DRAFT for Comment

U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD FOR mPOWER^{TM} iPWR DESIGN

9.2.5 ULTIMATE HEAT SINK and NORMAL POWER HEAT SINK

REVIEW RESPONSIBILITIES

Primary -Organization responsible for the review of cooling water systems

Secondary - Organization responsible for the review of chemical control
Organization responsible for the review of safety related ventilation
Organization responsible for the review of meteorological data
Organization responsible for radiation protection and monitoring
Organization responsible for the review of the UHS and passive containment

I. AREAS OF REVIEW

Active Plants

The UHS typically consists of an assured supply of water that is credited for dissipating reactor decay heat and essential station heat loads after a normal reactor shutdown or a shutdown following an accident or transient, including a loss-of-coolant accident (LOCA). Many commercial nuclear power plants also rely upon the atmosphere for performing the UHS function to some extent in conjunction with the assured supply of cooling water, such as in the case of spray ponds and cooling towers.

Passive Plants

The mPower^{TM} design relies on heat removal from the core and the containment through heat transfer from the containment structure to the UHS tank. The design basis is to remove decay heat after a shutdown or a LOCA for 72 hours without ac power or operator action. The mPower^{TM} containment heat removal system and UHS tank is further described and reviewed in DSRS 6.2.2.

The mPower^{TM} plant may rely upon the atmosphere and cooling towers for performing the normal power heat sink function in conjunction with the reliable supply of cooling water or other equipment such as mechanical chillers. The heat sink associated with the turbine and turbine bypass with the main condensers is described and reviewed in DSRS 10.4.1, “Main Condenser.”

The normal power heat sink consists of a reliable supply of water (or mechanical equipment such as chillers) that can remove normal station heat loads during normal power operations and dissipating reactor decay heat after a normal reactor shutdown or a shutdown following an accident or transient (post 72 hours). The normal power heat sink, the make-up water supply to the normal power heat sink and the make-up water supply to the UHS tank are reviewed in this DSRS section.

The normal power heat sink may perform cooling water functions to nonsafety-related risk significant and nonsafety-related nonrisk-significant equipment as part of the mPower^{TM} plant design. For these designs, the normal power heat sink may be subject to special regulatory treatment of nonsafety-related

system (RTNSS) considerations. The criteria for classifying nonsafety-related systems that perform risk significant or important functions (defense-in-depth) as RTNSS are provided by SECY 94-084, and SECY 95-132, (Reference 1). As indicated in Standard Review Plan (SRP) Chapter 19.3, the RTNSS process uses Criteria A through E to determine the SSC functions.

For the passive designs, normal power heat sink may be classified as either RTNSS Criterion B or RTNSS Criterion C, which are defined as:

1. Criterion B – Required to address the function of structures, systems, and components (SSCs) relied upon to resolve long term (post DBA and beyond 72 hours) safety and to address seismic events. This criterion pertains to SSCs required after 72 hours of a design basis accident initiation that are key to maintaining core cooling, containment integrity, control room habitability, and post accident monitoring that would require a RTNSS evaluation. RTNSS Criteron B SSCs are nonsafety-related defense-in-depth backups to safety related SSCs

2. Criterion C – Required to meet safety goals of core damage frequency (CDF) less than $1.0E^{-4}$ and large release frequency (LRF) less than $1.06E^{-6}$, each reactor year. This criterion pertains to active non-safety related components relied upon to reduce initiating event frequencies, CDF and LRF in the focused probabilistic risk assessment (PRA) sensitivity study, the baseline PRA, or in the assessment of uncertainties that would require a RTNSS evaluation. RTNSS Criterion C SSCs are considered nonsafety-related defense-in-depth backups.

Defense-in-depth principles consist of a number of elements as described in Reference 2.

For the mPower™ design the normal power heat sink should be available to maintain core cooling after 72 hours of a design basis accident initiation and to support bringing the plant to cold shutdown (CSD) conditions for inspection and repairs. Therefore, the nonsafety-related normal power heat sink is required to be “highly reliable” and is potentially subject to RTNSS Criterion B (or C), (Reference 1).

One example of a nonsafety-related system that is considered to be “highly reliable” is a system that has redundant trains with electrical backup power sources with the components being addressed in a design reliability assurance program (D-RAP). Single failure is considered to the extent that a single active failure does not prevent the intended function from occurring. The “highly reliable” nonsafety-related system is considered for Maintenance Rule in accordance with 10 CFR 50.65, (Reference 1).

The mPower™ plant design requires water makeup to the UHS tank associated with the containment heat removal system, post design basis accident (DBA) and beyond 7 days. Onsite water sources may vary and maybe supplied from a reliable water source, such as the fire protection system or condensate storage. Offsite water sources should also be considered such as water connections, flanges, or hose connections so that local fire truck pumpers can be utilized. The UHS tank water makeup system is evaluated for RTNSS consideration in accordance with SRP19.3.

Depending on the design and RTNSS analysis, the makeup water to the UHS tank and the makeup water to the normal power heat sink may be classified as:

Nonsafety-related risk-significant, which includes RTNSS B and RTNSS C

Nonsafety-related nonrisk-significant

The classification is determined in the review of SRP19.3 RTNSS (passive designs only).

The specific area of review for the normal power heat sink, makeup water to the UHS tank and the makeup water to the normal power heat sink is listed below. The nonsafety-related areas of review and RTNSS B and C functions, if they apply, are shown below in italics. For nonsafety-related nonrisk-significant normal power heat sink, nothing applies unless noted below in italics.

The specific areas of review are as follows:

1. Review safety/risk-significant classification as discussed above.

   RTNSS B and C and nonsafety-related (non-risk-significant): Safety/risk-significant classifications are to be verified.

2. The type of cooling water supply for the UHS tank.
   RTNSS B and C and nonsafety-related: apply.

3. The type of cooling water supply for the normal power heat sink.

   RTNSS B and C and nonsafety-related: apply.

4. The ability to dissipate the normal power heat load.

   RTNSS B and C: apply. The capability of the normal power heat sink to support the auxiliary cooling systems for normal and abnormal conditions and defense-in-depth SSCs, post DBA and beyond 72 hours.

5. The effect of environmental conditions on normal power heat sink capability to furnish the required quantities of cooling water at appropriate temperatures and with any required chemical and purification treatment for extended times after shutdown.

   RTNSS B and C: apply. The capability of the normal power heat sink to support auxiliary cooling systems for normal and abnormal conditions and defense–in-depth SSCs, post DBA and beyond 72 hours.

   Defense-in-depth functions and SSCs in support of CSD are expected to be available post DBA and beyond 72 hours to 7 days [1] with on-site SSCs with available water sources.

6. The effect of earthquakes, tornadoes, missiles, floods, and hurricane winds on the availability of the source water. The normal power heat sink is also reviewed for whether adverse environmental conditions including freezing preclude the defense-in-depth function. The normal power heat sink is also reviewed for whether adverse environmental conditions including freezing preclude the defense-in-depth function.

   RTNSS B and C: apply for defense-in-depth functions and functions that supports achieving and maintaining CSD post DBA and beyond 72 hours.

   Note: RTNSS B and C SSCs are designed to withstand the effects of natural phenomena without loss of function. SRP 19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

7. Sharing of UHS tank makeup sources in multi-unit stations.

   RTNSS B and C: apply.

1 The staff has previously accepted defense-in-depth functions be available post DBA and beyond 72 hours to 7 days for the Economic Simplified Boiling Water Reactor (ESBWR) and AP1000 Design Certifications.

SSCs that support defense-in-depth functions or support CSD functions shall be designed not to be shared among nuclear power units unless it can be shown that sharing will not significantly impair their ability to perform their defense-in-depth functions.

8. Applicable design requirements for the makeup water to the UHS tank.

   RTNSS B and C: applies for defense-in-depth functions and functions that supports UHS tank makeup post DBA and beyond 7 days.

9. Heat input for the normal power heat sink design as to reactor system heat, sensible heat, pump work, and station auxiliary system individual and total heat loads.

   RTNSS B and C: apply for defense-in-depth functions and functions that support achieving and maintaining CSD post DBA and beyond 72 hours.

10. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this DSRS section in accordance with DSRS Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this DSRS section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with DSRS Section 14.3 and RG 1.206 (Reference 24).

    RTNSS B and C: apply for defense-in-depth functions post DBA and beyond 72 hours for the normal power heat sink and beyond 7 days for the water makeup function to the UHS tanks.

11. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

    For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

    RTNSS B and C: apply for defense-in-depth functions post DBA and beyond 72 hours for the normal power heat sink and beyond 7 days for the water makeup function to the UHS tanks.

12. The provisions for minimization of contamination of the facility and environment, the generation of radioactive waste, and the provisions to facilitate eventual decommissioning.
    RTNSS B and C & nonsafety-related: all applies.

Review Interfaces

Other DSRS sections interface with this section for UHS and normal power heat sink as follows:

1. Sections 3.2.1 and 3.2.2: review of the acceptability of the seismic and quality group classifications for safety-related SSCs.

2. Sections 3.3.1, 3.3.2, 3.4.2, 3.5.3, 3.7.1 through 3.7.4, 3.8.4, and 3.8.5: review of the acceptability of the design analyses, procedures, and criteria establishing the capability of seismic Category I structures housing the system and supporting systems to withstand the effects of

natural phenomena like the safe shutdown earthquake (SSE),the probable maximum flood, and the tornado missiles.

3. Section 3.4.1: review of flood protection.
4. Section 3.5.1.1: review of the protection against internally-generated missiles.
5. Section 3.5.2: review of SSCs to be protected against externally-generated missiles.
6. Section 3.6.1: review of high- and moderate-energy pipe breaks.
7. Section 6.1.1: review of the inservice inspection requirements for system components and the compatibility of materials of construction with service conditions.
8. Section 6.2:2 review of the UHS for mPower™ designs
9. Section 7.1 and Appendix 7-A: review of the adequacy of the design, installation, inspection, and testing of all instrumentation and control systems required for proper operation.
10. Section 8.3.1: review of the adequacy of the design, installation, inspection, and testing of all electrical systems required for proper operation.
11. Section 9.2.2: review of the component cooling water system.
12. Section 9.5.1: review of fire protection.
13. Section11.5 as it relates to the review for radiation monitoring systems and specified detection sensitivity in response Table 2 of DSRS Section 11.5 in the context of IE Bulletin 80-10 about uncontrolled and unmonitored releases for systems not covered by the ODCM
14. Sections12.3-12.4: review for radiation protection design features and minimization of contamination.
15. Sections 14.2 and 14.3.7: review of the proposed pre-operational and startup test programs and ITAAC.
16. Chapter16.0: review of Technical Specifications and Short Term Availability Controls.
17. Section17.5: review for quality assurance.
18. Chapter19.0: review for probabilistic risk assessment and for the applicable risk classification.

The specific acceptance criteria and review procedures are contained in the referenced DSRS sections.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations. The nonsafety-related requirements are shown in italics. RTNSS B and C functions, if

they apply, are also shown below. For nonsafety-related (non-risk-significant) normal power heat sink, nothing applies unless noted below.

1. GDC 2 as to capability of structures housing the system and the system itself to withstand the effects of natural phenomena like earthquakes, tornadoes, hurricanes, and floods

   Note: RTNSS B and C SSCs are designed to withstand the effects of natural phenomena without loss of function. SRP19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

2. GDC 4 as to SSCs important to safety shall be designed to accommodate the effects of missiles inside and outside of containment, effects of pipe whip, jets, environmental conditions from high- and moderate energy line breaks, and dynamic effects of flow instabilities and attendant loads (i.e., water hammer) during normal plant operation as well as upset or accident conditions.

   Note: RTNSS B and C SSCs are designed to withstand the effects of environmental and dynamic effects without loss of function. SRP 19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

3. GDC 5 as to capability of shared systems and components between nuclear units which are important to safety to perform required safety functions.

   Note: GDC 5 is not applicable to RTNSS B or C functions.

4. GDC 44 as to:

   A. The capability to transfer heat loads from safety-related SSCs to the heat sink under both normal operating and accident conditions.

   B. Suitable component redundancy so that safety functions can be performed assuming a single, active component failure coincident with loss of offsite power.

   C. The capability to isolate components, systems, or piping if required so safety functions are not compromised.

   GDC 44 is applicable to the mPower^{TM} containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

   Note: GDC 44 is not applicable to RTNSS B or C functions.

5. GDC 45 as to the design provisions to permit inservice inspection of safety-related components and equipment.

   GDC 45 is applicable to the passive containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

   Note: GDC 45 is not applicable to RTNSS B or C functions.

6. GDC 46 as to the design provisions to permit operation functional testing of safety-related systems or components.

   GDC 46 is applicable to the passive containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

Note: GDC 46 is not applicable to RTNSS B or C functions.

7. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.

   RTNSS B and C: apply for the review for ITAAC to the importance of each defense-in-depth function.

8. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC's regulations.

   RTNSS B and C: apply for the review for ITAAC to the importance of each defense-in-depth function.

9. 10 CFR 20.1406, which requires that a DC or COL application describe how facility design will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.
   RTNSS B and C & nonsafety-related (non-risk significant): apply.

DSRS Acceptance Criteria

Specific DSRS acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for review described in this DSRS section. The DSRS is not a substitute for the NRC's regulations, and compliance with it is not required. Identifying the differences between this DSRS section and the design features, analytical techniques, and procedural measures proposed for the facility, and discussing how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria, is sufficient to meet the intent of 10 CFR 52.47(a)(9), "Contents of applications; technical information."

The nonsafety-related acceptance criteria are shown in italics. RTNSS B and C functions, if they apply, are also shown below. For nonsafety-related (non-risk-significant) normal power heat sink, nothing applies unless noted below.

1. Protection Against Natural Phenomena. Information that addresses the requirements of GDC 2 regarding the capability of structures housing the UHS and the UHS itself to withstand the effects of natural phenomena will be considered acceptable if the guidance of Regulatory Guide (RG) 1.27, Positions C.2 and C.3 are appropriately addressed.

   Note: RTNSS B and C SSCs are designed to the effects of natural phenomena without loss of function. SRP19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

2. Environmental and Dynamic Effects. Information that addresses the requirements of GDC 4

regarding consideration of environmental and dynamic effects will be considered acceptable if the acceptance criteria in the following DSRS sections, as they apply to the normal power heat sink and water makeup to the UHS tank, are met: DSRS Sections 3.5.1.1, 3.5.1.4, 3.5.2, and DSRS Section 3.6.1.

Note: RTNSS B and C SSCs are designed to withstand the effects of environmental and dynamic effects without loss of function. SRP19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

3. Sharing of Structures, Systems, and Components. Information that addresses the requirements of GDC 5 regarding the capability of shared systems and components important to safety to perform required safety functions will be considered acceptable if the use of the UHS in multiple-unit plants during an accident in one unit does not significantly affect the capability to conduct a safe and orderly shutdown and cool-down in the other unaffected unit(s).

   GDC 5 is applicable to the passive containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

   Note: GDC 5 is not applicable to RTNSS B or C functions. Water makeup to the UHS tank should be reviewed for system interaction, flow rate capacities, and system isolation between reactor for a multiply reactor site.

4. Cooling Water System. Information that addresses the requirements of GDC 44 regarding consideration of the cooling water system will be considered acceptable if the guidance of RG 1.27, Positions C.2 and C.3; RG 1.72, Positions C.1, C.4, C.5, C.6, and C.7.; and American National Standards Institute/American Nuclear Society (ANSI/ANS) 5.1 are applied appropriately.

   GDC 44 is applicable to the mPower™ containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

   Note: GDC 44 is not applicable to RTNSS B or C functions.

5. Cooling Water System Inspection. Information that addresses the requirements of GDC 45 regarding the inspection of cooling water systems will be considered acceptable if the design of the UHS permits inservice inspection of safety-related components and equipment.
   GDC 45 is applicable to the mPower™ containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

   Note: GDC 45 is not applicable to RTNSS B or C functions.

6. Cooling Water System Testing. Information that addresses the requirements of GDC 46 regarding the testing of cooling water systems will be considered acceptable if the UHS is designed for testing of safety-related systems or components for structural integrity and leak-tightness, operability, performance of active components, and the capability of the system to function as intended under accident conditions.
   GDC 46 is applicable to the passive containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

   Note: GDC 46 is not applicable to RTNSS B or C functions.

7. 10 CFR 20.1406. Minimization of contamination to the facility and the environment, and designs to facilitate eventual decommissioning, will be considered acceptable if the design identifies

provisions to detect contamination that may enter as inleakage from other systems, identifies potential collection points such as water treatment systems or system low points, and addresses the long term control of radioactive material in the system.
RTNSS B and C and nonsafety-related: all applies.

8. Programmatic Requirements. Commission regulations and policy mandate programs applicable to SSCs that include:
   - Maintenance Rule (Regulatory Guides 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants." and RG 1.182; "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants".
   - DSRS Section 17.6 and DSRS Section 13.4, Table 13.4, Item 17).
   - Technical Specifications (DSRS Sections 16.0 and 16.1) – including brackets value for DC and COL.

     Brackets are used to identify information or characteristics that are plant specific or are based on preliminary design information.

   - Reliability Assurance Program (DSRS Section 17.4).
   - Initial Plant Test Program (Regulatory Guide 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants, "DSRS Section 14.2, and DSRS Section 13.4, Table 13.4, Item 19).
   - ITAAC (Regulatory Guide 1.215, "Guidance for ITAAC Closure Under 10 CFR Part 52," and DSRS Section 14.3.7).

   The staff may use these programmatic requirements to augment or replace, as appropriate, technical analysis and other evaluation techniques that the staff currently applies to address satisfaction of the performance-based acceptance criteria.

   RTNSS B and C: apply, however, Technical Specification may not apply and are replaced with Short Term Availability Controls.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this DSRS section is discussed in the following paragraphs. The nonsafety-related technical rationale are shown in italics. RTNSS B and C functions, if they apply, are also shown below. For nonsafety-related (non-risk-significant) normal power heat sink, nothing applies unless noted below.

1. GDC 2 requires that nuclear power plant SSCs important to safety be designed to withstand the effects of natural phenomena like earthquake, tornado, hurricane, flood, tsunami, and seiche without loss of capability to perform intended safety functions.

   Note: RTNSS B and C SSCs are designed to the effects of natural phenomena without loss of function. SRP19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

2. GDC 4 requires that SSCs important to safety be designed to accommodate the effects of, and to be compatible with, the environmental conditions of normal operation, maintenance, testing, and postulated accidents and be protected appropriately against dynamic effects, including those of missiles, pipe whipping, water hammer, and discharging fluids, from equipment failures and external events. GDC 4 assures that the SSCs important to safety will remain functional under postulated environmental conditions and provide essential cooling water necessary for the

operation of safety-related components and decay heat removal.

Note: RTNSS B and C SSCs are designed to the effects of environmental and dynamic effects without loss of function. SRP19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

3. GDC 5 requires that SSCs important to safety not be shared by nuclear power units unless such sharing can be shown not to impair their capability to perform intended safety functions.

   RG 1.27 describes staff positions on UHS design for sharing of SSCs. GDC 5 applies to any multi-unit facility in which a UHS portion is shared by two or more units.

   GDC 5 requirements provide assurance that, in an active or a passive failure at a multi-unit site, the sharing of UHS SSCs will not affect the safe shutdown of any unit.

   GDC 5 is applicable to the passive containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

   Note: GDC 5 is not applicable to RTNSS B or C functions. Water makeup to the UHS tank should be reviewed for system interaction, flow rate capacities, and system isolation between reactor for a multiply reactor site.

4. GDC 44 requires systems to transfer heat from SSCs important to safety to a UHS. Systems must be able to function under normal and accident conditions, assuming a single failure.
   GDC 44 applies to this DSRS section because the reviewer evaluates the UHS design, including assumptions for heat loads, redundancy of components, capability to isolate components, and single failures. In addition, ANSI/ANS-5.1 describes methods acceptable to the staff for calculating residual decay energy.

   GDC 44 requirements provide assurance that the UHS will function as designed to transfer heat from SSCs as required under normal and accident conditions, assuming a single failure.

   GDC 44 is applicable to the mPower^{TM} containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

   Note: GDC 44 is not applicable to RTNSS B or C functions.

5. GDC 45 requires that the cooling water system be designed to permit appropriate periodic inspection of important components (e.g., heat exchangers and piping) to ensure the integrity and capability of the system. Meeting the requirements of GDC 45 provides assurance that components and equipment of the ultimate heat sink can and will be inspected, thereby ensuring that the system will perform its intended safety function.

   GDC 45 is applicable to the mPower^{TM} containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

   Note: GDC 45 is not applicable to RTNSS B or C functions.

6. GDC 46 requires that the cooling water system be designed to permit appropriate periodic pressure and functional testing to ensure the leaktight integrity and operability of its components, as well as the operability of the system as a whole, under conditions as close to the design basis as practical.

   Meeting the requirements of GDC 46 provides assurance that components and equipment of the ultimate heat sink can and will be tested, thereby ensuring that the system will perform its intended safety function.

   GDC 46 is applicable to the mPower^{TM} containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

   Note: GDC 46 is not applicable to RTNSS B or C functions.

7. 10 CFR 20.1406 requires the design of a nuclear power unit to address minimization of contamination of the facility and the environment, and ease of eventual decommissioning.

   10 CFR 20.1406 applies to this DSRS section because the CWS couples to the primary coolant system across heat exchangers, and the possibility of leakage of contaminated primary coolant into the CWS exists.

   RTNSS B and C and nonsafety-related: all apply.

III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below, as may be appropriate for a particular case.

These review procedures are based on the identified DSRS acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

The nonsafety-related review procedures are shown in italics. RTNSS B and C functions, if they apply, are also shown below. For nonsafety-related (non-risk-significant) normal power heat sink, nothing applies unless noted below. The safety analysis report (SAR) is reviewed for the overall arrangement and type of normal power heat sink and water makeup to the UHS tank. The reviewer verifies that the normal power heat sink and water makeup to the UHS tank is designed to maintain system function as required in adverse environmental phenomena including freezing and loss of offsite power. The reviewer evaluates the system for whether:

A. The heat inputs in the normal power heat sink design are conservative. The reviewer makes an independent evaluation of the applicant's calculated heat loads or elects to audit calculations. The normal power heat sink heat loads include heat due to decay of radioactive material, sensible heat, pump work, and the heat load from the operation of the station auxiliary systems serving and dependent upon the normal power heat sink.

   RTNSS B and C: apply since RTNSS B SSCs are considered risk-significant or support CSD conditions.

B. Operational data from plants of similar design confirm, where possible, the heat input values for sensible heat, pump work, and station auxiliary systems.

RTNSS B and C: apply since RTNSS B SSCs are considered risk-significant or supports CSD conditions.

1. The reviewer verifies whether:

   A. The total station heat load and system flow requirements are compatible with the normal power heat sink rejection capability.

      RTNSS B and C: apply since RTNSS B SSCs are considered risk-significant or supports CSD conditions. Replace sentence to read:

   B. The normal power heat sink can dissipate the maximum possible total heat load, under the expected combination of adverse environmental conditions, even freezing, and can cool the unit (or units) for an initial period of DBA and beyond 72 hours minimum out to 7 days without makeup unless acceptable reliable makeup capabilities can be demonstrated. Long term cooling and water makeup design features and long term operational programs should be considered to include out past the initial 7 days and out to 30 days. This capability is verified by the staff's audit to check applicable calculations.

      RTNSS B and C: applies since RTNSS B SSCs are considered risk-significant or supports CSD conditions.

   C. The single failure of any SSCs will not prevent the normal power heat sink from performing its defense-in-depth functions.

      RTNSS B: applies related to defense-in-depth functions.

      RTNSS C: applies related to bring the plant to cold shutdown conditions (CSD).

      The single failure of any SSCs will not prevent the normal power heat sink from performing its CSD functions. RTNSS C SSCs that support achieving and maintaining CSD conditions post DBA and beyond 72 hours should be design to be "highly reliable" and no single failure would result in inability to terminate use of the passive safety grade system and achieve cold shutdown if desires.

      Note: Regarding consideration of the UHS and normal power heat sink will be considered acceptable if a system can be isolated so the safety function or defense-in-depth function of the system is not compromised.

   D. Water makeup is required to the UHS tank associated with the containment heat removal system, post DBA and beyond 7 days. Onsite water sources may vary and maybe supplied from a clean reliable water source, such as the fire protection system or condensate storage.

      RTNSS B and C: apply related to the UHS makeup post DBA. The water supply should be designed for single failure. UHS makeup water system is protected from the effects of freezing, floods, hurricanes, tornadoes, and internally- or externally generated missiles. Flood protection and missile protection criteria are evaluated in detail under the DSRS sections for SAR Chapter 3. The reviewer uses the procedures in these DSRS

sections to ensure that the analyses presented are valid. A statement to the effect that the system is located in a seismic qualified (Category I or II) structure tornado-, missile-, and flood protected or that system components are located in individual cubicles or rooms that withstand both flooding and missiles is acceptable. The location and design of the system, structures, and pump rooms (cubicles) are reviewed for whether the degree of protection is adequate.

The fire protection system is one example of a UHS makeup source which is manually aligned post DBA and beyond 7 days. For example, the UHS makeup source should include, fire protection water tank(s), motor driven pump, diesel driven pumps (and support for fuel oil), piping interconnections, associated electrical power/diesel generators, instrumentation and controls, and dedicated associated valves and piping system. In addition, offsite water sources should also be considered such as water connections, flanges, or hose connections so that local fire truck pumpers can be utilized. The Short Term Availability Controls should include this UHS tank makeup source.

The passive containment cooling ancillary water storage and associated pumps and piping system is also one other example of a UHS tank makeup source which is manually aligned post DBA and beyond 7 days.

The UHS tank makeup source many be shared between reactors at a multiple reactor site.

2. For a reactor site that may utilize mechanical chillers for the design of the normal heat sink, guidance is provided in DSRS 9.2.2, III.4.K.

3. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

   For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals(e.g., manufacturing license, site suitability report or topical report).

   RTNSS B and C: apply to the extent to support defense-in-depth and CSD functions, post DBA and beyond 72 hours for the normal power heat sink and beyond 7 days for the water makeup function to the UHS tanks.

4. For review of both DC and COL applications, DSRS Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of this section.

   RTNSS B and C: applies to the extent to support defense-in-depth and CSD functions, post DBA and beyond 72 hours for the normal power heat sink and beyond 7 days for the water makeup function to the UHS tanks.

5. 10 CFR 20.1406 requires the design of a nuclear power unit to address minimization of contamination of the facility and the environment, and ease of eventual decommissioning. 10 CFR 20.1406 applies to this DSRS section because the SWS cools the CWS which couples to the

primary coolant system across heat exchangers, and the possibility of leakage of contaminated primary coolant into the CWS exists.

RTNSS B and C and nonsafety-related: all applies.

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The review has determined the adequacy of the applicant's proposed water makeup to the UHS tank and normal power heat sink design criteria, design bases, and safety classification and the requirements for cooling water delivery for a safe shutdown during normal and accident conditions. The staff concludes that the design is acceptable and meets the requirements of GDCs 2, 4, 44, 45 and 46. The nonsafety-related evaluation findings are shown in italics. RTNSS B and C functions, if they apply, are also shown below. For nonsafety-related (non-risk-significant) normal power heat sink, nothing applies unless noted below.

1. The applicant meets GDC 2 requirements for capability to withstand the effects of natural phenomena like earthquakes, tornadoes, tornado missiles, hurricanes, and floods. Acceptance is based on RG 1.27, Positions C.2 and C.3.

   Note: RTNSS B and C SSCs are designed to withstand the effects of natural phenomena without loss of function. SRP19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

2. The applicant meets GDC 4 requirements for the effects of missiles inside and outside of containment, effects of pipe whip, jets, and environmental conditions from high and moderate energy line breaks, and dynamic effects of flow instabilities (i.e., water hammer loads) as to impairment of required functions during normal plant operations and under upset or accident conditions. Acceptance for water hammer effects is based on the following:

   A. Vents are provided at high points for liquid-filled, but normally idle, piping (or systems) where voiding can occur. These vents should be designed for ease of periodic operational testing.

   B. Consideration is given to voiding following pump shutdown or during standby. If in the system design voiding could occur, the design should provide for a slow system fill upon pump start to avoid water hammer, or the design should maintain functions following an inadvertent water hammer occurrence. Keep-fill systems should be considered during standby conditions.

   C. Operating and maintenance procedures are reviewed by the applicant for assurance of sufficient measures for avoiding water hammer (e.g., rapid fill due to pump start, periodic fill and vent checks, avoidance of sudden valve movement or realignment).

   D. Preoperational testing maybe necessary to verify that during various system alignments or train transfers/shutdowns that there is no evidence of water hammer occurrence.

   Note: RTNSS B and C SSCs are designed to withstand the effects of environmental and dynamic effects without loss of function. SRP19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

3. The applicant meets GDC 5 requirements for sharing of SSCs by demonstrating that such sharing does not affect the safe shutdown of any unit in an active or passive failure.

Note: In many cases, the design certification addresses a single unit and a COL applicant may address a single unit or a multiple unit site.

GDC 5 is applicable to the mPower™ containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

Note: GDC 5 is not applicable to RTNSS B or C functions. Water makeup to the UHS tank should be reviewed.

4. The applicant meets GDC 44 UHS requirements. Acceptance is based on RG 1.27, Positions C.2 and C.3; RG 1.72, Positions C.1, C.4, C.5, C.6, and C.7; and ANSI/ANS 5.1.
   GDC 44 is applicable to the mPower™ containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

   Note: GDC 44 is not applicable to RTNSS B or C functions.

5. The applicant meets GDC 45 requirements for inservice inspection of the safety-related components and equipment by demonstrating the accessibility of the UHS system for periodic inspections.
   GDC 45 is applicable to the mPower™ containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

   Note: GDC 45 is not applicable to RTNSS B or C functions.

6. The applicant meets GDC 46 requirements for periodic pressure and functional testing to ensure structural and leak tight integrity, operability, and performance of its active components, and operability of the system as a whole by demonstrating the capability to operate the system at full capacity during normal startup or shutdown procedures or during normal operation without degrading the system to provide for a safe shutdown or to mitigate the consequences of an accident.

   GDC 46 is applicable to the mPower™ containment heat removal system and the UHS tank which is further described in DSRS 6.2.2.

   Note: GDC 46 is not applicable to RTNSS B or C functions.

7. The applicant meets 10 CFR 20.1406 requirements for minimization of contamination of the facility and the environment, and for avoiding design features that would interfere with eventual decommissioning.
   RTNSS B and C: does apply.

   Nonsafety-related: does apply.

For DC and COL reviews, the findings will also summarize the staff's evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this DSRS section.

RTNSS B and C: apply for the review for ITAAC to the importance of each defense-in-depth function.

In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable.

RTNSS B and C: apply for the review for ITAAC to the importance of each defense-in-depth function.

V. IMPLEMENTATION

The staff will use this DSRS section in performing safety evaluations of mPower™-specific design certification (DC), combined license (COL), or early site permit (ESP) applications submitted by applicants pursuant to 10 CFR Part 52. The staff will use the method described herein to evaluate conformance with Commission regulations.

Because of the numerous design differences between the mPower™ and large light-water nuclear reactor power plants, and in accordance with the direction given by the Commission in SRM-COMGBJ-10-0004/COMGEA-10-0001, "Use of Risk Insights to Enhance the Safety Focus of Small Modular Reactor Reviews," dated August 31, 2010 (ML102510405), to develop risk-informed licensing review plans for each of the small modular reactor (SMR) reviews including the associated pre-application activities, the staff has developed the content of this DSRS section as an alternative method for mPower™ -specific DC, COL, or ESP applications submitted pursuant to 10 CFR Part 52 to comply with 10 CFR 52.47(a)(9), "Contents of applications; technical information."

This regulation states, in part, that the application must contain "an evaluation of the standard plant design against the Standard Review Plan (SRP) revision in effect 6 months before the docket date of the application." The content of this DSRS section has been accepted as an alternative method for complying with 10 CFR 52.47(a)(9) as long as the mPower™ DCD FSAR does not deviate significantly from the design assumptions made by the NRC staff while preparing this DSRS section. The application must identify and describe all differences between the standard plant design and this DSRS section, and discuss how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria. If the design assumptions in the DC application deviate significantly from the DSRS, the staff will use the SRP as specified in 10 CFR 52.47 (a)(9). Alternatively, the staff may revise the DSRS section in order to address new design assumptions. The same approach may be used to meet the requirements of 10 CFR 52.17 (a)(1)(xii) and 10 CFR 52.79 (a)(41), for ESP and COL applications, respectively.

VI. REFERENCES

1. SECY 94-084, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in the Passive Plant Designs," and SECY 95-132, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems (RTNSS) in the Passive Plant Designs".

2. RG 1.182, "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants."
3. 10 CFR Part 50, Appendix A, GDC 1, Quality standards and records

4. 10 CFR Part 50, Appendix A, GDC 2, "Design Bases for Protection Against Natural Phenomena."
5. 10 CFR Part 50, Appendix A, GDC 4, "Environmental and Dynamic Effects Design Bases."

6. 10 CFR Part 50, Appendix A, GDC 5, "Sharing of Structures, Systems, and Components."
7. 10 CFR Part 50, Appendix A, GDC 44, "Cooling Water."
8. 10 CFR Part 50, Appendix A, GDC 45, "Inspection of Cooling Water System."

9. 10 CFR Part 50, Appendix A, GDC 46, “Testing of Cooling Water System.”
10. RG 1.27, “Ultimate Heat Sink for Nuclear Power Plants.”
11. RG 1.72, “Spray Pond Piping made from Fiberglass-Reinforced Thermosetting Resin.”
12. ANS 5.1, “Decay Heat Power for Light Water Reactors,” October 1979.
13. 10 CFR Part 52.47(b)(1), “Contents of Applications, Technical Information, Inspections, Tests, Analyses, and Acceptance Criteria.”
14. 10 CFR Part 52.80(a), “Contents of Applications, Additional Technical Information, Inspections, Tests, Analyses, and Acceptance Criteria.”
15. RG 1.29, “Seismic Design Classification.”
16. RG 1.153, “Criteria for Power, Instrumentation, and Control Portions of Safety Systems.”
17. RG 1.155, “Station Blackout.”
18. RG 1.160, “Monitoring the Effectiveness of Maintenance at Nuclear Power Plants.”
19. RG 1.215, “Guidance for ITAAC Closure Under 10 CFR Part 52.”
20. Nuclear Management and Resources Council (NUMARC) Report 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors,"
21. NRC Information Notice 96-36, “Degraded of Cooling Water Systems Due to Icing”.
22. 10 CFR 50.65, “Requirements for monitoring the effectiveness of maintenance at nuclear power plants.”
23. RG 1.174, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant Specific Changes to the Licensing Basis”.
24. RG 1.206, “Combined License Applications for Nuclear Power Plants”.