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SOUTHERN COMPANY

June 14, 2013

Docket Nos.: 50-424
50-425

NL-13-1177

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

Vogtle Electric Generating Plant – Units 1 and 2
Supplemental Response to NRC Request for Additional Information for License Amendment Request to Revise
Technical Specification 3.7.9 Ultimate Heat Sink (UHS)

Ladies and Gentlemen:

By letter dated September 1, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML112450171), Southern Nuclear Operating Company (SNC) submitted a license amendment request for revision of Technical Specification (TS) 3.7.9 "Ultimate Heat Sink (UHS)." Subsequently, by letter dated January 11, 2012 (ADAMS Accession Number ML11355A007), the Nuclear Regulatory Commission (NRC) submitted a Request for Additional Information (RAI) to enable completion of the review. The SNC responses to that RAI were provided in a series of letters dated February 10, 2012, April 30, 2012, and December 18, 2012.

By letter dated January 28, 2013, the NRC submitted another RAI to enable completion of the review (ADAMS Accession Number ML13024A226). SNC provided a complete response to that RAI by letter dated February 27, 2013. NRC has requested further explanation of the responses for the RAI dated January 28, 2013. This letter provides that supplemental response.

A calculation revision was required to provide the desired basis for the responses in Enclosure 1. Consequently, proposed TS Figure 3.7.9-1 provided in the submittal of September 1, 2011, and superceded by the December 18, 2012, letter has been revised and is provided in Enclosure 3 of this letter. This revised figure supersedes the TS figure provided in Enclosure 3 of the submittal dated December 18, 2012. This proposed new TS figure incorporates the results of the revised calculation in Enclosure 2 of this letter, as well as Enclosure 5 (Calculation X4C1202S31, "NSCW Ultimate Heat Sink Evaluation of Various Wet-Bulb and Basin Temperatures to Required Number of Fans") of the September 1, 2011 submittal.

This letter contains no NRC commitments. If you have any questions, please contact Ken McElroy at (205) 992-7369.

Mr. Charles R. Pierce states he is Regulatory Affairs Director of Southern Nuclear Operating Company, is authorized to execute this oath on behalf of Southern Nuclear Operating Company and, to the best of his knowledge and belief, the facts set forth in this letter are true.

Respectfully submitted,

C. R. Pierce

C. R. Pierce
Regulatory Affairs Director
CRP/cln/lac

Sworn to and subscribed before me this 14th *day of* June, *2013.*

Mercy Louise Henderson
Notary Public

My commission expires: March 23, 2014

Enclosures:
1. Response to Supplemental Questions
2. Calculation X4C1202V70, Version 4, "NSCW Cooling Tower - Operation With One Fan Out of Service at Low Ambient Wet Bulb Temperature"
3. New TS Figure 3.7.9-1

cc: Southern Nuclear Operating Company
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Vogtle Electric Generating Plant – Units 1 and 2
Supplemental Response to NRC Request for Additional Information for License Amendment Request to Revise
Technical Specification 3.7.9 Ultimate Heat Sink (UHS)

Enclosure 1

Response to Supplemental Questions

Supplemental Question 1

1. In response to RAI-2 dated February 17, 2013, the licensee stated that their analysis does not need to consider the first 4 hours after a loss of offsite power (LOSP) event because of a net reduction in total NSCW heat and the reduction of basin temperature during the first 4 hours after the LOSP. Their conclusion was based on their calculations which show an 80% reduction in auxiliary component cooling water (ACCW) heat load from normal operations to no load at hot shutdown with a LOSP. They further stated that the ACCW reduction is greater than the heat load of the diesel generator (DG) added at LOSP. From Table 9.2.2-1 of the FSAR, the staff notes that an 80% reduction in ACCW load is about 19.5 MBTU/hr and that the addition of the DG adds about 17.1 MBTU/hr to the NSCS heat load yielding a small net decrease of 2.4 MBTU/hr.

   However, the staff also notes that at the same time of LOSP, the operable cooling tower loses one fan from a tornado missile yielding 2 fans operable instead 3 fans operable. This fan reduction causes approximately a 33% reduction in cooling tower ability to remove heat energy from NSCW. Therefore, how can the licensee say that there will be a reduction in basin temperature during the first 4 hours after a LOSP and that the first 4 hours does not need to be considered? Please explain.

SNC Response to Supplemental Question 1

The basis calculation for this LAR, X4C1202V70, Version 3, made an assumption that the loss of one cooling tower fan due to a tornado missile occurs 4 hours after the LOSP event. This assumption allowed the use of three fans through the first four hours of the LOSP and assumes the loss of one additional fan due to a tornado missile after the fourth hour. Further review of the FSAR revealed that an LOSP is postulated to occur during or following a tornado scenario, resulting in the loss of two fans during the first four hours. This is more conservative than the assumption in Version 3 of the calculation. Therefore, the 33% reduction in cooling tower ability to remove heat energy from the NSCW at the start of the LOSP event as stated in the question is accurate and agrees with the assumption made in the FSAR. In this scenario, with two fans out of service during the first four hours, the basin temperature could indeed increase during the first four hours, which would impact the maximum wet-bulb temperature determined in this calculation.

As a result, calculation X4C1202V70 has been updated to consider the NSCW heat load during the first 4 hours with a reduction of two fans accounted for at the beginning of the LOSP event. This latest version of the calculation (version 4) adds a section in Addendum 1 that determines the total NSCW heat load for 0 to 4 hours. The heat loads determined do not include the RHR heat loads and are, therefore, significantly lower than the peak heat load after the fourth hour. The heat load profile developed includes the heat load due to the start of the diesel generators, auxiliary component cooling water loads that decrease with the reduction in RCS

temperature, and other constant NSCW heat loads (refer to Addendum 1, Section 4.1 of Enclosure 2 for more detail).

The results of this re-analysis, where two out of four fans are out of service due to one fan removed from service and an additional fan lost due to a tornado missile, reduces the maximum allowable wet bulb temperature as much as 0.6 °F (when compared to the February 27, 2013 response) for all initial basin temperatures analyzed, except for the 90 °F initial basin temperature. The maximum wet bulb temperature at 90 °F initial basin temperature was increased by 1.1 °F (when compared to the February 27, 2013 response) due to the performance characteristics of the cooling tower fans, (i.e., the performance of the cooling tower fans improve at higher NSCW temperatures). See Addendum 1, Section 5.0 of Enclosure 2 for more details.

The results of the re-analysis for the case where three out of four cooling tower fans are in service after an LOSP (one fan removed from service) show the three fan operation maximum allowable wet-bulb temperature is 82.0 °F for the initial basin temperature of 90 °F (see Addendum 2 of Enclosure 2). Initial basin temperatures less than 90 °F were not analyzed, since the results would show that a maximum wet-bulb temperature greater than 82.0 °F would be allowed and 82.0 °F is the maximum recorded/design basis wet-bulb temperature for VEGP.

The proposed TS Figure 3.7.9-1 has been revised per these results and is included in Enclosure 3 to this letter.

Calculation X4C1202V70, Version 4, is included in Enclosure 2.

The response to this question supersedes the response to RAI 2 submitted February 17, 2013.

Supplemental Question 2

2. Please explain the statement on E1-5 of the December 18, 2012 letter which states, "Thus, a resulting wet bulb temperature that is greater than or equal to the maximum recorded/design basis wet-bulb temperature of 82°F for Plant Vogtle will demonstrate that three cooling tower fans can mitigate a tornado induced LOSP when operating in the four fan/spray cell region.

SNC Response to Supplemental Question 2

Calculation, X4C1202V70, Version 3, "NSCW Cooling Tower-Operation with One Fan Out of Service at Low Ambient Wet Bulb Temperature" confirms the capability of the NSCW Cooling Tower system to mitigate an LOSP with three fans operating at the recorded/design maximum wet bulb temperature and maximum assumed basin temperature. This calculation determined the resulting maximum allowable wet bulb temperature for this three fan case based on an initial basin temperature of 90 °F to be 82 °F. Any lower initial basin temperature would be bounded by the 90 °F results since the resulting allowable wet-bulb temperature would be greater than 82

°F, which is the maximum recorded/design wet bulb temperature for VEGP. The 90 °F basin temperature was selected since it is the maximum allowable initial basin temperature per the Technical Specification.

The statement, "Thus, a resulting wet bulb temperature that is greater than the maximum recorded/design basis wet-bulb temperature of 82 °F for Plant Vogtle will demonstrate that three cooling tower fans can mitigate a tornado induced LOSP when operating in the four fan/spray cell region," was made as an attempt to further explain that a lower basin temperature from 90 °F would result in a maximum allowable wet-bulb temperature greater than the maximum recorded/design wet bulb temperature for VEGP. Therefore, the initial basin temperature of 90 °F, which results in a maximum allowable wet-bulb temperature of 82 °F, bounds all other initial basin temperatures.

Vogtle Electric Generating Plant – Units 1 and 2
Supplemental Response to NRC Request for Additional Information for License Amendment Request to Revise
Technical Specification 3.7.9 Ultimate Heat Sink (UHS)

Enclosure 2

Calculation X4C1202V70, Version 4
NSCW Cooling Tower – Operation With One Fan Out of Service At Low Ambient Wet Bulb Temperature

SOUTHERN COMPANY
Energy to Serve Your World℠

Southern Nuclear Design Calculation

Calculation Number:
X4C1202V70

Plant: Vogtle Electric Generating Plant (VEGP)	**Unit:** ☐ 1 ☐ 2 ☒ 1 & 2	**Discipline:** Mechanical
Title: NSCW Cooling Tower – Operation With One Fan Out Of Service At Low Ambient Wet Bulb Temperature		**Subject:** System 1202
Purpose / Objective: Determine the Wet Bulb (WB) temperature at which one NSCW tower fan can be removed from operation.		
System or Equipment Tag Numbers: 1-1202-W4-001, 1-1202-W4-002, 2-1202-W4-001, 2-1202-W4-002		

Contents

Nuclear Quality Level

☒ Safety-Related	☐ Safety Significant	☐ Non- Safety -Significant

Version Record

Version No.	Description	Originator Printed Name Initial / Date	Reviewer Printed Name Initial / Date	Approval 1 Printed Name Initial / Date	Approval 2 Printed Name Initial / Date
1	General editorial change for pages 1 through 8. Revise values in Part 2 (two fan operation). Revise Attachments 1 and 2.	WRCheatwood 6/30/05	RJBush 6/30/05	JEFridrichsen 7/1/05	N/A
2	Incorporated MC-V-07-0126. Revised sht 1 and added Appendix A.	M. D. Stephens 12/01/08	K. Gauthaman 12/01/08	J. A. Wade 12/05/08	N/A
3	Add Addendum 1 to evaluate two fan tower operation under various wet-bulb and basin temperatures. Also add Addendum 2 to calculate the maximum allowable wet-bulb temperature for three fan tower operation.	D. Zheng 12/10/12	J. M. Jarvis 12/10/12	A. T. Vieira E. Couch 12/11/12	C. M. Sellers 12/11/12
4	Determine NSCW heat load for hours 0 to 4 and update Addendum 1 and 2 results.	D. Zheng 5/30/13	J. M. Jarvis 5/30/13	A. T. Vieira E. Couch 6/4/13	C. M. Sellers CMS 6/4/13

Notes: UFSAR Sections 9.2.5-Ultimate Heat Sink; Technical Specification-3.7.9 Ultimate Heat Sink; Design Criteria DC-1202-A Nuclear Service Cooling Tower. Version 1 and 2 of this calculation is needed to demonstrate that during established cold weather conditions, the NSCW cooling towers have sufficient cooling capacity to meet design heat loads with one fan removed from service during modes 1, 2 ,3, and 4. This calculation will be used to obtain a Tech Spec change. Version 3 and 4 of this calculation are needed to evaluate the effect on the maximum allowable wet bulb temperature using the realistic range of initial basin temperatures and the more realistic cooling tower curves with two fans removed from service to meet LOSP loading loads. This version of the calculation will be used to support a subsequent TechSpec change.

Southern Nuclear Design Calculations

Plant: VEGP	Calculation Number: X4C1202V70	Sheet: 1 of 6

1.0 PURPOSE

RER 2003-0221 requested that Engineering determine the number of NSCW cooling tower fans required to operate in modes 1, 2, 3, and 4 taking into account colder atmospheric conditions which can temporarily reduce the number of fans required. This is being done to allow on-line maintenance of a fan cell during cold weather. This evaluation is needed to support a proposed change to the Technical Specifications 3.7.9 – Ultimate Heat Sink.

Addendum 1, per Version 3, evaluates the effect on the maximum allowable wet bulb temperatures and initial basin temperatures under two-fan operation. Addendum 2, per Version 3, calculates the maximum allowable wet-bulb temperature under three-fan operation. Both addendums use the more realistic cooling tower curves from Attachment 3 of X4C1202V70.

Version 4 determines the total NSCW heat load for hours 0 to 4 of 1-train RCS cool-down under LOSP and updates the maximum allowable wet-bulb temperature results in Addendum 1 and 2. 4

2.0 SUMMARY OF CONCLUSIONS

One fan can be removed from service during Modes 1, 2, 3 and 4 whenever the ambient wet bulb temperature is below 63 °F per Versions 1 and 2 (see Addendum 1 for updated wet bulb temperature limit per Version 3). The capacity of the cooling tower with one fewer fan will provide sufficient cooling capacity to satisfy all normal and accident conditions. Postulated abnormal conditions and accidents include a plant cooldown with LOSP, LOCA, MSLB and LOSP (during which a second fan is lost due to a missile).

Note: See Appendix A for MUR power uprate impact.
Using the two fan operation tower performance curves, Addendum 1 determines a maximum allowable wet bulb temperature for a range of initial basin temperatures for cases in which the peak basin temperature reaches 97 °F. The duration that the basin temperature is above 95 °F is also reported.

3.0 REFERENCES

3.1 Calculations

3.1.1 X4C1202W20 R2	Estimated NSCW temperatures during cooldown with LOSP
3.1.2 X4C1202V54 R1	Maximum Ultimate Heat Sink Temp. (Post LOCA)
3.1.3 X4C1202V20 R3	NSCW - MSLB-1 train
3.1.4 X4C1202V02 R3	NSCW cooling tower fan performance during cooldown transient after station blackout (1 fan out due to tornado)
3.1.5 X4C1202S26 R4	Ultimate Heat Sink Analysis (MC-V-07-0009)
3.1.6 X4C1202V03 R8	Verification of NSCW Constant Heat Loads and Flows and Cooldown Heat Loads
3.1.7 X4C1205V04 Ver. 2.0	One and Two Train Cooldown of RCS
3.1.8 X4C1217V02 Ver. 8.0	Auxiliary Component Cooling Water (ACCW) Constant Heat Load and Flow Rate Calculation 4

3.2 Manuals

3.2.1 AX4AD02-00147 R10	Instruction Manual (Marley Cooling Tower)

3.3 Design Criteria

3.3.1 DC1202-A Rev 11	Nuclear Service Cooling Towers

3.4 Technical References

3.4.1 Mechanical Engineering Reference Manual – Eighth Edition, Michael R. Lindeburg – 1990

4.0 ASSUMPTIONS

1) The tower performance curves in Marley Instruction Manual (Ref 3.2.1) provide the relationships between tower performance with one, two, three, or four fans in operation. It is essential to know under which tower operating conditions these curves apply. Joe Gosman of Marley and Jim Cuchens of SCS GEM Power Engineering were consulted. The required tower conditions are full water distribution and fan stacks not blocked (so that the non-operating fan stacks allow additional cooling due to natural draft).

2) Use of fewer fans at low wet bulb temperatures will not adversely affect the inventory of NSCW water for accident scenarios. This is because the air flow will be less and correspondingly the drift loss will be less.

3) Use of fewer fans at low wet bulb (WB) temperatures will not adversely affect the possibility of tower icing. During postulated accidents there could be 1 less fan in operation and thus less air flow through the tower to freeze water and form ice (if fans are operated manually).

4) This calculation does not provide guidance for selection of weather periods during which the wet bulb is sufficiently low to satisfy operation with a fan out for maintenance.

5.0 EVALUATION

Approach

The review of NSCW tower capability is to be conducted in two parts: ⚠

PART 1 - Evaluate three fan NSCW tower operation (one of four operating fans removed from service for maintenance)

This part of the calculation shows that the design capability of the tower with three fans operating at 67°F WB is equivalent to four fans operating at the NSCW tower design condition of 82°F WB and at the specified tower heat loads provided in Design Criteria DC1202-A Nuclear Service Cooling Towers- ref 3.3.1. This part of the calculation covers plant normal, shutdown, and emergency modes of operation that utilize four fans. Calculations for postulated accidents that rely on 4 fans were reviewed.

PART 2 – Evaluate two fan NSCW tower operation (one of three operating fans removed from service for maintenance)

This part of the calculation shows the design capability of the tower with two fans operating at 63°F WB is equivalent to three fans operating at the NSCW tower design condition of 82°F WB. The condition evaluated is the case in which the plant experiences a LOSP, and after 4 hours of coping, one fan is unavailable because of a tornado generated missile.

Body

PART 1 - Evaluate three fan operation.

The first step is to determine the wet bulb temperature at which three fans can provide the same CWT that four fans provide at 82° WB (which is the tower design condition). Four vendor supplied cooling tower curves are in the Marley Instruction Manual (ref 3.2.1) for the tower design flow of 15,600 gpm and ranges of 8.5, 15, 25 and 37.4°. These curves are used to obtain data points below:

Range	4 fan WB	3 fan WB
8.5	82	79.3
15.0	82	76.5
25.0	82	72.0
37.4	82	66.2

These values were graphed in the curve on Attachment 1 which allows us to determine the acceptable wet bulb for 3 fan operation for a variety of ranges. The curve is entitled "Three Fan NSCW Tower Operation" and provides the acceptable wet bulb temperature for which 3 fans provide the same CWT as 4 NSCW fans at an 82°F ambient wet bulb temperature.

Per Design Criteria DC-1202-A Table 1 (ref 3.3.1), the NSCW Cooling towers operate at a maximum ambient wet bulb temperature of 82°F in normal, shutdown and emergency conditions. Table 1 lists tower design information which is repeated below.

Tower Design criteria from DC1202-A Nuclear Service Cooling towers

Description	Normal	Shutdown	Design condition (Emergency)
Cooling water flow (gpm)	15,600	15,600	15,600
Heat Rejection (Btu / hr)	99.9 x 10^6	140.8 x 10^6	265x10 ^6
Maximum WB Degrees F	82	82	82
Cold Water temperature degrees F	90	95	95
Range (degrees F)	*	**	34

All cases above are for single tower operation with four (4) fans in operation.

The ranges for normal and shutdown conditions were not provided in DC1202-A, so it is necessary to convert heat load to Range at the tower design NSCW flow rate of 15,600 gpm.

This is done with the formula:
Heat rate = Mass flow rate (Cp) (Th –Tc)
(Mechanical Engineering Reference Manual - Eighth Edition; Michael R Lindeburg – 1990, equation 11.1) – ref. 4.4.1

In cooling tower application the temperature rise of the fluid is referred to as the range. Accounting for units we arrive at the following equation.

Heat Load (Btu / hr) = Mass flow (Gal / min) (60 min / hr)(1 cu ft / 7.48 gal) (1 lbm / .0161 cu ft) x Cp (1 Btu / lb x degree F) x Range in degrees F

* The range for the Normal column is thus calculated to be 12.7°F
** The range for the Shutdown column is thus calculated to be 18.0 ° F

From the chart above the tower range for the design emergency heat load is 34 ° F 

Assumptions relative to the use of tower design emergency heat load of 265 million BTUs / hr are developed further in Note 1.

Project	Calculation Number
Vogtle Electric Generating Station	**X4C1202V70**
Subject/Title **NSCW Cooling Tower – Operation with one fan out of service at low ambient Wet Bulb Temperature**	Sheet **4** of **6**

Using these three tower design ranges we can find the allowable wet bulb temperatures from the chart in Attachment 1. The allowable wet bulb temperatures for the tower with three fans operating that match four fan operation at design conditions are as follows.

Normal	77°F wb
Shutdown	75°F wb
Emergency	67°F wb

Based on tower data, three fans will produce the same CWT at 67°F WB that four fans can deliver at 82°F WB for the highest range which is the emergency condition. This is the bounding tower service condition for removing one of four operating fans from operation. ⚠1

NOTE 1

It should be noted that the NSCW tower design values do not necessarily match the conditions used in calculations that postulate the basin temperature of the ultimate heat sink (tower basin) for a plant cooldown with a LOSP, a MSLB and a LOCA for single train operation with four fans. The maximum cooldown heat load of 243 million BTUs/hr does not exceed the tower design heat load (sheet 31 of ref 3.1.1) and thus provides conservative results. The MSLB and LOCA however receive heat loads in excess of tower design heat load for emergencies (references, 3.1.2, and 3.1.3). For short periods of time the heat loads postulated in these analyses will exceed the tower design emergency heat load of 265 million BTUs/hr. This does not introduce excessive non conservatisms because the heat load excursions are sufficiently short in duration and the temperature rise in the basin is kept low and well within design limits. # For example:

In the postulated single train LOCA accident for power uprate conditions, the maximum heat load of 440 million BTUs /hr occurs in the first hour of the event and results in a basin temperature rise from 90°F to 92.1°F (sheet 19 and Attachment C of ref 3.1.2.). After 1 hour the system heat loads fall back below the tower design heat loads. There is sufficient water volume in the basin (30.1 million pounds – Sheet 8 of ref 3.1.2) that the NSCW basin temperature cannot rise to unacceptable temperature limits during the short time the heat load for this postulated accident exceeds the tower design heat load. The tower design heat load of 265 million BTUs / hr remains an acceptable assumption for this 3 fan wet bulb calculation.

In the postulated single train MSLB case, the heat loads vary widely above and below the tower design emergency range during the first five hours of the postulated event. The maximum heat load of 339 million BTUs /hr occurs in the fourth hour of the event. The highest calculated basin temperature for this period is 91.1°F and occurs in the first hour (sheet 8 of ref 3.1.3). It should be noted that the maximum heat load provided for each of the first 5 hours were averaged to obtain 232 million BTUs / hr. The use of the tower design emergency heat load of 265 million BTUs /hr remains an acceptable assumption for this three fan wet bulb calculation.

For comparison, the postulated LOSP in part 2 of this calculation with 1 fan removed from service by a tornado results in a basin temperature of 97° for over 14 hours (ref 3.1.4). ⚠1

Project **Vogtle Electric Generating Station**	Calculation Number **X4C1202V70**
Subject/Title **NSCW Cooling Tower – Operation with one fan out of service at low ambient Wet Bulb Temperature**	Sheet **5** of **6**

PART 2 – Evaluate 2 fan operation (LOSP with tornado generated missile)

The accident case which produces the highest NSCW tower cold water basin temperature is the one in which a single train of NSCW operates 4 hours after a LOSP with one fan lost from service due to a tornado missile. This case is analyzed in reference 3.1.4. The referenced calculation assumes a constant ambient wet bulb temperature of 82°F.

For this evaluation we must also assume that a fan is also out of service for maintenance. This leaves only two fans available for Nuclear Service Cooling. We again use the Marley curves to obtain data that relates two fan operations to three fan operation.

Range	**3 fan WB**	**2 fan WB**
8.5	82	76.4
15.0	82	73.0
25.0	82	66.7
37.4	82	59.5

These values were charted on the curve in Attachment 2 to determine the wet bulb for the heat load placed on the tower from this postulated emergency.

The associated calculation (reference 3.1.4) assumes a constant 82°F wet bulb temperature. The referenced calculation uses an NSCW flow rate of 15,600 gpm. The CWT reaches a 97°F peak and exceeds the 95° tower CWT design for 14 hours (Sheet 6 of 58). The calculation provides a maximum heat load of 235 million BTU's/ hr (sheet 32 of 58). At the design flow rate of 15,600 gpm this heat load is equivalent to a range (delta T) of ~~29.7~~ 30.2°F.

As shown previously, the formula used to derive the range is :

Heat Load (Btu / hr) = Mass flow (Gal / min) (60 min / hr)(1 cu ft / 7.48 gal) (1 lbm / .0161 cu ft) x Cp (1 Btu / lb x degree F) x Range in degrees F

Based on the range of ~~29.7~~ 30.2°, the allowable wet bulb temperature from the Attachment 2 curve is ~~63.9~~ 63.7°F. We will use the value of 63°F wet bulb for conservatism.

As a sensitivity check, we reviewed the affect of the actual NSCW system flow exceeding the 15,600 gpm design flow in this calculation (ref 3.1.4). The Marley curves for the tower operating at a 16,400 gpm flow rate were reviewed to determine the affect on the allowable wet bulb temperature for two fans. At the higher flow rates all curves are shifted to the right providing higher allowable wet bulb temperatures at all ranges for any number of fans. The use of 15,600 gpm as the NSCW flow rate for this calculation is conservative as it provides lower acceptable ambient wet bulb temperatures.

6.0 CONCLUSION

Part 1 of this calculation shows that taking one of four NSCW tower fans out of service for maintenance at ambient temperatures of 67°F wet bulb or lower is acceptable for normal, shutdown and emergency plant conditions.

Part 2 of this calculation shows that taking one of three NSCW tower fans out of service for maintenance at ambient temperatures of 63°F or lower is acceptable for the LOSP in which a tornado generated missile has disabled one NSCW tower fan.

The ambient wet bulb temperature of 63°F of this calculation serves as the limiting case and will be used whenever a fan is taken from service for maintenance in Plant Operating Modes 1, 2, 3, and 4.

This conclusion assumes that the fan maintenance operation does not prevent natural draft through the non-operating fan. This can be done by using pickboards as opposed to decking for conducting maintenance activities. This analysis also assumes that the tower water distribution system is in normal operation.

7.0 ATTACHMENTS

7.1 Attachment 1 - Three Fan NSCW Cooling Tower (1 sheet)
7.2 Attachment 2 - Two Fan NSCW Cooling Tower (1 sheet)
7.3 Attachment 3 - Marley Tower Performance Curves for 15,600 gpm (4 sheets)

Southern Nuclear Design Calculations

Plant: Vogtle Electric Generating Plant	Unit: ☐ 1 ☐ 2 ☒ 1 & 2	Calculation Number: X4C1202V70
Appendix A		Sheet 1 of 2

MUR POWER UPRATE IMPACTS:

This calculation has been reviewed for impact due to the Measurement Uncertainty Recapture (MUR) power uprate. The uprate does not affect the flow of the NSCW system. The MUR uprate also does not affect any atmospheric conditions used in this calculation.

PART 1

The current normal condition NSCW heat load is 92.7 x 10^6 Btu/hr (Reference 3.1.6). Assuming this heat load increases by 1.7% due to the MUR power uprate, the new NSCW heat load would be 94.3 x 106 BTU/hr. Part one lists a normal condition heat load of 99.99 x 10^6 Btu/hr. This heat load bounds the MUR uprate heat rejection of 94.3 x 10^6 Btu/hr. The shutdown and emergency design heat loads for part 1 are unchanged.

PART 2

Reference 3.1.4 provides the heat load during a LOSP after 4 hours to be 235 x 10^6 Btu/hr. Due to the MUR power uprate this heat load rises to 238 x 10^6 Btu/hr. This affects the maximum WB which allows for 2 fan operation as follows:

Reactor Decay Heat:

Original heat load from hour 4 to hour 5 after shutdown: 126.2 x 10^6 But/hr (Ref 3.1.4)

MUR uprate condition: 126.2 x 10^6 But/hr X 101.7% = 128.35 10^6 But/hr

MUR power uprate NSCW heat load (LOSP, single train, 3 fans operational)

Heat Source	Heat Load (x10^6 Btu/hr)	Reference
Spent Fuel Pool	20.66	Ref 3.1.5
Diesel Generator	17.93	Ref 3.1.4
Containment Air cooler	5.9	Ref 3.1.4
Control Room A/C	2.74	Ref 3.1.4
El. Emergency Room Chiller	1.47	Ref 3.1.4
Cavity Cooling Coolers	0.53	Ref 3.1.4
Pumping & System Loss	3.4	Ref 3.1.4
Reactor Thermal Mass	57.05	Ref 3.1.4
Reactor Decay Heat	128.35	
***Total**	238.03	

Southern Nuclear Design Calculations

Plant: Vogtle Electric Generating Plant	Unit: ☐ 1 ☐ 2 ☒ 1 & 2	Calculation Number: X4C1202V70
Appendix A		Sheet 2 of 2

$$Range = \frac{\text{Heat Load (Btu/hr)}}{\text{Mass flow}\left(\frac{gal}{\min}\right) \times \frac{60\,\min}{hr} \times \frac{1\,cu\,ft}{7.48\,\text{gal}} \times \frac{1\,lbm}{0.0161\,cu\,ft} \times Cp\left(1\frac{btu}{lb \times F^{\circ}}\right)}$$

$$Range = \frac{238 \times 10^{6}\ Btu/hr}{15600\frac{gal}{\min} \times \frac{60\,\min}{hr} \times \frac{1\,cu\,ft}{7.48\,\text{gal}} \times \frac{1\,lbm}{0.0161\,cu\,ft} \times 1\frac{btu}{lb \times F^{\circ}}}$$

$$Range = 30.6\,F^{\circ}$$

Based on the range of 30.6 F°, the allowable wet bulb temperature from the Attachment 2 curve is 63.48 F°. This calculation uses 63 F° for conservatism, thus it bounds the current MUR power uprate condition. The MUR power uprate does not impact the results of this calculation.

*These heat loads are for comparison purposes to demonstrate the impact of the MUR power uprate. The heat loads do not reflect design basis values.

Southern Nuclear Design Calculation

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Addendum 1: Two Fan Tower Operation Under Various Wet-Bulb and Basin Temperatures		

4

1.0 PURPOSE

The Ultimate Heat Sink (UHS) evaluation in this addendum determines the effect on the maximum allowable wet bulb temperatures and basin temperatures using:

- a single train of NSCW operating with only 2 cooling tower fans in service after a Loss of Offsite Power (LOSP);
- the more realistic cooling tower curves documented in Att. 3 of this calculation.

4

2.0 METHODOLOGY

Main body part 2 of this calculation, by extrapolation of the cooling tower performance curves, determines the maximum allowable wet bulb temperature for three fan operation for current Tech Spec 3.7.9 [1]. A constant bounding NSCW heat load is used in the main body. The UHS evaluation in this addendum considers a single train of the NSCW operating with only two out of four cooling tower fans in service after a LOSP (based on the assumption that one fan is removed from service and an additional fan is lost due to tornado missile at hour 0 of LOSP). The cooling tower performance characteristic (KaV/L) for 2-fan operation is calculated with the computer program PDAP based on the more realistic cooling tower curves documented in Att. 3 of this calculation. Then, with the tower performance characteristic and time-dependent NSCW heat load, the maximum allowable wet bulb temperatures are determined by computer program UHSSIM iteratively for a range of initial basin temperatures for cases in which the peak basin temperature stays below 97 °F.

4

PDAP and UHSSIM are Bechtel proprietary computer programs. There are no revision numbers associated with these two programs. Documentation and validation of PDAP and UHSSIM are provided in Att. A and B of [3]. For this UHS evaluation, these two programs were run on Bechtel System FREDB40349B (HP Compaq, Pentium 4, Microsoft Windows XP Professional, Service Pack 3). The user verified the successful completion of the power-on-self-test for the particular computer configuration prior to making all runs. A front-end validation was performed by re-running the validation inputs documented in [3] and obtained identical results.

4

Southern Nuclear Design Calculation

Plant: VEGP	Calculation Number: X4C1202V70	Sheet: 1-2
Addendum 1: Two Fan Tower Operation Under Various Wet-Bulb and Basin Temperatures		

4

3.0 ASSUMPTIONS

1. Per Sec. 2.0, a single-train of NSCW operating with only two (2) out of four (4) cooling tower fans in service after a LOSP (one fan is removed from service and an additional fan is lost due to tornado missile at hour 0 of LOSP) is assumed for this evaluation. For 2-fan operation cases, water is expected to run through both the operating and inoperable cooling tower cells and fan stacks are not blocked. Natural drafting cooling is assumed for the inoperable cells. It is conservative to lump this case as one NSCW train with full water flow (100% water flow rates at 15,600 gpm or 7.8E6 lbm/hr) and reduced air flow (2 out of 4 fans at air flow rate of 2,071,121 lbm/hr per fan, or 4.14e6 lbm/hr). See Design Input section for the listed water and air flow rates. 4

2. Per RER SNC442614, the bounding NSCW heat load for this two-fan operation case is provided by BC X4C1205V04, Att. AA- 3 (Reference [4]). This heat load was developed for 1-train RCS cool-down under LOSP (from 4 hours to 36 hours after the transient) and already reflects the MUR power uprate. The NSCW heat load for hours 0 to 4 of the transient is determined in Sec. 4.1 Design Inputs section using an approach similar to Calculation X4C1205V04 [4]. The heat load beyond 36 hours is linearly extrapolated to 72 hours based on the heat load values between 24 hours and 36 hours. Since the majority of the heat load are composed of the decay heat and Spent Fuel Pool (SFP) heat load, which both decrease exponentially by time, linear extrapolation is reasonable and acceptable. 4

3. It is assumed that the existing cooling tower data used in att. 3 of main body, such as the NSCW pump water flow rate and tower fan performance data, is valid and applicable to this UHS evaluation. The att. 3 tower data uses a nominal NSCW flow rate of 15,600 gpm and a tower design wet-bulb/dry-bulb/hot-water temperature of 82/95/129 °F. It is slightly different from the [2] analysis which used tower water flow rate of 16,400 gpm and tower design point of 82/98/129 °F (sht. 21 of [2]). Per discussions in part 2 of main body (sht. 5), the use of lower NSCW flow rate for this calculation is conservative as it provides lower acceptable ambient wet bulb temperature. Per a sensitivity run (not documented in this addendum), the slight difference (3 °F) on the tower design dry bulb has negligible effect on wet bulb temperature.

4. The ambient dry bulb temperature is assumed to be identical to the wet bulb temperature. Wet bulb temperature is the lowest temperature that can be obtained by evaporating water into the air at a constant pressure. It is always lower than the dry bulb temperature, but will be identical with 100% relative humidity. Assuming ambient dry bulb temperature identical to the ambient wet bulb temperature conservatively maximizes the basin return temperature.

5. The ambient pressure is assumed at 14.7 psia. The variation of ambient pressure is expected to be small and the impact of ambient pressure changes is negligible.

6. The water in the basin is assumed to be pure water.

Southern Nuclear Design Calculation

Plant: VEGP	Calculation Number: X4C1202V70	Sheet: 1-3
Addendum 1: Two Fan Tower Operation Under Various Wet-Bulb and Basin Temperatures		

4

4.0 DESIGN INPUTS

4.1 Determination of total NSCW heat load for hour 0 to hour 4

Per discussions of Assumption 2, the bounding NSCW heat loads for hours 4 to hours 36 are determined in Att. AA-3 of X4C1205V04 [4]. Per similar method, the NSCW heat load for hours 0 to 4 of the transient can be determined.

Per Eq. 19 on sht. 19 of X4C1205V04 [4], the total NSCW heat load Q_{NTOTAL} is:

$$Q_{NTOTAL} = Q_{NSCW} + Q_{ACCW} + Q_{MISC} + Q_{DIESEL} + Q_{CCW}$$

where Q_{NTOTAL} is total heat load rejected to tower basin, Q_{NSCW} is NSCW pump heat loads, Q_{ACCW} is heat load provided by ACCW Heat Exchanger (HX), Q_{DIESEL} is heat load for diesel water jacket HX, Q_{CCW} is heat load transferred by CCW HX, and Q_{MISC} is other heat loads rejected to tower.

Per Eq. 20 on sht. 20 of X4C1205V04 [4], the heat load transferred by CCW HX Q_{CCW} is:

$$Q_{CCW} = Q_{RHR} + Q_{PSC} + Q_{CCP} + Q_{SFP}$$

where Q_{RHR} is RHR heat removal rate, Q_{PSC} is RHR pump seal cooler heat load, Q_{SFP} is spent fuel pool heat load, Q_{CCP} is CCW pump heat load. 4

For hour 0 to hour 4 of 1-train cool-down under LOSP, the RHR is not tied in to CCW. Hence, between hour 0 and hour 4, the RHR heat removal rate to CCW is zero. Per sht. 27 of X4C1205V04 [4], the CCW pump load Q_{CCP} is estimated at 1.477 MBtu/hr and the RHR pump seal cooler heat load Q_{PSC} is estimated at 0.0254 MBtu/hr. Both of these loads are not to be affected by the MUR. Per sht. AA3 of X4C1205V04 [4], the spent fuel pool heat load Q_{SFP} is estimated at 25.82 MBtu/hr after accounting for MUR, spent fuel pool pump load, and additional SFP margin of 0.5 MBtu/hr. Hence, the combined heat load transferred by CCW HX Q_{CCW} between hour 0 and hour 4 is estimated as:

$$Q_{CCW} = Q_{RHR} + Q_{PSC} + Q_{CCP} + Q_{SFP}$$
$$= 0 + 0.0254 + 1.477 + 25.82 = 27.3224 \quad \text{MBtu/hr}$$

Per Table 2 on sht. 31 of X4C1205V04 [4], the ACCW heat load during 1-train RCS cool down is a function of RCS temperature T_{RCS}:

$$Q_{ACCW} = 5.411 + 0.03333*(T_{RCS} - 140) \quad \text{MBtu/hr}$$

Per Table 3 on sht. 33 of X4C1205V04 [4], the heat load for diesel water jacket HX Q_{DIESEL} is estimated at 14.4 MBtu/hr and the miscellaneous equipment heat loads rejected to NSCW Q_{MISC}, including containment fan cooler, essential chiller, etc, are estimated at 16.92 MBtu/hr. The NSCW pump heat loads Q_{NSCW} is estimated at 3.57 MBtu/hr. These loads are not to be affected by the MUR.

By summing up the individual heat load components discussed above, the total heat load provided to the NSCW system Q_{NTOTAL} is estimated as:

$$Q_{NTOTAL} = Q_{NSCW} + Q_{ACCW} + Q_{MISC} + Q_{DIESEL} + Q_{CCW}$$
$$= 3.57 + 5.411 + 0.03333*(T_{RCS} - 140) + 16.92 + 14.4 + 27.3224 \text{ MBtu/hr}$$
$$= 67.6234 + 0.03333*(T_{RCS} - 140) \quad \text{MBtu/hr}$$

Per sht. 4C of X4C1217V02 [5], the RCS temperature at reactor vessel outlet is increased to 620 °F as a result of the MUR-PU. Since using a higher RCS temperature value results

in higher ACCW heat loads, the RCS temperature at hour 0 of transient is conservatively assumed to be 620 °F. Per 1-train RCS cool down scenario defined on sht. 9 of X4C1205V04 [4], RCS is cooled down to 350 °F at hour 4 before RHR can be tied in. Assuming the RCS temperature drops linearly during these 4 hours, the total NSCW heat load Q_{NTOTAL} is estimated in following Table. Hour 4 heat load before RHR tied-in is conservatively applied as Hour 3.9999 to distinguish the hour 4 results after RHR tied-in per Att. AA-3 of X4C1205V04 [4].

4

time (hr)	T-RCS (F)	HL (MBTU/hr)
0	620.0	83.622
1	552.5	81.372
2	485.0	79.122
3	417.5	76.872
3.9999	350.0	74.623

4.2 PDAP and UHSSIM Input Parameter Lists

The PDAP input parameters, other than stated, are per att. 3 of main body:

- water flowrate = 15,600 gpm.
  For a nominal water density of 62.4 lbm/ft^3, this value is converted to lbm/hr:
  15,600 gpm x (60 min/hr) x (1 ft3/7.4805 gal) x (62.4 lbm/ft3) = 7.80 E6 lbm/hr
- air flowrate per fan = 2,071,121 lbm/hr per sht. 9 of [2].
  2,071,121 lbm/hr x 2 fans = 4.14 E6 lbm/hr
- solids content = 0 ppt
- design pressure = 14.696 psia
- design wet bulb temperature = 82 °F
- design dry bulb temperature = 95 °F
- design hot water temperature = 129 °F
- units flag for temperature = 0
- standard wet bulb depression = 13 °F
  The wet bulb depression is the difference between the dry bulb and the wet bulb temperatures. For the design conditions cited above, the wet bulb depression is 13 °F (95 – 82 °F).
- Manufacturer's performance data for 2-fan operation:

Range (°F)	WB (°F)	Cold Water (°F)	Range (°F)	WB (°F)	Cold Water (°F)
8.5	65	80.8	25	65	97.7
8.5	70	84.2	25	70	99.6
8.5	75	87.7	25	75	101.8
8.5	80	91.3	25	80	104.2
8.5	85	95	25	85	106.6
15	65	88.9	37.4	65	104.3
15	70	91.6	37.4	70	106
15	75	94.4	37.4	75	107.8
15	80	97.3	37.4	80	109.5
15	85	100.4	37.4	85	111.4

The PDAP-calculated 2-fan tower characteristics KaV/L is 0.69. The corresponding PDAP computer input and output are provided in Attachment 4.

Southern Nuclear Design Calculation

Plant: VEGP	Calculation Number: X4C1202V70	Sheet: 1-5
Addendum 1: Two Fan Tower Operation Under Various Wet-Bulb and Basin Temperatures		

4

The UHSSIM input parameters are:

- 1st Card – Design Data: per Att. 3 of main body
  design wet bulb temperature = 82 °F
  design dry bulb temperature = 95 °F
  design hot water temperature = 129 °F
  design pressure = 14.696 psia
  design solids content = 0 ppt
  units flag = 0

- 2nd Card – Initial Conditions: per sht. 21 of [2] and Assumption 6
  initial basin mass = 29,843,200 lbm
  initial basin temperature = Varied between 65 °F and 90 °F *
  * Initial basin temperature is varied of 90/85/80/75/70/65 °F respectively,
  initial solids content = 0 ppt
  number of towers = 1
  start time = 0 hr

4

- 3rd Card – Printout Control:
  Results are printed every 1 hour for 72 hours.

```
# Time Period Data -- every 1 hr between the 1th hr and the 72nd
hr after LOSP
# step size, number of steps
1,72
*
```

4

- 4th Card – Tower Operation Data: Time dependent lumped tower water flow rate and fan air flow rate in lbm/hr are listed below. The cooling tower characteristics KaV/L of 0.69 is per PDAP run result aforementioned.

```
# Tower Operating Data
# 5 character tower ID
# time [hr], water flow rate [lbm/hr], air flow rate [lbm/hr],
KaV/L
# Train A
Trn A
0.0,7.80e6,4.14e6,0.69
72.0,7.80e6,4.14e6,0.69
*
```

4

Southern Nuclear Design Calculation

Plant: VEGP	Calculation Number: X4C1202V70	Sheet: 1-6

Addendum 1: Two Fan Tower Operation Under Various Wet-Bulb and Basin Temperatures

4

- 5th Card – Heat Load

Follows the discussion of Assumption 2, the total tower heat rejection rates for this evaluation are determined per Sec. 4.1 and Att. AA- 3 of X4C1205V04 [2], with linear extrapolation to 72 hours after LOSP. Att. AA- 3 of X4C1205V04 heat load values are condensed due to UHSSIM limit for pairs of heat rejection data.

4

```
# Heat Rejection Data
# time, time units (s = second, h = hour, d = day), plant heat
# rejection [btu/hr]
0h,    0.8362E+08
1h,    0.8137E+08
2h,    0.7912E+08
3h,    0.7687E+08
3.9999h, 0.7462E+08
4h,    2.5782E+08
5h,    2.4283E+08
6h,    2.3455E+08
7h,    2.2896E+08
8h,    2.1036E+08
9h,    1.9697E+08
10h,    1.8700E+08
11h,    1.7951E+08
12h,    1.7374E+08
13h,    1.6903E+08
14h,    1.6522E+08
15h,    1.6203E+08
16h,    1.5931E+08
17h,    1.5696E+08
18h,    1.5499E+08
19h,    1.5323E+08
20h,    1.5164E+08
21h,    1.5020E+08
22h,    1.4890E+08
23h,    1.4785E+08
24h,    1.4675E+08
25h,    1.4579E+08
26h,    1.4482E+08
27h,    1.4384E+08
28h,    1.4301E+08
29h,    1.4216E+08
30h,    1.4149E+08
31h,    1.4052E+08
32h,    1.3940E+08
33h,    1.3901E+08
34h,    1.3875E+08
35h,    1.3819E+08
36h,    1.3742E+08
72h,    1.1E+08
```

- 6th Card – Meteorological Data:

Meteorological conditions (wet bulb temperature in °F, dry bulb temperature in °F, and ambient pressure in psia) are maintained constant. These values, as shown in Table Add-1, are determined iteratively to ensure the UHS basin temperature stays below 97 °F.

The UHSSIM computer inputs and outputs for 2-fan cases corresponding to a range of initial basin temperatures between 65 to 90°F are provided in Attachment 4.

Southern Nuclear Design Calculation

Plant: VEGP	Calculation Number: X4C1202V70	Sheet: 1-7
Addendum 1: Two Fan Tower Operation Under Various Wet-Bulb and Basin Temperatures		

4

5.0 BODY OF CALCULATION

Main body part 2, by extrapolation of the cooling tower performance curves, determines the maximum allowable wet bulb temperature of 63 °F. This result is based on a 2-fan operation with a bounding constant NSCW heat load and an initial basin temperature of 90 °F. The UHS evaluation in this addendum uses the more realistic cooling tower performance characteristic and time-dependent NSCW heat load. The maximum allowable wet bulb temperatures are determined iteratively for a range of initial basin temperatures for cases in which the basin temperature stays below 97 °F.

Table Add-1 summarizes the maximum allowable wet-bulb temperatures (that ensure the basin temperature stays below 97 °F) corresponding to different initial basin temperatures. The duration of basin temperature that exceeds 95 °F is also documented in the table. From the result table, the peak basin temperatures for different initial basin temperature cases (from 65 to 90 °F) all occur within 36 hours after the transient.

Table Add-1

Initial Basin Temperature (°F)	Maximum Allowable Wet-Bulb (°F)	Time of Peak Basin Temperature (hr)	Duration Basin Temperature over 95 °F (hr)
65	72.1	24	54
70	71.7	22	53
75	71.2	20	51
80	70.4	18	48
85	69.3	16	43
90	67.9	14	37

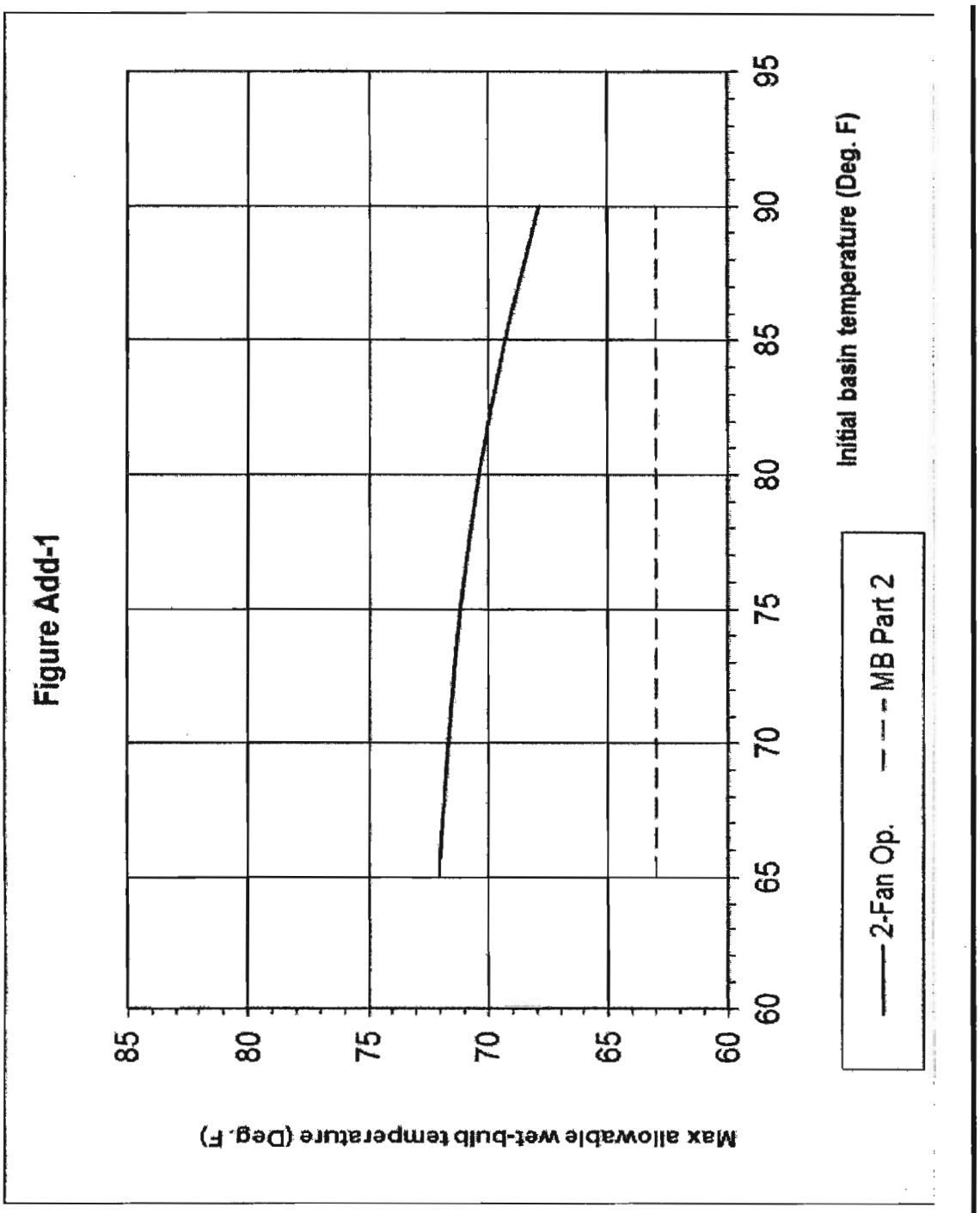
4

Figure Add-1 plots the change of the maximum allowable wet-bulb temperatures corresponding to a range of initial basin temperatures between 65 to 90°F. The main body (MB) part 2 wet bulb temperature result of 63 °F is also plotted for comparison purposes.

Southern Nuclear Design Calculation

Plant: VEGP	Calculation Number: X4C1202V70	Sheet: 1-8
Addendum 1: Two Fan Tower Operation Under Various Wet-Bulb and Basin Temperatures		

4



4

Southern Nuclear Design Calculation

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Addendum 1: Two Fan Tower Operation Under Various Wet-Bulb and Basin Temperatures		

4

6.0 REFERENCES

[1] Vogtle Units 1 and 2 Technical Specification 3.7.9, "Ultimate Heat Sink (UHS)", Amendment No. 167 (Unit 1) and Amendment No. 149 (Unit 2).

[2] SNC Calculation X4C1202V54, Ver. 2, "Maximum Ultimate Heat Sink Temperature (post LOCA)".

[3] SNC Calculation X4C1202S26, Ver. 5, "Ultimate Heat Sink Analysis".

[4] SNC Calculation X4C1205V04, Ver. 2, "One and Two Train Cooldown of RCS".

[5] SNC Calculation X4C1217V02, Ver. 8, "Auxiliary Component Cooling Water (ACCW) Constant Heat Load and Flow Rate Calculation".

4

7.0 SUMMARY OF CONCLUSIONS

Figure Add-1 determines the maximum allowable wet bulb temperature for a range of initial basin temperatures for cases in which the peak basin temperature stays below 97 °F. This addendum still uses conservative assumptions and increased heat loads for MUR. The improvement for this 2-fan tower operation case as compared to wet bulb temperature result in part 2 of main body are due to:

- the more realistic cooling tower performance curve (2-fan tower operation)
- the time-dependent NSCW heat load for LOSP
- the dynamic simulation of cooling tower performance using PDAP and UHSSIM
- the benefit from a lower initial basin temperature (NSCW basin temperature normally operates well below 90 °F)

Southern Nuclear Design Calculation

Plant: VEGP	Calculation Number: X4C1202V70	Sheet: 2-1
Addendum 2: Three Fan Tower Operation Maximum Allowable Wet-Bulb Temperature		

4

1.0 PURPOSE

This addendum calculates the three fan tower operation maximum allowable wet-bulb temperature for an UHS basin initial temperature of 90 °F, using the cooling tower basin simulation programs PDAP/UHSSIM , and more realistic cooling tower curves in Att. 3.

2.0 METHODOLOGY

Other than stated, the methodology used in this addendum are similar to Addendum 1. The cooling tower performance characteristic (KaV/L) for 3-fan operation is calculated using PDAP based on the 3-fan tower performance curves in Att. 3 of this calculation. Then, with the tower performance characteristic and time-dependent NSCW heat load, the maximum allowable wet bulb temperatures are determined by UHSSIM iteratively for cases in which the peak basin temperature stays below 97 °F.

3.0 ASSUMPTIONS

Other than stated, the assumptions used in this addendum are similar to Addendum 1. Similar to main body part 1, a single-train of NSCW operating with three (3) out of four (4) cooling tower fans in service after a LOSP (one fan is removed from service) is assumed. The initial basin temperature is assumed at 90 °F.

4

PDAP and UHSSIM were run on Bechtel System FREDB40349B (HP Compaq, Pentium 4, Microsoft Windows XP Professional, Service Pack 3). A front-end validation was performed by re-running the validation inputs documented in [3] and obtained identical results.

4.0 DESIGN INPUTS

The PDAP input parameters, other than stated, are per 3-fan tower operation curves in att. 3 of this calculation:

- water flowrate = 15,600 gpm.
  For a nominal water density of 62.4 lbm/ft^3, this value is converted to lbm/hr:
  15,600 gpm x (60 min/hr) x (1 ft3/7.4805 gal) x (62.4 lbm/ft3) = 7.80 E6 lbm/hr
- air flowrate per fan = 2,071,121 lbm/hr per sht. 9 of [2].
  2,071,121 lbm/hr x 3 fans = 6.21 E6 lbm/hr
- solids content = 0 ppt
- design pressure = 14.696 psia
- design wet bulb temperature = 82 °F
- design dry bulb temperature = 95 °F
- design hot water temperature = 129 °F
- units flag for temperature = 0
- standard wet bulb depression = 13 °F
  The wet bulb depression is the difference between the dry bulb and the wet bulb temperatures. For the design conditions cited above, the wet bulb depression is 13 °F (95 – 82 °F).
- Manufacturer's performance data for 3-fan operation:

Southern Nuclear Design Calculation

Plant: VEGP	Calculation Number: X4C1202V70	Sheet: 2-2
Addendum 2: Three Fan Tower Operation Maximum Allowable Wet-Bulb Temperature		

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Range (°F)	WB (°F)	Cold Water (°F)	Range (°F)	WB (°F)	Cold Water (°F)
8.5	65	75.8	25	65	89.1
8.5	70	79.5	25	70	91.6
8.5	75	83.2	25	75	94.1
8.5	80	87.3	25	80	97
8.5	85	91.1	25	85	100
15	65	82	37.4	65	95
15	70	85	37.4	70	97
15	75	88.3	37.4	75	99.1
15	80	91.8	37.4	80	101.4
15	85	95.1	37.4	85	104

The PDAP-calculated 3-fan tower characteristics KaV/L is 0.86. The corresponding PDAP computer input and output are provided in Attachment 5.

The UHSSIM input parameters are:

- 1st Card – Design Data: per Att. 3
  design wet bulb temperature = 82 °F
  design dry bulb temperature = 95 °F
  design hot water temperature = 129 °F
  design pressure = 14.696 psia
  design solids content = 0 ppt
  units flag = 0

- 2nd Card – Initial Conditions: per sht. 21 of [2] and Assumption 6 of Add. 1
  initial basin mass = 29,843,200 lbm
  initial basin temperature = 90 °F
  initial solids content = 0 ppt
  number of towers = 1
  start time = 0 hr

4

- 3rd Card – Printout Control:
  Results are printed every 1 hour for 0 to 72 hours

```
# Time Period Data -- every 1 hr between the 0th hr and the 72nd
hr after LOSP
# step size, number of steps
1,72
*
```

4

- 4th Card – Tower Operation Data: Time dependent lumped tower water flow rate and fan air flow rate in lbm/hr are listed below. The cooling tower characteristics KaV/L of 0.86 is per PDAP run result *(PDAP3-1.out)* in Att.5.

```
# Tower Operating Data
# 5 character tower ID
# time [hr], water flow rate [lbm/hr], air flow rate [lbm/hr],
KaV/L
# Train A
Trn A
0.0,7.80e6,6.21e6,0.86
72.0,7.80e6,6.21e6,0.86
*
```

4

Southern Nuclear Design Calculation

Plant: VEGP	Calculation Number: X4C1202V70	Sheet: 2-3
Addendum 2: Three Fan Tower Operation Maximum Allowable Wet-Bulb Temperature		

4

- 5th Card – Heat Load

Similar to Assumption 2 of Addendum 1, the total NSCW heat load for this evaluation are determined per Sec. 4.1 of Addendum 1 and Att. AA- 3 of X4C1205V04 [2], with linear extrapolation to 72 hours after LOSP. Att. AA- 3 of X4C1205V04 heat load values are condensed due to UHSSIM limit for pairs of heat rejection data.

4

```
# Heat Rejection Data
# time, time units (s = second, h = hour, d = day), plant heat
# rejection [btu/hr]
0h,    0.8362E+08
1h,    0.8137E+08
2h,    0.7912E+08
3h,    0.7687E+08
3.9999h, 0.7462E+08
4h,    2.5782E+08
5h,    2.4283E+08
6h,    2.3455E+08
7h,    2.2896E+08
8h,    2.1036E+08
9h,    1.9697E+08
10h,    1.8700E+08
11h,    1.7951E+08
12h,    1.7374E+08
13h,    1.6903E+08
14h,    1.6522E+08
15h,    1.6203E+08
16h,    1.5931E+08
17h,    1.5696E+08
18h,    1.5499E+08
19h,    1.5323E+08
20h,    1.5164E+08
21h,    1.5020E+08
22h,    1.4890E+08
23h,    1.4785E+08
24h,    1.4675E+08
25h,    1.4579E+08
26h,    1.4482E+08
27h,    1.4384E+08
28h,    1.4301E+08
29h,    1.4216E+08
30h,    1.4149E+08
31h,    1.4052E+08
32h,    1.3940E+08
33h,    1.3901E+08
34h,    1.3875E+08
35h,    1.3819E+08
36h,    1.3742E+08
72h,    1.1E+08
```

- 6th Card – Meteorological Data:

Similar to Addendum 1, meteorological conditions are maintained constant. These values are determined iteratively to ensure the basin temperature stays below 97 °F.

4

```
#  TIME    WB       DB       P
#  (hr)    (F)      (F)      (psia)
     0,    82.0,    82.0,    14.7
    72,    82.0,    82.0,    14.7
```

The UHSSIM inputs and outputs for 3-fan case with initial basin temperature of 90 °F (*Fan3N_90F*) are provided in Attachment 5.

Southern Nuclear Design Calculation

Plant: VEGP	Calculation Number: X4C1202V70	Sheet: 2-4
Addendum 2: Three Fan Tower Operation Maximum Allowable Wet-Bulb Temperature		

4

5.0 BODY OF CALCULATION

Main body part 1, by extrapolation of the cooling tower performance curves, determines the 3-fan operation maximum allowable wet bulb temperature of 67 °F. This result is based on a 3-fan operation with a bounding constant NSCW heat load and an initial basin temperature of 90 °F. The UHS evaluation in this addendum uses the more realistic cooling tower performance characteristic and time-dependent NSCW heat load. The maximum allowable wet bulb temperatures are determined iteratively for cases in which the basin temperature stays below 97 °F. Per Attachment 5 results, the three fan tower operation maximum allowable wet-bulb temperature is 82.0 °F (peak basin temperature below 97.0 °F @ Hour-14) for an UHS basin initial temperature of 90 °F. The duration of basin temperature that exceeds 95 °F is 40 hours (between Hour-7 and Hour-47). 4

6.0 REFERENCES

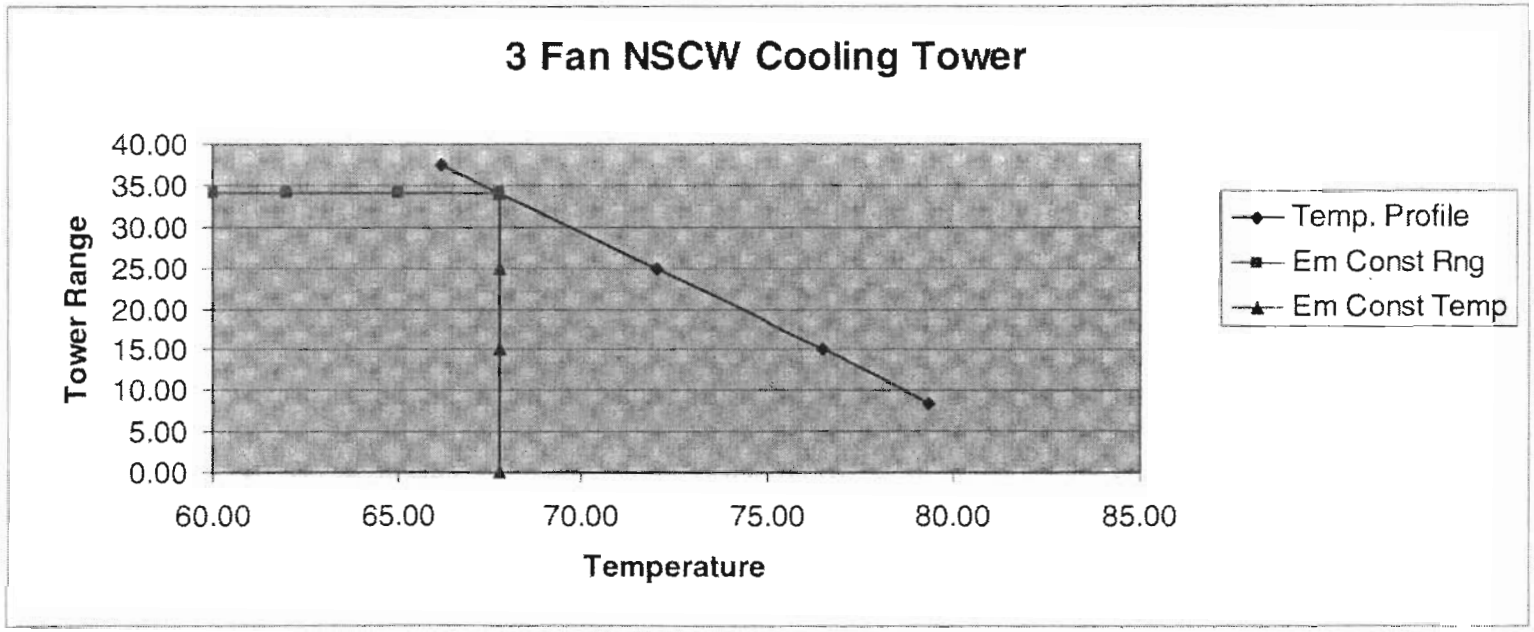
The references used in this addendum are the same as Addendum 1.

7.0 SUMMARY OF CONCLUSIONS

The three fan tower operation maximum allowable wet-bulb temperature is 82.0 °F for an UHS basin initial temperature of 90 °F. 4

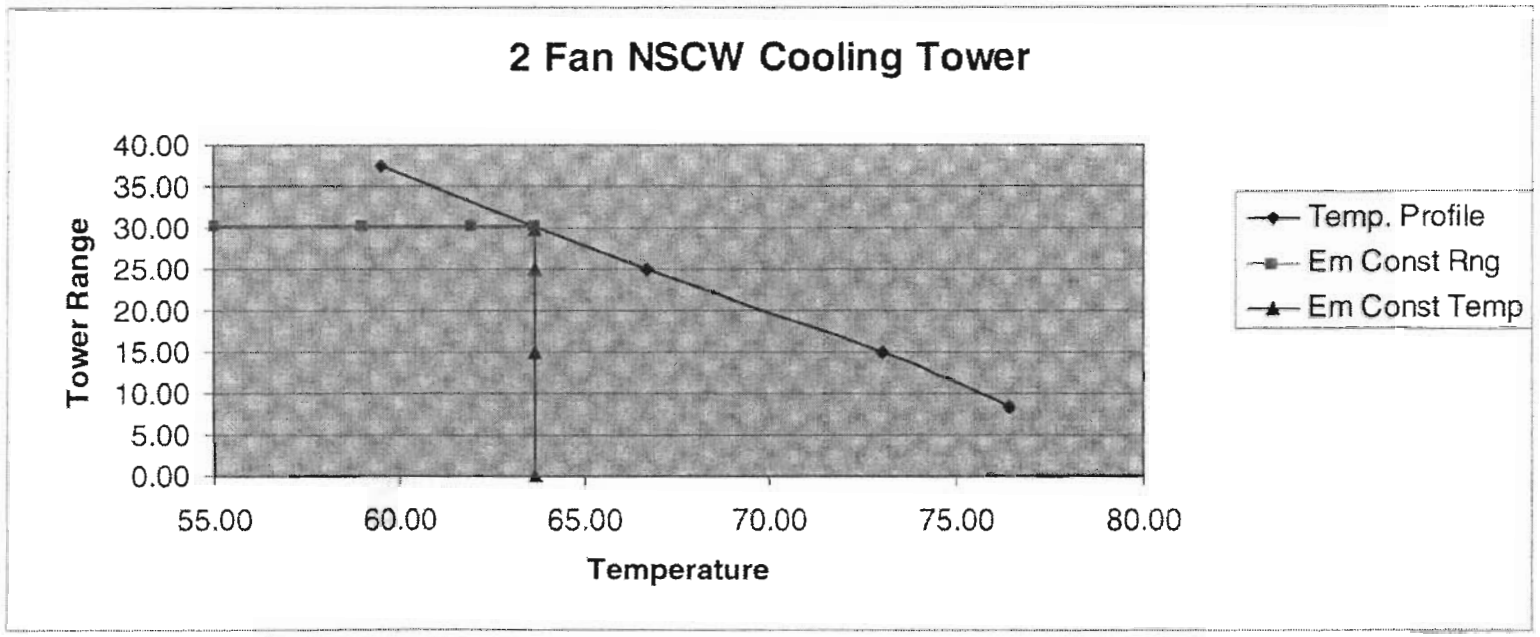
Attachment 1 **Calculation X4C1202V70**

Max. Temp	Temp	Range	Emerg. Constant Range	Emerg. Constant Temp	Emerg. Scaled Temp	Emerg. Scaled Range
82.00	79.30	8.50	34.00	67.80	60.00	0.00
82.00	76.50	15.00	34.00	67.80	62.00	15.00
82.00	72.00	25.00	34.00	67.80	65.00	25.00
82.00	66.20	37.40	34.00	67.80	67.80	34.00



Attachment 2 **Calculation X4C1202V70**

Temp	Range	Emerg. Constant Range	Emerg. Constant Temp	Emerg. Scaled Temp	Emerg. Scaled Range
76.40	8.50	30.20	63.70	55.00	0.00
73.00	15.00	30.20	63.70	59.00	15.00
66.70	25.00	30.20	63.70	62.00	25.00
59.50	37.40	30.20	63.70	63.70	29.70



Attachment 3

Marley cooling tower performance curves at 15,600 gpm - pages 1-4

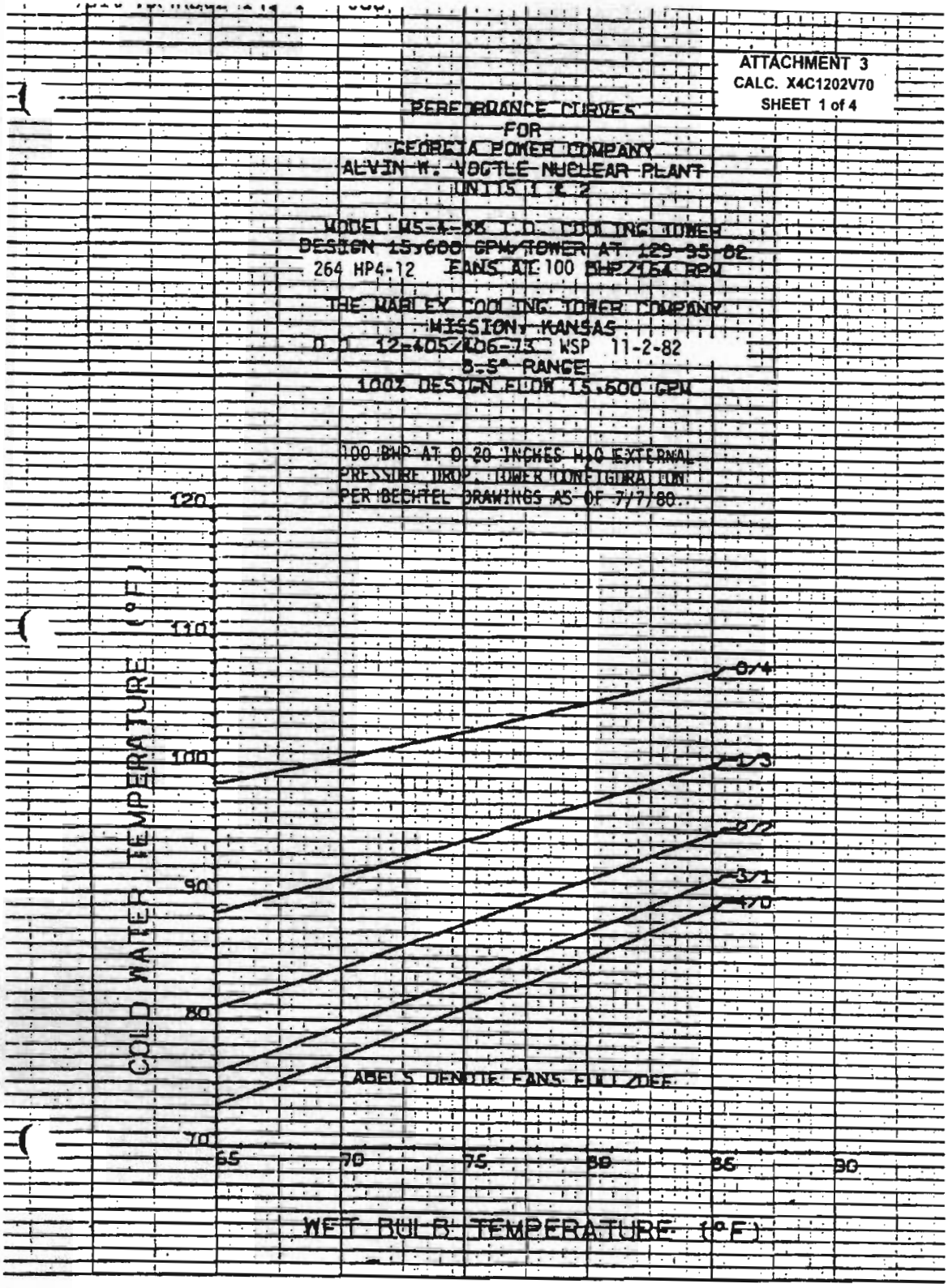
ATTACHMENT 3
CALC. X4C1202V70
SHEET 1 of 4

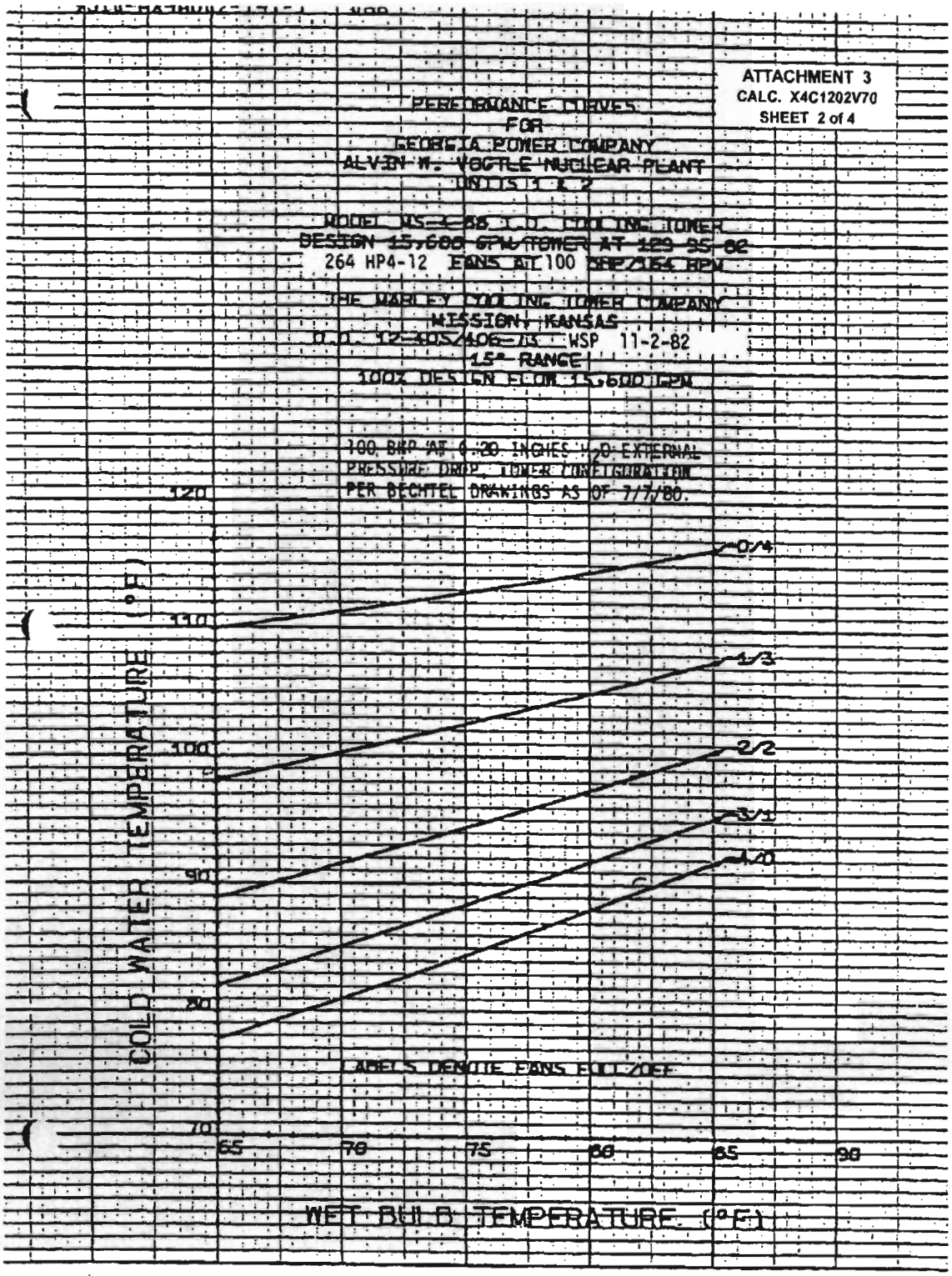
PERFORMANCE CURVES
FOR
GEORGIA POWER COMPANY
ALVIN W. VOGTLE NUCLEAR PLANT
UNITS 1 & 2

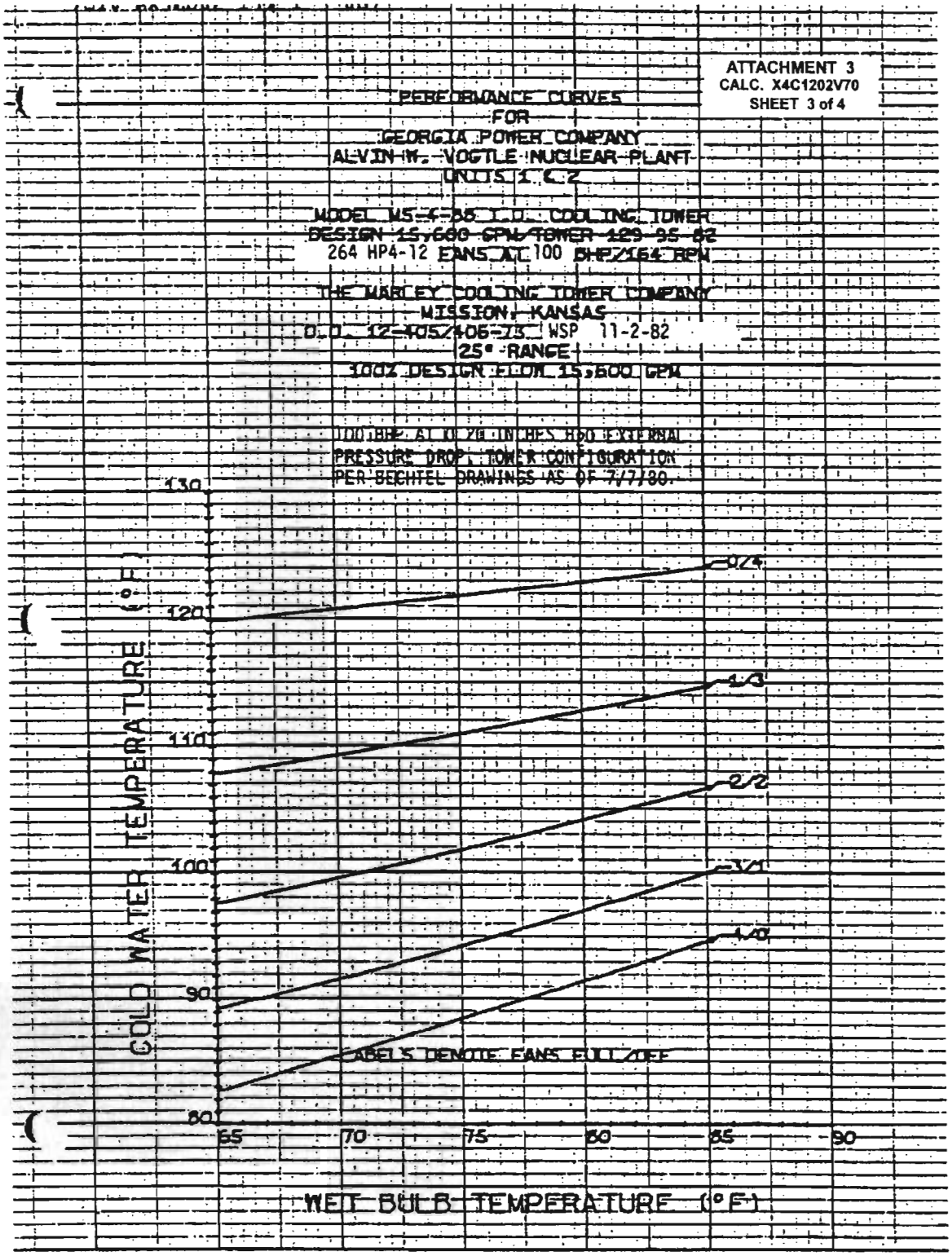
MODEL M5-4-86 C.D. COOLING TOWER
DESIGN 15,600 GPM/TOWER AT 129-95-82
264 HP4-12 FANS AT 100 BHP/164 RPM

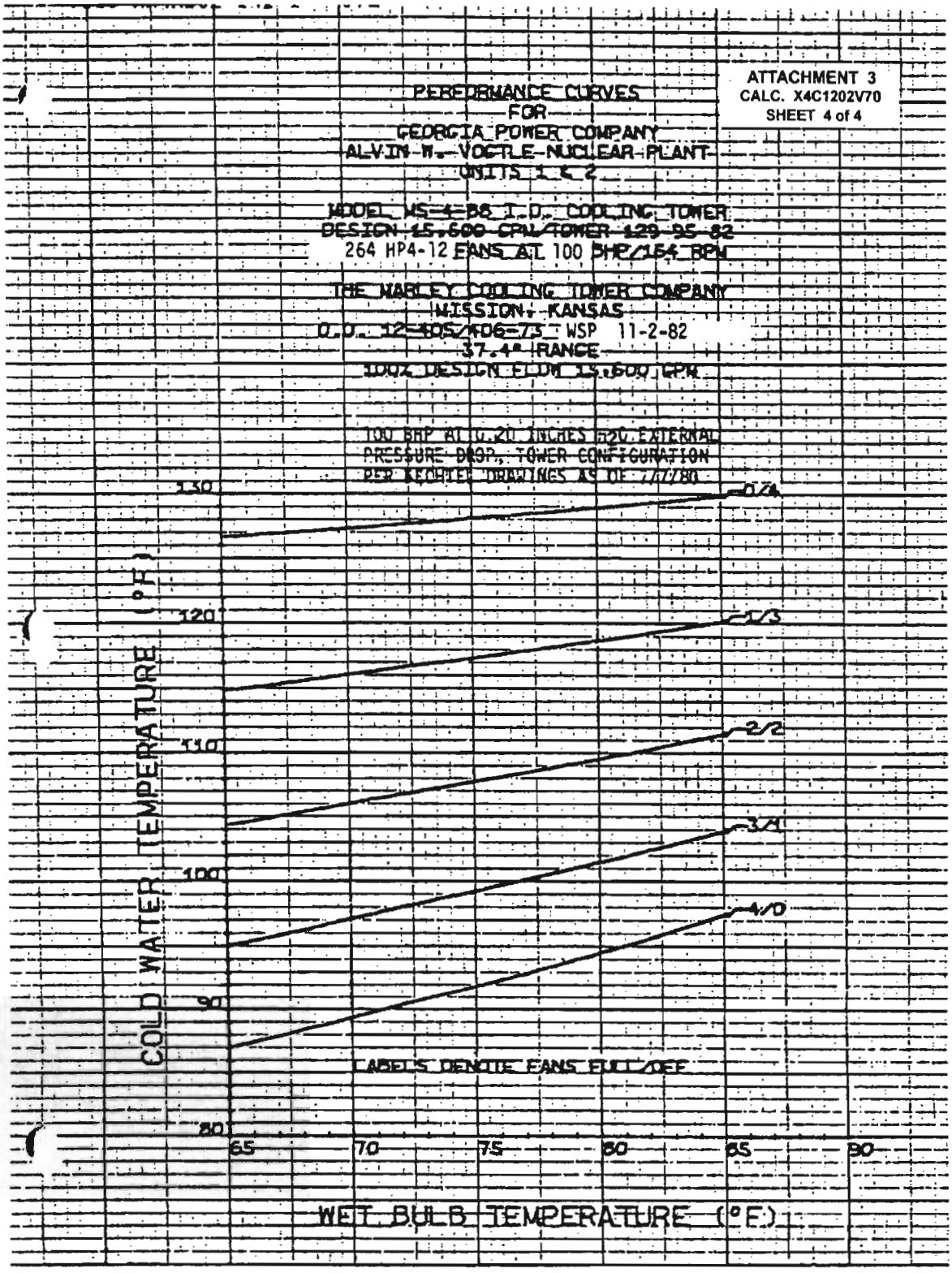
THE MARLEY COOLING TOWER COMPANY
MISSION, KANSAS
D.O. 12-405Z/06-13 WSP 11-2-82
8.5° RANGE
100% DESIGN FLOW 15,600 GPM

100 BHP AT 0.20 INCHES H2O EXTERNAL
PRESSURE DROP. TOWER CONFIGURATION
PER BECHTEL DRAWINGS AS OF 7/7/80.








ATTACHMENT 3
CALC. X4C1202V70
SHEET 4 of 4
PERFORMANCE CURVES
FOR
GEORGIA POWER COMPANY
ALVIN W. VOGTLE NUCLEAR PLANT
UNITS 1 & 2
MODEL MS-4-86 I.D. COOLING TOWER
DESIGN 15,600 GPM/TOWER 129-95-82
264 HP4-12 FANS AT 100 BHP/154 BPM
THE MARLEY COOLING TOWER COMPANY
MISSION, KANSAS
O.D. 12-405/4D6-73 WSP 11-2-82
37.4° RANGE
100% DESIGN FLOW 15,600 GPM
100 BHP AT 0.20 INCHES H2O EXTERNAL
PRESSURE DROP, TOWER CONFIGURATION
PER KECHTEL DRAWINGS AS OF 7/7/80
COLD WATER TEMPERATURE (°F)
130
120
110
100
90
80
4/4
3/3
2/2
3/1
4/0
LABELS DENOTE FANS FULL/OFF
65
70
75
80
85
90
WET BULB TEMPERATURE (°F)

ATTACHMENT 4

2-Fan Case PDAP/UHSSIM Runs

Attachment 4 Table of Contents **Page No.**

1. PDAP input/output for *pdap2-2.*, C/T characteristics for 2-Fan Case

pdap2-2.inp

```
#Vogtle C/T Performance Data Per X4C1202V70, Ver 2
#original water flow rate & 2 fan operation
#100% water flow rate = 15,600 gpm = 7.8e6 lbm/hr
#air flow rate = 2 * 2,071,121 lbm/hr = 4.14e6 lbm/hr
#original design point: twb = 82 F, tdb = 95 F, tw = 129 F
7.8e6, 4.14e6, 0.0, 14.696, 82, 95, 129, 0, 13.0
8.5, 65, 80.8
8.5, 70, 84.2
8.5, 75, 87.7
8.5, 80, 91.3
8.5, 85, 95.0
15.0, 65, 88.9
15.0, 70, 91.6
15.0, 75, 94.4
15.0, 80, 97.3
15.0, 85, 100.4
25.0, 65, 97.7
25.0, 70, 99.6
25.0, 75, 101.8
25.0, 80, 104.2
25.0, 85, 106.6
37.4, 65, 104.3
37.4, 70, 106.0
37.4, 75, 107.8
37.4, 80, 109.5
37.4, 85, 111.4
```

pdap2-2.out

```
#Vogtle C/T Performance Data Per X4C1202V70, Ver 2
#original water flow rate & 2 fan operation
#100% water flow rate = 15,600 gpm = 7.8e6 lbm/hr
#air flow rate = 2 * 2,071,121 lbm/hr = 4.14e6 lbm/hr
#original design point: twb = 82 F, tdb = 95 F, tw = 129 F
7.8e6, 4.14e6, 0.0, 14.696, 82, 95, 129, 0, 13.0
8.5, 65, 80.8
8.5, 70, 84.2
8.5, 75, 87.7
8.5, 80, 91.3
8.5, 85, 95.0
15.0, 65, 88.9
15.0, 70, 91.6
15.0, 75, 94.4
15.0, 80, 97.3
15.0, 85, 100.4
25.0, 65, 97.7
25.0, 70, 99.6
25.0, 75, 101.8
25.0, 80, 104.2
25.0, 85, 106.6
37.4, 65, 104.3
37.4, 70, 106.0
37.4, 75, 107.8
37.4, 80, 109.5
37.4, 85, 111.4
#KaV/L =     .69
#results: range, wb, hot, cold, cold-predicted, difference
#       8.5      65.0      89.3      80.8      81.4        .6
#       8.5      70.0      92.7      84.2      84.7        .5
#       8.5      75.0      96.2      87.7      88.1        .4
#       8.5      80.0      99.8      91.3      91.6        .3
#       8.5      85.0     103.5      95.0      95.2        .2
#      15.0      65.0     103.9      88.9      89.6        .7
#      15.0      70.0     106.6      91.6      92.2        .6
#      15.0      75.0     109.4      94.4      94.9        .5
#      15.0      80.0     112.3      97.3      98.1        .8
#      15.0      85.0     115.4     100.4     101.0        .6
#      25.0      65.0     122.7      97.7      98.1        .4
#      25.0      70.0     124.6      99.6      99.9        .3
#      25.0      75.0     126.8     101.8     102.0        .2
#      25.0      80.0     129.2     104.2     104.2        .0
#      25.0      85.0     131.6     106.6     106.5       -.1
#      37.4      65.0     141.7     104.3     104.2       -.1
#      37.4      70.0     143.4     106.0     105.8       -.2
#      37.4      75.0     145.2     107.8     107.4       -.4
#      37.4      80.0     146.9     109.5     109.1       -.4
#      37.4      85.0     148.8     111.4     111.0       -.4
Stop - Program terminated.
```

2. UHSSIM input/output for *Fan2N_90F*, 2-Fan Case with IBT of 90 °F

Fan2N_90F.inp

```
Vogtle UHS 1-train 2-Fan Case w/ 90F ini. basin temp. (X4C1202V70 ver4)
# ------------------------------------------------------------------------------
# Mixed C/T model of 2 operable (full speed) and 2 failure fans w/ natural draft
# initial basin temp. = 90 F, Max basin temp. < 97 F
# PDAP C/T characteristics KaV/L = 0.69 per tower performance data X4C1202V70 V2
# C/T bounding heat load for 1-train LOSP per Appendix AA of X4C1205V04 V2 (MUR)
# HL 0 - 4 hr determined by remove RHR HL
# HL beyond Hr-36 are extrapolated to Hr-72.
# 72 hr UHSSIM run time (Hr-0 - Hr-72)
# ------------------------------------------------------------------------------
# design wet-bulb temperature [F], design dry-bulb temperature [F],
# design hot-water temperature [F], design pressure [psia], design solids [ppt]
# 0 => F, psia, btu/hr, lbm/hr units
82, 95, 129.0, 14.696, 0.0, 0
# initial basin mass [lbm], initial basin temperature [F], initial solids [ppt],
# number of towers, starting time of simulation [hr]
29843200, 90, 0, 1, 0.
# Time Period Data -- every 1 hr between the 0th hr and the 72nd hr after LOSP
# step size, number of steps
1,72
*
# Tower Operating Data
# 5 character tower ID
# time [hr], water flow rate [lbm/hr], air flow rate [lbm/hr], KaV/L
# Train A
Trn A
0.0,7.80e6,4.14e6,0.69
72.0,7.80e6,4.14e6,0.69
*
# Heat Rejection Data
# time, time units (s = second, h = hour, d = day), plant heat
# rejection [btu/hr]
0h,    0.8362E+08
1h,    0.8137E+08
2h,    0.7912E+08
3h,    0.7687E+08
3.9999h, 0.7462E+08
4h,    2.5782E+08
5h,    2.4283E+08
6h,    2.3455E+08
7h,    2.2896E+08
8h,    2.1036E+08
9h,    1.9697E+08
10h,    1.8700E+08
11h,    1.7951E+08
12h,    1.7374E+08
13h,    1.6903E+08
14h,    1.6522E+08
15h,    1.6203E+08
16h,    1.5931E+08
17h,    1.5696E+08
18h,    1.5499E+08
19h,    1.5323E+08
20h,    1.5164E+08
21h,    1.5020E+08
22h,    1.4890E+08
23h,    1.4785E+08
24h,    1.4675E+08
25h,    1.4579E+08
26h,    1.4482E+08
27h,    1.4384E+08
28h,    1.4301E+08
29h,    1.4216E+08
30h,    1.4149E+08
31h,    1.4052E+08
32h,    1.3940E+08
33h,    1.3901E+08
34h,    1.3875E+08
35h,    1.3819E+08
36h,    1.3742E+08
72h,    1.1E+08
*
#  TIME    WB       DB       P
#  (hr)    (F)      (F)      (psia)
     0,    67.9,    67.9,    14.7
    72,    67.9,    67.9,    14.7
```

Fan2N_90F.out

Vogtle UHS 1-train 2-Fan Case w/ 90F ini. basin temp. (X4C1202V70 ver4)

Initial Basin Mass 2.984E+07 lbm
Initial Basin Temperature 90.0 F
Initial Basin Solids .0 ppt

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
.0	2.984E+07	90.0	.0	67.9	67.9	8.362E+07	Trn A	7.800E+06	4.140E+06	.69
1.0	2.977E+07	89.7	.0	67.9	67.9	8.137E+07	Trn A	7.800E+06	4.140E+06	.69
2.0	2.970E+07	89.3	.0	67.9	67.9	7.912E+07	Trn A	7.800E+06	4.140E+06	.69
3.0	2.964E+07	89.0	.0	67.9	67.9	7.687E+07	Trn A	7.800E+06	4.140E+06	.69
4.0	2.957E+07	88.7	.0	67.9	67.9	2.578E+08	Trn A	7.800E+06	4.140E+06	.69
5.0	2.942E+07	90.9	.0	67.9	67.9	2.428E+08	Trn A	7.800E+06	4.140E+06	.69
6.0	2.927E+07	92.7	.0	67.9	67.9	2.346E+08	Trn A	7.800E+06	4.140E+06	.69
7.0	2.912E+07	94.1	.0	67.9	67.9	2.290E+08	Trn A	7.800E+06	4.140E+06	.69
8.0	2.896E+07	95.2	.0	67.9	67.9	2.104E+08	Trn A	7.800E+06	4.140E+06	.69
9.0	2.881E+07	95.9	.0	67.9	67.9	1.970E+08	Trn A	7.800E+06	4.140E+06	.69
10.0	2.867E+07	96.4	.0	67.9	67.9	1.870E+08	Trn A	7.800E+06	4.140E+06	.69
11.0	2.853E+07	96.7	.0	67.9	67.9	1.795E+08	Trn A	7.800E+06	4.140E+06	.69
12.0	2.839E+07	96.9	.0	67.9	67.9	1.737E+08	Trn A	7.800E+06	4.140E+06	.69
13.0	2.825E+07	97.0	.0	67.9	67.9	1.690E+08	Trn A	7.800E+06	4.140E+06	.69
14.0	2.812E+07	97.0	.0	67.9	67.9	1.652E+08	Trn A	7.800E+06	4.140E+06	.69
15.0	2.799E+07	96.9	.0	67.9	67.9	1.620E+08	Trn A	7.800E+06	4.140E+06	.69
16.0	2.786E+07	96.9	.0	67.9	67.9	1.593E+08	Trn A	7.800E+06	4.140E+06	.69
17.0	2.773E+07	96.8	.0	67.9	67.9	1.570E+08	Trn A	7.800E+06	4.140E+06	.69
18.0	2.760E+07	96.7	.0	67.9	67.9	1.550E+08	Trn A	7.800E+06	4.140E+06	.69
19.0	2.747E+07	96.5	.0	67.9	67.9	1.532E+08	Trn A	7.800E+06	4.140E+06	.69
20.0	2.735E+07	96.4	.0	67.9	67.9	1.516E+08	Trn A	7.800E+06	4.140E+06	.69
21.0	2.722E+07	96.3	.0	67.9	67.9	1.502E+08	Trn A	7.800E+06	4.140E+06	.69
22.0	2.710E+07	96.2	.0	67.9	67.9	1.489E+08	Trn A	7.800E+06	4.140E+06	.69
23.0	2.698E+07	96.0	.0	67.9	67.9	1.479E+08	Trn A	7.800E+06	4.140E+06	.69
24.0	2.686E+07	95.9	.0	67.9	67.9	1.468E+08	Trn A	7.800E+06	4.140E+06	.69
25.0	2.674E+07	95.8	.0	67.9	67.9	1.458E+08	Trn A	7.800E+06	4.140E+06	.69
26.0	2.662E+07	95.7	.0	67.9	67.9	1.448E+08	Trn A	7.800E+06	4.140E+06	.69
27.0	2.650E+07	95.6	.0	67.9	67.9	1.438E+08	Trn A	7.800E+06	4.140E+06	.69
28.0	2.639E+07	95.5	.0	67.9	67.9	1.430E+08	Trn A	7.800E+06	4.140E+06	.69
29.0	2.627E+07	95.5	.0	67.9	67.9	1.422E+08	Trn A	7.800E+06	4.140E+06	.69
30.0	2.616E+07	95.5	.0	67.9	67.9	1.415E+08	Trn A	7.800E+06	4.140E+06	.69

Vogtle UHS 1-train 2-Fan Case w/ 90F ini. basin temp. (X4C1202V70 ver4)

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
31.0	2.605E+07	95.5	.0	67.9	67.9	1.405E+08	Trn A	7.800E+06	4.140E+06	.69
32.0	2.594E+07	95.5	.0	67.9	67.9	1.394E+08	Trn A	7.800E+06	4.140E+06	.69
33.0	2.583E+07	95.5	.0	67.9	67.9	1.390E+08	Trn A	7.800E+06	4.140E+06	.69
34.0	2.572E+07	95.5	.0	67.9	67.9	1.388E+08	Trn A	7.800E+06	4.140E+06	.69
35.0	2.561E+07	95.5	.0	67.9	67.9	1.382E+08	Trn A	7.800E+06	4.140E+06	.69
36.0	2.551E+07	95.4	.0	67.9	67.9	1.374E+08	Trn A	7.800E+06	4.140E+06	.69
37.0	2.540E+07	95.4	.0	67.9	67.9	1.367E+08	Trn A	7.800E+06	4.140E+06	.69
38.0	2.529E+07	95.3	.0	67.9	67.9	1.359E+08	Trn A	7.800E+06	4.140E+06	.69
39.0	2.518E+07	95.3	.0	67.9	67.9	1.351E+08	Trn A	7.800E+06	4.140E+06	.69
40.0	2.508E+07	95.2	.0	67.9	67.9	1.344E+08	Trn A	7.800E+06	4.140E+06	.69
41.0	2.497E+07	95.2	.0	67.9	67.9	1.336E+08	Trn A	7.800E+06	4.140E+06	.69
42.0	2.486E+07	95.1	.0	67.9	67.9	1.329E+08	Trn A	7.800E+06	4.140E+06	.69
43.0	2.476E+07	95.0	.0	67.9	67.9	1.321E+08	Trn A	7.800E+06	4.140E+06	.69
44.0	2.465E+07	95.0	.0	67.9	67.9	1.313E+08	Trn A	7.800E+06	4.140E+06	.69
45.0	2.455E+07	94.9	.0	67.9	67.9	1.306E+08	Trn A	7.800E+06	4.140E+06	.69
46.0	2.445E+07	94.8	.0	67.9	67.9	1.298E+08	Trn A	7.800E+06	4.140E+06	.69
47.0	2.434E+07	94.7	.0	67.9	67.9	1.290E+08	Trn A	7.800E+06	4.140E+06	.69
48.0	2.424E+07	94.7	.0	67.9	67.9	1.283E+08	Trn A	7.800E+06	4.140E+06	.69
49.0	2.414E+07	94.6	.0	67.9	67.9	1.275E+08	Trn A	7.800E+06	4.140E+06	.69
50.0	2.404E+07	94.5	.0	67.9	67.9	1.268E+08	Trn A	7.800E+06	4.140E+06	.69
51.0	2.394E+07	94.4	.0	67.9	67.9	1.260E+08	Trn A	7.800E+06	4.140E+06	.69
52.0	2.384E+07	94.3	.0	67.9	67.9	1.252E+08	Trn A	7.800E+06	4.140E+06	.69
53.0	2.374E+07	94.2	.0	67.9	67.9	1.245E+08	Trn A	7.800E+06	4.140E+06	.69
54.0	2.364E+07	94.2	.0	67.9	67.9	1.237E+08	Trn A	7.800E+06	4.140E+06	.69
55.0	2.355E+07	94.1	.0	67.9	67.9	1.229E+08	Trn A	7.800E+06	4.140E+06	.69
56.0	2.345E+07	94.0	.0	67.9	67.9	1.222E+08	Trn A	7.800E+06	4.140E+06	.69
57.0	2.335E+07	93.9	.0	67.9	67.9	1.214E+08	Trn A	7.800E+06	4.140E+06	.69
58.0	2.326E+07	93.8	.0	67.9	67.9	1.207E+08	Trn A	7.800E+06	4.140E+06	.69
59.0	2.316E+07	93.7	.0	67.9	67.9	1.199E+08	Trn A	7.800E+06	4.140E+06	.69
60.0	2.307E+07	93.6	.0	67.9	67.9	1.191E+08	Trn A	7.800E+06	4.140E+06	.69
61.0	2.297E+07	93.4	.0	67.9	67.9	1.184E+08	Trn A	7.800E+06	4.140E+06	.69
62.0	2.288E+07	93.2	.0	67.9	67.9	1.176E+08	Trn A	7.800E+06	4.140E+06	.69
63.0	2.278E+07	93.0	.0	67.9	67.9	1.169E+08	Trn A	7.800E+06	4.140E+06	.69
64.0	2.269E+07	92.8	.0	67.9	67.9	1.161E+08	Trn A	7.800E+06	4.140E+06	.69
65.0	2.259E+07	92.6	.0	67.9	67.9	1.153E+08	Trn A	7.800E+06	4.140E+06	.69

Vogtle UHS 1-train 2-Fan Case w/ 90F ini. basin temp. (X4C1202V70 ver4)

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
66.0	2.250E+07	92.5	.0	67.9	67.9	1.146E+08	Trn A	7.800E+06	4.140E+06	.69
67.0	2.241E+07	92.3	.0	67.9	67.9	1.138E+08	Trn A	7.800E+06	4.140E+06	.69
68.0	2.232E+07	92.2	.0	67.9	67.9	1.130E+08	Trn A	7.800E+06	4.140E+06	.69
69.0	2.223E+07	92.0	.0	67.9	67.9	1.123E+08	Trn A	7.800E+06	4.140E+06	.69
70.0	2.214E+07	91.9	.0	67.9	67.9	1.115E+08	Trn A	7.800E+06	4.140E+06	.69
71.0	2.205E+07	91.8	.0	67.9	67.9	1.108E+08	Trn A	7.800E+06	4.140E+06	.69
72.0	2.196E+07	91.7	.0	67.9	67.9	1.100E+08	Trn A	7.800E+06	4.140E+06	.69

Stop - Program terminated.

3. UHSSIM input/output for *Fan2N_85F*, 2-Fan Case with IBT of 85 °F

Fan2N_85F.inp

```
Vogtle UHS 1-train 2-Fan Case w/ 85F ini. basin temp. (X4C1202V70 ver4)
# ------------------------------------------------------------------------------
# Mixed C/T model of 2 operable (full speed) and 2 failure fans w/ natural draft
# initial basin temp. = 85 F, Max basin temp. < 97 F
# PDAP C/T characteristics KaV/L = 0.69 per tower performance data X4C1202V70 V2
# C/T bounding heat load for 1-train LOSP per Appendix AA of X4C1205V04 V2 (MUR)
# HL 0 - 4 hr determined by remove RHR HL
# HL beyond Hr-36 are extrapolated to Hr-72.
# 72 hr UHSSIM run time (Hr-0 - Hr-72)
# ------------------------------------------------------------------------------
# design wet-bulb temperature [F], design dry-bulb temperature [F],
# design hot-water temperature [F], design pressure [psia], design solids [ppt]
# 0 => F, psia, btu/hr, lbm/hr units
82, 95, 129.0, 14.696, 0.0, 0
# initial basin mass [lbm], initial basin temperature [F], initial solids [ppt],
# number of towers, starting time of simulation [hr]
29843200, 85, 0, 1, 0.
# Time Period Data -- every 1 hr between the 0th hr and the 72nd hr after LOSP
# step size, number of steps
1,72
*
# Tower Operating Data
# 5 character tower ID
# time [hr], water flow rate [lbm/hr], air flow rate [lbm/hr], KaV/L
# Train A
Trn A
0.0,7.80e6,4.14e6,0.69
72.0,7.80e6,4.14e6,0.69
*
# Heat Rejection Data
# time, time units (s = second, h = hour, d = day), plant heat
# rejection [btu/hr]
0h,    0.8362E+08
1h,    0.8137E+08
2h,    0.7912E+08
3h,    0.7687E+08
3.9999h, 0.7462E+08
4h,    2.5782E+08
5h,    2.4283E+08
6h,    2.3455E+08
7h,    2.2896E+08
8h,    2.1036E+08
9h,    1.9697E+08
10h,   1.8700E+08
11h,   1.7951E+08
12h,   1.7374E+08
13h,   1.6903E+08
14h,   1.6522E+08
15h,   1.6203E+08
16h,   1.5931E+08
17h,   1.5696E+08
18h,   1.5499E+08
19h,   1.5323E+08
20h,   1.5164E+08
21h,   1.5020E+08
22h,   1.4890E+08
23h,   1.4785E+08
24h,   1.4675E+08
25h,   1.4579E+08
26h,   1.4482E+08
27h,   1.4384E+08
28h,   1.4301E+08
29h,   1.4216E+08
30h,   1.4149E+08
31h,   1.4052E+08
32h,   1.3940E+08
33h,   1.3901E+08
34h,   1.3875E+08
35h,   1.3819E+08
36h,   1.3742E+08
72h,   1.1E+08
*
#  TIME    WB       DB       P
#  (hr)    (F)      (F)      (psia)
     0,    69.3,    69.3,    14.7
    72,    69.3,    69.3,    14.7
```

Fan2N_85F.out

Vogtle UHS 1-train 2-Fan Case w/ 85F ini. basin temp. (X4C1202V70 ver4)

Initial Basin Mass 2.984E+07 lbm
Initial Basin Temperature 85.0 F
Initial Basin Solids .0 ppt

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
.0	2.984E+07	85.0	.0	69.3	69.3	8.362E+07	Trn A	7.800E+06	4.140E+06	.69
1.0	2.979E+07	85.3	.0	69.3	69.3	8.137E+07	Trn A	7.800E+06	4.140E+06	.69
2.0	2.973E+07	85.5	.0	69.3	69.3	7.912E+07	Trn A	7.800E+06	4.140E+06	.69
3.0	2.968E+07	85.7	.0	69.3	69.3	7.687E+07	Trn A	7.800E+06	4.140E+06	.69
4.0	2.962E+07	85.8	.0	69.3	69.3	2.578E+08	Trn A	7.800E+06	4.140E+06	.69
5.0	2.949E+07	88.5	.0	69.3	69.3	2.428E+08	Trn A	7.800E+06	4.140E+06	.69
6.0	2.935E+07	90.7	.0	69.3	69.3	2.346E+08	Trn A	7.800E+06	4.140E+06	.69
7.0	2.920E+07	92.5	.0	69.3	69.3	2.290E+08	Trn A	7.800E+06	4.140E+06	.69
8.0	2.905E+07	93.9	.0	69.3	69.3	2.104E+08	Trn A	7.800E+06	4.140E+06	.69
9.0	2.891E+07	94.9	.0	69.3	69.3	1.970E+08	Trn A	7.800E+06	4.140E+06	.69
10.0	2.877E+07	95.6	.0	69.3	69.3	1.870E+08	Trn A	7.800E+06	4.140E+06	.69
11.0	2.864E+07	96.1	.0	69.3	69.3	1.795E+08	Trn A	7.800E+06	4.140E+06	.69
12.0	2.850E+07	96.5	.0	69.3	69.3	1.737E+08	Trn A	7.800E+06	4.140E+06	.69
13.0	2.837E+07	96.7	.0	69.3	69.3	1.690E+08	Trn A	7.800E+06	4.140E+06	.69
14.0	2.824E+07	96.8	.0	69.3	69.3	1.652E+08	Trn A	7.800E+06	4.140E+06	.69
15.0	2.810E+07	96.9	.0	69.3	69.3	1.620E+08	Trn A	7.800E+06	4.140E+06	.69
16.0	2.798E+07	96.9	.0	69.3	69.3	1.593E+08	Trn A	7.800E+06	4.140E+06	.69
17.0	2.785E+07	96.9	.0	69.3	69.3	1.570E+08	Trn A	7.800E+06	4.140E+06	.69
18.0	2.772E+07	96.9	.0	69.3	69.3	1.550E+08	Trn A	7.800E+06	4.140E+06	.69
19.0	2.760E+07	96.8	.0	69.3	69.3	1.532E+08	Trn A	7.800E+06	4.140E+06	.69
20.0	2.747E+07	96.7	.0	69.3	69.3	1.516E+08	Trn A	7.800E+06	4.140E+06	.69
21.0	2.735E+07	96.6	.0	69.3	69.3	1.502E+08	Trn A	7.800E+06	4.140E+06	.69
22.0	2.723E+07	96.6	.0	69.3	69.3	1.489E+08	Trn A	7.800E+06	4.140E+06	.69
23.0	2.710E+07	96.5	.0	69.3	69.3	1.479E+08	Trn A	7.800E+06	4.140E+06	.69
24.0	2.698E+07	96.4	.0	69.3	69.3	1.468E+08	Trn A	7.800E+06	4.140E+06	.69
25.0	2.686E+07	96.3	.0	69.3	69.3	1.458E+08	Trn A	7.800E+06	4.140E+06	.69
26.0	2.675E+07	96.2	.0	69.3	69.3	1.448E+08	Trn A	7.800E+06	4.140E+06	.69
27.0	2.663E+07	96.1	.0	69.3	69.3	1.438E+08	Trn A	7.800E+06	4.140E+06	.69
28.0	2.651E+07	96.0	.0	69.3	69.3	1.430E+08	Trn A	7.800E+06	4.140E+06	.69
29.0	2.640E+07	95.9	.0	69.3	69.3	1.422E+08	Trn A	7.800E+06	4.140E+06	.69
30.0	2.628E+07	95.8	.0	69.3	69.3	1.415E+08	Trn A	7.800E+06	4.140E+06	.69

Vogtle UHS 1-train 2-Fan Case w/ 85F ini. basin temp. (X4C1202V70 ver4)

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
31.0	2.617E+07	95.7	.0	69.3	69.3	1.405E+08	Trn A	7.800E+06	4.140E+06	.69
32.0	2.605E+07	95.7	.0	69.3	69.3	1.394E+08	Trn A	7.800E+06	4.140E+06	.69
33.0	2.594E+07	95.6	.0	69.3	69.3	1.390E+08	Trn A	7.800E+06	4.140E+06	.69
34.0	2.583E+07	95.6	.0	69.3	69.3	1.388E+08	Trn A	7.800E+06	4.140E+06	.69
35.0	2.572E+07	95.7	.0	69.3	69.3	1.382E+08	Trn A	7.800E+06	4.140E+06	.69
36.0	2.562E+07	95.7	.0	69.3	69.3	1.374E+08	Trn A	7.800E+06	4.140E+06	.69
37.0	2.551E+07	95.7	.0	69.3	69.3	1.367E+08	Trn A	7.800E+06	4.140E+06	.69
38.0	2.540E+07	95.7	.0	69.3	69.3	1.359E+08	Trn A	7.800E+06	4.140E+06	.69
39.0	2.529E+07	95.7	.0	69.3	69.3	1.351E+08	Trn A	7.800E+06	4.140E+06	.69
40.0	2.519E+07	95.7	.0	69.3	69.3	1.344E+08	Trn A	7.800E+06	4.140E+06	.69
41.0	2.508E+07	95.6	.0	69.3	69.3	1.336E+08	Trn A	7.800E+06	4.140E+06	.69
42.0	2.497E+07	95.6	.0	69.3	69.3	1.329E+08	Trn A	7.800E+06	4.140E+06	.69
43.0	2.487E+07	95.6	.0	69.3	69.3	1.321E+08	Trn A	7.800E+06	4.140E+06	.69
44.0	2.476E+07	95.5	.0	69.3	69.3	1.313E+08	Trn A	7.800E+06	4.140E+06	.69
45.0	2.466E+07	95.4	.0	69.3	69.3	1.306E+08	Trn A	7.800E+06	4.140E+06	.69
46.0	2.456E+07	95.4	.0	69.3	69.3	1.298E+08	Trn A	7.800E+06	4.140E+06	.69
47.0	2.445E+07	95.3	.0	69.3	69.3	1.290E+08	Trn A	7.800E+06	4.140E+06	.69
48.0	2.435E+07	95.2	.0	69.3	69.3	1.283E+08	Trn A	7.800E+06	4.140E+06	.69
49.0	2.425E+07	95.2	.0	69.3	69.3	1.275E+08	Trn A	7.800E+06	4.140E+06	.69
50.0	2.415E+07	95.1	.0	69.3	69.3	1.268E+08	Trn A	7.800E+06	4.140E+06	.69
51.0	2.405E+07	95.0	.0	69.3	69.3	1.260E+08	Trn A	7.800E+06	4.140E+06	.69
52.0	2.395E+07	94.9	.0	69.3	69.3	1.252E+08	Trn A	7.800E+06	4.140E+06	.69
53.0	2.385E+07	94.9	.0	69.3	69.3	1.245E+08	Trn A	7.800E+06	4.140E+06	.69
54.0	2.375E+07	94.8	.0	69.3	69.3	1.237E+08	Trn A	7.800E+06	4.140E+06	.69
55.0	2.365E+07	94.7	.0	69.3	69.3	1.229E+08	Trn A	7.800E+06	4.140E+06	.69
56.0	2.355E+07	94.6	.0	69.3	69.3	1.222E+08	Trn A	7.800E+06	4.140E+06	.69
57.0	2.346E+07	94.5	.0	69.3	69.3	1.214E+08	Trn A	7.800E+06	4.140E+06	.69
58.0	2.336E+07	94.4	.0	69.3	69.3	1.207E+08	Trn A	7.800E+06	4.140E+06	.69
59.0	2.326E+07	94.3	.0	69.3	69.3	1.199E+08	Trn A	7.800E+06	4.140E+06	.69
60.0	2.317E+07	94.3	.0	69.3	69.3	1.191E+08	Trn A	7.800E+06	4.140E+06	.69
61.0	2.308E+07	94.2	.0	69.3	69.3	1.184E+08	Trn A	7.800E+06	4.140E+06	.69
62.0	2.298E+07	94.1	.0	69.3	69.3	1.176E+08	Trn A	7.800E+06	4.140E+06	.69
63.0	2.289E+07	94.0	.0	69.3	69.3	1.169E+08	Trn A	7.800E+06	4.140E+06	.69
64.0	2.280E+07	93.9	.0	69.3	69.3	1.161E+08	Trn A	7.800E+06	4.140E+06	.69
65.0	2.270E+07	93.8	.0	69.3	69.3	1.153E+08	Trn A	7.800E+06	4.140E+06	.69

Vogtle UHS 1-train 2-Fan Case w/ 85F ini. basin temp. (X4C1202V70 ver4)

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
66.0	2.261E+07	93.7	.0	69.3	69.3	1.146E+08	Trn A	7.800E+06	4.140E+06	.69
67.0	2.252E+07	93.6	.0	69.3	69.3	1.138E+08	Trn A	7.800E+06	4.140E+06	.69
68.0	2.243E+07	93.4	.0	69.3	69.3	1.130E+08	Trn A	7.800E+06	4.140E+06	.69
69.0	2.234E+07	93.2	.0	69.3	69.3	1.123E+08	Trn A	7.800E+06	4.140E+06	.69
70.0	2.225E+07	93.0	.0	69.3	69.3	1.115E+08	Trn A	7.800E+06	4.140E+06	.69
71.0	2.216E+07	92.8	.0	69.3	69.3	1.108E+08	Trn A	7.800E+06	4.140E+06	.69
72.0	2.207E+07	92.6	.0	69.3	69.3	1.100E+08	Trn A	7.800E+06	4.140E+06	.69

Stop - Program terminated.

4. UHSSIM input/output for *Fan2N_80F*, 2-Fan Case with IBT of 80 °F

Fan2N_80F.inp

```
Vogtle UHS 1-train 2-Fan Case w/ 80F ini. basin temp. (X4C1202V70 ver4)
# ------------------------------------------------------------------------------
# Mixed C/T model of 2 operable (full speed) and 2 failure fans w/ natural draft
# initial basin temp. = 80 F, Max basin temp. < 97 F
# PDAP C/T characteristics KaV/L = 0.69 per tower performance data X4C1202V70 V2
# C/T bounding heat load for 1-train LOSP per Appendix AA of X4C1205V04 V2 (MUR)
# HL 0 - 4 hr determined by remove RHR HL
# HL beyond Hr-36 are extrapolated to Hr-72.
# 72 hr UHSSIM run time (Hr-0 - Hr-72)
# ------------------------------------------------------------------------------
# design wet-bulb temperature [F], design dry-bulb temperature [F],
# design hot-water temperature [F], design pressure [psia], design solids [ppt]
# 0 => F, psia, btu/hr, lbm/hr units
82, 95, 129.0, 14.696, 0.0, 0
# initial basin mass [lbm], initial basin temperature [F], initial solids [ppt],
# number of towers, starting time of simulation [hr]
29843200, 80, 0, 1, 0.
# Time Period Data -- every 1 hr between the 0th hr and the 72nd hr after LOSP
# step size, number of steps
1,72
*
# Tower Operating Data
# 5 character tower ID
# time [hr], water flow rate [lbm/hr], air flow rate [lbm/hr], KaV/L
# Train A
Trn A
0.0,7.80e6,4.14e6,0.69
72.0,7.80e6,4.14e6,0.69
*
# Heat Rejection Data
# time, time units (s = second, h = hour, d = day), plant heat
# rejection [btu/hr]
0h,    0.8362E+08
1h,    0.8137E+08
2h,    0.7912E+08
3h,    0.7687E+08
3.9999h, 0.7462E+08
4h,    2.5782E+08
5h,    2.4283E+08
6h,    2.3455E+08
7h,    2.2896E+08
8h,    2.1036E+08
9h,    1.9697E+08
10h,    1.8700E+08
11h,    1.7951E+08
12h,    1.7374E+08
13h,    1.6903E+08
14h,    1.6522E+08
15h,    1.6203E+08
16h,    1.5931E+08
17h,    1.5696E+08
18h,    1.5499E+08
19h,    1.5323E+08
20h,    1.5164E+08
21h,    1.5020E+08
22h,    1.4890E+08
23h,    1.4785E+08
24h,    1.4675E+08
25h,    1.4579E+08
26h,    1.4482E+08
27h,    1.4384E+08
28h,    1.4301E+08
29h,    1.4216E+08
30h,    1.4149E+08
31h,    1.4052E+08
32h,    1.3940E+08
33h,    1.3901E+08
34h,    1.3875E+08
35h,    1.3819E+08
36h,    1.3742E+08
72h,    1.1E+08
*
#  TIME    WB       DB       P
#   (hr)    (F)      (F)      (psia)
     0,    70.4,    70.4,    14.7
    72,    70.4,    70.4,    14.7
```

Fan2N_80F.out

Vogtle UHS 1-train 2-Fan Case w/ 80F ini. basin temp. (X4C1202V70 ver4)

Initial Basin Mass 2.984E+07 lbm
Initial Basin Temperature 80.0 F
Initial Basin Solids .0 ppt

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
.0	2.984E+07	80.0	.0	70.4	70.4	8.362E+07	Trn A	7.800E+06	4.140E+06	.69
1.0	2.980E+07	80.9	.0	70.4	70.4	8.137E+07	Trn A	7.800E+06	4.140E+06	.69
2.0	2.976E+07	81.7	.0	70.4	70.4	7.912E+07	Trn A	7.800E+06	4.140E+06	.69
3.0	2.972E+07	82.3	.0	70.4	70.4	7.687E+07	Trn A	7.800E+06	4.140E+06	.69
4.0	2.967E+07	82.8	.0	70.4	70.4	2.578E+08	Trn A	7.800E+06	4.140E+06	.69
5.0	2.955E+07	86.1	.0	70.4	70.4	2.428E+08	Trn A	7.800E+06	4.140E+06	.69
6.0	2.942E+07	88.7	.0	70.4	70.4	2.346E+08	Trn A	7.800E+06	4.140E+06	.69
7.0	2.928E+07	90.8	.0	70.4	70.4	2.290E+08	Trn A	7.800E+06	4.140E+06	.69
8.0	2.914E+07	92.6	.0	70.4	70.4	2.104E+08	Trn A	7.800E+06	4.140E+06	.69
9.0	2.901E+07	93.8	.0	70.4	70.4	1.970E+08	Trn A	7.800E+06	4.140E+06	.69
10.0	2.887E+07	94.8	.0	70.4	70.4	1.870E+08	Trn A	7.800E+06	4.140E+06	.69
11.0	2.874E+07	95.4	.0	70.4	70.4	1.795E+08	Trn A	7.800E+06	4.140E+06	.69
12.0	2.861E+07	96.0	.0	70.4	70.4	1.737E+08	Trn A	7.800E+06	4.140E+06	.69
13.0	2.848E+07	96.3	.0	70.4	70.4	1.690E+08	Trn A	7.800E+06	4.140E+06	.69
14.0	2.835E+07	96.6	.0	70.4	70.4	1.652E+08	Trn A	7.800E+06	4.140E+06	.69
15.0	2.822E+07	96.8	.0	70.4	70.4	1.620E+08	Trn A	7.800E+06	4.140E+06	.69
16.0	2.809E+07	96.9	.0	70.4	70.4	1.593E+08	Trn A	7.800E+06	4.140E+06	.69
17.0	2.797E+07	96.9	.0	70.4	70.4	1.570E+08	Trn A	7.800E+06	4.140E+06	.69
18.0	2.784E+07	97.0	.0	70.4	70.4	1.550E+08	Trn A	7.800E+06	4.140E+06	.69
19.0	2.772E+07	97.0	.0	70.4	70.4	1.532E+08	Trn A	7.800E+06	4.140E+06	.69
20.0	2.759E+07	96.9	.0	70.4	70.4	1.516E+08	Trn A	7.800E+06	4.140E+06	.69
21.0	2.747E+07	96.9	.0	70.4	70.4	1.502E+08	Trn A	7.800E+06	4.140E+06	.69
22.0	2.735E+07	96.8	.0	70.4	70.4	1.489E+08	Trn A	7.800E+06	4.140E+06	.69
23.0	2.723E+07	96.8	.0	70.4	70.4	1.479E+08	Trn A	7.800E+06	4.140E+06	.69
24.0	2.711E+07	96.7	.0	70.4	70.4	1.468E+08	Trn A	7.800E+06	4.140E+06	.69
25.0	2.699E+07	96.6	.0	70.4	70.4	1.458E+08	Trn A	7.800E+06	4.140E+06	.69
26.0	2.687E+07	96.5	.0	70.4	70.4	1.448E+08	Trn A	7.800E+06	4.140E+06	.69
27.0	2.675E+07	96.5	.0	70.4	70.4	1.438E+08	Trn A	7.800E+06	4.140E+06	.69
28.0	2.664E+07	96.4	.0	70.4	70.4	1.430E+08	Trn A	7.800E+06	4.140E+06	.69
29.0	2.652E+07	96.3	.0	70.4	70.4	1.422E+08	Trn A	7.800E+06	4.140E+06	.69
30.0	2.640E+07	96.2	.0	70.4	70.4	1.415E+08	Trn A	7.800E+06	4.140E+06	.69

Vogtle UHS 1-train 2-Fan Case w/ 80F ini. basin temp. (X4C1202V70 ver4)

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
31.0	2.629E+07	96.1	.0	70.4	70.4	1.405E+08	Trn A	7.800E+06	4.140E+06	.69
32.0	2.617E+07	96.0	.0	70.4	70.4	1.394E+08	Trn A	7.800E+06	4.140E+06	.69
33.0	2.606E+07	96.0	.0	70.4	70.4	1.390E+08	Trn A	7.800E+06	4.140E+06	.69
34.0	2.595E+07	95.9	.0	70.4	70.4	1.388E+08	Trn A	7.800E+06	4.140E+06	.69
35.0	2.584E+07	95.8	.0	70.4	70.4	1.382E+08	Trn A	7.800E+06	4.140E+06	.69
36.0	2.572E+07	95.7	.0	70.4	70.4	1.374E+08	Trn A	7.800E+06	4.140E+06	.69
37.0	2.561E+07	95.7	.0	70.4	70.4	1.367E+08	Trn A	7.800E+06	4.140E+06	.69
38.0	2.550E+07	95.7	.0	70.4	70.4	1.359E+08	Trn A	7.800E+06	4.140E+06	.69
39.0	2.540E+07	95.7	.0	70.4	70.4	1.351E+08	Trn A	7.800E+06	4.140E+06	.69
40.0	2.529E+07	95.8	.0	70.4	70.4	1.344E+08	Trn A	7.800E+06	4.140E+06	.69
41.0	2.519E+07	95.8	.0	70.4	70.4	1.336E+08	Trn A	7.800E+06	4.140E+06	.69
42.0	2.508E+07	95.8	.0	70.4	70.4	1.329E+08	Trn A	7.800E+06	4.140E+06	.69
43.0	2.498E+07	95.8	.0	70.4	70.4	1.321E+08	Trn A	7.800E+06	4.140E+06	.69
44.0	2.487E+07	95.8	.0	70.4	70.4	1.313E+08	Trn A	7.800E+06	4.140E+06	.69
45.0	2.477E+07	95.8	.0	70.4	70.4	1.306E+08	Trn A	7.800E+06	4.140E+06	.69
46.0	2.467E+07	95.7	.0	70.4	70.4	1.298E+08	Trn A	7.800E+06	4.140E+06	.69
47.0	2.456E+07	95.7	.0	70.4	70.4	1.290E+08	Trn A	7.800E+06	4.140E+06	.69
48.0	2.446E+07	95.6	.0	70.4	70.4	1.283E+08	Trn A	7.800E+06	4.140E+06	.69
49.0	2.436E+07	95.6	.0	70.4	70.4	1.275E+08	Trn A	7.800E+06	4.140E+06	.69
50.0	2.426E+07	95.5	.0	70.4	70.4	1.268E+08	Trn A	7.800E+06	4.140E+06	.69
51.0	2.416E+07	95.5	.0	70.4	70.4	1.260E+08	Trn A	7.800E+06	4.140E+06	.69
52.0	2.405E+07	95.4	.0	70.4	70.4	1.252E+08	Trn A	7.800E+06	4.140E+06	.69
53.0	2.396E+07	95.3	.0	70.4	70.4	1.245E+08	Trn A	7.800E+06	4.140E+06	.69
54.0	2.386E+07	95.2	.0	70.4	70.4	1.237E+08	Trn A	7.800E+06	4.140E+06	.69
55.0	2.376E+07	95.2	.0	70.4	70.4	1.229E+08	Trn A	7.800E+06	4.140E+06	.69
56.0	2.366E+07	95.1	.0	70.4	70.4	1.222E+08	Trn A	7.800E+06	4.140E+06	.69
57.0	2.356E+07	95.0	.0	70.4	70.4	1.214E+08	Trn A	7.800E+06	4.140E+06	.69
58.0	2.347E+07	94.9	.0	70.4	70.4	1.207E+08	Trn A	7.800E+06	4.140E+06	.69
59.0	2.337E+07	94.8	.0	70.4	70.4	1.199E+08	Trn A	7.800E+06	4.140E+06	.69
60.0	2.327E+07	94.8	.0	70.4	70.4	1.191E+08	Trn A	7.800E+06	4.140E+06	.69
61.0	2.318E+07	94.7	.0	70.4	70.4	1.184E+08	Trn A	7.800E+06	4.140E+06	.69
62.0	2.309E+07	94.6	.0	70.4	70.4	1.176E+08	Trn A	7.800E+06	4.140E+06	.69
63.0	2.299E+07	94.5	.0	70.4	70.4	1.169E+08	Trn A	7.800E+06	4.140E+06	.69
64.0	2.290E+07	94.4	.0	70.4	70.4	1.161E+08	Trn A	7.800E+06	4.140E+06	.69
65.0	2.281E+07	94.3	.0	70.4	70.4	1.153E+08	Trn A	7.800E+06	4.140E+06	.69

Vogtle UHS 1-train 2-Fan Case w/ 80F ini. basin temp. (X4C1202V70 ver4)

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
66.0	2.272E+07	94.2	.0	70.4	70.4	1.146E+08	Trn A	7.800E+06	4.140E+06	.69
67.0	2.262E+07	94.1	.0	70.4	70.4	1.138E+08	Trn A	7.800E+06	4.140E+06	.69
68.0	2.253E+07	94.0	.0	70.4	70.4	1.130E+08	Trn A	7.800E+06	4.140E+06	.69
69.0	2.244E+07	94.0	.0	70.4	70.4	1.123E+08	Trn A	7.800E+06	4.140E+06	.69
70.0	2.236E+07	93.8	.0	70.4	70.4	1.115E+08	Trn A	7.800E+06	4.140E+06	.69
71.0	2.227E+07	93.7	.0	70.4	70.4	1.108E+08	Trn A	7.800E+06	4.140E+06	.69
72.0	2.218E+07	93.5	.0	70.4	70.4	1.100E+08	Trn A	7.800E+06	4.140E+06	.69

Stop - Program terminated.

5. UHSSIM input/output for *Fan2N_75F,* 2-Fan Case with IBT of 75 °F

Fan2N_75F.inp

```
Vogtle UHS 1-train 2-Fan Case w/ 75F ini. basin temp. (X4C1202V70 ver4)
# --------------------------------------------------------------------------
# Mixed C/T model of 2 operable (full speed) and 2 failure fans w/ natural draft
# initial basin temp. = 75 F, Max basin temp. < 97 F
# PDAP C/T characteristics KaV/L = 0.69 per tower performance data X4C1202V70 V2
# C/T bounding heat load for 1-train LOSP per Appendix AA of X4C1205V04 V2 (MUR)
# HL 0 - 4 hr determined by remove RHR HL
# HL beyond Hr-36 are extrapolated to Hr-72.
# 72 hr UHSSIM run time (Hr-0 - Hr-72)
# --------------------------------------------------------------------------
# design wet-bulb temperature [F], design dry-bulb temperature [F],
# design hot-water temperature [F], design pressure [psia], design solids [ppt]
# 0 => F, psia, btu/hr, lbm/hr units
82, 95, 129.0, 14.696, 0.0, 0
# initial basin mass [lbm], initial basin temperature [F], initial solids [ppt],
# number of towers, starting time of simulation [hr]
29843200, 75, 0, 1, 0.
# Time Period Data -- every 1 hr between the 0th hr and the 72nd hr after LOSP
# step size, number of steps
1,72
*
# Tower Operating Data
# 5 character tower ID
# time [hr], water flow rate [lbm/hr], air flow rate [lbm/hr], KaV/L
# Train A
Trn A
0.0,7.80e6,4.14e6,0.69
72.0,7.80e6,4.14e6,0.69
*
# Heat Rejection Data
# time, time units (s = second, h = hour, d = day), plant heat
# rejection [btu/hr]
0h,   0.8362E+08
1h,   0.8137E+08
2h,   0.7912E+08
3h,   0.7687E+08
3.9999h, 0.7462E+08
4h,   2.5782E+08
5h,   2.4283E+08
6h,   2.3455E+08
7h,   2.2896E+08
8h,   2.1036E+08
9h,   1.9697E+08
10h,   1.8700E+08
11h,   1.7951E+08
12h,   1.7374E+08
13h,   1.6903E+08
14h,   1.6522E+08
15h,   1.6203E+08
16h,   1.5931E+08
17h,   1.5696E+08
18h,   1.5499E+08
19h,   1.5323E+08
20h,   1.5164E+08
21h,   1.5020E+08
22h,   1.4890E+08
23h,   1.4785E+08
24h,   1.4675E+08
25h,   1.4579E+08
26h,   1.4482E+08
27h,   1.4384E+08
28h,   1.4301E+08
29h,   1.4216E+08
30h,   1.4149E+08
31h,   1.4052E+08
32h,   1.3940E+08
33h,   1.3901E+08
34h,   1.3875E+08
35h,   1.3819E+08
36h,   1.3742E+08
72h,   1.1E+08
*
#  TIME   WB     DB      P
#  (hr)   (F)    (F)     (psia)
     0,   71.2,  71.2,   14.7
    72,   71.2,  71.2,   14.7
```

Fan2_75F.out

Vogtle UHS 1-train 2-Fan Case w/ 75F ini. basin temp. (X4C1202V70 ver4)

Initial Basin Mass 2.984E+07 lbm
Initial Basin Temperature 75.0 F
Initial Basin Solids .0 ppt

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
.0	2.984E+07	75.0	.0	71.2	71.2	8.362E+07	Trn A	7.800E+06	4.140E+06	.69
1.0	2.981E+07	76.4	.0	71.2	71.2	8.137E+07	Trn A	7.800E+06	4.140E+06	.69
2.0	2.978E+07	77.7	.0	71.2	71.2	7.912E+07	Trn A	7.800E+06	4.140E+06	.69
3.0	2.975E+07	78.8	.0	71.2	71.2	7.687E+07	Trn A	7.800E+06	4.140E+06	.69
4.0	2.971E+07	79.7	.0	71.2	71.2	2.578E+08	Trn A	7.800E+06	4.140E+06	.69
5.0	2.960E+07	83.4	.0	71.2	71.2	2.428E+08	Trn A	7.800E+06	4.140E+06	.69
6.0	2.948E+07	86.5	.0	71.2	71.2	2.346E+08	Trn A	7.800E+06	4.140E+06	.69
7.0	2.936E+07	89.0	.0	71.2	71.2	2.290E+08	Trn A	7.800E+06	4.140E+06	.69
8.0	2.923E+07	91.0	.0	71.2	71.2	2.104E+08	Trn A	7.800E+06	4.140E+06	.69
9.0	2.910E+07	92.6	.0	71.2	71.2	1.970E+08	Trn A	7.800E+06	4.140E+06	.69
10.0	2.897E+07	93.7	.0	71.2	71.2	1.870E+08	Trn A	7.800E+06	4.140E+06	.69
11.0	2.884E+07	94.6	.0	71.2	71.2	1.795E+08	Trn A	7.800E+06	4.140E+06	.69
12.0	2.871E+07	95.3	.0	71.2	71.2	1.737E+08	Trn A	7.800E+06	4.140E+06	.69
13.0	2.859E+07	95.8	.0	71.2	71.2	1.690E+08	Trn A	7.800E+06	4.140E+06	.69
14.0	2.846E+07	96.2	.0	71.2	71.2	1.652E+08	Trn A	7.800E+06	4.140E+06	.69
15.0	2.834E+07	96.5	.0	71.2	71.2	1.620E+08	Trn A	7.800E+06	4.140E+06	.69
16.0	2.821E+07	96.7	.0	71.2	71.2	1.593E+08	Trn A	7.800E+06	4.140E+06	.69
17.0	2.808E+07	96.8	.0	71.2	71.2	1.570E+08	Trn A	7.800E+06	4.140E+06	.69
18.0	2.796E+07	96.9	.0	71.2	71.2	1.550E+08	Trn A	7.800E+06	4.140E+06	.69
19.0	2.784E+07	97.0	.0	71.2	71.2	1.532E+08	Trn A	7.800E+06	4.140E+06	.69
20.0	2.771E+07	97.0	.0	71.2	71.2	1.516E+08	Trn A	7.800E+06	4.140E+06	.69
21.0	2.759E+07	97.0	.0	71.2	71.2	1.502E+08	Trn A	7.800E+06	4.140E+06	.69
22.0	2.747E+07	97.0	.0	71.2	71.2	1.489E+08	Trn A	7.800E+06	4.140E+06	.69
23.0	2.735E+07	96.9	.0	71.2	71.2	1.479E+08	Trn A	7.800E+06	4.140E+06	.69
24.0	2.723E+07	96.9	.0	71.2	71.2	1.468E+08	Trn A	7.800E+06	4.140E+06	.69
25.0	2.711E+07	96.8	.0	71.2	71.2	1.458E+08	Trn A	7.800E+06	4.140E+06	.69
26.0	2.699E+07	96.8	.0	71.2	71.2	1.448E+08	Trn A	7.800E+06	4.140E+06	.69
27.0	2.687E+07	96.7	.0	71.2	71.2	1.438E+08	Trn A	7.800E+06	4.140E+06	.69
28.0	2.676E+07	96.6	.0	71.2	71.2	1.430E+08	Trn A	7.800E+06	4.140E+06	.69
29.0	2.664E+07	96.6	.0	71.2	71.2	1.422E+08	Trn A	7.800E+06	4.140E+06	.69
30.0	2.653E+07	96.5	.0	71.2	71.2	1.415E+08	Trn A	7.800E+06	4.140E+06	.69

Vogtle UHS 1-train 2-Fan Case w/ 75F ini. basin temp. (X4C1202V70 ver4)

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
31.0	2.641E+07	96.4	.0	71.2	71.2	1.405E+08	Trn A	7.800E+06	4.140E+06	.69
32.0	2.630E+07	96.4	.0	71.2	71.2	1.394E+08	Trn A	7.800E+06	4.140E+06	.69
33.0	2.618E+07	96.3	.0	71.2	71.2	1.390E+08	Trn A	7.800E+06	4.140E+06	.69
34.0	2.607E+07	96.2	.0	71.2	71.2	1.388E+08	Trn A	7.800E+06	4.140E+06	.69
35.0	2.596E+07	96.1	.0	71.2	71.2	1.382E+08	Trn A	7.800E+06	4.140E+06	.69
36.0	2.585E+07	96.1	.0	71.2	71.2	1.374E+08	Trn A	7.800E+06	4.140E+06	.69
37.0	2.573E+07	96.0	.0	71.2	71.2	1.367E+08	Trn A	7.800E+06	4.140E+06	.69
38.0	2.562E+07	95.9	.0	71.2	71.2	1.359E+08	Trn A	7.800E+06	4.140E+06	.69
39.0	2.551E+07	95.9	.0	71.2	71.2	1.351E+08	Trn A	7.800E+06	4.140E+06	.69
40.0	2.541E+07	95.9	.0	71.2	71.2	1.344E+08	Trn A	7.800E+06	4.140E+06	.69
41.0	2.530E+07	95.8	.0	71.2	71.2	1.336E+08	Trn A	7.800E+06	4.140E+06	.69
42.0	2.519E+07	95.9	.0	71.2	71.2	1.329E+08	Trn A	7.800E+06	4.140E+06	.69
43.0	2.509E+07	95.9	.0	71.2	71.2	1.321E+08	Trn A	7.800E+06	4.140E+06	.69
44.0	2.498E+07	95.9	.0	71.2	71.2	1.313E+08	Trn A	7.800E+06	4.140E+06	.69
45.0	2.488E+07	95.9	.0	71.2	71.2	1.306E+08	Trn A	7.800E+06	4.140E+06	.69
46.0	2.478E+07	95.9	.0	71.2	71.2	1.298E+08	Trn A	7.800E+06	4.140E+06	.69
47.0	2.467E+07	95.9	.0	71.2	71.2	1.290E+08	Trn A	7.800E+06	4.140E+06	.69
48.0	2.457E+07	95.9	.0	71.2	71.2	1.283E+08	Trn A	7.800E+06	4.140E+06	.69
49.0	2.447E+07	95.9	.0	71.2	71.2	1.275E+08	Trn A	7.800E+06	4.140E+06	.69
50.0	2.437E+07	95.8	.0	71.2	71.2	1.268E+08	Trn A	7.800E+06	4.140E+06	.69
51.0	2.427E+07	95.8	.0	71.2	71.2	1.260E+08	Trn A	7.800E+06	4.140E+06	.69
52.0	2.417E+07	95.7	.0	71.2	71.2	1.252E+08	Trn A	7.800E+06	4.140E+06	.69
53.0	2.407E+07	95.6	.0	71.2	71.2	1.245E+08	Trn A	7.800E+06	4.140E+06	.69
54.0	2.397E+07	95.6	.0	71.2	71.2	1.237E+08	Trn A	7.800E+06	4.140E+06	.69
55.0	2.387E+07	95.5	.0	71.2	71.2	1.229E+08	Trn A	7.800E+06	4.140E+06	.69
56.0	2.377E+07	95.4	.0	71.2	71.2	1.222E+08	Trn A	7.800E+06	4.140E+06	.69
57.0	2.367E+07	95.4	.0	71.2	71.2	1.214E+08	Trn A	7.800E+06	4.140E+06	.69
58.0	2.358E+07	95.3	.0	71.2	71.2	1.207E+08	Trn A	7.800E+06	4.140E+06	.69
59.0	2.348E+07	95.2	.0	71.2	71.2	1.199E+08	Trn A	7.800E+06	4.140E+06	.69
60.0	2.338E+07	95.1	.0	71.2	71.2	1.191E+08	Trn A	7.800E+06	4.140E+06	.69
61.0	2.329E+07	95.0	.0	71.2	71.2	1.184E+08	Trn A	7.800E+06	4.140E+06	.69
62.0	2.319E+07	95.0	.0	71.2	71.2	1.176E+08	Trn A	7.800E+06	4.140E+06	.69
63.0	2.310E+07	94.9	.0	71.2	71.2	1.169E+08	Trn A	7.800E+06	4.140E+06	.69
64.0	2.301E+07	94.8	.0	71.2	71.2	1.161E+08	Trn A	7.800E+06	4.140E+06	.69
65.0	2.292E+07	94.7	.0	71.2	71.2	1.153E+08	Trn A	7.800E+06	4.140E+06	.69

Vogtle UHS 1-train 2-Fan Case w/ 75F ini. basin temp. (X4C1202V70 ver4)

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
66.0	2.282E+07	94.6	.0	71.2	71.2	1.146E+08	Trn A	7.800E+06	4.140E+06	.69
67.0	2.273E+07	94.5	.0	71.2	71.2	1.138E+08	Trn A	7.800E+06	4.140E+06	.69
68.0	2.264E+07	94.4	.0	71.2	71.2	1.130E+08	Trn A	7.800E+06	4.140E+06	.69
69.0	2.255E+07	94.3	.0	71.2	71.2	1.123E+08	Trn A	7.800E+06	4.140E+06	.69
70.0	2.246E+07	94.2	.0	71.2	71.2	1.115E+08	Trn A	7.800E+06	4.140E+06	.69
71.0	2.237E+07	94.1	.0	71.2	71.2	1.108E+08	Trn A	7.800E+06	4.140E+06	.69
72.0	2.229E+07	94.1	.0	71.2	71.2	1.100E+08	Trn A	7.800E+06	4.140E+06	.69

Stop - Program terminated.

6. UHSSIM input/output for *Fan2N_70F*, 2-Fan Case with IBT of 70 °F

Fan2N_70F.inp

```
Vogtle UHS 1-train 2-Fan Case w/ 70F ini. basin temp. (X4C1202V70 ver4)
# ------------------------------------------------------------------------------
# Mixed C/T model of 2 operable (full speed) and 2 failure fans w/ natural draft
# initial basin temp. = 70 F, Max basin temp. < 97 F
# PDAP C/T characteristics KaV/L = 0.69 per tower performance data X4C1202V70 V2
# C/T bounding heat load for 1-train LOSP per Appendix AA of X4C1205V04 V2 (MUR)
# HL 0 - 4 hr determined by remove RHR HL
# HL beyond Hr-36 are extrapolated to Hr-72.
# 72 hr UHSSIM run time (Hr-0 - Hr-72)
# ------------------------------------------------------------------------------
# design wet-bulb temperature [F], design dry-bulb temperature [F],
# design hot-water temperature [F], design pressure [psia], design solids [ppt]
# 0 => F, psia, btu/hr, lbm/hr units
82, 95, 129.0, 14.696, 0.0, 0
# initial basin mass [lbm], initial basin temperature [F], initial solids [ppt],
# number of towers, starting time of simulation [hr]
29843200, 70, 0, 1, 0.
# Time Period Data -- every 1 hr between the 0th hr and the 72nd hr after LOSP
# step size, number of steps
1,72
*
# Tower Operating Data
# 5 character tower ID
# time [hr], water flow rate [lbm/hr], air flow rate [lbm/hr], KaV/L
# Train A
Trn A
0.0,7.80e6,4.14e6,0.69
72.0,7.80e6,4.14e6,0.69
*
# Heat Rejection Data
# time, time units (s = second, h = hour, d = day), plant heat
# rejection [btu/hr]
0h,    0.8362E+08
1h,    0.8137E+08
2h,    0.7912E+08
3h,    0.7687E+08
3.9999h, 0.7462E+08
4h,    2.5782E+08
5h,    2.4283E+08
6h,    2.3455E+08
7h,    2.2896E+08
8h,    2.1036E+08
9h,    1.9697E+08
10h,    1.8700E+08
11h,    1.7951E+08
12h,    1.7374E+08
13h,    1.6903E+08
14h,    1.6522E+08
15h,    1.6203E+08
16h,    1.5931E+08
17h,    1.5696E+08
18h,    1.5499E+08
19h,    1.5323E+08
20h,    1.5164E+08
21h,    1.5020E+08
22h,    1.4890E+08
23h,    1.4785E+08
24h,    1.4675E+08
25h,    1.4579E+08
26h,    1.4482E+08
27h,    1.4384E+08
28h,    1.4301E+08
29h,    1.4216E+08
30h,    1.4149E+08
31h,    1.4052E+08
32h,    1.3940E+08
33h,    1.3901E+08
34h,    1.3875E+08
35h,    1.3819E+08
36h,    1.3742E+08
72h,    1.1E+08
*
#  TIME    WB       DB       P
#  (hr)    (F)      (F)      (psia)
     0,    71.7,    71.7,    14.7
    72,    71.7,    71.7,    14.7
```

Fan2N_70F.out

Vogtle UHS 1-train 2-Fan Case w/ 70F ini. basin temp. (X4C1202V70 ver4)

Initial Basin Mass 2.984E+07 lbm
Initial Basin Temperature 70.0 F
Initial Basin Solids .0 ppt

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
.0	2.984E+07	70.0	.0	71.7	71.7	8.362E+07	Trn A	7.800E+06	4.140E+06	.69
1.0	2.983E+07	71.9	.0	71.7	71.7	8.137E+07	Trn A	7.800E+06	4.140E+06	.69
2.0	2.980E+07	73.6	.0	71.7	71.7	7.912E+07	Trn A	7.800E+06	4.140E+06	.69
3.0	2.978E+07	75.2	.0	71.7	71.7	7.687E+07	Trn A	7.800E+06	4.140E+06	.69
4.0	2.975E+07	76.5	.0	71.7	71.7	2.578E+08	Trn A	7.800E+06	4.140E+06	.69
5.0	2.966E+07	80.7	.0	71.7	71.7	2.428E+08	Trn A	7.800E+06	4.140E+06	.69
6.0	2.955E+07	84.2	.0	71.7	71.7	2.346E+08	Trn A	7.800E+06	4.140E+06	.69
7.0	2.943E+07	87.1	.0	71.7	71.7	2.290E+08	Trn A	7.800E+06	4.140E+06	.69
8.0	2.931E+07	89.4	.0	71.7	71.7	2.104E+08	Trn A	7.800E+06	4.140E+06	.69
9.0	2.919E+07	91.2	.0	71.7	71.7	1.970E+08	Trn A	7.800E+06	4.140E+06	.69
10.0	2.907E+07	92.6	.0	71.7	71.7	1.870E+08	Trn A	7.800E+06	4.140E+06	.69
11.0	2.894E+07	93.7	.0	71.7	71.7	1.795E+08	Trn A	7.800E+06	4.140E+06	.69
12.0	2.882E+07	94.5	.0	71.7	71.7	1.737E+08	Trn A	7.800E+06	4.140E+06	.69
13.0	2.870E+07	95.2	.0	71.7	71.7	1.690E+08	Trn A	7.800E+06	4.140E+06	.69
14.0	2.857E+07	95.7	.0	71.7	71.7	1.652E+08	Trn A	7.800E+06	4.140E+06	.69
15.0	2.845E+07	96.1	.0	71.7	71.7	1.620E+08	Trn A	7.800E+06	4.140E+06	.69
16.0	2.833E+07	96.4	.0	71.7	71.7	1.593E+08	Trn A	7.800E+06	4.140E+06	.69
17.0	2.820E+07	96.6	.0	71.7	71.7	1.570E+08	Trn A	7.800E+06	4.140E+06	.69
18.0	2.808E+07	96.8	.0	71.7	71.7	1.550E+08	Trn A	7.800E+06	4.140E+06	.69
19.0	2.796E+07	96.9	.0	71.7	71.7	1.532E+08	Trn A	7.800E+06	4.140E+06	.69
20.0	2.784E+07	96.9	.0	71.7	71.7	1.516E+08	Trn A	7.800E+06	4.140E+06	.69
21.0	2.772E+07	97.0	.0	71.7	71.7	1.502E+08	Trn A	7.800E+06	4.140E+06	.69
22.0	2.759E+07	97.0	.0	71.7	71.7	1.489E+08	Trn A	7.800E+06	4.140E+06	.69
23.0	2.747E+07	97.0	.0	71.7	71.7	1.479E+08	Trn A	7.800E+06	4.140E+06	.69
24.0	2.736E+07	97.0	.0	71.7	71.7	1.468E+08	Trn A	7.800E+06	4.140E+06	.69
25.0	2.724E+07	96.9	.0	71.7	71.7	1.458E+08	Trn A	7.800E+06	4.140E+06	.69
26.0	2.712E+07	96.9	.0	71.7	71.7	1.448E+08	Trn A	7.800E+06	4.140E+06	.69
27.0	2.700E+07	96.9	.0	71.7	71.7	1.438E+08	Trn A	7.800E+06	4.140E+06	.69
28.0	2.688E+07	96.8	.0	71.7	71.7	1.430E+08	Trn A	7.800E+06	4.140E+06	.69
29.0	2.677E+07	96.7	.0	71.7	71.7	1.422E+08	Trn A	7.800E+06	4.140E+06	.69
30.0	2.665E+07	96.7	.0	71.7	71.7	1.415E+08	Trn A	7.800E+06	4.140E+06	.69

Vogtle UHS 1-train 2-Fan Case w/ 70F ini. basin temp. (X4C1202V70 ver4)

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
31.0	2.654E+07	96.6	.0	71.7	71.7	1.405E+08	Trn A	7.800E+06	4.140E+06	.69
32.0	2.642E+07	96.5	.0	71.7	71.7	1.394E+08	Trn A	7.800E+06	4.140E+06	.69
33.0	2.631E+07	96.5	.0	71.7	71.7	1.390E+08	Trn A	7.800E+06	4.140E+06	.69
34.0	2.619E+07	96.4	.0	71.7	71.7	1.388E+08	Trn A	7.800E+06	4.140E+06	.69
35.0	2.608E+07	96.4	.0	71.7	71.7	1.382E+08	Trn A	7.800E+06	4.140E+06	.69
36.0	2.597E+07	96.3	.0	71.7	71.7	1.374E+08	Trn A	7.800E+06	4.140E+06	.69
37.0	2.586E+07	96.2	.0	71.7	71.7	1.367E+08	Trn A	7.800E+06	4.140E+06	.69
38.0	2.575E+07	96.2	.0	71.7	71.7	1.359E+08	Trn A	7.800E+06	4.140E+06	.69
39.0	2.564E+07	96.1	.0	71.7	71.7	1.351E+08	Trn A	7.800E+06	4.140E+06	.69
40.0	2.553E+07	96.0	.0	71.7	71.7	1.344E+08	Trn A	7.800E+06	4.140E+06	.69
41.0	2.542E+07	95.9	.0	71.7	71.7	1.336E+08	Trn A	7.800E+06	4.140E+06	.69
42.0	2.531E+07	95.9	.0	71.7	71.7	1.329E+08	Trn A	7.800E+06	4.140E+06	.69
43.0	2.520E+07	95.8	.0	71.7	71.7	1.321E+08	Trn A	7.800E+06	4.140E+06	.69
44.0	2.510E+07	95.9	.0	71.7	71.7	1.313E+08	Trn A	7.800E+06	4.140E+06	.69
45.0	2.500E+07	96.0	.0	71.7	71.7	1.306E+08	Trn A	7.800E+06	4.140E+06	.69
46.0	2.489E+07	96.0	.0	71.7	71.7	1.298E+08	Trn A	7.800E+06	4.140E+06	.69
47.0	2.479E+07	96.0	.0	71.7	71.7	1.290E+08	Trn A	7.800E+06	4.140E+06	.69
48.0	2.469E+07	96.0	.0	71.7	71.7	1.283E+08	Trn A	7.800E+06	4.140E+06	.69
49.0	2.459E+07	96.0	.0	71.7	71.7	1.275E+08	Trn A	7.800E+06	4.140E+06	.69
50.0	2.449E+07	96.0	.0	71.7	71.7	1.268E+08	Trn A	7.800E+06	4.140E+06	.69
51.0	2.439E+07	95.9	.0	71.7	71.7	1.260E+08	Trn A	7.800E+06	4.140E+06	.69
52.0	2.429E+07	95.9	.0	71.7	71.7	1.252E+08	Trn A	7.800E+06	4.140E+06	.69
53.0	2.419E+07	95.8	.0	71.7	71.7	1.245E+08	Trn A	7.800E+06	4.140E+06	.69
54.0	2.409E+07	95.8	.0	71.7	71.7	1.237E+08	Trn A	7.800E+06	4.140E+06	.69
55.0	2.399E+07	95.7	.0	71.7	71.7	1.229E+08	Trn A	7.800E+06	4.140E+06	.69
56.0	2.389E+07	95.6	.0	71.7	71.7	1.222E+08	Trn A	7.800E+06	4.140E+06	.69
57.0	2.379E+07	95.6	.0	71.7	71.7	1.214E+08	Trn A	7.800E+06	4.140E+06	.69
58.0	2.369E+07	95.5	.0	71.7	71.7	1.207E+08	Trn A	7.800E+06	4.140E+06	.69
59.0	2.360E+07	95.4	.0	71.7	71.7	1.199E+08	Trn A	7.800E+06	4.140E+06	.69
60.0	2.350E+07	95.3	.0	71.7	71.7	1.191E+08	Trn A	7.800E+06	4.140E+06	.69
61.0	2.341E+07	95.3	.0	71.7	71.7	1.184E+08	Trn A	7.800E+06	4.140E+06	.69
62.0	2.331E+07	95.2	.0	71.7	71.7	1.176E+08	Trn A	7.800E+06	4.140E+06	.69
63.0	2.322E+07	95.1	.0	71.7	71.7	1.169E+08	Trn A	7.800E+06	4.140E+06	.69
64.0	2.312E+07	95.0	.0	71.7	71.7	1.161E+08	Trn A	7.800E+06	4.140E+06	.69
65.0	2.303E+07	94.9	.0	71.7	71.7	1.153E+08	Trn A	7.800E+06	4.140E+06	.69

Vogtle UHS 1-train 2-Fan Case w/ 70F ini. basin temp. (X4C1202V70 ver4)

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
66.0	2.294E+07	94.9	.0	71.7	71.7	1.146E+08	Trn A	7.800E+06	4.140E+06	.69
67.0	2.285E+07	94.8	.0	71.7	71.7	1.138E+08	Trn A	7.800E+06	4.140E+06	.69
68.0	2.276E+07	94.7	.0	71.7	71.7	1.130E+08	Trn A	7.800E+06	4.140E+06	.69
69.0	2.267E+07	94.6	.0	71.7	71.7	1.123E+08	Trn A	7.800E+06	4.140E+06	.69
70.0	2.258E+07	94.5	.0	71.7	71.7	1.115E+08	Trn A	7.800E+06	4.140E+06	.69
71.0	2.249E+07	94.4	.0	71.7	71.7	1.108E+08	Trn A	7.800E+06	4.140E+06	.69
72.0	2.240E+07	94.3	.0	71.7	71.7	1.100E+08	Trn A	7.800E+06	4.140E+06	.69

Stop - Program terminated.

7. UHSSIM input/output for *Fan2N_65F*, 2-Fan Case with IBT of 65 °F

Fan2N_65F.inp

```
Vogtle UHS 1-train 2-Fan Case w/ 65F ini. basin temp. (X4C1202V70 ver4)
# ------------------------------------------------------------------------------
# Mixed C/T model of 2 operable (full speed) and 2 failure fans w/ natural draft
# initial basin temp. = 65 F, Max basin temp. < 97 F
# PDAP C/T characteristics KaV/L = 0.69 per tower performance data X4C1202V70 V2
# C/T bounding heat load for 1-train LOSP per Appendix AA of X4C1205V04 V2 (MUR)
# HL 0 - 4 hr determined by remove RHR HL
# HL beyond Hr-36 are extrapolated to Hr-72.
# 72 hr UHSSIM run time (Hr-0 - Hr-72)
# ------------------------------------------------------------------------------
# design wet-bulb temperature [F], design dry-bulb temperature [F],
# design hot-water temperature [F], design pressure [psia], design solids [ppt]
# 0 => F, psia, btu/hr, lbm/hr units
82, 95, 129.0, 14.696, 0.0, 0
# initial basin mass [lbm], initial basin temperature [F], initial solids [ppt],
# number of towers, starting time of simulation [hr]
29843200, 65, 0, 1, 0.
# Time Period Data -- every 1 hr between the 0th hr and the 72nd hr after LOSP
# step size, number of steps
1,72
*
# Tower Operating Data
# 5 character tower ID
# time [hr], water flow rate [lbm/hr], air flow rate [lbm/hr], KaV/L
# Train A
Trn A
0.0,7.80e6,4.14e6,0.69
72.0,7.80e6,4.14e6,0.69
*
# Heat Rejection Data
# time, time units (s = second, h = hour, d = day), plant heat
# rejection [btu/hr]
0h,    0.8362E+08
1h,    0.8137E+08
2h,    0.7912E+08
3h,    0.7687E+08
3.9999h, 0.7462E+08
4h,    2.5782E+08
5h,    2.4283E+08
6h,    2.3455E+08
7h,    2.2896E+08
8h,    2.1036E+08
9h,    1.9697E+08
10h,   1.8700E+08
11h,   1.7951E+08
12h,   1.7374E+08
13h,   1.6903E+08
14h,   1.6522E+08
15h,   1.6203E+08
16h,   1.5931E+08
17h,   1.5696E+08
18h,   1.5499E+08
19h,   1.5323E+08
20h,   1.5164E+08
21h,   1.5020E+08
22h,   1.4890E+08
23h,   1.4785E+08
24h,   1.4675E+08
25h,   1.4579E+08
26h,   1.4482E+08
27h,   1.4384E+08
28h,   1.4301E+08
29h,   1.4216E+08
30h,   1.4149E+08
31h,   1.4052E+08
32h,   1.3940E+08
33h,   1.3901E+08
34h,   1.3875E+08
35h,   1.3819E+08
36h,   1.3742E+08
72h,   1.1E+08
*
#  TIME    WB       DB       P
#  (hr)    (F)      (F)      (psia)
     0,    72.1,    72.1,    14.7
    72,    72.1,    72.1,    14.7
```

Fan2N_65F.out

Vogtle UHS 1-train 2-Fan Case w/ 65F ini. basin temp. (X4C1202V70 ver4)

Initial Basin Mass 2.984E+07 lbm
Initial Basin Temperature 65.0 F
Initial Basin Solids .0 ppt

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
.0	2.984E+07	65.0	.0	72.1	72.1	8.362E+07	Trn A	7.800E+06	4.140E+06	.69
1.0	2.983E+07	67.4	.0	72.1	72.1	8.137E+07	Trn A	7.800E+06	4.140E+06	.69
2.0	2.982E+07	69.5	.0	72.1	72.1	7.912E+07	Trn A	7.800E+06	4.140E+06	.69
3.0	2.981E+07	71.4	.0	72.1	72.1	7.687E+07	Trn A	7.800E+06	4.140E+06	.69
4.0	2.979E+07	73.1	.0	72.1	72.1	2.578E+08	Trn A	7.800E+06	4.140E+06	.69
5.0	2.970E+07	77.8	.0	72.1	72.1	2.428E+08	Trn A	7.800E+06	4.140E+06	.69
6.0	2.961E+07	81.8	.0	72.1	72.1	2.346E+08	Trn A	7.800E+06	4.140E+06	.69
7.0	2.950E+07	85.1	.0	72.1	72.1	2.290E+08	Trn A	7.800E+06	4.140E+06	.69
8.0	2.939E+07	87.7	.0	72.1	72.1	2.104E+08	Trn A	7.800E+06	4.140E+06	.69
9.0	2.927E+07	89.7	.0	72.1	72.1	1.970E+08	Trn A	7.800E+06	4.140E+06	.69
10.0	2.916E+07	91.4	.0	72.1	72.1	1.870E+08	Trn A	7.800E+06	4.140E+06	.69
11.0	2.904E+07	92.6	.0	72.1	72.1	1.795E+08	Trn A	7.800E+06	4.140E+06	.69
12.0	2.892E+07	93.7	.0	72.1	72.1	1.737E+08	Trn A	7.800E+06	4.140E+06	.69
13.0	2.880E+07	94.5	.0	72.1	72.1	1.690E+08	Trn A	7.800E+06	4.140E+06	.69
14.0	2.868E+07	95.1	.0	72.1	72.1	1.652E+08	Trn A	7.800E+06	4.140E+06	.69
15.0	2.856E+07	95.6	.0	72.1	72.1	1.620E+08	Trn A	7.800E+06	4.140E+06	.69
16.0	2.844E+07	96.0	.0	72.1	72.1	1.593E+08	Trn A	7.800E+06	4.140E+06	.69
17.0	2.832E+07	96.3	.0	72.1	72.1	1.570E+08	Trn A	7.800E+06	4.140E+06	.69
18.0	2.820E+07	96.5	.0	72.1	72.1	1.550E+08	Trn A	7.800E+06	4.140E+06	.69
19.0	2.808E+07	96.7	.0	72.1	72.1	1.532E+08	Trn A	7.800E+06	4.140E+06	.69
20.0	2.795E+07	96.8	.0	72.1	72.1	1.516E+08	Trn A	7.800E+06	4.140E+06	.69
21.0	2.783E+07	96.9	.0	72.1	72.1	1.502E+08	Trn A	7.800E+06	4.140E+06	.69
22.0	2.771E+07	97.0	.0	72.1	72.1	1.489E+08	Trn A	7.800E+06	4.140E+06	.69
23.0	2.759E+07	97.0	.0	72.1	72.1	1.479E+08	Trn A	7.800E+06	4.140E+06	.69
24.0	2.748E+07	97.0	.0	72.1	72.1	1.468E+08	Trn A	7.800E+06	4.140E+06	.69
25.0	2.736E+07	97.0	.0	72.1	72.1	1.458E+08	Trn A	7.800E+06	4.140E+06	.69
26.0	2.724E+07	97.0	.0	72.1	72.1	1.448E+08	Trn A	7.800E+06	4.140E+06	.69
27.0	2.712E+07	96.9	.0	72.1	72.1	1.438E+08	Trn A	7.800E+06	4.140E+06	.69
28.0	2.701E+07	96.9	.0	72.1	72.1	1.430E+08	Trn A	7.800E+06	4.140E+06	.69
29.0	2.689E+07	96.9	.0	72.1	72.1	1.422E+08	Trn A	7.800E+06	4.140E+06	.69
30.0	2.677E+07	96.8	.0	72.1	72.1	1.415E+08	Trn A	7.800E+06	4.140E+06	.69

Vogtle UHS 1-train 2-Fan Case w/ 65F ini. basin temp. (X4C1202V70 ver4)

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
31.0	2.666E+07	96.7	.0	72.1	72.1	1.405E+08	Trn A	7.800E+06	4.140E+06	.69
32.0	2.654E+07	96.7	.0	72.1	72.1	1.394E+08	Trn A	7.800E+06	4.140E+06	.69
33.0	2.643E+07	96.6	.0	72.1	72.1	1.390E+08	Trn A	7.800E+06	4.140E+06	.69
34.0	2.632E+07	96.6	.0	72.1	72.1	1.388E+08	Trn A	7.800E+06	4.140E+06	.69
35.0	2.620E+07	96.5	.0	72.1	72.1	1.382E+08	Trn A	7.800E+06	4.140E+06	.69
36.0	2.609E+07	96.4	.0	72.1	72.1	1.374E+08	Trn A	7.800E+06	4.140E+06	.69
37.0	2.598E+07	96.4	.0	72.1	72.1	1.367E+08	Trn A	7.800E+06	4.140E+06	.69
38.0	2.587E+07	96.3	.0	72.1	72.1	1.359E+08	Trn A	7.800E+06	4.140E+06	.69
39.0	2.576E+07	96.2	.0	72.1	72.1	1.351E+08	Trn A	7.800E+06	4.140E+06	.69
40.0	2.565E+07	96.2	.0	72.1	72.1	1.344E+08	Trn A	7.800E+06	4.140E+06	.69
41.0	2.554E+07	96.1	.0	72.1	72.1	1.336E+08	Trn A	7.800E+06	4.140E+06	.69
42.0	2.543E+07	96.0	.0	72.1	72.1	1.329E+08	Trn A	7.800E+06	4.140E+06	.69
43.0	2.532E+07	96.0	.0	72.1	72.1	1.321E+08	Trn A	7.800E+06	4.140E+06	.69
44.0	2.522E+07	96.0	.0	72.1	72.1	1.313E+08	Trn A	7.800E+06	4.140E+06	.69
45.0	2.511E+07	95.9	.0	72.1	72.1	1.306E+08	Trn A	7.800E+06	4.140E+06	.69
46.0	2.501E+07	96.0	.0	72.1	72.1	1.298E+08	Trn A	7.800E+06	4.140E+06	.69
47.0	2.491E+07	96.0	.0	72.1	72.1	1.290E+08	Trn A	7.800E+06	4.140E+06	.69
48.0	2.481E+07	96.1	.0	72.1	72.1	1.283E+08	Trn A	7.800E+06	4.140E+06	.69
49.0	2.471E+07	96.1	.0	72.1	72.1	1.275E+08	Trn A	7.800E+06	4.140E+06	.69
50.0	2.460E+07	96.1	.0	72.1	72.1	1.268E+08	Trn A	7.800E+06	4.140E+06	.69
51.0	2.450E+07	96.0	.0	72.1	72.1	1.260E+08	Trn A	7.800E+06	4.140E+06	.69
52.0	2.440E+07	96.0	.0	72.1	72.1	1.252E+08	Trn A	7.800E+06	4.140E+06	.69
53.0	2.430E+07	96.0	.0	72.1	72.1	1.245E+08	Trn A	7.800E+06	4.140E+06	.69
54.0	2.420E+07	95.9	.0	72.1	72.1	1.237E+08	Trn A	7.800E+06	4.140E+06	.69
55.0	2.410E+07	95.9	.0	72.1	72.1	1.229E+08	Trn A	7.800E+06	4.140E+06	.69
56.0	2.401E+07	95.8	.0	72.1	72.1	1.222E+08	Trn A	7.800E+06	4.140E+06	.69
57.0	2.391E+07	95.7	.0	72.1	72.1	1.214E+08	Trn A	7.800E+06	4.140E+06	.69
58.0	2.381E+07	95.7	.0	72.1	72.1	1.207E+08	Trn A	7.800E+06	4.140E+06	.69
59.0	2.371E+07	95.6	.0	72.1	72.1	1.199E+08	Trn A	7.800E+06	4.140E+06	.69
60.0	2.362E+07	95.5	.0	72.1	72.1	1.191E+08	Trn A	7.800E+06	4.140E+06	.69
61.0	2.352E+07	95.5	.0	72.1	72.1	1.184E+08	Trn A	7.800E+06	4.140E+06	.69
62.0	2.343E+07	95.4	.0	72.1	72.1	1.176E+08	Trn A	7.800E+06	4.140E+06	.69
63.0	2.333E+07	95.3	.0	72.1	72.1	1.169E+08	Trn A	7.800E+06	4.140E+06	.69
64.0	2.324E+07	95.2	.0	72.1	72.1	1.161E+08	Trn A	7.800E+06	4.140E+06	.69
65.0	2.315E+07	95.1	.0	72.1	72.1	1.153E+08	Trn A	7.800E+06	4.140E+06	.69

Vogtle UHS 1-train 2-Fan Case w/ 65F ini. basin temp. (X4C1202V70 ver4)

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load (btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
66.0	2.306E+07	95.0	.0	72.1	72.1	1.146E+08	Trn A	7.800E+06	4.140E+06	.69
67.0	2.296E+07	95.0	.0	72.1	72.1	1.138E+08	Trn A	7.800E+06	4.140E+06	.69
68.0	2.287E+07	94.9	.0	72.1	72.1	1.130E+08	Trn A	7.800E+06	4.140E+06	.69
69.0	2.278E+07	94.8	.0	72.1	72.1	1.123E+08	Trn A	7.800E+06	4.140E+06	.69
70.0	2.269E+07	94.7	.0	72.1	72.1	1.115E+08	Trn A	7.800E+06	4.140E+06	.69
71.0	2.260E+07	94.6	.0	72.1	72.1	1.108E+08	Trn A	7.800E+06	4.140E+06	.69
72.0	2.252E+07	94.5	.0	72.1	72.1	1.100E+08	Trn A	7.800E+06	4.140E+06	.69

Stop - Program terminated.

ATTACHMENT 5
3-Fan Case PDAP/UHSSIM Runs

Attachment 5 Table of Contents **Page No.**

1. PDAP input/output for *pdap3-1*, C/T characteristics for 3-Fan Case

Pdap3-1.inp

```
#Vogtle C/T Performance Data Per X4C1202V70, Ver 2
#original water flow rate & 3 fan operation
#100% water flow rate = 15,600 gpm = 7.8e6 lbm/hr
#air flow rate = 3 * 2,071,121 lbm/hr = 6.21e6 lbm/hr
#original design point: twb = 82 F, tdb = 95 F, tw = 129 F
7.8e6, 6.21e6, 0.0, 14.696, 82, 95, 129, 0, 13.0
8.5, 65, 75.8
8.5, 70, 79.5
8.5, 75, 83.2
8.5, 80, 87.3
8.5, 85, 91.1
15.0, 65, 82
15.0, 70, 85
15.0, 75, 88.3
15.0, 80, 91.8
15.0, 85, 95.1
25.0, 65, 89.1
25.0, 70, 91.6
25.0, 75, 94.1
25.0, 80, 97
25.0, 85, 100
37.4, 65, 95
37.4, 70, 97
37.4, 75, 99.1
37.4, 80, 101.4
37.4, 85, 104
```

Pdap3-1.out

```
#Vogtle C/T Performance Data Per X4C1202V70, Ver 2
#original water flow rate & 3 fan operation
#100% water flow rate = 15,600 gpm = 7.8e6 lbm/hr
#air flow rate = 3 * 2,071,121 lbm/hr = 6.21e6 lbm/hr
#original design point: twb = 82 F, tdb = 95 F, tw = 129 F
7.8e6, 6.21e6, 0.0, 14.696, 82, 95, 129, 0, 13.0
8.5, 65, 75.8
8.5, 70, 79.5
8.5, 75, 83.2
8.5, 80, 87.3
8.5, 85, 91.1
15.0, 65, 82
15.0, 70, 85
15.0, 75, 88.3
15.0, 80, 91.8
15.0, 85, 95.1
25.0, 65, 89.1
25.0, 70, 91.6
25.0, 75, 94.1
25.0, 80, 97
25.0, 85, 100
37.4, 65, 95
37.4, 70, 97
37.4, 75, 99.1
37.4, 80, 101.4
37.4, 85, 104
#KaV/L =      .86
#results: range, wb, hot, cold, cold-predicted, difference
#        8.5       65.0       84.3       75.8       76.4         .6
#        8.5       70.0       88.0       79.5       80.1         .6
#        8.5       75.0       91.7       83.2       83.8         .6
#        8.5       80.0       95.8       87.3       87.8         .5
#        8.5       85.0       99.6       91.1       91.7         .6
#       15.0       65.0       97.0       82.0       82.8         .8
#       15.0       70.0      100.0       85.0       86.0        1.0
#       15.0       75.0      103.3       88.3       89.1         .8
#       15.0       80.0      106.8       91.8       92.2         .4
#       15.0       85.0      110.1       95.1       95.5         .4
#       25.0       65.0      114.1       89.1       89.6         .5
#       25.0       70.0      116.6       91.6       91.9         .3
#       25.0       75.0      119.1       94.1       94.4         .3
#       25.0       80.0      122.0       97.0       97.1         .1
#       25.0       85.0      125.0      100.0       99.9        -.1
#       37.4       65.0      132.4       95.0       94.8        -.2
#       37.4       70.0      134.4       97.0       96.7        -.3
#       37.4       75.0      136.5       99.1       98.7        -.4
#       37.4       80.0      138.8      101.4      100.9        -.5
#       37.4       85.0      141.4      104.0      103.3        -.7
Stop - Program terminated.
```

2. UHSSIM input/output for *Fan3N_90F*, 3-Fan Case with IBT of 90 °F

Fan3N_90F.inp

```
Vogtle UHS 1-train 3-Fan Case w/ 90F ini. basin temp. (X4C1202V70 ver4)
# ------------------------------------------------------------------------------
# Mixed C/T model of 3 operable (full speed) and 1 failure fans w/ natural draft
# initial basin temp. = 90 F, Max basin temp. < 97 F
# PDAP C/T characteristics KaV/L = 0.86 per tower performance data X4C1202V70 V2
# C/T bounding heat load for 1-train LOSP per Appendix AA of X4C1205V04 V2 (MUR)
# HL 0 - 4 hr determined by remove RHR HL
# HL beyond Hr-36 are extrapolated to Hr-72.
# 72 hr UHSSIM run time (Hr-0 - Hr-72)
# ------------------------------------------------------------------------------
# design wet-bulb temperature [F], design dry-bulb temperature [F],
# design hot-water temperature [F], design pressure [psia], design solids [ppt]
# 0 => F, psia, btu/hr, lbm/hr units
82, 95, 129.0, 14.696, 0.0, 0
# initial basin mass [lbm], initial basin temperature [F], initial solids [ppt],
# number of towers, starting time of simulation [hr]
29843200, 90, 0, 1, 0.
# Time Period Data -- every 1 hr between the 0th hr and the 72nd hr after LOSP
# step size, number of steps
1,72
*
# Tower Operating Data
# 5 character tower ID
# time [hr], water flow rate [lbm/hr], air flow rate [lbm/hr], KaV/L
# Train A
Trn A
0.0,7.80e6,6.21e6,0.86
72.0,7.80e6,6.21e6,0.86
*
# Heat Rejection Data
# time, time units (s = second, h = hour, d = day), plant heat
# rejection [btu/hr]
0h,    0.8362E+08
1h,    0.8137E+08
2h,    0.7912E+08
3h,    0.7687E+08
3.9999h, 0.7462E+08
4h,    2.5782E+08
5h,    2.4283E+08
6h,    2.3455E+08
7h,    2.2896E+08
8h,    2.1036E+08
9h,    1.9697E+08
10h,   1.8700E+08
11h,   1.7951E+08
12h,   1.7374E+08
13h,   1.6903E+08
14h,   1.6522E+08
15h,   1.6203E+08
16h,   1.5931E+08
17h,   1.5696E+08
18h,   1.5499E+08
19h,   1.5323E+08
20h,   1.5164E+08
21h,   1.5020E+08
22h,   1.4890E+08
23h,   1.4785E+08
24h,   1.4675E+08
25h,   1.4579E+08
26h,   1.4482E+08
27h,   1.4384E+08
28h,   1.4301E+08
29h,   1.4216E+08
30h,   1.4149E+08
31h,   1.4052E+08
32h,   1.3940E+08
33h,   1.3901E+08
34h,   1.3875E+08
35h,   1.3819E+08
36h,   1.3742E+08
72h,   1.1E+08
*
#  TIME    WB       DB       P
#  (hr)    (F)      (F)      (psia)
     0,    82.0,    82.0,    14.7
    72,    82.0,    82.0,    14.7
```

Fan3N_90F.out

Vogtle UHS 1-train 3-Fan Case w/ 90F ini. basin temp. (X4C1202V70 ver4)

Initial Basin Mass 2.984E+07 lbm
Initial Basin Temperature 90.0 F
Initial Basin Solids .0 ppt

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
.0	2.984E+07	90.0	.0	82.0	82.0	8.362E+07	Trn A	7.800E+06	6.210E+06	.86
1.0	2.978E+07	90.2	.0	82.0	82.0	8.137E+07	Trn A	7.800E+06	6.210E+06	.86
2.0	2.972E+07	90.3	.0	82.0	82.0	7.912E+07	Trn A	7.800E+06	6.210E+06	.86
3.0	2.966E+07	90.4	.0	82.0	82.0	7.687E+07	Trn A	7.800E+06	6.210E+06	.86
4.0	2.960E+07	90.4	.0	82.0	82.0	2.578E+08	Trn A	7.800E+06	6.210E+06	.86
5.0	2.944E+07	92.3	.0	82.0	82.0	2.428E+08	Trn A	7.800E+06	6.210E+06	.86
6.0	2.927E+07	93.7	.0	82.0	82.0	2.346E+08	Trn A	7.800E+06	6.210E+06	.86
7.0	2.910E+07	94.8	.0	82.0	82.0	2.290E+08	Trn A	7.800E+06	6.210E+06	.86
8.0	2.894E+07	95.6	.0	82.0	82.0	2.104E+08	Trn A	7.800E+06	6.210E+06	.86
9.0	2.878E+07	96.2	.0	82.0	82.0	1.970E+08	Trn A	7.800E+06	6.210E+06	.86
10.0	2.863E+07	96.5	.0	82.0	82.0	1.870E+08	Trn A	7.800E+06	6.210E+06	.86
11.0	2.848E+07	96.8	.0	82.0	82.0	1.795E+08	Trn A	7.800E+06	6.210E+06	.86
12.0	2.833E+07	96.9	.0	82.0	82.0	1.737E+08	Trn A	7.800E+06	6.210E+06	.86
13.0	2.819E+07	97.0	.0	82.0	82.0	1.690E+08	Trn A	7.800E+06	6.210E+06	.86
14.0	2.805E+07	97.0	.0	82.0	82.0	1.652E+08	Trn A	7.800E+06	6.210E+06	.86
15.0	2.792E+07	96.9	.0	82.0	82.0	1.620E+08	Trn A	7.800E+06	6.210E+06	.86
16.0	2.778E+07	96.9	.0	82.0	82.0	1.593E+08	Trn A	7.800E+06	6.210E+06	.86
17.0	2.765E+07	96.8	.0	82.0	82.0	1.570E+08	Trn A	7.800E+06	6.210E+06	.86
18.0	2.752E+07	96.8	.0	82.0	82.0	1.550E+08	Trn A	7.800E+06	6.210E+06	.86
19.0	2.739E+07	96.7	.0	82.0	82.0	1.532E+08	Trn A	7.800E+06	6.210E+06	.86
20.0	2.726E+07	96.6	.0	82.0	82.0	1.516E+08	Trn A	7.800E+06	6.210E+06	.86
21.0	2.713E+07	96.5	.0	82.0	82.0	1.502E+08	Trn A	7.800E+06	6.210E+06	.86
22.0	2.701E+07	96.4	.0	82.0	82.0	1.489E+08	Trn A	7.800E+06	6.210E+06	.86
23.0	2.688E+07	96.3	.0	82.0	82.0	1.479E+08	Trn A	7.800E+06	6.210E+06	.86
24.0	2.676E+07	96.3	.0	82.0	82.0	1.468E+08	Trn A	7.800E+06	6.210E+06	.86
25.0	2.663E+07	96.2	.0	82.0	82.0	1.458E+08	Trn A	7.800E+06	6.210E+06	.86
26.0	2.651E+07	96.1	.0	82.0	82.0	1.448E+08	Trn A	7.800E+06	6.210E+06	.86
27.0	2.639E+07	96.1	.0	82.0	82.0	1.438E+08	Trn A	7.800E+06	6.210E+06	.86
28.0	2.627E+07	96.0	.0	82.0	82.0	1.430E+08	Trn A	7.800E+06	6.210E+06	.86
29.0	2.615E+07	95.9	.0	82.0	82.0	1.422E+08	Trn A	7.800E+06	6.210E+06	.86
30.0	2.603E+07	95.9	.0	82.0	82.0	1.415E+08	Trn A	7.800E+06	6.210E+06	.86

Vogtle UHS 1-train 3-Fan Case w/ 90F ini. basin temp. (X4C1202V70 ver4)

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
31.0	2.592E+07	95.8	.0	82.0	82.0	1.405E+08	Trn A	7.800E+06	6.210E+06	.86
32.0	2.580E+07	95.7	.0	82.0	82.0	1.394E+08	Trn A	7.800E+06	6.210E+06	.86
33.0	2.568E+07	95.7	.0	82.0	82.0	1.390E+08	Trn A	7.800E+06	6.210E+06	.86
34.0	2.557E+07	95.6	.0	82.0	82.0	1.388E+08	Trn A	7.800E+06	6.210E+06	.86
35.0	2.545E+07	95.6	.0	82.0	82.0	1.382E+08	Trn A	7.800E+06	6.210E+06	.86
36.0	2.534E+07	95.5	.0	82.0	82.0	1.374E+08	Trn A	7.800E+06	6.210E+06	.86
37.0	2.523E+07	95.5	.0	82.0	82.0	1.367E+08	Trn A	7.800E+06	6.210E+06	.86
38.0	2.511E+07	95.4	.0	82.0	82.0	1.359E+08	Trn A	7.800E+06	6.210E+06	.86
39.0	2.500E+07	95.4	.0	82.0	82.0	1.351E+08	Trn A	7.800E+06	6.210E+06	.86
40.0	2.489E+07	95.3	.0	82.0	82.0	1.344E+08	Trn A	7.800E+06	6.210E+06	.86
41.0	2.478E+07	95.3	.0	82.0	82.0	1.336E+08	Trn A	7.800E+06	6.210E+06	.86
42.0	2.467E+07	95.2	.0	82.0	82.0	1.329E+08	Trn A	7.800E+06	6.210E+06	.86
43.0	2.456E+07	95.2	.0	82.0	82.0	1.321E+08	Trn A	7.800E+06	6.210E+06	.86
44.0	2.445E+07	95.1	.0	82.0	82.0	1.313E+08	Trn A	7.800E+06	6.210E+06	.86
45.0	2.434E+07	95.1	.0	82.0	82.0	1.306E+08	Trn A	7.800E+06	6.210E+06	.86
46.0	2.423E+07	95.0	.0	82.0	82.0	1.298E+08	Trn A	7.800E+06	6.210E+06	.86
47.0	2.412E+07	95.0	.0	82.0	82.0	1.290E+08	Trn A	7.800E+06	6.210E+06	.86
48.0	2.402E+07	94.9	.0	82.0	82.0	1.283E+08	Trn A	7.800E+06	6.210E+06	.86
49.0	2.391E+07	94.9	.0	82.0	82.0	1.275E+08	Trn A	7.800E+06	6.210E+06	.86
50.0	2.381E+07	94.8	.0	82.0	82.0	1.268E+08	Trn A	7.800E+06	6.210E+06	.86
51.0	2.370E+07	94.8	.0	82.0	82.0	1.260E+08	Trn A	7.800E+06	6.210E+06	.86
52.0	2.360E+07	94.7	.0	82.0	82.0	1.252E+08	Trn A	7.800E+06	6.210E+06	.86
53.0	2.349E+07	94.7	.0	82.0	82.0	1.245E+08	Trn A	7.800E+06	6.210E+06	.86
54.0	2.339E+07	94.6	.0	82.0	82.0	1.237E+08	Trn A	7.800E+06	6.210E+06	.86
55.0	2.329E+07	94.6	.0	82.0	82.0	1.229E+08	Trn A	7.800E+06	6.210E+06	.86
56.0	2.319E+07	94.5	.0	82.0	82.0	1.222E+08	Trn A	7.800E+06	6.210E+06	.86
57.0	2.309E+07	94.5	.0	82.0	82.0	1.214E+08	Trn A	7.800E+06	6.210E+06	.86
58.0	2.299E+07	94.4	.0	82.0	82.0	1.207E+08	Trn A	7.800E+06	6.210E+06	.86
59.0	2.289E+07	94.4	.0	82.0	82.0	1.199E+08	Trn A	7.800E+06	6.210E+06	.86
60.0	2.279E+07	94.3	.0	82.0	82.0	1.191E+08	Trn A	7.800E+06	6.210E+06	.86
61.0	2.269E+07	94.3	.0	82.0	82.0	1.184E+08	Trn A	7.800E+06	6.210E+06	.86
62.0	2.259E+07	94.2	.0	82.0	82.0	1.176E+08	Trn A	7.800E+06	6.210E+06	.86
63.0	2.250E+07	94.2	.0	82.0	82.0	1.169E+08	Trn A	7.800E+06	6.210E+06	.86
64.0	2.240E+07	94.1	.0	82.0	82.0	1.161E+08	Trn A	7.800E+06	6.210E+06	.86
65.0	2.231E+07	94.1	.0	82.0	82.0	1.153E+08	Trn A	7.800E+06	6.210E+06	.86

Vogtle UHS 1-train 3-Fan Case w/ 90F ini. basin temp. (X4C1202V70 ver4)

time [hr]	basin mass [lbm]	basin temp [F]	basin solids [ppt]	dry-bulb temp [F]	wet-bulb temp [F]	heat load [btu/hr]	tower	water flow rate [lbm/hr]	air flow rate [lbm/hr]	KaV/L [-]
66.0	2.221E+07	94.0	.0	82.0	82.0	1.146E+08	Trn A	7.800E+06	6.210E+06	.86
67.0	2.212E+07	94.0	.0	82.0	82.0	1.138E+08	Trn A	7.800E+06	6.210E+06	.86
68.0	2.202E+07	93.9	.0	82.0	82.0	1.130E+08	Trn A	7.800E+06	6.210E+06	.86
69.0	2.193E+07	93.9	.0	82.0	82.0	1.123E+08	Trn A	7.800E+06	6.210E+06	.86
70.0	2.184E+07	93.8	.0	82.0	82.0	1.115E+08	Trn A	7.800E+06	6.210E+06	.86
71.0	2.175E+07	93.7	.0	82.0	82.0	1.108E+08	Trn A	7.800E+06	6.210E+06	.86
72.0	2.166E+07	93.7	.0	82.0	82.0	1.100E+08	Trn A	7.800E+06	6.210E+06	.86

Stop - Program terminated.

Vogtle Electric Generating Plant – Units 1 and 2
Supplemental Response to NRC Request for Additional Information for License Amendment Request to Revise
Technical Specification 3.7.9 Ultimate Heat Sink (UHS)

Enclosure 3

New TS Figure 3.7.9-1

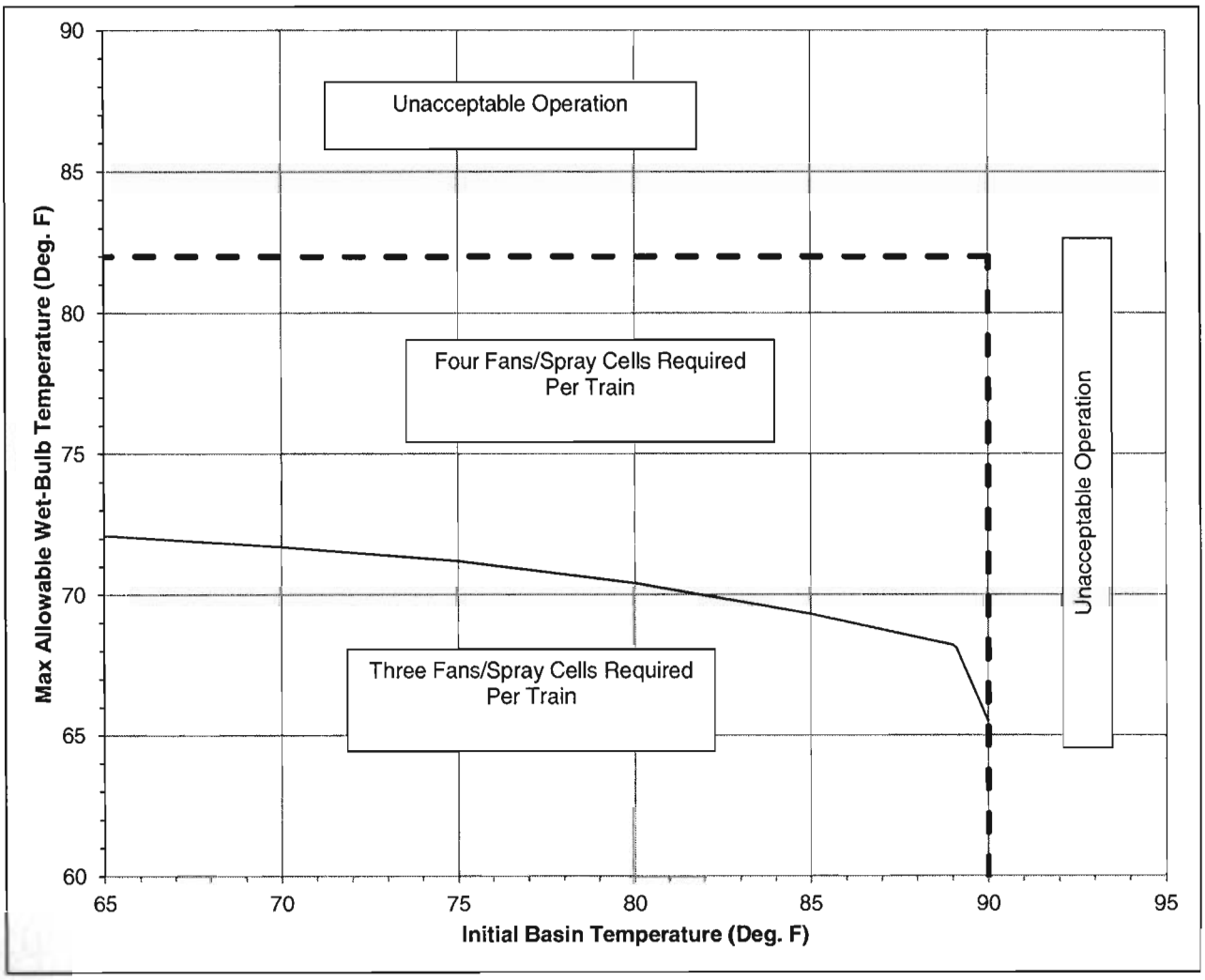


Figure 3.7.9-1
Required Number of Fans/Spray Cells