7.4 SYSTEMS REQUIRED FOR SAFE SHUTDOWN

This section describes the instrumentation and control systems that are required to establish and maintain a safe shutdown condition for the reactor. In many cases these instrumentation and control systems are utilized in the performance of normal and emergency plant operations and as such are not exclusively utilized for the safe shutdown functions. Two kinds of shutdown conditions are addressed in this section: hot shutdown and cold shutdown. A hot shutdown is a condition in which the reactor is subcritical and the reactor and its cooling system are at or near power operating temperature. A cold shutdown is a condition in which the reactor is subcritical and the reactor and its cooling system cooled to or near temperatures convenient for major maintenance. In either case the reactivity control systems maintain a subcritical condition of the core. Technical Specifications give further details on both hot and cold shutdown conditions of the plant.

The instrumentation and control functions, which are required to be aligned for maintaining safe shutdown of the reactor, are also discussed in this section. These functions permit the necessary operations that:

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a) Prevent the reactor from achieving unplanned criticality in violation of the Technical Specifications.

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b) Provide an adequate heat sink such that design and safety limits are not exceeded.

7.4.1 DESCRIPTION

In order to achieve safe plant shutdown, controls and instrumentation are provided to allow the operator to actuate, control and monitor operation of systems and components necessary to bring the unit from full power operation to cold shutdown. Indications and controls required to monitor shutdown are provided on the Auxiliary Control Panel (LCP-43), located outside the control room. These indications and controls are duplicates of those found in the control room, and are shown in Tables 7.4-1 and 7.4-3. Process instrumentation available to the operator in the main control room which can be used to assist in assessing post-LOCA conditions is shown in Section 7.5, Table 7.5-1.

The following systems and equipment are the minimum required for safe shutdown of the reactor:

- Emergency Feedwater System (EFS)
- Atmospheric Steam Dump Valves
- Shutdown Cooling System (SDCS)
- Chemical and Volume Control System (CVCS), Boron addition portion
- Emergency shutdown from outside of the main control room

The following ESF support systems are also required to function:

- Component Cooling Water System

- Onsite Power System, including diesel generator system
- Heating, ventilating, and air conditioning systems (HVAC) for areas containing systems and equipment required for safe shutdown.
- Diesel Fuel Oil Storage and Transport System

Descriptions of the systems required for safe shutdown of the reactor are described in the subsections which follow. A description of the ESF support systems is provided in Section 7.3.

Instrumentation and control requirements for systems required for safe shutdown are identified in Tables 7.4-1 and 7.4-3.

The systems required for safe shutdown are not protective systems as defined by IEEE-279. Therefore, the design basis (Section 3) of IEEE-279 do not apply. Nevertheless, the system conforms to many of the requirements of IEEE-279 as described in Subsection 7.4.2.

The instrumentation and controls required for safe shutdown as described in this section meet the following design criteria:

a) The systems conform to the provisions of IEEE-308 (1971), "Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations".

b) Any single failure will not prevent safe plant shutdown.

c) Channel independence is maintained by electrical and physical separation between redundant channels.

d) The systems are designed to withstand design basis earthquake loads in combination with other loads as specified in Section 3.10 without loss of their safety functions.

e) Those systems which cannot be tested with the plant in normal operation can be tested during plant shutdown. A further discussion is presented in Section 7.1.

f) Equipment is provided in appropriate locations outside the main control room to bring the plant to a hot standby condition with potential capability for subsequent cold shutdown.

7.4.1.1 <u>Emergency Feedwater System (EFS)</u>

The Emergency Feedwater System (EFS) is described in Subsection 10.4-9. Automatic initiation of the Emergency Feedwater Actuation System (EFAS) is described in Section 7.3.

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7.4.1.2 <u>Atmospheric Dump Valves</u>

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The atmospheric dump valves (2MS-PM629A, 630B) are discussed in Section 10.3. The valves are located outside the containment upstream of the main steam isolation valves.

The valves are used to remove reactor decay heat from the steam generator in the event of

→(DRN 03-2061, R14)

loss of condenser cooling. They are also credited with reducing RCS pressure during certain small break LOCA scenarios, but not actuated by any ESFAS actuation signal. The decay heat is dissipated by venting steam to the atmosphere. In this way the reactor coolant system can be maintained at hot standby conditions or cooled down to 350°F. The design features of these valves are as follows:

←(DRN 03-2061, R14)

a) Initiating Circuits and Logic

→(DRN 03-1275, R13)

The valves are electro-pneumatically operated and are controlled automatically or manually from either the main control room by means of hand/auto indicating controllers (MS IPIC 0303 A1 & B1) located on the control panel, or from the auxiliary control panel (MS IPIC 0303 A11 & B11). An electro-pneumatic transducer converts the electronic control signal to a corresponding pneumatic pressure. The valves are designed to fail closed on loss of instrument air.

←(DRN 03-1275, R13)

The hand/auto indicating controllers also indicate the value of their valve position control signals.

b) Bypasses, Interlocks and Sequencing

No bypasses or interlocks are provided for atmospheric dump valves.

c) Redundancy and Diversity

→(DRN 99-0459, R9; 01-367, R10; EC-41355, R307)

The atmospheric dump valves are sized such that the reactor can be brought to hot standby assuming the loss of one valve. The control of these valves are safety related. In the event of loss of the non-safety related Instrument Air System, cooldown of the reactor to 350°F can then be accomplished through manual operation of the atmospheric dump valves. Each atmospheric dump valve has a handwheel which can be operated locally to override the actuator spring. Procedures are established for operating manual handwheel overrides or lining up backup air supplies for continued safety function after the 10 hour mission time of the safety related Nitrogen Accumulator.

←(DRN 99-0459, R9; 01-367, R10; EC-41355, R307)

→(DRN 03-2061, R14)

d) IEEE 279 and GDC Compliance

Because of the SBLOCA mitigation function, the ADVs meet the requirements of section 3 of IEEE 279-1971, and the applicable requirements of section 4 of IEEE 279-1971. In addition, they comply with the GDCs applicable to the ESFAS, including criteria 1, 2, 3, 4, 5, 10, 13, 19, 20, 21, 22, 23, 24 and 29."

←(DRN 03-2061, R14)

7.4.1.3 Shutdown Cooling System

The SDCS is discussed in Subsection 9.3.6. The system instrumentation and controls necessary to achieve plant shutdown are discussed below.

a) Initiating Circuits and Logic

→(EC-14765, R305)

The SDCS is designed to be manually initiated when the RCS temperature and pressure are reduced to 350°F and 377 psig. The shutdown cool interlocks prevent overpressurizing of the low-pressure portions of the SDCS as discussed in Section 7.6. The shutdown cooling suction line isolation valves (ISI-V1503A, V1504A, V1501B, V1502B, SI-4052A, SI-4052B) arrangement ensures that a single failure of an isolation valve will not preclude positive isolation at the boundary of the low pressure portion SDCS from the high pressure of the RCS.

←(EC-14765, R305)

The shutdown cooling flow indicator controller maintains a constant shutdown cooling rate of the core by adjusting the shutdown heat exchanger bypass flow, thus regulating the flow rate through the heat exchangers.

During abnormal or accident conditions the SDCS system will require a local/manual mode of operation. Refer to Subsection 9.3.6 for additional details.

Control board mounted process instrumentation is provided to enable the operator to determine system status and evaluate system performance. Control board mounted control switches and valve position indicating lights are provided for the shutdown cooling heat exchanger outlet and bypass valves. See Table 7.4-1 for a listing of instruments required to monitor safe shutdown.

b) Interlocks, Sequencing and Bypasses

The Shutdown Cooling System is provided with electrical interlocks to prevent the possibility of overpressurizing the low pressure portions of the system. An independent interlock is provided for each of the four shutdown cooling suction line isolation valves inside the containment. Pressurizer pressure is utilized to provide RCS pressure as an input to the interlock circuits. Each interlock prevents opening of its associated valve whenever RCS pressure equals or exceeds 377 psig. An audible alarm is sounded in the main control room when any SDCS isolation valve inside containment is not in the fully closed position when RCS pressure equals or exceeds 392 psia. The interlocks are discussed in Section 7.6.

c) Redundancy and Diversity

There are two SDCS suction lines, each possessing two isolation valves as shown in Figure 7.4-1.

There are four separate control circuits for these valves, two are associated with Channel A and the other two are associated with Channel B.

There are four power supplies for these valves, two ac and two dc divided into two redundant channels.

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Power supplies to the SDCS suction line isolation valves are so arranged that they meet the following objectives, assuming single failure as discussed in Table 7.4-2:

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1) Both lines are closed above a set pressurizer pressure thus protecting the low pressure side of the lines.

2) At least one line can be opened manually below a set (377 psig) pressurizer pressure.

d) Supporting Systems

The SDCS uses the low pressure safety injection pumps to maintain flow and rejects heat to the CCWS through the shutdown heat exchanger. The Class IE onsite power system provides power to the various electrical devices needed to support these systems. Either of the two LPSI Pumps in combination with the associated shutdown heat exchanger is sufficient for proper system operation.

7.4.1.4 Chemical and Volume Control System (CVCS), Boron Addition Portion

The boron addition portion of the CVCS is used in the shutdown and cooldown process. It may also be automatically started by SIAS. The CVCS is discussed in Subsection 9.3.4. The CVCS instrumentation and controls that are utilized to achieve plant shutdown are delineated below:

a) Initiating Circuits, Logic and Actuated Devices

To help achieve a safe shutdown, the system component actuation steps required are:

1) Safe cooldown requires coordinated control of the charging pumps to adjust and maintain the correct pressurizer water level and also requires periodic sampling and adjustment of the boron concentration to compensate for the temperature decrease and other variables until shutdown concentration is reached.

The charging pumps are used to inject demineralized water and concentrated boric acid into the RCS as required. With one pump normally in operation, the other charging pumps are automatically started by the pressurizer level control system as needed.

The boric acid concentration is controlled during shutdown and cooldown to compensate for reactivity changes associated with a decreasing coolant temperature or other variables to ensure that a sufficient shutdown margin is maintained. Concentrated boric acid is mixed with demineralized water and injected into the RCS to achieve the desired coolant concentration by means of feed and bleed via the charging and letdown systems. In an emergency condition, only the charging portion of the CVCS is required for safety injection or to bring the plant to a cold shutdown condition. Sufficient volume exists in the pressurizer at the time of initiation of reactor coolant system boration and cooldown. During cooldown, the shrinkage within the reactor coolant system will permit sufficient boration to ensure an adequate shutdown margin under cold conditions without the requirement for letdown.

Control board mounted instrumentation is provided to enable the operator to evaluate system performance and control system operation.

b) Interlocks, Sequencing and Bypasses

System operation is achieved by the coordinated operation of the charging pump and boric acid pump control circuits. The charging pump control circuit sequences charging pump operation in response to pressurizer water level control circuit requirements. The CVCS boration control circuits sequence the boric acid pumps and valves required to achieve the desired boric acid concentration. System bypasses are discussed in Subsection 9.3.4.

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If automatic control is lost, pressurizer level can be maintained by manual control of the level control system. Manual control of any portion of these systems can be achieved while allowing the remainder to continue functioning in automatic.

←

c) Redundancy and Diversity

Three separate charging pumps are provided. Two charging pumps and supporting instrumentation are powered from two separate Class IE buses. The third pump is powered from AB bus as described in Section 8.3. The charging pumps can take a suction from either the volume control tank, the boric acid makeup tank, or the refueling water storage pool to supply borated water to the RCS.

d) Supporting System

The boron addition and charging subsystems use portions of the CVCS as described in Subsection 9.3.4.

7.4.1.5 Emergency Shutdown from Outside the Control Room

In the event of a required evacuation of the main control room, the operator trips the reactor manually before he leaves. Selected controls and instrumentation for shutdown of the reactor are provided at the auxiliary control panel (LPC-43) located at elevation +21.00 ft. MSL outside of the main control room.

The transfer of control stations from the main control board to the auxiliary control panel is done manually by the means of transfer switches mounted on auxiliary panels. The auxiliary panels are located outside of the main control room, at elevation +35.00 ft. MSL.

When not in use, the auxiliary control panel is deenergized and isolated from the 120V AC/DC control circuits by means of open contacts of the transfer switches located on auxiliary panels.

An alarm will be initiated in the main control room whenever any one of the transfer switches is operated into the transfer position.

Sufficient instrumentation and controls are provided outside the main control room to:

a) Achieve prompt hot shutdown of the reactor.

b) Maintain the unit in a safe condition during hot shutdown.

c) Achieve cold shutdown of the reactor through the use of suitable procedures.

The auxiliary control panel is designed to seismic Category I requirements and is located in a seismic Category I area of the RAB. A list of indicators, and controls located on the auxiliary control panel is provided in Tables 7.4-1 and 7.4-3. Figure 7.4-2 shows the general arrangement of the auxiliary control panel.

Postulated conditions and/or events which result in evacuation of the main control room are not defined. However, it is assumed that these circumstances are not attended by destruction of any equipment within the main control room, and are not accompanied by any other design basis accidents.

The indicators on Auxiliary Control panel are powered with low energy signals of 0 to 1OVDC and are permanently connected to the primary measurement loops through electronic isolators. The electronic isolators along with the logic circuitry of the primary measurement loops are installed in the process analog control panels, which are located inside of the main control room.

Any credible failure of circuits to indicators on auxiliary control panel, such as; an open circuit, a short circuit, a ground or an application of a stray 120 AC/DC volts signal, will have no effect on performance of their primary measuring loops.

The auxiliary control panel (LCP-43) contains the minimum instrumentation and controls necessary to bring the plant to a cold shutdown condition.

All safety and non-safety related channels of control and instrumentation components within the auxiliary control panel are physically and electrically separated in accordance with the Regulatory Guide 1.75.

Failure of a component in one channel will not affect the operation of components in any other channel, and therefore will not prevent achieving and/or to maintain the plant in a safe Shutdown Condition.

7.4.2 ANALYSIS

7.4.2.1 Conformance to IEEE Standard 279-1971

IEEE Standard 279-1971, Criteria for Protection Systems for Nuclear Power Generating Station, establishes minimum requirements for the reactor protective and engineered safety features instrumentation and control systems. The instrumentation and controls associated with the systems required for safe shutdown are not defined as a protective system in IEEE Standard 279, however, many criteria of IEEE Standard 279 have been incorporated in the design of the instrumentation and controls for safe shutdown systems.

Conformance with the applicable portions of IEEE Standard 279, Section 4, is discussed in the following Subsections:

a) 4.1, General Functional Requirements

The instrumentation and controls of the system required for safe shutdown enable the operator to:

1) Determine when a condition monitored by display instrumentation reaches a predetermined level requiring action, and

2) Manually accomplish the appropriate safety actions

b) 4.2, Single Failure Criterion

The instrumentation and controls required for safe shutdown are designed and arranged so that no single failure can prevent a safe shutdown, even in the event of loss of offsite power. Single failures considered include electrical faults (e.g., open, shorted, or grounded circuits) and physical events (e.g., fires, missiles). Compliance with the single failure criterion is accomplished by providing redundancy of power supplies and actuation circuits, and by separating the redundant elements electrically and physically to achieve the required independence. Each of the provisions is discussed below:

1) Redundancy

Each of the systems required for safe shutdown consists of redundant subsystems and/or components for maximum system reliability. For suction isolation valves as shown in Figure 7.4-1 there are two 120 V ac motor operated valves and two hydraulically controlled valves, divided into two redundant channels SA and SB. Process cabinets are fed by four 120 V ac Class IE power supplies divided into four protective channels SMA, SHB, SMC, SMD. The redundancy provides assurance that the isolation of lines are not affected in case one complete channel is lost. Each of the redundant systems has automatic and/or manual actuation circuits that are separate from those provided for its redundant counterpart. Redundant instrumentation is provided to monitor Reactor Coolant conditions.

2) Electric Separation

Electrical separation is achieved through the provision of independent power supplies and the elimination of electrical interconnection between redundant elements. Control power for redundant circuits is fed from separate 125 V dc buses. Power for redundant pumps and valves is supplied from separate emergency diesel generators. Components designated A are part of electrical load group A and components designated B are part of electrical load group B. There is a third load group AB which may be electrically tied to group A or B and is used only when equipment replacement on A or B group is required. Electrical separation between the electrical load groups is discussed in Subsection 8.2.3.2.

The provision of separate power supplies and electrical connections for redundant circuits ensures that loss of power or electrical faults on any circuit cannot affect the redundant circuit.

3) Physical Separation

Protection against the possibility of mechanical damage to both redundant channels of any instrumentation and control system required for safe shutdown has been achieved by spatial separation and/or the provision of physical barriers between redundant elements.

Physical separation between redundant components within control panels is achieved by providing at least six in. of spatial separation or by providing a metal barrier. This separation is provided between control switches, controllers, relays and wiring.

Cable trays and conduit for redundant components are physically separated as discussed in Subsection 8.3.1.2.19.

The redundant cables associated with the instrumentation and control systems required for safe shutdown are marked and identified as described in Subsection 8.3.1.3.

The physical arrangement drawings of instrumentation inside and outside the containment is shown in Section 1.7.

c) 4.3, Quality Control of Components and Modules

The quality control enforced during design, fabrication, shipment, field storage installation, and component checkout used for instrumentation and control components required for safe shutdown, and documentation of quality control is consistent with the recommendation of Regulatory Guides 1.28 (6/7/72), 1.30 (8/11/72) and 1.38 (3/16/73).

d) 4.4, Equipment Qualification

The instrumentation and controls necessary to achieve safe shutdown are designed to operate in the design ambient conditions in the area in which they are located. Components located in the main control room, which is normally air conditioned, are designed to operate in the ambient conditions associated with loss of normal air conditioning for the time necessary to achieve safe shutdown. Environmental design and qualification of electrical and instrumentation equipment is discussed in Section 3.11. Seismic qualification and testing are discussed in Section 3.10.

e) 4.5, Channel Integrity

Preoperational testing and inspection are performed to verify that all components, automatic and manual controls, and sequences of the integrated systems provided for safe shutdown accomplish the intended design function and maintain its integrity within each channel.

f) 4.6, Channel Independence

Safe shutdown system channel independence is achieved by electrical and physical separation as described in Subsection 7.4.2.1.

g) 4.7, Control and Protection System Interaction

→(DRN 03-2061, R14)

The ADV setpoint can be monitored by the plant computer. This is a monitoring system, not a control system. The connection to the non-safety related plant computer meets applicable isolation requirements.

←(DRN 03-2061, R14)

h) 4.8, Derivation of System Inputs

The safe shutdown system monitoring signals are direct measures of the desired variables. Refer to Table 7.4-1.

i) 4.9, Capability for Sensor Checks

The safe shutdown system monitoring sensors are checked by comparing the monitored variables or by introducing and varying a substitute input to the sensor similar to the measured variable.

j) 4.10, Capability for Test and Calibration

The instrumentation and control components required for safe shutdown which are not normally in operation will be periodically tested. This includes instrumentation and controls for the Emergency Feedwater System, atmospheric dump valves, and emergency power system. All automatic and manual actuation and control devices will be tested to verify their operability.

k) 4.11, Channel Bypass or Removal from Operation

This section is not applicable.

1) 4.12, Operating Bypass

This section is not applicable.

m) 4.13, Indication of Bypasses

A description of bypass indication is provided in Section 7.5.

n) 4.14, Access to Means for Bypassing

This section is not applicable.

o) 4.15, Multiple Setpoints

This section is not applicable.

p) 4.16, Completion of Protective Action Once it is Initiated

This section is not applicable.

q) 4.17, Manual Initiation

The safe shutdown systems are manually actuated. No single failure will prevent the safe shutdown.

r) 4.18, Access to Setpoint Adjustments

→(DRN 03-2061, R14)

Adjustment of the ADV setpoint is administratively controlled. Access to setpoint adjustments is not applicable to other systems addressed in Section 7.4.

s) 4.19, Identification of Protective Actions

For the ADVs, protective action is confirmed by monitoring of SG pressure to mitigate a SBLOCA. Identification of protective actions is not applicable to other systems addressed in Section 7.4.

←(DRN 03-2061, R14)

t) 4.20, Information Readouts

All safe shutdown system monitoring and control channels are indicated in the main control room.

u) 4.21, System Repair

The safe shutdown systems are capable of being manually actuated; therefore, replacement or repair of instrument and control components can be accomplished in reasonable time when the systems are not actuated, or after shutdown as governed by administrative procedures. Outage of system components for replacement or repair will be limited by the Technical Specifications.

v) 4.22, Identification

All safety equipment and cables associated with the systems required for safe shutdown are marked in order to facilitate identification.

7.4.2.2 Conformance to the Requirements of AEC GDC 19

As described in Subsection 7.4.1.5 and Section 3.1 and auxiliary control panel is provided to achieve and maintain the plant in the hot standby condition in the event that the main control room must be abandoned. Adequate instrumentation is provided to enable operator control of equipment necessary to maintain Reactor Coolant System and secondary system pressure, temperature and levels.

7.4.2.3 Loss of Instrument Air Systems

→(EC-41355, R307)

Pneumatically operated valves in systems required for safe shutdown are designed to fail in the position required for safe system operation in the plant shutdown mode, except for the atmospheric dump valves which are fail closed, and the CCW Cross-Connect Valves, which fail open. Valves which are in required flow paths will fail open on loss of instrument air. The atmospheric dump valves may be opened by local manual means in the event of loss of air. The CCW Cross-Connect valves may be gagged closed by local manual means in the event of loss of air. Procedures are established for operating manual handwheel overrides or lining up backup air supplies for continued safety function after 10 hour mission time of the safety related motive gas accumulator. Valves which isolate nonessential portions of the system from portions required for safe shutdown are designed to fail close. Valve failure positions are shown on the systems P&I diagrams.

←(EC-41355, R307)

The pressurizer spray valves and auxiliary spray valves fail closed on loss of instrument air. Pressurizer pressure is controlled by operation of the electric pressurizer heaters, and over pressure is relieved by pressurizer safety valves. The valves in the charging line of the CVCS fail open.

The loss of instrument air system will not preclude the safe shutdown of the plant.

7.4.2.4 Loss of Cooling Water to Vital Equipment

None of the instrumentation and controls required for safe shutdown rely on cooling water for operation.

7.4.2.5 Plant Load Rejection, Turbine Trip and Loss of Offsite Power

→(DRN 03-2155, R13)
The control systems described in Section 7.6 and 7.7 are designed to preclude reactor trip under these conditions with the exception that there is a probability that the reactor may trip at power levels between 50% and 70% at certain times in core life (a trip is more probable at 70% power at Beginning of Cycle). However, in the event of loss of offsite power, power for safe shutdown may be provided by the onsite Standby (Emergency) Power System. The description and analysis of the Standby (Emergency) Power System are discussed fully in Section 8.3. The standby (emergency) diesel generators provide power for operation of pumps and valves. The station batteries provide DC power for operation of control and instrumentation systems required to actuate and control essential components.
←(DRN 03-2155, R13)

The standby (emergency) diesel generators automatically start and begin supplying power to components necessary to achieve safe shutdown. The station batteries maintain continuity of DC control power if offsite power is lost. The standby (emergency) power system is designed to meet the single failure criterion and withstand design basis natural phenomena. Adequate onsite emergency power is available to safely shutdown the plant under all plant design conditions assuming a single failure, in the event of loss of offsite power.

The consequences of a loss of offsite power envelope the consequences expected from plant load rejection and turbine trip. Therefore, analyses for these two postulated occurrences are not presented.

7.4.2.6 Diagrams

Logic diagrams, elementary wiring diagrams and instrument arrangement drawings for shutdown systems are included in Section 1.7.

Table 7.4-1 (Sheet 1 of 3) Revision 10 (10/99)

INDICATORS ON AUXILIARY CONTROL PANEL LCP-43

Item No.	Channel	Service	Range	Shutdown	
				Hot	Cold
C1	SMA	Steam Gen. No. 1 Pressure	0 - 1200 PSIA	X	X
	SMA	Steam Gen. No. 2 Pressure	0 - 1200 PSIA	X	X
C2	SMA	Steam Gen. No. 1 Level	0 - 100%	X	
	SMA	Steam Gen. No. 2 Level	0 - 100%	X	
C3	SMA	PZR Pressure (Wide Range)	0 - 3000 PSIA	X	X
C4	SMA	Neutron Flux	2×10^{-8} - 200% (log)	X	X
C5	SMA	Pressurizer Level	0 - 100%	X	X
C11	SMB	Steam Gen. No. 1 Pressure	0 - 1200 PSIA	X	X
	SMB	Steam Gen. No. 2 Pressure	0 - 1200 PSIA	X	X
C12	SMB	Steam Gen. No. 1 Level (Narrow Range)	0 - 100%	X	
	SMB	Steam Gen. No. 2 Level (Narrow Range)	0 - 100%	X	
C13	SMB	Pressurizer Pressure (Wide Range)	0 - 3000 PSIA	X	X
C14	SMB	Neutron Flux	2×10^{-8} - 200% (log)	X	X
C15	SMB	Pressurizer Level	0 - 100%	X	X
C42	SA	Steam Gen. No. 1 Pressure	0 - 1200 PSIA	X	
C43	SA	CCW Sys "A" Temp	50 - 130°F	X	X
	SA	Wet Tower "A" Basin Temp	30 - 110°F	X	X
C51	SB	Steam Gen. No. 2 Pressure	0 - 1200 PSIA	X	
C53	SB	CCW System "B" Temp	50 - 130°F	X	X
	SB	Wet Tower "B" Basin Temp	30 - 110°F	X	X

Item No.	Channel	Service	Range	Shutdown Hot	Shutdown Cold
C63	NS	Letdown Temp Regen Heat Exch Shell Outlet	100 - 500°F	X	X
C64	NS	Letdown Temp	50 -200°F	X	X
	NS	Letdown Flow	0 - 150 GPM	X	X
C65	NS	Volume Control Tank Level	0 - 100%	X	X
C66	NS	RCS Loop 1A Cold Leg Temp	500 - 650°F	X	X
	NS	RCS Loop 2B Cold Leg Temp	500 - 650°F	X	X
C67	NS	Cond B Vacuum Wide	0 - 30 IN HG.	X	
C68	NS	Boric Acid Tank A Level	0 - 100%	X	X
	NS	Boric Acid Tank B Level	0 - 100%	X	X
C69	NS	Charging Header Pressure	0 - 3000 PSIG	X	X
	NS	Charging Header Flow	0 - 150 GPM	X	X
C70	NS	Neutron Flux (Startup Channel)	1 - 10^5 Counts/ Sec (Logarithmic Scale)	X	X
C71	SA	Steam Gen. No. 1 Level (Wide Range)	0 - 100%	X	
	SA	Steam Gen. No. 2 Level (Wide Range)	0 - 100%	X	
C72	SA	Shutdown A (Loop 2) Temp	0 - 400°F	X	
	SA	Shutdown A (Loop 2) Flow	0 - 5500 GPM		X
C73	SA	Saturation Margin Temp	200 - 50°F (Subcooled-Superheat)	X	X
C74	SA	Hot Leg No. 2 Temp	50 - 750°F	X	X
	SA	Cold Leg No. 2A Temp	50 - 750°F	X	X

Table 7.4-1 (Sheet 3 of 3)

Item No.	Channel	Service	Range	Shutdown Hot	Shutdown Cold
C75	SA	Hot Leg No. 1 Pressure	0 - 3000 PSIA	X	X
	SA	Pressurizer Level	0 - 100%	X	X
C76	SB	Hot Leg No. 1 Temp	50 - 750°F	X	X
	SB	Cold Leg No. 1B Temp	50 - 750°F	X	X
C77	SB	Saturation Margin Temp	200 - 50°F (Subcool Superheat)	X	X
C78	SB	Shutdown B (Loop 1) Temp	0 - 400°F		
	SB	Shutdown B (Loop 1) Flow	0 - 5500 GPM		
C79	SB	Steam Gen. No. 1 Level (Wide Range)	0 - 100%	X	
	SB	Steam Gen. No. 2 Level (Wide Range)	0 - 100%	X	
C80	NS	Pressurizer Pressure	100 - 750 PSIA	X	X
	NS	Pressurizer Pressure	100 - 750 PSIA	X	X
C81	NS	Pressurizer Pressure	0 - 3000 PSIA	X	X
	NS	Pressurizer Pressure	0 - 3000 PSIA	X	X
C82	NS	Neutron Flux	$2x10^{-8}$ - 200% (Log)	X	X
	NS	Neutron Flux	$2x10^{-8}$ - 200% (Log)	X	X
C83	SA	Cond. Storage Pool Level	0 - 100%	X	
	SA	Steam Gen. No. 1 Emergency Feedwater Flow	0 - 800 GPM	X	
C84	SB	Cond. Storage Pool Level	0 - 100%	X	
	SB	Steam Gen. No. 2 Emergency Feedwater Flow	0 - 800 GPM	X	

TABLE 7.4-2 Revision 305 (11/11)

SDCS SUCTION LINE
VALVES ACTION ON LOSS OF POWER SUPPLY

→(DRN 99-0459; EC-14765, R305)

Channel	SI-651 & SI-4052A	SI-652	SI-665 & SI-4052B	SI -666
Loss of 480 VAC Channel SA	Not Affected	Fails as is	Not Affected	Not Affected
Loss of 125 VDC Channel SA	Automatically Closes	Not Affected	Not Affected	Not Affected
Loss of 480 VAC Channel SB	Not Affected	Not Affected	Not Affected	Fails as is
Loss of 125 VDC Channel SB	Not Affected	Not Affected	Automatically Closes	Not Affected
Loss of 125 VAC Channel MA	Not Affected	Fails as is	Not Affected	Not Affected
Loss of 125 VAC Channel MB	Not Affected	Not Affected	Not Affected	Fails as is
Loss of 125 VAC Channel MC	Fails as is(2)	Not Affected	Not Affected	Not Affected
Loss of 125 VAC Channel MD	Not Affected	Not Affected	Fails as is(2)	Not Affected

←(EC-14765, R305)
→(EC-935, R302) ←(EC-935, R302) [revision bars around Loss of 480 VAC Channel SA and Channel SB rows]

→(EC-935, R302)
(1) Deleted.
←(EC-935, R302)

(2) The valve will continue to full open position if loss of 125 VAC power occurs during the opening cycle.

←(DRN 99-0459)

TABLE 7.4-3 (Sheet 1 of 11)

CONTROL STATIONS ON AUXILIARY CONTROL PANEL LCP-43

Item No.	Channel	Service	Shutdown Hot	Shutdown Cold
A1	SMA	STEAM GEN PRESS PRETRIP (CH-A)	X	
A2	SMA	STEAM GEN PRESS TRIP SET POINT RESET (CH-A)	X	
A3	SMA	RPS/ESFAS PRESSURIZER PRESS PRETRIP (CH-A)		X
A4	SMA	RPS/ESFAS PRESSURIZER TRIP SET POINT, RESET (CH-A)		X
A5	SMA	RPS/ESFAS PRESSURIZER PRESS TRIP BYPASS (CH-A)	X	X
A6	SMA	RPS/ESFAS PRESSURIZER TRIP BYPASS KEY SW (CH-A)	X	X
A11	SMB	STEAM GEN PRESS PRETRIP (CH-B)	X	
A12	SMB	STEAM GEN PRESS TRIP SET POINT RESET (CH-B)	X	
A13	SMB	RPS/ESFAS PESSURIZER PRESS PRETRIP (CH-B)	X	
A14	SMB	RPS/ESFAS PRESSURIZER TRIP SET POINT RESET (CH-B)	X	
A15	SMB	RPS/ESFAS PRESSURIZER PRESS TRIP BYPASS (CH-B)	X	X
A16	SMB	RPS/ESFAS PRESSURIZER TRIP BYPASS KEY SW (CH-B)	X	X
A21	SMC	STEAM GEN PRESS PRETRIP (CH-C)	X	
A22	SMC	STEAM GEN PRESS TRIP SET POINT RESET (CH-C)	X	

TABLE 7.4-3 (Sheet 2 of 11) Revision 10 (10/99)

Item No.	Channel	Service	Shutdown Hot	Shutdown Cold
A23	SMC	RPS/ESFAS PRESSURIZER TRIP SET POINT RESET (CH-C)	X	
A25	SMC	RPS/ESFAS PRESSURIZER PRESS TRIP BYHPASS (CH-C)	X	X
A26	SMC	RPS/ESFAS PRESSURIZER TRIP CYPASS KEY SW (CH-C)	X	X
A31	SMD	STEAM GEN PRESS PRETRIP (CH-D)	X	
A32	SMD	STEAM GEN PRESS TRIP SET POINT RESET (CH-D)	X	
A33	SMD	RPS/ESFAS PRESSURIZER PRESS PRETRIP (CH-D)	X	
A34	SMD	RPS/ESFAS PRESSURIZER TRIP SET POINT RESET (CH-D)	X	
A35	SMD	RPS/ESFAS PRESSURIZER PRESS TRIP BYPASS (CH-D)	X	X
A36	SMD	RPS/ESFAS PRESSURIZER TRIP BYPASS KEY SW (CH-D)	X	X
A41	SA	S I TNK 1A ISOL VA 1SI-V1505 TK 1A (SI-614)	X	
A42	SA	S I TNK 2A ISOL VA 1SI-V1507 TK 2A (SI-634)	X	
→ A43 ←	SA	REFUELING WATER STORAGE POOL OUTLET VA 2SI-L103A		X

TABLE 7.4-3 (Sheet 3 of 11) Revision 305 (11/11)

Item No.	Channel	Service	Shutdown Hot	Shutdown Cold
A44	SA	RCS LOOP NO. 2 SHUTDOWN COOLING ISOL VA 1SI-V154A (SI-652)		X
A45	SA	STM GEN 1 EMERG FEEDWATER ISOL VA 2FW-V848A	X	
A46	SA	STM GEN 2 EMERG FEEDWATER ISOL VA 2FW-V849A	X	
A47	SA	RCS LOOP NO. 2 SHUTDOWN COOLING ISOL VA 2SI-V327A (SI-440)		X
→(EC-14765, R305) A48	SA	RCS LOOP NO. 2 SHUTDOWN COOLING ISOL VA 1SI-V1503A (SI-651 & BYPASS FILL VALVE (SI-4052A))		X
←(EC-14765, R305) A49	SA	LETDOWN STOP VA 1CH-F1516A/B (CH-515)	X	-
A50	SA	LETDOWN CONT ISOL VA 2CH-F1518A/B (CH-523)	X	-
A51	SA	LOW PRESSURE SAFETY INJ PUMP A		X
A52	SA	BORIC ACID PUMP A	X	X
A53	SA	BORIC ACID PUMP B	X	X
A54	SA	SHUTDOWN COOLING LINE A FLOW CONTROL VA 2SI-FM317A (SI-307)		X
A55	SA	SHUTDOWN COOLING LINE A TEMP CONTROL VA SI-FM318A (SI-657)		X
A56	SA	EMERGENCY BORATION VA 3CH-V112A/B (CH-514)	X	X
A57	SA	VCT MAKEUP VA 3CH-F117A/B (CH-512)	X	X

TABLE 7.4-3 (Sheet 4 of 11)

Item No.	Channel	Service	Shutdown Hot	Shutdown Cold
A58	SA	LOOP 2A LPSI FLOW CONTROL VA 2SI-V1541A2 (SI-635)		X
A59	SA	LOOP 2B LPSI FLOW CONTROL VA 2SI-V1543B2 (SI-645)		X
A60	SA	CHARGING PUMP A	X	X
A61	SA	COMPONENT COOLANT WATER PUMP A	X	X
A62	SA	DRY TOWER A FAN NO. 1	X	X
A63	SA	DRY TOWER A FAN NO. 2	X	X
A64	SA	DRY TOWER A FAN NO. 3	X	X
A65	SA	DRY TOWER A FAN NO. 4	X	X
A66	SA	DRY TOWER A FAN NO. 5	X	X
A67	SA	DRY TOWER A FAN NO. 6	X	X
A68	SA	DRY TOWER A FAN NO. 7	X	X
A69	SA	DRY TOWER A FAN NO. 8	X	X
A70	SA	DRY TOWER A FAN NO. 9	X	X
A71	SA	DRY TOWER A FAN NO. 10	X	X
A72	SA	DRY TOWER A FAN NO. 11	X	X
A73	SA	DRY TOWER A FAN NO. 12	X	X
A74	SA	DRY TOWER A FAN NO. 13	X	X
A75	SA	DRY TOWER A FAN NO. 14	X	X
A76	SA	DRY TOWER A FAN NO. 15	X	X
A77	SA	AUX COMPONENT COOLANT WATER PUMP A	X	X

TABLE 7.4-3 (Sheet 5 of 11) Revision 10 (10/99)

Item No.	Channel	Service	Shutdown Hot	Shutdown Cold
A78	SA	WET TOWER A FAN NO. 1 THRU FAN NO. 4	X	X
A79	SA	WET TOWER A FAN NO. 5 THRU FAN NO. 8	X	X
A80	SA	EMERG FEEDWATER PUMP A	X	
A81	SA	COMPONENT COOLANT WATER MAKEUP PUMP A	X	X
A82	SA	EMERG FEEDWATER PUMP TURB SHUTOFF VA 2M S-611A	X	
→ A83	SA	CEDM COOLING UNIT E-16 (3A)	X	-
A84 ←	SA	CEDM COOLING UNIT E-16 (3C)	X	-
A85	SA	CONT FAN COOLER AH-1 (3A-SA)	X	X
A86	SA	CONT FAN COOLER AH-1 (3C-SA)	X	X
A87	SA	CVAS FILTRATION UNIT E-23 (3A-SA)	-	-
A88	SA	CONTROL ROOM TOILET EXH FAN E-34 (3A-SA)	-	-
A89	SA	CONTROL ROOM AIR HANDLING UNIT AH-12 (3A-SA)	-	-
A90	SA	SHUTDOWN HEAT EXCH A OUTLET VA 3CC-F130A	-	-
A111	SAB	COMPONENT COOLANT WATER PUMP A/B	X	X
A112	SAB	CHARGING PUMP A/B	X	X
A121	SB	S I TNK 1B ISOL VA 1SI-V1506 TK 1B (SI-624)		X
A122	SB	S I TNK 2B ISOL VA 1SI-V1508 TK 2B (SI-644)		X

TABLE 7.4-3 (Sheet 6 of 11) Revision 305 (11/11)

Item No.	Channel	Service	Shutdown Hot	Shutdown Cold
A123	SB	REFUELING WATER STORAGE POOL OUTPUT VA 2SI-L104B	-	X
A124	SB	RCS LOOP NO. SHUTDOWN COOLING ISOL VA 1SI-V1502B (SI-666)		X
A125	SB	STEAM GEN 1 BACKUP EMERG FEEDWATER ISOL VA 2FW-V847B	X	
A126	SB	STEAM GEN 2 PRIMARY EMERG FEEDWSATER ISOL VA 2FW-V850B	X	
A127	SB	RCS LOOP NO. 1 SHUTDOWN COOLING ISOL VA 2SI-V326B (SI-441)		X
→(EC-14765, R305) A128	SB	RCS LOOP NO. 1 SHUTDOWN COOLING ISOL VA 1SI-V1501B (SI-665 & BYPASS FILL VALVE (SI-4052B))		X
←(EC-14765, R305) A129	SB	LETDOWN CONT ISOL VA 1CH-F2501A/B (CH-516)	X	-
A130	SB	LOW PRESS SAFETY INJ PUMP B		X
A131	SB	BORIC ACID GRAVITY FEED VA 3 CH-V106A (CH-509)	X	X
A132	SB	BORIC ACID GRAVITY FEED VA 3CH-V107B (CH-508)	X	X
A133	SB	SHUTDOWN COOLING LINE B FLOW CONTROL VA 2SI-FM348B (SI-306)		X
A134	SB	SHUTDOWN COOLING TEMP-LINE B CONR VAL 2SI-FM349B (SI-656)		X
A135	SB	VOLUME CONTROL TANK DISCH VA 2CH-V123A/B (CH-501)	X	-
A136	SB	LOOP 1A LPSI FLOW CONTR VA 2SI-V1549A1 (SI-615)		X

TABLE 7.4-3 (Sheet 7 of 11)

Item No.	Channel	Service	Shutdown Hot	Shutdown Cold
A137	SB	LOOP 1B LPSI FLOW CONTR VA 2SI-V1539B1 (SI-625)		X
A138	SB	CHARGING PUMP B	X	X
A139	SB	COMPONENT COOLANT WATER PUMP B	X	X
A140	SB	DRY TOWER B FAN NO. 1	X	X
A141	SB	DRY TOWER B FAN NO. 2	X	X
A142	SB	DRY TOWER B FAN NO. 3	X	X
A143	SB	DRY TOWER B FAN NO. 4	X	X
A144	SB	DRY TOWER B FAN NO. 5	X	X
A145	SB	DRY TOWER B FAN NO. 6	X	X
A146	SB	DRY TOWER B FAN NO. 7	X	X
A147	SB	DRY TOWER B FAN NO. 8	X	X
A148	SB	DRY TOWER B FAN NO. 9	X	X
A149	SB	DRY TOWER B FAN NO. 10	X	X
A150	SB	DRY TOWER B FAN NO. 11	X	X
A151	SB	DRY TOWER B FAN NO. 12	X	X
A152	SB	DRY TOWER B FAN NO. 13	X	X
A153	SB	DRY TOWER B FAN NO. 14	X	X
A154	SB	DRY TOWER B FAN NO. 15	X	X
A155	SB	AUX COMPONENT COOLANT WATER PUMP B	X	X
A156	SB	WET TOWER B FAN NO. 1 THRU FAN NO. 4	X	X

TABLE 7.4-3 (Sheet 8 of 11) Revision 10 (10/99)

Item No.	Channel	Service	Shutdown Hot	Shutdown Cold
A157	SB	WET TOWER B FAN NO. 5 THRU FAN NO. 8	X	X
A158	SB	EMERGENCY FEEDWATER PUMP B	X	
A159	SB	COMPONENT COOLING WATER MAKEUP PUMP B	X	X
A160	SB	EMERG FEEDWATER PUMP TURB SHUTOFF VA 2MS-612B	X	
A161	SB	CEDM COOLING UNIT E-16 (3B)	X	-
A162	SB	CEDM COOLING UNIT E-16 (3D)	X	-
A163	SB	CONT FAN COOLER AH-1 (3B-SB)	X	X
A164	SB	CONT FAN COOLER AH-1 (3D-SB)	X	X
A165	SB	CVAS FILTRATION UNIT E-23 (3B-SB)	-	-
A166	SB	CONTR FOOM TOILET EXHAUST FAN E-34 (3B-SB)	-	-
A167	SB	CONTR ROOM AIR HANDLING UNIT AH-12 (3B-SB)	-	-
A168	SB	SHUTDOWN HEAT EXCH B OUTLET VA 3CC-F131B	-	-
A191	NS	PRESSURIZER PROPORTIONAL HEATER BAN - 1	X	
A192	NS	PRESSURIZER PROPORTIONAL HEATER BANK - 2	X	
A193	NS	LETDOWN FLOW CONTROL VALVES 2CH-FM1536A/B (CH-110P) & 2CH-FM1535A/B (CH-110Q)	X	-

TABLE 7.4-3 (Sheet 9 of 11) Revision 10 (10/99)

Item No.	Channel	Service	Shutdown Hot	Shutdown Cold
A194	NS	VOLUME CONTROL TANK VENT VA 2CH-F185A/B (CH-513)	-	-
A195	NS	BORIC ACID MAKEUP CONTROL VA 3CH-FM172A/B (CH-210Y)	X	X
→ A196 ←	NS	LETDOWN BACK PRESS CONTROL VALVES 2CH-PM628A/B (CH-201P) & 2CH-PM627A/B (CH-201Q)	X	-
A198	NS	REFUELING WATER TO CHARGING PUMP VA 3CH-V121A/B (CH-504)	-	-
A202	NS	CONTROL RM CONFERENCE/ KITCHEN EXH FAN E-42 (3)	-	-
A203	NS	CONDENSATE DUMP VA 6CD-V352	X	X
A204	NS	CONT RM NORM & PURGE DAMPERS D-43, D-44, D-64 & D-67	-	-
A205	NS	CONT RM AREA NORM & PURGE DAMPERS D-45, D-46 & D-58	-	-
→ A207	NS	LETDOWN CONTROL VALVES POS INDICATION 2CH-FM1563A/B (CH-110P) & 2CH-FM1535A/B (CH-110Q)	X	-
A208	NS	LETDOWN CONTROL VALVES SEL POS INDICATION 2CH-FM1536A/B (CH-201P) & 2CH-FM1535A/B (CH-110Q)	X	-
A209 ←	NS	LETDOWN BACK PRESS CONTROL VALVES POS INDICATION 2CH-PM628A/B (CH-201P) & 2CH-PM627A/B (CH-201Q)	X	-

TABLE 7.4-3 (Sheet 10 of 11) Revision 10 (10/99)

Item No.	Channel	Service	Shutdown Hot	Shutdown Cold
→ A210 ←	NS	LETDOWN BACK PRESS CONTROL VALVES SEL POS INDICATION 2CH-P 628A/B (CH-201P) & 2CH-PM627A/B (CH-201Q)	X	-
A211	SA	CHARGING LINE TO RCS LOOP 1A SHUTOFF VA 1CH-E2503A	X	X
A212	SA	PRESSURIZER AUX SPRAY VA 1CH-E2505A	X	
A213	SB	CHARGING LINE TO RCS LOOP 2A SHUTOFF VA 1CH-E2504B	X	X
A214	SB	PRESSURIZER AUX SPRAY VA 1CH-E-2505B	X	
A215	SA	SHUTDOWN LINE "A" WARM UP VA 2SI-V353A		X
A216	SA	SHUTDOWN HEAT EXCH "A" ISOLATION VA'S		X
A217	SB	SHUTDOWN LINE "B" WARM UP 2SI-V346B		X
A218	SB	SHUTDOWN HEAT EXCH "B" ISOLATION VALVES		X
A219	SA	LPSI PUMP A MINIFLOW ISOLATION VALVE		X
A221	SB	LPSI PUMP B MINIFLOW ISOLATION VALVE		X
E1	SA	BACKUP EMERG FEEDWATER TO STEAM GEN 1	X	
E2	SA	PRIMARY EMERG FEEDWATER TO STEAM GEN 2	X	
E3	SA	MAIN STEAM ATM DUMP VA (VA 2MS-PM629A)	X	

TABLE 7.4-3 (Sheet 11 of 11) Revision 10 (10/99)

Item No.	Channel	Service	Shutdown Hot	Shutdown Cold
E4	SA	CCW TEMP CONTROL VA (TCV-CC7072A)	X	X
E11	SB	PRIMARY EMERG FEEDWATER TO STEAM GEN 1	X	
E12	SB	BACKUP EMERG FEEDWATER TO STEAM GEN 2	X	
E13	SB	MAIN STEAM ATM DUMP VA (VA 2MS-PM630B)	X	
E14	SB	CCW TEMP CONTROL VA (TCV-CC7072B)	X	X
→ E21	NS	PRESSURIZER PRESS CONTROL	X	-
E22	NS	PRESSURIZER LEVEL CONTROL	X	-
E23 ←	NS	LETDOWN BACKPRESSURE CONTROL	X	-