2

CERTIFICATION: See Sheet iii for RPE Certification for this Design Specification

DESIGN SPECIFICATION

FOR

NUCLEAR SERVICE PIPING

FOR THE

CONSUMERS POWER COMPANY

MIDLAND PLANT UNITS 1 AND 2

MIDLAND, MICHIGAN

FOR INFORMATION ONLY

WORKING COPY

MPQAD QAE 5/9/83

No.	DATE	REVISION	BY	CH'K	APPR
2	5-9-83	Revised as Noted; Added Appendix A; New Cover Sheet, Facing Sheet, and New Certification Sheets for Design Specification and B&W Referenced Documents; deleted Reference List 1 and Figure 1			EMH

ORIGIN DATE

BECHTEL

JOB No. 7220

SPEC/DES GUIDE No.	REV
7220-M-321(Q)	2

SHEET 1 OF ix

8311100259 831028
PDR ADOCK 05000329
A PDR

CERTIFICATION:

S.D. Thadhani, the undersigned, certify that this Design Specification is correct and complete and is in compliance with the requirements of ASME Boiler and Pressure Vessel Code, Section III, Division 1, Subsubarticle NA-3250, 1971 Edition with Addenda through Summer 1973. 2

STATE OF MICHIGAN SURENDER D. THADHANI ENGINEER No. 28192 LICENSED PROFESSIONAL ENGINEER

S.D. Thadhani 11/12/82

DESIGN SPECIFICATION

FOR

NUCLEAR SERVICE PIPING

FOR THE

CONSUMERS POWER COMPANY

MIDLAND PLANT UNITS 1 & 2

MIDLAND, MICHIGAN

STATE OF MICHIGAN GORDON TUVESON ENGINEER No. 22376 REGISTERED PROFESSIONAL ENGINEER

STATE OF MICHIGAN RONALD W. ZORNEY ENGINEER No. 17926 REGISTERED PROFESSIONAL ENGINEER

Certification:

We, R. W. Zorney, and G. Tuveson, certify that this Design Specification covers the requirements as prescribed by ASME Boiler and Pressure Vessel Code, Section III, paragraph NA-3255.

Ronald W. Zorney 4/28/76
Signature Date

Gordon Tuveson 4/23/76
Signature Date

No.	DATE	REVISIONS	BY	CHK.D	GROUP LEAD	GROUP SUPV.	PROJ. ENGR.	CHIEF ENGR.
2		Revised as noted; defined seismic boundaries for field-routed piping; Incorporated SCN 1 and						
1	12/3/82	SNC 2 (MODIFIED) DMR Dm/QA						
0	4/26/76	Issued						

SCALE | DESIGNED | DRAWN

ORIGIN: BECHTEL

MIDLAND PLANT UNITS 1 AND 2
CONSUMERS POWER COMPANY

JOB No. 7220

DRAWING No. 7220-M-321(Q) Sheet ii REV. 2

AA-G-122673 "A" SIZE

CERTIFICATION FOR NSSS VENDOR DOCUMENTS REFERENCED IN THE DESIGN SPECIFICATION

We, the undersigned, certify that, to the best of our knowledge based on information provided by the Babcock & Wilcox Company (nuclear steam supply system supplier), References Y and Z of this specification conform to the requirements of NA-3252(b), 1971 Edition with Addenda through Summer 1973.

Rev	Date	RPE(s) Signature(s)	RPE(s) Stamp(s)
2	5/5/83	W. A. Skelley	STATE OF MICHIGAN WILLIAM A. SKELLEY ENGINEER No. 29831 LICENSED PROFESSIONAL ENGINEER

SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV
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NO.	DATE	REVISIONS	BY	CHK'D	APP'D	NO.	DATE	REVISIONS	BY	CHK'D	APP'D
2	5-9-83	Revised as Noted; Added Facing Sheet	[illegible]	[illegible]	[illegible]						

FACING SHEET

MIDLAND PLANT UNITS 1 AND 2
CONSUMERS POWER COMPANY

JOB No. 7220

Specification 7220-M-321(Q)

REV 2

Sheet v

AAPD-0254 7/82

DESIGN SPECIFICATION

FOR

NUCLEAR SERVICE PIPING

CONTENTS

APPENDIX

REFERENCES

The latest revision of the following documents are applicable:

Bechtel Documents

A Drawing 7220-M-481(Q), Piping Class Sheets

B Drawing 7220-M-480(Q), Piping Class Summary Sheets

C Earthquake Resistance Design and Wind Loads for ASME III, Division 1 Nuclear Service Piping, Drawing 7220-C-353(Q)

D Specification 7220-M-324(Q), Code Effective Dates for the Construction of Nuclear Service Piping Systems, Including Piping Supports

2

CONTENTS (Continued)

Referenced P&IDs

P&ID	Sheet	Description
M-401A(Q), M-401B(Q)		Reactor coolant and pressure control, Unit 1
M-402A(Q), M-402B(Q)		Reactor coolant and pressure control, Unit 2
M-403(Q)	1A, 1B, 2A, 2B	Makeup and purification, Unit 1
M-404(Q)	1A, 1B, 2A, 2B	Makeup and purification, Unit 2
M-408(Q)	1	Boron recovery, Units 1 and 2
M-409A(Q), M-409B(Q)		Radwaste gas, Units 1 and 2
M-410(Q)		Decay heat removal and core flooding, Unit 1
M-411(Q)		Decay heat removal and core flooding, Unit 2
M-412A(Q), M-412B(Q)		Reactor building spray, Unit 1
M-413A(Q), M-413B(Q)		Reactor building spray, Unit 2

2

CONTENTS (Continued)

CONTENTS (Continued)

1.0 SCOPE

This specification covers the design basis for construction of nuclear service piping and instrument tubing/piping (instrument tubing/piping is hereafter referred to as instrument piping) as mandated by Subsubarticle NA-3250 of ASME Boiler and Pressure Vessel (B&PV) Code, Section III, 1971 Edition, Summer 1973 Addenda. ASME Class 1, 2, and 3 are addressed by this specification. Piping, as referred to in this specification (unless specifically stated otherwise), includes nuclear service piping and instrument piping.

2.0 FUNCTION

The function of piping is to contain and transport process fluids, and to maintain pressure boundary under conditions defined by this specification (including appendix and/or references). The function of instrument piping is to contain the process fluids for measurement of the process parameters by the associated instruments. The function of piping components is defined in Appendix A.

3.0 DESIGN REQUIREMENTS

Piping systems are constructed in accordance with ASME Section III, 1971 Edition, up to and including Summer 1973 Addenda. As permitted in NA-1140, code cases and later code editions and addenda are used as defined in Specification 7220-M-324(Q) (Reference D).

All piping shall be Seismic Category I. Seismic pressure class and ASME class boundaries are indicated in Article 6.0.

3.1 DESIGN CRITERIA FOR ASME CLASS 1 PIPING IN THE BALANCE-OF-PLANT SCOPE OF SUPPLY

Condition	Stress Limit(1)
Normal	NB-3222, NB-3653
Upset	NB-3223, NB-3654
Emergency	NB-3224, NB-3655(2)
Faulted	NB-3225, NB-3656(2)

(1) As specified by ASME Section III

(2) For those systems that must remain functional during and following a specified plant emergency or faulted condition, the maximum stress level will be limited to one of the following:

a) The yield strength of the material

b) The functional capability criteria based on NRC NUREG/CR-0261. If the stress in any portion of the piping system exceeds NRC criteria, the inelastic behavior will be evaluated on a case-by-case basis for its effect on the system's structural stability.

3.2 DESIGN CRITERIA FOR ASME CLASS 2 AND 3 PIPING IN THE BALANCE-OF-PLANT SCOPE OF SUPPLY

Condition	Stress Limit
Design, Normal Upset	The piping shall conform to the requirements of Section III, Sub-articles NC-3600 and ND-3600.
Emergency and Faulted	The piping shall conform to the requirements of Code Case 1606-1.

For those systems that must remain functional during and following a specified plant emergency or faulted condition, the maximum stress level will be limited to one of the following:

a) The yield strength of the material

b) The functional capability criteria based on NRC NUREG/CR-0261. If the stresses in any portion of the piping system exceed the NRC criteria, the inelastic behavior will be evaluated on a case-by-case basis for its effect on the system's structural stability.

3.3 DESIGN LOADINGS

3.3.1 Internal Design Pressure

Internal design pressures for the piping systems are listed in detail by pipe class and line number in the piping class summary sheets, Drawing 7220-M-480(Q), Reference B. The instrument piping is designed for the associated nuclear service piping internal design pressures.

2

3.3.2 External Design Pressure

For those piping systems that operate under vacuum (e.g., service water system) or where the external pressure exceeds the internal pressure (e.g., containment building penetrations for fire protection, plant heating, air room supply/exhaust, purge supply/exhaust, H_2 vent supply/exhaust), the piping is designed for the differential pressure acting externally.

3.3.3 Weight of the Component and Normal Contents Under Operating or Test Conditions

The piping (excluding instrument piping) weight is computed based on pipe thickness and size specified by the piping class sheets, Drawing 7220-M-481(Q), Reference A. The instrument piping weights are computed from the materials specified in Drawing 7220-J-401-2(Q), Sheet 2, Instrument Piping Specification for ASME Section III Nuclear Piping or Seismic Category 1 (Reference F). The piping fluid loads are included in weight calculations.

3.3.4 Superimposed Loads

a. Weights of components superimposed on piping are obtained from the vendor drawings and/or component data sheets.

b. Insulation weight is included in calculations for superimposed loads.

c. The effect of soil is considered by modeling the buried piping approximately 30 feet into the soil by using fictitious, two-way restraints and anchors considering the soil stiffness and piping settlement.

3.3.5 Wind, Snow, and Earthquake Loads

a. The wind load is determined as a uniformly distributed load considering the effects of dynamic pressure, wind velocity, and gust factor as described in Drawing 7220-C-353(Q) (Reference C). The snow loads are obtained from the Uniform Building Code. Maximum snow loads are considered.

b. Earthquake loads for Class 1, Seismic Category I piping are obtained from B&W Specification 18-1391000012 (Reference Z) and general earthquake resistance design Drawing 7220-C-353(Q) (Reference C).

c. Seismic information for Class 2 and 3 piping is obtained from the general earthquake resistance design specifications (Reference C) for the specific building and elevation in which the piping system is located. Seismic information for piping outside the buildings is obtained from site design response spectra curves shown in Drawing 7220-C-353(Q) (Reference C).

3.3.6 Reactions of Supporting Lugs, Rings, Saddles, or Other Types of Supports

The stresses induced in the pipe by thrust and moment loadings applied to lugs and other integral attachments are calculated and combined with other design loads.

3.3.7 Thermal Expansion Loads Produced by System Restraints

The effects of the restraints of free thermal expansion produced by external attachments and connected equipment (either calculated or obtained from the equipment manufacturers) are evaluated for both the thermal service conditions in the piping and thermal displacements of equipment.

3.3.8 LOCA and Jet Impingement Loads

a. LOCA loads are obtained from B&W Specification 18-1391000012 (Reference Z).

b. Jet impingement loads shall be included (as a dynamic event associated with faulted conditions) in analysis for Class 1, 2, and 3 piping systems. 2

3.4 DESIGN LOADING COMBINATIONS(5) FOR ASME CODE CLASS 1,(4) 2, AND 3 COMPONENTS(1) FOR BALANCE-OF-PLANT SCOPE OF SUPPLY (PRIMARY STRESSES ONLY)

Condition	Design Loading Combinations
Design	PD
Normal	PO + DW
Upset(2)	(a) PO + DW + OBE (b) PO + DW + RVC (c) PO + DW + FV (d) PO + DW + OBE + RVO (e) PO + DW + DU
Emergency	(a) PO + DW + DE
Faulted	(a) PO + DW + SSE (b) PO + DW + SSE + RVO (3)(c) PO + DW + SSE + DF (d) PO + DW + DF

2

LEGEND:

PD - Design pressure
PO - Operating pressure
DW - Piping dead weight
OBE - Operating earthquake (inertia portion) (50% of SSE)
SSE - Safe shutdown earthquake (inertia portion)
FV - Fast valve closure
RVC - Relief valve - closed system (transient)(6)
RVO - Relief valve - open system (sustained)(6)
DU - Transient dynamic events associated with an upset service condition
DE - Dynamic events associated with an emergency service condition
DF - Dynamic events associated with a faulted service condition (includes jet impingement) 2

NOTES:

(1)If active valve function must be assured during emergency/faulted conditions, these requirements shall be included in the design specification, and the specified emergency/faulted condition for the plant shall be considered as the normal condition for the valve.

(2)As required by the appropriate subsection (i.e., NB, NC, ND, or NF) of ASME Section III Division I, other loads such as system transient, thermal expansion, and anchor point displacement portion of the OBE may require additional consideration beyond those primary stress-producing loads listed. | 2

(3)The seismic (SSE) loads are combined with LOCA-related faulted loads (DF) for the components of the reactor coolant pressure boundary up to the second isolation valve. SSE loads are not combined with non-LOCA-related faulted loads. The stresses and loads associated with a LOCA will be combined by the square-root-of-the-sum-of- the-squares method with stresses and loads from SSE for balance-of-plant ASME Class 1 components which are part of the main reactor coolant system extending to the second branch line isolation valve. This is not considered as a credible load combination which could actually occur and thus the ASME Class 1 stress reports for the Midland plant balance-of-plant Class 1 systems will not include this combination. This margin is thus considered by Consumers Power Company to be an additional margin which is being provided to account for any possible additional credible loads which might be identified in the future. Use of this margin will not be made without prior notification and discussion with the NRC.

(4)ASME Section III Class 1 analysis includes consideration of transients listed in Reference Y. | 2

(5)All loading combinations except those described in Footnote 3 are by direct summation. The absolute value of the loads are used except in those cases where the loads act in only one direction, as in thermal and dead weight loads. In these cases, the algebraic sign on the loads is taken into consideration.

(6) Relief valve thrust load will be combined with OBE unless it can be shown that the thrust load is transient.

3.5 BASIS FOR ASME CLASS 1 PIPING ANALYSIS

The transients to be used for Class 1 piping design defining normal, upset, emergency, faulted, and testing conditions are given in Babcock & Wilcox Specification 18-1092000012, Reactor Coolant System (Reference Y).

Information affecting piping analysis will be provided as supplementary information attached to the request for piping stress analysis forms submitted with each isometric drawing.

The equivalent full temperature cycles for design are given in Reference Y.

3.6 BASIS FOR ASME CLASS 2 AND 3 PIPING ANALYSIS

Temperature and pressure conditions to be used for design of Class 2 and 3 piping (excluding instrument piping) are given on supplemental system design data sheets or equivalent, submitted with the request for piping stress analysis forms for each piping isometric drawing.

Instrument piping shall be designed for the associated nuclear service piping design conditions; however, instrument piping downstream of the root valve shall be designed for ambient conditions (heat is dissipated because of nonflow conditions).

Equipment nozzle loading allowables pertinent to the piping system design will also be provided as supplementary information.

Unless specifically noted otherwise on the request for piping stress analysis form, piping is designed for less than 7,000 equivalent full temperature cycles. Allowable stress values are decreased to reflect full temperature cycles exceeding 7,000.

4.0 ENVIRONMENTAL CONDITIONS, INCLUDING RADIATION

4.1 RADIATION

Because piping within the scope of this specification is subjected to neutron radiation of inconsequential dosage, radiation has no impact on the metallic pipe. Only piping in the immediate vicinity of the reactor vessel may be subjected to radiation dosage of 4.0×10^{10} rads over a 40-year life.

Maximum integrated radiation over a 40-year life is 2×10^{8} rads inside and outside containment.

4.2 AMBIENT CONDITIONS

4.2.1 Inside Containment

a. Temperature Range

Normal	70 to 120F

During normal plant operation, the containment temperature may drop to 50F.

Faulted (post-accident) LOCA	321F
Main steam line break (MSLB)	469.1F

The faulted temperatures are peak LOCA and MSLB temperatures. Piping will not be subject to these peak temperatures. Piping analysis shall include the effect of actual faulted temperatures.

b. Relative Humidity — Up to 100%

c. Pressure Range

Normal	-3 to 3 psig
Faulted (post-accident - LOCA/MSLB)	-3 to 61.15 psig

2

d. Test Pressures

Structural integrity test pressure	80.5 psig
Integrated leak rate test	61.15 psig

4.2.2 Outside Containment, Inside Plant

a. Temperature Range

Normal	70 to 120F

During normal plant operation, the temperature inside the plant may drop to 50F.

b.	Relative Humidity	Up to 100%
c.	Pressure	Atmospheric

4.2.3 Outside of Plant

a. Temperature Range

Normal

Above Grade	-20 to 120F
Buried Piping	50 to 60F

b.	Relative Humidity	Up to 100%
c.	Pressure Above Grade	Atmospheric

5.0 CODE CLASSIFICATION

Code classifications conform to Paragraph NA-2131 of ASME Section III and are committed to in response to Regulatory Guide 1.26 for pressurized water reactor.

5.1 NUCLEAR SERVICE PIPING (EXCLUDING INSTRUMENT PIPING)

The piping class summary sheets, Drawing 7220-M-480(Q) (Reference B), and the piping and instrument diagrams (P&IDs) (Reference G) designate code classification of nuclear piping systems.

2

5.2 INSTRUMENT PIPING

Instrument piping has the same code classification as the associated nuclear service piping up to the root valve. The instrument piping class corresponding to the main line piping class is designated in Drawing 7220-J401-2(Q), Sheet 2 (Reference F). The locations of ASME Section III boundaries are defined in Section 6.3.

5.3 Components of a higher class may be substituted for a lower class in accordance with Paragraph NA-2134.

6.0 <u>PIPING BOUNDARIES</u>

6.1 SHOP-FABRICATED PIPING

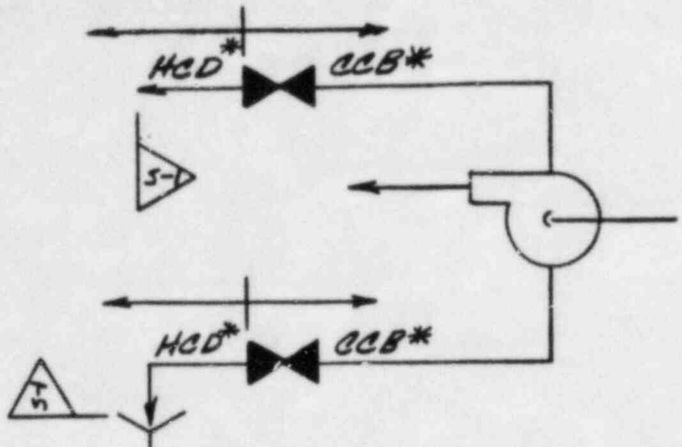
ASME Section III code jurisdiction boundaries are shown on P&IDs (Reference G).

6.2 SMALL-BORE PIPING (EXCLUDING INSTRUMENT PIPING)

Code jurisdiction boundaries of small-bore nuclear piping conform to the requirements of Sections 6.2.1 through 6.2.3.

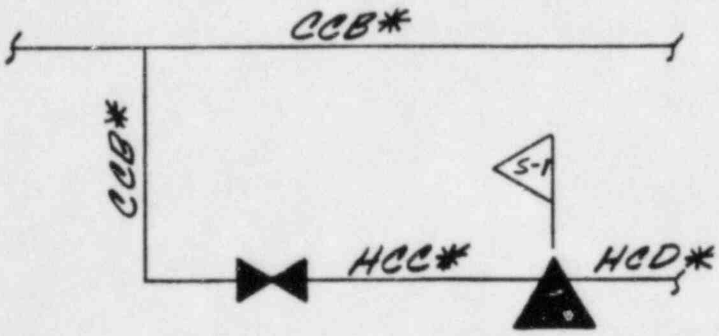
6.2.1 Seismic and piping class boundaries are shown on P&IDs (Reference G).

6.2.2 Small-bore nuclear piping that vents or drains ASME III components directly (without leading to a downstream header) shall be of the same class as the component up to and including the last isolation valve as shown in the sketch below. Thereafter, it shall be, classified as ANSI B31.1, Seismic Category 1; however, as a minimum, construction shall conform to ASME III, Class 3 with the exception of hydrotesting. In some cases, this guideline may result in long runs of ASME III piping. In such cases, it is permissible to use a configuration similar to that described in Section 6.2.3.



*For detail of piping class see Drawing 7220-M-481(Q), Reference A.

6.2.3 Small-bore piping that is connected to a downstream header shall be of the same class as the main line piping up to and including the last isolation valve and thereafter as a minimum, ASME III, Class 3, Seismic Category I up to the seismic anchor on the given line. The pressure class interface shall be made, if appropriate, at the last valve within the seismic boundary.



*For detail of piping class see Drawing 7220-M-481(Q), Reference A.

6.3 INSTRUMENT PIPING

6.3.1 Boundaries between the Class 1 root valve and Class 2 instrument piping shall be at the end of the Class 1 adapter installed in the piping root valve. Instrument piping after the Class 1 adapter shall be constructed to the requirements of ASME Section III Class 2 components [as permitted by 10 CFR 50.55(a) codes and standards, Footnote 2].

2

6.3.2 Boundaries for Class 2 and 3 instrument piping lines between the piping root valve and instrument shall be the end of the weld adapter installed in the piping root valve. The weld adapter shall be of of the same class or higher than the root valve. Instrument piping after the weld adapter shall be constructed to the requirements of the ASME Class 2 components.

6.3.3 Boundaries of Class 1 instrument piping associated with the pressurizer are shown on P&IDs M-401(Q) and M-402(Q) (Reference G).

6.4 ATTACHED COMPONENTS OR STRUCTURES

The structural characteristics of the attached components or structures shall be in accordance with Specification 7220-M-345(Q), Design Specification for Component Supports for Nuclear Service Piping (Reference E).

7.0 MATERIALS

7.1 NUCLEAR SERVICE PIPING MATERIALS (EXCLUDING INSTRUMENT PIPING)

Materials to be used for design of nuclear service piping shall comply with Drawing 7220-M-481(Q) (Reference A).

Impact testing requirements are noted on the piping class sheets (Reference A) for the piping classes where applicable.

Corrosion/erosion allowances used for specifying wall thicknesses are as follows:

a. Carbon steel pipe, in.	0.063
b. Stainless steel pipe	None

2

7.2 INSTRUMENT PIPING MATERIALS

Instrument piping materials (except carbon steel pipe) shall conform to Drawing 7220-J-401-2(Q), Sh 2, Instrument Piping Specification for ASME Section III Nuclear Piping or Seismic Category 1, Reference F.

There are no impact testing requirements for instrument piping. There are no requirements for corrosion/erosion allowances for stainless steel instrument tubing. Where carbon steel piping connects the main line to the instrument root valve, materials shall conform to the requirements specified in Section 7.1.

2

APPENDIX A
FUNCTIONAL DESCRIPTIONS OF PIPING COMPONENTS

REACTOR COOLANT AND PRESSURE CONTROL SYSTEM [M-401A(Q), M-401B(Q), M-402A(Q), and M402B(Q)]

The reactor coolant system (RCS) is arranged as two closed loops connected in parallel to the reactor vessel. Each loop consists of one 36-inch, inside-diameter outlet pipe (hot leg), one steam generator, and two 28-inch inside-diameter inlet pipes (cold legs), with one reactor coolant pump (RCP) in each cold leg.

The reactor coolant enters the reactor vessel through four inlet nozzles, turns and flows downward between the reactor vessel shell and the core support barrel, and enters the lower plenum. The coolant then turns and flows upward and continues its upward flow, then turns and leaves the reactor vessel through the two outlet nozzles and the hot leg pipes, which lead to the steam generators. The coolant flows through the tube side of the two steam generators, where heat is transferred to the secondary system. Reactor coolant pumps return the reactor coolant to the reactor vessel.

The pressure in the RCS is controlled by regulating the temperature of the coolant in the pressurizer, where steam and water are held in thermal equilibrium. Steam is formed by the pressurizer heaters or condensed by the pressurized spray to reduce pressure variations caused by expansion and contraction of the reactor coolant due to system temperature changes.

MAKEUP AND PURIFICATION/HIGH-PRESSURE INJECTION SYSTEM [M-403(Q) and M-404(Q); Sheets 1A, 1B, 2A, and 2B]

The makeup and purification (MU&P) system is designed to control and maintain reactor coolant inventory and to control the reactor coolant chemistry through the processes of makeup, letdown, and RCP seal injection. The MU&P system also serves the high-pressure injection (HPI) system upon receipt of a signal from the emergency core cooling actuation system (ECCAS).

The HPI mode of the operations involves two HPI pumps providing injection of borated water from the borated water storage tank (BWST). There are three HPI pumps, each sized to deliver 100% of the design HPI flow. Two of these pumps are capable of being powered by the emergency diesel, and one serves as a spare (which can be racked into either diesel). One pump operates continuously in its dual role as a makeup pump. Each HPI pump discharges to headers that are cross connected to provide flow to the four cold legs through motor-operated injection valves that open upon receipt of any emergency core cooling actuation signal. The cross-connect lines allow any one HPI pump to inject water through all four cold leg injection nozzles.

BORON RECOVERY SYSTEM [M-408(Q)]

The function of the boron recovery system (BRS) is to collect and process the reactor coolant and low conductivity drainage from RCP seals and other equipment containing borated water in order to recover the boric acid and reduce the radioactivity level of the reactor coolant.

The main input to the BRS comes from the letdown from the MU&P system. The MU&P system, in conjunction with the chemical addition system, continuously processes reactor coolant to control the concentration of boric acid, lithium hydroxide, and dissolved hydrogen during reactor operation.

The BRS removes dissolved gases, suspended solids (crud), fission products, and boric acid from clean wastes by means of degasification, filtration, evaporation, and/or ion exchange. After degassing, the clean wastes are usually evaporated to concentrate the boric acid. The distillate of the evaporator is condensed and passed through the polishing ion exchanger and a filter for further decontamination. The distillate is then sent to the primary water storage tank for reuse.

RADWASTE GAS SYSTEM [M-409A(Q) and M409B(Q)]

The radwaste gas system (RGS) collects the radioactive noble gases, airborne halogens, and particulates generated during plant operation. The gases are then retained for radioactive decay before being released to the atmosphere. The RGS is shared between the two units and is located in the auxiliary building.

The RGS consists of a surge tank, redundant gas analyzers, three compressors, and six decay tanks. Waste gases, primarily hydrogen and nitrogen, are collected in vent headers and flow to the surge tank. The gas analyzers continuously monitor oxygen concentrations at the surge tank inlet to prevent an explosive oxygen-hydrogen mixture. The compressors direct the surge tank gas through an aftercooler to the decay tanks. After an appropriate holdup time and subject to the results of a radioactivity analysis, the waste gases are released to the auxiliary building exhaust stack.

<u>DECAY HEAT REMOVAL SYSTEM</u> [M-410(Q) and M-411(Q)]

The decay heat removal (DHR) system is designed to remove the decay heat generated by the core and the sensible heat from the RCS during the latter stages of reactor cooldown. The DHR system provides auxiliary spray to the pressurizer for complete depressurization of the RCS and also maintains the RCS at a temperature permissible for refueling. In the event of a loss-of-coolant accident (LOCA), the DHR system serves an emergency cooling function by injecting low-pressure, borated water through two separate paths to the reactor vessel.

The DHR system is normally put into operation approximately 6 hours after initiation of plant shutdown at reduced RCS pressures and temperatures.

<u>CORE FLOODING SYSTEM</u> [M-410(Q) and M-411(Q)]

The core flooding system (CFS) provides core cooling protection continuity for intermediate and large RCS pipe failures. It automatically begins flooding the core when the RCS pressure drops below 600 psig.

The CFS is self-contained, self-actuating, and passive. The system consists of two core flood tanks (CFTs) connected to the RCS via two separate and completely independent injection lines. The injection lines, each containing a normally open, motor-operated gate valve and two check valves, are attached directly to the reactor vessel core flooding nozzles. During power operation when the RCS pressure is higher than the CFS pressure, the two check valves in the line prevent high-pressure reactor coolant from entering the CFT. Following a LOCA, the check valves will open when the RCS pressure is reduced below the 600 psig pressure normally maintained in the CFTs by the nitrogen cover gas. The loss of RCS pressure resulting from a LOCA, therefore, directly causes initiation of core flooding.

<u>REACTOR BUILDING SPRAY SYSTEM</u> [M-412A(Q), M-412B(Q), M-413A(Q), and M-413B(Q)]

The primary functions of the reactor building spray systems are to remove sensible heat and subsequent decay heat from the reactor building and to remove fission products from the reactor building atmosphere following a LOCA or main steam line break accident. The reactor building spray actuation system (RBSAS) initiates the reactor building spray system when containment pressure reaches nominally 30 psig.

The spray system consists of two separate trains of equal capacity, each independently capable of meeting system requirements. Each train includes a reactor building spray pump, spray header and nozzles, positive displacement hydrazine pump, valves, and necessary piping, instrumentation, and controls. A single hydrazine storage tank supplies hydrazine to each train. The BWST supplies injection water to each train of the reactor building spray system through separate connections. Both trains take suction from the containment sump during the recirculation phase through separate lines.

<u>FUEL POOL COOLING AND PURIFICATION SYSTEM</u> [M-414A(Q) and M-414B(Q)]

The fuel pool cooling and purification system (FPCPS) is designed to remove the decay heat generated by stored spent fuel assemblies. A second function of the system is to control and maintain visual clarity, purity, and radioactive contamination contents of the spent fuel pool water, cask loading pit water, tilt pit water, and refueling canal water.

The one or two pumps of the FPCPS will operate to provide circulating flow. Supplemental cooling is available from the DHR system. Makeup can be provided from the safety-grade service water system.

<u>POST-LOSS-OF-COOLANT ACCIDENT PROTECTION SYSTEM</u> [M-415(Q), M-435(Q)]

The post-loss-of-coolant accident protection (PLOCAP) system, currently on "design hold," will not be implemented. The design consisted of a pressurized water storage tank containing borated water, which automatically floods the reactor vessel cavity (i.e., around the vessel, inside the primary shield wall) for a large pipe failure in the RCS.

<u>COMPONENT COOLING WATER SYSTEM</u> [M-416(Q) and M-417(Q); Sheets 1A, 1B, 2A and 2B]

The component cooling water (CCW) system provides cooling water to selected nuclear auxiliary components during normal plant operation and provides cooling water to engineered safety features (ESF) systems during a LOCA. This system is a closed loop system that serves as an intermediate barrier between the service water system and

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potentially radioactive systems to reduce the possibility of radioactivity release.

SERVICE WATER SYSTEM [M-418A(Q), M-418B(Q), M-419A(Q), and M-419B(Q)]

The service water system (SWS) is considered a shared system comprised of two redundant essential service water trains and two turbine building service water trains. The SWS provides treated cooling water for various components during normal plant operation and provides cooling water to ESF equipment and backup water supply for several safety-related systems during a design basis accident. Each essential service water train serves one-half the safety-related cooling components of both units. Each turbine building service water train serves all the components of the unit's turbine building.

REACTOR BUILDING PENETRATION PRESSURIZATION SYSTEMS [M-421(Q) and 422(Q), Sheets 1, 2, and 3]

The reactor building penetration pressurization systems are two independent and identical systems, one for each unit. Each system consists of two subsystems: isolation valve seal water system and penetration air pressurization system.

The isolation valve seal water system uses demineralized water to pressurize containment penetrations that are either connected to the RCS or potentially open to the containment atmosphere and not required for operation of ESF system upon actuation of the Type I reactor building isolation signal (RBIS-I).

The penetration air pressurization system serves to pressurize, with instrument air, penetrations that are open or potentially open to the containment atmosphere during normal operation. Upon actuation of the RBIS (RBIS-I or RBIS-II), pressurization to penetrations is provided by a safety-grade nitrogen source.

REACTOR COOLANT PUMPS [M-423(Q) and M-424(Q), Sheets A, B, C, and D]

The RCPs are designed to provide coolant flow between the reactor vessel and the steam generators. The RCPs are single-stage, single-suction, constant-speed, vertical, centrifugal pumps. Each of these pumps employs a sealing system consisting of mechanical seal assemblies arranged in a removable cartridge and a seal leakage chamber to prevent reactor coolant fluid leakage to the atmosphere. Each mechanical seal is designed for full RCS pressure.

Component cooling water is furnished to the pump seal coolers as a backup to the seal injection water system. The cooling water flows to an internal heat exchanger that cools the water entering the mechanical seals. The heat exchanger is sized to provide enough cooling capacity to prevent excessive heating of the mechanical seals upon loss of seal injection water.

<u>MAIN STEAM AND TURBINE STEAM</u> [M-431(Q), M-432(Q), Sheet 1A]

The main steam and turbine steam system is designed to deliver steam from the steam generators to the high-pressure turbine for a range of flows and pressures varying from the warmup to rated conditions. The Unit 1 main steam and turbine steam system also normally supplies steam to the process steam evaporators. When Unit 1 main steam is not available, Unit 2 is capable of supplying steam to the process steam evaporators. The system is also designed to provide steam to the moisture separator reheaters, main feedwater pump turbines, steam jet air ejectors, turbine gland sealing system, deaerating feedwater heaters, plant auxiliary steam header, and turbine bypass system.

The system provides a means of discharging steam to the atmosphere to prevent system overpressurization.

The system is Seismic Category I from the steam generators to the auxiliary feedwater pump turbine driver, the main steam safety valves and power-operated atmospheric vent valve outlets, and the first anchors downstream of the main steam isolation valves.

<u>MAIN FEEDWATER AND AUXILIARY FEEDWATER SYSTEMS</u> [M-438(Q) and M-439(Q), Sheets 3A and 3B]

The main feedwater system (MFWS) provides a continuous feedwater supply to the steam generators during power operation. The MFWS is Seismic Category 1 from the steam generator back to the MFW isolation valves, which automatically isolate MFW to the steam generators.

The auxiliary feedwater system (AFWS) is designed to provide feedwater to the steam generators when the MFWS is not available for service, such as during normal startup, hot standby, and normal shutdown and during emergency shutdown of the reactor. The AFWS is designed so that a single failure of any active component cannot cause loss of the system's ability to mitigate the consequences of an accident or to support shutdown of the reactor. The AFWS is designed to remain functional following a safe shutdown earthquake or during complete loss of ac power.

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INSTRUMENT AND SERVICE AIR SYSTEM [M-448(Q), Sheet 2]

The instrument and service air system is designed to provide a reliable, continuous supply of filtered, dry, and oil-free instrument air for pneumatic instrument operation and control of pneumatic valves. The instrument and service air system also supplies service air to service outlets throughout the plant for operation of pneumatic tools and other service requirements.

PLANT WATER STORAGE AND TRANSFER SYSTEM [M-449(Q), Sheet 1B]

The plant water storage and transfer system supplies both demineralized and primary water to the reactor building hose stations, pressurizer quench tanks, reactor vessel head lay down area, and RCP standpipes as needed during reactor cooldown operation. The penetration into the reactor building is ASME Section III.

EMERGENCY DIESEL FUEL OIL STORAGE AND TRANSFER SYSTEM [M-452(Q), Sheets 1A and 1B]

The emergency diesel fuel oil storage and transfer system is designed to provide onsite storage and delivery of diesel fuel oil for the diesel generators for each unit during a design basis accident assuming loss of all offsite power sources. The fuel oil system is designed so that a single failure of any active component cannot prevent the system's ability to mitigate the consequences of an accident or support shutdown of the reactor.

The fuel oil storage and transfer system for each unit consists of two storage tanks, two transfer pumps, and two day tanks that supply fuel oil to two diesel generators, associated piping, and instrumentation.

HVAC - REACTOR BUILDING (M-453 and M-462)

Hydrogen Vent System Containment Isolation Valves and Penetrations

Hydrogen vent system isolation valves are provided to maintain the containment integrity during accident conditions. They are normally locked closed except during system testing or when the hydrogen vent system is required to supplement hydrogen removal from containment.

Purge Air Supply System and Purge Air and Refueling Canal Exhaust System Isolation Valves and Penetrations

The purge air system isolation valves are provided to maintain the containment integrity during accident conditions and are normally locked closed. They are opened only when this system is operating before and during personnel occupancy of the reactor building during refueling and maintenance periods.

Air Room Supply and Exhaust system Isolation Valves and Penetrations

The air room system isolation valves are provided to maintain the containment integrity during accident conditions and are normally closed except when this system is operated for the following modes:

1. Before and during personnel access to the air room during power operation

2. During plant shutdown for refueling or maintenance

3. While acting as a low-volume purge during startup, normal plant operation, hot standby, or hot shutdown

PLANT HEATING SYSTEM [M-456(Q), Sheet 2A]

The reactor building penetrations and isolation valves for the plant heating system are classified as ASME III. The plant heating system has no reactor-related function.

CHILLED WATER - SAFEGUARD EQUIPMENT (M-457, Sheets 2A, 2B, 3A, and 3B)

The function of safeguards chilled water system (SCWS) is to maintain air temperature of the control room, switchgear rooms, battery rooms, and ESF equipment rooms at/or below the room design ambient air temperature during both normal and post-accident operations.

The SCWS consists of two redundant trains per unit. Each individual train consists of a chiller, two 100% capacity circulating pumps, piping, valves, room unit coolers, expansion tanks, air separator, instrumentation, and controls.

FIRE PROTECTION SYSTEM (M-458, Sheets 1A and 1B)

The reactor building penetrations for the fire protection system are classified as ASME Section III. The fire protection system has no reactor-related function.

HVAC - CONTROL ROOM (M-465, Sheets 1 and 2)

The main control room (MCR) HVAC system provides environmental temperature control during normal, abnormal,

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and post-accident plant operation. Chilled water from the SCWS is circulated through a finned tube coil in a central air-handling unit.

A subsystem of the HVAC system is a room pressurization system, which provides a supply of uncontaminated air from remote underground storage tanks and delivers the air to the MCR to maintain a positive pressure within the room of 1/8 inch water column

MISCELLANEOUS INSTRUMENTATION REACTOR BUILDING/PLANT RADIATION MONITORING SYSTEM [P&ID M-472(Q), Sheets 1, 2, and 3, and M-479(Q), Sheet 1]

The ASME III piping contained in the miscellaneous instrumentation reactor building/plant radiation monitoring system is designed to transport the containment atmosphere sample to serve the hydrogen monitoring system, radiation monitoring system, and post-accident sampling system. It consists of piping and valves to extract a representative sample of the containment atmosphere, monitor it, and return it to containment.

EMERGENCY BORATION SYSTEM [M-782(Q)]

The emergency boration system (EBS) is designed to provide a 6 weight percent boric acid solution to the RCS via the MU&P system during accident conditions, which results in the loss of letdown capability coupled with maximum reactivity worth control rod stuck in the withdrawn position.

The EBS for each unit consists of one storage tank equipped with two independently controlled electric heaters and containing 6 weight percent boric acid, one recirculating pump, valves, pipe fittings, heat tracing, and necessary instrumentation.

During normal plant operations, the 6 weight percent boric acid is heated to approximately 160F by one of the heaters in the tank and is continuously recirculated through heat traced piping to maintain homogeneous tank contents.

If required during accident conditions, the EBS is valved into the suction of a HPI pump for injection into the RCS.