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THREE MILE ISLAND - UNIT NO. 2

MINI DECAY HEAT REMOVAL SYSTEM

DESIGN CRITERIA

REVISION	DATE	PREPARED BY	APPROVED BY
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REVISION	DATE	PREPARED BY	APPROVED BY
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MINI DECAY HEAT REMOVAL SYSTEM

DESIGN CRITERIA

1.0 SCOPE

This document establishes the design criteria for a small scale decay heat removal system to be used to cool the reactor core for three years. The system consists of a pump/heat exchanger subloop to be installed in parallel with the existing decay heat system and in parallel with the Westinghouse designed Alternate Decay Heat Removal System. The system will be used to remove decay heat from the reactor core until full defueling has been performed.

2.0 INTRODUCTION

The reactor coolant system is currently in a natural circulation mode with heat being removed through Steam Generator "A" in a steaming mode. In order to reduce the vulnerability of the plant cooling mode, a force circulation system with a minimum of supporting systems is preferred.

A small scale decay heat system capable of removing the small amount of decay heat remaining ($\leq$1 MW) in the Unit 2 core will suit this purpose. All system components shall be enclosed in the existing Unit 2 Fuel Handling Building or Auxiliary Building to minimize the potential for release of radioactivity to the environment.

3.0 FUNCTIONAL AND DESIGN REQUIREMENTS

3.1 Performance Requirements

3.1.1 The system shall recirculate reactor coolant through the core for removal of decay heat. The ultimate heat sink shall be river water with the Nuclear Services closed cooling loop to transfer heat from the reactor coolant to river water.

3.2 Applicable Codes and Standards

Piping shall be:

Description	Manufacturing Code	Installation Code
Connection to the decay heat system downstream of DH-V3 up to and including the first isolation valve.	ASME - Section III Class 2	ANSI B31.7 Class 2
Connection to the decay heat system downstream of DH-V3 from the first isolation valve up to and including the second isolation valve	ASME - Section III Class 3	ANSI B31.7 Class 2
Connection to the decay heat system upstream of DH-V4B up to and including the second isolation valve	ASME - Section III Class 2	ANSI B31.7 Class 2
Connections to the existing Nuclear Services closed cooling system		
piping up to isolation valve	ANSI B31.1*	ANSI B31.1*
isolation valves	ASME - Section III Class 3	ANSI B31.1*
Balance of piping	ANSI B31.1	ANSI B31.1
Heat Exchangers	ASME - Section VIII TEMA Standard (ASME Section III if available)	- - -
Pumps	Hydraulic Institute Standards (ASME Section III if available)	- - -
Filter	ASME - Section VIII	- - -

Rev 1 Rev 5 Rev 6

* Seismically supported for Category I loadings

Rev 5

3.3 Design Basis

3.3.1 The portions of the system that are ANSI B31.7 Class 2 shall be seismic Category I. The remaining portions of the system that convey reactor coolant shall be designed to operating basis-earthquake (OBE) loads. The balance of the system can be designed as nonseismic except the NSCC tie-in lines up to the isolation valves shich shall be category I seismically supported. Rev 3 Rev 5

3.3.2 The system shall be designed to operate with a loss of offsite power.

3.3.3 The system shall be equipped with test and instrumentation connections for system pre-operational testing and normal operation.

3.3.4 The system shall be designed to supply cooled reactor coolant water to the RCS through the Decay Heat Injection lines and receive heated coolant through the Decay Heat return lines.

3.3.5 The system design shall employ all welded connections to the greatest extent possible to minimize system leakage. All two inch and larger piping shall be welded except flanges at equipment connections. All connections to the process piping shall be welded or screwed with seal weld up to the root valve. Rev. 2

3.3.6 The piping system and equipment shall be provided with adequate vent and drain connections.

3.3.7 The system design shall minimize the use of auxiliary support systems (bearing cooling water, lubrication oil and instrument air). Loss of instrument air shall not change the operating parameters (flow and temperature) of the system.

3.3.8 The system shall be designed to remove the required heat load at the temperature of the cooling water shown in Section 3.4.

3.3.9 The system shall have provisions for the future installation of a water purification system with the capability (resin disposal and shielding) to handle radioactive water. Installation and startup of this equipment shall not interrupt system function.

3.3.10 The system shall be provided with proper overpressure relief devices. The discharge of the overpressure relief devices shall be piped such that they minimize the spread of contaminated fluids and shall be provided with some means of visual indication of leakage. Rev 5

3.3.11 The system shall have proper connections and other provisions for flushing of new piping and components prior to startup. New piping and components shall be in a clean and neutralized state when installed. Chemical cleaning shall not be used after installation.

3.3.12 Provisions shall be made to handle system leakage or drainage such as pump seal leak-offs, flanges, and valve stems. Consideration shall be given to containing both gaseous and liquid effluents, and safely delivering the wastes to GPU approved processing systems.

3.3.13 A recirculation line to meet the startup flow requirements of the pumps shall be provided. Rev. 2

A system recirculation line is acceptable for this service. Rev. 3

3.3.14 The system shall be designed for long-term continuous cooling for a minimum of three years.

3.3.15 For increased system availability considerations, the system shall have redundant heat exchangers and pumps.

3.3.16 The system shall be designed to be isolated from the existing plant safety systems. The system, when in the isolated mode, shall not jeopardize the operability or pressure integrity of the existing plant safety systems. The isolation from the Decay Heat Removal System shall be with double isolation valves.

3.3.17 The system shall have provisions for remote isolation, draining, and flushing to minimize radiation exposure to maintenance personnel Rev 5

3.3.18 The MDHR System Design shall include a filter which will be located in the supply line to the MDHRS. The filter will be replacable, and will be replaced should plugging occur and filter bypassing not be technically acceptable. Rev. 8

3.4 Sizing Requirements

3.4.1 The system shall be designed to meet the following requirements:

(a)	Flow through reactor core	120 to 175 gpm
(b)	System inlet temperature	180° F
(c)	System outlet temperature	130° F
(d)	Design Pressure	
	Coolers and pump suction	235 psig
	Pump and discharge piping	235 psig
(e)	NSCC water temperature	100° F (maximum)
(f)	NSCC water flow rate	200 gpm
(g)	Heat Exchanger duty	See Curve 1

Rev. 6

Rev. 2

3.5 Layout Requirements

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

3.5.2 The system flow path shall consist of cooled reactor coolant entering the Decay Heat Removal System upstream of valve DH-V4B, flowing through the reactor core and returning back to the heat exchanger through the Decay Heat Removal drop line and the new system connection downstream of DH-V3. On the cooling water side, the Nuclear Services closed cooling system shall be connected to the shell side of the new Mini Decay Heat Exchanger (refer to Figure 1, attached).

3.5.3 The ultimate heat sink shall be provided by the Nuclear Services River Water System.

3.5.4 Radiation shielding shall be provided between the pumps and other equipment and piping to minimize the radiation exposure to maintenance personnel while working on either of the pumps. This shall include shielding between the two pumps.

Radiation Shielding and reach rods shall be provided to minimize the exposure to operating personnel when realigning system valving. Rev. 2 & Rev. 6 & Rev. 7

3.6 Equipment Requirements

3.6.1 All equipment shall be located inside the Fuel Handling Building and Auxiliary Building.

3.6.2 Consideration shall be given to the integrated radiation exposure to all sensitive materials (electrical equipment, elastomers, etc.) over the design life of the system. If equipment cannot be satisfactorily shielded, the materials shall be compatible with expected exposure.

3.6.3 If area radiation levels at the pumps are expected to inhibit routine maintenance operations on the pumps, consideration shall be given to provide remote bearing lubrication to the pumps and motors.

3.7 Sampling Requirements

Connections shall be provided for future sampling lines.

3.8 Materials Requirements

All wetted materials shall be compatible with fluids having water chemistry specified in Section 3.12. It is expected that austenitic stainless steel type 304 or 316 shall be used. | Rev. 2

3.9 Electrical Requirements

3.9.1 Electrical equipment shall be capable of being started and powered from an on site 1E diesel generator set in the event of a loss of off site power. Loads shall be sequenced on to the diesel generator set manually. | Rev 3

3.9.2 Electrical classification of the system is non-1E, however the electrical power to the operators on the system isolation valves and the pump motors shall be class 1E. The instrumentation shall be powered from one class 1E bus. | Rev. 5

3.9.3 Motor rated starting voltage shall be verified and consistent with the voltage regulation capability for the diesel generator to be used. Motor feeders shall be protected consistent with the original plant design and the normal trips for overload, etc., shall be used.

3.9.4 Electrical Load list: will be provided in the system description. Rev. 5

3.9.5 "Criteria for General Modification to the BOP Electrical System" are applicable. Also, refer to "Criteria for Loss of Offsite BOP Electrical Power".

3.9.6 The power supply to the pump motors shall be supplied from separate 1E buses.

3.9.7 The Mini Decay Heat Removal pump motor power supplys are to be interrupted when the installed decay heat removal pumps are started. This provision shall not inhibit the operation of the decay heat pumps. Rev. 5

3.10 <u>Testing Requirements</u>

Provisions shall be made for pre-operational testing of the system, including hydrostatic tests, flushing of new piping, and demonstration of required pumping capability.

3.11 <u>Instrumentation and Control Requirements</u>

3.11.1 The system shall be designed to provide instrumentation to monitor functional performance requirements, including but not limited to:

(a) Pump discharge pressure 0-300 psig

(b) Heat Exchanger inlet and outlet 50-250° F

(c) Flow Rate

Nominally	120 gpm
Maximum	200 gpm

(d) N.S.C.C. inlet and outlet

Temperature	50-150° F

(e) Pump Suction Pressure 0-200 psig Rev. 2

3.11.2 Control circuits for existing eqipment shall be reviewed to ensure that no spurious automatic, or interlock signals will cause incorrect operation of the system.

3.11.3 Provisions shall be made for installation of controls and remote indicators in the Unit 2 Control Room. Controls and indicators shall be located in the new control panel provided. Rev. 7

3.11.4 Control shall be manual. The pump control switch shall have start, normal, stop and spring return to normal positions. Run/off indicator lights shall be provided for motors and open/close lights shall be provided for the system isolation valves. (Both lights shall be on when valves are in intermediate position). Rev. 3

3.11.5 Control cables should have 50%, and preferably 100%, spare conductors to allow for future modifications.

3.11.6 Loss of system flow shall be alarmed locally and in the main control room.

3.11.7 (Deleted) Rev. 4

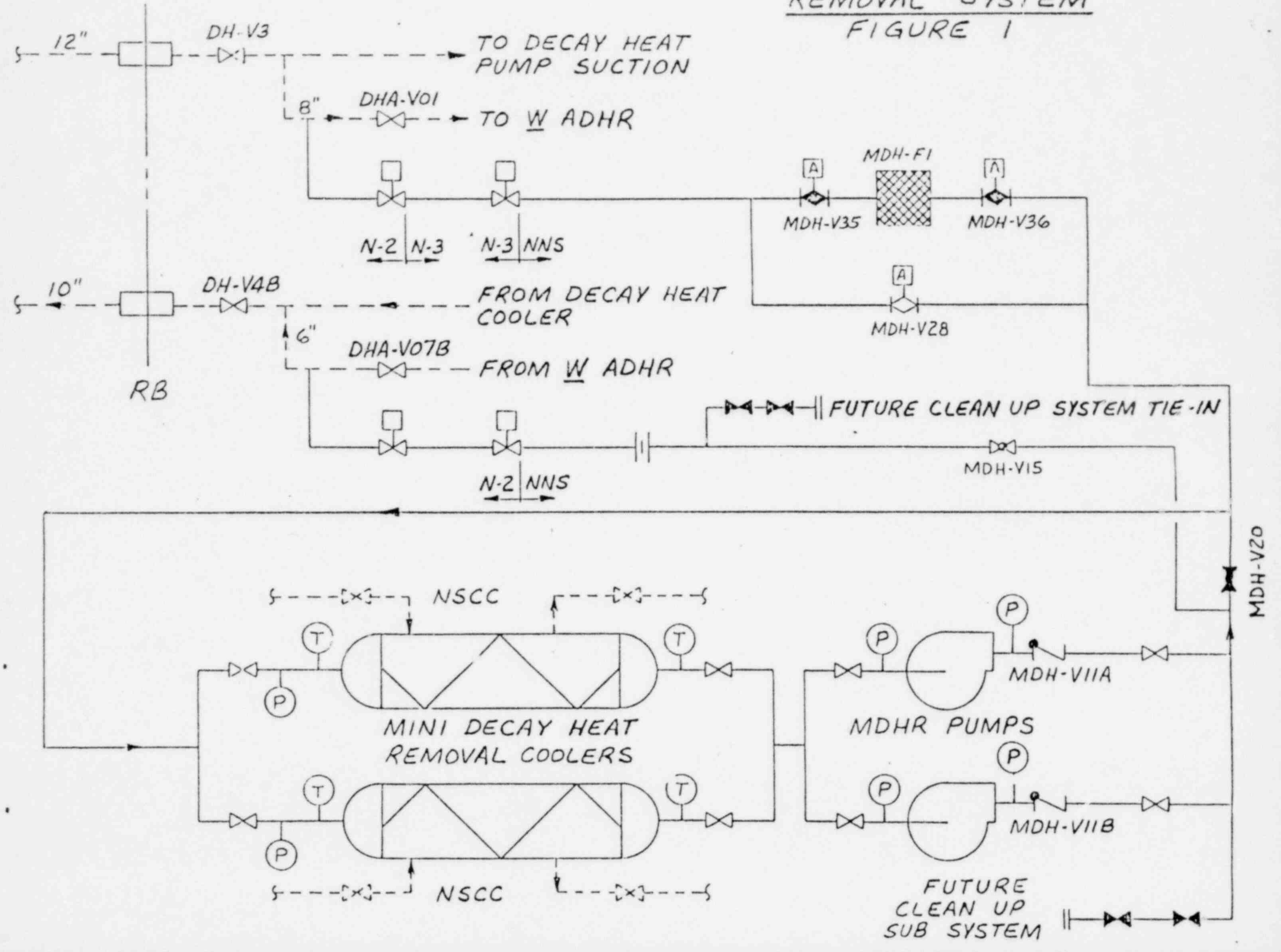
3.11.8 The isolation valve(s) on the NSCC system shall automatically close on detection of a leak, i.e., imbalance in the flow to and from the Mini Decay Heat Removal cooler.

3.11.9 Area radiation monitors shall be provided and shall alarm on the local control panel and in the Control Room.

3.12 Water Chemistry

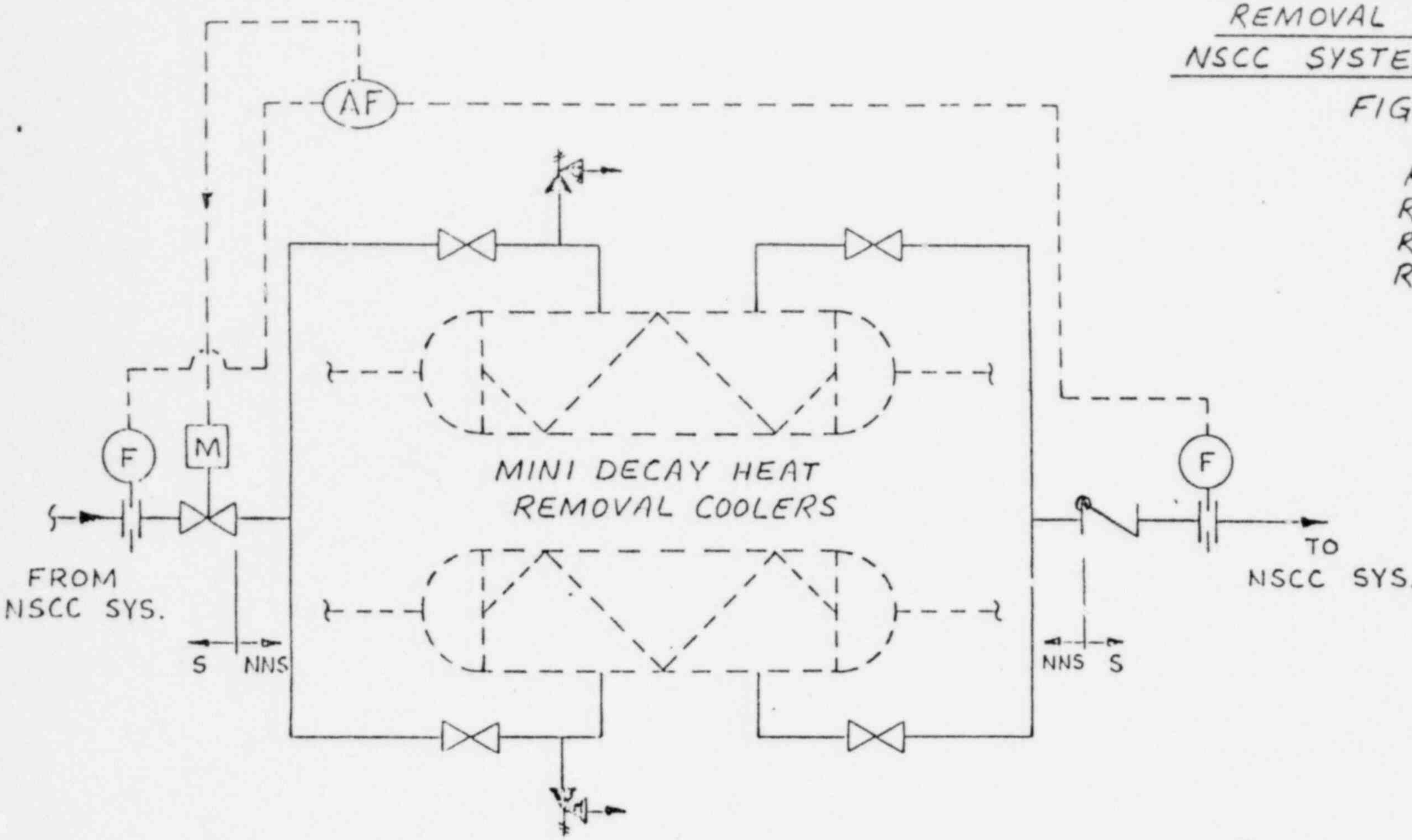
pH	7.5 - 9.5 (nominal 8.5)	
Boron	3000 - 4000 ppm	
Hydrogen	5-40 cc/Kg (nominal 15-40 cc/Kg)	Rev. 2
Chloride	$<$4 ppm	
Fluoride	$<$1 ppm	
Dissolved Oxygen	$<$0.1 ppm	

"MINI" DECAY HEAT REMOVAL SYSTEM
FIGURE 1



"MINI" DECAY HEAT
REMOVAL SYSTEM
NSCC SYSTEM CONNECTION
FIGURE 2

REV. 1 7-19-79
REV. 2 8-1-79
REV. 3 9-10-79
REV. 4 9-21-79



NOTES: ① NNS- B31.1 (NON NUCLEAR SAFETY)
② S- B31.1 SEISMICALLY SUPPORT FOR SAME

THI-2 EXPECTED DECAY HEAT LOAD VS. TIME, 1980