APPENDIX A

A FUNCTIONAL EVALUATION OF THE COMPONENTS OF THE SYSTEMS WHICH ARE SHARED BY THE TWO UNITS

A discussion is presented of the operation of those items of shared equipment which are components of the Engineered Safety Features System.

Certain components of the Auxiliary, Emergency, and Waste Disposal Systems are shared by the two units. Where relevant, Table A-1 presents a functional evaluation of the components of the system which are shared by the two units. In addition, any emergency and/or shutdown function of each system is indicated, together with the ability of the system to meet the emergency condition with either a failure of an active component or during maintenance outage of a single item of equipment.

Table A-1 shows that only certain components of shared equipment may be called upon to fulfill either an emergency and/or shutdown function. As previously stated, it is not considered a credible event that both units can simultaneously develop accident conditions, where each accident is independent of, and not related in any way, to the other. Thus the criterion for design is to have the capability to deal with the affected unit, while maintaining safe control of the second unit. For a two unit plant, the worst situation which is credible is when an accident condition on one unit causes tripping of that unit which in turn leads to the tripping of the second unit. Further, in the event that the loss of the output of the two units leads to the loss of all outside AC supply to the Station, the emergency diesel power supply is required to control the accident situation on the one unit, and maintain the second unit in a safe condition.

<u>Loss-of-Coolant Situations</u>

Situations in which both the high head safety injection pumps and emergency diesel power supply would be simultaneously required are restricted to loss of reactor coolant or a steambreak incident in one unit.

Automatic Operations

In the event of an accident requiring safety injection in one unit which is accompanied by a sequential trip of the second unit together with loss of all AC power to the nuclear units, the sequence of automatic operations is as follows:

Unit No. 3 - which has the accident condition

1. Safety injection actuation signal is initiated by the accident condition.

2. Reactor and Turbine both trip.

3. When the reactor coolant pressure has fallen below approximately 600 psig, at least two of the accumulators attached to the cold legs of loops A, B, and C will discharge their contents of borated water into the reactor coolant system.

4. Automatic starting of all four emergency diesel generators is initiated by the safety injection signals. Each emergency diesel generator then runs on a standby basis until there is a loss of voltage on its associated 4160 volt bus.

5. The auxiliary steam driven feedwater pump will begin operation.

Emergency Power Supply

The four emergency diesel generators have adequate capacity to supply all of the power required for both units under these emergency conditions for any credible single failure. Refer to Section 8.2.

Upon receipt of the command signal the emergency diesel generator will be started. Within 15 seconds the unit will be up to speed and voltage, ready to accept load. If there has been a loss of AC power, the output breakers will close, placing the emergency diesel generator on the bus which feeds the Engineered Safeguards equipment. The sequence is described in Section 8.2.

Sharing of the High Head Safety Injection Pumps

The high head safety injection pumps are the only pumps of the Engineered Safeguards shared by the two units which are not completely duplicated and redundant in sizing, since simultaneous accidents requiring their operation in both units are not deemed credible.

The high head safety injection lines to the reactor coolant system contain isolation valves which are normally in the closed position, opening automatically when a safety injection signal is generated. The sequence of opening is discussed in Section 6.2 under "Injection Phase".

Since all components of the Engineered Safeguards system except the high head injection pumps are separate for each unit, safety injection water from the high head injection pumps can only be delivered to the reactor coolant system of the unit which, as a result of its accident condition, has caused the isolation valves in its high head injection lines to be in the open position by generating a safety injection signal.

Operation of the Refueling Water Storage Tanks

In the current design of the system, separate refueling water storage tanks are provided for each unit. Since the high head injection pumps are common components to both units, they can draw from either one of the two tanks as shown in Figures 6.2-6 and 6.2-8. The connection from each tank to the suction of the pumps is open. The isolation valves (870A and 870B) on the suction side between pumps 3A/3B and 4A/4B are normally closed. Further, separate and independent residual heat (low head injection) and containment spray system both with an open connection to the associated refueling water tank, are provided for each unit.

The utilization of the water in one tank either to refuel or to control an accident in the unit with which it is associated, neither interferes with nor places any restriction on the operational mode of the second unit.

Unit No. 4 which does not have an accident condition

1. Turbine trips.
2. Reactor trips following turbine trip.
3. Automatic steam dump actuation may occur.
4. The auxiliary steam driven feedwater pump will begin operation.
5. The component cooling pump starts.

Manual Operations

The following manual operations will be carried out by the operator from the control room:

Unit 3 - which has the accident condition

1. In the event that the accident which caused one unit to generate a safety injection actuation signal is a loss of coolant accident, the safety injection phase when complete is followed by the recirculation phase. The component cooling and intake cooling water systems serve as heat sinks for the recirculation loop. Depending upon the size of the rupture in the reactor coolant system, the initial stage of the recirculation phase may require the use of a high head injection pump, (to supplement the head capacity of the residual heat removal pumps). Hence for the unit which has the accident condition, the refueling water tank will be isolated from the suction of the low head injection pumps, the containment spray pumps, and the shared high head injection pumps, in order to complete the changeover from the injection phase to the recirculation phase. Suction to the residual heat removal pump is from the containment sump during recirculation mode.

2. When the pressure in this unit has been reduced to a level where operation of a high head injection pumps during the recirculation phase is no longer required to cool the core, the pump can be shut off, and the isolation valves in the high head injection lines will be closed.

Common Control Console

The two units are served by various common shared systems and emergency console in the control room. Thus the operation of these common shared systems during changeover from the injection to the recirculation phase is accomplished from a single location.

Unit 4 - which has tripped

1. When the no load average coolant temperature is reached, the control of the steam dump is transferred to the steam pressure control.

2. Reactor coolant water level in the pressurizer is maintained by operating one of the three charging pumps on the emergency diesel bus; secondary side water level is maintained by operating the auxiliary feedwater system.

In addition to the double-ended break of a reactor coolant pipe, all other less severe ruptures of the reactor coolant system will require the operation of the Engineered Safety Features to an extent which depends upon the size of the rupture.

As pointed out previously there is one further type of accident which, although not directly associated with a rupture of the reactor coolant system, can nevertheless require the operation of the Engineered Safeguards system for shutdown and control of the unit. This accident is the rupture of a steam line. A steamline break constitutes an uncontrolled heat removal from the reactor coolant system which is limited by the steam line non-return and trip isolation valves. However, these valves cannot always preclude the blowdown of one steam generator, e.g., if the break occurs upstream of the isolation valve. In this case, there is a rapid cooldown of the reactor coolant system which particularly at the end of core life results in a reduction in shutdown reactivity margin after trip. The associated coolant contraction has the characteristics of the beginning of a loss of coolant and results in the initiation of the Engineered Safety Features as the pressurizer is emptied. The injection of borated water compensates for the temperature effect on reactivity.

For single unit plants, the design criterion for the main steam pipes is such that a rupture of one main steam pipe shall in no way affect the integrity of the other main steam pipe(s). In practice this means that the main steam piping is adequately anchored at the containment wall and is routed so that any whipping of the ruptured pipe will not result in the compounding of a break.

For a two unit plant, the layout of the two units and in particular the turbine building ensures that the main steam pipes of the respective units remain physically separated so that interaction between a ruptured steam pipe of one unit and any steam pipe of the second unit is not credible.

The double-ended rupture of a reactor coolant pipe remains the most severe of all of these accidents in terms of required operation of the Engineered Safety Features, and thus it is used together with a shutdown condition on the second unit as the basis for determining the requirements of the diesel generator emergency power supply system. See Section 8.

System	Components Shared	Function	Quantity Provided	Explanation	Serves Shutdown Function	Serves Emergency Function	Emergency (and Shutdown where Associated) Conditions Which Make the Maximum Demand on the System	Quantity Required to Meet the Maximum Demand	Ability to olerate Under Emergency Conditions Either Maintenance of a Single Item of Equipment or Failure of One Active Component
Chemical and Volume Control System	Boric Acid Tanks	Storage of boric acid for refueling shutdown and normal reactor makeup	3	Three tanks are provided such that all the boric acid required during the operating cycles of both units may be stored in them at 3.0-3.5% concentration. Each tank is capable of storing enough boric acid to shutdown one of the units at any time.	Yes (See Note 1)	No	N/A	N/A	N/A
	Boric Acid transfer pumps	Supply boric acid solution to charging pump suction headers	4	Two pumps are normally available with each unit with each pump having the capability to supply rated flow of boric acid to the charging pump suction header	Yes	No	N/A	N/A	N/A
	Batching Tank	Makeup of fresh concentrated boric acid	1	One tank is provided for the two units. It is seldom used after initial charging.	No	No	N/A	N/A	N/A
	Hold-up Tanks	Storage of dilute boric acid prior to recycle processing	3	Three tanks are provided to handle the rejected chemical shim solution from all expected operating and start up transients for two unit operation.	No	No	N/A	N/A	N/A
	Recirculation Pump	Handling of tank inventory	1	Serves the common holdup tanks infrequently	No	No	N/A	N/A	N/A

(1) Boric acid injection affords back up reactivity shutdown capability, independent of control rod cluster which normally servethis function in the short term situation. Normally boric acid injection is only used either to supplement rod control for xenon decay or for reactor cooldown

N/A Not applicable, i.e., Serves No Emergency Function

System	Components Shared	Function	Quantity Provided	Explanation	Serves Shutdown Function	Serves Emergency Function	Emergency (and Shutdown where Associated) Conditions Which Make the Maximum Demand on the System	Quantity Required to Meet the Maximum Demand	Ability to Tolerate Under Emergency Conditions Either Maintenance of a Single Item of Equipment or Failure of One Active Component
chemical and volume Control System	Gas Stripper Feed Pumps	Pumping of chemical shim solution to waste disposal to supply one	3	Three pumps are provided each with sufficient capacity processing train. One pump serves as a spare.	No	No	N/A	N/A	N/A
	Recycle Monitor Tank	Reservoirs for processed water for analysis prior to storage in primary water storage tank.	2	Two tanks are provided to permit continuous operation of of each evaporator train and so that one may be filling while the other is examined and emptied.	No	No	N/A	N/A	N/A
	Recycle Monitor Tank Pumps	Pump water from the monitor tanks to the primary water storage tank.	2	Two pumps are provided each with adequate capacity to handle both units. One pump serves as a spare to the other.	No	No	N/A	N/A	N/A

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Fire Protection system	Electric Fire Pump	Supplies dedicated amount of water to fire zones		Two separate tanks are provided, each with a respective fire pump, are provided as fire water sources	No	Yes	Fire		N/A
	Diesel Engine Driven Fire Pump		2 pumps					1 pump	
	Raw Water Tanks		2 tanks					1 tank	
Primary Makeup De-Mineralized water system	Demineralized water Storage tank	Supplies condensate makeup and the standby steam generator feedwater pumps	1	Adequate water available to ensure decay heat removal from reactor in either or both units. One tank is shared by both.	Yes	No	N/A	1	N/A

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Feedwater System	Auxiliary turbine-driven feed-water pumps	Provide a back up supply of feedwater in the event of loss of main feedwater supply to either one or both units.	3	One steam driven auxiliary feedwater pump will normally supply either unit with feedwater in the event of the loss of main feed-water pumps.	Yes	Yes	Loss of main feedwater supply to either unit.	1	Yes
	Standby Steam Generator Feedwater Pumps (SSGFP)	Feedwater supply to either one or both units. Used to supply feedwater during startups, shutdown and hot standby conditions.	2	One SGFP may be used during startup or shutdown operation at < 5% power when main SGFPs may not be available (or it is not desirable to run main SGFPs).	Yes	No	Both Units in Mode3 and main feedwater is not available (normal shutdown conditions, non-emergency).	1	N/A
Engineered Safe-guards System	High head Safety In-jection pumps	Supply coolant to the core in the event of either a LOCA or a main steam line break accident.	4	A set of four high head S.I. pumps is provided as common equipment for the two units. A.S.I. initiation signal from one unit will automatically direct the flow from two of these pumps to that unit.	No	Yes	LOCA in one unit	2	Yes
	Refueling storage tanks	Supply water for re-fueling and for delivery to the core following either a LOCA or steam line rupture accident.	2	One tank is supplied for each unit with the capacity to safely mitigate a LOCA in the unit.	Yes	Yes	LOCA in one unit	1	Yes

System	Components Shared	Function	Quantity Provided	Explanation	Serves Shutdown Function	Serves Emergency Function	Emergency (and Shutdown where Associated) Conditions Which Make the Maximum Demand on the System	Quantity Required to Meet the Maximum Demand	Ability to Tolerate Under Emergency Conditions Either Maintenance of a Single Item of Equipment or Failure of One Active Component
Electrical System	Emergency Diesel Generators	Supply emergency power in the event of a loss of the A.C. power supply.	4	Four emergency diesel generators are supplied and power loads common to both units. The emergency diesel generators have adequate capacity to safely control a LOCA in one unit and a concurrent trip of the second unit to the hot shutdown condition for any credible single failure Refer to Section 8.	No	Yes	LOCA in one Unit 1 with concurrent trip of the second unit (to the hot shutdown condition) when all A.C. power supply is simultaneously lost.	1	Yes
Waste Disposal	A common waste disposal system is to be used for the two units. Each containment structure is to have its own reactor coolant drain tank, and containment sump, and each is serviced by two reactor coolant drain tank pumps. All other waste disposal equipment is sized to adequately serve two units and the common auxiliary and service building. This shared equipment includes: Laundry and Hot Shower Tanks Waste Holdup Tank Gas Decay Tanks Waste Condensate Tanks Waste Condensate Pumps In addition, the Radwaste Solidification Building is shared by both units.			Waste Gas Compressors Drumming Station Boiling Station Gas Manifolds Gas Analyzer					The Waste Disposal System serves on no emergency function.
Fuel Handling	Spent Fuel Storage Facility	To store spent fuel removed from reactor core either during refueling or during defueling.	2	One spent fuel facility provided for each unit with enough capacity to store 1404 fuel assemblies. A common spent fuel cask crane allows movement of spent fuel from one unit to the other.	No	No	N/A	N/A	N/A