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SAFE - SHUTDOWN CAPABILITY ASSESSMENT AND PROPOSED MODIFICATIONS

10 CFR 50, APPENDIX R

R. E. GINNA UNIT NO. 1

ROCHESTER GAS AND ELECTRIC CORPORATION

ROCHESTER, NEW YORK

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1.0 INTRODUCTION

This report has been prepared in response to the requirements for fire protection of Ginna Station as expressed in 10 CFR Part 50.48 and Appendix R to 10 CFR Part 50. Consistent with the regulations, the current analysis does not take credit for fire detection or suppression systems currently installed nor for trained fire brigades in preventing damage to redundant shutdown equipment located in a single fire area.

This study is based upon an earlier fire protection safe shutdown report which was submitted to the NRC by letter from RG&E dated December 28, 1979. The study evaluates cable and equipment locations for equipment which could be used for plant shutdown. Both failure of the equipment to function when called upon and inadvertent operation have been postulated in order to address all possible scenarios. The pressure boundary integrity of valves, pumps, pump casings, pipes and tanks are assumed to be unaffected by postulated fires.

The report identifies the installation of a number of plant modifications including a remote shutdown control system to provide additional assurance of ability to bring the Ginna Station to a cold shutdown following an unmitigated fire within any fire area.

Abbreviations

AVT	-	All Volatile Treatment
CC	-	Component Cooling
CVCS	-	Chemical and Volume Control System
HVAC	-	Heating Ventilation and Air Conditioning
HX	-	Heat Exchanger
MAFW	-	Main Auxiliary Feedwater
MDP	-	Motor Driven Pump
MSIV	-	Main Steam Isolation Valve
MS	-	Main and Reheat Steam

PORV	-	Power Operated Relief Valve
RC System	-	Reactor Coolant System
RHR System	-	Residual Heat Removal System
RHRP	-	RHR Pump
RMW	-	Reactor Makeup Water
RWST	-	Refueling Water Storage Tank
RS	-	Remote Shutdown
RSCS	-	Remote Shutdown Control System
SBAFW	-	Standby Auxiliary Feedwater
SG	-	Steam Generator
SI	-	Safety Injection
SISP	-	SI System Pump
SW	-	Service Water
TAFWP	-	Turbine Driven Auxiliary Feedwater Pump

2.0 FIRE AREAS

In the submittal of December 28, 1979, the entire plant was divided into fire areas. Each building was assumed to be a separate fire area because they are separated by fire barriers or distance. Each floor within a building was examined individually and in many cases divided into smaller fire areas within the floor zone. In general, these areas were delineated by walls or column lines and were primarily designed to ease the gathering of data as to the contents of a given area. The fire areas are illustrated in the drawings which were previously submitted on December 28, 1979.

This study has employed the earlier fire zones in defining requirements for plant modifications including the addition of rated fire barriers to provide more formal separation between fire areas.

3.0 METHOD OF ANALYSIS

The information from all applicable plant circuit schedules was placed in a computer file. This information initially included the connected equipment, cable tray and conduit, but not physical location. The file was then supplemented with the physical location of the cable trays and conduit and was coded to indicate the associated fire zones. At this point it was possible for the computer to identify all systems and equipment which would potentially be affected by a fire in any particular fire zone. The computer also provided a cross-indexing by circuit schedule number of all fire zones that contained the circuit.

A systems analysis was then performed to determine the complement of equipment normally available to bring the plant to a safe (cold) shutdown condition. The equipment complement was then compared with the list of equipment which could potentially be affected by a fire in each zone. The equipment that could potentially be lost was then reviewed with respect to the consequences of actual fire effects. Conservative assumptions were made for fire induced effects on the circuits. Effects due to shorts, opens, and impressed voltages equal to the highest voltage carried in the tray system were evaluated and the "worst case" was used for the analysis.

The system level consequences of these circuit effects were then evaluated on a "worst case" basis. It was assumed that all active components (MOVs, solenoid-operated valves, circuit breakers, etc.) could fail in any position (state), or spuriously change state due to the fire. No credit was taken for physical separation within the fire zone although in many cases the physical separation exceeds the requirements of IEEE-384. Shutdown methods for each fire zone were then developed based on this analysis and recommendations for system functional modifications made.

A specific set of equipment hardware modifications is proposed to implement the recommended functional modifications. In cases where the design approach for a proposed modification has not been finalized, alternative approaches presently being evaluated are identified.

4.0 GENERAL SHUTDOWN METHODS

The following is a series of shutdown and cooldown methods that can be used at the Ginna Station to achieve cold shutdown. Both normal and abnormal general shutdown methods are presented. The abnormal methods reflect the unavailability of offsite power and/or major system elements (e.g., steam dump valves or the instrument air system). Section 4.0 does not address any restrictions on plant operation or access due to the effects of a fire; however, it establishes the baseline from which the fire-initiated shutdown scenarios were generated.

4.1 NORMAL SHUTDOWN AND COOLDOWN, OFFSITE POWER AVAILABLE

Turbine load and reactor power are reduced automatically at a prescribed rate dependent upon the rate selected on the E-H governor control. Normal boron addition may take place before and during load reduction. At 50 MW of generator load, the main feedwater valves are closed, one feedwater pump is removed from service, and the feedwater valve bypass valves are used for feedwater control. As generator load is removed, steam dump to the condenser is initiated and the "hot standby" condition is achieved.

If a faster power decrease is desired the reactor may be manually tripped. If the steam dump controller is set on auto, automatic steam dump will occur. If the steam dump controller is set on manual, steam pressure will be regulated. At this time all control rods are fully inserted, the turbine governor and throttle valves are closed, and the main feedwater valves are open. Soon (5 minutes) after reactor trip, hot shutdown conditions are achieved.

At this point, normal boration and makeup can be performed depending upon the final RC system condition to be achieved.

To initiate cooldown, the amount of steam dump to the condenser is increased. Steam dump to the condenser is maintained until the air ejector can no longer maintain condenser vacuum (approximately 350°F) and then atmospheric steam dump is initiated. As the volume of reactor coolant shrinks due to temperature decrease, automatic makeup to the system is provided by the pressurizer level control of the charging and makeup system.

The RHR system is aligned and started to recirculate through the RWST. Upon verification that the boron concentration of the RHR system is compatible with the RC system the RHR system is stopped. When the RC system reaches 360 psi and 350°F, the RHR system is pressurized to the pressure of the RC system through HCV-133 at a slow rate. The RHR system is then aligned for normal cooldown of the RC system, and the RHR pumps started while the RC system pressure is maintained by sprays and heaters. As the cooldown continues, the pressurizer is slowly filled to the solid condition at which time pressure control is assumed by PCV-135 and the RC pumps may be taken out of service. Charging pump flow is slowly reduced as cooldown continues to insure pressure of the RCS is maintained at 360 psi by PCV-135. Just prior to achieving 150°F the reactor coolant pumps are taken out of service. Auxiliary feedwater pumps are used to maintain steam generator level. The remainder of the cooldown is performed and maintained with the RHR system. Any time after the RC pumps are taken out, the charging pumps can be taken out and RC system pressure reduced to atmospheric.

4.2 Normal Shutdown and Cooldown - Offsite Power Not Available

Loss of offsite power is assumed to occur simultaneous with plant trip: the emergency diesels and turbine-driven auxiliary feedwater pump will start automatically. The diesels automatically tie to the 480-V Class 1E buses, energizing the component cooling water, service water, and motor-driven auxiliary feedwater pumps.

Bus 13 is manually tied to Bus 14 and Bus 15 is manually tied to Bus 16 to provide power for the air compressors. Other loads such as the charging pumps and containment fan coolers are manually energized if necessary. Heat removal will be accomplished by the secondary system utilizing the atmospheric power operated relief valves (PORVs). Steam generator level is maintained by the auxiliary feedwater pumps or standby auxiliary pumps. As decay heat decreases, all auxiliary feedwater pumps are not needed and are removed from service at operator discretion. Primary system volume is maintained by the charging flow and letdown rate. Pressure control of the primary system is provided by auxiliary spray and pressurizer heaters. Cooldown is initiated by manipulation of the steam relief rate. The primary system is cooled to 360 psi and 350°F at which time the RHR system is put into operation as described above. The RHR system is utilized to achieve and maintain the cold shutdown condition.

4.3 Shutdown and Cooldown - No Steam Dump, Offsite Power Available

This method is identical to the normal method - offsite power available (Subsection 4.1), except that heat removal will be accomplished by the secondary system utilizing the main steam PORVs.

4.4 Shutdown and Cooldown - No Steam Dump, Offsite Power Not Available

This method is identical to the normal method - offsite power not available (Subsection 4.2).

4.5 Shutdown and Cooldown - No Instrument Air, Offsite Power Available

The plant is tripped and the secondary system safety valves will stabilize the RC system near hot shutdown conditions. The

turbine-driven, motor-driven or standby auxiliary feedwater pumps can be used to supply auxiliary feedwater. Charging will be accomplished through the RC pump seals and valves 392A and B acting as relief valves. Charging water will come from the emergency boration path or from the RWST by opening manual valve 358. Letdown is isolated by the loss of instrument air. If primary system relief is required, the pressurizer PORVs can be operated manually. The component cooling water system and the RHR system are not affected by the loss of instrument air.

4.6 Shutdown and Cooldown - No Instrument Air, Offsite Power Not Available

This method is identical to the above method with offsite power available, except that all AC power is supplied from the diesel generators and the RC pumps are off.

4.7 Shutdown and Cooldown - No Instrument Air to Containment, Offsite Power Available

The plant is tripped and the main steam PORVs can be used to stabilize the RC system at hot shutdown conditions. The turbine driven, motor-driven or standby auxiliary feedwater pumps can be used to supply auxiliary feedwater. Charging will be accomplished through the RC pump seals and valves 392A and B acting as relief valves. Charging water will come from the normal boration paths or the emergency boration path. Letdown is isolated by the loss of instrument air. If primary system relief is required, the pressurizer PORVs can be operated manually. The component cooling water system and the RHR system are not affected by the loss of instrument air.

4.8 Shutdown and Cooldown - No Instrument Air to Containment, Offsite Power Not Available

This method is identical to the above method with offsite power (Subsection 4.7), except that all AC power is supplied from the diesel generators. Therefore, the RC pumps are off and Buses 13 and 15 must be supplied from Buses 14 and 16.

4.9 Shutdown and Cooldown - Solid Steam Generators, No RHR, Offsite Power Available

The plant is brought to the point where RHR cooling is normally initiated by the methods described in Normal Shutdown and Cooldown - with offsite power. Since the RHR is unavailable, the reactor coolant system is cooled below the 350°F point by the secondary system. After a time, the secondary system will approach 225°F and decay heat in the primary system has become small enough to not significantly increase temperature and pressure of the primary system, with heat removal accomplished by using the steam generators as water-to-water heat exchangers. The main steam line supports can be pinned (as is done during system hydrotest) in order to prevent possible damage to the piping caused by the water load. To continue the cooldown after 225°F is achieved in the secondary system, the main steam isolation valves are closed, the steam generator blowdown lines are aligned to the blowdown flash tank for discharge to the circulating water canal, the turbine-driven auxiliary feedpump is secured with all drains open, the main steam line drains and bypass valves are opened, and the water level is brought up in the steam generators until the steam piping is filled to the main steam isolation valves. Heat removal is now accomplished through the drains and steam generator blowdown lines. As the steam piping is filled, the hot water can be drained through the main steam line drains and turbine driven auxiliary feedwater pump drains. The steam generator blowdown system drains hot water directly from the steam generators to the circulating water discharge canal. The rate

of cooldown, which in this mode of operation is slow, is regulated by the amount of demineralized water available. Secondary system cooldown of the primary system can be augmented by "feed and bleed" of the primary system utilizing the safety injection or charging pumps with refueling water and the pressurizer relief valves. Before exhaustion of the demineralized water supply, efforts are made to transfer water from the hot well or AVT condensate storage tanks before resorting to service water as supply for the auxiliary feedwater pumps. It should be noted that since the RHR heat exchangers are not in use, it is not imperative that the component cooling water system be in operation. This method of cooling is used until the primary system has been cooled to the cold shutdown condition. This shutdown method has previously been described to the NRC in a letter dated July 27, 1978 and was accepted by the NRC in the Systematic Evaluation Program Safe Shutdown Systems Topic Review transmitted by letter dated November 14, 1980 from Mr. Dennis M. Crutchfield.

4.10 Shutdown and Cooldown - Solid Steam Generators, No RHR, Offsite Power Not Available

This method is identical to the above method with offsite power (Subsection 4.9), except that all AC power is supplied from the emergency diesel generators.

4.11 Shutdown and Cooldown - Inoperable RHR Valves, Offsite Power Available

This method is used in the event that one of the RHR suction valves (V-700, V-701) or RHR return valves (V-720, V-721) are stuck closed. The reactor coolant system has been brought to the 350°F point using normal methods. If one of the suction valves is stuck closed, the other letdown valve is closed and the two return valves are opened. In this mode of operation, the return line will provide suction for the RHR pumps through the three-inch recirculation line of the RHR pumps. The return

route to the reactor coolant system is established by closing RHR heat exchanger outlet valves HCV-624 and HCV-625, and RHR heat exchanger bypass valve V-626, and their respective guard valves V-717, V-715, and V-712B and opening valves V-857 A, B, and C to the suction of the safety injection pumps. To assure circulation through the core, valves V-878 B and D are closed and valves V-878 A and C are opened. When this path of flow has been established, the RHR system pressure is equalized to the reactor coolant system pressure by using HCV-133. The RHR pumps and safety injection pumps are started. Cooldown is continued to cold shutdown with rate of cooldown controlled by the number of safety injection pumps running. If one of the return valves is stuck closed, the other return valve is closed, both suction valves are opened, and the remainder of system alignment and operation remains the same, except that the recirculation line will not be necessary.

4.12 Shutdown and Cooldown - Inoperable RHR Valves, Offsite Power Not Available

This method is identical to the above method with offsite power (Subsection 4.11), except that all AC power is supplied from the emergency diesel generators.

4.13 Shutdown and Cooldown - No Charging Pumps, Offsite Power Available

This method of cooldown is used when the charging pumps are not available for maintaining the RC system inventory. The hot shutdown condition is achieved using normal methods. Cooldown is initiated using the turbine-driven auxiliary feedwater pump (the motor driven auxiliary feedwater pumps are used when required) with steam dump to atmosphere. The safety injection pumps are aligned to take suction from the RWST providing the necessary boration and makeup. Reactor coolant system pressure is reduced by opening the main steam PORVs. If additional depressurization is required, the pressurizer PORVs could be opened to a point

where the discharge pressure of the safety injection pumps is higher than the RC system pressure. A safety injection pump is then started. RC system pressure is controlled with pressurizer heaters, the pressurizer relief valves, and letdown. When the RC system reaches 360 psi and 350°F, the safety injection pumps are stopped. The RHR system is aligned for normal letdown and cooling of the RC system and the RHR pumps are started. The safety injection pumps still have suctions aligned to the RWST and are started as required to makeup to the RC system.

4.14 Shutdown and Cooldown - No Charging Pumps, Offsite Power Not Available

This method is identical to the above method with offsite power available (Subsection 4.13), except all AC power is supplied by the emergency diesel generators.

5.0 SYSTEMS AND COMPONENTS REQUIRED FOR SAFE SHUTDOWN

The R. E. Ginna Station was assessed in order to define the systems or system elements that must be operable in order to meet the functional requirements for achieving and maintaining cold shutdown conditions. Table 5-1 presents an overview of the assessment.

To achieve and maintain cold shutdown conditions, the following functions are required:

- o Monitor and control primary system inventory and pressure.
- o Remove decay heat.
- o Borate the reactor coolant.
- o Monitor RCS boron concentration to ensure that subcriticality is maintained.

The following subsections of Section 5.0 identify, on a system-by-system basis, the components required for safe shutdown and cooldown operations. Manually-operated valves are not identified in Section 5.0. The system-by-system evaluation assessed redundancy within the system, alternative backup systems to perform a required function, system vulnerability to fire in a selected plant area, loss of offsite power coincident with a fire, modification requirements to eliminate or to minimize system vulnerability to a fire event, and post-fire system control requirements.

The evaluation identified the need for a new system, the remote shutdown control system RSCS, for use in shutdown operations during and after a fire in the plant. The remote shutdown control system is used when the control room is disabled by a fire in the control

TABLE 5-1

FUNCTIONAL AND HARDWARE REQUIREMENTS FOR ACHIEVING AND MAINTAINING COLD SHUTDOWN CONDITIONS

Plant Functional Requirements	Equipment Functional Requirements	Minimum Equipment Requirements
Monitor and control primary system inventory and pressure	Monitor RCS inventory	One wide-range pressurizer level indicator
	Provide borated makeup water	One charging pump and injection path or one SI pump and injection path
	Borated makeup water source	RWST
	Monitor RCS pressure	One wide-range pressure indicator
	Pressure control-increase	One charging pump and injection path or one SI pump and injection path
	Pressure control-decrease	One pressurizer PORV or one main steam PORV

TABLE 5-1 (continued)

FUNCTIONAL AND HARDWARE REQUIREMENTS FOR ACHIEVING AND MAINTAINING COLD SHUTDOWN CONDITIONS

Plant Functional Requirements	Equipment Functional Requirements	Minimum Equipment Requirements
Remove decay heat by:		
a) Feedwater addition to the steam generators with steam venting to atmosphere	Provide feedwater	One pump and associated valves from the MAFW system or the SBAFW system
	Monitor steam generator level	One wide-range level indicator per loop
	Vent main steam to atmosphere	One main steam PORV and positioner
	Monitor RCS temperature	One temperature sensor and associated instrumentation
b) Decay heat removal to cold shutdown	Remove residual heat	One RHR pump, heat ex changer and associated valve train. If RHR is unavailable, utilize secondary coolant loop in solid steam genera tor operation (refer to Section 5.0).

Table 5-1 (continued)

FUNCTIONAL AND HARDWARE REQUIREMENTS FOR ACHIEVING AND MAINTAINING COLD SHUTDOWN CONDITIONS

Plant Functional Requirements	Equipment Functional Requirements	Minimum Equipment Requirements
Verify reactor is subcritical	Monitor RCS boron concentration to ensure that subcriticality is maintained	One sample cooler HX and valve train
Auxiliary services required by the components that directly perform the above functions	Component cooling	One pump HX and associated valve train
	Service water	One pump and associated valve train
	480-Vac power distribution	One 480-V bus--either Train A or Train B
	120-Vac power distribution	As required to energize instrumentation
	125-Vdc power distribution	DC system A or B

Table 5-1 (continued)

FUNCTIONAL AND HARDWARE REQUIREMENTS FOR ACHIEVING AND MAINTAINING COLD SHUTDOWN CONDITIONS

Plant Functional Requirements	Equipment Functional Requirements	Minimum Equipment Requirements
	Emergency power source	One diesel generator and support systems
	Pump cooling: RHR, charging, and SI	One cooler per system
Auxiliary services provided for operator convenience	Instrument air	One compressor, containment isolation valves

room or when a fire in another plant area disables important control or instrumentation circuits that interface with the control room. The remote shutdown control system is discussed in Subsection 5.15.

5.1 REACTOR COOLANT SYSTEM

5.1.1 FUNCTIONS REQUIRED

The following parameters associated with the reactor coolant system (RCS) are essential to safe shutdown:

- Pressurizer level to verify primary system inventory.
- Reactor coolant system pressure.
- Reactor coolant system temperature for control of cooldown rate.

5.1.2 MINIMUM EQUIPMENT REQUIREMENTS

The reactor coolant system has been assessed to determine the components that, as a minimum, must remain functional in a post-fire condition to ensure safe shutdown and cooldown. The following list represents those components of the reactor coolant system that will be designated for post-fire shutdown operation. Electrically-actuated equipment will generally be aligned with emergency AC and DC power train A.

- Pressurizer level - provide indication from one train of wide-range (0-100%) pressurizer level instrumentation.
- Reactor coolant system pressure - provide indication from one train of wide-range RCS pressure instrumentation.

- Reactor coolant system temperature - provide representative temperature indication.

- Reactor coolant system inventory - provide for the isolation of both pressurizer relief lines, with remote status indication to verify that both paths are isolated.

5.1.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

Reactor coolant system pressure will be maintained by control of the primary system cooldown rate in conjunction with operation of the charging or safety injection pumps (to increase pressure) and the pressurizer or steam line PORVs (to decrease pressure). The control or backup group of pressurizer heaters may be available for use in RCS pressure control, depending upon the location of the postulated fire. Either group has sufficient capacity to perform this function.

5.1.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

5.1.4.1 Instrumentation

The existing reactor coolant system instrumentation (pressurizer level and pressure, RCS temperature) is presently subject to loss of function in the event of a fire in either the cable tunnel, relay room, air handling room, or control room. Instrumentation components subject to loss of function may include signal wiring, AC power source or wiring, or instrument loop power supply/signal converter.

5.1.4.2 Pressurizer Relief Lines

The pressurizer PORVs are susceptible to spurious actuation in the event of specific postulated fires. The postulated failure of a "hot short" to PORV control wiring may cause the PORVs to open.

Consequently, relief line isolation capability is required to prevent an uncontrolled loss of coolant.

5.1.4.3 RCS Pressure Control

RCS pressure will be maintained by control of the primary system cooldown rate with the charging or safety injection pumps providing for pressure increase and the steam line or pressurizer PORVs providing for pressure decrease. The charging and safety injection pumps are discussed in Subsections 5.5.4.1 and 5.4.4.1, respectively. The steam line and pressurizer PORVs are presented in Subsections 5.3.4.2 and 5.1.5.2, respectively.

5.1.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTIONS

5.1.5.1 Dedicated Instrumentation

Dedicated instrument loops will be installed to provide monitoring of RCS pressure and pressurizer level. The transmitters will utilize existing process taps, but the loop power supplies, wiring, and power source will be independent of those fire zones occupied by the existing instrumentation. The existing RCS temperature indication will be upgraded or new instrumentation will be installed to provide an appropriate RCS temperature monitoring capability. The indicators associated with these instrument channels will be provided by the remote shutdown control system.

5.1.5.2 Pressurizer Relief Control

Alternative controls will be provided to isolate both pressurizer relief flow paths; these controls will be provided by the RSCS, along with status indication to allow verification that both valves are closed. The remote shutdown controls will be activated through a remote manual transfer switch. Placing of this switch

in the "local" position (i.e., RS panel controls activated) will be annunciated in the control room.

All control and indication wiring from the control room to the RSCS control circuits will be provided with suitable isolation devices, so that a fault occurring between these points cannot disable both the normal and the RSCS controls. In addition, the control transfer switch will provide for isolation of the existing Class-1E control circuits from the non-Class-1E RSCS circuits.

A remote manual transfer/alternative control scheme will be implemented for the pressurizer relief valve trains to ensure that both relief paths can be secured in the event of a fire in any fire zone.

5.1.5.3 RCS Pressure Control

The modifications planned for charging and safety injection pump trains; steam line and pressurizer PORVs are presented in Subsections 5.5.5, 5.4.5, 5.3.5, and 5.1.5.2, respectively.

5.2 REACTIVITY MONITORING SYSTEM

5.2.1 FUNCTIONS REQUIRED

Sampling of the reactor coolant for boron concentration is required for shutdown and cooldown operations in order to verify that subcriticality is maintained.

5.2.2 MINIMUM EQUIPMENT REQUIREMENTS

The RCS sample valves and the sample heat exchanger are required in order to draw a reactor coolant sample. Component cooling water is required for cooling of the sample heat exchangers.

5.2.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

The source-range nuclear instrumentation available in the control room can be utilized to verify that the reactor is subcritical. The sampling room, the sample heat exchangers, the laboratory facility, and the component cooling loop equipment required to support the sample heat exchangers are not in fire zones common to elements that would cause the loss of the source-range nuclear instrumentation. Control circuits for the component cooling loop equipment are located in fire zones that are common to the source-range nuclear instrumentation circuits. The RSCS modification for the component cooling loop will enable operation of the component cooling loop following a fire in zones that contain the source-range nuclear instrumentation circuits.

5.2.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

Refer to Subsection 5.2.3.

5.2.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTIONS

Modifications to ensure the availability of component cooling water are discussed in Subsection 5.14.5. No additional modifications are required.

5.3 MAIN AND REHEAT STEAM SYSTEM

5.3.1 FUNCTIONS REQUIRED

The main and reheat steam (MS) system is required to provide the following functions for shutdown and cooldown operation:

- o Supply steam to turbine-driven auxiliary feedwater pump.

- Provide decay heat removal by atmospheric venting of steam through main steam PORVs.

- Provide decay heat removal by dumping steam to the main condenser (only with offsite power available).

- Provide remote indication of main steam line pressure.

5.3.2 MINIMUM EQUIPMENT REQUIREMENTS

In order to ensure the availability of the decay heat removal function, the following equipment must be operable:

- Turbine-driven auxiliary feedwater pump steam supply valve and remote position indication.

- Main steam PORV remote position indication. Actuation of the PORVs, as required, will be through local manual/pneumatic (not electrically assisted) control.

- One channel of steam line pressure indication per steam line.

5.3.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

The motor-driven auxiliary feedwater pumps and/or the standby auxiliary feedwater pumps provide alternative sources of feedwater in the event that the turbine-driven pump is not available (i.e., interruption of steam flow to turbine). Although steam dumping to the main condenser is the primary means of decay heat removal through the secondary system, it is anticipated that atmospheric steam venting through the PORVs will generally be used for post-fire cooldown operation.

5.3.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

5.3.4.1 Turbine-Driven Auxiliary Feedwater Pump Steam Supply Valves

The control circuits for the TAFWP steam supply valves are both presently vulnerable to fires occurring in the air handling room, battery room 1A or 1B, the cable tunnel, and the intermediate building basement. The anticipated worst-case failure is the spurious closure of these valves (as a result of "hot shorts" to control circuits), terminating the steam supply to the TAFWP.

5.3.4.2 Main Steam PORVs

A fire occurring in the vicinity of the air compressors may cause a loss of air supply to the main steam PORVs, requiring the use of an alternative scheme (e.g., connection of nitrogen cylinder) to permit the use of these valves for controlled steam venting. The control circuits for these valves are also vulnerable to fires in the air handling room, cable tunnel, relay room, and control room.

5.3.4.3 Steam Line Pressure Indication

These indication circuits are presently susceptible to damage (and loss of function) in the event of a fire occurring in several fire zones, including the cable tunnel, relay room, and control room. The postulated failure will result from damage to the cables, instrumentation, or the power source.

5.3.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTIONS

5.3.5.1 Turbine-Driven Auxiliary Feedwater Pump Steam Supply

A TAFWP steam supply valve will be provided with auxiliary controls and position indication from the RSCS. These controls will

be activated through a remote manual transfer switch; actuation of this switch will be annunciated in the control room. All existing control and indication circuits will be provided with suitable isolation at all interfaces with the RS control circuits. Control and power circuits for the loop A and loop B valves will be rerouted, as required, to avoid routing these circuits through common high-hazard fire zones.

5.3.5.2 Main Steam PORVs

Position indication for both PORVs will be provided by the RS control system. These circuits will be isolated from the existing PORV status circuits, and will be routed so as to avoid high-hazard fire zones occupied by the existing position indication circuits.

5.3.5.3 Steam Line Pressure Indication

One channel of dedicated pressure instrumentation will be provided (by the RSCS) for each steam line. The cable routing, loop power supplies, and AC power source will be independent of high-hazard fire zones occupied by existing pressure instrumentation circuits such as the relay room, cable tunnel, and control room.

5.4 SAFETY INJECTION SYSTEM

5.4.1 FUNCTIONS REQUIRED

Although not directly required for safe-shutdown operation, the safety injection (SI) system provides alternative functional capabilities in the event that specific shutdown-related systems are unavailable; these functions are listed below:

- Provides an alternative primary system makeup capability in the event of loss of all charging pumps.

- Provides alternative suction/injection paths in the event of isolation of the RHR system.

5.4.2 MINIMUM EQUIPMENT REQUIREMENTS

The components that are required, as a minimum, to provide the SI safe-shutdown functions are listed below. It should be noted that the SI accumulator discharge valves must be secured or the accumulator nitrogen overpressure must be vented, regardless of the SI shutdown operating mode, to ensure that depressurization can proceed below 700 psig.

- One safety injection pump (pump A).

- One safety injection pump cooling unit.

- Two (series) refueling water storage tank (RWST) discharge valves. The RWST is utilized in this mode as the primary makeup/boration source in lieu of the boric acid and the reactor makeup water systems. Using water borated to refueling concentration, under worst-case conditions of alternative injection and pumping paths, adequate shutdown margin is readily maintained.

- One RWST to safety injection pump suction valve (train A or B).

- One safety injection discharge valve (train A or B).

- One channel of SI discharge line flow.

5.4.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

As described in Subsection 5.4.1, the SI system provides alternative functional capabilities for charging (chemical and volume control system) and RHR (auxiliary coolant system).

5.4.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

5.4.4.1 Safety Injection Pumps

The safety injection system provides an alternative means of reactor water makeup in the event of loss of all charging pumps. The SI pumps, their associated cooling units, and the charging room cooling units are all vulnerable to loss of function in the event of a severe fire in the auxiliary building basement, as the result of damage to cables, power sources, or the pump motors. As presently configured, the SI and charging pumps are therefore subject to loss of normal and alternative reactor water makeup function.

5.4.4.2 SI Discharge Line Flow Instrumentation

The existing SI discharge line flow instrumentation is subject to failure in the event of a fire occurring in selected plant areas, including the cable tunnel, relay room, and control room. The postulated failure may result from fire-induced damage to cables, the instrument power source, or instrumentation components.

5.4.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTION

5.4.5.1 Safety Injection Pump

Safety injection pump 1A is presently aligned with 480-Vac power train A. Alternative controls for this pump will be provided by the RSCS. These controls will be activated through a remote

manual transfer switch; actuation of the transfer switch will be annunciated in the control room. All existing control and indication circuits will be provided with suitable isolation at all interfaces with the RS control circuits.

5.4.5.2 Safety Injection Pump Cooling Unit

Alternative controls for one safety injection pump cooling unit will be provided by the RSCS. These controls will be activated through a remote manual transfer switch; actuation of this switch will be annunciated in the control room. All existing control and indication circuits will be provided with suitable isolation at all interfaces with the RS control circuits.

5.4.5.3 RWST Discharge Valves, SI Discharge Valves

The RWST discharge valves (V-896A, V-896B) are normally maintained in the position required for injection/shutdown operation, with DC power removed. Consequently, fire-induced, inadvertent closure of these valves is not probable.

Remote flow indication will be provided for both SI cold leg injection lines. The circuits will be routed and powered so as to avoid high-hazard fire zones occupied by existing flow indication circuits.

5.4.5.4 RWST to SI Pump Suction Valve

Two parallel valves are provided for SI pump suction; they are supplied from redundant emergency power sources. Alternative controls will be provided for one valve by the RSCS. This control will be activated through a remote manual transfer switch; actuation of this switch will be annunciated in the control room. All existing control and indication circuits will be provided with suitable isolation at all interfaces with the RS control circuits.

5.4.5.5 SI Accumulator Discharge Valves

Prior to depressurizing the primary system below 700 psig, it is necessary to secure the SI accumulator by closing the discharge valves or removing the nitrogen overpressure. This action will be accomplished by direct manual operation.

5.5 CHEMICAL AND VOLUME CONTROL SYSTEM

5.5.1 FUNCTIONS REQUIRED

The chemical and volume control system (CVCS) provides the essential shutdown functions of primary system makeup, letdown (see Subsection 5.5.3.3), and boration.

5.5.2 MINIMUM EQUIPMENT REQUIREMENTS

- o One charging pump
- o One charging pump cooling unit
- o One charging/makeup path valve train
- o One letdown path (closure only)
- o RWST to charging pumps isolation valve

5.5.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

5.5.3.1 Makeup Function

As discussed in Subsection 3.2.3, the safety injection system provides an alternative makeup function in the event of loss of all charging pumps.

5.5.3.2 Charging Path

The CVCS is provided with normal and alternative charging paths. In the alternative charging mode, powered control of the injection

isolation valves is not required; they are essentially operated as relief valves.

5.5.3.3 Letdown Function

In order to maintain hot shutdown or to reach cold shutdown, borated water must be added to the reactor coolant system to ensure subcriticality. During a normal shutdown, this is provided by simultaneous charging and letdown. Letdown would be provided through the letdown isolation valve, the letdown orifice valves, and the associated heat exchangers. However, analyses have shown that coolant shrinkage within the reactor coolant system is sufficient such that only addition of borated water to the reactor coolant system is required to ensure subcriticality. This approach has been accepted in the NRC's Systematic Evaluation Program Safe Shutdown System Topic Review, transmitted by letter dated November 14, 1980 from Mr. Dennis M. Crutchfield. Only isolation of the letdown function is required following a fire to maintain RCS inventory. Isolation of the letdown can be accomplished by closing either the letdown isolation valve or the orifice isolation valve.

5.5.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

5.5.4.1 Charging Pumps

The charging pumps are presently susceptible to loss of function in the event of a fire in the charging pump room or in the safety injection pump area (which contains the charging room coolers). The postulated failures are addressed in Subsection 5.4.4.1.

5.5.4.2 Letdown Paths

Although the letdown function is not specifically required for safe shutdown, the letdown isolation and/or orifice valves may be subject to spurious actuation in the event of fires occurring

in selected plant areas, including the cable tunnel, relay room, air handling room, and control room. The spurious actuations (inadvertent opening of valves) would result from fire-induced "hot shorts" to control circuits.

5.5.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTIONS

5.5.5.1 Charging Pump Room

The charging pump room will be enclosed with an appropriately rated fire barrier to provide protection from the auxiliary building basement-safety injection pump area. This modification will include the following:

- Two rated fire doors.
- Sealing of all electrical and mechanical penetrations and blockouts.

5.5.5.2 Charging Pumps

Alternative controls will be installed for the train A charging pump; these controls will be part of the remote shutdown control system, and will be activated by a remote manual transfer switch. The transfer switch will be provided with annunciation in the control room, which will alarm when the RSCS controls have been activated.

Control and/or power cables for the train A pump will be rerouted as required to ensure that the following conditions are met:

- Train A cables are not routed through high-hazard fire zones occupied by train B or train C cables.

- Train A cables are not routed through the auxiliary building basement-safety injection pump area, the cable tunnel, control room, relay room, or air handling room.

5.5.5.3 Charging Pump Room Cooling Units

The existing charging pump room cooling units are subject to loss of function as a result of a fire in the auxiliary building basement-safety injection pump area.

Although subject to further study, it is anticipated that the resolution of this situation will involve one of the following options:

- Relocate (or protect with an adequate barrier) the existing cooling units, control and power cables, and realign to train A power source, as required. If relocated, the units would be placed outside the safety injection pump area, and in all cases, cable routing would avoid the cable tunnel, control room, relay room, and air handling room. The existing local/automatic control function would be retained.

- Install a new, dedicated cooling unit, independent of the existing coolers. This unit, which would be configured only for post-fire dedicated shutdown use, would be aligned with power train A and provided with remote manual controls. All control and power cables would be routed so as to avoid fire zones occupied by cables servicing the existing coolers.

5.5.5.4 Charging/Makeup Piping Path

Alternative charging paths are available, using CVCS injection valves that will function as relief valves, thereby opening to allow injection flow without the use of control power. However, flow indication information will be provided. The flow indication circuits will be energized from the alternative (RS) power source,

and will be part of the remote shutdown control system. Cables associated with the RS flow indication channel will be routed so as to avoid high-hazard fire zones occupied by existing flow indication circuits, to the extent practicable.

5.5.5.5 Letd wn Isolation and Orifice Valves

Remote status indication will be provided to indicate that the letdown path has been isolated. The status indication circuitry will be consistent with that described in Subsection 5.5.5.4.

Cable routing to the RS control system will avoid the cable tunnel, control room, and air handling room, and will avoid, to the extent practicable, high-hazard fire zones occupied by the pressurizer PORV control cables.

5.6 SERVICE WATER SYSTEM

5.6.1 FUNCTIONS REQUIRED

The service water (SW) system provides the following safe-shutdown-related functions:

- o Cooling water for safe-shutdown equipment.
- o Alternative water source for auxiliary feedwater system.
- o Primary water source for standby auxiliary feedwater system.

5.6.2 MINIMUM EQUIPMENT REQUIREMENT

For post-fire shutdown and cooldown operations, the following components must be operable:

- o One service water pump.
- o Two service water auxiliary building isolation valves.

5.6.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

Piping provisions will be made to permit emergency connection of selected loads to the yard hydrant system or portable pumps so that they may continue to function in the event of loss of all service water. These loads include the diesel generator jacket cooling systems and the water supply to the turbine-driven auxiliary feedwater pump.

5.6.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

5.6.4.1 Service Water Pumps

All four service water pumps are susceptible to simultaneous loss of function in the event of a severe fire occurring in any of the following areas: air handling room, cable tunnel, diesel generator "B" cable vault, relay room, control room, intermediate building basement, screen house operating floor, or screen house basement. The postulated failures may result from fire-induced damage to any of the following:

- o Service water pump motors.

- o Electrical distribution panels - 480-Vac train A and B switchgear and 125-Vdc train A and B distribution panels.

- o Control and power cables.

5.6.4.2 Service Water Isolation Valves

The auxiliary building service water isolation valves are subject to spurious actuation (inadvertent closure, as the worst case) in the event of fires occurring in areas including the cable tunnel, air handling room, relay room, or control room. The spurious actuations would result from fire-induced "hot shorts" to control circuits.

Closure of the auxiliary building SW isolation valves would result in termination of service water flow to most safe-shutdown-related components.

5.6.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTION

5.6.5.1 Service Water Pumps

To ensure the availability of at least one pump, an appropriately rated fire barrier will be installed in the screen house, so that one pump is completely independent of fire hazards affecting the remaining three pumps. Alternative AC power and DC control power will be routed to the screen house for operation of this pump. In addition, alternative controls for the protected pump will be available as part of the RSCS. Consequently, this pump will not be affected by any fire-induced failures which are common to the other pumps.

5.6.5.2 Auxiliary Building Isolation Valves

Alternative controls and status indication will be provided for one train of the auxiliary building isolation valves. Because these valves control cooling water to hot-shutdown-related loads, alternative remote controls will be provided for rapid valve re-positioning, if required. These controls will be activated by

a remote manual transfer switch; actuation of this switch will be annunciated in the control room.

The cables associated with the remote shutdown controls will be routed so as to avoid the cable tunnel, relay room, control room, and diesel generator cable vaults.

5.7 INSTRUMENT AIR SYSTEM

5.7.1 FUNCTIONS REQUIRED

The instrument air system provides compressed air for valve actuation. Instrument air is not required for shutdown and cooldown. Subsection 5.7 describes equipment which is desirable for plant operation, although not specifically required, following a fire.

5.7.2 MINIMUM EQUIPMENT REQUIREMENTS

- o One instrument or service air compressor.
- o Instrument air containment isolation valves.

5.7.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

In the event of complete loss of instrument air supply, all air-actuated components (valves) that interface with safety-related plant systems are designed to fail in the "safe" or preferred position, predominantly to avoid compromising primary system integrity.

Although the fail-safe mode does protect primary system integrity, it also causes the isolation of several flow paths that may be desirable for shutdown or cooldown operations. For those selected components that require a pneumatic pressure source for operation (e.g., primary and secondary PORVs), alternative sources such as nitrogen cylinders are available for temporary connection to power the valve actuators.

5.7.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

The instrument air system is susceptible to loss of function in the event of fires occurring in plant areas, including the air compressor area, the relay room, and the control room. The failures may result from fire-induced damage to compressor motors, power sources, and control and power cables. For instrument air loads in containment, the loss of function may result from spurious actuation (closure) of the containment isolation valves.

5.7.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTIONS

The following modifications are presently under consideration for enhancement of the availability of control air for the pressurizer PORVs and the RWST supply valve to charging pump suction.

- Provide an additional or existing spare breaker in 480-V power train A switchgear, which would function as the new supply for one instrument air compressor. This circuit breaker would be provided with appropriate trip functions (e.g., undervoltage) to ensure that this non-safety-related load cannot compromise the ESF functions of the bus.

  The existing control scheme would be retained, but would include an alternative control capability with all wiring independent of the control room, relay room, cable tunnel, and air handling room. The isolation and control transfer concepts applied would be identical to those described herein for other shutdown-related modifications.

- Provide alternative controls, remote status indication, and DC power for the instrument air containment isolation

valves. The circuit isolation and control transfer concepts applied to these alternative controls would be identical to those described herein for other shutdown-related modifications.

5.8 HEATING, VENTILATION, AND AIR CONDITIONING SYSTEM

5.8.1 FUNCTIONS REQUIRED

The HVAC systems required to function for continued operation of safety-related equipment are delineated in the R. E. Ginna Environmental Qualification of Electrical Equipment Report submitted to the NRC on October 31, 1980. The required systems are the residual heat removal, safety injection, containment spray, charging and standby auxiliary feedwater pump coolers, and the battery room ventilation systems. All other equipment, including that in the control room, will function properly in the ambient environment and require no cooling or ventilation.

5.8.2 MINIMUM EQUIPMENT REQUIREMENTS

- o RHR room cooler
- o SI and CS pump cooler
- o Charging room cooler
- o SBAFW room cooler

Ventilation for the present battery rooms is not required because of the alternative DC power source to be provided for operation of the remote shutdown control system.

5.8.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

The safety injection pumps are not separated from the rest of the auxiliary building environment by room walls. Since the auxiliary building is a very large-volume building, it is not expected that

there would be an increase in the ambient temperature due to SI pump operation, even if the main building ventilation system is inoperable. Thus, it may be possible to cool the SI pumps using portable fans.

The SBAFW system is housed in a separate building with no other heat sources. The building can be opened to the outside and thus these pumps may be cooled using portable fans exhausting out of the building.

5.8.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

Hazards affecting each of the pump coolers are delineated in the sections of this report which discuss the associated pumps.

5.8.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTION

Modifications planned for each of the required cooling units are discussed in the sections of this report which address the associated pumps.

5.9 <u>CONDENSATE SYSTEM</u>

5.9.1 FUNCTIONS REQUIRED

The condensate system is the primary water source for the auxiliary feedwater system.

5.9.2 MINIMUM EQUIPMENT REQUIREMENTS

- o Condensate storage tank.
- o Condensate storage tank level indication.

5.9.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

The service water system is the alternative source of water for the auxiliary feedwater system.

5.9.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

The existing condensate tank level instrumentation is subject to loss of function in the event of a fire occurring in selected plant areas, including the cable tunnel, relay room, and control room.

5.9.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTION

A new, dedicated channel of condensate storage tank level instrumentation will be installed; indication will be provided as part of the remote shutdown control system. Cable routing, instrumentation, and the power source will be independent of that utilized by the existing level instrumentation channel.

5.10 NORMAL/EMERGENCY POWER DISTRIBUTION SYSTEM

5.10.1 FUNCTIONS REQUIRED

The power distribution system provides AC and DC power to safe-shutdown-related (and other) plant loads under all postulated conditions of offsite/onsite power availability.

5.10.2 MINIMUM EQUIPMENT REQUIREMENTS

- One 480-Vac ESF power train.
- One emergency diesel generator and auxiliaries (aligned with above bus).

- One 480-Vac ESF motor control center (aligned with above bus).

- One 125-Vdc battery and distribution panel.

- One 120-Vac instrument bus (inverter powered from above battery).

5.10.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

With incorporation of the features described in Subsection 5.10.5, either of the two power trains, in an onsite or offsite supply mode, is capable of accommodating all safe-shutdown-related loads.

5.10.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

Inadequate separation (with respect to fire zones) of power trains A and B at several locations throughout the plant make both trains of AC and DC power susceptible to simultaneous loss of function as the result of a single postulated fire.

5.10.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTIONS

- The train A 480-Vac switchgear bus will be provided with a new feeder from its associated emergency diesel generator. The cable routing will be completely independent of all zones occupied by train B.

- Selected train A and/or train B cable rerouting will be accomplished such that safe-shutdown-related circuits from redundant trains will generally not occupy common fire zones.

- o An alternative source of 125-Vdc control power and 120-Vac instrument power, independent of the existing plant AC and DC systems, will be provided. This power source will be capable of supplying all necessary control power (and AC instrument power) for dedicated shutdown operation. A remote manual transfer switch scheme will enable the operator to align the train A switchgear and actuated devices with either the existing plant battery system or the alternative, dedicated shutdown DC source. Suitable isolation/interlocks will be provided to preclude the possibility of degrading the safety-related DC system by inadvertent cross-connection with the dedicated shutdown source.

5.11 RESIDUAL HEAT REMOVAL SYSTEM

5.11.1 FUNCTIONS REQUIRED

The residual heat removal (RHR) system provides cooling of the primary system to achieve cold shutdown. Either the RHR or the secondary system in the solid steam generator mode can be utilized to remove the decay heat and achieve cold shutdown.

5.11.2 MINIMUM EQUIPMENT REQUIREMENTS

The RHR system has been assessed to determine the components that, as a minimum, must remain functional in a post-fire condition to ensure safe shutdown and cooldown. The RHR has two 100%-redundant trains (i.e., trains 1A and 1B). Either train is capable of providing the required cooling. The following list represents those components of the RHR system that will be aligned with the remote shutdown control system (RSCS) for post-fire shutdown operation.

- o RHR train components
  - Heat exchanger (HX)
  - Component cooling isolation valve to HX

- RHR pump
- RHR pump suction valve
- HX discharge control valve.

o RHR room cooler.

o Flow control valve.

o Suction valves from loop A.

o Discharge valves to loop B.

o Containment sump B isolation valves.

5.11.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

The RHR can be totally disabled and the reactor can still be brought to safe shutdown by utilizing a less efficient cooling approach. At the point in the cooldown cycle where the RHR cooling is normally initiated, the secondary system will continue to cool the reactor coolant system, as described in Subsection 4.9.

The RHR system, in combination with selected elements of the SI system, can provide alternative flow paths to provide cooling if either the RHR suction valves from loop A or the RHR discharge valves to loop B block normal RHR flow. Subsection 4.11 describes the alternative RHR/SI system flow paths.

RHR train 1A is 100% redundant to train 1B. Either RHR train is capable of providing the required cooling.

5.11.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

Both trains of the RHR are located in the auxiliary building basement and are vulnerable to a fire in that area. In addition, a fire occurring in the auxiliary building mezzanine, cable tunnel, control room, or the air handling room could cause the loss of control circuits, power feeds, or the power source itself for redundant RHR components.

5.11.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTION

The RHR power feeds and control circuits will be rerouted to provide separation of active safe shutdown circuits aligned with each power division, diesel generator 1A/battery 1A and diesel generator 1B/battery 1B. In the auxiliary building basement, both power divisions are present to support redundant RHR components. The applicable circuits will be rerouted to minimize the common fire hazard exposure of redundant power division cables and conduits.

The RHR is not required to achieve hot shutdown, therefore, there is no requirement, based on time response restrictions, to control the RHR from the RSCS. The RHR may be aligned using manual operation of valves which are normally operated using electric power or pneumatic assist. The RSCS will incorporate the following RHR features:

- Train 1A valves:
  - Shed load from the present MCC or DC supply
  - Provide valve status information independent of the control room.
- Transfer control of RHR pump 1A to RS panel.
- Transfer control of RHR room cooler to RS panel.
- Provide flow indication for RHR.
- Component cooling isolation valve to HX - shed load.
- Flow control valve - shed load.

- o Align SIS interface with the RSCS. (SI/RSCS interfaces are presented in Subsection 5.4.5.)

In addition, the spurious opening of sump B valves V-850A or V-850B will disable the RHR and also cause the RWST to drain into the sump. Modifications to the valve under administrative control (e.g., disable normal DC control power or open the breaker at the MCC) and plumbing modifications that would inhibit backflow into the sump are under evaluation.

5.12 MAIN AUXILIARY FEEDWATER SYSTEM

5.12.1 FUNCTIONS REQUIRED

The main auxiliary feedwater (MAFW) system provides feedwater to steam generators following a safety injection signal or loss of offsite power.

5.12.2 MINIMUM EQUIPMENT REQUIREMENTS

The MAFW system has been assessed to determine the components that, as a minimum, must remain functional in a post-fire condition to ensure safe shutdown and cooldown. The MAFW has three trains (i.e., two trains have a motor-driven pump, the third train has a turbine-driven pump). Any one of the three trains can supply the required feedwater to both steam generators (only a single steam generator is required).

The standby auxiliary feedwater (SBAFW) system provides a backup to the MAFW system. The SBAFW system consists of two motor-driven pump (MDP) trains, either of which can supply the required feedwater to the steam generators (SGs). When both the MAFW system and SBAFW systems were assessed for post-fire operation, it was determined that the RSCS will interface with the TAFWP train and an MDP train from the SBAFW system.

The following list represents those components of the MAFW system that will be designated to interface with the RSCS for post-fire operation.

- o Turbine-driven pump train

  - Turbine-driven pump
  - Discharge valve
  - SW isolation valve
  - Steam generator (SG) control valves
  - Lubricating oil supply tank and pumps
  - Steam supply valve (Part of the MS system. Refer to Subsection 5.3).

In addition to the MAFW system equipment, SG level instrumentation is required to monitor operation of the MAFW.

5.12.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

The SBAFW system provides a backup to the MAFW system. The SBAFW system consists of two MDP trains.

Either SBAFW train can supply the required feedwater to both steam generators. The SBAFW system is discussed in Subsection 5.13.

5.12.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

All three trains of the MAFW are located in the intermediate building on the intermediate floor and are vulnerable to a fire in that area. In addition, a fire occurring in the auxiliary building mezzanine, cable tunnel, battery rooms, or the intermediate building basement could cause the loss of control circuits, power feeds, or the power source itself for redundant AFW components.

5.12.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTION

The TAFWP train power feeds and control circuits will be rerouted to provide separation of active safe shutdown circuits aligned with each power division. The TAFWP train circuits will be re-routed so that they are not in a common fire zone with the SBAFW power feeds and control circuits.

Auxiliary feedwater is not required during the first 30 minutes following the start of the fire because the SG will not boil dry during that time. Within that period of time, the operator must initiate operation of either the MAFW or the SBAFW. The RSCS will incorporate the following features to enable manual operation of the TAFWP train.

- o Isolate the control circuits of the TAFWP DC auxiliary oil pump and provide for local control of the pump.

- o Enable local manual control of the following valves (no power or air assist)

  - TAFWP discharge valve
  - SG FW control valves.

5.13 <u>STANDBY AUXILIARY FEEDWATER SYSTEM</u>

5.13.1 FUNCTIONS REQUIRED

If the MAFW system is unavailable, the SBAFW system provides feedwater to the steam generators following a safety injection signal or loss of offsite power.

5.13.2 MINIMUM EQUIPMENT REQUIREMENTS

The SBAFW system has been assessed to determine the components that, as a minimum, must remain functional in a post-fire condition to ensure safe shutdown and cooldown. The SBAFW system has two 100%-redundant MDP trains. Either of the trains can supply the required feedwater to both steam generators (only a single steam generator is required).

The SBAFW system provides backup to the MAFW system. When both the MAFW system and the SBAFW system were assessed for post-fire operation, it was determined that the RSCS will interface with the TAFWP train and an MDP train from the SBAFW system.

The following list represents those components of the SBAFW system that will be designated to interface with the RSCS and for post-fire operation if the MAFW system is unavailable.

- o MDP train
  - MDP
  - Motor starter
  - Suction valve
  - Discharge valve
  - SG isolation valve.
- o SW isolation valve (part of SW system).
- o SG level instrumentation (part of SG instrumentation required to monitor the operation of the SBAFW).

5.13.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

The SBAFW system provides a backup to the MAFW system.

The MAFW system consists of two MDP trains and one TAFWP train. Any of the three MAFW trains can supply the required feedwater to both steam generators. The MAFW system is discussed in Subsection 5.12.

5.13.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

Both trains of the SBAFW are located in the standby auxiliary feedwater pump building and are vulnerable to fire in that area. In addition, a fire occurring in the auxiliary building basement or mezzanine, cable tunnel, air handling room and the control room could cause the loss of control circuits or power feeds for the redundant pump trains.

5.13.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTION

The SBAFW train power feeds and remote shutdown control circuits will be rerouted so that they are not in a common fire zone with the TAFWP train power feeds and normal control circuits.

The RSCS will provide the operator the ability to align and operate a single train of the SBAFW system from a remote panel, independent of any control room interfaces.

5.14 COMPONENT COOLING LOOP

5.14.1 FUNCTIONS REQUIRED

The component cooling (CC) loop removes heat from the following heat sources during normal plant operation:

- o RHR HXs
- o Reactor coolant pumps
- o Nonregenerative HX
- o Excess letdown HX

- o Seal water HX
- o Boric acid recycle evaporator
- o Sample HXs
- o Waste gas compressor
- o Waste gas condenser
- o Reactor support cooling pads
- o RHR pumps
- o SI pumps
- o Containment spray pumps.

5.14.2 MINIMUM EQUIPMENT REQUIREMENTS

The CC has been assessed to determine the components that, as a minimum, must remain functional in a post-fire condition to ensure safe shutdown and cooldown. The CC loop has two 100%-redundant trains of HXs and circulating pumps. Only one CC HX and one CC pump is required to meet the shutdown and cooldown requirements for the R. E. Ginna Station. The CC loop distribution to redundant equipment (e.g., both RHR HXs) is a single train. The following list represents those components of the CC loop that will be designated for post-fire shutdown operation.

- o CC HX
- o CC pump
- o Surge tank

5.14.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

No functional backup exists for the loss of the CC loop. However, alternative shutdown and cooldown methods are available when the

following shutdown-and-cooldown-related components are disabled by the lack of CC.

- o SI pumps
- o RHR HXs
- o RHR pumps

The SI system is not a principal shutdown-related system. It provides alternative functional capabilities in the event that specific shutdown-related systems are unavailable. The SI system provides an alternative primary system makeup capability in the event of loss of all charging pumps and it also provides alternative suction/injection paths in the event of isolation of the RHR system.

The RHR can be totally disabled and the reactor can still be brought to safe shutdown by utilizing a less efficient cooling approach. At the point in the cooldown cycle where the RHR cooling is normally initiated, the secondary system will continue to cool the reactor coolant system, as described in Subsection 4.9.

5.14.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

Both CC pumps are located in the auxiliary building operating floor and are vulnerable to a fire in that area. In addition, a fire occurring in the auxiliary building mezzanine, cable tunnel, control room, or the air handling room could cause the loss of control circuits, power feeds, or the power source itself to the CC pumps.

5.14.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTION

The CC loop power feeds and control circuits will be rerouted to provide separation of active safe shutdown circuits aligned with

each power division, diesel generator 1A/battery 1A and diesel generator 1B/battery 1B.

On the auxiliary building operating floor, both power divisions are present to support the redundant CC pumps. The applicable circuits will be rerouted to minimize the hazards between redundant power division cables and conduits.

The RSCS will incorporate a transfer of control of CC pump 1A to the RSCS.

5.15 REMOTE SHUTDOWN CONTROL SYSTEM

5.15.1 FUNCTIONS REQUIRED

The RSCS provides an alternative means of bringing the plant to a cold shutdown state when the control room is disabled by a fire in the control room or by a fire in another plant area which disables important control circuits that interface with the control room.

The RSCS incorporates a remote shutdown (RS) panel concept for the transfer of control of selected components from the control room and to provide a single channel of all instrumentation required to achieve and maintain cold shutdown. The location or locations of the new RS panel(s) is under evaluation. The RS panel concept has not been finalized; the design will incorporate either a single new remote control panel, or a system of distributed panels located in selected plant areas. The RS panel will have the following functions available for operator use.

- o Instrumentation continuously available
    - SG level, wide range (1 channel per SG)
    - RCS pressure, wide range
    - Pressurizer level, wide range
    - RCS temperature

- Steam line pressure, wide range (1 channel per steam line)
- Condensate tank level, wide range
- SI system cold leg injection line flow (1 channel)
- RHR system flow
- Charging pump flow.

o Transfer control to DS panel and provide status

- Pressurizer PORVs (2, status only)
- Pressurizer PORV relief line isolation (2)
- SI train (1)
- SI pump cooling unit (1)
- Charging pump train (1)
- Charging pump room cooling unit
- Charging pump/RWST suction valve (1)
- SW pump train (1)
- Auxiliary building SW isolation valves (2)
- RHR pump (1)
- SBAFW train (1)
- TAFWP steam supply valve (1)
- Letdown line isolation
- RHR room cooler (1).

o Provide control room alarm when control is transferred.

o Shed specific non-RS loads from AC and DC load groups aligned with RS panel.

o Override normal control circuit inputs to enable non-power or non-pneumatically assisted local control. Provide status information.

- RWST discharge valves (2)
- RHR valves (1 train)
- RHR suction valves from loop A

- RHR discharge valves to loop B
- Component cooling isolation valve to RHR HX (2).

o Override normal control circuit inputs to enable non- or non-pneumatic assisted local control.

  - TAFWP train valves

All control and indication wiring from the control room to the RSCS control circuits will be provided with suitable isolation devices so that a fault occurring between these points cannot disable both the normal and the RSCS control. In addition, the control transfer switch will provide for isolation of the existing Class-1E control circuits from the non-Class-1E RSCS circuits.

5.15.2 MINIMUM EQUIPMENT REQUIREMENTS

The RSCS is a single-train system. The minimum equipment/functions are defined in the previous subsection, 5.15.1.

5.15.3 ALTERNATIVE COMPONENTS CAPABLE OF PROVIDING REQUIRED FUNCTIONS

The RSCS is not the primary means of control. It provides an alternative to the normal control function performed from the control room. See Subsection 5.15.1 for details.

5.15.4 EXISTING FIRE-HAZARD-RELATED PROBLEM AREAS

The RSCS is a new system. There are no existing fire-hazard-related problem areas. However, the RSCS design will include consideration of the impact of high-hazard fire zones, particularly when routing cables and locating the RSCS control panel(s).

5.15.5 MODIFICATIONS PLANNED TO ENSURE AVAILABILITY OF SAFE-SHUTDOWN FUNCTION

The RSCS is a new system. The system will be designed so that no single postulated fire will be capable of disabling both the normal control/power train and the RSCS.

6.0 SUMMARY OF MODIFICATIONS REQUIRED TO ENSURE SAFE SHUTDOWN AND COOLDOWN CAPABILITY

The safe shutdown analyses have identified a number of plant modifications in order to provide additional assurance of the ability to reach a safe shutdown following a major fire within any single fire area. These modifications and the bases for their recommendation are discussed in Section 5.0 of this document, with specific references made to the components or areas that must be upgraded. In each case, the conceptual approach and options under consideration for accomplishing these modifications have been identified.

At least one hardware train, subsystem, or component will be made available for performance of each of the required safe shutdown functions in the event of a severe fire in <u>any</u> <u>one</u> of the designated plant fire zones.

The required modifications, although affecting many plant components, may be classified into several generic types, as follows:

- Establishment of alternative control and monitoring station(s), incorporating alternative primary and secondary system instrumentation to provide continuous displays of critical safe-shutdown-related parameters. The station is identified as the remote shutdown (RS) control panel. A control transfer scheme is provided to activate the alternative controls and status indication for critical safe-shutdown-related actuated devices.

- Provide for disconnection/override of normal electrical or pneumatic supply to safe-shutdown-related actuated device to permit local manual control. Device status indication is provided on the RS control panel when required.

- Provide for deenergizing of AC or DC power to the actuated device during normal plant operation, to preclude the possibility of fire-induced spurious actuations.

- Reroute control and/or power cables to avoid specific high-hazard fire zones generally occupied by redundant cables or components.

- Protect critical shutdown-related cables in selected areas with an appropriately rated fire barrier.

- Protect equipment by constructing new fire areas (i.e., enclosing areas within existing zones with appropriately rated barrier).

The generic types of required modifications and the affected systems or components are summarized on Table 6-1.

Table 6-1. Modifications to Enhance Safe Shutdown and Cooldown Capability

Type of Modification	Systems or Components Affected	Number of Channels or Trains Affected
Install remote shutdown (RS) control panel(s)	New system	One remote shutdown equipment train; number of panels not yet defined
Provide alternative remote indication - DS panel	Steam generator level, wide range	2
	Pressurizer level, wide range	1
	RCS pressure, wide range	1
	RCS temperature	Note 1
	Steam line pressure, wide range	2
	Condensate storage tank level, wide range	1
	SI system cold leg injection line flow	1
	RHR system flow	1
	Charging pump flow	1
Provide alternative controls, consisting of remote manual transfer of control with status indication and annunciation of control transfer in control room	Pressurizer relief isolation valves	2
	SI injection train	1
	SI pump cooling unit	1
	CC pump	1
	Charging pump - injection train	1
	Charging pump room cooling unit	1
	Letdown path isolation	Note 1
	Pressurizer PORV relief path isolation	2
	RWST to charging suction valve	
	Service water pump train	1
	SW auxiliary building isolation valves	2

Table 6-1. Modifications to Enhance Safe Shutdown and Cooldown Capability (Continued)

Type of Modification	Systems or Components Affected	Number of Channels or Trains Affected
(cont'd. from sheet 1)	RHR pump train	1
	Standby auxiliary feedwater pump train	1
	Instrument air compressor	1
	Pressurize PORVs (status indication only)	2
Provide for remote manual shedding of non-shutdown-related loads from DS-aligned switchgear	480-Vac distribution train A	1
Provide for remote manual transfer of DC power source from ESF (normal) DC supply to DS alternative DC supply	125-Vdc distribution train A	1
Provide for disconnection of normal electrical or pneumatic supply to actuated device to permit manual control; provide remote status indication	Main steam PORVs	2
	RHR valves	1
	Turbine-driven auxiliary feed pump valve train (status indication not required)	1
	RWST discharge valves	2
Reroute or protect power and/or control cables to avoid exposing redundant trains or components to common fire hazards	AC and DC electrical distribution train A	1
	Turbine-driven auxiliary feed pump	1
Plant physical (structural) modifications - install rated fire barriers, which may include fire doors, walls, and penetration seals	Charging pump room	
	Screen house operating floor service water pump area	

Note: 1.
To be defined based on subsequent analyses.

7.0 REFERENCES

1. RG&E - NRC letter dated July 27, 1978; SEP Safe Shutdown Review

2. RG&E - NRC letter dated December 28, 1979; Fire Protection - Shutdown Analysis

3. NRC SEP Safe-Shutdown Review dated November 14, 1980.

4. RG&E - NRC letter dated October 31, 1980; Environmental Qualification of Electrical Equipment