# 7.0 CONTROL AND INSTRUMENTATION

## 7.1 SUMMARY DESCRIPTION

The control and instrumentation section presents the details of the more complex control and instrumentation systems in the plant. Some of these systems are safety systems; others are power generation systems.

### 7.1.1 Safety Systems

The safety systems described in the control and instrumentation section are given below.

a. Nuclear safety systems and engineered safeguards (required for accidents and abnormal operational transients):

   Reactor Protection System,

   Primary Containment Isolation System,

   Core Standby Cooling Systems Control and Instrumentation,

   Neutron Monitoring System (specific portions), and

   Reactor Vessel Instrumentation (specific portions), and Anticipated Transients Without SCRAM.

b. Process safety systems (required for planned operation):

   Neutron Monitoring System (specific portions),

   Refueling Interlocks,

   Reactor Vessel Instrumentation (specific portions), and

   Process Radiation Monitors (except Main Steam Line Radiation Monitoring System).

### 7.1.2 Power Generation Systems

The power generation systems described in the section are as follows.

Reactor Manual Control System,

Recirculation Flow Control System,

Feedwater System Control and Instrumentation,

Pressure Regulator and Turbine-Generator Controls,

Area Radiation Monitors, Main Steam Line Radiation Monitors,

Site Environs Radiation Monitors,

Health Physics and Laboratory Analysis Radiation Monitors, and

Process Computer System.

### 7.1.3 Safety Functions

The major functions of the safety systems are summarized as follows.

1. Reactor Protection System

   The Reactor Protection System initiates an automatic reactor shutdown (scram) if monitored system variables exceed preestablished limits. This action limits fuel damage and system pressure and thus restricts the release of radioactive material.

2. Primary Containment Isolation System

   This system initiates closure of various automatic isolation valves in response to off-limit system variables. The action provided limits the loss of coolant from the reactor vessel and contains radioactive materials either inside the reactor vessel or inside the primary containment. The system responds to various indications of pipe breaks or radioactive material release.

3. Core Standby Cooling Systems Control and Instrumentation

   This subsection describes the equipment required for the initiation and control of the High Pressure Coolant Injection System, Automatic Depressurization System, Core Spray System, and the Low Pressure Coolant Injection System.

4. Neutron Monitoring System

The Neutron Monitoring System uses in-core neutron detectors to monitor core neutron flux. The safety function of the Neutron Monitoring System is to provide a signal to shut down the reactor when an overpower condition is detected. High average neutron flux is used as the overpower indicator. In addition, the Neutron Monitoring System provides the required power level indication during planned operation.

5. Main Steam Line Radiation Monitoring System

Deleted

6. Refueling Interlocks

The refueling interlocks serve as a backup to procedural core reactivity control during refueling operation.

7. Reactor Vessel Instrumentation

The safety function of the reactor vessel instrumentation is to provide input to the reactor protection system and the core standby cooling systems. This instrumentation also provides information for the operator to take manual actions in addition to the above mentioned automatic system actions during abnormal and accident conditions. In addition, during planned operations the reactor vessel instrumentation monitors and transmits information concerning key reactor vessel parameters to ensure that sufficient control of these parameters is possible.

8. Process Radiation Monitors (except Main Steam Line Radiation Monitoring System)

A number of radiation monitoring systems are provided on process liquid and gas lines to provide sufficient control of radioactive material release from the site.

9. (Deleted)

10. Anticipated Transients Without SCRAM

The design objective of the Anticipated Transients Without SCRAM (ATWS) is to provide an alternate means of bringing the reactor from full power operation (MODE 1) to a cold shutdown (MODE 4) condition independent of the normal means of shutdown. The ATWS design is intended to mitigate any abnormal operational transients, as defined in FSAR Section 1.4. The systems and equipment required by 10 CFR 50.62 for ATWS do not have to meet all of the stringent requirements normally applied to safety-related equipment. However, this equipment is part of the broader class of structures, systems and components important to safety.

### 7.1.4 Plant Operational Control

The major systems used to control the plant during planned operations are the following:

1. Reactor Manual Control System

   This system allows the operator to manipulate control rods and determine their positions. Various interlocks are provided in the control circuitry to avoid unnecessary protection system action resulting from operator error.

2. Recirculation Flow Control System

   This system controls the speed of the two reactor recirculation pumps by varying the electrical frequency of the power supply for the pumps. By varying the coolant flow rate through the core, power level may be changed. The system is arranged to allow for manual control (operator action).

3. Feedwater System Control and Instrumentation

   This system regulates the feedwater system flow rate so that proper reactor vessel water level is maintained. The feedwater system controller uses reactor vessel water level, main steam flow, and feedwater flow signals to regulate feedwater flow. The system is arranged to permit single-element (level only), three-element (level, steam flow, feed flow), or manual operation.

4. Pressure Regulator and Turbine-Generator Controls

   The pressure regulator and turbine-generator controls work together to allow proper generator and reactor response to load demand changes. The pressure regulator acts to maintain nuclear system pressure essentially constant, so that pressure-induced core reactivity changes are controlled. To maintain constant pressure, the pressure regulator adjusts the turbine control valves or turbine bypass valves. The turbine-generator controls act to maintain turbine speed constant, so that electrical frequency is maintained. The turbine-generator speed-load controls respond to load or speed changes. The turbine-generator speed-load controls can initiate rapid closure of the turbine control valves (coincident with fast opening of the bypass valves) to prevent excessive turbine overspeed in case of loss of generator electrical load.

5. Process Computer System (RWM)

   The process computer is provided to supplement procedural requirements for the control of rod worth during control rod manipulations during reactor startup and shutdown.

### 7.1.5 Definitions

The complexity of the control and instrumentation systems requires the use of certain terminology for clarification in the description of the protection systems. See additional definitions in Subsection 1.2, "Definitions."

1. Channel--A channel is an arrangement of one or more sensors and associated components used to evaluate plant variables and to produce discrete outputs used in logic. A channel terminates and loses its identity where individual channel outputs are combined in logic. See Figure 7.1-1.

2. Sensor--A sensor is that part of a channel used to detect variations in the measured power plant variable. See Figure 7.1-1.

3. Logic--Logic is an arrangement of relays, contacts, and other components that produces a decision output. See Figure 7.1-1.

4. Trip System--A trip system means an arrangement of instrument channel trip signals and auxiliary equipment required to initiate action to accomplish a protective trip function. A trip system may require one or more instrument channel trip signals related to one or more plant parameters in order to initiate trip system action. Initiation of protective action may require the tripping of a single trip system or the coincident tripping of two trip systems. See Figure 7.1-1.

5. Actuation Device--An actuation device is an electrical or electromechanical module controlled by an electrical decision output used to produce mechanical operation of one or more activated devices to accomplish the necessary action. See Figure 7.1-1.

6. Activated Device--An activated device is a mechanical module in a system used to accomplish an action. An activated device is controlled by an actuation device. See Figure 7.1-1.

7. Trip--A trip is the change of state of a bistable device which represents the change from a normal condition. A trip signal, which results from a trip, is generated in the channels of a trip system and produces subsequent trips and trip signals throughout the system as directed by the logic.

8. Setpoint--A setpoint is that value of the monitored plant variable which causes a channel trip.

9. Component--A component includes those items from which the system is assembled (e.g., resistors, capacitors, wires, connectors, transistors, switches, springs, pumps, valves, piping, heat exchangers, vessels, etc.).

10. Module--A module is any assembly of interconnected components which constitutes an identifiable device, instrument, or piece of equipment.

11. Incident Detection Circuitry--Incident detection circuitry includes those trip systems which are used to sense the occurrence of an incident. Such circuitry is described and evaluated separately where the incident detection circuitry is common to several systems.

12. Channel calibration, channel check, channel functional test, and logic system functional definitions are provided in Technical Specification Section 1.1.

7.1.6 Environmental Qualification of Electrical Equipment

Safety-related electrical equipment is capable of performing its safety-related function under environmental conditions associated with all normal, abnormal, and plant accident operation (See subsection 1.5).