HOPE CREEK GENERATING STATION
FACILITY OPERATING LICENSE NPF-57
DOCKET NO. 50-354
SUPPLEMENT TO REQUEST FOR LICENSE AMENDMENT
ULTIMATE HEAT SINK

Calculation No. EG-0047, Rev. 3
HCGS Ultimate Heat Sink Temperature Limits

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CALCULATION NUMBER: EG-0047		**REVISION:** 3
TITLE: HCGS Ultimate Heat Sink Temperature Limits		
#SHTS (CALC): 31 **#ATT/#SHTS:** 8 / 59	**#IDV/50.59 SHTS:** 2 / 8	**#TOTAL SHTS:** 100

CHECK ONE:

☒ FINAL ☐ INTERIM (Proposed Plant Change) ☐ VOID

☐ FINAL (Future Confirmation Req'd, enter tracking Notification number:) ______

SALEM OR HOPE CREEK: ☒ Q – LIST ☐ IMPORTANT TO SAFETY ☐ NON-SAFETY RELATED

HOPE CREEK ONLY: ☒Q ☐Qs ☐Qsh ☐F ☐R

☒ ARE STATION PROCEDURES IMPACTED? YES ☒ NO ☐

IF "YES", INTERFACE WITH THE SYSTEM ENGINEER & PROCEDURE SPONSOR. ALL IMPACTED PROCEDURES SHOULD BE IDENTIFIED IN A SECTION IN THE CALCULATION BODY [CRCA 70038194-0280]. INCLUDE AN SAP OPERATION FOR UPDATE AND LIST THE SAP ORDERS HERE AND WITHIN THE BODY OF THIS CALCULATION.

80087020 / 0010

☒ CP and ADs/CDs INCORPORATED (IF ANY): 80075972 AD M03R0

DESCRIPTION OF CALCULATION REVISION (If applicable.):
Incorporating 80075972 (AD M03R0). Revising the degraded pump curve from EG-0046, Revision 5. Simplifying the calculation complexity by making all non-bounding alignments history cases only to be used as a justification for limiting cases.

PURPOSE:
The purpose of this calculation is to determine the maximum allowable UHS temperature to maintain the SACS header temperature below 95°F or 100°F. The maximum UHS temperature will be determined for a range of Station Service Water System (SSWS) flow rates for three different accident scenarios, Loss of Coolant Accident (LOCA), Loss of Offsite Power with a coincident Safe Shutdown Earthquake (LOP/SSE), and a Loss of Offsite Power (LOP). Normal conditions will also be reviewed.

CONCLUSIONS:
The UHS temperature limit for conditions resulting from design basis failures is 90.1°F. This meets the Technical Specification limit of 89°F. The UHS temperature limit for conditions resulting from design basis failures concurrent with equipment outgages permitted by Technical Specifications AOT Action Statements is 88°F. This meets the Technical Specification limit of 88°F. See section 6 for further conclusion details.

	Printed Name / Signature	Date
ORIGINATOR/COMPANY NAME:	James Murphy / PSEG Nuclear	November 30, 2005
REVIEWER/COMPANY NAME:	N/A	
VERIFIER/COMPANY NAME:	Robert Down / PSEG Nuclear	December 6, 2005
CONTRACTOR SUPERVISOR (If applicable)	N/A	
PSEG SUPERVISOR APPROVAL:	Emin Ortelan / PSEG Nuclear	12/7/05

CALC. NO.: EG-0047				REFERENCE: N/A			
ORIGINATOR, DATE	REV:	RED 3/12/2002	Rev. 2	JBM 11/30/2005	3		
REVIEWER/VERIFIER, DATE		KCK 3/20/2002		RED 12/06/2005			

REVISION HISTORY

Revision	Issue Date	Revision Description
0	1/17/2000	Initial Issue.
1	2/27/2000	The purpose of this calculation is to revise the SACS hydraulic model to account for by-pass leakage of the RHR heat exchanger SACS outlet valve 1EGHV-2512A (1EGV-023), and to analyze the effects of plugged tubes in the SACS heat exchanger. The calculation did not account for bypass leakage of the valve, which could have leakage upwards to 3000 gpm. In addition, the model assumed that the SACS heat exchanger did not have any tubes plugged. This revision also determines the impact of 50 plugged tubes in the SACS heat exchanger.
2	4/09/2002	The calculation is being revised to determine the impact to the Ultimate Heat Sink (UHS) temperature limit due to the Residual Heat Removal (RHR) heat load transferred to the Safety Auxiliaries Cooling System (SACS) during automatic Low Pressure Coolant Injection (LPCI) of the LOCA short-term.
3	See cover sheet	Incorporating 80075972 (AD M03R0). Revising the degraded pump curve from EG-0046, Revision 5. Simplifying the calculation complexity by making all non-bounding alignments history cases only to be used as a justification for limiting cases.

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1.0 PURPOSE

The purpose of this calculation is to determine the maximum allowable Ultimate Heat Sink (UHS) temperature to maintain the Safety Auxiliaries Cooling System (SACS) header temperature below 95°F or 100°F. The maximum UHS temperature will be determined for a range of Station Service Water System (SSWS) flow rates for Normal conditions and three different accident scenarios, Loss of Coolant Accident (LOCA), Loss of Offsite Power with a coincident Safe Shutdown Earthquake (LOP/SSE), and a Loss of Offsite Power (LOP).

2.0 SCOPE

This calculation is being performed for the SACS and SSWS (the ultimate heat sink) for the Hope Creek Generating Station (HCGS). The scope is limited to the bounding cases determined in previous revisions to this calculation and cases that justify operator action.

3.0 ASSUMPTIONS / INPUTS / CONDITIONS

3.1 SACS Supply Temperature Limits

3.1.1 The SACS heat exchanger outlet design temperature (or inlet to the RHR heat exchanger) shall be limited to 95°F during normal operations.

3.1.2 The SACS system design allows for a SACS heat exchanger outlet temperature limit of 100°F during accident/transient conditions with the exception listed below (Reference 4.1.8).

3.1.3 The SACS post-accident design temperature shall be limited to 95°F for a SACS AOT in which only one SACS pump in each loop is operable. In this configuration, insufficient SACS flow is supplied to the RHR Hx to support 100°F.

3.1.4 Due to limitations in maintaining the suppression pool temperature at a maximum temperature of 95°F, the SACS design temperature must remain less than or equal to 95°F during normal conditions. The scope of increasing the SACS temperature to 100°F was limited to the SACS portion of the Safety and Turbine Auxiliary Cooling System (STACS). The non-safety related TACS portion of the system is isolated following a LOP and/or LOCA scenario, and is not evaluated for 100°F SACS temperatures.

3.2 SACS Heat Loads

3.2.1 The heat loads used for this calculation were obtained from References 4.1.1, 4.1.8, 4.1.9, 4.1.10, 4.1.11, and 4.4.1.

3.2.2 For the LOP/SSE and the LOP accident scenarios, the suppression pool temperature could raise up to 212°F for one RHR heat exchanger operation with an RHR flow rate of 10,000 gpm (Reference 4.4.1, Table 5-4). For two RHR heat exchanger operation with an RHR flow rate of 10,000 gpm each, the suppression pool temperature could raise to 183°F (Reference 4.4.1, Table 5-5). For the LOCA accident scenarios, the suppression pool temperature could raise to 210°F for one RHR heat

exchanger operation with an RHR flow rate of 10,000 gpm (Reference 4.4.1, Tables 5-2 and 5-3). For two RHR heat exchanger operation with an RHR flow rate of 10,000 gpm each, the suppression pool temperature could raise to 185°F (Reference 4.4.1, Table 5-1).

3.2.3 The process side controls for the Emergency Diesel Generator (EDG) heat exchangers are assumed to control the process side flow rates so that a fixed design heat load is removed through these heat exchangers. This will prevent over cooling of the EDG's.

3.2.4 Following the failure of an EDG, the heat load on the associated EDG room cooler is assumed to be zero. This is reasonable since the primary heat source for the EDG room coolers is the EDG itself.

3.2.5 The heat load removed (shown below) by SACS for any Emergency Auxiliaries Cooling System (EACS) pump room cooler is assumed to be the required heat load determined in Reference 4.1.11, regardless of the number of room coolers operating for the room.

VH210, RHR Pump Room = 360,000 Btu/hr
VH210, RHR Pump / HX Room = 346,000 Btu/hr
VH211, Core Spray Pump Room = 185,400 Btu/hr
VH209, HPCI Pump Room = 144,000 Btu/hr
VH208, RCIC Pump Room = 50,400 Btu/hr

3.2.6 For the Filtration Ventilation and Recirculation System (FRVS), during a LOCA the long-term heat load is 0.85 Mbtu/hr for both three and four operating FRVS units. During the short term, the heat load to each operating FRVS unit is 0.52 Mbtu/hr (Conservatively obtained from Reference 4.1.11).

3.2.7 For this analysis, the SFP heat exchangers are isolated if the SACS header temperature cannot be maintained below 95°F (normal conditions) or 100°F (LOCA and/or LOP). Following a LOP signal, the fuel pool pumps trip and are not automatically loaded onto the EDG; fuel pool heat exchangers would remain isolated if river temperatures were high. Following a LOCA scenario, the instrument air system is assumed to be lost (since the RACS and TACS systems that cool the air compressors would automatically be isolated). The Loss of Instrument Air (LIA) would cause the fuel pool heat exchanger outlet valves to fail closed preventing fuel pool cooling pump flow, and fuel pool heat exchangers would remain isolated if river temperatures were high. If a LOP or LIA did not occur, and SACS temperature reaches the design value (95°F or 100°F), operator action in accordance with Reference 4.3.6 would isolate the SFP heat exchangers.

3.2.8 EDG room cooler heat load is 1.9 MBtu/hr for one operating EDG room cooler, and 2.2 MBtu/hr (1.1 Mbtu/hr each) when two EDG room coolers are operating (see Reference 4.1.1). At 100°F SACS temperatures, two EDG room coolers are required to maintain EDG rooms below their design temperature of 120°F (Reference 4.1.10).

3.2.9 The RHR pump seal coolers' heat load depends on the source of water aligned to the RHR pump. For the RHR pump seal coolers, a post LOCA heat load of 0.09 MBtu/hr was used since it is assumed that the water is from the suppression pool at a maximum temperature of 212°F. The post-LOP heat load of 0.35 MBtu/hr (applied to the A & B coolers only) was used since it is assumed that the water is taken directly from the reactor vessel at a maximum shutdown cooling temperature of 350°F. These heat loads are taken directly from Reference 4.1.1.

3.3 SACS/SSWS System Alignments

3.3.1 The heat load between the "A" and "B" SACS loop are assumed identical except for the RCIC and HPCI heat loads. Since the RCIC pump room cooler required heat load is significantly lower (by a factor of two) than the HPCI pump room cooler heat load the "A" SACS loop is assumed to produce the limiting UHS temperature.

3.3.2 The Emergency Overboard (EOB) valves are opened under administrative controls when the SSWS temperature reaches 85°F and the breakers (10B212 MCC No. 131 and 10B222 MCC No. 131) are racked out to prevent the spurious actuation of the valve (Reference 4.3.2).

3.3.3 The control room chiller and 1E panel chiller control valves were set to control the flow rate through these units to the required flow rate stated in the UFSAR, which bounds the minimum required flow rate from Reference 4.1.1, 1588 gpm and 408 gpm respectively. Higher SACS flow increases the heat load transferred to SACS, resulting in a lower UHS temperature (see Attachment 7 for a detailed explanation). The chiller water controls will continue to control following a loss of instrument air. These valves have their own separate compressed gas cylinders that are designed to maintain pressure and allow the control valves to remain functional after a loss of instrument air.

3.3.4 Following a LOCA, during a SSWS loop outage; it is assumed that the SSWS pumps within that loop are out of service. In addition, a SSWS loop outage due to a pump outage limits the SSWS loop outage due to a SACS heat exchanger outage (see Attachment 5 for results).

3.3.5 The EDG crosstie configuration provided in the UHS spreadsheet analysis (see Attachment 5) assumes that the configuration when three EDG's are crosstied is bounded by the configuration when four EDG's are crosstied. Only the limiting temperature for the four EDG's crosstied is provided.

3.3.6 For the crosstie configurations, the SACS flow to the EDG room coolers is throttled according to the SACS System Operation Procedure (Reference 4.3.1).

3.3.7 For the limiting case from the 95°F SACS LOP/SSE UHS spreadsheet of Attachment (5) (represented by the 212.2 – 212.2 configuration on line 1 of the "AOT - One SACS Pump Per Loop", and the A1&2 - B1&2 configuration in the PROTO-FLO™ model runs), a sensitivity study was performed for the Probabilistic Risk Assessment Group to determine the UHS temperature for two special alignments: The A1&2 - B1&1 PROTO-FLO™ model line-up (represented by the 212.2 – 211.2 configuration on line 2 of the "AOT - One SACS Pump Per Loop"), and the A1&1 - B1&1 PROTO-FLO™ model line-up (represented by the 211.2 – 211.2 configuration on line 3 of the "AOT - One SACS Pump Per Loop"). These sensitivity studies are not part of the design basis, and are not used to determine the limiting UHS temperature. However, the PSA group will use the results as a model for their success criteria for the Safety System requirements in their probabilistic risk assessment of the SACS/SSWS system. Note that in the actual model runs, all the heat loads and component alignments for the A1&2, A1&1, B1&2, B1&1 model runs were analyzed by the "A" loop in PROTO-FLO™.

a) The A1&2 – B1&1 alignment: Two SACS Hx's in one loop and one SACS Hx in the other loop. In the A1&2 configuration (1 SACS pump and 2 SACS heat exchangers), only the "A" loop is being analyzed. Flow is directed to the RHR heat exchanger and isolated to the control room chiller. The "B" loop is analyzed in the B1&1 configuration (1 SACS pump and 1 SACS heat exchanger), in which flow is isolated to the RHR heat exchanger and directed to the control room chiller.

b) The A1&1 – B1&1 alignment: One SACS Hx in one loop and one SACS Hx in the other loop. In the A1&1 configuration (1 SACS pump and 1 SACS heat exchanger), only the "A" loop is being analyzed. Flow is directed to the RHR heat exchanger and isolated to the control room chiller. The "B" loop is analyzed in the B1&1 configuration (1 SACS pump and 1 SACS heat exchanger), in which flow is isolated to the RHR heat exchanger and directed to the control room chiller.

3.4 Assumptions

Common Assumptions

3.4.1 The uncertainty of the temperature instrumentation for the SSWS and SACS temperatures is assumed to be 0.79°F (see Reference 4.1.6). For a listing of the overall uncertainty see Section 5.11.

3.4.2 The service fluid for the SACS heat exchanger models is "Brackish Water - 12 ppt" in the PROTO-FLO™ model (Reference 4.1.3).

3.4.3 The RHR heat exchanger SACS outlet valves are assumed to be in the full-open position for all cases, with the exception of the "one SACS pump per loop" configuration. For this case, the valve is assumed to be closed to isolate flow to one of the RHR heat exchangers (see the discussion in Section 5.2.1.5 for details). The vendor-provided calculation in Attachment (9) shows that the valve has the potential for leakage of 360 gpm with the valve seat removed (based on a disc clearance of 0.019 inches). Based on a visual inspection of the valve, the disc clearance could be up to 0.125 inches. Using this value, the possible leakage rate was re-calculated using the equation found in Attachment (9), resulting in a bypass leakage rate of approximately 2500 gpm. To account for leakage in this configuration, the valve (1EGV-026) has been flow balanced to allow 3000 gpm of flow through the RHR heat exchanger isolation valve.

Revision 2 Assumptions

3.4.4 For situations where both SACS heat exchangers in the same SACS loop received SACS and SSWS flow, the average SACS flow rate, heat load, and shell outlet temperature from the PROTO-FLO™ run were used in the PROTO-HX™ model.

3.4.5 For the LOCA short-term analysis (less than 10 minutes), the suppression pool temperature is assumed 170°F per Reference 4.4.1.

3.4.6 During LPCI injection phase of the LOCA short-term, the "RHR HX shell bypass MOV (BC-HV-F048A(B))" opens, and cannot be closed for 3 minutes, after which the Operator is directed to close this bypass valve as soon as possible (Reference 4.3.5).

3.5 SOFTWARE QUALITY ASSURANCE

3.5.1 The PROTO-FLO™ thermal hydraulic model of SACS was developed and benchmarked by EG-0043 (Reference 4.1.3) and balanced by EG-0046 (Reference 4.1.2). The heat exchanger models used for this calculation were developed in EG-0044 (Reference 4.1.4).

3.5.2 The PROTO-FLO™ program is CRITICAL SOFTWARE as defined by ND.DE-AP.ZZ-0052(Q) designated Proto-Flo (A-0-ZZ-MCS-0149, Reference 4.2.1). This program was developed and validated in accordance with Proto-Power's Nuclear Software Quality Assurance Program (SQAP), documented in Reference 4.2.2. This program meets the requirements of 10CFR50 Appendix B, 10CFR21, and ANSI NQA-1, and was developed according to the guidelines and standards contained in ANSI/IEEE Standard 730/1984 and ANSI NQA-2b-1991. PROTO-FLO™ Version 4.51 is approved for use on safety-related applications as documented in Reference 4.2.2.

3.5.3 The PROTO-HX™ program is CRITICAL SOFTWARE as defined by ND.DE-AP.ZZ-0052(Q) designated Proto-Hx (A-0-ZZ-MCS-0169, Reference 4.2.3). This program was developed and validated in accordance with Proto-Power's Nuclear Software Quality Assurance Program (SQAP). This program meets the requirements of 10CFR50 Appendix B, 10CFR21, and ANSI NQA-1, and was developed according to the guidelines and standards contained in ANSI/IEEE Standard 730/1984 and ANSI NQA-2b-1991. PROTO-HX™ Version 4.01 was verified and approved for use as documented in Reference 4.2.4.

3.5.4 The PIPE-FLO™ program is CRITICAL SOFTWARE as defined by ND.DE-AP.ZZ-0052(Q) designated Pipe-Flo (A-0-ZZ-MCS-0023) - Steady State Hydraulic Analysis (Reference 4.2.5). This program is used to calculate the SSWS flow rates to each SACS heat exchanger under the various conditions that are input into the analysis spreadsheet lookup tables. The SSWS flow rates are contained in EA-0003 (Reference 4.1.5).

4.0 REFERENCES

4.1 Design Calculations / Evaluations

4.1.1 EG-0020, "STACS - Required Flows and Heat Loads", Revision 8.
4.1.2 EG-0046, "Safety and Turbine Auxiliaries Cooling System (STACS) Operation" Revision 5.
4.1.3 EG-0043, "Safety and Turbine Auxiliaries Cooling System (STACS) PRTOTO-FLOTM Thermal Hydraulic Model", Revision 4.
4.1.4 EG-0044, "Safety and Turbine Auxiliaries Cooling System (STACS) PROTO-HXTM Heat Exchanger Models" Revision 1.
4.1.5 EA-0003, "Station Service Water System Hydraulic Analysis" Revision 9.
4.1.6 H-1-EA-CEE-1126, "Evaluation of Service Water Pump Output Temperature Loop Accuracy", Revision 0.
4.1.7 EA-0001,"Station Service Water System Hydraulic Model", Revision 3.
4.1.8 H-1-EG-MEE-1301, "100°F SACS Design Temperature Limit Evaluation", Revision 1.
4.1.9 H-0-EA-MEE-1237, "Station Service Water System Failure Mode And Effects Analysis", Revision 1.
4.1.10 GM-0027, "Diesel Generator Area HVAC Analysis", Revision 1.
4.1.11 11-0066, HCGS FRVS Drawdown And Long-Term Post-Loca Reactor Building Temperature, Revision 7.
4.1.12 BC-0056, "RHR Hydraulic Analysis (Torus Cooling, Shutdown Cooling, LPCI)", Revision 4.

4.2 Critical Software

4.2.1 A-0-ZZ-MCS-0149, "Critical Software Document for PROTO-FLO™" Version 4.51, Revision 8.
4.2.2 Thermal Hydraulic Modeling Software Program PROTO-FLO™ Version 4.5 Software Validation and Verification Report (SVVR) SQA No. 93948-01, Revision M, dated 9/10/99
4.2.3 A-0-ZZ-MCS-0169, "Critical Software Document for PROTO-HX™" Version 4.01, Revision 6.
4.2.4 Heat Exchanger Thermal Performance Modeling Software Program PROTO-HX™ Version 4.01 Software Validation and Verification Report (SVVR) SQA No. SVVR-93948-02, Revision G, dated 5/28/99
4.2.5 A-0-ZZ-MCS-0023, "Pipe-Flo – Steady State Hydraulic Analysis", Ver. 4.06, Revision 0.

4.3 Procedures

4.3.1 HC.OP-SO.EG-0001, Safety and Turbine Auxiliaries Cooling Water System Operation, Revision 35
4.3.2 HC.OP-AB.COOL-0001, Station Service Water, Revision 7.
4.3.3 HC.OP-AB.ZZ-0135, Station Blackout//Loss of Offsite Power/Diesel Generator Malfunction, Revision 23.
4.3.4 ND.DE-AP.ZZ-0052, Software Control, Revision 1.
4.3.5 HC.OP-SO.BC-0001, Residual Heat Removal System Operation, Revision 41.
4.3.6 HC.OP-AB.COOL-0002, Safety/Turbine Auxiliaries Cooling System, Revision 0.

4.4 Vendor Documents

4.4.1 323835, Sheet 2, Containment Analysis with 100°F SACS Temperature, Revision 1.

5.0 ANALYSIS

5.1 Methodology

5.1.1 Revision 2 Methodology

For the accident scenario and failure alignments discussed below, the following method was used to determine the UHS temperature. Using the PROTO-FLO™ thermal hydraulic model of SACS, the temperature at the tube-side (SSWS side) of the SACS heat exchangers was iteratively reduced until a temperature of 95°F (or 100°F) was achieved at the SACS inlet to the Residual Heat Removal (RHR) heat exchanger. This process was performed using a SSWS flow of 10,000 gpm on the tube-side of the SACS heat exchangers. The PROTO-HX™ model of the SACS heat exchangers was then used with the SACS flow rate, SACS heat load, and SACS heat exchanger shell-side outlet temperature from the PROTO-FLO™ run. The required UHS temperature was determined for SSWS flow of 5,000 gpm, 7,500 gpm, 10,000 gpm, 12,500 gpm, and 15,000 gpm on the tube side of the heat exchanger for each case. The resulting UHS temperature versus SSWS flow rate data was then plotted and curve fit. The coefficients for the curve-fits were then incorporated into the EXCEL spreadsheet along with SSWS system flowrates to determine the limiting UHS temperature for each scenario. This process was performed for each failure alignment (discussed in Section 5.3.1) during the three accident modes at SACS temperatures for either 95°F or 100°F.

Six different case alignments were then created in the default database (STACS99.DBD) to represent the three accident conditions, under both crosstied and non-crosstied configurations, at SACS temperatures of 95°F and 100°F. These case alignments were used to evaluate the UHS temperature limit for the following conditions: LOCA/LIA, LOP-EOB, LOP-CTB, LOP/SSE, and Normal (where LIA is a Loss of Instrument Air, CTB is the Cooling Tower Basin, EOB is the Emergency Over Board valve and SSE is a Safe Shutdown Earthquake). An uncertainty analysis was performed, and the calculated value was used to determine the final UHS temperature.

APPROACH

Step 1: Determine the failure modes

Step 2: Run the SACS thermal/hydraulic model using a SSWS flowrate of 10,000 gpm.

Step 3: Iterate the tube-side temperature of the SACS heat exchanger until the desired SACS temperature is achieved at the inlet to RHR Heat exchangers.

Step 4: Repeat for each failure mode.

Step 5: Using PROTO-HX, determine the corresponding SSWS (UHS) temperature based on SSWS flowrates of 5000 - 15000 gpm (2500 gpm increments) using SACS flowrate, heat load, and heat exchanger shell-side temperature results from PROTO-FLO in steps 2-4

Step 6: Tabulate, plot and curve-fit the UHS temperature vs SSWS flow using the results of step 5

Step 7: Determine the required UHS temperature for various SSWS flowrates (through SACS heat exchangers)

Step 8: Perform a curve fit verification

Step 9: Operability determination

Step 10: Input the curve-fit coefficients from step 6 and flowrates from Reference 4.1.5 into the UHS spreadsheet analysis to determine the required UHS temperature for various SSWS flowrates (through SACS heat exchangers)

Step 11: Calculate uncertainty for the limiting UHS temperature limits

Step 12: Select the limiting UHS temperature limits

5.1.2 <u>Methodology Using Limiting Alignment / Accident Conditions</u>

The methodology from previous revisions has changed. Revision 2 to this calculation went through a thorough process of identifying all case alignments (i.e., single failures and AOT's) for each accident scenario (i.e., LOCA, LOP, LOP/SSE). The resulting limiting alignments are used for future UHS analyses to determine the necessary UHS temperatures required for accident mitigation. In addition, any alignment / accident condition that is used to justify operator action will be continued in future analyses.

For historical and justification purposes, the process of finding the limiting alignment / accident conditions will not be deleted from future revisions, but are identified as "Revision 2" in all appropriate sections of this calculation.

APPROACH

Step 1: Determine the limiting failure modes.
Step 2: Run the SACS thermal/hydraulic model using SSWS flowrates identified in Attachment (5) (rows is highlighted in bold borders).
Step 3: Iterate the tube side temperature of the SACS heat exchanger until the desired SACS temperature is achieved at the inlet to RHR Heat exchangers.
Step 4: Repeat for each failure mode.
Step 5: Calculate uncertainty for the limiting UHS temperature limits.
Step 6: Select the limiting UHS temperature limits.

5.2 Failure Modes

5.2.1 Revision 2 Determination of Failure Modes

Scenarios

This calculation investigates accident conditions and normal operation. The three accident conditions considered for this analysis are a LOCA, a LOP/SSE, and a LOP. Heat loads (obtained from Reference 4.1.1) and system configurations vary between failure modes, and are discussed in greater detail below.

LOCA

Following a LOCA, the station instrument air system fails, resulting in a Loss of Instrument Air (LIA). In SACS, the instrument air system provides the motive force for the Air Operated Valves (AOV's) that isolate the redundant pump room coolers and the pressure control valves associated with the control room and the 1E panel room chiller units. As a result of the LIA, the AOV's that isolate the redundant room coolers all fail wide open. With all the isolation valves failing open, SACS flow is provided to all components with the exception of the Post Accident Sampling System (PASS) coolers. For this analysis, the PASS coolers are assumed to be aligned to the SACS loop being analyzed since this will produce the highest heat load on SACS. Note that the heat loads and valve alignments are slightly different for the LOCA short-term (t < 10 minutes) due to system configuration and Operator action response times.

- For the RHR heat exchanger, the required heat load following a LOCA is 121.7 and 123.8 MBtu/hr with 10,000 gpm of RHR flow at 212°F and a SACS temperature of 95°F and 100°F, respectively.
- For the RHR pump seal coolers, the post LOCA heat load of 0.09 MBtu/hr was used.
- Each SACS loop assumes to have three FRVS cooling coils operating in the non cross-tied configuration.
- For the cross-tied configuration.
- The full-required heat load was applied to the operating room coolers for the non cross-tied failure alignments; no heat load was applied to the redundant coolers.
- The full-required heat load was applied to the operating room cooler in the cross-tied failure alignments, with the exception of the EDG room coolers (equal heat load to the operating and redundant EDG room coolers).
- Half the design heat load was applied to each of the PASS coolers.

LOCA Short-term

During a Quality Assurance In-Service Test (IST) Audit no. 97-012, it was identified that during normal operations, the RHR system is aligned for Low Pressure Coolant Injection (LPCI) with both the RHR heat exchanger and bypass valves open (AR#970815134). Previous analyses state that there is no RHR heat load during the short-term. However, following a large break LOCA scenario, a portion of the RHR flow would be directed from the suppression pool through the RHR heat exchanger to the reactor vessel. The flow to the vessel by one RHR pump would be split through the RHR heat exchanger and the bypass line. The RHR hydraulic analysis (Reference 4.1.12)

shows that RHR flow is 1945-gpm through the "A" RHR heat exchanger and 2340-gpm for the "B" heat exchanger during LPCI injection using a degraded pump (Reference 4.1.12, Attachments E and F respectively). To maximize flow (and maximize the heat load transferred to SACS), a sensitivity was performed using the design pump curve. The results show that flow through the "B" RHR heat exchanger is 2479-gpm (see Attachment 10). This flow has been increased to 2504-gpm to account for 1% model error in accordance with Reference 4.1.12. An RHR flow of 2504 gpm will conservatively be used for both RHR heat exchangers, since the higher flow yields a higher heat input into SACS.

As stated in Assumption 3.4.6, the RHR heat exchanger bypass valve can be closed through operator action after three minutes. The assumed RHR temperature of 170°F is based on the heat-up of the suppression pool after a period of ten minutes prior to establishing shutdown cooling. If the bypass valve is closed prior to ten minutes and shutdown-cooling mode is initiated, the resulting SACS temperature is bounded by the pre-analyzed long-term LOCA, since the long-term LOCA case assumes a higher suppression pool temperature (212°F vs. 170°F). Therefore, for the purpose of this analysis the bypass valve is assumed to remain open for the duration of the short-term LOCA.

In the long-term accident analyses, all failure alignments assume RHR flow to the RHR heat exchangers. The RHR heat exchanger SACS outlet valves are assumed to be in the full-open position for all cases, with the exception of the "one SACS pump per loop" configuration. For this alignment, the valve is assumed "closed" to isolate flow to one of the RHR heat exchangers (see Section 3.4.3). For all alignments (with the exception of the "one SACS pump per loop" configuration), the long-term analyses bound the LOCA short-term since the RHR flow rate and heat load of the long-term LOCA (10000-gpm at 212°F) exceed the flow rate and heat load of the short-term LOCA (2504-gpm at 170°F).

To verify that that SACS temperature limits are not exceeded during the short-term LOCA, a model run using the LOCA short-term RHR flow rate and heat load in the "one SACS pump per loop" configuration was performed. The UHS temperature is conservatively assumed at its bounding limit of 89°F. Upon receiving the LOCA signal, the assumptions stated in Sections 3.2.7 and 5.2.1 for a LOCA apply with the exception of (or in addition to) the following:

- The RHR flow through the RHR heat exchangers is 2504-gpm at 170°F
- The SACS flow through the aligned RHR heat exchanger is 7524-gpm, determined by the system configuration in the model run (see Attachment 11). The SACS flow through the isolated RHR heat exchanger is 3000-gpm per Section 3.4.3.
- All RHR pumps auto-start (unless tagged out-of-service)
- All SACS pumps auto start (unless tagged out-of-service)
- TACS is auto-isolated
- The SFP and PCIG cross-connect valves auto-close
- All six FRVS fans auto-start

For the purpose of this model run (Case 25), it is assumed that one SACS pump is tagged out-of-service on the standby loop, and one pump on the opposite loop supplying TACS is lost. Both SACS heat exchangers in each loop are available and in service.

The results of Case 25 show that SACS reaches a temperature of 93.1°F in the "A" Loop, and 92.9°F in the "B" Loop. For this system configuration, the RHR heat exchanger transfers a heat load of 48.965 Mbtu/hr to SACS in the "A" Loop, and 39.822 Mbtu/hr to SACS in the "B" Loop. For all configurations, the LOCA short-term analysis is bounded by the LOCA long-term analysis. See Attachment (11) for additional details.

<u>LOP/SSE</u>

- Following a LOP/SSE, the instrument air system also fails, resulting in nearly the same SACS operational alignment as following a LOCA. However, for this scenario, the PASS coolers are not placed on line.
- The RHR heat exchanger inlet temperature is 212°F at 10,000 gpm when removing the required heat from the Suppression Pool. This assumes that the RHR conditions will be modified so that the required heat load is removed while maintaining the SACS header temperature at or below its design temperature. The SACS operating procedure directs the operator to throttle SACS flow.
- The FRVS cooling coils and the Core Spray pump room coolers have no heat load but still receive flow due to the failure of the instrument air system.
- The RHR pump seal cooler heat load is 0.35 MBtu/hr when the cooler is aligned to the RHR heat exchanger. All other RHR pump seal coolers have a 0.09 Mbtu/hr heat load applied.
- The full-required heat load was applied to the operating room coolers for the non cross-tied failure alignments; no heat load was applied to the redundant coolers.
- The full-required heat load was applied to the operating room cooler in the cross-tied failure alignments, with the exception of the EDG room coolers (equal heat load to the operating and redundant EDG room coolers).

<u>LOP</u>

The post LOP SACS operating configuration is the same as the post LOP/SSE SACS operating configuration, except for the following.

- Following a LOP only, it is assumed that the instrument air system does not fail.
- The FRVS cooling coils and the core spray pump room coolers (which are not required following a LOP) do not receive flow.
- The PASS coolers are isolated.

<u>Normal</u>

Under normal operating conditions, all systems and components are assumed to be operating as designed. Heat loads include the Turbine Auxiliaries Cooling System (TACS) and are taken from Reference 4.1.1.

5.2.1.1 Failure Modes and Consequences

The failure modes considered encompass the plausible combinations of single failures and/or AOT conditions, and the consequences of the assumed failures and alignments. Table 5.2.1 lists the active failures that directly impact UHS temperatures and the consequences of each. The following is an example of a failure mode and its effect on other components from Reference 4.1.9.

Design Basis: SACS Heat Exchanger SSWS outlet valve: 1EAHV-2371A(B). Opens to allow SSWS flow through the SACS heat exchanger.

Controls: The valve is normally open when its associated SSWS pump is operating. The valve can be manually operated using 1EAHS-2371A,B. 1EAHV-2371B can be operated from the RSP. When the valve is in auto, it is signaled to open when its associated SSWS pump starts. The valve is signaled to close when its associated SSWS pump is not running (i.e., failure or out-of-service). 1EAHV-2371A and 1EAHV-2371B are powered by the class 1E channel A and B buses respectively.

For this failure mode, when a SSWS pump fails, the valve gets a signal to automatically close (unless a previously running pump fails due to a loss of an EDG following a LOP, then it is assumed the valve remains open).

Table 5.2.1 - Failure Modes and Consequences

System	Failure Mode	Consequences
SSWS	EOB valve fails shut	Reduction of SSWS flow (with SSE (Note 1)) (loss of 1/2 discharge path)
SSWS	SSWS pump failure	Reduced SSWS flow to both SACS heat exchangers in that loop (For AOT cases or cases where the pump fails to start, the associated SACS heat exchanger discharge isolation valve also fails to open)
SSWS	SACS heat exchanger valve fails to open	Loss of all SSWS flow to one SACS heat exchanger
SACS	SACS pump failure	Reduced SACS flow
SACS	SACS heat exchanger valve fails to open	Loss of all SACS flow to one SACS heat exchanger
EDG	"A" or "B" EDG failure	Loss of "A" or "B" SSWS and SACS pumps; Loss of power to EOB valve; Loss of power to "A1" or "B1" SACS heat exchanger valves (both sides); Loss of RHR pumps; Loss of ECCS heat loads (flow is still provided due to the LIA); etc.
EDG	"C" or "D" EDG failure	Loss of "C" or "D" SSWS and SACS pumps; Loss of power to "A2" or "B2" SACS heat exchanger valves (both sides); Loss of ECCS heat loads (flow is still provided due to the LIA); etc.
All	LIA	AOVs reposition to fail position (Note 2)

Notes: 1. SSE = Safe Shutdown Earthquake which bounds the Operating Basis Earthquake (OBE).
2. All SACS AOVs fail open except the SACS heat exchanger bypass valves (that fail shut), and the chiller water valves (that continue to control due to the back-up air supply).

5.2.1.2 AOT Case

The design basis cases were developed accounting for single failure conditions as well as consequences of these failures. The AOT cases are four (4) additional conditions; complete loss of one SACS loop, complete loss of one SSWS loop, one SACS pump in each loop, and one SSWS pump in each. These four special cases are addressed specifically in the Technical Specifications.

Loop Out of Service

When a loop of SSWS or SACS becomes unavailable, the operators cross-tie at least one EDG to the remaining operable loop. This EDG is typically the "C" or "D" EDG depending if the A or B loop is unavailable since the "C" or "D" EDG will power the required fourth FRVS unit which is cross-tied. The "A" and "B" EDG's power the EOB valves; so two additional cases are listed to simulate only one EOB available under these conditions. This temperature is the limit at which the EOB powered from the EDG that was not cross-tied in a loop outage must be opened.

One Pump Per Loop

Each case (one SACS pump/loop and one SSWS pump/loop) considers progressive operator action to determine the optimum condition for the least limiting UHS temperature limit.

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5.2.1.3 Unique SACS Failure Conditions

A set of cases for each scenario, namely LOCA/LIA, LOP, and LOP/SSE, were developed. The different case scenarios were necessary because the heat loads differed for each scenario. The failure mode matrix was set up with a row representing one case. A separate column was included for each component potentially affected. For example, SSWS pump failures receive a separate column for each of the four pumps. The cases were developed by applying one of each type of failure for each combination of component and loop. Failures were marked in the appropriate column with an "X". Consequences of the specified failures were marked with a "C", and operator actions were marked with a "P". The specific AOT conditions considered were developed by marking the AOT failures with an "A". Table 5.2.3 shows an example of an abridged EXCEL UHS spreadsheet. The complete spreadsheets can be found in Attachment (5).

Table 5.2.3 – UHS temperature spreadsheet (abridged) – 100°F LOP/SSE

A LOOP	B LOOP	AOT	A SWPUMP	C SWPUMP	B SWPUMP	A1 SWHX	A2 SWHX	A EOB	B EOB	C SACS PUMP	B SACS PUMP	A2 SACS HX	C EDG	A+B LOOP	A1 SSWS FLOW	A2 SSWS FLOW	B1 SSWS FLOW	B2 SSWS FLOW	A LOOP UHS	B LOOP UHS	SSWS CONFIG
SSWS Pump Failures																					
122.2	222.2	30d		X			C								10797	0.0	10538	10625	67.48	92.95	18x2_c.plu
EDG Failures																					
112.1	222.2	14 d		C			C			C			X		10797	0.0	10538	10625	66.60	92.95	18x2_c.plu
212.1	222.2	14 d		C						C			X		9026	8990	8966	9031	93.49	91.22	14x2_c.plu
111.1	222.2	14 d		C			C			C		C	X		10797	0.0	10538	10625	84.07	92.95	18x2_c.plu
211.1	222.2	14 d		C						C		C	X		9026	8990	8966	9031	79.97	91.22	14x2_c.plu
AOT - SSWS Loop Failures																					
22.2	222.4	72 h	A	A		C	C								0	0	10514	10599	0.00	91.43	55x2_c.plu
22.2	222.4	72 h				A	A								0	0	13221	13343	0.00	93.66	11x2_c.plu
22.2	222.4	72 h	A	A		C	C								0	0	9353	9427	0.00	89.97	55x1b_c.plu

5.2.1.4 Worse-Case Representation

Cases representing similar SACS failure modes, such as an "A", "B", "C", or "D" SACS pump, were consolidated into one failure case since the UHS temperature curves assume the failure of given components are equivalent. The others were eliminated from this analysis since they are bounded by the worst-case pump failure (A, B, C, or D).

Considering the "A" and "B" SACS loops to be interchangeable, based on the assigned index number the cases distilled into 10 unique SACS failure conditions as indicated in Table 5.2.4. The specific "A" loop component lineups used for this evaluation are also provided next to each index number.

Table 5.2.4: Unique SACS Failure Conditions

Index Number	Active SACS HXs (SSWS Side)	Operating SACS Pumps	Active SACS HXs (SACS Side)	EDGs Receiving SACS Flow (See Note)	Operating EDGs (Generating Heat Load)
X11.1	A1	A	A1	A, (C)	A
X11.2	A1	A	A1	A, C	A, C
112.1	A1	A	A1, A2	A, (C)	A
112.2	A1	A	A1, A2	A, C	A, C
X21.2	A1	A, C	A1	A, C	A, C
122.2	A1	A, C	A1, A2	A, C	A, C
212.1	A1, A2	A	A1, A2	A, (C)	A
212.2	A1, A2	A	A1, A2	A, C	A, C
222.2	A1, A2	A, C	A1, A2	A, C	A, C
222.3	A1, A2	A, C	A1, A2	A, C, B	A, C, B
222.4	A1, A2	A, C	A1, A2	A, C, B, D	A, C, B, D

Note: EDGs shown in parentheses receive flow only with concurrent LIA.

5.2.1.5 Failure Alignments

Eleven different failure alignments were evaluated for each of the three accident scenarios. The failure scenarios are tabulated below in Table 5.2.5 and designated by the following code:

ABC.D

Where:
- A is the number of SACS heat exchangers receiving SSWS flow
- B is the number of SACS pumps operating
- C is the number of SACS heat exchangers receiving SACS flow
- D is the number of EDG's being cooled by SACS

The limiting failure alignment(s) for each failure mode is presented below.

EOB Failure – one EOB valve fails, resulting in less SSWS flow. The limiting alignment is the 222.2

SSWS failure – one SSWS pump fails, resulting in a SSWS heat exchanger valve closing. The limiting alignment is the 122.2.

SSWS heat exchanger failure – one SSWS heat exchanger valve fails closed. The limiting alignment is the 122.2.

EDG failure – one EDG fails to start, resulting in the possible loss of one or more of the following: SSWS pump, SSWS heat exchanger, SACS pump, and SACS heat exchanger. The possible limiting alignments are: 112.1, 212.1, 111.1, 211.1.

SACS pump failure – one SACS pump fails to start, resulting in reduced SACS flow. The limiting alignment is the 212.2.

SACS heat exchanger failure – one SACS heat exchanger valve fails to open, resulting in less heat removal capability. The limiting alignment is the 221.2.

Table 5.2.5 - Failure Alignments

222.2	X21.2	212.2	212.1	X11.2	X11.1
122.2	112.2	112.1	222.3	222.4	

An alignment with only one SACS heat exchanger on line will create the same SACS conditions regardless of whether the isolated SACS heat exchanger receives SSWS flow. Therefore, it is concluded that a 2X1.X and a 1X1.X failure alignment produce the same SACS conditions. The X21.2, X11.2, and the X11.1 alignments correspond to the alignments with both one and two SACS heat exchangers receiving SSWS flow. For example, the 221.2 and the 121.2 failure alignments are both represented by the X21.2 failure alignment.

The 222.3 and 222.4 alignments are alignments where one SACS loop has become inoperable and one or two EDG's have been cross-tied to the opposite SACS loop. These alignments are referred to as the cross-tied alignments. The cross tying of the EDG's is assumed to have been performed in accordance with Reference 4.3.1. When the EDG's are cross tied, the "D" FRVS cooling coil, the HPCI or RCIC room coolers, the RHR pump coolers, and the RHR pump room coolers are also cross tied to the operable SACS loop. In addition, the redundant room coolers are manually isolated when the EDG's are cross-tied. For the 222.3 alignment with only one EDG crosstied in the LOP scenario, the RHR pump powered by the non-cross tied EDG will not start. Since the instrument air system is not assumed to fail under the LOP scenario, the RHR pump seal and bearing coolers and the RHR pump room coolers associated with the non operating RHR pump will not come on line. The HCGS Technical Specification allows for operation with one SACS pump operating in each SACS loop. While evaluating this alignment, Reference 4.1.2 determined that the Control Room chiller, 1-A(B)K-400, must be isolated in one SACS loop to provide adequate cooling to the RHR heat exchanger. In addition, the RHR heat exchanger must remain isolated in one SACS loop to

provide adequate cooling to the 1E and Control Room chillers. This alignment was evaluated for the single pump alignments that do not result from an EDG failure (alignments 212.2, X11.2 and 112.2). For the analysis of these alignments, both SACS loops are operating with the following configuration: One loop has the RHR heat exchanger aligned and the control room chiller isolated, the other loop has the RHR heat exchanger isolated and the control room chiller aligned. See Section 3.3.7 for more details.

5.2.2 Limiting Failure Modes for Current / Future UHS Analyses

5.2.2.1 Limiting with Compensatory Actions

The limiting alignment / accident conditions were identified from Attachment (5). The limiting accidents conditions for the SACS system are as follows:

- LOCA
- LOP/SSE

The limiting case alignments (i.e., single failures and AOT's) are as follows:

- Failure of an EDG
- Failure of an EOB Valve (SSWS Failure)
- Failure of an EDG concurrent with a Failure of an EOB valve
- One SACS Pump per SACS Loop
- One SSWS Pump per SSWS Loop

Each case alignment is run for each accident condition to determine the UHS temperature.

5.2.2.2 Limiting without Compensatory Actions

To determine when compensatory actions are required, the AOT case of one SSWS pump per SSWS loop without compensatory actions in Attachment (5) was reviewed and indicates the accident which results in the lowest UHS temperature is a LOP. Therefore, this case alignment is also run.

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5.2.2.3 Special Maintenance Alignments

When an EDG room cooler is taken out of service for maintenance, the remaining room cooler still must maintain its respective EDG room temperature within acceptable temperature limits. Reference 4.1.2 (Section 6.4.13) determined the required SACS temperature needed for a single room cooler to maintain design temperatures for two limiting alignments.

- Single Failure of an EDG
- AOT Configuration of One SACS Loop Operable / One SACS Loop Inoperable (i.e., Crosstied)

From Attachment (5), the LOP/SSE accident condition is limiting for these two alignments. Note that if one SACS pump and one SSWS pump are operating on the same SACS loop, Reference 4.3.6 has operators close the SACS heat exchanger's inlet SACS valve and outlet SW valve associated with the idle / failed SACS pump.

5.3 Case Alignments Baseline Database

5.3.1 Revision 2 Database

The default PROTO-FLO™ database, "STACS99.DBD" from Reference 4.1.3 was used to create the six baseline databases, representing the three different failure scenarios for both 95°F and 100°F SACS temperatures. The six case alignments of the default database are documented as electronic Attachments on CD-ROM, and are identified as follows: "LOCA-95", "LOP-95", "LOP/SE-95", "LOCA-100", "LOP-100", and "LOP/SSE-100".

5.3.2 Database for Current / Future UHS Analyses

The database from Reference 4.1.2 was used to create two databases, "SACS-LOCA.PDB" and "SACS-LOP/SSE.PDB", that represent the limiting failure alignments.

5.4 SACS Heat Exchanger Tube-side Temperature

Using the PROTO-FLO™ thermal hydraulic model of SACS, the temperature at the tube side (SSWS side) of the SACS heat exchangers was iterated until the desired temperature was achieved at the SACS inlet to the RHR heat exchanger. This process was performed with 10,000 gpm on the SSWS side of the SACS heat exchangers for revision 2. For current / future analyses, the process wsa performed using the flows identified in Attachment (5) for the limiting alignments.

5.5 Generate Output Files

Using the baseline databases from above, PROTO-FLO™ models runs were performed for all failure alignments for the limiting accident conditions (LOCA and LOP/SSE) assuming a SACS temperature of 95°F and 100°F. A set of eight PROTO-FLO™ output reports (Calculation Summary, Flow

Summary, Node Summary, Boundary Conditions, Pump Status, Control Valve Line-up, Manual Valve Line-up, and Heat Exchanger Data) for each model run were generated, and are included in Attachment (1) as an electronic file on CD. The files are named accordingly:

NLOCA##: No failures during LOCA
1LOCA##: Failure of an EDG during LOCA
2LOCA##: Failure of an EOB Valve (SSWS Failure) during LOCA
3LOCA##: Failure of an EDG concurrent with a Failure of an EOB valve during LOCA
4LOCA##: One SACS Pump per SACS Loop during LOCA
5LOCA##: One SSWS Pump per SSWS Loop during LOCA

1LOP##: Failure of an EDG during LOP/SSE
1aLOP##: Failure of an EDG with EDG room cooler maintenance during LOP/SSE
2LOP##: Failure of an EOB Valve (SSWS Failure) during LOP/SSE
3LOP##: Failure of an EDG concurrent with a Failure of an EOB valve during LOP/SSE
4LOP##: One SACS Pump per SACS Loop during LOP/SSE
4aLOP##: One SACS Pump per SACS Loop during LOP/SSE (PRA Analysis A1&2 – B1&1)
4bLOP##: One SACS Pump per SACS Loop during LOP/SSE (PRA Analysis A1&1 – B1&1)
5LOP##: One SSWS Pump per SSWS Loop during LOP/SSE
5aLOP##: One SSWS Pump per SSWS Loop during LOP
6LOP##: One Operable SACS Loop with EDG room cooler maintenance during LOP/SSE

Normal##: Normal Operation for Two Loops

5.6 Approximate SSWS Temperatures For Varying Flows (Revision 2 Only)

The PROTO-HX™ model of the SACS heat exchangers was used to determine the corresponding SSWS temperature at various flowrates. The SACS flowrate, heat load, and heat exchanger shell-side temperatures (taken from the heat exchanger data report for each run) were tabulated and the average values calculated. Based on these average values, the SACS heat exchanger model was analyzed for SSWS flows at 5000 gpm, 7500 gpm, 10000 gpm, 12500 gpm, and 15000 gpm.

5.7 Plot and Curve-fit the UHS Temperature vs SSWS (Revision 2 Only)

The resulting UHS temperature versus SSWS flow rate data from Section 5.6 was tabulated, plotted, and curve fit using the computer program TableCurve™. The UHS temperature and SSWS flow rate data were curve fit using the following expression.

$$T = a + \frac{b}{Q^{1.5}} + \frac{c}{Q^2}$$

Where: T is the maximum UHS temperature (°F)
Q is the SSWS flow rate (gpm)
a, b, and c are curve fit coefficients

The curve-fits coefficients were incorporated into the UHS EXCEL spreadsheet along with SSWS system flowrates (from Reference 4.1.5) to determine the limiting UHS temperature for each scenario. This process was performed for each failure alignment during the three accident modes at SACS temperatures for either 95°F or 100°F. The spreadsheets can be found in Attachment (5).

5.8 Limiting Conditions

5.8.1 Revision 2 Limiting Conditions

Attachment (5) contains the UHS analysis spreadsheets for LOCA/LIA, LOP/SSE, and LOP scenarios, respectively with the reduced scope alignments updated accordingly. The maximum UHS temperature limit between the "A" and "B" loops is the overall limit for the case represented by a row in the spreadsheet. If one of the loops is completely inoperable, a zero is shown as the temperature limit. The use of the maximum UHS temperature limit reflects the fact that only one loop must remove the RHR heat load to meet the design basis of the system because the loops are redundant. The loop with the lower UHS temperature limit will be rendered inoperable at the UHS temperature limit for the other loop due to excessive SACS supply header temperature if the operators continue to remove the design RHR heat loads on both loops. If the RHR heat exchanger were isolated on the degraded loop, the loop would remain operable; however, for conservatism it is assumed to fail. Only at UHS temperatures less than both loop limits will it be possible to remove the design RHR heat load with both loops.

Under the "1 SSWS Pump per Loop" failure mode, operator action is credited in accordance with Reference 4.3.2. The SACS heat exchanger SSWS isolation valves corresponding to the out-of-service SSWS pumps are shut as an automatic consequence when a SSWS pump is secured. Un-isolating 2 SSWS heat exchanger meets the intent of the stated procedure that actually applies if 4 SSWS pumps are available. In the analysis spreadsheet, Attachment (5), 1 and 2 SSWS heat exchangers were un-isolated to determine the impact.

5.8.2 Limiting Conditions for Current / Future UHS Analyses

The same method was used for determining the limiting UHS temperature for LOCA/LIA and LOP/SSE.

5.9 Operability Determination (Revision 2 Only)

Reference 4.1.2 demonstrated that SACS is operable under all possible failure conditions, with respect to individual cooler flowrate. Because of this, the flow rates through the SACS components were not evaluated for this analysis. However, for the LOCA scenario, the heat removal across the RHR heat exchanger was compared to the required heat removal contained in Reference 4.1.1 to determine whether a lower SACS header temperature limit was required for that particular failure alignment. All the single SACS pump failure alignments did not remove the required heat load from the RHR system (121.7 Mbtu/hr for SACS at 95°F and 123.8 MBtu/hr for SACS at 100°F), but the SACS loop opposite a SACS pump failure alignment will be a fully operable SACS loop and will be capable of removing the required heat load.

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For the "One SACS pump per loop" alignments, the SACS temperature is limited to 95°F, and only one RHR heat exchanger is aligned. The model run shows that in the limiting alignment (LOCA) with the RHR and Control Room Chiller on opposite loops (see the last paragraph of Section 5.2.1.5 for details), that SACS was able to remove 124.0 Mbtu/hr from the RHR system. This exceeds the requirement of 121.7 Mbtu/hr as listed above for SACS at 95°F.

5.10 Required UHS Temperature

5.10.1 Temperature Limits for Design Basis (Single Failure) Conditions

Table 5.10.1 provides the UHS temperature limits for the limiting failure modes considered, for the LOCA/LIA and LOP/SSE. The values are taken from the "Heat Exchanger Data" reports included in Attachment (1) (electronic files on CD). **Caution: The values do not take into consideration the uncertainty analysis (discussed in Section 5.11).**

The following methodology was used in analyzing the Attachment (5) spreadsheets:

a) No failures - the limiting loop temperature was used.

b) Failures – the degraded loop (A or B) was discarded, because RHR would not be applied to the degraded loop, and the temperature was bounded by a SACS loop failure. Then the lowest temperature for each failure mode of the remaining loops was used as the limiting UHS temperature.

Table 5.10.1 summarizes the best achievable conditions for each failure mode considering the compensatory action required by current procedures.

Table 5.10.1: Design Basis Conditions
100°F SACS
Best Achievable UHS Temperature Limit (without uncertainty)

Failure Mode	LOCA/LIA UHS Temp. Limit (°F)	LOP/SSE UHS Temp. Limit (°F)
None	93.55	92.80
EOB	**90.95**	89.80
EDG	93.85	**91.60**
EDG w/EOB failure	91.95	**88.70**

The overall UHS temperature limit for the Design Basis conditions is 88.85°F (without uncertainty) due to a failure of the EOB valve to open. The EOB valves and their breakers are procedurally opened at a temperature of 85°F, this failure mode would no longer be considered credible. After the removal of this failure mode, the UHS temperature limit without uncertainty is 91.60°F for a normal alignment assuming a limiting single active failure.

With an EDG room cooler out for maintenance, the UHS temperature limit, considering a single failure, is 82.5°F without uncertainty. This corresponds to a SACS temperature of 94°F (Reference 4.1.2, section 6.4.13). This assumes two RHR heat exchangers in service at a suppression pool temperature of 183°F (see section 3.2.2).

5.10.2 Temperature Limits for AOT Conditions:

Table 5.10.2 provides the UHS temperature limits for the four multiple failure modes considered for the LOCA/LIA and LOP/SSE scenarios.

In both the LOCA/LOP and LOP/SSE scenarios, the one (1) SSWS pump per loop condition is limiting with and without operator action. Clearly, operator action is essential for the one (1) SSWS pump, one (1) SACS heat exchanger (two (2) SACS heat Exchangers total) per loop case.

The overall limiting AOT condition for a SACS temperature of 100°F is the "1 and 1" SSWS pump AOT following a LOCA/LIA with a required UHS temperature of 90.8°F, without uncertainty. However, the heat loads being removed in this configuration are based on both RHR heat exchangers receiving 10,000 gpm of 212°F flow from the suppression pool. From section 3.2.2, the actual suppression pool temperature with both RHR heat exchangers is 185°F.

Using the same methodology and logic as Section 5.10.1, the "best achievable" UHS temperature limit for AOT conditions has been summarized in Table 5.10.2 below. Note that the temperatures listed below for the "one SSWS pump per loop" are the best achievable values taken from the UHS temperature spreadsheets, but are not limiting per the discussion in the previous paragraph.

Table 5.10.2: AOT Conditions
100°F SACS (95°F for 1 SACS pump/loop)
Best Achievable UHS Temperature Limit (without uncertainty)

Failure Mode	LOCA/LIA UHS Temp. Limit (°F)	LOP/SSE UHS Temp. Limit (°F)
1 SSWS Pump Per Loop (Note 1)	**90.80**	91.35
1 SACS Pump Per Loop (Note 2)	90.00	**89.50**
1 SACS Pump Per Loop (Notes 2, 3)	N/A	89.35
1 SACS Pump Per Loop (Notes 2, 4)	N/A	78.15
1 SACS Loop Operable (Note 5)	N/A	81.75

Note 1. One operator action (four SACS heat exchangers required) see Section 5.8.1.
Note 2. Based on 95°F SACS temperature.
Note 3. PRA case (A1&2-B1&1) defined in section 3.3.7 for the "B" loop
Note 4. PRA case (A1&1-B1&1) defined in section 3.3.7 for the "A" loop
Note 5. AOT case with an EDG room cooler out for maintenance

The overall UHS temperature limit for the AOT conditions is 89.50°F (without uncertainty). Compensatory actions when in these AOT configurations are only required if the UHS temperature exceeds 67.95°F (without uncertainty, 66.45°F with 1.5°F uncertainty).

With an EDG room cooler out for maintenance, the UHS temperature limit, considering an AOT configuration, is 81.75°F without uncertainty. This corresponds to a SACS temperature of 91°F (Reference 4.1.2, section 6.4.13). Physically isolating the maintenanced room cooler from the SACS system does not result in a higher UHS temperature.

5.11 Uncertainty Analysis

Analysis uncertainty is applied to the final UHS temperature limit results consistent with the method introduced in Engineering Evaluation H-0-EG-MEE-1205 (now voided). Since UHS temperature is the parameter of interest, the sensitivity of UHS temperature to variations in each uncertainty parameter is established using a PROTO-HX™ model of the SACS heat exchanger. The additional uncertainties introduced by the analysis technique introduced in this evaluation are considered. Then the impacts of variation of each uncertainty parameter are combined using the square-root-sum-of-the-squares (SRSS) method to arrive at the overall UHS temperature limit uncertainty.

For the uncertainty analysis, engineering judgment was used to select the appropriate bias to apply to each parameter considered since benchmark testing of the SACS heat exchangers has not been performed. These biases are listed below. The SSWS flow rate uncertainty is based on Reference 4.1.7.

Thermal-Hydraulic Model Uncertainty Parameters

Parameter	Uncertainty	Reference	Method
SACS Flow Rate	+5%	4.1.3 (assumed value)	SRSS
SSWS Flow Rate	-3.0%	4.1.7	SRSS
Total SACS Heat Load	+5%	assumed	SRSS
SACS and SSWS Header Temp.	-0.79°F	4.1.6	SRSS
Tube Pluggage (SACS HX)	50 Tubes Max.	assumed	Bias
Fouling (Design)	+0%	assumed	Bias

These are consistent with the uncertainties and biases assumed in H-0-EG-MEE-1205, except that tube pluggage was previously ignored. Bias will be discussed later in this section. Five additional uncertainty considerations are necessary to account for the technique for determining and using the equations for UHS temperature limit versus average SSWS flow rate per active SACS heat exchanger.

First, on the SSWS side of the SACS heat exchangers, the average SSWS flow rate is used with the equation to determine the limiting UHS temperature. When two heat exchangers receive SSWS flow, slight flow imbalances will be present, observed from Reference 4.1.5 data to be about ± 0.4 percent of the average flow rate for the "A" loop. In cases where only one heat exchanger receives SACS flow, the active heat exchanger could actually receive 0.4 percent less flow than the average SSWS flow rate. However, the flow rates contained in Reference 4.1.5 are the limiting flow rates for the SACS heat exchangers and the minimum SSWS flow rates are used to calculate the required UHS temperature.

Second, in cases where both SACS heat exchangers receive flow but only one heat exchanger receives SSWS flow (always assumed to be 1A1E201), the active heat exchanger could actually receive the other SACS heat exchanger flow rate based on the random occurrence of the failure. Referring to results of Reference 4.1.2, based on the benchmark flow balance, the 1A2E201 SACS

heat exchanger typically receives about four to five percent more SACS flow than the 1A1E201 heat exchanger. The marginal impact of this different flow rate is difficult to assess due to competing factors. Therefore, the impact of this uncertainty will be determined by performing a model run with the 1A2E201 heat exchanger active vice the 1A1E201 heat exchanger for a limiting case, and this produces a negligible impact on the required UHS temperature.

Third, uncertainty is introduced due to potential SACS flow differences between the "A" and "B" loops. A similar consideration is unnecessary for SSWS flow because model predictions are generally available for both loops. Section 3.3.1 indicates that the conservative SACS loop has been used.

Fourth, this analysis is performed using degraded SACS pump curves as opposed to design curves. Although higher flow generally results in more total SACS heat load which more than offsets the marginally improved effectiveness of the SACS heat exchangers as it affects the UHS temperature limit, the heat loads are essentially fixed as inputs for the LOP/SSE and LOP scenarios (as long as the EDG heat loads truncate). Therefore the UHS temperature limit may be lower with a degraded pump curve due solely to the reduced effectiveness of the SACS heat exchanger. The impact of using a design pump curve will be determined for a limiting case in the LOP/SSE scenario, and the difference will be added to the overall uncertainty.

Fifth and finally, this analysis is performed for single SACS pump cases using the "A" pump only. Pump-to-pump variations in SACS flow rate due to piping arrangement differences may impact the results. The LOP-SSE 212.2 configuration was evaluated with a failure of the C SACS pump and this had no impact on the required UHS temperature.

The additional parameters from above (with the exception of the design SACS pump curve) are captured by the total uncertainty by using the most limiting values. The design SACS pump curve introduces an uncertainty of 0.2°F. This will be added to the overall uncertainty found by SRSS methodology.

The effects of bias have to be addressed separately to determine the overall uncertainty. For the parameters listed above, the results would fall somewhere in a given range of values, and the SRSS methodology could be applied to the overall uncertainty. In determining the result due to bias, the error is either present or it is not, and the bias uncertainty must be added to the total uncertainty. In the case of plugged tubes, the analysis assumes 50 plugged tubes.

A sensitivity study was performed on the effects of plugged tubes on the SACS heat exchanger. Using the limiting alignment determined in Sections 5.10.1 and 5.10.2 (LOP/SSE with 1 SACS pump per loop), the maximum UHS temperature was calculated for zero plugged tubes and for 50 plugged tubes. The results of the study show that the temperature limit for the UHS based on a SSWS flow of 10000 gpm are the same to the nearest tenth of a degree (see Attachment 8), therefore, the effects of plugged tubes produces a negligible impact on the required UHS temperature, and is not included for the calculation of overall uncertainty. The impact of greater-than-design fouling was previously calculated but ignored for the final computation of overall uncertainty. These biases are applied to the operating point conditions for a limiting case and the impact on SSWS inlet temperature is calculated using the PROTO-HX™ model of the SACS heat exchanger.

For the LOP/SSE scenario, the 212.2 failure alignment was considered for the uncertainty analysis. The output for this uncertainty analysis is contained as an Attachment on CD (see Table 5.11a).

Table 5.11a - Uncertainty Analysis for the 212.2 Failure Alignment of the LOP/SSE Scenario

Parameter	Nominal Value	Uncert. Bias	Input Value	Nom. UHS Temp. (°F)	Calc. UHS Temp. (°F)	UHS Temp. Diff. (°F)
SSWS Temp. (°F)	88.9	-0.79	N/A	88.9	88.1	-0.8
SACS Flow Rate (gpm)	7118.38	+5%	7474.30	88.9	88.7	-0.2
SSWS Flow Rate (gpm)	10,000	-3.0%	9700	88.9	88.7	-0.2
SACS Heat Load (MBtu/hr)	84.098	+5%	88.303	88.9	88.6	-0.3
SACS Temp. (°F)	94.98	-0.79	94.18	88.9	88.1	-0.8
Total Uncert. (SRSS)				88.9	87.7	-1.2

For the LOCA scenario, the 222.2 failure alignment was considered for the uncertainty analysis. The output for this uncertainty analysis is contained as an Attachment on CD (see Table 5.11b).

Table 5.11b - Uncertainty Analysis for the 222.2 Failure Alignment of the LOCA Scenario

Parameter	Nominal Value	Uncert. Bias	Input Value	Nom. UHS Temp. (°F)	Calc. UHS Temp. (°F)	UHS Temp. Diff. (°F)
SSWS Temp. (°F)	87.2	-0.79	N/A	87.2	86.4	-0.8
SACS Flow Rate (gpm)	9416.85	+5%	9887.74	87.2	86.9	-0.3
SSWS Flow Rate (gpm)	10,000	-3.0%	9700	87.2	86.9	-0.3
SACS Heat Load (MBtu/hr)	86.150	+5%	90.4575	87.2	86.8	-0.4
SACS Temp. (°F)	95.00	-0.79	94.21	87.2	86.4	-0.8
Total Uncert. (SRSS)				87.2	85.9	-1.3

To be conservative, the higher of the uncertainties should be used and an uncertainty of 1.3°F is the overall uncertainty. An additional uncertainty of 0.2°F is added to the overall uncertainty to account

for the difference between the design and degraded pumps. The total uncertainty that should be applied to the UHS temperatures is 1.3°F + 0.2°F = **1.5°F**.

5.12 Limiting UHS Temperature

Table 5.12 provides the SACS UHS temperature limits compiled from Tables 5.10.1 and 5.10.2 for the limiting conditions. The values listed include the temperature uncertainty of 1.5°F (calculated in the previous section) and have been rounded down to the nearest tenth of a degree.

Table 5.12 - Best Achievable UHS Temperature Limit for Each Scenario (Limiting Conditions Shown In boldface - 1.5°F Uncertainty Applied)

Condition	Failure Mode	SACS Temperature (°F)	LOCA/LIA – UHS Temp. Limit (°F)	LOP/SSE - UHS Temp. Limit (°F)
Design Basis	None	100	92.0	91.3
Design Basis	EOB	100	89.4	**88.3**
Design Basis	EDG	100	92.3	90.1
Design Basis	EDG with EOB failure	100	90.4	**87.2**
AOT	1 SACS Pump Per Loop	95	88.5	**88.0**
AOT	1 SSWS Pump Per Loop (Note 1)	100	**89.3**	89.8

Notes 1. One (1) operator action, see Section 5.8.1.

The UHS temperature is limited to 81.0°F assuming a single failure and an EDG room cooler out for maintenance. The UHS temperature is limited to 80.2°F in an AOT condition when a SACS pump and an EDG room cooler are out for maintenance simultaneously.

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REVIEWER/VERIFIER, DATE		KCK 3/20/2002		RED 12/06/2005		

6.0 CONCLUSIONS

The maximum UHS temperature curves produced by this calculation determined the maximum allowable UHS temperature for a given SACS configuration and SSWS flow rate. An uncertainty of 1.5°F was applied to the values determined from these curves.

Adequate cooling to all safety related loads can be provided for the design basis and limited multiple failure conditions considered with a SACS header temperature of 95°F and 100°F.

No Failures	91.3°F
EOB Valve Failure	88.3°F
EDG Failure	90.1°F
EDG w/EOB Failure	87.2°F
1 SACS Pump/Loop	88.0°F
1 SSWS Pump/Loop	89.3°F
Normal	88.7°F

The Ultimate Heat Sink (UHS) temperature limit for DBA scenarios assuming a single active failure is 87.2°F. This failure mode is dependent on an EOB valve, 1EA-HV2356A(B), failure. It can be eliminated by opening the EOB under administrative controls, and racking out the breakers (10B212 MCC No. 131 and 10B222 MCC No. 131) to prevent the spurious actuation of the valve. Reference 4.3.2 directs the operators to open the EOB valves at a river temperature of 85°F. No change is recommended to this requirement.

The UHS temperature limit for conditions resulting from combinations of design basis failures concurrent with equipment outages permitted by Technical Specification AOT Action Statements with only one (1) SACS pump per loop and two (2) SACS heat exchangers per loop is 88.0°F. This meets the Technical Specification limit of 88°F.

The SACS system design allows for a SACS heat exchanger outlet temperature limit of 100°F with the exceptions listed below. The Technical Specification has been updated to reflect the UHS temperature limits using the higher SACS temperatures. It is recommended that for a SSWS/SACS loop outage, normal design basis alignments with all equipment operating, or a 30-day SSWS/SACS pump AOT, **the UHS limit should be 88.0°F. This limit may be exceeded for an indefinite period of time up to a value of 89.0°F provided that all SSWS/SACS/EDGs components are operable.** An indefinite period of time is allowed since the analysis demonstrates that a limiting single failure (active short-term or passive long-term) can be accommodated up to 90.1°F (the limiting single failure is an EDG failure without a concurrent EOB failure). This recommendation was included in LCR H98-02.

The UHS temperature limit for normal operating conditions is required to be 89°F. This temperature limit will ensure that the normal SACS operating temperature limit of 95°F can be maintained while supplying the non-safety related TACS loads. The results of the normal two-loop alignment model run show that the limiting temperature is 88.7°F. This is based on the A-loop removing the full TACS load as specified in Reference 4.1.1 and the B-Loop removing the SFP, PCIG, Control Room Chiller and 1E Panel Chiller heat loads. The SACS abnormal operating procedure (Reference 4.3.6) states that the operators can reduce reactor power or remove components from service as needed to

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maintain SACS temperatures less than 95°F. This ensures that the Technical Specification limit of 89°F can be met.

7.0 Output Documents

7.1 SH.OP-AP.ZZ-0108, Exhibit 3
7.2 HC.OP-AB.COOL-0001, Conditions H and I
7.3 HC.OP-AB.COOL-0002, Conditions H and I
7.4 Technical Specification 3/4.7.1.3, Ultimate Heat Sink

8.0 Design Margin

The margin to the Technical Specification requirement of 88°F is zero when considering the AOT cases. When all SSWS/SACS/EDGs components are operable and when the EOB valves are opened, the margin to the Technical Specification requirement of 89°F is 1.1°F.

9.0 DOCUMENTS AFFECTED

Procedure SH.OP-AP.ZZ-0108(Q), Exhibit 3, should be revised as follows for the EDG Room Recirc Units 1-A-V-412 through 1-H-V-412 (Reference Order 80087020, Activity 0010):

Required Action when one EDG room cooler is inoperable:

- When a SACS pump is out of service and when river water temperature is greater than 80°F, declare its respective EDG inoperable.
- In any other SACS configuration, when river water temperature is greater than 81°F, declare its respective EDG inoperable.

Required Action when two EDG room coolers are inoperable:

- With both EDG room coolers inoperable, declare its respective EDG inoperable.

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REVIEWER/VERIFIER, DATE		KCK 3/20/2002		RED 12/06/2005				

ATTACHMENT 5

UHS TEMPERATUARE ANALYSIS SPREADSHEET

A Loop	B Loop	AOT	A SW Pmp	C SW Pmp	B SW Pmp	D SW Pmp	A Supply	B Supply	A1 SW Hx	A2 SW Hx	B1 SW Hx	B2 SW Hx	A Discharge	B Discharge	A EOB	B EOB	A SACS Pmp	C SACS Pmp	B SACS Pmp	D SACS Pmp	A1 SACS Hx	A2 SACS Hx	B1 SACS Hx	B2 SACS Hx	A EDG	C EDG	B EDG	D EDG	A+B Loop	A1 SSWS Flow	A2 SSWS Flow	B1 SSWS Flow	B2 SSWS Flow	A Loop UHS	B Loop UHS	SSWS Config
No Failures																																				
222.2	222.2																												22	11025.0	10977.0	10954.0	11049.0	88.12	88.12	01x2_c.plu
222.2B	222.2B																												22	11025.0	10977.0	10954.0	11049.0	88.24	88.24	01x2_c.plu
EOB Failures																																				
222.2	222.2															X													22	8344.0	8310.0	8520.0	8591.0	84.97	85.33	01x1b_c.plu
SSWS Pump Failures																																				
122.2	222.2	30d		X						C																			22	11545.0	0.0	11546.0	11647.0	62.81	88.59	18x2_c.plu
SSWS HX Failures																																				
122.2	222.2	72 h								X																			22	14203.0	0.0	11420.0	11520.0	65.85	88.49	04x2_c.plu
122.2	222.2	72 h							X																				22	0.0	14154.0	11423.0	11523.0	65.81	88.50	05x2_c.plu
EDG Failures																																				
112.1	222.2	14 d		C						C								C								X			12	11545.0	0.0	11546.0	11647.0	63.68	88.59	18x2_c.plu
112.1	222.2	14 d		C						C						C		C								X			12	9462.0	0.0	9698.0	9781.0	60.76	86.90	18x1a_c.plu
212.1	222.2	14 d		C														C								X			12	7745.0	7714.0	11334.0	11433.0	87.09	88.43	14x2_c.plu
212.1	222.2	14 d		C												C		C								X			12	6068.0	6045.0	9283.0	9361.0	83.86	86.40	14x1a_c.plu
111.1	222.2	14 d		C						C								C				C				X			12	11545.0	0.0	11546.0	11647.0	81.08	88.59	18x2_c.plu
111.1	222.2	14 d		C						C						C		C				C				X			12	9462.0	0.0	9698.0	9781.0	77.14	86.90	18x1a_c.plu
211.1	222.2	14 d		C														C				C				X			12	7745.0	7714.0	11334.0	11433.0	71.87	88.43	14x2_c.plu
211.1	222.2	14 d		C												C		C				C				X			12	6068.0	6045.0	9283.0	9361.0	63.24	86.40	14x1a_c.plu
SACS Pump Failures																																				
212.2	222.2	30 d																X											22	11025.0	10977.0	10954.0	11049.0	89.87	88.12	01x2_c.plu
SACS HX Failures																																				
221.2	222.2	72 h																				X							22	11025.0	10977.0	10954.0	11049.0	78.13	88.12	01x2_c.plu
AOT - SACS Loop Failures																																				
202.2	222.4	72 h															A	A											24	11025.0	10977.0	10954.0	11049.0	0.00	86.70	01x2_c.plu
102.2	222.4	72 h							P								A	A											24	0.0	14154.0	11423.0	11523.0	0.00	87.14	05x2_c.plu
2.2	222.4	72 h							P	P							A	A											24	0.0	0.0	11974.0	12080.0	0.00	87.61	55x2_c.plu
202.2	222.4	72 h													A		A	A											24	8344.0	8310.0	8520.0	8591.0	0.00	83.39	01x1b_c.plu
AOT - SSWS Loop Failures																																				
22.2	222.4	72 h	A	A					C	C																			24	0.0	0.0	11974.0	12080.0	0.00	87.61	55x2_c.plu
22.2	222.4	72 h	A	A					C	C					A														24	0.0	0.0	10915.0	11009.0	0.00	86.66	55x1b_c.plu
AOT - One SACS Pump Per Loop																																				
212.2	212.2	72 h															A		A										22	11025.0	10977.0	10954.0	11049.0	90.21	94.12	01x2_c.plu
AOT - One SSWS Pump Per Loop																																				
122.2	122.2	72 h		A	A					C	C																		22	12392.0	0.0	0.0	12447.0	63.95	64.02	52x2_c.plu
122.2	222.2	72 h		A	A					C																			22	12198.0	0.0	8392.0	8462.0	63.71	85.13	45x2_c.plu
222.2	222.2	72 h		A	A																								22	8211.0	8178.0	8246.0	8315.0	84.75	84.89	34x2_c.plu

Note: Failures were marked in the appropriate column with an "X". Consequences of the specified failures were marked with a "C", and operator actions were marked with an "P". The specific AOT conditions considered were developed by marking the AOT failures with an "A".

A Loop	B Loop	AOT	A SW Pmp	C SW Pmp	B SW Pmp	D SW Pmp	A Supply	B Supply	A1 SW Hx	A2 SW Hx	B1 SW Hx	B2 SW Hx	A Discharge	B Discharge	A EOB	B EOB	A SACS Pmp	C SACS Pmp	B SACS Pmp	D SACS Pmp	A1 SACS Hx	A2 SACS Hx	B1 SACS Hx	B2 SACS Hx	A EDG	C EDG	B EDG	D EDG	A+B Loop	A1 SSWS Flow	A2 SSWS Flow	B1 SSWS Flow	B2 SSWS Flow	A Loop UHS	B Loop UHS	SSWS Config
No Failures																																				
222.2	222.2																												22	10262.0	10217.0	10054.0	10137.0	88.33	88.20	01x2_p.plu
EOB Failures																																				
222.2	222.2														X														22	7459.0	7427.0	7778.0	7840.0	84.58	85.26	01x1b_p.plu
SSWS Pump Failures																																				
122.2	222.2	30d		X						C																			22	10797.0	0.0	10538.0	10625.0	61.02	88.62	18x2_p.plu
SSWS HX Failures																																				
122.2	222.2	72 h								X																			22	11922.0	0.0	11519.0	11621.0	62.58	89.35	04x2_p.plu
122.2	222.2	72 h							X																				22	0.0	11877.0	11523.0	11625.0	62.53	89.35	05x2_p.plu
EDG Failures																																				
112.1	222.2	14 d		C						C								C								X			12	10797.0	0.0	10538.0	10625.0	60.53	88.62	18x2_p.plu
112.1	222.2	14 d		C						C						C		C								X			12	8609.0	0.0	8628.0	8697.0	56.79	86.59	18x1a_p.plu
212.1	222.2	14 d		C														C								X			12	9026.0	8990.0	8966.0	9031.0	88.83	87.02	14x2_p.plu
212.1	222.2	14 d		C												C		C								X			12	6852.0	6826.0	7232.0	7284.0	85.73	84.20	14x1a_p.plu
111.1	222.2	14 d		C						C								C				C				X			12	10797.0	0.0	10538.0	10625.0	79.55	88.62	18x2_p.plu
111.1	222.2	14 d		C						C						C		C				C				X			12	8609.0	0.0	8628.0	8697.0	74.38	86.59	18x1a_p.plu
211.1	222.2	14 d		C														C				C				X			12	9026.0	8990.0	8966.0	9031.0	75.54	87.02	14x2_p.plu
211.1	222.2	14 d		C												C		C				C				X			12	6852.0	6826.0	7232.0	7284.0	67.13	84.20	14x1a_p.plu
SACS Pump Failures																																				
212.2	222.2	30 d																X											22	10262.0	10217.0	10054.0	10137.0	89.45	88.20	01x2_p.plu
SACS HX Failures																																				
221.2	222.2	72 h																				X							22	10262.0	10217.0	10054.0	10137.0	75.34	88.20	01x2_p.plu
AOT - SACS Loop Failures																																				
202.2	222.4	72 h															A	A											24	10262.0	10217.0	10054.0	10137.0	0.00	86.21	01x2_p.plu
102.2	222.4	72 h							P								A	A											24	0.0	11877.0	11523.0	11625.0	0.00	87.69	05x2_p.plu
2.2	222.4	72 h							P	P							A	A											24	0.0	0.0	13221.0	13343.0	0.00	88.91	11x2_p.plu
AOT - SSWS Loop Failures																																				
22.2	222.4	72 h	A	A					C	C																			24	0.0	0.0	10514.0	10599.0	0.00	86.73	55x2_p.plu
22.2	222.4	72 h							A	A																			24	0.0	0.0	13221.0	13343.0	0.00	88.91	11x2_p.plu
AOT - One SACS Pump Per Loop																																				
212.2	212.2	72 h															A		A										22	10262.0	10217.0	10054.0	10137.0	89.96	94.40	01x2_p.plu
AOT - One SSWS Pump Per Loop																																				
122.2	122.2	72 h		A	A					C	C																		22	11049.0	0.0	0.0	10911.0	61.40	61.20	52x2_p.plu
122.2	222.2	72 h		A	A					C																			22	9090.0	0.0	8783.0	8868.0	57.69	86.81	45x2_p.plu
222.2	222.2	72 h		A	A																								22	7511.0	7480.0	7367.0	7425.0	84.68	84.48	34x2_p.plu

Note: Failures were marked in the appropriate column with an "X". Consequences of the specified failures were marked with a "C", and operator actions were marked with an "P". The specific AOT conditions considered were developed by marking the AOT failures with an "A".

A Loop	B Loop	AOT	A SW Pmp	C SW Pmp	B SW Pmp	D SW Pmp	A Supply	B Supply	A1 SW Hx	A2 SW Hx	B1 SW Hx	B2 SW Hx	A Discharge	B Discharge	A EOB	B EOB	A SACS Pmp	C SACS Pmp	B SACS Pmp	D SACS Pmp	A1 SACS Hx	A2 SACS Hx	B1 SACS Hx	B2 SACS Hx	A EDG	C EDG	B EDG	D EDG	A+B Loop	A1 SSWS Flow	A2 SSWS Flow	B1 SSWS Flow	B2 SSWS Flow		A Loop UHS	B Loop UHS	SSWS Config
No Failures																																					
222.2	222.2																												22	12099.0	12044.0	11844.0	11945.0		89.67	89.56	01x0_p.plu
SSWS Pump Failures																																					
122.2	222.2	30d		X						C																			22	12363.0	0.0	11877.0	11977.0		63.10	89.58	18x0_p.plu
SSWS HX Failures																																					
122.2	222.2	72 h								X																			22	13913.0	0.0	13232.0	13352.0		64.60	90.31	04x0_p.plu
122.2	222.2	72 h							X																				22	0.0	13858.0	13236.0	13355.0		64.55	90.31	05x0_p.plu
EDG Failures																																					
112.1	222.2	14 d		C						C								C								X			12	12363.0	0.0	11877.0	11977.0		62.21	89.58	18x0_p.plu
212.1	222.2	14 d		C														C								X			12	10506.0	10464.0	10419.0	10497.0		90.05	88.52	14x0_p.plu
111.1	222.2	14 d		C						C								C				C				X			12	12363.0	0.0	11877.0	11977.0		81.96	89.58	18x0_p.plu
211.1	222.2	14 d		C														C				C				X			12	10506.0	10464.0	10419.0	10497.0		78.97	88.52	14x0_p.plu
SACS Pump Failures																																					
212.2	222.2	30 d																X											22	12099.0	12044.0	11844.0	11945.0		90.63	89.56	01x0_p.plu
SACS HX Failures																																					
221.2	222.2	72 h																				X							22	12099.0	12044.0	11844.0	11945.0		78.88	89.56	01x0_p.plu
AOT - SACS Loop Failures																																					
202.2	222.4	72 h															A	A											24	12099.0	12044.0	11844.0	11945.0		0.00	87.95	01x0_p.plu
102.2	222.4	72 h							P								A	A											24	0.0	13858.0	13236.0	13355.0		0.00	88.92	05x0_p.plu
2.2	222.4	72 h							P	P							A	A											24	0.0	0.0	14798.0	14938.0		0.00	89.74	11x0_p.plu
AOT - SSWS Loop Failures																																					
22.2	222.4	72 h	A	A					C	C																			24	0.0	0.0	11648.0	11743.0		0.00	87.79	55x0_.plu
22.2	222.4	72 h							A	A																			24	0.0	0.0	14798.0	14938.0		0.00	89.74	11x0_p.plu
AOT - One SACS Pump Per Loop																																					
212.2	212.2	72 h															A		A										22	12099.0	12044.0	11844.0	11945.0		91.03	94.55	01x0_p.plu
AOT - One SSWS Pump Per Loop																																					
122.2	122.2	72 h		A	A					C	C																		22	12393.0	0.0	0.0	12252.0		63.13	62.97	52x0_p.plu
122.2	222.2	72 h		A	A					C																			22	10381.0	0.0	9893.0	9978.0		60.33	88.05	45x0_p.plu
222.2	222.2	72 h		A	A																								22	8573.0	8537.0	8403.0	8470.0		86.44	86.27	34x0_p/plu

Note: Failures were marked in the appropriate column with an "X". Consequences of the specified failures were marked with a "C", and operator actions were marked with an "P". The specific AOT conditions considered were developed by marking the AOT failures with an "A".

A Loop	B Loop	AOT	A SW Pmp	C SW Pmp	B SW Pmp	D SW Pmp	A Supply	B Supply	A1 SW HX	A2 SW HX	B1 SW HX	B2 SW HX	A Discharge	B Discharge	A EOB	B EOB	A SACS Pmp	C SACS Pmp	B SACS Pmp	D SACS Pmp	A1 SACS HX	A2 SACS HX	B1 SACS HX	B2 SACS HX	A EDG	C EDG	B EDG	D EDG	A+B Loop	A1 SSWS Flow	A2 SSWS Flow	B1 SSWS Flow	B2 SSWS Flow		A Loop UHS	B Loop UHS	SSWS Config
No Failures																																					
222.2	222.2																												22	10262.0	10217.0	10054.0	10137.0		87.83	87.49	01x2_p.plu
EOB Failures																																					
222.2	222.2															X													22	7459.0	7427.0	7778.0	7840.0		83.60	84.33	01x1b_p.plu
SSWS Pump Failures																																					
122.2	222.2	30d		X						C																			22	10797.0	0.0	10538.0	10625.0		62.35	87.95	18x2_p.plu
SSWS HX Failures																																					
122.2	222.2	72 h								X																			22	11922.0	0.0	11519.0	11621.0		64.05	88.74	04x2_p.plu
122.2	222.2	72 h							X																				22	0.0	11877.0	11523.0	11625.0		63.98	88.75	05x2_p.plu
EDG Failures																																					
112.1	222.2	14 d		C						C								C								X			12	10797.0	0.0	10538.0	10625.0		61.47	87.95	18x2_p.plu
112.1	222.2	14 d		C						C						C		C								X			12	8609.0	0.0	8628.0	8697.0		57.55	85.75	18x1a_p.plu
212.1	222.2	14 d		C														C								X			12	9026.0	8990.0	8966.0	9031.0		88.41	86.22	14x2_p.plu
212.1	222.2	14 d		C												C		C								X			12	6852.0	6826.0	7232.0	7284.0		85.13	83.20	14x1a_p.plu
111.1	222.2	14 d		C						C								C				C				X			12	10797.0	0.0	10538.0	10625.0		79.37	87.95	18x2_p.plu
111.1	222.2	14 d		C						C						C		C				C				X			12	8609.0	0.0	8628.0	8697.0		73.67	85.75	18x1a_p.plu
211.1	222.2	14 d		C														C				C				X			12	9026.0	8990.0	8966.0	9031.0		74.87	86.22	14x2_p.plu
211.1	222.2	14 d		C												C		C				C				X			12	6852.0	6826.0	7232.0	7284.0		66.29	83.20	14x1a_p.plu
SACS Pump Failures																																					
212.2	222.2	30 d																X											22	10262.0	10217.0	10054.0	10137.0		89.09	87.49	01x2_p.plu
SACS HX Failures																																					
221.2	222.2	72 h																				X							22	10262.0	10217.0	10054.0	10137.0		74.30	87.49	01x2_p.plu
AOT - SACS Loop Failures																																					
202.2	222.4	72 h															A	A											24	10262.0	10217.0	10054.0	10137.0		0.00	85.89	01x2_p.plu
102.2	222.4	72 h							P								A	A											24	0.0	11877.0	11523.0	11625.0		0.00	87.38	05x2_p.plu
2.2	222.4	72 h							P	P							A	A											24	0.0	0.0	13221.0	13343.0		0.00	88.61	11x2_p.plu
202.2	222.4	72 h													A		A	A											24	7459.0	7427.0	7778.0	7840.0		0.00	82.14	01x1b_p.plu
AOT - SSWS Loop Failures																																					
22.2	222.4	72 h	A	A					C	C																			24	0.0	0.0	10514.0	10599.0		0.00	86.41	55x2_p.plu
22.2	222.4	72 h							A	A																			24	0.0	0.0	13221.0	13343.0		0.00	88.61	11x2_p.plu
22.2	222.4	72 h	A	A					C	C					A														24	0.0	0.0	9353.0	9427.0		0.00	84.97	55x1b_p.plu
AOT - One SACS Pump Per Loop																																					
212.2	212.2	72 h															A		A										22	10262.0	10217.0	10054.0	10137.0		89.53	93.92	01x2_p.plu
212.2	211.2	72 h															A		A				X						22	10262.0	10217.0	10054.0	10137.0		89.53	91.34	01x2_p.plu
211.2	211.2	72 h															A		A			X	X						22	10262.0	10217.0	10054.0	10137.0		77.71	91.34	01x2_p.plu
AOT - One SSWS Pump Per Loop																																					
122.2	122.2	72 h		A	A					C	C																		22	11049.0	0.0	0.0	10911.0		62.77	62.55	52x2_p.plu
122.2	222.2	72 h		A	A					C																			22	9090.0	0.0	8793.0	8868.0		58.77	85.99	45x2_p.plu
222.2	222.2	72 h		A	A																								22	7511.0	7480.0	7367.0	7425.0		83.71	83.50	34x2_p.plu

Note: Failures were marked in the appropriate column with an "X". Consequences of the specified failures were marked with a "C", and operator actions were marked with an "P". The specific AOT conditions considered were developed by marking the AOT failures with an "A".

A Loop	B Loop	AOT	A SW Pmp	C SW Pmp	B SW Pmp	D SW Pmp	A Supply	B Supply	A1 SW Hx	A2 SW Hx	B1 SW Hx	B2 SW Hx	A Discharge	B Discharge	A EOB	B EOB	A SACS Pmp	C SACS Pmp	B SACS Pmp	D SACS Pmp	A1 SACS Hx	A2 SACS Hx	B1 SACS Hx	B2 SACS Hx	A EDG	C EDG	B EDG	D EDG	A+B Loop	A1 SSWS Flow	A2 SSWS Flow	B1 SSWS Flow	B2 SSWS Flow	A Loop UHS	B Loop UHS	SSWS Config
No Failures																																				
222.2	222.2																												22	11025.0	10977.0	10954.0	11049.0	93.45	93.45	01x2_c.plu
222.2B	222.2B																												22	11025.0	10977.0	10954.0	11049.0	93.49	93.49	01x2_c.plu
EOB Failures																																				
222.2	222.2															X													22	8344.0	8310.0	8520.0	8591.0	90.43	90.79	01x1b_c.plu
SSWS Pump Failures																																				
122.2	222.2	30d		X						C																			22	11545.0	0.0	11548.0	11647.0	68.97	93.90	18x2_c.plu
SSWS HX Failures																																				
122.2	222.2	72 h								X																			22	14203.0	0.0	11420.0	11520.0	71.89	93.81	04x2_c.plu
122.2	222.2	72 h							X																				22	0.0	14154.0	11423.0	11523.0	71.85	93.81	05x2_c.plu
EDG Failures																																				
112.1	222.2	14 d		C						C								C								X			12	11545.0	0.0	11546.0	11647.0	69.78	93.90	18x2_c.plu
112.1	222.2	14 d		C						C						C		C								X			12	9462.0	0.0	9698.0	9781.0	66.96	92.28	18x1a_c.plu
212.1	222.2	14 d		C														C								X			12	7745.0	7714.0	11334.0	11433.0	92.45	93.75	14x2_c.plu
212.1	222.2	14 d		C												C		C								X			12	6068.0	6045.0	9283.0	9361.0	89.15	91.81	14x1a_c.plu
111.1	222.2	14 d		C						C								C				C				X			12	11545.0	0.0	11546.0	11647.0	86.61	93.90	18x2_c.plu
111.1	222.2	14 d		C						C						C		C				C				X			12	9462.0	0.0	9698.0	9781.0	82.81	92.28	18x1a_c.plu
211.1	222.2	14 d		C														C				C				X			12	7745.0	7714.0	11334.0	11433.0	77.72	93.75	14x2_c.plu
211.1	222.2	14 d		C												C		C				C				X			12	6068.0	6045.0	9283.0	9361.0	69.37	91.81	14x1a_c.plu
SACS Pump Failures																																				
212.2	222.2	30 d																X											22	11025.0	10977.0	10954.0	11049.0	95.09	93.45	01x2_c.plu
SACS HX Failures																																				
221.2	222.2	72 h																				X							22	11025.0	10977.0	10954.0	11049.0	81.79	93.45	01x2_c.plu
AOT - SACS Loop Failures																																				
202.2	222.4	72 h															A	A											24	11025.0	10977.0	10954.0	11049.0	0.00	91.98	01x2_c.plu
102.2	222.4	72 h							P								A	A											24	0.0	14154.0	11423.0	11523.0	0.00	92.41	05x2_c.plu
2.2	222.4	72 h							P	P							A	A											24	0.0	0.0	11974.0	12080.0	0.00	92.86	55x2_c.plu
202.2	222.4	72 h													A		A	A											24	8344.0	8310.0	8520.0	8591.0	0.00	88.79	01x1b_c.plu
AOT - SSWS Loop Failures																																				
22.2	222.4	72 h	A	A					C	C																			24	0.0	0.0	11974.0	12080.0	0.00	92.86	55x2_c.plu
22.2	222.4	72 h	A	A					C	C					A														24	0.0	0.0	10915.0	11009.0	0.00	91.94	55x1b_c.plu
AOT - One SSWS Pump Per Loop																																				
122.2	122.2	72 h		A	A					C	C																		22	12392.0	0.0	0.0	12447.0	70.07	70.13	52x2_c.plu
122.2	222.2	72 h		A	A					C																			22	12198.0	0.0	8392.0	8462.0	69.83	90.59	45x2_c.plu
222.2	222.2	72 h		A	A																								22	8211.0	8178.0	8246.0	8315.0	90.22	90.36	34x2_c.plu

Note: Failures were marked in the appropriate column with an "X". Consequences of the specified failures were marked with a "C", and operator actions were marked with an "P". The specific AOT conditions considered were developed by marking the AOT failures with an "A".

A Loop	B Loop	AOT	A SW Pmp	C SW Pmp	B SW Pmp	D SW Pmp	A Supply	B Supply	A1 SW Hx	A2 SW Hx	B1 SW Hx	B2 SW Hx	A Discharge	B Discharge	A EOB	B EOB	A SACS Pmp	C SACS Pmp	B SACS Pmp	D SACS Pmp	A1 SACS Hx	A2 SACS Hx	B1 SACS Hx	B2 SACS Hx	A EDG	C EDG	B EDG	D EDG	A+B Loop	A1 SSWS Flow	A2 SSWS Flow	B1 SSWS Flow	B2 SSWS Flow		A Loop UHS	B Loop UHS	SSWS Config
No Failures																																					
222.2	222.2																												22	10262.0	10217.0	10054.0	10137.0		93.39	93.26	01x2_p.plu
EOB Failures																																					
222.2	222.2															X													22	7459.0	7427.0	7778.0	7840.0		89.61	90.30	01x1b_p.plu
SSWS Pump Failures																																					
122.2	222.2	30d		X						C																			22	10797.0	0.0	10538.0	10625.0		66.19	93.69	18x2_p.plu
SSWS HX Failures																																					
122.2	222.2	72 h								X																			22	11922.0	0.0	11519.0	11621.0		67.75	94.43	04x2_p.plu
122.2	222.2	72 h							X																				22	0.0	11877.0	11523.0	11625.0		67.69	94.44	05x2_p.plu
EDG Failures																																					
112.1	222.2	14 d		C						C								C								X			12	10797.0	0.0	10538.0	10625.0		65.60	93.69	18x2_p.plu
112.1	222.2	14 d		C						C						C		C								X			12	8609.0	0.0	8628.0	8697.0		61.90	91.63	18x1a_p.plu
212.1	222.2	14 d		C														C								X			12	9026.0	8990.0	8966.0	9031.0		93.84	92.07	14x2_p.plu
212.1	222.2	14 d		C												C		C								X			12	6852.0	6826.0	7232.0	7284.0		90.70	89.23	14x1a_p.plu
111.1	222.2	14 d		C						C								C				C				X			12	10797.0	0.0	10538.0	10625.0		84.65	93.69	18x2_p.plu
111.1	222.2	14 d		C						C						C		C				C				X			12	8609.0	0.0	8628.0	8697.0		79.46	91.63	18x1a_p.plu
211.1	222.2	14 d		C														C				C				X			12	9026.0	8990.0	8966.0	9031.0		80.64	92.07	14x2_p.plu
211.1	222.2	14 d		C												C		C				C				X			12	6852.0	6826.0	7232.0	7284.0		72.23	89.23	14x1a_p.plu
SACS Pump Failures																																					
212.2	222.2	30 d																X											22	10262.0	10217.0	10054.0	10137.0		94.51	93.26	01x2_p.plu
SACS HX Failures																																					
221.2	222.2	72 h																				X							22	10262.0	10217.0	10054.0	10137.0		80.46	93.26	01x2_p.plu
AOT - SACS Loop Failures																																					
202.2	222.4	72 h															A	A											24	10262.0	10217.0	10054.0	10137.0		0.00	91.30	01x2_p.plu
102.2	222.4	72 h							P								A	A											24	0.0	11877.0	11523.0	11625.0		0.00	92.76	05x2_p.plu
2.2	222.4	72 h							P	P							A	A											24	0.0	0.0	13221.0	13343.0		0.00	93.96	11x2_p.plu
AOT - SSWS Loop Failures																																					
22.2	222.4	72 h	A	A					C	C																			24	0.0	0.0	10514.0	10599.0		0.00	91.81	55x2_p.plu
22.2	222.4	72 h							A	A																			24	0.0	0.0	13221.0	13343.0		0.00	93.96	11x2_p.plu
AOT - One SSWS Pump Per Loop																																					
122.2	122.2	72 h		A	A					C	C																		22	11049.0	0.0	0.0	10911.0		66.57	66.36	52x2_p.plu
122.2	222.2	72 h		A	A					C																			22	9090.0	0.0	8793.0	8868.0		62.87	91.85	45x2_p.plu
222.2	222.2	72 h		A	A																								22	7511.0	7480.0	7367.0	7425.0		89.71	89.51	34x2_p.plu

Note: Failures were marked in the appropriate column with an "X". Consequences of the specified failures were marked with a "C", and operator actions were marked with an "P". The specific AOT conditions considered were developed by marking the AOT failures with an "A".

A Loop	B Loop	AOT	A SW Pmp	C SW Pmp	B SW Pmp	D SW Pmp	A Supply	B Supply	A1 SW Hx	A2 SW Hx	B1 SW Hx	B2 SW Hx	A Discharge	B Discharge	A EOB	B EOB	A SACS Pmp	C SACS Pmp	B SACS Pmp	D SACS Pmp	A1 SACS Hx	A2 SACS Hx	B1 SACS Hx	B2 SACS Hx	A EDG	C EDG	B EDG	D EDG	A+B Loop	A1 SSWS Flow	A2 SSWS Flow	B1 SSWS Flow	B2 SSWS Flow	A Loop UHS	B Loop UHS	SSWS Config
No Failures																																				
222.2	222.2																												22	12099.0	12044.0	11844.0	11945.0	94.75	94.64	01x0_p.plu
SSWS Pump Failures																																				
122.2	222.2	30d		X						C																			22	12363.0	0.0	11877.0	11977.0	68.26	94.66	18x0_p.plu
SSWS HX Failures																																				
122.2	222.2	72 h								X																			22	13913.0	0.0	13232.0	13352.0	69.76	95.41	04x0_p.plu
122.2	222.2	72 h							X																				22	0.0	13858.0	13236.0	13355.0	69.71	95.41	05x0_p.plu
EDG Failures																																				
~~112.1~~	~~222.2~~	~~14 d~~		~~C~~						~~C~~								~~C~~								~~X~~			~~12~~	~~12363.0~~	~~0.0~~	~~11877.0~~	~~11977.0~~	~~87.27~~	~~94.66~~	~~18x0_p.plu~~
212.1	222.2	14 d		C														C								X			12	10506.0	10464.0	10419.0	10497.0	95.06	93.59	14x0_p.plu
111.1	222.2	14 d		C						C								C				C				X			12	12363.0	0.0	11877.0	11977.0	87.06	94.66	18x0_p.plu
211.1	222.2	14 d		C														C				C				X			12	10506.0	10464.0	10419.0	10497.0	84.07	93.59	14x0_p.plu
SACS Pump Failures																																				
212.2	222.2	30 d																X											22	12099.0	12044.0	11844.0	11945.0	95.67	94.64	01x0_p.plu
SACS HX Failures																																				
221.2	222.2	72 h																				X							22	12099.0	12044.0	11844.0	11945.0	84.02	94.64	01x0_p.plu
AOT - SACS Loop Failures																																				
202.2	222.4	72 h															A	A											24	12099.0	12044.0	11844.0	11945.0	0.00	93.02	01x0_p.plu
102.2	222.4	72 h							P								A	A											24	0.0	13858.0	13236.0	13355.0	0.00	93.97	05x0_p.plu
2.2	222.4	72 h							P	P							A	A											24	0.0	0.0	14798.0	14938.0	0.00	94.78	11x0_p.plu
AOT - SSWS Loop Failures																																				
22.2	222.4	72 h	A	A					C	C																			24	0.0	0.0	11648.0	11743.0	0.00	92.86	55x0_.plu
22.2	222.4	72 h							A	A																			24	0.0	0.0	14798.0	14938.0	0.00	94.78	11x0_p.plu
AOT - One SSWS Pump Per Loop																																				
122.2	122.2	72 h		A	A					C	C																		22	12393.0	0.0	0.0	12252.0	68.30	68.14	52x0_p.plu
122.2	222.2	72 h		A	A					C																			22	10381.0	0.0	9893.0	9978.0	65.50	93.11	45x0_p.plu
222.2	222.2	72 h		A	A																								22	8573.0	8537.0	8403.0	8470.0	91.48	91.31	34x0_p/plu

Note: Failures were marked in the appropriate column with an "X". Consequences of the specified failures were marked with a "C", and operator actions were marked with an "P". The specific AOT conditions considered were developed by marking the AOT failures with an "A".

A Loop	B Loop	AOT	A SW Pmp	C SW Pmp	B SW Pmp	D SW Pmp	A Supply	B Supply	A1 SW Hx	A2 SW Hx	B1 SW Hx	B2 SW Hx	A Discharge	B Discharge	A EOB	B EOB	A SACS Pmp	C SACS Pmp	B SACS Pmp	D SACS Pmp	A1 SACS Hx	A2 SACS Hx	B1 SACS Hx	B2 SACS Hx	A EDG	C EDG	B EDG	D EDG	A + B Loop	A1 SSWS Flow	A2 SSWS Flow	B1 SSWS Flow	B2 SSWS Flow		A Loop UHS	B Loop UHS	SSWS Config
No Failures																																					
222.2	222.2																												22	10262.0	10217.0	10054.0	10137.0		92.63	92.49	01x2_p.plu
EOB Failures																																					
222.2	222.2															X													22	7459.0	7427.0	7778.0	7840.0		88.60	89.33	01x1b_p.plu
SSWS Pump Failures																																					
122.2	222.2	30d		X						C																			22	10797.0	0.0	10538.0	10625.0		67.48	92.95	18x2_p.plu
SSWS HX Failures																																					
122.2	222.2	72 h								X																			22	11922.0	0.0	11519.0	11621.0		69.16	93.74	04x2_p.plu
122.2	222.2	72 h							X																				22	0.0	11877.0	11523.0	11625.0		69.10	93.75	05x2_p.plu
EDG Failures																																					
112.1	222.2	14 d		C						C								C								X			12	10797.0	0.0	10538.0	10625.0		66.60	92.95	18x2_p.plu
112.1	222.2	14 d		C						C						C		C								X			12	8609.0	0.0	8628.0	8697.0		62.71	90.75	18x1a_p.plu
212.1	222.2	14 d		C														C								X			12	9026.0	8990.0	8966.0	9031.0		93.49	91.22	14x2_p.plu
212.1	222.2	14 d		C												C		C								X			12	6852.0	6826.0	7232.0	7284.0		90.26	88.20	14x1a_p.plu
111.1	222.2	14 d		C						C								C				C				X			12	10797.0	0.0	10538.0	10625.0		84.67	92.95	18x2_p.plu
111.1	222.2	14 d		C						C						C		C				C				X			12	8609.0	0.0	8628.0	8697.0		78.77	90.75	18x1a_p.plu
211.1	222.2	14 d		C														C				C				X			12	9026.0	8990.0	8966.0	9031.0		79.97	91.22	14x2_p.plu
211.1	222.2	14 d		C												C		C				C				X			12	6852.0	6826.0	7232.0	7284.0		71.39	88.20	14x1a_p.plu
SACS Pump Failures																																					
212.2	222.2	30 d																X											22	10262.0	10217.0	10054.0	10137.0		94.17	92.49	01x2_p.plu
SACS HX Failures																																					
221.2	222.2	72 h																				X							22	10262.0	10217.0	10054.0	10137.0		79.40	92.49	01x2_p.plu
AOT - SACS Loop Failures																																					
202.2	222.4	72 h															A	A											24	10262.0	10217.0	10054.0	10137.0		0.00	90.90	01x2_p.plu
102.2	222.4	72 h							P								A	A											24	0.0	11877.0	11523.0	11625.0		0.00	92.41	05x2_p.plu
2.2	222.4	72 h							P	P							A	A											24	0.0	0.0	13221.0	13343.0		0.00	93.66	11x2_p.plu
202.2	222.4	72 h													A		A	A											24	7459.0	7427.0	7778.0	7840.0		0.00	87.13	01x1b_p.plu
AOT - SSWS Loop Failures																																					
22.2	222.4	72 h	A	A					C	C																			24	0.0	0.0	10514.0	10599.0		0.00	91.43	55x2_p.plu
22.2	222.4	72 h							A	A																			24	0.0	0.0	13221.0	13343.0		0.00	93.66	11x2_p.plu
22.2	222.4	72 h	A	A					C	C					A														24	0.0	0.0	9353.0	9427.0		0.00	89.97	55x1b_p.plu
AOT - One SSWS Pump Per Loop																																					
122.2	122.2	72 h		A	A					C	C																		22	11049.0	0.0	0.0	10911.0		67.89	67.67	52x2_p.plu
122.2	222.2	72 h		A	A					C																			22	9090.0	0.0	8793.0	8868.0		63.91	90.99	45x2_p.plu
222.2	222.2	72 h		A	A																								22	7511.0	7480.0	7367.0	7425.0		88.71	88.50	34x2_p.plu

Note: Failures were marked in the appropriate column with an "X". Consequences of the specified failures were marked with a "C", and operator actions were marked with an "P". The specific AOT conditions considered were developed by marking the AOT failures with an "A".

ATTACHMENT 6

PROTO-HX^{TM} Output for Uncertainty Analysis

13:49:33 **PROTO-HX 3.01 by Proto-Power Corporation (SN#PHX 1006)** 11/29/99

PSE&G - Hope Creek

Calculation Report for 1A1E201 - SACS Heat Exchanger

LOCA 222.2 - 10000 SW - 95°F SACS

Calculation Specifications

Constant Heat Load/Hot Outlet Temperature Method Was Used
Extrapolation Was to User Specified Conditions
Design Fouling Factors Were Used

Test Data		Extrapolation Data	
Data Date		Tube Flow (gpm)	10,000.0
Shell Flow (gpm)		Shell Flow (gpm)	9,416.9
Shell Temp In (°F)		Shell Outlet Temp (°F)	95.0
Shell Temp Out (°F)		Constant Heat Load (BTU/hr)	86,150,005
Tube Flow (gpm)			
Tube Temp In (°F)			
Tube Temp Out (°F)			

Fouling Calculation Results

Shell Mass Flow (lbm/hr)		U Overall (BTU/hr·ft²·°F)	
Tube Mass Flow (lbm/hr)		Shell-Side ho (BTU/hr·ft²·°F)	
		Tube-Side hi (BTU/hr·ft²·°F)	
Heat Transferred (BTU/hr)		1/Wall Resis (BTU/hr·ft²·°F)	
LMTD		LMTD Correction Factor	
Effective Area (ft²)			
		Overall Fouling (hr·ft²·°F/BTU)	

Property	Shell-Side	Tube-Side		
Velocity (ft/s)			Shell Temp In (°F)	
Reynold's Number			Shell Temp Out (°F)	
Prandtl Number			Tav Shell (°F)	
Bulk Visc (lbm/ft·hr)			Shell Skin Temp (°F)	
Skin Visc (lbm/ft·hr)			Tube Temp In (°F)	
Density (lbm/ft³)			Tube Temp Out (°F)	
Cp (BTU/lbm·°F)			Tav Tube (°F)	
K (BTU/hr·ft·°F)			Tube Skin Temp (°F)	

Extrapolation Calculation Results

Shell Mass Flow (lbm/hr)	4.711E+6	Overall Fouling (hr·ft²·°F/BTU)	0.001200
Tube Mass Flow (lbm/hr)	5.045E+6	Shell-Side ho (BTU/hr·ft²·°F)	815.5
		Tube-Side hi (BTU/hr·ft²·°F)	1,481.4
Heat Transferred (BTU/hr)	8.615E+7	1/Wall Resis (BTU/hr·ft²·°F)	3,917.5
LMTD	8.3	LMTD Correction Factor	0.7692
Effective Area (ft²)	46,295.0		
		U Overall (BTU/hr·ft²·°F)	293.2

Property	Shell-Side	Tube-Side		
Velocity (ft/s)	3.38	5.98	Shell Temp In (°F)	113.3
Reynold's Number	2.988E+04	4.410E+04	Shell Temp Out (°F)	95.0
Prandtl Number	4.32	4.82	Tav Shell (°F)	104.1
Bulk Visc (lbm/ft·hr)	1.58	1.77	Shell Skin Temp (°F)	101.2
Skin Visc (lbm/ft·hr)	1.63	1.73	Tube Temp In (°F)	87.2
Density (lbm/ft³)	61.94	62.57	Tube Temp Out (°F)	104.6
Cp (BTU/lbm·°F)	1.00	0.98	Tav Tube (°F)	95.9
K (BTU/hr·ft·°F)	0.36	0.36	Tube Skin Temp (°F)	97.6

** Reynolds Number Outside Range of Equation Applicability
!! With Zero Fouling The Test Heat Load Could Not Be Achieved

13:53:07 **PROTO-HX 3.01 by Proto-Power Corporation (SN#PHX 1006)** 11/29/99

PSE&G - Hope Creek

Calculation Report for 1A1E201 - SACS Heat Exchanger

LOCA Uncertainty 5% SACS Flow

Calculation Specifications

Constant Heat Load/Hot Outlet Temperature Method Was Used
Extrapolation Was to User Specified Conditions
Design Fouling Factors Were Used

Test Data

Data Date	
Shell Flow (gpm)	
Shell Temp In (°F)	
Shell Temp Out (°F)	
Tube Flow (gpm)	
Tube Temp In (°F)	
Tube Temp Out (°F)	

Extrapolation Data

Tube Flow (gpm)	10,000.0
Shell Flow (gpm)	9,887.7
Shell Outlet Temp (°F)	95.0
Constant Heat Load (BTU/hr)	86,150,005

Fouling Calculation Results

Shell Mass Flow (lbm/hr)	
Tube Mass Flow (lbm/hr)	
Heat Transferred (BTU/hr)	
LMTD	
Effective Area (ft²)	

Property	Shell-Side	Tube-Side
Velocity (ft/s)		
Reynold's Number		
Prandtl Number		
Bulk Visc (lbm/ft·hr)		
Skin Visc (lbm/ft·hr)		
Density (lbm/ft³)		
Cp (BTU/lbm·°F)		
K (BTU/hr·ft·°F)		

U Overall (BTU/hr·ft²·°F)	
Shell-Side ho (BTU/hr·ft²·°F)	
Tube-Side hi (BTU/hr·ft²·°F)	
1/Wall Resis (BTU/hr·ft²·°F)	
LMTD Correction Factor	
Overall Fouling (hr·ft²·°F/BTU)	
Shell Temp In (°F)	
Shell Temp Out (°F)	
Tav Shell (°F)	
Shell Skin Temp (°F)	
Tube Temp In (°F)	
Tube Temp Out (°F)	
Tav Tube (°F)	
Tube Skin Temp (°F)	

Extrapolation Calculation Results

Shell Mass Flow (lbm/hr)	4.946E+6
Tube Mass Flow (lbm/hr)	5.045E+6
Heat Transferred (BTU/hr)	8.615E+7
LMTD	8.1
Effective Area (ft²)	46,295.0

Property	Shell-Side	Tube-Side
Velocity (ft/s)	3.55	5.98
Reynold's Number	3.123E+04	4.396E+04
Prandtl Number	4.34	4.84
Bulk Visc (lbm/ft·hr)	1.58	1.77
Skin Visc (lbm/ft·hr)	1.63	1.74
Density (lbm/ft³)	61.95	62.58
Cp (BTU/lbm·°F)	1.00	0.98
K (BTU/hr·ft·°F)	0.36	0.36

Overall Fouling (hr·ft²·°F/BTU)	0.001200
Shell-Side ho (BTU/hr·ft²·°F)	838.9
Tube-Side hi (BTU/hr·ft²·°F)	1,479.0
1/Wall Resis (BTU/hr·ft²·°F)	3,917.5
LMTD Correction Factor	0.7756
U Overall (BTU/hr·ft²·°F)	296.0
Shell Temp In (°F)	112.4
Shell Temp Out (°F)	95.0
Tav Shell (°F)	103.7
Shell Skin Temp (°F)	100.8
Tube Temp In (°F)	86.9
Tube Temp Out (°F)	104.3
Tav Tube (°F)	95.6
Tube Skin Temp (°F)	97.4

** Reynolds Number Outside Range of Equation Applicability
!! With Zero Fouling The Test Heat Load Could Not Be Achieved

18:30:26 **PROTO-HX 3.01 by Proto-Power Corporation (SN#PHX 1006)** 12/14/99

PSE&G - Hope Creek

Calculation Report for 1A1E201 - SACS Heat Exchanger

LOCA Uncertainty - 3.0% SSWS Flow

Calculation Specifications

Constant Heat Load/Hot Outlet Temperature Method Was Used
Extrapolation Was to User Specified Conditions
Design Fouling Factors Were Used

Test Data		Extrapolation Data	
Data Date		Tube Flow (gpm)	9,700.0
Shell Flow (gpm)		Shell Flow (gpm)	9,416.9
Shell Temp In (°F)		Shell Outlet Temp (°F)	95.0
Shell Temp Out (°F)		Constant Heat Load (BTU/hr)	86,150,005
Tube Flow (gpm)			
Tube Temp In (°F)			
Tube Temp Out (°F)			

Fouling Calculation Results

Shell Mass Flow (lbm/hr)		U Overall (BTU/hr·ft²·°F)	
Tube Mass Flow (lbm/hr)		Shell-Side ho (BTU/hr·ft²·°F)	
		Tube-Side hi (BTU/hr·ft²·°F)	
Heat Transferred (BTU/hr)		1/Wall Resis (BTU/hr·ft²·°F)	
LMTD		LMTD Correction Factor	
Effective Area (ft²)			
		Overall Fouling (hr·ft²·°F/BTU)	

Property	Shell-Side	Tube-Side		
Velocity (ft/s)			Shell Temp In (°F)	
Reynold's Number			Shell Temp Out (°F)	
Prandtl Number			Tav Shell (°F)	
Bulk Visc (lbm/ft·hr)			Shell Skin Temp (°F)	
Skin Visc (lbm/ft·hr)			Tube Temp In (°F)	
Density (lbm/ft³)			Tube Temp Out (°F)	
Cp (BTU/lbm·°F)			Tav Tube (°F)	
K (BTU/hr·ft·°F)			Tube Skin Temp (°F)	

Extrapolation Calculation Results

Shell Mass Flow (lbm/hr)	4.711E+6	Overall Fouling (hr·ft²·°F/BTU)	0.001200
Tube Mass Flow (lbm/hr)	4.894E+6	Shell-Side ho (BTU/hr·ft²·°F)	815.5
		Tube-Side hi (BTU/hr·ft²·°F)	1,445.4
Heat Transferred (BTU/hr)	8.615E+7	1/Wall Resis (BTU/hr·ft²·°F)	3,917.5
LMTD	8.3	LMTD Correction Factor	0.7669
Effective Area (ft²)	46,295.0		
		U Overall (BTU/hr·ft²·°F)	291.6

Property	Shell-Side	Tube-Side		
Velocity (ft/s)	3.38	5.80	Shell Temp In (°F)	113.3
Reynold's Number	2.988E+04	4.275E+04	Shell Temp Out (°F)	95.0
Prandtl Number	4.32	4.83	Tav Shell (°F)	104.2
Bulk Visc (lbm/ft·hr)	1.58	1.77	Shell Skin Temp (°F)	101.2
Skin Visc (lbm/ft·hr)	1.63	1.73	Tube Temp In (°F)	86.9
Density (lbm/ft³)	61.94	62.58	Tube Temp Out (°F)	104.8
Cp (BTU/lbm·°F)	1.00	0.98	Tav Tube (°F)	95.8
K (BTU/hr·ft·°F)	0.36	0.36	Tube Skin Temp (°F)	97.6

** Reynolds Number Outside Range of Equation Applicability
!! With Zero Fouling The Test Heat Load Could Not Be Achieved

14:04:45 **PROTO-HX 3.01 by Proto-Power Corporation (SN#PHX 1006)** 11/29/99

PSE&G - Hope Creek

Calculation Report for 1A1E201 - SACS Heat Exchanger

LOCA Uncertainty - 5% Heat Load

Calculation Specifications

Constant Heat Load/Hot Outlet Temperature Method Was Used
Extrapolation Was to User Specified Conditions
Design Fouling Factors Were Used

Test Data

Data Date	
Shell Flow (gpm)	
Shell Temp In (°F)	
Shell Temp Out (°F)	
Tube Flow (gpm)	
Tube Temp In (°F)	
Tube Temp Out (°F)	

Extrapolation Data

Tube Flow (gpm)	10,000.0
Shell Flow (gpm)	9,416.9
Shell Outlet Temp (°F)	95.0
Constant Heat Load (BTU/hr)	90,457,505

Fouling Calculation Results

Shell Mass Flow (lbm/hr)	
Tube Mass Flow (lbm/hr)	
Heat Transferred (BTU/hr)	
LMTD	
Effective Area (ft²)	

Property	Shell-Side	Tube-Side
Velocity (ft/s)		
Reynold's Number		
Prandtl Number		
Bulk Visc (lbm/ft·hr)		
Skin Visc (lbm/ft·hr)		
Density (lbm/ft³)		
Cp (BTU/lbm·°F)		
K (BTU/hr·ft·°F)		

U Overall (BTU/hr·ft²·°F)	
Shell-Side ho (BTU/hr·ft²·°F)	
Tube-Side hi (BTU/hr·ft²·°F)	
1/Wall Resis (BTU/hr·ft²·°F)	
LMTD Correction Factor	
Overall Fouling (hr·ft²·°F/BTU)	
Shell Temp In (°F)	
Shell Temp Out (°F)	
Tav Shell (°F)	
Shell Skin Temp (°F)	
Tube Temp In (°F)	
Tube Temp Out (°F)	
Tav Tube (°F)	
Tube Skin Temp (°F)	

Extrapolation Calculation Results

Shell Mass Flow (lbm/hr)	4.711E+6
Tube Mass Flow (lbm/hr)	5.045E+6
Heat Transferred (BTU/hr)	9.046E+7
LMTD	8.7
Effective Area (ft²)	46,295.0

Property	Shell-Side	Tube-Side
Velocity (ft/s)	3.38	5.98
Reynold's Number	3.002E+04	4.412E+04
Prandtl Number	4.30	4.82
Bulk Visc (lbm/ft·hr)	1.57	1.77
Skin Visc (lbm/ft·hr)	1.62	1.73
Density (lbm/ft³)	61.93	62.57
Cp (BTU/lbm·°F)	1.00	0.98
K (BTU/hr·ft·°F)	0.37	0.36

Overall Fouling (hr·ft²·°F/BTU)	0.001200
Shell-Side ho (BTU/hr·ft²·°F)	816.6
Tube-Side hi (BTU/hr·ft²·°F)	1,482.0
1/Wall Resis (BTU/hr·ft²·°F)	3,917.5
LMTD Correction Factor	0.7690
U Overall (BTU/hr·ft²·°F)	293.3
Shell Temp In (°F)	114.2
Shell Temp Out (°F)	95.0
Tav Shell (°F)	104.6
Shell Skin Temp (°F)	101.5
Tube Temp In (°F)	86.8
Tube Temp Out (°F)	105.0
Tav Tube (°F)	95.9
Tube Skin Temp (°F)	97.8

** Reynolds Number Outside Range of Equation Applicability
!! With Zero Fouling The Test Heat Load Could Not Be Achieved

14:08:24 **PROTO-HX 3.01 by Proto-Power Corporation (SN#PHX 1006)** 11/29/99

PSE&G - Hope Creek

Calculation Report for 1A1E201 - SACS Heat Exchanger

LOCA Uncertainty -0.79°F SACS Temp

Calculation Specifications

Constant Heat Load/Hot Outlet Temperature Method Was Used
Extrapolation Was to User Specified Conditions
Design Fouling Factors Were Used

Test Data	
Data Date	
Shell Flow (gpm)	
Shell Temp In (°F)	
Shell Temp Out (°F)	
Tube Flow (gpm)	
Tube Temp In (°F)	
Tube Temp Out (°F)	

Extrapolation Data	
Tube Flow (gpm)	10,000.0
Shell Flow (gpm)	9,416.9
Shell Outlet Temp (°F)	94.2
Constant Heat Load (BTU/hr)	86,150,005

Fouling Calculation Results

Shell Mass Flow (lbm/hr)	
Tube Mass Flow (lbm/hr)	
Heat Transferred (BTU/hr)	
LMTD	
Effective Area (ft²)	

Property	Shell-Side	Tube-Side
Velocity (ft/s)		
Reynold's Number		
Prandtl Number		
Bulk Visc (lbm/ft·hr)		
Skin Visc (lbm/ft·hr)		
Density (lbm/ft³)		
Cp (BTU/lbm·°F)		
K (BTU/hr·ft·°F)		

U Overall (BTU/hr·ft²·°F)	
Shell-Side ho (BTU/hr·ft²·°F)	
Tube-Side hi (BTU/hr·ft²·°F)	
1/Wall Resis (BTU/hr·ft²·°F)	
LMTD Correction Factor	
Overall Fouling (hr·ft²·°F/BTU)	
Shell Temp In (°F)	
Shell Temp Out (°F)	
Tav Shell (°F)	
Shell Skin Temp (°F)	
Tube Temp In (°F)	
Tube Temp Out (°F)	
Tav Tube (°F)	
Tube Skin Temp (°F)	

Extrapolation Calculation Results

Shell Mass Flow (lbm/hr)	4.711E+6
Tube Mass Flow (lbm/hr)	5.045E+6
Heat Transferred (BTU/hr)	8.615E+7
LMTD	8.3
Effective Area (ft²)	46,295.0

Property	Shell-Side	Tube-Side
Velocity (ft/s)	3.38	5.98
Reynold's Number	2.963E+04	4.371E+04
Prandtl Number	4.36	4.87
Bulk Visc (lbm/ft·hr)	1.59	1.78
Skin Visc (lbm/ft·hr)	1.64	1.75
Density (lbm/ft³)	61.95	62.58
Cp (BTU/lbm·°F)	1.00	0.98
K (BTU/hr·ft·°F)	0.36	0.36

Overall Fouling (hr·ft²·°F/BTU)	0.001200
Shell-Side ho (BTU/hr·ft²·°F)	813.1
Tube-Side hi (BTU/hr·ft²·°F)	1,474.5
1/Wall Resis (BTU/hr·ft²·°F)	3,917.5
LMTD Correction Factor	0.7698
U Overall (BTU/hr·ft²·°F)	292.6
Shell Temp In (°F)	112.5
Shell Temp Out (°F)	94.2
Tav Shell (°F)	103.4
Shell Skin Temp (°F)	100.4
Tube Temp In (°F)	86.4
Tube Temp Out (°F)	103.8
Tav Tube (°F)	95.1
Tube Skin Temp (°F)	96.9

** Reynolds Number Outside Range of Equation Applicability
!! With Zero Fouling The Test Heat Load Could Not Be Achieved

14:15:20 **PROTO-HX 3.01 by Proto-Power Corporation (SN#PHX 1006)** 11/29/99

PSE&G - Hope Creek

Calculation Report for 1A1E201 - SACS Heat Exchanger

LOP/SSE 212.2 - SSWS Flow = 10000

Calculation Specifications

Constant Heat Load/Hot Outlet Temperature Method Was Used
Extrapolation Was to User Specified Conditions
Design Fouling Factors Were Used

Test Data	
Data Date	
Shell Flow (gpm)	
Shell Temp In (°F)	
Shell Temp Out (°F)	
Tube Flow (gpm)	
Tube Temp In (°F)	
Tube Temp Out (°F)	

Extrapolation Data	
Tube Flow (gpm)	10,000.0
Shell Flow (gpm)	7,118.4
Shell Outlet Temp (°F)	95.0
Constant Heat Load (BTU/hr)	83,968,500

Fouling Calculation Results

Shell Mass Flow (lbm/hr)	
Tube Mass Flow (lbm/hr)	
Heat Transferred (BTU/hr)	
LMTD	
Effective Area (ft²)	

Property	Shell-Side	Tube-Side
Velocity (ft/s)		
Reynold's Number		
Prandtl Number		
Bulk Visc (lbm/ft·hr)		
Skin Visc (lbm/ft·hr)		
Density (lbm/ft³)		
Cp (BTU/lbm·°F)		
K (BTU/hr·ft·°F)		

U Overall (BTU/hr·ft²·°F)	
Shell-Side ho (BTU/hr·ft²·°F)	
Tube-Side hi (BTU/hr·ft²·°F)	
1/Wall Resis (BTU/hr·ft²·°F)	
LMTD Correction Factor	
Overall Fouling (hr·ft²·°F/BTU)	
Shell Temp In (°F)	
Shell Temp Out (°F)	
Tav Shell (°F)	
Shell Skin Temp (°F)	
Tube Temp In (°F)	
Tube Temp Out (°F)	
Tav Tube (°F)	
Tube Skin Temp (°F)	

Extrapolation Calculation Results

Shell Mass Flow (lbm/hr)	3.561E+6
Tube Mass Flow (lbm/hr)	5.045E+6
Heat Transferred (BTU/hr)	8.397E+7
LMTD	9.0
Effective Area (ft²)	46,295.0

Property	Shell-Side	Tube-Side
Velocity (ft/s)	2.56	5.99
Reynold's Number	2.321E+04	4.482E+04
Prandtl Number	4.19	4.74
Bulk Visc (lbm/ft·hr)	1.53	1.74
Skin Visc (lbm/ft·hr)	1.59	1.70
Density (lbm/ft³)	61.91	62.56
Cp (BTU/lbm·°F)	1.00	0.98
K (BTU/hr·ft·°F)	0.37	0.36

Overall Fouling (hr·ft²·°F/BTU)	0.001200
Shell-Side ho (BTU/hr·ft²·°F)	693.1
Tube-Side hi (BTU/hr·ft²·°F)	1,494.5
1/Wall Resis (BTU/hr·ft²·°F)	3,917.5
LMTD Correction Factor	0.7301
U Overall (BTU/hr·ft²·°F)	276.2
Shell Temp In (°F)	118.6
Shell Temp Out (°F)	95.0
Tav Shell (°F)	106.8
Shell Skin Temp (°F)	103.0
Tube Temp In (°F)	88.9
Tube Temp Out (°F)	105.8
Tav Tube (°F)	97.4
Tube Skin Temp (°F)	99.2

** Reynolds Number Outside Range of Equation Applicability
!! With Zero Fouling The Test Heat Load Could Not Be Achieved

14:39:48 **PROTO-HX 3.01 by Proto-Power Corporation (SN#PHX 1006)** 11/29/99

PSE&G - Hope Creek

Calculation Report for 1A1E201 - SACS Heat Exchanger

LOP/SSE Uncertainty - 5% SACS Flow

Calculation Specifications

Constant Heat Load/Hot Outlet Temperature Method Was Used
Extrapolation Was to User Specified Conditions
Design Fouling Factors Were Used

Test Data		Extrapolation Data	
Data Date		Tube Flow (gpm)	10,000.0
Shell Flow (gpm)		Shell Flow (gpm)	7,474.3
Shell Temp In (°F)		Shell Outlet Temp (°F)	95.0
Shell Temp Out (°F)		Constant Heat Load (BTU/hr)	83,968,500
Tube Flow (gpm)			
Tube Temp In (°F)			
Tube Temp Out (°F)			

Fouling Calculation Results

Shell Mass Flow (lbm/hr)		U Overall (BTU/hr·ft²·°F)	
Tube Mass Flow (lbm/hr)		Shell-Side ho (BTU/hr·ft²·°F)	
		Tube-Side hi (BTU/hr·ft²·°F)	
Heat Transferred (BTU/hr)		1/Wall Resis (BTU/hr·ft²·°F)	
LMTD		LMTD Correction Factor	
Effective Area (ft²)			
		Overall Fouling (hr·ft²·°F/BTU)	

Property	Shell-Side	Tube-Side		
Velocity (ft/s)			Shell Temp In (°F)	
Reynold's Number			Shell Temp Out (°F)	
Prandtl Number			Tav Shell (°F)	
Bulk Visc (lbm/ft·hr)			Shell Skin Temp (°F)	
Skin Visc (lbm/ft·hr)			Tube Temp In (°F)	
Density (lbm/ft³)			Tube Temp Out (°F)	
Cp (BTU/lbm·°F)			Tav Tube (°F)	
K (BTU/hr·ft·°F)			Tube Skin Temp (°F)	

Extrapolation Calculation Results

Shell Mass Flow (lbm/hr)	3.739E+6	Overall Fouling (hr·ft²·°F/BTU)	0.001200
Tube Mass Flow (lbm/hr)	5.045E+6	Shell-Side ho (BTU/hr·ft²·°F)	712.9
		Tube-Side hi (BTU/hr·ft²·°F)	1,492.2
Heat Transferred (BTU/hr)	8.397E+7	1/Wall Resis (BTU/hr·ft²·°F)	3,917.5
LMTD	8.8	LMTD Correction Factor	0.7372
Effective Area (ft²)	46,295.0		
		U Overall (BTU/hr·ft²·°F)	279.1

Property	Shell-Side	Tube-Side		
Velocity (ft/s)	2.68	5.99	Shell Temp In (°F)	117.5
Reynold's Number	2.423E+04	4.469E+04	Shell Temp Out (°F)	95.0
Prandtl Number	4.22	4.75	Tav Shell (°F)	106.2
Bulk Visc (lbm/ft·hr)	1.54	1.74	Shell Skin Temp (°F)	102.6
Skin Visc (lbm/ft·hr)	1.60	1.71	Tube Temp In (°F)	88.7
Density (lbm/ft³)	61.91	62.56	Tube Temp Out (°F)	105.6
Cp (BTU/lbm·°F)	1.00	0.98	Tav Tube (°F)	97.1
K (BTU/hr·ft·°F)	0.37	0.36	Tube Skin Temp (°F)	98.9

** Reynolds Number Outside Range of Equation Applicability
!! With Zero Fouling The Test Heat Load Could Not Be Achieved

18:42:22 **PROTO-HX 3.01 by Proto-Power Corporation (SN#PHX 1006)** 12/14/99

PSE&G - Hope Creek

Calculation Report for 1A1E201 - SACS Heat Exchanger

LOP/SS Uncertainty - 3.0% SSWS Flow

Calculation Specifications

Constant Heat Load/Hot Outlet Temperature Method Was Used
Extrapolation Was to User Specified Conditions
Design Fouling Factors Were Used

Test Data		Extrapolation Data	
Data Date		Tube Flow (gpm)	9,700.0
Shell Flow (gpm)		Shell Flow (gpm)	7,118.4
Shell Temp In (°F)		Shell Outlet Temp (°F)	95.0
Shell Temp Out (°F)		Constant Heat Load (BTU/hr)	83,968,500
Tube Flow (gpm)			
Tube Temp In (°F)			
Tube Temp Out (°F)			

Fouling Calculation Results

Shell Mass Flow (lbm/hr)		U Overall (BTU/hr·ft²·°F)	
Tube Mass Flow (lbm/hr)		Shell-Side ho (BTU/hr·ft²·°F)	
		Tube-Side hi (BTU/hr·ft²·°F)	
Heat Transferred (BTU/hr)		1/Wall Resis (BTU/hr·ft²·°F)	
LMTD		LMTD Correction Factor	
Effective Area (ft²)			
		Overall Fouling (hr·ft²·°F/BTU)	

Property	Shell-Side	Tube-Side		
Velocity (ft/s)			Shell Temp In (°F)	
Reynold's Number			Shell Temp Out (°F)	
Prandtl Number			Tav Shell (°F)	
Bulk Visc (lbm/ft·hr)			Shell Skin Temp (°F)	
Skin Visc (lbm/ft·hr)			Tube Temp In (°F)	
Density (lbm/ft³)			Tube Temp Out (°F)	
Cp (BTU/lbm·°F)			Tav Tube (°F)	
K (BTU/hr·ft·°F)			Tube Skin Temp (°F)	

Extrapolation Calculation Results

Shell Mass Flow (lbm/hr)	3.561E+6	Overall Fouling (hr·ft²·°F/BTU)	0.001200
Tube Mass Flow (lbm/hr)	4.894E+6	Shell-Side ho (BTU/hr·ft²·°F)	693.2
		Tube-Side hi (BTU/hr·ft²·°F)	1,458.8
Heat Transferred (BTU/hr)	8.397E+7	1/Wall Resis (BTU/hr·ft²·°F)	3,917.5
LMTD	9.1	LMTD Correction Factor	0.7275
Effective Area (ft²)	46,295.0		
		U Overall (BTU/hr·ft²·°F)	274.8

Property	Shell-Side	Tube-Side		
Velocity (ft/s)	2.56	5.81	Shell Temp In (°F)	118.6
Reynold's Number	2.322E+04	4.348E+04	Shell Temp Out (°F)	95.0
Prandtl Number	4.19	4.74	Tav Shell (°F)	106.8
Bulk Visc (lbm/ft·hr)	1.53	1.74	Shell Skin Temp (°F)	103.1
Skin Visc (lbm/ft·hr)	1.59	1.70	Tube Temp In (°F)	88.7
Density (lbm/ft³)	61.91	62.56	Tube Temp Out (°F)	106.1
Cp (BTU/lbm·°F)	1.00	0.98	Tav Tube (°F)	97.4
K (BTU/hr·ft·°F)	0.37	0.36	Tube Skin Temp (°F)	99.3

** Reynolds Number Outside Range of Equation Applicability
!! With Zero Fouling The Test Heat Load Could Not Be Achieved

14:29:23 **PROTO-HX 3.01 by Proto-Power Corporation (SN#PHX 1006)** 11/29/99

PSE&G - Hope Creek

Calculation Report for 1A1E201 - SACS Heat Exchanger

LOP/SSE Uncertainty - 5% Heat Load

Calculation Specifications

Constant Heat Load/Hot Outlet Temperature Method Was Used
Extrapolation Was to User Specified Conditions
Design Fouling Factors Were Used

Test Data		Extrapolation Data	
Data Date		Tube Flow (gpm)	10,000.0
Shell Flow (gpm)		Shell Flow (gpm)	7,118.4
Shell Temp In (°F)		Shell Outlet Temp (°F)	95.0
Shell Temp Out (°F)		Constant Heat Load (BTU/hr)	88,167,000
Tube Flow (gpm)			
Tube Temp In (°F)			
Tube Temp Out (°F)			

Fouling Calculation Results

Shell Mass Flow (lbm/hr)		U Overall (BTU/hr·ft²·°F)	
Tube Mass Flow (lbm/hr)		Shell-Side ho (BTU/hr·ft²·°F)	
		Tube-Side hi (BTU/hr·ft²·°F)	
Heat Transferred (BTU/hr)		1/Wall Resis (BTU/hr·ft²·°F)	
LMTD		LMTD Correction Factor	
Effective Area (ft²)			
		Overall Fouling (hr·ft²·°F/BTU)	

Property	Shell-Side	Tube-Side		
Velocity (ft/s)			Shell Temp In (°F)	
Reynold's Number			Shell Temp Out (°F)	
Prandtl Number			Tav Shell (°F)	
Bulk Visc (lbm/ft·hr)			Shell Skin Temp (°F)	
Skin Visc (lbm/ft·hr)			Tube Temp In (°F)	
Density (lbm/ft³)			Tube Temp Out (°F)	
Cp (BTU/lbm·°F)			Tav Tube (°F)	
K (BTU/hr·ft·°F)			Tube Skin Temp (°F)	

Extrapolation Calculation Results

Shell Mass Flow (lbm/hr)	3.561E+6	Overall Fouling (hr·ft²·°F/BTU)	0.001200
Tube Mass Flow (lbm/hr)	5.045E+6	Shell-Side ho (BTU/hr·ft²·°F)	694.4
		Tube-Side hi (BTU/hr·ft²·°F)	1,495.8
Heat Transferred (BTU/hr)	8.817E+7	1/Wall Resis (BTU/hr·ft²·°F)	3,917.5
LMTD	9.4	LMTD Correction Factor	0.7297
Effective Area (ft²)	46,295.0		
		U Overall (BTU/hr·ft²·°F)	276.4

Property	Shell-Side	Tube-Side		
Velocity (ft/s)	2.56	5.99	Shell Temp In (°F)	119.8
Reynold's Number	2.335E+04	4.488E+04	Shell Temp Out (°F)	95.0
Prandtl Number	4.17	4.73	Tav Shell (°F)	107.4
Bulk Visc (lbm/ft·hr)	1.52	1.74	Shell Skin Temp (°F)	103.4
Skin Visc (lbm/ft·hr)	1.59	1.70	Tube Temp In (°F)	88.6
Density (lbm/ft³)	61.90	62.56	Tube Temp Out (°F)	106.4
Cp (BTU/lbm·°F)	1.00	0.98	Tav Tube (°F)	97.5
K (BTU/hr·ft·°F)	0.37	0.36	Tube Skin Temp (°F)	99.5

** Reynolds Number Outside Range of Equation Applicability
!! With Zero Fouling The Test Heat Load Could Not Be Achieved

14:31:45 **PROTO-HX 3.01 by Proto-Power Corporation (SN#PHX 1006)** 11/29/99

PSE&G - Hope Creek

Calculation Report for 1A1E201 - SACS Heat Exchanger

LOP/SE Uncertainty -0.79°F SACS Tmp

Calculation Specifications

Constant Heat Load/Hot Outlet Temperature Method Was Used
Extrapolation Was to User Specified Conditions
Design Fouling Factors Were Used

Test Data	
Data Date	
Shell Flow (gpm)	
Shell Temp In (°F)	
Shell Temp Out (°F)	
Tube Flow (gpm)	
Tube Temp In (°F)	
Tube Temp Out (°F)	

Extrapolation Data	
Tube Flow (gpm)	10,000.0
Shell Flow (gpm)	7,118.4
Shell Outlet Temp (°F)	94.2
Constant Heat Load (BTU/hr)	83,968,500

Fouling Calculation Results

Shell Mass Flow (lbm/hr)	
Tube Mass Flow (lbm/hr)	
Heat Transferred (BTU/hr)	
LMTD	
Effective Area (ft²)	

Property	Shell-Side	Tube-Side
Velocity (ft/s)		
Reynold's Number		
Prandtl Number		
Bulk Visc (lbm/ft·hr)		
Skin Visc (lbm/ft·hr)		
Density (lbm/ft³)		
Cp (BTU/lbm·°F)		
K (BTU/hr·ft·°F)		

U Overall (BTU/hr·ft²·°F)	
Shell-Side ho (BTU/hr·ft²·°F)	
Tube-Side hi (BTU/hr·ft²·°F)	
1/Wall Resis (BTU/hr·ft²·°F)	
LMTD Correction Factor	
Overall Fouling (hr·ft²·°F/BTU)	
Shell Temp In (°F)	
Shell Temp Out (°F)	
Tav Shell (°F)	
Shell Skin Temp (°F)	
Tube Temp In (°F)	
Tube Temp Out (°F)	
Tav Tube (°F)	
Tube Skin Temp (°F)	

Extrapolation Calculation Results

Shell Mass Flow (lbm/hr)	3.561E+6
Tube Mass Flow (lbm/hr)	5.045E+6
Heat Transferred (BTU/hr)	8.397E+7
LMTD	9.0
Effective Area (ft²)	46,295.0

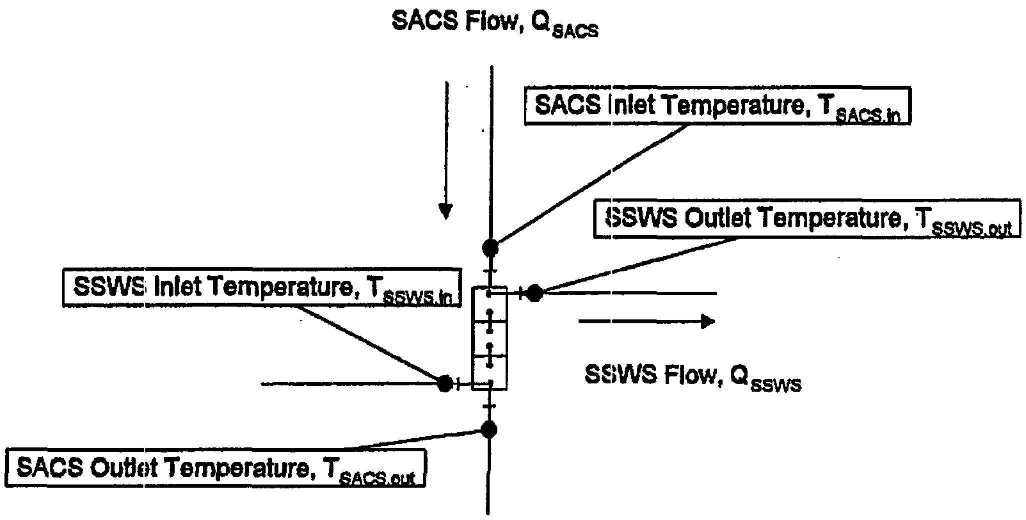
Property	Shell-Side	Tube-Side
Velocity (ft/s)	2.56	5.98
Reynold's Number	2.302E+04	4.443E+04
Prandtl Number	4.23	4.79
Bulk Visc (lbm/ft·hr)	1.55	1.76
Skin Visc (lbm/ft·hr)	1.61	1.72
Density (lbm/ft³)	61.92	62.57
Cp (BTU/lbm·°F)	1.00	0.98
K (BTU/hr·ft·°F)	0.37	0.36

Overall Fouling (hr·ft²·°F/BTU)	0.001200
Shell-Side ho (BTU/hr·ft²·°F)	691.2
Tube-Side hi (BTU/hr·ft²·°F)	1,487.6
1/Wall Resis (BTU/hr·ft²·°F)	3,917.5
LMTD Correction Factor	0.7308
U Overall (BTU/hr·ft²·°F)	275.6
Shell Temp In (°F)	117.8
Shell Temp Out (°F)	94.2
Tav Shell (°F)	106.0
Shell Skin Temp (°F)	102.2
Tube Temp In (°F)	88.1
Tube Temp Out (°F)	105.0
Tav Tube (°F)	96.6
Tube Skin Temp (°F)	98.5

** Reynolds Number Outside Range of Equation Applicability
!! With Zero Fouling The Test Heat Load Could Not Be Achieved

ATTACHMENT 7

Effects of Increased SACS Flow Rate



Items that must remain constant:

SACS Heat Exchanger Heat Load: Qheat
SACS Outlet Temperature: TSACS.out
SSWS Flow Rate: QSSWS
SACS Heat Exchanger Area

Assumption:

Increased SACS flow rate has negligible impact on SACS heat exchanger overall heat transfer coefficient, U. Therefore, U is constant. This is reasonable since the SACS flow increase is about 150 gpm out of approximately 6,000 gpm delivered to the SACS heat exchanger.

Action:

Increased SACS flow rate due to chiller control valves controlling to UFSAR flow rates rather the EG-20 required flow rates.

Effect:

Decreased SACS inlet temperature.

Reason:

The governing equation is Q (heat) = M (SACS mass flow) * cp * (TSACS.in -TSACS.out)
The increased SACS mass flow rate will increase the heat transfer across the SACS heat exchanger if the temperature difference (TSACS.in - TSACS.out) remains the same.
Since the heat transfer across the SACS heat exchanger must remain the same (Qheat is constant), the temperature difference must decrease to maintain the same heat transfer with the higher SACS mass flow rate.
Since the SACS outlet temperature cannot increase (TSACS.out is constant), the SACS inlet temperature must decrease.

Action:

Decreased SACS inlet temperature (see above)

Effect:

Decreased Log Mean Temperature Difference across the SACS heat exchanger.

However, the LMTD must remain constant.

Reason:

The governing equation for the heat transfer across the SACS heat exchanger is Q (heat) = U (overall heat transfer coefficient) * A (heat transfer area) * LMTD.
Since the overall heat transfer coefficient and the heat transfer area are constant, the LMTD must remain constant in order for the SACS heat load (Qheat) to remain constant.

With the SACS outlet temperature remaining constant and the decrease in the SACS inlet temperature, there are two options for maintaining a constant LMTD.

1. Increase the temperature rise of the SSWS flow, or
2. Decrease a SSWS temperature.

Option 1 is not possible because:

The governing equation for the temperature rise of the SSWS flow is Q (heat) = M (SSWS flow rate) * cp * (TSSWS.out – TSSWS.in). Since the SSWS flow rate is constant, the SSWS temperature difference (TSSWS.out – TSSWS.in) must remain constant to maintain the constant heat input (Qheat is constant). Therefore, the temperature rise for the SSWS flow **cannot** increase.

Therefore, to maintain the same LMTD, a SSWS temperature must decrease. Since the temperature rise in the SSWS flow cannot change, both the inlet and outlet SSWS temperatures must decrease.

Therefore, the increased SACS flow rate through the SACS heat exchanger results in a lower SSWS inlet and outlet temperature.

ATTACHMENT 8

PROTO-HX^{TM} output for uncertainty analysis for plugged tubes

PSE&G - Hope Creek

Calculation Report for 1A1E201 - SACS Heat Exchanger

LOP/SSE - 212.2 - A1&2 - SSWS = 10000 - (0 tubes plugged)

Calculation Specifications

Constant Heat Load/Hot Outlet Temperature Method Was Used
Extrapolation Was to User Specified Conditions
Design Fouling Factors Were Used

Test Data

Data Date
Shell Flow (gpm)
Shell Temp In (°F)
Shell Temp Out (°F)
Tube Flow (gpm)
Tube Temp In (°F)
Tube Temp Out (°F)

Extrapolation Data

Tube Flow (gpm)	10,000.00
Shell Flow (gpm)	6,881.50
Shell Outlet Temp (°F)	94.97
Constant Heat Load (BTU/hr)	80,367,750.00

Fouling Calculation Results

Shell Mass Flow (lbm/hr)
Tube Mass Flow (lbm/hr)

Heat Transferred (BTU/hr)
LMTD
Effective Area (ft²)

Property	Shell-Side	Tube-Side
Velocity (ft/s)		
Reynold's Number		
Prandtl Number		
Bulk Visc (lbm/ft·hr)		
Skin Visc (lbm/ft·hr)		
Density (lbm/ft³)		
Cp (BTU/lbm·°F)		
K (BTU/hr·ft·°F)		

U Overall (BTU/hr·ft²·°F)
Shell-Side ho (BTU/hr·ft²·°F)
Tube-Side hi (BTU/hr·ft²·°F)
1/Wall Resis (BTU/hr·ft²·°F)
LMTD Correction Factor

Overall Fouling (hr·ft²·°F/BTU)

Shell Temp In (°F)
Shell Temp Out (°F)
Tav Shell (°F)
Shell Skin Temp (°F)
Tube Temp In (°F)
Tube Temp Out (°F)
Tav Tube (°F)
Tube Skin Temp (°F)

Extrapolation Calculation Results

Shell Mass Flow (lbm/hr)	3,442,467.18
Tube Mass Flow (lbm/hr)	5,045,457.04
Heat Transferred (BTU/hr)	80,367,750.74
LMTD	8.7
Effective Area (ft²)	46,295.0

Property	Shell-Side	Tube-Side
Velocity (ft/s)	2.47	5.99
Reynold's Number	22,412	44,847
Prandtl Number	4.1979	4.7352
Bulk Visc (lbm/ft·hr)	1.5353	1.7381
Skin Visc (lbm/ft·hr)	1.5959	1.7042
Density (lbm/ft³)	61.9065	62.5556
Cp (BTU/lbm·°F)	0.9989	0.9840
K (BTU/hr·ft·°F)	0.3653	0.3612

Overall Fouling (hr·ft²·°F/BTU)	0.001200
Shell-Side ho (BTU/hr·ft²·°F)	678.7
Tube-Side hi (BTU/hr·ft²·°F)	1,495.0
1/Wall Resis (BTU/hr·ft²·°F)	3,917.5
LMTD Correction Factor	0.7253
U Overall (BTU/hr·ft²·°F)	273.9
Shell Temp In (°F)	118.3
Shell Temp Out (°F)	95.0
Tav Shell (°F)	106.7
Shell Skin Temp (°F)	102.9
Tube Temp In (°F)	89.3
Tube Temp Out (°F)	105.5
Tav Tube (°F)	97.4
Tube Skin Temp (°F)	99.3

** Reynolds Number Outside Range of Equation Applicability
!! With Zero Fouling The Test Heat Load Could Not Be Achieved

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ATTACHMENT 8 page 1 of 2

PSE&G - Hope Creek

Calculation Report for 1A1E201 - SACS Heat Exchanger

LOP/SSE - 212.2 - A1&2 - SSWS = 10000 - (50 tubes plugged)

Calculation Specifications

Constant Heat Load/Hot Outlet Temperature Method Was Used
Extrapolation Was to User Specified Conditions
Design Fouling Factors Were Used

Test Data

Data Date	
Shell Flow (gpm)	
Shell Temp In (°F)	
Shell Temp Out (°F)	
Tube Flow (gpm)	
Tube Temp In (°F)	
Tube Temp Out (°F)	

Extrapolation Data

Tube Flow (gpm)	10,000.00
Shell Flow (gpm)	6,881.50
Shell Outlet Temp (°F)	94.97
Constant Heat Load (BTU/hr)	80,367,750.00

Fouling Calculation Results

Shell Mass Flow (lbm/hr)	
Tube Mass Flow (lbm/hr)	
Heat Transferred (BTU/hr)	
LMTD	
Effective Area (ft²)	

Property	Shell-Side	Tube-Side
Velocity (ft/s)		
Reynold's Number		
Prandtl Number		
Bulk Visc (lbm/ft·hr)		
Skin Visc (lbm/ft·hr)		
Density (lbm/ft³)		
Cp (BTU/lbm·°F)		
K (BTU/hr·ft·°F)		

U Overall (BTU/hr·ft²·°F)	
Shell-Side ho (BTU/hr·ft²·°F)	
Tube-Side hi (BTU/hr·ft²·°F)	
1/Wall Resis (BTU/hr·ft²·°F)	
LMTD Correction Factor	
Overall Fouling (hr·ft²·°F/BTU)	
Shell Temp In (°F)	
Shell Temp Out (°F)	
Tav Shell (°F)	
Shell Skin Temp (°F)	
Tube Temp In (°F)	
Tube Temp Out (°F)	
Tav Tube (°F)	
Tube Skin Temp (°F)	

Extrapolation Calculation Results

Shell Mass Flow (lbm/hr)	3,442,467.18
Tube Mass Flow (lbm/hr)	5,045,457.04
Heat Transferred (BTU/hr)	80,367,749.67
LMTD	8.8
Effective Area (ft²)	45,888.9

Property	Shell-Side	Tube-Side
Velocity (ft/s)	2.47	6.04
Reynold's Number	22,412	45,230
Prandtl Number	4.1979	4.7369
Bulk Visc (lbm/ft·hr)	1.5353	1.7387
Skin Visc (lbm/ft·hr)	1.5962	1.7048
Density (lbm/ft³)	61.9065	62.5559
Cp (BTU/lbm·°F)	0.9989	0.9840
K (BTU/hr·ft·°F)	0.3653	0.3612

Overall Fouling (hr·ft²·°F/BTU)	0.001200
Shell-Side ho (BTU/hr·ft²·°F)	678.7
Tube-Side hi (BTU/hr·ft²·°F)	1,505.3
1/Wall Resis (BTU/hr·ft²·°F)	3,917.5
LMTD Correction Factor	0.7282
U Overall (BTU/hr·ft²·°F)	274.2
Shell Temp In (°F)	118.3
Shell Temp Out (°F)	95.0
Tav Shell (°F)	106.7
Shell Skin Temp (°F)	102.9
Tube Temp In (°F)	89.3
Tube Temp Out (°F)	105.5
Tav Tube (°F)	97.4
Tube Skin Temp (°F)	99.2

** Reynolds Number Outside Range of Equation Applicability

|| With Zero Fouling The Test Heat Load Could Not Be Achieved

EG-0047 Rev 1
ATTACHMENT 8 page 2 of 2

ATTACHMENT 9

Calculation for bypass flow on 20-inch butterfly valve

FAX TRANSMITTAL SHEET

Solutions for Today... Standards of Tomorrow

ENERTECH

Curtiss-Wright Flow Control Corporation

2950 Birch Street, Brea, CA 92821, USA
Tel: (714) 528-2301 x 221 / Fax: (714) 528-0128

TO:	Chris Zehrer	**FROM:**	Larry Waterworth
COMPANY:	PSE&G	**DATE:**	January 24, 2000
TEL:	(856) 339-1995	**PAGES:**	2
FAX:	(856) 339-5250	**CC:**	

SUBJECT: Bypass flow for 20" BIF

Chris,

Attached are the calculations for the bypass flow on the 20" BIF valve as requested. After careful study of the body, disc and seat detail drawings we determined that the exposed cross-sectional area will be approximately 1.1 in^2. (See attached).

If you have any questions please give me a call.

Sincerely,

Larry Waterworth
Applications Engineer

EG-0047 Rev 1 ATTACHMENT 9

Page 1 of 2

BY-PASS FLOW CALCULATION FOR 20" B1F w/ SEAT REMOVED

- BODY BORE RADIUS = 9.535" (w/ SEAT REMOVED)
- DISC RADIUS = 9.516"

CROSS SECTIONAL AREA

- $A_{BODY} = \pi r^2 = \pi (9.535)^2 = 285.6$

$A_{DISC} = \pi (9.516)^2 = 284.5 \text{ in}^2$

$A_T = 285.6 - 284.5 = 1.1 \text{ in}^2$

$$d = \sqrt{\frac{4A}{\pi}} = \sqrt{\frac{4(1.1)}{\pi}} = 1.183 \text{ in}$$

$$C_V = \frac{29.9\, d^2}{\sqrt{K}}$$ ASSUMING $K = 1.5$

$$C_V = \frac{29.9(1.183)^2}{\sqrt{1.5}} = 34.17$$

FLOW CALCULATION

$$Q = C_V \sqrt{\frac{\Delta P}{S_g}}$$ WHERE $S_g = 1$ AND $\Delta P = 112$ psig

$$Q = 34\sqrt{\frac{112}{1}} = \boxed{360 \text{ GPM}}$$

ATTACHMENT 10

PROTO-FLO™ Flow Summary and Pump Status Reports for "B" LPCI injection – Design Pump

Utility - S:\Mechanical\Specialty\Computer Programs\Hope Creek\BC-0056\BC-0056R3.pdb - Version
Plant - System

Flow Summary Report

Convergence: Pressure=1.0E-4 Sum Q=1.0E-2 Friction=1.0E-5 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

"B" LPCI Injection - Design Pump

Flow Summary Title	Diameter (in)	Flow (gpm)	Minimum Flow (gpm)	NPSHA (ft)	NPSH Ratio
B RHR Strainer	23.250	10,860.37			
B RHR Pump	29.250	10,860.37		32.05	11.45
B RHR Hx Input	17.000	2,478.87			
B RHR Hx Output	17.000	2,478.87			
B RHR Hx Bypass	17.000	8,381.50			
FE-N014B	17.000	10,860.37			
B LPCI Flow	11.374	10,860.38			

!! Reverse Flow Through Check Valve
** Flow Below Minimum
&& Pump Flow is Past End of Curve
$$ NPSH Available Below NPSH Required

Utility - S:\Mechanical\Specialty\Computer Programs\Hope Creek\BC-0056\BC-0056R3.pdb - Version
Plant - System

Pump Status Report

"B" LPCI Injection - Design Pump

Pump Name: AP202

Manufacturer:		Model:	
Drawings:			
Pump Status:	OFF		
Flow (gpm):		Total Head (ft):	
Hydraulic Horsepower:		Speed (RPM):	0
Efficiency Curve:	NONE		
Efficiency (%):		Pump Heat (BTU/hr):	
Pump Impeller Datum (ft):			
Pump Suction Temp (°F):			
NPSH Curve:	XP-202 NPSH		
NPSH Available:		NPSH Required:	

Pump Name: CP228

Manufacturer:		Model:	
Drawings:			
Pump Status:	OFF		
Flow (gpm):		Total Head (ft):	
Hydraulic Horsepower:		Speed (RPM):	0
Efficiency Curve:	NONE		
Efficiency (%):		Pump Heat (BTU/hr):	
Pump Impeller Datum (ft):			
Pump Suction Temp (°F):			
NPSH Curve:	NONE		
NPSH Available:		NPSH Required:	

Pump Status Report

"B" LPCI Injection - Design Pump

Pump Name: CP202

Manufacturer:		Model:	
Drawings:			
Pump Status:	OFF		
Flow (gpm):		Total Head (ft):	
Hydraulic Horsepower:		Speed (RPM):	0
Efficiency Curve:	NONE		
Efficiency (%):		Pump Heat (BTU/hr):	
Pump Impeller Datum (ft):			
Pump Suction Temp (°F):			
NPSH Curve:	XP-202 NPSH		
NPSH Available:		NPSH Required:	

Pump Name: BP202

Manufacturer:		Model:	
Drawings:			
Pump Status:	XP-202 Design		
Flow (gpm):	10,860.37	Total Head (ft):	337.22
Hydraulic Horsepower:	902.02	Speed (RPM):	0
Efficiency Curve:	NONE		
Efficiency (%):		Pump Heat (BTU/hr):	
Pump Impeller Datum (ft):		Inlet Node Elev. (ft) :	55.75
Pump Suction Temp (°F):	170.00		
NPSH Curve:	XP-202 NPSH		
NPSH Available:	32.05	NPSH Required:	2.80

Pump Status Report

"B" LPCI Injection - Design Pump

Pump Name: DP202

Manufacturer:		Model:	
Drawings:			
Pump Status:	OFF		
Flow (gpm):		Total Head (ft):	
Hydraulic Horsepower:		Speed (RPM):	0
Efficiency Curve:	NONE		
Efficiency (%):		Pump Heat (BTU/hr):	
Pump Impeller Datum (ft):			
Pump Suction Temp (°F):			
NPSH Curve:	XP-202 NPSH		
NPSH Available:		NPSH Required:	

Pump Name: DP228

Manufacturer:		Model:	
Drawings:			
Pump Status:	OFF		
Flow (gpm):		Total Head (ft):	
Hydraulic Horsepower:		Speed (RPM):	0
Efficiency Curve:	NONE		
Efficiency (%):		Pump Heat (BTU/hr):	
Pump Impeller Datum (ft):			
Pump Suction Temp (°F):			
NPSH Curve:	NONE		
NPSH Available:		NPSH Required:	

ATTACHMENT 11

PROTO-FLO^{TM} Heat Exchanger report for LOCA Short-term

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

00E129 | HX Type: Fixed Heat Load | HX Status: On / Not in Flow Path
Mfr: Basco, Inc. | Model: ES-24/18096 | Dwgs: PM050-0039-3
System Fluid:
Heat Load = 574,700.00 BTU/hr

00K107 | HX Type: Fixed Heat Load | HX Status: On / Not in Flow Path
Mfr: American Std. | Model: 06060 | Dwgs: PM050-0022-5
System Fluid:
Heat Load = 2,240,323.00 BTU/hr

10C150 | HX Type: Fixed Heat Load | HX Status: On / Not in Flow Path
Mfr: | Model: | Dwgs:
System Fluid:
Heat Load = 500,000.00 BTU/hr

10E1110 | HX Type: Fixed Heat Load | HX Status: On / Not in Flow Path
Mfr: Basco, Inc. | Model: 8A24A08072 | Dwgs: P1-342287
System Fluid:
Heat Load = 741,434.00 BTU/hr

10E114 | HX Type: Fixed Heat Load | HX Status: On / Not in Flow Path
Mfr: Gen. Elect. Co. | Model: MDE0965400 | Dwgs: PM003-G-1-7
System Fluid:
Heat Load = 392,415.00 BTU/hr

10E129 | HX Type: Fixed Heat Load | HX Status: On / Not in Flow Path
Mfr: Basco, Inc. | Model: ES-24/18096 | Dwgs: PM050-0039-3
System Fluid:
Heat Load = 574,700.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1OK107 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: American Std. Model: 06060 Dwgs: PM050-0022-5

System Fluid:

Heat Load = 2,240,323.00 BTU/hr

1A1E118 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: DeLaval/IMO Model: MDE1328000 Dwgs: PM012-0099

System Fluid:

Heat Load = 400,000.00 BTU/hr

1A1E201 HX Type: Shell & Tube HX Status: On / in Flow Path

Mfr: Graham Mfg. Co. Model: 92-6-504 CGN Dwgs: PM069Q-0058

Tube Fluid: Brackish Water - 12 ppt Shell Fluid: Fresh Water

Shell Flow = 6,775.67 Shell Temperatures = 104.45°F - 93.00°F

Tube Flow = 10,000.00 Tube Temperatures = 90.30°F - 98.09°F

Construction Type: TEMA-G

1 Shells, 0 Shell Passes, 4 Tube Passes

Shell Min Area = 6.3120 ft^2, Design Shell Velocity = 3.900 ft/s, Shell Diameter = 92.000

Baffle Info: Spacing = 62.000 in, Thickness = 0.000 in, Area = 0.000 ft^2, K = 0.000

Tubes: Din = 0.694 in, Dout = 0.750 in, Length = 42.00 ft, K = 9.50

Tube Pitch = 0.9375 in Tube Pitch Type = Triangular

5,700 of 5,700 Tubes Active UTubes = No

Effective Area = 46,295.00 ft^2 Area Factor = 0.9849

Fouling = 0.0000 (inside) 0.0012 (outside) Hoff = 0.4842

LMTD = 4.2758 LMTD Corrections FF = 0.7298 Fb = 1.0000

Heat Load = 38,505,051.58 BTU/hr UOverall = 266.52 BTU/hr/ft^2/°F

1A2E118 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: DeLaval/IMO Model: MDE1328000 Dwgs: PM012-0099

System Fluid:

Heat Load = 400,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1A2E201 HX Type: Shell & Tube HX Status: On / in Flow Path

Mfr: Graham Mfg. Co. Model: 92-6-504 CGN Dwgs: PM069Q-0058
Tube Fluid: Brackish Water - 12 ppt Shell Fluid: Fresh Water
Shell Flow = 7,115.28 Shell Temperatures = 104.45°F - 93.21°F
Tube Flow = 10,000.00 Tube Temperatures = 90.30°F - 98.33°F
Construction Type: TEMA-G
1 Shells, 0 Shell Passes, 4 Tube Passes
Shell Min Area = 6.3120 ft^2, Design Shell Velocity = 3.900 ft/s, Shell Diameter = 92.000
Baffle Info: Spacing = 62.000 in, Thickness = 0.000 in, Area = 0.000 ft^2, K = 0.000
Tubes: Din = 0.694 in, Dout = 0.750 in, Length = 42.00 ft, K = 9.50
Tube Pitch = 0.9375 in Tube Pitch Type = Triangular
5,700 of 5,700 Tubes Active UTubes = No
Effective Area = 46,295.00 ft^2 Area Factor = 0.9849
Fouling = 0.0000 (inside) 0.0012 (outside) Hoff = 0.4842
LMTD = 4.3161 LMTD Corrections FF = 0.7364 Fb = 1.0000
Heat Load = 39,714,559.46 BTU/hr UOverall = 269.90 BTU/hr/ft^2/°F

1AE1109 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Basco Inc. Model: 8A43A08048 Dwgs: P1-342287
System Fluid:
Heat Load = 537,626.00 BTU/hr

1AE111 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: General Elect. Model: 264A4808 Dwgs: PM003-TR-18-5
System Fluid:
Heat Load = 9,360,000.00 BTU/hr

1AE112 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: General Elect. Model: 114D8270 Dwgs: PM003-G-1-7
System Fluid:
Heat Load = 5,487,500.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1AE115 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path
Mfr: H.K. Porter Co. Model: T-140963X45 Dwgs: PE005-0012-9
System Fluid:
Heat Load = 515,000.00 BTU/hr

1AE116 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path
Mfr: General Elect. Model: 155B8243P001 Dwgs: PM003-T6-1-2
System Fluid:
Heat Load = 42,500.00 BTU/hr

1AE117 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path
Mfr: General Elect. Model: MDE0924300 Dwgs: PM003-G-1-7
System Fluid:
Heat Load = 8,050,000.00 BTU/hr

1AE126 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path
Mfr: American Std. Model: 5-046-17-168-3 Dwgs: N1-B31-S1-120
System Fluid:
Heat Load = 5,630,000.00 BTU/hr

1AE130 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path
Mfr: Ametek/Whitlock Model: 4-W18HT-4-A-CB Dwgs: PM007-0031-3
System Fluid:
Heat Load = 42,300.00 BTU/hr

1AE202 HX Type: Fixed Heat Load HX Status: Off
Mfr: Alfa-Laval Inc. Model: A-20-BXS Dwgs: PM071Q-0010
System Fluid: Fresh Water
Heat Load = 0.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1AE205 HX Type: Shell & Tube HX Status: On / in Flow Path

Mfr: Delta Southern Model: 21A9227AN Dwgs: N0-E11-B001-5
Tube Fluid: Fresh Water Shell Fluid: Fresh Water

Shell Flow = 2,504.00 Shell Temperatures = 170.00°F - 129.89°F

Tube Flow = 7,524.39 Tube Temperatures = 93.11°F - 106.20°F

Construction Type: TEMA-E

1 Shells, 0 Shell Passes, 2 Tube Passes

Shell Min Area = 5.0880 ft^2, Design Shell Velocity = 4.200 ft/s, Shell Diameter = 0.000

Baffle Info: Spacing = 0.000 in, Thickness = 0.000 in, Area = 0.000 ft^2, K = 0.000

Tubes: Din = 0.902 in, Dout = 1.000 in, Length = 33.94 ft, K = 9.40

Tube Pitch = 1.3750 in Tube Pitch Type = Triangular

430 of 430 Tubes Active UTubes = Yes

Effective Area = 3,740.00 ft^2 Area Factor = 0.9789

Fouling = 0.0005 (inside) 0.0005 (outside) Hoff = 0.7815

LMTD = 49.0546 LMTD Corrections FF = 0.9620 Fb = 1.0000

Heat Load = 48,965,025.60 BTU/hr UOverall = 277.44 BTU/hr/ft^2/°F

1AE214 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: CVI Inc. Model: C735-9934 Dwgs: PM048Q-0071-4
System Fluid:
Heat Load = 9,565.00 BTU/hr

1AE218 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: CVI Inc. Model: C735-9934 Dwgs: PM048Q-0071-4
System Fluid:
Heat Load = 10,750.00 BTU/hr

1AE278 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: CVI Inc. Model: Dwgs: PM048Q
System Fluid:
Heat Load = 6,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1AE328 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Parker-Hanison Model: HDTC-SS-6-2 Dwgs:

System Fluid:

Heat Load = 55,000.00 BTU/hr

1AE404 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: American Std. Model: 17072 CPT Dwgs: PM018Q

System Fluid: Fresh Water

Tube Flow = 883.09 Tube Temperatures = 112.61°F - 115.70°F

Heat Load = 1,353,000.00 BTU/hr

1AE405 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: American Std. Model: 19084 CPT Dwgs: PM018Q

System Fluid: Fresh Water

Tube Flow = 880.69 Tube Temperatures = 100.24°F - 112.61°F

Heat Load = 5,412,000.00 BTU/hr

1AE408 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: American Std. Model: 19198 Dwgs: PM018Q

System Fluid: Fresh Water

Tube Flow = 879.46 Tube Temperatures = 93.11°F - 100.24°F

Heat Load = 3,118,000.00 BTU/hr

1AK111 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Carrier Corp. Model: 19FA553B5005932 Dwgs: PM623-0002-9

System Fluid:

Heat Load = 19,500,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1AK202 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: CVI Inc. Model: C735-9909 Dwgs: PM048Q-0044-2

System Fluid: Fresh Water

Tube Flow = 4.98 Tube Temperatures = 93.11°F - 113.31°F

Heat Load = 50,000.00 BTU/hr

1AK400 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Carrier Corp. Model: 19FA455B122022 Dwgs: PM723Q

System Fluid:

Heat Load = 7,530,000.00 BTU/hr

1AK403 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Carrier Corp. Model: 19FA441B1142020 Dwgs: PM723Q

System Fluid:

Heat Load = 2,520,000.00 BTU/hr

1AP176 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Carrier Corp. Model: 19FA999-1007-18 Dwgs: PM623-118

System Fluid:

Heat Load = 100,000.00 BTU/hr

1AP202-1 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Graham Mfg. Co. Model: 8X4C-12 Dwgs: N1-E11-C002-51

System Fluid: Fresh Water

Tube Flow = 18.76 Tube Temperatures = 93.11°F - 102.76°F

Heat Load = 90,000.00 BTU/hr

1AP202-2 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Graham Mfg. Co. Model: 992C430BX Dwgs: N1-E11-C002-6

System Fluid: Fresh Water

Tube Flow = 8.02 Tube Temperatures = 93.11°F - 95.62°F

Heat Load = 10,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1AVE412 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Trane Co. Model: MDE1291600 Dwgs: PM731Q

System Fluid: Fresh Water

Tube Flow = 367.96 Tube Temperatures = 93.11°F - 99.12°F

Heat Load = 1,100,000.00 BTU/hr

1AVH113 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Amer. Air Fltr. Model: H36MPACYA Dwgs: PM611A-0030-4

System Fluid:

Heat Load = 502,781.00 BTU/hr

1AVH116 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Amer. Air Fltr. Model: H36MPACYA Dwgs: PM611A-0033-4

System Fluid:

Heat Load = 530,000.00 BTU/hr

1AVH208 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Amer. Air Fltr. Model: MDE1572400 Dwgs: PM711Q

System Fluid: Fresh Water

Tube Flow = 30.11 Tube Temperatures = 92.87°F - 98.87°F

Heat Load = 90,000.00 BTU/hr

1AVH209 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Amer. Air Fltr. Model: MDE1571400 Dwgs: PM711Q

System Fluid: Fresh Water

Tube Flow = 62.78 Tube Temperatures = 93.11°F - 100.48°F

Heat Load = 230,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1AVH210 HX Type: Fixed Heat Load HX Status: On / in Flow Path
Mfr: Amer. Air Fltr. Model: MDE1570300 Dwgs: PM711Q
System Fluid: Fresh Water
Tube Flow = 115.61 Tube Temperatures = 93.11°F - 100.42°F
Heat Load = 420,000.00 BTU/hr

1AVH211 HX Type: Fixed Heat Load HX Status: On / in Flow Path
Mfr: Amer. Air Fltr. Model: MDE1573500 Dwgs: PM711Q
System Fluid: Fresh Water
Tube Flow = 90.74 Tube Temperatures = 93.11°F - 99.09°F
Heat Load = 270,000.00 BTU/hr

1AVH213 HX Type: Fixed Heat Load HX Status: On / in Flow Path
Mfr: Amer. Air Fltr. Model: MDE2478600 Dwgs: PM786Q
System Fluid: Fresh Water
Tube Flow = 337.78 Tube Temperatures = 93.11°F - 99.66°F
Heat Load = 1,100,000.00 BTU/hr

1BHE118 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path
Mfr: DeLaval/IMO Model: MDE1328000 Dwgs: PM012-0099
System Fluid:
Heat Load = 400,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1B1E201 HX Type: Shell & Tube HX Status: On / in Flow Path

Mfr: Graham Mfg. Co. Model: 92-6-504 CGN Dwgs: PM069Q-0058

Tube Fluid: Brackish Water - 12 ppt Shell Fluid: Fresh Water

Shell Flow = 6,104.78 Shell Temperatures = 105.67°F - 92.79°F

Tube Flow = 10,000.00 Tube Temperatures = 90.30°F - 98.19°F

Construction Type: TEMA-G

1 Shells, 0 Shell Passes, 4 Tube Passes

Shell Min Area = 6.3120 ft^2, Design Shell Velocity = 3.900 ft/s, Shell Diameter = 92.000

Baffle Info: Spacing = 62.000 in, Thickness = 0.000 in, Area = 0.000 ft^2, K = 0.000

Tubes: Din = 0.694 in, Dout = 0.750 in, Length = 42.00 ft, K = 9.50

Tube Pitch = 0.9375 in Tube Pitch Type = Triangular

5,700 of 5,700 Tubes Active UTubes = No

Effective Area = 46,295.00 ft^2 Area Factor = 0.9849

Fouling = 0.0000 (inside) 0.0012 (outside) Hoff = 0.4842

LMTD = 4.5402 LMTD Corrections FF = 0.7150 Fb = 1.0000

Heat Load = 39,014,231.01 BTU/hr UOverall = 259.62 BTU/hr/ft^2/°F

1B2E118 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: DeLaval/IMO Model: MDE1328000 Dwgs: PM012-0099

System Fluid:

Heat Load = 400,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1B2E201 HX Type: Shell & Tube HX Status: On / in Flow Path

Mfr: Graham Mfg. Co. Model: 92-6-504 CGN Dwgs: PM069Q-0058

Tube Fluid: Brackish Water - 12 ppt Shell Fluid: Fresh Water

Shell Flow = 6,326.62 Shell Temperatures = 105.67°F - 92.94°F

Tube Flow = 10,000.00 Tube Temperatures = 90.30°F - 98.39°F

Construction Type: TEMA-G

1 Shells, 0 Shell Passes, 4 Tube Passes

Shell Min Area = 6.3120 ft^2, Design Shell Velocity = 3.900 ft/s, Shell Diameter = 92.000

Baffle Info: Spacing = 62.000 in, Thickness = 0.000 in, Area = 0.000 ft^2, K = 0.000

Tubes: Din = 0.694 in, Dout = 0.750 in, Length = 42.00 ft, K = 9.50

Tube Pitch = 0.9375 in Tube Pitch Type = Triangular

5,700 of 5,700 Tubes Active UTubes = No

Effective Area = 46,295.00 ft^2 Area Factor = 0.9849

Fouling = 0.0000 (inside) 0.0012 (outside) Hoff = 0.4842

LMTD = 4.5763 LMTD Corrections FF = 0.7199 Fb = 1.0000

Heat Load = 39,976,485.28 BTU/hr UOverall = 262.11 BTU/hr/ft^2/°F

1BE1109 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Basco Inc. Model: 8A44A08048 Dwgs: P1-342287

System Fluid:

Heat Load = 481,650.00 BTU/hr

1BE111 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: General Elect. Model: 264A4808 Dwgs: PM003-TR-18-5

System Fluid:

Heat Load = 9,360,000.00 BTU/hr

1BE112 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: General Elect. Model: 114D8270 Dwgs: PM003-G-1-7

System Fluid:

Heat Load = 5,487,500.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1BE115 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: H.K. Porter Co. Model: T-140963X45 Dwgs: PE005-0012-9

System Fluid:

Heat Load = 515,000.00 BTU/hr

1BE116 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: General Elect. Model: 155B8243P001 Dwgs: PM003-T6-1-2

System Fluid:

Heat Load = 42,500.00 BTU/hr

1BE117 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: General Elect. Model: MDE0924300 Dwgs: PM003-G-1-7

System Fluid:

Heat Load = 8,050,000.00 BTU/hr

1BE126 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: American Std. Model: 5-0046-17-168-3 Dwgs: N1-B31-S1-120

System Fluid:

Heat Load = 5,630,000.00 BTU/hr

1BE130 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Ametek/Whitlock Model: 4-W18HT-4-A-CB Dwgs: PM007-0031-3

System Fluid:

Heat Load = 42,300.00 BTU/hr

1BE202 HX Type: Fixed Heat Load HX Status: Off

Mfr: Alfa-Laval Inc. Model: A-20-BXS Dwgs: PM071Q-0010

System Fluid: Fresh Water

Heat Load = 0.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1BE205 HX Type: Shell & Tube HX Status: On / in Flow Path

Mfr: Delta Southern Model: 21A9227AN Dwgs: N0-E11-B001-5

Tube Fluid: Fresh Water Shell Fluid: Fresh Water

Shell Flow = 2,504.00 Shell Temperatures = 170.00°F - 137.39°F

Tube Flow = 2,982.66 Tube Temperatures = 92.87°F - 119.71°F

Construction Type: TEMA-E

1 Shells, 0 Shell Passes, 2 Tube Passes

Shell Min Area = 5.0880 ft^2, Design Shell Velocity = 4.200 ft/s, Shell Diameter = 0.000

Baffle Info: Spacing = 0.000 in, Thickness = 0.000 in, Area = 0.000 ft^2, K = 0.000

Tubes: Din = 0.902 in, Dout = 1.000 in, Length = 33.94 ft, K = 9.40

Tube Pitch = 1.3750 in Tube Pitch Type = Triangular

430 of 430 Tubes Active UTubes = Yes

Effective Area = 3,740.00 ft^2 Area Factor = 0.9789

Fouling = 0.0005 (inside) 0.0005 (outside) Hoff = 0.7815

LMTD = 47.3481 LMTD Corrections FF = 0.9311 Fb = 1.0000

Heat Load = 39,822,296.86 BTU/hr UOverall = 241.52 BTU/hr/ft^2/°F

1BE214 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: CVI Inc. Model: C735-9934 Dwgs: PM048Q-0071-4

System Fluid:

Heat Load = 9,565.00 BTU/hr

1BE218 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: CVI Inc. Model: C735-9934 Dwgs: PM048Q-0071-4

System Fluid:

Heat Load = 10,750.00 BTU/hr

1BE278 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: CVI Inc. Model: Dwgs: PM048Q

System Fluid:

Heat Load = 6,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1BE328 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Parker-Hanison Model: HDTC-SS-6-2 Dwgs:

System Fluid:

Heat Load = 55,000.00 BTU/hr

1BE404 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: American Std. Model: 17072 CPT Dwgs: PM018Q

System Fluid: Fresh Water

Tube Flow = 1,012.42 Tube Temperatures = 109.86°F - 112.56°F

Heat Load = 1,353,000.00 BTU/hr

1BE405 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: American Std. Model: 19084 CPT Dwgs: PM018Q

System Fluid: Fresh Water

Tube Flow = 1,010.07 Tube Temperatures = 99.08°F - 109.86°F

Heat Load = 5,412,000.00 BTU/hr

1BE408 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: American Std. Model: 19198 Dwgs: PM018Q

System Fluid: Fresh Water

Tube Flow = 1,008.85 Tube Temperatures = 92.87°F - 99.08°F

Heat Load = 3,118,000.00 BTU/hr

1BK111 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Carrier Corp. Model: 19FA553B5005932 Dwgs: PM623-0002-9

System Fluid:

Heat Load = 19,500,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1BK202 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: CVI Inc. Model: C735-9909 Dwgs: PM048Q-0044-2

System Fluid: Fresh Water

Tube Flow = 5.55 Tube Temperatures = 92.87°F - 110.97°F

Heat Load = 50,000.00 BTU/hr

1BK400 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Carrier Corp. Model: 19FA455B122022 Dwgs: PM723Q

System Fluid: Fresh Water

Tube Flow = 1,585.11 Tube Temperatures = 92.87°F - 102.41°F

Heat Load = 7,530,000.00 BTU/hr

1BK403 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Carrier Corp. Model: 19FA441B1142020 Dwgs: PM723Q

System Fluid: Fresh Water

Tube Flow = 406.99 Tube Temperatures = 92.87°F - 105.31°F

Heat Load = 2,520,000.00 BTU/hr

1BP176 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Carrier Corp. Model: 19FA999-1007-18 Dwgs: PM623-118

System Fluid:

Heat Load = 100,000.00 BTU/hr

1BP202-1 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Graham Mfg. Co. Model: 8X4C-12 Dwgs: N1-E11-C002-51

System Fluid: Fresh Water

Tube Flow = 26.50 Tube Temperatures = 92.87°F - 99.69°F

Heat Load = 90,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1BP202-2 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Graham Mfg. Co. Model: 992C430BX Dwgs: N1-E11-C002-6

System Fluid: Fresh Water

Tube Flow = 9.51 Tube Temperatures = 92.87°F - 94.98°F

Heat Load = 10,000.00 BTU/hr

1BVE412 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Trane Co. Model: MDE1291600 Dwgs: PM731Q

System Fluid: Fresh Water

Tube Flow = 493.72 Tube Temperatures = 92.87°F - 97.34°F

Heat Load = 1,100,000.00 BTU/hr

1BVH113 HX Type: Fixed Heat Load HX Status: Off

Mfr: Amer. Air Fltr. Model: H36MPACYA Dwgs: PM611A-0030-4

System Fluid:

Heat Load = 0.00 BTU/hr

1BVH116 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Amer. Air Fltr. Model: H36MPACYA Dwgs: PM611A-0033-4

System Fluid:

Heat Load = 530,000.00 BTU/hr

1BVH208 HX Type: Fixed Heat Load HX Status: Off

Mfr: Amer. Air Fltr. Model: MDE1572400 Dwgs: PM711Q

System Fluid: Fresh Water

Heat Load = 0.00 BTU/hr

1BVH209 HX Type: Fixed Heat Load HX Status: Off

Mfr: Amer. Air Fltr. Model: MDE1571400 Dwgs: PM711Q

System Fluid: Fresh Water

Heat Load = 0.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1BVH210 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Amer. Air Fltr. Model: MDE1570300 Dwgs: PM711Q

System Fluid: Fresh Water

Tube Flow = 139.03 Tube Temperatures = 92.87°F - 98.94°F

Heat Load = 420,000.00 BTU/hr

1BVH211 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Amer. Air Fltr. Model: MDE1573500 Dwgs: PM711Q

System Fluid: Fresh Water

Tube Flow = 104.60 Tube Temperatures = 92.87°F - 98.05°F

Heat Load = 270,000.00 BTU/hr

1BVH213 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Amer. Air Fltr. Model: MDE2478600 Dwgs: PM786Q

System Fluid: Fresh Water

Tube Flow = 396.64 Tube Temperatures = 92.87°F - 98.44°F

Heat Load = 1,100,000.00 BTU/hr

1C1E118 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: DeLaval/IMO Model: MDE1328000 Dwgs: PM012-0099

System Fluid:

Heat Load = 400,000.00 BTU/hr

1C2E118 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: DeLaval/IMO Model: MDE1328000 Dwgs: PM012-0099

System Fluid:

Heat Load = 400,000.00 BTU/hr

1CE112 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: General Elect. Model: 114D8270 Dwgs: PM003-G-1-7

System Fluid:

Heat Load = 5,487,500.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1CE130 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path
Mfr: Ametek/Whitlock Model: 4-W18HT-4-A-CB Dwgs: PM007-0031-3
System Fluid:
Heat Load = 42,300.00 BTU/hr

1CE404 HX Type: Fixed Heat Load HX Status: On / in Flow Path
Mfr: American Std. Model: 17072 CPT Dwgs: PM018Q
System Fluid: Fresh Water
Tube Flow = 890.54 Tube Temperatures = 112.45°F - 115.51°F
Heat Load = 1,353,000.00 BTU/hr

1CE405 HX Type: Fixed Heat Load HX Status: On / in Flow Path
Mfr: American Std. Model: 19084 CPT Dwgs: PM018Q
System Fluid: Fresh Water
Tube Flow = 888.14 Tube Temperatures = 100.18°F - 112.45°F
Heat Load = 5,412,000.00 BTU/hr

1CE408 HX Type: Fixed Heat Load HX Status: On / in Flow Path
Mfr: American Std. Model: 19198 Dwgs: PM018Q
System Fluid: Fresh Water
Tube Flow = 886.91 Tube Temperatures = 93.11°F - 100.18°F
Heat Load = 3,118,000.00 BTU/hr

1CK111 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path
Mfr: Carrier Corp. Model: 19FA553B5005932 Dwgs: PM623-0002-9
System Fluid:
Heat Load = 19,500,000.00 BTU/hr

1CP176 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path
Mfr: Carrier Corp. Model: 19FA999-1007-18 Dwgs: PM623-118
System Fluid:
Heat Load = 100,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1CP202-1 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Graham Mfg. Co. Model: 8X4C-12 Dwgs: N1-E11-C002-51

System Fluid:

Shell Flow = 22.97 Shell Temperatures = 93.11°F - 100.99°F

Heat Load = 90,000.00 BTU/hr

1CP202-2 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Graham Mfg. Co. Model: 992C430BX Dwgs: N1-E11-C002-6

System Fluid: Fresh Water

Tube Flow = 8.40 Tube Temperatures = 93.11°F - 95.51°F

Heat Load = 10,000.00 BTU/hr

1CVE412 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Trane Co. Model: MDE1291600 Dwgs: PM731Q

System Fluid: Fresh Water

Tube Flow = 371.05 Tube Temperatures = 93.11°F - 99.07°F

Heat Load = 1,100,000.00 BTU/hr

1CVH113 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Amer. Air Fltr. Model: H36MPACYA Dwgs: PM611A-0030-4

System Fluid:

Heat Load = 502,781.00 BTU/hr

1CVH210 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Amer. Air Fltr. Model: MDE1570300 Dwgs: PM711Q

System Fluid: Fresh Water

Tube Flow = 102.16 Tube Temperatures = 93.11°F - 100.98°F

Heat Load = 400,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1CVH211 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Amer. Air Fltr. Model: MDE1573500 Dwgs: PM711Q

System Fluid: Fresh Water

Tube Flow = 91.15 Tube Temperatures = 93.11°F - 99.07°F

Heat Load = 270,000.00 BTU/hr

1CVH213 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Amer. Air Fltr. Model: MDE2478600 Dwgs: PM786Q

System Fluid: Fresh Water

Tube Flow = 333.44 Tube Temperatures = 93.11°F - 99.74°F

Heat Load = 1,100,000.00 BTU/hr

1DE112 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: General Elect. Model: 114D8270 Dwgs: PM003-G-1-7

System Fluid:

Heat Load = 5,487,500.00 BTU/hr

1DE404 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: American Std. Model: 17072 CPT Dwgs: PM018Q

System Fluid: Fresh Water

Tube Flow = 1,006.95 Tube Temperatures = 109.95°F - 112.66°F

Heat Load = 1,353,000.00 BTU/hr

1DE405 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: American Std. Model: 19084 CPT Dwgs: PM018Q

System Fluid: Fresh Water

Tube Flow = 1,004.59 Tube Temperatures = 99.11°F - 109.95°F

Heat Load = 5,412,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1DE408 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: American Std. Model: 19198 Dwgs: PM018Q

System Fluid: Fresh Water

Tube Flow = 1,003.37 Tube Temperatures = 92.87°F - 99.11°F

Heat Load = 3,118,000.00 BTU/hr

1DK111 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Carrier Corp. Model: 19FA553B5005932 Dwgs: PM623-0002-9

System Fluid:

Heat Load = 19,500,000.00 BTU/hr

1DP176 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Carrier Corp. Model: 19FA999-1007-18 Dwgs: PM623-118

System Fluid:

Heat Load = 100,000.00 BTU/hr

1DP202-1 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Graham Mfg. Co. Model: 8X4C-12 Dwgs: N1-E11-C002-51

System Fluid: Fresh Water

Tube Flow = 23.88 Tube Temperatures = 92.87°F - 100.44°F

Heat Load = 90,000.00 BTU/hr

1DP202-2 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Graham Mfg. Co. Model: 992C430BX Dwgs: N1-E11-C002-6

System Fluid: Fresh Water

Tube Flow = 9.34 Tube Temperatures = 92.87°F - 95.02°F

Heat Load = 10,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1DVE412 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Trane Co. Model: MDE1291600 Dwgs: PM731Q

System Fluid: Fresh Water

Tube Flow = 490.24 Tube Temperatures = 92.87°F - 97.37°F

Heat Load = 1,100,000.00 BTU/hr

1DVH113 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Amer. Air Fltr. Model: H36MPACYA Dwgs: PM611A-0004-7

System Fluid:

Heat Load = 502,781.00 BTU/hr

1DVH210 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Amer. Air Fltr. Model: MDE1570300 Dwgs: PM711Q

System Fluid: Fresh Water

Tube Flow = 135.14 Tube Temperatures = 92.87°F - 98.81°F

Heat Load = 400,000.00 BTU/hr

1DVH211 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Amer. Air Fltr. Model: MDE1573500 Dwgs: PM711Q

System Fluid: Fresh Water

Tube Flow = 104.63 Tube Temperatures = 92.87°F - 98.05°F

Heat Load = 270,000.00 BTU/hr

1DVH213 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Amer. Air Fltr. Model: MDE2478600 Dwgs: PM786Q

System Fluid: Fresh Water

Tube Flow = 389.04 Tube Temperatures = 92.87°F - 98.55°F

Heat Load = 1,100,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1EVE412 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Trane Co. Model: MDE1291600 Dwgs: PM731Q

System Fluid: Fresh Water

Tube Flow = 431.14 Tube Temperatures = 93.11°F - 98.24°F

Heat Load = 1,100,000.00 BTU/hr

1EVH113 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Amer. Air Fltr. Model: H36MPACYA Dwgs: PM611A-0004-7

System Fluid:

Heat Load = 502,781.00 BTU/hr

1EVH210 HX Type: Fixed Heat Load HX Status: Off

Mfr: Amer. Air Fltr. Model: MDE1570300 Dwgs: PM711Q

System Fluid: Fresh Water

Heat Load = 0.00 BTU/hr

1EVH211 HX Type: Fixed Heat Load HX Status: Off

Mfr: Amer. Air Fltr. Model: MDE1573500 Dwgs: PM711Q

System Fluid: Fresh Water

Heat Load = 0.00 BTU/hr

1EVH213 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Amer. Air Fltr. Model: MDE2478600 Dwgs: PM786Q

System Fluid: Fresh Water

Tube Flow = 330.26 Tube Temperatures = 93.11°F - 99.81°F

Heat Load = 1,100,000.00 BTU/hr

1FVE412 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Trane Co. Model: MDE1291600 Dwgs: PM731Q

System Fluid: Fresh Water

Tube Flow = 493.72 Tube Temperatures = 92.87°F - 97.34°F

Heat Load = 1,100,000.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1FVH113 HX Type: Fixed Heat Load HX Status: On / Not in Flow Path

Mfr: Amer. Air Fltr. Model: H36MPACYA Dwgs: PM611A-0004-7

System Fluid:

Heat Load = 502,781.00 BTU/hr

1FVH210 HX Type: Fixed Heat Load HX Status: Off

Mfr: Amer. Air Fltr. Model: MDE1570300 Dwgs: PM711Q

System Fluid: Fresh Water

Heat Load = 0.00 BTU/hr

1FVH211 HX Type: Fixed Heat Load HX Status: Off

Mfr: Amer. Air Fltr. Model: MDE1573500 Dwgs: PM711Q

System Fluid: Fresh Water

Heat Load = 0.00 BTU/hr

1FVH213 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Amer. Air Fltr. Model: MDE2478600 Dwgs: PM786Q

System Fluid: Fresh Water

Tube Flow = 393.22 Tube Temperatures = 92.87°F - 98.49°F

Heat Load = 1,100,000.00 BTU/hr

1GVE412 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Trane Co. Model: MDE1291600 Dwgs: PM731Q

System Fluid: Fresh Water

Tube Flow = 434.76 Tube Temperatures = 93.11°F - 98.20°F

Heat Load = 1,100,000.00 BTU/hr

1GVH210 HX Type: Fixed Heat Load HX Status: Off

Mfr: Amer. Air Fltr. Model: MDE1570300 Dwgs: PM711Q

System Fluid: Fresh Water

Heat Load = 0.00 BTU/hr

Hope Creek Generating Station - STACS

Heat Exchanger Data Report

Convergence: Pressure=1.0E-5 Sum Q=1.0E-2 Friction=1.0E-6 FCV=1.0E-4 PCV=1.0E-3 Temperature=5.0E-3 - Balancing Parameters Used

LOCA Short-term - 1 SACS Pump 2 Hx per Loop

1GVH211 HX Type: Fixed Heat Load HX Status: Off

Mfr: Amer. air Fltr. Model: MDE1573500 Dwgs: PM711Q

System Fluid: Fresh Water

Heat Load = 0.00 BTU/hr

1HVE412 HX Type: Fixed Heat Load HX Status: On / in Flow Path

Mfr: Trane Co. Model: MDE1291600 Dwgs: PM731Q

System Fluid: Fresh Water

Tube Flow = 571.96 Tube Temperatures = 92.87°F - 96.73°F

Heat Load = 1,100,000.00 BTU/hr

1HVH210 HX Type: Fixed Heat Load HX Status: Off

Mfr: Amer. Air Fltr. Model: MDE1570300 Dwgs: PM711Q

System Fluid: Fresh Water

Heat Load = 0.00 BTU/hr

1HVH211 HX Type: Fixed Heat Load HX Status: Off

Mfr: Amer. Air Fltr. Model: MDE1573500 Dwgs: PM711Q

System Fluid: Fresh Water

Heat Load = 0.00 BTU/hr

FORM-1

CERTIFICATION FOR DESIGN VERIFICATION
(SAP Standard Text Key "NR/CDV1")

Reference No. EG-0047 Revision 3

SUMMARY STATEMENT

A line-by-line check and IDV was performed IAW NC.CC-AP.ZZ-0010.

The approach taken for evaluating the "HCGS Ultimate Heat Sink Temperature Limits" is conservative and appropriate. The assumptions and inputs for the design calculation are complete and correct.

Minor errors marked-up within the design calculation have been incorporated. The conclusion addresses the issues as identified in the Purpose of the design calculation.

The individual named below in the right column hereby certifies that the design verification for the subject document has been completed, the questions from the generic checklist have been reviewed and addressed as appropriate, and all comments have been adequately incorporated. SAP Order/Operation final confirmations are the legal equivalent of signatures.

Design Verifier Assigned By (print name of Manager/Director)*	Name of Design Verifier* / Date
Ali Fakhar	Robert Down 12/5/2005

*If the Manager/Supervisor acts as the Design Verifier, the name of the next higher level of technical management is required in the left column.

FORM-2

COMMENT / RESOLUTION FORM FOR DESIGN DOCUMENT REVIEW/CHECKING OR DESIGN VERIFICATION (SAP Standard Text Key "NR/CDV2")

REFERENCE DOCUMENT NO. /REV. EG-0047 Revision 3

COMMENTS

1. **Cover sheet – Check CP and ADs/CDs incorporated and add DCP/AD number.**
2. **Section 3.2.2 – add data for LOCA with 2 heat exchangers**
3. **Section 4.0 – update reference 4.1.12 to revision 4 and verify no impact to EG-0047.**
4. **Page 14 LOP/SSE second bullet – provide clarification as noted.**
5. **Section 5.2.2.2 – clarify first paragraph for compensatory actions as noted.**
6. **Section 5.2.2.3 – clarify first paragraph as noted.**
7. **Section 5.4 – clarify last sentence as noted.**
8. **Section 5.8.1 – add clarification to first sentence as noted.**
9. **Page 24 last paragraph – state that temperature does not include uncertainty.**
10. **Section 5.10.2 last paragraph – state that temperature does not include uncertainty.**
11. **Table 5.11a – add summary similar to that above Table 5.11b.**
12. **Section 6.0 last paragraph – add clarification to shed RX power to reduce TACS loads.**

RESOLUTION

1. Checked.
2. Added LOCA case.
3. Updated.
4. Clarification provided.
5. First paragraph clarified.
6. First paragraph clarified.
7. Last sentence clarified.
8. First sentence clarified.
9. Stated.
10. Stated.
11. Added.
12. Added clarification.

ACCEPTANCE OF RESOLUTION

Resolution accepted - R. Down

Robert Down	12/5/2005	James Murphy	12/6/2005
SUBMITTED BY	DATE	RESOLVED BY	DATE

FORM-1
REGULATORY CHANGE PROCESS DETERMINATION

Document I.D.: EG-0047 Revision: 3

Title: HCGS Ultimate Heat Sink Temperature Limits

Activity Description: The UHS analysis was revised for EDG room cooler maintenance. All heat loads were reviewed and revised according to appropriate up to date references.

Note that more than one process may apply. If unsure of any answer, contact the cognizant department for guidance.

Activities Affected	Yes	No	Action
1. Does the proposed activity involve a change to the Technical Specifications or the Operating License?	☐	☒	If Yes, contact Licensing. **See NOTE in Section 4.1.1 LCR No. ________**
2. Does the proposed activity involve a change to the Quality Assurance Plan? Example: • Changes to Chapter 17.2 of UFSAR	☐	☒	If Yes, contact Quality Assessment.
3. Does the proposed activity involve a change to the Security Plan? Examples: • Change program in NC.NA-AP.ZZ-0033(Q) • Change indoor/outdoor security lighting • Placement of component or structure (permanent or temporary) within 20 feet of perimeter fence • Obstruct field of view from any manned post • Interfere with security monitoring device capability • Change access to any protected or vital area • Modify safeguards systems or equipment	☐	☒	If Yes, contact Security Department.
4. Does the proposed activity involve a change to the Emergency Plan? Examples: • Change ODCM/accident source term • Change liquid or gaseous effluent release path • Affect radiation monitoring instrumentation or EOP/AOP setpoints used in classifying accident severity • Affect emergency response facilities or personnel, including control room • Affect communications, computers, information systems or Met tower	☐	☒	If Yes, contact Emergency Preparedness
5. Does the proposed activity involve a change to the ISI Program Plan? Example: • Affect Nuclear Class 1, 2, or 3 Piping, Vessels, or Supports (Guidance in NC.CC-AP.ZZ-0007(Q))	☐	☒	If Yes, contact Engineering Programs ISI/IST.

FORM-1
REGULATORY CHANGE PROCESS DETERMINATION

Document I.D.: EG-0047 Revision: 3

Title: HCGS Ultimate Heat Sink Temperature Limits

Activities Affected	Yes	No	Action
6. Does the proposed activity involve a change to the IST Program Plan? Example: • Affect the design or operating parameters of a Nuclear Class 1, 2, or 3 Pump or Valve (Guidance in NC.CC-AP.ZZ-0007(Q))	☐	☒	If Yes, contact Engineering Programs ISI/IST.
7. Does the proposed activity involve a change to the Fire Protection Program? Examples: • Change program in NC.DE-PS.ZZ-0001(Q) • Change combustible loading of safety related space • Change or affect fire detection system • Change or affect fire suppression system/component • Change fire doors, dampers, penetration seal or barriers • See NC.CC-AP.ZZ-0007 for details	☐	☒	If Yes, contact Design Engineering.
8. Does the proposed activity involve Maintenance which restores SSCs to their original design and configuration? Examples: • CM or PM activity • Implements an approved Design Change? • Troubleshooting (which does not require 50.59 screen per SH.MD-AP.ZZ-0002)	☐	☒	If Yes, process in accordance with NC.WM-AP.ZZ-0001(Q)
9. Is the proposed activity a temporary change (T-Mod) which ***meets all the following conditions***? • Directly supports maintenance and is NOT a compensatory measure to ensure SSC operability. • Will be in effect at power operation **less than 90 days.** • Plant will be restored to design configuration upon completion. • SSCs will NOT be operated in a manner that could impact the function or operability of a safety related or Important-to-Safety system.	☐	☒	If Yes, contact Engineering.

FORM-1
REGULATORY CHANGE PROCESS DETERMINATION

Document I.D.: EG-0047 Revision: 3

Title: HCGS Ultimate Heat Sink Temperature Limits

Activities Affected	Yes	No	Action
10. Does the proposed activity consist of changes to maintenance procedures which do NOT affect SSC design, performance, operation or control? **Note:** Procedure information *affecting* SSC design, performance, operation or control, including Tech Spec required surveillance and inspection, ***requires 50.59 screening***. Examples include acceptance criteria for valve stroke times or other SSC function, torque values, and types of materials (e.g., gaskets, elastomers, lubricants, etc.)	☐	☒	If Yes, process in accordance with NC.NA-AP.ZZ-0001(Q)
11. Does the proposed activity involve a *minor* UFSAR change (including documents incorporated by reference)? Examples: • Reformatting, simplification or clarifications that do not change the meaning or substance of information • Removes obsolete or redundant information or excessive detail • Corrects inconsistencies within the UFSAR • Minor correction of drawings (such as mislabeled ID)	☐	☒	If Yes, process in accordance with NC.NA-AP.ZZ-0035(Q)
12. Does the proposed activity involve a change to an Administrative Procedure (NAP, SAP or DAP) governing the conduct of station operations? Examples: • Organization changes/position titles • Work control/ modification processes	☐	☒	If Yes, process in accordance with NC.NA-AP.ZZ-0001(Q) and NC.DM-AP.ZZ-0001(Q)
13. Does the proposed activity involve a change to a regulatory commitment?	☐	☒	If Yes, contact Licensing.
14. Does the activity impact other programs controlled by regulations, operating license or Tech Spec? Examples: • Chemical Controls Program • NJ "Right-to-know" regulations • OSHA regulations • NJPDES Permit conditions • State and/or local building, electrical, plumbing, storm water management or "other" codes and standards • 10CFR20 occupational exposure	☐	☒	If Yes, process in accordance with applicable procedures such as: NC.NA-AP.ZZ-0038(Q) NC.LR-AP.ZZ-0037(Q)

FORM-1
REGULATORY CHANGE PROCESS DETERMINATION

Document I.D.: EG-0047 Revision: 3

Title: HCGS Ultimate Heat Sink Temperature Limits

Activities Affected	Yes	No	Action
15. Does the proposed activity affect the **Independent Spent Fuel Storage Installation (ISFSI)** or the **Dry Cask Storage System (DCSS)** or their analyses? Examples: • Affect the spent fuel canisters or casks • Affect the method of lifting, rigging or transporting DCSS • Challenge Spent Fuel Pool level limits or reactivity limits • Affect fire hazard analyses for the Heavy Haul Path • Affect procedures for DCSS operation or ISFSI activities	☐	☒	If Yes, contact Licensing and initiate the 10CFR72.48 screening process per NC.NA-AS.ZZ-0041 (NAS-41).
16. Has the activity already received a **10CFR50.59 Screen or Evaluation** under another process? Examples: • Calculation • Design Change Package or OWD change • Procedure for a Test or Experiment • DR/Nonconformance • Incorporation of previously approved UFSAR change	☐	☒	Take credit for **10CFR50.59 Screen or Evaluation** already performed. ID: ______
17. Is the proposed change a change to a Chemistry procedure as described in paragraph 4.1.7?	☐	☒	If YES, no 50.59 Screen is required.

If any other program or regulation *may be* affected by the proposed activity, contact the department indicated for further review in accordance with the governing procedure. If responsible department determines their program is not affected, attach a written explanation.

If ALL of the answers on the previous pages are "No," then check A below:

A. [x] None of the activity is controlled by any of the processes above, therefore a 10CFR50.59 review **IS** required. Complete a 10CFR50.59 screen.

If one or more of the answers on the previous pages are "Yes," then check either B or C below as appropriate and explain the regulatory processes which govern the change:

B. [ ] All aspects of the activity are controlled by one or more of the processes above, therefore a 10CFR50.59 review **IS NOT** required.

C. [ ] Only part of the activity is controlled by the processes above, therefore a 10CFR50.59 review **IS** required. Complete a 50.59 screen.

Explanation: ______

PREPARER (SIGN)	DATE	NAME (PRINT)	QUAL EXPIRES
[signature]	November 30, 2005	James Murphy	12/31/2005
[signature]	12/6/05	Robert Down	12/31/2005

FORM-2
10CFR50.59 SCREENING
Page 1 of 4
Revision 0

Document I.D.: EG-0046 & EG-0047 Revision: 5 & 3
Title: STACS Operation & HCGS Ultimate Heat Sink Temperature Limits

Applicability:

____	Salem 1	____	Salem 3 (Gas Turbine)	____	PSEG Common
____	Salem 2	x	Hope Creek		
____	Salem 1 & 2 Common	____	Hope Creek & Salem Common		

1. Brief Description of activity
Change to: ☒ Facility ☒ Procedures ☐ Methodology ☐Test/Experiment ☐ Fission Barrier

What is being changed and why

The following is a list of revisions or additions the STACS analyses & UHS analyses:

- Degraded pump curve has been revised
- Cv value for EG-V023 has been revised and does not require a leakage bypass value in model
- Special cases have been added to determine the affects of taking an EDG room cooler out for maintenance.
- Minor revisions to SACS heat loads due to input calculation revisions

Design Functions

The Safety and Turbine Auxiliaries Cooling System (STACS) is a closed loop cooling water system consisting of two subsystems: a Safety Auxiliaries Cooling System (SACS) and a Turbine Auxiliaries Cooling System (TACS).

The SACS, which has a safety-related function, is designed to provide cooling water to the engineered safety features (ESF) equipment, including the residual heat removal (RHR) heat exchanger, during normal operation, normal plant shutdown, loss of offsite power (LOP), and a loss-of-coolant accident (LOCA).

The TACS, which has no safety-related function, is designed to provide cooling water to the turbine auxiliary equipment during normal plant operation and normal plant shutdown.

The heat from both systems is transferred to the Station Service Water System (SSWS) via the SACS heat exchangers.

Effect on Design Functions

The STACS and UHS analyses show all equipment will receive their minimum required SACS flow equal to or above the Technical Specification UHS temperature limit of 89°F for all modes of operation and accident scenarios. Therefore, the individual sub-components of SACS will perform its safety function during accident conditions.

2. Summarize regulatory change determination (Other applicable regulatory processes identified on Form-1)

FORM-2
10CFR50.59 SCREENING
Page 2 of 4
Revision 0

Document I.D.: EG-0046 & EG-0047 Revision: 5 & 3
Title: STACS Operation & HCGS Ultimate Heat Sink Temperature Limits

No other regulatory processes were identified on Form 1.

3. Does the proposed activity require a change to Technical Specifications or the Operating License? Yes ___ No _x_

If YES, then a License Amendment is required prior to implementation of the activity.
LCR Number: N/A

4. Does the proposal require a UFSAR change? Yes ___ No _x_
UFSAR Change Notice No. N/A

Describe UFSAR change: N/A

5. 50.59 Screening Questions

	Answer ALL screening questions	Yes	No
a.	Does the proposed activity involve a change to the facility that ***adversely*** affects a UFSAR described design function?	☐	☒
b.	Does the proposed activity involve a change to procedures that ***adversely*** affects how UFSAR described SSC design functions are performed or controlled?	☐	☒
c.	Does the proposed activity revise or replace evaluation methodology described in the UFSAR that either: • is used in the safety analyses or • establishes the design bases?	☐	☒
d.	Does the proposed activity involve a test or experiment NOT described in the UFSAR? (SSC is utilized or controlled in a manner that is outside the reference bounds of its design or inconsistent with analyses or descriptions in the UFSAR)	☐	☒
e.	Does the proposed activity require a change in the Technical Specifications or Operating License?	☐	☒

6. Select the appropriate conditions:

☒ If all questions are answered NO, **then** complete the 50.59 Screen and implement the activity in accordance with the applicable governing procedure(s).

☐ If question a, b, c, or d is answered YES and question e is answered NO, **then** perform a 50.59 Evaluation (Form-3).

FORM-2
10CFR50.59 SCREENING
Page 3 of 4
Revision 0

Document I.D.: EG-0046 & EG-0047 Revision: 5 & 3
Title: STACS Operation & HCGS Ultimate Heat Sink Temperature Limits

☐ If question a, b, c, and d is answered NO, and question e is answered YES, **then** a License Amendment is required prior to implementation of the activity.

☐ If question e is answered YES for any portion of the activity, **then** a License Amendment is required prior to implementation of that portion of the activity. In addition, if question a, b, c, or d is answered YES for the remaining portions of the activity, **then** a 50.59 Evaluation shall be performed for the remaining portions of the activity.

50.59 Evaluation No: N/A

7. If a 50.59 Evaluation is not required, provide justification for that determination:

All sub-components cooled by the STACS will receive its minimum required flow to perform its safety function or normal operating design function. The UHS temperature limit for conditions resulting from design basis failures is 90.1°F. This meets the Technical Specification limit of 89°F. The UHS temperature limit for conditions resulting from design basis failures concurrent witih equipment outgages permitted by Technical Specifications AOT Action Statements is 88°F. This meets the Technical Specification limit of 88°F. Any maintenance work performed on EDG room coolers will be limited to a UHS temperature that corresponds to a SACS temperature necessary for all equipment to perform their safety functions. Therefore, the revision to the STACS and UHS analyses does not involve a change that adversely affects a UFSAR described design function.

Procedure SH.OP-AP.ZZ-0108 will be revised to update the limitations of the UHS temperature when an EDG room cooler is taken out for maintenance. Procedures HC.OP-IS.EG-0001 through 0004 will be revised to update the required differential pressure across the SACS pump during Inservice Testing. Procedures HC.OP-SO.EG-0001 and HC.OP-AB.ZZ-0135 will be revised to update the SACS pumps maximum flow rate. All changes to system procedures ensure the SACS system meets the design requirements necessary to mitigate a design basis accident. The changes ensure Operators do not operate the STACS outside of its design bases. Therefore, the revision to the calculations does not involve a change to procedures that adversely affects how UFSAR described SSC design functions are performed or controlled.

The methodology used in Safety Analyses are unaffected by these revisions. All inputs to such analyses are unchanged. These calculations do not establish design bases of any kind. They, in fact, ensure the design bases are met for the STACS. Therefore, the revision to the calculation does not revise or replace evaluation methodology described in the UFSAR.

The revision to the calculations does not involve a test or experiment of any kind. Since the UHS limiting temperature is greater than or equal to the Technical Specification temperature limit, it does not involve a change to the Hope Creek Technical Specifications.

FORM-2
10CFR50.59 SCREENING
Page 4 of 4
Revision 0

Document I.D.: EG-0046 & EG-0047 Revision: 5 & 3
Title: STACS Operation & HCGS Ultimate Heat Sink Temperature Limits

8. List the documents reviewed containing relevant information, including section numbers
(UFSAR, Tech Specs, and others):

UFSAR Section 5.4.7, "RHR System"
UFSAR Section 6.3.1.2.4, "Low Pressure Coolant Injection"
UFSAR Section 6.8, "FRVS"
UFSAR Section 9.2.2, "Safety and Turbine Auxiliary Cooling System"
UFSAR Section 9.2.7.2, "Control Area Chilled Water System"
UFSAR Section 9.4.1, "Control Room and Control Area HVAC Systems"
UFSAR Section 9.4.2, "Reactor Building HVAC"
UFSAR Section 9.4.6, "Standby Diesel Generator Area Ventilation System"
UFSAR Table 9.2-4, "STACS Flows and Heat Loads"
Technical Specifications Section 3.4.9, "Residual Heat Removal"
Technical Specifications Section 3.5.1, "Emergency Core Cooling System"
Technical Specifications Section 3.6.5.3, "Filtration, Recirculation and Ventilation System"
Technical Specifications Sections 3.7.1.1, "Safety Auxiliaries Cooling System"
Technical Specifications Section 3.7.2, "Control Room Emergency Filtration System"
Technical Specifications Section 3.9.11.1, "Residual Heat Removal and Coolant Circulation"

COMPLETION AND APPROVAL

[signature] PREPARER (SIGN)	November 30, 2005 DATE	James Murphy NAME (PRINT)	12/31/2005 QUAL EXPIRES
[signature] REVIWER (SIGN)	December 6, 2005 DATE	Robert Down NAME (PRINT)	12/31/2005 QUAL EXPIRES
[signature] APPROVER (SIGN)	December 7, 2005 DATE	Emin Ortalan NAME (PRINT)	9/20/2005 QUAL EXPIRES