1.0 REVISION SUMMARY

Initial Issue.

2.0 PURPOSE:

The purpose of this Engineering Evaluation is to document the review performed to justify a Safety and Turbine Auxiliaries Cooling System (STACS) post-accident operating temperature of 100°F. The current operating limit for the SACS heat exchanger outlet temperature is 95°F.

3.0 SCOPE:

This Engineering Evaluation is being performed for the STACS system of the HCGS. For the remainder of this evaluation the Safety Auxiliaries Cooling System (SACS) will be used interchangeably with STACS. STACS refers to both the non-safety related Turbine Auxiliaries Cooling System (TACS) and the safety related SACS portions of the system.

4.0 DISCUSSION:

4.0.1 Raising the UHS Temperature Limit:

In an effort to raise the Ultimate Heat Sink (UHS) temperature limit, several design parameters were investigated. The critical parameters which determine the UHS temperature limits are the SACS heat loads, SACS flow rates, Station Service Water System (SSWS) flow rates, and the SACS design temperature. Each parameter was investigated to determine its impact on the UHS temperature limit.

The SACS heat loads and flow rates are independent of the UHS temperature limit. They are dependent on the equipment and coolers served by the SACS system. The heat loads for all the SACS components were reviewed and documented under Reference 5.1.23. The heat loads were reanalyzed to ensure that conservative and accurate values have been used. During this effort, however, the heat loads could not be significantly reduced to impact the UHS temperatures (i.e., less than 1°F change).

The SACS system flow rates are dependent on the SACS hydraulic resistance. Higher total SACS flow rates through the SACS heat exchangers require lower UHS temperatures; therefore, the UHS temperature analysis uses the alignments yielding high SACS flow rate (e.g., loss of instrument air). With total required SACS flow rate established by system alighment, further economies of flow rate are not possible since the required flows to the individual components have already been minimized during the system benchmarking and flow balance effort.

The SSWS flow to the SACS heat exchangers is dependent on the hydraulic characteristics of the SSWS system. Analysis of SSWS flow to the SACS heat exchangers requires the use of the safety related SSWS discharge path, called the Emergency Over-Board (EOB) lines. These lines are much smaller and at a higher elevation than the normal flow path to the Cooling Tower Basin (CTB). Evaluations were performed by Sargent and Lundy to determine the effect of conceptual modifications of the EOB lines to try to increase SSWS flow rates to the SACS heat exchangers. The effect of these modifications would be an increase of less than 1°F in UHS temperature limits. The design change would require lowering the EOB lines discharge points by drilling through the secondary containment wall (approximately seven feet thick). This option would be expensive with little gain in allowable UHS temperature limits. (The Sargent & Lundy analysis remains in draft form, because of its unusable results--other options using proposed alternate safety related discharge paths yielded similar results.)

The remaining option is to raise the SACS design temperature. If the permissible temperature of SACS water leaving the SACS heat exchangers is increased from 95°F to 100°F, it is "easier" to maintain the required SACS heat exchanger outlet design temperature. In other words, an UHS temperature limit five degrees higher can be used to remove the same heat loads from the SACS heat exchangers while maintaining the SACS heat exchanger outlet temperatures at 100°F. The purpose of this evaluation is to justify a SACS temperature limit of 100°F following an accident scenario. The conditions under which this limit is acceptable will be discussed in the following sections.

During the initial stages of investigating an increase to the SACS temperature limit from 95°F to 100°F, several issues were noted. During normal operation, the suppression pool maximum temperature allowed by the Technical Specifications is 95°F. The 95°F suppression pool temperature is used in the HCGS UFSAR Chapter 15 accident analyses. The SACS system provides cooling to the suppression pool during normal operation if the pool temperature approaches the 95°F limit. If the SACS temperature limit was 100°F during normal operation, the suppression pool temperature could not be maintained at a temperature of 95°F. Due to this limitation, the SACS normal design temperature must remain at 95°F. Because of the suppression pool temperature considerations, maintaining SACS at 95°F will limit the scope of the evaluation to only the SACS portion of STACS. The non-safety related TACS portion of the system will not need to be evaluated for 100°F SACS cooling water temperatures since it automatically isolates following a LOP and/or LOCA scenario when higher SACS temperatures are expected.

4.1 DESIGN INPUTS:

4.1.1 The computer program Proto-Hx is used in this analysis to predict the safety-related SACS coolers and heat exchangers' performance. The Proto-Hx program is critical software as defined by ND.DE-AP.ZZ-0052(Q), designated Proto-Hx, Reference 5.3.1.

4.1.2 A potentially limiting design condition exists for the STACS following a postulated Loss of Coolant Accident (LOCA). The non-safety, non-seismic compressed air system (KB) is assumed to be lost following a LOCA. The compressed air system is normally supplied by the service air compressors, 0(1)0-K-107, with an emergency air compressor, 10-K-100, as a back-up. The service air compressors are cooled by TACS and the emergency air compressor is cooled by Reactor Auxiliaries Cooling System (RACS). The cooling water supply to the RACS portion of Station Service Water System (SSWS) and the TACS portion of SACS is automatically isolated following a LOCA signal. Since the cooling flow to the air compressors in RACS and TACS would be isolated, the service and emergency air compressors are assumed to fail. A Loss of Instrument Air (LIA) will occur. Components which are serviced by instrument air should be assumed to fail. For example, air operated valves will fail to their loss-of-air failure position.

4.1.3 In the event that a SACS loop becomes inoperable, Reference 5.5.2 states that the Emergency Diesel Generators (EDGs) and their associated room coolers serviced by the inoperable SACS loop are to be re-aligned so that cooling flow is supplied by the operable SACS loop. One Filtration, Recirculation, and Ventilation System (FRVS) cooling coil; the RHR room coolers; the High Pressure Coolant Injection (HPCI) or Reactor Core Isolation Cooling (RCIC) room coolers, depending on which loop is inoperable; the PCIG compressor, if necessary; and, the fuel pool heat exchanger, if necessary, are also cross-tied to the operable SACS loop in accordance with Reference 5.7.3. The Core Spray (CS) room coolers are not cross-tied. The redundant Emergency Core Cooling System (ECCS), HPCI/RCIC, and EDG room coolers are manually isolated should the situation occur, in accordance with Reference 5.7.3.

4.1.4 The Sections 9.4.2.2.6 and 9.4.2.2.7 of the Updated Final Safety Analysis Report (UFSAR), Reference 5.5.1, deal with the Reactor Building Ventilation System Normal and Abnormal System Operation. It states that "Equipment Area Cooling System (EACS) unit coolers for the Emergency Core Cooling System (ECCS) compartments are actuated by a room temperature switch. The lead cooler starts automatically when the room temperature exceeds 110°F. The standby cooler starts automatically when the room temperature exceeds 115°F or when the lead cooler fails." Further, "Should a room temperature exceed 150°F an alarm will be actuated in the main control room."

The EACS room cooling system, which includes the RHR, HPCI, RCIC, and CS room coolers, have two 100% capacity coolers in each compartment. The unit coolers are actuated automatically by room temperature switches when the room temperature reaches the thermostats' setpoints (Reference 5.2.4). When the room coolers are signaled to start, SACS flow is initiated to the coolers. The maximum design temperature for these rooms is equal to 125°F (Reference 5.1.13). The setpoints for the ECCS room coolers to ensure that the limits in the UFSAR and Reference 5.2.4 are maintained are 107°F +/-2.3°F for the lead coolers and 111°F +/- 2.3°F for the standby coolers (Reference 5.1.14).

4.1.5 Normally, one Control Room chiller is operating and one is on standby (Reference 5.2.5). On a Loss-of-Offsite (LOP) or LOCA, the operating chilled water system is tripped and sequenced onto power from the EDGs after a time delay of 60 seconds for chillers and 65 seconds for the chilled water pumps (Reference 5.6.27).

4.1.6 Normally, one 1E Panel Chiller is operating and one is on standby (Reference 5.2.5). On a LOP or LOCA, the operating chilled water system is tripped and sequenced on to power from the EDGs after a time delay of 75 seconds (Reference 5.6.27).

4.1.7 In the event of low reactor water level, high drywell pressure, a fuel handling accident, or a signal of high radioactivity in the reactor building, FRVS shall start automatically to place the reactor building under a controlled and filtered ventilation mode (Reference 5.4.4). During normal operations FRVS is in standby and the Reactor Building Ventilation System (RBVS) provides cooling to the reactor building (Reference 5.2.4).

4.1.8 Upon a LOP, the Primary Containment Instrument Gas (PCIG) compressors do not automatically load onto their respectively EDGs. In addition, a LOCA signal trips the PCIG compressors. The plant operators can manually load the PCIG compressors onto the EDGs following a LOP or re-start the PCIG compressors following a LOCA (Reference 5.2.6).

4.1.9 The EDG room coolers shall be actuated automatically by room temperature switches when the room temperature reaches the thermostats' setpoints or when the EDG has been operating for over 45 minutes (Reference 5.4.7). SACS cooling water flow is initiated to the EDG coolers when the EDG room coolers start (Reference 5.2.7). The setpoints for the EDG room coolers are 98°F +/-4°F for the lead coolers and 115°F +/-4°F for the standby coolers (Reference 5.1.15).

4.1.10 The RHR pump seal cooler and motor bearing cooler are assumed to receive SACS flow whenever their associated RHR pump is in operation (Reference 5.4.8).

4.1.11 The EDG coolers for the jacket water, intercooler, and lube oil subsystems are assumed to remove heat whenever their associated EDG is in operation (Reference 5.4.9). The EDGs automatically start whenever a LOCA or LOP signal is received.

4.1.12 The Core Spray (CS) pumps automatically initiate when the reactor low level setpoint or high drywell pressure setpoint is reached. They do not automatically start following a LOP only (Reference 5.2.8 and 4.6.7).

4.1.13 To express the heat loads and flow rates in consistent units the following conversion factors will be used:

1 KW = 3414 Btu/hr
1 ton of Refrigeration = 12000 Btu/hr

4.1.14 The effect of raising the SACS heat exchanger outlet temperatures from 95°F to 100°F on the SACS supply piping was investigated. The SACS supply temperature piping was originally designed for a maximum temperature of 150°F. The effect of a SACS cooling water supply temperature of 100°F is already bounded by the current piping specification.

5.0 REFERENCES

5.1 Design Calculations/Engineering Evaluations:

5.1.1 Calculation SC-KJ-0235, Diesel Generator A-D Jacket Water Temperature High, Revision 1
5.1.2 Calculation SC-KJ-0192, Diesel Generator A-D Lube Oil Temperature High from Diesel, Revision 1
5.1.3 Calculation EG-0044, HCGS SACS Proto-Flo Heat Exchanger Models, Revision 1
5.1.4 Calculation 11-0066, FRVS Drawdown Analysis, Revision 6
5.1.5 Calculation GU-0009, Reactor Building Post LOCA Room Temperatures, Revision 1
5.1.6 Calculation 12-0140, Suppression Pool Temp Analysis Isolation Mode with One RHR, Revision 1
5.1.7 Calculation GM-0027, Diesel Generator Area HVAC Analysis, Revision 0
5.1.8 Calculation SC-BB-0047, Reactor Pressure to RHR Interlock, Revision 5
5.1.9 Calculation EC-0033, Fuel Pool Temp with 1 FPCC Pump & Two Hx Operating per NRC, Revision 2
5.1.10 Calculation EC-0007, Fuel Pool Temp with High Den Racks and Only One HX Oper, Revision 2
5.1.11 Calculation H-1-EG-MDC-0478, Pressure Drop and Flow Calc Demin Loop, SACS, Revision 0
5.1.12 Calculation EG-0046, STACS Operations, Revision 2
5.1.13 Engineering Evaluation H-1-GR-MEE-1279, Evaluation to Determine the Maximum Ambient Temperature for the EACS Rooms, Revision 0
5.1.14 Calculation GU-0023, Instrument Setpoint for Pump Room Unit Cooler Temperature Switches, Revision 1
5.1.15 Calculation SC-GM-0025, DG Recirc AV412 Room Temp, Revision 1
5.1.16 Engineering Evaluation H-1-GK-MEE-1292, Performance of AVH403 Control Room Cooler, Revision 0
5.1.17 Engineering Evaluation H-1-GK-MEE-1293, Performance of 1A-VH407 Control Equipment Room Supply Cooler, Revision 0
5.1.18 Engineering Evaluation H-1-GM-MEE-1294, Performance of 1A-VH408 1E Panel Supply Air Cooler, Revision 0
5.1.19 Engineering Evaluation H-1-GR-MEE-1298, Performance of 00VH314 TSC Cooler, Revision 0
5.1.20 Engineering Evaluation H-1-GL-MEE-1295, Performance of 00VH316 Remote Shutdown Panel Room Cooler, Revision 0
5.1.21 Calculation KL-0006, PCIG Compressor Performance During LOCA and LOP, Revision 0
5.1.22 Calculation GJ-0002, Control Area Chilled Water System, Revision 4
5.1.23 Calculation EG-0020, STACS Flow Rates and Heat Loads, Revision 7
5.1.24 Engineering Evaluation H-1-GJ-MEE-1291, Evaluation to Determine the Operating Limits of Chillers Cooled by 100°F SACS Water, Revision 0
5.1.25 Engineering Evaluation H-1-EG-MEE-1206-1, UHS Temp Limit for Summer 97 and LCR H97-005, Revision 1
5.1.26 Calculation EG-0010, SACS Pump Runout Trip Setpoint, Revision 3

5.2 Engineering Documents:

5.2.1 Standards of the Tubular Exchanger Manufacturers Association, Seventh Edition, 1988
5.2.2 Fundamentals of Heat and Mass Transfer, Incropera and DeWitt, Second Edition, Wiley, 1985
5.2.3 Technical Paper Crane 410, Flow of Fluids, 1988
5.2.4 Design, Installation, and Test Specification (DITS) D3.48, Reactor Building HVAC Systems, Revision 8
5.2.5 DITS D3.19, Control Area Chilled Water System, Revision 6
5.2.6 DITS D3.41, Primary Containment Instrument Gas System, Revision 4
5.2.7 DITS D3.51, Design, Inst, Test Spec for Aux Bldg Diesel Gen Area HVC Sys, Revision 7
5.2.8 DITS D3.36, Core Spray System, Revision 5
5.2.9 DITS D7.5, HCGS Environmental Design Criteria, Revision 17

5.3 Critical Software:
5.3.1 Critical Software A-0-ZZ-MCS-0169, Critical Software Document for Proto-Hx, Revision 0
5.3.2 Critical Software A-0-ZZ-MCS-0180, Critical Software Document for PCFLUD, Revision 0

5.4 Drawings:
5.4.1 Drawing E-0324-0, Elect Schematic Diagram Fuel Pool Cooling Water Pumps, Revision 7
5.4.2 Drawing H-88-0, Sheet 5, Logic Diagram Aux Building Diesel Area, Revision 12
5.4.3 Logic Diagram J-11, Sheet 16, Logic Diagram Safety Auxiliaries Cooling, Revision 7
5.4.4 Logic Diagram H-83-0, Sheet 4, Logic Diagram Reactor Building Supply, Revision 11
5.4.5 Drawing H-84, Logic Diagram Reactor Building Exhaust, Sheet 4, Revision 9
5.4.6 E-1410-0, Sheet 149A, Panel Schedule # 10Y205, Revision 10

5.5 Regulatory Documents:
5.5.1 Hope Creek Generating Station Updated Final Safety Analysis Report (UFSAR), Revision 8
5.5.2 HCGS Technical Specifications

5.6 Vendor Documents
5.6.1 Vendor Manual PM018Q-0499, Volume III, Emergency Diesel Generator Operation and Maintenance Manual, Revision 26
5.6.2 Vendor Document PM018Q-0290, Heat Exchanger Data Sheet Lube Oil Heat Exchangers, Revision 1
5.6.3 Vendor Document PM018Q-0288, Jacket Water Heat Exchangers, Revision 2
5.6.4 Vendor Document PM018Q-0289, Combustion Air Cooling Water Heat Exchangers, Revision 3
5.6.5 Vendor Document PN1-E11-B001-0039, Instruction Manual, Revision 1
5.6.6 Vendor Document PN1-A61-2050-0004, Sheet 2, Reactor Sys. Outline, Revision 2
5.6.7 Vendor Document PN1-E21-1030, Sheet 1, Core Spray System FSD, Revision 8
5.6.8 Vendor Document PM723Q-0228, Appendix A Spec 10855-M-723(Q) Centrifugal Water Chillers, Revision 1
5.6.9 Vendor Document PM723Q-0225, Performance Test Report, 19FA-455-B-12-20/2-20-2-SDH, Revision 1
5.6.10 Vendor Document PM723Q-0242, Performance Test Report, 19FA-441-B-114202-SDB, Revision 1
5.6.11 Vendor Document PN1-E11-C001-0040, Manual-Vertical Induction Motors, Sheet 1, Revision 2
5.6.12 Vendor Document PN1-E11-C002-0006, Outline Induction Motor, Revision 6
5.6.13 Vendor Document PM071Q-0031, Alfa Laval Data Sheet, Revision 7
5.6.14 Vendor Document PM048Q-0084, Oper/Main Man for Containment Instr Gas Compressor, Revision 17
5.6.15 Vendor Document PM048Q-0057, Compressor Skid Technical Data Sheets, Sheet 1, Revision 7
5.6.16 Vendor Document PN1-B31-S001-0120, Instruction Manual Variable Frequency Motor Generator Set, Revision 12
5.6.17 Vendor Document PM003-TR-0018, Main Turbine Oil Cooler Specification Sheet, Revision 5
5.6.18 Vendor Document PM003-T6-0001, EHC Coolers Operating and Water Requirements, Revision 2
5.6.19 Vendor Document PM003-G-0001, Generator Station Service Data, Revision 7
5.6.20 Vendor Document PE005-0076, Iso-Phase Bus Cooling Unit, Revision 2
5.6.21 Vendor Document PM012-0066, Heat Exchanger Data Sheet Lube Oil, Revision 2
5.6.22 Vendor Document PM007-0031, Heat Exchanger Data Sheet, Revision 3
5.6.23 Vendor Document PM623-0127, Performance Test Report, Revision 2
5.6.24 Vendor Document PM050-0039, Heat Exchanger Data Sheets, Sheets C-1, C-2, & C-3, Revision 3
5.6.25 Vendor Document PM050-0056, 304-1000 & 2000 Series Lubricators Inst & Oper Instr, Revision 19
5.6.26 Vendor Document PM611A-0004, H36MPACYA, Data Sheet, Revision 7

5.6.27 Vendor Document PJ810Q-0097, Operating/Maintenance Instruction for Emergency Load Sequencer, Revision 3
5.6.28 Vendor Document PM018Q-0366, Sheet 8, Elect Schem Dwg, Revision 12
5.6.29 PSBP 309343, Post Accident Sampling System, Revision 6
5.6.30 PSBP 313225, Operating Instructions Basco Type "500" Exchangers, Revision 1
5.6.31 Vendor Document PM082Q-0140, Control Room Chilled Water Pump Data Sheet, Revision 5
5.6.32 Vendor Document PM707Q-0017, SACS Expansion Tank, Revision 7
5.6.33 PSBP 323835, Containnment Analysis With Increased SACS Temperature, Revision 1

5.7 Procedures
5.7.1 HC.CH-AD.KJ-0001(Q), Chemical Addition to the Diesel Generator Jacket Water System, Revision 5
5.7.2 HC.OP-SO.EC-0001(Q), Fuel Pool Cooling & Cleaning System, Revision 13
5.7.3 HC.OP-SO.EG-0001(Q): Safety and Turbine Auxiliaries Cooling Water System, Revision 22
5.7.4 HC.CH-SO.EG-0001(Q), Operation of the STACS Demineralizer, Revision 3
5.7.5 HC.OP-AB.ZZ-0122(Q), Station Service Water System Malfunction, Revision 15
5.7.6 HC.OP-AB.ZZ-0124(Q), Safety Auxiliaries Cooling System Malfunction, Revision 11

6.0 ANALYSIS

6.1 Methodology

This engineering evaluation has been performed to evaluate the SACS system performance using a temperature limit of 100°F in lieu of 95°F. The approach used in this evaluation is as follows:

APPROACH

Step 1:	Review the original design specifications for the SACS components.
Step 2:	Review calculations associated with interfacing systems.
Step 3:	If necessary, using the Proto-Hx computer models of the SACS components (Reference 5.3.1) determine the minimum required flow to remove the design heat loads.
Step 4:	Determine the effect of raising the SACS temperature limit.
Step 5:	Provide recommendations to allow a higher SACS design limit under certain scenarios.

6.2 Emergency Diesel Generators (EDG) Coolers - 1A(B-D)-E-404, 405, 408

Each EDG has three sub-systems which are cooled by the SACS system: jacket water, lube oil, and intercooler. The EDG coolers, each of which serve an individual EDG, are located in series through a single SACS flow path, see Figure 1 on Page 13. As the SACS fluid passes through one cooler, the SACS fluid temperature increases, enters the next cooler and so on. The heat load and flow for each cooler must therefore be analyzed together with each cooler's inlet temperature based on the previous cooler's outlet temperature.

The original system design information was reviewed and compared with the current EDG vendor manual, setpoint calculations, and operating procedures to determine the minimum flow rates for the EDG coolers. The required heat loads for an EDG operating at 100% of its full load are located in the EDG vendor manual (Reference 5.6.1) and are as follows:

Intercooler	-	3.118 MBtu/hr	[Drawing 11909604 of Reference 5.6.1]
Jacket Water	-	5.412 MBtu/hr	[Drawing 11909605 of Reference 5.6.1]
Lube Oil	-	1.353 MBtu/hr	[Drawing 11909606 of Reference 5.6.1]

The maximum process side fluid temperatures were determined based on a review of the EDG vendor manual and several I&C calculations. The maximum allowable temperatures (i.e., process limits) and nominal flow values during emergency conditions are:

Intercooler	-	125°F @	880 gpm	[Reference 5.6.1]
Jacket Water	-	195°F @	880 gpm	[Reference 5.6.1 and Reference 5.1.1]
Lube Oil	-	175°F @	400 gpm	[Reference 5.6.1 and Reference 5.1.2]

The maximum allowable jacket water temperature is 195°F. The high temperature alarm, 1KJTSH-6609A(B,C,D), is set at 185 °F ± 5°F per Reference 5.1.1. The maximum allowable lube oil design temperature is 175°F. The high temperature alarm, 1KJTSH-8579A(B,C,D), is set at 170°F ± 4°F per Reference 5.1.2. The maximum temperature which will be analyzed for the lube oil is 170°F. No high temperature alarm is installed for the Intercooler subsystem.

EDG Cooler Performance

The Proto-Hx model of the EDG coolers from Reference 5.1.3 was used to determine the EDG coolers' performance. The SACS flow rate delivered to the series of coolers was varied to determine the effect on EDG process fluid temperatures. The outlet temperatures were recorded and the steady state process fluid temperatures were calculated assuming constant EDG heat loads and maximum fouling conditions. The table below documents the results of the computer runs (see Attachment 1 for actual results). The SACS hydraulic analysis was reviewed to determine the anticipated SACS flow rates to the EDG coolers under various scenarios. The minimum SACS flow to the EDG coolers, assuming no failures in the SACS loop, was equal to 1000 gpm. As shown in the table below, the process side fluid temperatures remain less than the limits using 100°F SACS cooling water temperatures. During the long term, assuming a single active failure in the short term, only two EDGs are required to safely shutdown the plant. The two EDGs on the SACS loop without a single failure would adequately cool the EDG coolers.

SACS Flow (gpm)	T_{sacs} (°F)	T_1 (°F)	T_2 (°F)	$T_{i\text{-}Int}$ (°F)	$T_{i\text{-}JW}$ (°F)	$T_{i\text{-}LO}$ (°F)
1000	100	106.1	116.9	122.0	183.5	160.2
900	100	106.9	118.9	122.7	186.0	162.2
800	100	107.8	121.3	123.5	189.1	164.6
775	100	108.1	122.1	123.8	190.0	165.4
750	100	108.3	122.7	124.0	190.8	166.1
700	100	108.9	124.4	124.6	192.8	167.8
650	100	109.6	126.3	125.2	195.1	169.7

TABLE 1
EDG Process Fluid Temperatures with 100°F SACS

Under certain SACS single failure modes, SACS flow rates to the EDG coolers of less than 1000 gpm are expected; however, the SACS loop which sustained the single failure would not be capable of removing large RHR heat loads in its degraded condition.

High RHR heat loads are required to obtain SACS loop temperatures approaching 100°F. Since such loads are not present in the short term, SACS water to the EDG coolers on the degraded loop would remain below 100°F.

In the long term, however, if it is assumed that the degraded SACS loop is at 100°F, SACS flow rates as low as 700 gpm are still acceptable, as shown in Table 1 above, since the process fluid output temperatures are less than the maximum design values. (Per the SACS hydraulic analysis, Reference 5.1.12, the minimum flow to the EDG coolers is 700 gpm.) Under these conditions, however, nuisance alarms would be sounded signifying a degraded condition.

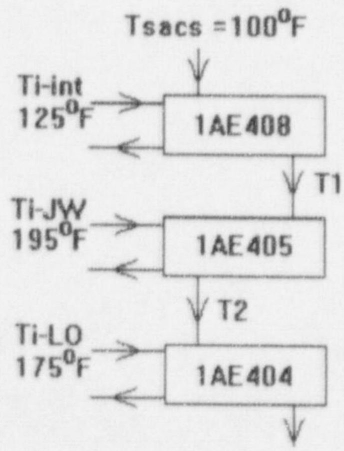

Figure 1
EDG Coolers

6.3 Filtration Ventilation and Recirculation System (FRVS) Units

The cooling water to the FRVS cooling coils is supplied by the SACS system. The FRVS system provides two functions which the proposed increase in the SACS cooling water temperature may impact. The first is that FRVS provides the HVAC cooling and filtration in the reactor building in the long term LOCA scenario. The second is that FRVS provides cooling in the short term LOCA scenario to drawdown the reactor building to a pressure less than or equal to 0.25" of water.

A review of the long-term post-LOCA FRVS calculation (Reference 5.1.5) was performed to determine the effect of raising the SACS temperature from 95°F to 100°F. The calculation analyzes two cases. The first case assumes that four FRVS cooling coils/fans are available due to a single active failure of an EDG in the short term. The second case assumes that only three FRVS cooling coils/fans are available following a passive failure of a SACS loop in the long term (also assumes a single active failure did not occur during the short term). The calculation determines the steady-state reactor building temperatures during the long term (greater than 10 minutes) following a LOCA scenario. Both cases use a SACS cooling water temperature of 100°F.

The results of the FRVS sensitivity analysis using a 100°F SACS cooling water temperature demonstrate that the bulk average FRVS return air temperature is less than 140°F and the reactor building room temperatures are less than 148°F, except for the pipe chase in Room 4329. This pipe chase exceeds the maximum room design temperature of 148°F (Reference 5.2.9) by three degrees. A review of the equipment in this area was performed to determine the impact of the temperature increase. The results of the review indicate that this temperature increase is insignificant. There is no EQ related equipment located in this area. In addition, the duration of time at which this temperature would occur is short (i.e., less than 24 hours). There would be no impact on the structure (concrete walls or piping). Reference 5.2.9 will be updated to indicate this exception.

The FRVS drawdown analysis was also reviewed to determine the impact of raising the SACS cooling water temperature. The SACS system will normally be maintained at a temperature less than or equal to 95°F. It is not expected that the SACS temperature could reach 100°F during the short-term of a LOCA scenario ($t<10$ minutes) since the RHR heat exchanger would not be aligned to the suppression pool cooling mode. Regardless, the drawdown analysis (Reference 5.1.4) performed a sensitivity study using a 100°F SACS cooling water temperature to be conservative. The results demonstrate that the maximum drawdown time of 375 seconds allowed by Section 4.6.5.1 of the Technical Specifications would not be exceeded. A SACS cooling water temperature of 100°F or less is acceptable.

6.4 Residual Heat Removal (RHR) Heat Exchanger

To determine the effect of the higher proposed post-accident SACS design temperature of 100°F, the limiting case for the RHR heat exchanger performance must be selected. During the GE UHS work performed for PSE&G during 1997, many UHS cases under various accident modes were analyzed. The limiting case based on that work was determined to be a LOP scenario in which aligning the RHR heat exchanger to shutdown cooling could not be accomplished. In this scenario, the RHR heat exchanger remains aligned to suppression pool cooling. The case is similar to a LOCA since the heat loads from the reactor are similar. The predominant reason that the LOP scenario is more limiting than a LOCA scenario is that suppression pool cooling is assumed to be initiated after 30 minutes following a LOP compared to 10 minutes following a LOCA. This delay in suppression pool cooling will allow the suppression pool to attain a higher temperature.

GE was requested to perform an analysis of the LOP scenario assuming various SACS temperatures (Reference 5.6.33). For a SACS cooling water temperature of 100°F, the required RHR heat exchanger K-value is 307 Btu/sec-°F. The suppression pool and containment response, post-LOP, were calculated assuming that one full train of RHR is lost and that shutdown cooling can not be aligned. The heat removal rate of the remaining RHR heat exchanger under these conditions is:

$$Q_{RHR} = 3600\ \alpha_{RHR}\ (T_{RHR} - T_{sacs})$$
$$Q_{RHR} = 3600\ \text{sec/hr}\ (307\ \text{Btu/sec-°F})\ (212°\text{F} - 100°\text{F})$$
$$Q_{RHR} = 123{,}800{,}000\ \text{Btu/hr}$$

To ensure that this heat transfer can be met, the Proto-Hx computer model of the RHR heat exchanger was used to determine the SACS flow rate. A flow rate of 10,000 gpm was assumed for RHR flow. The results, see Attachment 3, show that a SACS flow of 8,650 gpm is required to ensure that the RHR heat exchanger heat transfer coefficient is greater than or equal to 307 Btu/sec °F. The SACS flow rate is only valid provided that a minimum RHR shell side flow rate of 10,000 gpm is supplied.

$$m_{RHR} = 10{,}000\ \text{gpm}$$
$$m_{sacs} = 8{,}650\ \text{gpm}$$
$$T_{RHR} = 212\ °\text{F}$$
$$T_{sacs} = 100\ °\text{F}$$
$$Q = 123{,}800{,}000\ \text{Btu/hr}$$

This heat exchanger analysis assumes the maximum fouled conditions for the RHR heat exchanger. It does not assume that any RHR heat exchanger tubes are plugged. Current maintenance procedures indicate that if the RHR heat exchanger tubes are plugged, engineering is contacted to specify the maximum allowable tubes which can be plugged. When the RHR heat exchanger tubes are plugged, the SACS flow to the RHR heat exchanger will need to be re-evaluated. If the current system flow balance does not allow for adequate tube plugging, the RHR heat exchanger valve will be repositioned to allow more flow

The SACS hydraulic model was reviewed to ensure that adequate SACS flow can be supplied to the RHR heat exchanger. Under all cross-tie and normal operating modes, adequate SACS cooling water flow is supplied to the RHR heat exchanger. However, if a single active failure is assumed on one of the two redundant SACS loops, the RHR heat exchanger is not provided with adequate flow. Under this scenario, the degraded SACS loop will not provide adequate suppression pool cooling; however, the RHR heat exchanger on the redundant loop can be credited. Only one RHR heat exchanger is required to safely shutdown the plant following an accident scenario. This is consistent with the current design and licensing basis.

Another limiting alignment for the SACS system is when only one SACS pump in each loop is operable. This alignment is permitted by Section 3/4.7.1.1 of the Technical Specifications. Under this scenario, the RHR heat exchanger is not provided with adequate flow if the SACS cooling water temperature is 100°F; however, the RHR heat exchanger is provided with adequate flow if the SACS cooling water temperature is 95°F. For this alignment, a SACS cooling water temperature of 100°F can not be allowed. This will ensure that adequate cooling is provided to the suppression pool. The current UHS limit for this alignment is 88°F, and serves as the basis for the proposed UHS temperature limit.

6.5 Control Room Chiller (1A(B)-K-400)

The minimum required heat load to be removed by the Control Room Chiller is based on the following equipment heat loads served by the Chiller:

Component	Heat Load Req'd - Accident Conditions (Btu/hr)	Heat Load Req'd - Normal Conditions (Btu/hr)	Reference
Control Room A/C Unit	792,000	792,000	5.1.16
Control Equipment Room A/C Unit	2,232,000	2,232,000	5.1.17
Switchgear Room Cooling Unit	1,498,000 (4 total, 374,500 each)	1,498,000 (4 total, 374,500 each)	5.1.7
SACS Room Cooling Units	1,214,800 (total for both SACS room clrs)	1,214,800 (total for both SACS room clrs)	5.1.5
Chilled Water Pump, 1A(B)-P-400 Heat	133,900	133,900	5.6.31
Total Chiller Load	5,870,700	5,870,700	
Chiller Compressor Heat Load	1,660,000	1,660,000	5.1.23
Total SACS Heat Load	7,530,700	7,530,700	

TABLE 2

As shown in the table above, the required tonnage to be removed by the chiller unit is 5.87 MBtu/hr or 489 tons. An engineering evaluation (Reference 5.1.24) has been performed to determine the response of the control room chiller using a SACS cooling water temperature of 100°F. The results of this analysis provide an acceptable range within which the control room chiller can operate with 100°F SACS cooling water temperatures. The range is dependent on the heat load (in tonnage) removed by the chiller and the chilled water temperature limit setpoint. The analysis shows that for a required tonnage equal to 489 tons, the chilled water temperature setpoint must be greater than or equal to 46.5°F. The current chilled water temperature setpoint is equal to 47°F; however, the temperature element has an inaccuracy equal to ± 2°F. To ensure that the minimum chilled water temperature limit setpoint is met, a chilled water temperature limit setpoint of 48.5°F + 0.5°F/-0.0°F is recommended. This indicates that the chilled water temperatures will be in the range of 46.5°F and 51°F including instrument inaccuracies (± 2°F) and the setpoint bias (+0.5°F, -0.0°F).

Since the Control Room chilled water temperature setpoint must be raised, the effect of raising the chilled water temperature from a value of 47°F to a temperature as high as 51°F was evaluated. The evaluations (References 5.1.7, 5.1.16, and 5.1.17) show that the room temperatures served by the Control Room coolers, Control Equipment Room coolers, and Switchgear Room coolers are acceptable. The SACS room coolers were not specifically analyzed for the higher control room chilled water temperatures; however, the room temperatures supplied by these coolers were increased by the recommended increase in the chilled water temperature compared to the value used in the calculation. For example, the SACS room coolers were analyzed using a chilled water temperature of 50°F (Reference 5.1.5). Since the maximum proposed chilled water temperature is 51°F, the SACS room temperature using 50°F was increased by 1°F to ensure that the design room temperature would not be exceeded. The results of these evaluations demonstrate that the rooms served by chillers 1A(B)-K-400 are maintained within their design criteria.

6.6 1E Panel Chiller (1A(B)-K-403)

The required heat load to be removed by the 1E Panel Chiller is based on the following equipment heat loads served by the Chiller:

Component	Heat Load Req'd (Btu/hr)	Reference
1E Panel Room A/C Unit	1,242,000	5.1.18
Control Equipment Room A/C Unit	421,200	5.1.19
Remote Shutdown Panel Room Cooler	43,200	5.1.20
Chilled Water Pump, 1A(B)-P-414	79,920	5.1.22
Chiller Load	1,786,320	
Chiller Compressor Heat Load	730,845	5.1.23
Total SACS Heat Load	2,517,165	

TABLE 3

As shown in the table above, the required tonnage to be removed by the chiller unit is 1.79 MBtu/hr or 148.7 tons. An engineering evaluation (Reference 5.1.24) has been performed to determine the response of the chiller using a SACS cooling water temperature of 100°F. The results of this analysis provide an acceptable range within which the 1E Panel (TSC) chiller can operate with 100°F SACS cooling water temperatures. The range is dependent on the heat load (in tonnage) removed by the chiller and the chilled water temperature limit setpoint. The analysis shows that for a required tonnage equal to 149 tons, the chilled water temperature setpoint must be greater than or equal to 44.5°F. The current chilled water temperature setpoint is equal to 45°F; however, the temperature element has an inaccuracy equal to ± 2°F. To ensure that the minimum chilled water temperature limit setpoint is not exceeded, a chilled water temperature limit setpoint of 47°F ± 0.5°F is recommended. This indicates that the chilled water temperatures will be in the range of 44.5°F and 49.5°F including instrument inaccuracies (± 2°F) and the setpoint bias (± 0.5°F).

Since the 1E Panel chilled water temperature must be raised, the effect of raising the chilled water temperature from a value of 45°F to a temperature as high as 49.5°F was evaluated to determine the resulting room temperatures cooled by room coolers supplied by chilled water (References 5.1.18, 19, & 20). The results of these evaluations demonstrate that the rooms served by chillers 1A(B)-K-403 are maintained within their design criteria.

6.7 Emergency Diesel Generator Room Cooler (1A(B-H)-VH412)

The EDG room coolers provide cooling to the EDG rooms during normal and accident conditions. Two 100% capacity EDG room coolers are provided in each EDG room. A review of the EDG room cooler HVAC calculations was performed to determine the effect of raising the SACS cooling water temperature.

Reference 5.1.7 shows that the majority of the rooms in the diesel generator area operate at temperatures below the permitted maximum delineated in the UFSAR (Reference 5.5.1). However, the Diesel Generator rooms would exceed their design temperature of 120°F by 5°F with an EDG room cooler SACS flow rate of 260 gpm at 100°F water temperature (Reference 5.1.7). In order to provide adequate cooling to the EDG rooms, the redundant EDG room cooler would be required to be available and two EDG room coolers credited. The analysis shows that the resulting EDG room temperatures are maintained below the design point when two EDG room coolers are used.

During certain alignments, such as a SACS loop outage, the current SACS operating procedures (References 5.7.3 & 5.7.6) require that the redundant ECCS/RCIC room coolers and redundant EDG room coolers be isolated, and that the EDGs and their primary room coolers be cross tied to the operable SACS loop. The isolation of redundant coolers is necessary in order to provide adequate flow to the RHR heat exchanger and other SACS loads. While this configuration provides sufficient cooling to the EDG room when SACS flow is at its current maximum of 95°F, when the SACS temperature was raised to 100°F, the elimination of redundant EDG room coolers caused the temperature of the EDG rooms to exceed their maximum, as discussed above. The SACS hydraulic model was run in the cross tied configuration <u>without</u> isolating the redundant EDG room coolers, but with <u>all</u> EDG room coolers throttled to 25% open (Attachment 3). It was shown that this configuration held the EDG room temperatures below their design limits with a SACS flow of 220 gpm at 100°F. It is therefore recommended that current operating procedures be modified to have <u>all</u> EDG room coolers throttled to 25% for a cross tie configuration, instead of the current isolation of redundant coolers and full open primary coolers.

When flow to the EDG room coolers was set to 25%, the flow to the RHR heat exchanger remained above the minimum required. The hydraulic analysis assumes that the flow control valves on the control room chillers and the 1E Panel chillers fail open on a loss of air. Back-up air supply accumulators were installed on the chiller flow control valves. The accumulators are required when the UHS temperature is less than 70°F to prevent the chillers from tripping on low pressure. If it is assumed that the flow control valves do not fail open, adequate SACS flow to the RHR heat exchanger is achieved; therefore, it is recommended that the safety-related accumulators installed on the control room and 1E panel chillers be maintained in a fully operable state at <u>all</u> times, instead of only when river temperature is below 70°F.

6.8 Residual Heat Removal Pump Seal Cooler

The RHR pump seal flow is taken directly from the RHR pump discharge header. The RHR pump seal flow rate is assumed to be approximately 4 gpm (Reference 5.1.23). The RHR seal water cooler inlet temperature depends on the RHR pump discharge temperature. Two scenarios are considered to determine the maximum pump discharge temperatures, a LOP and a LOCA.

For a LOP scenario, the maximum seal water temperature (RHR pump discharge) would be based on the maximum reactor water temperature when shutdown cooling is initiated. Reference 5.1.8 states that the maximum analytical reactor pressure interlock limit for shutdown cooling is 115 psig. The nominal set point for this interlock is 82 psig; however, considering uncertainties, the reactor pressure may be as high as 115 psig. The reactor water temperature at a saturation pressure of 115 psig is 347°F (Reference 5.2.3). Attachment 5 of Reference 5.1.23 shows that the required SACS flow rate at a SACS temperature of 105°F is 18 gpm with an RHR temperature of 360°F and seal flow of 4 gpm. The total heat load under these conditions would be 350,000 Btu/hr. Since the original SACS design temperature under these conditions was 105°F, a temperature of a 100°F would be acceptable.

For a LOCA scenario, the maximum seal water temperature is based on the maximum suppression pool temperature since the RHR pump would be in suppression pool cooling mode. The maximum suppression pool temperature during worst-case accident scenarios is 212°F (Chapter 6 of Reference 5.5.1). The inlet seal water temperature during a LOCA is less than the value assumed for a LOP scenario; therefore, a LOCA scenario is bounded by the LOP data. A SACS cooling water temperature of 100°F is acceptable.

6.9 Residual Heat Removal Pump Motor Bearing Cooler

The RHR pump motor bearing cooler directly removes heat from the RHR motor lube oil. The maximum allowable lube oil temperature from the vendor is 130°F (Reference 5.6.11). The heat which is rejected to the lube oil during pump operation is based on a thrust bearing loss of 2.5 kW (Reference 5.6.12). This assumes all thrust bearing losses are transferred to the lube oil. The conversion factors are from Reference 5.2.1.

Heat load = 2.5 kW (1000 W/kW)(1 / 0.29307 Btu/hr-W) = 8,530 Btu/hr

To be conservative, a heat load of 10,000 Btu/hr will be assumed for the RHR pump motor bearing cooler during normal and accident conditions. Attachment 4 of Reference 5.1.23 is an analysis of the motor bearing cooling coil with SACS flow at a temperature of 100°F. The required SACS flow rate to the cooler is 6 gpm at a SACS temperature of 100°F. The analysis shows that this minimum flow maintains the lube oil cooler at a temperature less than 130°F. The SACS hydraulic model, Reference 5.1.12, shows that under all normal and failure modes, six gpm can be delivered to the cooler. A SACS temperature of 100°F is acceptable.

6.10 ECCS and RCIC Pump Room Coolers

Reference 5.1.13 was performed to raise the room design temperatures in the ECCS and RCIC rooms from 115°F to 125°F during normal and abnormal conditions. This increase in the allowable room temperatures provided margin. To determine the effect of raising the SACS cooling water temperature from 95°F to 100°F following an accident scenario, the reactor building HVAC analysis (Reference 5.1.5) was reviewed.

The post LOCA conditions show that the maximum room temperatures in the ECCS and RCIC rooms can be maintained less than 125°F using the minimum flow rates specified in Table 9.2-4 of the UFSAR. Only one of the two redundant room coolers was assumed to operate. Table 4 below shows the heat loads removed by the coolers, the SACS flow rates, the SACS cooling water temperature and the resulting room temperatures (Data is taken from Reference 5.1.13). These values apply to both LOCA and LOP scenarios. The heat loads and resulting room temperatures are not expected to significantly change between these two cases. The review demonstrates that a SACS temperature of 100°F is acceptable.

Using the proposed 100°F SACS cooling water, the resulting room temperatures indicate that the redundant room coolers would reach their starting setpoint. Only one room cooler is required. To prevent the redundant room cooler from unnecessarily cycling on/off, it is recommended that the redundant room cooler setpoints are raised from their current setpoint of 111°F ± 2.3°F to 122.7°F ± 2.3°F.

Cooler	Cooler Designator	Cooling Water Flow (gpm)	Cooling Water Temp (°F)	Sensible Heat Load (Btu/hr)	Room Temperature (°F)
RHR Pump Room Clr - 4107	1D-VH210	78	100	378000	119
RHR Pump Room Clr - 4114	1B-VH210	78	100	377000	118
RHR Pump/Hx Rm Clr - 4109	1C-VH210	89	100	377000	119
RHR Pump/Hx Rm Clr - 4113	1A-VH210	89	100	382000	118
CS Rm Clr - 4104	1B-VH211	68	100	228000	116
CS Rm Clr - 4105	1D-VH211	68	100	223000	117
CS Rm Clr - 4116	1C-VH211	68	100	222000	117
CS Rm Clr - 4118	1A-VH211	68	100	223000	116
HPCI Rm Clr	1A-VH209	35	100	177100	115
RCIC Rm Clr	1A-VH208	13	100	63500	114

TABLE 4

6.11 Fuel Pool Heat Exchanger, 1A(B)-E-202

The fuel pool heat exchanger is required to remove the decay heat associated with the fuel core off-load for an 18 month refueling interval. Reference 5.1.9 determined that the maximum heat load for high density fuel racks is equal to 16.1 MBtu/hr. Reference 5.6.13 shows that each fuel pool heat exchanger has the capacity to remove 9.515 MBtu/hr at a SACS flow rate and temperature of 1000 gpm and 95°F and a fuel pool temperature of 135°F.

If two fuel pool heat exchangers are in service, the fuel pool can be maintained at a temperature less than 135°F (Reference 5.1.9). If only one fuel pool heat exchanger is in service, the maximum fuel pool temperature would be 174°F per Reference 5.1.10. These values are based on normal operating conditions using a SACS temperature of 95°F.

Following a LOP signal, the fuel pool pumps trip and are not automatically loaded onto the EDG (Reference 5.6.27). Operator action in accordance with Reference 5.7.2 is required to re-start the fuel pool pumps. There would be no fuel pool heat load to SACS following a LOP scenario until the fuel pool pumps are sequenced onto their respective EDGs and fuel pool cooling is manually re-initiated. During periods of high river water temperature, the fuel pool heat exchangers would remain isolated following a LOP if the SACS heat exchanger outlet temperature could not be maintained below its current maximum design value of 95°F (Reference 5.7.5). The heat load during the long term (>30 minutes) after a LOP would be dependent on the river water temperature.

Following a LOCA scenario, the fuel pool pumps would not automatically trip unless there was a concurrent LOP or a failure of the instrument air system (Reference 5.4.1). The instrument air system is assumed to be lost following a LOCA scenario since the RACS and TACS systems, which cool the air compressors, would be automatically isolated. The loss of instrument air would cause the fuel pool heat exchanger outlet valves to fail closed preventing fuel pool cooling pump flow. If a LOP or loss of instrument air did not occur, the fuel pool pumps would deliver heat to the SACS system. As was the case during a LOP, the fuel pool heat exchangers would be isolated following a LOCA (>10 minutes) if the SACS heat exchanger outlet temperature could not be maintained below its current maximum design value of 95°F. During the short-term accident scenario, the heat load transfer to the SACS system via the fuel pool heat exchanger is assumed to be 16.1 MBtu/hr or 8.05 MBtu/hr depending on the number of heat exchangers on-line prior to the event.

Per Section 9.1.3 of Reference 5.5.1, the fuel pool heat exchanger is not required to safety shutdown the plant following an accident scenario. Under elevated river water temperatures, the operators are procedurally directed to isolate the fuel pool cooling system if SACS temperatures can not be maintained less than their design values. Since the operators may isolate the fuel pool heat exchangers, the effect of the raising of the SACS cooling water temperature to 100°F was not specifically analyzed. The normal operating conditions will not change since the normal operating design temperature of 95°F is unchanged by this proposal.

6.12 Primary Containment Instrument Gas (PCIG) Compressor, 1A(B)-K-202

A review of the PCIG compressor, 1A(B)-K-202, design documents was performed to determine the required heat load to be removed by the SACS system. The SACS cooling water flows in series through the PCIG compressor intercooler, 1A(B)-E-218; PCIG Compressor Aftercooler, 1A(B)-E-214; PCIG Compressor Cylinder Head, 1A(B)-K-202; and, the PCIG Thermosyphon, 1A(B)-E-278. The heat removal by SACS is equal to the heat gain of all four of these components. The total heat gain is equal to a maximum of 26,400 Btu/hr at a SACS flow rate of 4 gpm (Reference 5.1.21). Reference 5.1.21 also performed a sensitivity study using a 100°F SACS cooling water temperature. The results of this analysis indicate that the PCIG compressor high temperature trip setpoints are not reached under LOCA conditions.

Reference 5.1.21 identified an issue with the PCIG compressor following a LOP scenario. When using a SACS cooling water temperature of 95°F, the PCIG compressor would trip if it is aligned to the drywell following a LOP scenario. This issue is independent of the SACS cooling water temperature. Compensatory actions have been initiated to re-align the PCIG compressor, if needed, to the reactor building following a LOP. Under this alignment, the PCIG compressor does not trip. Corrective actions have been initiated to raise the PCIG compressor trip setpoint to prevent this from occurring. With the proposed setpoints and compensatory actions, no significant issues exist. The trip setpoints will remain below the design limits using either 95°F or 100°F under the current and proposed conditions; therefore, a SACS cooling water temperature of 100°F is acceptable.

6.13 Post Accident Sampling System (PASS) Cooler - 1A(B)-E-328

The Post Accident Sampling System is designed to obtain representative liquid and gas samples from within the primary containment for radiological analysis following a LOCA. It also obtains liquid samples from the vessel for boron concentration analysis following an Anticipated Transient Without Scram (ATWS) event. This cooling function requires a SACS flow of 10 gpm with a maximum temperature of 100°F (Reference 5.6.29). The heat load on the closed cooling water system (i.e., SACS) was specified not to exceed 0.11 MBtu/hr (Reference 5.6.29). Since the original design specified a SACS cooling water temperature of 100°F, the proposed SACS post-accident temperature limit of 100°F is acceptable.

6.14 Turbine Auxiliaries Cooling System (TACS) Components

The normal operating SACS design temperature of 95°F is unchanged by this evaluation. Since the design temperature has not changed, the TACS components were not evaluated. Following a LOCA and/or LOP scenario, TACS automatically isolates and would be unaffected by the higher SACS temperature of 100°F. No further reviews are required.

6.15 SACS Pump NPSH

The required and available SACS pump NPSH as documented in Reference 5.1.26 was reviewed. The results of the current analysis using 95°F water show that the water level in the SACS expansion tank must be at a minimum elevation of 148.64 ft. The bottom of the SACS expansion tank is at an elevation of 203 ft (Reference 5.6.32). There is approximately 54 feet of margin in the NPSH available. The only change in the available NPSH will be the difference between the vapor pressure at 95°F and at 100°F. The difference is less than 1 foot. Adequate NPSH will be available with a SACS temperature of 100°F.

6.16 UHS Temperature Limits

The current UHS temperature analysis was reviewed to determine the limiting UHS temperature limits (Reference 5.1.25). Since the SACS design temperature was raised by 5°F under certain alignments and failure modes, the resulting UHS temperature limit can be increased by approximately 5°F based on previous sensitivity studies. Several cases were selected to be limiting cases and re-run. These cases are provided in Attachment 3. From Reference 5.1.25, all the cases include a margin of 1.3°F due to instrument inaccuracies. [All cases listed, except normal operations are for a LOP/SSE event.]

No Failures	91.1°F
EOB Valve Failure	86.6°F
SACS Loop Outage	89.8°F
Normal Operations	89°F
1 SACS Pump Per Loop	88°F

The Ultimate Heat Sink (UHS) temperature limit for DBA scenarios assuming a single active failure is 86.6°F. This failure mode is dependent on an EOB valve, 1EA-HV2356A(B), failure. It can be eliminated by manually opening the EOB valve under administrative controls. The breaker (10B212 MCC No. 131 and 10B222 MCC No. 131) should also be opened to prevent the spurious actuation of the valve. Reference 5.5.2 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°F.

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.

7.0 CONCLUSIONS:

The SACS systern design allows for a SACS heat exchanger outlet temperature limit of 100°F with the exceptions listed below. The Technical Specification should be 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 89.0°F. This recommendation will be included in LCR H98-02.

The following recommendations are provided to implement the proposed UHS temperature limits:

A. A control room chilled water temperature limit setpoint of 48.5°F + 0.5°F/-0.0°F is recommended. (Section 6.5)
B. A 1E Panel (TSC) chilled water temperature limit setpoint of 47°F ± 0.5°F is recommended. (Section 6.6)
C. The EDG room coolers be throttled to 25% open during a SACS Loop Outage with 2 EDGs cross tied. Currently the redundant EDG room coolers are isolated under this scenario. (Section. 6.7)
D. The safety-related accumulators on the control room and 1E panel chilled water flow control valves be operable throughout the year. The accumulators are currently only required during periods of river water temperatures less than 70°F. (Section. 6.7)
E. The SACS design temperature be limited to 95°F during normal operations. (Section. 4.0.1)
F. The SACS post-accident design temperature be limited to 95°F when in a one SACS pump per loop configuration. (Section 6.4)
G. It is recommended that the redundant EACS room cooler setpoints be raised from their current setpoint of 111°F ± 2.3°F to 122.7°F ± 2.3°F. (Section 6.10)

8.0 ATTACHMENTS:

(1) EDG Room Cooler Performance Evaluation

(2) RHR Heat Exchanger Minimum SACS Flow Evaluation

(3) UHS Temperature Limit Evaluation Lineups based on Previous EE

(4) UHS Temperature Limit Evaluation Lineups (Microsoft Excel™ Spreadsheet)

9.0 SIGNATURES

Preparer: Robert W. DeNight ROBERT DENIGHT Date: 6/5/98

Peer Reviewer: Gregory W. Marini Date: 5 Jun '98

Verifier: Gregory W. Marini Date: 5 Jun '98

Licensing Reviewer: Date: 6/9/98

Functional Supervisor: for J. Fulans Date: 6/9/98

Attachment (1)

EDG Cooler Performance Evaluations