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# 9. AUXILIARY AND EMERGENCY SYSTEMS



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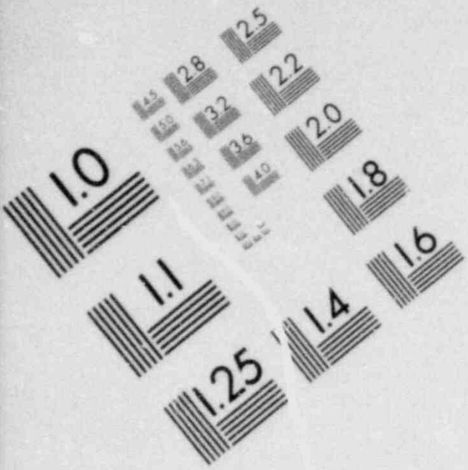
IMAGE EVALUATION
TEST TARGET (MT-3)

6"

MICROCOPY RESOLUTION TEST CHART



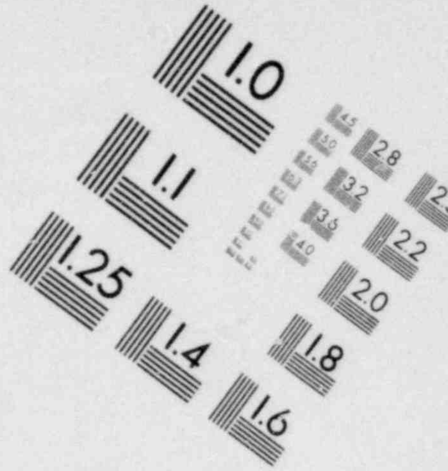
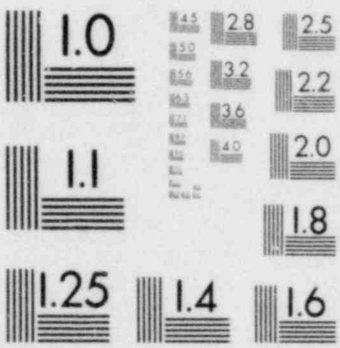
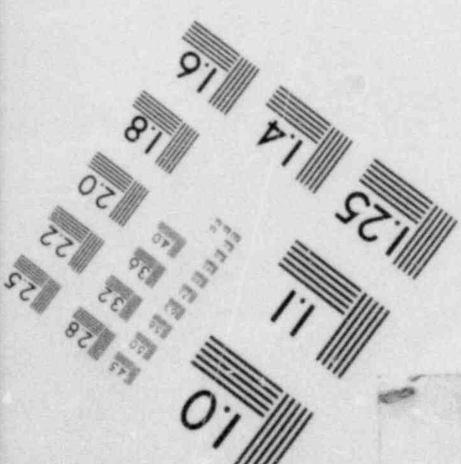


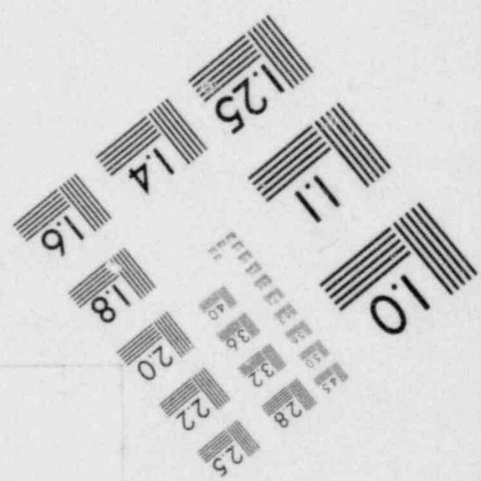
IMAGE EVALUATION
TEST TARGET (MT-3)




6"

MICROCOPY RESOLUTION TEST CHART





## LIST OF TABLES



## LIST OF FIGURES

## 9. AUXILIARY AND EMERGENCY SYSTEMS

The auxiliary systems required to support the reactor coolant system during normal operation of Rancho Seco Nuclear Generating Station Unit 1 are described in the following sections and listed below.

a. Makeup and Purification System

b. Chemical Addition and Sampling System

c. Cooling Water Systems

d. Spent Fuel Cooling System

e. Decay Heat Removal System 3

f. Fuel Handling System

g. Heating, Ventilating and Air Conditioning Systems

Some of these systems are described in detail in Section 6 since they serve as engineered safeguards. The information in this section deals primarily with the functions served during normal operation.

Most of the components within these systems are located within the auxiliary building. Those systems with connecting piping between the reactor building and the auxiliary building are equipped with reactor building isolation valves as described in 5.6.

The codes and standards used, as applicable, in the design, fabrication, and testing of components, valves, and piping are as follows.

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

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

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

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

e. AWWA Specification for Welded Steel Pipe.

f. ACI Standards for Reinforced Concrete.

g. Standards of the American Society of Testing Materials.

h. USASI, B31.1, Section I (Power Piping).

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i. USASI C50.20-1954 Test Code for Polyphase Induction Motors and Generators.

j. USASI, C50.2-1955 for Alternating Current Motors, Induction Machines, and General and Universal Motors.

k. Standards of the American Institute of Electrical and Electronics Engineers.

l. Standards of the National Electrical Manufacturers Association.

m. Hydraulic Institute Standards.

n. Heating, Ventilating, and Air Conditioning Guide: American Society of Heating, Refrigerating, and Air Conditioning Engineers.

o. Standards of Tubular Exchanger Manufacturers Association.

p. Air Moving and Conditioning Association.

q. USASI, B96.1, Aluminum Tanks.

r. Valves and piping, will be designed and fabricated to meet the requirements of USASI B16.5 or MSS SP-66 and USASI B31.1, respectively.

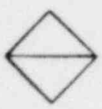
s. The pressure-containing parts of all pumps of stainless steel material will be liquid penetrant-examined in accordance with Appendix VIII of Section VIII of the ASME Code. The pressure containing welds of all engineered safeguards pumps will be radiographically examined in accordance with paragraph UW51 of Section VIII of the ASME Code.

As an aid to review of the system drawings, a standards set of symbols and abbreviations has been used and is summarized in Figure 9.0-1

## ABBREVIATIONS

| | |
|---|---|
| ES | ENGINEERED SAFEGUARD SIGNAL |
| D | DRAIN |
| DW | DEMINERALIZED WATER |
| G | GAS ANALYZER |
| $H_2$ | HYDROGEN |
| $N_2$ | NITROGEN |
| S | SAMPLING |
| VH | VENT HEADER |
| V | VENT |
| FDW | FEEDWATER |

## INSTRUMENTATION SYMBOLS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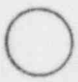
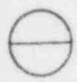

LOCALLY MOUNTED

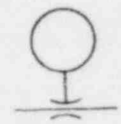

CONTROL ROOM MOUNTED

| 1st LETTER | | 2nd THRU 5th LETTER | |
|---|---|---|---|
| F | FLOW | A | ALARM |
| L | LEVEL | C | CONTROLLER |
| P | PRESSURE | I | INDICATOR |
| R | RADIATION | R | RECORDER |
| T | TEMPERATURE | S | SWITCH |
| | | Z | INTEGRATOR |

## SYSTEM ABBREVIATIONS

| | |
|---|---|
| CA | CHEMICAL ADDITION AND SAMPLING |
| DH | DECAY HEAT REMOVAL |
| CC | COMPONENT COOLING |
| MU | MAKEUP AND PURIFICATION |
| RBV | REACTOR BUILDING VENTILATION |
| RBS | REACTOR BUILDING SPRAY |
| RC | REACTOR COOLANT |
| SF | SPENT FUEL COOLING |
| WD | WASTE DISPOSAL |
| CF | CORE FLOODING |
| SP | SECONDARY PLANT |
| CW | PLANT COOLING WATER |
| CCW | CIRCULATING COOLING WATER |
| DW | DEMINERALIZED WATER |
| NS | NUCLEAR SERVICE COOLING WATER |

## FLOW DEVICES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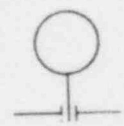
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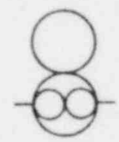
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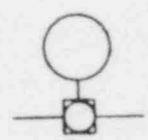
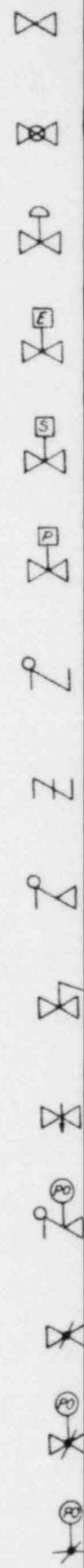

IN-LINE DISPLACEMENT



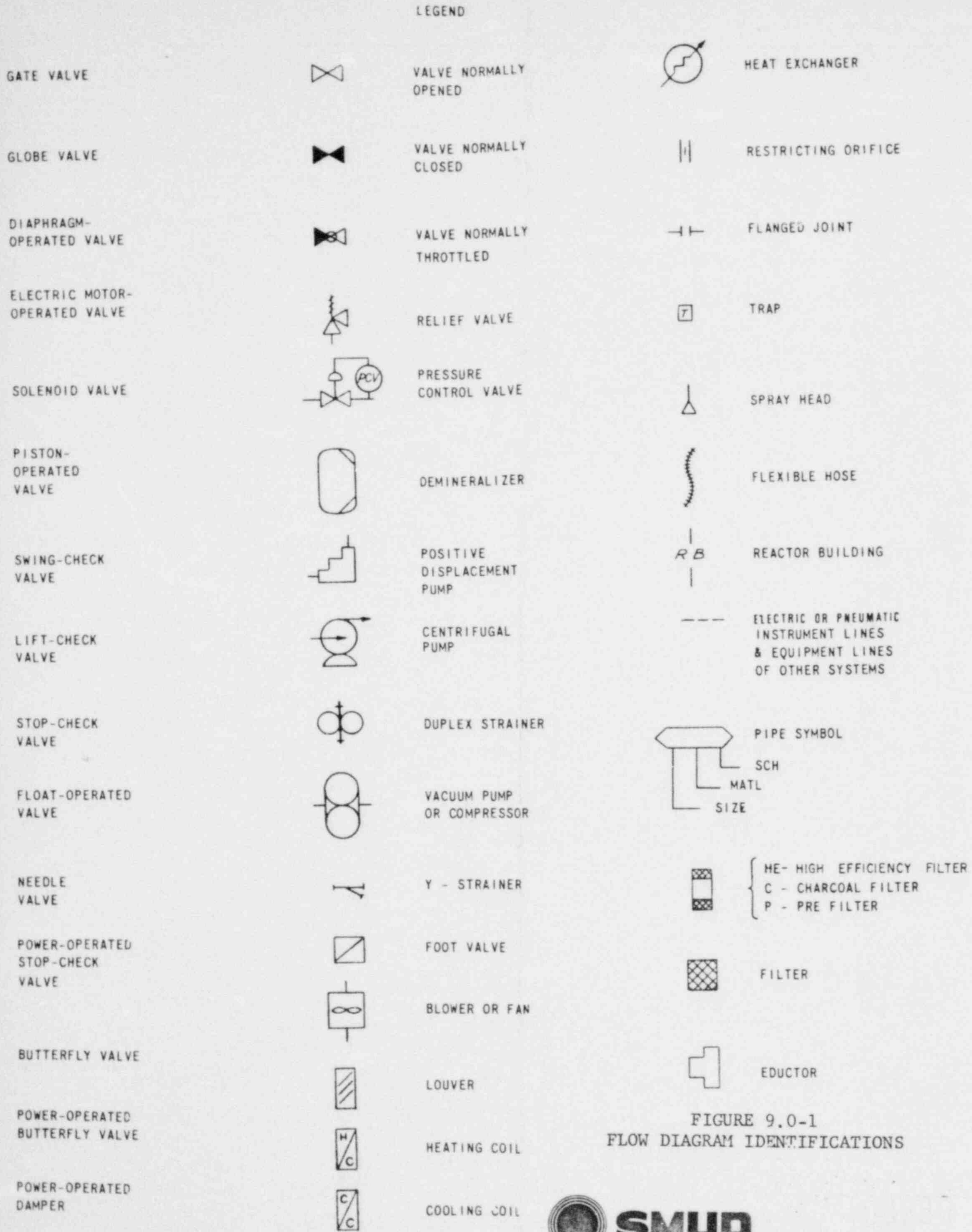



FIGURE 9.0-1
FLOW DIAGRAM IDENTIFICATIONS

## 9.1 MAKEUP AND PURIFICATION SYSTEM

### 9.1.1 DESIGN BASES

#### 9.1.1.1 General System Function

The system shown on Figure 9.1-1 supplies the reactor coolant system with fill and operational makeup water; circulates seal water for the reactor coolant pumps and control rod drives; receives, purifies, and recirculates reactor coolant system letdown to provide water quality and reactor coolant boric acid concentration control; and accommodates temporary changes in the required reactor coolant inventory.

#### 9.1.1.2 Letdown Coolers

The letdown coolers cool the letdown flow from reactor coolant temperature to a temperature suitable for demineralization and injection to the reactor coolant pump seals and control rod drive seals. The maximum letdown flow for reactor coolant boron control is required for a startup from a cold condition late in core life wherein the reactor coolant boron concentration is reduced by an amount corresponding to the change due to moderator temperature reactivity deficit. Heat in the letdown coolers is rejected to the component cooling water system.

#### 9.1.1.3 Letdown Control

The letdown control orifice is sized for the normal letdown rate for purification. The letdown control orifice and control valve together are sized for the letdown rate required when heating the reactor coolant system at the maximum rate during plant heatup.

#### 9.1.1.4 Purification Demineralizer

The letdown flow is passed through the purification demineralizer to remove reactor coolant impurities other than boron. The purification letdown flow to maintain the reactor coolant water quality is equal to one reactor coolant volume per 24 hours. Each purification demineralizer is sized for the maximum letdown flow rate as required for boron concentration control. Refer to Table 11.1-3 for the maximum anticipated equilibrium fission product accumulation in the reactor coolant.

#### 9.1.1.5 Makeup Pumps

Each makeup pump is designed to return the letdown flow to the reactor coolant system and supply the seal water flow to the reactor coolant pumps and the control rod drives. The design flow capacity is equal to the 2

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maximum makeup flow plus the seal water flow to the reactor coolant pumps
2 and the control rod drives. Each pump is sized to meet these requirements. Two additional makeup pumps each of identical size and capacity, are also supplied. Two of the three makeup pumps are available for high pressure coolant injection during accident conditions.

#### 9.1.1.6 Seal Return Coolers

The seal return coolers are sized to remove the heat added by the makeup pumps and the heat picked up in passage through the reactor coolant pump seals and the control rod drive seals. Heat from these coolers is rejected to the component cooling water system.

#### 9.1.1.7 Makeup Tank

This tank serves as a surge vessel for the makeup pumps and as a receiver for the letdown flow, chemical addition, and outside makeup; it also accommodates temporary changes in reactor coolant system volume. The volume of the tank is such that the useful tank volume is equal to the maximum expected expansion and contraction of the reactor coolant system during power transients.

#### 9.1.1.8 Filters

The filters will prevent the entry of resin fines from the demineralizer and other particulates from the Waste Disposal System, Chemical Addition System, and the Plant demineralized water supply into the system and into the seals of the reactor coolant pumps and control rod drives.

### 9.1.2 SYSTEM DESCRIPTION AND EVALUATION

#### 9.1.2.1 Schematic Diagram

The makeup and purification system is shown on Figure 9.1-1.

#### 9.1.2.2 Performance Requirements

Tables 9.1-1 and 9.1-2 list the system performance requirements and data for individual system components.

#### 9.1.2.3 Mode of Operation

2 During normal operation of the reactor coolant system, one make-up pump continuously supplies high pressure water from the make-up tank to the seals of each of the reactor coolant pumps, to a header which supplies the seals of the control rod drives, and to a makeup line connection to one of the reactor inlet lines. The other two makeup pumps are on standby and are only used
2 when the operating make-up pump is down for maintenance. Except for this temporary make-up pump service and periodic tests, these additional pumps are reserved for emergency high pressure coolant injection.

Makeup flow to the reactor coolant system is regulated by the makeup control valve, which operates on signals from the liquid level controller of the reactor coolant system pressurizer. A control valve in the injection line to the pump seals, and in the header of the control rod drive seals, automatically maintains the desired inlet pressure to the seals. A small part of the water supplied to the seals leaks into the reactor coolant system. The remainder returns to the makeup tank after passing through one of the two seal return coolers.

Seal water inleakage to the reactor coolant system requires a continuous letdown of reactor coolant to maintain the desired coolant inventory. In addition, bleed and feed of reactor coolant are required for removal of impurities and boric acid from the reactor coolant. Reactor coolant is removed from one of the reactor inlet lines, cooled during passage through one of the letdown coolers, passed from the reactor building through reactor building isolation valves, reduced in pressure during flow through either the letdown control orifice or control valve station, and then passed through one purification demineralizer to a three-way valve which directs the coolant either to the makeup tank or to the waste disposal system.

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 waste disposal system. Boric acid removal is accomplished in the waste disposal system. The level in the makeup tank is maintained with the letdown or with demineralized water pumped from the plant demineralized water storage tank. The quantity of unborated water received is measured and limited by inline instrumentation and interlocked with shim rod position controls.

The makeup tank also receives chemicals for addition to the reactor coolant. A hydrogen overpressure maintained in the makeup tank supplies the hydrogen added to the reactor coolant. Other chemicals are injected in solution to the makeup tank.

System control is accomplished remotely from the control room with the exception of the seal return coolers. The letdown flow rate is set by remotely opening the stop valve upstream of the orifice and/or positioning the letdown 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. Diverting the letdown flow to the waste disposal system is accomplished by remote positioning of the three-way valve and the valves in the waste disposal system. The control valve in the injection line to the reactor coolant pump seals and the control rod drive seals is automatically controlled by the pressure differential controller connected to the reactor coolant system to maintain the desired inlet pressure to the seals. The pressurizer makeup control valve is automatically controlled by the pressurizer level controller. During heatup and cooldown, the reactor coolant system pressure varies from 100 to 2185 psig, and the discharge pressure of the makeup pumps remains about 2600 psig. The letdown control valve is designed for letdown flow rate control at reduced reactor coolant system pressure.

2 The makeup pumps are controlled remotely. The pumps and pump motors are designed to operate at the higher flow rates and lower discharge pressures associated with emergency operation as a high pressure injection supply. Emergency operation is discussed in detail in 6.1.

### 9.1.2.4 Reliability Considerations

2 The system has three letdown control paths in parallel (remotely operated control valve, block orifice, and manual control valve) and two, full-capacity letdown coolers to ensure the flow capability needed to adjust boric acid concentration Two full-capacity seal return coolers are supplied.

2 Three makeup pumps are supplied; any one is capable of supplying the required reactor coolant pump seal, control rod drive seal, and makeup flow. The letdown coolers, and the seal return coolers transfer heat to the component cooling water system.

### 9.1.2.5 Codes and Standards

The equipment in this system will be designed to applicable codes and standards tabulated in Section 9.

Components which are designed to the ASME Code are:

| Component | Code Section |
|---|---|
| Letdown Cooler | - ASME Section III-C |
| Seal Return Cooler | - ASME Section III-C |
| Purification Demineralizer | - ASME Section III-C |
| Makeup Tank | - ASME Section III-C |

### 9.1.2.6 System Isolation

The letdown line and the seals return line penetrate the reactor building. Both lines contain an electric motor-operated isolation valve inside and an air operated isolation valve outside the reactor building which are automatically closed with operation of the engineered safeguards.

2 Four emergency injection lines are used for injecting coolant to the reactor vessel after a loss-of-coolant accident. Check valves in the discharge of each makeup pump provide further backup for reactor building isolation if required. After use of the lines for emergency injection is discontinued, the electric motor operated valves in each line outside the reactor building are closed remotely by the control room operator.

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### 9.1.2.7 Leakage Considerations

Reactor coolant is normally let down to this system. The purification demineralizer will remove essentially 100 per cent of the ionic and solid contaminants except for boric acid, while gaseous contaminants will tend to collect in the makeup tank as the letdown flow is sprayed into the gas space of this tank.

The gas void in the makeup tank may be vented to the waste disposal system by opening a remotely operated valve in the vent line. The equipment in this system is shielded by concrete. Shielding design criteria are discussed further in Section 11.

### 9.1.2.8 Operating Conditions

The makeup tank will be maintained with a fluid inventory between 100 $ft^3$ and 500 $ft^3$. Oxygen accumulation in the tank will be less than 2 percent by volume. One letdown cooler and two makeup pumps will be functional at all times. 2

To prevent an inadvertent excessive dilution of the reactor coolant boric acid concentration, three safety measures are applied to each of the two methods of diluting, i.e., the bleed and feed method and the deborating demineralizer method. The first safety measure is a 140 gpm limitation on the maximum rate of adding demineralized water; for either dilution method, the demineralized water makeup control valve to the makeup tank is 2
automatically controlled to prevent exceeding a preset flow rate. The second safety measure is a control rod assembly position interlock which either permits or prohibits dilution depending on the control rod pattern. The third safety measure consists of closing the makeup tank makeup valves, and diverting the letdown flow through the three-way valve back to the makeup tank when the flow has integrated to a preset value. Initiation of dilution must be by the operator, and the operator can terminate dilution at any time.

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TABLE 9.1-1
MAKEUP AND PURIFICATION SYSTEM PERFORMANCE DATA

| Component | Performance Data* |
|---|---|
| 2 Letdown Flow (cold), gpm | 45-140 |
| Total Flow to Each Reactor Coolant Pump Seal, gpm | 45-50 |
| Seal Inleakage to Reactor Coolant System per Reactor Coolant Pump, gpm | 6 |
| Injection Pressure to Reactor Coolant Pump Seals at Startup, psig | 135-2235 |
| Injection Pressure to Reactor Coolant Pump Seals (normal), psig | 2235 |
| Injection Pressure to Reactor Coolant Pump Seals (maximum), psig | 2535 |
| 2 Temperature to Reactor Coolant Pump Seals, F | 125 |
| Total Flow to Each Control Rod Drive Seal, gph | 30 |
| Seal Inleakage to Reactor Coolant System per Control Rod Drive, gph | 5 |
| Injection Pressure to Control Rod Drive Seals at Startup, psig | 135-2235 |
| Injection Pressure to Control Rod Drive Seals (normal), psig | 2235 |
| Injection Pressure to Control Rod Drive Seals (maximum), psig | 2535 |
| 2 Temperature to Control Rod Drive Seals, F | 125 |
| 2 Purification Letdown Fluid Temperature, F | 120 |
| Makeup Tank Normal Operating Pressure, psig | 15 |
| Makeup Tank Volume Between Minimum and Maximum Operating Levels, $ft^3$ | 400 |
| Reactor Coolant Water Quality | See Table 9.2-2 |

* Capacities are for single components.

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TABLE 9.1-2
MAKEUP AND PURIFICATION SYSTEM EQUIPMENT DATA

| Component | Performance Data* | |
|---|---|---|
| Makeup Pump | | |
| Quantity | 3 | 2 |
| Type | Multistage centrifugal, mechanical seal | |
| Capacity | See Figure 6.1-2 | |
| Head, ft at sp. gr. = 1 | See Figure 6.1-2 | 2 |
| Motor Horsepower, hp | 700 | |
| Pump Material | SS wetted parts | |
| Design Pressure, psig | 2850 | |
| Design Temperature, F | 200 | |
| Makeup Filter | | |
| Quantity | 2 | |
| Capacity, gpm | 150 | |
| Design Pressure, psig | 150 | |
| Design Temperature, F | 200 | |
| Letdown Cooler | | |
| Quantity | 2 full-capacity | |
| Type | Shell and tube | 2 |
| Heat Transferred, Btu/hr | $16.1 \times 10^6$ | |
| Letdown Flow, lb/hr | $3.5 \times 10^4$ | |
| Letdown Temperature Change, F | 555 to 120 | 2 |
| Material, shell/tube | CS/SS | |
| Design Pressure, psig | 2500 | |
| Design Temperature, F | 600 | |
| Seal Return Cooler | | |
| Quantity | 2 full-capacity | |
| Type | Shell and tube | |
| Heat Transferred, Btu/hr | $2.2 \times 10^6$ | |
| Seal Return Flow, lb/hr | $1.025 \times 10^5$ | |
| Seal Return Temperature Change, F | 144 to 122 | 2 |
| Material, shell/tube | CS/SS | |
| Design Pressure, psig | 100 | |
| Design Temperature, F | 200 | |
| Cooling Water Flow, lb/hr | $1.025 \times 10^5$ | 2 |
| Makeup Tank | | |
| Quantity | 1 | |
| Volume, $ft^3$ | 600 | |
| Design Pressure, psig | 100 | |
| Design Temperature, F | 200 | |
| Material | SS | 2 |

* Capacities are for single components.

TABLE 9.1-2 Continued

| Component | Performance Data* |
|---|---|
| Purification Demineralizer | |
| Quantity | 2 |
| Type | Mixed bed, boric acid saturated |
| Cation:Anion Ratio | 2:1 |
| Material | SS |
| Resin Volume, $ft^3$ | 40 |
| Flow, gpm | 70 |
| Vessel Design Pressure, psig | 150 |
| Vessel Design Temperature, F | 200 |

* Capacities are for single components.

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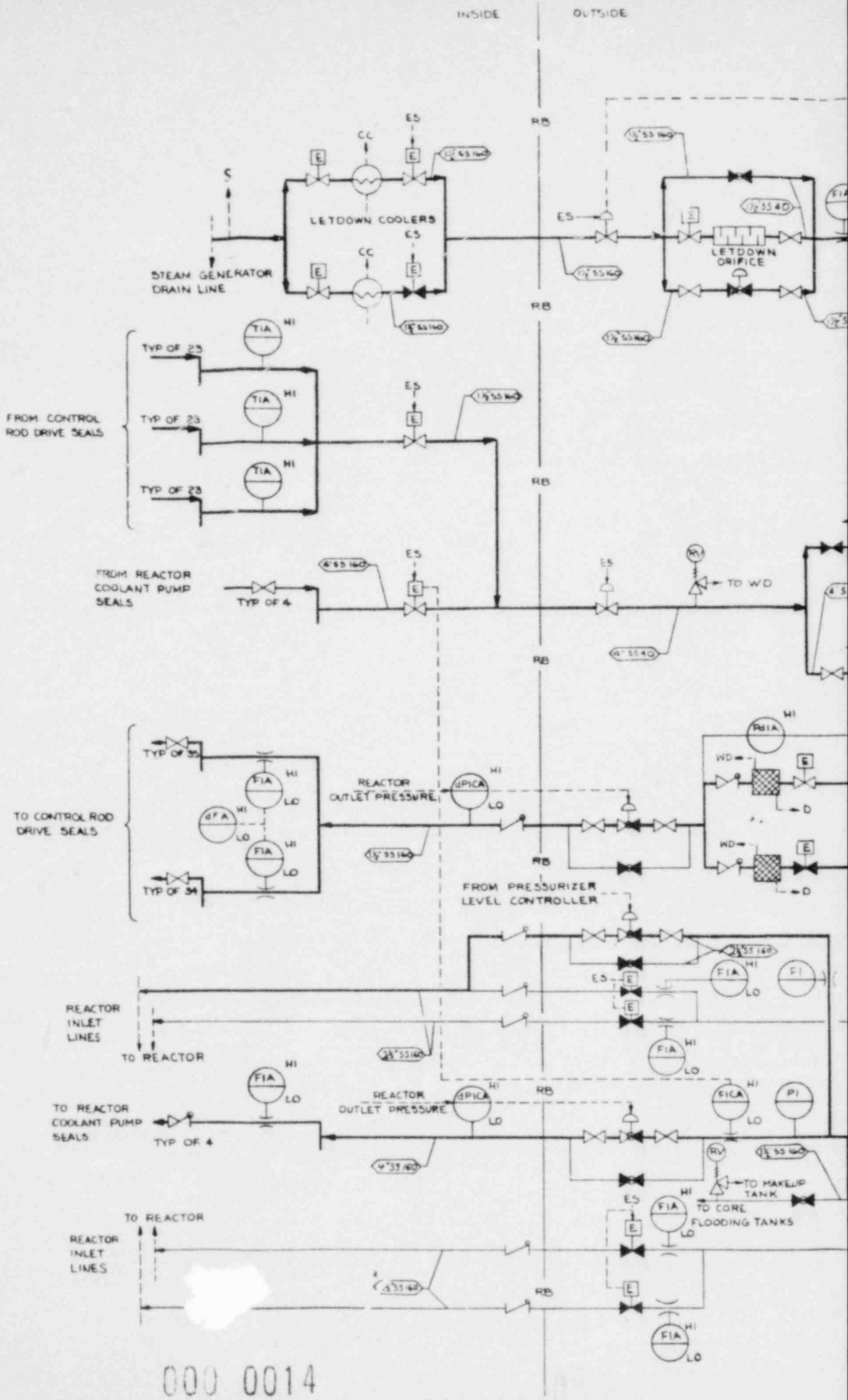
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CC
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STEAM GENERATOR
DRAIN LINE
LETDOWN
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TIA
HI
FROM REACTOR
COOLANT PUMP
SEALS
TYP OF 4
TO WD
RV
TO CONTROL ROD
DRIVE SEALS
TYP OF 35
TYP OF 34
FIA
dFA
LO
REACTOR
OUTLET PRESSURE
dPICA
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D
FROM PRESSURIZER
LEVEL CONTROLLER
REACTOR
INLET
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SEALS
FICA
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TO MAKEUP
TANK
TO CORE
FLOODING TANKS

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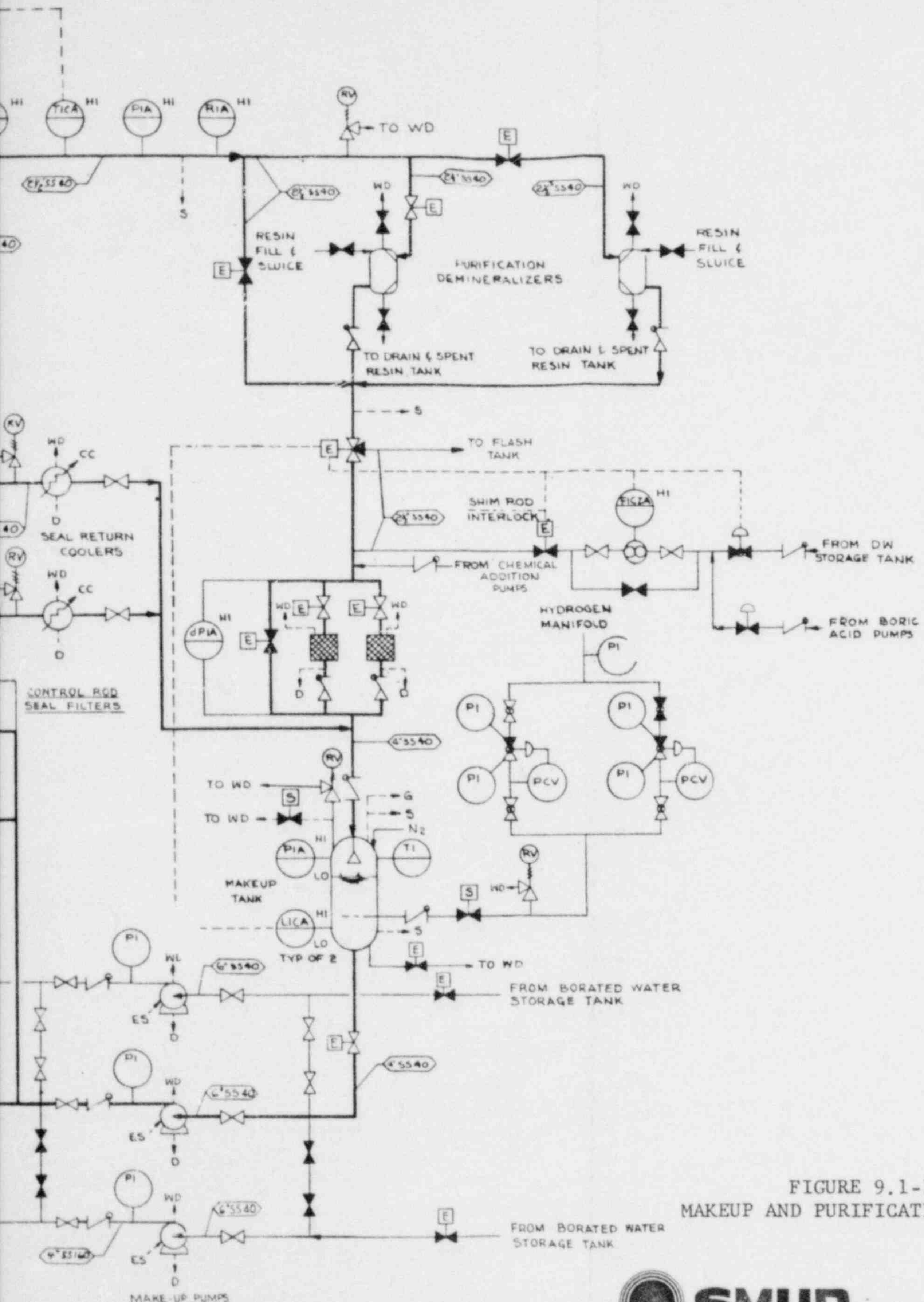


FIGURE 9.1-1
MAKEUP AND PURIFICATION SYSTEM

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SACRAMENTO MUNICIPAL UTILITY DISTRICT

## 9.2 CHEMICAL ADDITION AND SAMPLING SYSTEM

### 9.2.1 DESIGN BASES

#### 9.2.1.1 General System Function

Chemical addition and sampling operations are required to alter and monitor the concentration of various chemicals in the reactor coolant and auxiliary systems. The system shown on Figure 9.2-1 is designed to add boric acid to the reactor coolant system for reactivity control (see Table 3.2-5 and Figure 3.2-1), potassium hydroxide for pH control, and hydrogen or hydrazine for oxygen control. The system is designed to take reactor coolant samples and steam generator water samples.

#### 9.2.1.2 Boric Acid Mix Tank

A single boric acid tank is provided as a source of concentrated boric acid solution. The volume of the tank will provide sufficient boric acid solution to increase the boron concentration of the reactor coolant system to that required for cold shutdown. Heaters in the tank maintain the temperature above that required to ensure solubility of the boric acid. Transfer lines will be electrically traced.

#### 9.2.1.3 Boric Acid Pumps

Two boric acid pumps are provided to facilitate transfer of the concentrated boric acid solution from the boric acid mix tank to the borated water storage tank, the makeup tank, or the spent fuel storage pool.

The pumps are sized so that when both are operating, one complete tank volume of concentrated boric acid solution from the boric acid mix tank may be injected into the reactor coolant system in 12 hours.

#### 9.2.1.4 Chemical Addition Mix Tank

The tank volume was established to contain a sufficient amount of KOH for continual addition to the reactor coolant system so that a concentration of 3-6 ppm can be maintained while letting down at the maximum rate.

### 9.2.2 SYSTEM DESCRIPTION AND EVALUATION

#### 9.2.2.1 Schematic Diagram and System Description

Figure 9.2-1 is a schematic diagram illustrating the features of the system. The system is operated from local controls. Two boric acid pumps, connected in parallel, take suction from the boric acid mix tank and discharge to either the spent fuel storage pool, borated water storage tank, or the makeup tank. At the end of core life, both boric acid pumps are required to raise the reactor coolant system boron concentration from the minimum end-of-life concentration to the refueling concentration in approximately 12 hours. The boric acid mix tank has a mechanical mixing device and a heating unit.

The chemical addition equipment consists of a mix tank, a single positive displacement pump, and connecting piping. The pump discharges to the makeup tank.

A hydrazine drum is connected to a positive displacement pump, which discharges to a line leading to the makeup tank. A nitrogen blanket is used to displace the hydrazine as it is removed from the drums.

A nitrogen supply manifold with controls and distribution lines is used to supply a gas blanket or a gas purge for the makeup tank, core flooding tanks, hydrazine drum, liquid waste tanks, and waste gas decay tanks.

The liquid sampling portion of the system receives samples of the reactor coolant from upstream and downstream of the purification demineralizers, from upstream of the letdown coolers, from the makeup tank, and from the secondary side of the steam generators. Water qualities to be maintained are listed in Tables 9.2-1 and 9.2-2. Gaseous samples are taken from the pressurizer vapor space and from the makeup tank. Sample lines from these points are piped to a sampling cubicle outside the reactor building. Samples
2 are collected, in containers designed for full operating temperature and pressure, at flow rates of 0.66 and 1.67 gpm.

An automatic gas analyzer is used to monitor various tanks and equipment in the waste disposal system, reactor coolant system, and make-up and purification system in a continuous sequence for hydrogen-oxygen mixtures and to alarm at a preset level.

The pertinent parameters for each major component in the chemical addition and sampling system are shown in Table 9.2-3.

#### 9.2.2.2 Performance Requirements

This system permits sampling of, and chemical addition to, the reactor coolant system and the reactor auxiliary systems, during normal operation and has no active emergency function. During a loss-of-coolant accident, this system is isolated at the reactor building boundary.

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9.2.2.3 Mode of Operation

The system is capable of drawing reactor coolant samples during reactor operation and during nuclear unit cooldown when the decay heat removal system is in operation. Access to the reactor building is not required.

Sampling of other process coolant, such as process streams or tanks in the waste disposal system, is accomplished locally. Equipment for sampling non-radioactive fluids is separated from the equipment provided for reactor coolant samples. Leakage and drainage resulting from the sampling operations are collected and drained to the miscellaneous waste tank located in the waste disposal system.

During normal operation, liquid and vapor samples may be taken from the following points:

a. Liquid

(1) Steam generator secondary water

(2) Reactor coolant system pressurizer | 2

(3) Purification demineralizer inlet

(4) Purification demineralizer outlet

(5) Deborating ion exchanger outlet

(6) Makeup tank

(7) Decay heat removal pump discharge

(8) Decay heat cooler outlet (reactor coolant) | 2

b. Vapor and Gas

(1) Pressurizer

(2) Makeup tank

(3) Pressurizer relief tank

(4) Waste gas decay tank | 2

In addition, an oxygen and hydrogen analyzer automatically samples the gas spaces in the waste disposal system tanks and equipment in an automatic sequence.

000 0018

TABLE 9.2-1
STEAM GENERATOR FEEDWATER QUALITY

| | Parameter | Value |
|---|---|---|
| 2 | Total Solids (including dissolved and undissolved, ppm | 0.05 |
| 2 | Hardness, ppm | 0.0 |
| | Organic, ppm | 0.0 |
| | Maximum Dissolved Oxygen, ppm | 0.007 |
| 2 | Carbon Dioxide, ppm | 0.0 |
| | Maximum Total Silica (as $SiO_2$), ppm | 0.02 |
| 3 | Free Caustic, ppm | 0.0 |
| | Maximum Total Iron (as Fe), ppm | 0.01* |
| | Maximum Total Copper (as Cu), ppm | 0.002* |
| 2 | pH (adjusted with ammonia) | 9.3 to 9.5 |
| | Lead and heavy metals | None |

TABLE 9.2-2
REACTOR COOLANT QUALITY

| | Parameter | Value |
|---|---|---|
| 2 | Total Solids, max. (including dissolved and undissolved but excluding $H_3BO_3$) | 1.0 |
| | Boron, ppm | See Figure 3.2-1 |
| | KOH, ppm | 3-6 |
| 2 | pH at 77 F | 4.8-9.8 |
| 2 | pH at 560 F (calculated) | 6.4-7.6 |
| 2 | $O_2$ (max.), ppm | 0.01 |
| | Cl (max.), ppm | 0.1 |
| 2 | $H_2$, std cc/l | 15-40 |
| | Hydrazine (required during shutdown), ppm | 25 |

2 * Included in TS as a soluble compound.

TABLE 9.2-3
CHEMICAL ADDITION AND SAMPLING SYSTEM EQUIPMENT DATA

| Equipment | Performance Data* |
|---|---|
| Tanks | |
| Boric Acid Mix Tank | |
| Quantity | 1 |
| Type | Vertical Cylindrical |
| Volume, $ft^3$ | 1,015 2 |
| Design Pressure, psig | Atmospheric |
| Design Temperature, F | 200 |
| Material | SS |
| Chemical Addition Mix Tank | |
| Quantity | 1 |
| Type | Vertical Cylindrical |
| Volume, gal | 50 |
| Design Pressure, psig | Atmospheric |
| Design Temperature, F | 150 2 |
| Material | SS |
| Hydrazine Drum | |
| Quantity | 1 |
| Type | Std. Commercial 55 gal Drum |
| Pumps | |
| Boric Acid Pump | |
| Quantity | 2 |
| Type | Diaphragm, Variable Stroke 2 |
| Capacity, gpm | 0-10 |
| Head, psig | 75 2 |
| Design Pressure, psig | 100 |
| Design Temperature, F | 200 |
| Pump Material | SS |

* Capacities are for single components.

000 0020

TABLE 9.2-3 continued

| | Equipment | Performance Data* |
|---|---|---|
| | Chemical Addition Pump | |
| | Quantity | 1 |
| 2 | Type | Diaphragm, Variable Stroke |
| | Capacity, gph | 0-10 |
| | Head, psig | 50 |
| 2 | Design Pressure, psig | 250 |
| | Design Temperature, F | 200 |
| | Pump Material | SS |
| | Hydrazine Pump | |
| | Quantity | 1 |
| 2 | Type | Diaphragm, Variable Stroke |
| | Capacity, gph | 0-10 |
| | Head, psig | 50 |
| | Design Pressure, psig | 100 |
| | Design Temperature, F | 100 |
| | Pump Material | SS |
| | Sampling | |
| | Sampling Containers | |
| | Quantity | 10 |
| | Design Pressure, psig | 2,500 |
| | Design Temperature, F | 670 |
| 2 | Reactor Coolant Pressurized Sample Cooler | |
| | Quantity | 1 |
| 2 | Type | Double Pipe |
| | Heat Transferred, Btu/hr | $2.1 \times 10^5$ |
| 2 | Sample Flow Rate, gpm | 0.66 |
| | Max. Sample Inlet Temperature, F | 650 |
| 2 | Sample Outlet Temperature, F | 120 |
| | Cooling Water Flow, lb/hr | $5 \times 10^3$ |
| | Coil Side Design Temperature, F | 670 |
| | Coil Side Design Pressure, psig | 2,500 |

* Capacities are for single components.

000 0021

TABLE 9.2-3 continued

| Equipment | Performance Data* |
|---|---|
| Steam Generator Sample Cooler | |
| Quantity | 1 |
| Type | Double Pipe |
| Heat Transferred, Btu/hr | $2.31 \times 10^5$ |
| Sample Flow Rate, gpm | 1.67 |
| Sample Inlet Temperature, F | 535 |
| Sample Outlet Temperature, F | 100 |
| Cooling Water Flow, lb/hr | $5 \times 10^3$ |
| Coil Side Design Temperature, F | 600 |
| Coil Side Design Pressure, psig | 1,050 |

2

* Capacities are for single components.

During normal operation, this system delivers the following chemicals

a. Boric acid to the spent fuel storage pool, the borated water storage tank, and the makeup tank.

b. Potassium hydroxide to the makeup tank.

c. Hydrazine to the makeup tank.

d. Nitrogen as required for the core flooding tanks, makeup tank, hydrazine drum, and tanks and equipment in the waste disposal system.

### 9.2.2.4 Reliability Considerations

The system is not required to function during an emergency, nor is it required to take action to prevent an emergency condition. It is therefore designed to perform in accordance with standard practice of the chemical process industry with duplicate equipment such as pumps and high pressure gas regulating valves as required.

### 9.2.2.5 Codes and Standards

The equipment in this system will be designed to applicable codes and standards tabulated in Section 9. Equipment applicable to the ASME Codes are: the reactor coolant sample cooler which will be designed to ASME Section III, Class C, and the steam generator sample cooler which will be designed to ASME Section VIII.

000 0022

### 9.2.2.6 System Isolation

Isolation of this system from the reactor building is accomplished by signals from the safeguards actuation system as described in 5.6 and Section 7.

### 9.2.2.7 Leakage Considerations

Leakage of radioactive reactor coolant from this system within the reactor building will be collected in the reactor building sumps. Leakage of radioactive material from this system outside the reactor building is collected by placing the entire sampling station under a hood provided with an offgas vent to waste gas processing. Liquid leakage from the valves in the hood is drained to the miscellaneous waste tank.

The chemical addition portion of this system delivers additives to the spent fuel storage pool, the borated water storage and the makeup tank. Additives to the spent fuel storage pool are delivered above the water level. Backflow from the makeup tank to the positive displacement pumps is prevented by check valves. Backflow from a makeup tank through the hydrogen addition line is prevented by a check valve and a remote manual hydrogen addition valve.

### 9.2.2.8 Failure Considerations

To evaluate system safety, the following failures or malfunctions were assumed concurrent with a loss-of-coolant accident, and the consequences were analyzed. As a result of this evaluation, it is concluded that proper consideration has been given to plant safety in the design of the system.

| Component | Failure | Comments and Consequences |
|---|---|---|
| Pressurizer Sample | Electrically-operated sampling valve inside reactor building fails to close on ES signal. | Diaphragm-operated valve outside the reactor building will close. |
| Reactor Letdown Sample | Electrically-operated sampling valve inside reactor building fails to close on ES signal. | Same as above. |

000 0023

| Component | Failure | Comments and Consequences |
|---|---|---|
| Steam Generator Steam Sample | Diaphragm-operated sampling valve outside reactor building fails to close on ES signal. | Sample line is not connected directly to reactor coolant system, and steam generator therefore provides first barrier. |
| Sample Line From Either of the Preceding Components | Line breaks inside reactor building downstream of EMO valves. | Diaphragm-operated valves outside reactor building close on signal from ES system. 2 |

9.2.2.9 Operating Conditions

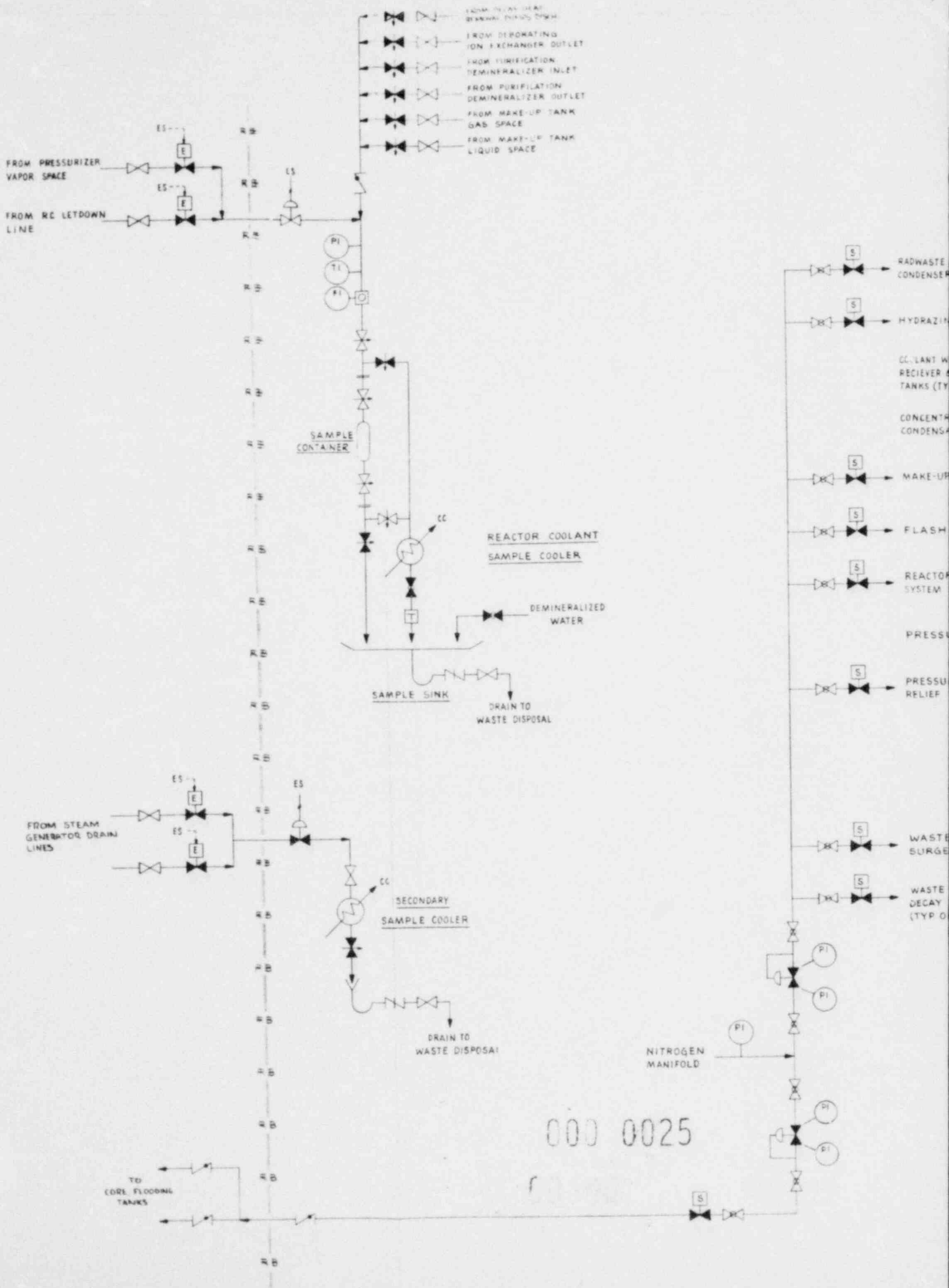
9.2.2.9.1 Boric Acid Concentration

The boric acid mix tank is to be maintained at an average temperature of 95 F to maintain a boric acid concentration of seven percent.

9.2.2.9.2 Coolant Sample Temperature

The high pressure reactor coolant samples leaving the reactor coolant sample cooler will be held to a temperature of 200 F to minimize the generation of radioactive aerosols.

000 0024


FROM DEBORATING ION EXCHANGER OUTLET
FROM PURIFICATION DEMINERALIZER INLET
FROM PURIFILATION DEMINERALIZER OUTLET
FROM MAKE-UP TANK GAS SPACE
FROM MAKE-UP TANK LIQUID SPACE
FROM PRESSURIZER VAPOR SPACE
FROM RC LETDOWN LINE
ES
E
LS
RB
PI
TI
FI
SAMPLE CONTAINER
CC
REACTOR COOLANT SAMPLE COOLER
DEMINERALIZED WATER
SAMPLE SINK
DRAIN TO WASTE DISPOSAL
FROM STEAM GENERATOR DRAIN LINES
SECONDARY SAMPLE COOLER
DRAIN TO WASTE DISPOSAI
NITROGEN MANIFOLD
TO CORE FLOODING TANKS
S
RADWASTE
HYDRAZIN
RECIEVER
FLASH
REACTOR
SYSTEM
RELIEF
WASTE
SURGE
DECAY
000 0025

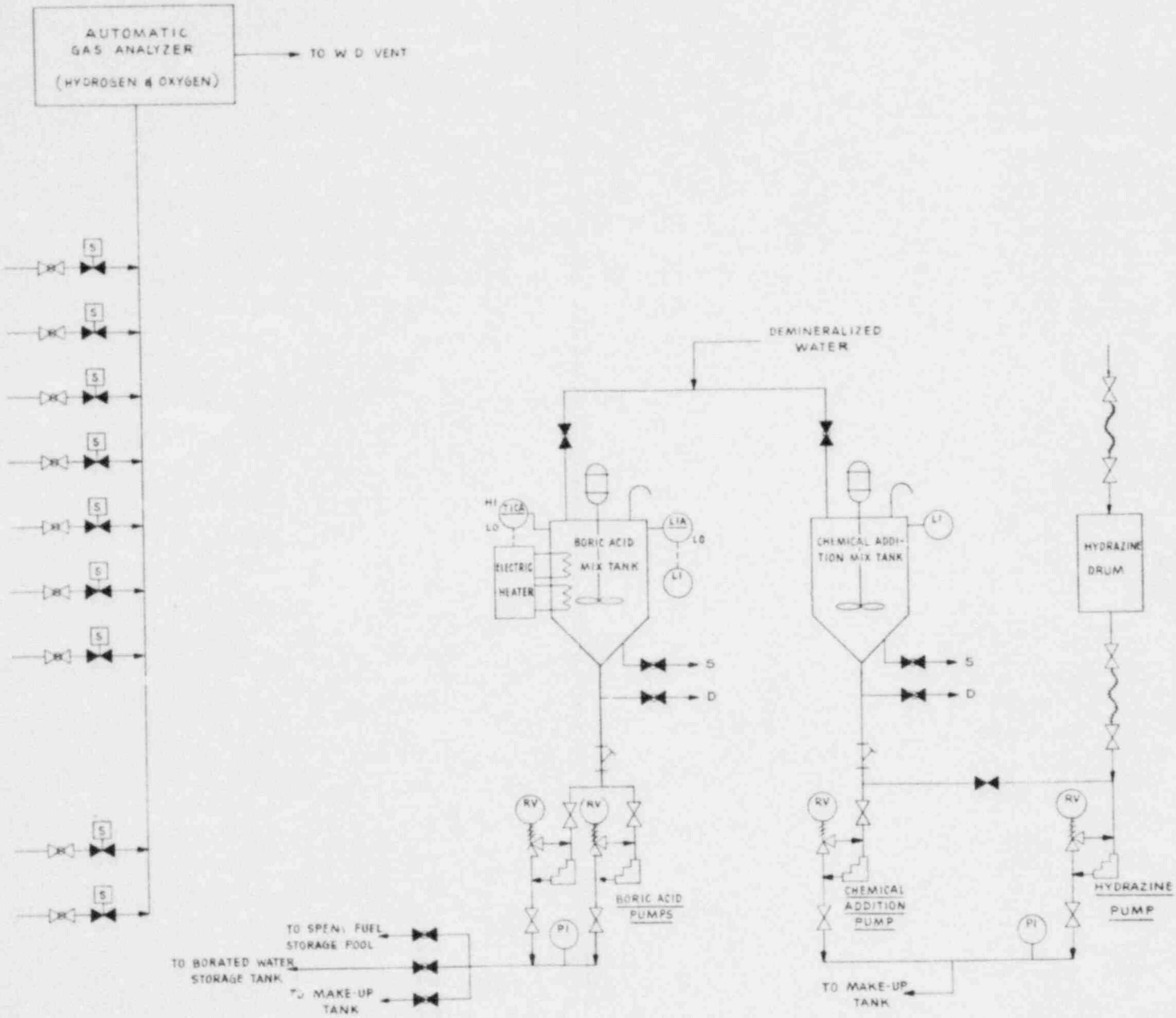



FIGURE 9.2-1
CHEMICAL ADDITION AND
SAMPLING SYSTEM

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## 9.3 COOLING WATER SYSTEMS

### 9.3.1 DESIGN BASES

The cooling water systems will have sufficient redundancy to ensure continuous heat removal from components requiring cooling.

The power plant water requirements will be supplied from a pumping station
located on the Folsom South Canal, about five miles west of the plant site.
The canal water will be used in-plant and also as make-up to the cooling 2
towers and the on-site reservoir which is located approximately one mile
east of the plant. Cooling towers will be used for cooling the condenser
circulating water. The reservoir will provide plant cooling water require-
ments and cooling tower make-up water in the unlikely event of outage of
the canal water supply system. 2

Cooling of engineered safeguards systems will be accomplished by separate nuclear service raw water and cooling water systems using two separate spray ponds as system heat sinks; one located north of the reactor building and the other east of the administration building.

Each system will be independently sized to ensure adequate heat removal
based on highest expected temperatures of cooling water and maximum loadings. 2
The equipment in these systems will be designed to applicable codes and
standards.

The cooling water systems will be designed to prevent a component failure from curtailing normal station operation. It will be possible to isolate all heat exchangers and pumps.

All system components will be hydrostatically tested prior to plant startup and excepting buried pipe will be accessible for periodic inspections during operation. All electrical components, switchgear, and starting controls will be tested periodically.

### 9.3.2 SYSTEM DESCRIPTION AND EVALUATION

#### 9.3.2.1 Condenser Circulating Water System

A cooling tower system composed of six 5-celled, induced draft cooling
towers installed on a line perpendicular to the wind during warm weather
conditions, and extending approximately 2,000 feet from the condenser
centerline will serve to dissipate the heat rejected to the circulating
water by the condenser. Figure 9.3-1 shows the arrangement of this system.
Total cooling tower losses by evaporation and drift are estimated to be
13,000 gallons per minute at maximum load. The system will be designed
for zero blowdown. Four quarter-capacity, vertical, wet pit, mixed flow 2
circulating water pumps will be installed in a common pump and screen
intake structure. Two pumps will supply each half of a cross mounted
series connected dual pressure condenser.

In order to achieve maximum flexibility of operation with a minimum of
valves, one of the divided water boxes of the low pressure condenser shell
2 will be connected to two circulating water pumps and the other box to the
second pair of pumps. The circulating water side of the high and low
pressure condensers will be series connected. Butterfly valves will be
attached to the discharge of the circulating water pumps and high pressure
condenser waterboxes. The valves on the pump discharges will be inter-
2 locked with the circulating water pump motors. In addition each pair of
pumps are interlocked together so that failure of one pump trips the
other to protect it from overloading. Thus, in the event of failure of a
pump and/or the need of plugging or cleaning of tubes in the corresponding
condenser half, 50 percent of the condensing surface will remain available.
Leaving the condenser, the circulating water will flow through pipes and
headers to the mechanical draft cooling towers. Due to the high head
2 required to deliver water to the cooling towers, the condenser water box
pressure will be approximately 35 psig.

Removable stationary screens will be installed in the intake structure and provisions will be provided to facilitate the manual washing of the screens. Chlorinating facilities for algae and slime control will be provided.

Make-up to the circulating water system will be normally provided by pumping the supply water from the Folsom South Canal through the plant cooling
water system and discharging it into the circulating water intake basin.
The pipeline from the canal will be sized for two units. Pumping facili-
ties will be provided for one unit with provision for future expansion to
accommodate additional units. In the unlikely event of canal system outage,
2 make-up will be provided from the reservoir through the plant cooling water
system.

### 9.3.2.2 Plant Cooling Water System

The plant cooling water system provides cooling to the component cooling water system, turbine plant cooling water system, main turbine lube oil coolers, and the generator hydrogen coolers. It also supplies the make-up water to the condenser circulating water system. Figure 9.3-1 shows the arrangement of this system.

The plant cooling water system receives water from either the plant canal
water supply line or the reservoir supply line. The reservoir supply line
is sized to supply the total cooling tower make-up water requirements.
This system supplies cooling water to the component cooling water and
2 turbine plant cooling water heat exchangers. Discharge from these heat
exchangers will be directed to the cooling towers for make-up. The turbine
lube oil coolers and generator hydrogen coolers will be normally cooled
by the cooling towers using the plant raw water pumps. Alternatively,
these coolers may be cooled by canal water when the cooling tower make-up
water requirement is sufficient for this purpose, such as during full load
operation in cool weather.

000 0028

The system includes two 10,000 gpm plant raw water pumps, one of which supplies water from the cooling tower intake structure and delivers it to the turbine lube oil coolers and generator hydrogen coolers. Discharge from these coolers will discharge into the circulating water return lines to the 2
cooling towers. The second pump is available as standby or may be used to pump canal water to the reservoir for make-up. Both pumps can take suction from the cooling tower intake structure or the hot water return 3
from the component cooling water and turbine plant cooling water heat exchangers. The pumps can also supply cooling water to the various heat exchangers and coolers during shut down, no load or start up conditions when cooling tower make-up is insufficient for the cooling water requirements of the component cooling water and turbine plant cooling water heat exchangers.

9.3.2.2.1 Normal Operation 2

During normal operation, two canal pumps will supply sufficient water to meet the make-up demands of the cooling towers and the cooling requirements of the component cooling water and turbine plant cooling water heat exchangers. The canal pumps will develop sufficient head to permit flow directly through the cooling system to the cooling towers. The excess make-up water may be pumped by either of the plant raw water pumps to the reservoir as make-up for seepage and natural evaporation. A level controller on the cooling tower canal will temporarily shut down a canal pump should the excess water not be required in the reservoir.

In the event water is not available from the Folsom South Canal the reservoir will serve as a source of plant cooling water and cooling tower make-up.

9.3.2.3 <u>Component Cooling Water System</u>

The component cooling system removes heat from the spent fuel pool cooler, 2
seal return coolers, letdown coolers and sample heat exchangers, reactor building normal ventilation coolers, reactor coolant pumps, reactor shield 3
cooling coils, and the radioactive waste disposal system. Cooling water flows through these units in closed loop parallel flow circuits, picks up 2
heat from the various components and flows to the component cooling heat exchanger which is cooled by the plant cooling water system. The component cooling system thus serves as an intermediate system between the reactor coolant and the plant cooling water system. This double barrier arrangement reduces the possibility of leakage of high pressure, potentially radioactive coolant to the plant cooling water system. Figure 9.3-2 shows the arrangement of this system. Water level and pressure of the component cooling water surge tank is monitored continuously in the control room with 3
both high and low level and pressure annunciation. Demineralized water make-up to the surge tank is introduced manually. Radiation detectors are located in the component cooling water system. If the radiation level of the cooling water exceeds a predetermined value, an alarm is actuated.

(Deleted) 3

000 0029

2 System components consist of two half-capacity component cooling water pumps, two half-capacity component cooling water heat exchangers, the component cooling water surge tank, and a chemical pot feeder for adding the corrosion inhibitor.

The spare turbine plant cooling water heat exchanger and pump is shared by
2 the component cooling water system and is used when one of the component cooling water heat exchangers or pumps is down for maintenance.

4 Operating pressures of the cooling systems involved are as follows: component cooling water 60 psig, plant cooling water 20 psig.

### 9.3.2.4 Turbine Plant Cooling Water System

There will be one turbine plant cooling water system to serve the secondary plant components. This closed-loop system consists of a surge tank, two
2 motor-driven pumps and two heat exchangers cooled by the plant cooling water system. Figure 9.3-3 shows the arrangement of this system.

For normal operation, one of the turbine plant cooling water pumps and one turbine plant heat exchanger will be required. The other components will serve as common spares with the component cooling water system.

Make-up to the turbine plant cooling water system is introduced manually from the demineralized water system. High and low surge tank water levels will be annunciated in the control room.

2

### 9.3.2.5 Nuclear Service Raw Water System

The nuclear service raw water system supplies water for cooling to the nuclear service cooling water heat exchanger. This system acts as a heat sink for both decay heat removal and emergency core and reactor building cooling. The system comprises of two independent systems, entirely separate
3 from each other, each consisting of a spray pond, a 15,000 gpm full-capacity nuclear service raw water pump and a full-capacity nuclear service cooling water heat exchanger. The nuclear service raw water pump takes suction from the cold well of the spray pond and discharges to the nuclear service cooling water heat exchanger, where it cools the nuclear service cooling water. The hot raw water is returned to the spray pond, where it is cooled by spraying in the air. Chemical addition and a filtering system will maintain the purity of the water.

2 Make-up to the spray ponds during normal plant operation can be from several sources; the plant canal water supply line and the reservoir water supply line, should these sources fail during emergency operation, makeup can be supplied from the cooling tower canal by means of a fire pump at the intake structure or from an on-site ground well. Figure 6.0-1 shows the arrangement of this system. During an emergency each spray pond individually contains sufficient water to provide 10 days cooling without make-up. With make-up from the non-operating pond or cooling tower canal, cooling can be provided for periods of 49 and 75 days respectively.

000 0030

#### 9.3.2.5.1 System Failure Considerations

The stored quantity of water in the spray ponds is sufficient for several weeks operation without any additional make-up. If, however, one spray pond was inoperable, it would be possible to transfer water from the inoperable pond to the operating pond by means of a small portable pump, thus supplying the operating pond's make-up requirements. In addition to the Class I spray pond structures, the cooling tower intake structure has an engine driven fire pump connected to the spray pond make-up system thus enabling either pond to use the full stored volume of the intake structure and canal. With these three volumes of stored water, safeguards operation can be extended for several months as indicated in Table 9.3-1. The average make-up requirements are low and drops quite rapidly from approximately 300 gpm during the first few hours to less than 80 gpm by the end of the third day.

### 9.3.2.6 Nuclear Service Cooling Water System 2

The nuclear service cooling water system is a closed system which supplies cooling water to the decay heat removal coolers and reactor building emergency coolers. This system absorbs the core decay heat from the decay heat removal system, and during an accident cools the reactor building atmosphere and the decay heat removal system, rejecting the absorbed heat to the nuclear service raw water system in the nuclear service cooling water heat exchanger. The system comprises of two entirely independent closed loop systems each having one 6000 gpm full capacity nuclear service cooling water pump, one full-capacity decay heat removal cooler, two quarter-capacity reactor building emergency coolers, a surge tank and a chemical mixing system for the addition of corrosion inhibitors. Failure of either system does not affect the other. The cooling water is in a closed loop system with manual demineralized water make-up to the surge tank.

Operating pressure of the cooling systems involved are as follows: nuclear service cooling water 60 psig, nuclear service raw water 20 psig. 4

000 0031

## TABLE 9.3-1
## EMERGENCY SPRAY POND MAKE-UP WATER AVAILABILITY

2

| Source | Capacity | Power Supply | Flow[a] (gpm) | Duration |
|---|---|---|---|---|
| Spray Ponds | 1,360,000[b] Gal. | None | 300 | 10.5 Days |
| | 2,930,000[c] Gal. | None | 300 | 49 Days |
| Cooling Tower Canal | 3,560,000[b] Gal. | Engine Driven Fire Pump | 300 | 75 Days |
| | 5,130,000[c] Gal. | Engine Driven Fire Pump | 300 | 139 Days |
| Reservoir | 2600 Ac Ft | Gravity | 300 | 6 Mos.[d] |
| Canal | Unlimited | Pacific Gas & Electric Co. | 300 | Unlimited |

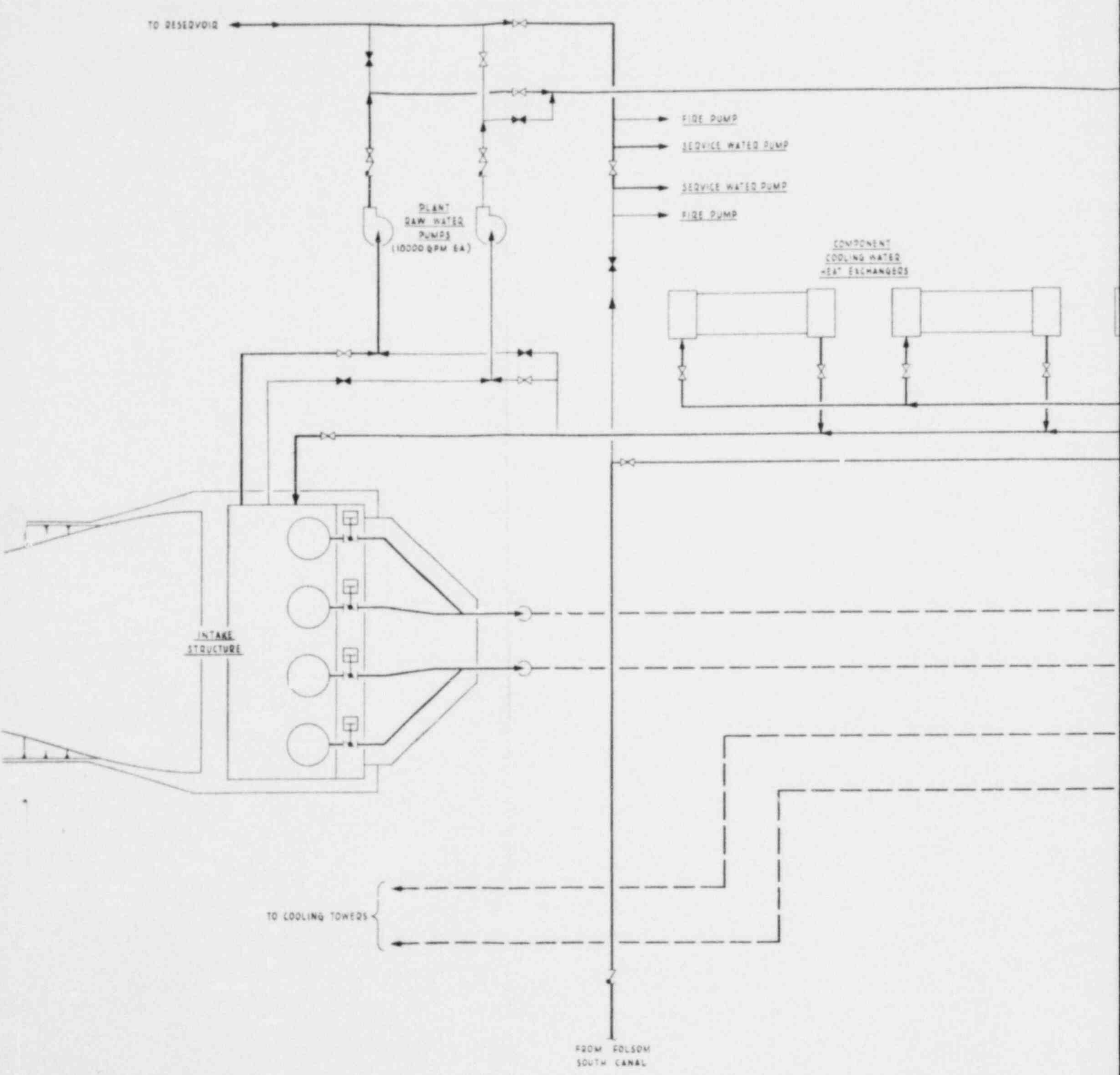
Notes:

a. Flow shown is maximum and reduces with decay heat.

b. Includes stored capacity of operating spray pond to minimum operating level.

c. Includes stored capacity of second spray pond.

d. Time shown is in addition to spray pond time and assumes other normal water uses and losses.



TO RESERVOIR
FIRE PUMP
SERVICE WATER PUMP
SERVICE WATER PUMP
FIRE PUMP
PLANT
RAW WATER
PUMPS
(10000 GPM EA)
COMPONENT
COOLING WATER
HEAT EXCHANGERS
INTAKE
STRUCTURE
TO COOLING TOWERS
FROM FOLSOM
SOUTH CANAL


000 0033

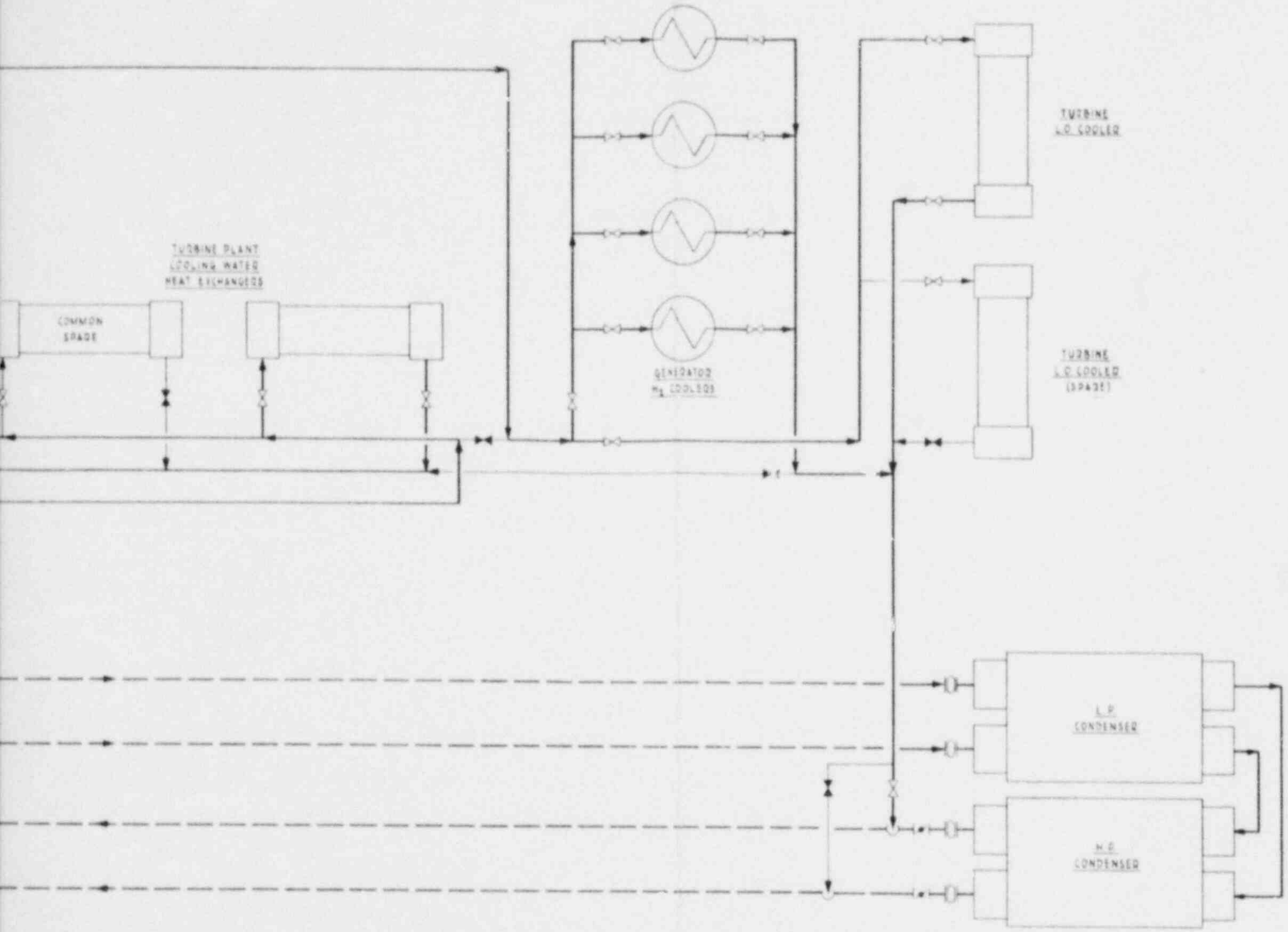



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FIGURE 9.3-1
CIRCULATING WATER AND PLANT
COOLING WATER SYSTEMS

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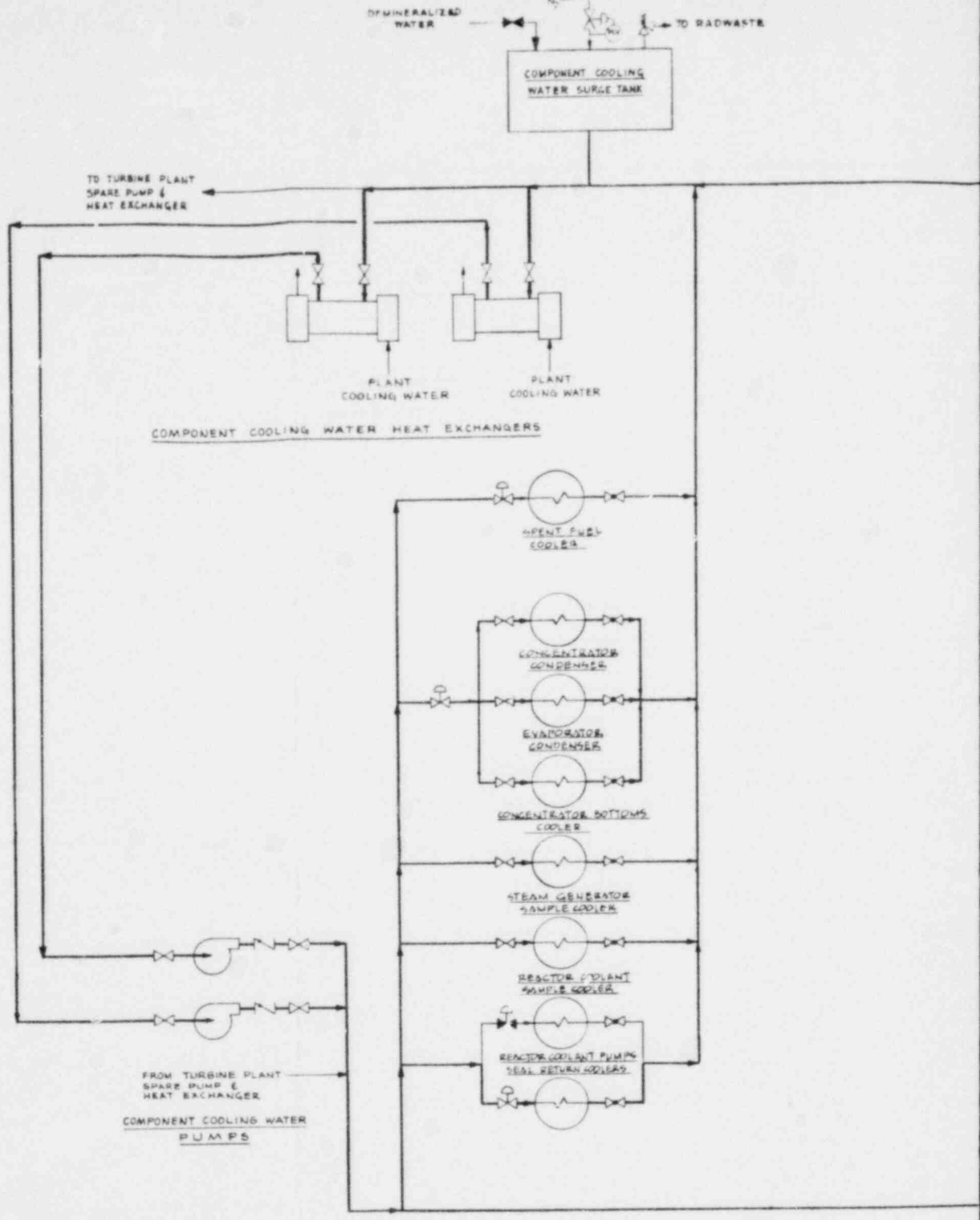
DEMINERALIZED WATER
TO RADWASTE
COMPONENT COOLING WATER SURGE TANK
TO TURBINE PLANT SPARE PUMP & HEAT EXCHANGER
PLANT COOLING WATER
PLANT COOLING WATER
COMPONENT COOLING WATER HEAT EXCHANGERS
SPENT FUEL COOLER
CONCENTRATOR CONDENSER
EVAPORATOR CONDENSER
CONCENTRATOR BOTTOMS COOLER
STEAM GENERATOR SAMPLE COOLER
REACTOR COOLANT SAMPLE COOLER
REACTOR COOLANT PUMPS SEAL RETURN COOLERS
FROM TURBINE PLANT SPARE PUMP & HEAT EXCHANGER
COMPONENT COOLING WATER PUMPS

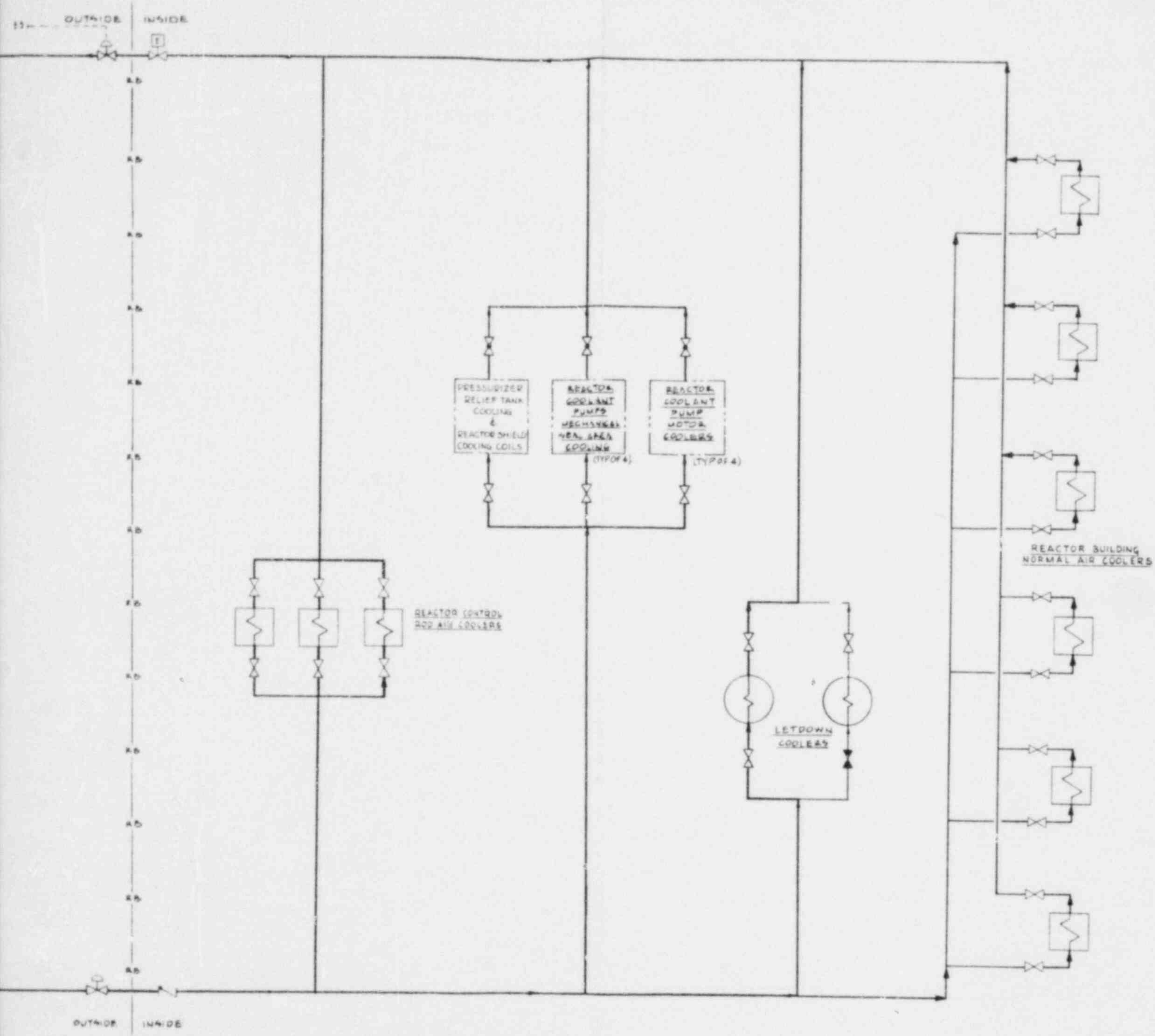


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FIGURE 9.3-2
REACTOR COMPONENTS
COOLING WATER SYSTEM

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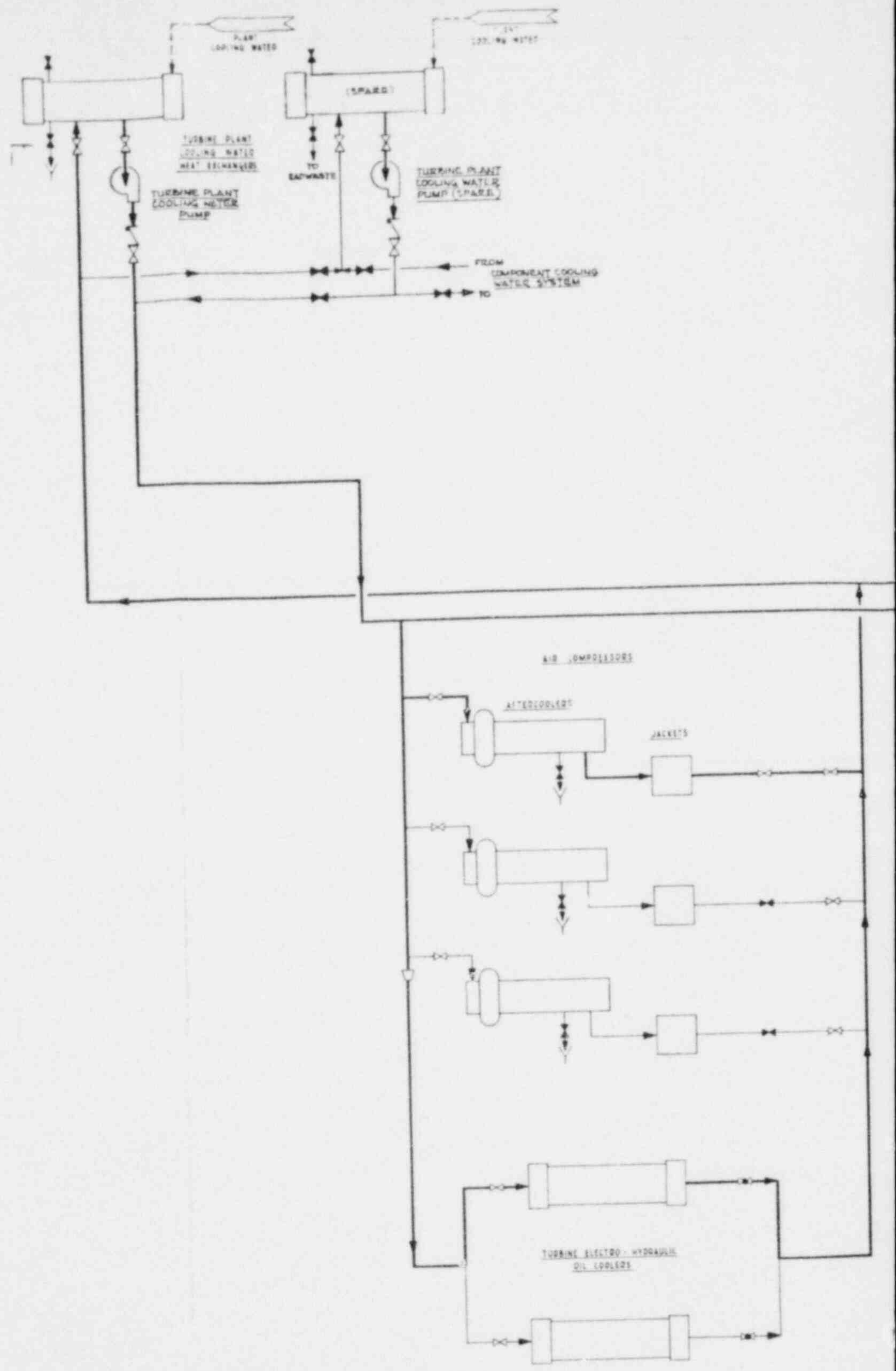
(SPARE)
TURBINE PLANT COOLING WATER HEAT EXCHANGERS
TO RADWASTE
TURBINE PLANT COOLING WATER PUMP
TURBINE PLANT COOLING WATER PUMP (SPARE)
FROM
COMPONENT COOLING WATER SYSTEM
TO
AIR COMPRESSORS
AFTERCOOLERS
JACKETS
TURBINE ELECTRO - HYDRAULIC OIL COOLERS

000 0037

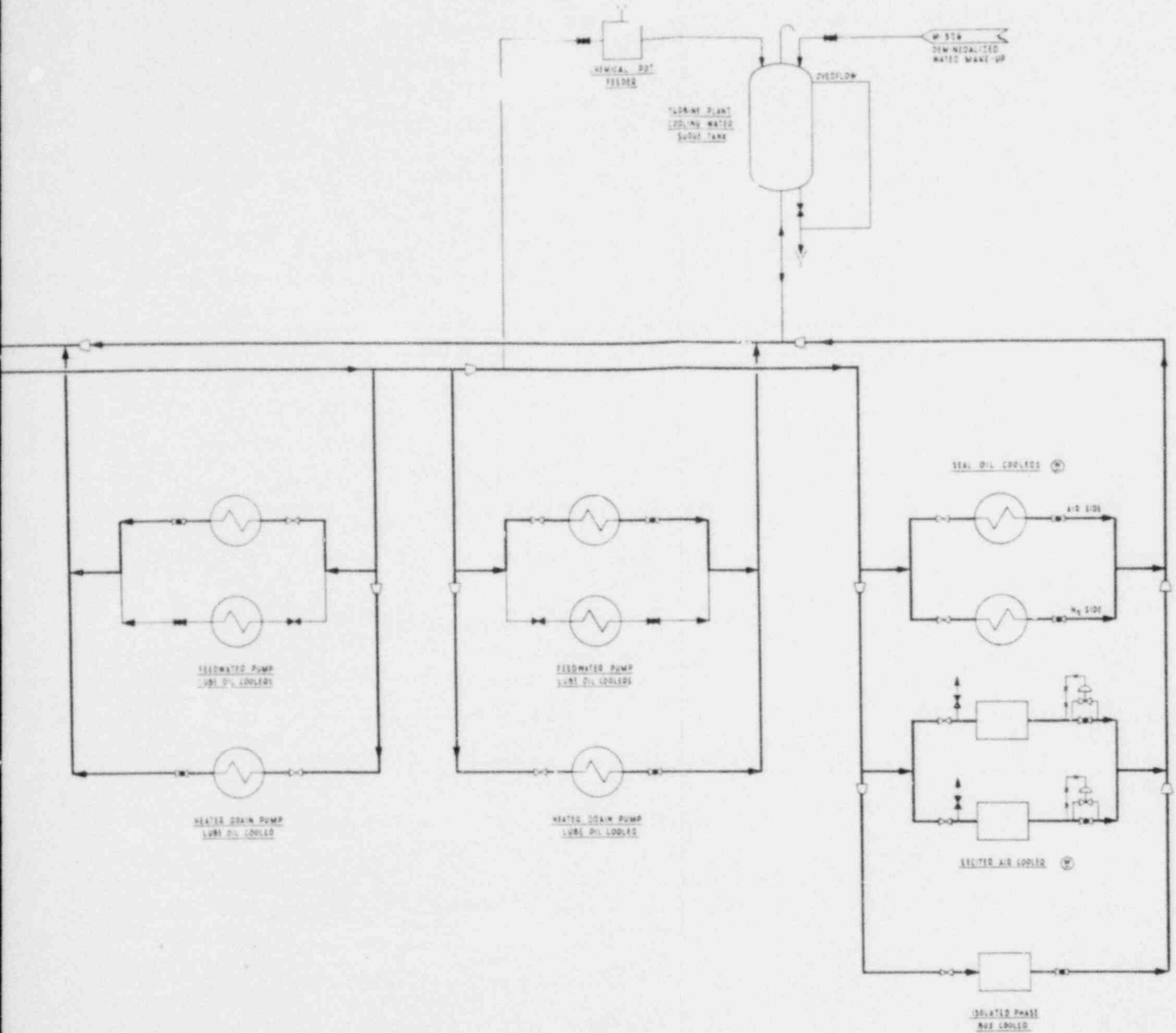


FIGURE 9.3-3
TURBINE PLANT
COOLING WATER SYSTEM

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## 9.4 SPENT FUEL COOLING SYSTEM

### 9.4.1 DESIGN BASES

The spent fuel cooling system is shown on Figure 9.4-1. It is designed to maintain the spent fuel storage pool at 120 F with a heat load based on removing the decay heat generation from one 1/3 core, which has been irradiated for 930 days and cooled for 150 hours. In meeting the design bases above, the system, supplemented as required by a decay heat removal pump and cooler, has the additional capability to maintain the spent fuel storage pool at 120 F while removing the decay heat from the following combination of stored fuel assemblies.

a. 1/3 core irradiated for 930 days and cooled for 100 days.

b. 1/3 core irradiated for 720 days and cooled for 150 hours.

c. 1/3 core irradiated for 410 days and cooled for 150 hours.

d. 1/3 core irradiated for 100 days and cooled for 150 hours.

### 9.4.2 SYSTEM DESCRIPTION AND EVALUATION

#### 9.4.2.1 Schematic Diagram

The schematic diagram for the spent fuel cooling system is shown in Figure 9.4-1. Spent fuel is cooled by pumping spent fuel storage pool water through the cooler and back to the spent fuel storage pool. In addition to this primary function, the system also provides for purification of both the spent fuel storage pool water and the contents of the borated water storage tank (after it has been used in the fuel transfer canal during refueling).

#### 9.4.2.2 Performance Requirements

The first design basis of the system predicates an operating schedule in which the nuclear unit is on an equilibrium refueling period (310 days per cycle) with approximately 1/3 of a core being removed from the unit at the end of each period. The removed fuel assemblies will have been in the reactor for three cycles, i.e., 930 days at the time of discharge.

The second design basis for the system considers that it is possible that during the life of the plant it will be necessary to unload the reactor vessel totally for maintenance or inspection at the time that the 1/3 core is already residing in the spent fuel storage pool.

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

TABLE 9.4-1
SPENT FUEL COOLING SYSTEM PERFORMANCE & EQUIPMENT DATA

| Component | Quantities and Capacities |
|---|---|
| System Cooling Capacity, Btu/hr | |
| Normal (1/3 core) | $8.75 \times 10^6$ |
| Maximum (1-1/3 cores) | $25.85 \times 10^6$ |
| System Design Pressure, psig | 75 |
| System Design Temperature, F | 212 |
| Spent Fuel Cooler Data | |
| Quantity | 1 |
| Type | Tube and Shell |
| Material, shell tube | SS/CS |
| Duty, Btu/hr * | $8.75 \times 10^6$ |
| Cooling Water Flow, lb/hr | $5.0 \times 10^5$ |
| Spent Fuel Pump Data | |
| Quantity | 1 |
| Type | Horizontal, Centrifugal |
| Material | Stainless Steel |
| Flow, gpm | 1,000 |
| Head, ft | 100 |
| Motor Horsepower, hp | 40 |
| Spent Fuel Coolant Ion exchanger | |
| Flow rate, gpm | 160 |
| Bed Volume, $ft^3$ | 20 |
| Type | Nonregenerative |
| Vessel Material | Carbon Steel - Lined |
| Design Pressure, psig | 75 |
| Design Temperature, F | 200 |
| Spent Fuel Storage Pool Water Volume, $ft^3$ | 81,000 |

* Assumes pool water to cooler at 120 F and cooling water to cooler at 95 F.

9.4.2.3 Mode of Operat on

During normal conditions 1/3 of a core will be stored in the pool. At this time the pump and the cooler will handle the load and maintain 120 F. The pool is initially filled with water from the borated water storage tank.

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For the case where 1-1/3 cores are stored due to complete unloading of the reactor vessel, a decay heat removal pump and cooler will be used to supplement the pump and cooler to maintain the spent fuel storage pool temperature at 120 F. If only the spent fuel pump and cooler are used when this storage condition exists, the water temperature will eventually rise to 169 F, although considerable time will be required to heat the large spent fuel storage pool to this temperature. If no cooling is provided, the time required for the spent fuel storage pool to reach 212 F for each of the foregoing quantities of stored fuel is:

a. One-third of a core 43 hours

b. One and one-third cores 13 hours

### 9.4.2.4 Reliability Considerations

During the time when a 1/3 core is stored in the pool, the installed equipment will be utilized to maintain the pool at 120 F. Equipment maintenance can be performed in less than eight hours.

### 9.4.2.5 Codes and Standards

The equipment in this system will be designed to applicable codes and standards tabulated in Section 9.

Components which are designed to the ASME code are:

a. Spent Fuel Cooler - ASME Section III-C

b. Spent Fuel Coolant Ion Exchanger - ASME Section III-C

### 9.4.2.6 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 small purification loop is provided for removing these fission products and other contaminants from the water.

The fuel handling and storage area housing the spent fuel storage pool will be ventilated on a controlled basis, exhausting circulated air to the outside through the plant vent.

Provisions have been made in the design to air-test the valved and flanged end of the fuel transfer tube for leak-tightness after it has been used. A valve and blind flange are used to isolate the fuel transfer tube.

9.4.2.7 Failure Considerations

The most serious failure of this system would be complete loss of water in the storage pool. To protect against this possibility, the spent fuel storage pool cooling connections enter near or above the water level so that the pool cannot be gravity-drained. For this same reason care is also exercised in the design and installation of the fuel transfer tube.

9.4.2.8 Operating Conditions

The pool will normally be limited to 120 F except in most unusual circumstances as previously described. Boric acid concentration in the pool fluid will be maintained at 12,000 to 13,000 ppm (2,090 to 2,270 ppm boron).

For the case where 1-1/3 cores are stored due to complete unloading of the reactor vessel, a decay heat removal pump and cooler will be used to supplement the pump and cooler to maintain the spent fuel storage pool temperature at 120 F. If only the spent fuel pump and cooler are used when this storage condition exists, the water temperature will eventually rise to 169 F, although considerable time will be required to heat the large spent fuel storage pool to this temperature. If no cooling is provided, the time required for the spent fuel storage pool to reach 212 F for each of the foregoing quantities of stored fuel is:

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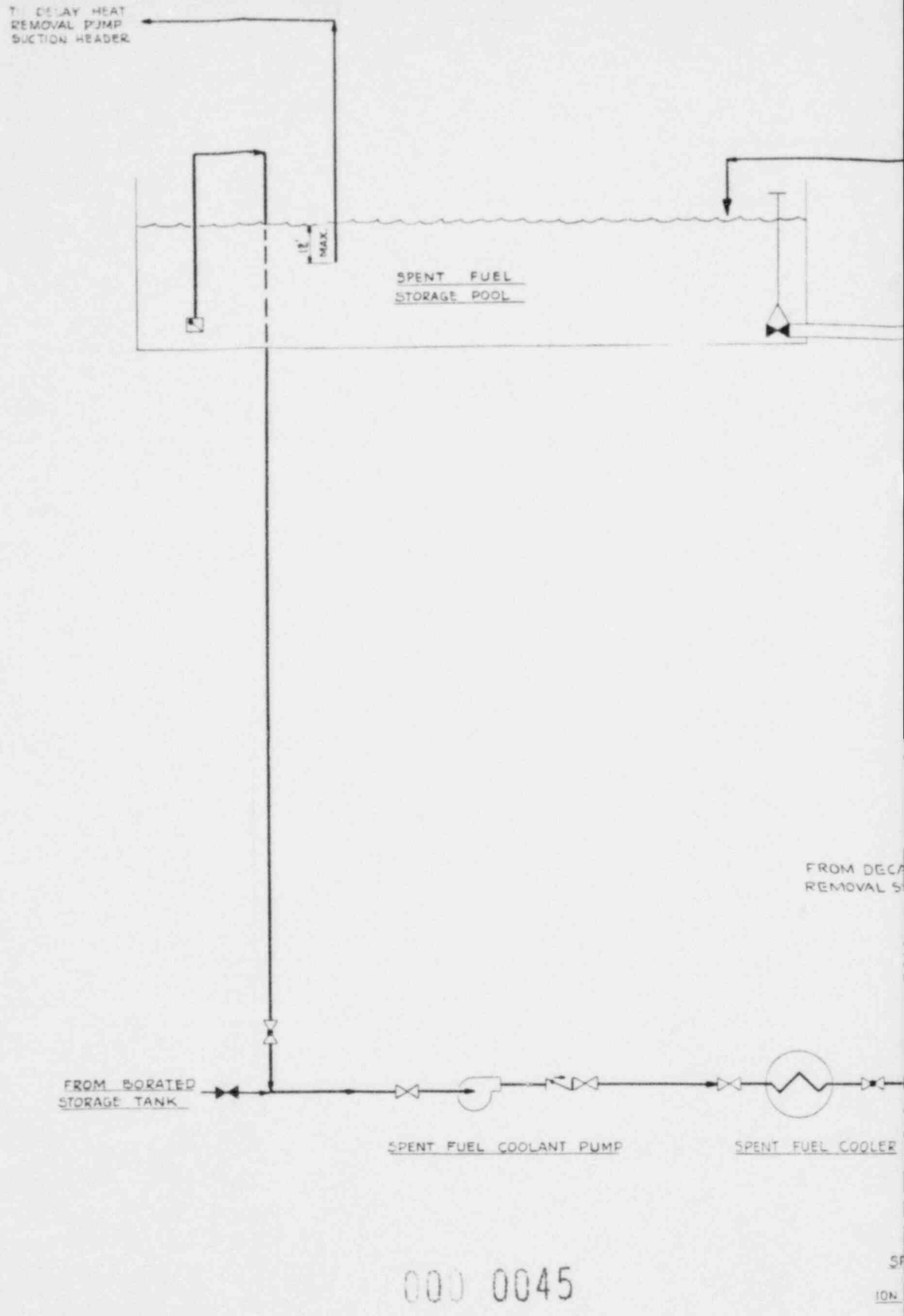
REMOVAL PUMP
SUCTION HEADER
MAX
SPENT FUEL
STORAGE POOL
FROM DECA
REMOVAL S
FROM BORATED
STORAGE TANK
SPENT FUEL COOLANT PUMP
SPENT FUEL COOLER

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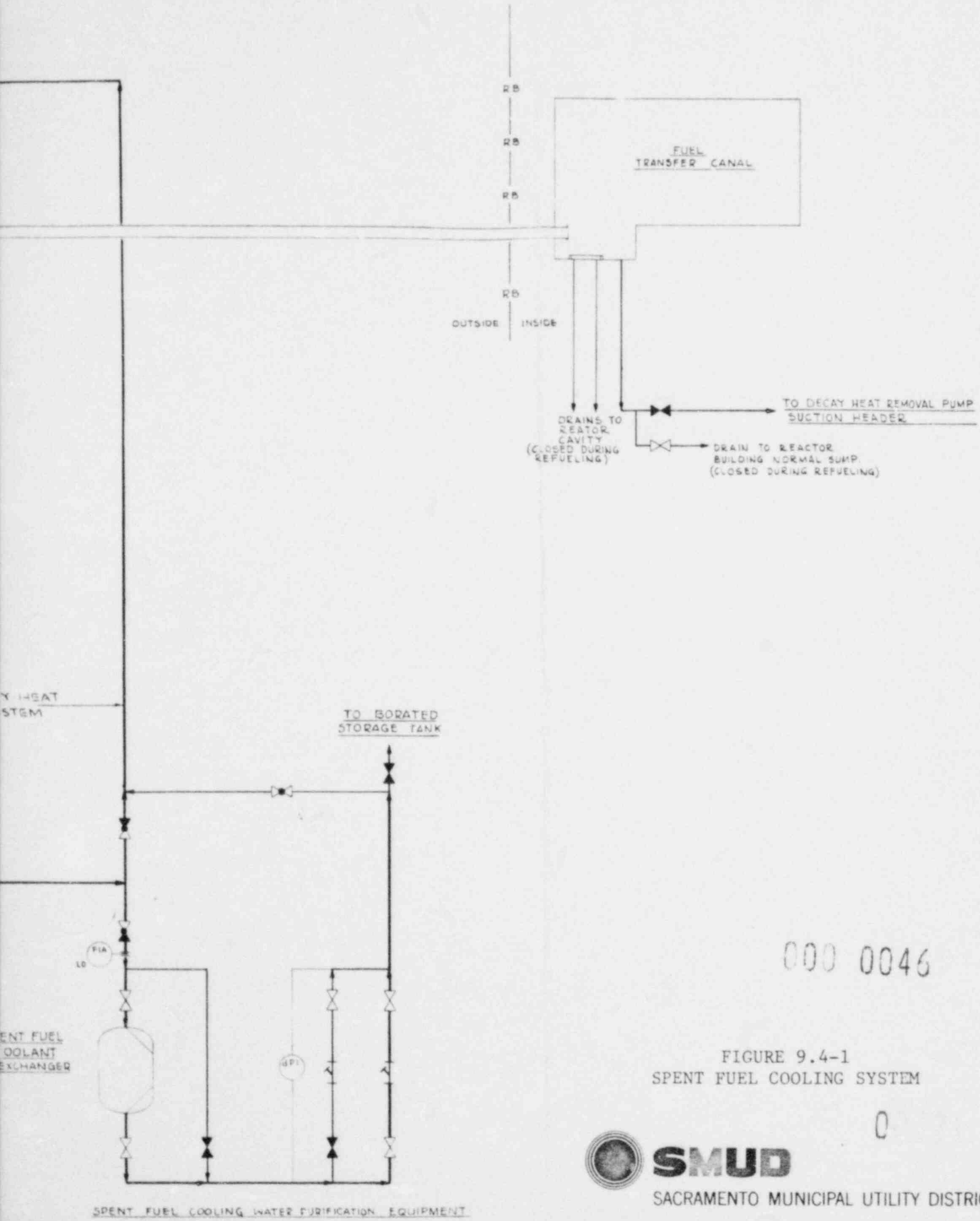


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FIGURE 9.4-1
SPENT FUEL COOLING SYSTEM

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from the reactor outlet line and discharges through the coolers into the
2 reactor vessel. If only one pump or one cooler is available, the reactor
coolant temperature is reduced at a lower rate.

The equipment utilized for decay heat cooling is also used for low pressure injection into the core during accident conditions.

### 9.5.2.4 Reliability Considerations

The nuclear unit is provided with two pumps and two coolers. These operate
2 in two separate and isolated systems and the pumps are connected to the
diesel backed nuclear service bus.

### 9.5.2.5 Codes and Standards

The equipment in this system will be designed to applicable codes and standards tabulated in Section 9. The decay heat removal cooler which is applicable to the ASME Code, will be designed to Section III, Class C.

TABLE 9.5-1
DECAY HEAT REMOVAL SYSTEM PERFORMANCE DATA

| System | Performance |
|---|---|
| Reactor Coolant Temperature at Startup of Decay Heat Removal, F | 250 |
| Time to Cool Reactor Coolant System From 250 F to 140 F, hr | 14 |
| Refueling Temperature, F | 140 |
| Decay Heat Generation | Figure 9.5-2 |
| Fuel Transfer Canal Fill Time, hr | 1 |
| Fuel Transfer Canal Drain Time, hr | 1 |
| Boron Concentration in the Borated Water Storage Tank, ppm boron | 2,270 |

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### 9.5.2.7 Leakage Considerations

During reactor operation all equipment of the decay heat removal system is idle, and all isolation valves are closed. During the accident condition, fission products will be recirculated through the exterior piping system. To obtain the total radiation dose to the public due to leakage from this system, the potential leaks have been evaluated and discussed in 6.3 and 14.2.

### 9.5.2.8 Failure Considerations

Failure considerations for the accident case are evaluated and tabulated in 6.1.3.

### 9.5.2.7 Leakage Considerations

During reactor operation all equipment of the decay heat removal system is idle, and all isolation valves are closed. During the accident condition, fission products will be recirculated through the exterior piping system. To obtain the total radiation dose to the public due to leakage from this system, the potential leaks have been evaluated and discussed in 6.3 and 14.2.

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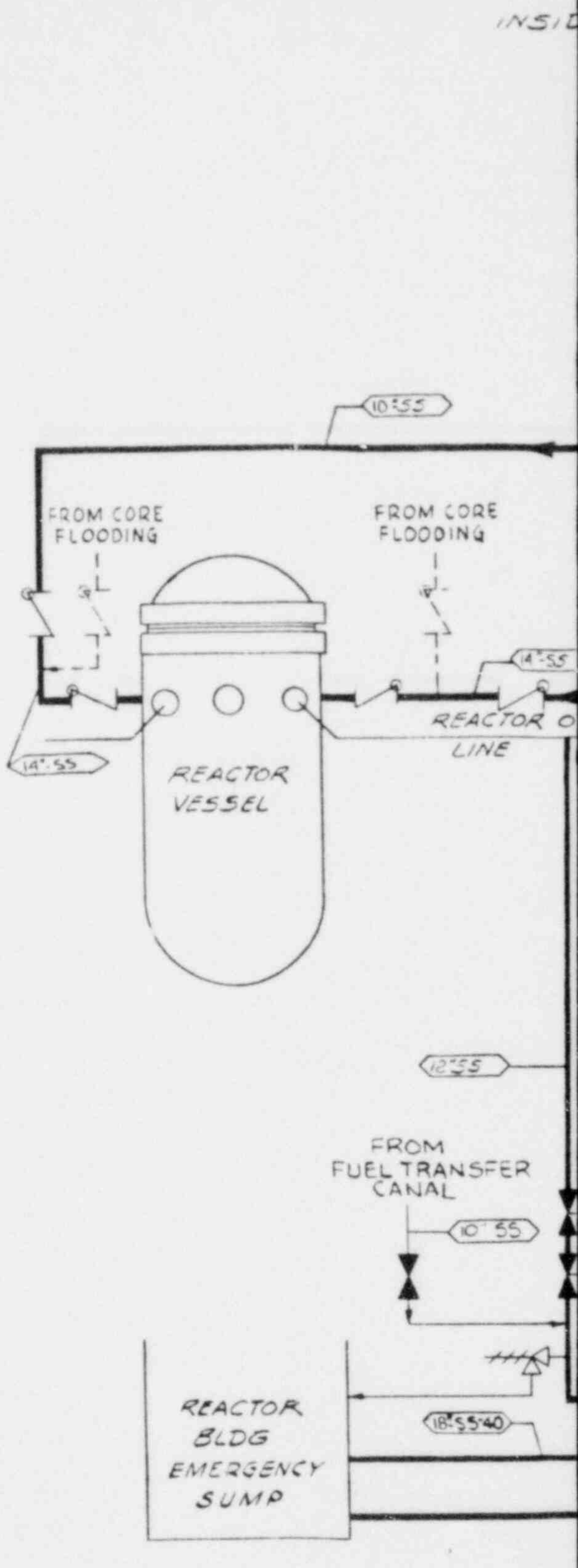
Failure considerations for the accident case are evaluated and tabulated in 6.1.3.


INSID
10"SS
FROM CORE
FLOODING
FROM CORE
FLOODING
14"SS
REACTOR O
LINE
14"SS
REACTOR
VESSEL
12"SS
FROM
FUEL TRANSFER
CANAL
10"SS
REACTOR
BLDG
EMERGENCY
SUMP
18"SS-40

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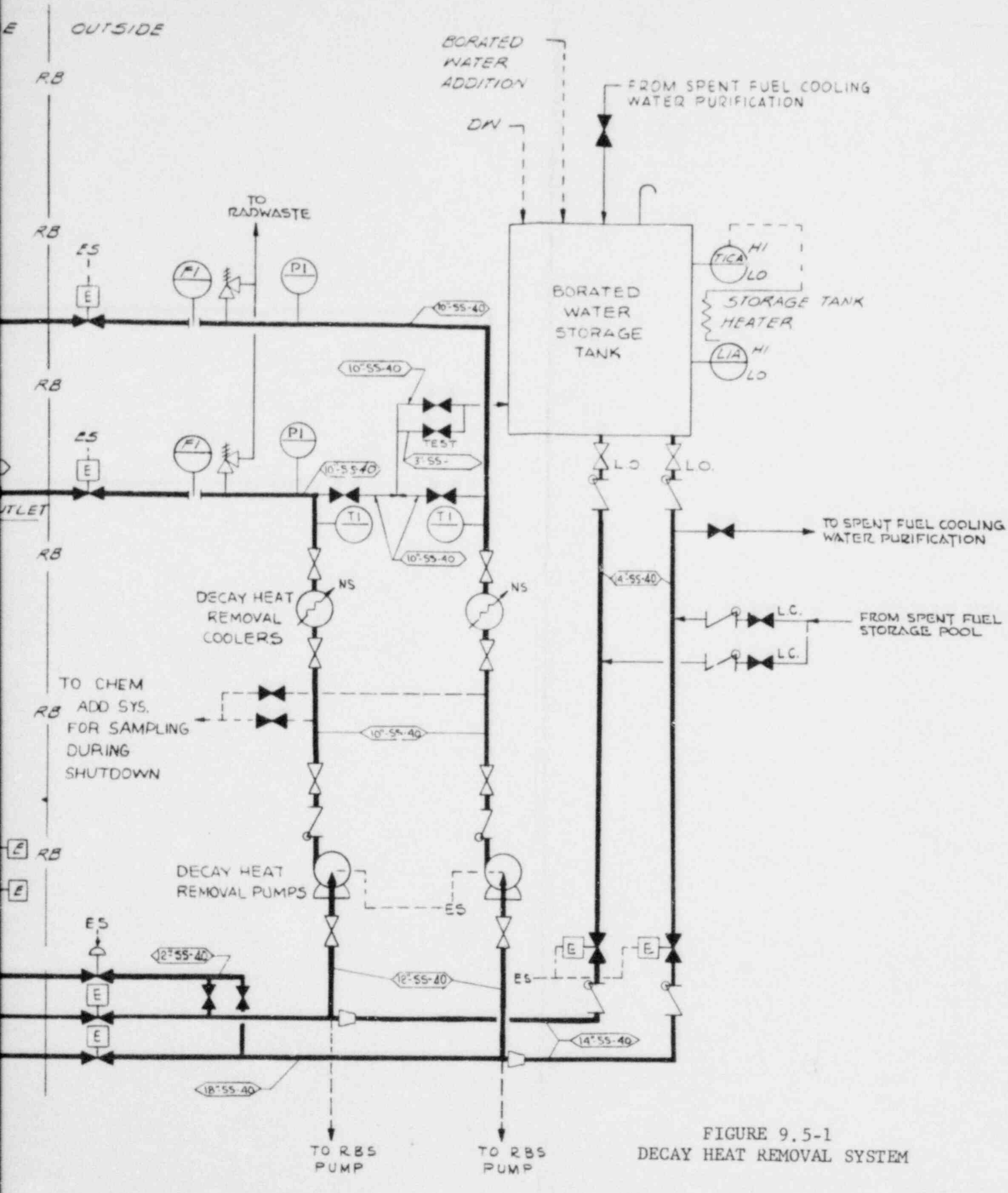


FIGURE 9.5-1
DECAY HEAT REMOVAL SYSTEM

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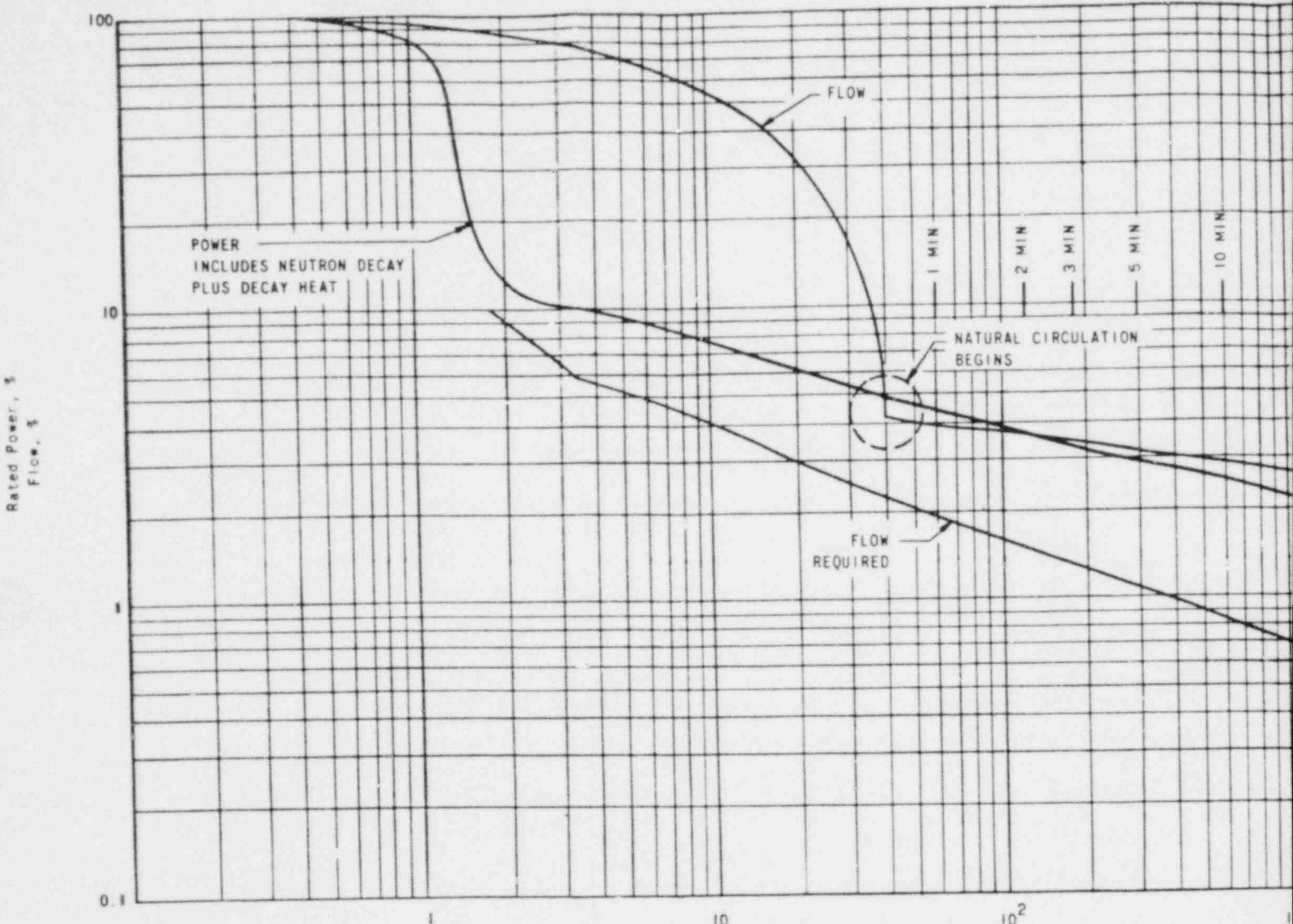
Rated Power, %
Flow, %
100
10
1
0.1
1
10
10^2
FLOW
POWER
INCLUDES NEUTRON DECAY
PLUS DECAY HEAT
1 MIN
2 MIN
3 MIN
5 MIN
10 MIN
NATURAL CIRCULATION
BEGINS
FLOW
REQUIRED

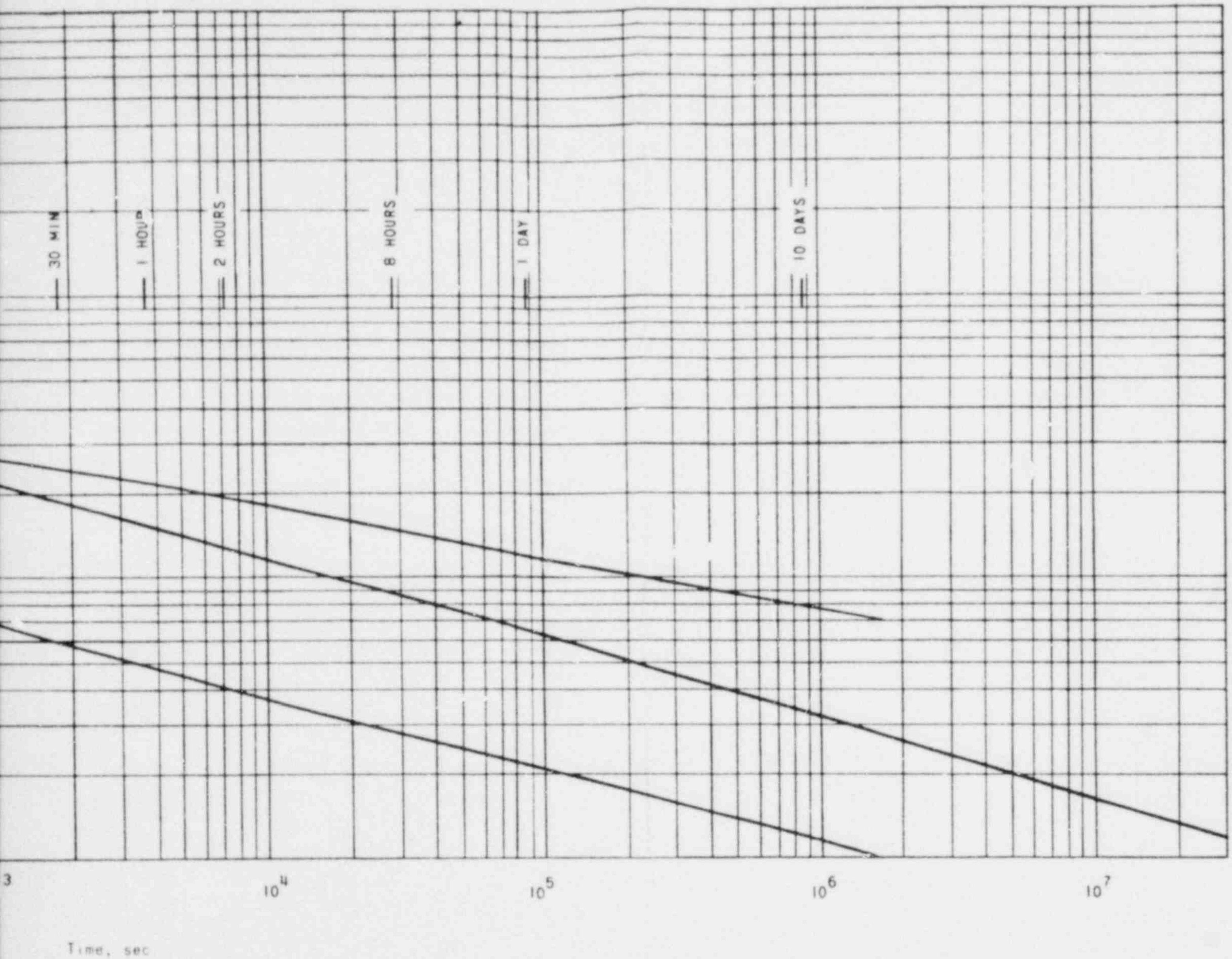


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FIGURE 9.5-2
DECAY HEAT GENERATION
VERSUS TIME AFTER SHUTDOWN

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## 9.6 FUEL HANDLING SYSTEM

### 9.6.1 DESIGN BASES

#### 9.6.1.1 General System Function

The fuel handling system (Figure 9.6-1) is designed to provide a safe, effective means of transporting and handling fuel from the time it reaches the plant in an unirradiated condition until it leaves the plant after postirradiation cooling. The system is designed to minimize the possibility of mishandling or maloperations that could cause fuel assembly damage and/or potential fission product release.

The reactor is refueled with equipment designed to handle the spent fuel assemblies under water 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, transparent radiation shield, as well as a reliable cooling medium for removal of decay heat. Borated water insures subcritical conditions during refueling.

#### 9.6.1.2 New Fuel Storage Area

The new fuel storage area is a separate and protected area for the dry storage of new fuel assemblies. The new fuel storage area is sized to accommodate the maximum number of new fuel assemblies required for refueling of the reactor as dictated by the fuel management program. The new fuel assemblies are stored in racks in parallel rows having a center-to-center distance of 21 in. in both directions. This spacing is sufficient to maintain a $k_{eff}$ of less than 0.9 when wet.

#### 9.6.1.3 Spent Fuel Storage Pool

The spent fuel storage pool is a reinforced concrete pool lined with stainless steel; it is located in the fuel storage building. The pool is sized to accommodate 255 spent fuel assemblies which allows for a full core of irradiated fuel assemblies in addition to the concurrent storage of the largest quantity of spent fuel assemblies from the reactor as established by the fuel management program. The spent fuel assemblies are stored in racks in parallel rows having a center-to-center distance of 21 in. in both directions. Control rod assemblies requiring removal from the reactors are stored in the spent fuel assemblies. |2

#### 9.6.1.4 Spent Fuel Transfer Tube

A horizontal tube is provided to convey spent fuel between the reactor building and the spent fuel storage pool. This tube contains a track for the fuel transfer carriages, a gate valve on the spent fuel storage pool side, and a means for flanged closure on the reactor building side. The spent fuel transfer tube penetrates into the fuel transfer canal at the lower depth, where space is provided for the rotation of the fuel transfer carriage basket containing a fuel assembly.

#### 9.6.1.5 Fuel Transfer Canal

The fuel transfer canal is a passageway in the reactor building extending from the reactor vessel to the 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; it forms a canal above the reactor vessel, which is filled with borated water for refueling.

Space is available in the fuel transfer canal for underwater storage of the reactor vessel internals upper plenum assembly.

The deeper fuel transfer station portion of the fuel transfer canal, can be used for storage of the reactor vessel internals core barrel and thermal shield assemblies.

#### 9.6.1.6 Miscellaneous Fuel Handling Equipment

This equipment consists of fuel handling bridges, fuel handling tools, new fuel storage racks, spent fuel storage racks, new fuel handling racks, fuel transfer containers, control rod handling tools, viewing equipment, 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 closure head and the upper plenum assembly to expose the core for refueling.

### 9.6.2 SYSTEM DESCRIPTION AND EVALUATION

#### 9.6.2.1 Receiving and Storing Fuel

New fuel assemblies are received in shipping containers and stored dry in racks having a center-to-center distance of at least 21 in. They are subsequently moved into the reactor building in one of the following ways.

a. After reactor shutdown, new fuel assemblies can be transferred from new fuel storage area into the reactor building using the new fuel transfer trolly and stored directly in the new fuel handling racks in the transfer canal.

b. After reactor shutdown, new fuel assemblies can be transferred from the new fuel storage area into the reactor building transfer canal by way of the spent fuel storage pool with the use of the fuel transfer carriage and the fuel transfer tube.

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9.6.2.2 Loading and Removing Fuel

Following the reactor shutdown and reactor building entry, the refueling procedure is begun by removing the reactor closure head and control rod drives assembly. Head removal and replacement time is minimized by the use of two stud tensioners. The stud tensioner is a hydraulically operated device that permits preloading and unloading of the reactor closure studs at cold shutdown conditions. The studs are tensioned to their operational load in two steps in a predetermined sequence. Required stud elongation after tensioning is verified by micrometer measurements.

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. Removal of the studs with the reactor closure head minimizes handling time and reduces the chance of thread damage.

The reactor closure head assembly is handled by a lifting fixture supported from the reactor building crane. It is lifted out of the canal onto a head storage stand located on the operating floor. The stand is designed to protect the gasket surface of the closure head. The lift is guided by two closure head alignment pins installed in two of the stud holes. These pins also provide proper alignment of the reactor closure head with the reactor vessel and internals when the closure head is replaced after refueling. The studs 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 stud and alignment pin storage rack is provided.

The annular space between the reactor vessel flange and the bottom of the fuel transfer canal is sealed off, before the canal is filled, by a seal clamped to the canal shield plate flange and the reactor vessel flange. The fuel transfer canal is then filled with borated water.

The upper plenum assembly is removed from the reactor by the reactor building crane and stored under water on a stand on the fuel transfer canal floor using a lifting device with special adapters.

Refueling operations are carried out using the fuel handling bridge crane which spans the fuel transfer canal. This bridge is used to shuttle spent fuel assemblies from the core to the transfer station and new fuel assemblies from the new fuel handling racks to the core. This bridge also relocates partially spent fuel assemblies in the core as specified by the fuel management program.

Fuel assemblies are handled by a pneumatically operated fuel handling tool attached to a telescoping and rotating mast which moves laterally on the bridge. Control rod assemblies are handled by a control rod handling tool attached to a second mast located on the bridges in the reactor building.

The fuel handling bridge moves a spent fuel assembly from the core under water to the transfer station where the fuel assembly is lowered into the fuel transfer carriage fuel basket. The control rod handling tool attached to the second mast is used to transfer a control rod assembly to a new fuel assembly in the adjacent new fuel handling racks. This new fuel assembly with control rod assembly is carried to the reactor by the fuel handling tool and located in the core.

Spent fuel assemblies removed from the reactor are transported to the spent fuel storage pool from the reactor building via a fuel transfer tube by means of a cable-operated fuel transfer carriage. The spent fuel assemblies are removed from the fuel transfer carriage basket using a pneumatically-operated fuel handling tool attached to a movable mast located on a fuel handling bridge. This motor-driven bridge spans the spent fuel storage pool and permits the refueling crew to store or remove new fuel assemblies in any one of the many vertical storage rack positions.

The fuel transfer mechanism is an underwater cable-driven carriage that runs on tracks extending from the spent fuel storage pool through the transfer tube and into the reactor building. A rotating fuel basket is mounted on one end of the fuel transfer carriage to receive fuel assemblies in a vertical position. The hydraulically operated fuel basket on the end of the carriage being used for refueling is rotated to a horizontal position for passage through the transfer tube, and then rotated back to a vertical position in the spent fuel storage pool for vertical removal of the fuel assembly.

Once refueling is completed, the fuel transfer canal water is drained by suction through a pipe located in the deep transfer station area. The canal water is pumped to the borated water storage tank to be available for the next refueling or for emergency cooling following a loss-of-coolant accident.

During operation of the reactor, the carriage is stored in the spent fuel storage pool, thus permitting the gate valve on the spent fuel storage pool side of the transfer tube to be closed and the blind flanges to be installed on the reactor building side of the tube.

The spent fuel storage pool has space for a spent fuel shipping cask, as well as for required fuel storage. Following a sufficient decay period, the spent fuel assemblies are removed from storage and loaded into the spent fuel shipping cask under water for removal from the site. Casks up to 100 tons in weight can be handled.

A decontamination area is located in the building adjacent to the spent fuel storage pool; in this area the outside surfaces of the casks can be decontaminated before shipment by using steam, water, or detergent solutions, and manual scrubbing to the extent required.

### 9.6.2.3 Safety Provisions

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

All fuel assembly storage facilities, new and spent, maintain an eversafe geometric spacing of 21 in. between assemblies. The new and spent 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. Although new fuel assemblies are stored dry, the 21 x 21 in. spacing ensures an eversafe geometric array in unborated water. Under these conditions, a criticality accident during refueling or storage is not considered credible.

All fuel handling and transfer containers are also designed to maintain an eversafe geometric array. Mechanical damage to the fuel assemblies during transfer operations is possible, although remote. Since the fission product release would occur under water, the amount of activity reaching the environment will present no appreciable hazard. A fuel handling accident analysis is included in Section 14.

All spent fuel assembly transfer operations are conducted under water. The water level in the fuel transfer canal provides a minimum of 10 ft of water over the active fuel line of the spent fuel assemblies during movement from the core into storage; this limits radiation at the surface of the water to less than 10 mrem/hr. The spent fuel storage racks are located to provide a minimum of 13 ft of water shielding over stored assemblies to limit radiation at the surface of the water to no more than 2.5 mrem/hr during the storage period. The depth of the water over the fuel assemblies, as well as the thickness of the concrete walls of the transfer canal, is sufficient to limit the maximum continuous radiation levels in the working area to 2.5 mrem/hr.

Water in the reactor vessel is cooled during shutdown and refueling by the decay heat removal system described in 9.5. In case of a power failure, this system will be operated by the auxiliary power supply. The spent fuel storage pool water is cooled by the spent fuel cooling system as described in 9.4. A power failure during the refueling cycle will create no immediate hazardous condition owing to the large water volume in both the fuel transfer canal and spent fuel storage pool. With a normal quantity of spent fuel assemblies in the storage pool and no cooling available, the water temperature in the spent fuel storage pool would increase as discussed in 9.4.2.3.

During the refueling period the water level in both the fuel transfer canal and the spent fuel storage pool is the same, and the fuel transfer tube valve is continuously open. This eliminates the necessity for interlocks between the fuel transfer carriage and fuel transfer tube valve operations.

The simplified movement of a transfer carriage through the horizontal fuel transfer tubes minimizes the danger of jamming or derailing. To cope with such an eventuality, the open tube design provides access to the entire length of the fuel transfer carriage travel from the fuel transfer canal. All operating mechanisms of the system are located in the fuel storage building for ease of maintenance and accessibility for inspection before the start of refueling operations.

During reactor operation a bolted and gasketed closure plate located on the reactor building flange of the fuel transfer tube, prevents leakage of water from the spent fuel storage pool into the transfer canal in the event of a leak through the fuel transfer tube valve. Both the spent fuel storage pool and the fuel transfer canal are completely lined with stainless steel for leak-tightness and ease of decontamination. The fuel transfer tube will be appropriately attached to the liner to maintain leak integrity. The spent fuel storage pool cannot be accidentally drained since water must be pumped out through a suction pipe. The fuel transfer mechanisms are designed to permit initiation of the carriage travel and the carriage fuel basket rotation from the building in which the carriage fuel basket is being loaded or unloaded.

All electrical gear is located above water for greater integrity and ease of maintenance. The hydraulic systems that actuate the rotating fuel baskets use storage pool water for operation to eliminate contamination.

The fuel transfer canal and storage pool water will have a boron concentration of 2,270 ppm. Although this concentration is sufficient to maintain core shutdown if all of the control rod assemblies were removed from the core, only a few control rods will be removed at any one time during the fuel shuffling and replacement. Although not required for safe storage of spent fuel assemblies, the spent fuel storage pool water will also be borated so that the transfer canal water will not be diluted during fuel transfer operations.

The fuel handling bridge mast travel is designed to limit the maximum lift of a fuel assembly to a safe shielding depth.

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

Gross failures of fuel are prevented by safety margins in the design and control of the core. The fuel assembly utilizes a free-standing Zircaloy fuel rod of sufficient length to accommodate the expected fission gas release from the fuel.

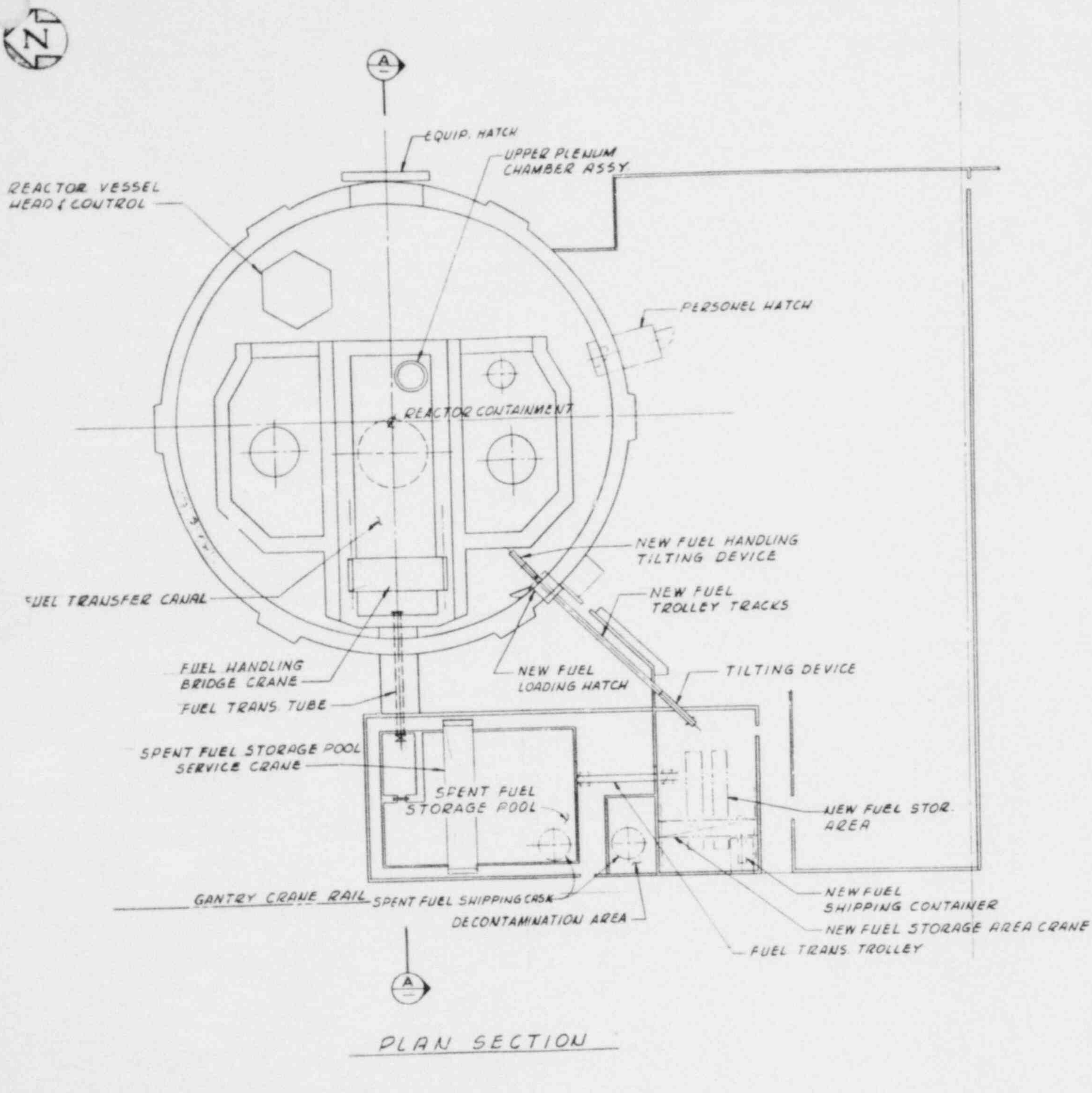
Any leaking fuel assemblies will be removed from the core for verification of leakage and placed in a failed fuel container. This operation is done in the fuel transfer canal and completely seals off the leaking fuel assembly before the fuel transfer mechanism transfers it out of the fuel transfer canal into the spent fuel storage pool. The design of the failed fuel containers will comply with 10 CFR 71 so that a defective fuel assembly can be safely stored and shipped while sealed in the failed fuel container.

### 9.6.2.4 Operational Limits

Certain manipulations of the fuel assemblies and reactor internals during refueling may result in short-term exposures with radiation levels greater than 2.5 mrem/hr. The exposure time will be limited so that the integrated doses to operating personnel do not exceed the limits of 10 CFR 20.

The fuel handling bridge is limited to the handling of fuel and control rod assemblies and reactor closure head studs only. All lifts for handling the reactor closure head and reactor internals will use the reactor building crane.

Travel speeds for the fuel handling bridge, masts, and fuel transfer carriage will be controlled to ensure safe handling conditions.




PLAN SECTION

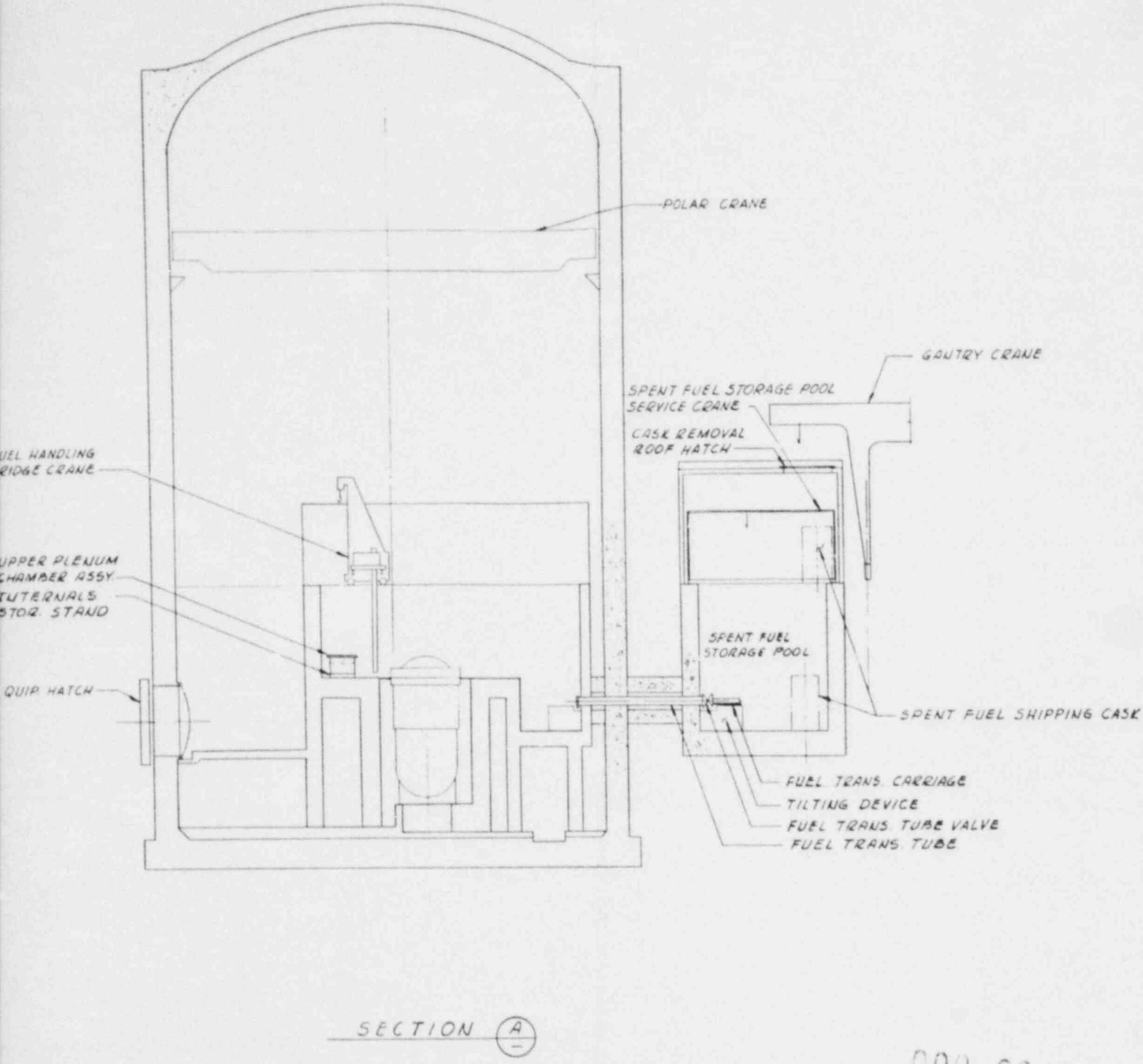



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FIGURE 9.6-1
FUEL HANDLING SYSTEM

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## 9.7 STATION VENTILATION SYSTEMS

### 9.7.1 DESIGN BASES

The station will be designed to provide maximum safety and convenience for operating personnel with equipment arranged in zones so that potentially contaminated areas are separated from clean areas. The heating, ventilating, and air-conditioning systems for the station will be designed to provide a suitable environment for equipment and personnel. The path of ventilating air in the auxiliary building will be from areas of low activity toward areas of progressively higher activity. Conditioned air will be recirculated in clean areas only.

### 9.7.2 SYSTEM DESCRIPTION AND EVALUATION

The reactor building normal ventilation system is discussed in 5.7 and shown on Figure 9.7-1. The remaining ventilation systems for the station are discussed here and shown on Figure 9.7-1. The equipment used to ventilate each area is independent from that used in any other area. The systems handling potentially contaminated air all discharge to the plant vent.

The auxiliary building will be served by separate ventilation systems for the fuel handling area, the radwaste area, the non-radioactive area, and the control room area. These systems are shown on Figure 9.7-1. The system serving the non-radioactive areas of the auxiliary building will also supply air to the decontamination area, hot laboratory, showers, and toilets. The discharge air from these areas will go to the plant vent. The control room area system will be equipped with redundant fans, filters, and mechanical refrigeration equipment, plus the necessary dampers and controls for switching to full recirculation for postaccident ventilation.

The administration building ventilation system shown on Figure 9.7-1 will consist of a multizone-type air handling unit with a chilled water cooling coil and a heating coil. The system will be arranged to receive makeup from a fresh air louver. Exhaust air will be discharged directly to the atmosphere through several exhaust fans from different areas.

The ventilating equipment will be in accordance with accepted industry standards for power station equipment. Redundant ventilation fans will be provided for the potentially contaminated areas, and a completely redundant ventilation system will be provided for the control room area. The control room area system performance will be continually monitored with alarms for high radiation, fan failure and excessive pressure drop through filters. The control room operator will have manual control for selecting backup fan and filter operation in order to ensure satisfactory control room conditions following an accident.

All control area ventilating system fans and filters will be remote from the control area and will not be exposed to fire hazards.

The ventilation systems will be designed in accordance with the applicable codes and standards tabulated in Section 9.

The ventilating equipment will be accessible for periodic testing, inspection and servicing during normal operation. Where redundant equipment is provided, it will be operated alternately to provide assurance of operability.

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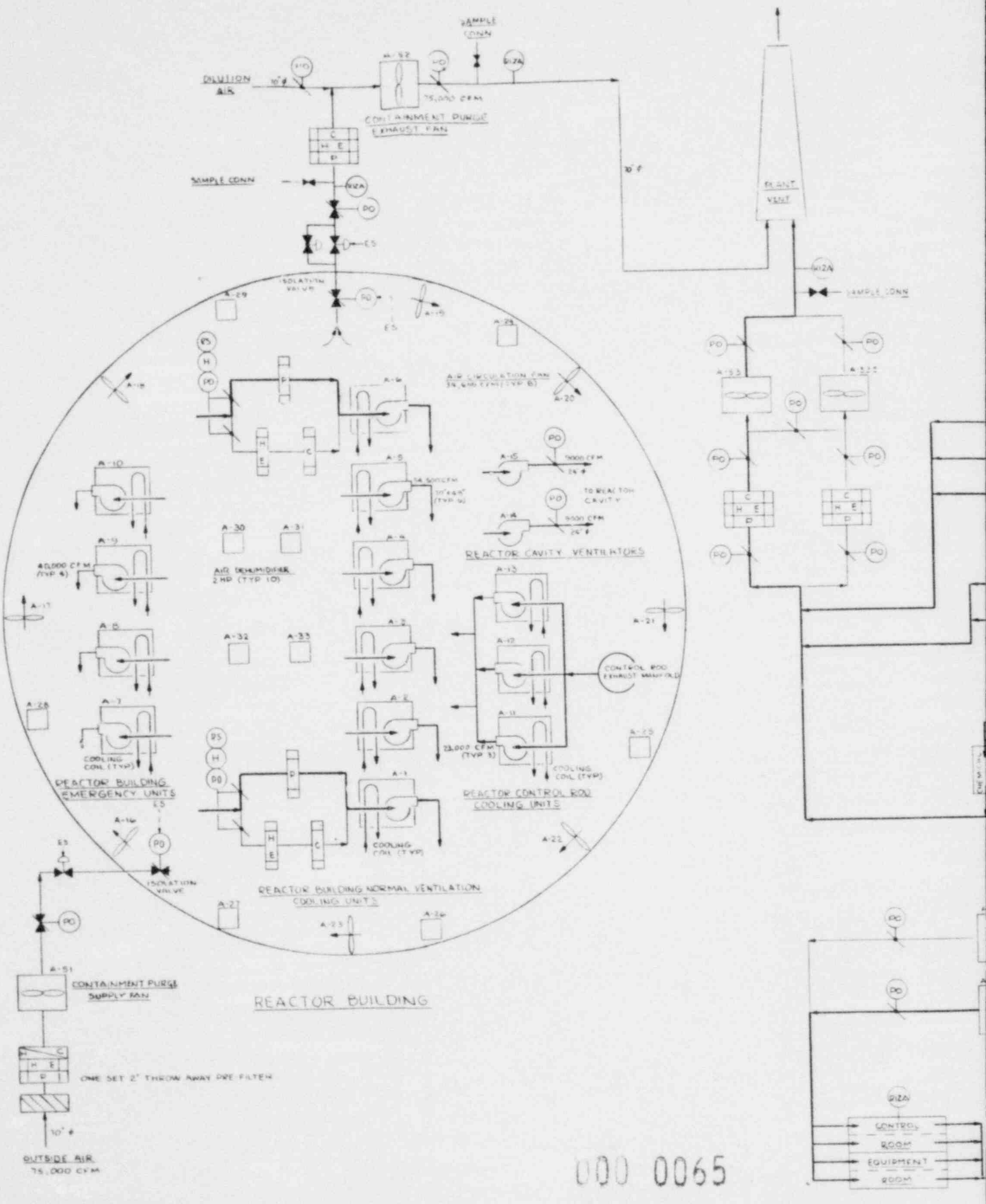
SAMPLE CONN
DILUTION AIR
75,000 CFM
CONTAINMENT PURGE EXHAUST FAN
SAMPLE CONN
ISOLATION VALVE
PLANT VENT
SAMPLE CONN
AIR CIRCULATION FAN
REACTOR CAVITY VENTILATORS
TO REACTOR CAVITY
AIR DEHUMIDIFIER 2 HP (TYP 10)
40,000 CFM (TYP 4)
CONTROL ROD EXHAUST MANIFOLD
COOLING COIL (TYP)
REACTOR BUILDING EMERGENCY UNITS
REACTOR CONTROL ROD COOLING UNITS
ISOLATION VALVE
REACTOR BUILDING NORMAL VENTILATION COOLING UNITS
CONTAINMENT PURGE SUPPLY FAN
REACTOR BUILDING
ONE SET 2" THROW AWAY PRE-FILTER
OUTSIDE AIR 75,000 CFM
CONTROL ROOM
EQUIPMENT ROOM

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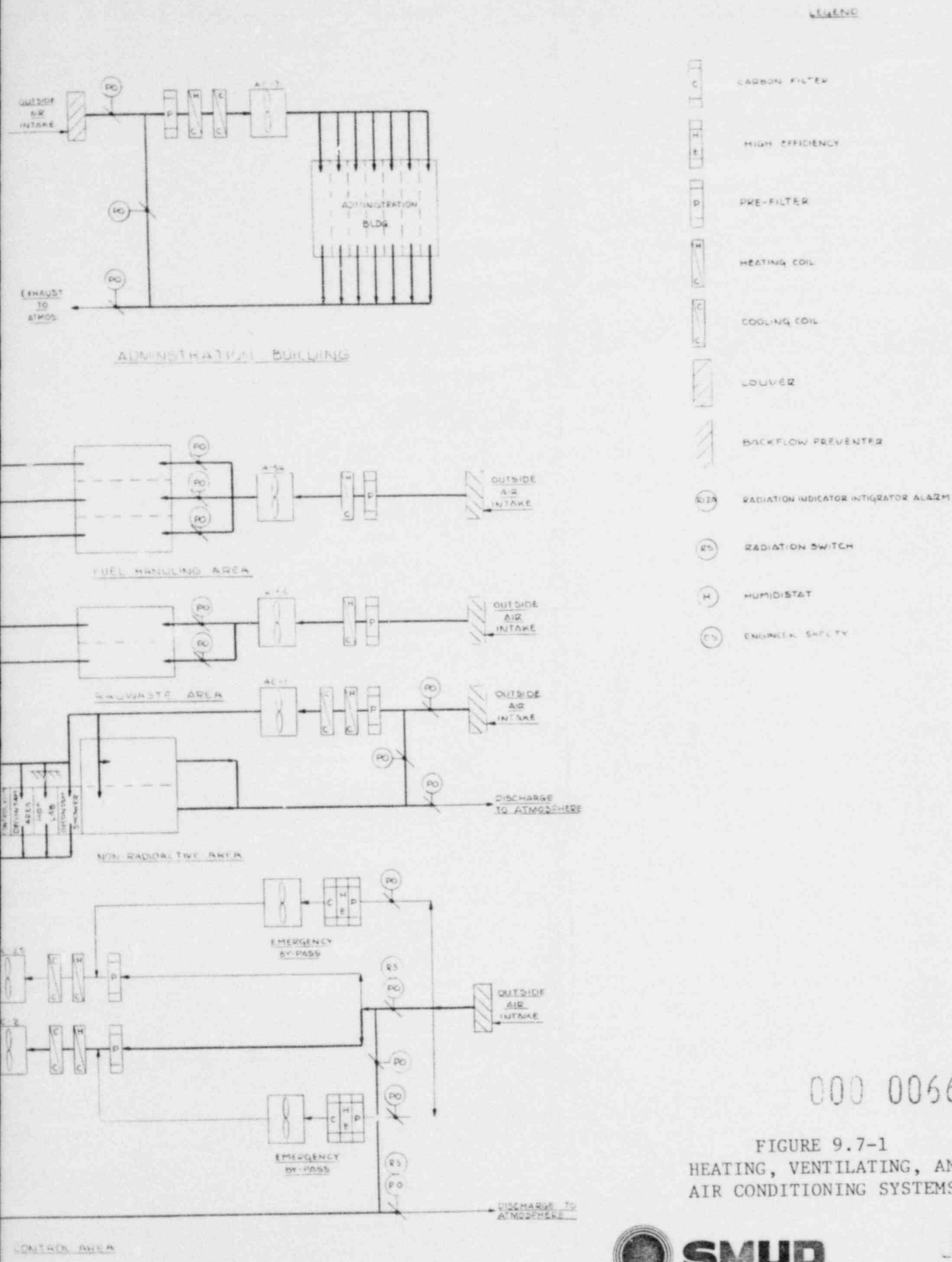


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FIGURE 9.7-1
HEATING, VENTILATING, AND
AIR CONDITIONING SYSTEMS

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