9.0 AUXILIARY AND EMERGENCY SYSTEMS

The auxiliary and emergency systems required to support the reactor during normal operation and servicing of TMI-1 are described in this Chapter. Some of these systems have also been described and discussed in Chapter 6, since they also serve as engineered safeguards. The information in this Chapter deals primarily with the functions served by these systems during normal operation.

The majority of the components in these systems are located within the Auxiliary Building. Those systems connected by piping between the Reactor Building and the Auxiliary Building are equipped with Reactor Building isolation valves as described in Section 5.3.

The systems considered in this Chapter are:

a. Makeup and Purification System

b. Chemical Addition and Sampling System

c. Intermediate Cooling System

d. Spent Fuel Cooling System

e. Decay Heat Removal System

f. Cooling Water Systems

g. Fuel Handling System

h. Ventilation Systems

i. Fire Protection Systems

j. Auxiliary Systems

In general, the following codes and standards are used as applicable in the design, fabrication, and testing of components and structures associated with the above systems; the actual codes and standards used for each system are noted in the individual sections.

a. ASME Boiler & Pressure Vessel Code, Section II, Material Specifications

b. ASME Boiler & Pressure Vessel Code, Section III, Nuclear Vessels

c. ASME Boiler & Pressure Vessel Code, Section VIII, Unfired Pressure Vessels and ASME Nuclear Case Interpretations

d. ASME Boiler & Pressure Vessel Code, Section IX, Welding Qualifications

e. Standards of the American Society for Testing Materials

f. USA Standard Code for Pressure Piping, USAS B31.1.0 1967 (Design of Nuclear and Power Piping; Fabrication and Testing of Power Piping)[1]

g. USA Standard Code for Nuclear Power Piping, USAS B31.7, February 1968 Draft including June 1968 Errata; issued for trial use and comment (fabrication, testing, and inspection of nuclear piping)

h. Standards of the Institute of Electrical and Electronics Engineers

i. Standards of the National Electrical Manufacturers Association

j. Hydraulic Institute standards

k. Standards of Tubular Exchanger Manufacturers Association

l. Air Moving and Conditioning Association standards

m. Standard D-100 of the American Water Works Association

The specific codes for components in safety-related systems are listed in the various tables of this Chapter. To assist in review of the system drawings, a standard set of symbols and abbreviations has been used and is summarized on Drawings 302001, 302002 and 302003.

(1) Inspection of Nuclear piping may meet the requirements of USAS B31.6, Addenda, and Code Cases which became effective after February, 1968 with regard to undercutting.

9.1 MAKEUP AND PURIFICATION SYSTEM

9.1.1 DESIGN BASES

The Makeup and Purification System is designed to accommodate the following functions during normal reactor operation:

a. Supply the Reactor Coolant System with fill and operational makeup water.

b. Provide seal injection water for the reactor coolant pumps.

c. Provide for purification of the reactor coolant to remove corrosion and fission products.

d. Control the boric acid concentration in the reactor coolant.

e. In conjunction with the pressurizer, the system will accommodate temporary changes in reactor coolant volume due to small temperature changes.

f. Maintain the proper concentration of hydrogen and corrosion- inhibiting chemicals in the Reactor Coolant System.

g. Provides makeup for core flood tanks.

h. Vent gases from Reactor Coolant System.

The Makeup and Purification System serves to control the reactor coolant inventory and the boric acid concentration in the Reactor Coolant System through the processes of letdown and makeup and to remove impurities in the water. The maximum letdown capability is 140 gpm at full reactor temperature and pressure.

At other conditions, the maximum letdown flow is based on assuring that resin temperature limits are not exceeded. The normal letdown flow rate of 45 gpm permits recirculation of one Reactor Coolant System volume per day through the purification demineralizers and the makeup filters. Each letdown cooler, makeup filter, and demineralizer is sized for half of the maximum letdown flow rate. The letdown and makeup functions also accommodate thermal expansion and contraction of the reactor coolant water during startup and shutdown transients.

9.1.2 SYSTEM DESCRIPTION AND EVALUATION

The Makeup and Purification System is shown schematically on Drawings 302660 and 302661. Tables 9.1-1 and 9.1-2 list the system performance requirements and data for individual components. The following is a brief functional description of system components.

a. Letdown Cooler

The letdown cooler reduces the temperature of the letdown flow from the Reactor Coolant System to a temperature suitable for demineralization and injection to the reactor coolant pump seals. Heat in the letdown coolers is rejected to the intermediate cooling system. Two letdown coolers are normally in service.

b. Letdown Flow Control

The normal letdown flow rate at reactor operating pressures is controlled by a fixed block orifice. A parallel, normally closed, remotely operated valve can be opened to obtain flow rates up to the maximum letdown capability. This valve is also used to maintain the desired letdown rate at reduced reactor coolant pressures. In addition there is a second parallel, normally closed valve which may be manually positioned for flow control.

c. Letdown Flow Radiation Monitor

A radiation monitor is installed downstream of the block orifice to signal high gamma activity levels in the letdown flow.

d. Letdown Filters

Two letdown filters in parallel are provided to remove particulates from the letdown stream prior to its entering the purification demineralizers. During steady state operation, these filters are bypassed. One filter is normally placed in service during plant conditions that could cause crud bursts.

e. Purification Demineralizers

The mixed-bed demineralizers are boric acid saturated and are used to remove reactor coolant impurities other than boron. Each demineralizer can process one reactor coolant volume in 24 hours at the normal letdown rate. Since the reactor coolant may be contaminated with fission products, the resins will remove certain radioactive impurities. Chapter 11 describes coolant activities, coolant handling and storage, and expected limits on activity discharge.

f. Makeup Filters

Two makeup filters in parallel are provided to remove particulates from the fluid streams entering the makeup tank with the exception of the seal water return stream. One filter is normally in use.

g. Makeup Pumps

There are three makeup and purification pumps. Normally, one is operating and two are on engineered safeguards standby. The operating pump takes suction from the makeup tank and discharges to the normal makeup and the seal injection lines. Upon engineered safeguards initiation, the pumps on engineered safeguards standby are activated. They take suction from the borated water storage tank, discharging into each of the four reactor coolant pump discharge lines.

h. Reactor Coolant Pump Seal Return Coolers

The seal return coolers are sized to remove the heat added by the makeup and purification pumps and the heat picked up in passage through the reactor coolant pump seals. Heat from the coolers is rejected to the nuclear services cooling water system. Two coolers are provided, and one is normally in operation.

i. Reactor Coolant Pump Seal Return Filter

A single filter is installed in the seal return line upstream of the seal return coolers to remove particulate matter. A bypass is installed to permit servicing during operation.

j. Reactor Coolant Pump Seal Injection Filters

The filters are installed in the seal injection line in parallel to prevent particulate matter from entering the reactor coolant pump seals. One filter is designed for normal use and the other is used during replacement of the normal filter element.

k. Makeup Tank

The makeup tank serves as a receiver for letdown, seal return, chemical addition, and system makeup. The tank also accommodates temporary changes in system coolant volume, the tank is designed to withstand the pressure and vacuum conditions associated with all modes of system operation and anticipated operational transients, such as a loss of cover gas.

9.1.2.1 System Operation

During normal operation of the Reactor Coolant System, one makeup pump continuously supplies high pressure water from the makeup tank to the seals of each of the reactor coolant pumps and to a makeup line connection to one of the reactor inlet lines. Makeup flow to the Reactor Coolant System is regulated by the reactor coolant volume control valve, which operates on signals from the pressurizer level controller.

If greater than normal makeup is required, motor operated valve MU-V217 allows the operator to provide makeup to the Reactor Coolant System by bypassing valve MU-V17 without initiating HPI. High makeup flow is alarmed in the Control Room.

Seal injection flow will be automatically controlled to the desired rate. A portion of the water supplied to the pump seals leaks off as controlled bleed-off and returns to the makeup tank after passing through one of the two reactor coolant pump seal return coolers and the seal return filter. The remainder is injected into the Reactor Coolant System or passes through the next stage of the RCP seal into the RCDT.

Seal water inleakage to the Reactor Coolant System makes necessary a continuous letdown of reactor coolant to maintain the desired coolant inventory. Letdown is also required for removal of impurities and boric acid from the reactor coolant. The letdown is capable of being cooled by one or both of the letdown coolers and pressure is reduced by the letdown orifice. Letdown flow then passes through the purification demineralizer to a three way valve which directs the coolant to the makeup tank or to the Liquid Waste Disposal System (WDL).

Normally, the three way valve is positioned to direct the letdown flow to the makeup tank. If the boric acid concentration in the reactor coolant is to be reduced, the three way valve is positioned to divert the letdown flow to the WDL System. Boric acid is removed in the WDL system either by directing the letdown flow through a deborating demineralizer with the effluent returned directly to the makeup tank or by the feed and bleed method. Feed and bleed is the process of directing the letdown flow to a reactor coolant bleed tank and maintaining the level in the makeup tank with demineralized water pumped from another reactor coolant bleed tank. The flow of demineralized water is measured and totaled by in-line flow instrumentation. The flow of demineralized water returning to the makeup tank is controlled remotely by the makeup control valve. During normal operation, the batch controller and the operator will control dilution.

Reactor coolant boron concentration is increased by adding boron in the form of concentrated boric acid solution. Concentrated boric acid is available from either the Liquid Waste Disposal System, where boron may be reclaimed, or the Chemical Addition System. The concentrated boric acid enters the makeup system upstream from the batch controller; it can be mixed directly at this point with makeup water, or it can pass through the heat-traced line and the batch controller and can be mixed with the letdown flow upstream of the purification filters.

The makeup tank also receives chemicals for addition to the reactor coolant. A hydrogen overpressure is maintained in the tank to assure a slight amount of excess hydrogen in the circulating reactor coolant. To scavenge excess oxygen, other chemicals are injected in solution and the tank serves as a final mixing location.

System control is accomplished remotely from the Control Room with the exception of periodic switching of the reactor coolant pump seal return coolers. The letdown flow rate is set for flow rates other than normal by remotely positioning the letdown flow control valve to pass the desired flow rate. The spare purification demineralizer can be placed in service by remote positioning of the demineralizer isolation valves. The letdown flow to the WDL System is diverted by remote positioning of the three-way valve and the valves in the WDL System. The reactor coolant volume control valve is automatically controlled by the pressurizer level controller.

The Makeup and Purification System may also be used independently of the Chemical Addition System to inject boric acid into the Reactor Coolant System to achieve cold shutdown. One makeup pump taking suction from the Borated Water Storage Tank is capable of injecting boric acid into the Reactor Coolant System at a rate sufficient to achieve cold shutdown accounting for all transient xenon effects.

Emergency operation of this system is described in Chapter 6.

9.1.2.2 Reliability Considerations

The Makeup and Purification System provides essential functions for normal operation of the unit. Redundant components and alternate flow paths have been provided to improve system reliability.

In addition to the letdown orifice, the system has two full-capacity control valves in parallel with the orifice. One of these control valves is operated manually and the other is remotely operated.

The unit has three makeup pumps, each sized to be capable of supplying the required reactor coolant pump seal and makeup flow. One is normally in operation while the other two are on standby status to be used as needed.

The makeup system equipment is sized to provide 100 percent redundancy. One of each of the two letdown coolers, purification demineralizers, and makeup filters will perform the required duty with normal letdown flow. When letdown greater than normal is required, the redundant component is used.

9.1.2.3 Codes And Standards

Each component of this system is designed, fabricated, and inspected to the code or standard, as applicable, noted in Tables 9.1-2 and 6.1-5.

9.1.2.4 System Isolation

The letdown line and the reactor coolant pump seal return line are outflow lines which penetrate the Reactor Building. Both lines contain motor operated isolation valves inside the Reactor Building and pneumatic valves outside which are automatically closed by an ES signal (See Section 7.1.3). The injection line to the reactor coolant pump seals is an inflow line penetrating the Reactor Building. This line contains a check valve inside the Reactor Building and a remotely operated valve outside of the Reactor Building. Check valves in the discharge of each high pressure injection pump provide further backup for Reactor Building isolation. The emergency coolant injection lines are used for injection of coolant into the reactor vessel after a loss of coolant accident (LOCA). After use of the lines for emergency injection is discontinued, the motor-operated isolation valves in each line outside the Reactor Building may be closed remotely by the Control Room operators for isolation.

9.1.2.5 Leakage Considerations

Design and installation of the components and piping in the Makeup and Purification System considers radioactive service.

A leakage reduction program for systems outside containment has been developed consistent with the requirements of NUREG 0578. This program will maintain the leak tightness of the system at acceptable levels. Except where flanged connections have been installed for ease of maintenance, all piping connections are welded.

9.1.2.6 Failure Considerations

The effects of failures and malfunctions in the Makeup and Purification System concurrent with a LOCA are presented in Chapter 6. Section 9.1.2.4 describes system isolation. These analyses show that redundant safety features are provided where required.

For pipe failures in the Makeup and Purification System, the consequences depend upon the location of the rupture. If the rupture were to occur between the reactor coolant loop and the first isolation valve or check valve, it would lead to an uncontrolled loss of coolant from the Reactor Coolant System. This LOCA is considered in Chapter 14. If the rupture were to occur beyond the first isolation valve or outside the Reactor Building, any release of radioactivity would be detected and is limited by the small line size and by the closing of the isolation valve or check valve. If the letdown line were to rupture in the auxiliary building upstream of the block orifice, the high letdown temperature would automatically close the reactor building isolation valves and isolate the leak. The effects of this event are discussed further in Appendix 14A.

A single failure will not prevent boration when desired for reactivity control because several alternate paths are available for adding boron to the Reactor Coolant System. These are: (1) through the normal makeup lines, (2) through the reactor coolant pump seals, and (3) through the high pressure injection connections. If pump suction is unavailable from the makeup tank, a source of borated water will be available from the borated water storage tanks during reactor power operation.

9.1.2.7 Operational Limits

Alarms, interlocks, and administrative controls are provided to limit variables or conditions of operation that could cause system malfunctions. The variables or conditions of operation that are limited are as follows.

a. Makeup Tank Level and Pressure

   Low water level in the makeup tank is alarmed and interlocked to the three way bleed valve. Low-low water level will switch the three way valve from the bleed position to its normal (to makeup tank) position.

   Makeup Tank level and pressure are administratively controlled to assure adequate pump suction conditions for all design basis LOCA's.

b. Letdown Line Temperature

   A high letdown temperature in the letdown line downstream of the letdown coolers is alarmed and interlocked to close the pneumatic letdown isolation valve, thus protecting the purification demineralizer resins.

c. Dilution Control

   The dilution cycle is initiated by the operator. Several safeguards are incorporated into the design to prevent inadvertent excessive dilution of the reactor coolant, including:

   1) The dilution valves are interlocked so that the operator must preset the desired dilution batch size before initiating the dilution cycle. The dilution cycle will automatically terminate when the dilution flow has delivered the preset batch size.

   2) The dilution cycle (i.e. continuous feed & bleed) is permitted when all safety rods are out. The dilution cycle will automatically terminate when this condition is no longer satisfied.

   3) The operator may manually terminate the dilution cycle at any time.

TABLE 9.1-1
(Sheet 1 of 1)

MAKEUP AND PURIFICATION SYSTEM PERFORMANCE DATA

Nominal letdown flow, gpm	53
Maximum letdown flow, gpm	140
Total seal flow to each reactor coolant pump, gpm (minimum for continuous RCP operation)	8
Seal inleakage to Reactor Coolant System per reactor coolant pump, gpm (nominal)	5
Injection pressure to reactor coolant pump seals, psig (nominal)	2190
Temperature to seals, normal/maximum, °F	90/130
Purification letdown fluid temperature, normal/maximum, °F	120/135

TABLE 9.1-2
(Sheet 1 of 4)
MAKEUP AND PURIFICATION SYSTEM COMPONENT DATA

Makeup Pump (MU-P-1A/B/C)

Type	Horizontal, multistage, centrifugal, mechanical seal
Capacity, gpm	(See Figure 6.1-2)
Head, ft H_2O	(See Figure 6.1-2)
Motor horsepower, nameplate hp	700
Pump material	SS wetted parts
Design pressure, psig	3000
Design temperature, °F	200

Letdown Cooler (MU-C-1A/B)

Type	Shell and spiral tube
Heat transferred, Btu/hr	16.1×10^6
Letdown flow, lb/hr	3.5×10^4
Letdown cooler inlet/outlet Temperature, °F	555/120
Material, shell/tube	CS/SS
Design pressure (shell/tube), psig	200/2500
Design temperature (shell/tube), °F	350/600
Component cooling water flow (each), lb/hr	2×10^5
Code	ASME Sections III-C and VIII

TABLE 9.1-2
(Sheet 2 of 4)

MAKEUP AND PURIFICATION SYSTEM COMPONENT DATA

Reactor Coolant Pump Seal Return Cooler (MU-C-2A/B)

Type	Shell and tube
Heat transferred, Btu/hr	1.1×10^6
Flow rate, lb/hr	5.23×10^4
Temperature change, °F	141 to 120
Material (shell/tube)	CS/SS
Design pressure (shell/tube), psig	150/150
Design temperature (shell/tube), °F	250/200
Recirculated cooling water flow (each), lb/hr	1.25×10^5
Code	ASME Sections III-C and VIII

Reactor Coolant Pump Seal Return Filter (MU-F-3)

Design flow rate, gpm	20
Material	SS
Design temperature, °F	200
Design pressure, psig	150
Code	USAS B31.7

TABLE 9.1-2
(Sheet 3 of 4)
MAKEUP AND PURIFICATION SYSTEM COMPONENT DATA

Reactor Coolant Pump Seal Injection Filter (MU-F-4A/B)

	MU-F-4A:	MU-F-4B:
Design flow rate, gpm	80	50
Design temperature, °F	250	200
Design pressure, psig	3100	3050
Material	SS	SS
Code	ASME Sect III Class 2	USAS B31.7

Makeup Tank (MU-T-1)

Volume, ft^3	600
Design pressure, psig	100
Design temperature, °F	200
Material	SS
Code	ASME Section III-C

Purification Demineralizer (MU-K-1A/B)

Type	Mixed bed, boric acid, saturated
Material	SS
Resin bed volume, ft^3	50
Flow, gpm	70
Vessel design pressure, psig	150
Vessel design temperature, °F	200
Code	ASME Section III-C

TABLE 9.1-2
(Sheet 4 of 4)

MAKEUP AND PURIFICATION SYSTEM COMPONENT DATA

Letdown Filter (MU-F-2A/B) and Makeup Filters (MU-F-1A/B)

Design flow rate, gpm	80
Material	SS
Design pressure, psig	300
Design temperature, °F	250
Code	ASME Section III-C

9.2 CHEMICAL ADDITION AND SAMPLING SYSTEMS

The Chemical Addition System and the Sampling System both provide their respective functions for both the Primary System and the Radioactive Liquid and Gas Waste Systems. The major equipment of the Chemical Addition System, with the exception of the filter precoat skid, is located on elevation 331 ft of the Auxiliary Building. The filter precoat skid is located on elevation 305 ft of the Auxiliary Building. The major equipment of the Sampling System is located in a shielded sampling room on elevation 306 ft of the Control Room tower. The equipment for continuous sampling of waste gases is located within a shielded cubicle on elevation 305 ft of the Auxiliary Building. Equipment for maintaining the quality of the feedwater to the steam generators is located within the Turbine Building. (See Section 10.4.2).

9.2.1 CHEMICAL ADDITION SYSTEM

The Chemical Addition System comprises a number of individual systems (each having their major equipment components and piping system with valves and controls) as required to perform various functions related to the operation of the Primary System, the spent fuel pools, and the Radioactive Liquid and Gas Waste Disposal Systems. The Chemical Addition System is shown on Drawings 302669 and 302670. The major equipment components of the Chemical Addition and Sampling Systems are listed with pertinent data in Table 9.2-1. The hydrogen and nitrogen manifold systems are shown on Drawing 302720.

Other chemical addition equipment is provided in the Turbine Building as required to maintain the quality of feedwater to the steam generators as indicated in Table 9.2-2.

9.2.1.1 System Functions

The Chemical Addition System provides gas manifolds, tanks, pumps, piping systems and associated valves and controls as required to furnish the following functions:

Boric Acid Mix Tank and Pumps	Provides a source of fresh, concentrated boric acid solution for chemical shim control in the Primary System; normal makeup to spent fuel pools; normal makeup to the borated water storage tank; and, to maintain boron concentration levels, and emergency boration.
4 percent Boric Acid Mix Tank and Pump	Provides a source of boric acid solution containing 4 percent by weight (7,000 ppm boron) to the core flood tanks.

Item	Function
Reclaimed Boric Acid Storage Tank	Provides a source of concentrated boric acid solution in addition to the borated water storage tank
Lithium Hydroxide Mix Tank and Pump	Provides a strong basic solution for pH control of primary coolant.
Caustic Mix Tank and Pump	Provides a strong base (NaOH) for regenerating deborating resins and for neutralizing solutions in the neutralizer tank. Provides Lithium/Sodium Hydroxide addition capability for Decay Heat and primary Makeup Systems.
Hydrazine Drum and Pump	Provides a reducing agent for control of oxygen dissolved in reactor coolant.
Zinc Injection Skid	Provides capability to inject small amounts of zinc to reduce dose rates due to corrosion product deposits and to reduce potential for PWSCC.
Reclaimed Water Storage Tank, Reclaimed Water Pressure Tank, and Reclaimed Water Pump	Provides a source of reclaimed (or demineralized) water for various uses in the Primary System, the Radioactive Liquid Waste System, the spent fuel pools, and the Chemical Addition System. The storage and pressure tanks are nitrogen blanketed to maintain low oxygen content in the water.
Filter Precoat Skid (includes mix tank, pumps, piping, valves, and controls)	Provides a slurry of fresh precoat filters and recirculation to hold precoat in place on a filter in the event that it is not in use.
Resin Add Tank	Provides gravity-fed charges of fresh resin to demineralizers in the Makeup and Purification and Radioactive Liquid Waste Systems.
Hydrogen Manifold	Provides hydrogen for control of dissolved oxygen in reactor coolant.
Nitrogen Manifold	Provides blanket gas for makeup tank and Waste Gas System and makeup gas to core flood tanks.

9.2.1.2 Design Bases

A single boric acid mix tank is provided as a basic source of concentrated boric acid solution for use throughout the nuclear portions of the plant. The quantity of boric acid retained in this tank or that retained in the reclaimed boric acid tanks of the Radioactive Liquid Waste System provide more than sufficient boric acid solution to increase the boron concentration of the Reactor Coolant System to a one percent subcritical margin in the cold condition at the worst time in core life with the maximum worth control rod stuck out and accounting for xenon decay. The minimum boron solution volume and concentration required in the BAMT or RBAST for the current cycle are given in plant operating procedures and in the Core Operating Limits Report.

The boric acid pumps are provided to facilitate transfer of the concentrated boric acid solution from the boric acid mix tank to the makeup tank, core flood tanks, the reactor coolant bleed tanks, the spent fuel storage pools, or the borated water storage tank. The two pumps are sized so that, when one pump is operating, a complete charge of concentrated boric acid solution from the boric acid mix tank may be injected into the Reactor Coolant System to achieve cold shutdown at a rate sufficient to account for all transient xenon effects.

Concentration of boron in the boric acid mix tank or a reclaimed boric acid storage tank may be higher than the concentration which would crystallize at ambient conditions. For this reason, the boric acid mix tank is provided with an immersion electric heating element and the reclaimed boric acid tanks are provided with low pressure steam heating jackets to maintain the temperature of their contents well above (10°F or more) the crystallization temperature of the boric acid solution contained in them. Both types of heaters are controlled by temperature sensors immersed in the solution contained in the tanks. Further, all piping, pumps and valves associated with the boric acid mix tank and the reclaimed boric acid storage tanks through which flow is required to transport boric acid solution from them to the makeup and purification system are provided with redundant electrical heat tracing to ensure that the boric acid solution will be maintained 10°F or more above its crystallization temperature. The electrical heat tracing is controlled by the temperature of the external surfaces of the piping systems. Once in the makeup and purification system, the boric acid solution is sufficiently well mixed and diluted so that normal system temperatures assure boric acid solubility.

Parallel filters are provided in the suction line to the boric acid pumps to remove particulates and thus protect the pumps. A valved bypass line is provided.

The volume of the lithium hydroxide mix tank is based on maintaining a sufficient quantity of lithium hydroxide solution available for addition to the Reactor Coolant System so that the required concentration (See Table 9.2-3) can be maintained in the primary coolant while letting down at the maximum rate. The capacity of the lithium hydroxide pump is also based on this criterion.

The volume of the caustic mix tank is based on providing adequate sodium hydroxide solution to regenerate the resin in a deborating demineralizer. Technical Specification Change Request #337 has deleted the requirement of injecting NaOH using the caustic mix tank into the suction line of either of the two decay heat pumps for the Reactor Building sump pH control. Note, however, that the caustic mix tank and caustic supply are not safety related. The caustic mix tank and pump may also be used to add Lithium Hydroxide to the suction line of either of the two Decay Heat Removal System pumps. A cross connecting pipe with isolation valves allows the caustic tank and pump to add Lithium Hydroxide to the Makeup System at a faster rate than the Lithium Hydroxide pump.

The zinc injection skid provides capability to inject a flow of up to 3 ml/min of zinc acetate solution into the letdown stream to achieve a target concentration of 6 to 10 ppb zinc in the RCS in order to reduce dose rates due to ex-core corrosion product deposits and to reduce potential for PWSSC of the RCS pressure boundary materials.

The capacity of the reclaimed water storage tank is 13,000 gallons. The reclaimed water pump and reclaimed water pressure tank are sized based on continuously supplying 100 gpm of reclaimed water, at a pressure of 55 to 75 psig, to the various distribution headers being supplied.

The filter precoat tank and pumps are sized based on applying a precoat of filter material to one of the precoat filters of the Radioactive Liquid Waste System. The precoat pumps are also capable of maintaining a precoat in place in a precoat filter when there is no process fluid flowing through it. The process flow rate through the precoat filters is sensed and, when it declines to a level just adequate to maintain precoat, the appropriate precoat pump automatically starts to ensure that the precoat is maintained on the filter.

The resin tank is sized to permit gravity replacement of resin in any of the demineralizers of the Makeup and Purification or Radioactive Liquid Waste System. The routing of resin to the proper pair of demineralizers is assured by the manual installation of a "dutchman" between the resin tank outlet and the resin fill line to the pair of demineralizers being serviced.

The Chemical Addition System tanks are designed to withstand the pressure and vacuum conditions associated with all modes of system operation and anticipated operational transients.

A hydrogen manifold is provided to maintain adequate hydrogen partial pressure in the gas space of the makeup tank to limit the dissolved oxygen content in the reactor coolant to an acceptable level during normal operation.

Two nitrogen manifolds are provided. One supplies fresh nitrogen blanket gas to the makeup tank and the low pressure vent header portion of the Radioactive Waste Gas Disposal System and provides miscellaneous nitrogen source throughout the nuclear systems. (See Section 11.2.2.4.) The second nitrogen manifold has two pressure reducing stations, one to supply high pressure nitrogen to the core flooding tanks and the other to provide low pressure backup gas supply to penetration pressurization.

A relief valve is provided in the high pressure nitrogen manifold to prevent inadvertent over pressurization of the Reactor Coolant System during shutdown.

9.2.1.3 Methods of Operation

The individual systems of the Chemical Addition System are operated independently as required to perform the various functions each is designed to provide. The only fully automatic functioning systems are the reclaimed water supply system and the nitrogen manifolds. The functions of all other systems constituting the Chemical Addition System are initiated by operator action and may thereafter be subject to local or remote manual control, automatic control, or a combination of these.

9.2.1.4 System Evaluation

Each of the individual subsystems of the Chemical Addition System provides makeup/storage capacity and flow capability to adequately fulfill all functions required of it. The concentrated boric acid storage and injection capability of the Chemical Addition System is supplemented by that of the Liquid Waste Disposal System to always ensure an adequate supply for cold shutdown capability. (See Section 11.2.1.)

If the BWST is lost, a source of concentrated boric acid is needed to achieve cold shutdown. The concentrated boric acid can be supplied from the Boric Acid Mix Tank/Pumps or the Reclaimed Boric Acid Tank/Pump as described in 9.2.1.2 above.

The system (except for the Boric Acid Mix Tank/Pumps or the Reclaimed Boric Acid Tank/Pumps) is not required to function during an emergency nor is it required to take action to prevent an emergency condition. It is designed to perform in accordance with standard practice of the chemical process industry with duplicate equipment, such as pumps and high pressure regulating valves, as required.

9.2.2 SAMPLING SYSTEM

The Liquid and Gas Sampling System provides the capability for remote sampling of liquids and gases from various points in the primary and secondary systems, the Decay Heat System, the OTSG, the Core Flood System, and the Liquid and Gas Waste Systems. The Liquid and Gas Sampling System is shown on Drawings 302671 and 302673. The major components of the system are the "hot" sample hood and sink, the post accident pressurized sample panel, the three sample coolers, and the continuous waste gas analyzers. The Steam Generator Blowdown and Liquid Sample System provide continuous OTSG blowdown flow to the condenser as well as continuous OTSG shell side sample flow to the secondary sample lab sodium analyzers. The SGBD and Liquid Sample System are shown on drawing 302-710. The major components of the system are the containment isolation valves, pressure reducing 'drag' valves, two sample coolers, exchange board, sample hood and sink, and the sodium analyzers.

9.2.2.1 System Functions

The Liquid and Gas Sampling System permits the remote sampling of liquids and gases from various points in the primary and secondary systems, the Decay Heat Removal System, the OTSG, the Core Flooding System, and Waste Systems during normal operation, unit nuclear cooldown, and postaccident conditions.

The Steam Generator Blowdown and Liquid Sampling System provides continuous 22 gpm (nominal, 44 gpm max, based on EPRI NP-7380) per OTSG blowdown flow to the condenser as well as continuous OTSG shell side sample flow to the secondary sample lab sodium analyzers from 0-15% power. Blowdown system operation is normally performed during low power startup (<15%) operations, when dissolved impurities can accumulate and increase impurity concentrations within the water levels internal to the OTSG. Flow is controlled by pressure-reducing and flow control valves (FW-V-86A/B) installed at penetrations 37 and 38 on the main condenser. These valves ensure the system is maintained subcooled and the entire pressure drop is accounted for (minus line losses) across the control valve.

The combined SGBD and Liquid Sampling System piping separate in the turbine building downstream of the containment isolation valves. Containment isolation valves replace the spectacle flanges in the system in order to maintain containment integrity and provide automatic isolation.

9.2.2.2 Design Bases

Remote sampling is provided for all critical locations in the plant nuclear systems as follows:

a. Cool, depressurize, and provide grab samples in the sample hood of the following:

   1) Pressurizer steam space

   2) Pressurizer water space

   3) Reactor coolant

   4) Steam generator "A" (shell side)

   5) Steam generator "B" (shell side)

b. Depressurize and provide grab samples in the sample hood of the following:

   1) Decay heat cooler "A" primary side outlet

   2) Decay heat cooler "B" primary side outlet

   3) Makeup tank water space

   4) Core flooding tank "A" water space

   5) Core flooding tank "B" water space

   6) Purification demineralizer outlet
   7) Deborating demineralizer inlet
   8) Deborating demineralizer outlet
   9) Evaporator condenser demineralizer outlet
   10) Cation demineralizer "A" inlet
   11) Cation demineralizer "A" outlet
   12) Cation demineralizer "B" inlet
   13) Cation demineralizer "B" outlet
   14) Miscellaneous waste storage tank water space
   15) Reactor coolant bleed tanks water space
   16) Laundry waste storage tank water space

c. Provide a pressurized sample in sample cylinders of the following:

   1) Pressurizer steam space
   2) Pressurizer water space
   3) Reactor coolant letdown

d. Provide gas samples for hydrogen and oxygen analysis of the following tank gas spaces:

   1) Miscellaneous waste evaporator
   2) Miscellaneous waste storage tank
   3) Reactor coolant bleed tanks (3)
   4) Waste gas decay tanks (3)
   5) Reactor coolant evaporator
   6) Reactor coolant drain tank
   7) Inlet to waste gas delay tank, i.e., low pressure inlet header
   8) Makeup tank gas space

Sample lines are routed via shielded locations to the sample station and, where necessary, delay lines are provided for the decay of the short-lived, high-energy N-16 activity.

Two Beckman Industrial waste gas analyzer panels are provided where each panel is capable of monitoring oxygen (O_2) and hydrogen (H_2) gas concentrations in the gas spaces of critical tanks and equipment in the Liquid and Gas Waste Systems. Each of the panels can continuously monitor any one of the eleven sample points described in subparagraph d. above. The two analyzer sample points are manually chosen where potentially nonhomogeneous concentrations of O_2 and H_2 could be expected to occur. Following are the features of each analyzer panel pertaining to O_2 and H_2 gas measurements:

- local indication
- local and remote alarms
- pressure regulators for the high pressure sample points
- sample moisture removal equipment, sampling pump, local sample flow and analyzer bypass flow indications, and various pressure relief and calibration provisions.

The hydrogen and oxygen analyzers are a completely contained unit. The units are located in the Auxiliary Building at elevation 305 ft. Provision is also made to bypass a gas sample to a sample cylinder, where the gas sample can be taken to the radiochemistry laboratory for more complete analysis.

As part of the SGBD and Liquid Sampling System, two fully self contained sodium analyzer units (one for each OTSG) are provided to monitor the sodium concentration of the OTSG shell side feedwater. They are located in the secondary sample lab and are normally in service below 15% reactor power.

The piping and equipment in the Liquid and Gas Sampling System was designed, furnished, and installed to applicable codes and standards. The applicable ASME codes are as follows: Reactor Coolant Sample Cooler - ASME Section III, Class C; Steam Generator Sample Cooler - ASME Section VIII.

The SGBD and Liquid Sampling System is designed and procured in accordance with R.G. 1.143. Pipe supports inside containment and up to and including the CIVs outside containment are designed in accordance with AISC 9th Ed. and classified as Seismic Class I. The remainder of the system is Seismic Class III.

The quality of the reactor coolant to be determined by the Sampling System and maintained by the Chemical Addition System is given in Table 9.2-3.

9.2.2.3 Methods of Operation

All sampling functions are manually initiated and completed.

The SGBD and Liquid Sampling System operating procedures outline the steps necessary to initiate and terminate OTSG blowdown and sampling.

The gas analyzers also function to provide samples in a pressurized vessel for further analysis from all its sample points. The isolation valves in all sample lines penetrating containment are normally closed and are opened only as required to obtain the desired sample. Open isolation valves in sample lines penetrating containment are automatically closed by their applicable isolation signals as described in Section 5.3.

9.2.2.4 System Evaluation

All sample lines and SGDB lines penetrating containment were designed, fabricated, and installed to applicable codes and standards for the design service. All such lines are provided with double isolation valves, one inside and the other outside containment. The isolation valves inside containment are electrically operated while those outside are pneumatically operated, and both are automatically closed by their applicable isolation signals as described in Section 5.3. The routing of sample lines within containment has been selected to afford a high degree of protection.

Most sample lines are routed through Class I structures hardened to withstand the hypothetical aircraft incident. The remote sample station is also located in a Class I structure hardened to withstand the hypothetical aircraft incident. Sample lines are specially shielded, as required, to protect plant personnel from radiation in the course of their normal duties.

The TMI-1 sampling system is completely independent of the TMI-2 sampling system. Previously installed TMI-2 sample lines into the TMI-1 sample laboratory have been removed.

Within the sampling station, sampling system equipment components were designed, fabricated, and installed to applicable codes and standards for the design service. Special shielding is provided as required for protection of plant personnel or maintaining system integrity.

All of the SGBD and Liquid Sampling System piping is considered high energy piping while the system is in service. While the system is not in service only the piping inside the containment building is considered high energy piping. HELB has been considered for areas inside the containment building and the piping is restrained as appropriate. HELB is not considered for areas outside of containment as the configuration does not affect safety related equipment or the Turbine Building environment.

9.2.2.5 Postaccident Sampling Capability

Note: Technical Specifications Amendment #253 eliminated the requirements to maintain a Post Accident Sampling System. The Post Accident Sampling System will be maintained for contingency actions and long-term post accident recovery operations (see Section 1.3.2.10 Postaccident Sampling). Postaccident analysis of reactor coolant samples and the containment atmosphere is recognized as a means to better define long–term recovery operations.

The key parameters to be determined are containment hydrogen concentration, reactor coolant boron concentration, reactor coolant total gas and/or hydrogen concentration, and gross activity. The on-line containment hydrogen monitoring system is described in Chapter 6.

A design and operational review of the reactor coolant and containment atmosphere sampling systems has been performed. This review has been based on the radiation levels derived from Reg. Guide 1.3 and 1.4 source terms. The results of this review are as follows.

Regarding postaccident reactor coolant sampling, the experience gained during the TMI-2 accident has developed special procedures, long handle tooling, and portable shielding for use with the TMI-1 reactor coolant sampling system. Additionally provision has been made to obtain post accident decay heat samples via the shielded reactor coolant sample lines when in the boron precipitation mode. With these special procedures and equipment, pressurized and depressurized reactor coolant samples can be obtained.

Once the reactor coolant sample is obtained, it will be taken to the chemistry laboratory located adjacent to the sample room. The shielding afforded by the concrete shield walls separating these rooms provides sufficient shielding for personnel to prepare samples for spectrum analysis or chemical analysis, or both.

A Gamma Spectroscopy Multi-Channel Analyzer is used for identification and quantification of radionuclides in the reactor coolant. One is located outside of the Control Tower to ensure that background radiation levels do not interfere with the analysis of the sample. Two other Gamma Spectroscopy Multi-Channel Analyzers are located in the Control Tower, which also ensures that background levels do not interfere when samples are taken there.

On the basis of the above, it is concluded that with the use of the existing reactor coolant sampling facilities:

a. Reactor Coolant System sampling can be accomplished.

b. Personnel can obtain samples under accident conditions without incurring a radiation exposure to any individual in excess of 5 rems to the whole body and 75 rems to the extremities.

c. The equipment and procedures available for sample analysis are of sufficient sensitivity and resolution to permit identification of gamma-emitting isotopes in the Reactor Coolant System.

d. Chemical analysis capability will include the capability for boron total gas/hydrogen and chloride analysis.

The postaccident sampling system for containment atmosphere is capable of providing a sample of the Reactor Building atmosphere following an accident coincident with a loss of offsite power and with limited personnel exposure.

The sampling system is located in a postaccident, accessible area. Only the amount of Reactor Building gaseous atmosphere required for the analysis will be transported away from the sampling station.

This system is capable of obtaining a representative sample of the Reactor Building atmosphere under the following postaccident conditions:

Relative humidity	-	100 percent
Temperature	-	150F
Pressure	-	-2 to +55 psig
Flow	-	0.1 to 1.5 $ft.^3$/min
Radiation	-	1 x 10^6 rads maximum integrated dose for items in contact with containment atmosphere

The essential features of the postaccident containment atmosphere sampling system are as follows:

a. The system shares the same Reactor Building penetrations as the existing radiation monitor RM-A2. The existing sample line includes a three way ball valve to divert the sample to the postaccident sampling system.

b. The Reactor Building atmosphere is drawn by an eductor.

c. To minimize condensation in the sample line, heat tracing is applied to all lines. The unused portion of the sample is disposed of, at the sampling station, by sending it back into the containment.

d. Valves located in high radiation areas, postaccident, are provided with remote operators.

e. All lines are capable of being flushed with either instrument air or compressed air/gas from bottles.

f. The existing RM-A2 sample line and containment isolation valves are capable of being operated with a bottled air source in the event the instrument air system is inoperable.

g. Instrumentation is provided to monitor flow, temperature, and absolute pressure.

h. The system is operated from a locally mounted control panel. The panel provides switches for valve operation.

9.2.2.6 Normal Operation Iodine Sampling System

In 1986, a modification was completed which provides the capability for continuous sampling of radioiodines from the condenser and auxiliary condenser exhaust stack. This sampling system is only intended for use under normal plant operating conditions as it is not qualified for a postaccident environment. The particulate and radioiodine samples are collected in a filter cartridge in the sampling unit located in the common discharge header of the condenser vacuum pumps. The filter is manually removed at least once per week during condenser operation to be analyzed in order to detect small increases in primary to secondary leakage that could be a precursor to a serious leakage problem. Sampling is performed as required per the Offsite Dose Calculation Manual (ODCM) Table 3.2-2 for primary to secondary leakage. In order to minimize condensation in the sample line, heat tracing is provided.

TABLE 9.2-1
(Sheet 1 of 7)

CHEMICAL ADDITION
SYSTEM AND SAMPLING SYSTEM COMPONENT DATA

TANKS:

Item No.	Name	Type	Volume Total (gal)	Volume Liquid (gal)
CA-T-1	Boric acid mix tank	Vertical	8,000	6,250
CA-T-2	Caustic mix tank	Vertical	150	145
CA-T-3	Lithium hydroxide mix tank	Vertical	50	45
CA-T-4	Resin add tank	Vertical	75	70
CA-T-5	Filter precoat	Vertical	300	275
CA-T-6	Reclaimed water tank	Horizontal	13,000	----
CA-T-7	Reclaimed water pressure tank	Vertical	2,900	----
CA-T-8	4% boric acid mix tank	Vertical	750	----

TABLE 9.2-1
(Sheet 2 of 7)

CHEMICAL ADDITION
SYSTEM AND SAMPLING SYSTEM COMPONENT DATA

TANKS:

Item No.	Design Temp. (F)	Design Press. (psig)	Materials of Construction Body	Materials of Construction Lining	Comments
CA-T-1200	4.3 at top of tank		Aluminum	None	Provided with electric immersion heater and agitator
CA-T-2200	NA		304 SS	None	Provided with agitator
CA-T-3140	NA		304 SS	None	Provided with agitator
CA-T-4NA	NA		CS	Phenoline 368	
CA-T-5NA	NA		304 SS	None	Provided with agitator
CA-T-6100	5		CS	Phenoline 368	Nitrogen gas blanketed
CA-T-7100	150		CS	Phenoline 368	Pressurized with nitrogen gas
CA-T-8200	NA		304 SS	None	

TABLE 9.2-1
(Sheet 3 of 7)

CHEMICAL ADDITION
SYSTEM AND SAMPLING SYSTEM COMPONENT DATA

PUMPS:

Item No.	Name	Type	Capacity
CA-P-1A&B	Boric acid pumps	Pos. displ. metering pump (variable stroke)	600 gph
CA-P-2	Lithium hydroxide pump	Pos. displ. metering pump (variable stroke)	10 gph
CA-P-3	Hydrazine pump	Pos. displ. metering pump (variable stroke)	10 gph
CA-P-4	Caustic pump	Pos. displ. metering pump (variable stroke)	120 gph
CA-P-5A&5B	Precoat pumps	Horiz. shaft single stage centrifugal	75 gpm
CA-P-6	Reclaimed water pump	Vert. shaft single stage centrifugal	100 gpm
CA-P-7	High pressure boric acid pump	Pos. displ. metering pump (variable stroke)	50 gph
CA-P-9	Zinc Injection Pump	Pos. Displ. Metering Pump	3 ml/min

TABLE 9.2-1
(Sheet 4 of 7)

CHEMICAL ADDITION
SYSTEM AND SAMPLING SYSTEM COMPONENT DATA

PUMPS:

Item No.	Discharge Head (ft H20)	Materials of Construction (Wetted Parts)	Reference
CA-P-1A&B	173.25	304 SS	Vendor Technical Manual VM-TM-0208
CA-P-2	173.25	304 SS	Vendor Technical Manual VM-TM-0208
CA-P-3	173.25	304 SS	Vendor Technical Manual VM-TM-0208
CA-P-4	115.5	304 SS	Vendor Technical Manual VM-TM-0208
CA-P-5A&5B	50	304 SS	Vendor Technical Manual VM-TM-0670
CA-P-6	185	316 SS	Vendor Technical Manual VM-TM-0242
CA-P-7	1617	316 SS	Vendor Technical Manual VM-TM-0002

TABLE 9.2-1
(Sheet 5 of 7)

CHEMICAL ADDITION
SYSTEM AND SAMPLING SYSTEM COMPONENT DATA

COOLERS:

Item No.	NAME	Type	Design Temp. (F)	Design Press. (psig)	Flow Rate (lb/hr)
CA-C-1	Reactor coolant sample cooler	Jacketed helical tube coil	670	2,500	200
CA-C-2A	Steam gen. A sample cooler	Jacketed helical tube coil	600	1,050	500
CA-C-2B	Steam gen. B sample cooler	Jacketed helical tube coil	600	1,050	500

TABLE 9.2-1
(Sheet 6 of 7)

CHEMICAL ADDITION
SYSTEM AND SAMPLING SYSTEM COMPONENT DATA

COOLERS:

Item No.	Sample Cooler Inlet Temp. (F)	Sample Cooler Outlet Temp. (F)	Sample Cooler Heat Trans. (Btu/hr)	Cooling Water Source	Cooling Water Flow Rate (lb/hr)
CA-C-1	650	120	2.1×10^5	Nuclear services	5,000
CA-C-2A	535	100	2.31×10^5	Nuclear services	5,000
CA-C-2B	535	100	2.31×10^5	Nuclear services	5,000

TABLE 9.2-1
(Sheet 7 of 7)

CHEMICAL ADDITION
SYSTEM AND SAMPLING SYSTEM COMPONENT DATA

COOLERS:

Item No.	Design Code	Seismic Class
CA-C-1	ASME IIIC	Class I
CA-C-2A	ASME VIII	Class II
CA-C-2B	ASME VIII	Class II

TABLE 9.2-2
(Sheet 1 of 1)

NORMAL STEAM GENERATOR FEEDWATER QUALITY

Cation conductivity (maximum), umho/cm	0.5
Dissolved oxygen (maximum), ppb	5
Silica (maximum), ppb	20
Total iron as Fe (maximum), ppb	10
Chloride (maximum), ppb	5
Sodium (maximum), ppb	3
pH_T (adjusted with approved advanced amines)	$\geq$ 6.39[a]

NOTE:

[a] pH_T is the pH at system temperature of 459.6°F and pH_N is the neutral pH at system temperature, which is 5.59. A pH_T at least 0.8 higher than pH_N has been determined to reduce corrosion.

TABLE 9.2-3
(Sheet 1 of 1)

REACTOR COOLANT QUALITY[3]

Boron, ppm	See Table 3.2-4
Lithium as ^7Li, ppm (when required for pH adjustment)	0.25- 3.5[1]
pH at 77F	4.6 - 9.7[2]
Dissolved oxygen as O_2 (maximum), ppm	0.1
Chlorides as C1 (maximum), ppm	0.15
Hydrogen as H_2, std $cm^3/kg\ H_2O$	15 - 50
Fluorides as F (maximum), ppm	0.1
Total sulfur as SO_4 ppm	Less than the smaller of 0.1 ppm or 0.1 times lithium
Total dissolved gas (maximum), std $cm^3/kg\ H_2O$	100
Zinc, ppb	6 - 12
Nickel, ppb	< 6
Silica, ppm	< 1.5

1 Equivalent range as ^7LiOH is 0.858 to 12.00 ppm
2 Equivalent pH at 600F is 6.4 to 7.8
3 Limits are for normal operation

9.3 INTERMEDIATE COOLING SYSTEM

9.3.1 DESIGN BASES

The Intermediate Cooling System is designed to provide cooling water for various components in the Reactor Building as follows:

Letdown Coolers
Reactor Coolant Pump Seals and Thermal Barrier Heat Exchangers
Reactor Coolant Drain Tank Cooler
Control Rod Drive Cooling Coils.

The design cooling requirement for the system is based on the maximum heat loads from these sources. The system also provides an additional barrier between high pressure reactor coolant and service water to prevent an inadvertent release of activity.

9.3.2 SYSTEM DESCRIPTION AND EVALUATION

The Intermediate Cooling System is shown schematically on Drawing 302-620, and the performance requirements of the system are tabulated in Table 9.3-1. The following is a brief functional description of the major components of the system.

a. Intermediate Cooler

Each Intermediate Cooler is designed to reject the typical heat loads that may be imposed upon it by the components which are cooled by the Intermediate Cooling System. The station is equipped with two coolers. Both Intermediate Coolers and Letdown Coolers are normally operating. The Intermediate Coolers reject the heat load to the Nuclear Services River Water System.

b. Intermediate Cooling Pumps

Each Intermediate Cooling Pump is designed to deliver the necessary flows to the heat exchangers to be cooled. Two pumps are installed, with one pump operating and the other on standby for use as a spare or during periods of high letdown flow when more Intermediate Cooling flow is required to control letdown temperatures.

c. Intermediate Cooling Surge Tank

This tank accommodates expansion, contraction, and leakage of coolant into or out of the system and provides the required NPSH for the Intermediate Cooling Pumps. The surge tank also provides a reservoir of cooling water until the cooling line can be isolated (see Section 9.3.2.4).

d. Control Rod Drive Filters

Two filters are provided in the cooling water circuit to the control rod drives to prevent particulates from entering the drive cooling coils.

e. Intermediate Cooling Chemical Mix Tank

This tank is provided to mix and add corrosion-inhibiting chemicals to the closed-loop system.

9.3.2.1 Methods Of Operation

During normal operation, one Intermediate Cooling Pump is operating with system flow normally going through the shell side of both Intermediate Coolers. River water from the Nuclear Services River Water System flows through the tube side of either one or both coolers depending on heat load and river water temperature. During periods of abnormally high letdown flow rates, two Intermediate Closed Cooling Pumps would be operating to control letdown temperatures. Makeup water from the Demineralized Water Storage Tank is added to the system in the surge tank. Corrosion inhibiting chemicals are added through the chemical mixing tank.

9.3.2.2 Reliability Considerations

The Intermediate Cooling System performs no emergency functions. Redundancy in active components is provided to improve system reliability. The pumps, coolers, surge tank, and most of the instrumentation are located in the Auxiliary Building and are accessible for inspection and maintenance.

9.3.2.3 Codes And Standards

The components of the system are designed to the codes and standards given in Table 9.3-2.

9.3.2.4 System Isolation

The Intermediate Cooling System is not an engineered safeguards system. Reactor Building isolation valves IC-V2, IC-V3, IC-V4, and IC-V6 are automatically closed on any ESAS signal coincident with a low level signal in the Intermediate Cooling

Surge Tank or on a 30 psig Reactor Building pressure signal (also an ESAS actuation signal) regardless of surge tank level. The Reactor Building inlet lines are isolated by an air operated valve on the outside and a check valve on the inside of the Reactor Building. The Reactor Building outlet line is isolated by an electric motor operated valve on the inside and by an air operated valve on the outside of the Reactor Building.

9.3.2.5 Leakage Considerations

Water leakage from piping, valves, and other equipment in the system is not considered to be detrimental because the cooling water is normally nonradioactive. Welded construction is used throughout the system to minimize the possibility of leakage except where flanged connections are required for servicing.

Inleakage of reactor coolant to the system is detected by a radiation monitor (RM-L-9) located in a recirculation line at the surge tank and is also indicated by an increase in surge tank level. A Letdown Cooler leak can be remotely isolated with motor operated valves on the reactor coolant side of the cooler. The cooling water side can be completely isolated by closing the valves on the cooling lines. Leakage from the Reactor Coolant Drain Tank Cooler can be isolated by manual valves on the reactor coolant side. The cooling water side can be completely isolated by two valves, (one motor-operated and one manual). For additional information on Leakage Detection see Section 6.4.

9.3.2.6 Failure Considerations

Since the system serves no engineered safeguards function, the only consideration following a LOCA is the operation of the isolation valves. Redundant isolation valves are provided as described in Section 9.3.2.4.

Failures and malfunction of components during normal operation were evaluated. Operation of the Intermediate Cooling System is essential to normal reactor operation. In the event of loss of a pump, the standby pump will automatically start and maintain cooling water flow. The complete loss of cooling water flow does not require immediate reactor shutdown. However, the procedures require the operator to shut down the reactor to protect the control rod drive coils because after about 7 minutes without cooling, the insulation will begin to overheat. The Reactor Coolant Pumps can be operated indefinitely without cooling water if seal injection flow is available.

TABLE 9.3-1
(Sheet 1 of 1)

INTERMEDIATE COOLING SYSTEM PERFORMANCE DATA

Number of intermediate cooling pumps	2
Number of pumps normally operating	1
Nominal design flow, gpm	1000
Number of coolers	2
Number of coolers normally operating	2
Nominal design heat removal requirements, Btu/hr per cooler	19.1×10^6
System piping design code	USAS B31.1.0

TABLE 9.3-2
(Sheet 1 of 1)

INTERMEDIATE COOLING SYSTEM COMPONENT DATA

Intermediate Cooling Pumps (IC-P-1A/B)	
Type	Centrifugal
Rated capacity, gpm	830
Rated head, ft H_2O	250
Motor nameplate horsepower, hp	75
Casing material	CS
Design pressure, psig	175
Design temperature, 0F	350
Intermediate Coolers (IC-C-1A/B)	
Type	Shell and tube
Rated flow, lb/hr	0.394×10^6
Rated capacity, Btu/hr	19.1×10^6
Intermediate cooling water inlet temp, °F	150
Intermediate cooling water outlet temp, °F	105
Nuclear services river water inlet temp, °F	85
Code	ASME Section VIII
Surge Tank (IC-T-1)	
Volume, ft^3	50
Material	CS
Design pressure, psig	Atmospheric
Design temperature, °F	200
Code	AWWA D-100
Control Rod Drive Filter (IC-F-1A/B)	
Design flow rate, gpm	140
Code	ASME Section VIII

9.4 SPENT FUEL COOLING SYSTEM

The major equipment components of the Spent Fuel Cooling System are located in the west side of the Fuel Handling Building, a Class I structure hardened to withstand the hypothetical aircraft incident. Part of the piping of the system extends into the Reactor and Auxiliary Buildings; however, both of the structures are Class I and hardened to withstand the hypothetical aircraft incident. The principal functions of the Spent Fuel Cooling System are the removal of decay heat from the spent fuel stored in the pools it serves and maintaining the clarity of, and a low activity level in the water of the pools. Cleanup of pool water is accomplished by diverting part of the flow, maintained for removal of decay heat, through filters and/or demineralizers of the Liquid Waste Disposal System (see Section 11.2.1).

9.4.1 DESIGN BASES

The Spent Fuel Cooling System is designed to limit the pool bulk temperature in spent fuel storage pools A and B to a maximum of 161.5°F with a heat load based on a normal discharge with one pump/heat exchanger train operating, and 159.1°F after a full core offload with both pump/heat exchanger trains operating. The spent fuel pool structural concrete has been evaluated as being capable to withstand temperatures to 199°F. In addition, at the above pool bulk temperatures, the maximum temperature leaving the spent fuel heat exchanger(s) would be 135°F. The ion exchange resins are capable of withstanding 150°F; the precoat filters are designed for 200°F; the rest of the liquid radwaste system is designed for a temperature of 150°F.

The analyses performed to support spent fuel pool reracking (References 8, 10, and 11) have qualified the above pool bulk temperatures through the normal discharge of Cycle 23 (with 1,640 previously discharged fuel assemblies in the spent fuel pool from 22 successive cycles) and through the full core offload of Cycle 24 (with 1,720 previously discharged fuel assemblies in the spent fuel pool from 23 successive cycles). The analyses assumed biennial refueling outages after Cycle 9 consisting of 80 fuel assemblies discharged with exposures of 60 GWD/MTU.

For the normal discharge, 80 fuel assemblies with exposures of 60 GWD/MTU are discharged into the spent fuel pool following a wait period subsequent to reactor shutdown. The delay is required to allow decay heat loads to decrease to the level assumed in the rerack thermal-hydraulic (T-H) analyses and is enforced via refueling procedures.

9.4.2 SYSTEM FUNCTIONS

In addition to its principal functions of circulating spent fuel pool water for decay heat removal, the equipment of the Spent Fuel Cooling System is designed to fulfill the following functions:

a. Transfer borated refueling water from the borated water storage tank to the fuel transfer canal.
b. Transfer water from the fuel transfer canal to the borated water storage tank.

c. Circulate refueling water through cleanup equipment:

   1) During transfer from the fuel transfer canal to the borated water storage tank, or

2) During storage in the borated water storage tank.

d. Circulate fuel transfer canal water through cleanup equipment.

e. "Skim" pool water surfaces for the removal of any floating debris.

f. Empty spent fuel pool A to permit direct maintenance of refueling equipment.

g. Draw down and replace the water in the spent fuel shipping cask pit to prevent "dunking" of the spent fuel building crane hook and cables.

9.4.3 SYSTEM DESCRIPTION

The schematic diagram for the Spent Fuel Cooling System is shown on Drawing 302630.

Spent fuel is cooled by pumping spent fuel storage pool water through coolers and back to the spent fuel storage pools. Either of the two spent fuel cooling pump-spent fuel cooler combinations may be used to cool either spent fuel pool A, spent fuel pool B, both spent fuel pool A and spent fuel pool B or transfer refueling water in either direction. Both pumps and coolers will be used to remove decay heat from spent fuel stored in spent fuel pool A and spent fuel pool B, if required.

The borated water recirculation pump is used to accomplish water circulation from either spent fuel pool, the fuel transfer canal, or the borated water storage tank for cleanup or "skimming" functions. It is also used to empty spent fuel pool A, if required, and to lower and raise the water level in the spent fuel cask pit as required for the placement, loading, and removal of the spent fuel shipping cask.

9.4.4 PERFORMANCE REQUIREMENTS

The first design basis of the system is based on the normal refueling operation with up to 80 fuel assemblies being removed from the unit each time. The removed fuel assemblies will have exposures of 60 GWD/MTU at the time of discharge.

The second design basis for the system considers that it is possible to unload the reactor vessel for maintenance or inspection at a time when a total of 1,720 spent fuel assemblies are already residing in the spent fuel pools.

The basic system performance and equipment data are presented in Table 9.4-1.

9.4.5 METHODS OF OPERATION

Spent fuel cooling functions are monitored and controlled from the Main Control Room. All other functions of the Spent Fuel Cooling System are accomplished by local manipulation of valves and control of equipment. However, after a piping lineup for filling or emptying the fuel transfer canal (via a spent fuel cooling pump) has been set up, the transfer may be monitored and controlled from the Main Control Room.

9.4.6 LEAKAGE CONSIDERATIONS

Whenever a leaking fuel assembly is transferred from the fuel transfer canal to the spent fuel storage pool, a small quantity of fission products may enter the spent fuel cooling water. A purification loop is provided within the Liquid Waste Disposal System for removing these fission products and other contaminants from the water. A small quantity of flow from the spent fuel cooling pumps is diverted to a radiation monitor. This provides monitoring of radiation levels in the spent fuel pool water to indicate when cleanup should be initiated.

The fuel handling and storage area housing the spent fuel storage pool is ventilated on a controlled basis, normally exhausting circulated air to the outside through the unit vent. A separate Emergency Safety Feature (ESF) ventilation system is in service to support fuel movement. The Fuel Handling Building normal and ESF ventilation systems are described in Section 9.8.2. The Fuel Handling Building and Auxiliary Building exhaust duct ventilation monitors (RM-A4 and RM-A6 respectively) are described in Section 11.4.3.

Provisions have been made to air-test the valved and flanged ends of each fuel transfer tube for leaktightness after it has been used. A valve (on the Fuel Handling Building side) and blind flange (on the Reactor Building side) are used to isolate each fuel transfer tube.

9.4.7 SYSTEM EVALUATION

Because all the equipment and piping of the spent fuel cooling system are housed in Class I structures designed to withstand aircraft impact, it is not considered credible that any accident or series of accidents could violate the integrity of the system.

During normal conditions, up to 80 fuel assemblies will be stored in either spent fuel pool during each refueling. At this time, one of the pumps and one of the coolers will handle the load and maintain 161.5°F.

For the design case when 1,897 spent fuel assemblies are stored (1,720 spent fuel assemblies plus 177 fuel assemblies from a core offload), two pumps and two coolers will maintain the spent fuel storage pool at the maximum temperature of 159.1°F. If both a pump and a cooler are out for maintenance when this storage condition exists, the water temperature will eventually rise to 212°F, although considerable time will be required to heat the large spent fuel storage pools to this temperature. If all cooling is lost the water temperature will rise to 212°F in 10 hours. This should provide enough time to get one of the spent fuel cooling loops back into service.

The most serious failure of the Spent Fuel Cooling System would be complete loss of water from both spent fuel storage pools. To protect against this possibility, the cooling water inlet and outlet connections to spent fuel pool B all enter slightly below, or at, the normal water level in the pool.

Fuel pool A has a drain connection from the spent fuel cooling system extending downward from elevation 330 ft (10 ft above the top of fuel stored in this pool) to 2 inches above the bottom of the pool. This line has a syphon breaker with a normally locked open valve to prevent water from syphoning from the pool below elevation 330 ft in the highly unlikely event that the line should break outside the pool.

A combination drain/fill line enters the spent fuel cask pit at elevation 332 ft (approximately 12 ft above the top of the spent fuel stored in pool B). This line extends down inside the pit to elevation 323 ft 6 inches. There is a syphon breaker on this line with a normally locked open valve to prevent draining the spent fuel cask pit below elevation 332 ft in the unlikely event that the line should break outside the pit.

Therefore, it is concluded that the Spent Fuel Cooling System provides adequate protection against serious depression of the water level in either of the spent fuel pools in the highly unlikely event of the rupture of any of its lines.

TABLE 9.4-1
(Sheet 1 of 3)
SPENT FUEL COOLING SYSTEM PERFORMANCE AND EQUIPMENT DATA
(Capacities are on a per unit basis)

Item	Design Data	Design Code(s)	Seismic Design
System cooling capacity, (Btu/hr)			
Normal (80 assemblies)	18.6×10^6	Not applicable	N.A.
Maximum (entire core plus 80 assemblies)	32.9×10^6	Not applicable	N.A.
System design pressure, psig	75	Not applicable	N.A.
System design temperature, °F	250	Not applicable	N.A.
Spent Fuel Cooler (SF-C-1A/B)			
Number	2	Tube ASME Section III-C	Class I
Type	Tube and Shell	Shell Section VIII	
Material			
Shell	CS	Shell	
Tube	SS	Tube ASME Section III-C	Class I
Duty, Btu/hr*	8.75×10^6		
Cooling water flow, lb/hr	0.5×10^6		
Design Pressure			
Shell	150 psig		
Tube	125 psig		

* Assumes pool water to cooler at 130.5°F and cooling water to cooler at 95°F.

TABLE 9.4-1
(Sheet 2 of 3)
SPENT FUEL COOLING SYSTEM PERFORMANCE AND EQUIPMENT DATA
(Capacities are on a per unit basis)

Item		Design Data	Design Code(s)	Seismic Design
Spent Fuel Pump (SF-P-1A/B)				
Number		2		
Material of wetted parts		SS		
Type		Horizontal, centrifugal	Not applicable	Class I
Flow, gpm		1,000		
Head, ft		100[1]		
Motor horsepower, hp		40		
Spent Fuel Storage Pool Water				
Volume, gal	Pool A	435,000	Not applicable	N.A.
	Pool B	214,000		
	Spent Fuel Cask Pool	21,000		
Piping				
Material		USAS B31.1.0 SS	Class I	

[1] SF-P-1A/B will perform their safety function of pumping 1000 gpm to the Spent Fuel Pools at 50 feet of head.

TABLE 9.4-1
(Sheet 3 of 3)

SPENT FUEL COOLING SYSTEM PERFORMANCE AND EQUIPMENT DATA
(Capacities are on a per unit basis)

Item	Design Data	Design Code(s)	Seismic Design
Borated Water Recirculation Pump (SF-P-2)			
Number	1		Class I
Materials of wetted parts	Stainless steel		
Type	Vertical, centrifugal		
Flow, gpm	180		
Head, TDH, ft	140		
Motor horsepower, hp	15		

9.5 DECAY HEAT REMOVAL SYSTEM

9.5.1 DESIGN BASES

The Decay Heat Removal System removes decay heat from the core and sensible heat from the Reactor Coolant System during the latter stages of cooldown. The system also provides auxiliary spray to the pressurizer for complete depressurization, maintains the reactor coolant temperature during refueling, and provides a means for filling and draining the fuel transfer canal. In the event of a LOCA, the system injects borated water into the reactor vessel for long-term emergency cooling. The emergency functions of this system are described in Chapter 6.

9.5.2 SYSTEM DESCRIPTION AND EVALUATION

The Decay Heat Removal System is shown schematically on Drawing 302640. Component data are shown in Tables 9.5-2 and Table 6.4-2. The Decay Heat Removal System normally takes suction from the reactor coolant outlet line and delivers the water back to the reactor through the core flooding nozzles after passing through the decay heat removal pumps and coolers. The Decay Heat Removal System may be lined up to cool the RCS down to refueling temperature when the reactor pressure is below the limits established based on DH system piping design pressure. The pressurizer is cooled by an auxiliary spray line. Decay heat is transferred to the Decay Heat River Water System by the Decay Heat Closed Cycle Cooling Water System (See Section 9.6).

The major system components are described as follows.

a. Decay Heat Removal Pumps

   Two pumps are arranged in parallel and are designed for continuous operation during the period required for removal of decay heat during a routine shutdown and refueling. The design flow is that required to cool the Reactor Coolant System from 250°F to 140°F in 14 hours with both pumps in operation. Both pumps are available for low-pressure injection operation.

b. Decay Heat Removal Coolers

   The coolers remove the decay heat from the circulated reactor coolant during a routine shutdown and refueling. With both coolers in operation, the Decay Heat Removal System is designed to cool the circulated reactor coolant from 250°F to 140°F in 14 hours. The use of two decay heat removal loops ensures that cooling capacity is only partially lost should one train become inoperable.

9.5.2.1 System Operation

The system is designed to operate two pumps and two coolers to perform the decay heat cooling function. A single Decay Heat Removal train is normally used to cooldown the reactor coolant system and maintain reactor coolant temperature at cold shutdown or refueling conditions. During plant cooldown, when RC temperature and pressure are in the range allowable for operation of the DH system, Decay Heat Removal (DHR) system start-up is initiated. Decay heat cooling is initiated by aligning pumps to take suction from the reactor outlet line and discharge through the coolers back into the reactor vessel. The equipment used for decay heat cooling is also used for low pressure injection during accident conditions.

During refueling, the decay heat from the reactor core is rejected to the decay heat removal coolers in the same manner as it is during cooldown to 140°F. At the beginning of the refueling period, the system is designed so that both coolers and both pumps be used to maintain 140°F in the core and fuel transfer canal. However, experience has shown that one cooler and pump can maintain the required 140°F.

The fuel transfer canal is normally filled and drained by the spent fuel pool cooling system. However, it may also be filled above the reactor vessel flange by switching the suction of one decay heat removal pump from the reactor outlet to the borated water storage tank. When the transfer canal is filled, suction to that pump can be switched back to the reactor outlet pipe.

After refueling, the transfer canal may be drained to the reactor vessel flange level by switching the discharge of one of the pumps from the reactor injection nozzle to the borated water storage tank. The other pump will continue the recirculation mode of decay heat removal.

9.5.2.2 Reliability Considerations

Since the equipment is designed to perform both normal and emergency functions, separate and redundant flow paths and equipment are provided to prevent a single component failure from reducing the system performance below a safe level. All rotating equipment and most valves are located in the Auxiliary Building to facilitate maintenance and periodic operational testing inspection.

9.5.2.3 Codes And Standards

Each component of this system is designed, fabricated, and inspected to the code or standard, as applicable, as noted in Table 9.5-2.

9.5.2.4 System Isolation

The Decay Heat Removal System is connected to the reactor coolant outlet line on the suction side and to the reactor vessel on the discharge side. There is double check valve isolation for reactor coolant pressure on Decay Heat Pump discharge lines. The system is isolated at the Reactor Building on the suction side by two motor-operated valves located inside the Reactor Building and one motor-operated valve located outside the Reactor Building. All of these valves are normally closed during reactor operation. In the event of a LOCA, the motor-operated valves DH-V4A/B on the system discharge side open. The valves between the reactor vessel and the suction side of the pumps are closed when the DH system is in the low pressure injection and sump recirculation modes. Valves DH-V1, DH-V2 and DH-V3 remain closed throughout the accident except during long-term post-LOCA core circulation cooling mode when they are opened to prevent excess concentration of Boron in the reactor vessel.

9.5.2.5 Leakage Considerations

During reactor power operation, all equipment of the decay heat removal system is idle and all isolation valves between the RCS and the Decay Heat Removal System are closed. Under

LOCA conditions, fission products may be recirculated in the coolant through the exterior piping system. Potential leaks have been evaluated to obtain the total radiation dose due to leakage from this system. The evaluation is discussed in Chapter 6 (6.4.4) and Chapter 14 (Section 14.2.2.5.d). Leak testing is described in Section 6.1.4.

9.5.2.6 Failure Considerations

Failures and malfunctions in the Decay Heat Removal System in conjunction with a LOCA are discussed in Chapter 6, Table 6.1-4.

9.5.2.7 Operational Limits

Alarms or interlocks are provided to limit variables or conditions of operation that might affect system or plant safety. Those variables or conditions of operation are as follows:

a. Decay Heat Removal Flow Rate

   Low flow from the pumps during the decay heat removal mode of operation is alarmed to signal a reduction or stoppage of flow and cooling of the core.

b. Reactor Coolant Pressure Interlock

   The first two valves from the Reactor Coolant System in the suction line to the pumps are automatically closed by Reactor Coolant System pressure instrumentation to prevent inadvertent overpressurization of the system piping while the Reactor Coolant System is still above the system design pressure. The redundant interlocks conform to the intent of the single failure criteria in IEEE-279. (See 7.5, Reference 2).

c. Decay Heat Pump Suction Temperature

   High temperature of the reactor coolant inlet to the pumps is alarmed to signal that system placed in service too soon on RCS cooldown or left on too long on RCS heatup.

TABLE 9.5-1
(Sheet 1 of 1)

DECAY HEAT REMOVAL SYSTEM PERFORMANCE DATA

Reactor coolant temperature at startup of decay heat removal, °F (normal operations)	250
Time to cool Reactor Coolant System from 250°F to 140°F, hr (using both DHR trains)	14
Refueling temperature, °F	140
Fuel transfer canal fill time, hr	6
Fuel transfer canal drain time, hr	6

Table 9.5-2
(Sheet 1 of 2)

DECAY HEAT REMOVAL SYSTEM COMPONENT DATA

Pump (DH-P-1A/B)	
Type	Single stage, centrifugal
Capacity (each), gpm	3000
Head at rated capacity, ft H_2O	350
Motor horsepower, hp	350
Material	SS (wetted parts)
Design pressure, psig	550
Design temperature, °F	300
Seismic classification	I
Cooler (DH-C-1A/B)	
Type	Shell and tube
Capacity (at 140°F), Btu/hr	30×10^6
(at 280°F), Btu/hr	125×10^6
Reactor coolant flow, gpm	3,000
Decay closed cooling water flow, gpm	3,000
Decay closed cooling water inlet temperature, °F	95[1]
Material, shell/tube	CS/SS
Shell design pressure, psig	100
Shell design temperature, °F	250

(1) This cooler will perform its safety function with an inlet temperature of 99.5°F.

Table 9.5-2
(Sheet 2 of 2)
DECAY HEAT REMOVAL SYSTEM COMPONENT DATA

Tube design pressure, psig	505
Tube design temperature, °F	250
Code	Shell-ASME Section VIII, Division I Tube-ASME Section III, Class C
Seismic classification	I

9.6 COOLING WATER SYSTEMS

9.6.1 DESIGN BASES

The cooling water systems are arranged into <u>five</u> separate pumping systems:

a. A decay heat services cooling water system comprises two separate 100 percent capacity systems from the Decay Heat Removal Coolers back to the ultimate heat sink (Susquehanna River). Two 100 percent capacity Decay Heat River Water Pumps cool two 100 percent capacity Decay Heat Services Coolers. Two 100 percent capacity Decay Heat Closed Cycle Cooling Water Pumps circulate closed cycle cooling water through two 100 percent capacity Decay Heat Removal Coolers and those pumps and motors associated with the Decay Heat Removal System, the Decay Heat Closed Cycle Cooling Water System, the Makeup and Purification System, and the Reactor Building Spray System.

   Refer to the following:

   Drawing 302640, Decay Heat Removal System

   Drawing 302202, Nuclear Services River Water System

   Drawing 302645, Decay Heat Closed Cycle Cooling Water System

   The 100 percent capacity referred to above is 100 percent of the LOCA emergency cooling capacity. The LOCA emergency cooling required performance for each Decay Heat River Water system to provide a minimum of 6000 GPM through DC-C-2 and each Decay Heat Closed Cycle Cooling Water Pump to circulate a minimum of 3129 GPM through DH-C-1 and component coolers. This minimum capacity ensures adequate component cooling and energy removal from the containment as described in Appendix 6B. The LOCA emergency functions are described in the following UFSAR sections: Section 6.1 HPI (Makeup Pumps) and LPI (DH pumps) and Section 6.2 for the Reactor Building Spray System.

   Either of the two decay heat systems will permit cooling down the plant under normal shutdown; operating both will provide a faster cooldown.

b. A Reactor Building Emergency Cooling Water System comprises two 100 percent capacity trains. Each river water pump is capable of providing > 1450 gpm through each emergency cooling coil. Following an engineered safeguards signal, two 100 percent capacity Reactor Building Emergency Cooling River Water Pumps deliver water from the river directly to the emergency cooling coils. The emergency cooling coil pressure is maintained above the maximum design basis accident containment pressure by an automatic control valve on the discharge. RR-V-6 is provided with a remote operated bypass valve, RR-V-5. If RR-V-6 fails and excessively restricts flow, the RR-V-5 is opened. RR-V-5 will also be opened if RR-PI-224, 225, and 226 are not available to determine if RR-V-6 is properly controlling backpressure.

   The 2 Hour Air System supplies a backup supply of control air to the Reactor Building Emergency Cooling Water System Pressure Control Valve, RR-V-6, in the event of a loss of the normal Instrument Air system. RR-V-6 is provided with a bypass valve, RR-V-5.

If a rupture or major leak occurred during emergency operation, it would be detected through indication of outlet flow, cooler outlet pressure, changes in Reactor Building sump level or boron concentration. The coil and lines can be isolated from the Control Room.

With the system in standby, leakage from the emergency coils can be detected by a rotameter via a 1/2 inch connection from the Nuclear Services Closed Cooling Water System.

Reactor Emergency Cooling Water System test is performed each refueling period by discharging through the Reactor Building Emergency Coolers. After testing the emergency cooling coils will be drained and filled with water from the Nuclear Services Closed Cooling Water System.

The redundant Reactor Building Emergency Cooling River Pumps may also be used in the event of the loss of all condensate inventory as a means of providing river water to the suction of the Emergency Feedwater Pumps.

Refer to the following:

Drawing 302082, Emergency Feedwater
Drawing 302202, Nuclear Services River Water System
Drawing 302610, Nuclear Services Closed Cycle Cooling Water System
Drawing 302611, Reactor Building Normal and Emergency Cooling Water System

c. The nuclear services cooling water system comprises three Nuclear Services River Water Pumps, four Nuclear Services Coolers, and three Nuclear Services Closed Cooling Cycle Pumps. This system, along with the Intermediate Cooling System, satisfies the cooling requirements of all nuclear oriented services other than decay heat and Reactor Building emergency cooling (Items a. and b. above).

The Nuclear Services River Water System is capable of serving its intended safety function in the event of a single active failure of a mechanical component or a single failure of an electrical component. Sufficient component redundancy and redundant power sources has been provided, such that the Nuclear Services River Water System will function and supply cooling water to enable safe shutdown of the plant and maintain the plant in the safe shutdown condition. See Reference 13 for details. This Nuclear Services River Water System, while having redundancy in itself, can be supplemented by Secondary Services River Water Pumps, as an additional backup. Operator action is required to supply this backup capability.

The Nuclear Services Closed Cooling Water System is capable of serving its intended safety function in the event of a single active failure of a mechanical component or a single failure of an electrical component. Sufficient component redundancy and redundant power sources has been provided, such that the Nuclear Services Closed Cooling Water System will function and supply cooling water to enable safe shutdown of the plant and maintain the plant in the safe shutdown condition. See Reference 13 for details.

The Nuclear Services River Water Pumps are sized to cool the Nuclear Services Coolers and also the Intermediate Service Coolers (see Section 9.3).

Refer to the following:

Drawing 302620, Intermediate Cooling System

Drawing 302202, Nuclear Services River Water System

Drawing 302610, Nuclear Services Closed Cycle Cooling Water System

d. A Secondary Services Cooling Water System covers all non-nuclear related cooling water requirements. This system may be shut down when normal power sources are lost. The instrument air compressors are normally cooled from this system; on shutdown of the system, the instrument air compressors IA-P-1A/B are automatically shifted to the filtered fire service head tank cooling media via three way valves with the discharge to the floor drain system.

The primary function of the Secondary Services River Water System is to supply cooling water to the Secondary Services Heat Exchangers and to provide makeup water to compensate for evaporation, drift, and blowdown losses sustained by the Circulating Water System at the Natural Draft CoolingTower.

The secondary functions of the Secondary Services River Water System include supplying water to the Nuclear Services Heat Exchangers, the Intermediate Service Coolers, and the de-icing makeup in the event that there is a loss of the normal supply from the Nuclear Services River Water Pumps. Additional secondary functions are supplying water to the Biocide Injection System and to the Clarifier.

The Decay Heat, Nuclear and Secondary Services River Water Systems are provided with a chemical treatment system to prevent biofouling and corrosion in the various heat exchangers and piping systems involved. This chemical addition system provides intermittent treatment of the cooling systems. The system is designed to be operated for automatic addition of biocide to the river water. The system uses sodium hypochlorite to control biofouling, and potassium sulfite for dechlorination of the service water before discharge to the river. The system also injects corrosion inhibitors into the river water piping

Refer to the following:

Drawing 302202, Nuclear Services River Water System

Drawing 302221, Secondary Services Closed Cooling System

Drawing 302174, River Cooling Water Chlorination

e. A Condenser Circulating Water System provides cooling water to the Main Surface Condenser and Feedwater Pump Turbine Condensers under normal operation. Upon loss of electrical power, this system will not be operated. The cycle cooldown requirements are adequately handled by other means.

Refer to the following:

Drawing 302202, Nuclear Services River Water System

Drawing 302201, Circulating Water

Drawing 302173, Circulating Water Biocide and Chemical Feed

Drawing 302204, Condenser Cleaning

The Circulating Water System is provided with a biocide injection system for the prevention of the growth of slime in the surface condensers and circulating water piping and elimination of bacterial and algae growths in the hyperbolic cooling towers. The system is designed to be manually operated for batch additions of biocide. The biocide injection system consists of sodium hypochlorite, sulfuric acid and other associated chemicals such as sodium bromide, scale inhibitor and dispersant. The system is designed to be operated for automatic additions of biocide. The CW Chemical Control System uses Sodium Hypochlorite and Sulfuric Acid. Since cross filling of these two tanks will create an IDLH atmosphere, procedural controls shall exist to prevent this event. A separate system injects zinc phosphate to reduce general corrosion of carbon steel piping and components.

Amertap condenser cleaning operates on a closed cycle recirculating basis.

These systems were originally sized to ensure adequate heat removal based on 85°F river water temperature, maximum loadings, and leakage allowances. Subsequent evaluations have demonstrated that river water temperatures of 95°F will support operation of all safe shutdown equipment with the exception of the Control Building chiller units, AH-C4A/B. The river water threshold temperature for AH-C4A/B, in its emergency configuration, is 92°F. Therefore, river water temperatures of 92°F or less will support operation of all safe shutdown equipment.

The equipment in these systems is designed to applicable codes and standards tabulated in Section 9.0 and Table 9.6-1.

All cooling water systems are designed to prevent component failure from curtailing normal station operation. It is possible to isolate all heat exchangers and pumps except the decay heat systems which are separate and therefore require no component isolation.

All systems are monitored and operated from the Control Room.

Isolation valves are incorporated in all cooling service water lines penetrating the Reactor Building.

Electrical power requirements can be supplied from any of the redundant sources described in Section 8.2.3 for: (1) Decay Heat River Water System, (2) Decay Heat Closed Cooling Water

System, (3) Reactor Building Emergency Cooling Water System, (4) Nuclear Services Cooling River Water System, and (5) Nuclear Services Closed Cooling Water System. The Condenser Circulating Water, CW Biocide, and River Water Chlorination Systems are not intended to be operated from the diesel generator or the engineered safeguards transformer power sources. The Intermediate Cooling System can be manually loaded to them. A Secondary Services River Water Pump can be manually started by the operator and fed from the emergency safeguards source, as a backup to the Nuclear Services River Water Pumps.

All nuclear safety related system components have been hydrostatically tested prior to initial startup and are accessible for periodic testing and inspections during operation. Electrical components, switchovers, and starting controls are tested periodically.

Operation of the MDCT was permanently discontinued based on calculation C1101-502-E210-002, Rev. 0. Plant discharge continues to flow via its normal flow path through the MDCT basin.

The 48 inch river water discharge line has been made double ended. Normal discharge is to the mechanical draft tower basin. In the highly unlikely event this line should become plugged between the plant and tower basin, flow would back up to a high point and, thus, dump to the east channel. Redundancy has thus been provided. If the outlet of the tower basin to the river plugs, another overflow discharge is provided to the river.

These systems were originally sized to ensure adequate heat removal based on 85°F river water temperature, maximum loadings, and leakage allowances. Subsequent evaluations have demonstrated that river water temperatures of 95°F will support operation of all safe shutdown equipment with the exception of the Control Building chiller units, AH-C4A/B. The river water threshold -temperature for AH-C4A1B,-initsemergency-configuration, is 92°F. Therefore, river water temperatures of 92°F or less will support operation of all safe shutdown equipment.

9.6.2 SYSTEM DESCRIPTION AND EVALUATION

9.6.2.1 Condenser Circulating And River Water System

The condenser circulating water is cooled in two hyperbolic natural draft cooling towers located to the east of the station proper. Drawing 302201 shows schematically the arrangement of the system with respect to the Susquehanna River, condensers, and cooling towers. Drawing 302202 shows the river water system with respect to the river and cooling water system heat exchangers. Original component data are shown in Table 9.6-1.

The condensing equipment consists of a single-pass main condenser with an intermediate water box, also vertically divided. The auxiliary condensers are two-pass units having vertically divided circulating water circuits.

Makeup for Natural Draft Cooling Tower evaporation, wind loss, and blowdown is obtained from the Secondary Services River Water System (SSRWS). After passing through the Secondary Services Coolers, river water is mixed with the circulating water in the common suction of the circulating water pumps. If a greater demand is indicated, additional makeup may be obtained by manual initiation of NSRWS in conjunction with the automatically controlled evaporation makeup from SSRWS. The NSRWS makeup line to the Circulating Water System is located upstream of the Nuclear Services Coolers. Maximum makeup from the SSRWS is approximately 12,000 gpm.

Blowdown from the cooling towers is discharged to the Susquehanna River via the 48 inch river discharge line at the normal rate of 2000 gpm with maximum capability of 6000 gpm.

The Circulating Water Pump Building is located between the unit and the cooling towers. It contains six Circulating Water Pumps arranged so that three pumps discharge through each of the two 102 inch diameter mains. A 48 inch cross-connection permits the discharge of one pump to pass to the other main.

The impact of a failure of the 102-inch line or the expansion joint within the Turbine Building was evaluated (Reference 22). Operators in the control room will shut down all of the Circ water pumps within 5 minutes of a valid high condenser pit level alarm (PLA-4-9) and open the Turbine Building exterior doors within 30 minutes to prevent any impact to safe shutdown equipment.

The Intake Screen and Pump House is provided with automatic bar rakes, screen wash and sluice system, traveling screens, and a deicing water line. Under normal operation in subfreezing weather, condenser circulating water discharge will be the source of deicing water.

On loss of Circulating Water Pump power, the Nuclear Services Cooling River Water discharge can be utilized. Makeup to the Circulating Water System to offset deicing water loss will be provided from the discharge of the Nuclear Services Cooling River Water Pumps by running additional pump(s).

The nuclear services cooling river water normally discharges to the river and is normally available for additional dilution of treated nuclear wastes; when utilized for deicing during "blackout," it can be provided on an intermittent basis for waste dilution with alternate operation between the two. Also, the Decay Heat River System may be used for station discharge dilution purposes.

The Nuclear Services, Decay Heat Removal Services, and Intermediate Service Coolers are located in an underground vault next to the Auxiliary Building. The vault is designed to resist the hypothetical aircraft incident and is connected to the Auxiliary Building by a tunnel. All of these heat exchangers can be backwashed.

The pump room portion of the Intake Screen and Pump House is divided by a wall. River pumps are arranged in the two sections in order to provide physical separation as shown in Drawing IE-168-02-002. The river pumps are vertical wet pit pumps of the water-lubricated enclosed line-shaft type and open line shaft type.

The river water, upon entering the intake structure, passes under a skimmer wall, through automated bar rakes or trash racks with 1 inch vertical bar spacings, through traveling screens with 3/8 inch screen openings, through the river water pumps, and finally through automatic strainers of 1/8 inch mesh before passing to the heat exchangers.

The river pumping systems are designed to pump from the "loss of York Haven Dam", normal level of 278 ft, and flood levels. They pump to a high point at the plant and drain by gravity through the double ended 48 inch diameter discharge line, normally through the mechanical draft postcooling tower basin. In either case, the discharge of the tower basin is measured by a propeller meter. The plant radioactive waste effluent, which is both flow measured and radiation monitored, is then mixed with this discharge and the mixture passes 100 ft to a weir box, where the well mixed dilution is radiation monitored. Discharge is by gravity to the river from the weir.

The River Water Pump Lubrication System (RWPLS) provides filtered water to the River Water Pumps for bearing flushing and lubrication. The bearings will receive adequate lubrication to maintain the pumps operable for the duration of postulated accident events without the RWPLS. On the pumps with RWPLS flow to the line shaft bearings, if no RWPLS external lubrication flow is provided, the unfiltered pumped fluid travels upward through the line shaft bearings and out of the pump packing gland, thereby continuing to lubricate the bearings.

The RWPLS is classified Augmented Quality (A), and Seismic Category S-Ix to maintain passive pressure boundary integrity, as this system must not adversely affect nuclear safety related equipment. The RWPLS pumps draw power from the 1A and 1B Screenhouse MCC's, which are nuclear safety related. In the event of a loss of offsite power, the 1A and 1B Screenhouse MCC's are de-energized, then re-energized by the associated emergency diesel generator. When the MCC's are de-energized, the contactors for the RWPLS Pumps drop out and shut down the pumps. The RWPLS pumps do not automatically restart on restoration of power after blackout. Therefore, the RWPLS imposes no automatically connected load on the emergency diesel generators. Although the RWPLS are powered from safety-related 1E sources (1A/B Screenhouse MCC's), electrical isolation is provided via 1E-qualified molded case circuit breakers. Cable for the RWPLS meet the flame retardant requirements of IEEE Standard 383.

Although the RWPLS is powered from safety-related 1E sources (1A/B Screenhouse MCC's), electrical isolation is provided via 1E-qualified molded case circuit breakers. The RWPLS pumps do not automatically restart on restoration of power after blackout.

The RWPLS is not high energy. The maximum combination of filtered water inlet pressure and booster pump outlet pressure does not exceed the HELB pressure limit for cold fluid systems. The loss of the RWPLS has no impact on safety related equipment performance and the RWPLS power connections are isolated from safety related power supplies.

9.6.2.2 Secondary Services Cooling Water System

The secondary services cooling water system supplies all non-nuclear-related cooling requirements. The secondary services cooling water system consists of:

a) Three Secondary Services River Water Pumps (two required for normal operation). These pumps are located in the Intake and Screen House and deliver river water through the tube side of the Secondary Services Heat Exchangers.

b) Three Secondary Services Closed Cycle Cooling Water Pumps (two required for normal operation) and four Secondary Services Heat Exchangers (three required for normal operation). These pumps are located in the Turbine Building and normally two of the pumps circulate water through the shell side of the Secondary Services Heat Exchangers.

Original system performance and equipment data are listed in Table 9.6-1. Refer to Drawings 302221 and 302202. Sufficient redundancy is provided so that loss of any one pump and/or heat exchanger will not affect normal operation.

On the closed cycle portion of the system, an elevated surge tank of 2900 gal normal capacity (5000 gal maximum capacity) provides storage of coolant with makeup from the demineralized storage tank being added automatically. Abnormal tank levels will be annunciated in the Control Room. Chemicals are added into the system from the chemical mixing tank for corrosion inhibition. Periodic feed of the chemicals into the tank is performed manually.

In the event of a postulated accident, all heat loads served by this system are expendable, except for the instrument air compressors IA-P-1A/B, which are provided with backup source of cooling water at that time from the station fire service head tank. This pumping system is dropped on loss of electric power. No nuclear oriented services will be serviced by this system.

9.6.2.3 Nuclear Services Cooling Water System

All services cooled by the Nuclear Services Closed Cooling Water System, Drawing 302610 and Drawing 302620, are of a nuclear nature and, hence, contained within this system. The system is divided into two basic circuits, as follows. Coolers designated by an asterisk (*) will be isolated on any ESAS signal coincident with a low level signal in the Nuclear Services Closed Cooling Water Surge Tank or on a 30 psig Reactor Building pressure signal (also an ESAS actuation signal) regardless of NSCCW surge tank level.

Intermediate coolers (Drawing 302620) serving:

- Letdown Coolers
- Reactor Coolant Pump Coolers and Jackets
- Reactor Coolant Drain Tank Cooler
- Control Rod Drive Cooling Coils

Nuclear services coolers (Drawing 302610) serving:

- Spent Fuel Pool Coolers
- Reactor Coolant Pump Motors - air and oil coolers*
- Reactor Coolant Pump Seal Return Coolers
- Reactor Building Cooling Unit Fan Motor Coolers
- Makeup Pump and motor - 1B
- Makeup Pumps and motors - 1A and 1C (during maintenance of 1B)

Waste Evaporator Condensers, Distillate Coolers, and Vacuum Pump Seal Water Coolers

Waste Gas Compressors

Steam Generator and Pressurizer Sample Coolers

Control Building air-conditioning

Air coolers - emergency feed pump, instrument air compressor area

Air coolers - nuclear services closed cycle, decay heat closed pump area

Air coolers - spent fuel pump area

Both the Intermediate Coolers and Nuclear Service Coolers are serviced by the Nuclear Services Cooling River Water System. See Drawing 302202. Original system equipment data are listed in Table 9.6-1.

In an emergency, river water to the Intermediate Coolers can be shut off and the additional flow made available to the Nuclear Services Coolers by operator action. As an additional backup, Nuclear Services Cooling River Water can be supplemented by the Secondary Services Cooling River Water Pumps. This arrangement permits the following system operation and redundancy:

Three Nuclear Services Cooling River Water Pumps:

Two operated for normal cooling

One required for emergency cooling

Four Nuclear Services Coolers:

Three operated for normal cooling (two are required for emergency cooling)

One available for maintenance and backup operation

Three Nuclear Services Closed Cooling Water Pumps:

Two run for normal cooling

One required for emergency cooling

Two Intermediate Coolers:

Two operated for normal cooling

Two Intermediate Closed Cooling Water Pumps:

One run for normal cooling

The Nuclear Services Cooling River Water Pumps are located in the Intake Screen and Pump House and are arranged to take suction in the same manner as the Secondary Services Cooling River Pumps.

River water is circulated on the tube side in the coolers with closed cooling water circulated on the shell side by the closed cooling water pumps. After passing through the coolers, the river water can be used for emergency deicing purposes or diverted to the cooling tower collecting sump and returned to the river.

Radioactive fluid leakage will be prevented from returning to the river with this closed system unless a tube leak occurs simultaneously in a Nuclear Services Cooler and in a cooler served by the closed system. Thus, this design provides a double barrier against leakage. This is true also for the Intermediate Coolers and the coolers which they serve. The closed loops are continuously monitored for radioactivity, and if any is detected, the system will be tested and the leaking cooler isolated. Where spare coolers exist, the spare will be put into service.

The Nuclear Services Closed Cooling Water System (NSCCW) is normally pressurized by an instrument air supply at the surge tank to keep the piping inside containment for the Reactor Building Emergency Cooling fan motor cooling at greater than design containment pressure. This prevents the NSCCW system from being a potential leak path from containment during a LOCA.

The Reactor Building Fan Motor Coolers, Drawing 302610, have relief valves which are located outside the Reactor Building upstream of the respective NS isolation valves NSV-53A/B/C. The relief valves provide overpressure protection of the motor coolers due to thermal expansion of isolated cooling water. These valves do not present a leak path from containment because of the following:

1) Each relief valve is set to lift at 175 psig, which is approximately 3 times the design pressure of the Reactor Building. Therefore, even if the coolers are breached during accident conditions which pressurize the building the relief valves should not lift.

2) If the valve did lift, it would pass uncontaminated closed cooling water at higher pressure than the Reactor Building and would imply an intact cooler pressure boundary.

On the closed cycle portion of the Nuclear Services Cooling System, an elevated surge tank of 1470 gal liquid capacity (1600 gallon total capacity) provides storage of coolant with makeup from the demineralized water storage tank being manually added from the Control Room console. Abnormal tank levels will be monitored in the Control Room. Overflow will be piped to the Waste Disposal System.

The Nuclear Services Cooling Water System is protected in the following manner from turbine or tornado missiles and from the hypothetical aircraft incident:

Redundant river water pumps are located in the Intake Screen and Pump House at the river and are physically separated by a single wall and by pumps of other services. This structure is designed to withstand the hypothetical aircraft incident.

Underground concrete pipe lines connect the Intake Screen and Pump House with the Heat Exchanger Vault.

Redundant heat exchangers are located in the underground Heat Exchanger Vault that is designed to withstand the hypothetical aircraft incident. The piping from the shell side of the Nuclear Services Coolers enters the Auxiliary Building via an underground tunnel which is also designed for the hypothetical aircraft incident.

An analysis of pipe whip and jet impingement loads on the Nuclear Service Closed Cooling Water (NSCCW) piping inside containment has been performed. Degradation of NSCCW piping due to High Energy Line Break (HELB) effects could result in loss of NSCCW safety function since the NSCCW isolation valves may not isolate this portion of the piping in sufficient time to prevent pump cavitation and excessive loss of system inventory. It was determined that the jet impingement effects due to a HELB in the pressurizer surge line would not degrade the NSCCW piping inside the containment, adequate pipe rupture restraints provide protection from a main steam line break, and "Leak-Before-Break" criteria provides protection against RCS hot and cold leg piping breaks. Details of this analysis are further described in Section 4.2.2.3.

The Nuclear Services Closed Cooling water is chemically treated to inhibit corrosion. The chemicals are added into the 18 inch pump suction manifold through a chemical mixing tank and recirculation line.

All services served by this system are located in the Auxiliary Building, Fuel Handling Building, and a portion of the Intermediate Building or Reactor Building, which provide protection from the hypothetical aircraft incident.

9.6.2.4 Reactor Building Emergency Cooling System

The Reactor Building Emergency Cooling System is an open system (refer to Drawings 302610 and 302611) whereby river water is pumped directly into the emergency cooling coils. In the event of coil leakage, inflow of river water into containment will occur and will be detected by the detection method described in Item b of Subsection 9.6.1.

The System starts on actuation signals as discussed in Section 6.3.3. These redundant river pumps may also be used to provide the Emergency Feedwater Pumps with a source of water if the condensate inventories are ever depleted.

9.6.2.5 Decay Heat Services Cooling System

This closed cooling system, as coupled with the Decay Heat Removal System, is designed to provide two entirely separate 100-percent- capacity systems from the core all the way to the ultimate heat sink. (See Section 9.5 for decay heat removal portion.) Refer to Drawings 302202 and 302645.

Two 100 percent capacity river water pumps are located in the Intake Screen and Pump House.

Two 100 percent capacity coolers are located in the vault in the Auxiliary Building.

Two 100 percent capacity closed cycle pumps are located in the Auxiliary Building.

Tornado and turbine missile protection and protection from the hypothetical aircraft incident is afforded to the Decay Heat Services Cooling Systems in the same manner as to the Nuclear Services Cooling Water Systems described in Subsection 9.6.2.3.

The Decay Heat Closed Cycle System is so arranged that the following pumps associated with decay heat are cooled by the closed-cycle coolant:

A. Decay Heat Closed Cycle Pumps

B. Decay Heat Removal Pumps and Motors

C. Reactor Building Spray Pumps and Motors

D. Makeup and Purification Pumps and Motors – 1A and 1C

The Makeup and Purification Pump 1A or 1C may be run when the normally operated 1B Pump is down for maintenance by providing Nuclear Services Cooling Water as the coolant; an entire Decay Heat Services Cooling system need not be run to cool the one makeup and purification pump substituted for the 1B pump. The closed cycle cooling water is monitored for radioactivity.

An elevated 375 gallon capacity vented surge tank is used on each of the two closed cycle loops. A double barrier is provided between the Decay Heat Removal System and the river by using closed cycle system.

The chemical mixing tanks, one per Decay Heat Closed Cooling Water Pump, may be used to add chemicals into the system for corrosion inhibition.

TABLE 9.6-1 (Sheet 1 of 4)
COOLING WATER SYSTEMS PERFORMANCE AND EQUIPMENT DATA
(Capacities are on a per unit basis.)

HISTORICAL INFORMATION
The pump head/flow, cooler heat exchanger values and system design temperatures in this table are original equipment bills of material nominal parameters used by the manufacturer for fabrication. The information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant. Actual system/equipment design bases performance requirements are captured in other sections of the UFSAR and/or supporting calculations.

Condenser Circulating Water Pumps (CW-P-1 A to F)	
Number	6
Flow, gpm	74,000
Design head, ft	95
Condenser Circulating Water System	
System design temperature,°F	100
System piping design code/seismic class	AWWA/III
Cooling Towers (CW-C-1A/B)	
Cooling Tower (CW-C-1A)	Counter Flow, Natural Draft
Cooling Tower (CW-C-1B)	Cross Flow, Natural Draft Hyperbolic Shell
Design Capacity w/o overflow, gpm	272,000
Normal Circulating rate, gpm	215,000
Design hot water temperature, °F	116
Design cold water temperature, °F	88
Design temperature range, °F	28
Secondary Services River Water Pumps (SR-P-1A/B/C)	
Number	3
Flow, gpm	7250
Design head, ft	95
Secondary Services River Water System	
System design temperature, °F	85
System piping design code/seismic class	Inside USAS B31.1.0 Outside AWWA
Seismic class	Inside HEV-S-Ix Outside - SIII
Secondary Services Closed Cooling Water Coolers (SC-C-1A/B/C/D)	
Number	4
Type	Shell and tube
River cooling water flow (tubeside), gpm	4335
River cooling water temperature, °F	85
Closed cycle cooling water outlet temperature, °F	95
Closed cycle cooling water flow (shell side), gpm	2775
Tube material	Admiralty
Shell material	Carbon steel
Design pressure, shell/tube, psig	120/75
Design temperature, shell/tube, °F	150/150
Code/seismic class	ASME Section VIII/III
Heat exchanged (per cooler)	16.24×10^6 Btu/hr

TABLE 9.6-1 (Sheet 2 of 4)
COOLING WATER SYSTEMS PERFORMANCE AND EQUIPMENT DATA
(Capacities are on a per unit basis.)

HISTORICAL INFORMATION
The pump head/flow, cooler heat exchanger values and system design temperatures in this table are original equipment bills of material nominal parameters used by the manufacturer for fabrication. The information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant. Actual system/equipment design bases performance requirements are captured in other sections of the UFSAR and/or supporting calculations.

Secondary Services Closed Cooling Water Pumps (SC-P-1A/B/C)	
Number	3
Flow, gpm	4400
Design head, ft	110
Secondary Services Closed Cooling Water System	
System design temperature, °F	95
System piping design code/seismic class	USAS B31.1.0/III
Nuclear Services River Water Pumps (NR-P-1A/B/C)	
Number	3
Flow, gpm	6000
Design head, ft	77
Nuclear Services River Water System	
System design temperature, °F	85
System piping design code/seismic class	Inside USAS B31.1.0/I, Outside AWWA/I
Nuclear Services Closed Cooling Water Coolers (NS-C-1A/B/C/D)	
Number	4
Type	Shell and tube
River cooling water flow (tubeside), gpm	3400
River cooling water temperature, °F	85
Closed cycle cooling water outlet temperature, °F	95
Closed cycle cooling water flow (shell side), gpm	1775
Tube material	Admiralty
Shell material	Carbon steel
Design pressure, shell/tube, psig	175/100
Design temperature, shell/tube, °F	150/150
Code/seismic class	ASME Section VIII/I
Heat exchanged (per cooler) Btu/hr	19.33×10^6
Nuclear Services Closed Cooling Water Pumps (NS-P-1A/B/C)	
Number	3
Flow, gpm	2800
Design head, ft	136
Nuclear Services Closed Cooling Water System	
System design temperature, °F	95
System piping design code/seismic class	USAS B31.1.0/I

TABLE 9.6-1 (Sheet 3 of 4)
COOLING WATER SYSTEMS PERFORMANCE AND EQUIPMENT DATA
(Capacities are on a per unit basis.)

HISTORICAL INFORMATION
The pump head/flow, cooler heat exchanger values and system design temperatures in this table are original equipment bills of material nominal parameters used by the manufacturer for fabrication. The information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant. Actual system/equipment design bases performance requirements are captured in other sections of the UFSAR and/or supporting calculations.

Decay Heat River Water Pumps (DR-P-1A/B)	
Number	2
Flow, gpm	7900
Design head, ft	68
Decay Heat River Water System	
System design temperature, °F	85
System piping design code/seismic class	Inside USAS B31.1.0/I Outside AWWA/I
Decay Heat Service Closed Cooling Water Coolers (DC-C-2A/B)	
Number	2
Type	Shell and Tube
River cooling water flow (tubeside), gpm	7500
River cooling water temperature, °F	85
Closed cycle cooling water outlet temperature, °F	95
Closed cycle cooling water flow (shell side), gpm	3700
Tube material	Admiralty
Shell material	Carbon steel
Design pressure, shell/tube, psig	80/75
Design temperature, shell/tube, °F	195/195
Code/seismic class	ASME Section VIII/I
Heat exchanged (per cooler) Btu/hr	135×10^6
Decay Heat Service Closed Cooling Water Pumps (DC-P-1A/B)	
Number	2
Flow, gpm	3900
Design head, ft	75
Decay Heat Closed Cooling Water System	
System design temperature, °F	95
System piping design code/seismic class	Inside USAS B31.1.0/I
Reactor Building Emergency Cooling Water Pumps (RR-P-1A/B)	
Number	2
Flow, gpm	5400
Design head, ft	242
Reactor Building Emergency Cooling Water System	
System design temperature, °F	85
System piping design code/seismic class	
Inside	USAS B31.1.0/I
Outside	AWWA/I

TABLE 9.6-1 (Sheet 4 of 4)

COOLING WATER SYSTEMS PERFORMANCE AND EQUIPMENT DATA

(Capacities are on a per unit basis.)

HISTORICAL INFORMATION

The pump head/flow, cooler heat exchanger values and system design temperatures in this table are original equipment bills of material nominal parameters used by the manufacturer for fabrication. The information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant. Actual system/equipment design bases performance requirements are captured in other sections of the UFSAR and/or supporting calculations.

Screen House Ventilation Equipment Pumps (SW-P-2A/B)	
Number	2
Flow, gpm	150
Design head, ft	130
Screen House Ventilation System	
System design temperature, °F	85
System piping design code/seismic class	USAS B31.1.0/II
Screen Wash Pumps (SW-P-1A/B)	
Number	2
Flow, gpm	1400
Design head, ft	270
Screen Wash System	
System design temperature, °F	85
System piping design code/seismic class	USAS B31.1.0/I
Service Water Cooling Tower Pumps (SR-P-3A/B)	
Number	2
Flow, gpm	17,500
Design head, ft	71
Service Water Cooling System	
System design temperature, °F	150
System piping design code/seismic class	USAS B31.1.0/III
Service Water Cooling Tower (CW-C-2)	
Number	1
Flow, gpm	33,000
Inlet hot water temperature, °F	108
Outlet cold water temperature, °F	85
Design wet bulb temperature, °F	78

9.7 HEAVY LOADS AND NUCLEAR FUEL HANDLING

9.7.1 DESIGN BASES

Activities involving the handling of Irradiated Fuel and activities involving the handling of heavy loads over spent fuel, fuel in the reactor core, or safety-related equipment are part of the TMI design basis.

The evaluations and commitments regarding heavy load handling operations in accordance with NUREG-0612 are documented in the TMI Heavy Load Submittal dated February 25, 1984 (DRF# 018495). As part of the evaluation, the Reactor Building and Fuel Handling Building were divided into impact regions and an assessment was performed to determine the load drop consequences for a dropped heavy load in each impact region. Specific commitments regarding the potential drop of a fuel cask were incorporated into TMI Technical Specifications (Section 3.11), “Handling of Irradiated Fuel” by License Amendment 109, dated July 30, 1985. Although few heavy load lifts are specifically discussed in the FSAR, the planned movements of heavy loads must be reviewed against the evaluations/submittals described above.

The process and system design for movement of nuclear fuel is described within this FSAR section. Planned Fuel movement/refueling activities must be evaluated against the following description as well as the Heavy Load (NUREG 0612) Submittal.

9.7.1.1 Fuel Handling System

The fuel handling system shown on Figure 9.7-1 is designed to provide a safe, effective means of storing and handling fuel from the time it reaches the station in an unirradiated condition until it leaves the station after post-irradiation cooling. The system is designed to minimize the possibility of mishandling or maloperations that could cause fuel assembly damage, potential fission product release, or both.

The fuel handling crane during its normal operation is prevented from handling heavy loads over the spent fuel pool and its adjacent area by a key-interlock system. The automatic travel interlock system is administratively imposed during normal operation from a keylock switch whenever the fuel handling crane is to transport loads in excess of 15 tons and confines the crane bridge and trolley horizontal motions to the shaded areas indicated on Figure 9.7-2. The vertical lift height of such a load is under strict administrative control. The only area of the spent fuel pool structure that may be exposed to a spent fuel cask accidentally dropped from a height greater than 1 foot is the shipping cask area (Figure 9.7-1) which has been designed to withstand the impact from a dropped spent fuel cask. The bottom of the spent fuel cask storage area is constructed of solid reinforced concrete to bedrock. During its travel from the shipping cask area to the receiving/shipping area (Figure 9.7-1), the fuel handling crane travel interlock limit automatically confines the travel of the centerline of the spent fuel cask to a 1 ft wide corridor about the north-south centerline of the 5 ft wide west wall of the spent fuel storage pool. During this travel, the height of the bottom of the spent fuel cask is administratively maintained at less than 1 foot above the top surface of the concrete spent fuel pool wall. The 5 ft wide, reinforced concrete spent fuel pool wall is based on bedrock and is designed to withstand the impact from an accidentally dropped spent fuel cask. Tech. Spec. 3.11.7 currently restricts the movement of a spent fuel cask in the Unit 1 Fuel Handling Building to a specific transfer path.

The reactor is refueled with equipment designed to handle the spent fuel assemblies underwater from the time they leave the reactor vessel until they are placed in a cask for shipment from the site. Underwater transfer of spent fuel assemblies provides an effective, economic, and transparent radiation shield, as well as a reliable cooling medium for removal of decay heat. Borated water assures reactor subcriticality during refueling.

9.7.1.2 Fuel Storage

Fuel storage capabilities are tabulated in Table 9.7-1. These areas are designated for fuel storage:

a. New fuel may be stored dry in the long term dry storage area within the Fuel Handling Building and then transferred to fuel pool A or B when refueling is about to be initiated. New fuel may also be stored in spent fuel pool A, Region I storage racks, or spent fuel pool B. Fuel must meet the respective enrichment criteria of T.S. 5.4.1 for each storage area. The boron concentration of the pools must be at least 600 ppm (not including sampling uncertainties) when storing new fuel in them, concurrent with manipulating fuel in or above the pools.

b. Spent fuel meeting the burnup/enrichment criteria of T.S. 5.4.2 is stored in spent fuel pool A, Region I and II storage racks.

c. Spent fuel meeting the burnup/enrichment criteria of T.S. 5.4.2 is stored in spent fuel pool B.

Maximum new fuel storage requirements occur in storage of the initial core, at which time no spent fuel is stored. Permanent dry new fuel storage is provided for 66 fuel assemblies. (Note: This number includes the twelve storage locations which must be left vacant of fissile or moderating material due to criticality concerns). The fuel assemblies are stored in racks in parallel rows, having a nominal center-to-center distance of 21 1/8 inches in both directions for the new fuel storage vault. This spacing is sufficient to maintain a k effective of less than 0.95 based on storage of fuel assemblies in clean unborated water or less than 0.98 based on storage in an optimum hypothetical low density moderator (fog or foam) for fuel assemblies with a nominal enrichment of 5.0 weight percent U-235.

Both the new and the spent fuel pools (A and B) are constructed of reinforced concrete and lined with stainless plate, and are located in the Fuel Handling Building. The fuel management program is scheduled so that the required spaces are available to accommodate both new and spent fuel.

For Spent Fuel Pool A, the spent or new fuel assemblies are stored in racks in parallel rows having a nominal center-to-center distance of 11.1 inches for Region I racks and 9.2 inches in both directions for Region II racks. Both Region I and II racks contain boral neutron absorber panels to mitigate criticality concerns. The spacing in the Spent Fuel Pool "A" storage locations for both Region I and II is adequate to maintain k effective less than 0.95. Region I will store fuel with a maximum 5.0 percent initial enrichment. Region II will store higher burnup spent fuel, and contains three locations for storing failed fuel.

For Spent Fuel Pool B, the fuel assemblies are stored in racks in parallel rows having a center-to-center distance of 13 5/8 inches in both directions. This spacing is sufficient to maintain a k effective less than 0.95 based on new fuel assemblies with a maximum enrichment of 4.37 weight percent U-235.

Fuel to be stored in Spent Fuel Pool A Region II or Spent Fuel Pool B must meet the combined initial enrichment and burnup limits of Technical Specification 5.4.2.

Control components requiring removal from the reactor are stored in the spent fuel assemblies.

9.7.1.3 Fuel Transfer Tubes

Two horizontal tubes are provided to convey fuel between the Reactor Building and the Fuel Handling Building. These tubes contain tracks for the fuel transfer carriages, gate valves on the Fuel Handling Building side, and a flanged closure on the Reactor Building side. The fuel transfer tubes penetrate from the fuel storage pool into the fuel transfer canal at the lower depth, where space is provided for the rotation of the fuel transfer carriage baskets, each containing a fuel assembly.

9.7.1.4 Fuel Transfer Canal

The fuel transfer canal is a passageway in the Reactor Building extending from north of the reactor vessel to the south Reactor Building wall. It is formed by an upward extension of the primary shield walls. The enclosure is a reinforced concrete structure lined with stainless steel plate to form a canal above the reactor vessel which is filled with borated water for refueling.

The south (deep) portion of the fuel transfer canal is normally used for the storage of the reactor vessel internals and plenum assembly.

9.7.1.5 Fuel Handling Equipment

This equipment consists of fuel handling bridges with integral fuel handling mechanisms, control rod handling mechanisms, fuel storage racks, fuel transfer mechanisms, and shipping casks. In addition to the equipment directly associated with the handling of fuel, equipment is provided for handling the reactor vessel closure head and the plenum assembly to expose the core for refueling.

9.7.1.6 Fuel Handling Building Crane

The fuel handling building crane is equipped with a main hook and hoisting system designed to accommodate loads up to 110 tons and an auxiliary hook and hoisting system designed to accommodate up to 15 tons. The span of the fuel handling crane, between wheel truck centerlines, is 47 ft 4 inches. The air space of the Fuel Handling Building operation level is common for both Units 1 and 2. Therefore, the fuel handling crane is capable of traveling north and south throughout the full length of the Unit 1 and Unit 2 Fuel Handling Buildings (Figure 9.7-1).

The trolley travel on the bridge is such that the main hook and auxiliary hook may approach the east wall of the Fuel Handling Building within 5 ft 10 inches and 9 ft 11 inches, respectively, and the west wall of the Fuel Handling Building within 9 ft 4 inches and 5 ft 3 inches, respectively.

The fuel handling crane was designed for periodic load testing to 125 percent of rated capacity and was designed to meet the regulations for cranes, booms, and hoists as stated by the Commonwealth of Pennsylvania Department of Labor and Industry and Electric Overhead Crane Institute Specification No. 61, Class A Indoor Service. A safety factor of at least 5, at rated load and based on ultimate strength of the material used, was required of all parts, including the hoist cable. The major structural material of the bridge and trolley meets ASTM Standard A7. The safety factor, based on yield strength of these parts, is 2 for the rated load. The safety factor of the concrete corbel which supports the fuel handling crane, based on yield strength of the rebar in it, is 2.25 at rated load. The supporting walls and foundation, of which the corbel is an integral part, provide a safety factor considerably in excess of that of the corbel.

The structural design of the fuel handling crane is also required to ensure no loss of function during and after a seismic Class I event while lifting rated load. Rail holddown devices are provided to prevent derailment while lifting the load. The crane is also designed to operate continually under maximum operating environmental conditions of 120F and 90 percent relative humidity and for storage conditions between 60F and 120F at 65 percent relative humidity. The crane is capable of microinching to maximum load on either lifting or lowering operations.

Should the main hoist motor fail to turn the drive shaft to the gear train, the mechanical brake will immediately "seize" the load, stop it, and hold it in position during either lifting or lowering of the load. The electric brake is sized to have a torque rating greater than the full load torque of the motor and operates automatically upon termination of crane power. Either the mechanical load brake or solenoid brake is designed to preclude acceleration of the load and to maintain the load in position when brought to rest.

A Whiting automatic paddle-type limit switch and a screw-type limit switch is installed for upper hoist limit to prevent two-blocking situations.

The crane is equipped with an overhead bridge cage and pendant controls. The bridge cage is the main control center with pendant control accomplished by an electrical switchover from the cab. Cab control handles are oriented in the direction of hook function. Pendant controls are spring-loaded to assure automatic return to "off" when hand pressure is released.

The crane controls contain a forward and reversing starting contactor, four accelerating contactors, and a pneumatic time-delay relay. Moving the master control switch to its first position actuates the starting contactor. This connects the motor's stator windings directly to the line and its rotor current to a series of grid resistors. As the master switch is advanced to each further position, a contactor is actuated which speeds up the motor by shunting out one section of resistance external to the rotor. When the master switch is advanced to its final position, all the external resistance is cut from the motor rotor circuit, and the motor operates at full speed. The initial starting contactors, plus the accelerating contactors, provide five points of acceleration for all the crane motors, main and auxiliary hoists, bridges, and trolley travel. A time-delay relay is provided between all but the first and second points of the master control switches to preclude excessive acceleration.

Fifty percent electric braking is furnished on the bridge and trolley in order to keep load sway to a minimum in the event brakes are applied.

Testing, maintenance, and operation of the crane is conducted in accordance with American National Standard B30.2.

Two monorail hoists, which provide east-west travel, are mounted underneath the north-south beams of the bridge of the fuel handling crane. A 5 ton capacity monorail hoist, which provides a maximum 53 ft lift, is mounted underneath the south beam of the bridge of the fuel handling crane. A 3 ton capacity monorail hoist, which provides a maximum 40 ft lift, is mounted underneath the north beam of the bridge of the fuel handling crane. The hooks of the 5 and 3 ton hoists can approach the east wall of the Fuel Handling Building within 8 ft 0 inches and 6 ft 6 inches, respectively, and the west wall of the Fuel Handling Building within 5 ft 4 inches and at a distance to allow full servicing of dry fuel storage racks, respectively.

The hoisting mechanisms and lifting equipment of the main and auxiliary crane and the 5 and 3 ton monorail hoists are all designed with a factor of safety of 5. The structural members are designed in accordance with Electric Overhead Crane Institute Specification No. 61 for Class A indoor service. All hoisting mechanisms are provided with an automatic mechanical load brake.

Further data on the fuel handling crane and the 5 and 3 ton hoists are listed below:

	Main Crane	Aux. Crane			5 Ton		3 Ton	
Item	Hook	Hook	Bridge	Trolley	Hoist	Travel	Hoist	Travel
Speeds, ft/min	4-2/3	20	50	40	20	50	20	50
Speeds, * Inches/min		15	12	12	-	-	-	-
Control from:	Cab or Pendant	Cab or Pendant	Cab or Pendant	Cab or Pendant	Cab or Pendant	Cab or Pendant	Cab or Pendant	Cab Only

* Slow speed (micro) drives have been added to provide Dual Speed Selection capability for the Auxiliary Crane Hook, Bridge and Trolley drives.

The key-interlock system, which limits the travel of the bridge and trolley of the fuel handling crane when it is to lift and transport loads in excess of 15 tons, is described in Section 9.7.1.1.

9.7.2 SYSTEM DESCRIPTION AND EVALUATION

9.7.2.1 Receiving And Storing Fuel

New fuel assemblies are received in shipping containers in the rail car bay inside the Fuel Handling Building. The new fuel containers are normally unloaded from the shipping conveyance by means of the 15 ton auxiliary hook of the Fuel Handling Building crane. The shipping containers are rotated and placed on the loading dock such that the new fuel elements within them can be placed in the upright position when the container is opened. The shipping container is then opened and the new fuel elements placed in the upright position, and then the fuel assemblies are removed from the container by means of a manually operated tool suspended from the small traveling hoist. The new fuel element is then inspected and placed in either fuel storage pool A or B or the new fuel storage vault.

When storing new fuel in the spent fuel pools concurrent with manipulation of fuel in the pools, a boron concentration of at least 600 ppm (<u>not</u> including sampling uncertainties) must be maintained in the pools.

The new fuel unloading and storage operations, described above, constitute a part of the normal operation for the fuel handling crane. In this case, because the crane is carrying loads of less than 15 tons, the travel interlock system is not imposed and the crane may carry its load anywhere within its possible travel limits except above the spent fuel pool operating floor and east of the floor marking in the Truck Bay due to safety system considerations. Loads in excess of 3000 lbs. which are to be handled above the spent fuel pool operating floor shall meet the restrictions of Technical Specification Section 3.11.6.

9.7.2.2 Loading And Removing Fuel

Following the reactor shutdown and Reactor Building entry, the refueling procedure is begun by removal of the reactor closure head. Head removal and replacement time is minimized by the use of either two or four stud tensioners. The stud tensioners are hydraulically operated to permit preloading and unloading of the reactor vessel closure studs at cold shutdown conditions. The studs are tensioned to their operational load in a predetermined sequence. Required stud elongation after tensioning is verified by an elongation gage.

Following removal of the studs from the reactor vessel tapped holes, the studs and nuts are supported in the closure head bolt holes with specially designed spacers. The studs and nuts are either transported with the closure head, or removed from the closure head and placed into racks for temporary storage.

The reactor closure head is lifted out of the canal onto a head storage stand on the operating floor by a head and internals handling fixture attached to the polar crane. The stand is designed to protect the gasket surface of the closure head. The lift is guided by two alignment studs installed in two of the stud holes. These studs also provide proper alignment of the reactor closure head with the reactor vessel and internals when the closure head is replaced after refueling. If transported with the closure head, the stud and nuts can be removed from the reactor closure head at the storage location for inspection and cleaning using special stud and nut handling fixtures. A storage rack is provided for closure head studs and alignment studs.

The annular space between the reactor vessel and transfer canal floor is sealed off by the transfer canal seal plate. The transfer canal seal plate is permanently welded in place. During normal plant operation this Permanent Canal Seal Plate (PCSP) provides for reactor cavity ventilation through access ports around the circumference of the PCSP. The access ports in the PCSP are designed to provide for the required ventilation area and airflow. Prior to refueling, bolted covers are installed over the access ports to provide a water tight seal around the reactor cavity to allow for flooding of the fuel transfer canal. Upon completion of refueling activities, the bolted covers are removed to restore the required ventilation area.

The plenum assembly is removed from the reactor and stored underwater in the transfer canal shallow end or on a stand on the fuel transfer canal floor using the head and internals handling fixture and adaptor attached to the polar crane. An internals handling extension is used when removing the plenum with the fuel transfer canal fully flooded.

The fuel handling building crane will be used to remove the cover from the top of the dry (new) fuel storage area. This will be moved in a due south direction (away from the spent fuel pools) and temporarily stored over the decontamination pit area. Thereafter, one new fuel element at a time is removed from the dry (new) fuel storage area, inspected, and moved to the location of the new fuel storage elevator. Alternatively, new fuel elements are inspected after removal from their shipping container and moved directly to the new fuel elevator. The new fuel elevator lowers the fuel element to an elevation from which it may be removed by the fuel storage handling bridge, and the latter moves the new fuel element to a predesignated storage location in fuel storage pool A or pool B if required. This procedure is repeated until all new fuel elements required for the refueling are in temporary storage in fuel storage pool A or B. The new fuel transfer operation, described above, constitutes another part of the normal operation of the fuel handling building crane.

Refueling operations are carried out from two fuel handling bridges which span the fuel transfer canal. One bridge is used to shuttle spent fuel assemblies from the core to the fuel transfer station and new fuel assemblies from the transfer station to the core. During this operation, the second bridge can be occupied with relocating partially spent fuel assemblies in the core as specified by the fuel management program.

The fuel handling bridge which transfers fuel assemblies between the reactor vessel and the fuel transfer station is equipped with two trolley mounted hoists. One hoist (fuel handling mechanism) is equipped with a fuel grapple and the second hoist (control rod handling mechanism) houses the control rod grapple. The second fuel handling bridge in the Reactor Building has only one trolley mounted hoist equipped with a fuel grapple and is used primarily for shuffling or rearranging partially spent fuel assemblies from one position in the core to another.

The two-hoist bridge moves a spent fuel assembly from the core underwater to the transfer station where the fuel assembly is lowered into the fuel transfer carriage fuel basket. The stainless steel guide tube of the control rod handling mechanism can be used to transfer a rod assembly to a new fuel assembly waiting in the second fuel transfer carriage basket. This new fuel assembly with a rod assembly is carried to the reactor by the fuel handling hoist and located in the core while the spent fuel assembly is being transferred to the spent fuel pool.

Spent fuel assemblies removed from the reactor are transported to the spent fuel pool from the Reactor Building via fuel transfer tubes by means of the fuel transfer mechanism. The fuel transfer mechanisms are underwater carriages that run on tracks extending from the fuel storage pool through the transfer tubes and into the Reactor Building. An upending device is provided at each end of each fuel transfer tube to rotate fuel assemblies to a vertical position. The hydraulically operated fuel basket frame is rotated to a horizontal position for passage through the transfer tube and then rotated back to a vertical position in the fuel pool or Reactor Building for vertical removal or insertion of the fuel assembly.

The spent fuel assemblies are removed from the fuel transfer carriage fuel basket using a fuel handling bridge equipped with a fuel handling mechanism and fuel grapple and a control rod handling mechanism and grapple. This bridge spans the fuel storage pool and permits the refueling crew to store or remove new or spent fuel assemblies in designated storage rack positions.

When refueling is complete, the fuel transfer carriages are stored in the fuel storage pool, thus permitting the gate valves on the fuel storage pool side of each transfer tube to be closed. The fuel transfer canal water is drained through a pipe located in the deep transfer station area of the canal, and pumped to the borated water storage tank for future use. Blind flanges are then installed on the Reactor Building side of the tubes.

Space is provided in spent fuel pool B to receive a spent fuel shipping cask as well as to provide for required long-term fuel storage. Following a decay period, the spent fuel assemblies could be removed from storage and loaded into the spent fuel shipping cask underwater for removal from the site, if so desired. The Fuel Handling Building crane can handle casks up to 110 tons in weight.

After water is pumped from the shipping cask area down to elevation 324 ft 0 inch, the automatic travel interlock system, described in Section 9.7.1.1, is administratively imposed on the fuel handling crane. It is then used to lift the spent fuel shipping cask from its transport vehicle (in the receiving/shipping area, Figure 9.7-1) and to transport it, via the administratively imposed, automatically enforced "travel corridor" (Figure 9.7-1), into place in the shipping cask area (Figure 9.7-1) of spent fuel storage pool B and to remove the cask lid to the receiving/shipping area. While the water removed from the shipping cask area is being replaced, the spent fuel shipping cask lifting yoke is removed from the main crane hook. Thereafter, the administrative interlock on crane travel is removed. The cask pit gate is removed using the main crane hook. The fuel handling crane is then moved to the receiving/shipping area for replacement of the spent fuel shipping cask lifting yoke on its main hook. At this time, the automatic travel interlock system is imposed.

The spent fuel stored in spent fuel storage pool is moved into the spent fuel shipping cask utilizing the fuel storage handling bridge. The fuel handling building crane (with automatic travel interlock system imposed) is then used to replace the lid on the spent fuel shipping cask and lift it up out of the shipping cask area. After the bottom of the cask is above elevation 348 ft 0 inches, it is moved, following the established safe load path, to the loading dock and truck bay area for shipping.

9.7.2.3 Safety Provisions

Safety provisions are designed into the fuel handling system to prevent the development of hazardous conditions in the event of component malfunction, accidental damage, or operation and administrative failures during refueling or transfer operations.

New fuel will normally be stored in the New Fuel Storage Vault racks, the spent fuel pool A racks, or the spent fuel pool B racks. Spent fuel may be stored in the spent fuel pool A racks or the spent fuel pool B racks. The fuel storage racks are designed so that it is impossible to insert fuel assemblies in other than the prescribed locations, thereby ensuring the necessary spacing between assemblies. In the New Fuel Storage Vault, two transverse rows of six storage locations each (transverse rows, numbers four and eight) are required to be left vacant of fissile or moderating material. Fuel transfer and handling containers are designed to maintain an 'eversafe' geometric array. When handling and storing new fuel in the pool A or pool B racks, a boron concentration of at least 600 ppm (<u>not</u> including sampling uncertainties) must be maintained in the pool. Under these conditions, a criticality accident during storage or refueling is not considered credible. The results of the criticality analyses for the pool A, pool B and the New Fuel Storage Vault are contained in Reference 8. An additional criticality analysis for the Mark B12 fuel design is contained in Reference 14. (Note that any changes to fuel designs that increase fuel reactivity relative to the design assumptions of Reference 8 (e.g. uranium loading, fuel pin geometry, fuel assembly materials, etc. must be reviewed for any impact on safety.) The criticality analysis for the Mark-B12 fuel design is valid for the Mark-B-HTP design, as these designs are neutronically equivalent based on use of identical fuel rod designs, uranium loading, and lattice geometry.

The criticality safety analysis contained in References 8 and 14 verifiy that the more highly enriched fuel can be stored in these locations without exceeding NRC guidelines on K effective under normal and accident conditions. The criticality analysis is based on the final rerack configuration, that is, all 1494 storage locations in Pool A of which 195 locations are for Region I.

The results of the reactivity calculations for the new fuel vault show that the limiting reactivity condition for low-density optimum moderation occurs at a hypothetical moderator density of 9%. This resulted in a k effective of 0.9571 which included all appropriate uncertainties at the 95% probability/95% confidence level (95/95 probability/confidence), thus meeting the NRC criterion of 0.98. For the fully flooded accident condition, the maximum K effective, including 95/95 uncertainties, was 0.9487 which is within the NRC criterion of 0.95 and, therefore, acceptable.

The spent fuel storage racks in Pool A were reevaluated for 5.0 w/o U-235 enriched fuel based on the as-built boron-10 (B-10) loading in the Boral panels (rather than the original design loading). The calculations were made at 4°C which corresponds to the highest possible reactivity. For the nominal storage cell design in Region I, uncertainties due to boron loading tolerances, boral width tolerances, tolerances in cell lattice spacing, stainless steel thickness tolerances, and fuel enrichment and density tolerances were accounted for as well as eccentric fuel positioning. These uncertainties were appropriately determined at the 95/95 probability/confidence level. In addition, calculational bias and uncertainty were determined from benchmark calculations. The final Region I design, when fully loaded with fuel enriched to 5.0 w/o U-235, resulted in a K effective of 0.9470 when combined with all known uncertainties. This meets the NRC criterion of K effective no greater than 0.95 including all uncertainties at the 95/95 probability/confidence level and is, therefore, acceptable.

The storage racks in Pool B are unpoisoned and use a stainless steel and water flux trap between cells as a means of controlling reactivity. These racks are designed to accommodate fuel of various initial enrichments which have accumulated sufficient minimum burnups. The reactivity analysis for these racks show that the 0.95 K effective limit is met for fresh (unirradiated) fuel of 4.37 w/o enrichment.

Calculations to determine the required discharge fuel burnup of 5.0 w/o initially enriched fuel showed that a burnup of only 2.48 MWD/KgU was adequate for unrestricted storage in the Pool B racks. These minimum burnup requirements are given in Technical Specification Figure 5-5.

Most abnormal storage conditions will not result in an increase in the K effective of the racks. However, it is possible to postulate events, such as the misloading of an assembly with a burnup and enrichment combination outside of the acceptable area in Figure 5-4 or 5-5 or dropping an assembly between the pool wall and the fuel racks, which could lead to an increase in reactivity. However, for such events credit may be taken for the presence of a minimum of 600 ppm (<u>not</u> including sampling uncertainties) of boron in the pool water required during fuel handling operations. The reduction in K effective caused by the boron more than offsets the reactivity addition caused by credible accidents.

An evaluation of the thermal-hydraulic effects on spent fuel pool temperature for both a normal refueling discharge and a full core off-load was performed (Reference 8) based on the 5.0 weight percent U-235 new enriched fuel and 60 MWD/KgU burnup. A full core off-load of 177 spent fuel assemblies at the beginning of cycle (with 36 days of reactor power operation) was found to be the limiting condition. This is due to the heat load contribution of the 80 assemblies discharged during the just completed refueling outage. With two spent fuel coolers operating in parallel, the analysis indicated that the maximum pool bulk temperature would be 159.1°F which remains considerably lower than the pool bulk boiling temperature (212°F). Loss of both cooling trains would result in a time-to-boil of 10 hrs. which should provide enough time to get one of the spent fuel cooling loops back to service. There is no impact on the TMI-1 spent fuel pool structural concrete since it has been previously evaluated as being capable to withstand temperatures to 199°F. The maximum temperature of the coolant leaving the spent fuel pool heat exchanger would be 135°F. The ion exchange resins are capable of withstanding 150°F; the precoat filters are designed for 200°F; the rest of the liquid radwaste system is designed for a temperature of 150°F. Based on the evaluations, no thermal-hydraulic concerns were identified with respect to the use of 5.0 weight percent U-235 new enriched fuel. Although Technical Specifications permit unloading spent fuel from the reactor vessel after a 72 hour decay period, a cycle specific fuel pool heatup analysis is performed to determine the decay period before fuel unloading would be initiated. Plant procedures are in place which specify the required decay period before fuel unloading can be initiated.

The free-standing high density spent fuel storage racks store fuel in two discrete regions of the Spent Fuel Pool "A". Region I includes two modules having a total of 195 storage cells. Each cell in Region I is designed for storage of fresh or irradiated fuel assemblies with Uranium-235 initial enrichments up to 5.0 weight percent while maintaining the required subcriticality (K effective $\leq$ 0.95). Region I has enough locations to store a full core discharge (177 fuel assemblies). Region II includes ten modules having a total of 1299 storage cells, which are available for storage of spent fuel assemblies.

There are 1494 storage cells presently installed in Pool "A," three of which are reserved to accommodate failed fuel containers. Region II is designed to store fuel which has experienced sufficient burnup such that storage in Region I is not required

The high density spent fuel storage rack cells are fabricated from 0.075 inch thick Type 304 austenitic stainless steel sheet material. In Region I, strips of Boral neutron absorber material nominal B-10 loading of 0.0211 gm/sq.cm are between the checkerboard boxes and the sheathing without a water gap. The sheathings have openings through which the gases which may be generated by radiolysis and/or water aluminum reaction can escape, thus preventing swelling and bulging due to pressure buildup. The cells are welded together in a specified manner to become a free-standing structure which is seismically qualified without depending on neighboring modules or fuel pool walls for support. The nominal center-to-center spacings of the cells within Region I are 11.1 inches. The nominal pitch in Region II is 9.20 inches. A poison surveillance program has been implemented which allows access to representative poison samples without disrupting the integrity of the storage system. This program provides the capability to evaluate the material in a normal use mode, and to forecast changes that might occur within the storage system prior to occurrence of such changes. This is accomplished utilizing test "coupons" removed at periodic intervals and tested, as well as direct testing of installed poison panels in the fuel racks.

The final 432 high density spent fuel storage rack cells installed in Region II are utilizing the Metamic panels as neutron absorbers. The following specifications are used for the Metamic panels: Thickness 0.098 $\pm$ 0.005 inches (this is the same nominal thickness as that of the original Boral panels, but with a slightly larger tolerance for manufacturing flexibility); Nominal B_4C content 30.5 wt%; and Minimum B_4C content 29 wt% (Reference 17).

The Metamic panels, the specification is based on B_4C content of the material. The acceptance criteria for the Metamic panels therefore is a B_4C content that results in a B-10 areal density equal to or higher than that of the Boral panels.

A comparison between the B-10 areal densities of Boral and Metamic panels shows that the values for Metamic panels bound those for Boral, for the nominal and minimum values (Reference 17). The NRC has reviewed and approved the use of Metamic as a neutron absorber material in spent fuel storage racks (Reference 18).

The high density spent fuel storage racks and fuel pool structural considerations have been evaluated in Reference 10. Structural adequacy of the rack design is shown for normal and accident loading combinations. The spent fuel storage racks are Seismic Class I and are designed to remain functional during and after a Safe Shutdown Earthquake (SSE) under all fuel loading conditions. The analysis shows that no rack-to-rack or rack-to-wall impacts will occur for either the interim reracking installation or the final reracking configuration. The analysis shows that significant margins of safety exist against local deformation of the fuel storage cell due to rattling impact of fuel assemblies. The potential for overturning has been analyzed and shown to be not possible. The maximum mechanical loading due to the fuel handing bridge has been shown to be acceptable.

Due to the potential for rack movement during or after seismic events, an inspection of the racks to maintain rack gaps is to be performed after an earthquake equivalent to or larger than an Operating Basis Earthquake (OBE).

Pool slab analysis has demonstrated adequate structural integrity for all postulated loading conditions and thermal gradients as described in Reference 10.

The following fuel handling accidents have been evaluated in Reference 10: (1) a fuel assembly dropped from elevation 355 feet-0 inches above a storage location and impacts the base of the module, (2) a fuel assembly dropped from elevation 355 feet-0 inches above the racks and hitting the top of the racks, and (3) a fuel assembly dropped from elevation 355 feet-0 inches above the racks in an inclined manner on the top of the rack. This evaluation has shown that a dropped spent fuel assembly on the racks will not distort the racks such that they would not perform their safety function.

Fuel handling equipment is designed to minimize the possibility of mechanical damage to the fuel assemblies during transfer operations. If fuel damage should occur, the amount of radioactivity reaching the environment will present no hazard. The fuel handling accident is analyzed in Section 14.2.2.1. Modifications in the spent fuel transfer path and changes in operational procedures have been made since the initial plant startup to prevent damage to safeguard piping and equipment in the Auxiliary Building and to fuel assemblies in the pools due to a postulated spent fuel cask drop. In the unlikely event of a cask drop accident, the resulting site boundary doses from noble gases and iodine would be within the limits specified in 10CFR100, as described in Section 14.2.2.

All spent fuel assembly transfer operations are conducted underwater. The water level in the fuel transfer canal provides a minimum of 8 ft 1+1/4 inches of water over the active fuel (7 feet above top of fuel assembly) of the spent fuel assemblies during movements in the Reactor Building to limit radiation at the surface of the water. In the Spent Fuel Pool, the fuel storage racks provide a minimum of 23 feet of water shielding over stored assemblies and a minimum of 6.5 feet of water over the active fuel is provided during movements. The radiation levels associated with fuel handling are discussed in Section 11.3.2.6.

Water in the reactor vessel is cooled during shutdown and refueling by the Decay Heat Removal System as described in Section 9.5. Adequate redundant electrical power supply assures continuity of heat removal. The fuel storage pool water is cooled by the spent fuel cooling system described in Section 9.4. A power failure during the refueling cycle will create no immediate hazardous condition because of the large water volume in both the transfer canal and fuel pool. With a normal quantity of spent fuel assemblies in the storage pool and no cooling available, the water temperature in the spent fuel pool would increase very slowly, as discussed in Section 9.4.5.

During reactor operations, bolted and gasketed closure plates, located on the Reactor Building flanges of the fuel transfer tube, guarantee that spent fuel pool water will not leak into the transfer canal in the event of a leak through the transfer tube valves. Both the storage pool and the fuel transfer canals are completely lined with stainless steel plate for leaktightness and for ease of decontamination. The fuel transfer tubes are attached to these liners to maintain leak integrity. The spent fuel pool cannot be inadvertently drained by gravity because water must be pumped out.

During the refueling period, the water level in the fuel transfer canal and the spent fuel pool is the same because the fuel transfer tube valves are open. This eliminates the necessity for interlocks between the fuel transfer carriages and transfer tube valve operations except to verify full-open valve position.

The fuel transfer canal and spent fuel pool water will have a boron concentration sufficient to maintain core shutdown if all of the control rod assemblies are removed from the core. Although not required for safe storage of spent fuel assemblies, the fuel storage pool water will also be borated so that the transfer canal water will not be diluted during fuel transfer operations.

The fuel transfer mechanisms permit initiation of the fuel basket rotation only from the building in which the fuel basket is being loaded or unloaded.

Carriage travel and fuel basket rotation are interlocked to prevent inadvertent carriage movement when the fuel baskets are in the vertical position. Rotation of the fuel baskets is possible only when the carriages are in the rotating frame at the end of travel.

The fuel handling and control rod handling mechanisms are so designed that the fuel and stainless steel rod guide are withdrawn into the mast tube for protection prior to transfer. Interlocks are provided to prevent operation of the bridges or trolleys until the assemblies have been hoisted to the upper limit in the mast tube. Mandatory slow zones are provided for the hoisting mechanisms during insertion of fuel and rod assemblies. The slow zones will be in effect during entry into the reactor core, fuel transfer basket, or fuel rack and just before and during bottoming of the fuel and rod assemblies. The controls are appropriately interlocked to prevent simultaneous movement of the bridge, trolley or hoists.

Interlocks provided with key bypasses may be bypassed with the permission of the Senior Reactor Operator in charge of fueling operations. The grapple mechanisms are interlocked with the hoists to prevent vertical movement unless the grapples are either fully opened or fully closed. The fuel grapple is so designed that when loaded with the fuel assembly, the fuel grapple cannot be opened as a result of operator error or electrical or mechanical failure. Hard stops are provided to prevent raising an assembly above minimum shielding depth in the event of an up-limit failure.

All operating mechanisms of the fuel transfer system are located in the fuel handling and storage area for ease of maintenance and accessibility for inspection prior to start of refueling operations. All electrical equipment is located above water level for greater integrity and ease of maintenance. The hydraulic systems which actuate the fuel basket rotating frames use demineralized water from their own independent systems as the working fluid.

Relief valves are provided on each stud tensioner to prevent overtensioning of the studs because of excessive pressure.

Suspected defective fuel is normally removed from the core and checked for leakage.

The fuel handling bridges are limited to handling of fuel assemblies and rod assemblies only. All lifts for handling of reactor closure heads and reactor internal assemblies will be made using the Reactor Building crane.

Travel speeds for the fuel handling bridges, hoists, and fuel transfer carriages will be controlled to ensure safe handling conditions.

Technical Specification Section 3.8 specifies administrative controls to assure fuel loading and refueling operations are performed in an acceptable manner. Radiation monitoring for the spent fuel storage area is described in Section 11.4.2.

TABLE 9.7-1
(Sheet 1 of 1)

FUEL STORAGE CAPABILITIES

	No. of Assemblies
Wet Fuel Storage	
New fuel and spent fuel storage and handling pool (Pool A)***	
Region I	195
Region II	1296*
Spent fuel pool (Pool B)****	496
Dry Fuel Storage	
Dry storage area	66**

* Three additional spaces are provided for accommodating failed fuel containers. When spent fuel assemblies are stored in Region II storage racks of Spent Fuel Pool "A", the combination of initial enrichment and cumulative burnup for spent fuel assemblies shall be within the acceptable area of Technical Specification Figure 5-4.

** This number includes the twelve spaces that are required to be vacant of fissile or moderating material due to criticality concerns.

*** The present installation of an additional 648 cells in Pool A provides a total of 1494 locations. This total storage capacity has been analyzed and licensed in Technical Specification Amendment No.164 (NRC letter to GPUN, dated April 27, 1992).

**** When spent fuel assemblies are stored in Spent Fuel Pool "B", the combination of initial enrichment and cumulative burnup for spent fuel assemblies shall be within the acceptable area of Technical Specification Figure 5-5.

9.8 VENTILATION SYSTEMS

9.8.1 CONTROL BUILDING VENTILATION SYSTEM

For a description of Control Room Habitability see Section 7.4.5.

9.8.1.1 Design Basis

The Control Building Ventilation System (CBVS) is designed to continuously maintain the inside building ambient within the desired limits of temperature, maximum humidity, and radiation and to provide a ventilation rate sufficient for odor control and healthful human occupancy.

The design temperatures for the system are listed in Table 9.8-1. The expected relative humidity during cooling is less than 50%, but is not controlled. The normal operating mode minimum ventilation rate of outside air is set to provide at least 35 cfm per inhabitant in accordance with American Society of Heating, Refrigeration and Air Conditioning Engineers ASHRAE Report 62-1981; Ventilation for Acceptable Indoor Air Quality. This is accomplished by permanently setting the manual balancing dampers in the outside air supply duct (AH-D-605 and AH-D-39) to provide at least 4500 cfm. This is greater than the amount of air required to elevation 306 ft, which, during normal operation, is exhausted to the plant vent.

Reheat coils are selected and sized to raise the temperature of air passing through them not less than 25°F.

In the unlikely event of complete loss of all HVAC due to an Appendix R fire event, the maximum ambient temperature expected 72 hours after the loss of HVAC has been determined for each area of the Control Building. These temperatures are tabulated in Section 7.1.1.7. Evaluation of these temperatures has shown that the failure of Control Building ventilation during an Appendix R event does not adversely affect safe shutdown in the event of a fire. A description of the temperature analysis is provided in Section 9.8.1.5.

9.8.1.2 System Functions

The functions of the Control Building ventilation system are:

a. To distribute throughout the building, during normal plant operation, a mixture of outside and recirculated air which has been passed through roughing filters, then cooled and dehumidified or heated to the degree necessary to maintain conditions of temperature required by the various spaces served.

b. To place selected areas in a recirculation mode and to place the chemical hood in the nuclear sample room and radiochemistry laboratory in a recirculating mode during which the recirculated air is passed through HEPA and charcoal filters following a plant emergency. Finally, for this area, to provide connections for purging the hood areas through the Reactor Building purge exhaust filters when required.

c. To maintain the Main Control Room at a positive pressure of ≥ 0.10 inches w.g. with respect to areas outside the Control Building Envelope (CBE) while the CBVS is in the Emergency Recirculation mode of operation. A positive pressure of ≥ 0.10 inches w.g. is not a criterion for the entire CBE. The pressure requirement in the cubicles of the

CBE, other than the Main Control Room, is that they are maintained at a positive pressure with respect to the areas outside the CBE (FSAR Section 7.4.5).

9.8.1.3 System Description

The Control Building ventilation system shown schematically on Drawing 302842 is a central system employing electric reheat for zone temperature regulation. The supply duct carries air from the conditioning equipment to the rooms of the building. A return duct delivers air from the conditioned areas on the second, third, and fourth floors to the return fan to be mixed with fresh outside air, filtered and cooled, and supplied to the building.

Under no circumstance is the conditioned air that is delivered from the central system to the first floor ever recirculated because of the possibility that it will become contaminated with radioactive particulates or gases. All air removed from the first floor is rough filtered and passed through a booster fan to the Auxiliary and Fuel Handling Building roughing, HEPA, and charcoal filters before being exhausted to the atmosphere through the plant vent.

During emergency periods, air from selected areas of the first floor is recirculated, cooled, and filtered through HEPA and charcoal filters.

Detailed Description of Systems

The following major components are employed in the Control Building ventilation system.

There are two, normal duty supply fans, each sized to handle 100 percent of the required air supply. These fans have sufficient capacity to move air at the required rate against the total system resistance, including the roughing filters, cooling coil, electric preheating coil, duct system, reheating coil, and air-distribution device.

There are two, emergency duty supply fans, each sized to handle 100 percent of the required air supply. These fans have sufficient capacity to move air at the required rate against the total system resistance, including the roughing, HEPA, and charcoal filters, cooling coil, electric preheating coil, duct system, reheating coil, and air-distribution device.

There are two, normal duty filter banks, each sized to handle 100 percent of the required air supply. These filter banks are for roughing service only. They are built up of standard cells rated for an average ASHRAE efficiency between 80 and 85 percent.

There are two, emergency duty filter banks, each sized to handle 100 percent of the required air supply. These filter banks are for the complete removal of particulate and gaseous contaminants which may be radioactive. The banks are built up of: (1) roughing cells rated for an average ASHRAE efficiency between 80 and 85 percent, (2) HEPA cells rated for an efficiency of 99.97 percent on 0.3-micron-diameter particles, and (3) charcoal cells of a type approved for the service.

There are two cooling coil banks, each sized for 100 percent of the design load. Coils are of a standard finned-tube type. They are cooled by chilled water from mechanical water chillers. The coils are balanced to remove both sensible and latent heat in proper proportion to keep the building temperature and relative humidity in the desired range. The coil banks are constructed with drain pans to carry off the water resulting from removal of latent heat. Air velocities resulting from coil sizing are low enough so that water droplets will not be carried downstream with the air and reevaporated.

There are two mechanical water chillers, each sized for 100 percent of the design load. Each chiller is a factory-assembled unit complete with all major components mounted on a base structure. Chiller compressors are of centrifugal design, and chiller condensers are of the water-cooled type. These are supplied with cooling water from the nuclear service closed cycle system.

There are two chilled water pumps, each sized for 100 percent of the design water flow. These pumps are of the close-coupled, centrifugal type with mechanical seal.

The Control Building Automatic Temperature Control (ATC) compressed air system has two sets of compressors with associated prefilters, dryers and afterfilters. One compressor set provides a redundant air supply to “A” train components (control valves, damper operators, heater controls and fan controls), while the other compressor set provides a redundant air supply to the “B” train components. Both sets of compressors are able to supply a common header, which provides air to dampers and controls common to both trains of equipment.

There are two electric preheating coils, each sized for 100 percent of the air circulated.

There are 24 reheat coils, one for each of the rooms or zones served. The capacity of each of these coils is sufficient to raise the temperature of the air passing through them no less than 250F. Each reheat coil is controlled by a silicon controlled rectifier (SCR) and a room thermostat in the space served by it.

All electric heating coils operate on 480 V, 3 phase, 60 Hz power. Equipment rooms are heated by unit space heaters placed adjacent to mechanical equipment.

The second, third, fourth, and Mechanical Equipment Rooms on the fifth floors of the Control Building are served by two return fans, each sized to handle 100 percent of the circulated air. The air removed from these floors by the fans is directed back to the supply fans. The return fans (AH-E-19A/B) are required for the ventilation system to perform it’s safety function. The system has not been analyzed to be able to move the correct air flow rate through the air treatment system, (AH-F-3A/B), if a return fan does not start. TMI-1 accident analysis uses specific CBVS air flow rates through the filter banks to calculate dose values for control room operators (FSAR Chapter 14). Therefore, AH-E-19A(B) are considered as required supporting components to the AH-E-18A(B) supply fans.

The first floor of the Control Building is served by two exhaust fans, each sized to handle 100 percent of the air supplied to the controlled access area by the Control Building ventilation system and to the Hot Tool Room by the Hot Tool Room air handling unit. These fans deliver air to the Auxiliary and Fuel Handling Building exhaust system, which causes it to pass through roughing, HEPA, and charcoal filters before it is discharged to the atmosphere through the plant vent.

The first floor exhaust fans are protected both by a bank of two inch prefilters and by 80 to 85 percent efficient roughing filters.

The Hot Tool Room and sample hoods on the first floor of the Control Building are supplied with ventilation by a separate air handling unit. The Hot Tool Room air handling unit is designed to maintain suitable and safe ambient conditions for operating equipment and personnel during normal operating conditions. The air handling unit includes a 2 in thick prefilter bank, preheating and electric heating coils, and fan.

The emergency recirculation system for elevation 306 ft 0 inches is designed to recirculate, cool, and filter air through selected areas during emergency periods. The system is designed to recirculate cool, filtered air to the following areas: hot lavatory area, computer room, mens and womens toilets, office and lunch room area, monitor area, health physics areas, and count room.

The emergency hood recirculation system is designed to recirculate and filter air to the chemical hood in the radiochemistry laboratory and nuclear sample room. This system also provides for purging these areas, if required. The purge air is directed to the Reactor Building exhaust filter plenum system, for removal of radioactive iodine before discharging to the vent stack.

The system includes fire dampers (see Section 9.9) and automatic dampers to isolate the affected areas in case of fire.

The Control Building hallway ventilation system consists of two supply fans and two exhaust fans, each sized to handle 100 percent of the required air flow. The supply fans deliver outside air from the intake tunnel to the hallway areas, while the exhaust fans draw air from the hallway areas and discharge it to atmosphere.

Elevation 322 ft 0 inches is served by two booster supply fans (AH-E-95A/B), each sized to handle 100 percent of the required air flow. The booster fans assist in delivering air from the Control Building ventilation system to the rooms on this floor. Fan AH-E-95A or AH-E-95B are required for the ventilation system to perform it’s design basis function of maintaining the Control Building Envelope (CBE) at a positive pressure with respect to outside adjacent areas (FSAR 7.4.5). Test Procedure (TP 141/24) showed the 322’ 0” elevation of the CBE was at a negative pressure when AH-E-95A or B were not run. TMI-1 does not have a Technical Specification for pressurization but AH-E-95A or AH-E-95B must operate in it’s respective ventilation train to allow the Control Building Emergency Ventilation System (CBEVS) to perform it’s Design Basis Function (as required per Chapter 14 FSAR). Thus, each AH-E-95A or B are required to the system train operability.

9.8.1.4 Methods Of Operation

The Control Building supply and return system is operated from the Control Room and runs continuously. Where standby systems have been provided, the inactive system is automatically isolated by control dampers. During normal operation the Control Building Ventilation System (CBVS) supplies a mixture of outside air and recirculated air to Control Building elevation 380’, 355', 338', 322', and to controlled access area elevation 306', (excluding the Hot Tool Room). The air from elevation 355', 388' and 322' is recirculated by the return fans. The controlled access area exhausts to the Auxiliary and Fuel Handling Building Ventilation Exhaust. The Control Building Hallway (patio area) and the Hot Tool Room are each provided with independent ventilation.

A special or infrequent operating mode for the Control Building Ventilation system is its emergency mode. Should a design basis accident in the Reactor Building occur, resulting in an engineered safeguard signal (4 psig), or should one or more of the hazards in the outside air intake tunnel be detected, or should an abnormally high radiation level in the Control Room be detected; the system emergency recirculation mode sequence takes place automatically. The isolation dampers AH-D-28 and AH-D-617 close. The system remains in the emergency recirculation mode until an investigation is made and the tripped device is manually reset. In the emergency mode of operation associated with Reactor Building (4 psig) ES Signal or Tunnel device signal, the system normal operating fan AH-E-17A/B continues to operate in the recirculation mode through the normal filter bank.

In the emergency mode of operation associated with high radiation signal from the Control Room, the system's normal operating fan AH-E-17A/B is shut down and the system emergency fan AH-E-18A/B is manually started to recirculate all the air from elevations 322 ft, 338 ft and 355 ft (except in hallways) through the emergency filter bank. Elevation 306 ft has a separate filtered recirculation system which is started manually following a system emergency mode sequence. Furthermore, the Ventilation Equipment Rooms on elevation 380’ are supplied with conditioned, filtered air to pressurize the rooms with respect to outside adjacent areas.

During emergency mode of operation, the Control Room operator is protected as per the requirements of NUREG 0737 Item III D.3.4. as described in Section 7.4.5, Habitability. Provisions have been made so that smoke in any of the switchgear, relay, or battery rooms is alarmed in the Control Room. The concerned area is automatically isolated from the system by isolation dampers actuated by the smoke detectors, described in Section 9.9. The mechanical equipment room "A" is provided with fire dampers actuated by thermo-fusible links.

9.8.1.5 System Evaluation

The Control Building heating, ventilating, and air-conditioning (HVAC) system is provided with instrumentation and controls which continuously monitor system performance. In addition, a return air duct radiation monitor is provided to alarm in the Control Room any malfunctioning or high radiation and to allow operator action to ensure that safe operational conditions for equipment and personnel are provided
during all modes of operation.

System fans, filter banks, water chillers and control instrument air compressors were designed with redundant components to allow reliability of operation in the event of a component failure.

An analysis and testing program was conducted to evaluate the loss of all Control Building ventilation due to an Appendix R Fire. An evaluation was performed of the computer analysis results and the field test data to reconcile the differences and to more accurately predict the expected room temperature response with loss of the ventilation system. The findings are included in GPU Technical Data Report (TDR 900), entitled "Reconciliation of Ventilation Systems Analyses and Tests." The computation of the temperatures profile under HVAC failure conditions was performed using Thermal System Analysis Program (TSAP) (Reference 9). The room air is assumed to be well mixed providing a uniform temperature. Stratification is not considered in the model. The heat transfer to adjacent rooms accounts for the heat transfer through ceilings, floors, and walls. Heat sources were obtained by engineering estimates and calculations of the heat loads of the various electrical equipment and lighting fixtures, based on typical equipment and vendor data. The mass of duct work, cable trays, equipment supports, and structural beams are also estimated. Conservatisms result from both the input and the model representation having simplified assumptions. The internal heat load has the most direct impact on the room temperature. Estimates of passive heat sinks are conservative. The mass of cables is not included as a heat sink.

The mass of heat producing equipment, which tends to absorb the heat before releasing it to the room, was not considered (this mass was considered for rooms CB-FA-2a, 2b, 2d, and 2e as described below). This assumption produces a conservatively high rate of initial temperature rise. Radiant heat transfer from source to sink was considered, which reduced excess conservatism.

In order to reconcile the computer analysis and field test, a comprehensive temperature evaluation was made to compare the actual test data and the results of the computer analysis. This evaluation provided the basis for the degree of correlation that could be drawn between the results of the computer analysis and test results. For the Control Building temperature responses, the temperature evaluation extrapolated the test data out to 72 hours based on the results of the computer analysis. Temperatures under 104F are considered within equipment allowables and acceptable due to the conservative nature of the analysis. The heat load imposed on the equipment mass and direct source to sink radiant heat transfer were factored into the model for four rooms (CB-FA-2a, 2b, 2d, and 2e) to reduce excessive conservatism. Outside air temperature is not considered to be a contributing factor. Initial ambient room temperatures up to 95F were analyzed for in CB-FA-2a, 2b, 2d, and 2e to bound previously experienced ambient room temperatures. This evaluation has shown that upon loss of Control Building ventilation, the temperature rise in the Control Building during Appendix R shutdown operation is enveloped by the specified equipment design limits except for CB-FA-2d (Inverter Room), CB-FA-2e (Inverter Room), and CB-FA-4b (Control Room). In CB-FA-2d, opening of the door between CB-FA-2d and CB-FA-2f (Battery Room) within 24 hours after loss of ventilation provides preventive action to limit the temperature rise to acceptable levels. In CB-FA-2e, opening of the door between CB-FA-2e and CB-FA-2g (Battery Room) within 24 hours after loss of ventilation provides preventive action to limit the temperature rise to acceptable levels. In CB-FA-4b, manual deenergizing of electrical lighting loads provides preventive action to limit the temperature rise to acceptable levels. (The total heat contribution of all lighting loads and ballast contribution is approximately 64,000 Btu/hr as contained in GPUN Technical Data Report TDR 900.) Reducing the Control Room lighting by one half results in a reduction of heat load from approximately 129,000 Btu/hr to 97,000 Btu/hr.

Important input assumptions and variables which could effect these results include internal room heat loads, openings for natural convective airflow, heat producing equipment, room heat sink mass, normal operating space temperature, space configuration (room size, wall construction) and normal HVAC system operating characteristics.

In June 2005 the TSAP Model was replaced with the GOTHIC Model. The GOTHIC Model was benchmarked against the TSAP Model to maintain the validity of the licensing basis temperature response. The GOTHIC Model was then updated to reflect Control Building heat loads as of June 2005 (Reference 15).

The design ambient temperatures indicated in Table 9.8-1 were considered in the Appendix R evaluation for the loss of the Control Building Ventilation System (Reference 2).

These design ambient temperatures are compatible with the design limits of the essential equipment located within the Control Room Envelope. During a degraded voltage accident one of the 480 V 1P and 1S unit substation transformers may be loaded up to rated capacity. The ambient room temperature under this condition may approach 104°F. FSAR Section 8.2.2.10 provides further information regarding operation of essential electrical equipment under design ambient temperatures.

During both normal or emergency operation of the CBVS, one of the booster fans, AH-E-95 A/B, operate to provide cooling requirements for Control Building 322 foot elevation, with the redundant fan in standby mode.

9.8.2 FUEL HANDLING BUILDING VENTILATION SYSTEM

The Fuel Handling Building Ventilation system is comprised of two (2) parts: The Fuel Handling Building Normal Ventilation System and the Fuel Handling Building Engineered Safety Feature Ventilation System.

9.8.2.1 Design Basis

a.) Fuel Handling Building Normal Ventilation System (FHBNVS)

The system is designed to maintain a minimum temperature of 60°F, and the supply and exhaust duct systems are arranged to direct the air flow to areas of progressively greater potential radioactivity prior to exhaust through a roughing, HEPA, and radioiodine adsorber filter system (charcoal). The system is also designed to maintain a negative pressure in the building with respect to the outside to preclude the unmonitored release of radioactive material to the environs.

The dissipation of heat from the spent fuel coolant pumps is accomplished by using a separate recirculation auxiliary cooling system to maintain the pump rooms below the maximum permissible temperature of 104°F. Table 9.8-1 lists the design temperatures. This system is described in Section 9.8.5.

Isolation dampers in both the supply and exhaust branches, the employment of enclosures for ductwork, judicious routing of ductwork as well as the use of a removable wall, and pressure resistant doors, as shown on Figure 9.8-2, provide an environmental barrier between the Fuel Pool Area and the Auxiliary Building in the event of a fuel handling accident.

b.) Fuel Handling Building Engineered Safety Feature Ventilation System (FHBESFVS)

The system was installed in response to a commitment in the TMI Restart Hearing Partial Initial Decision (PID), Section III.B, paragraph 1265, Vol. I, dated December 14, 1981, and in the GPUN Letter 5211-83-103, R.C. Arnold to J.F. Stolz “Engineered-Safety-Feature (ESF) System” dated March 31, 1983.

The system is designed to mitigate, monitor and record the radiation release resulting from a postulated TMI-1 irradiated fuel handling accident in the Fuel Handling Building as described in FSAR Section 14.2.2.1. Furthermore, the system is designed in accordance with the intent of the design, testing and maintenance criteria of NRC Regulatory Guide 1.52, Revision 2. Several exceptions to Regulatory Guide 1.52 are taken, and are deemed acceptable by the NRC staff in an explanation given in the Safety Evaluation supporting Amendment No. 122 to Facility Operating License No. DPR-50. Those exceptions are:

- Reg Guide 1.52 does not address the acceptablity of ESF atmosphere cleanup systems with regard to the radiological consequences of postulated fuel handling accidents. Therefore, the NRC staff used the acceptance criterion from Standard Review Plan (SRP) section 15.7.4, “Radiological Consequences of Fuel Handling Accidents”, Rev. 1, July 1981, to evaluate the design of the ESF ventilation filter system. That is, the plant site and dose mitigating ESF systems are acceptable with respect to the radiological consequences of a postulated fuel handling accident if the calculated whole-body and thyroid doses at the exclusion area and low population zone boundaries are <u>well within</u> the exposure guideline values of 10CFR100, paragraph 11. “Well within” the guideline values is defined as 25% of the 10CFR100 limits (this yields: 75 Rem thyroid and 6 Rem whole-body).

- Demisters are not required.

- No additional protection for high energy rupture and natural phenomena is needed.

- A non-seismically qualified system meets the intent of the RG 1.52 guidelines, since a system failure during a design basis seismic event would result in onsite and offsite doses below those of the criteria of SRP Section 15.7.4. This is based upon the TMI-1 FSAR design basis fuel handling accident of 56 damaged fuel rods. The NRC staff performed independent analyses of the dose consequences of this accident assuming failure of the ESF Air Treatment System, and concluded that the calculated doses to personnel in the TMI-1 and TMI-2 control rooms, and at the exclusion area boundary, for the design basis fuel handling accident without a functional ESF system are below those of the acceptance criteria of SRP Sections 6.4 and 15.7.4 respectively. Thus the corresponding releases of fission products to working and outdoor environments are “well within” the exposure guidelines of 10CFR100, and are not considered significant.

- Protection from pressure surges resulting from postulated accidents is not required.

- HEPA filter and carbon adsorber testing is required to be performed at least once per refueling interval. The laboratory acceptance criterion for minimum removal efficiency for methyl iodide for the ESF carbon adsorber is 90%. (Note that License Amendment No. 226 changed the acceptance criterion for results of laboratory carbon sample analysis to show greater than or equal to 95% radioactive methyl iodide decontamination efficiency. This allows use of the 90% efficiency value in accident analysis.)

- Redundant Class 1E power circuits for each ESF fan and filter preheater, as well as instrumentation circuits, also meet RG 1.52 requirements where applicable. However, due to bus loading limitations, the system will not be operated whenever one of the station aux transformers (or 4160 V ESF bus) is out of service while Unit 1 is operating. During such conditions there will be no irradiated fuel movement. This restriction does not apply when Unit 1 is shutdown. In the event of a loss of offsite power, the capability to manually load the ESF ventilation system onto the diesel is provided.

When the FHBESFVS was installed, the Quality Classification of the system was “Important to Safety (ITS)”, with the ESF motor control centers electrical isolation devices serving as the boundary between ITS and the Nuclear Safety Related (NSR) power supplies. Since then, “ITS” has been redefined as “Augmented Quality (A)”. Therefore, the Quality Classification of the FHBESFVS is “Augmented Quality (A)”, with commitments made to Reg. Guide 1.52 (Rev. 2, 1978), TMI Restart Hearing Partial Initial Decision (PID), Section III.B, paragraph 1265, Vol. I dated December 14, 1981 and in the TMI-1 Technical Specifications. The ESF Ventilation System Motor Control Centers (MCCs) are classified as "Safety Related (Q)" since the electrical isolation capability is the boundary between the A system and the Q power supply.

9.8.2.2 System Functions

a. The functions of the FHBNVS are:

1. To supply filtered and tempered outside air for ventilation of the Fuel Handling Building operating floors at Units 1 and 2 (Elevation 348 ft.), and the truck bay.

2. To exhaust air from the Fuel Handling Building operating floors (Elevation 348 ft.), and truck bay, and maintain a negative pressure with respect to the outside environment. This prevents radioactive material release during normal and refueling operations.

3. To filter air normally exhausted from the Unit 1 and Unit 2 operating floors (Elevation 348 ft.), and truck bay through roughing, HEPA, and charcoal filters and then to discharge this air to the atmosphere through the plant vent. The exhaust flow is continuously monitored for radioactivity and appropriate action is taken to protect the public in the event of high radiation. This is achieved by isolating the Fuel Handling Building operating floor from the normal ventilation system while the FHBESFVS is operating.

4. To cool selected areas where heat generation is unusually high.

5. To continuously monitor inlet air against smoke, fumes, and combustible vapors and isolate buildings from them if their presence is detected.

b. The functions of the FHBESFVS are:

1. To exhaust air from the fuel handing area while handling irradiated fuel. This ensures system operation in the event of a fuel handling accident.

2. To continuously monitor exhaust air for radioactivity while handling irradiated fuel.

3. To reduce the possibility of unacceptable airborne radioactive releases to the environment resulting from a design basis fuel handling accident in the Fuel Handling Building. This is done by isolating the Fuel Handling operating floor from the normal ventilation supply and exhaust system, and filtering air through the FHBESFVS (roughing, HEPA and charcoal adsorber) to an outside vent.

4. To maintain a negative pressure in the Fuel Handling floor (elevation 348' and Truck Bay) with respect to the outside environment in the event of a design basis fuel handling accident in the Fuel Handling Building.

9.8.2.3 System Description

a. Fuel Handling Building Normal Ventilation System (FHBNVS)

The FHBNVS is shown on Drawings 302-831 and 302-841.

The supply system fan (AH-E10) delivers filtered and tempered air from the air intake tunnel to elevation 348 ft. of the Fuel Handling Building, supplying both Unit 1 and Unit 2 operating floors, and the truck bay. The electric heating coil is sized to heat 100 percent of the outside air to a comfortable temperature when it is 0°F outside. The electric reheat coil is sized to raise the supply air to 75°F, and is controlled by a silicon controlled rectifier (SCR) and room thermostat.

Ventilation exhaust flow from the Unit 1 and Unit 2 Fuel Handling Building operating floors (Elevation 348 ft.) and the truck bay is monitored for radioactive particulate, iodine and gaseous activity (RM-A4), then combined with Auxiliary Building ventilation exhaust flow prior to filtration. The common exhaust flow is filtered by eight parallel filter banks, each consisting of roughing filters, HEPA filters, and charcoal adsorber. The exhaust is drawn through two of four exhaust fans, AH-E14A/B/C/D, each sized to 50% of system capacity. The final fan exhaust is discharged to the outside through a single stack which is not common with any other building exhaust system. The exhaust in the stack is monitored for radioactive particulate, iodine and gaseous activity by monitor RM-A8.

Control dampers in the supply and exhaust ducts throttle to maintain a negative pressure in the Fuel Handling Building operating floors and truck bay with respect to the outside environment. A static pressure controller for the supply damper senses pressure in the air intake tunnel and in the supply duct, and controls damper position to maintain a positive pressure differential setpoint. The damper will throttle closed if pressure in the duct begins rising with respect to the outside, and will throttle open if pressure in the duct drops. A static pressure controller for the exhaust damper senses pressure in the air intake tunnel and in the exhaust duct, and controls damper position to maintain a negative pressure differential setpoint. The damper will throttle open if pressure in the duct begins raising with respect to the outside, and will throttle closed if pressure in the ducts drops. Both dampers act together keeping supply air flow less than exhaust air flow, resulting in building pressure less than the outside pressure.

With the supply and exhaust control dampers maintaining their static pressure setpoints, the FHBNVS exhaust flow adds a minimum of 27,320 cfm to the combined Auxiliary and Fuel Handling Buildings exhaust flowrate to the plant vent stack. The minimum flow of 27,320 cfm, when added to the minimum exhaust flow from the Auxiliary Building, Controlled Access Area, Machine Shop and Penetration Cooling System (73,260 cfm), yields the minimum exhaust flowrate requirement of 100,580 cfm. This total minimum exhaust flowrate is approximately 85% of the original design flowrate of 118,810 cfm. (Reference 12).

In addition, a separate redundant recirculation cooling system provides cooling air for the spent fuel coolant pumps room.

b. <u>Fuel Handling Building Engineered Safety Feature Ventilation System (FHBESFVS)</u>

The FHBESFVS is an exhaust air system placed into operation prior to any movement of irradiated fuel within the FHB, and continuously operated during the entire fuel handling operation.

The major components of the FHBESFVS are located on the roof of the Auxiliary Building in a seismically qualified enclosure. The FHBESFVS draws approximately 5000 ft^3/min of exhaust air from the fuel handling operating floor above the fuel pool through two (2) fire dampers which will close upon indication of high hydrocarbon combustible concentration. The exhaust air is routed to a common exhaust duct which runs along the side of the FHB north wall and over the Auxiliary Building (Aux. Bldg.) roof. On the Aux. Bldg. roof, the duct work branches into two (2) ducts which are connected to the two (2) 100 percent capacity redundant filter trains (AH-F-14A/B). Each filter train is composed of a prefilter, an electric heater (AH-C-57A/B), a HEPA filter, charcoal absorber filter, a second HEPA filter, contrifugal fan (AH-E-137A/B), inlet and outlet valves and associated instrumentation. The discharge from each train is connected to a common discharge duct that terminates at a local release point on the east wall of the FHBESFVS enclosure. Prior to the release point, the exhaust air is monitored for radioactive particulate, iodine and gaseous activity by a separate dedicated off-line radiation monitor (RMA-14). RMA-14 is designed to detect and measure the concentrations of noble gas fission products to provide continuous or intermittent collection of radioactive iodine/particulates and to provide intermittent grab sampling of tritium and fission gasses during normal and accident conditions.

The radiation monitor is comprised of three (3) parts; the valve rack, the gas skid and the remote digital read-out. The valve rack is located in the ESF ventilation enclosure, directly below the exhaust duct with which it communicates. The valve rack incorporates the grab sampling capability from the system.

The gas skid, including the power cabinet and local control unit, is located on the 312' 0" elevation platform inside the Auxiliary building ventilation equipment room. The gas skid contains a pump and detectors. Complete local control of RMA-14 can be affected from the Auxiliary Building ventilation equipment room. The remote digital ratemeter is installed in the Unit 1 Control Room on the control board panel identified and tagged as the PRF panel (Panel-Right-Front). This remote digital ratemeter provides alarm, read-out and recording capabilities.

A by-pass flow of 1,000 ft^3/min is drawn from the FHBESFVS enclosure. This bypass flow is drawn through a duct heater (AH-C-56A/B) and through the filter train not in service at the time. This assures a supply of low humidity air and also aids in removal of decay heat from the filter train not in service due to trapped radioisotopes from previous service.

Dampers are provided in the ductwork leading to and from each filter train and fan and in each bypass flow duct. This allows for the entire system to be isolated from the FHB environment or each train and fan to be isolated from the rest of the FHBESFVS. These dampers also allow for the establishment of the isolation of bypass flow.

The normal supply duct going to and exhaust duct coming from the Fuel Handling Area are provided with isolation dampers which will automatically close upon detection of high radiation in the operating floor (RM-G9) and/or in the normal exhaust duct (RM-A4).

The FHBESFVS enclosures are provided with unit heaters for winter heating and exhaust fan for summer ventilation. On a design basis Fuel Handling Accident concurrent with loss of offsite power, the enclosure within the operating unit is ventilated by the bypass bleed air of 1000 ft^3/min.

9.8.2.4 Methods Of Operation

a. Fuel Handling Building Normal Ventilation System (FHBNVS)

During normal operation, the supply fan to and exhaust fans from the Fuel Handling Building operate continuously. Where standby fans have been provided, the inactive fan is isolated by automatic control dampers. All FHBNVS systems are operated from the Control Room. Heating coils in the supply system are automatically controlled.

All Systems Include the Following:

1. High temperature detection devices in the discharges of the fans to stop fans, and alarm the Control Room Personnel on detection of high temperature.

2. Flow switches in the exhaust fans to alarm the Control Room Personnel upon loss of air flow.

3. Flow switches in the supply fans to de-energize the electric heaters upon loss of air flow.

4. Heat, smoke, and vapor detectors in the outside air intake tunnel to stop air supply and close off applicable fire dampers in the outside air supply system.

In addition to the smoke and fire protection devices, described in the Fire Hazards Analysis Report, the system provides the following emergency control functions:

High radiation detected in the operating floor and/or in the exhaust duct from the Fuel Handling Building initiates an alarm, stops the supply air fan, and closes the isolation dampers. The exhaust system continues to operate to exhaust air from the Auxiliary Building until manually stopped by an operator to preclude the migration of radioactive material from the fuel handling operating floor to the Auxiliary Building.

b. Fuel Handling Building Engineered Safety Feature Ventilation System (FHBESFVS)

During movements of irradiated TMI-1 fuel, the FHBESFVS is operated in conjunction with the FHBNVS as a prerequisite for the movements. Only one (1) filter train and fan are employed; the other train and fan serve as a redundant backup in case of filter loadup or equipment malfunction. In the event of a fuel handling accident involving irradiated TMI-1 fuel, radiation monitor interlocks stop the FHBNVS supply fan, and close isolation dampers in the FHBNVS to isolate the fuel handling floor from the rest of the FHB and the Auxiliary Building. As soon as the high radiation alarm is annunciated in the TMI-1 Control Room, an operator will be dispatched to man and monitor the remote control panels located on EL. 305' 0" of the Auxiliary Building. The Unit 2 operating floor is isolated from the Unit 2 Fuel Handling Building ventilation system with low leakage isolation dampers. This prevents release of radioactive material up the Unit 2 stack.

The FHBESFVS includes the following:

1. High temperature detection devices in the Electric Heater section to shut down the heaters, indicate and annunciate locally and in the remote control panel on detection of high temperature.

2. Air flow detection devices of the discharge of each fan to record the air flow and indicate and alarm in the remote control panel on loss of air flow.

3. High temperature detection devices in the charcoal adsorber section to annunciate in the remote control panel on detection of high temperature in the charcoal beds.

4. Radiation monitor at the fan discharge common duct to monitor and record the gasses as effluent from the FHB operating floor.

5. Differential pressure detection devices across each filter component and across the entire filter train to indicate locally and annunciate in the remote control panel on detection of high differential pressure.

6. Area radiation monitors in the operating floor of the FHB and in the exhaust duct from the operating floor to indicate and annunciate in the TMI-1 Control Room and automatically isolate the operating floor from normal ventilation systems upon detection of high radiation.

7. Smoke and combustible vapor detectors located near the penetration opening to close the fire doors upon detection of smoke, fumes and combustible vapors.

8. Local temperature indication of the exhaust air in the inlet and outlet of the filter train.

9. Temperature detection devices in the ESF Filtration enclosure to activate the unit heaters and ventilating exhaust fan for ESF filtration enclosure.

9.8.2.5 System Evaluation

a. Fuel Handling Building Normal Ventilation System (FHBNVS)

Exhaust air from potentially radioactive areas is passed through roughing, HEPA, and charcoal filters for the removal of radioactive iodine.

Shutdown of Fuel Handling Building supply fan and isolation of the Fuel Handling Operating floors (Elevation 348 ft.) is automatic in the event of a high radiation signal from the Fuel Handling Building exhaust duct monitor, RM-A4 and/or the Fuel Handling Building area monitor, RM-G9.

In the event of a high radiation signal from the vent stack monitor, RM-A8, the supply fans AH-E-10 and AH-E-11 (for Fuel Handling and Auxiliary Buildings) will stop and the waste gas discharge valve will close.

b. FHBESFVS

Exhaust air from the FHB during a fuel handling accident involving TMI-1 irradiated fuel is passed through the FHBESFVS for removal of a significant portion of the radioactive iodine, gasses and particulates.

The FHBESFVS is in continuous operation during all movements of TMI-1 irradiated fuel. The system has been demonstrated to maintain a negative pressure in the fuel handling area with respect to the outside environment (demonstrated via the TMI Unit 1 STP 141/19, Revision 0) (Reference 7).

All active components of the filtration trains and their associated fans and dampers are redundant. This fact enables the system to sustain a single active failure without loss of function. Changeover from the FHBESFVS train in operation to the back-up train is manually initiated at a remote control panel by a single integrated control system. The train in back-up mode is continuously provided with low pressure, low humidity cooling air via the by-pass system. Fire, loss of power, loss of equipment function and high radiation readings in the discharge duct are all alarmed at the remote control panels and alarm signals are transmitted for display to the TMI-1 Control Room.

Any change in the configuration of the FHBNVS, FHBESFVS or the FHB walls, ceilings or other barriers to migration of radioactive emissions to the environment which could have the potential to adversely effect the ability of the FHBESFVS to maintain a negative pressure in the fuel handling area shall be evaluated (configuration used for a single pre-operational negative pressure test per Reference 7). If need be, a negative pressure test shall be performed to demonstrate the acceptability of the proposed modifications.

9.8.3 AUXILIARY BUILDING VENTILATION SYSTEM

9.8.3.1 Design Bases

The Auxiliary Building ventilation system is designed to maintain suitable and safe ambient conditions for operating equipment and personnel during normal plant operation.

The system is arranged so that air flow is routed to areas of progressively greater radioactive contamination potential prior to final exhaust through roughing, HEPA, and radioiodine adsorber filter system (charcoal). Design air flow control requires maintenance of flow direction and flow rate so that gaseous or particulate contaminants are effectively prevented from entering the cleaner zone.

The differential pressure between low radiation areas and high radiation areas is determined by the face velocities across transfer openings and depends on the geometry of the opening, thermal effects, and other parameters. The Auxiliary Building is maintained under negative pressure with respect to the outside to preclude the release of radioactive material to the environs.

The system is designed to maintain the temperature above a minimum temperature of 60°F, as stated in Table 9.8-1.

The dissipation of heat from the nuclear service closed cooling pump rooms and decay heat service pump rooms is accomplished by using separate recirculation cooling units to maintain these rooms below the maximum permissible temperature of 104°F. This system is described in Section 9.8.5.

9.8.3.2 System Functions

The functions of the Auxiliary Building ventilation system are:

a. To supply filtered and tempered outside air to the Auxiliary Building for ventilation.

b. To add heat to the supply air on a zone basis for temperature control.

c. To exhaust air from the Auxiliary Building, and maintain a negative pressure in the building with respect to outside.

d. To filter air exhausted from potentially radioactive areas of the Auxiliary and Control Buildings through roughing, HEPA, and charcoal filters, and then to discharge this air to the atmosphere through the plant vent. The exhaust flow is continuously monitored for radioactivity, and appropriate action is taken to protect the public in the event of high radiation.

e. To maintain a pressure differential between occupied areas and areas specifically designated as potentially contaminated. Contaminated areas are maintained at a lower pressure than clean areas.

f. To continuously monitor inlet air against smoke, fumes, and combustible vapors and isolate buildings from them if their presence is detected.

9.8.3.3 System Description

The Auxiliary Building ventilation system is shown schematically on drawings 302-832, 302-831 and 302-841.

The supply system fan (AH-E11) delivers filtered and tempered air from the air intake tunnel to elevations 281 ft. and 305 ft. of the Auxiliary Building. The supply fan is sized to handle 100 percent of the required air supply. The electric heating coil is sized to heat 100 percent outside air to a comfortable temperature when it is 0°F outside. Electric reheat coils are sized to raise supply air to 75°F, and are controlled by local silicon controlled rectifiers (SCR) and room thermostats.

Ventilation exhaust flow from Auxiliary Building floors below 331 ft., Control Building Controlled Access Area and Hot Tool Room, and Reactor Building Penetration Cooling System is monitored for radioactive particulate, iodine and gaseous activity (RM-A6), then combined with Fuel Handling Building ventilation exhaust flow and Waste Gas discharge prior to filtration. This common exhaust flow is filtered by eight parallel filter banks, each consisting of roughing filters, HEPA filters, and charcoal adsorber.

The exhaust is drawn through two of four exhaust fans, AH-E14A/B/C/D, each sized to 50% of system capacity. The final fan exhaust is discharged to the outside through a single stack which is not common with any other building exhaust system. The exhaust in the stack is monitored for radioactive particulate, iodine and gaseous activity by monitor RM-A8.

Control dampers in the supply and exhaust ducts throttle to maintain a negative pressure in the Auxiliary Building with respect to the outside environment. A static pressure controller for the supply damper senses pressure in the air intake tunnel and in the supply duct, and controls damper position to maintain a positive pressure differential setpoint. The damper will throttle closed if pressure in the duct begins rising with respect to the outside, and will throttle open if pressure in the duct drops. A static pressure controller for the exhaust damper senses pressure in the air intake tunnel and in the Auxiliary Building, and controls damper position to maintain a negative pressure differential setpoint. The damper will throttle open if pressure in the building begins rising with respect to the outside, and will throttle closed if pressure in the building drops. Both dampers act together keeping supply air flow less than exhaust air flow, resulting in building pressure less than the outside pressure.

With supply and exhaust dampers maintaining their static pressure setpoints, the exhaust flow from the Auxiliary Building, Controlled Access area of the Control Building, and the RB Penetration Cooling System adds a minimum of 73,260 cfm to the combined Auxiliary and Fuel Handling Buildings exhaust flowrate to the plant vent stack. The minimum flow of 73,260 cfm, when added to the minimum exhaust flow from the Fuel Handling Building (27,320 cfm), yields the minimum exhaust flowrate requirement of 100,580 cfm. This total minimum exhaust flowrate is approximately 85% of the original design flowrate of 118,810 cfm (Reference 12).

In addition, a recirculation and/or once-through ventilation system provides makeup air directly from the outside through a wall louver on elevation 331 ft. (Chem Storage Room). The excess air is exhausted directly to the outside. The Hot Instrument Repair Shop, which is located in the Chem Storage Room, has a separate HEPA-filtered exhaust system that discharges to the Chem Storage Room.

The Reactor Building Penetration Cooling System is a separate system which supplies filtered and cooled air from the outside or from the turbine hall to the Reactor Building penetration area.

Air from the Elevator Machine Room is exhausted by a separate exhaust fan.

A separate redundant recirculation cooling system provides cooling air for the Nuclear Services Closed Cooling Pumps and Decay Closed Cooling Pumps rooms.

9.8.3.4 Methods Of Operation

In the Auxiliary Building the supply fan to and exhaust fans from the Auxiliary Building operate continuously. Where standby fans have been provided, the inactive fan is isolated by automatic control dampers. All Auxiliary Building systems excluding the Auxiliary Building system on the 331 ft. elevation are operated from the Control Room. Heating coils in the supply system are automatically controlled.

All Systems Include the Following:

a. High temperature detection devices in the discharges of the fans to stop fans, and alarm in the Control Room on detection of high temperature.

b. Upon loss of air flow a flow switch in the exhaust fans causes an alarm indication in the Control Room.

c. Flow switches in the supply ducts to de-energize the electric heaters upon loss of air flow.

d. Heat, smoke, and vapor detectors in the Auxiliary Building Supply System to stop all supply and exhaust system and close off applicable fire dampers in the outside air supply system.

In addition to the smoke and fire protection devices, the system provides the following emergency control functions:

a. High radiation detected in the exhaust duct from the Auxiliary Building general areas initiates an alarm and stops the supply air fan to this area. The main exhaust system continues to operate, to exhaust air from the Fuel Handling Building, Auxiliary Building, Hot Tool Room, CB Controlled access area, and Waste Gas discharge line.

b. High radiation in the Auxiliary & Fuel Handling Building exhaust vent downstream of the filter bank initiates an alarm and stops the supply fans AH-E-10 and AH-E-11 to the Auxiliary and Fuel Handling Building general area. The exhaust system continues to operate, to maintain a negative pressure in both buildings. The waste gas discharge valve will also close on high radiation.

9.8.3.5 System Evaluation

Exhaust air from potentially radioactive areas is passed through roughing and HEPA filters, and charcoal adsorber for removal of radioactive iodine.

Shutdown of supply units while exhaust units continue to operate is automatic in the event of high radiation signals from monitor RM-A8 in the exhaust vent. The high radiation interlock from RM-A6 will stop supply fan AH-E-11 only.

Redundancy in all active components enables the exhaust system to sustain a single active failure without loss of function during normal operation and maintain a negative pressure in the Auxiliary and Fuel Handling Buildings.

Exhaust air from the hot instrument repair shop, located in the Chemical Storage Room on elevation 331 of the Auxiliary Building, is passed through roughing and HEPA filters for removal of potential radioactive particulates. Iodine adsorber filters are not required because of the absence of any iodine. The exhaust air from this repair shop is continuously sampled for potential airborne activity using a portable air sampler with a built-in high radiation alarm.

Failure of the HEPA filters in the HVAC system for the new Hot Instrument Repair Shop could result in a release of radioactivity to the environment. However, the resultant quantity released would be the same as would be released upon failure of the HEPA filters in the HVAC system servicing the existing hot instrument repair shop. In either case, a radiation monitor will alarm, but the exhaust fan will continue to run until an operator isolates the system manually or takes other corrective action. The only difference would be that the point of release would change. The new release point has been evaluated. It is concluded that the releases are below 10 CFR

Part 100 accident doses. Any potential release would be an abnormal condition and therefore is not considered a routine release pathway. It should be noted that the hot instrument repair shop is used only infrequently and that the amount of contamination on the instruments being repaired is estimated to be very small, allowing hands-on decontamination with little or no shielding required. Therefore, in either case, the amount of activity released by this accident condition would be a small fraction of the guidelines set forth in 10 CFR Part 100.

A fire in various areas of the plant (reference TMI-1 Fire Hazards Analysis Report) could affect ventilation units AH-E-15A and AH-E-15B. An analysis and testing program was conducted to evaluate the loss of ventilation to the Nuclear Services and Decay Heat Closed Cycle Cooling Water (NSCCW) Pump Room due to an Appendix R fire. An evaluation was performed of the computer analysis results and the field test data (45 hours) to reconcile the differences and to more accurately predict the expected room temperature response with loss of ventilation in the NSCCW Pump Room. The findings are included in GPU Technical Data Report (TDR-900), entitled, "Reconciliation of Ventilation Systems Analyses and Tests." The evaluation concludes that the test data depict the actual heat loads and transient responses for this area. The test was conducted with two nuclear services pumps and one intermediate cooling pump in operation. Since the outside air temperature does not have a significant impact on the temperature under loss of ventilation, the NSCCW Pump Room test data was used directly in the assessment of expected room temperatures given a loss of ventilation for a 72 hour time period. The maximum temperature reached 72 hours after loss of ventilation is 99F which is within equipment operating limits. The limiting components in this area are the intermediate cooling pump motors, IC-P-1A and IC-P-1B, which are designed to continuously operate at an ambient temperature of 104F. A review of the heat load from a fourth pump in operation (decay heat closed cycle cooling) concluded that the room temperature is expected to stay within equipment operational limits. The failure of AH-E-15A and AH-E-15B during an Appendix R fire event does not adversely affect Appendix R safe shutdown components.

Important input assumptions and variables which could effect these results include internal room heat loads, openings for natural convection air flow, heat producing equipment, room heat sink mass, normal operating space temperature, space configuration (room size, wall construction), and normal HVAC system operating characteristics.

9.8.4 TURBINE BUILDING VENTILATION SYSTEM

9.8.4.1 Design Bases

To maintain suitable and safe ambient conditions for operating equipment and personnel during normal operating conditions.

9.8.4.2 System Functions

The function of the Turbine Building ventilation system is to remove heat from the building during normal operating conditions.

9.8.4.3 System Description

Ventilation air is introduced into the building by fans which discharge directly into areas of excessive heat. Ventilation air is relieved from the building through roof-mounted ventilators. There are 13 supply fans and 12 roof ventilators.

Supply air to the switchgear room is passed through a filter and electric heating coil. Flow switch will deenergize the electric heating coil upon detection of loss of air flow.

9.8.4.4 Methods Of Operation

During normal operation, the supply units operate continuously after a manual start from local control stations. After startup, the units operate under control of the automatic temperature control system.

9.8.4.5 System Evaluation

Outside air intakes are provided with temperature switches which annunciate locally upon detection of high temperature. Supply air to the switch gear room is filtered with 80 to 85 percent filter to prevent dust from accumulating in the electrical contacts and relays. The room is pressurized to prevent the dust from getting in. To control the room temperature, electric heater is provided.

9.8.5 RECIRCULATION COOLING UNITS

9.8.5.1 Design Bases

Separate recirculation cooling units (AH-E-15A & B and AH-E-8A & B) are provided for the removal of heat dissipated from the safety-related pumps to maintain suitable and safe ambient conditions for operating equipment and personnel on all modes of operation. These coolers are not essential to achieve or maintain a safe shutdown condition (Reference 23).

9.8.5.2 System Function

To maintain the air temperature in the rooms where the SF, NS, and DC pumps are located at or below the maximum limit of 104^{o}F.

9.8.5.3 System Description

The room containing the nuclear service and decay heat closed cycle cooling pumps is cooled by seismic Category I recirculation coolers (AH-E-15A & B) using nuclear service cooling water. Two redundant 100 percent capacity units are provided, as shown on Drawing 302841.

The room containing the spent fuel coolant pumps is cooled by seismic Category I recirculation coolers (AH-E-8A & B) using nuclear service cooling water. Two redundant 100 percent capacity units are provided, as shown on Drawing 302831.

9.8.5.4 Methods of Operation

The auxiliary cooling units operate continuously to maintain air temperature.

9.8.5.5 Systems Evaluation

Temperature switches provided in the supply ducts will stop the fan and alarm in the Control Room upon detection of high temperature. Flow switches provided at the discharge ducts will alarm in the Control Room upon detection of loss of air flow. Operator action is required to start the redundant standby unit. Each redundant auxiliary cooler is operated periodically to assure availability in an emergency.

9.8.6 INTERMEDIATE BUILDING VENTILATION SYSTEM

9.8.6.1 Design Bases

To maintain suitable and safe ambient conditions in the Intermediate Building for operating equipment and personnel during normal operating condition. To maintain a controlled environment in the emergency feedwater pump area.

9.8.6.2 System Function

The function of the Intermediate Building ventilation system is to remove heat from the areas containing various equipment, penetration cooling piping, and emergency feedwater pumps, and maintain a controlled environment for the operating equipment.

9.8.6.3 System Description

The air handling units for the penetration cooling piping and equipment areas (located at elevation 322' 0") and the emergency feedwater pump areas operate continuously to remove heat to maintain the areas at predetermined temperatures. Ten percent outside air is introduced to penetration piping and equipment areas while the air in the emergency feedwater pump areas is completely recirculated by one hundred percent redundant air handling units.

9.8.6.4 Methods of Operation

During normal operation, the air handling units for the penetration piping and equipment areas and emergency feedwater pump areas operate continuously after a manual start from the Control Room stations. After start-up the units operate under thermostatic control valves continuously regulating the flow of cooling water to the coils to limit the temperature within the design basis.

9.8.6.5 Systems Evaluation

Temperature switches located in the supply ducts will stop the fans upon detection of High Temperature. For emergency feedwater pump areas Air Handling unit, an alarm will be annunciated in the Control Room upon detection of low air flow and high temperature. One hundred percent redundancy is provided to control the environment in emergency feedwater pump areas in all modes of operations.

A fire in various areas of the plant (reference TMI-1 Fire Hazards Analysis Report) could affect ventilation units AH-E-24A and AH-E-24B. An analysis and testing program was conducted to evaluate the loss of ventilation to the emergency feedwater pump room due to an Appendix R fire. An evaluation was performed of the computer analysis results and the field test data (2 hours) to reconcile the differences and to more accurately predict the expected room temperature response with loss of ventilation in the emergency feedwater pump room. The findings are included in GPU Technical Data Report (TDR-900), entitled, "Reconciliation of Ventilation Systems Analyses and Tests." The temperature evaluation concludes that the test data represents the actual temperature response for the emergency feedwater pump area. The evaluation also concludes that the emergency feedwater pump area is not affected by outdoor ambient temperature due to its location in respect to the outside, and that the room peak temperature is not a function of the initial starting temperature but affects the amount of time it takes to reach the peak temperature. The limiting components are the emergency feedwater pump motors which are rated for full load operation at 122°F ambient temperature. The analysis concludes that the maximum temperature in the area of required equipment is expected to be 113°F during the 72 hour time period, which is well within equipment operating limits and is acceptably low for personnel occupancy required to manually control the emergency feedwater control valves. The failure of AH-E-24A and AH-E-24B during an Appendix R fire event does not adversely affect Appendix R safe shutdown components.

Important input assumptions and variables which could effect these results include internal room heat loads, openings for natural convection air flow, heat producing equipment, room heat sink mass, normal operating space temperature, space configuration (room size, wall construction), and normal HVAC system operating characteristics.

9.8.7 DIESEL GENERATOR BUILDING

9.8.7.1 Design Bases

To maintain suitable and safe ambient conditions in the Diesel Generator Building for operating equipment and personnel on all modes of operation.

9.8.7.2 System Function

The function of Diesel Generator Building ventilation system is to remove heat generated by diesel generator and other heat generating components and to maintain a controlled environment for personnel and operating equipment during all modes of operation.

9.8.7.3 System Description

The Ventilation System for the Diesel Generator Building consists of an air handling unit and associated ductwork and controls. The air handling unit includes an 80-85 percent filter, electric heating coil, and a fan. In addition, fire protected intake openings and missile protected discharge hood are provided for cooling the diesel when operating. The ventilation system is shown diagramatically on Drawing 302-844

9.8.7.4 Methods Of Operation

The ventilation system is started manually in the Control Room and operates continuously during all modes of operation. Depending upon the room temperature, room air is either recirculated or totally discharged to atmosphere.

9.8.7.5 System Evaluation

This system is connected to class 1E power. Instrument & Controls are provided to:

a. Alarm locally and stop the fan on high temperature of the supply air.

b. Alarm in the Control Room and de-energize the electric heater upon loss of air flow.

c. Control the recirculation air in response to the room temperature.

A fire in various areas of the plant (reference TMI-1 Fire Hazards Analysis Report) could affect ventilation units AH-E-29A or AH-E-29B. An analysis and testing program was conducted to evaluate the loss of ventilation to the Diesel Generator Building due to an Appendix R fire. An evaluation was performed of the computer analysis results and the field test data (2 hours) to reconcile the differences and to more accurately predict the expected room temperature response with loss of ventilation in the the Diesel Generator Building. The findings are included in GPU Technical Data Report (TDR-900) entitled, "Reconciliation of Ventilation Systems Analyses and Tests." The diesel generator was started and fully loaded to 3MW during the test. The operation of the diesel engine radiator fan creates a negative pressure in the diesel generator room, resulting in cooling air being drawn in from the surrounding areas including outside air.

The temperature evaluation concludes that the test temperatures, when adjusted for the temperature difference between the test-day and the design-day ambient outdoor temperatures, depict the worst indoor temperatures expected at the diesel generator building during loss of ventilation. The limiting components in the diesel generator rooms are the diesel generator components themselves which will operate acceptably at 120°F. Manual actions to open Doors D-106 and D-107 within one hour after loss of ventilation is required to limit Diesel Generator Room A temperatures to below 120°F after 72 hours. Manual actions to open the Service Building roll-up door and Doors SB-157 and D-101 is required to limit Diesel Generator Room B temperatures to below 120ºF after 72 hours. The failure of AH-E-29A or AH-E-29B during an Appendix R fire event does not adversely affect Appendix R safe shutdown components when the above manual actions are taken.

Important input assumptions and variables which could effect these results include internal room heat loads, openings for natural convection air flow, heat producing equipment, room heat sink mass, normal operating space temperature, space configuration (room size, wall construction), and normal HVAC system operating characteristics.

9.8.8 INTAKE SCREEN AND PUMP HOUSE VENTILATION SYSTEM

9.8.8.1 Design Bases

To maintain suitable and safe ambient conditions in the intake screen and pump house for operating equipment and personnel during normal plant operation. Indoor design conditions are indicated in Table 9.8-1.

9.8.8.2 System Function

The function of the intake screen and pump house ventilation system is to remove building internal heat under normal operating conditions to maintain the building below a predetermined maximum temperature, and to add sensible heat to maintain the building above a predetermined minimum temperature in the event the intake pumps are not operating.

9.8.8.3 System Description

Two air handling units are provided, one being a standby. Each unit has the capacity to filter (roughing only), cool and recirculate the air within the building. Ductwork is used to convey the air from the air handling units to the pump rooms, where it is discharged. Air circulates from the pump rooms through transfer openings provided in the walls and returns to the air handling units.

Outdoor air for ventilation is introduced into the building through a wall mounted fan. The ventilation fan is interlocked electrically with the air handling units for simultaneous operation. Electric unit heaters provide heat to maintain minimum building ambient temperatures as required.

River water is pumped through strainers and through the cooling coils to provide building heat removal during normal plant operation. During a design basis accident (DBA) cooling water is not required for building heat removal. Analysis has demonstrated that safety related equipment within the intake screen and pump house can operate safely without any adverse affects up to 120°F. The analysis conservatively predicted that it would take at least 15 hours to reach 120°F starting from 104°F. Portable ventilation will be provided as necessary to keep temperatures less than 120°F following a DBA. The intake screen and pump house ventilation is shown schematically in Drawing 302-844

9.8.8.4 Methods of Operation

The operation of the air handling units is controlled manually from the Control Room. When the air handling unit is energized, one of the two Screen House Vent Equipment cooling water pumps will start, the motorized damper in the air handling unit discharge will open, and the cooling coil valve will modulate as required by the room thermostat. The cooling water pumps are interlocked electrically to prevent simultaneous operation. The ventilation air fan will operate when either air handling unit is operating. The unit heater power circuit is energized locally, but the units will not operate until the building ambient temperatures cause the thermostats to close.

9.8.8.5 System Evaluation

The system is connected to Class 1E power instrument, and controls are provided as follows:

1. An air flow alarm to illuminate a light and sound an alarm in the Control Room on loss of air flow.

2. High temperature detection devices are located in the duct downstream of each cooler fan, to stop the fan and outdoor air ventilation fan, and alarm in the Control Room on detection of high temperature. This device is to be manually reset locally.

3. A room thermostat controls the water valve attached to the air handling unit cooling coil.

4. Thermostats adjacent to the unit heaters control the unit heater heating element and fan.

Fires in various areas of the plant (reference TMI-1 Fire Hazards Analysis Report) could affect the operation of the intake screen and pump house ventilation system due to fire damage of power and control cables. An analysis has been performed which demonstrates that under a worst case condition of 95°F outside air temperature, the loss of intake screen and pump house ventilation concurrent with normal operating conditions will result in slowly increasing temperatures in the area. Based on the design flow, the normal heat loads, and the design cooling capacity of the intake screen and pump house ventilation system, the initial temperature in the area for the worst case conditions of 95°F outside air was calculated to be 108°F. Results of the analysis indicate that for the worst case conditions, the temperature in the intake screen and pump house will increase from 108°F to 111°F in four hours and to 120°F in 16 hours. Portable ventilation will be provided in the intake screen and pump house within four hours to limit maximum temperatures to well within the allowable operating temperature limit of 120°F for safe shutdown equipment in the area. Dedicated portable ventilation equipment is provided and maintained to accomplish this action.

9.8.9 WASTE HANDLING AND PACKAGING FACILITY (WHPF) VENTILATION SYSTEM

9.8.9.1 Design Bases

Maintains a negative pressure with respect to ambient conditions within the contaminated areas of the WHPF by exhausting more air than is supplied and filtering the air being exhausted in order to limit the quantity of airborne contaminants released to the environment.

To maintain suitable and safe ambient conditions for operating equipment and personnel during normal operating conditions.

9.8.9.2 System Functions

The functions of the WHPF ventilation system are:

To supply filtered and tempered outside air to the WHPF for ventilation.

To add heat to the supply air for temperature control.

To filter air exhausted from potentially radioactive areas of the WHPF through roughing and HEPA filters, and then to discharge this air to the atmosphere through the building vent, continuously monitoring this discharge for radioactivity and taking appropriate action to protect the public in the event of high radiation alarm from vent stack monitor WHP-RIT-1.

9.8.9.3 System Description

The WHPF HVAC system is divided into several areas. The administrative area, shipping and receiving area, and the equipment room are clean areas and are served by separate heating and ventilation systems which are not associated with the HVAC system for the potentially contaminated work areas of the WHPF. All penetrations are sealed between clean areas, e.g., the administrative area, and the processing areas.

A radiation monitor is provided in the exhaust to the atmosphere from potentially contaminated areas, downstream of the filter, to monitor radioactive releases to the environment. Excessive levels will automatically shut down the exhaust and supply systems. Supply units are not permitted to run unless the exhaust system is on.

Flow direction from relatively clean to more contaminated areas is maintained by appropriately arranging supply and exhaust quantities to each air space.

9.8.9.4 Methods of Operation

During the handling of radioactive materials within the facility, the ventilation system operates continuously after a manual start from the local control station.

Outside air is supplied to the WHPF for cooling and heating the air, and for ventilation, as required. Air may also be taken from clean areas for makeup to this HVAC system. Recirculated air or induction units may be used to maintain the required air supply temperature. If recirculated air is used, it is HEPA filtered.

Exhaust hoods are installed at equipment locations or rooms where fumes or other contaminates are generated, in order to reduce the exposure to operating personnel. Air flow through these hoods may be continuous.

Exhaust and supplied air quantities are regulated to ensure a negative pressure is maintained in the potentially contaminated areas relative to ambient condition. Preferably, some of the exhaust hoods are in continuous operation when the system is operated. As additional hoods are placed in use, the quantities exhausted and supplied are adjusted to maintain a constant exhaust rate from the building.

9.8.9.5 System Evaluation

Exhaust air from potentially radioactive areas is passed through roughing and HEPA filters for removal of radioactive particulates.

A radiation monitor is provided in the exhaust to the atmosphere from potentially contaminated areas, downstream of the filter, to monitor radioactive releases to the environment. Excessive levels will automatically shut down the exhaust and supply systems.

Exhaust to the atmosphere is sampled for particulate activity. An exhaust monitor is provided with local alarm, readout, and recorder, and remote alarm in the TMI-1 control room. Excessive levels of airborne radioactivity in the ventilation discharge will automatically shut down the exhaust and supply systems.

Air samples from the building exhaust are used to assess and quantify radiological releases to the environment.

9.8.10 CHEMICAL CLEANING BUILDING (CCB) VENTILATION SYSTEM

9.8.10.1 Design Bases

Maintains a negative pressure with respect to ambient conditions within the contaminated areas of the CCB by exhausting more air than is supplied and filtering the air being exhausted in order to limit the quantity of airborne contaminants released to the environment.

To maintain suitable and safe ambient conditions for operating equipment and personnel during normal operating conditions.

9.8.10.2 System Functions

The functions of the CCB ventilation system are:

To maintain the CCB at a negative pressure.

To filter air exhausted from the CCB through roughing and HEPA filters and then to discharge this air to the atmosphere through the building vent, continuously monitoring this discharge for radioactivity and taking appropriate action to protect the public in the event of high radiation alarm from vent stack monitor ALC-RMI-18.

9.8.10.3 System Description

The CCB HVAC system is divided into several areas. The CCB control room and ventilation room are clean areas and are served by separate heating and ventilation systems which are not associated with the HVAC system for the potentially contaminated processing areas of the CCB.

A radiation monitor is provided in the exhaust to the atmosphere from the CCB, downstream of the filter, to monitor radioactive releases to the environment. Excessive levels will cause the monitor to alarm locally with indication in the TMI-1 control room. Manual actions can then be taken to mitigate and terminate any potential release of airborne radioactive materials.

Negative pressure is maintained in the CCB by exhausting air from the building and allowing filtered outside makeup air to flow into the building through a louvered intake as a result of the pressure differential created by the exhaust flow.

9.8.10.4 Methods of Operation

During the movement or processing of liquid radwaste within the CCB, the ventilation system operates continuously after a manual start from the local control station.

Outside air is supplied to the CCB to makeup air removed by the exhaust system. This air is filtered but is not heated. Heating of the CCB is accomplished by the use of radiant heaters.

Exhaust inlets are installed at numerous locations in the CCB in order to reduce the exposure to operating personnel. Air flow through these inlets is continuous.

Negative pressure is maintained in the CCB by exhausting air from the building and allowing filtered outside makeup air to flow into the building through a louvered intake as a result of the pressure differential created by the exhaust flow.

9.8.10.5 System Evaluation

Exhaust air from the CCB is passed through roughing and HEPA filters for removal of radioactive particulates.

Exhaust to the atmosphere is sampled for particulate and iodine activity. A radiation monitor is provided in the exhaust to the atmosphere from the CCB, downstream of the filter, to monitor radioactive particulates, iodines, and noble gases released to the environment. The exhaust monitor is provided with local alarm, readout, and recorder, and alarm indication in the TMI-1 control room. Excessive levels will cause the monitor channel(s) to alarm. Manual actions can then be taken to mitigate and terminate any potential release of airborne radioactive material.

Air samples from the building exhaust are used to assess and quantify radiological releases to the environment.

9.8.11 RESPIRATOR AND LAUNDRY MAINTENANCE (RLM) FACILITY VENTILATION SYSTEM

9.8.11.1 Design Bases

Maintains a negative pressure with respect to ambient conditions within the respirator cleaning room and the RLM by exhausting more air than is supplied and filtering the air being exhausted in order to limit the quantity of airborne contaminants released to the environment.

To maintain suitable and safe ambient conditions for operating equipment and personnel during normal operating conditions.

9.8.11.2 System Functions

The functions of the RLM ventilation system are:

To supply filtered and tempered outside air to the RLM for ventilation.

To add heat to the supply air for temperature control.

To filter air exhausted from the respirator cleaning room of the RLM through roughing and HEPA filters and then to discharge this air to the atmosphere through the building vent, continuously monitoring this discharge for radioactivity and taking appropriate action to protect the public in the event of high radiation alarm from vent stack monitor RLM-RM-1.

9.8.11.3 System Description

The RLM HVAC system is divided into several areas. The administrative areas, laundry shipping and receiving area, the respirator repair room and the equipment room are clean areas and are served by separate heating and ventilation systems which are not associated with the HVAC system for the potentially contaminated work area of the respirator cleaning room.

A radiation monitor is provided in the exhaust to the atmosphere from the respirator cleaning room, downstream of the filter, to monitor radioactive releases to the environment. Excessive levels will cause the monitor to alarm locally with trouble alarm indication in the TMI-1 control room. Manual actions can then be taken to mitigate and terminate any potential release of airborne radioactive materials.

Flow direction from clean areas of the RLM to the more contaminated respirator cleaning room is maintained by appropriately arranging supply and exhaust quantities to each air space.

9.8.11.4 Methods of Operation

During the handling of radioactive materials within the respirator cleaning room the ventilation system operates continuously after a manual start from the local control station.

Outside air is supplied to the RLM for cooling and heating the air, and for ventilation, as required. Air is also taken from clean areas for makeup to the respirator cleaning room. Recirculated air or induction units may be used to maintain the required air supply temperature to the respirator cleaning room. Recirculated air to supply the respirator cleaning room is HEPA filtered.
Exhaust hoods are installed in the respirator cleaning room in order to reduce the exposure to operating personnel. Air flow through these hoods may be continuous.

Exhaust and supplied air quantities are regulated to ensure a negative pressure is maintained in the respirator cleaning room relative to ambient conditions.

9.8.11.5 System Evaluation

Exhaust air from the respirator cleaning room is passed through roughing and HEPA filters for removal of radioactive particulates.

Exhaust to the atmosphere is sampled for particulate activity. A radiation monitor is provided in the exhaust to the atmosphere from the respirator cleaning room downstream of the filter, to monitor radioactive releases to the environment. The exhaust monitor is provided with local alarm, readout, and recorder, and trouble alarm indication in the TMI-1 control room. Excessive levels will cause the monitor to alarm. Manual actions can then be taken to mitigate and terminate any potential release of airborne radioactive material.

Air samples from the building exhaust are used to assess and quantify radiological releases to the environment.

TABLE 9.8-1
(Sheet 1 of 1)

DESIGN CONDITIONS - INDOORS

Control Building	1P/1S Switchgear Rooms: 95°F max. 1A, 1C & 1E Inverter Room: 88.6°F max. 1B & 1D & 1F Inverter Room: 86.5°F max. Other Areas (Including the Control Room): 75 $\pm$ 5°F
Auxiliary and Fuel Handling Buildings	Summer 104°F maximum Winter following areas 60°F minimum 1. AH-V-1A immediate vicinity 2. RBAT/CWST tank and pump room 60°F minimum 3. 281' Aux. Bldg. Hall between RBAT room and Precoat Slurry Pump room 4. MW Evap room 5. RC Evap room 6. Decant Slurry pump room 7. 281' Elev FHB hallway from MU-V-51 North to end of hall but not past corners 8. Mini Valve Alley 9. Solid Waste Disposal Valve Gallery All other areas 50°F minimum
Turbine Building	Summer outside ambient Winter outside ambient
Diesel Building	Summer outside ambient Winter outside ambient
Intake Screen and Pump House	Summer 104°F maximum Winter 40°F minimum

9.9 PLANT FIRE PROTECTION PROGRAM

9.9.1 PROGRAM FUNCTIONS

The functions of the plant fire protection program are as follows:

a. Reduce the likelihood of fire occurrences;

b. Promptly detect and extinguish fires if they occur;

c. Maintain the capability to safely shutdown the plant in the event of a fire; and,

d. Prevent the subsequent release of a significant amount of radioactive material.

9.9.2 PROGRAM DESCRIPTION

The fire protection program consists of the following:

1. Three Mile Island Nuclear Station Unit 1 Administrative Procedure 1038 "Administrative Controls - Fire Protection Program".

2. TMI-1 Fire Hazards Analysis Report.

3. Fire Protection systems.

The Administrative Procedure AP 1038 outlines and describes the organization, responsibilities, quality assurance, maintenance, inspection, testing and training associated with TMI-1 Fire Protection Program functions. TMI-1 Technical Specification Sections 3.5.7 and 4.1.4 specify limiting conditions of operation and surveillance requirements for the remote shutdown system.

The Fire Hazards Analysis Report (FHAR) describes the fire protection configuration for confinement, detection, extinguishment of fires and demonstrates the capability to achieve and maintain safe shutdown condition in the event of a fire in support of the TMI-1 Fire Protection Program functions. Specific exemptions to 10CFR50 Appendix R which have been granted by the NRC are identified in the FHAR.

The Administrative Procedure AP 1038 and the Fire Hazards Analysis Report are considered to be part of the Safety Analysis Report, by reference. Changes to these documents are governed by 10CFR50.59. Changes to the Fire Protection Program are also governed by the Operating License Condition 2.C.4.

The Fire Protection systems described throughout Section 9.9 provide fire protection configuration details in addition to the descriptions provided in the Fire Hazards Analysis Report, in support of the TMI-1 Fire Protection Program functions. The Fire Protection systems are discussed in further detail as follows.

9.9.2.1 Water Extinguishing Systems

Three fire pumps and an elevated storage tank supply water through the yard mains to all points requiring water for fire protection. These include fixed deluge water spray systems, wet pipe sprinkler systems, preaction systems, interior hose reels, and yard hydrants. Water extinguishing systems are provided in a number of locations in the plant.

9.9.2.2 Halogenated Fire Suppression Systems

Halogenated fire suppression systems are provided in the plant ventilation air intake tunnel to inhibit combustion of any fuel/air mixture that might enter the intake structure. Detection of an embryonic explosion releases Halon 1301 gas into the mixture in sufficient quantity to render it incombustible within a fraction of the time required for the explosion to reach destructive proportions.

9.9.2.3 CO_2 Fire Suppression System

Automatic CO_2 fire suppression is provided for the Relay Room in the Control Building. System actuation may be accomplished automatically or by operator action.

9.9.3 SYSTEM DESIGN REQUIREMENTS

9.9.3.1 Codes And Standards

The plant fire protection systems comply with the following codes and regulating bodies, where pertinent:

a. American Nuclear Insurers (ANI).

b. National Fire Protection Association (NFPA). NFPA codes are considered in the design, installation, maintenance and testing of fire protection systems.

c. Commonwealth of Pennsylvania Code.

d. American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code.

e. American National Standards Institute (ANSI) Piping Codes.

f. Nuclear Electric Insurance Limited (NEIL).

9.9.3.2 Specific Requirements

Specific requirements and considerations which are unique to these plant fire protection systems include:

a. The Control Building is provided with adequate protection to permit continuous occupancy.

b. Specific areas of the plant are able to exclude solids, fuel, flame, heat, or smoke resulting from a postulated crash of an aircraft.

c. The Control Building air intake tunnel is protected to prevent explosions of fuel/air mixtures in the confined space.

d. The emergency diesel generators are arranged so that one will remain operable should the structure housing them be engulfed in a fire resulting from the fuel discharged from a postulated crash of an aircraft.

9.9.3.3 Interface Relationships

The plant fire protection systems impose certain interfaces with other systems as follows:

a. Plant drains must accommodate all water discharged automatically or by manual control.

b. Water to fill the elevated storage tank is derived from cycle makeup pretreatment or wells and conveyed to the tank by means of filtered water pumps WT-P-5A and B. The tank is arranged to permit a limited amount of water in the upper portion of the tank to flow by gravity to the cycle makeup demineralizers. All water in the tank can flow by gravity through the fire mains to the point of use.

c. Circulating water is abundantly and readily available as a source of water.

d. Actuation of automatic fire protection devices in the air intake tunnel will trip selected dampers and fans in the ventilation systems which normally receive air from the tunnel.

e. Actuation of smoke detectors in the Control Building ventilating ducts will close selected dampers in that system to isolate potential fires and will sound an alarm.

f. Actuation of combustible vapor detectors in selected areas will sound alarms and trip fans, valves, and pumps to restrict further dissemination of the combustible vapor (or liquid).

9.9.4 FIRE SUPPRESSION SYSTEMS

The following make up the plant fire protection system.

9.9.4.1 Fire Suppression Water Systems

a. The altitude tank (FS-T-1) has a 100,000 gal capacity above elevation 430 ft. It is located about 400 ft northeast of the Reactor Building. Internal piping in the tank permits 10,000 gallons to flow to the makeup demineralizers. The entire contents can flow to the fire main. The accessories include roof hatch and fire main. A recirculation pump (FS-P6) and three heaters are provided for maintaining water temperature in the tank above freezing.

b. Fire Pumps

No.	Drive	Location	Capacity (gpm)	Total Dynamic Head (ft)	(psi)
FS-P-1 (Unit 1)	Diesel	Circ. Water Pump House	2500	289	125
FS-P-2	Electric	Intake Screen Pump House	2500	326	140
FS-P-3	Diesel	Diesel Fire Pump House (Unit 1)	2500	326	140

Circulating water flume fire pump FS-P-1 (Unit 1) is a horizontal, diesel-driven unit that has a capacity of 2500 gpm and total dynamic head of 289 ft. It is located in the east end of the circulating water pump house approximately 700 ft northeast of the reactor containment. The horizontal suction pump takes circulating water under positive head from the common intake flume. It discharges into the section of the yard fire main serving the natural draft cooling towers (B only). This section is not isolated from the balance of the fire main since a check valve bypass is open.

Motor-driven vertical fire pump FS-P-2 and diesel-engine-driven fire pump FS-P-3 each take suction from the pump intake bay at the Intake Screen Pump House. Fire pumps FS-P-2 and FS-P-3 discharge into the yard fire main.

The Three Unit 1 fire pumps will be started automatically by a sudden pressure drop in the system, or can be started remotely from the Unit 1 Control Room, or started locally. Each fire pump must be manually shut off, with the following exception:

> The motor driven fire pump, FS-P-2, is tripped from service on an ES signal, because in the event of a LOCA concurrent with LOOP and a diesel failure a severe voltage dip on Class 1E busses could occur. FS-P-2 can be started from the Control Room after bypassing the ES signal, provided offsite power is available or sufficient diesel generator capacity is available. FS-P-2 may also be secured remotely from the Control Room.

c. The jockey fire pump (FS-P-4) is a hydro pumping unit which cuts in at 108 psig and cuts out at 125 psig to maintain a 108 to 125 psig pressure in the yard fire main. It is located along the east wall in the turbine room building (elevation 305'0"). The pump takes filtered or well water from the 6 inch filtered water line from the altitude tank to the makeup demineralizers.

d. The pumps for the kidney filter deluge water spray system located in the Reactor Building (elevation 281' 0") are motor driven vertical in-line, centrifugal pumps each rated at 90 gpm. Each pump takes suction from a 1500 gallon tank which is fed from the industrial cooler system. The pumps are set to start when charcoal temperature in the kidney filter plenum reaches 190°F. Two of the filter temperature actuated switches must actuate in order for the pumps to start.

e. The yard fire main is comprised of two, 12 inch underground pipe loops (See Drawing 302231). One loop surrounds the main plant, and the other loop surrounds the Unit 1 natural draft cooling towers. The 12 inch piping loop surrounding Unit "1A" Cooling Tower no longer serve the "1A" Cooling Tower directly, but the 12 inch piping will continue to serve the remainder of the underground main loop. The two loops are connected by a 16 inch tie line. Each loop has internal cross ties to increase flow area and improve reliability. Post indicator valves (PIVs) are provided to permit isolating sections of the yard fire main in the event of a break, and for repairs or extensions. Each of the three fire pumps supply 125 psi water at 2500 gpm to the yard fire main and to cooling tower loop. Relief valves on the discharge of each fire pump are set at 150± 7.5 psig. Any of the yard hydrants may be used to receive water from a fire department pumper to supplement the water supply to the yard fire main. The piping is sized and arranged to transport 3155 gpm to the most remote deluge system plus 500 gpm to hoses with a minimum residual pressure of 100 psi at the most remote deluge system.

The maximum demand on site for a shutdown/safety-related area is 1720 gpm (Section 9.11, Reference 2, Chapter 6) at a residual pressure of 50 psig. This is based on the maximum fire suppression flow requirement for an area determined necessary to support a plant safe shutdown. This maximum fire suppression flow rate demand is based on an Air Intake Tunnel deluge system actuation, when all three Air Intake Tunnel deluge systems actuate.

The Fire Service supply piping within the Control Building, Fuel Handling Building and Auxiliary Building will maintain pressure boundary integrity following an SSE, and not present a flooding or water spray threat to safe shutdown systems (Reference 19).

9.9.4.2 Deluge Water Spray Systems

The deluge water spray systems consist of an adequate water supply which meets the requirements of NFPA Standard No. 15, "Water Spray Fixed Systems For Fire Protection," a controlling gate valve, deluge valve, strainer, fixed open spray nozzles connected to hydraulically balanced piping system, and heat detectors. The deluge valve opens when actuated by the heat detectors to permit water to flow through the open spray nozzles except as noted below for the deluge water spray systems provided for the natural and mechanical draft cooling tower basin and most of the charcoal filter banks. Systems are provided to protect the following areas:

a. The three main power transformers located outdoors along the east turbine room wall;

b. The two station auxiliary transformers located outdoors along the east turbine room wall;

c. The east turbine room wall located behind the main power and station auxiliary transformers;

d. The main turbine oil reservoir and oil conditioner;

e. The feedwater pump turbine oil reservoir and the two feedwater pump turbines;

f. The generator hydrogen seal oil unit;

g. The two diesel generators located in the tornado/missile proof Diesel Generator Building, approximately 30 ft north of the Reactor Building. Each diesel is protected by a deluge system in the combustion air inlet and an additional deluge system for the common cooling air intake (three deluge systems total);

h. The plant ventilating air intake located approximately 300 ft southwest of the Reactor Building. The air intake and connecting tunnel are provided with three deluge systems. One is immediately inside the intake superstructure, one is completely within the crashproof tunnel inside a protective curtain wall, and one is further inside the tunnel but upstream from the fire dampers. Each system is actuated (See Table 9.9-1) by temperature rate of rise detectors, remote manual control from the Central Control Room, or actuation of any one of the halogenated fire suppression systems. Actuating these deluge systems also closes air intake fire dampers and trips ventilation fans;

i. Natural draft cooling tower B is located approximately 600 ft northeast of the Reactor Building. Cooling tower B is zoned into six segments separated by fire breaks and each segment is provided with a deluge system. Actuation of these deluge water spray systems is in the form of dry pipe pilot actuation. In lieu of thermal detectors, a piping line equipped with fusible heads and pressurized with nitrogen is located over the area protected by the spray piping. A fire which fuses the heads drops nitrogen pressure in the line such that the pressure, which normally holds the clapper of the deluge valve closed, can no longer be maintained. This drop in nitrogen pressure causes the deluge valve to open thus pressurizing the spray piping and discharging water through the open spray nozzles;

j. Most charcoal filtration units located in various areas of the plant are provided with heat detection systems and are manually actuated fire suppression systems;

k. The charcoal filtration units for the Reactor Building Atmospheric Cleanup System (Kidney System) is provided with an automatically actuated deluge water spray system. Two 100 percent capacity pumps (FS-P-5A and 5B) pump water to the deluge water spray system upon detection of high temperature in the charcoal by any two of the 15 installed temperature actuated switches. The storage tanks and pumps are located in the Reactor Building basement, elevation 281'-0"; and,

l. Diesel fuel storage tank room in the Station Blackout Diesel Building.

9.9.4.3 Sprinkler Systems

The hydraulically balanced wet pipe sprinkler systems consist of an adequate water supply which meets the requirements of NFPA Standard No. 13, "Installation of Sprinkler Systems," and fixed closed sprinklers connected to a hydraulically balanced piping system full of water and under normal line pressure. Each sprinkler head is held closed by a fusible link. When the fusible link is subjected to its preset temperature limit, it will release the closure, permitting water to flow. An alarm check valve or flow switch in the water supply line detects the water flow.

Automatic and manual sprinkler systems are provided in various areas of the plant and in most support buildings. Systems are provided to protect building areas as follows:

a. Turbine room ground floor.

b. Turbine room mezzanine floor. The system extends to protect the Turbine operating floor under the west turbine walkway (catwalk). Control valves for the walkway system are normally closed and piping drained, because the system is manually activated.

c. Turbine building below the main condenser (Condenser pit, elevation 292'). This system does not have an alarm check valve to detect water flow (see Section 9.9.5.4).

d. Service Building.

e. Intake screen and pump house.

   The sprinkler piping within the River Water pump rooms will maintain pressure boundary integrity following an SSE, and not present a flooding or water spray threat to safe shutdown systems (Reference 21).

f. Building which houses the diesel-driven vertical fire pump above floor elevation 308'.

g. Circulating water pump house.

h. Diesel generator rooms.

   The sprinkler piping within the Diesel Generator Building will maintain pressure boundary integrity following an SSE, and not present a flooding or water spray threat to safe shutdown systems (Reference 20).

i. Fuel Handling Building elevation 281' 0".

j. Processing Center.

k. Uninterrupted Power Supply Building. The alarm check valve is located in the Service Building at elevation 305'. (Note: The alarm check valve serves both the Service Building and the Uninterrupted Power Supply Building with a flow alarm installed in the piping for the latter building).

l. Outage equipment storage building

m. Operations Office Building (2 wet pipe and 1 dry pipe system)

n. Outage Support Fabrication Shop

o. Instrument Calibration Facility

p. Warehouses 1, 2 and 3

q. Operations Support Facility

r. North and South Office Buildings

s. Respirator Cleaning Facility

t. Maintenance Training Facility

u. Flammable Liquids Warehouse

v. Industrial Waste Treatment Facility

w. Station Blackout Diesel Building

x. Waste Handling Packaging Facility

y. Control Building Chiller Room. This system uses a flow alarm switch and is not equipped with an alarm check valve.

z. Outage Support Building

9.9.4.4 Manual Preaction Systems

The manual preaction systems consist of an adequate water supply, a controlling gate valve, deluge valve, strainer, fixed closed spray nozzles connected to a hydraulically balanced piping system filled with supervisory air, and heat detectors. Systems are manually operated from manual control stations following automatic alarm in the Control Room. Preaction systems are provided on turbine generator bearings and feed pump (turbine) bearings. Manual systems which are not provided with supervisory air are located over decay heat valves DH-V1 and DH-V2 in the Reactor Building and in the ESF Relay Cabinet Room on elevation 338'-6" of the Control Building. Water supply to these systems is via a controlling gate valve only. The system over decay heat valves DH-V1 and DH-V2 is supplied from the Reactor Building hose reel standpipe system.

9.9.4.5 Automatic Preaction System

The preaction system consists of an adequate water supply, a control gate valve, deluge valve, fixed closed spray nozzles connected to a hydraulically balanced piping system filled with supervisory air, and cross zoned ionization detectors. The following areas are covered by this type system: The Auxiliary Building Pipe Penetration area on elevation 281' and the area east of the Decay Heat and Nuclear Service Closed Cycle cooling area on elevation 305'. A manually actuated pushbutton for system operation is also provided at the valve location.

9.9.4.6 Halogenated Fire Suppression Systems

The halogenated fire suppression systems consist of the gas Halon 1301 stored under pressure in liquid form. When actuated by a detector, the liquid is released (in gaseous form) through the distribution manifold to the protected area. Dispersing the gas into the combustible vapor inhibits combustion therein. Reaction time from detection to inhibition is a small fraction of the time required for a destructive explosion to develop after the first spark. Four systems are provided to protect the plant ventilation air intake.

The four systems are physically separated. One is immediately inside the intake superstructure, one is completely within the crash proof tunnel inside a protective curtain wall, and the other two are further inside the tunnel but upstream from the fire dampers. The detectors which actuate these systems comprise two embryonic explosion types. One type detects the light of the initial flame front. The other type detects the pressure wave which accompanies the flame propagation. Actuating any one of these systems (see Table 9.9-1) also closes fire dampers, trips ventilation fans, and actuates all three deluge water spray systems. Ancillary equipment is located in underground vaults adjacent to and accessible from the air intake tunnel.

9.9.4.7 CO_2 Fire Suppression System

The system consists of a refrigerated, low pressure CO_2 storage unit located outside the Turbine Building on the east side at ground level, fixed distribution piping, valves, nozzles, thermostats, and the associated instrumentation and control equipment. The CO_2 fire suppression system protects the Control Building 338 ft. elevation Relay Room.

9.9.4.8 Reactor Coolant Pump Lube Oil Collection System

Each reactor coolant pump motor in the Reactor Building Steam Generator Compartments is equipped with an oil collection system.

9.9.4.9 Fire Detection Systems

Fire detection systems are located in various areas of the plant to provide indication of fire both locally and in the Control Room. Specific fire detection systems also serve as the means for automatic actuation of fixed fire suppression systems. In addition, combustible gas detectors are provided in the Auxiliary Building, Intermediate Building, Control Building, Fuel Handling Building and the Air Intake Tunnel with alarms at local panels and in the Control Room. Some non-safety related areas provide alarms locally and to the Security Processing Center Security Site Protection Officer who then notifies the Control Room of the alarm.

9.9.4.10 Miscellaneous Fire Protection Devices

The devices include yard hydrants and hose houses, fire dampers, fire doors, fire rated cable enclosures, fire resistant cable, radiant energy heat shields, hose reels, accelerometer (for fresh air intake tunnel), Class A, B and C portable fire extinguishers, fixed temperature thermostats for substation Control Building, emergency equipment and turnout gear lockers, and fire barrier penetration seals. For additional details on fire resistant cable and radiant energy heat shields, see the descriptions contained in the Fire Hazards Analysis Report.

9.9.4.11 CB 306 Acetylene Monitor

Acetylene is used in the TMI-1 Primary Chemistry Lab. This system monitors for acetylene leakage from the supply line and inside the lab itself. The acetylene monitor system consists of a central control panel and multiple detector heads. The control panel houses readouts of acetylene levels at the remote sensor heads and provides an audible alarm when acetylene leakage is detected. The detector heads are located above the ceiling on CB 306 and inside the Primary Chemistry Lab. This system was installed to support the evaluation of safe shutdown related fire barrier circuit protection used on CB 306. For additional details on the protected circuits in this area, see the Fire Hazards Analysis Report.

9.9.5 INSTRUMENTS, CONTROLS, ALARMS, AND PROTECTIVE DEVICES

The instruments, controls, alarms, and protective devices for the various components of the plant fire protection systems are as follows:

9.9.5.1 Altitude Tank (FS-T-1)

a. Level switch LS 165 at elevation 458 ft and higher actuates a high level alarm in the Central Control Room and stops the filtered water pumps WT-P-5 A and B.

b. Level switch LS 164 starts filtered water pump(s) on level below elevation 455 ft 8 inches.

c. Level switch LS 108 at elevation 455 ft 1/4 inch actuates low level alarm in the Central Control Room. This condition is also transmitted to the data logger.

d. Temperature switch TS 364. At tank water temperatures below 40°F, this switch actuates a low temperature alarm in the Central Control Room. This condition is also transmitted to the data logger.

e. Dual temperature indicating switches TIS 632 and 633. At tank water temperatures below 51°F, TIS 632 or TIS 633 starts tank circulating pumps and Electric Heater 1 in the tank pedestal. Additionally, at temperatures below 47°F and 43°F, Electric Heaters 2 and 3 are actuated by TIS 632 and TIS 633, respectively.

f. Temperature indicator TI 631 provides local standpipe water temperature indication.

g. Level indicator LI 107 provides local water level indication.

h. Tank level control is provided by level switches that cycle fill pumps to maintain water level.

9.9.5.2 Fire Pumps

a. River Fire Pump FS-P-2 (Electric)

   1) Pressure indicator PI-193A provides local pump discharge pressure indication.

   2) Pressure switch PS-220 starts the pump at main pressure below 90 psig.

   3) Actuation of any of the release valves in the deluge water spray systems starts the pump.

   4) Class 1E, seismically qualified relays installed in unit Substations 1R and 1T are energized on an ES actuation to trip the pump or stop it from starting automatically. The pump may be started from the Control Room after clearing the ES signal or may be started locally in any event.

   5) A remote stop is available in the Control Room for this pump.

b. River Fire Pump FS-P-3 (Diesel)

1) Pressure indicator PI-193B provides local pump discharge pressure indication.

2) Pressure switch PS-221 in the diesel engine controller starts the pump at main pressures below 80 psig.

3) Actuation of any of the release valves in the deluge water spray systems starts the pump.

4) Flow indicator FI 155 provides local pump test flow indication for both river fire pumps.

5) Flow switch FS 156 sounds local alarm when fire pump test flow passes to drain.

6) The diesel engine is equipped to transmit the following conditions to the Control Room and computer:

High water temperature
Low oil pressure
Engine fail to start
Engine running
Engine overspeed

c. Circulating Water Flume Fire Pump FS-P-1 (Unit 1)

1) Pressure indicator PI-192 and PI-153 provide local indication of pump suction and discharge pressures, respectively.

2) Pressure switch PS-154 in the diesel engine controller starts pump at main pressures below 70 psig.

3) The diesel engine is equipped to transmit the following conditions to the Control Room and computer:

High water temperature

Low oil pressure

Engine fail to start

Engine running

Engine overspeed

d. Fire Service Jockey Pump FS-P-4

Two modes of operation are provided:

1) Automatic mode - When the "HAND-OFF-AUTO" selector switch is placed in the "AUTO" position, the pump is controlled by pressure switch PS-586. This pressure switch energizes the pump motor at a pressure of 108 psig and de-energizes the pump at a pressure of 125 psig. Also included in the automatic circuit is a time delay relay to insure that the pump operates for a minimum of one minute following actuation.

2) Hand mode - When the "HAND-OFF-AUTO" selector switch is placed in the "HAND" position, the automatic mode of operation is eliminated. The pump is started by depressing and releasing the "START" pushbutton. In this mode the pump remains in operation until the "HAND-OFF-AUTO" switch is placed in the "OFF" position.

e. Kidney Filter Deluge Water Spray System Pumps FS-P-5A,5B

1) Two temperature switches out of fifteen start one pump when charcoal filter temperature reaches 190F. Pumps must be manually stopped after temperature alarm condition clears and local panel reset button is depressed.

2) Pumps can be manually started when the Kidney System fan (AH-E-101) is stopped.

9.9.5.3 Deluge Water Spray Systems

Each deluge water spray system is equipped with temperature detectors which actuate a fire alarm in the Control Room. With the exception of deluge systems in the HVAC charcoal filter banks, the deluge systems also automatically actuate and spray fire service water from the detector actuation. The deluge systems in the HVAC systems are manual actuated either locally or from the Control Room upon confirmation of a fire. Two fire pumps receive a signal to auto start upon a deluge actuation. Deluge valve actuation in the air intake tunnel also trips the ventilating fans and closes dampers. Also the cooling tower deluge valves are actuated by the dry pipe pilot actuated method as described in Section 9.9.4.2.i.

9.9.5.4 Wet Pipe Sprinkler Systems

Most automatic sprinkler systems are equipped with an alarm check valve except for the Control Building Chiller Room uninterrupted power supply systems, which each use a flow alarm switch and the condenser pit system which relies on the Turbine Building sump level alarm and automatic fire pump starts to indicate an abnormal condition. When water flow occurs through a sprinkler system alarm check valve or flow alarm switch, electrical contact signals alarm in the Control Room.

9.9.5.5 Manual Preaction System

Each manual preaction system is equipped with temperature detectors which actuate a fire alarm in the Control Room. The systems are actuated from the turbine building.

The sprinklers over DH-V1, DH-V2, and the system in the ESAS room are dry pipe, manually actuated, closed head systems.

9.9.5.6 Automatic Preaction Systems

The preaction system is equipped with smoke detectors which actuate the valve and alarms in the Control Room and at the local control panel. When water flow occurs through the flow control valve an electrical contact signals an alarm in the Control Room. Trouble alarms at the local control panel and in the Control Room result from a loss of supervisory air pressure.

9.9.5.7 Halogenated Fire Suppression Systems

Each Air Intake Tunnel halogenated fire suppression system has both ultraviolet and pressure detectors in the area protected. Actuation of either type of detector will discharge the halogenated fire suppression agent.

When any one system is actuated, electrical contact will signal alarm in the Control Room and actuate all three deluge water spray systems in the air intake.

9.9.5.8 CO_2 Fire Suppression System

a. Four heat actuated detectors located in the 338 ft. elevation Relay Room are set to actuate the system at a temperature of 140F ±10F.

b. The push button timer station controls the automatic operation of the system and provides for operator actuation. Upon system actuation, a timer motor in this station is activated which, in turn, energizes a relay in the relay cabinet and energizes circuits for master selector valve operation and actuation of Electro Thermal Links (ETLs) on supply and return ventilation fire dampers.

c. The relay cabinet contains the operating relay which energizes a local audible alarm to warn personnel of system actuation and locks out the thermostats to prevent subsequent discharges if thermostat contacts have been welded together. A manual reset feature on the relay cabinet prevents subsequent automatic discharge until the relay is reset by the operator.

e. A liquid level gauge and pressure gauge are provided on the storage unit to indicate, locally, liquid CO_2 level and pressure, respectively.

f. Storage unit CO_2 pressure is automatically controlled between 295 and 305 psig.

g. Two alarms are provided. One, actuated by the relay in the relay cabinet, warns personnel in the vicinity of the 338 ft. elevation Relay Room of system actuation. The second, activated by a pressure switch on the storage unit, indicates high or low storage unit CO_2 pressure.

h. The system has the capacity for a second application of CO_2 which may be manually released if needed.

9.9.6 FIRE DETECTION AND SUPPRESSION FOLLOWING A HYPOTHETICAL AIRCRAFT INCIDENT

Ventilation systems include features which maintain the selected plant areas safe for occupancy during a hypothetical aircraft incident.

Intake and discharge openings are provided with heavy shielding. They are located to take advantage of the shielding afforded by the plant structures. Curbs and fire dampers provide further protection.

Sensing devices detecting hazards to the air intake automatically close redundant dampers to isolate the hazard and put the Control Building ventilation in the recirculation mode. Personnel in the Control Room can perform this same function manually from the Control Room. When ventilation is in the recirculation mode, the Control Building is safely and comfortably habitable for a continuous period of time, conservatively calculated to exceed 200 man-days.

All makeup air to the Control, Fuel Handling, and Auxiliary Buildings enters through the louvered intake structure which is located approximately 120 ft from the nearest plant structure. Outdoor air flows from this point through the underground tunnel and plant ducts to the fan inlets.

The intake structure and connecting tunnel arrangement is illustrated on Figure 9.9-2. The various measures providing air intake security against the aircraft hazard are described in the following paragraphs.

The Air Intake Tunnel is a noncombustible structure. Air openings are louvered and screened to inhibit the intake of small mass debris. Massive projectiles can cause the intake structure to accelerate and may demolish the structure. The shear planes between the intake and tunnel structures will permit breakaway of the intake structure without damaging either the tunnel or its contents.

The sump beneath the intake will contain the fuel from the maximum hypothetical aircraft incident. The sump is equipped with automatically controlled pumps which discharge into the yard drainage system. The entire length of the tunnel is equipped with floor drains which drain to the sump. The sump pumps are sized to remove water at the rate it may enter from all fire protection equipment.

The curtain wall over the sump shields the tunnel from possible entry of solid projectiles from the intake. The 3 ft thick reinforced concrete tunnel roof is covered with 8 ft of compacted soil. This construction renders the tunnel impregnable against the maximum anticipated projectile of the hypothetical aircraft incident.

Under normal operating conditions the air will flow through the tunnel at the maximum velocity of 16 ft/sec. The tunnel is about 210 ft long from the curtain wall at the inlet to the fire dampers. Thus, an airborne particle at the curtain wall could reach the fire dampers in no less than 13 seconds. The fire dampers are Class A, 3 hour fire rating, off-center hinged pivot type (trap door), actuated by either of two explosion proof solenoid air valves and release mechanisms. The fire dampers are gravity actuated to fall freely to their closed position. This closing would require approximately 1 second following the release impulse. Since the dampers close with the air flow directions, this period of time would be lessened when air is flowing normally.

The air intake structure and tunnel automatic fire protection systems are zoned. The first zone extends from the screened inlets to the bottom of the sump. The second zone comprises the tunnel space immediately inside the curtain wall. The balance of the tunnel to the fire dampers makes up the third zone.

Fire protection equipment in the first zone will normally protect the integrity of this air intake. However, in the extreme event of the maximum hypothetical aircraft incident, the first zone would be demolished and the protective equipment rendered ineffectual. In such case, the equipment in the second zone would become the first line of defense against the fire hazards. Equipment in the third zone would then provide the desired redundancy to back up the second zone equipment.

Two different types of fire protection are installed in each of the three zones. One type is the halogenated extinguishing agent system consisting of Halon 1301 gas stored under pressure in liquid form. When actuated, the gas is released through distribution manifolds to disperse a 5 percent mixture with the air. This mixture renders all matter in the treated space non-combustible. Because of the gaseous and, therefore, fleeting nature of this protective system, it is actuated only when embryonic explosion is detected in the protected zone. Its speed of response is such that the embryonic explosion is extinguished before it can reach destructive proportion. The Halon system reacts to suppress an explosion and pressure buildup. Total reaction time from introduction of triggering to start of full flow of the Halon does not exceed 250 milliseconds. The fire damper would not be subjected to a differential pressure during the suppression period since the damper closing would not have been completed.

The other type of fire protection is the deluge water spray system, consisting of fixed open spray heads connected normally dry to the release valve. When actuated by a temperature detector or a Halon system actuation, each deluge release valve permits water from the yard fire main to flow through the spray heads. As a secondary benefit, this spray action washes contaminants from the air following the initial suppression of the explosion by the Halon.

Identification of hazard detectors and the protective devices they actuate is tabulated in Table 9.9-1. The accelerometer is attached to the intake structure to detect its displacement.

The photocells detect the ultraviolet radiation from the flame front of an embryonic explosion. The pressure rise detectors react to the pressure wave accompanying this flame front.

Rate-of-temperature rise detectors are conventional for deluge water spray systems. Smoke and combustible vapor detectors are the ionization type.

Halon 1301 actuation indicates explosive conditions. By stopping fans and closing dampers, the discharged Halon will be contained in the area thus containing any fire as well. The deluge system activates automatically at the same time as the Halon system. Until such time as the tunnel is cleared and Halon recharged, there is no further protection available for the Halon system which discharged. Since the deluge spray systems can sustain an explosion proof atmosphere for as long as the water supply persists, this backup is provided automatically. As the water spray washes the explosive mixture from the tunnel atmosphere, it will also wash away the Halon gas.

Since the sole purpose of the Halon systems is rapid and reliable explosion suppression, and since the discharge of any one Halon system will actuate all three water deluge systems for fire control, it is only necessary to discharge one halon system at a time. Location of Halon spheres in the three zones is shown on Figure 9.9-3.

9.9.7 TESTING OF FIRE PROTECTION SYSTEMS

The testing of fire protection systems is governed by the TMI-1 Administrative Procedure 1038 which is included in the Fire Protection Program as stated in Section 9.9.2.

TABLE 9.9-1
(Sheet 1 of 1)
AIR INTAKE TUNNEL PROTECTIVE DEVICES

	Stop Fans	Deluge	Halon						
Detectors	In Zone	Alarm Indicates	Close Dampers	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3
Accelerometer	1	x	x						
Photocell	1	x	x				x		
Photocell	2	x	x					x	
Photocell	3	x	x						x
Pressure Rise	1	x	x				x		
Pressure Rise	2	x	x					x	
Pressure Rise	3	x	x						x
Temperature Rise	1	x	x	x	x	x			
Temperature Rise	2	x	x	x	x	x			
Temperature Rise	3	x	x	x	x	x			
Smoke	1	x	x						
Smoke	2	x	x						
Smoke	3	x	x						
Combustible Vapor	1	x	x						
Combustible Vapor	2	x	x						
Combustible Vapor	3	x	x						
Remote Manual	-		x						
Remote Manual	1			x					
Remote Manual	2				x				
Remote Manual	3					x			
Halon 1301 Actuates	1			x	x	x			
Halon 1301 Actuates	2			x	x	x			
Halon 1301 Actuates	3			x	x	x			

9.10 AUXILIARY SYSTEMS

9.10.1 INSTRUMENT AND CONTROL AIR SYSTEM

9.10.1.1 Design Bases

The function of the Instrument and Control Air System is to continuously deliver clean, dry air at 100 psig (-40°F dewpoint, filtered to 0.9 micron) in sufficient quantities to points throughout the plant where instrument quality air is required.

One compressor can supply all the instrument quality air required for normal plant operation. Instrument quality air is not required by the engineered safeguards systems.

9.10.1.2 System Description And Evaluation

Although the system is not required by the engineered safeguards systems, it has been designed to provide a highly reliable supply of air during normal plant operation. Critical EFW, MS and RBEC components have an independent air supply as described in section 9.10.3.

a. In addition to the primary BOP instrument air train (instrument air compressor after cooler, receiver and air dryer) located in the Turbine bldg, two instrument air compressors, after coolers and receivers, and their common air dryer are located in the tornado and aircraft protected Intermediate Building. These instrument air compressors (IA-P-1AIB) can be manually loaded onto the emergency diesel generator supplied buses from the Control Room.

b. Equipment supports for the Instrument Air compressors, after coolers, receivers, and dryer in the Intermediate Building are designed to structurally withstand seismic conditions.

c. The instrument air system is provided for with additional backup from the plant service air system. Two lubricated plant service air compressors, SA-P-1 A/B can supply the instrument air system automatically through an oil removal filter and then through the IA dryer IA-Q-1 to provide dry air to the plant.

d. Additional backup instrument air compressors IA-P-2 A/B will automatically supply un-dried air through distribution piping independent of the normal IA system headers to key secondary plant components necessary to maintain the use of the main condenser and main feedwater.

e. The instrument air distribution system piping in the Seismic Class I structures (Auxiliary Building, Intermediate Building) as shown in Drawing 302271, is Anti-Falldown as per Reg. Guide 1.29.

f. The air piping associated with containment isolation and accumulators required to maintain an air operated safety related valve in the safety position are Seismic Class I.

g. Non-seismic piping to the Turbine and Intermediate Buildings, as shown in Drawing 302271, is arranged to be isolated from the balance of the system in the event of loss of integrity. This is accomplished when the isolation valve (IA- V-26) closes on low downstream pressure. This interlock can be overridden to initially pressurize the system.

h. All pressure vessels are designed in accordance with the ASME codes for Unfired Pressure Vessels.

9.10.2 NUCLEAR PLANT HYDROGEN AND NITROGEN SUPPLY SYSTEM

9.10.2.1 Design Bases

The purpose of the hydrogen supply system is to furnish a supply of prepurified grade hydrogen gas at 50 psig to the Makeup and Purification System as required. This hydrogen is used as an overpressure gas in the makeup tank and is dissolved in the reactor coolant to act as a scavenger for free oxygen during reactor operation.

The nitrogen supply system furnishes nitrogen gas at various pressures to several reactor plant systems. Nitrogen, an inert gas, is used as a cover gas in tanks, a source of pressurization, and a flushing agent.

9.10.2.2 System Description And Evaluation

The piping flow diagram for the nuclear plant hydrogen and nitrogen supply system is shown on Drawing 302720.

Prepurified grade hydrogen is furnished directly to the makeup tank from isolated pressurized cylinders.

The high pressure storage cylinder pressure is regulated to a delivery low pressure hydrogen as required by the makeup tank.

The nitrogen supply system has two separate isolated sources of nitrogen. The backup supply is three separate banks of high purity nitrogen in high-pressure storage cylinders. The normal source is provided by two independent banks of high-pressure nitrogen cylinders and a low-pressure liquid nitrogen tank connected into common manifolds serving both sources.

The nitrogen supply system is divided into three separate sections consisting of backup storage cylinders, regulators, manifolds, and shutoff valves.

Manifold N1, with backup nitrogen from a cylinder storage bank supplies the following users at the stated pressures:

a. Makeup tank, cover gas (100 psig).

b. Chemical Addition System, assist water in breaking loose and flushing resins from the demineralizers; a cover gas in the reclaimed water storage tank and reclaimed water pressure tank; and the reclaimed water storage tank level bubbler (20 psig).

c. Liquid Waste Disposal System, level indicator bubbler in the reactor coolant waste tank (20 psig).

d. Waste Gas System, entire header and cover gas in the reactor coolant bleed tanks (20 psig), waste storage tank (20 psig), and waste gas compressors (100 psig).

Manifold N2, with backup nitrogen from a cylinder storage bank supplies the following users at the stated pressures:

a. Penetration pressurization system, supply pressure of 100 psig to all electrical penetrations in the containment vessel and as a backup pressurization for all mechanical penetrations.

Manifold N3, with backup nitrogen from a cylinder storage bank supplies the following users at the stated pressures:

a. Core Flooding System, pressurize the core flooding tanks to 600 psig for initial plant startup, maintenance of pressure against leakages during plant operation and whenever the core flooding tanks must be repressurized (600 psig).

b. Reactor Coolant System, cover gas blanketing both the primary and secondary sides of the steam generators when the reactor is shut down, and the control rod drives and pressurizer as necessary during a plant shutdown (100 psig).

The types of operations requiring large quantities of nitrogen include initial pressurization of the core flooding tanks (600 psig), and purging of the steam generators (600 psig), pressurizer (600 psig), waste storage tank (20 psig), and reactor coolant bleed tanks (20 psig).

9.10.3 TWO-HOUR BACKUP AIR SUPPLY

9.10.3.1 Design Bases

The function of the system is to provide compressed air for operation of components within the Main Steam and Emergency Feedwater Systems for a period of 2 hours without the availability of the plant instrument air compressors. The components that are supplied by this system are valves EF-V30A, EF-V30B, EF-V30C, EF-V30D, MS-V6, MS-V4A, MS-V4B and RR-V-6 along with the positioners and electric-to-pneumatic signal converters associated with these valves. The system is designed to permit uninterrupted valve operation for the valves for a period of 2 hours. The 2 hour Backup Air System is schematically shown on Drawing 302273.

9.10.3.2 System Description And Evaluation

This system is required because the plant instrument air compressors (IA-P1A/B and IA-P-4) and backup air compressors (IA-P2A/B) are not qualified for seismic events or for a postulated high-energy line break in the Intermediate Building (the area where these compressors are installed). Compressors IA-P1A/B and IA-P-4 are not automatically provided power from the emergency diesel generators, and compressors IA-P2A/B do not have sufficient capacity to meet the air demand imposed by the emergency feedwater and main steam valves and associated components and do not supply air with a sufficiently low moisture content.

This system mitigates the loss of instrument air as a result of a design basis situation such as high energy line break, loss of offsite power, station blackout, or seismic event that could preclude reactor decay heat removal via the Emergency Feedwater and Main Steam Systems.

This system will function to supply instrument quality air to the Emergency Feedwater, Main Steam and Reactor Building Emergency Cooling Water Systems' air operated devices for a minimum of 2 hours, assuming loss of all AC power sources (Station Blackout), except the uninterruptible (battery backed) power sources, and consequently loss of the plant air system compressors.

The 2 hour backup air system does not interfere with operation of the Instrument Air System. This system will serve as a backup compressed- air source. The primary source of compressed air supply to the air operated devices in the Emergency Feedwater, Main Steam and Reactor Building Emergency Cooling Water Systems will be from the plant Instrument Air System.

Upon reduction in the primary supply pressure to 60 psig coincident with a loss of offsite power, the 2 hour backup air source will be automatically cut in and become the source of motive air for the Emergency Feedwater, Main Steam and Reactor Building Emergency Cooling Water Systems' components. The automatic switchover from the primary to the backup air system will be performed by air operated switching valves.

The compressed air supply will be of a moisture and particulate content equal to or better than that provided by the plant Instrument Air System.

Valves, Instrumentation racks, and associated piping and pipe supports are seismically designed and analyzed in accordance with the requirements of seismic Class I. Additionally, where applicable portions of the system are supported to preclude pipe whip or jet impingement loads in addition to seismic forces. Seismically qualified manual isolation valves separating the two air banks are maintained in the closed position to ensure system redundancy and thereby satisfy single failure criteria.

The system design pressure is 2500 psig for the portion of the system up to and including the regulating valve, and 150 psig for the rest of the system.

The system design meets single failure criteria. Compressed air for the system will be supplied from high pressure gas storage cylinders (bottles) connected by a manifold to form a supply station. Supply gas pressure is reduced to Instrument Air System operating pressure by a gas pressure regulator located at the gas supply station. Overpressure protection is provided downstream of the gas supply regulator to protect against regulator failure.

All components, to the extent possible, are located in a non-hostile environment. The bottle and valve manifold, including regulating and relief valves, is located in the Emergency Diesel Generator Room. All components, hardware, tubing, and so forth that are required to be functional during a high energy line break (HELB) and that are located in a HELB area are qualified for the HELB environmental conditions at the location of their installation.

The moderate energy portions of the two trains are separated such that a failure of one train will not jeopardize the operation of the other train. Provisions are made in the high pressure gas line downstream of the high pressure storage bottles to accept high pressure air/gas for charging, via a charging air compressor, tanker truck or equivalent. Normal makeup to the 2 hour air system is through the charging compressor IA-P-3.

The system consists of two trains: Train A serves EF-V30A, EF-V-30C, RR-V-6 and MS-V-4A and Train B serves EF-V-30B EF-V-30D and MS-V4B. MS-V6 is supplied from the "A" Train of 2 hour air, if desired the "B" Train may also be utilized as supply to MS-V6 by opening a manual valve.

9.11 REFERENCES

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2. TMI-1 Fire Hazards Analysis Report.
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4. Appendix A to Branch Technical Position APCSB 9-5-1 "Guidelines for Fire Protection for Nuclear Power Plants Docketed prior to July 1, 1976".
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7. TMI Unit 1 STP 141/19, Rev 0.
8. Holtec International Report No. HI-91671, "Criticality Safety Evaluation of Three Mile Island Unit 1 Fuel Storage Facilities with Fuel of 5% Enrichment", Revision 3, dated August 10, 1992, transmitted to the NRC by GPUN letter No. C311-92-2053, dated August 25, 1992, and NRC SER, Docket No. 50-289, "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment No. 170 to Facility Operating License No. DPR-50."
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10. Holtec International Report No. HI-89407, Licensing Report for Pool A Reracking, Revision 6, dated October 30, 1990 and NRC SER, Docket No. 50-289, "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment No. 164 to Facility Operating License No. DPR-50."
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19. Technical Evaluation 2705855-08, Integrity of Fire Sprinkler Piping in Control Building, Fuel Handling Building and Auxiliary Building after SSE.

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21. Technical Evaluation 620316, Integrity of Fire Sprinkler Piping in ISPH after SSE.

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