7.4 Systems Required for Safe Shutdown

The information in this section of the reference ABWR DCD, including all subsections, tables and figures, is incorporated by reference with the following departures and supplements.

STD DEP T1 2.4-1 (Figure 7.4-2, 7.4-3)

STD DEP T1 2.14-1 (Figures 7.4-2, 7.4-3)

STD DEP T1 3.4-1

STP DEP 1.1-2

STD DEP 1.8-1

STD DEP 7.4-1

STD DEP 7.4-2

STD DEP 8.3-1 (Figures 7.4-2, 7.4-3)

STD DEP Admin (Figure 7.4-2)

7.4.1 Description

STD DEP 1.8-1

See Subsection 7.1.2.4 which addresses the design basis information required by Section ~~3~~4 of IEEE-~~279~~603.

7.4.1.1 Alternate Rod Insertion Function–Instrumentation and Controls

STD DEP T1 3.4-1

STD DEP 7.4-1

The alternate rod insertion (ARI) function is accomplished independently and diversely from the Reactor Protection System (RPS). ~~*Independent sensors (i.e., ECCS sensors) provide reactor trip signals, via the Recirculation Flow Control System (RFCS), both to ARI valves (part of the Control Rod Drive System) and to the Rod Control and Information System (RCIS).*~~ *The* Recirculation Flow Control System (RFCS) receives isolated, low reactor level signals from the four ESF Logic and Control System (ELCS) divisions from reactor level sensors and safety controller equipment separate from that used for the RPS low reactor level SCRAM function. The RFCS also receives redundant high reactor dome pressure status signals from the non-safety Steam Bypass and Control System. The low reactor level signals and high reactor dome pressure signals are used for the RFCS logic for automatic initiation of the ARI function. In addition, the reactor operator, using two dedicated switches located on the Main Control Room Panel, can initiate the ARI function manually. When the ARI function is activated, either automatically or manually, ARI activation signals are

provided to the ARI valves of the Control Rod Drive System and simultaneously to the Rod Control and Information System. Energization of the *ARI valves (separate from the scram valves), ~~cause~~* causes *reactor shutdown by hydraulic ~~scram~~* insertion *of the control rods. The RCIS, acting upon ~~the same ARI signals that are provided to ARI valves,~~* ARI initiation signals from the RFCS, *causes reactor shutdown by electromechanical ~~(i.e., through the usage of FMCRD motors)~~ insertion of control rods* using the FMCRD motors.

7.4.1.3 Reactor Shutdown Cooling Mode–Instrumentation and Controls

STD DEP T1 2.4-1

STD DEP T1 3.4-1

STD DEP 8.3-1

STD DEP Admin

(3) Power Sources

This system utilizes normal plant power sources. These include 4.16 kV *~~6900 VAC~~ for the pumps, 480 VAC/120 VAC instrument buses, and as backed up by DC sources. If for any reason the normal plant sources become unavailable, the system is designed to utilize the emergency buses and sources.*

(4) Equipment

If it is necessary to discharge a complete core load of reactor fuel to the fuel pool, a means is provided for making a physical intertie between the Spent Fuel Pool Cooling and Cleanup (SFPC) System and the RHR heat exchangers. This increases the cooling capacity of the SFPC System to handle the heat load for this situation. ~~The fuel pool intertie is applied only to Loops B and C (see Figure 5.4-10 for RHR System P&ID).~~

(9) Actuated Devices

All valves in the SDC ~~System~~ mode *are equipped with remote manual switches in the main control room. The only automatically activated modes of the RHR are the LPFL mode for the ECCS and the suppression pool cooling mode, as described in Subsections 7.3.1.1.1.4 and 7.3.1.1.4, respectively. Other modes of RHR are described in Subsection~~s *7.3.1.1.3 ~~and 7.3.1.1.4~~*.

(11) Testability

~~The logic is tested by automatic self test. The sixth test,~~ SSLC testing as *discussed in Subsection 7.1.2.1.6, is also applicable here for the reactor SDC mode function of RHR System.*

7.4.1.4 Remote Shutdown System

7.4.1.4.2 Postulated Conditions Assumed to Exist as the Main Control Room Becomes Inaccessible

STD DEP 8.3-1

(2) The plant is not experiencing any transient situations. Even though the loss of offsite AC power is considered unlikely, the remote shutdown panel or facilities are powered from the *Class 1E power system ~~buses E and F~~ so that backup AC power would be automatically supplied by the plant diesel generator. Manual controls of the diesel generator are also available locally.*

7.4.1.4.4 Remote Shutdown Capability Controls and Instrumentation–Equipment, Panels, and Displays

STD DEP T1 2.14-1

STD DEP T1 3.4-1

STD DEP 8.3-1

STD DEP Admin

*(1) **Main Control Room**–Remote Shutdown Capability Interconnection Design Considerations*

Some of the existing systems used for normal reactor shutdown operations are also utilized in the remote shutdown capability to shut down the reactor from outside the main control room. The functions needed for remote shutdown control are provided with manual transfer devices which override controls from the main control room and transfer the controls to the remote shutdown control. Control signals are interrupted by the transfer devices at the hardwired, analog loop. Process signals to the main control room are routed from the sensor, through the transfer devices on the remote shutdown panels, and then to the ~~multiplexing system remote multiplexing units (RMUs)~~ Remote Digital Logic Controllers (RDLCs) *for ~~transmission to~~* use in *the main control room. Similarly, control signals from the main control room are routed from the ~~RMUs~~*RDLCs*, through the remote shutdown transfer devices, and then to the interfacing system equipment. Actuation of the transfer devices interrupts the connection to the ~~RMUs~~* RDLCs *and transfers control to the Remote Shutdown System. Control of all necessary power supply circuits are also transferred to the remote shutdown system. Remote shutdown control is not possible without actuation of the transfer devices. Operation of the transfer devices causes an alarm in the main control room. The remote shutdown control panels are located outside the main control room. Access to this point is administratively and procedurally controlled.*

(4) Nuclear Boiler System

~~(c) The following function has transfer and control switches located at the Division 2 remote shutdown control panel: one air-operated relief valve. (The valve is 125 volt DC solenoid pilot operated.)~~

(7) Electrical Power Distribution System (EPDS)

(a) The following functions have transfer and control switches located on the Division I remote shutdown panel:

(i) ~~6.9 kV feeder breaker: Unit auxiliary transformer A to M/C E~~ Safety Bus A3 Breaker from UAT A

(ii) ~~6.9 kV feeder breaker: Reserve auxiliary transformer A to M/C E~~ Safety Bus A3 Breaker from RAT A

(iii) ~~6.9 kV feeder breaker: Emergency diesel generator A to M/C E~~ Safety Bus A3 Breaker from Emergency Diesel Generator A

(iv) ~~6.9 kV feeder breaker: Combustion turbine generator to M/C E~~ Safety Bus A3 Breaker from Bus CTG3

(v) ~~6.9 kV load breaker: M/C E to P/C E20~~ Safety Bus A3 Breaker to P/C E20

(vi) 480V feeder breaker: TR to P/C E20

(b) The following functions have transfer and control switches located on the Division II remote shutdown panel:

(i) ~~6.9 kV feeder breaker: Unit auxiliary transformer B to M/C F~~ Safety Bus B3 Breaker from UAT B

(ii) ~~6.9 kV feeder breaker: Reserve auxiliary transformer A to M/C F~~ Safety Bus B3 Breaker from RAT A

(iii) ~~6.9 kV feeder breaker: Emergency diesel generator B to M/C F~~ Safety Bus B3 Breaker from Emergency Diesel Generator B

(iv) ~~6.9 kV feeder breaker: Combustion turbine generator to M/C F~~ Safety Bus B3 *Breaker* from Bus CTG3

(v) ~~6.9 kV load breaker: M/C F to P/C F20~~ Safety Bus B3 Breaker to P/C F20

(vi) 480V feeder breaker: TR to P/C F20

(c) ~~A 6.9 kV M/C (E,F)~~ A 4160V voltmeter is provided on RSS panels A,B, respectively.

~~(8) Flammability Control System (FCS)~~ Not Used

~~(a) The following FCS equipment function has transfer and control switches located on both remote shutdown panels as indicated:~~

~~(i) Valve (cooling water inlet) B~~

7.4.2 Analysis

7.4.2.1 Alternate Rod Insertion Function

7.4.2.1.1 General Functional Requirements Conformance

STD DEP 7.4-1

STD DEP Admin

The Recirculation Flow Control System (RFCS) includes the logic for both automatic initiation and manual initiation of the ARI function. When the RFCS initiates the ARI function, related ARI activation signals are provided to the ARI valves of the CRD system and to the Rod Control and Information System for activation of the ARI motor run-in function.

Upon initiation of the ARI function, the RFCS logic assures that the activation signals for the ARI valves will remain continuously energized sufficiently long to assure that the time-delayed, rapid hydraulic insertion of the control rods will occur by depressurizing the scram valves of the CRD hydraulic control units. This provides for a diverse means of hydraulic insertion of the control rods from the normal Reactor Protection System (RPS) initiated scram hydraulic insertion function.

The alternate rod insertion (ARI) motor run-in *function is accomplished by the Rod Control and Information System (RCIS) and the Fine-Motion Control Rod Drive (FMCRD) Subsystem. This function provides an alternate method of driving control rods into the core which is diverse from the hydraulic ~~scram system~~*insertion functions*.*

~~The RCIS and the active run-in function of the FMCRD motors~~ The RFCS, the ARI valves and the FMCRD components associated with the motor run-in function of the CRD System, and the RCIS *are not required for safety; nor are these components qualified in accordance with safety-related criteria. However, the FMCRD components associated with hydraulic scram are qualified in accordance with safety criteria.*

The ARI design is in full compliance with the design considerations cited in NEDE~~-31906~~ 31096*-P-A (Reference 7.4-1).*

7.4.2.1.2 Specific Regulatory Requirements Conformance

STD DEP 1.8-1

STD DEP 7.4-1

STD DEP 8.3-1

(1) 10CFR50.55a (IEEE-~~279~~603)

With regard to IEEE-~~279~~603, Section ~~4.7~~5.6.3, signals ~~which interface between ARI and RPS are optically isolated such that postulated failures within the ARI controls cannot affect the safety-related scram function.~~ from safety system equipment that interface with the non-safety system equipment that implements the ARI function (e.g., the low reactor water level status signals provided to the RFCS) are optically isolated so that failure of the non-safety equipment that implements the ARI function cannot affect any safety-related function.

The RCIS logic has been designed such that ~~a~~ the only *single failure~~,~~* that *~~only in the inverter controller part of a given rod logic,~~ may result in insertion failure of that rod when the ARI function is activated* is the failure of the logic and individual local control equipment (e.g., stepping motor driver module or rod brake controller) associated with FMCRD motor movement of one control rod*. Also, two manual actions are required at the ~~dedicated operator interface panel~~* Main Control Room Panel *to manually initiate ARI.*

(3) Regulatory Guides (RGs)

(a) RG 1.75–"Physical Independence of Electric Systems"

In addition, each FMCRD inverter has current limiting features to limit the FMCRD motor fault current. ~~Continuous operation of all the FMCRD motors at the limiting fault current of the inverter shall not degrade operation of any Class 1E loads (i.e., the diesel generators shall be of appropriate design capacity).~~ Refer to Subsection 8.3.1.1.1 for additional description of design features incorporated for preventing degradation of operation of any Class 1E loads if a fault condition exists in the non-Class 1E equipment that provides power for the FMCRD motors.

There are three separate groups of non-1E drives with each receiving power from Division I Class 1E bus. Class 1E circuit breakers are used as isolation devices in accordance with IEEE-384. The breakers are designed to trip on fault current only and are not tripped for LOCA. ~~However, the breaker coordination is assured through the use of zone selective interlocks (ZSI) (Subsection 8.3.1.1.1).~~

The ~~ZSI feature~~ circuit protection coordination and testing of breakers *assures that the FMCRDs ~~power~~ breaker time-overcurrent trip characteristic for all circuit faults shall cause the breaker to interrupt the fault current prior to trip initiation of any upstream breaker. The power source shall supply the necessary fault current for sufficient time to ensure the proper coordination without loss of function of Class 1E loads. ~~The ZSI is a new technology which assures breaker coordination, and thus meets the intent of position C.1 of Reg. Guide 1.75.~~*

7.4.2.2 Standby Liquid Control System (SLCS) — Instrumentation and Controls

7.4.2.2.2 Specific Regulatory Requirements Conformance

STP DEP 1.1-2

STD DEP 1.8-1

STD DEP Admin

(1) 10CFR50.55a (IEEE-~~279~~603)

The SLCS design is similar to the GESSAR II design, except the explosive (squib) injection valves are replaced with motor-operated injection valves. It is designed to meet all applicable portions of IEEE-~~279~~603 as clarified above.

(3) Regulatory Guides (RGs)

As indicated in Paragraph (1), the SLCS is not required to meet the single-failure criterion (RG 1.53) since it is designed to be redundant (and diverse) from the control rod scram system. However, the two channels of active components assure that no single failure of these components will prevent the SLCS from accomplishing its ~~safety~~ boron injection function. Passive components which are not redundant include the boron tank, injection pipeline, etc.

(4) Branch Technical Positions (BTPs)

In accordance with the Standard Review Plan for Section 7.3 and with Table 7.1-2, only BTPs 21 and 22 are considered applicable for the SLCS. They are addressed as follows:

(a) BTP ICSB 21– "Guidance for Application of Regulatory Guide 1.47" The SLCS is not shared between units. ~~ABWR design is a single unit.~~ Therefore, Item B-2 of the BTP is not applicable. Otherwise, the SLCS is in full compliance with this BTP.

7.4.2.3 Reactor Shutdown Cooling Mode — Instrumentation and Controls

7.4.2.3.1 General Functional Requirements Conformance

STD DEP T1 3.4-1

STD DEP 1.8-1

STD DEP 7.4-2

The design of the reactor shutdown cooling mode of the RHR System meets the general functional requirements as follows:

(3) Alarms

The following system functional alarms apply to all modes of the RHR System and to each of the three RHR loops except as noted:

(f) ~~*RHR logic power failure*~~ELCS Out of Service*.*

(l) LPFL *Manual initiation armed.*

7.4.2.3.2 Specific Regulatory Requirements Conformance

STD DEP 1.8-1

(1) 10CFR50.55a (IEEE-~~279~~603):

~~A clarification should be made with regard to IEEE 279, Section 4.19.~~ *The parent RHR System annunciates activity at the loop level (i.e., "RHR LOOP A,B,C ACTIVATED"). However, the individual mode of the RHR System is not separately annunciated.*

Those portions of IEEE-~~279~~603 which relate to automatically initiated systems are not applicable to the manually actuated shutdown cooling mode of the RHR System. However, the system is designed in accordance with all other requirements of IEEE-~~279~~603 as described in Subsection 7.4.1.3.

7.4.2.4 Remote Shutdown System–Instrumentation and Controls

7.4.2.4.2 Specific Regulatory Requirements Conformance

STD DEP T1 2.14-1

STD DEP 1.8-1

(1) 10CFR50.55a (IEEE-~~279~~603)

The Remote Shutdown System (RSS) consists of two panels (Division I and Division II) which are located in separate rooms in the Reactor Building.

The RSS provides remote control capability as defined by the following interfaces:

System	Total Channels	RSS Interface
~~*Flammability Control System*~~	~~*B, C*~~	~~*B*~~

Separation and isolation is preserved both mechanically and electrically in accordance with IEEE ~~279~~603 and Regulatory Guide 1.75.

With regard to Paragraph ~~4.2~~5.1 of IEEE ~~279~~603 a single-failure event is assumed to have occured to cause the evacuation of the control room. The RSS is not designed to accommodate additional failures for all scenarios. The effects of such failures are analyzed as follows:

Other sections of IEEE ~~279~~603 which relate to testability of sensors, etc., are not applicable to the RSS of itself, but are applicable to the primary systems which interface with the RSS. All other applicable criteria of IEEE ~~279~~603 are met by the RSS.

7.4.3 References

STD DEP Admin

7.4-1 ~~*NEDE 31906 P A, A. Chung, "Laguna Verde Unit 1 Reactor Internals Vibration Measurement", February 1991.*~~ NEDE-31096-P-A, L. B. Claassen, et. al., Anticipated Transients Without Scram Response to NRC ATWS Rule, 10 CFR 50.62, February 1987.

The following figures are located in Chapter 21:

Figure 7.4-2 Remote Shutdown System IED

Figure 7.4-3 Remote Shutdown System IBD (Sheets 1-3)