Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

CNL-14-103

August 14, 2014

10 CFR 50.4
10 CFR 50.90

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Sequoyah Nuclear Plant, Units 1 and 2
Facility Operating License Nos. DPR-77 and DPR-79
NRC Docket Nos. 50-327 and 328

Subject: **Response to Request for Additional Information #2 Regarding Sequoyah Nuclear Plant, Units 1 and 2, Ultimate Heat Sink License Amendment Request (TAC Nos. MF2852 and MF2853)**

References:

1. Letter from TVA to NRC, “Sequoyah Nuclear Plant, Units 1 and 2 - Proposed Technical Specification Change, Ultimate Heat Sink Temperature Limitations Supporting Alternate Essential Raw Cooling Water Loop Alignments,” dated October 2, 2013 [ML13280A267]

2. Electronic Mail from NRC to TVA, “Request For Additional Information Related To License Amendment Request To Revise Technical Specification On Ultimate Heat Sink,” dated May 13, 2014 [ML14133A653]

By letter dated October 2, 2013 (Reference 1), the Tennessee Valley Authority (TVA) proposed changes to Sequoyah Nuclear Plant (SQN), Units 1 and 2, Technical Specification (TS) 3.7.5, “Ultimate Heat Sink,” to place additional limitations on the maximum average Essential Raw Cooling Water (ERCW) system supply header water temperature during operation with one ERCW pump per loop and during operation with one ERCW supply strainer per loop. In addition, the one-time limitations on Unit 1 Ultimate Heat Sink (UHS) temperature and the associated License Condition requirements for the Unit 2 steam generator replacement project were proposed to be deleted.

In the Reference 2 electronic mail, the Nuclear Regulatory Commission (NRC) transmitted a request for additional information (RAI) and requested that TVA provide a response by July 24, 2014. Due to the complexity of the RAI, TVA requested an extension until September 24, 2014, and the NRC Project Manager, Mr. Andrew Hon agreed to the extension. Enclosure 1 contains TVA’s response to the Reference 2.

The TS 3.7.5, TS Bases 3.7.4 and 3.7.5, Tables 4.2-6, 4.2-12, 4.2-13 and 4.2-14 have been revised in Enclosure 2 and supersedes their predecessors in the Reference 1.

Consistent with the standards set forth in 10 CFR 50.92(c), TVA has determined that the additional information, as provided in this letter, does not affect the no significant hazards considerations associated with the proposed application previously provided in Reference 1.

There are no new regulatory commitments contained in this letter. If you have any questions, please contact Henry Lee at 423-751-2683.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 14th day of August 2014.

Respectfully,

J.W. Shea
Vice President, Nuclear Licensing

Enclosures: Response to NRC Request for Additional Information
Enclosures:

1. TVA Response to NRC Request for Additional Information
2. Revised ERCW Technical Specification and Bases
    A. Proposed Cleaned Technical Specifications (TS) 3.7.5 for both Units
    B. Proposed Cleaned TS Bases 3.7.4 and 3.7.5 for both Units
    C. Revised Tables 4.2-6, 4.2-12, 4.2-13 and 4.2-14
    D. Wiegmann And Rose EDG Vendor Data

cc (Enclosures):

NRC Regional Administrator - Region II
NRC Senior Resident Inspector - Sequoyah Nuclear Plant
NRC SQN Project Manager - Andrew.Hon@nrc.gov
H. Lee

ENCLOSURE 1

Tennessee Valley Authority

Sequoyah Nuclear Plant, Units 1 and 2

Responses to NRC Request for Additional Information

RAI-1 <u>BACKGROUND</u>

The License Amendment Request (LAR) states, “With one unit shutdown and the Reactor Coolant System (RCS) temperature < 200 degrees Fahrenheit (°F), minimum combined safety requirements for one "accident" unit and one "non-accident" unit, or two "non-accident" units, are met by only one pump on one plant train when the Essential Raw Cooling Water (ERCW) system is aligned as delineated in the proposed Technical Specification (TS) Bases.”

Assume the following simultaneous plant conditions:

The plants are in either an Outage 1 or Outage 3 scenario as defined in your LAR where one unit is in Mode 5 and the other unit has a Loss-Of-Coolant Accident (LOCA).

- *a) The Mode 5 shutdown unit has been brought to Mode 5 in the fastest allowed time by procedure where the remaining decay heat is at its maximum.*
- *b) Decay heat is at maximum possible considering all times in core life.*
- *c) The assumed single failure is the A Train ERCW leaving only B Train ERCW components where the only Component Cooling System (CCS) Heat Exchanger (HX) receiving ERCW flow is 0B1/0B2.*

<u>Request</u>

- *a) For the above conditions, please identify the total required ERCW flow rate necessary to the Component Cooling System (CCS) HX in order to mitigate a LOCA in one unit and simultaneously remove maximum decay heat in the other unit that has just entered Mode 5. Please identify all assumptions.*
- *b) For the above conditions, please explain how the CCS HX 0B1/0B2 is able to mitigate the LOCA in one unit and keep the other unit in Mode 5 in the above described conditions.*

<u>TVA Response to RAI-1</u>

Throughout this response the phrase “ERCW loop” and “ERCW train” are interchangeable. For ease of the response, Unit 1 is assumed to be the accident unit, and Unit 2 is assumed to be the shutdown unit. The analysis outcome would be the same if the units’ roles were reversed.

a) The result of the analysis shows that approximately 7,670 gallon per minute (gpm) of ERCW flow to the B-train CCS 0B1/0B2 HX is required to mitigate a large break loss of coolant accident (LBLOCA) on Unit 1 and simultaneously remove maximum decay heat in the shutdown Unit 2.

   The B-train ERCW loop (with only one running pump) cannot deliver a flow rate of 7,670 gpm to the B-train CCS 0B1/0B2 HX.

The analysis which determined that 7670 gpm of ERCW flow to the B-train CCS 0B1/0B2 HX would be required was based on the following assumptions:

- Unit 2 has been subcritical for at least 10 hours, and has just achieved Mode 5.
- Unit 2 decay heat load used in the calculation is the highest actual decay heat curve observed from the last 19 SQN refueling outage shutdowns, core specific analyses.
- Unit 1 experiences a design basis LBLOCA
- Time since Unit 1 is subcritical is 0 hour; actual heat load used in the calculation is from the analysis for containment pressure, WCAP-12455, Revision 1, supplement 1R. This is the current analysis of record for LBLOCA containment pressure response.
- The UHS temperature used in the calculation is 82°F, which is conservatively higher than the 79°F proposed in the Technical Specification (TS) 3.7.5(a), the temperature restriction for a single pump per loop.
- The A-train ERCW is out of service (OOS), completely unavailable to both units, as specified by *"…single failure is the A Train ERCW leaving only B Train ERCW…"*
- One B-train ERCW pump is operable.
- The required ERCW-supported safety related loads are supplied by the B-train.
- Two B-train CCS pumps are aligned to the B-train CCS, which are operable.
- B-train CCS (HX 0B1/0B2) and the units' B-train RHR equipment are used to keep Unit 2 in Mode 5 and mitigate the Unit 1 LBLOCA, at reduced ERCW flow because only one operable ERCW pump is in service
- Required CCS-supported safety related loads are supplied by the B-train.
- The A-train CCS is OOS.
- The B-train RHR for Unit 2 is in normal operation, and operable.
- Both units' A-train RHR are not available, and equipment in the A-train is not available.
- Design HXs fouling factors were used.
- The tube plugging model used the actual SQN tube plugging data, and currently there are no RHR HXs tube plugs at SQN.
- Analysis assumptions in the accident analysis of the accident unit are met.
- The LBLOCA occurs in Unit 1. Unit 2 has been shutdown/subcritical for at least 10 hours. The calculation outcome would be the same if the units' roles were reversed.

<u>Note</u>: It is not required to postulate a hypothetical situation that causes the removal of one complete ERCW loop with two operable pumps for the following reasons:

- In the LAR, TVA intended to align the ERCW system to have only one pump per loop on one loop at a time to support one 6.9 kV Shutdown Board (SDB) 7-day preventative maintenance (PM) outage. Please review the October 2, 2013 LAR submittal, page E-19, 2nd paragraph, [ML13280A267].
  Thus, during a one 6.9 kV SDB 7-day PM outage, three 6.9 kV SDBs, three emergency diesel generators (EDGs), and three ERCW pumps are OPERABLE and protected for defense in depth (DID) before aligning one pump per ERCW loop operation. To further clarify this point, TS Bases (TSB) Tables B 3/4.7-1,2 have been revised.
- If the plant is placed in the one ERCW pump configuration for 6.9 kV SDB PM, the TS LCO for the 6.9 kV SDB 7-day outage would be entered. Therefore, additional failures are not required to be postulated.

- Four ERCW pumps are routinely available per loop, and all four pumps can be started when both 6.9 kV SDBs (per ERCW loop) are powered from offsite power. Eight pumps are available in two loops. In the scenario stated in RAI-1.a, only one pump is operable out of the eight ERCW pumps available. If one 6.9 kV SDB is OOS, then there are six pumps available. This is a DID consideration.
- Four of the eight pumps are operable when they are backed by their respective 6.9 kV SDBs/EDGs. In the scenario above, one out of the four 6.9 kV SDBs/EDGs is available.
- The single failure criteria only requires that a passive failure be considered at greater than 24 hours into an accident. Additionally, the single failure criteria describes that on a qualified system, such as ERCW, leakage from a single failure is limited to 50 gpm, consistent with valve packing failures, pump packing leakage, etc.
- Each ERCW loop has multiple isolation points and crossties that can be used to mitigate any conservatively postulated ERCW piping leak. In the scenario above, no credit is given to this SQN ERCW system characteristic and only one loop is available. Furthermore, the postulated scenario in this RAI assumes that operators take no actions to restore the other loop back to service. This is a DID consideration.

b) The RAI-1.a response described how the CCS HX 0B1/0B2 can mitigate a LOCA in Unit 1 and keep Unit 2 in Mode 5.
   - Two B-train CCS pumps are aligned to the B-train CCS; the B-train CCS is operable.
   - B-train CCS (HX 0B1/0B2) and the units' B-train RHR equipment are used to keep Unit 2 in Mode 5 and mitigate the Unit 1 LBLOCA, at reduced ERCW flow because only one operable ERCW pump is in service
   - Required CCS-supported safety related loads are supplied by the B-train.
   - A-train CCS is out of service (OOS).

<u>Additional TVA response/clarification for RAI-1</u>:
Since RAI-1.a response specifies an unachievable 7,670 gpm ERCW flow when in single pump per loop, TVA has added a new requirement for the shutdown unit (Unit 2) to be subcritical for greater than 60 hours prior to entry into the one pump per ERCW loop configuration in the TS Bases (TSB). This delay ensures that the combined units' decay heat has decreased low enough so that the ERCW system with a single pump and single loop can mitigate a LOCA in Unit 1 and keep Unit 2 in Mode 5.

The TS 3.7.5 and the TSB for 3.7.4 and 3.7.5 have been revised with new restrictions in Enclosure 2 (A and B) and supersede those found in the October 2, 2013, submittal. TSB Table B 3/4.7-1 has been revised with additional restrictions.

1. ERCW System supply header average water temperature is ≤ 79°F, and reasonable assurance exists (based on historical river temperature and predicted weather conditions) that UHS temperature will remain ≤ 79°F for the duration that one ERCW loop is aligned for a single OPERABLE pump.
2. Unit 2 (the shutdown unit) is subcritical for greater than 60 hours and in Mode 5, 6 or core empty.
3. If either unit is in modes 1, 2, 3, or 4, then only one ERCW loop can be aligned with one OPERABLE pump.

4. Ensure the other ERCW loop has two OPERABLE pumps. Three 6.9 kV SDBs, three EDGs, and three ERCW pumps are OPERABLE and protected for DID when aligned for one pump per ERCW loop operation, while either unit is in modes 1, 2, 3, or 4.

The following three cases demonstrate the ability to simultaneously cool down both units to Mode 5 within the ERCW flow rate that is achievable when only one ERCW pump in one loop is operable and the shutdown unit has been subcritical beyond a specific time.

<u>Case 1</u>: A-train ERCW/RHR/CCS loop fails; B-train available with one operable pump; ERCW is in the one pump per loop configuration.

Assumptions used in this analysis are the same as in the RAI-1.a response with these exceptions:

- Unit 2 has been subcritical for at least 53 hours, instead of 10 hours; a smaller decay heat value from Unit 2 is used in the calculation.
- This is not a difference to the RAI-1.a assumption, but an explanation is necessary:
  - B-train ERCW has a flow rate of at least 4121 gpm to the B-train CCS 0B1/0B2 HX.
  - With the ERCW flow rate of at least 4121 gpm, the system can remove 15.9 megawatts (MW) of decay heat from Unit 2, which occurs within 53 hours after Unit 2 is subcritical.

The result of the Case 1 analysis shows that when only one ERCW pump from the B-train is operable, with a flow rate of at least 4121 gpm to the B-train CCS 0B1/0B2 HX, the ERCW configuration can mitigate the Unit 1 LBLOCA while keeping Unit 2 in Mode 5, provided Unit 2 has been subcritical for greater than 53 hours.

<u>Case 2</u>: B-train ERCW (with only one pump) fails; ERCW is in the one pump per loop configuration; single failure analysis removed the B-train completely; A-train is operable with two pumps.

Assumptions used in this analysis are the same as in the RAI-1.a response with these exceptions:

- B-train CCS/RHR are inoperable for both units.
- A-train CCS/RHR (both units) are operable
- ERCW flow is higher than case 1 because A-train has two pumps in service
- With two pumps, the nominal available flow rates from the analysis are 4023 gpm to the LBLOCA accident Unit 1 and 1569 gpm to the non-accident Unit 2 CCS HXs.
- This is not a difference to the RAI-1.a assumption, but an explanation is necessary:
  - The Unit 2 systems could reject 16.5 MW of decay heat which occurs within 48 hours after Unit 2 is subcritical.
  - The accident unit analysis remains valid for Unit 1.
- Unit 2 has been subcritical for at least 48 hours, instead of 10 hours; a smaller decay heat value from Unit 2 as stated in RAI-1.a; but larger than Case 1

The result of the Case 2 analysis shows that when two ERCW pumps from the A-train are operable, the ERCW configuration can mitigate the Unit 1 LBLOCA while keeping Unit 2 in Mode 5, provided Unit 2 has been subcritical for greater than 48 hours.

<u>Case 3</u>: A-train ERCW with two pumps per loop; one of the two A-train pumps fails (based on single failure criteria); ERCW is in the one pump per loop configuration; B-train is available with one operable pump, ERCW flow is available to both units from both loops, with one pump per loop.

Assumptions used in this analysis are the same as in the RAI-1.a response with these exceptions:

- ERCW flow is driven by one pump per loop. Both trains of CCS/RHR are available to both units.
- The ERCW flow that is available to the CCS HXs is:
  4,121 gpm to the B-train CCS HX;
  3,081 gpm to the 1A CCS HX
  1,206 gpm to the 2A CCS HX.

- With the higher available flow rates, and with two trains in service, the plant systems can remove at least 26.8 MW of decay heat from the outage unit, which occurs within 10 hours after Unit 2 is subcritical.
- The ERCW system can mitigate the LBLOCA in Unit 1 while keeping Unit 2 in Mode 5, provided Unit 2 has been subcritical for at least 10 hours.

The result of the Case 3 analysis shows that when one ERCW pump from each loop is operable, the ERCW configuration can mitigate the Unit 1 LBLOCA while keeping Unit 2 in Mode 5, provided Unit 2 has been subcritical for greater than 10 hours.

Summary:

Under the worst case, the plant ERCW/CCS/RHR cooling systems can mitigate an accident on Unit 1 and simultaneously remove maximum decay heat in Unit 2, provided Unit 2 has been subcritical at least 53 hours. The analysis outcome would be the same if the units' roles were reversed.

To increase analysis margin, 60 hours will be used in the TSB.

The Unit 1 TS temperature limit when operating with one pump per ERCW loop has been lowered from 81°F to 79°F to reduce the potential for human error while keeping both units' TS the same, and adding additional margin to the ERCW heat load analysis.

In the one operable ERCW pump per loop configuration, three EDGs HXs will have ERCW. Because one EDG will be inoperable, this one ERCW pump per loop configuration duration is limited to the EDG allowable outage time (AOT), which is 7 days.

The TS 3.7.5 and the TSB for 3.7.4 and 3.7.5 have been revised with new restrictions in Enclosure 2 (A and B) and supersede those found in the October 2, 2013 submittal.

RAI-2 <u>BACKGROUND</u>

Final Safety Analysis Report (FSAR) Section 9.2.2.2 on ERCW states that the primary cooling source for each Diesel Generator (DG) heat exchangers (HXs) is from the Unit 1 headers. Each diesel also has an alternate supply from the unit 2 headers of the opposite train.

Request

a) *Describe how the primary cooling source of ERCW is supplied to each DG by describing which ERCW valves are opened automatically and manually upon DG startup.*
b) *Similarly describe how the alternate supply of ERCW is supplied to each DG and which ERCW valves are opened automatically and manually upon DG startup.*
c) *Describe how the alternate supply of ERCW replaces the primary source of ERCW.*

TVA Response to RAI-2

a) Upon automatic EDG start, ERCW is automatically supplied to the EDG heat exchangers via motor operated ERCW supply valves. These valves are normally closed when the EDGs are in standby and auto-open upon EDGs start. In addition, they can be either remotely operated from the control room or locally in the EDG room.

   If all equipment is operating as designed and tested, there is no manual manipulation of the primary ERCW supply valves needed by the control room or local operator when the EDG automatic starts.

EDG	**Primary ERCW supply valve**
1A-A	1-FCV-67-66, A-train
2A-A	2-FCV-67-66, A-train
1B-B	1-FCV-67-67, B-train
2B-B	2-FCV-67-67, B-train

b) The alternate ERCW supply valves for the EDGs are also motor operated valves and are normally closed when the EDGs are in standby. These valves remain closed upon automatic EDG start. There are no automatic valve actions for these alternate ERCW supply valves.

   The alternate ERCW supply valves for the EDGs are opened remotely by the control room operator if the primary ERCW valves do not open upon EDG start. They can also be opened locally in the EDG room.

EDG	**Alternate ERCW supply valve**
1A-A	1-FCV-67-68, B-train
2A-A	2-FCV-67-68, B-train
1B-B	1-FCV-67-65, A-train
2B-B	2-FCV-67-65, A-train

c) The alternate ERCW supply valve for each EDG is opened remotely by the control room operator if the primary same-train ERCW valve fails to open upon EDG start. It can also be opened locally in the EDG room.

   The alternate EDG ERCW supply is from the opposite ERCW train and can replace the normal ERCW supply; however, that EDG will be considered inoperable by TS, but the EDG is available to power its 6.9 kV SDB.

RAI-3 <u>BACKGROUND</u>

TVA proposed ERCW lineups to allow Strainer Outage and has performed calculations stating that there is sufficient ERCW flow to mitigate a Design-Basis Accident (DBA) in one unit and maintain the non-accident unit in hot standby. In a Request for Additional Information (RAI) dated November 11, 2013, the U.S. Nuclear Regulatory Commission (NRC) staff asked the licensee to describe calculations that show that the non-accident unit can be cooled down in accordance with the guidance of Regulatory Guide 1.27, which was specified in the original submittal dated October 2, 2013. SQN stated in their response dated December 11, 2013, that "because the SQN Updated Final Safety Analysis Report (UFSAR) does not place any limit on cool down time for the non-accident unit, Tennessee Valley Authority (TVA) does not have formal calculations that demonstrate cool down time.

SQN TS 3.7.4, "Essential Raw Cooling Water System," requires at least two independent essential raw water cooling loops to be OPERABLE. Both Units 1 and 2 have these TS. If any ERCW loop is inoperable the TS ACTION requires cold shutdown within the specified times.

In the Strainer Outage Cases, a DBA is assumed in one unit with a single failure of one of the ERCW loops. With ERCW being a shared system, the failure of one ERCW loop places the non-accident unit in TS 3.7.4 ACTION where cold shutdown is required within the specified time.

<u>Request</u>

Identify and discuss additional action needed to confirm that SQN can comply with TS 3.7.4 ACTION for the non-accident unit for both the Strainer Outage Cases and now during current operation.

<u>TVA Response to RAI-3</u>

When SQN enters the condition for one ERCW strainer OOS in one loop, all four 6.9 kV SDBs are operable.

With one strainer per loop OOS, ERCW flow in that two-pumps per loop configuration is less than when both strainers are in service, but more than the flow from the one pump per loop configuration. The flow reduction requires a lower limit on the UHS temperature ($\leq 83°F$) in order for all components to have sufficient cooling.

TVA has completed calculation MDQ0009992014000134, Rev 0, to show that both units can be simultaneously taken from 100% power to Mode 5 in 30 hours with only one operating ERCW loop with two operable pumps, and one operable strainer.

RAI-4 BACKGROUND

TVA has listed in the LAR that each Emergency Diesel Generator (EDG) HX requires 522 GPM of ERCW at 87°F temperature.

Request

Please provide the vendor data sheets for the EDGs that list:

a) The design flow rate and temperature for the ERCW that cools the EDG HXs, and

b) The corresponding fouling factors and heat transferred for the EDG HXs cooled by ERCW.

Provide justification for any changes in the data of the vendor data sheet used to determine that 522 GPM ERCW is the required cooling water flow rate at 87°F.

TVA Response to RAI-4

a) Enclosure 2.D is the vendor (Wiegman and Rose) datasheet used to determine the ERCW design flow rate for the EDG heat exchangers, who bought the original heat exchanger manufacturer (Thermxchanger). TVA had requested this information from the vendor as part of the development of a change to the UHS TS maximum ERCW temperature to 87^{o}F License Amendment Request, which was approved by NRC.

The SQN EDGs have a 100% load capacity of 4400 kW. The SQN TS 3.8.1.1 requires each EDG to be capable of operating at 110% of full load, or 4840 kW, for a 2-hour period. TVA calculation MDQ00006720040142 has determined that the heat load to be removed by the EDG HXs at 100% load is 6.1 MBTU/hr. The heat load is 6.27 MBTU/hr when the EDG is at 110% load.

Enclosure 2.D heat exchanger data sheet specified that 554 gpm of service water is required to support a heat load of 6.27 MBTU/hr with the corresponding fouling factors of 0.00275 . TVA calculation MDQ00006720040142 determined that 522 gpm is required to support a heat load of 6.1 MBTU/hr. These flow values were determined using an overall fouling factor of 0.00275 (hr ft^{2} ^{o}F / BTU). The conservatively high fouling factor provides margin to address the ERCW flow requirement for 110% EDG loading.

In the letter from TVA to NRC dated August 14, 2007, (ADAMS No. ML072290326, Enclosure 1, page 20 of 26), the fouling factor of the EDG HXs are discussed in some detail. On page 21 of this letter, there is discussion that the EDG will be operating at full load 100 days, post-accident. It is also stated that the overload condition, if any, will exist at the onset of an accident response. The NRC GL 89-13 program maintains the EDG fouling factor to a relatively low value that would exist if an overload condition were encountered during the first two hours of an accident, as allowed by TS.

Subsequently, the fouling factor might increase over the postulated 100 day operating time, but with the EDG loading not exceeding 100% the cooling water design flow of 522 gpm will maintain the EDG within its nominal operating parameters.

To further illustrate the effects of a lower, but still reasonable, fouling factor of 0.0015, and a higher EDG loading of 7.099 MBTU/hr, the required ERCW flow to the EDG is 365 gpm.

b) Enclosure 2.D lists the corresponding fouling factors of 0.00275 and heat transferred of 6.27 MBTU/hr for the EDG HXs cooled by ERCW.

RAI-5 <u>BACKGROUND</u>

TVA has proposed that the change to Limiting Condition for Operation (LCO) 3.7.5 for Unit 1 and Unit 2 be consistent with Improved Standard TSs (NUREG-1431), such that specifics associated with Ultimate Heat Sink (UHS) temperature limitations are relocated to the Surveillance Requirements (SRs).

TS 3.7.9 of NUREG 1431 requires the licensee to verify UHS temperature once per hour when the UHS temperature approaches within several degrees of the maximum allowed UHS temperature based on limitations of equipment.

TVA appeared to have proposed change to the SRs requires UHS temperature verification at least once every 24 hours no matter what the UHS temperature, even at the maximum allowed temperature.

<u>Request</u>

Please clarify SR 4.7.5.1 and/or TS 3.7.5 such that when ERCW supply temperature is within several degrees of the maximum temperature limits that verification of UHS temperature is hourly to be consistent with NUREG 1431.

<u>TVA Response to RAI-5</u>

SR 4.7.5.2 has been revised in Enclosure 2.A so that when the ERCW supply temperature is ≤ 2°F of the maximum applicable temperature limits, SQN will verify that the UHS temperature is within limit, at least once per hour.

RAI-6 <u>BACKGROUND</u>

The LAR for TS Bases 3/4.7.4, "ERCW System," in discussing OPERABILITY uses the term "single active failure."

Section 5 of the licensee's submittal lists GDC 44 as an applicable regulatory requirement. GDC 44 requires consideration of a "single failure" which includes a single passive electrical failure.

The TS Bases appeared not to be consistent with GDC 44.

<u>Request</u>

Please clarify the TS Bases to include a single passive electrical failure.

<u>TVA Response to RAI-6</u>

In the TSB 3/4.7.4 (ERCW System), and 3/4.7.5 (UHS, the Applicable Safety Analyses section) LAR submittal, TVA used the term "single *active* failure" in the LAR submittal. TVA has deleted the word "*active*" in the phrase; thus TVA will include both active and passive electrical failures. Enclosure 2.B shows the revision.

RAI-7 <u>BACKGROUND</u>

Outage 3 as described in Table 4.2-6 lists the 1A and 1B EDGs as shutdown. For Outage 3, Tables 4.2-12 and 4.2-13 show EDGs 2A and 2B with ERCW flow and EDGs 1A and 1B without ERCW flow; this is consistent with Table 4.2-6 for Outage 3. With EDGs 1A and 1B without ERCW flow, the NRC staff notes that this lineup does not meet the LCO for TS 3.8.1.2, Electrical Power Systems Shutdown, for Unit 1.

<u>Request</u>

Please identify all other TSs whose LCOs are not met for Outage 3; then also for Outage 1; and all Strainer Outage cases. Identify required TS actions and equipment to be declared INOPERABLE for each LCO not met.

<u>TVA Response to RAI-7</u>

Outage 3 refers to the ERCW alignment of one ERCW pump in one loop. The other loop has two OPERABLE pumps. TSB Table B 3/4.7-1 has been revised with new restrictions in Enclosure 2.B, stating that this configuration will be performed on one ERCW loop at a time.

In the one operable ERCW pump per loop configuration, three EDGs HXs will have ERCW. Because one EDG will be inoperable, this one ERCW pump per loop configuration duration is limited to the EDG AOT, which is 7 days.

In the one strainer OOS configuration, four EDGs HXs will have ERCW.

Currently, there are no approved/current TS that allow the ERCW configuration of one operable pump per loop. If SQN enters this ERCW configuration, the affected units will enter TS 3.7.4, ERCW System, LCO.

Following the NRC approval of the SQN UHS LAR, no TS LCO will be entered if the required conditions of TSB Table B 3/4.7-1, relevant TS 3.7.5 actions, and Surveillance Requirements of TS 3.7.5 are met. The same explanation can be said for Outage 1, and all Strainer Outage cases.

TVA understands the NRC staff's confusion of "*Table 4.2-6 lists the 1A and 1B EDGs as shutdown. For Outage 3, Tables 4.2-12 and 4.2-13 show EDGs 2A and 2B with ERCW flow and EDGs 1A and 1B without ERCW….* "

SQN does not have any intention to take two 6.9 kV SDBs (or EDGs) OOS at the same time. The revised TSB Table B 3/4.7-1 in Enclosure 2.B is clear in this regard.

In the October 2, 2013, TVA LAR submittal, Table 4.2-6 states:

- Outages 3 and 4, lists the 1A *and* 1B EDGs as shutdown.
- Outages 1 and 2, lists the 2A *and* 2B EDGs as shutdown.

<u>TVA Clarification of Table 4.2-6</u>: Outage 3 is the case that was performed assuming that the 1A *and* 1B EDGs/SDBs are out of service, thereby only one B-train ERCW pump would be running. A-train ERCW is completely out of service and not available to both units.

The analysis submitted as Outage 1 and Outage 3 had an 'A' *and* a 'B' train EDG out of service together. The trains of ERCW are independent. The analysis results of analyzing the EDGs being out of service together or one at a time is insignificant.

SQN intends to remove only one 6.9 kV SDB from service at a time. Tables 4.2-6, 4.2-12, 4.2-13 and 4.2-14 (in Enclosure 2.C) are revised to show that:

- Either 1A _or_ 1B EDG is shutdown; out of four EDGs, three EDGs are operable to support their respective 6.9 kV SDBs.
- Either 2A _or_ 2B EDG is shutdown; out of four EDGs, three EDGs are operable to support their respective 6.9 kV SDBs.

Tables 4.2-6, 4.2-12, 4.2-13 and 4.2-14 in Enclosure 2.C supersedes their predecessors in the October 2, 2013, TVA LAR submittal.

RAI-8 ***Request***

Please clarify the information presented in Tables 4.2-12 and 4.2-13 by answering the following questions:

a) Each table shows 1 EDG receiving ERCW flow. With the loss of either the A train or the B train as the single failure, does that mean 1 EDG is both mitigating the LOCA in one unit and keeping the non-accident unit in Mode 5? Explain.

b) Clarify the required ERCW flow for each EDG. Tables 4.2-12 and 4.2-13 show 1044 GPM needed for each EDG. Table 4.2-1 lists flow for EDG HX.

TVA Response to RAI-8

a) TVA RAI-7 response is relevant to the RAI-8 response because it discussed Tables 4.2-12 and 4.2-13.

SQN will remove only one 6.9 kV SDB from service at a time for the 7-day PM. Tables 4.2-12 and 4.2-13 in Enclosure 2.C are revised to show that:

- Either 1A *or* 1B EDG is shutdown; out of four EDGs, three EDGs are operable to support their respective 6.9 kV SDBs.
- Either 2A *or* 2B EDG is shutdown; out of four EDGs, three EDGs are operable to support their respective 6.9 kV SDBs.

Thus, during a 6.9 kV SDB 7-day PM, three 6.9 kV SDBs/EDGs are available to mitigate the LOCA in one unit while keeping the non-accident unit in Mode 5.

b) Each SQN EDG has two engines that together drive one 6.9 kV generator. There is a heat exchanger for each engine. Each heat exchanger requires 522 gpm. In order to operate one EDG set, a total of 1044 gpm is required.

RAI-9 ***BACKGROUND***

The Strainer Outage cases listed in Tables 4.2-8 through 4.2-11 describe flow from two ERCW pumps through one strainer.

Request

Is the flow rate and differential pressure across the single operable strainer within design specifications? In answering this question identify for strainer outage cases 1 through 8 the flow rate through the single operable strainer, the differential pressure across the strainer and compare that to the maximum allowed flow rate and differential pressure for each strainer as specified by the manufacturer and/or other limiting design criteria.

TVA Response to RAI-9
The flow rates and differential pressures across the single operable strainer are within design limits. These strainers have been operated in this condition since 1980 (Unit 1 first start-up) with no adverse effects in multiple hydraulic conditions such as one or two pumps running.

Per the strainer manufacturer, the maximum flow allowable through one ERCW strainer is 22,000 gpm. The ERCW system analyses do not have any case where the total ERCW flow on one train is as high as 22,000 gpm, even with both strainers on one train in service. The ERCW system, as it is normally operated, would not be able to provide 22,000 gpm flow through one strainer, due to ERCW pump hydraulic limitations.

The ERCW strainers are capable of withstanding high differential pressure. These strainers are capable of withstanding 150 pound per square inch differential (psid). The limitation on the strainers is based on flow in the strainers, which SQN does not approach in normal routine operation. See the table below.

The following information extracted from the hydraulic analysis calculations:

CASE	A-train Strainer in Service	Flow in the A-train Strainer (gpm)	Strainer dP (psid)	B-train Strainer in Service	Flow in the B-train Strainer (gpm)	Strainer dP (psid)
STRAINER 1	A2A-A	15604	5.7	B2B-B	15164	5.4
STRAINER 2	A2A-A	15984	6.0	B2B-B	15113	5.4
STRAINER 3	A1A-A	14768	5.1	B1B-B	14770	5.1
STRAINER 4	A1A-A	14724	5.1	B1B-B	14387	4.9
STRAINER 5	A2A-A	15643	5.4	B2B-B	15186	5.4
STRAINER 6	A2A-A	16049	6.0	B2B-B	15192	5.4
STRAINER 7	A1A-A	14796	5.1	B1B-B	14819	5.1
STRAINER 8	A1A-A	15079	5.3	B1B-B	14791	5.1

RAI-10 BACKGROUND
In Outage Cases 1 thru 4 the 6" ESF header crossties and the 16" Aux Building crossties are all open.

Request
Please explain the purposes for having these crossties open when aligning for Outages 1 thru 4.

TVA Response to RAI-10
For outage cases 1 thru 4, having the crossties open versus closed will have little difference to the delivered flow. For example, in Outage 3, the overall ERCW system total flow is within 3 gpm of over 20,000 gpm of total flow, if the crossties are open or closed.

With the crossties opened or closed, some components had minor flow improvement while others had minor flow reductions.

The overall effect is that a slight hydraulic improvement is realized when the crossties are open.

RAI-11 <u>BACKGROUND</u>

Table 4.2-6 states for Outages 2 and 4, the accident unit's FCV-67-146 may have to be placed in the 35% position in post recirculation in order to provide adequate flow to the Lower Containment Coolers (LCCs) to ensure Equipment Qualification (EQ) limits are not exceeded.

<u>Request</u>

Please explain how the CCS is able to mitigate the MSLB in one unit and keep the other unit in Mode 5 when the accident unit's FCV-67-146 is in the 35% position as stated in Table 4.2-6.

Do calculations support your response? Explain.

<u>TVA Response to RAI-11</u>

The CCS mitigates a MSLB accident by providing a heat sink to these components:

- If containment pressure is high from the MSLB and Containment Spray (CS) pumps are required, then the CS pump oil and stuffing box HXs use CCS as a heat sink.
- If the ECCS pumps are running (in response to a safety-injection signal), then CCS cools the RHR HXs during the recirculation mode of operation. It also supplies cooling water to the mechanical seal coolers for the centrifugal charging pumps (CCPs) and the safety injection pumps (SIP), and the seal water HXs for the RHR pumps.
- If the accident unit is required to cool down to Mode 5, the CCS is used as a heat sink for the RHR HXs.

The CCS keeps the shutdown unit in Mode 5 by providing a heat sink to these components:

- RHR pump seal water HX
- RHR HX.

The response to RAI-1 includes discussion about the ERCW flow being sufficient in a LBLOCA accident, which has a greater heat removal requirement by the ERCW/CCS than a MSLB accident. Furthermore, analyses were run in RAI-1 for removing the maximum possible decay heat from a LBLOCA with just one ERCW/CCS loop available. This assumption is far more limiting than when both ERCW/CCS loops are available for the postulated MSLB in the RAI-11 assumption. RAI-11 assumes that both ERCW/CCS loops are available. The TVA response in RAI-1 bounds the MSLB discussion in RAI-11.

<u>LCC</u>: The Lower Compartment Coolers (LCC, cooled by ERCW) are needed for MSLB inside containment in order to provide long term cooling for Equipment Qualification of various components. The LCCs are placed in service from 1 to 4 hours after the MSLB initiation.

One of the means of controlling ERCW header pressure is by manipulation of the CCS HX ERCW flow using the CCS HX outlet valve (1, 2-FCV-67-146). Modulating FCV-67-146 will affect the flow to LCC and the lower containment temperature.

After operator actions for MSLB have stabilized the plant, FCV-67-146 can be positioned as needed in order to supply a minimum 200 gpm ERCW to the LCCs, as required by TS 3.6.2.2. FCV-67-146 must be positioned to the 35% position to give the required minimum 200 gpm for each LCC based on past ERCW flow balance performance.

The following pages contain the ERCW available flow rates for the Outage 1 (LOCA) and the Outage 2 (MSLB) conditions, in order to illustrate the available flow rate differences for Outage 1 versus Outage 2.

RAI-11: ERCW FLOW RATES FOR Outage 1 (LOCA) and Outage 2 (MSLB)

	Outage 1 (LOCA) gpm	Outage 2 (MSLB) gpm		Outage 1 (LOCA) gpm	Outage 2 (MSLB) gpm
A TRAIN ERCW FLOWS			**B TRAIN ERCW FLOWS**		
D/G 1A1	481.1	626.8	D/G 1B1	539.1	623.6
D/G 1A2	473.8	620.8	D/G 1B2	503.5	584.6
D/G 2A1	0.0	0.0	D/G 2B1	0.0	0.0
D/G 2A2	0.0	0.0	D/G 2B2	0.0	0.0
CCS HX 1A1/1A2	3057.2	**1993.3**	CCS HX 0B1/0B2	4089.0	4892.7
CCS HX 2A1/2A2	1197.4	1597.6	CSS HX 1B	3025.8	0.0
CSS HX 1A	3022.2	0.0	CSS HX 2B	0.0	0.0
CSS HX 2A	0.0	0.0	ELECT BD RM CHR B	162.7	196.1
ELECT BD RM CHR A	153.3	206.3	MCR CHILLER B	119.7	144.1
MCR CHILLER A	108.8	146.5	SHUTDOWN BD RM CHR B	349.8	414.8
SHUTDOWN BD RM CHR A	361.9	486.6	CCP OIL CLR 1B	30.2	36.5
CCP OIL CLR 1A	38.7	52.3	CCP Pump OIL CLR 1B	19.5	23.5
CCP Pump OIL CLR 1A	24.7	33.3	CCP Gear OIL CLR 1B	10.7	12.9
CCP Gear OIL CLR 1A	14.0	19.0	CCP RM CLR 1B	29.2	35.3
CCP RM CLR 1A	35.1	47.4	CCP OIL CLR 2B	41.3	49.3
CCP OIL CLR 2A	42.0	56.4	CCP Pump OIL CLR 2B	27.0	32.1
CCP Pump OIL CLR 2A	27.1	36.2	CCP Gear OIL CLR 2B	14.3	17.2
CCP Gear OIL CLR 2A	15.0	20.2	CCP RM CLR 2B	37.3	44.4
CCP RM CLR 2A	39.5	52.7	SIS PMP RM CLR 1B	23.1	27.8
SIS PMP RM CLR 1A	26.7	35.9	SIS OIL CLR 1B	9.0	10.9
SIS OIL CLR 1A	7.9	10.8	SIS PMP RM CLR 2B	28.3	33.7
SIS PMP RM CLR 2A	25.6	34.2	SIS OIL CLR 2B	9.7	11.6
SIS OIL CLR 2A	9.7	13.3	EGTS 2B	11.6	13.9
EGTS 2A	11.1	14.9	AUX CONT AIR B	5.3	6.3
AUX CONT AIR A	4.7	6.3	SFP & TBBP CLR 1B	27.4	33.3
SFP & TBBP CLR 1A	29.2	39.6	CCS & AFW CLR 1B	77.5	93.8
CCS & AFW CLR 1A	84.0	113.8	BAT & AFW CLR 2B	57.0	68.3
BAT & AFW CLR 2A	57.4	77.4	714 PEN RM CLR 1B	24.7	29.8
714 PEN RM CLR 1A	23.9	32.1	714 PEN RM CLR 2B	25.9	31.0
714 PEN RM CLR 2A	23.9	32.1	690 PEN RM CLR 1B	23.9	28.9
690 PEN RM CLR 1A	23.7	31.9	690 PEN RM CLR 2B	24.4	29.1
690 PEN RM CLR 2A	22.7	30.5	669 PEN RM CLR 1B	29.3	35.3
669 PEN RM CLR 1A	39.5	53.1	669 PEN RM CLR 2B	46.8	55.9
669 PEN RM CLR 2A	46.0	62.1	PIPE CHASE CLR 1B	36.5	44.0
PIPE CHASE CLR 1A	47.4	64.0	PIPE CHASE CLR 2B	38.4	46.0
PIPE CHASE CLR 2A	37.8	51.0	CNT SPR PMP RM CLR 1B	21.4	25.8
CNT SPR PMP RM CLR 1A	19.8	26.7	CNT SPR PMP RM CLR 2B	29.7	35.4
CNT SPR PMP RM CLR 2A	27.7	37.1	RHR PMP RM CLR 1B	12.9	15.6
RHR PMP RM CLR 1A	13.6	18.3	RHR PMP RM CLR 2B	15.5	18.5
RHR PMP RM CLR 2A	17.5	23.5	1B-B STRAINER BACKWASH	449.7	513.2
1A-A STRAINER BACKWASH	431.7	547.7	2B-B STRAINER BACKWASH	455.1	518.5
2A-A STRAINER BACKWASH	490.3	621.1			
1AA LCC	0.0	318.2	1BB LCC	0.0	225.0
1CA LCC	0.0	288.2	1DB LCC	0.0	264.2

RAI-12 <u>BACKGROUND</u>
Table B 3/4.7-1 for B loop One Pump Operation requires isolating ERCW flow to the 1B Control Rod Drive Vent Cooler.

<u>Request</u>

a) *Provide justification for isolating 1B Control Rod Drive Vent Cooler, when Unit 1 is in Mode 1.*
b) *Why is this necessary for the B Loop of unit 1 only and not the A loop for unit 1 nor either loop for unit 2?*

<u>TVA Response to RAI-12</u>

a) There are four Control Rod Drive Vent Coolers (CRDVCs) on each unit. Two of the CRDVCs can operate at one time for cooling the Control Rod Drive Mechanisms (CRDMs), because of ductwork airflow limitations.

   If there are less than two CRDVCs operating and aligned to the Reactor head shroud for CRD cooling, then the CRDMs may overheat, causing inaccurate Control Rod Position Indicators, and possibly leading to a dropped rod when Unit 1 is in Mode 1. Any of these failures could lead to a Unit 1 shutdown.

   With four CRDVCs available, isolating ERCW to one of the two non-operating Unit 1 CRDVCs (1B) for seven days to support the 6.9 kV SDB outage when Unit 1 is in Mode 1, and having one spare CRDVC available (to take the place of the two running if one happens to fail) is justifiable when the unit is aligned for the Unit 1 B-loop one ERCW pump configuration.

   Furthermore, CRDVCs are not safety related equipment; and are not required to operate during or following any design basis accident. The ERCW flow to the four CRDVCs is isolated on a Phase-B containment isolation.

b) In order to get the required ERCW flow rate to the safety related Unit 1 LCC 1B-B in the hydraulic analysis, ERCW flow has to be isolated to the non-safety related Unit 1 CRDVC 1B.

   LCC 1B is the only affected LCC in the hydraulic analysis of both ERCW loops for both units.

   The remaining LCC's received the required ERCW flow without any special alignments, except as discussed in RAI-11.

ENCLOSURE 2

Tennessee Valley Authority

Sequoyah Nuclear Plant, Units 1 and 2

Revised ERCW Technical Specification and Bases

Index:

A. Proposed Cleaned Technical Specifications (TS) 3.7.5 for both Units
B. Proposed Cleaned TS Bases 3.7.4 and 3.7.5 for both Units
C. Revised Tables 4.2-6, 4.2-12, 4.2-13 and 4.2-14
D. Wiegmann And Rose EDG Vendor Data

ENCLOSURE 2

Tennessee Valley Authority

Sequoyah Nuclear Plant, Units 1 and 2

Revised ERCW Technical Specification and Bases

A. Proposed Cleaned Technical Specifications (TS) 3.7.5 for both Units

3/4.7.4 ESSENTIAL RAW COOLING WATER SYSTEM

LIMITING CONDITION FOR OPERATION

3.7.4 At least two independent essential raw cooling water (ERCW) loops shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With only one ERCW loop OPERABLE, restore at least two loops to OPERABLE status within 72 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.7.4 At least two ERCW loops shall be demonstrated OPERABLE:

a. At least once per 31 days by verifying that each valve (manual, power operated or automatic) servicing safety related equipment that is not locked, sealed, or otherwise secured in position, is in its correct position.

b. At least once per 18 months, during shutdown, by:

   1. Verifying that each automatic valve servicing safety related equipment actuates to its correct position on a Safety Injection test signal.

   2. Verifying that each ERCW pump starts automatically on a Safety Injection test signal.

3/4.7.5 ULTIMATE HEAT SINK

LIMITING CONDITION FOR OPERATION

3.7.5 The ultimate heat sink shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

a. With only one ERCW pump OPERABLE on any ERCW loop, and any of the following conditions exist:

   1. ERCW loop is not aligned to support one pump per loop OPERABILITY, or
   2. The average ERCW supply header water temperature is > 79°F,

   immediately declare the associated ERCW loop inoperable and comply with the ACTION requirements of Specification 3.7.4.

b. With one ERCW supply strainer inoperable on one or more loops, and the average ERCW supply header water temperature is > 83°F, immediately declare the associated ERCW loop inoperable and comply with the ACTION requirements of Specification 3.7.4.

c. With the average ERCW supply header water temperature > 87°F or ultimate heat sink water level < 674 feet, be in at least HOT STANDBY within 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.7.5.1 The ultimate heat sink shall be determined OPERABLE at least once per 24 hours by verifying the UHS water level is ≥ 674 feet mean sea level USGS datum.

4.7.5.2 The ultimate heat sink shall be determined OPERABLE at least once per 24 hours, and at least once per hour when within 2°F of the applicable maximum limit, by verifying the average ERCW supply header water temperature is:

a) ≤ 79°F with any ERCW loop aligned to support one pump per loop OPERABILITY and only one ERCW pump OPERABLE on that loop, or

b) ≤ 83°F with one ERCW supply strainer and two ERCW pumps OPERABLE on that loop, or

c) ≤ 87°F with two ERCW supply strainers and two ERCW pumps OPERABLE per loop.

3/4.7.4 ESSENTIAL RAW COOLING WATER SYSTEM

LIMITING CONDITION FOR OPERATION

3.7.4 At least two independent essential raw cooling water (ERCW) loops shall be OPERABLE.

APPLICABILITY: Modes 1, 2, 3 and 4.

ACTION:

With only one ERCW loop OPERABLE, restore at least two loops to OPERABLE status within 72 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.7.4 At least two ERCW loops shall be demonstrated OPERABLE:

a. At least once per 31 days by verifying that each valve (manual, power operated or automatic) servicing safety related equipment that is not locked, sealed, or otherwise secured in position, is in its correct position.

b. At least once per 18 months, during shutdown, by:

    1. Verifying that each automatic valve servicing safety related equipment actuates to its correct position on a Safety Injection test signal.

    2. Verifying that each ERCW pump starts automatically on a Safety Injection test signal.

3/4.7.5 ULTIMATE HEAT SINK

LIMITING CONDITION FOR OPERATION

3.7.5 The ultimate heat sink shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

a. With only one ERCW pump OPERABLE on any ERCW loop, and any of the following conditions exist:

   1. ERCW loop is not aligned to support one pump per loop OPERABILITY, or
   2. The average ERCW supply header water temperature is > 79°F,

   immediately declare the associated ERCW loop inoperable and comply with the ACTION requirements of Specification 3.7.4.

b. With one ERCW supply strainer inoperable on one or more loops, and the average ERCW supply header water temperature is > 83°F, immediately declare the associated ERCW loop inoperable and comply with the ACTION requirements of Specification 3.7.4.

c. With the average ERCW supply header water temperature > 87°F or ultimate heat sink water level < 674 feet, be in at least HOT STANDBY within 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.7.5.1 The ultimate heat sink shall be determined OPERABLE at least once per 24 hours by verifying the UHS water level is ≥ 674 feet mean sea level USGS datum.

4.7.5.2 The ultimate heat sink shall be determined OPERABLE at least once per 24 hours, and at least once per hour when within 2°F of the applicable maximum limit, by verifying the average ERCW supply header water temperature is:

   a. ≤ 79°F with any ERCW loop aligned to support one pump per loop OPERABILITY and only one ERCW pump OPERABLE on that loop, or

   b. ≤ 83°F with only one ERCW supply strainer and two ERCW pumps OPERABLE on that loop, or

   c. ≤ 87°F with two ERCW supply strainers and two ERCW pumps OPERABLE per loop.

ENCLOSURE 2

Tennessee Valley Authority

Sequoyah Nuclear Plant, Units 1 and 2

Revised ERCW Technical Specification and Bases

B. Proposed Cleaned TS Bases 3.7.4 and 3.7.5 for both Units

3/4.7.3 COMPONENT COOLING WATER SYSTEM

The OPERABILITY of the component cooling water system ensures that sufficient cooling capacity is available for continued operation of safety related equipment during normal and accident conditions. The redundant cooling capacity of this system, assuming a single failure, is consistent with the assumptions used in the accident analyses.

3/4.7.4 ESSENTIAL RAW COOLING WATER SYSTEM

The OPERABILITY of the essential raw cooling water system ensures that sufficient cooling capacity is available for continued operation of safety related equipment during normal and accident conditions. The redundant cooling capacity of this system, assuming a single failure, is consistent with the assumptions used in the accident conditions within acceptable limits.

To meet the OPERABILITY requirements for ERCW loops, two ERCW loops are required to be OPERABLE to provide the required redundancy to ensure that the system functions as designed to remove post accident heat loads, assuming that the worst case single failure occurs coincident with the loss of offsite power. Different sources refer to an ERCW loop or an ERCW train; for ERCW, the term loop and train are interchangeable.

An ERCW loop is considered OPERABLE during MODES 1, 2, 3, and 4 when the associated piping, valves, heat exchanger, and instrumentation and controls required to perform the safety related function are OPERABLE and:

a. At least two ERCW pumps are OPERABLE per loop (with one pump fed from each shutdown board(SDB)) and two ERCW supply strainers are OPERABLE per loop, or

b. At least two ERCW pumps are OPERABLE per loop (with one pump fed from each SDB), one ERCW supply strainer is inoperable, and the ERCW system is aligned in accordance with Table B 3/4.7-2, or

c. Only one ERCW pump is OPERABLE per loop (fed from its associated SDB), two ERCW supply strainers are OPERABLE per loop, and the ERCW system is aligned in accordance with Table B 3/4.7-1.

An ERCW pump is OPERABLE when the following requirements are met:

1. Pump is fed from its respective 6.9kv SDB, and the pump is selected on the Blackout Start Selector Switches, and

2. Traveling screen and screen wash pump must be functional as the pump's attendant equipment.

3. All applicable surveillance requirements of 4.0.5 (Inservice Testing Program) and 4.7.4.b.2 are met.

B 3/4.7 Plant Systems

B 3/4.7.5 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 and shutdown. This is done by utilizing the Essential Raw Cooling Water (ERCW) System and the Component Cooling System (CCS). The UHS has been defined as that complex of water sources, including necessary retaining structures (e.g., a river with its dam), and the canals or conduits connecting the sources with, but not including, the cooling water system intake structures as discussed in the UFSAR, Section 9.2.5 (Ref. 1). The two principal functions of the UHS are the dissipation of residual heat after reactor shutdown, and dissipation of residual heat after an accident. Chickamauga Lake (Tennessee River system) qualifies as a single source. The basic performance requirements are that a 30-day supply of water be available, and that the design basis temperatures of safety-related equipment not be exceeded
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. SQN uses the UHS as the normal heat sink for condenser cooling via the Circulating Water System; so unit operation at full power is its maximum heat load. Its maximum post accident heat load occurs approximately 25 minutes after a design basis loss-of-coolant accident (LOCA). Near this time, the unit switches from injection to recirculation and the containment cooling systems and RHR are required to remove the core decay heat. The operating limits are based on conservative heat transfer analyses for the worst-case LOCA. References 1, 2, and 3 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 failure. The UHS is designed in accordance with Regulatory Guide 1.27 (Ref. 4), which requires a 30-day supply of cooling water in the UHS The UHS satisfies Criterion 3 of 10 CFR 50.36(c)(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 ERCW to operate for at least 30 days following the design basis LOCA without the loss of net positive suction

LCO (continued)

head (NPSH), and without exceeding the maximum design temperature of the equipment served by the ERCW. To meet this condition, the UHS temperature shall be ≤ 87°F and the level shall not fall below the 674 feet mean sea level during normal unit operation.

When the ERCW System is in the alignment to support an ERCW supply strainer inoperable, the UHS temperature shall be ≤ 83°F. The alignment to support the operation with one ERCW supply strainer inoperable, which maintains the ERCW System OPERABLE, is described in Table B 3/4.7-2.

When the ERCW System is in the alignment to support one pump per loop operation the UHS temperature shall be ≤ 79°F. The alignment to support the one pump per loop OPERABILITY configuration, which maintains the ERCW System OPERABLE, is described in Table B 3/4.7-1.

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.

APPLICABILITY

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

ACTIONS

The maximum allowed UHS temperature value is based on temperature limitations of the equipment that is relied upon for accident mitigation and safe shutdown of the unit and the configuration of the ERCW System. Measurement of this temperature is in accordance with NUREG/CR-3659 methodology which includes measurement uncertainties (Ref: 5).

With average water temperature of the UHS ≤ 87°F (when the ERCW System is aligned in its normal configuration) or ≤ 83°F (with one strainer inoperable per loop), or ≤ 79°F (to support one pump per loop operation), the associated design basis assumptions remain bounded for all accidents, transients, and shutdown. Long-term cooling capability is provided to the Emergency Core Cooling System (ECCS) and Emergency Diesel Generator loads.

ACTIONS (continued)

a.

Conditions specified in Table B 3/4.7-1 must be met while in single OPERABLE pump per loop configuration.

With the ERCW system aligned to support one OPERABLE pump per loop, and average ERCW supply header water temperature > 79°F, the ERCW heat removal capability for that loop is less than that assumed in the accident analysis and the associated ERCW loop must be immediately declared inoperable.

In Condition a, the OPERABLE ERCW loop is adequate to perform the heat removal function. However, the overall reliability is reduced because a single failure could result in a loss of the UHS function. Therefore, to ensure action is taken to restore the inoperable ERCW loop to an OPERABLE status, the affected ERCW loop is immediately declared inoperable and the applicable ACTION(S) of TS 3/4.7.4, "Essential Raw Cooling Water System," entered.

The accident analysis criteria are met when the average ERCW supply temperature is ≤ 79°F with only one ERCW loop aligned to support one pump per loop OPERABILITY. For this condition, one unit must be subcritical.

Following the emergency procedures will ensure that the accident unit's cooling requirements are met. However, if a LOCA occurs on the operating unit concurrently with the shutdown unit being in MODE 5 or 6, then it is possible that the heat removal capability of RHR cooling on the shutdown unit may be less than the core decay heat. This could result in the inability to maintain RCS temperature within Technical Specification limits for MODE 5 or 6. This situation can exist regardless of any failures, but may be worsened by the loss of other ERCW components or power supplies.

To prevent the described situation, the one ERCW pump per loop configuration is delayed until > 60 hours has passed since the outage unit became subcritical. This will ensure the decay heat removal capacity of the plant systems is greater than the decay heat rate of the outage unit. Reference 6 has examined the plant cooling systems capability, including the range of possible single failures that could occur while in a one-pump-per-loop alignment. The results indicate that the plant systems cannot maintain the outage unit in Mode 5 until approximately 53 hours has passed, when the worst case single failure is considered. For conservatism, the 53 hour time was raised to 60 hours. The conditions specified in Table B 3/4.7-1 must be met in order for the accident unit analysis assumptions to be met, and to ensure that the outage unit decay heat can be removed to prevent an inadvertent mode change.

ACTIONS (continued)

b.

Conditions specified in Table B 3/4.7-2 must be met while a supply strainer is out of service.

With the ERCW system aligned for an inoperable ERCW supply strainer, and the average ERCW supply header water temperature > 83°F, the ERCW heat removal capability for that loop is less than that assumed in the accident analysis and the associated ERCW loop must be immediately declared inoperable.

In Condition b, the remaining OPERABLE ERCW loop is adequate to perform the heat removal function. However, the overall reliability is reduced because a single failure could result in a loss of the UHS function. Therefore, to ensure action is taken to restore the inoperable ERCW loop to an OPERABLE status, the affected ERCW loop is immediately declared inoperable and the applicable Action(s) of TS 3/4 7.4, "Essential Raw Cooling Water System," entered.

c.

While in the normal ERCW configuration with two OPERABLE pumps and two strainers per loop, and in two loops configuration, if the water temperature of the UHS exceeds the normal configuration temperature limit (> 87°F) or the level is less than the limit (< 674 feet mean sea level USGS datum), 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 the following 30 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 4.7.5.1

This SR verifies that the ERCW is available to cool the CCS to at least its maximum accident design temperature with the maximum accident or normal design heat loads for 30 days following a Design Basis Accident.

This SR also verifies that adequate long-term (30 day) cooling can be maintained. The specified level ensures that sufficient reservoir volume exists at the initiation of a LBLOCA concurrent with loss of downstream dam to meet the short-term recovery. NPSH of the ERCW pumps is not challenged with a loss of downstream dam. This SR verifies that the UHS water level is ≥ 674 feet mean sea level United States Geological Survey (USGS) datum. The 24-hour Frequency is based on operating experience related to trending of the parameter variations during the applicable MODES.

SR 4.7.5.2

When the ERCW System is aligned in its normal two OPERABLE pumps and two strainers per loop, this SR verifies that the average water temperature of the UHS is ≤ 87°F.

When an ERCW loop is aligned in accordance with Table B 3/4.7-2 with one ERCW supply strainer is inoperable, this SR verifies that the average water temperature of the UHS is ≤ 83°F.

When an ERCW loop is aligned in accordance with Table B 3/4.7-1 and only one ERCW pump is OPERABLE per loop, this SR verifies that the average water temperature of the UHS is ≤ 79°F.

These actions verify that the ERCW is available to cool plant components following a Design Basis Accident when aligned in either the Table B 3/4.7-1 or Table B 3/4.7-2 alternate configuration.

The 24-hour temperature surveillance frequency is based on operating experience related to trending of the parameter variations during the applicable MODES when the water temperature is > 2°F from the applicable limit.

The at least once per hour temperature surveillance frequency (when the water temperature is ≤ 2°F from the applicable limit) is to ensure design basis assumptions are not exceeded when average ERCW water temperature may change quickly such that the 24 hour monitoring frequency would not identify exceeding the applicable temperature limit. The at least once per hour temperature surveillance may start at 77°F, 81°F, or 85°F, depending on ERCW configuration.

REFERENCES

1. UFSAR, Section 9.2.5, Ultimate Heat Sink

2. UFSAR, Section 6.2.1, Containment Functional Design

3. UFSAR, Section 9.2.2, Essential Raw Cooling Water (ERCW)

4. Regulatory Guide 1.27 R0, “Ultimate Heat Sink For Nuclear Power Plants,” 1972

5. NUREG/CR-3659, “A Mathematical Model For Assessing The Uncertainties Of Instrumentation Measurements For Power And Flow Of PWR Reactors,” February 1985.

6. Calculation MDQ 000999 2014 000134, UHS RAI calculation to support the shutdown unit being > 60 hour subcritical, for Condition ‘a’ decay heat; and the TVA to NRC RAI Question 1 response in letter CNL-14-103

Table B 3/4.7-1
MINIMUM REQUIREMENTS FOR ERCW
Prerequisite Actions to One Pump per Loop Operation

A-Loop One Pump Operation

1. ERCW System supply header average water temperature is ≤ 79°F, and reasonable assurance exists (based on historical river temperature and predicted weather conditions) that UHS temperature will remain ≤ 79°F for the duration that one ERCW loop is aligned for a single OPERABLE pump.

2. Unit 2 is subcritical for > 60 hours and in MODE 5 or 6, or core empty.

3. If either unit is in MODES 1, 2, 3, or 4, then only one ERCW loop can be aligned with one OPERABLE pump.

4. Ensure B-train ERCW has two OPERABLE pumps. Three 6.9kv SDBs, three EDGs, and three ERCW pumps are OPERABLE and protected for defense in depth when aligned for one pump per ERCW loop operation, while either unit is in modes 1, 2, 3, or 4.

5. Place the ERCW System in the alignment to support A-Loop one pump operation as follows:
   a. Isolate ERCW Flow to the following components;
      1) 2A-A EDG Heat Exchangers; the EDG is inoperable
      2) Unit 2 Containment Spray Heat Exchanger 2A
      3) Unit 2 TDAFW Pump from the "2A" ERCW Main Supply Header
      4) Unit 2 Lower Containment Vent Cooler 2A, Control Rod Drive Vent Cooler 2A, and Reactor Coolant Pump 2-1 Motor Cooler
      5) Unit 2 Lower Containment Vent Cooler 2C, Control Rod Drive Vent Cooler 2C, and Reactor Coolant Pump 2-3 Motor Cooler
      6) Unit 2 Upper Containment Vent Cooler 2A
      7) Unit 2 Upper Containment Vent Cooler 2C
      8) Unit 2 Incore Instrumentation Room Water Cooler 2A.
   b. Place in service;
      1) A-Loop ERCW yard header crosstie
      2) A-Loop ERCW 16-inch Auxiliary Building header crosstie
      3) A-Loop ERCW 6-inch Engineered Safety Features (ESF) header crosstie.

Table B 3/4.7-1 (continued)
MINIMUM REQUIREMENTS FOR ERCW
Prerequisite Actions to One Pump per Loop Operation

B-Loop One Pump Operation

1. ERCW System supply header average water temperature is ≤ 79°F, and reasonable assurance exists (based on historical river temperature and predicted weather conditions) that UHS temperature will remain ≤ 79°F for the duration that one ERCW loop is aligned for a single OPERABLE pump.

2. Unit 2 is subcritical for > 60 hours and in MODE 5, MODE 6, or core empty.

3. If either unit is in modes 1, 2, 3, or 4, then only one ERCW loop can be aligned with one OPERABLE pump.

4. Ensure A-train ERCW has two OPERABLE pumps. Three 6.9kv SDBs, three EDGs, and three ERCW pumps are OPERABLE and protected for defense in depth when aligned for one pump per ERCW loop operation, while either unit is in modes 1, 2, 3, or 4

5. Place the ERCW System in the alignment to support B-Loop one pump operation as follows:
   a. Isolate ERCW flow to the following components;
      1) 2B-B EDG Heat Exchangers; the EDG is inoperable
      2) Unit 2 Containment Spray Heat Exchanger 2B
      3) Unit 2 TDAFW Pump from the "2B" ERCW Main Supply Header
      4) Unit 2 Lower Containment Ventilation Cooler 2B, Control Rod Drive Vent Cooler 2B, and Reactor Coolant Pump 2-2 Motor Cooler
      5) Unit 2 Lower Containment Ventilation Coolers 2D, Control Rod Drive Vent Cooler 2D, and Reactor Coolant Pump 2-4 Motor Cooler
      6) Unit 2 Upper Containment Ventilation Coolers 2B
      7) Unit 2 Upper Containment Ventilation Coolers 2D
      8) Unit 2 Incore Instrumentation Room Water Coolers 2B
      9) Unit One Control Rod Drive Vent Cooler 1B
   b. Place in service;
      1) B-Loop ERCW yard header crosstie
      2) B-Loop ERCW 16-inch Auxiliary Building header crosstie
      3) B-Loop ERCW 6-inch Engineered Safety Features (ESF) header crossties.

TABLE B 3/4.7-2
MINIMUM REQUIREMENTS FOR ERCW
One ERCW Supply Strainer Inoperable

FEATURE	**Condition**
Average ERCW System supply header water temperature is ≤ 83°F, and reasonable assurance exists (based on historical river temperature and predicted weather conditions) that UHS temperature will remain ≤ 83°F for the duration that one supply strainer is out of service.	≤ 83°F
Two OPERABLE ERCW pumps in the loop with the supply strainer out of service	Two OPERABLE pumps in the ERCW loop with the inoperable strainer
Only one ERCW supply strainer can be out of service at a time in a loop	At least one strainer OPERABLE in each loop
ERCW Yard header crosstie (associated loop)	In service

3/4.7.3 COMPONENT COOLING WATER SYSTEM

The OPERABILITY of the component cooling water system ensures that sufficient cooling capacity is available for continued operation of safety related equipment during normal and accident conditions. The redundant cooling capacity of this system, assuming a single failure, is consistent with the assumptions used in the accident analyses.

3/4.7.4 ESSENTIAL RAW COOLING WATER SYSTEM

The OPERABILITY of the essential raw cooling water system ensures that sufficient cooling capacity is available for continued operation of safety related equipment during normal and accident conditions. The redundant cooling capacity of this system, assuming a single failure, is consistent with the assumptions used in the accident conditions within acceptable limits.

To meet the OPERABILITY requirements for ERCW loops, two ERCW loops are required to be OPERABLE to provide the required redundancy to ensure that the system functions as designed to remove post accident heat loads, assuming that the worst case single failure occurs coincident with the loss of offsite power. Different sources refer to an ERCW loop or an ERCW train; for ERCW, the term loop and train are interchangeable.

An ERCW loop is considered OPERABLE during MODES 1, 2, 3, and 4 when the associated piping, valves, heat exchanger, and instrumentation and controls required to perform the safety related function are OPERABLE and:

a. At least two ERCW pumps are OPERABLE per loop (with one pump fed from each shutdown board(SDB)) and two ERCW supply strainers are OPERABLE per loop, or

b. At least two ERCW pumps are OPERABLE per loop (with one pump fed from each SDB), one ERCW supply strainer inoperable, and the ERCW system is aligned in accordance with Table B 3/4.7-2, or

c. Only one ERCW pump is OPERABLE per loop (fed from its associated SDB), two ERCW supply strainers are OPERABLE per loop, and the ERCW system is aligned in accordance with Table B 3/4.7-1.

An ERCW pump is OPERABLE when the following requirements are met:

1. Pump is fed from its respective 6.9kv SDB, and the pump is selected on the Blackout Start Selector Switches, and

2. Traveling screen and screen wash pump must be functional as the pump's attendant equipment.

3. All applicable surveillance requirements of 4.0.5 (Inservice Testing Program) and 4.7.4.b.2 are met.

B 3/4.7 Plant Systems

B 3/4.7.5 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 and shutdown. This is done by utilizing the Essential Raw Cooling Water (ERCW) System and the Component Cooling System (CCS). The UHS has been defined as that complex of water sources, including necessary retaining structures (e.g., a river with its dam), and the canals or conduits connecting the sources with, but not including, the cooling water system intake structures as discussed in the UFSAR, Section 9.2.5 (Ref. 1). The two principal functions of the UHS are the dissipation of residual heat after reactor shutdown, and dissipation of residual heat after an accident. Chickamauga Lake (Tennessee River system) qualifies as a single source. The basic performance requirements are that a 30-day supply of water be available, and that the design basis temperatures of safety-related equipment not be exceeded
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. SQN uses the UHS as the normal heat sink for condenser cooling via the Circulating Water System; so unit operation at full power is its maximum heat load. Its maximum post accident heat load occurs approximately 25 minutes after a design basis loss-of-coolant accident (LOCA). Near this time, the unit switches from injection to recirculation and the containment cooling systems and RHR are required to remove the core decay heat. The operating limits are based on conservative heat transfer analyses for the worst-case LOCA. References 1, 2, and 3 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 failure. The UHS is designed in accordance with Regulatory Guide 1.27 (Ref. 4), which requires a 30-day supply of cooling water in the UHS The UHS satisfies Criterion 3 of 10 CFR 50.36(c)(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 ERCW to operate for at least 30 days following the design basis LOCA without the loss of net positive suction

LCO (continued)

head (NPSH), and without exceeding the maximum design temperature of the equipment served by the ERCW. To meet this condition, the UHS temperature shall be ≤ 87°F and the level shall not fall below the 674 feet mean sea level during normal unit operation.

When the ERCW System is in the alignment to support an ERCW supply strainer inoperable, the UHS temperature shall be ≤ 83°F. The alignment to support the operation with one ERCW supply strainer inoperable, which maintains the ERCW System OPERABLE, is described in Table B 3/4.7-2.

When the ERCW System is in the alignment to support one pump per loop operation the UHS temperature shall be ≤ 79°F. The alignment to support the one pump per loop OPERABILITY configuration, which maintains the ERCW System OPERABLE, is described in Table B 3/4.7-1.

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.

APPLICABILITY

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

ACTIONS

The maximum allowed UHS temperature value is based on temperature limitations of the equipment that is relied upon for accident mitigation and safe shutdown of the unit and the configuration of the ERCW System. Measurement of this temperature is in accordance with NUREG/CR-3659 methodology which includes measurement uncertainties (Ref: 5).

With average water temperature of the UHS ≤ 87°F, (when the ERCW System is aligned in its normal configuration) or ≤ 83°F (with one strainer inoperable per loop), or ≤ 79°F (to support one pump per loop operation), the associated design basis assumptions remain bounded for all accidents, transients, and shutdown. Long-term cooling capability is provided to the Emergency Core Cooling System (ECCS) and Emergency Diesel Generator loads.

BASES

ACTIONS (continued)

a.

Conditions specified in Table B 3/4.7-1 must be met while in single OPERABLE pump per loop configuration.

With the ERCW system aligned to support one OPERABLE pump per loop, and the average ERCW supply header water temperature > 79°F, the ERCW heat removal capability for that loop is less than that assumed in the accident analysis and the associated ERCW loop must be immediately declared inoperable.

In Condition a, the OPERABLE ERCW loop is adequate to perform the heat removal function. However, the overall reliability is reduced because a single failure could result in a loss of the UHS function. Therefore, to ensure action is taken to restore the inoperable ERCW loop to an OPERABLE status, the affected ERCW loop is immediately declared inoperable and applicable ACTION(S) of TS 3/4.7.4, "Essential Raw Cooling Water System," entered.

The accident analysis criteria are met when the average ERCW supply temperature is ≤ 79°F with only one ERCW loop aligned to support one pump per loop OPERABILITY. For this condition, one unit must be subcritical.

Following the emergency procedures will ensure that the accident unit's cooling requirements are met. However, if a LOCA occurs on the operating unit concurrently with the shutdown unit being in MODE 5 or 6, then it is possible that the heat removal capability of RHR cooling on the shutdown unit may be less than the core decay heat. This could result in the inability to maintain RCS temperature within Technical Specification limits for MODE 5 or 6. This situation can exist regardless of any failures, but may be worsened by the loss of other ERCW components or power supplies.

To prevent the described situation, the one ERCW pump per loop configuration is delayed until > 60 hours has passed since the outage unit became subcritical. This will ensure the decay heat removal capacity of the plant systems is greater than the decay heat rate of the outage unit. Reference 6 has examined the plant cooling systems capability, including the range of possible single failures that could occur while in a one-pump-per-loop alignment. The results indicate that the plant systems cannot maintain the outage unit in Mode 5 until approximately 53 hours has passed, when the worst case single failure is considered. For conservatism, the 53 hour time was raised to 60 hours. The conditions specified in Table B 3/4.7-1 must be met in order for the accident unit analysis assumptions to be met, and to ensure that the outage unit decay heat can be removed to prevent an inadvertent mode change.

ACTIONS (continued)

b.

Conditions specified in Table B 3/4.7-2 must be met while a supply strainer is out of service.

With the ERCW system aligned for an inoperable ERCW supply strainer and the average ERCW supply header water temperature > 83°F, the ERCW heat removal capability for that loop is less than that assumed in the accident analysis and the associated ERCW loop must be immediately declared inoperable.

In Condition b, the remaining OPERABLE ERCW loop is adequate to perform the heat removal function. However, the overall reliability is reduced because a single failure could result in a loss of the UHS function. Therefore, to ensure action is taken to restore the inoperable ERCW loop to an OPERABLE status, the affected ERCW loop is immediately declared inoperable and applicable ACTION(S) of TS 3/4.7.4, "Essential Raw Cooling Water System," entered.

c.

While in the normal ERCW configuration with two OPERABLE pumps and two strainers per loop, and in two loops configuration, if the water temperature of the UHS exceeds normal configuration temperature limit (> 87°F) or the level is less than the limit (< 674 feet mean sea level USGS datum), 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 the following 30 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.
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 4.7.5.1

This SR verifies that the ERCW is available to cool the CCS to at least its maximum accident design temperature with the maximum accident or normal design heat loads for 30 days following a Design Basis Accident.

This SR also verifies that adequate long-term (30 day) cooling can be maintained. The specified level ensures that sufficient reservoir volume exists at the initiation of a LBLOCA concurrent with loss of downstream dam to meet the short-term recovery. NPSH of the ERCW pumps is not challenged with a loss of downstream dam. This SR verifies that the UHS water level is ≥ 674 feet mean sea level United States Geological Survey (USGS) datum. The 24-hour Frequency is based on operating experience related to trending of the parameter variations during the applicable MODES.

SR 4.7.5.2

When the ERCW System is aligned in its normal two OPERABLE pumps and two strainers per loop, this SR verifies that the average water temperature of the UHS is ≤ 87°F.

When an ERCW loop is aligned in accordance with Table B 3/4.7-2 with one ERCW supply strainer is inoperable, this SR verifies that the average water temperature of the UHS is ≤ 83°F.

When an ERCW loop is aligned in accordance with Table B 3/4.7-1 and only one ERCW pump is OPERABLE per loop, this SR verifies that the average water temperature of the UHS is ≤ 79°F.

These actions verify that the ERCW is available to cool plant components following a Design Basis Accident when aligned in either Table B 3/4.7-1 or Table B 3/4.7-2 alternate configuration.

The 24-hour temperature surveillance frequency is based on operating experience related to trending of the parameter variations during the applicable MODES when the water temperature is > 2°F from the applicable limit.

The at least once per hour temperature surveillance frequency (when the water temperature is ≤ 2°F from the applicable limit) is to ensure design basis assumptions are not exceeded when average ERCW water temperature may change quickly such that the 24 hour monitoring frequency would not identify exceeding the applicable temperature limit. The at least once per hour temperature surveillance may start at 77°F, 81°F, or 85°F, depending on ERCW configuration.

REFERENCES

1. UFSAR, Section 9.2.5, Ultimate Heat Sink

2. UFSAR, Section 6.2.1, Containment Functional Design

3. UFSAR, Section 9.2.2, Essential Raw Cooling Water (ERCW)

4. Regulatory Guide 1.27 R0, "Ultimate Heat Sink For Nuclear Power Plants," 1972

5. NUREG/CR-3659, "A Mathematical Model For Assessing The Uncertainties Of Instrumentation Measurements For Power And Flow Of PWR Reactors," February 1985.

6. Calculation MDQ 000999 2014 000134, UHS RAI calculation to support the shutdown unit being > 60 hour subcritical, for Condition 'a' decay heat; and the TVA to NRC RAI Question 1 response in letter CNL-14-103

Table B 3/4.7-1
MINIMUM REQUIREMENTS FOR ERCW
Prerequisite Actions to One Pump per Loop Operation

A-Loop One Pump Operation

1. ERCW System supply header average water temperature is ≤ 79°F, and reasonable assurance exists (based on historical river temperature and predicted weather conditions) that UHS temperature will remain ≤ 79°F for the duration that one ERCW loop is aligned for a single OPERABLE pump.

2. Unit 1 is subcritical for > 60 hours and in MODE 5, MODE 6, or core empty.

3. If either unit is in MODES 1, 2, 3, or 4, then only one ERCW loop can be aligned with one OPERABLE pump.

4. Ensure B-train ERCW has two OPERABLE pumps. Three 6.9kv SDBs, three EDGs, and three ERCW pumps are OPERABLE and protected for defense in depth when aligned for one pump per ERCW loop operation, while either unit is in modes 1, 2, 3, or 4.

5. Place the ERCW System in the alignment to support A-Loop one pump operation as follows:

    a. Isolate ERCW flow to the following components;
        1) 1A-A EDG Heat Exchangers; the EDG is inoperable
        2) Unit 1 Containment Spray Heat Exchanger 1A
        3) Unit 1 TDAFW Pump from the "1A" ERCW Main Supply Header
        4) Unit 1 Lower Containment Ventilation Coolers 1A, Control Rod Drive Vent Cooler 1A, and Unit 1 Reactor Coolant Pump 1-1 Motor Cooler
        5) Unit 1 Lower Containment Ventilation Coolers 1C, Control Rod Drive Vent Cooler 1C and Unit 1 Reactor Coolant Pump 1-3 Motor Cooler
        6) Unit 1 Incore Instrumentation Room Water Coolers 1A

    b. Place in service;
        1) A-Loop ERCW yard header crosstie
        2) A-Loop ERCW 16-inch Auxiliary Building header crosstie
        3) A-Loop ERCW 6-inch Engineered Safety Features (ESF) header crosstie

Table B 3/4.7-1 (continued)
MINIMUM REQUIREMENTS FOR ERCW
Prerequisite Actions to One Pump per Loop Operation

B-Loop One Pump Operation

1. ERCW System supply header average water temperature is ≤ 79°F, and reasonable assurance exists (based on historical river temperature and predicted weather conditions) that UHS temperature will remain ≤ 79°F for the duration that one ERCW loop is aligned for a single OPERABLE pump.

2. Unit 1 is subcritical for > 60 hours and in MODE 5, MODE 6, or core empty.

3. If either unit is in modes 1, 2, 3, or 4, then only one ERCW loop can be aligned with one OPERABLE pump.

4. Ensure A-train ERCW has two OPERABLE pumps. Three 6.9kv SDBs, three EDGs, and three ERCW pumps are OPERABLE and protected for defense in depth when aligned for one pump per ERCW loop operation, while either unit is in modes 1, 2, 3, or 4.

5. Place the ERCW System in the alignment to support B-Loop one pump operation as follows:

   a. Isolate ERCW flow to the following components;
      1) 1B-B EDG Heat Exchangers; the EDG is inoperable
      2) Unit 1 Containment Spray Heat Exchanger 1B
      3) Unit 1 TDAFW Pump from the "1B" ERCW Main Supply Header
      4) Unit 1 Lower Containment Ventilation Coolers 1B, Control Rod Drive Vent Cooler 1B, and Unit 1 Reactor Coolant Pump 1-2 Motor Cooler
      5) Unit 1 Lower Containment Ventilation Coolers 1D, Control Rod Drive Vent Cooler 1D, and Unit 1 Reactor Coolant Pump 1-4 Motor Cooler
      6) Unit 1 Incore Instrumentation Room Water Coolers 1B

   b. Place in service;
      1) B-Loop ERCW yard header crosstie
      2) B-Loop ERCW 16-inch Auxiliary Building header crosstie
      3) B-Loop ERCW 6-inch Engineered Safety Features (ESF) header crosstie

TABLE B 3/4.7-2
MINIMUM REQUIREMENTS FOR ERCW
One ERCW Supply Strainer Inoperable

FEATURE	Condition
Average ERCW System supply header water temperature is ≤ 83°F, and reasonable assurance exists (based on historical river temperature and predicted weather conditions) that UHS temperature will remain ≤ 83°F for the duration that one supply strainer is out of service.	≤ 83°F
Two OPERABLE ERCW pumps in the loop with the supply strainer out of service	Two OPERABLE pumps in the ERCW loop with the inoperable strainer
Only one ERCW supply strainer can be out of service at a time in a loop	At least one strainer OPERABLE in each loop
ERCW Yard header crosstie (associated loop)	In service

ENCLOSURE 2

Tennessee Valley Authority

Sequoyah Nuclear Plant, Units 1 and 2

Revised ERCW Technical Specification and Bases

C. Revised Tables 4.2-6, 4.2-12, 4.2-13 and 4.2-14

Table 4.2-6
One Pump per Loop ERCW Operation Case Description

Case Number[a]	Crosstie Operation	Plant Condition	Component Alignment
Outage 1a	Yard Header Crossties, 6" ESF Header Crossties and 16" Aux Bldg Header Crossties are all open.	U1 LOCA, Unit 2 outage	The 2A EDG is shutdown. U2 CS HX, U2 UCCs, U2 TDAFWP, U2 IIRC, U2 LCC groups are isolated.
Outage 1b	Yard Header Crossties, 6" ESF Header Crossties and 16" Aux Bldg Header Crossties are all open.	U1 LOCA, Unit 2 outage	The 2B EDG is shutdown. U2 CS HX, U2 UCCs, U2 TDAFWP, U2 IIRC, U2 LCC groups are isolated.
Outage 2a	Yard Header Crossties, 6" ESF Header Crossties and 16" Aux Bldg Header Crossties are all open.	U1 MSLB, Unit 2 outage	The 2A EDG is shutdown. U2 CS HX, U2 UCCs, U2 TDAFWP, U2 IIRC, U2 LCC groups are isolated. This analysis is the same as Outage 1, except what is being examined is the ability of the LCCs to receive 200 gpm. The U1 CSS HXs are isolated, 1-Flow Control Valve (FCV)-67-146 is in the 35% position.[b] The 1B CRD cooler is required to be isolated in order to have sufficient flow to the 1B LCC.[c]
Outage 2b	Yard Header Crossties, 6" ESF Header Crossties and 16" Aux Bldg Header Crossties are all open.	U1 MSLB, Unit 2 outage	The 2B EDG is shutdown. U2 CS HX, U2 UCCs, U2 TDAFWP, U2 IIRC, U2 LCC groups are isolated. This analysis is the same as Outage 1, except what is being examined is the ability of the LCCs to receive 200 gpm. The U1 CSS HXs are isolated, 1-Flow Control Valve (FCV)-67-146 is in the 35% position.[b] The 1B CRD cooler is required to be isolated in order to have sufficient flow to the 1B LCC.[c]

(a) Case Number refers to a specific plant condition (e.g., Outage 1) as described in the "Crosstie Operation", "Plant Condition", and "Component Alignment" columns.
(b) Isolating the operating unit's CSS HX and placing valve FCV-67-146 in the 35% position are actions that may be necessary in the post-recirculation phase as discussed in Section 4.2.4, Equipment Qualification Issue.
(c) To ensure 1B CRD cooler is isolated, it is included in the prerequisite line up for one-pump operation.

Table 4.2-6 One Pump per Loop ERCW Operation Case Description			
Case Number[a]	**Crosstie Operation**	**Plant Condition**	**Component Alignment**
Outage 3a	Yard Header Crossties, 6" ESF Header Crossties and 16" Aux Bldg Header Crossties are all open.	U2 LOCA, Unit 1 outage	The 1A EDG is shutdown. U1 CS HX, U1 TDAFWP, U1 IIRC, U1 LCCs are isolated.
Outage 3b	Yard Header Crossties, 6" ESF Header Crossties and 16" Aux Bldg Header Crossties are all open.	U2 LOCA, Unit 1 outage	The 1B EDG is shutdown. U1 CS HX, U1 TDAFWP, U1 IIRC, U1 LCCs are isolated.
Outage 4a	Yard Header Crossties, 6" ESF Header Crossties and 16" Aux Bldg Header Crossties are all open.	U2 MSLB, Unit 1 outage	The 1A EDG is shutdown. U1 CS HX, U1 TDAFWP, U1 IIRC, U1 LCC groups are isolated. This analysis is the same as Outage 3, except what is being examined is the ability of the LCCs to receive 200 gpm. The U2 CSS HXs are isolated, 2-FCV-67-146 is in the 35% position[b].
Outage 4b	Yard Header Crossties, 6" ESF Header Crossties and 16" Aux Bldg Header Crossties are all open.	U2 MSLB, Unit 1 outage	The 1B EDG is shutdown. U1 CS HX, U1 TDAFWP, U1 IIRC, U1 LCC groups are isolated. This analysis is the same as Outage 3, except what is being examined is the ability of the LCCs to receive 200 gpm. The U2 CSS HXs are isolated, 2-FCV-67-146 is in the 35% position[b].

[a] Case Number refers to a specific plant condition (e.g., Outage 1) as described in the "Crosstie Operation", "Plant Condition", and "Component Alignment" columns.

[b] Isolating the operating unit's CSS HX and placing valve FCV-67-146 in the 35% position are actions that may be necessary in the post-recirculation phase as discussed in Section 4.2.4, Equipment Qualification Issue.

Table 4.2-12
Train A One Pump Outages 1 and 3

A-Train ERCW components	Required Flow (gpm)	Outage 1a			Outage 3a		
		Multiflow Results (gpm)	minus 5% (gpm)	Temp Limit(*) (°F)	Multiflow Results (gpm)	minus 5% (gpm)	Temp Limit(*) (°F)
EDG 1A1	522.0	481.1	457.0	82.8	0.0	0.0	---
EDG 1A2	522.0	473.8	450.1	82.3	0.0	0.0	---
EDG 2A1	522.0	0.0	0.0	---	460.7	437.7	81.4
EDG 2A2	522.0	0.0	0.0	---	435.6	413.8	79.5
ELECT BD RM CHR A	163.9	153.3	145.6	85.1	145.9	138.6	84.4
MCR CHILLER A	95.4	108.8	103.4	---	103.5	98.3	---
SHUTDOWN BD RM CHR A	380.0	361.9	343.8	84.9	347.2	329.8	84.1
CCP PMP OIL CLR 1A	23.0	24.7	23.5	---	23.5	22.3	86.1
CCP Gear OIL CLR 1A	12.0	14.0	13.3	---	13.3	12.6	---
CCP RM CLR 1A	34.0	35.1	33.3	86.6	33.5	31.8	86.1
CCP PMP OIL CLR 2A	23.0	27.1	25.7	---	25.2	23.9	---
CCP Gear OIL CLR 2A	12.0	15.0	14.3	---	13.9	13.2	---
CCP RM CLR 2A	34.0	39.5	37.5	---	36.7	34.9	---
SIS PMP RM CLR 1A	18.0	26.7	25.4	---	25.2	23.9	---
SIS OIL CLR 1A	4.1	7.9	7.5	---	7.5	7.1	---
SIS PMP RM CLR 2A	18.0	25.6	24.3	---	23.9	22.7	---
SIS OIL CLR 2A	4.1	9.7	9.2	---	9.1	8.6	---
EGTS 2A	9.0	11.1	10.5	---	10.2	9.7	---
AUX CONT AIR A	5.1	4.7	4.5	84.9	4.5	4.3	84.2
SFP & TBBP CLR 1A	28.0	29.2	27.7	86.8	27.9	26.5	86.3
CCS & AFW CLR 1A	55.0	84.0	79.8	---	79.9	75.9	---
BAT & AFW CLR 2A	62.0	57.4	54.5	85.7	53.1	50.4	85.2
714 PEN RM CLR 1A	19.0	23.9	22.7	---	22.6	21.5	---
714 PEN RM CLR 2A	19.0	23.9	22.7	---	22.4	21.3	---
690 PEN RM CLR 1A	12.0	23.7	22.5	---	22.4	21.3	---
690 PEN RM CLR 2A	12.0	22.7	21.6	---	21.3	20.2	---
669 PEN RM CLR 1A	17.0	39.5	37.5	---	37.3	35.4	---
669 PEN RM CLR 2A	17.0	46.0	43.7	---	43.0	40.9	---
PIPE CHASE CLR 1A	29.0	47.4	45.0	---	44.8	42.6	---
PIPE CHASE CLR 2A	29.0	37.8	35.9	---	35.4	33.6	---
CNT SPRAY PMP RM CLR 1A	10.0	19.8	18.8	---	18.7	17.8	---
CNT SPRAY PMP RM CLR 2A	10.0	27.7	26.3	---	25.9	24.6	---
RHR PMP RM CLR 1A	15.0	13.6	12.9	85.6	12.8	12.2	85.2
RHR PMP RM CLR 2A	15.0	17.5	16.6	---	16.3	15.5	---

(*) Only temperatures less than the TS UHS maximum temperature limit of 87°F are indicated.

Table 4.2-12 (continued)
Train A One Pump Outages 1 and 3

A-Train ERCW components	Required Flow (gpm)	Outage 1a			Outage 3a		
		Multiflow Results (gpm)	minus 5% (gpm)	Temp Limit(*) (°F)	Multiflow Results (gpm)	minus 5% (gpm)	Temp Limit(*) (°F)
CCS HX 1A1/1A2	3605.0	3243.1	3080.9	81.7	1504.4	1429.2	---
CCS HX 2A1/2A2	1348.0	1269.7	1206.2	82.0	3366.2	3197.9	82.5
CSS HX 1A	3400.0	3205.8	3045.5	82.6	0.0	0.0	---
CSS HX 2A	3400.0	0.0	0.0	---	3202.2	3042.1	82.5
MINIMUM TEMPERATURE:				81.7			79.5

(∗) Only temperatures less than the TS UHS maximum temperature limit of 87°F are indicated.

Table 4.2-13
Train B One Pump Outages 1 and 3

B-Train ERCW components	Required Flow (gpm)	Outage 1b			Outage 3b		
		Multiflow Results (gpm)	minus 5% (gpm)	Temp Limit(*) (°F)	Multiflow Results (gpm)	minus 5% (gpm)	Temp Limit(*) (°F)
EDG 1B1	522.0	539.1	512.1	86.0	0.0	0.0	---
EDG 1B2	522.0	503.5	478.3	84.2	0.0	0.0	---
EDG 2B1	522.0	0.0	0.0	---	501.7	476.6	84.1
EDG 2B2	522.0	0.0	0.0	---	515.1	489.3	84.8
ELECT BD RM CHR B	163.9	162.7	154.6	85.8	167.0	158.7	86.0
MCR CHILLER B	95.4	119.7	113.7	---	122.8	116.7	---
SHUTDOWN BD RM CHR B	380.0	349.8	332.3	84.2	349.0	331.6	84.2
CCP PMP OIL CLR 1B	23.0	19.5	18.5	84.7	20.0	19.0	84.9
CCP Gear OIL CLR 1B	12.0	10.7	10.2	84.5	11.0	10.5	84.7
CCP RM CLR 1B	34.0	29.2	27.7	85.3	30.0	28.5	85.4
CCP PMP OIL CLR 2B	23.0	27.0	25.7	---	27.0	25.7	---
CCP Gear OIL CLR 2B	12.0	14.3	13.6	---	14.4	13.7	---
CCP RM CLR 2B	34.0	37.3	35.4	---	37.4	35.5	---
SIS PMP RM CLR 1B	18.0	23.1	21.9	---	23.5	22.3	---
SIS OIL CLR 1B	4.1	9.0	8.6	---	9.2	8.7	---
SIS PMP RM CLR 2B	18.0	28.3	26.9	---	28.5	27.1	---
SIS OIL CLR 2B	4.1	9.7	9.2	---	9.7	9.2	---
EGTS 2B	9.0	11.6	11.0	---	11.6	11.0	---
AUX CONT AIR B	5.1	5.3	5.0	86.0	5.3	5.0	86.0
SFP & TBBP CLR 1B	28.0	27.4	26.0	86.2	28.2	26.8	86.4
CCS & AFW CLR 1B	55.0	77.5	73.6	---	79.6	75.6	---
BAT & AFW CLR 2B	62.0	57.0	54.2	85.6	57.2	54.3	85.7
714 PEN RM CLR 1B	19.0	24.7	23.5	---	25.2	23.9	---
714 PEN RM CLR 2B	19.0	25.9	24.6	---	26.1	24.8	---
690 PEN RM CLR 1B	12.0	23.9	22.7	---	24.4	23.2	---
690 PEN RM CLR 2B	12.0	24.4	23.2	---	24.5	23.3	---
669 PEN RM CLR 1B	17.0	29.3	27.8	---	29.8	28.3	---
669 PEN RM CLR 2B	17.0	46.8	44.5	---	47.1	44.7	---
PIPE CHASE CLR 1B	29.0	36.5	34.7	---	37.2	35.3	---
PIPE CHASE CLR 2B	29.0	38.4	36.5	---	38.7	36.8	---
CNT SPRAY PMP RM CLR 1B	10.0	21.4	20.3	---	21.8	20.7	---
CNT SPRAY PMP RM CLR 2B	10.0	29.7	28.2	---	29.9	28.4	---

(*) Only temperatures less than the TS UHS maximum temperature limit of 87°F are indicated.

Table 4.2-13 (continued)
Train B One Pump Outages 1 and 3

B-Train ERCW components	Required Flow (gpm)	Outage 1b			Outage 3b		
		Multiflow Results (gpm)	minus 5% (gpm)	Temp Limit(*) (°F)	Multiflow Results (gpm)	minus 5% (gpm)	Temp Limit(*) (°F)
RHR PMP RM CLR 1B	15.0	12.9	12.3	85.3	13.1	12.4	85.4
RHR PMP RM CLR 2B	15.0	15.5	14.7	86.7	15.6	14.8	86.8
CCS HX 0B1/0B2	3365.0	4338.3	4121.4	---	4395.7	4175.9	---
CSS HX 1B	3400.0	3210.7	3050.2	82.6	0.0	0.0	---
CSS HX 2B	3400.0	0.0	0.0	---	3182.4	3023.3	82.3
MINIMUM TEMPERATURE:				82.6			82.3

(∗) Only temperatures less than the TS UHS maximum temperature limit of 87°F are indicated.

Table 4.2-14a
LCC Available Flow Outages 2a and 4a

Lower Containment Vent Coolers	Required Flow (gpm)	Outage 2a			Outage 4a		
		Multiflow Results (gpm)	minus 5% (gpm)	Temp Limit(*) (°F)	Multiflow Results (gpm)	minus 5% (gpm)	Temp Limit(*) (°F)
1AA LCC	170.0	318.2	302.3	---	---	---	---
1CA LCC	170.0	288.2	273.8	---	---	---	---
2AA LCC	170.0	---	---	---	288.0	273.6	---
2CA LCC	170.0	---	---	---	247.8	235.4	---
MINIMUM TEMPERATURE:				---			---

(∗) Only temperatures less than the TS UHS maximum temperature limit of 87°F are indicated.

Table 4.2-14b
LCC Available Flow Outages 2b and 4b

Lower Containment Vent Coolers	Required Flow (gpm)	Outage 2b			Outage 4b		
		Multiflow Results (gpm)	minus 5% (gpm)	Temp Limit(*) (°F)	Multiflow Results (gpm)	minus 5% (gpm)	Temp Limit(*) (°F)
1BB LCC	170.0	225.0	213.8	---	---	---	---
1DB LCC	170.0	264.2	251.0	---	---	---	---
2BB LCC	170.0	---	---	---	242.1	230.0	---
2DB LCC	170.0	---	---	---	287.7	273.3	---
MINIMUM TEMPERATURE:				---			---

(∗) Only temperatures less than the TS UHS maximum temperature limit of 87°F are indicated.

ENCLOSURE 2

Tennessee Valley Authority

Sequoyah Nuclear Plant, Units 1 and 2

Revised ERCW Technical Specification and Bases

D. Wiegmann And Rose EDG Vendor Data

Wiegmann & Rose

A Subsidiary of Xchanger Manufacturing Corp.

P.O. Box 4187, Oakland, CA 94614-4187 9131 San Leandro St., Oakland, CA 94603

Phone: (510) 632-8828 Fax.: (510) 632-8920

Heat Exchanger Specification sheet

1					Job No. C4782	
2	Customer	TVA - SEQUOYAH NUCLEAR PLANT			Ref No. KG300B	
3	Address	SEQUOYAH ACCESS RD, SODDY DAISY, TN. 37379			Proposa	
4	Plant Location				Date 10/29/2007	
5	Service of Unit	ENGINE JACKET WATER COOLER			Item No E-101	Rev. 1
6	Size	1607	Type NEN - HORZ	Connected in	1 Parallel	1 Series
7	Surf/Unit (Eff)	334 ft^2	Shells/Unit 1	Surface/Shell (Effective)	334 ft^2	
8	PERFORMANCE OF ONE UNIT					
9	Fluid Allocation		**Shellside**		**Tubeside**	
10	Fluid Name		JACKET WATER		SERVICE WATER	
11	Total Fluid Entering	lb/h	850 GPM		554 GPM	
12	Vapor	lb/h				
13	Liquid	lb/h	850 GPM		554 GPM	
14	Steam					
15	Noncondensable					
16	Fluid Vaporized or Condensed	lb/h				
17	Liquid Density (In/Out)	lb/ft^3	59.885 / 60.237		62.306 / 61.784	
18	Liquid Viscosity	cP	0.360		0.692	
19	Liquid Specific Heat	Btu/lb.F	1.025		1.021	
20	Liquid Thermal Conductivity	Btu/h.ft.F	0.377		0.363	
21	Vapor Mol. Weight (In/Out)		0.0 / 0.0		0.0 / 0.0	
22	Vapor Viscosity	cP	0.0000		0.0000	
23	Vapor Specific Heat	Btu/lb.F	0.000		0.000	
24	Vapor Thermal Conductivity	Btu/h.ft.F	0.000		0.000	
25	Temperature (In/Out)	°F	190.0 / 175.0		87.0 / 109.2	
26	Operating Pressure	psi (Abs)	60.00		100.000	
27	Velocity	ft/s	2.362		4.880	
28	Pressure Drop (Allow/Calc)	psi	5.000 / 2.916		10.000 / 2.475	
29	Fouling resistance	$h.ft^2.F/Btu$	0.000500		0.002000	
30	Heat Exchanged	6,270,000.00 Btu/h		MTD (corr)	83.686 °F	
31	Transfer Rate, Service	221.7 $Btu/h.ft^2.F$		Clean	568.7 $Btu/h.ft^2.F$	
32	CONSTRUCTION OF ONE SHELL					
33			**Shellside**	**Tubeside**	Sketch	
34	Design/Test Pres.	psi	75 /	150 /		
35	Design Temp.	°F	200.0	200.0		
36	No. Passes per Shell		1	2		
37	Corrosion Allow.	in	0.0625	0.0625		
38	Connections	In	6" - 150# RFSO	6" - 150# RFSO		
39	Size &	Out	6" - 150# RFSO	6" - 150# RFSO		
40	Rating	Intermediate				
41						
42	Tube No	302	OD 0.625 in	Thk 0.035	Length 7.00 ft	Pitch 0.78125 in/ 60 deg.
43	Tube Type	PLAIN		Material	SA 249-T304L	
44	Shell	SA 53 GR B	16" OD	Shell Cover		
45	Channel or Bonnet		SA 53 GR B	Channel Cover	SA 36	
46	Tubesheet-Stationary		SA 285 GR C	Tubesheet-Floating		
47	Floating Head Cover			Impingement Protection	NO	
48	Baffles Cross	SA 36	Type VERTICAL	%Cut (Area)	Spacing-cc	8"
49	Baffles-Long			Seal Type		
50	Supports-Tube		U-Bend		Type	
51	Bypass Seal Arrangement			Tube-Tubesheet Joint		
52	Expansion Joint			Type		
53	Rho-V2 Inlet Nozzle	5,559	Bundle Entrance	9,159	Bundle Exit	9,106
54	Gasket-Shellside		Tubeside	1/16" ASB	Floating Head	
55	Code Requirement	ASME Section 8, Divsion 1			TEMA Class	
56	Weight/Shell	1800#	Filled with Water		Bundle	
57	Remarks:	Per Drawing B6209				
58		Shellside Coefficient = 1801				
59		Tubeside Coefficient = 1309				
60		Overall Fouling Factor = 0.00275				