Inter-Office Memorandum

GPU Service

Date April 10, 1979
Time: 19:00

Subject TMI-2 Modification Criteria for use of Steam Generators for Short & Long Term Cooldown

To W. R. Cobean

Location: Three Mile Island

The attached criteria is forwarded for use in designing plant modifications to use the "A" and "B" steam generators as water to water heat exchangers for decay heat removal.

The attached implementation plan has been developed in conjunction with on site design personnel and identifies the schedule for this work, priorities, justifications, and responsible organizations.

In developing procedures for operation and start up of these systems, the following items must be considered:

1. The means to be used during start up of the "B" generator schemes to minimize any possible carry over of radioactive contaminants throughout the closed cooling loop and hence additional portions of the plant.

2. The threshold level of activity at which the closed loop should be shut down. This should be predicated on expected leakage rates and consequent rate of contamination.

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Implementation Plan for Decay Heat Removal Using The "A" + "B" Steam Generators

Item	Justification	Sched. Date	Priority	Action
Finalize criteria for B+R design of long & short term schemes using S/G's.	Basis for design + design concurrence	4/9/79	1	B+R/GPU/NRC
Design S/G "B" short term cooling scheme - review design + concur	Req'd for water to water short term cooling. Most readily available means.	4/11/79	1	B+R/GPU/NRC
Design electrical mods. to implement "A" S/G short term w/w scheme - review + concur	Req'd for loss of off-site power condition - mechanical components now exist; readily available cooling means.	4/12/79	1	B+R/GPU/NRC
Design long term scheme using "A+B" S/G's - review + concur	Req'd for long term natural circ. cooling	4/17/79	2	B+R/GPU/NRC

Install "B" S/G short term cooling scheme	To have short term "B" cooling with intermediate loop for S/G leak containment	4/16/79	1	Catalytic
Startup/operate "B" S/G short term	Confirm operation- have alternate available once steaming of "A" is stopped	4/17/79	1	
Install "A" S/G short term cooling scheme	To provide 2nd water to water loop for short term	4/14/79	1	Catalytic
Start "A" S/G short term cooling scheme	To provide 2nd water to water cooling	4/15/79	1	
Install "A"+"B" long term cooling scheme	To achieve a high pressure long term cooling scheme.	5/24/79 (BOP components)	2	Catalytic
Start "A"+"B" long term cooling scheme	To achieve a high pressure long term Cooling scheme that prevents S/G out	5/25/79	2	

THREE MILE ISLAND UNIT 2

SYSTEM CRITERIA

FOR USE OF STEAM GENERATORS

FOR SHORT AND LONG TERM

COOLDOWN

(REV. 1)

J. Capodanno 4/10/79
APPROVED

4/10/79
17:00
B&R Task #TS 3

I N D E X

(Continued)

THREE MILE ISLAND UNIT 2

System Criteria For Use Of Steam Generators For Short And Long Term Cooldown

1.0 SYSTEMS CRITERIA

This document defines the design criteria for providing for water to water cooling in the steam generators to remove decay heat on a short term and long term basis.

2.0 SHORT TERM BASIS

2.1 Functional Performance Requirements

Recirculation of low pressure closed cycle water thru the secondary side of the steamy generators for removal of decay heat from the primary coolant. The ultimate sink shall be river water.

2.2 Applicable Code And Standards

Piping	- ANSI B31.1
Heat Exchanges	- ASME Section VIII
Tanks	- ASME Section VIII
Pumps	- ASME Section VIII or API
Valves	- ANSI B16.5, B16.34

2.3 Design Basis

2.3.1 Steam, Generator A

Use the existing condensate - feedwater system. Operate one condensate pump with the others standby.. The condensate booster pump and feedwater pump are not running and the cooling water is pumped thru (impellers removed and aux. cooling water not required). The feedwater heaters are bypassed and the water enters the steam generator thru normal main feedwater connection and out the main steam connection to the main condenser via the condenser makeup line. A manual means of locking the makeup control valve in position shall be provided. Alternate diesel generator power must be supplied to electrical components where necessary in case of loss of off-site power to provide proper system operation.

Circulating water system in normal operation will be used. In case of loss of off-site power, diesel powered alternate cooling water source (river water) will be employed. Diesel power to circulating water pump discharge valve will be used. Makeup shall be taken from th condensate storage tanks by gravity to the condenser.

Loss of condenser vacuum requires opening of the vacuum breaker (to be diesel powered), and recirculation of the condensate pump discharge to cool condensate in hotwell. System shall be checked for correct valve alignment. Those items which could interfere with the proper function of the system shall be locked out.

Connections shall be provided for tie in of the long term cooling system. These connections and any non-isolatable portions of the short term cooling scheme shall be of adequate pressure class to be compatible with the design pressure of the long term system.

Sismic classification shall be non-siesmic Category I.

Provisions shall be made for slow, controlled filling of the steam generator to avoid water hammer (steam bubble collapse) and too rapid cooling of the steam generator.

2.3.7 Steam Generator "B"

System to be closed cycle, to contain contamination, utilizing an existing heat exchanger - pump system. This system to be cross connected to existing feedwater system downstream of feedpumps and to main steam system. Flow direction in the steam generator is in through the main feedwater connection and out through the main steam nozzle. Flow control shall be manual via a valve (either existing or new) in the pump discharge line. Alternate diesel power shall be supplied to electrical components where necessary in the closed loop to provide proper system operation in the event of loss of offsite power. Closed cycle system to use demineralized water with makeup taken from the demineralized water system.

Provide new surge tank if necessary.
Provide connections for tie in of long term cooling system. Connections provided for the future addition of the long term cooling scheme and non-isolatable portions of the short term scheme shall be of adequate pressure class to be compatible with the design pressure of the long term system. For temperature control, provisions shall be made to bypass the heat exchanges on the closed cycle side. Siesmic classification shall be non-siesmic Category I.

Provisions shall be made for slow, controlled filling of the steam generator to avoid water hammer (steam bubble collapse) and too rapid cooling of the steam generator.

System shall be checked for correct valve alignment. Those items which could interfere with the proper function of the system shall be locked out. Vents and drains shall be provided.

2.4 Sizing Requirements

Flow to Steam Generator	3000 gpm
Heat Exchanger Outlet Temp/S.G. Inlet	100^{o} F
Heat Exchanger Inlet/S.G. Outlet	120^{o} F - 200^{o} F
System Pressure	Capability of existing components
Heat Exchanger Duty	30 x 10^{6} Btu/hr
River Water Inlet Temperature	32 to 85^{o} F
River Water Flow	Steam Gen. "A" 17,100 gpm
River Water Flow	Steam Gen. "B" Approx. 4,000 gpm

163 170

2.5 Layout Requirements

2.5.1 Steam Generator "A"

Reference Figure 1 attached.

Secondary side shall utilize existing condensate, feedwater, and main steam systems.
On the river water side, the nuclear services cooling water system shall be cross connected to the circulating water system to provide cooling on loss of offsite power. Cross connections shall be made in the pumphouse from the nuclear services river water to the secondary services river water system, and in the turbine building from the secondary services river water system to the circulating water system.

The cooling water system to steam generator "A" must be isolated from steam generator "B" cooling system.

2.5.2 Steam Generator "B"

Reference Figure 2 attached.

Secondary side shall utilize portions of the existing feedwater and main steam system cross connected with new piping to the existing secondary services closed cooling water system. These cross connections shall be made in the turbine building.

On the river water side, the nuclear services cooling water system shall be cross connected to the secondary services river water system in the river water pump house.

Provision shall be made to bypass the heat exchanges on the closed loop for temperature control.

2.6 Environmental Requirement

All equipment is or shall be located indoors in the river water pump house or turbine building except the alternate diesel generators which shall be suitable for outdoor installation.

2.7 Sampling Requirements

Sampling provisions on the steam generators inlet and outlet for water chemistry and radiation monitoring.

2.8 Material Requirement

All materials shall be compatible with the fluids being pumped.

163 171

2.9 Electrical Requirements

(Later)

2.10 Testing Requirements

Provision shall be made for preoperational testing of the system, including hydrostatic testing and flushing of new piping.

2.11 Instrumentation And Control

Review existing instrumentation and controls to assure proper function of system under new conditions. Specific consideration shall be given to the affects on system operation of spurious automatic control signals to existing plant components that are part of this system.

Instrumentation to be provided for the following:

Flow	0 - 6000 GPM range
Temperature	0 - 500°F
Pressure	Pump shut off head
Radiation Monitoring	Area monitoring where equipment and components are installed

Instrumentation and controls shall be local.
Flow and temperature control shall be manual.

Critical instrumentation shall be redundant.

2.12 Water Chemistry Requirements

Water chemistry shall be maintained in accordance with the following:

PH @ 77°F	9.3 - 10.5
O_2 (dissolved)	100 PPB max (OTSG < 300°F)
Cation Conductivity	1.0 μ mho / cm^2
Hydrazine	At least 300% of stoichimetric O_2 concentration

LONG TERM BASIS

Functional Performance Requirements

Recirculation of high pressure closed cycle cooling water thru the secondary side of the steam generators for removal of decay heat from the primary coolant. The ultimate heat sink shall be river water.

Applicable Codes and Standards

Piping	- ANSI B31.1
Heat Exchanges	- ASME Section VIII
Tanks	- ASME Section VIII
Pumps	- ASME Section VIII or API
Valves	- ANSI B16.5, B16.34

Electrical (later)

Note: ASME Section III components will be utilized when available

Design Bases

.1 The system shall be designed as non-seismic category I.

.2 The system shall be designed for long term continuous cooling for a minimum of two years.

.3 The system shall be designed to operate with a loss of off-site power.

.4 The system shall have the ability to accommodate changes in fluid volume and temperature in the closed loop.

.5 The system shall have the capability to regulate the temperature of cooling water entering the steam generator.

.6 The system shall be designed to operate at 100% capacity with a loss of a single active component.

.7 The system shall be equipped with sufficient test and instrumentation connections for system preoperational testing and normal operation.

.8 The system shall be designed to supply cooled water to the steam generator through the main feedwater nozzle and receive heated water through the main steam nozzle.

.9 The system design shall employ all welded connections to the greatest extent possible to minimize system leakage.

.10 The cooling system loop for the "A" steam generator shall be designed to minimize the unavailability of the "A" steam generator when bringing the cooling system on line.

.3.11 The system shall include provisions for future addition of automatic controls and alarms.

.3.12 The system design shall maintain containment integrity.

.3.13 The system design shall provide means for controlling cooling water chemistry requirements as specified by B & W.

.3.14 The system design shall minimize the use of auxiliary support systems (bearing cooling water, lubrication oil, instrument air).

.3.15 The system shall be designed to operate at a pressure higher than the primary coolant pressure so there will be no leakage of primary water into the closed cooling system.

.3.16 The system shall be designed to remove the required heat load with variations in the temperature of the ultimate heat sink.

.3.17 The system design must include the capability to degas the cooling water.

.3.18 The system shall have provisions for a future clean-up system should the cooling water become contaminated.

.3.19 The system shall be provided with proper overpressure relief devices.

.3.20 The system shall have provisions for proper system flushing prior to startup.

.4 Sizing Requirements

.4.1 The system shall be designed to meet the following requirements:

(a)	flow through steam generator	3000 gpm
(b)	steam generator inlet temperature	100°F
(c)	steam generator outlet temperature	120° to 200°F
(d)	design pressure at S/G inlet	800 psi
(e)	river water temperatures	34° to 85°F
(f)	river water flow rate	as required to remove heat load with a 10°F or less increase in river water temperature

.5 Layout Requirements

.5.1 The system equipment shall be located to facilitate construction and ease of access during operation.

.5.2 The system flow path shall consist of cooled water entering the steam generator through the main feedwater nozzle, exiting the steam generator through the main steam line, entering the heat exchanges (coolers) and returned back to the steam generator using the system pumps. (Refer to figure 3). The ultimate heat sink shall be provided by the nuclear services river water system.

1.6 Environmental Requirements

1.6.1 All equipment shall be located indoors except the alternate diesel generators which shall be suitable for outdoor installation.

1.7 Sampling Requirements

1.7.1 Adequate sampling connections shall be provided for water chemistry and radiation monitoring.

1.8 Material Requirements

1.8.1 All wetted materials shall be compatible with the water being handled.

1.9 Electrical Requirements

1.9.1 (later)

1.10 Testing Requirements

1.10.1 Provisions shall be made for preoperational testing of the system, including hydrostatic tests.

1.11 Instrumentation and Control Requirements

1.11.1 The system shall be designed to provide instrumentation sufficient to monitor functional performance requirements including:

(a) pump discharge pressure, 0 - 800 psig.
(b) steam generator inlet and outlet temperatures 50 - 250 F
(c) flow rate, nominally 3000 gpm
(d) river water inlet and outlet temperatures 0 - 100 F

1.12 Water Chemistry

1.12.1 Water chemistry shall be maintained in accordance with the following:

(a)	ph @ 77° F	9.3 - 10.5
(b)	O_2 dissolved	100 ppb max. (otsg<300 F)
(c)	Cation conductivity	1.0 μmhs / cm^2
(d)	Hydrazine	at least 300% of stoichiometric O_2 concentration

Critical instrumentation shall be redundant.

Area radiation monitoring shall be provided where the equipment and components are installed.

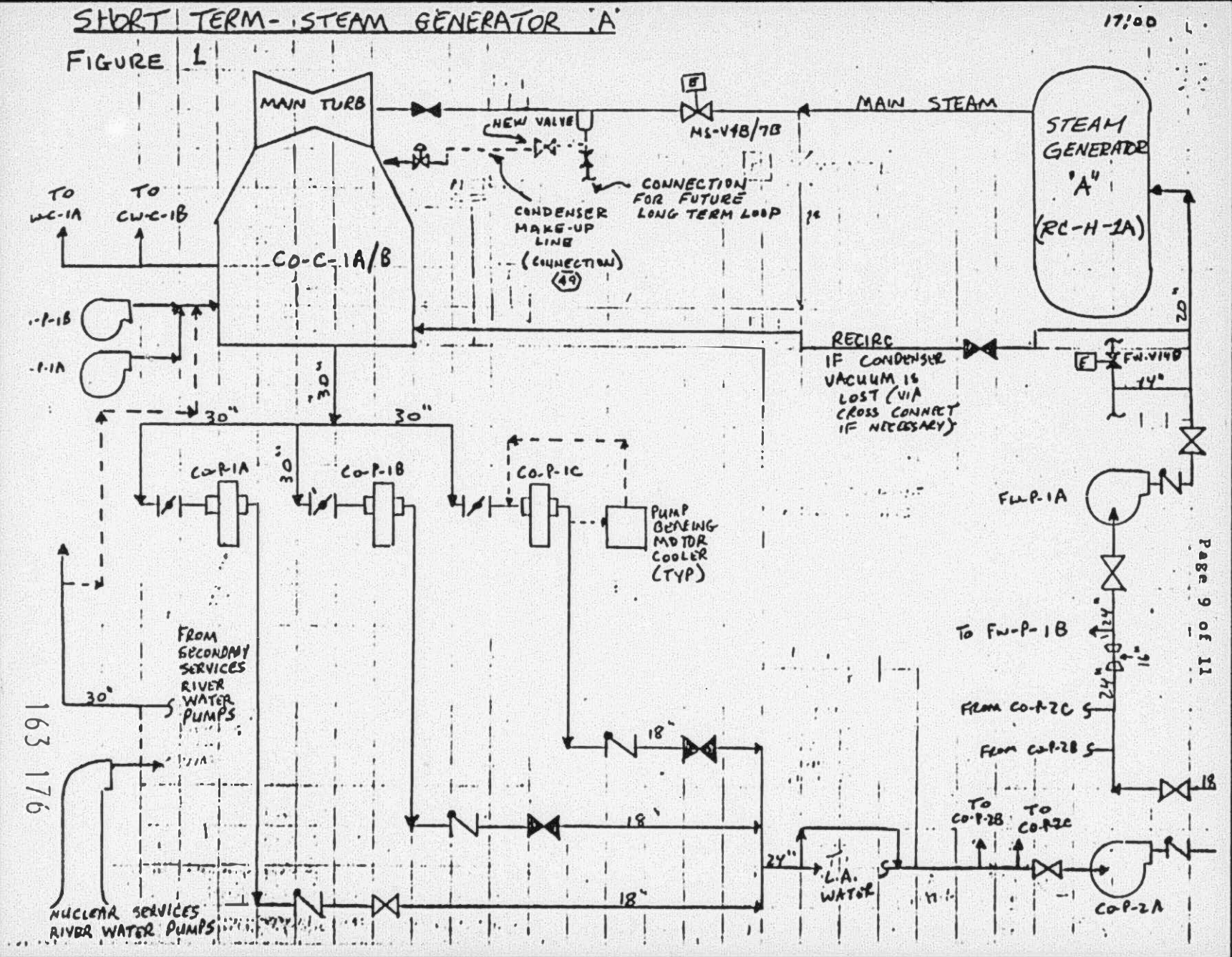
Specific consideration shall be given to the affects on system operation of spurious automatic control signals to existing plant components that are part of this system.

163 175

SHORT TERM - STEAM GENERATOR 'A'

17:00

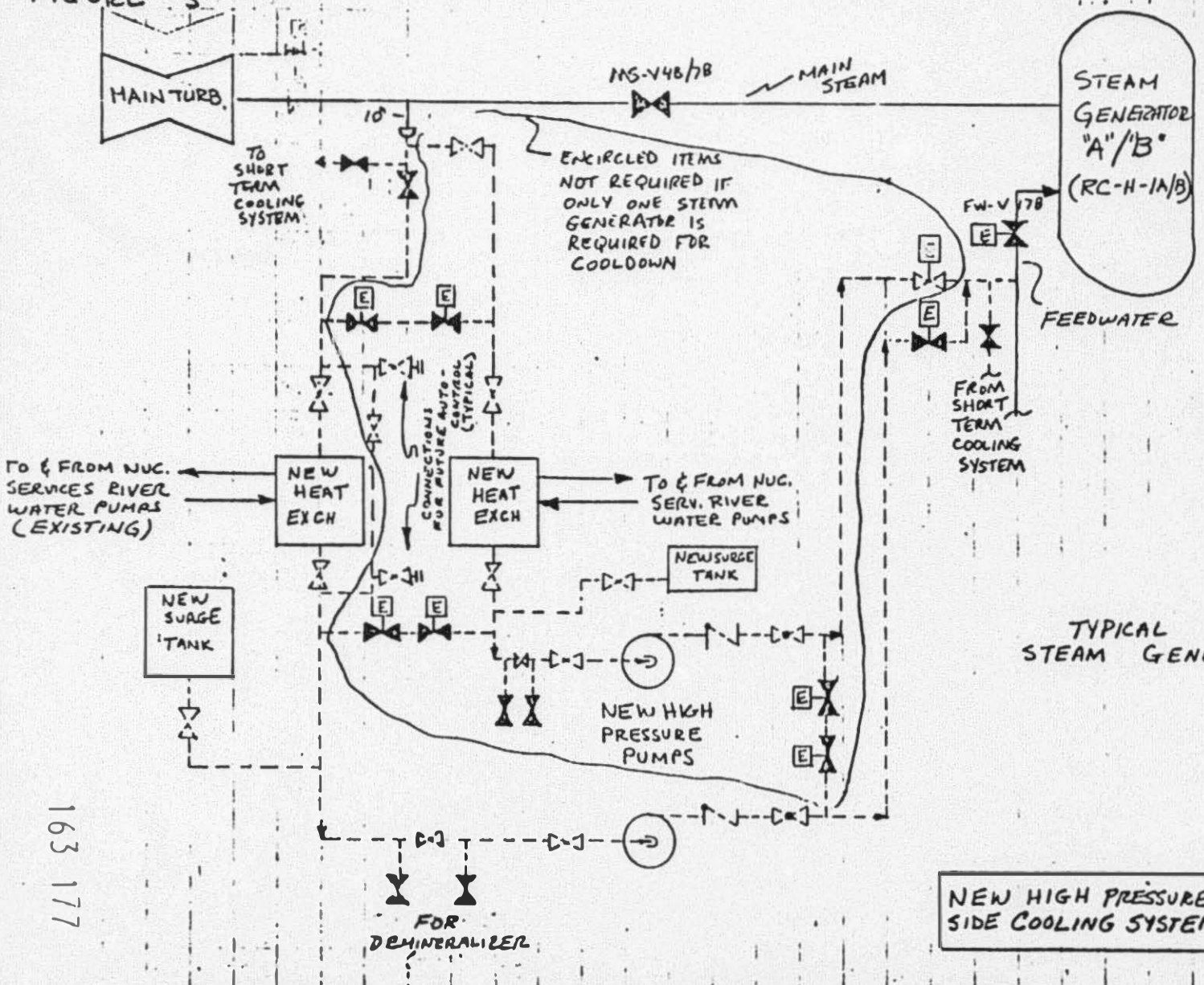
FIGURE 1



LONG TERM GEN'S A&B

FIGURE 3

REV. 1 4/21/ 17:00



NEW HIGH PRESSURE SECONDARY SIDE COOLING SYSTEM