MITSUBISHI HEAVY INDUSTRIES, LTD.
16-5, KONAN 2-CHOME, MINATO-KU
TOKYO, JAPAN

July 07, 2010

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-10191

Subject: MHI's Revised Responses to US-APWR DCD RAI No. 286-2145 Revision 1

Reference: [1] "Request for Additional Information No. 286-2145 Revision 1, SRP Section: 09.02.05 – Ultimate Heat Sink- Design Certification and New License Applicants, Application Section: 9.2.5," dated March 25, 2009.
[2] MHI letter UAP-HF-09235 "MHI's Responses to US-APWR DCD RAI No. 286-2145 Revision 1," dated May 12, 2009.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Revised Response to Request for Additional Information No. 286-2145 Revision 1". This transmittal supersedes the Reference 2 responses.

Enclosure 1 is the responses to 9 questions that are contained within Reference [1].

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of the submittals. His contact information is below.

Sincerely,

Y. Ogata

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Enclosures:

1. Revised Responses to Request for Additional Information No. 286-2145 Revision 1

CC: J. A. Ciocco
C. K. Paulson

Contact Information
C. Keith Paulson, Senior Technical Manager
Mitsubishi Nuclear Energy Systems, Inc.
300 Oxford Drive, Suite 301
Monroeville, PA 15146
E-mail: ck_paulson@mnes-us.com
Telephone: (412) 373-6466

D081
NRO

Docket No. 52-021
MHI Ref: UAP-HF-09235

Enclosure 1

UAP-HF-10191
Docket No. 52-021

Revised Responses to Request for Additional Information
No. 286-2145 Revision 1

July 2010

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/7/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 286-2145 REVISION 1**
SRP SECTION:	**9.2.5 – Ultimate Heat Sink**
APPLICATION SECTION:	**9.2.5**
DATE OF RAI ISSUE:	**3/25/2009**

QUESTION NO.: 09.02.05-1

Based on a review of the information provided in Tier 2 of the Design Control Document (DCD), Section 9.2.5, "Ultimate Heat Sink," the staff found that the description of the ultimate heat sink (UHS) is incomplete as it does not adequately explain how the applicable regulatory requirements are satisfied by the proposed design, what limiting assumptions apply, how much excess margin is available, what operating experience insights are relevant and how they were addressed. Consequently, Tier 1 and Tier 2 of the DCD needs to be revised to include information that is sufficient to demonstrate that the UHS is capable of performing its design-bases functions, that applicable regulatory requirements are satisfied by the proposed design, and that reasonable assurance exists that the availability and design-bases capability will be maintained over the life of the plant. In addition, the DCD needs to be revised to include a conceptual design for the UHS in accordance with 10 CFR 52.47(a)(24). The conceptual design should be described in sufficient detail to establish interface requirements that must be satisfied by combined license (COL) applicants.

Inspection, test, analysis and acceptance criteria (ITAAC) for the UHS have not been provided in the DCD Tier 1. DCD Tier 1, section 3.2 provides only a temperature requirement for the UHS. 10 CFR 52.47(b) requires the DCD to contain ITAAC that are necessary and sufficient to provide reasonable assurance that the plant will be built and will operate according to the DCD. The DCD should provide ITAAC for the UHS design. Technical specifications (TS) have not been identified for the UHS in Chapter 16 (TS 3.7.9). 10 CFR 52.47(a) requires the DCD to contain technical specifications. Regulatory Guide 1.206, "Combined License Applications (COL) for Nuclear Power Plants (LWR Edition)," provides guidance on the specific information that should be included in the application for evaluation by the staff.

Specifically, the applicant is requested to demonstrate in the DCD how the UHS design complies with the following General Design Criteria (GDC) or Regulatory Guide (RG). In addition, existing COL information items in the DCD related to the UHS should be evaluated once the conceptual design for the UHS has been provided.

- GDC 2, "Design Bases for Protection Against Natural Phenomena" and RG 1.27, "Ultimate Heat Sink."

- GDC 44, "Cooling Water," and RG 1.72, "Spray Pond Piping Made from Fiberglass."
- GDC 44, "Cooling Water," and RG 1.27, "Ultimate Heat Sink."
- GDC 44, "Cooling Water," and single failure evaluation.
- GDC 44, "Cooling Water," and essential service water system (ESWS) pump net positive suction head (NPSH).
- GDC 44, "Cooling Water," and instrumentation and controls and electrical features.
- TS Section 3.7.9 and its bases.
- Preoperational testing for the UHS.
- Tier 1, DCD and ITAAC for the UHS.

ANSWER:

As stated in DCD Tier 2 Table 1.8-1, the ultimate heat sink (UHS) and portions of the essential service water system (ESWS) are significant system interfaces with the standard US-APWR design. The design concepts used by a COL applicant to address these interfaces are dependent on site characteristics, and the DCD therefore focuses on their design basis functional requirements in lieu of prescribing specific design features. The applicants can select from various UHS systems (such as cooling towers, ponds or dams) that meet US-APWR interface requirements consistent with site-specific conditions. The UHS design bases in the DCD are presented in terms of the applicable regulatory criteria such that the design bases are relevant to the UHS interface requirements regardless of the specific design selected by a COL applicant.

The US-APWR DCD's treatment of the UHS and portions of the ESWS as site-specific is consistent with current regulations, including 10 CFR 52.47(c), which states in part:

> "An application for certification of a nuclear power reactor design...must provide an essentially complete nuclear power plant design except for site-specific elements such as the service water intake structure and the ultimate heat sink..."

Notwithstanding the site-specific nature of the UHS, MHI has revised the DCD to provide a representative conceptual UHS design to facilitate NRC staff review of the DCD and enable an assessment of the adequacy of the ESWS and UHS interface requirements. The DCD provides the overarching design basis requirements for the UHS, and a representative design concept that may be used by a COL applicant referencing the US-APWR design certification. However, a COL applicant that proposes an alternative UHS design concept would not necessarily depart from the DCD provided that the DCD design bases are satisfied.

The specific GDC and RG criteria cited in this RAI question are addressed as follows:

<u>GDC 2, "Design Bases for Protection Against Natural Phenomena" and RG 1.27, "Ultimate Heat Sink."</u>

The UHS is designed to withstand the effects of natural phenomena, including the capability to remain functional following a safe shutdown earthquake (SSE). As stated in the DCD Table 1.9.1-1 position on RG 1.27, the US-APWR is designed in accordance with the functional requirements described in RG 1.27, and the UHS design is site-specific. The basis for the structural adequacy of the UHS related structures (UHSRS) is provided in the following DCD sections:

- 3.3, Wind and Tornado Loads
- 3.4, Water Level (Flood) Design
- 3.5, Missile Protection
- 3.7, Seismic Design
- 3.8, Design of Category I Structures

Site-specific UHS design features to address limiting hydrology-related events are addressed as required by DCD Section 2.4, Hydrologic Engineering (specifically Subsections 2.4.8, 2.4.11 and 2.4.14).

GDC 44, "Cooling Water," and RG 1.72, "Spray Pond Piping Made from Fiberglass."

RG 1.72 is not applicable to the US-APWR standard plant design, nor does it apply to the UHS design concept described in revised DCD Subsection 9.2.5.2.1.

GDC 44, "Cooling Water," and RG 1.27, "Ultimate Heat Sink."

UHS performance capability consistent with GDC 44 and RG 1.27 is addressed in DCD Subsection 9.2.5.1, "Design Bases." For the design concept presented in DCD Subsection 9.2.5.2.1, the thirty-day cooling water supply criterion of RG 1.27 is met by four, one-third capacity UHS basins, with each basin serving one of the four 50% capacity ESWS divisions.

GDC 44, "Cooling Water," and single failure evaluation.

Consistent with NUREG-0800 Standard Review Plan (SRP) Subsection 9.2.5 acceptance criterion II.3 pertaining to GDC 44, the UHS design bases include:

- Component redundancy such that the system's safety functions can be performed in the event of a single active component failure using either offsite power or onsite emergency power sources.
- The capability to isolate components, systems or piping such that safety functions are not compromised.

GDC 44, "Cooling Water," and essential service water system (ESWS) pump net positive suction head (NPSH).

COL 9.2(6) requires the COL applicant to provide ESWP details including NPSH available. DCD Subsection 9.2.5.1 has been revised to include the UHS design basis requirement that adequate pump NPSH be maintained under all operating modes. DCD Subsection 9.2.5.2 provides details of design features to maintain adequate NPSH for the UHS design concept using cooling towers and ESW intake basins.

GDC 44, "Cooling Water," and instrumentation and controls and electrical features.

As stated in DCD Subsection 9.2.5.5, the COL Applicant will provide the required alarms, instrumentation and controls details based on the type of UHS to be provided. DCD Subsection 9.2.5.5 has been revised to include alarms and displays for UHS water level and UHS water temperature, which are expected to be applicable to any site-specific UHS designs that reference the US-APWR certified design.

The UHS design bases in DCD Subsection 9.2.5.1 require that the system's safety functions can be performed in the event of a single active component failure using either offsite power or onsite emergency power sources. COL 9.2(19) requires the COL Applicant to design the UHS to receive its electrical power supply, if required by the UHS design, from safety busses, and to provide standby electrical power from the onsite emergency power supplies during a LOOP. For the design concept described in DCD Subsection 9.2.5.2.1, the cooling tower fans are powered from the same division as the ESWP in their respective basin. The cooling tower fans are supplied with backup power by the onsite emergency power sources.

TS Section 3.7.9 and its bases.

Although COL 16.3.7.9 requires the COL applicant to develop UHS Technical (TS) and their Bases, a sample TS from a conceptual plant is added to DCD 16.3.7.9 and DCD 16.B 3.7.9 to facilitate review by the NRC staff.

Preoperational testing for the UHS.

DCD Subsection 9.2.5.4 has been revised to reflect the following:

> "The UHS supports ESWS operation and is therefore tested as part of the ESWS preoperational test described in Subsection 14.2.12.1.34. As indicated in Subsection 14.2.12, the COL applicant is responsible for testing (systems and components) outside the scope of the certified design."

Tier 1, DCD and ITAAC for the UHS.

The UHS design is site-specific and is not in the scope of the standard plant design certification. The UHS is therefore subject to Tier 1 interface requirements, requiring plant-specific ITAAC in Part 10 of a COLA referencing the US-APWR design certification. MHI has expanded the interface requirements for the UHS in DCD Tier 1 Subsection 3.2.1.

Impact on DCD

See Attachment 1 for changes to DCD Tier 2, Subsection 9.2.5, Attachment 2 for changes to DCD Tier 1, and Attachment 3 for changes to DCD Tier 2, Subsections 16.3.7.9 and 16.B 3.7.9.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA because there is no change in the scope of the certified design with respect to the UHS.

This completes the responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/7/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 286-2145 REVISION 1**
SRP SECTION:	**9.2.5 – Ultimate Heat Sink**
APPLICATION SECTION:	**9.2.5**
DATE OF RAI ISSUE:	**3/25/2009**

QUESTION NO.: 09.02.05-2

The Design Control Document (DCD), needs to be revised to include a conceptual design for the ultimate heat sink in accordance with 10 CFR 52.47(a)(24). The conceptual design should be described in sufficient detail to establish interface requirements that must be satisfied by combined license (COL) applicants.

Based on a review of the information provided in Tier 2 of the DCD, Section 9.2.5, "Ultimate Heat Sink," and Table 3.2-2, "Classification of Mechanical and Fluid Systems, Components, and Equipment," the staff found that the description of the ultimate heat sink as it relates to equipment classification incomplete. Specifically, the applicant is requested to add equipment classification to Table 3.2-2 for the UHS.

ANSWER:

DCD Subsection 9.2.5.2 has been revised to include a conceptual UHS design that may be used by a COL applicant referencing the US-APWR design certification. This conceptual design description is provided to facilitate review of UHS interface requirements with the standard design. UHS design is site-specific and not limited to the design alternative described in DCD Subsection 9.2.5.2.

The Tier 2 DCD Subsection 3.2.3 on COL information 3.2(5) states that, "*The COL Applicant is to identify the equipment class and seismic category of the site-specific, safety-related and nonsafety-related fluid systems, components (including pressure retaining), and equipment as well as the applicable industry codes and standard,*" hence, the identification of the UHS equipment classification in Table 3.2-2, which includes component-level data, is outside the scope of the DCD. A general discussion of UHS safety classification is included in DCD Subsection 9.2.5.1, Design Bases.

Impact on DCD

See Attachment 1 for changes to DCD Tier 2, Subsection 9.2.5.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

This completes the responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/7/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 286-2145 REVISION 1**
SRP SECTION:	**9.2.5 – Ultimate Heat Sink**
APPLICATION SECTION:	**9.2.5**
DATE OF RAI ISSUE:	**3/25/2009**

QUESTION NO.: 09.02.05-3

The Design Control Document (DCD), needs to be revised to include a conceptual design for the ultimate heat sink in accordance with 10 CFR 52.47(a)(24). The conceptual design should be described in sufficient detail to establish interface requirements that must be satisfied by combined license (COL) applicants.

Standard Review Plan (SRP) 9.2.5 Section III, paragraph 1 instructs the reviewer to confirm the overall arrangement of the ultimate heat sink (UHS). The description and piping and instrumentation diagram (P&IDs) or flow diagrams are incomplete or inaccurate and the DCD needs to be revised to address the following considerations:

- P&ID, flow diagrams, or drawings were not provided for the conceptual design of the UHS. The DCD should explain the criteria that were used in establishing the appropriate pipe sizes (such as limiting flow velocities).
- The UHS system description does not provide design details such as system operating temperatures, pressures, fan speeds (if used), and flow rates for all operating modes and alignments.
- The UHS flow diagram/drawings should show where indications are displayed (e.g., local, remote panel, control room), and what instruments provide input to a process computer and/or have alarm and automatic actuation functions.
- The UHS flow diagram/drawings should show what the normal valve positions are, what valves are locked in position, and what valves have automatic functions; and these design features are not described.
- The UHS flow diagram/drawings should show any UHS bypass flow rates for low load/low ambient temperature conditions to maintain ESW cold water temperature within established limits.
- If using a UHS with mechanical fans, the UHS fan alarms discussions should be included in the DCD.
- If using a cooling tower, the UHS flow diagram should show the cooling tower basin instruments (level and temperature).

ANSWER:

As indicated in the response to question number 09.02.05-1, the UHS is an interface with the US-APWR and the design is site-specific. The DCD Subsection 9.2.5.1 design bases address the acceptance criteria based on GDCs and NRC guidance documents such as RG 1.27 A representative conceptual design has been added to DCD Subsection 9.2.5.2, recognizing that a COL applicant may select an alternative design consistent with site characteristics and the UHS design bases. The specific information requested in this RAI question is addressed as follows:

<u>P&ID, flow diagrams, or drawings were not provided for the conceptual design of the UHS. The DCD should explain the criteria that were used in establishing the appropriate pipe sizes (such as limiting flow velocities).</u>

A P&ID representing a conceptual design alternative has been added as DCD Figure 9.2.5-1. Typical pipe sizes are provided in the P&ID using industry standard velocity criteria.

<u>The UHS system description does not provide design details such as system operating temperatures, pressures, fan speeds (if used), and flow rates for all operating modes and alignments.</u>

Table 9.2.5-3 has been added to the DCD to provide key process parameters for the design concept that includes mechanical draft cooling towers. Specific parameters such as fan speed, which varies with the design, are not included.

<u>The UHS flow diagram/drawings should show where indications are displayed (e.g., local, remote panel, control room), and what instruments provide input to a process computer and/or have alarm and automatic actuation functions.</u>

As stated in DCD Subsection 9.2.5.5, the COL Applicant will provide the required alarms, instrumentation and controls details (including location of displays) based on the type of UHS to be provided (during the detailed design phase). DCD Subsection 9.2.5.5 has been revised to include alarms and displays for UHS water level and UHS water temperature, which are expected to be applicable to any site-specific UHS designs that reference the US-APWR certified design. Figure 9.2.5-1 also includes the alarms, instrumentation and automatic actuation signals for the conceptual UHS design.

<u>The UHS flow diagram/drawings should show what the normal valve positions are, what valves are locked in position, and what valves have automatic functions; and these design features are not described.</u>

For the design concept described in revised DCD Subsection 9.2.5.2, operating characteristics of key UHS valves as applicable to the conceptual design are described, such as automatic operation of make-up control valves, blowdown isolation during an accident, and ESWP discharge MOV operation to avoid water hammer. A complete description of UHS valves' safety functions is dependent on the site-specific UHS design.

<u>The UHS flow diagram/drawings should show any UHS bypass flow rates for low load/low ambient temperature conditions to maintain ESW cold water temperature within established limits.</u>

UHS bypass for low load/low ambient temperature conditions is not included in the conceptual design because it is dependent on the UHS design and site characteristics.

If using a UHS with mechanical fans, the UHS fan alarms discussions should be included in the DCD.

Specific instrumentation added to DCD Subsection 9.2.5.5 has been revised to include instrumentation that is expected to be applicable to any UHS design selected by a COL applicant referencing the US-APWR design certification. Cooling tower fan alarms are not included in this category and are therefore not included in the DCD.

If using a cooling tower, the UHS flow diagram should show the cooling tower basin instruments (level and temperature).

These instruments are shown in new DCD Figure 9.2.5-1.

Impact on DCD

See Attachment 1 for changes to DCD Tier 2, Subsection 9.2.5.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on the PRA.

This completes the responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/7/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 286-2145 REVISION 1**
SRP SECTION:	**9.2.5 – Ultimate Heat Sink**
APPLICATION SECTION:	**9.2.5**
DATE OF RAI ISSUE:	**3/25/2009**

QUESTION NO.: 09.02.05-4

The Design Control Document (DCD), needs to be revised to include a conceptual design for the ultimate heat sink in accordance with 10 CFR 52.47(a)(24). The conceptual design should be described in sufficient detail to establish interface requirements that must be satisfied by combined license (COL) applicants.

Tier 2, DCD Section 9.2.5.1 states that the ultimate heat sink along with ESWS is designed to remove the peak heat loads rejected from the ESWS under all conditions in order to mitigate the consequences of a design basis event and for a safe shutdown with or without offsite power. The staff has determined that insufficient information is provided to confirm this capability. Standard Review Plan (SRP) 9.2.5 Section III, paragraph 2.B of "Evaluation Procedures" instructs the reviewer to verify whether "the UHS can dissipate the maximum possible total heat load including that of a loss of coolant accident (LOCA) under the worst combination of adverse environmental conditions." Provide key assumptions and inputs for the design calculations that demonstrate sufficient capability and margin. Additional information that is needed in the DCD includes (for example):

1. Key assumptions and inputs (including justification) for calculations that demonstrate sufficient heat rejection capability to meet maximum predicted heat loads and define the available margin with limited system temperatures and pressures. These assumptions should include sufficient margin to account for uncertainties in the analysis, anticipated degradation in performance over time, and fluctuations in the frequency of electric current. These calculations should be made available for staff audit.
2. For cooling tower performance (if used), explanation of how the wet bulb correction was determined to be sufficient for potential tower interferences.
3. For cooling tower performance or other heat sink designs such as cooling ponds, curves that show the minimum required tower heat rejection capability verses time (including spent fuel pool cooling) for post LOCA cooldown, and cooldown to cold shutdown conditions following a reactor trip with and without offsite power available.
4. Explanation of how UHS heat rejection capability will be monitored to ensure adequate performance over time.

ANSWER:

The response concerning the UHS conceptual design mentioned in the first paragraph of the question is addressed in the responses to question number 09.02.05-1. The additional information requested in items 1 through 4 of this question is addressed as follows:

1. As stated in revised DCD Subsection 9.2.5.3, Safety Evaluation, the heat loads provided in DCD Table 9.2.5-2 establish the basis for the required UHS cooling water inventory and maximum temperature limits, to maintain the ESW supply water temperature less than or equal to 95 °F under design basis heat load conditions. The calculations that demonstrate acceptable UHS performance are site-specific, as are key assumptions, inputs and design margins. Anticipated degradation in performance over time is addressed below in item 4 of this response. The UHS active components are designed to accommodate electrical frequency fluctuations in order to maintain their safety functions at all plant operating conditions.

2. For the UHS conceptual design using cooling towers as described in revised DCD Subsection 9.2.5.2.3, a 2°F recirculation penalty is added to the wet bulb design temperature. This value is selected based on operating experience and preliminary vendor input, and is subject to confirmation during finalization of a specific UHS design using this value.

3. For the UHS conceptual design using cooling towers as described in revised DCD Subsection 9.2.5.2, cooling tower heat removal is based on the peak heat loads presented in DCD Table 9.2.5-2, using the limiting case of two-train operation during a safe shutdown with LOOP scenario. UHS water basin volume available and temperature limits are specified to assure that ESWS inlet temperature remains at or below 95° F under design basis heat load conditions, thereby meeting the ESWS design basis temperature limit. Although cooling tower performance curves are not part of the US-APWR standard plant design, this design method assures that the specified cooling tower performance will satisfy DCD design basis heat removal requirements.

4. As stated in DCD Subsection 9.2.5.4, Inspection and Testing Requirements:

   > "The COL Applicant will provide test and inspection details based on type of UHS to be provided. These details will include inspection and testing requirements necessary to demonstrate that fouling and degradation mechanisms are adequately managed to maintain acceptable UHS performance and integrity."

Impact on DCD

See Attachment 1 for changes to DCD Tier 2, Subsection 9.2.5.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

This completes the responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/7/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 286-2145 REVISION 1**
SRP SECTION:	**9.2.5 – Ultimate Heat Sink**
APPLICATION SECTION:	**9.2.5**
DATE OF RAI ISSUE:	**3/25/2009**

QUESTION NO.: 09.02.05-5

General Design Criteria (GDC) 44 requires that "A system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided." The staff noted the protection of the essential service water system (ESWS) pump suction supports compliance with GDC 44 since these components are essential for the overall system function. Describe in the Design Control Document (DCD) how the ESWS pump suction is protected from potential debris intrusion (e.g. tower fill degradation, etc.). The staff noted that some plants have found this type of protection to be necessary (e.g. screens) due to damage to the fill from failed cooling tower spay nozzles. Also, provide in the DCD a description of the cooling tower (if used) spray and fill design arrangements related to failure modes.

ANSWER:

The nature and type of the UHS is not identified in the DCD as they are site-specific items, hence the type of protection for the ESWS will vary accordingly and will be addressed by the COL applicant. As stated in DCD Subsection 9.2.1.2.1 and COL 9.2(26), the COL applicant is to develop maintenance and test procedures to monitor debris build up and flush out debris.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

This completes the responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/7/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 286-2145 REVISION 1**
SRP SECTION:	**9.2.5 – Ultimate Heat Sink**
APPLICATION SECTION:	**9.2.5**
DATE OF RAI ISSUE:	**3/25/2009**

QUESTION NO.: 09.02.05-6

General Design Criteria (GDC) 45 requires the ultimate heat sink (UHS) to be designed so that periodic inspections of piping and components can be performed to assure that the integrity and capability of the system will be maintained over time. The staff finds the design to be acceptable if the Design Control Document (DCD) describes inspection program requirements that will be implemented and are considered to be adequate for this purpose. While Tier 2, DCD Section 9.2.5.4 indicates that the combined license (COL) applicant will provide test and inspection details based on the type of UHS to be provided, the staff cannot determine if the criteria of GDC 45 is met in the DCD. Consequently, additional information needs to be provided in the DCD to describe the extent and nature of inspections that will be performed and procedural controls that will be implemented commensurate with this requirement. For example, the accessibility and periodic inspection of safety related buried piping and the cooling tower spray header system, tower fill, cooling pond systems are of particular interest. The DCD needs to be revised to state that the requirements of GDC 45 have been met.

ANSWER:

Conformance to the requirements of General Design Criteria (GDC) 45 has been addressed in the Tier 2 DCD Subsection 9.2.5.2 on the UHS system description. Subsection 9.2.5.4, "Inspection and Testing Requirements," also states that the COL applicant will provide the periodic tests and inspections which vary according to the type of UHS. A similar statement is reiterated in the COL information Subsection 9.2.10 where the COL applicant will be responsible in providing the UHS test and inspection requirements. Since the UHS design is site-specific, the rationale provided in the responses to question 09.02.05-1 applies. Therefore, the following is added to DCD Subsection 9.2.5.1, Design Bases to address GDC 45 in a generic manner:

> "The UHS is designed to permit appropriate periodic inspection of important components to assure the integrity and capability of the system. The UHS design permits inservice inspection of safety-related piping and components (GDC 45)."

Impact on DCD

See Attachment 1 for changes to DCD Tier 2, Subsection 9.2.5.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

This completes the responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/7/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 286-2145 REVISION 1**
SRP SECTION:	**9.2.5 – Ultimate Heat Sink**
APPLICATION SECTION:	**9.2.5**
DATE OF RAI ISSUE:	**3/25/2009**

QUESTION NO.: 09.02.05-7

General Design Criteria (GDC) 46 requires the ultimate heat sink (UHS) to be designed so that periodic pressure and functional testing of components can be performed to assure the structural and leak tight integrity of system components, the operability and performance of active components, and the operability of the system as a whole and performance of the full operational sequences that are necessary for accomplishing the UHS safety functions. The staff finds the design to be acceptable if the DCD describes pressure and functional test program requirements that will be implemented and are considered to be adequate for this purpose.

While Tier 2, DCD Section 9.2.5.4 indicates that the combined license (COL) applicant will provide test and inspection details based on the type of UHS to be provided, the staff cannot determine if the criteria of GDC 46 is met in the DCD. This should include the extent and nature of these tests and procedural controls that will be implemented to assure continued UHS structural and leak tight integrity and system operability over time were not described.

Consequently, additional information needs to be provided in the DCD to describe the extent and nature of testing that will be performed and procedural controls that will be implemented commensurate with this requirement. The DCD needs to be revised to state that the requirements of GDC 46 have been met.

ANSWER:

The UHS will be designed in conformance with General Design Criteria (GDC) 46 as stated in the Tier 2 DCD Subsection 9.2.5.2. Because the UHS design is site-specific, details of the periodic pressure and functional testing of components are outside the scope of the DCD and will vary according to the individual designs by the COL applicants referencing the DCD. Furthermore, Tier 2 DCD Subsection 3.9.9 on COL Information items 3.9.10, 3.9.11, and 3.9.12 state that for the site-specific components such as pumps and valves, the type and frequency of tests will be provided by the COL applicant. The following is added to DCD Subsection 9.2.5.1, Design Bases:

"The UHS is designed to permit appropriate periodic pressure and functional testing per GDC 46 to assure the following:

- Structural and leaktight integrity of safety-related UHS components.
- Operability and performance of UHS components with active safety functions.
- UHS system operability, and under conditions as close to design as possible, performance of the full operational sequence that brings the UHS into operation for reactor shutdown and LOCA, including operation of appropriate portions of the PSMS and transfer between normal and emergency power sources."

Impact on DCD

See Attachment 1 for changes to DCD Tier 2, Subsection 9.2.5.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

This completes the responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/7/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 286-2145 REVISION 1**
SRP SECTION:	**9.2.5 – Ultimate Heat Sink**
APPLICATION SECTION:	**9.2.5**
DATE OF RAI ISSUE:	**3/25/2009**

QUESTION NO.: 09.02.05-8

The Design Control Document (DCD) needs to be revised to include a conceptual design for the ultimate heat sink (UHS) in accordance with 10 CFR 52.47(a)(24). The conceptual design should be described in sufficient detail to establish interface requirements that must be satisfied by COL applicants.

Means must be provided for monitoring effluent discharge paths and the plant environs for radioactivity that may be released in accordance with General Design Criteria (GDC) 64 requirements. Also, 10 CFR 52.79(a)(45) and 10 CFR 20.1406 require combined license (COL) applicants to describe how facility design and procedures for operation will minimize contamination of the facility and the environment. The staff's review criteria (Standard Review Plan (SRP) Section 9.2.1, Paragraph III.3.D) specify that provisions should be provided to detect and control leakage of radioactive contamination into and out of the essential service water system (ESWS) which is part of the UHS. The design is considered to be acceptable by the staff if the UHS/ ESWS flow diagrams, or piping and instrumentation diagrams (P&IDs), show that radiation monitors at components that are susceptible to leakage, and if the components that are susceptible to leakage can be isolated. However, the staff noted that Tier 2, DCD, Section 9.2.5 and the UHS/ESWS flow diagrams, or P&ID, do not include radiation monitors in the system design and the NRC regulations in this regard have not been addressed. Therefore, additional information needs to be included in Tier 2, DCD Section 9.2.5 to address the NRC requirements referred to above.

ANSWER:

Regarding control of radioactive contamination, the ESWS essentially does not handle radioactive cooling water nor release radioactive materials into the environment. Radiation sensors are installed in the component cooling water (CCW) heat exchangers' ESW side outlets to monitor accidental CCW leaks, if any, into the ESW lines. The ESW radiation monitors are described in DCD Subsection 11.5.2.5.2 and shown in Figure 11.5-2a. The monitors alert the control room operators if leaking CCW contains radioactivity so that the operator can isolate the leak, thus prevent possible radioactive contamination to the ESWS and the UHS. This is further discussed in the Tier 2 DCD Subsection 9.2.1.2.1 and illustrated in the ESWS Piping and Instrument Diagram in Figure 9.2.1-1.

The first paragraph of Tier 2 DCD Subsection 9.2.1.2.1 is revised as follows:

The UHS, which is usually a freshwater (or saltwater) source, is the source of water to the intake basin. It follows that the ESWS cooling water does not contain radioactive materials nor release radioactive contaminants to the environment. The essential chiller units also do not include the radioactive fluid, and CCWS is the intermediate loop between the reactor auxiliaries and the ESWS. This arrangement minimizes direct leakage of the radioactive fluid from the ESWS to the environment. In addition, radiation monitors are provided in each discharge line of the CCW HX essential service water (ESW) side. See also the description of these monitors in DCD Subsection 11.5.2.5.2. Radiation alarms are provided to t~~T~~he monitors to alert the operator if the leaking CCW contains radioactivity so that the operator can isolate the leaking train and prevent possible radiation contamination to the ESWS and UHS. Prior to any radiation leakage being detected in the ESWS, however, radiation alarms in the CCWS side would have already alerted the operators to notify of a radiation breach in the CCWS. The affected CCWS train is immediately isolated followed by the isolation of the aligned ESWS to prevent possible contamination to the UHS and finally to the environment.

The following is also added at the last bullet of Tier 2 DCD Subsection 9.2.5.1 Design Bases:

- The UHS is designed to satisfy the requirements of 10 CFR 52.79(a)(45) and 10 CFR 20.1406 for the minimization of radioactive contamination.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD Subsection 9.2.5.1 and Attachment 4 for changes to Tier 2 DCD Subsection 9.2.1.2.1.

Impact on COLA

There is no impact on the COLA

Impact on PRA

There is no impact on the PRA.

This completes the responses to NRC's questions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/7/2010

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 286-2145 REVISION 1**
SRP SECTION:	**9.2.5 – Ultimate Heat Sink**
APPLICATION SECTION:	**9.2.5**
DATE OF RAI ISSUE:	**3/25/2009**

QUESTION NO.: 09.02.05-9

10 CFR 52.47(a)(25) relates to requirements for site specific items to be identified by the design certification applicant that must be addressed by the combined license (COL) applicant.

1. As a result of this review the staff recommends the addition of a new item to address the final election of ultimate heat sink (UHS) system piping materials. The staff notes that for some site locations the selection of service water system materials in combination with chemical treatment and ongoing inspection programs have proven to be essential for continued assurance of system integrity. Accordingly, the staff recommends that a new COL information item be added to Design Control Document (DCD), Tier 2 Table 1.8-2, "Compilation of All Combined License Applicant Items for Chapters 1-19," that states a COL applicant that references the US-APWR will identify the site specific materials selected for UHS piping and components, including the bases for the selections.
2. The staff notes in Tier 2, DCD that COL 9.2 (21) address UHS makeup water blowdown, but did not specifically address chemical treatment for the control of biofouling. In accordance with 10 CFR 52.47(a)(24) a conceptual design of makeup water and blowdown is needed in order to aid the staff's review and to determine the adequacy of the interface requirements. In addition, due to the importance of the UHS makeup, the UHS makeup should be a separate DCD section and not addressed under Tier 2, DCD Section 9.2.5. RG 1.206 states Section 9 of the application should discuss each of the plant's water systems and because these auxiliary water systems vary in number, type, and nomenclature for various plant designs, the standard format does not assign specific subsection numbers to these system discussions. The applicant should provide separate subsections (numbered 9.2.1 through 9.2.x) for each of the systems. This separate section of the DCD would be consistent with other new plant applications (raw water system) including the AP1000 and Evolutionary Power Reactor (EPR).
3. The staff has identified that a specific COL information item did not specifically address the means for providing UHS makeup sufficient to meet the maximum evaporative and drift water loss after 72 hours through the remainder of the 30 day period consistent with RG 1.27. This item may need clarification due to Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plant", Rev 2, Jan 1976, Section C3, which states in part the UHS should consist of at least two highly reliable water sources. In general a specific

COL information item did not address all of the regulatory positions in RG 1.27 that have to be met for the specific site COL (reference Tier 2, DCD Table 1.9.1-1, "US-APWR Conformance with Division 1 Regulatory Guides").

ANSWER:

1. The type of material for the UHS piping will vary according to the COL applicant's design and is considered outside the scope of the DCD. This item is addressed as part of COL 9.2(20), which requires the COL applicant to provide a detailed description of the UHS. A new COL item below which requires the COL applicant to provide the piping, valves, materials specifications, and other design details of the UHS has also been added.

COL 9.2.28 ***The COL Applicant is to provide the piping, valves, materials specifications, and other design details related to the site specific UHS.***

2. Description of the appropriate monitoring and neutralizing chemistry of the ESW discharges to the environment is outside the scope of the DCD but will be addressed by the COL applicant as described in the Tier 2 DCD Subsection 9.2.5.2 and COL 9.2(20), which require the COL Applicant specify the following ESW chemistry requirements:

- "A chemical injection system to provide non-corrosive, non-scale forming conditions to limit biological film formation.
- Type of biocide, algaecide, pH adjuster, corrosion inhibitor, scale inhibitor and silt dispersant based on the site conditions".

Also, MHI considers these water chemistry features to be germane to the site-specific UHS design, and therefore are appropriately addressed in Subsection 9.2.5 of a COLA FSAR.

MHI has revised Section 9.2.5 and believes it provides the necessary description for UHS makeup capability. Further, MHI has reviewed the DCD sections for the water systems and believes they are complete and further subsections are unnecessary.

3. The 30-day makeup capacity of the UHS without external makeup provided ensures that adequate cooling water is being supplied to the ESWS during accident conditions coincident with LOOP. Since there is no external makeup water source necessary during this event, the Regulatory Guide 1.27 position regarding the need to have two separate (external) water sources for the UHS does not apply. For the design concept involving cooling towers and basins, four separate basins are provided with divisional separation compatible with the ESWS. DCD Subsection 9.2.5.1, Design Bases, includes a general statement that the UHS is designed in accordance with RG 1.27. The applicability of individual RG 1.27 regulatory positions depends on the site characteristics and specific UHS design.

Impact on DCD

See Attachment 1 for changes to Tier 2 DCD 9.2.10.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

This completes the responses to NRC's questions.

- A storage tank water level indicator with alarm signals, control signals for the fill valve and the potable water pumps is provided. The potable water pumps are tripped on low-low water level in the potable water system storage tank.
- A pressure transmitter located on the discharge of the potable water system pumps controls the stop/start sequence of the pumps.
- Instrumentation is provided for the continuous operation of the jockey pump to maintain system pressure during low-flow requirement periods.
- Instrumentation is provided for indication and for automatic potable water system pump start if the jockey pump fails to maintain system pressure.
- Instrumentation necessary for proper operation of all three pumps to satisfy the system distribution flow rates and to maintain an acceptable system pressure is provided.

9.2.5 Ultimate Heat Sink

The ultimate heat sink (UHS) consists of an assured source of water with associated safety-related structures designed to dissipate the heat rejected from the ESWS during normal and accident conditions. UHS peak heat loads and long term heat loads are shown in Tables 9.2.5-1 and 9.2.5-2, respectively. The UHS system is safety-related and designed to meet the requirements of Regulatory Guide 1.27 (Ref. 9.2.11-2).

The following subsections contain conceptual design information enclosed in brackets and are outside the scope of the standard design, thus shall not be incorporated by reference in COLA.

9.2.5.1 Design Bases

The UHS is a site-specific interface with the ESWS. The design information provided in this subsection establishes interface requirements applicable to the UHS design and to be provided by the COL applicant based on specific site characteristics including meteorological data.

The UHS is designed in accordance with GDC 44 to:

- Dissipate the maximum total heat load from the ESWS under normal and accident condition, including that of a LOCA or safe shutdown scenario with LOOP under the worst combination of adverse environmental conditions, even freezing, and cool the unit for a minimum of 30 days (or minimum of 36 days for cooling pond) in accordance with Regulatory Guide 1.27 without makeup water. The decay heat is estimated using ANSI/ANS 5.1, "Decay Heat Power for Light Water Reactors" (Ref. 9.2.10-6).
- Provide suitable component redundancy such that the system's safety functions can be performed in the event of a single active component failure, coincident with

an accident such as a LOCA and safe shutdown with LOOP under extreme meteorological conditions, using either offsite power or onsite emergency power sources.

- Provide the capability to isolate components, systems or piping such that safety functions are not compromised.

The UHS is designed for a single nuclear power unit and is not shared between units (GDC 5). The UHS is designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing and postulated accidents, including LOCA. These environmental effects include dynamic effects that may result from equipment failures or external events (GDC 4).

The UHS is designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami and seiches without loss of capability to perform its safety functions (GDC 2). As indicated in Table 3.2-4, the ultimate heat sink related structures (UHSRS) are Seismic Category I structures selected based on site-specific conditions and site-specific meteorological data.

The UHS is designed to permit appropriate periodic inspection of important components to assure the integrity and capability of the system. The UHS design permits inservice inspection of safety-related piping and components (GDC 45).

The UHS is designed to permit appropriate periodic pressure and functional testing per GDC 46 to assure the following:

- Structural and leaktight integrity of safety-related UHS components.
- Operability and performance of UHS components with active safety functions.
- UHS system operability, and under conditions as close to design as possible, performance of the full operational sequence that brings the UHS into operation for reactor shutdown and LOCA, including operation of appropriate portions of the PSMS and transfer between normal and emergency power sources.

Other UHS design bases to meet the safety-related functional requirements are provided below:

- The UHS is designed in accordance with the requirements of Regulatory Guide 1.27.
- The maximum UHS water temperature to ESWS is 95 °F.
- The safety-related components of the UHS are designed to withstand design loadings.
- Provision is provided to protect the UHS essential structures and components against adverse environmental conditions such as freezing.

- The UHS is designed with inventory sufficient to provide cooling for at least 30 days (or at least 36 days for cooling pond) in accordance with Regulatory Guide 1.27) following an accident, with no makeup water. The COL Applicant is to decide the cooling period in accordance with the site specific UHS. The most severe meteorological condition is based upon [30 years] maximum historical conditions of dry and wet bulb temperatures. The water inventory also assures the available NPSH at the lowest expected water level for the ESW pumps at the end of the 30-day emergency cooling period.

- The safety-related structures and components of the UHS are designed to equipment Class 3 and seismic category I requirements to remain functional during and following an SSE.

- The UHS is designed to satisfy the requirements of 10 CFR 52.79(a)(45) and 10 CFR 20.1406 for the minimization of radioactive contamination.

9.2.5.2 System Description

The decay heat is estimated using ANSI/ANS 5.1, 'Decay Heat Power for Light Water Reactors" (Ref. 9.2.11-6).

The UHS operates in conjunction with the ESWS. The ESWS is described in Section 9.2.1. The UHS is safety-related and supports the four separate and redundant divisions of the ESWS.

The COL Applicant is to determine the type of UHS (e.g. cooling pond, cooling towers) based on specific site conditions and meteorological data.

The COL Applicant is to design the UHS to receive its electrical power supply, if required by the UHS design, from safety buses so that the safety functions are maintained during LOOP. [The UHS receives its standby electrical power from the onsite emergency power supplies during a LOOP.]

A typical UHS interface with ESWS is shown in Figure 9.2.1-1. The COL Applicant is to provide a detailed description and drawings of the UHS, including water inventory, temperature limits, heat rejection capabilities under limiting conditions, instrumentation, and alarms.

The COL Applicant is to determine the normal source of makeup water to the UHS inventory and the blowdown discharge location which are in operation at any time before the start of the 30-day emergency cooling during an accident or safe shutdown with LOOP. The blowdown discharge is provided as a check point for monitoring and neutralizing chemistry of ESW discharges to the environment.

The COL Applicant is to determine source and location of the UHS.

The COL Applicant is to determine location and design of the ESW intake structure.

The COL Applicant is to determine location and design of the ESW discharge structure.

9.2.5.2.1 General Description

[The UHS consists of four 50 percent capacity mechanical draft cooling towers, one for each ESWS train, and four 33 and one-third percent capacity basins.] The COL Applicant's design will assure sufficient water inventory to satisfy the cooling water supply criteria of RG 1.27.

[Each cooling tower consists of two cells with fans and motors, drift eliminators, film fills, risers, and water distribution system all enclosed and supported by a seismic category I reinforced concrete structure. Cooling tower components are designed per equipment Class 3 and quality group C requirements.]

[The fan motors are powered from the Class 1E ac power buses. On loss of offsite power (LOOP), the motors are automatically powered from their respective division's emergency power source, i.e. the Class 1E gas turbine generators (GTG).]

UHS [cooling tower] design water flow rate and [hot (inlet)] water temperature are specified to maintain the [cold (outlet)] water temperature to ESWS less than or equal to 95 °F under design basis heat load conditions.

As noted in Subsection 5.4.7.1, "Design Bases," and Subsection 5.4.7.3, "Performance Evaluation," with ESW water temperature of 95° F, the RHRS is capable of reducing the reactor coolant temperature from 350° F to 200° F within 36 hours after shutdown.

[The cooling towers utilize the basins for structural foundation. The ESW intake basin located underneath the ESW pump house occupies a corner of the UHS basin. The ESW intake basin is deeper than the UHS basin. This is to assure adequate NPSH to the ESW pump.]

[The UHS design concept described herein is depicted in Figure 9.2.5-1. The UHS design and process parameters are provided in Table 9.2.5-3.]

9.2.5.2.2 System Operation

[Each ESWP takes suction from its ESW intake basin located beneath the pump house as described in Subsection 9.2.5.2.1.] The water flows through the CCW heat exchangers and essential chiller units [and then is cooled by the cooling tower before being returned to the basin. A portion of the water is discharged as blowdown to maintain water chemistry. The blowdown operation is terminated during accident mitigation or loss of make-up water].

[Heat rejection to the environment is effected by direct contact with the cooling tower forced airflow, which provides evaporative cooling of the ESW return flow. During normal operation, evaporation, drift and blowdown losses are replaced with the makeup water. Water level controllers provided in each basin automatically open and close the makeup control valves.] Low and high water level are annunciated in the main control room (MCR).

The maintained water level in each UHS [basin] assures adequate NPSH for the ESWP under all operating modes. Assuming one train is out of service for maintenance and the source of makeup water is unavailable for a period of thirty days after the accident, the combined inventory [of three basins] provides a thirty-day cooling water supply.

The ESWS together with the UHS are designed, arranged and operated to minimize the effects of water hammer forces. The system layout assures water pressure remains above saturation conditions throughout the system. High point vents and low point drains are provided. [The ESW pump is designed to provide positive pressure at the spray nozzle headers. This, together with the high point vents, minimizes system drain down in the idle trains or upon loss of offsite power and subsequent pump trip.]

[The following features preclude or minimize water hammer forces:

- On loss of off-site power (LOOP), the discharge MOV of the operating train is closed by DC power. This, together with the pump discharge check valve, prevents draindown to the basin.
- The ESW pump start logic interlocks the discharge MOV operation with the pump operation. The re-start of the tripped pump or start of the stand-by pump opens the discharge valve slowly, sweeping out voids from the discharge piping and CT riser and distribution piping.
- The system valve lineup and periodic inservice testing of the idle trains, including high point venting, help minimize potential voids and water hammer forces.]

[The UHS transfer pumps are designed to transfer cooling water from a non-operating UHS basin to the operating UHS basins. The transfer pump and their associated components (e.g., piping, valves) are designed to Equipment Class 3, Seismic Category I and single failure criteria consistent with the UHS design bases.]

[The cooling tower fans are automatically activated by the emergency core cooling system (ECCS) actuation signal, the LOOP sequence actuation signal, or the remote manual actuation signal.]

The ECCS actuation signal ensures continuous cooling to the reactor during accidents. [The LOOP sequence actuation signal automatically starts the Class 1E gas turbine generators (GTGs) to resume power to the active components in each UHS train during LOOP events.]

Operational details of the ESWS are provided in Subsection 9.2.1.

9.2.5.2.3 System Performance

The UHS is designed with sufficient inventory to provide cooling for at least 30 days following an accident with no makeup water. The UHS must be capable of dissipating the design bases heat loads under the worst environmental conditions that minimize heat dissipation without exceeding the maximum ESW supply temperature of 95°F.

The wet bulb design temperature is based on [a minimum of 30 years] of climatological data in accordance with RG 1.27. [A 2°F recirculation penalty is added to the maximum average wet bulb temperature.]

The required total water usage [(due to cooling tower drift and evaporation) over the postulated 30 day period] is determined using industry standard methodology as follows:

[Total Evaporation (E) and Drift (D) rates were calculated using the ESW flow rate (GPM) times the temperature rise (CR) and a conservative cooling tower factor of 0.0009, E (total) = GPM x CR x 0.0009].

[a. The cooling tower factor of 0.0009 is considered conservative since it is based on standard cooling tower evaporation factor of 0.0008, and typical cooling tower drift rate of 0.0002. This is expressed as

Total Evaporation (E) = GPM x CR x 0.0008 + GPM x 0.0002]

[b. The ESW temperature rise (CR) was based on heat rate equation of H as Heat Rate (H) = m x specific heat x CR, where, m = mass flow rate.]

[c. Accumulative evaporation (gallons/cooling tower) is calculated by multiplying the evaporation rate (gpm) and its corresponding time interval.]

[d. The total water loss due to evaporation and drift for the 30 days period is calculated and is defined as the plant unit minimum required water capacity for the basin design in accordance with RG 1.27.]

For this conceptual design using worst case heat loads during two train operation, the maximum required 30-day cooling water capacity is approximately [8.40 million gallons]. [The minimum water level to be maintained is determined by accounting for expected debris accumulation, level instrument uncertainties and system leakage.]

9.2.5.3 Safety Evaluation

The UHS is capable of rejecting the heat load under limiting conditions. **The COL Applicant will provide results of UHS capability and safety evaluation of the UHS based on specific site conditions and meteorological data.**

The UHS is arranged to support separation of the four divisions of ESWS. System functional capability is maintained assuming one division is unavailable due to on-line maintenance during a design basis accident with a single active failure, with or without a LOOP.

The UHS is designed to withstand the effects of natural phenomena, including the capability to remain functional following a safe shutdown earthquake (SSE). [The basis for the structural adequacy of the UHSRS is provided in the following sections:

- 3.3, Wind and Tornado Loads

- 3.4, Water Level (Flood) Design
- 3.5, Missile Protection
- 3.7, Seismic Design
- 3.8, Design of Category I Structures]

Site-specific UHS design features to address limiting hydrology-related events are addressed as required by DCD Section 2.4, Hydrologic Engineering (specifically Subsections 2.4.8, 2.4.11 and 2.4.14).The UHS is sufficiently sized to accept the heat rejected (Table 9.2.5-1) from the ESWS.

The heat loads for LOCA and safe shutdown conditions with LOOP for up to 36 days are provided in Table 9.2.5-2. These heat loads establish the basis for minimum allowable UHS cooling water inventory and maximum temperature limits, to maintain the ESW supply water temperature less than or equal to 95 °F under design basis heat load conditions. [At the minimum water following UHS operation in the limiting scenario in Table 9.2.5-2, ESW pump NPSH requirements are met without assuming UHS inventory make-up from external sources, in accordance with RG 1.27.] Technical Specifications by the COL applicant (COL 16.1_3.7.9 (1)) prescribe operating limits for [minimum UHS usable water capacity and maximum UHS initial water temperature.

[Table 9.2.5-4 on Failure Modes and Effects Analysis (FMEA) of the UHS concludes that no single failure, coincident with one train being unavailable due to maintenance and a loss of offsite power compromises the safety functions.]

9.2.5.4 Inspection and Testing Requirements

The COL Applicant will provide test and inspection details based on type of UHS to be provided. These details will include inspection and testing requirements necessary to demonstrate that fouling and degradation mechanisms are adequately managed to maintain acceptable UHS performance and integrity.

The UHS supports ESWS operation and is therefore tested as part of the ESWS preoperational test described in Subsection 14.2.12.1.34. As indicated in Subsection 14.2.12, the COL applicant is responsible for testing outside the scope of the certified design.

Periodic inspections and tests of UHS and ESWS components and subsystems are performed to verify proper operation and system operability. This includes ASME Section XI requirements as discussed in Section 6.6.

The COL Applicant is to develop maintenance and test procedures to monitor debris build up and flush out debris.

The COL Applicant is to develop (if required by the type of UHS selected) inspection and testing requirements necessary to demonstrate that fouling and degradation mechanisms are adequately managed to maintain acceptable UHS performance and integrity.

9.2.5.5 Instrumentation Requirements

The COL Applicant will provide the required alarms, instrumentation and control details based on the type of UHS to be provided.

Alarms and displays are provided in the main control room (MCR) and remote shutdown console (RSC) for the following parameters:

- UHS Water Level – MCR/RSC display, high level alarm and low level alarm.
- UHS Water Temperature (ESW supply) – MCR/RSC display, high temperature alarm and low temperature alarm.
- [UHS transfer pump discharge pressure – local and MCR/RSC display]
- [UHS transfer pump discharge flow rate – local and MCR/RSC display]

9.2.6 Condensate Storage Facilities (Demineralized Water, Condensate Storage, and Primary Makeup Water)

The condensate storage facilities (CSF) system consists primarily of three systems:

- Demineralized water system
- Condensate storage and transfer system
- Primary makeup water system

The demineralized water treatment package is not within the scope of this DCD. The demineralized water treatment package supplies demineralized water to demineralized water storage tank (DWST), which in turn supplies demineralized water to the condensate storage tank (CST), primary makeup water tanks (PMWTs), and other users throughout the plant.

The CSF system is shown schematically in Figures 9.2.6-1, 9.2.6-2, and 9.2.6-3.

9.2.6.1 Design Bases

9.2.6.1.1 Safety-Related Design Basis

The CSF system has no safety-related function and therefore has no nuclear safety design basis.

9.2.6.1.2 Power Generation Design Basis

The demineralized water system is designed to provide:

- Sufficient demineralized water volume for makeup of the CST and to meet the demands and usages of the demineralized water in various other plant systems.

COL 9.2(1) *The COL Applicant is to provide the evaluation of the ESWP at the lowest probable water level of the UHS. The COL Application is to develop recovery procedures in the event of approaching low water level of UHS.*

COL 9.2(2) *The COL Applicant is to provide the protection against adverse environmental, operating, and accident conditions that can occur, such as freezing, thermal overpressurization. The COL Applicant it to provide the preventive measures for protection against adverse environmental conditions.*

COL 9.2(3) *The COL Applicant is to determine source and location of the UHS.*

COL 9.2(4) *The COL Applicant is to determine location and design of the ESW intake structure.*

COL 9.2(5) *The COL Applicant is to determine location and design of the ESW discharge structure.*

COL 9.2(6) *The COL Applicant is to provide ESWP design details – required total dynamic head, NPSH available, and the mode of cooling of the ESWP.*

COL 9.2(7) *The COL Applicant is to provide the piping, valves, including those at the boundary between the safety-related and nonsafety-related portions, and other design of the ESWS related to the site specific conditions, including the safety evaluation.*

COL 9.2(8) *The COL Applicant is to specify the following ESW chemistry requirements:*

- *A chemical injection system to provide non-corrosive, non-scale forming conditions to limit biological film formation.*
- *Type of biocide, algaecide, pH adjuster, corrosion inhibitor, scale inhibitor and silt dispersant based on the site conditions.*

COL 9.2(9) *COL Applicant is to confirm the storage capacity and usage of the potable water.*

COL 9.2(10) *COL Applicant is to confirm that all State and Local Department of Health and Environmental Protection Standards are applied and followed.*

COL 9.2(11) *The COL Applicant is to confirm the source of potable water to the site and the necessary required treatment.*

COL 9.2(12) *COL Applicant is to confirm that the sanitary waste is sent to the onsite plant treatment area or they will use the city sewage system.*

COL 9.2(13) *COL Applicant is to identify the potable water supply and describe the system operation.*

COL 9.2(14) COL Applicant is to confirm Table 9.2.4-1 for required components and their values.

COL 9.2(15) The COL Applicant is to determine the total number of people at the site and identify the usage capacity. Based on these numbers the COL Applicant is to size the potable water tank and associated pumps.

COL 9.2(16) The COL Applicant is to provide values to the component Table 9.2.4-1 based on system and component descriptions from Section 9.2.4.2.1 and 9.2.4.2.2 respectively.

COL 9.2(17) The COL Applicant is to determine the total number of sanitary lift stations and is to size the appropriate interfaces.

COL 9.2(18) The COL Applicant is to determine the type of the UHS based on specific site conditions and meteorological data.

COL 9.2(19) The COL Applicant is to design the UHS to receive its electrical power supply, if required by the UHS design, from safety busses so that the safety functions are maintained during LOOP.

COL 9.2(20) The COL Applicant is to provide a detailed description and drawings of the UHS, including water inventory, temperature limits, heat rejection capabilities, instrumentation, and alarms.

COL 9.2(21) The COL Applicant is to determine the source of makeup water to the UHS inventory and the blowdown discharge location based on specific site conditions.

COL 9.2(22) The COL Applicant is to provide results of UHS capability and safety evaluation of the UHS based on specific site conditions and meteorological data. The COL Applicant is to use at least 30 years site specific meteorological data and heat loads data for UHS performance analysis per Regulatory Guide 1.27.

COL 9.2(23) The COL Applicant is to provide test and inspection requirements of the UHS. These is to include inspection and testing requirements necessary to demonstrate that fouling and degradation mechanisms are adequately managed to maintain acceptable UHS performance and integrity.

COL 9.2(24) The COL Applicant is to provide the required alarms, instrumentation and controls details based on the type of UHS to be provided.

COL 9.2(25) The COL applicant will develop operating and maintenance procedures for the ESWS to address water hammer issues in accordance with NUREG-0927.

COL 9.2(26) The COL applicant is to develop maintenance and test procedures to monitor debris build up and flush out debris.

COL 9.2(27) The COL Applicant is to develop a milestone schedule for implementation of the operating and maintenance procedures for water hammer prevention.

COL 9.2.28 The COL Applicant is to provide the piping, valves, materials specifications, and other design details related to the site specific UHS.

9.2.11 References

9.2.11-1 General Design Criteria for Nuclear Power Plants, NRC Regulations Title 10, Code of Federal Regulations, 10CFR Part 50, Appendix A.

9.2.11-2 Ultimate Heat Sink for Nuclear Power Plants, Regulatory Guide 1.27 Revision 2, January 1976.

9.2.11-3 Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants, NRC Regulatory Guide 1.26 Revision 4, March 2007.

9.2.11-4 National Primary Drinking Water Standards, Environmental Protection Agency, Title 40, Code of Federal Regulations, 40CFRPart 141.

9.2.11-5 Occupational Safety and Health Standard, Occupational Safety and Health Administration, Department of Labor, Title 29, Code of Federal Regulations, 29CFRPart 1910.

9.2.11-6 American Nuclear Society Standards Committee Working Group, American National Standard for Decay Heat Power in Light Water Reactors, ANS 5.1, August 1979.

9.2.11-7 Electric Power Research Institute Palo Alto, California, Advanced Light Water Reactor Utility Requirements Document, Rev.8.

9.2.11-8 ANSI B31.1 Power Piping Code.

Table 9.2.5-1 UHS Peak Heat Loads

Plant Operating Mode	Peak Heat Load
Safe shutdown (2-train operation)	196 x 10^6 Btu/h/train
LOCA (2-train operation)	158 x 10^6 Btu/h/train

Table 9.2.5-2 UHS Heat Load for LOCA and Safe Shutdown with LOOP (Sheet 1 of 2)

Time after incident	LOCA (4 trains operation)	LOCA (2 trains operation)	Safe shutdown (4 trains operation)	Safe shutdown (2 trains operation)
	(x 10^6 Btu/h/4 trains)	(x 10^6 Btu/h/2 trains)	(x 10^6 Btu/h/4 trains)	(x 10^6 Btu/h/2 trains)
1 h	534	303	76	59
2 h	466	316	76	59
3 h	379	303	76	59
4 h	321	286	409	392
5 h	283	269	399	382
6 h	258	253	391	319
7 h	242	239	384	271
8 h	232	228	278	241
9 h	224	218	229	221
10 h	217	209	214	208
11 h	211	202	207	199
12 h	206	196	203	193
13 h	203	191	199	188
14 h	199	186	196	184
15 h	197	182	194	180
16 h	194	178	191	177
17 h	191	175	189	175
18 h	189	172	187	172
19 h	187	170	185	170
20 h	185	167	184	168
21 h	183	165	182	166
22 h	181	163	180	165
23 h	180	162	179	163
24 h	179	160	178	162
2 days	161	140	160	144
3 days	151	130	150	133
4 days	144	123	143	126
5 days	138	117	138	121
6 days	135	113	134	117
7 days	131	110	131	114
8 days	129	108	128	111
9 days	127	106	126	109
10 days	125	104	124	107

Table 9.2.5-2 UHS Heat Load for LOCA and Safe Shutdown with LOOP
(Sheet 2 of 2)

Time after incident	LOCA (4 trains operation)	LOCA (2 trains operation)	Safe shutdown (4 trains operation)	Safe shutdown (2 trains operation)
	(x 10^6 Btu/h/4 trains)	(x 10^6 Btu/h/2 trains)	(x 10^6 Btu/h/4 trains)	(x 10^6 Btu/h/2 trains)
11 days	123	102	123	106
12 days	122	100	122	105
13 days	121	99	121	104
14 days	120	98	120	102
15 days	119	98	118	101
16 days	118	97	117	100
17 days	117	96	116	99
18 days	117	95	116	98
19 days	116	94	115	98
20 days	115	93	114	97
21 days	114	93	114	96
22 days	113	92	113	96
23 days	112	91	112	95
24 days	112	90	112	95
25 days	112	90	111	94
26 days	111	90	111	94
27 days	111	90	110	93
28 days	111	89	110	93
29 days	111	89	110	93
30 days	110	88	109	92
31 days	110	88	109	92
32 days	109	88	108	91
33 days	109	87	108	91
34 days	109	87	108	91
35 days	108	87	108	91
36 days	108	86	107	90

[Table 9.2.5-3 Ultimate Heat Sink System Design Data]

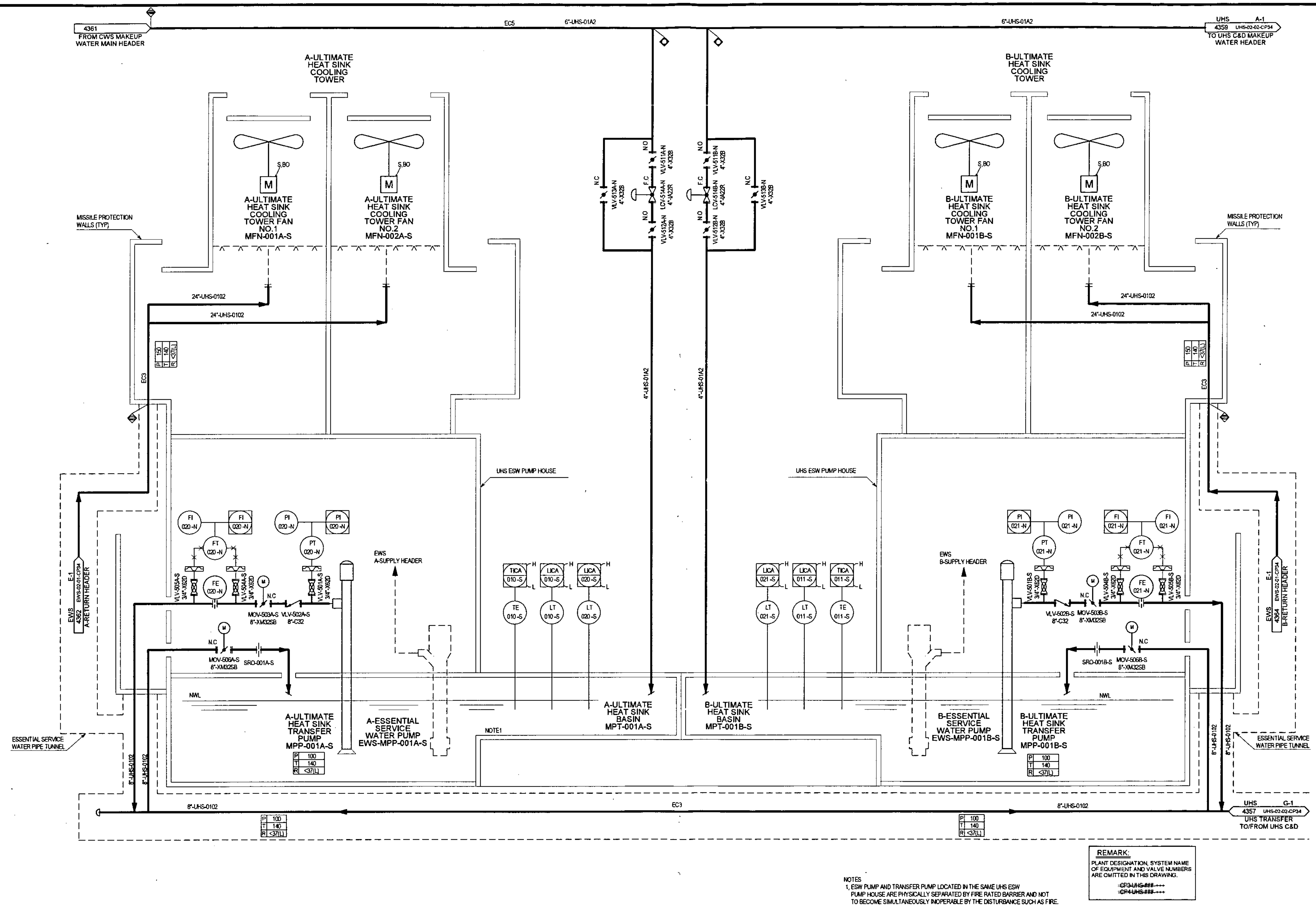
UHS Cooling Tower and Basin (Typical)	
Physical Data	
Type and Quantity	Wet, mechanical draft Four (4) – 50 percent cooling tower with basin Two (2) cells per cooling tower
Basin Size	Footprint Approx 123 feet x 123 feet (inside dimensions) Depth Approx 31 feet (at normal water level)
Usable Basin Water Volume / Required Volume	3.12×10^6 gallons per basin (at minimum maintained water level) / 2.8×10^6 gallons per basin
Fan and Motor Quantity	One (1) each per cell
Fan driver	200 rated hp
Design Air Flow	685,900 cfm per fan
Cooling Tower Design Life	60 years
Process Parameters	
Design Cooling Water Flow Rate	12,000 (gpm per cooling tower)
Design Heat Load	1.96×10^8 (Btu/hr per cooling tower)
Cooling Water Temperature	Hot (Inlet) 128° F Cold (Outlet) 95° F
Design Wet Bulb Temperature	80° F
Design Approach	15° F

[Table 9.2.5-4 Failure Modes and Effects Analysis for the Ultimate Heat Sink (Sheet 1 of 2)]

Item	Description of Component	Safety Function	Plant Operating Mode	Failure Mode(s)	Method of failure Detection	Failure Effect on System Safety Function Capability	General Remarks
1	UHS Cooling Tower Fan (UHS-MFN-001A, B, C, D and UHS-MFN-002A, B, C, D)	Circulates ambient air through cooling tower to cool ESW	All	Fails to start upon command Trips for any reason	Fan status indication light in MCR Fan status indication light in MCR	None. Remaining three 50 percent capacity cooling towers are available. A minimum of two towers are required for safe shutdown. None. Same as the failure mode "Fails to start upon command".	One Train out due to maintenance does not affect safety function, because only a minimum of two cooling towers are required.
2	UHS Transfer Pump (UHS-OPPMPP-001A, B, C, D)	Transfers 33-1/3 percent of required 30-day cooling water from one inoperable basin to two (2) operating basins	Accident, Safe shutdown, Cooldown – loss of offsite power	Fails to start upon command	Pump status indication light in MCR	None. Even if single failure is assumed for the transfer pump, the cooling tower with the inoperable transfer pump can use its own basin water. It is not necessary to transfer this basin water to other basins.	

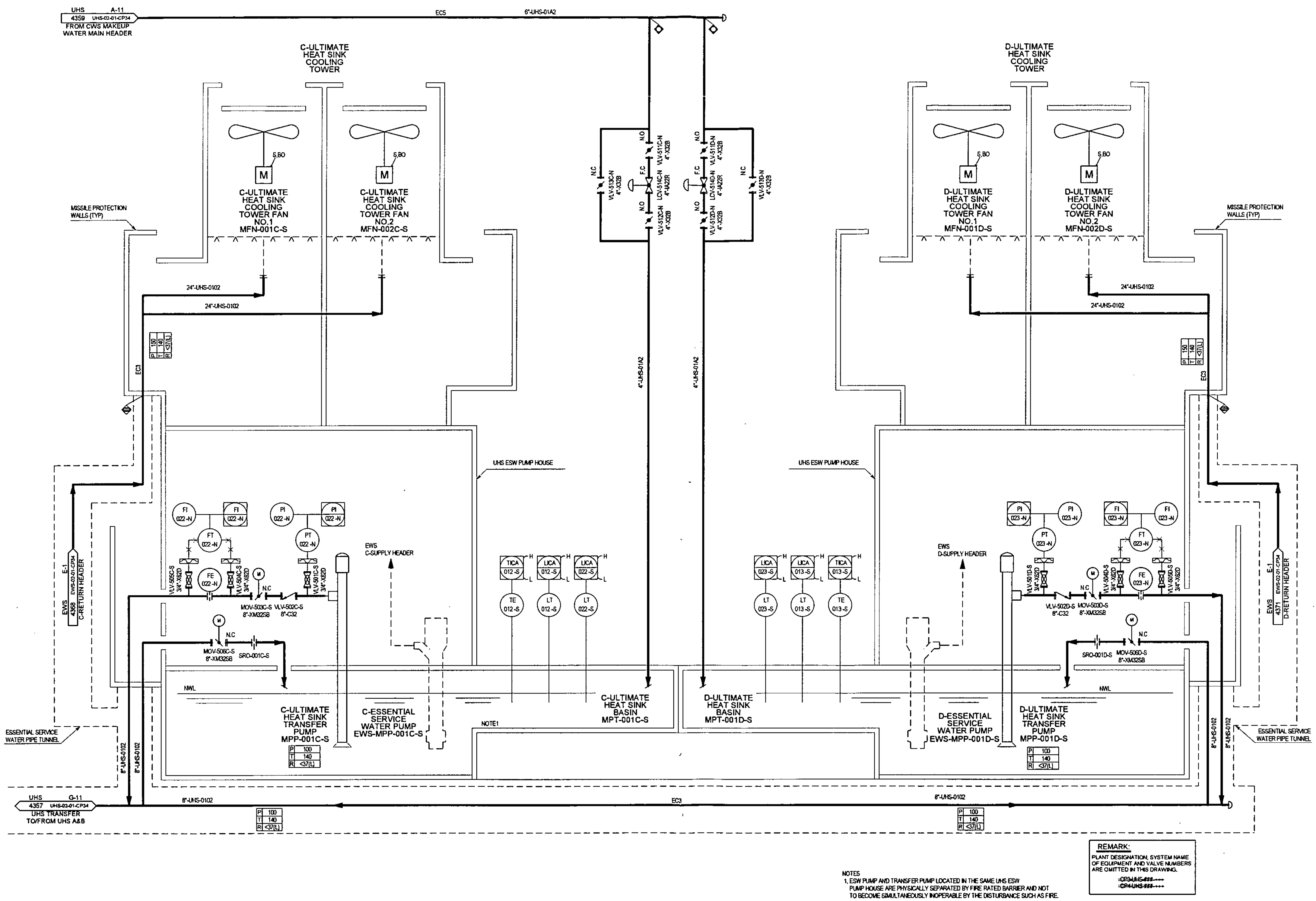
[Table 9.2.5-4 Failure Modes and Effects Analysis for the Ultimate Heat Sink (Sheet 2 of 2)]

Item	Description of Component	Safety Function	Plant Operating Mode	Failure Mode(s)	Method of failure Detection	Failure Effect on System Safety Function Capability	General Remarks
3	UHS Transfer Pump Discharge Valve (MOV-503A, B, C, D), fail as is, motor operated valve	Opens to provide flow path	Accident, Safe shutdown, Cooldown – loss of offsite power	Fails to open upon command	Position indication in MCR	None. Even if single failure is assumed for the valve, the cooling tower with the inoperable valve can use its own basin water. It is not necessary to transfer this basin water to other basins.	
4	UHS Transfer Line Basin Inlet valve (MOV-506A, B, C, D), fail as is, motor operated valve	Opens to provide flow path	Accident, Safe shutdown, Cooldown – loss of offsite power	Fails to open upon command	Position indication in MCR	None. This failure effect is bounded by the failure effect of the UHS Cooling Tower Fan.	
5	UHS Basin Blowdown Control Valve (EWS-HCV-010, 011, 012, 013) fail close air operated valve	Closes to isolate blowdown	All	Fails to close upon command	Position indication in MCR	None. Blowdown can be isolated by closing the manual valves (VLV-541A,B,C,D, VLV-543A,B,C,D) Effect of uncontrolled blowdown for 30 minutes on basin inventory is insignificant.	



[Figure 9.2.5-1 Ultimate Heat Sink Flow Diagram (Sheet 1 of 2)]

Attachment 1



[Figure 9.2.5-1 Ultimate Heat Sink Flow Diagram (Sheet 2 of 2)]

Attachment 1

3.0 INTERFACE REQUIREMENTS

3.1 Design Description

This section identifies the safety significant interfaces between the US-APWR standard plant design and the Combined License (COL) applicant.

The US-APWR standard plant design consists of several buildings (reactor building including the prestressed concrete containment vessel and containment internal structure, power source buildings, auxiliary building, turbine building and access building); the equipment located in those buildings, and structures (power source fuel storage vaults and essential service water pipe tunnel). As allowed by the regulations, conceptual designs for systems that are not part of the US-APWR standard design are included in the DCD for purposes of allowing the NRC to evaluate the overall acceptability of the design. However, the final details of these conceptual designs are subject to change due to site-specific conditions.

Although the system descriptions of the PSFSVs and ESWPT are within the scope of the US-APWR standard design, the structural design of the PSFSVs and ESWPT, including seismic and dynamic qualification as applicable, are to be finalized based on the site specific arrangement.

An interface requirement as specified in this section is the portion of a system that must be added to the standard design package to complete the design of the US-APWR at a specific site.

COL applicant referencing the certified design is responsible to assure that the site specific design meets the interface requirement and verify the conformance in the ITAAC process that is similar to those provided in the certified design.

3.2 Interface Requirements

3.2.1 Ultimate Heat Sink

Ultimate heat sink (UHS) is a safety-related system and is site-specific. The following are site specific interface requirements:

a. The UHS system design is consistent with ESWS divisional separation and is capable of performing its safety function under design basis events and coincident single failure with or without offsite power available.

b. The safety related, pressure retaining components including supports, are designed, constructed and inspected in accordance with ASME Code Section III.

c. The UHS is designed to withstand seismic, wind, tornado, missile, and flooding design basis loads without the loss of safety function.

d. The maximum supply water temperature is 95 °F under the peak heat loads condition to provide sufficient cooling capacity to ESWS.

e. The UHS keeps the water level at a net positive suction head (NPSH) greater than the pump's required NPSH during normal operation, AOOs and accident conditions.

f. The UHS system, regardless of type and design, is designed to have MCR and RSC alarms and displays for UHS water level and water temperature.

g. The UHS system has MCR and RSC controls for UHS components' active safety functions if applicable to the site-specific design.

h. UHS components that have PSMS control (if applicable to the site-specific design) perform an active safety function after receiving a signal from PSMS.

i. The UHS is designed to cool the unit for a minimum of 30 days without make-up during a design basis event.

j. The UHS is designed for periodic inspection and testing.

3.2.2 Fire Protection System

The seismic standpipe system can be supplied from a safety-related water source which capacity is at least 18,000 gallons.

3.7 PLANT SYSTEMS

3.7.9 Ultimate Heat Sink (UHS)

LCO 3.7.9 [Three UHS cooling towers shall be OPERABLE including their associated fans and three OPERABLE transfer pumps.]

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. [One required cooling tower with associated cooling tower fans inoperable]	A.1 [Restore three cooling towers with associated fans to OPERABLE status.] OR A.2 -------------NOTES------------- This Required Action is not applicable in MODE 4. ------------------------------------ Apply the requirements of Specification 5.5.18.	[72 hours] [72 hours]
B. [One or more required] UHS [basins with] water temperature not within limits.	B.1 Verify that water temperature of the UHS is [≤93°F] averaged over the previous 24 hour period.	once per hour
C. One or more required UHS basins with water level not within limits.	C.1 Restore water level(s) to within limits.	72 hours
D. [One or more required UHS transfer pump(s) inoperable.]	D.1 [Restore the transfer pump(s) to OPERABLE status.] [OR D.2.1 [Implement an alternate method of basin transfer.] [AND D.2.2 [Restore the transfer pump(s) to OPERABLE status.]	[7 days] [7 days] [31 days]

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
E. Required Action and associated Completion Time of Condition [A, B, C, or D] not met. OR] UHS inoperable [for reasons other than Condition A, B, C, or D.]	E.1 Be in MODE 3. AND E.2 Be in MODE 5.	6 hours 36 hours

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE	FREQUENCY
SR 3.7.9.1	Verify each required UHS basin water level is [≥ 2,800,000 gallons.]	In accordance with the Surveillance Frequency Control Program
SR 3.7.9.2	Verify water temperature of UHS is [≤ 93°]F.	In accordance with the Surveillance Frequency Control Program
SR 3.7.9.3	[Operate each cooling tower fan for ≥ 15 minutes.]	In accordance with the Surveillance Frequency Control Program
SR 3.7.9.4	[Verify each cooling tower fan starts automatically on an actual or simulated actuation signal.]	In accordance with the Surveillance Frequency Control Program
SR 3.7.9.5	[Verify each UHS transfer pump starts on manual actuation.]	In accordance with the Surveillance Frequency Control Program
SR 3.7.9.6	Verify each UHS manual, power-operated, and automatic valve in the flow path servicing safety related equipment, that is not locked, sealed or otherwise secured in position, is in the correct position.	In accordance with the Surveillance Frequency Control Program
SR 3.7.9.7	Verify each UHS automatic valve and each control valve in the flow path that is not locked, sealed, or otherwise secured in position, actuates to the correct position on an actual or simulated actuation signal.	In accordance with the Surveillance Frequency Control Program

B 3.7 PLANT SYSTEMS

B 3.7.9 Ultimate Heat Sink (UHS)

BASES

BACKGROUND

The UHS provides a heat sink for processing and operating heat from safety related components during a transient or accident, as well as during normal operation. This is done by utilizing the Essential Service Water System (ESWS) and the Component Cooling Water (CCW) system.

[The UHS consists of four 50 percent capacity mechanical draft cooling towers, one for each ESWS train. Each cooling tower consists of two cells with one fan per cell. The combined inventory of three of the four UHS basins provides a 30-day storage capacity as discussed in FSAR Chapter 9 (Ref. 1). Each unit is provided with its own independent UHS with no cross connection between the two units.] The two principal functions of the UHS are the dissipation of residual heat after reactor shutdown, and dissipation of residual heat after an accident.

The basic performance requirements are that an adequate inventory of cooling water be available for [30] days without makeup, and that the design basis temperatures of safety related equipment not be exceeded. [Each UHS basin provides 33-1/3 percent of the combined inventory] for the 30-day storage capacity to satisfy the short-term recommendation of Regulatory Guide 1.27 (Ref. 2). There is one safety-related UHS transfer pump per UHS basin which is used to transfer water between the UHS basins.]

The [stored] water level provides adequate net positive suction head (NPSH) to the ESW pump during a 30-day period of operation following the design basis LOCA or safe shutdown with LOOP scenario without makeup.

Additional information on the design and operation of the system, along with a list of components served, can be found in Reference 1.

APPLICABLE SAFETY ANALYSES

The UHS is the sink for heat removed from the reactor core following all accidents and anticipated operational occurrences in which the unit is cooled down and placed on residual heat removal (RHR) operation.

[The operating limits are based on safe shutdown with LOOP. A conservative heat transfer analysis for the worst case LOCA was performed to ensure that the cooling tower capacity and the basin water inventory] adequately remove the heat load for the worst case LOCA. Reference 1 provides the details of the assumptions used in the analysis, which include worst expected meteorological conditions, conservative uncertainties when calculating decay heat, and worst case single active failure. The UHS is designed in accordance with Regulatory Guide 1.27 (Ref. 2), which requires a 30 day supply of cooling water in the UHS.]

The UHS satisfies Criterion 3 of 10 CFR 50.36(d)(2)(ii).

LCO

[The UHS is required to be OPERABLE and is considered OPERABLE if it contains a sufficient volume of water at or below the maximum temperature that would allow the ESWS to operate for at least 30 days following a design basis LOCA or safe shutdown with LOOP, without makeup water, and provide adequate net positive suction head (NPSH) to the ESWS pumps, and without exceeding the maximum design temperature of the equipment served by the ESWS. To meet this condition, three UHS cooling towers with the UHS temperature not exceeding 93°F during MODES 1, 2, 3 and 4 and the level in each of three basins being maintained above 2,800,000 gallons are required—a volume correspondent to the safe shutdown with LOOP conditions that bounds the LOCA condition. Additionally, three of the UHS transfer pumps shall be OPERABLE, with each pump capable of transferring flow from a UHS basin meeting water inventory and temperature limits, and powered from an independent Class 1E electrical division.]

APPLICABILITY

In MODES 1, 2, 3, and 4, the UHS is required to support the OPERABILITY of the equipment serviced by the UHS and required to be OPERABLE in these MODES.

In MODE 5 or 6, the OPERABILITY requirements of the UHS are determined by the systems it supports.

ACTIONS

[A.1 and A.2

If one of the required cooling towers and associated fans is inoperable (i.e., one or more fans per cooling tower inoperable), action must be taken to restore the inoperable cooling tower and associated fan(s) to OPERABLE status within 72 hours. In this Condition, the remaining OPERABLE cooling towers with associated fans are adequate to perform the heat removal function. However, the overall reliability is reduced because a single failure in the OPERABLE UHS cooling towers could result in a loss of UHS function.

ACTIONS (continued)

Required Action A.2 allows the option to apply the requirements of Specification 5.5.18 to determine a Risk Informed Completion Time (RICT). This Required Action is not applicable in MODE 4. The 72-hour Completion Time is based on the capability of the OPERABLE cooling towers to provide the UHS cooling capability and the low probability of an accident occurring during the 72 hours that one required cooling tower and associated fans are inoperable.]

B.1

With water temperature of the UHS [> 93°F], the design basis assumption associated with initial UHS temperature is bounded provided the temperature of the UHS averaged over the previous 24-hour period is [≤ 93°F]. With the water temperature of the UHS [> 93°F], long-term cooling capability of the ECCS loads may be affected. Therefore, to ensure long-term cooling capability is provided to the ECCS loads when water temperature of the UHS is [> 93°F], Required Action B.1 is provided to monitor the water temperature of the UHS more frequently and verify the temperature is [≤ 93°F] when averaged over the previous 24 hour period. The once per hour Completion Time takes into consideration UHS temperature variations and the increased monitoring frequency needed to ensure design basis assumptions and equipment limitations are not exceeded in this condition. If the water temperature of the UHS exceeds [93°F] when averaged over the previous 24 hour period, Condition E must be entered immediately.

[C.1

If one or more required UHS basins have a water level not within the limits, action must be taken to restore the water level to within limits within 72 hours.

The 72 hour Completion Time is reasonable based on the low probability of an accident occurring during the 72 hours, the considerable cooling capacity still available in the basin(s), and the time required to reasonably complete the Required Action. Furthermore, there would be no significant loss in the UHS cooling capacity when the water level drops below the normal level during a 72-hour period because of sufficient cooling tower basin inventory. The UHS has a combined design heat removal capacity of approximately 20 days from two operable cooling tower basins and 30 days from three operable cooling tower basins.]

BASES

ACTIONS (continued)

[D.1, D.2.1, and D.2.2

If one or more required UHS transfer pump(s) are inoperable, action must be taken to restore the pump(s) to OPERABLE status or implement an alternate method of transferring the affected basin within 7 days. If an alternate method is utilized, action still must be taken to restore the transfer pump(s) to OPERABLE status within 31 days.

The Completion Times are reasonable based on the low probability of an accident occurring during the time allowed to restore the pump(s) or implement an alternate method, the availability of alternate methods, and the amount of time available to transfer the water from one basin to the other under the worst case accident assumptions. Furthermore, the inoperability of all required transfer pumps leaves only two cooling tower basins with a combined design heat removal capacity of approximately 20 days. This cooling period bounds and justifies the 7-day completion time to restore the transfer pumps to operable status.]

E.1 and E.2

If the Required Actions and Completion Times of Condition [A, B, C, or D] are not met, or the UHS is inoperable for reasons other than Condition [A, B, C, or D] the unit must be placed in a MODE in which the LCO does not apply. To achieve this status, the unit must be placed in at least MODE 3 within 6 hours and in MODE 5 within 36 hours.

The allowed Completion Times are reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems.

SURVEILLANCE REQUIREMENTS

SR 3.7.9.1

This SR verifies that adequate long term (30 day) cooling can be maintained. The specified level also ensures that sufficient NPSH is available to operate the ESWS pumps. The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program. This SR verifies that each required UHS [basin] water level is [≥ 2,800,000] gallons. Plant procedures provide the corresponding water level to be verified to assure a usable volume of [2,800,000] gallons, accounting for unusable volume and measurement uncertainty.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.7.9.2

This SR verifies that the ESWS is available to cool the CCW System and essential chiller unit to at least its maximum design temperature with the maximum accident or normal design heat loads for 30 days following a design basis LOCA or safe shutdown with LOOP. The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program. This SR verifies that the water temperature of the UHS is [≤ 93°F].

[SR 3.7.9.3

Operating each cooling tower fan for ≥15 minutes ensures that all fans are OPERABLE and that all associated controls are functioning properly. It also ensures that fan or motor failure, or excessive vibration, can be detected for corrective action. The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.]

[SR 3.7.9.4

This SR verifies that each UHS fan starts and operates on an actual or simulated actuation signal. The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.]

[SR 3.7.9.5

This SR verifies that each UHS transfer pump starts and operates on a manual actuation signal. Verification of the UHS transfer pump operation includes testing to verify the pump's developed head at the flow test point is greater than or equal to the required developed head. Testing also includes verification of required valve position.

The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.]

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.7.9.6

This SR verifies the correct alignment for manual, power-operated, and automatic valves in the UHS flow path to assure that the proper flow paths exist for UHS operation. This SR does not apply to valves that are locked, sealed or otherwise secured in position, since they are verified to be in the correct position prior to being locked, sealed, or secured. This SR does not require any testing or valve manipulation; rather, it involves verification that those valves capable of being mispositioned are in the correct position. This SR does not apply to valves that cannot be inadvertently misaligned, such as check valves.

The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk, and is controlled under the Surveillance Frequency Control Program.

SR 3.7.9.7

This SR verifies proper manual and automatic operation of the UHS valves on remote manual or on an actual or simulated actuation signal. The UHS is a normally-operating system that cannot be fully actuated as part of normal testing. This Surveillance is not required for valves that are locked, sealed, or otherwise secured in the required position under administrative controls.

The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk, and is controlled under the Surveillance Frequency Control Program.

REFERENCES

1. FSAR Subsection 9.2.5.
2. Regulatory Guide 1.27.

CCW HXs and the essential chiller units. The UHS, which is usually a freshwater (or saltwater) source, is the source of water to the intake basin. It follows that the ESWS cooling water does not contain radioactive materials nor release radioactive contaminants to the environment. The essential chiller units also do not include the radioactive fluid, and CCWS is the intermediate loop between the reactor auxiliaries and the ESWS. This arrangement minimizes direct leakage of the radioactive fluid from the ESWS to the environment. In addition, radiation monitors are provided in each discharge line of the CCW HX essential service water (ESW) side. See also the description of these monitors in DCD Subsection 11.5.2.5.2. Radiation alarms are provided to the monitors to alert the operator if the leaking CCW contains radioactivity so that the operator can isolate the leaking train and prevent possible radiation contamination to the ESWS and UHS. Prior to any radiation leakage being detected in the ESWS, however, radiation alarms in the CCWS side would have already alerted the operators to notify of a radiation breach in the CCWS. The affected CCWS train is immediately isolated followed by the isolation of the aligned ESWS to prevent possible contamination to the UHS and finally to the environment. DCD 09.02.05-8

The ESWS is arranged into four independent trains (A, B, C, and D). Each train consists of one ESWP, two 100% strainers in the pump discharge line, one 100% strainer upstream of the CCW HX, one CCW HX, one essential chiller unit, and associated piping, valves, instrumentation and controls.

Each supply line after the strainer is tapped to supply cooling water to each component. Each CCW HX is provided with piping and isolation valves around the heat exchanger, which facilitates back flushing of the CCW HX of the ESW side when required. Heat from the reactor auxiliaries is removed from the CCW HX and the heated service water flows to UHS via independent lines.

The ESW piping from the pump discharge after passing through the discharge strainers drops underground and runs to the reactor building. The ESW tunnels near the building are located at -26' 4" elevation. After serving the CCW HXs and the essential chiller units ESW piping runs to the UHS.

The ESWPs are sized to provide positive pressure at the highest point in the system. The system is designed for 140° F. The system layout and the design assure that the fluid remains above saturation conditions at all locations during all modes of operation.

The ESWS layout ensures that the fluid pressure in the system is above saturation conditions at all locations. The ESWS layout, in combination with the motor-operated valves at the discharge of each ESWP, minimizes the potential for transient water hammer. The starting logic of the ESWP interlocks the operation of the motor operated valve with the pump operation. The voiding in any train may occur on loss of offsite power and subsequent pump trip. To preclude water hammer on pump re-start, the MOV at each pump discharge is interlocked to close when the pump is not running or is tripped. This interlock prevents the pump from starting if the valve is not closed. After a predetermined time delay after the pump starts, the MOV starts to gradually open to preclude water hammer. If the valve fails to open the pump is tripped and alarmed in the MCR. The short time duration during which the pump is dead headed is not detrimental