Automation of LP ECC for Wolsong 1

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1. Introduction

When low dousing tank level alarm comes in, the operator manually initiates Low Pressure (LP) injection. Valves PV1 and PV2 are selected open and once the valves are open, valves PV10 and PV11 are selected closed. Valves PV506#1 and 506#2 are selected open to supply cooling water to heat exchanger (HX1). Manual initiation of LP injection can cause human error resulting in ECC unavailable. To eliminate this kind of error, the Wolsong 1 ECC is required to be changed from Manual to Automatic LP injection similar to Wolsong 2 ECC.

2. Design Changes

In this section design changes for the automation of LP ECC are described.

2.1 Sensors

The present loop for LP injection consists of one differential pressure transmitter (63432-LT-8) and one indicator (63432-LI-8) with alarm unit. They provide the operator with the information for the dousing tank water level. Through the design change, the sensors are triplicated (63432-L8K, -L8L, -L8M) for the more reliable monitoring which are to be located in rooms R-007 and R-008 in the reactor building basement.

2.2 Reference Leg

The current transmitter "high" pressure line is connected to the dousing tank to sense level and the "low" pressure connection is vented to atmosphere at the dousing tank elevation. Since the transmitter is located in the reactor building basement and a dry reference leg connection is used, it is suppressed at the normal ambient temperature in the calibration of the instrument. Ambient change in temperature of the water in the high pressure measurement leg causes a shift in measured level and hence introduces an error in level measurement. This error terminates Medium Pressure (MP) ECC prematurely. To compensate the instrument line fluid temperature changes, the reference leg is converted from the dry type to the wet type which employs a seal pot with continuous make-up from the de-mineralized water system. Since the "high" and "low" pressure tubing follows the same route down to the transmitter room, change in ambient temperature affects both legs equally and any instrument line temperature effects on the measurement are canceled out. [7]

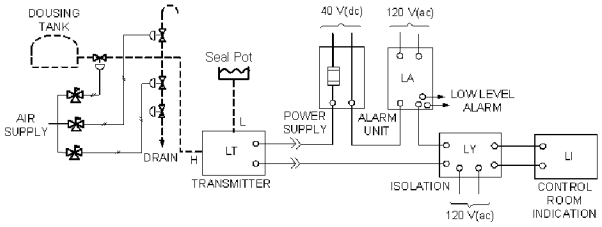


Fig. 1. Dousing Tank Level Measurement Loop

2.3 Logic Cabinet

Three seismically qualified drip proof cabinets, one per channel, are newly equipped for the automation of LP ECC and installed in the equipment room, S-327. The cabinet is designed in accordance with Reference [1]. The cabinet is used to mount 19 inch racks containing relay logic modules and cages, current alarm units, isolated signal transmitters and associated electronic hardware. The alarm unit in each cabinet generates trip signal upon the monitored signal exceeds the predetermined setpoint. This signal is transferred to the odd and the even cabinets and coincided with the signals from other two channels to initiate LP ECC.

2.4 Equipment for LP ECC

The following 12 valves are added or changed their operation type for the refurbishment for Wolsong-1 (see Figure 2) and automatically controlled by the signal of LP injection.

PV505#1/#2 and PV506#1/#2
Valves PV505#1 and PV505#2 are added to prevent a heat exchanger from corrosion due to the seawater (saltwater). These valves are normally closed and the pipe line is filled with the light water from the emergency water supply. PV505#1/#2 and PV506#1/#2 are normally closed and automatically opened during long term ECC operation.

PV10, PV11, PV162 and PV163
In the present ECC, if valve PV11 or PV10 is not closed due to any single failure during LP stage after completion of MP stage, the ECC pumps could be damaged by air flowed from spray tank. To minimize

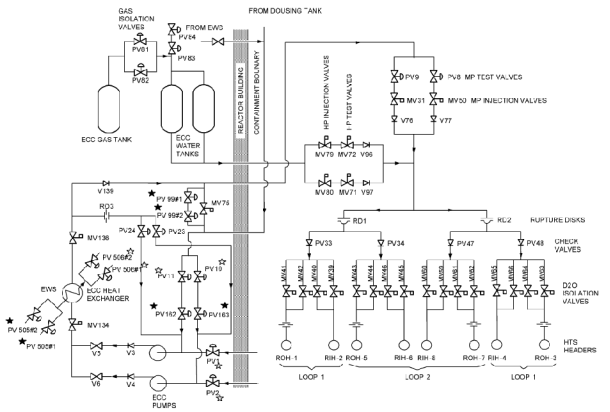
the possibility of this damage, redundant ECC spray tank isolation valves are installed. Valves PV162 and PV163 are installed at the downstream of valves PV11 and PV10, respectively. These valves (PV10, PV11, PV162 and PV163) are automatically opened during MP injection and closed upon receiving the LP ECC signal.

PV99#1 and PV99#2

During the LP ECC injection, the injection water partly could leak out to the spray tank through valve V99. In the result, the suction pressure of the ECC pump would be lost. To address this problem, manual valve V99 is changed to pneumatic, and redundant valves PV99#1 and PV99#2 automatically are closed before starting the LP injection.

PV1 and PV2

Valves PV1 and PV2 are automatically opened without operator action at the start of LP injection. Water collected in the basement sump is then recycled to cool the reactor core, form the sump through the primary heat transport system, and then back to sump through the break point.



★ : Newly added
☆ : Changed from Manual to Auto

Fig. 2. Emergency Core Cooling System (ECCS)

2.5 MCR Panel (PL3)

The following major equipment is installed on Panel 3 (PL3) in the MCR:

Equipment	Description	No.
Indicator	Dousing Tank Level (63432-LI-8K/8L/8M)	3
Window Tile	Alarm	9
Handswitch	Valves and Test Switches	12
Switch Module	Pushbutton for Test (PB346*, 348*~350*)	12
Indicator (EMI)	Valve Position (ZI**)	6

* : K/L/M

** : 99#1/#2, 505#1/#2, 162, 163

Table 1. Major Equipment to be installed on PL3

The alarms provide the operator with the poised, actuated and test status of equipment for the LP injection. Test switches and pushbuttons are installed for the operator to check component's integrity periodically.

2.6 Qualification Testing

The classification of ECC cabinet is safety. The seismic qualification testing is performed in accordance with References [2] and [5] to show its physical and functional integrity is maintained during and after the seismic event. The cabinet is tested under the EMI environment required by Reference [3] to prove its electromagnetic compatability. The environmental qualification testing is also taken in accordance with References [4] and [6].

3. Conclusions

As a result of the above design changes, more reliable ECC system will be equipped in Wolsong 1 and thereby alleviate operator's burden to initiate manual LP injection which cause a human error. However, because the original design concepts including test methods are maintained and analog system is adopted for the logics, the system becomes more complex and bigger system.

REFERENCES

[1] IEEE 603-1998, "Standard Criteria for Safety Systems for Nuclear Power Generating Stations".
[2] RG 1.100, Rev.2, 1988, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants".
[3] RG 1.180, Rev.1, 2003, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-related Instrumentation and Control Systems".
[4] IEEE 323-1983, "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations".
[5] IEEE 344-1987, "Recommended practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations".
[6] RG 1.89, Rev.1, 1984, "Environmental Qualification of Certain Electrical Equipment Important to Safety for Nuclear Power Plants".
[7] Engineering Instruction EI#381 Rev.01, W2/3/4 ECC Dousing Tank Level Measurement Correction, March 1998.