calibration of the instrument.
- sub-assembly functional test, on-site calibration of level meters, on-site calibration of flow meters.
- safety tests : test for the verification of the proper working of the loop control command including the safety actions.
- functional tests :
 - . verification of the operation procedures
 - . test of equipments in actual process conditions
 - . debugging of equipments instrumentation and control
 - . test of alarms, safety actions with actual process
 - . adjustments of the process regulation parameters
 - . thermohydraulic behaviour

The functional tests are split into several phases. These phases are classified according to the conditions of the operation schemes. In the commissioning stage, all tests are performed without the IPS, so the temporary IPS is installed instead of the IPS. A flow adjustment of the control valves compensates for the different mass balance due to the temporary IPS.

3. Operation Scheme of the FTL

There are five steady state operation schemes in the loop operation. They are a loop shut down(LSD), cold stand-by 1(CS1), cold stand-by 2(CS2), hot stand-by(HSB) and a hot operation(HOP). The operation schemes are responded to the following works :

- well defined ranges of the parameter values
- required operation and availability of components
- allowed loading schemes of IPS
- allowed power level of the reactor
- allowed repair
- allowed test or maintenance work

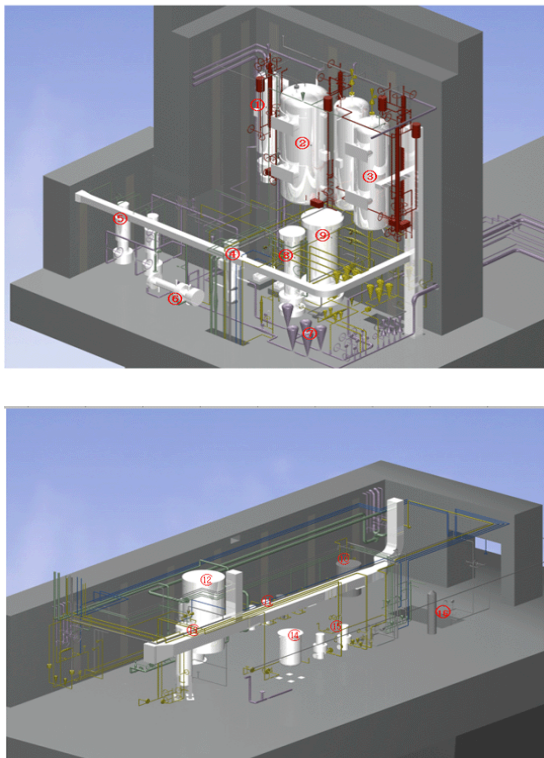
According to the operation schemes, the operation condition, the allowed repair, the maintenance work and the reactor power are specified. One steady state condition is followed by another steady state condition. In the LSD condition, the real fuel rod is unloaded, main cooling water pumps are in a shut down, and the pressurizer heaters are de-energized. The pressurizer shall be maintained at the minimum water level to avoid the gas accumulation. The LSD is the condition to perform the unloading/loading of the fuel rods. In the CS1 condition, the hydrazin is introduced to get rid of the residual dissolved oxygen. During the CS2 condition, the hydrazin can be added but is limited according to the main loop pressure. The HSB is the conditions to be obtained just before the reactor is operated. The pressure of the pressurizer is controled automatically to the normal value. The HOP is the extension of the HSB operation scheme, after the reactor has been started and when it is operated in steady state condition. The operation procedures are classified to the preparation, starting, steady state and shutdown procedures. There are groups and sequences of procedures according to the operation schemes. There are normally executable procedures and procedures that may be executed at any moment. The preparation procedures are the procedures that are to be carried out to bring the loop circuits from the initial empty condition to the loop shut down condition and back. The starting procedures are the procedures to be carried out to pass from a steady state operation scheme to another one which is nearer to the conditions required for the reactor start. The steady state procedures are the procedures that may be executed at any moment of the loop operation. The shut down

procedures are the procedures to be carried out to pass from a steady state operation scheme to another one which is nearer to the loop shut down conditions(Fig. 2).

When the alarms occur, the procedures of the automatic actions shall be performed. The automatic action procedures are possibly coupled with actions for the loop, for the reactor operation or for the confinement building accessibility. It has been considered that the interfacing between the loop procedure and the reactor procedure is important during the alarms were occurred.

There are some types of automatic actions triggered by the control systems of the loop :

- corrective actions
- reactor actions and coupled actions
- loop action
- building evacuation and associated actions.



No.	Equipment Name	No.	Equipment Name
①	Pressurizer	⑨	LMP Interchanger
②	Disposal Tank	⑩	Degasifier
③	Accumulator	⑪	Aux. Pumps
④	Main Cooler	⑫	ICL Cooler
⑤	Main Pump	⑬	Expansion Tank
⑥	Main Heater	⑭	Ion Exchanger
⑦	Isolation Valve	⑮	Filters
⑧	LMP Cooler	⑯	H2/N2 Gas Bombe

Fig.1 Equipments Arrangement of the FTL Facility

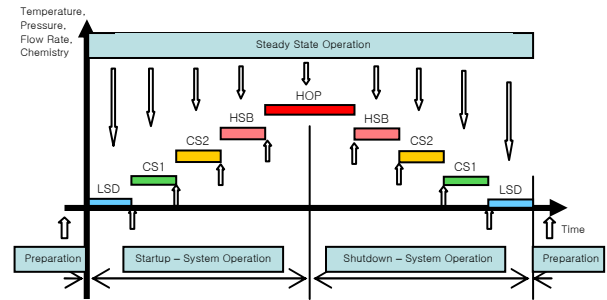


Fig.2 Relation between the operation schemes and the operation procedures

4. Conclusion

FTL(Fuel Test Loop for 3 pin test fuel) facility has been installed and is performing its pre-operation. During the commissioning, the functional and performance requirements of the systems are confirmed. The operation schemes and the procedures are developed to operate the FTL. The commissioning and functional tests of the loop are categorized in accordance with the operation schemes, which are a loop shut down(LSD), cold stand-by 1(CS1), cold stand-by 2(CS2), hot stand-by(HSB) and a hot operation(HOP). The operation schemes respond to the repair and maintenance works. When alarms occur, the procedures of the automatic actions shall be performed. The automatic action procedures are possibly coupled with actions for the loop, for the reactor operation or for the confinement building accessibility.

Acknowledgements

This work was performed under the Nuclear R&D Program of the Ministry of Science and Technology of Korea.

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