The Refurnishment for SDS No.1 Low Level Steam Generator Trip Instrumentation Redundancy for Wolsong Nuclear Power Plant Unit 1

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1. Introduction

The steam generator (S/G) low level trip for Wolsong Nuclear Power Plant Unit 1 provides protection against secondary side failures (e.g. feedwater or steam main breaks). Shutdown System (SDS) No. 1 is monitoring the level parameters for S/G No. 1 and 4. (SDS No. 2 is monitoring the level parameters for S/G No. 2 and 3.) This refurnishment is to add the S/G No. 2 and 3 level parameter on SDS No. 1 to improve the diversity and redundancy capability of Shutdown system.

2. The Details and Results

In this section, safety systems including SDS for Wolsong Nuclear Power Plant are described in advance, and the content and the details of the refurnishment are added.

2.1 Safety Systems

In the Canadian approach to reactor safety, for the purpose of safety assessment, all systems in the plant are categorized as either process or safety systems. Process systems are those required for normal operation, and the safety systems are those provided to limit any release of radioactivity that may follow failures in the process systems.

Process Systems	Safety Systems
Heat Transport	Shutdown System No. 1
Control	Shutdown System No. 2
Electrical Power	Emergency Core Cooling
Turbine	Containment System

SDS No. 1, as one of four special CANDU safety systems, uses an independent triplicated logic system, which senses the requirement for reactor trip and de-energizes the direct current clutches to release the spring assisted gravity drop shutoff rods. SDS No. 1 has nine neutron and process trip parameters. (Another refurnishment for the Moderator High Temperature is in progress, adding up to ten parameters.) The S/G Low Level Trip is one of ten parameters, and is designed to detect secondary side failures and provide a trip in time for at least 15 or 30 minutes of cooling.

2.2 The requirement

SDS No. 1 design should meet Canadian Nuclear Safety Commission (CNSC) Regulatory Document R-8, "Requirements for Shutdown Systems for CANDU Nuclear Power Plants". The requirement for this refurnishment is as follows:

CNSC Regulatory Document R-8, Section 3.4.2
The design shall have sufficient redundancy such that no failure of any single component of a shutdown system can result in impairment of that system to an extent that the system will not meet its minimum allowable performance standards under accident conditions.

CNSC Regulatory Document R-8, Section 3.5.1
As far as practicable, the shutdown systems shall be of diverse designs and shall be physically and operationally independent from each other, from process systems and from other special safety systems.

2.3 The boundary

The design philosophy being applied to the two shutdown systems is to keep them functionally and geometrically independent of each other and functionally independent of the regulating systems. This is achieved by the use of unique transmitter mounting racks, electrical cubicles and power supplies for each channel, and individual nozzle tap used to measure the level of the transmitter. Therefore, this refurnishment will be performed with independent facilities according to this design concept.

2.4 The contents

There are four steam generators in the Heat Transport (HT) system, two in each HT loop. If there is a break on the secondary side (e.g. feedwater or steam main breaks), all four steam generator levels will decrease. Level measurements from one S/G in each loop (i.e. S/G No.1 in loop 1 and S/G No.4 in loop 2) are provided for the SDS No.1 in the current design for Wolsong Unit 1. After this refurnishment is accomplished, level measurements from each of four S/Gs are provided for SDS No.1. This can be satisfied the requirement for CNSC Regulatory Document R-8.

Three sets of taps on each S/G are used for channels D, E, F which are independent from those used for the level control of the regulating system.

Each loop consists of level transmitter, A/I to Programmable Digital Comparators (PDC), indicating meter, signal isolator, and power supplies. In addition, pilot solenoid valves and instrument isolating valves are

provided for loop testing purposes. The transmitter, isolating valves and solenoid valves are located in instrument rooms. The signal is located in the control equipment room. The indicating meter is located on the main control panel (MCP). Fig. 1 shows Channel D loop diagram for S/G low level trip. Channel E and F consist of similar scheme except design of drain line.

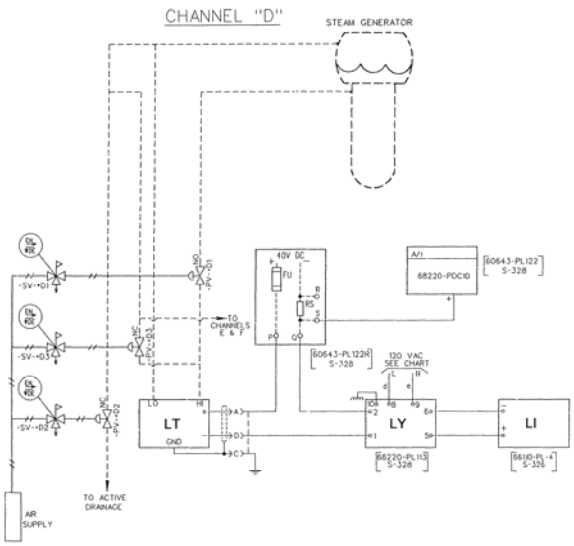
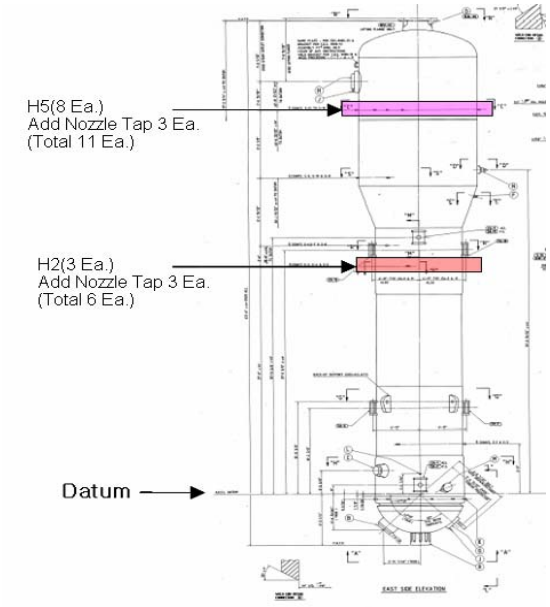


Fig. 1. SDS # 1 Steam Generator Trip Channel D Diagram

2.5 The details

. Install Nozzle Tap for Level Transmitter

Three newly nozzle tap for each S/G should be installed to meet the diversity requirement to the SDS No. 2. Actual location is referred to Fig. 2.



H5 : 46' 6-23/32" Height above the basis point (Datum)
H2 : 27' 6" Height above the basis point (Datum)

Fig. 2. Location of nozzle tap for measuring S/G level for Wolsong Unit 1

. Install Level Transmitter

Three newly level transmitters on S/G No. 2 and 3 respectively for SDS No. 1 should be installed.

. Design for signal isolation and MCP

Each loop includes signal isolator and indicator, annunciation and push button for the test. This will result in rearrangement for some facilities (indicator, switch).

. SDS No.1 trip logic complement

There are four level measurements per channel and each of these four signals is fed into PDC. If any one of the monitored levels is less than the setpoint, the PDC opens a single D/O to de-energized relay for a channel trip. (PDC facilities have revised to prepare for this refurnishment in 2002.) If any two channels indicate low S/G level, the reactor is tripped.

. Test logic

Test circuitry and relay logic for the test and monitoring of newly installed transmitter

3. Conclusions

This refurnishment can fully satisfy the requirement of CNSC Regulatory Document R-8, Section 3.4.2 and 3.5.1, and newly designed facilities will maximize the diversity and redundancy capability of Shutdown system.

REFERENCES

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