7.19 ANTICIPATED TRANSIENT WITHOUT SCRAM

7.19.1 Design Objectives

The objective of the design is the mitigation of Anticipated Transient Without Scram (ATWS). 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. For BWR's, the required systems are Standby Liquid Control system, the Alternate Rod Injection portion of Control Rod Drive system and the Recirculation Pump Trip (RPT) system.

The ATWS/RPT-ARI system is designed to meet the requirements of 10 CFR 50.62 and NRC guidance (NRC Generic Letters 85-03 and 85-06), which require the following:

- the system must be diverse and independent of the Reactor Protection System (RPS), from sensor output to the final actuation devices,
- redundant scram air header exhaust valves, and
- designed to perform its functions in a reliable manner.

It is not required to be redundant, or to function during or after a seismic event, a design basis accident or a sense line failure.

The ATWS design is intended to mitigate any abnormal operational transients, as defined in FSAR section 1.4.

The BFN Standby Liquid Control system is described in section 3.8, and the ARI-RPT system is described in the following sections.

7.19.1.1 Alternate Rod Injection (ARI) Design Objectives

The performance objective for ARI is that rod insertion should be completed within one minute of initiation to preclude degradation of the fuel cladding, and should also be completed prior to scram discharge volume pressurization or fill.

7.19.1.2 Recirculation Pump Trip (RPT) Design Objectives

To automatically trip the reactor coolant recirculation pumps on conditions indicative of an ATWS.

7.19.1.3 Standby Liquid Control System (SLCS) Design Objectives

To provide a soluble boron concentration to the reactor vessel sufficient to bring the reactor from full power (MODE 1) to a cold shutdown (Mode 4) condition.

7.19.2 Design Bases

7.19.2.1 ARI Design Bases

1. The ARI function is initiated by high reactor vessel pressure or low reactor water level conditions. Setpoints to initiate ARI should allow the normal scram function to actuate first.

2. The scram air header should be depressurized in sufficient time that rod insertion following the ARI actuation signal occurs quickly enough that all rods will be fully inserted by the time the scram discharge volume (SDV) is full.

3. Rod insertion motion should be completed within sufficient time from ARI initiation for the safety considerations to be met.

4. Within thirty seconds following ARI initiation, the ARI function shall be capable of being reset, if automatic initiation signals have cleared, so that manual scram may again be attempted if it has been reset.

5. The ARI must be capable of functioning during loss of off-site power, but the power source is not required to be Class 1E. The power supply for ARI must be from non-interruptable power.

6. The ARI logic, circuitry and valves (and all other components, unless specifically excluded in 10CFR50.62 or elsewhere in this document) should be energize-to-trip.

7. The ARI system shall be diverse from the Reactor Protection System from sensor output to the actuation devices.

8. The ARI system shall have redundant scram air header exhaust valves.

9. The ARI system shall be designed to perform its function in a reliable manner.

7.19.2.2 RPT Design Bases

The reactor coolant recirculation pumps shall automatically trip on high reactor vessel pressure or low reactor water level conditions. The allowable value for the ATWS-RPT instrumentation functions are provided in Technical Specification Section 3.3.4.2. Nominal trip setpoints are specified in the setpoint calculations for the reactor vessel water level - low-low, (level 2) function and for the reactor steam dome pressure - high function.

7.19.2.3 SLCS Design Bases

To meet 10 CFR 50.62, the SLCS shall have the capability of injecting into the reactor pressure vessel a borated water solution at such a flow rate, boron concentration and boron-10 enrichment that the resulting reactivity control is at least equivalent to 86 gallons per minute of 13 weight percent sodium pentaborate solution at the natural boron-10 isotope abundance. ATWS analyses supporting unit operation up to 3952 MWt within the operating map shown in Figure 3.7-1 assume a flow capacity and boron content equivalent to 50 gpm of 8.7 weight percent and 94 atom percent Boron-10 enriched sodium pentaborate solution, which exceeds the requirements of 10 CFR 50.62.

7.19.3 Descriptions

An ATWS is an expected operational transient (such as loss of feedwater, loss of condenser vacuum, or loss of offsite power) which is accompanied by a failure of the Reactor Protection System (RPS) to shutdown the reactor. The ATWS rule 10CFR50.62 requires specific improvements in the design and operation of commercial nuclear power facilities to reduce the likelihood of failure to shutdown the reactor following anticipated transients, and to mitigate the consequences of an ATWS event.

7.19.3.1 ARI Description

The Alternate Rod Injection System (ARI) provides a path to reactor shutdown which is diverse and independent from the RPS. The ARI system consists of one three-way scram valve per trip system which will act to block control air upstream of the control rod drive system hydraulic control units (HCUs) while dumping the downstream side to atmosphere when an ATWS initiation signal is present for that train. Additionally, three vent valves in each trip system ensure a rapid blowdown of the air supply pressure to the HCU banks, as well as the scram discharge volume (SDV) vent and drain header branch. Loss of control air pressure to the HCUs causes control rod insertion by the control rod drive system.

7.19.3.2 RPT Description

The Recirculation Pump Trip (RPT) design will automatically trip the reactor coolant recirculation pumps under conditions indicative of an ATWS.

7.19.3.3 SLCS Description

The Standby Liquid Control System (SLCS) has the capability of injecting into the Reactor Pressure Vessel a borated water solution to bring the reactor from full power to a cold shutdown condition.

7.19.4 Design Evaluation

7.19.4.1 ARI Design Evaluation

Slave trip units in the Analog trip units provide the ATWS reactor low level trip at the Level 2 setpoint and the ATWS high reactor pressure trip. The trip setpoints are selected such that a Reactor Protection System (RPS) low level scram and high pressure scram will occur prior to reaching the ATWS initiation setpoints. A coincident trip of either two low levels, or two high pressures, causes a reactor scram by energizing one of two identical, independent trains of four alternate rod injection valves (one to block the air supply, two to vent the hydraulic control headers and one to vent the scram discharge volume drain and vent valve air header). This depressurizes the control air supply to the hydraulic control units which inserts the control rods independently of the reactor protection system.

The ARI system is designed to assure rod insertion within sufficient time to meet safety considerations. In order to meet this criterion, it is necessary for BFN to depressurize the scram air header as fast as possible. Therefore, several air dump valves as well as air supply block valves are installed on the air supply headers for the Control Rod Drive (CRD) Hydraulic System.

Within thirty seconds following ARI initiation, the ARI function is capable of being reset if automatic initiation signals have cleared, so that manual scram may again be attempted if it has been reset.

The ATWS ARI system is supplied power from the 250V DC RMOV Board which has battery backup. This provides a continuous, non-interruptable source of power, so that the ARI system can perform its function in the event of loss-of-offsite power. The power is isolated from the 1E source via safety-related isolation fuses.

All ARI logic, circuitry and valves are energize-to-function and are diverse from the RPS.

Additionally, depressurization of the scram valve operators are assisted by venting the air headers by two pairs of ARI vent valves. Each pair of vent valves are located close to each of the two HCU banks in order to minimize the depressurizing time of the scram air headers.

7.19.4.2 RPT Design Evaluation

The ATWS RPT system utilizes the Monticello design where the end-of-life (EOL) breakers are used to trip the recirculating pumps. Two-out-of-two logic is utilized to prevent spurious trip signals. This design provides inputs to two class 1E breakers installed between each recirculation pump motor and its VFDs on Units 1, 2, and 3. These breakers receive trip signals from both the End of Cycle RPS RPT and the

ATWS RPT. Separation between the End of Cycle RPS RPT and the ATWS RPT is provided by separate trip coils. Physical separation is maintained between the ATWS RPT and the RPS RPT wiring via a separate terminal block in the 4160V RPT Board switchgear.

7.19.4.3 SLCS Safety Design Evaluation

(See FSAR Section 3.8, "Standby Liquid Control System")

7.19.5 Containment Cooling

The containment response to an ATWS was evaluated. The details are provided in Subsection 14.12.5.3. A loss of offsite power is the ATWS initiating event that is limiting regarding containment cooling. Following the postulated event, reactor vessel coolant inventory makeup would be accomplished with the HPCI system which takes suction from the condensate storage tank. Reactor vessel pressure control is accomplished with operation of the Main Steam Relief Valves (MSRVs). The steam discharge from the reactor vessel would be through the MSRV tailpipes directly to the suppression pool, with a resulting suppression pool water temperature increase. As discussed in Subsection 6.5.5.6, the NPSH analysis does not take credit for any containment pressure greater than that assumed to exist at the start of the postulated ATWS event.