9.2.5 Ultimate Heat Sink

The function of the ultimate heat sink (UHS) is to dissipate heat rejected from the essential service water system (ESWS) during normal operations and post accident shutdown conditions. System interface heat loads are listed on Table 9.2.5-1. The UHS for the U.S. EPR is sized to provide adequate cooling capacity as required by RG 1.27.

Essential and dedicated ESWS components including some UHS valves and some UHS instrumentation are addressed in Section 9.2.1.

9.2.5.1 Design Basis

UHS structures, systems and components which provide cooling for safety-related equipment are designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, and external missiles without loss of capability to perform their safety-related functions (GDC 2). Structures housing the system as well as the system components are capable of withstanding the effects of earthquakes. The seismic design of this system meets the guidance of RG 1.29 (Position C.1 for the safety-related portion, and Position C.2 for the non-safety-related portion). Table 3.2.2-1 provides the seismic and other design classifications for the components in the UHS.

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. These shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from external events (GDC 4).

The UHS does not share structures, systems or components important to safety with other nuclear power plant units unless it has been shown that such sharing does not significantly impair the ability to perform their safety-related functions; including, the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units (GDC 5).

The UHS functions to provide heat removal from the ESWS during normal operation and accident conditions, and transfers that energy to the environment (GDC 44).

The UHS is designed to permit appropriate periodic inspection of important components necessary to maintain the integrity and capability of the system (GDC 45).

The UHS is designed to permit operational functional testing of safety-related components to ensure system operability (GDC 46).

The UHS operates in conjunction with the ESWS and component cooling water system (CCWS) and other reactor auxiliary components to provide a means to cool the reactor core and reactor coolant system (RCS) to achieve a safe shutdown.

The UHS operates for a nominal 30 days following a loss of coolant accident (LOCA) without requiring any makeup water to the source or demonstrates that replenishment or use of an alternate or additional water supply can be effected to ensure continuous capability of the sink to perform its safety-related functions.

9.2.5.2 System Description

The UHS consists of four separate, redundant, safety-related divisions. Also included is one dedicated non-safety-related division which is located in division 4. Each safety-related UHS division consists of one mechanical draft cooling tower with two fans, spray nozzles, tower fill, wind drift eliminator, piping, valves, controls and instrumentation. Each safety-related division also includes a cooling tower basin intake structure with removable coarse and fine screens. The screens protect the ESWS pumps and the dedicated ESWS pump against debris. System design parameters are listed on Table 9.2.5-2. The system is shown in Figure 9.2.5-1—Ultimate Heat Sink Piping and Instrumentation Diagram. Parts of the blowdown system, emergency blowdown system and dedicated ESWS are shown in Figure 9.2.1-1.

A COL applicant that references the U.S. EPR design certification will provide site-specific information for the UHS support systems such as makeup water, blowdown and chemical treatment (to control biofouling).

A COL applicant that references the U.S. EPR design certification will compare site-specific chemistry data for normal and emergency makeup water to the parameters in Table 9.2.5-5. If the specific data for the site fall within the assumed design parameters in Table 9.2.5-5, then the U.S. EPR standard design is bounding for the site. For site-specific normal and emergency makeup water data or characteristics that are outside the bounds of the assumptions presented in Table 9.2.5-5, the COL applicant will provide an analysis to confirm that the U.S. EPR UHS cooling towers are capable of removing the design basis heat load for a minimum of 30 days without exceeding the maximum specified temperature limit of the ESWS and minimum required basin water level.

A COL applicant that references the U.S. EPR design certification will provide a description of materials that will be used for the UHS at their site location, including the basis for determining that the materials being used are appropriate for the site location and for the fluid properties that apply.

The UHS contains isolation valves at the cooling towers to isolate the safety related portions of the system from the non-safety-related basin support systems provided by

the COL applicant. The site-specific UHS systems are shown in Figure 9.2.5-2—[[Conceptual Site-Specific UHS Systems]].

9.2.5.3 Component Description

9.2.5.3.1 Mechanical Draft Cooling Towers

The cooling towers are rectangular mechanical-induced draft-type towers. Each tower consists of two cells in a back-to-back arrangement. The two cells of the cooling tower in a particular division share a single cooling tower basin and each cell is capable of transferring fifty percent of the design basis heat loads for one division from the ESWS to the environment under worst-case ambient conditions. The division four cooling tower shares use with the dedicated ESW train and can transfer severe accident (SA) heat loads to the environment under worst-case ambient conditions.

The Division 4 cooling tower fans can be supplied by a standby EDG or a station blackout diesel generator (SBODG) that is provided as an alternate AC power source.

The cooling tower fill design and arrangement maximize contact time between water droplets and air inside the tower. The tower fill spacing is chosen to minimize the buildup of biofilm and provide for ease of cleaning, maintenance, and inspection.

UHS cooling tower fill is constructed of ceramic tile, supported on reinforced concrete beams. Spray piping and nozzles are fabricated of corrosion resistant materials (e.g., stainless steel, bronze). UHS cooling tower internals are seismically designed and supported to withstand a safe shutdown earthquake (SSE). Passive failures of the cooling tower spray or fill systems are considered extremely unlikely due to their materials of construction, supporting systems and Seismic Category I design.

The UHS fans are designed to withstand the effects of tornado including differential pressure effects, overspeed, and the impact of differential pressure effects on other equipment located within the cooling tower structure (e.g., capability to function, potential to become missile/debris hazard). The method to be used to protect the UHS fans from overspeed due to tornado effects will be a brake system or the resistance of the fan gear reducer.

To prevent the entrainment of debris from the UHS cooling tower, each cell of the UHS cooling tower includes a debris screen located between the cooling tower internals and the ESW pump.

To account for potential recirculation and interference effects of the cooling towers, an inlet wet bulb correction factor is used. A COL applicant that references the U.S. EPR design certification will confirm that the site characteristic sum of 0% exceedance maximum non-coincident wet bulb temperature and the site-specific wet bulb correction factor does not exceed the value provided in Table 9.2.5-2. If the value in

Table 9.2.5-2 is exceeded, the maximum UHS cold-water return temperature of 95°F is to be confirmed by analysis (see Section 9.2.5.3.3).

Depending on site layout and site meteorological conditions, the UHS cooling tower could have interference effects that would impact nearby safety-related air intakes. A COL applicant that references the U.S. EPR design certification will perform an evaluation of the interference effects of the UHS cooling tower on nearby safety-related air intakes. This evaluation will confirm that potential UHS cooling tower interference effects on the safety related air intakes does not result in air intake inlet conditions that exceed the U.S. EPR Site Design Parameters for Air Temperature as specified in Table 2.1-1.

Each cooling tower basin is sized to provide for a minimum 72-hour supply of cooling water to the associated ESW division under design basis accident (DBA) conditions assuming loss of normal makeup water capability. In the event of torrential rains and hurricanes, water would enter through the air inlet and air outlet area of the cooling tower portion of the Essential Service Water Buildings. Refer to Figure 3.8-95 through Figure 3.8-102 for details of the Essential Service Water Building. As the water level reaches the high level, an alarm in the control room will alert the operator. Operator action is performed to remove water from the cooling tower basin through the use of the safety related emergency blowdown to maintain normal water level. Therefore, no adverse effects on the safety related equipment is anticipated within the ESW pump room if the water level rises due to torrential rains and hurricanes.

9.2.5.3.2 Piping, Valves, and Fittings

System materials are selected that are suitable to the site location, UHS fluid properties and site installation. System materials that come into contact with one another are chosen to minimize galvanic corrosion. All safety-related piping, valves, and fittings are in accordance with ASME Code Section III, Class 3 (Reference 1).

Pipe diameters for all branches of UHS piping are based on limiting the flow velocity to 10 ft/sec for normal modes of operation that are expected to occur frequently.

Inservice testing of valves will be performed as described in Section 3.9.6.3. Leakage rates for boundary isolation valves that require testing are based on ASME OM Code, Subsection ISTC (Reference 2).

UHS valve functions are addressed in Section 9.2.1.3.5.

9.2.5.3.3 Cooling Tower Basin

The 72-hour basin water volume is the minimum water volume that must be present in the basin to accommodate system water inventory losses experienced in that basin due to UHS Cooling tower operation during a Design Basis Accident. The required

volume is determined based on water losses under worst case environmental conditions with the highest ESW heat load during a Design Basis Accident for a 72 hour period without incurring pump vortexting during operation. Inventory losses consist of evaporation losses, tower drift losses as well as valve seat leakage and seepage.

A margin of 6" was applied for the minimum pump submergence and a 10" margin for the 72-hour water volume. Drift loss from the UHS tower is 0.005 percent; however, a conservative 0.01 percent was used in the analysis. The valve leakage is calculated assuming all isolated valves leak simultaneously at a maintained rate of 0.5 D (inch) gpm. The 30 day seepage loss is 360,000 lb_m and a 3-day seepage loss of 40,000 lb_m was chosen for this analysis. This analysis also assumes that ESW pumps operate at design flow for the 72-hour duration. A water height of 21" is provided above the technical specification height required to account for the operating band and other instrument margins. Also 6" is provided for freeboard.

UHS Cooling tower blowdown is automatically secured during the initial 72 hour post-accident period through system instrumentation and control design features. As a result, the only significant system water inventory losses are due to evaporation, cooling tower drift, valve seat leakage, and seepage.

Meteorological conditions resulting in the maximum evaporative and drift loss of water for the UHS over a 72-hour period are presented in Table 9.2.5-3—Design Values for Maximum Evaporation and Drift Loss of Water from the UHS. A COL applicant that references the U.S. EPR design certification will confirm by analysis of the highest average site-specific wet bulb and dry bulb temperatures over a 72-hour period from a 30-year hourly regional climatological data set that the site-specific evaporative and drift losses for the UHS are bounded by the values presented in Table 9.2.5-3.

Meteorological conditions for the U.S. EPR that result in minimum cooling tower cooling that are the worst combination of controlling parameters (wet bulb and dry bulb), including diurnal variations for the first 24 hours of a DBA LOCA, are presented in Table 9.2.5-4 and do not result in a maximum ESWS supply temperature from the UHS basin exceeding 95°F. A COL applicant that references the U.S. EPR design certification will confirm that the maximum UHS cold-water return temperature of 95°F is met by an analysis that confirms that the worst combination of site-specific wet bulb and dry bulb temperatures over a 24-hour period from a 30-year hourly regional climatological data set are bounded by the values presented in Table 9.2.5-4.

For site-specific meteorological conditions that are outside the bounds of the assumptions presented in Table 9.2.5-3 and Table 9.2.5-4 the COL applicant will confirm by analysis that the U.S. EPR design acceptably meets any additional requirements that may be imposed by the more limiting site-specific meteorological

conditions and that the design maintains conformance to the design commitments and acceptance criteria described in this FSAR.

Water makeup to the UHS cooling tower basin beyond 72 hours is site specific. A COL applicant that references the U.S. EPR design certification will confirm that the site-specific UHS makeup capacity is 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.

9.2.5.3.4 Coarse and Fine Screens

Coarse and fine screens are provided in the ESWS cooling tower basin intake structure to protect the ESWS pumps and dedicated ESWS pump against debris. Both of these screens are safety related and extend across the full width of the pump bay opening and above the maximum water level to provide full control of the debris across the flow cross-section. The screens are removable for manual maintenance and cleaning. The coarse screen mesh is sized (2" x 2") to prevent large debris from entering the pump intake structure, and the fine screen mesh is sized (0.5" x 0.5") to allow the debris with sizes acceptable for pump operation to pass the screen. Differential water-level setpoints across the coarse and fine screens are provided and continuously monitored. Inspection and maintenance at pre-set intervals are carried out. An inspection and cleaning of the screens is initiated anytime the water-level differential reaches alarm-level setpoint.

The collected debris must be treated in accordance with federal and state regulations relevant to the site location.

9.2.5.4 System Operation

The safety related ESWS pumps cooling water from the cooling tower basin to supply ESWS loads and back to the mechanical draft cooling tower. The four safety-related divisions of the UHS are powered by Class 1E electrical buses and are emergency powered by the emergency diesel generators (EDG).

The nominal HP of each UHS fan is 250 as indicated in Table 8.3-4 through Table 8.3-7. The ESWS flowrate into the UHS cooling tower is indicated in Table 9.2.5-2. The ESWS flowrate out of the UHS cooling tower basin is indicated as the “normal flowrate of each ESW pump” in Table 9.2.1-1.

The non-safety-related dedicated ESWS pumps cooling water from the division four cooling tower basin to the dedicated system heat load and back to the division four mechanical draft cooling tower during SA and beyond DBAs.

The cooling tower fans are driven with multi-speed drives that are capable of fan operation in the reverse direction. Consistent with vendor recommendations, the fan

may be operated in the reverse direction for short periods to minimize ice buildup at the air inlets. To prevent or eliminate ice buildup within the cooling tower fill during low load/low temperature operation, multiple methods are utilized. Operation of a cooling tower fan in the reverse direction is the last option used if all other airside control methods fail to remove ice buildup. When a cooling tower fan is operated in the reverse direction to eliminate ice build-up, the system (associated train) is considered operable. Upon receipt of a safety injection (SI) signal, any fan(s) operating in the reverse direction will automatically trip and re-start following coast-down, and accelerate to full speed in the forward direction to dissipate the maximum heat to the environment. Similarly, upon receipt of an SI signal, cooling tower fans in the standby train(s) will automatically start and accelerate to full speed, and the cooling tower fans in the operating train(s) will continue to operate at full speed. If the fans in the operating train(s) are operating at reduced speed at the onset of a DBA, they will be automatically switched to full speed upon receipt of an SI signal, to dissipate the maximum heat to the environment. All of these actions are automatic following the receipt of an SI signal and do not require operator action.

Cooling tower fan start time, as well as the time required for fan coast-down, re-start and acceleration to full speed of a fan(s) operating in reverse, have no impact on the ability of the UHS cooling towers to mitigate the consequences of a DBA. Fans start automatically and accelerate to full speed in response to an SI signal. With respect to cooling tower fan start time, it is noted that the peak heat load on the ESWS occurs hours after the start of the DBA, and thus, hours after the fans have started and accelerated to full speed in response to an SI signal. In the case of cooling tower fans operated in reverse to eliminate ice from the fill, this operating mode is utilized only for brief periods of time (e.g., minutes) during cold weather, when the ESWS temperature is well below the design cold water temperature, and, consequently capable of accommodating the initial heat load. The time to change from reverse fan operation to full speed forward is less than five minutes.

The cooling tower bypass piping provides a means for diverting ESW return flow directly to the tower basin under low load/low ambient temperature conditions to maintain ESW cold water temperature within established limits and to protect against freezing. The bypass has the capability of diverting the full flow to the basin by paired operation of the bypass valve and return header valve.

Pumps, piping, valves, and other components essential to the operation of the UHS are located within the boundary of the ESWPB, except the short section of emergency blowdown pipe exiting the building that is protected by the building structure. As stated in Section 9.4.11, the ESWPB ventilation system maintains a minimum temperature. Moreover, the ESWS riser is located within the ESWPB and then branches off laterally to the spray nozzle header. The first of the self-draining spray nozzles are attached to the header immediately after the header exits the ESWPB. As

needed, any other piping and components subject to freezing conditions are provided with freeze protection design features, such as heat tracing.

Based on the increase in heat removal during a DBA, a temperature of less than or equal to 90°F is maintained in the UHS basin during normal operation, so that the cooling tower basin temperature does not exceed 95°F. 95 °F is the maximum design basis UHS basin temperature for the duration of a DBA. The normal UHS basin temperature of less than or equal to 90 °F and DBA UHS basin temperature of less than or equal to 95 °F are the bases for ESWS temperatures listed in Table 9.2.5-1. A value of 92 °F normal ESWS temperature is used for sizing the CCWS heat exchanger.

If the ambient wet bulb temperature increases to above the design inlet wet bulb temperature (81°F) specified in U.S. EPR FSAR Tier 2, Table 9.2.5-2, due to diurnal variations shown in U.S. EPR FSAR Tier 2, Table 9.2.5-4, the UHS basin water temperature will increases. However, analyses demonstrate that the maximum basin water temperature does not exceed the maximum design cold water (outlet) temperature (95°F) given in U.S. EPR FSAR Tier 2, Table 9.2.5-2 during a DBA condition.

9.2.5.5 Safety Evaluation

The UHS pump buildings and cooling towers are designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles and other natural phenomena. Sections 3.3, 3.4, 3.5, 3.7, and 3.8 provide the basis for the adequacy of the structural design of these structures. The aboveground piping and components are protected by the structures.

The UHS is designed to remain functional after a safe shutdown earthquake (SSE). Sections 3.7 and 3.9 provide the design loading conditions that are considered. Sections 3.5, 3.6 and 9.5.1 provide the hazards analyses to verify that a safe shutdown, as outlined in Section 7.4, can be achieved and maintained.

The four division design of the UHS provides complete redundancy; therefore a single failure will not compromise the UHS system safety-related functions. Each division of UHS is independent of any other division and does not share components with other divisions or with other nuclear power plant units.

Considering preventative maintenance and a single failure, two UHS divisions may be lost, but the ability to achieve the safe shutdown state under DBA conditions can be reached by the remaining two UHS divisions. In case of LOOP the four UHS cooling towers have power supplied by their respective division EDGs. Isolation valves can isolate non-safety-related portions of the system if necessary without compromising the safety-related function of the system.

The cooling towers must operate for a nominal 30 days following a LOCA without requiring any makeup water to the source or it must be demonstrated that replenishment or use of an alternate or additional water supply can provide continuous capability of the heat sink to perform its safety-related functions. The tower basin contains a minimum 72-hour supply of water. After the initial 72 hours, the site-specific emergency makeup water system will provide sufficient flow rates of makeup water to compensate for system volume losses for the remaining 27 days. The normal blowdown isolation valves and the normal filter blowdown isolation valves provide automatic isolation of the ESWS from downstream non-safety-related blowdown piping under DBA conditions to prevent loss of ESW inventory. The emergency blowdown isolation valves and the emergency filter blowdown isolation valves provide automatic isolation of the ESWS under DBA conditions to prevent loss of ESW inventory. The emergency blowdown discharges outside of the Essential Service Water Pump Building (ESWPB) at an elevation above the flood level. The emergency blowdown pipe exiting the building is protected from tornado generated missiles by the building structure. The ESW emergency makeup water system also provides isolation of the normal makeup water system from the tower basins under DBA conditions to prevent loss of ESW inventory.

The heat load after 72 hours post-DBA is lower than the peak heat load due to a reduction in the decay heat from the reactor. Consequently, the makeup flow rate required after 72 hours is lower than the peak condition. Since the UHS basin contains at least 72 hours of water inventory for the DBA, in combination with the worst ambient evaporation conditions, the UHS emergency makeup is not required to start until after 72 hours. At that point, the makeup requirements are diminished. The minimum makeup supply rate is based on the maximum evaporation rate at the end of the 72 hour period post-DBA and considers such losses as drift, seepage and valve seat leakage.

During the 27 days following the 72-hour post-accident period the UHS cooling towers are capable of removing the design basis heat load without exceeding the maximum specified temperature limit for ESWS with minimum specified water inventory available and the most limiting site-specific ambient conditions that are assumed for heat removal. Analyses will demonstrate that the cooling towers are capable of removing the design basis heat load without exceeding the maximum specified temperature limit for ESWS. Transient analyses shall be completed by qualified individuals and the results will be documented in the Cooling Tower Design Report. This report shall include:

1. Performance curves for the cooling towers.

2. The period of record for the temperature data and the specific worst case periods used in the analysis, together with selection methods and validation techniques for the meteorological data.

3. A trend of water temperature in the cooling tower for the 30-day period.

4. The effect of concentrated impurities in the cooling tower basin on the ESWS flow rate and the cooling tower performance.

The report shall also include limiting assumptions and inputs, analytical methods, uncertainty analyses that demonstrate conservative results, and a list of references. Qualifications of the individuals performing the analysis and independent verification will also be included.

During the 27 days following the 72-hour post-accident period the UHS cooling towers are capable of removing the design basis heat load without water level dropping below the minimum required level in the cooling tower with minimum specified water inventory available and the most limiting site-specific ambient conditions that are assumed for water usage. Analyses will demonstrate that the cooling towers are capable of removing the design basis heat load without the water inventory dropping below the minimum required level in the cooling tower. Transient analyses shall be completed by qualified individuals and the results will be documented in the Cooling Tower Design Report. The report shall include:

1. Performance curves for the cooling towers.

2. The period of record for the temperature data and the specific worst case periods used in the analysis together with selection methods and validation techniques for the meteorological data,

3. A trend of water temperature and water level in the cooling tower for the 30-day period.

4. The effect of concentrated impurities in the cooling tower basin on the ESWS flow rate and the cooling tower performance.

The report shall also include limiting assumptions and inputs, analytical methods, uncertainty analyses that demonstrate conservative results, and a list of references. Qualifications of the individuals performing the analysis and independent verification will also be included.

As noted in Section 9.2.5.3, COL applicants that reference the U.S. EPR will verify that the makeup water supply is sufficient for the ambient conditions corresponding to their plant location. In accordance with Section 3.4.3.9, ESWPBs are physically separated by division and connected to their respective ESW cooling tower. The flooding analysis considers a postulated pipe failure in the ESWS piping to be the bounding internal flooding source. In the event of an ESWS piping failure in the building, the affected division of the ESWS is considered lost. As indicated in Section 3.4.1, if there is a failure of one division of ESWS and one division is out for

maintenance, there are two remaining divisions of ESWS to perform the system safety function.

9.2.5.6 Inspection and Testing Requirements

Prior to initial plant startup, a comprehensive preoperational test is performed to demonstrate the ability of the ESWS and UHS to supply cooling water as designed under normal and emergency conditions. The UHS is tested as described in Chapter 14.2, Test # 49.

The installation and design of the UHS provides accessibility, as described in Section 6.6.2, for the performance of periodic inspection and testing, including inservice inspection. Periodic inspection and testing of safety-related equipment verifies its structural and leaktight integrity and its availability and ability to fulfill its functions. Inservice inspection and testing requirements are in accordance with Section XI of the ASME BPV Code and the ASME OM Code.

Sections 3.9 and 6.6 outline the inservice testing and inspection requirements. Refer to Section 16.0, Surveillance Requirements (SR) 3.7.19 for surveillance requirements that verify continued operability of the UHS.

Design considerations for the safety-related portions of the UHS and provisions for monitoring of UHS heat rejection capability to confirm adequate performance over time will be as indicated in Section 9.2.1.6 concerning GL-89-13. The inspections will include periodic inspections of the UHS cooling tower basins to identify macroscopic biological fouling organisms, such as blue mussels, American oysters and Asiatic clams, sediment and corrosion, biocide treatment of the system, flushing and flow testing of redundant and infrequently used cooling loops and equipment, and periodic sampling to identify the presence of Asiatic clams. Chemical treatment with the appropriate biocide(s) will be performed in response to positive biological fouling test results, and the frequency of treatment will be adjusted as appropriate. Biocide treatment will be in accordance with applicable Federal, State and local environmental regulations.

9.2.5.7 Instrumentation Applications

Instrumentation is provided in order to control, monitor and maintain the safety-related functions of the UHS. Indications of the process variables measured by the instrumentation are provided to the operator in the main control room.

UHS fan status and controls, including fan speed selection (low speed, high speed, etc.) and forward or reverse direction, are provided to the control room operator.

UHS valve positions are addressed in Section 9.2.1.7.

UHS basin level sensors and temperature sensors are shown on Figure 9.2.1-1, Sheet 1.

UHS basin level alarm summary is addressed in Table 9.2.1-3.

9.2.5.7.1 System Monitoring

- Cooling tower basin water level.
- Cooling tower water temperature.
- Cooling tower basin intake structure differential water level across screens.

9.2.5.7.2 System Alarms

- Cooling tower water temperature low.
- Cooling tower basin water level low.
- Cooling tower basin water level high.
- Cooling tower basin intake structure differential water level across screens high.

9.2.5.8 References

1. ASME Boiler and Pressure Vessel Code, Section III: “Rules for Construction of Nuclear Facility Components,” Class 3 Components, The American Society of Mechanical Engineers, 2004.

2. ASME OM Code, “Code for Operation and Maintenance of Nuclear Power Plants,” Subsection ISTC, The American Society of Mechanical Engineers, 2004 edition.

Table 9.2.5-1—Ultimate Heat Sink System Interface

Component	Max Heat Load MBTU/hr	Total Required ESW Flow (10^6 lb_m/hr)	Required ESW Temperature °F	Comments
CCWS heat exchanger	128.1	7.540 min	≤92	Normal Operation
	120.1	7.540 min	≤90	Spring/Fall Outage Cooldown
	293.35[1]	7.540 min	≤95	DBA
Dedicated CCWS heat exchanger	51.2 nominal)	1.102 min	≤95	Severe Accident
EDG heat exchangers	22.0[2]	0.8985[3] min	≤95	EDG Operation
ESW pump room cooler for 31/32/ 33/34 UQB	0.619	0.0685	≤ 95	Normal Operations Shutdown/ Cooldown and DBA
ESW pump room cooler for 34 UQB	0.314	0.0347	≤ 95	Severe Accident - ESW flow supplied by dedicated ESW pump
ESW pump PEB 10/20/30/40 AP001	2.80	N/A	N/A	Normal Operations/ Cooldown/and DBA
UHS	318.77	N/A	N/A	Total from the CCWS and EDG heat exchangers, the ESWPBVS room cooler, and the ESW pump mechanical work.

Notes:

1. The CCWS heat exchanger load on the UHS in DBA is equal to the LHSI DBA heat load of 241 x 106 Btu/hr in Table 9.2.2-2 plus the additional loads from the CCWS common users.

2. Heat load includes all three associated heat exchangers (intercooler loop HX, lube oil cooler, and jacket water loop HX).

3. Heat exchangers are in series.

Table 9.2.5-2—Ultimate Heat Sink Design Parameters

Cooling Tower Cells 31/32/33/34 URB	
Description	**Technical Data**
Cooling Tower Type	Mechanical Induced Draft
Design Water Flow (total both cells)	19,200 gpm
Design Hot (Inlet) Water Temperature	135°F
Design Cold (Outlet) Water Temperature	≤95°F (max, DBA)
Winter Design Cold (Outlet) Water Temperature @ 50°F Inlet WB	71°F Normal Ops/72°F Cooldown 78.5°F DBA
Design Inlet Wet Bulb Temperature	81°F (non-coincident, 0% exceedance value)(1)(2)
Maximum Drift Loss (Percent of Water Flow)	< 0.005%
Maximum Evaporation Loss at Design Conditions (total both cells)	571 gpm
Number of Cells	2 Cell/Tower
Basin Water Volume (Min)	≥295,120 ft^3
Basin Water Level (Min)	23.75 ft
Required Cooling Tower Emergency Makeup Flow, -post-DBA (72 hours through 30 days)	≥300 gpm

Note:

1. COL applicant to determine wet bulb temperature correction factor to account for potential interference and recirculation effects. (Refer to COL Item 9.2-7 in Table 1.8-2).

2. An important meteorological design point for the establishment of the cooling tower performance for the U.S. EPR DBA maximum load case and consequently establishes all subsequent cooling tower performance for other wet bulb conditions and lower loads.

Table 9.2.5-3—Design Values for Maximum Evaporation and Drift Loss of Water from the UHS[1]

Time (hr)	Wet Bulb Temp (°F)	Dry Bulb Temp (°F)	Time (hr)	Wet Bulb Temp (°F)	Dry Bulb Temp (°F)	Time (hr)	Wet Bulb Temp (°F)	Dry Bulb Temp (°F)
1	69.87	84	25	70.49	86	49	74.14	91
2	68.69	82	26	71.03	86	50	72.99	87
3	66.82	78	27	71.03	86	51	70.96	84
4	67.02	77	28	71.03	86	52	69.33	84
5	69.04	78	29	71.03	86	53	68.90	81
6	68.48	78	30	70.02	81	54	69.46	81
7	68.14	77	31	68.24	79	55	69.13	80
8	67.10	74	32	68.25	79	56	69.69	80
9	67.10	74	33	68.13	77	57	67.70	79
10	67.80	76	34	68.13	77	58	67.70	79
11	67.23	76	35	69.70	80	59	68.58	80
12	69.79	82	36	71.79	83	60	71.53	84
13	70.98	84	37	72.98	85	61	72.40	85
14	72.71	86	38	75.02	88	62	73	87
15	74.15	89	39	76.71	92	63	73.29	88
16	74.71	93	40	77.49	95	64	73.58	89
17	74.98	94	41	78.24	98	65	73.58	89
18	75.82	93	42	78.72	100	66	73.33	92
19	74.98	98	43	78.48	99	67	73.08	93
20	74.20	97	44	77.91	99	68	73.36	94
21	74.19	97	45	77.91	99	69	74.42	94
22	74.16	95	46	77.10	98	70	74.14	93
23	74.15	93	47	76.85	97	71	74.68	93
24	72.22	90	48	75.24	93	72	73.28	88

Note:

1. Only 72 hours of temperature data are provided because the site specific makeup water system will provide sufficient flow rates of makeup water to compensate for system volume losses for the remaining 27 days of the required 30-day period.

Table 9.2.5-4—Design Values for Minimum Water Cooling in the UHS

Time (hr)	Wet Bulb Temp (°F)	Dry Bulb Temp (°F)
1	75.8	82
2	76.1	83
3	76.1	83
4	77.3	85
5	79.7	89
6	80.8	91
7	82.0	93
8	84.6	99
9	85.3	99
10	85.3	99
11	84.2	100
12	84.2	100
13	84.6	99
14	83.9	99
15	83.9	99
16	82.6	96
17	82.6	93
18	82.1	91
19	82.1	91
20	81.9	90
21	80.7	88
22	80.7	88
23	79.5	86
24	79.5	86

Table 9.2.5-5—Ultimate Heat Sink - Initial Chemistry to be Maintained at the Start of a DBA

Constituent	Limits	
	Without Scale Inhibitors	With Scale Inhibitors
pH (pH units)	6.8-7.2	7.8-8.4
Total Alkalinity (mg/l as CaCO3	30-50	200-250
Calcium Sulfate (mg/l of Ca as CaCO3	Maintain Ca <900	Maintain Ca <900
Silica (mg/l as SiO2)	<150	<150
Magnesium Silicate (mg/l of Mg as CaCO3 and mg/l of silica as SiO2	Mg x SiO2 <35,000	Mg x SiO2 <75,000
Suspended Solids (mg/l)	<150	<150
Total Dissolved Solids (mg/l)	<5,000[1]	<5,000[1]
Calcium Phosphate (mg/l as PO4)	<5 orthophosphate	As required on an individual basis per supplier's recommendation
Scale Inhibitor (mg/l)	Zero	As required on an individual basis per supplier's recommendation

Notes:

1. The UHS design is based on normal makeup supply <500 mg/l TDS to allow 10 cycles of concentration with TDS <5,000 at the start of the DBA.