7.1S Site Specific Instrumentation and Control Platforms

This site specific supplemental section provides platform information for safety-related instrumentation and control (I&C) systems.

7.1S.1 Field Programmable Gate Array Based Platforms

The Reactor Trip and Isolation System (RTIS) and the Neutron Monitoring Systems (NMS), including the Local Power Range Monitoring (LPRM) system, the Average Power Range Monitoring (APRM) system, the Oscillation Power Range Monitor (OPRM) system, and the Startup Range Neutron Monitoring (SRNM) system are Non-Rewritable (NRW)-Field Programmable Gate Array (FPGA)-based systems.

Each FPGA-based system is a modular, chassis-based, rack-mounted system. FPGA-based systems are built as units, which provide the chassis and backplanes. The units perform specific functions, based on the modules placed in the backplane. Therefore, each module has unique architectural features, based on the differences in interfaces and requirements. The module design is implemented using only FPGAs. The design uses relatively simple medium-scale integrated (MSI) discrete logic chips for all simple logic functions, such as a monostable multivibrator to implement a watchdog timer. Data is transferred between units over fiber optic links.

Each module consists of one or more printed circuit boards and a front panel. The purpose of the front panel is to fix boards to the unit and to provide mounting for a Human-Machine Interface (HMI) and setpoints adjustment. The FPGA-based system also includes power supplies, analog and digital input/output modules, status modules, and all cabling and wiring necessary for operation. Each circuit board can contain one or more FPGAs.

The FPGA-based systems use logic chips that can be configured. The logic is physically embedded in FPGA chips using special tools. The logic is built from simple functional elements (FEs) that are designed to perform simple logic functions that can be combined and arranged in specific patterns to perform signal processing and logic operations, and thus construct the logic necessary to perform a defined function. Once the logic is embedded, the logic is hard coded and cannot be changed. After the logic is defined and embedded, the FPGA components are treated as hardware. Only an FPGA can implement digital logic.

The FPGA-based system has self-diagnostic functions that continuously verify proper FPGA and communications performance and provide outputs used to alert the operator.

7.1S.2 Microprocessor Based Platforms

The Engineered Safety Features Logic and Control System (ELCS) provides the instrument and control functions of automatic actuation and control, manual control, and display for the Engineered Safety Features (ESF) systems. The ELCS Controller subsystem is modular. A passive backplane connects individual module slots, which can house the controller module intra-division communication module, and input/output modules. Major elements of the ELCS include the following:

- Controller (including high speed serial link communications)
- Input/Output (I/O)
- Intra-division network communications
- Flat panel display
- Maintenance and test panel
- Power supplies
- Component interface and module

Sensors provide signal inputs to the Digital Trip Function (DTF) I/O that provide signal data acquisition and signal output capability for each division's DTF.

The DTF provides a comparison of signal inputs to associated setpoints, which determine the trip status for each ESF safety function. The DTF communicates trip status to the Safety Logic Function (SLFs) in each division by means of fiber optic based HSL communication links.

SLFs are provided in each of the three ESF divisions that provide electromechanical component actuation. Each division's SLFs receive ESF safety function actuation status signals from each of the DTFs in the four redundant divisions. The division's SLFs calculate ESF system level actuation status by determining whether there is a two-out-of-four coincidence of DTF ESF safety function trip signals.

In addition to the Class 1E actuation functions, ELCS provides the following safety-related support functions:

- Operator Human-Machine Interface (HMI) for display and manual component control. Each division contains a dedicated Operator HMI on the Main Control Panel and on the Large Display Panel.
- Maintenance and Test Panel (MTP), which provides the technician interface for periodic testing, surveillance, and maintenance. Each division of ELCS has a dedicated MTP. The MTP also provides a unidirectional, fiber optically isolated, output link to the non-safety systems.

The equipment includes self-diagnostics to detect hardware failures and problems with communication messages. These diagnostics typically indicate fault detection when the equipment communicates with the controller, such as when the controller communicates with an I/O module over the backplane to perform I/O.