FirstEnergy

CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

☐ BV1	☐ BV2	☐ DB	☒ PY
ORIGINATOR/DATE	REVIEWER/DATE	DESIGN VERIFIER/DATE	APPROVER/DATE
James E. Praser		David J. Godshalk	Tom O'Reilly

OBJECTIVE OR PURPOSE OF ADDENDUM:

This addendum contains two parts. The purpose of Part 1 to this Addendum is to evaluate the temperature response in the Turbine Building to a new limiting Main Steam leak of 32.90 Lb_m/sec. This evaluation is performed in line with the objective of Calculation 2.4.6.14. Conclusions will be based on whether the results meet the specified acceptance criteria in order that boundary dose limits are not exceeded.

The purpose of Part 2 to this Addendum is to evaluate the temperature response in the Turbine Building to a Main Steam leak after two temporary fans, each with a flowrate of 1000 cfm, have been installed to circulate air in the vicinity of temperature switches 1E31N0361A/B/C/D. This information will be compared to the results of PNPP Calculation 2.4.6.14 Rev. 0, as well as Part 1 of this Addendum, and will aid in evaluating the ability of this interim measure to eliminate the possibility of nuisance trips of the Turbine Building temperature switches (1E31N0361A/B/C/D) that trigger MSIV isolation.

SCOPE OF ADDENDUM:

The scope of Part 1 to this Addendum falls in line with the scope of Calculation 2.4.6.14. The only change made to the base analytical models was the mass flow rate of the leak.

The calculation results from Part 2 to this Addendum apply to operation of the fans during the summer months (June 1st - October 1st). The addition of the fans in the Turbine Building is a temporary modification that will be removed during RF10 (April, 2005).

SUMMARY OF RESULTS/CONCLUSIONS OF ADDENDUM:

Part 1

The analysis indicates that a steam leak rate of 32.90 Lbm/sec will result in elevated temperatures of 145°F and 160°F near the E31 thermocouples well within the acceptable time limit of 1 hr 11 min 46 sec.

Part 2

Comparing the results of the GOTHIC model, before and after the addition of the fans, reveals minor yet generally consistent effects. Beyond the special case of Summer Leak Location #1 (discussed further in the Conclusions section), the results are consistent in predicting that the fans will help to homogenize the volumes and decrease the time for detection. Even in the instance that the time required is increased, all of the detection times still remain well within the acceptance criteria.

LIMITATIONS OR RESTRICTIONS CREATED BY ADDENDUM:

N/A

IMPACT OF ADDENDUM ON OUTPUT DOCUMENTS:

N/A

DESCRIBE WHERE THE ADDENDUM HAS BEEN EVALUATED FOR 10CFR50.59 APPLICABILITY::

Refer to TM-1-03-011 and 10CFR50.59 Evaluation 03-00748.

LIST SUPPORTING DOCUMENTS:

The DIS and DIE's are part of TM-1-03-011.

FirstEnergy

CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01
TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks			

TABLE OF CONTENTS

FirstEnergy

CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

DOCUMENT INDEX

DIN No.	Document Number/Title	Revision, Edition, Date	Reference	Input	Output
1	GOTHIC Containment Analysis Package Users Manual	Version 7.0, July, 2001	☒	☐	☐
2	PNPP Temp Mod TM-1-03-011	-	☐	☒	☐
3	PNPP Calculation 2.4.6.15, “Main Steam Crack Flow in the Turbine Building”	Rev. 0	☐	☒	☐

FirstEnergy	CALCULATION ADDENDUM NOP-CC-3002-02 Rev. 00		
INITIATING DOCUMENT TM-1-03-011	CALCULATION NO. 2.4.6.14	CALCULATION REV. 0	ADDENDUM NO. A-01
TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks			

This Addendum was prepared in accordance with the methodology of Calculation 2.4.6.14. Therefore, review of this Addendum shall be done in association with Calculation 2.4.6.14.

Analysis Methodology

Part 1

The purpose of this part of the addendum is simply to provide additional Turbine Building temperature response data for the new limiting leak rate of 32.90 Lb_m/sec established in Calculation 2.4.6.15 Rev. 0 (DIN 3). Therefore, the analysis methodology used in Calculation 2.4.6.14 remains the same with the only difference being the leak flow rate (Boundary Condition 2F). Evaluations will also be performed, and subsequent results represented, in a manner consistent with the original calculation (Summer, Winter, and Average conditions at Leak Locations 1, 2, 3 for a total of nine (9) new scenarios).

Part 2

This part of the addendum evaluates the Turbine Building temperature response, after two (2) temporary fans have been installed to circulate air in the vicinity of temperature switches 1E31N0361A/B/C/D, using the GOTHIC computer code (Version 7.0) (DIN 1). Referring to the base calculation as well as Part 1 of this Addendum, the fans were added to the GOTHIC models that predict the highest and fastest temperature rise at the location of the thermocouples at the East end of the Turbine Building. The highest leak rate under Summer Conditions fits this criteria. However, the highest leak rate of 45.11 Lb_m/sec was not selected, because according to Calculation 2.4.6.15 Rev. 0 the limiting leak rate due to critical crack length is 32.90 Lb_m/sec. Therefore, the applicable "worst-case" scenarios being analyzed for this part of the addendum are the following:

- Summer Conditions, Leak Location #1, 32.90 Lb_m/sec
- Summer Conditions, Leak Location #2, 32.90 Lb_m/sec
- Summer Conditions, Leak Location #3, 32.90 Lb_m/sec

The basis and methodology of these original GOTHIC models is described thoroughly in PNPP Calculation 2.4.6.14 Rev. 0, as well as Part 1 to this Addendum.

In addition to the above three (3) scenarios, additional GOTHIC models were run under identical conditions (Summer Conditions, Leak Locations 1, 2, and 3) but with a leak rate of 19.68 Lb_m/sec. The purpose for analyzing these specific scenarios is two-fold. First, the analysis will provide sensitivity data on the effect of the fans as the leak rate decreases. Second, a leak rate of 19.68 Lb_m/sec meets the 10CFR100 site boundary dose limit criteria set forth in the base calculation that the total mass effluent from the steam line leak shall not exceed the total mass release from the main steam line break (141,687 Lb_m) within two hours.

Each evaluation will determine the time required to reach 145°F and 160°F at the location of temperature sensors 1E31N0361A/B/C/D. These results will be compared to those predicted in the absence of the two temporary fans. The E31 leak detection thermocouples are located on the East wall at column TB14, approximate Elevation 632-feet (GOTHIC sub-volume V7s15).

FirstEnergy

CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

A code-generated diagram in Attachment A indicates the basic layout of the Turbine Building GOTHIC model, showing the control volumes, the boundary conditions, the interconnecting flow paths, and the volumetric fans.

The GOTHIC model for this calculation analyzes the addition of two fans each blowing air at 1000 cfm through a hydraulic line. Each hydraulic line takes suction from the East end of the Turbine Building at Elevation 602 ft (GOTHIC sub-volume V7s9) and discharges air at the East end of the Turbine Building at Elevation 621 ft (GOTHIC sub-volume V7s15) up towards the E31 thermocouples (DIN 2). Refer to Attachment B for a sketch of the fan locations.

Control Volumes

Refer to the base calculation for information on how the Control Volumes were set up in the GOTHIC models. No changes were made to the control volumes for this addendum to the calculation.

Thermal Conductors

Refer to the base calculation for information on how thermal conductors were set up in the GOTHIC models. No changes were made to the thermal conductors for this addendum to the calculation.

Flow Paths (Junctions)

Refer to the base calculation for information on how the Flow Paths were set up in the GOTHIC models. The following additions were made for this addendum to the calculation:

Flow Paths 38 and 39 were added to represent the two hydraulic lines used to discharge air from the fans up towards the E31 thermocouples. Both flow paths connect sub-volume V7s9 to sub-volume V7s15. Suction is taken at Elevation 602 ft, and discharge is located at Elevation 621 ft. The hydraulic diameter is set equal to the 8-inch diameter of the round flex duct (DIN 2), and the corresponding flow cross-sectional area is set at .35 ft^2.

$$\text{Area} = \frac{\pi \times \text{Diameter}^2}{4} = .35\ \text{ft}^2$$

The inertia length of a GOTHIC flow path is the center-to-center distance between the connected volumes. For this application, since the flow velocities are relatively small for volume-to-volume flow, the flow path inertia length is approximated at 1 foot for each volume-to-volume connection. The flow path friction length is considered non-critical for this application and is set to 1 foot for all flow paths. The flow path friction length only becomes important when the model is concerned with buoyancy and thermally-induced flow. In this case, air movement is driven by forced convection (i.e. the fans).

FirstEnergy

CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Components

Two volumetric fans were added to the model, representing the temporary vane-axial ventilator fans being installed in the Turbine Building (DIN 2). One volumetric fan was placed on Flow Path 38, and the other was placed on Flow Path 39. They are both set to blow air at 1000 cfm (DIN 2), discharging just below the E31 thermocouples (sub-volume V7s15). Note that according to DIN 2, the estimated flow of 1000 cfm for each fan takes into account losses through the flex duct and grating.

Boundary Conditions

Refer to the base calculation for information on how the boundary conditions were set up in the GOTHIC models. Boundary Condition #2F is adjusted for each scenario in order to model the desired leak rate.

Initial Conditions

Refer to the base calculation for information on how the initial conditions were set up in the GOTHIC models. No changes were made to the initial conditions for this addendum to the calculation.

Turbine Building Thermal Characteristics

Refer to the base calculation for information on how the thermal characteristics were determined for the GOTHIC models. No changes were made to the Turbine Building thermal characteristics for this addendum to the calculation.

FirstEnergy	CALCULATION ADDENDUM NOP-CC-3002-02 Rev. 00		
INITIATING DOCUMENT TM-1-03-011	CALCULATION NO. 2.4.6.14	CALCULATION REV. 0	ADDENDUM NO. A-01
TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks			

Assumptions

Parts 1 and 2

1. All assumptions stated in PNPP Calculation 2.4.6.14 Rev. 0 apply to this calculation.

2. All other assumptions are stated within the calculation.

Acceptance Criteria

Parts 1 and 2

The temperature in the Turbine Building due to the 32.90 Lb_m/sec steam leak must reach the particular analytical limit (145°F or 160°F) in less than 1 hour 11 minutes 46 seconds.

The temperature in the Turbine Building due to the 19.68 Lb_m/sec steam leak must reach the particular analytical limit (145°F or 160°F) in less than 1 hour 59 minutes 59 seconds (2 hours).

Basis: The total mass effluent from the steam line leak shall not exceed the total mass release from the main steam line break (141,687 Lb_m). A leak rate that satisfies this criterion would ensure that the 10CFR100 site boundary dose limit is not exceeded.

Computation

Parts 1 and 2

The thermal response over a 24-hour period at the location of the temperature sensors and at the steam leak is calculated by the GOTHIC computer program. For calculation brevity, only one input deck is included in Attachment C representing the Summer – Leak #1 – 32.90 Lb_m/sec case. The required changes for all other cases are noted in the attachment. For further information on how GOTHIC performs its analysis, refer to the GOTHIC Users Manual (DIN 1).

FirstEnergy	CALCULATION ADDENDUM NOP-CC-3002-02 Rev. 00		
INITIATING DOCUMENT TM-1-03-011	CALCULATION NO. 2.4.6.14	CALCULATION REV. 0	ADDENDUM NO. A-01
TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks			

Results

Part 1

The resultant temperature graphs predict the temperature of the sub-volume that contains the E31 leak detection thermocouples (located on the east wall at TB14, approximate Elevation 632-feet, GOTHIC sub-volume V7s15[1]). Also shown is the sub-volume temperature at the leak location[2] if the leak location lies in a sub-volume different from the thermocouple sub-volume. The results over a 24-hour period for all cases are displayed below. A 24-hr period was analyzed in order to assure that steady-state temperatures were reached (the graphs confirm that this occurred). The following three summary items are listed below each graph.

- The maximum temperature realized at the location of the thermocouples, along with the time required to reach the maximum temperature.
- The time required to reach 145°F at the thermocouples.
- The time required to reach 160°F at the thermocouples.

A summary of the times required to reach 145°F and 160°F can be found in Tables 1 and 2, respectively, at the end of this section.[3]

Attachment D contains the output data from which the results were derived. Note that the data produced by GOTHIC covers the time period from t = 0 seconds to t = 90,000 seconds (25 hours). As mentioned in Calculation 2.4.6.14, the steam leak is delayed to t = 3600 seconds (1 hour) in order to allow the transient to steady. Therefore, times reported in the following results equal the output data minus 3600 seconds.

[1] The legend in the GOTHIC-produced graphs denote sub-volume names with a 'T' in front (e.g. TV7s15 is the same as V7s15).
[2] Leak Locations 1, 2, and 3 lie in sub-volumes V7s15, V7s11, and V7s12, respectively.
[3] Data points created by the GOTHIC analysis typically did not occur exactly at 145°F or 160°F. Consistent with Calculation 2.4.6.14, the data point was chosen that occurred at a time with a realized temperature closest to, but not less than, the target temperature (usually within a few tenths of a degree).

FirstEnergy

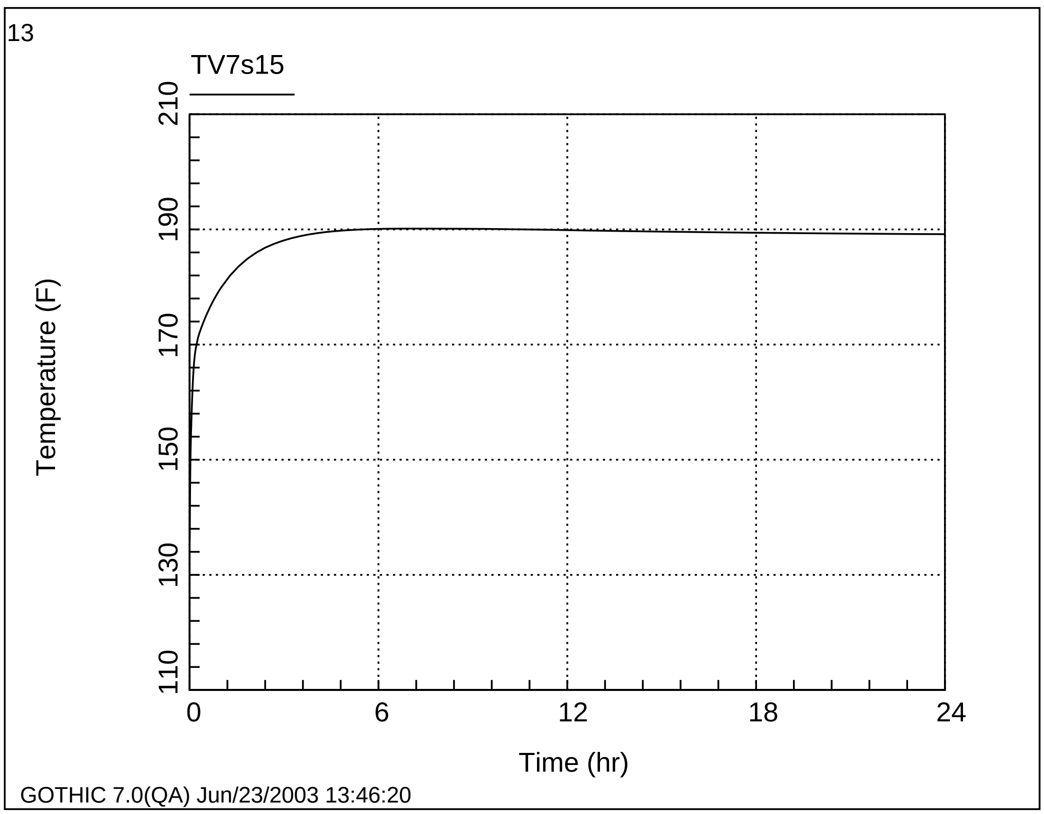
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 1 – Summer
32.90 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 190.1°F after 7 hrs 7 min 0 sec

Time required to reach 145°F – 59 sec

Time required to reach 160°F – 4 min 41 sec

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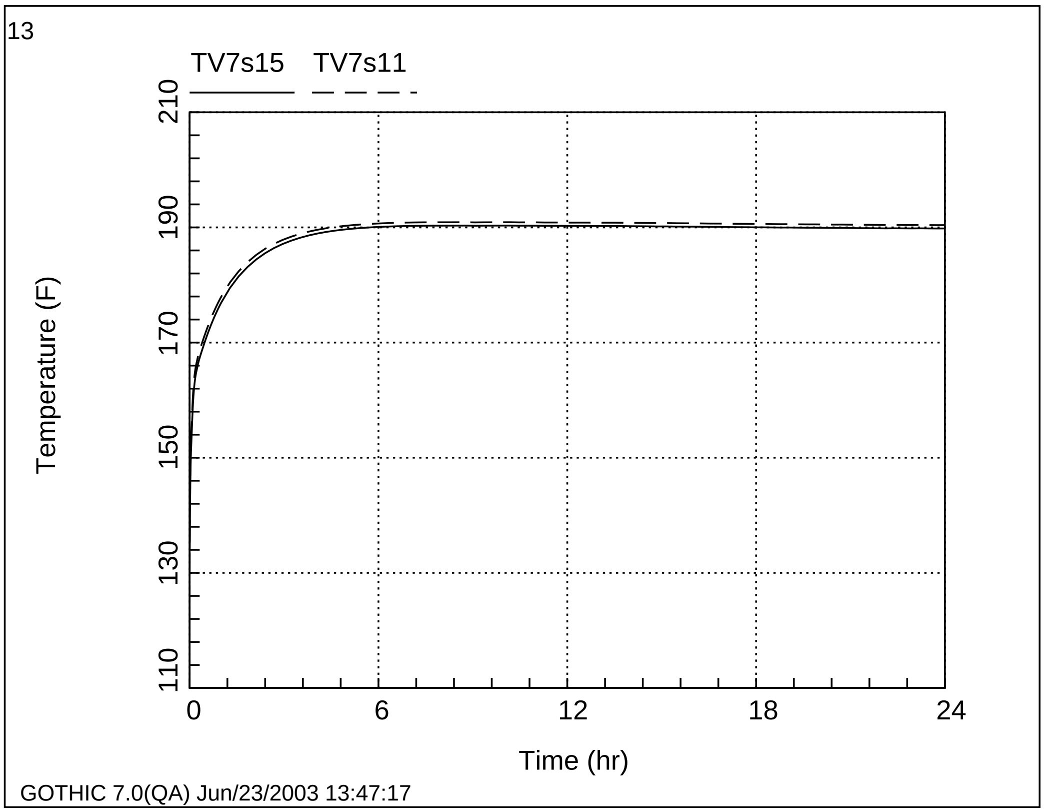
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 2 – Summer
32.90 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 190.3°F after 10 hrs 10 min 20 sec

Time required to reach 145°F – 1 min 19 sec

Time required to reach 160°F – 7 min 2 sec

FirstEnergy

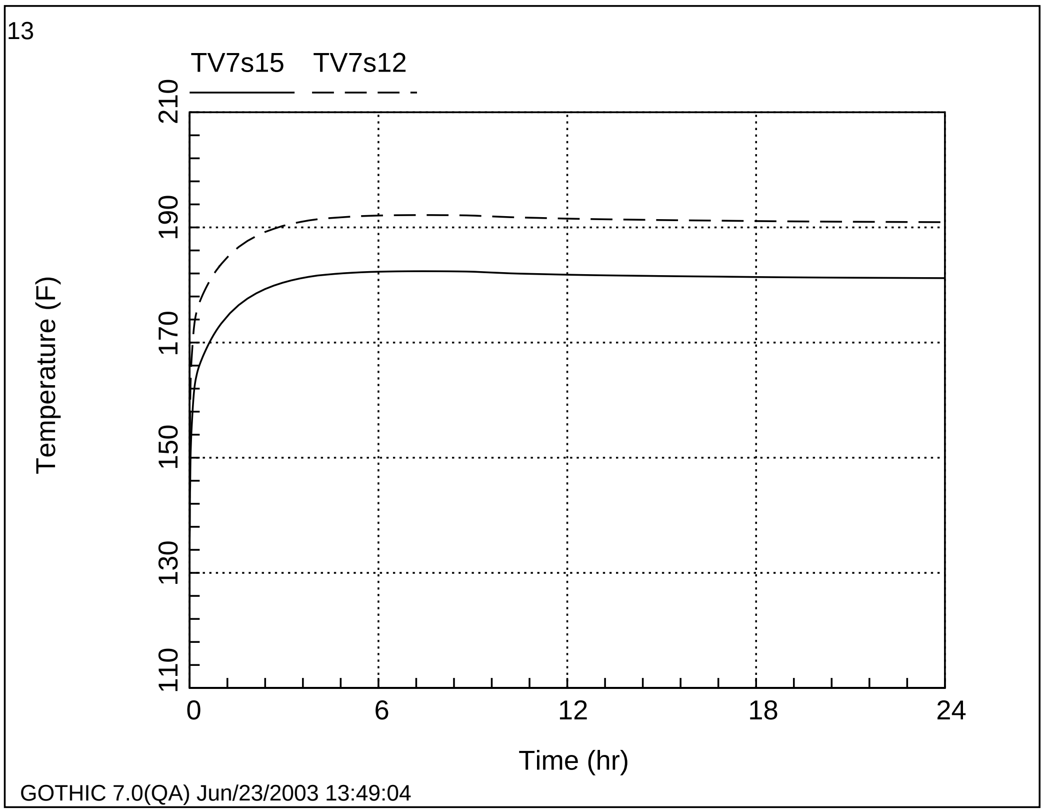
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 3 – Summer
32.90 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 182.4°F after 7 hrs 24 min 20 sec

Time required to reach 145°F – 1 min 3 sec

Time required to reach 160°F – 7 min 13 sec

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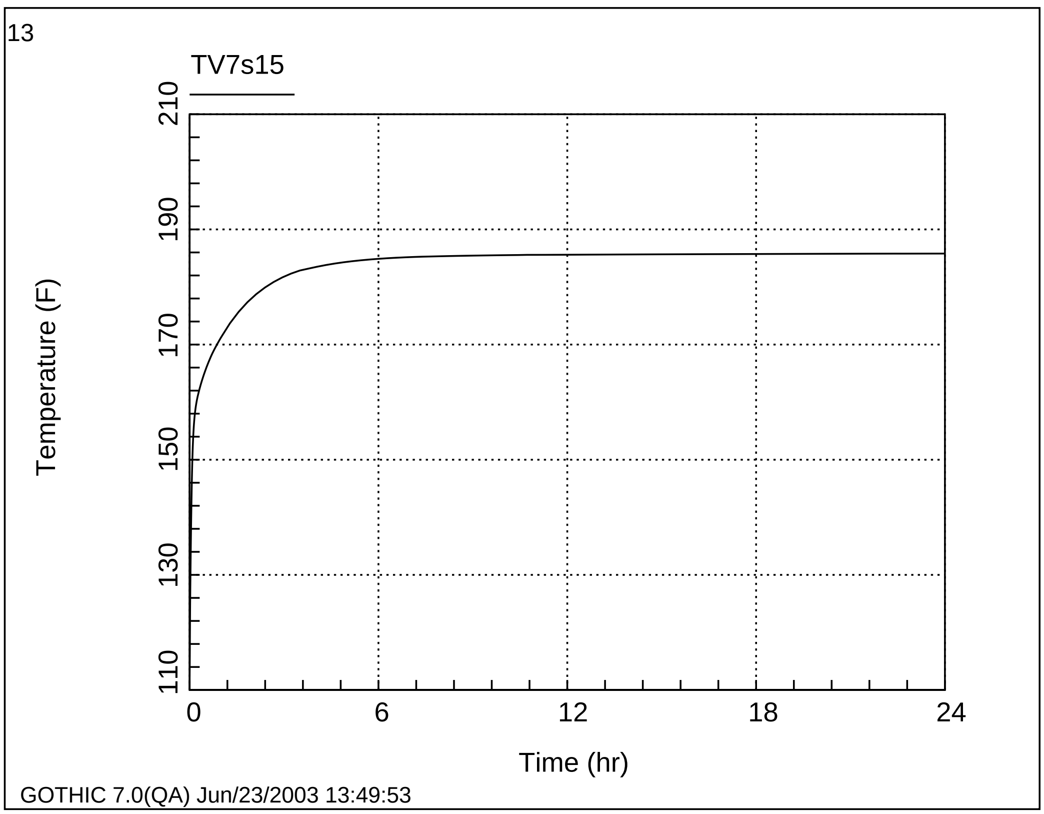
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 1 – Winter
32.90 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 185.8°F after 24 hrs 0 min 0 sec

Time required to reach 145°F – 4 min 3 sec

Time required to reach 160°F – 13 min 28 sec

FirstEnergy

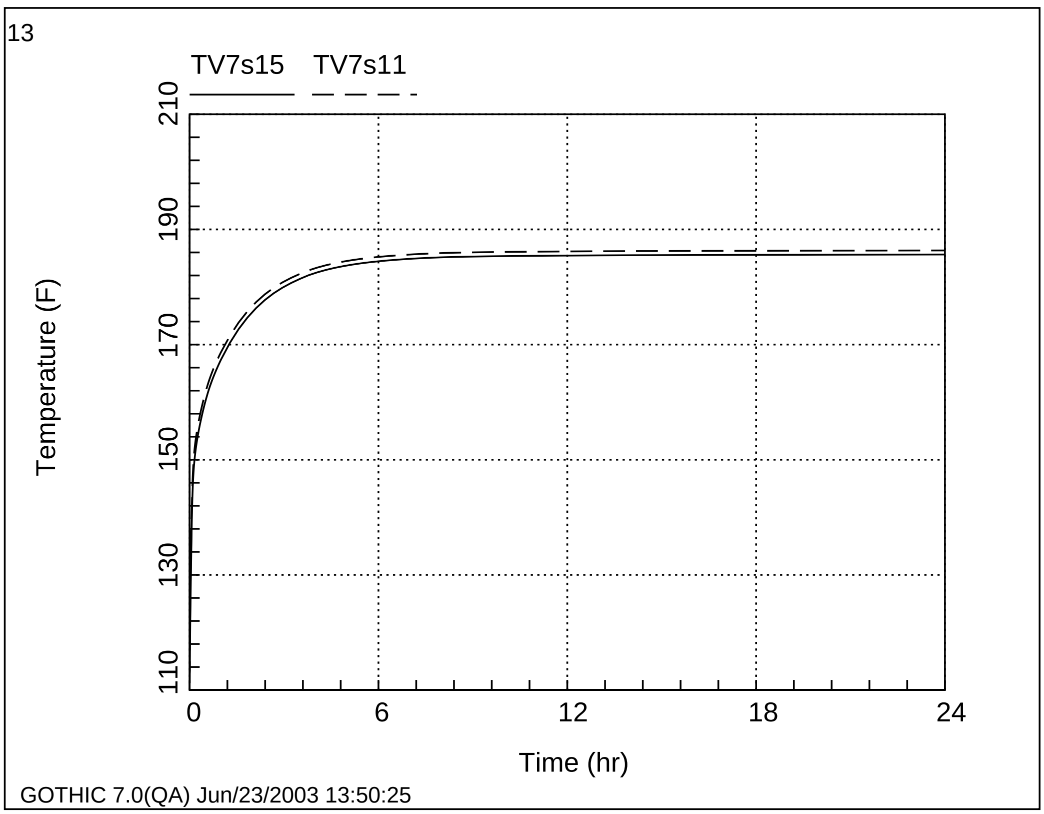
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 2 – Winter
32.90 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 185.6°F after 24 hrs 0 min 0 sec

Time required to reach 145°F – 6 min 6 sec

Time required to reach 160°F – 29 min 58 sec

FirstEnergy

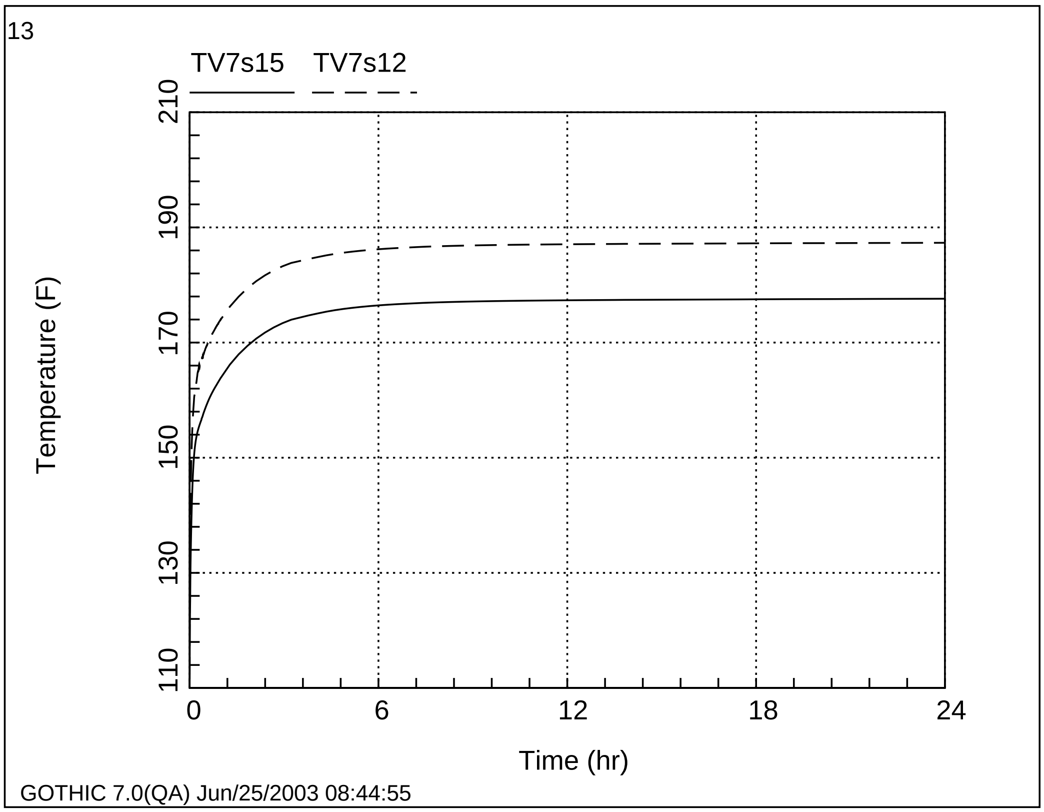
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 3 – Winter
32.90 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 177.6°F after 24 hrs 0 min 0 sec

Time required to reach 145°F – 5 min 42 sec

Time required to reach 160°F – 36 min 29 sec

FirstEnergy

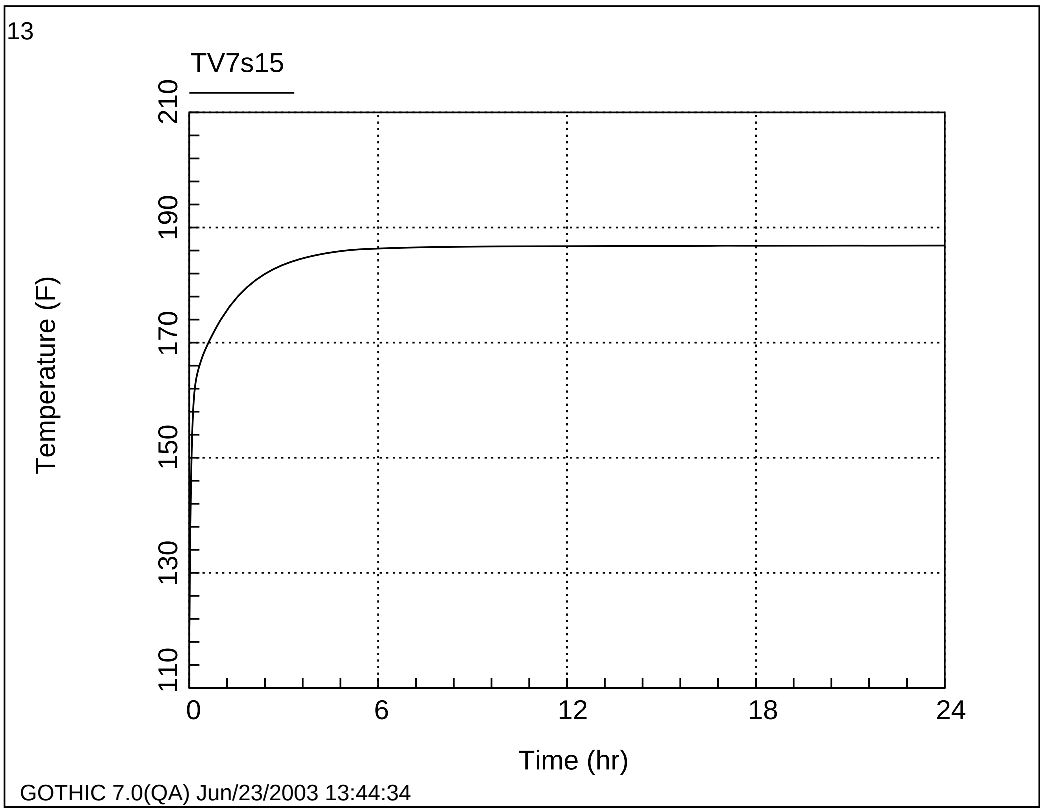
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 1 – Average
32.90 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 186.9°F after 24 hrs 0 min 0 sec

Time required to reach 145°F – 3 min 9 sec

Time required to reach 160°F – 8 min 32 sec

FirstEnergy

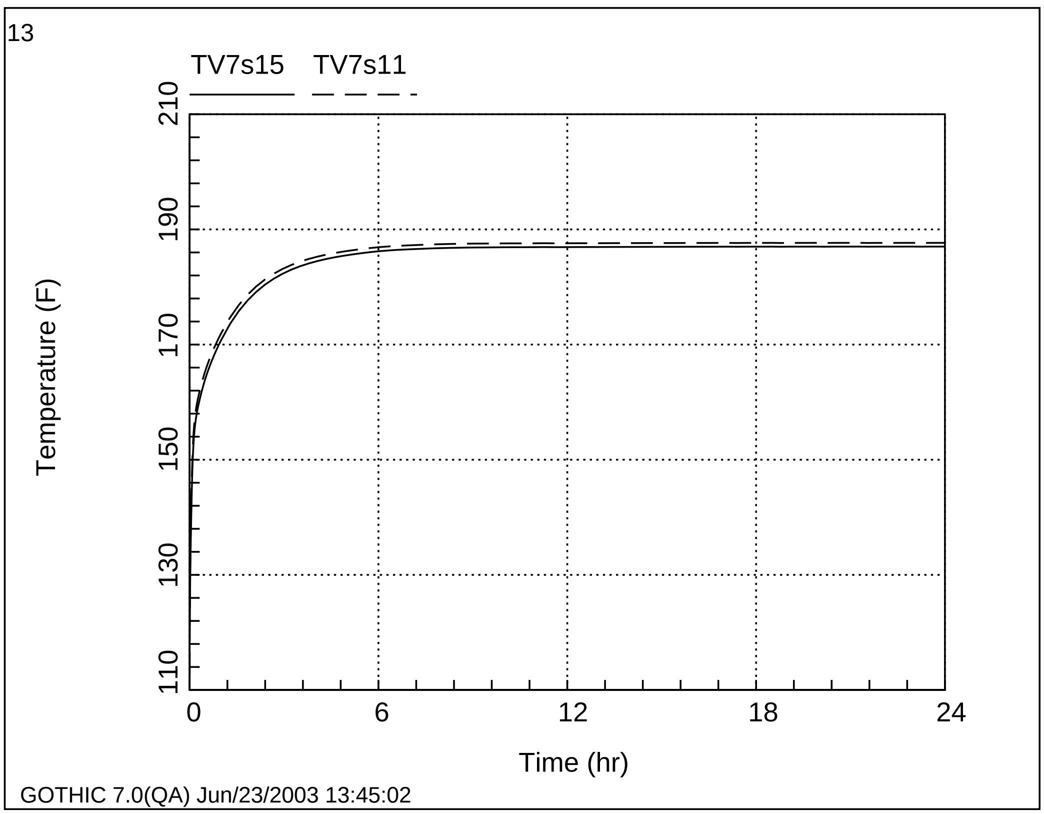
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 2 – Average
32.90 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 187.0°F after 24 hrs 0 min 0 sec

Time required to reach 145°F – 4 min 30 sec

Time required to reach 160°F – 18 min 17 sec

FirstEnergy

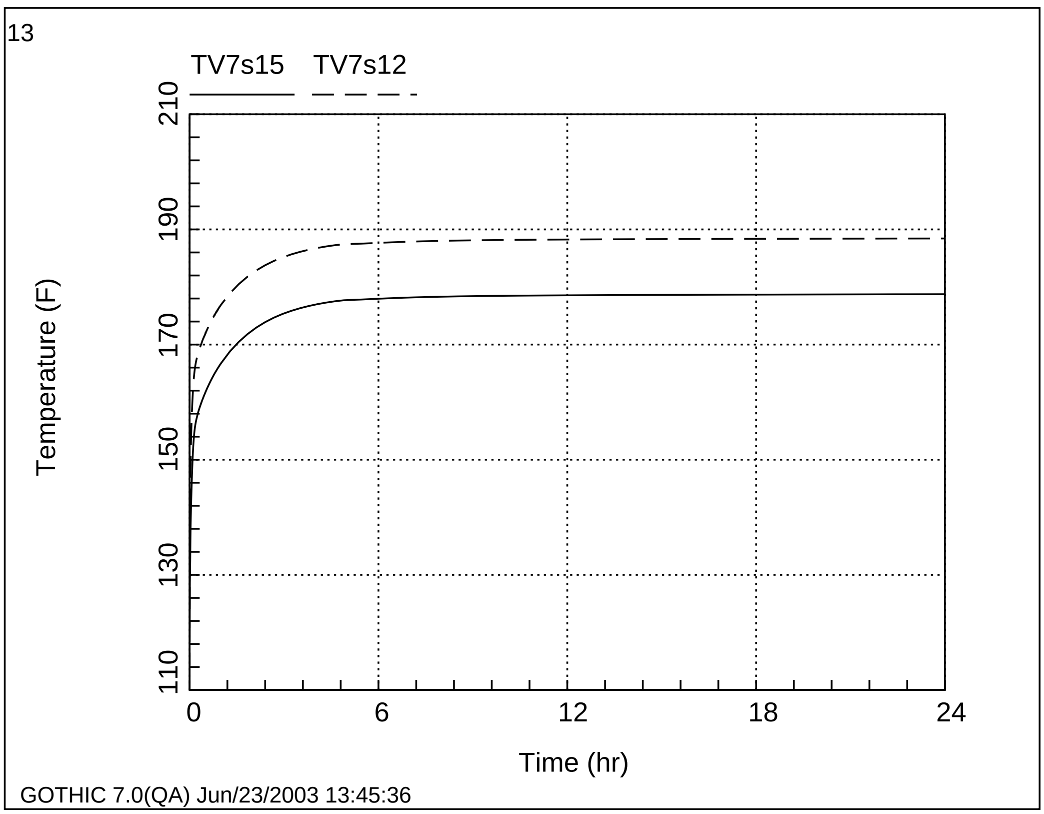
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 3 – Average
32.90 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 178.7°F after 24 hrs 0 min 0 sec

Time required to reach 145°F – 4 min 0 sec

Time required to reach 160°F – 22 min 53 sec

FirstEnergy

CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Table 1 – Time Required to Reach 145°F at the Thermocouples

	Summer	Winter	Average
32.90 Lb_m/sec	Leak 1 - 59 sec Leak 2 - 1 min 19 sec Leak 3 - 1 min 3 sec	Leak 1 - 4 min 3 sec Leak 2 - 6 min 6 sec Leak 3 - 5 min 42 sec	Leak 1 - 3 min 9 sec Leak 2 - 4 min 30 sec Leak 3 - 4 min 0 sec

Table 2 – Time Required to Reach 160°F at the Thermocouples

	Summer	Winter	Average
32.90 Lb_m/sec	Leak 1 - 4 min 41 sec Leak 2 - 7 min 2 sec Leak 3 - 7 min 13 sec	Leak 1 - 13 min 28 sec Leak 2 - 29 min 58 sec Leak 3 - 36 min 29 sec	Leak 1 - 8 min 32 sec Leak 2 - 18 min 17 sec Leak 3 - 22 min 53 sec

FirstEnergy

CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Part 2

The resultant temperature graphs indicate the temperature of the sub-volume that contains the E31 leak detection thermocouples (located on the east wall at TB14, approximate Elevation 632-feet, GOTHIC sub-volume V7s15[4]). Also shown is the sub-volume temperature at the leak location[5] if the leak location lies in a sub-volume different from the thermocouple sub-volume. The results over a 24-hour period for all cases (plus each corresponding case without the fan modification) are displayed below. A 24-hr period was analyzed in order to assure that steady-state temperatures were reached (the graphs confirm that this occurred). The following three summary items are listed below each graph.

- The maximum temperature realized at the location of the thermocouples, along with the time required to reach the maximum temperature.
- The time required to reach 145°F at the thermocouples.
- The time required to reach 160°F at the thermocouples.

A summary of the times required to reach 145°F and 160°F can be found in Tables 3 and 4, respectively, at the end of this section.[6]

Note that the output data produced by GOTHIC covers the time period from t = 0 seconds to t = 90,000 seconds (25 hours). As done in Calculation 2.4.6.14 and Part 1 of this Addendum, the steam leak is delayed to t = 3600 seconds (1 hour) in order to allow the transient to steady. Therefore, times reported in the following results equal the output data minus 3600 seconds.

[4] The legend in the GOTHIC-produced graphs denote sub-volume names with a 'T' in front (e.g. TV7s15 is the same as V7s15).
[5] Leak Locations 1, 2, and 3 lie in sub-volumes V7s15, V7s11, and V7s12, respectively.
[6] Data points created by the GOTHIC analysis typically did not occur exactly at 145°F or 160°F. In order to increase the accuracy of the comparison between cases with and without fans, data points were interpolated and then rounded up to the nearest full second.

FirstEnergy

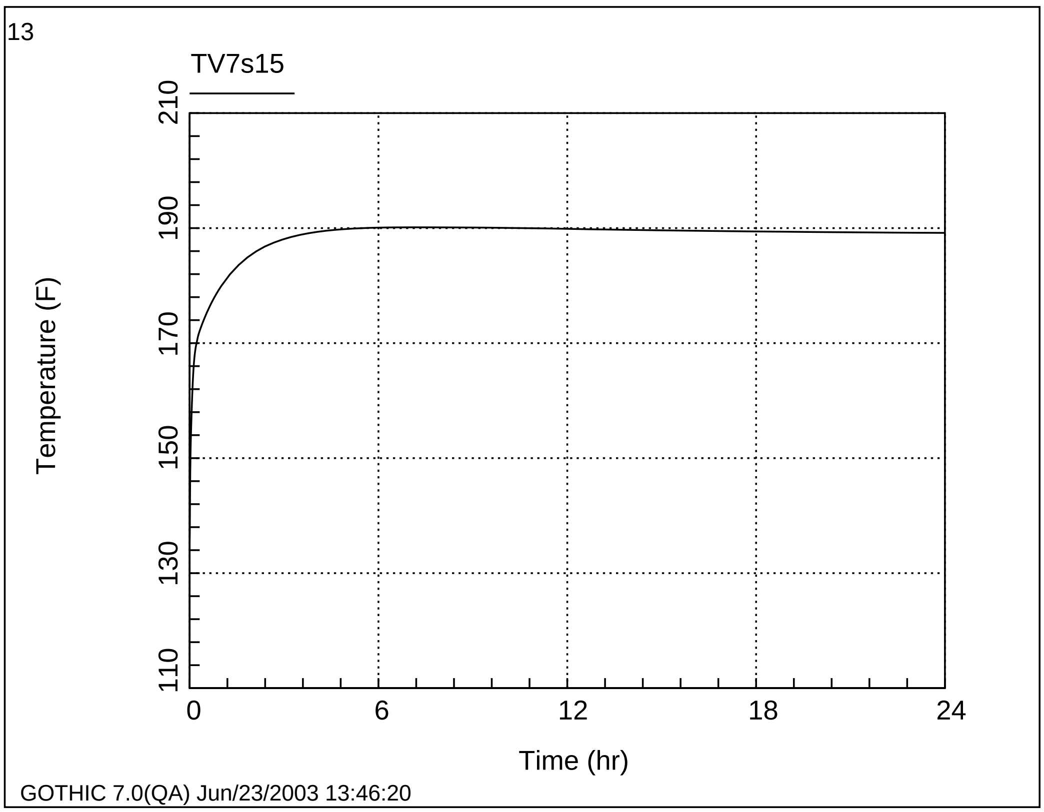
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 1 – Summer (No Fans)
32.90 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 190.1°F after 7 hrs 7 min 0 sec

Time required to reach 145°F – 57 sec

Time required to reach 160°F – 4 min 35 sec

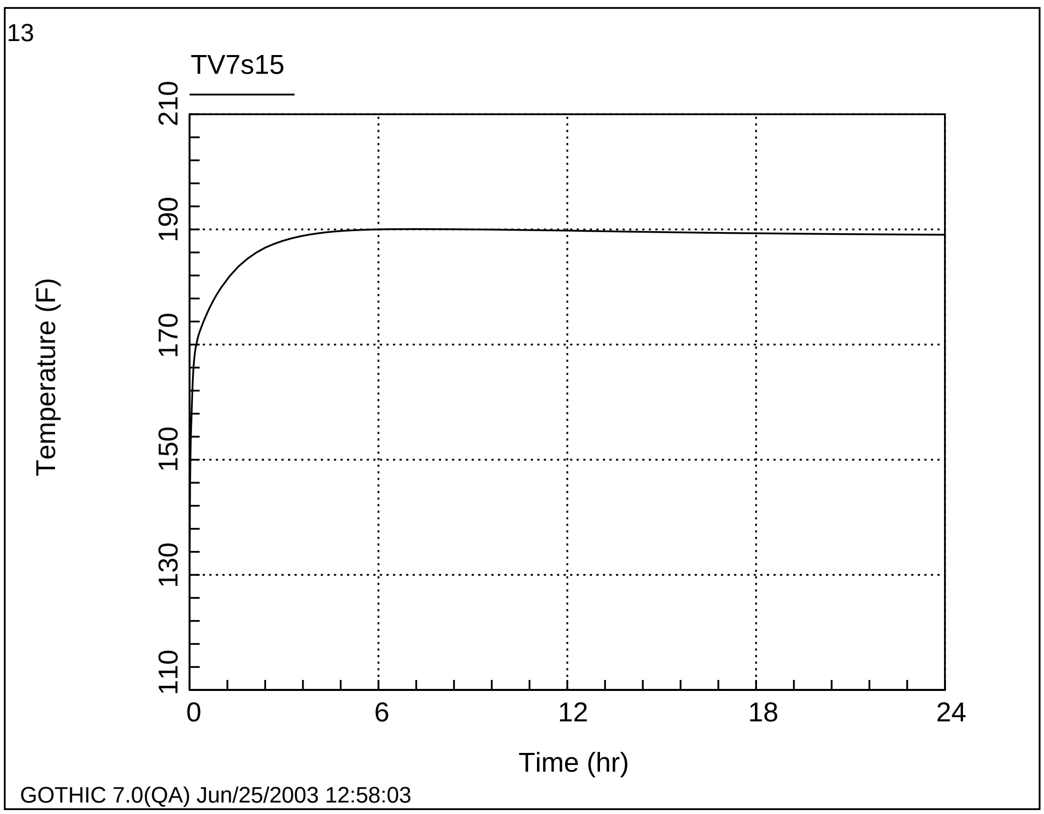
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 1 – Summer (Fan Modification)
32.90 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 190.1°F after 7 hrs 6 min 40 sec

Time required to reach 145°F – 51 sec

Time required to reach 160°F – 4 min 29 sec

FirstEnergy

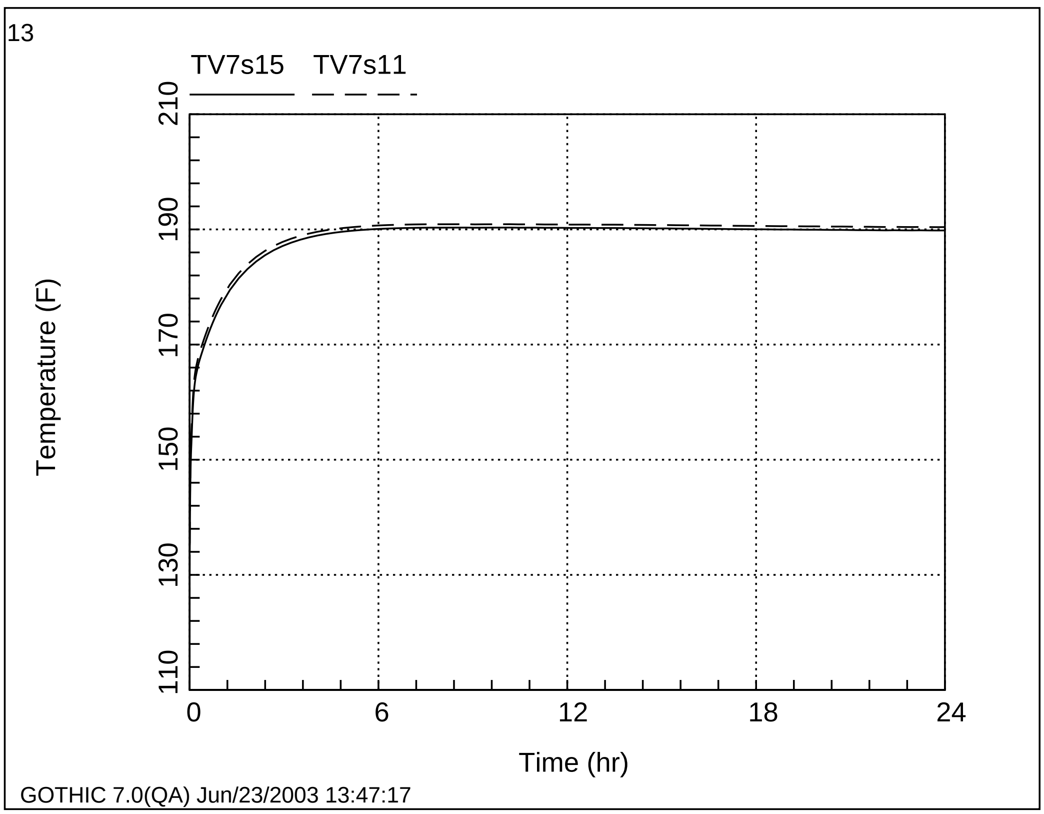
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 2 – Summer (No Fans)
32.90 Lb_m/sec Leak Rate



GOTHIC Sub-Volume V7s15

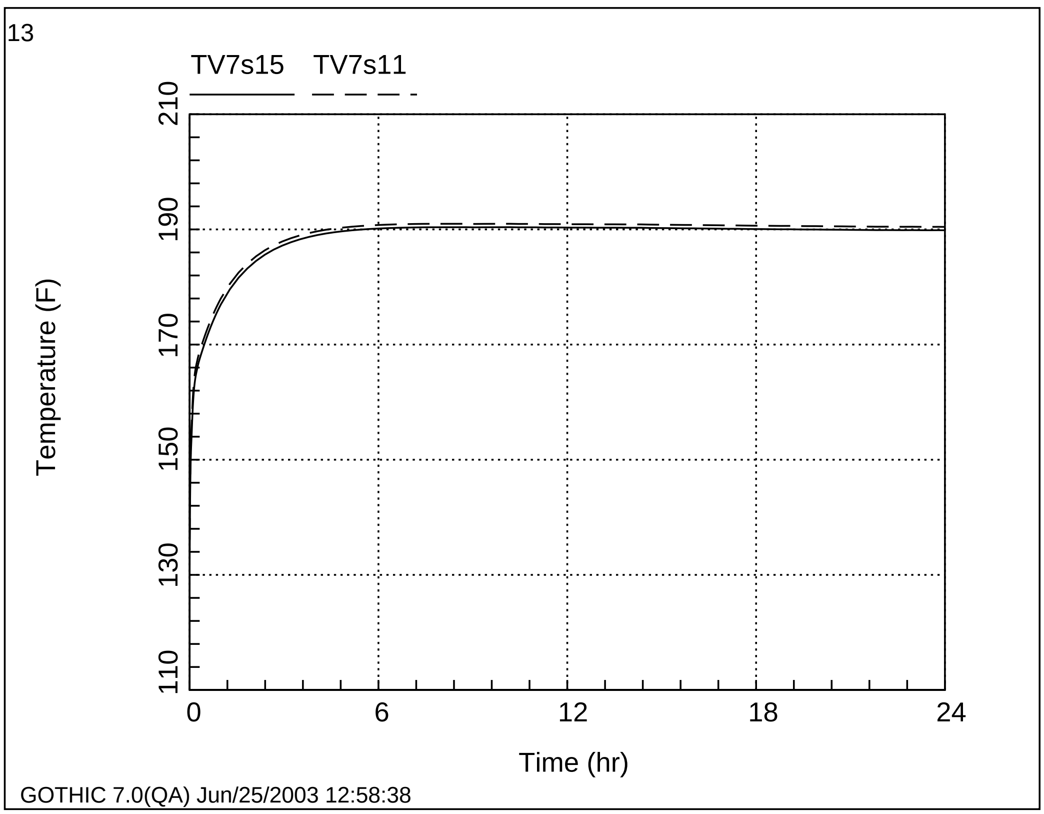
Maximum temperature realized – 190.3°F after 10 hrs 10 min 20 sec

Time required to reach 145°F – 1 min 16 sec

Time required to reach 160°F – 6 min 49 sec

FirstEnergy	CALCULATION ADDENDUM		
	NOP-CC-3002-02 Rev. 00		
INITIATING DOCUMENT TM-1-03-011	CALCULATION NO. 2.4.6.14	CALCULATION REV. 0	ADDENDUM NO. A-01
TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks			

Leak Location 2 – Summer (Fan Modification)
32.90 Lb_m/sec Leak Rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 190.4°F after 10 hrs 10 min 10 sec

Time required to reach 145°F – 1 min 10 sec

Time required to reach 160°F – 6 min 38 sec

FirstEnergy

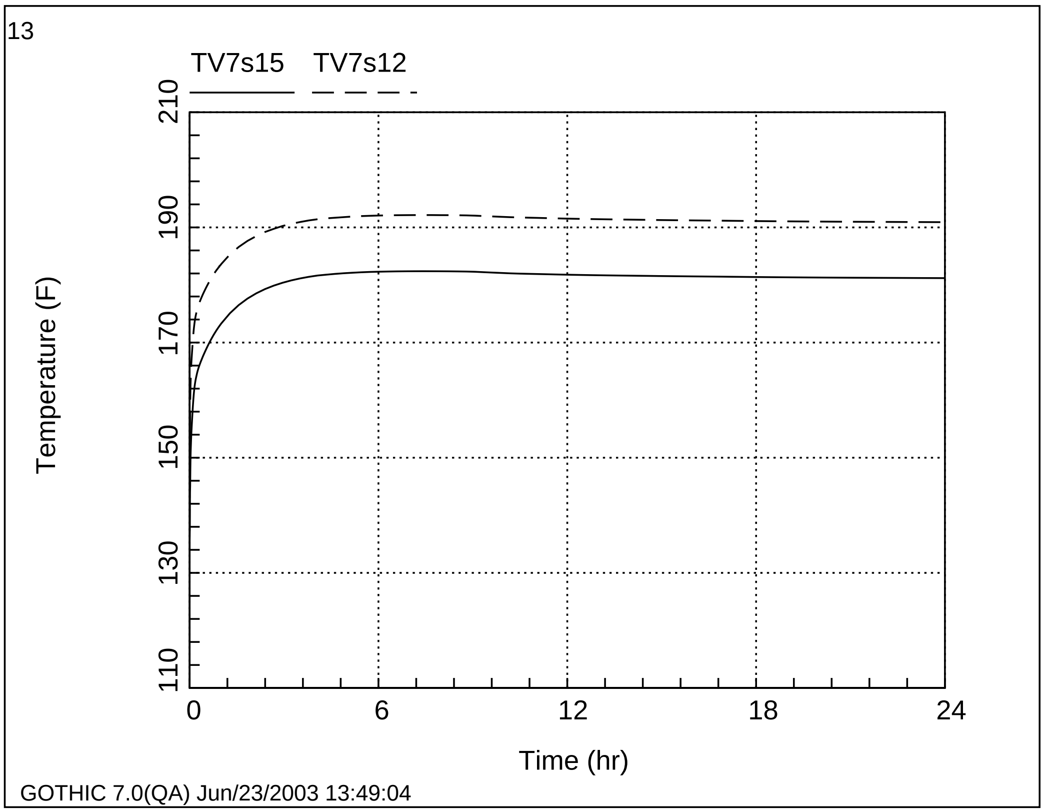
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 3 – Summer (No Fans)
32.90 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 182.4°F after 7 hrs 24 min 20 sec

Time required to reach 145°F – 1 min 2 sec

Time required to reach 160°F – 7 min 2 sec

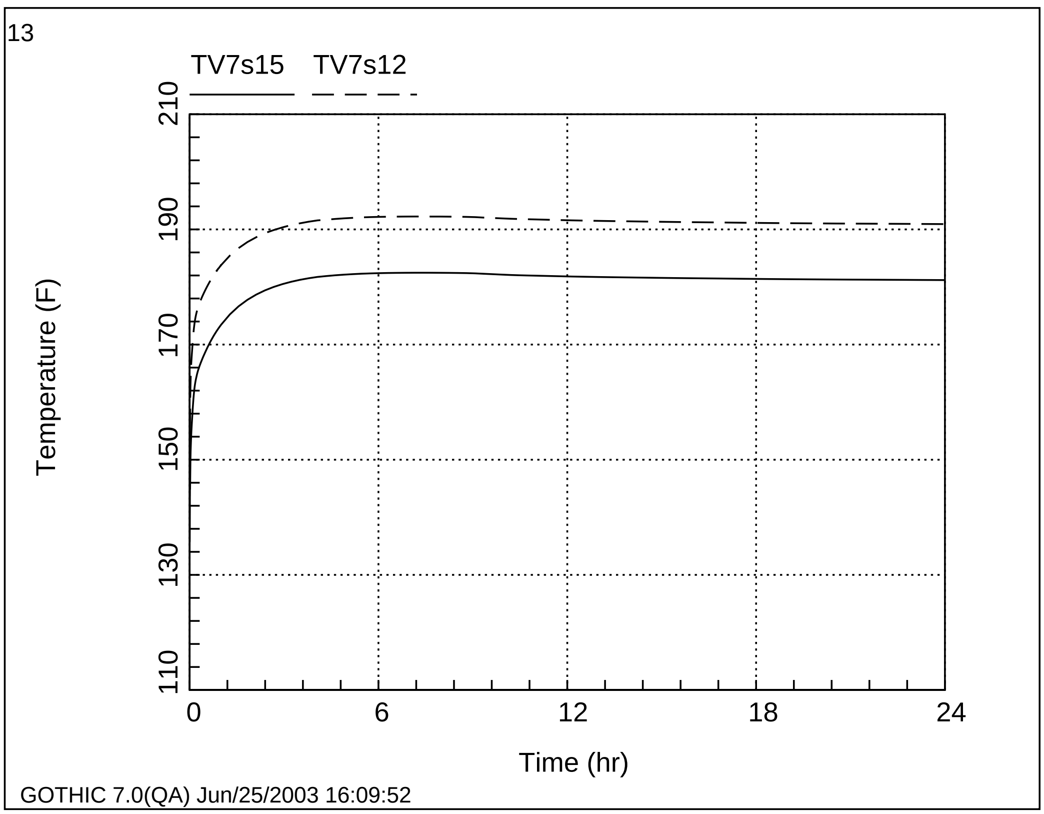
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 3 – Summer (Fan Modification)
32.90 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

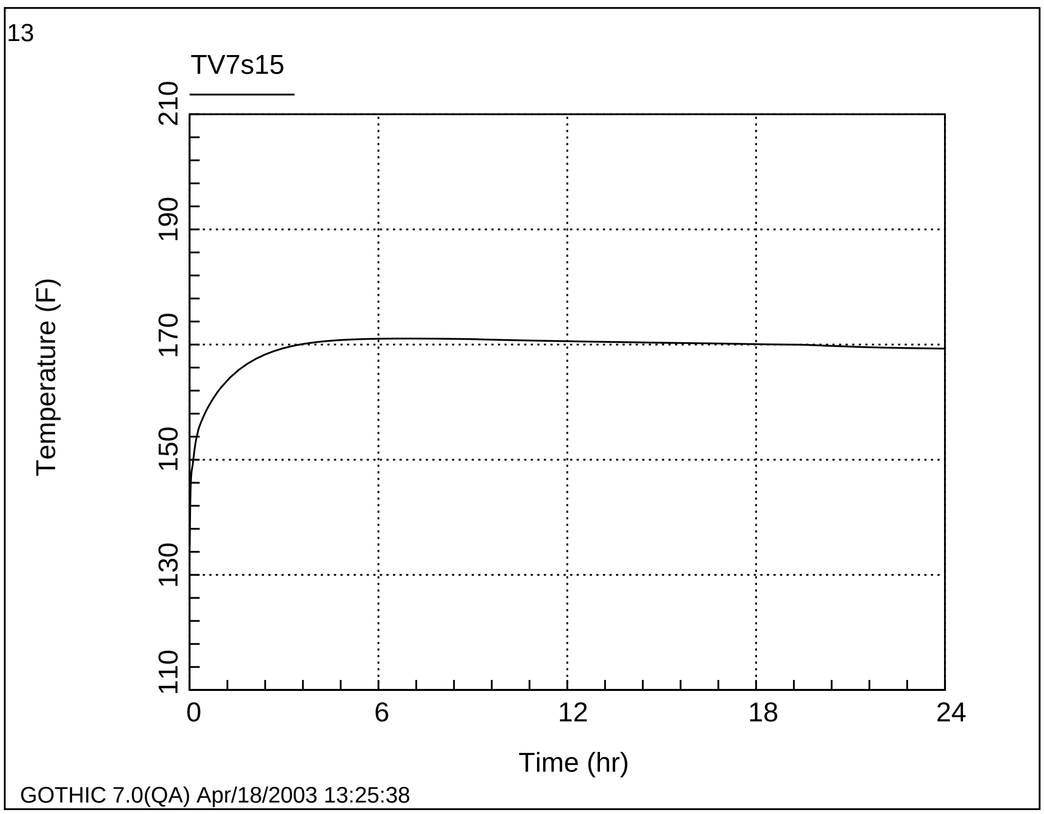
Maximum temperature realized – 182.5°F after 7 hrs 24 min 20 sec

Time required to reach 145°F – 56 sec

Time required to reach 160°F – 6 min 48 sec

FirstEnergy	CALCULATION ADDENDUM NOP-CC-3002-02 Rev. 00		
INITIATING DOCUMENT TM-1-03-011	CALCULATION NO. 2.4.6.14	CALCULATION REV. 0	ADDENDUM NO. A-01
TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks			

Leak Location 1 – Summer (No Fans)
19.68 Lb_m/sec leak rate



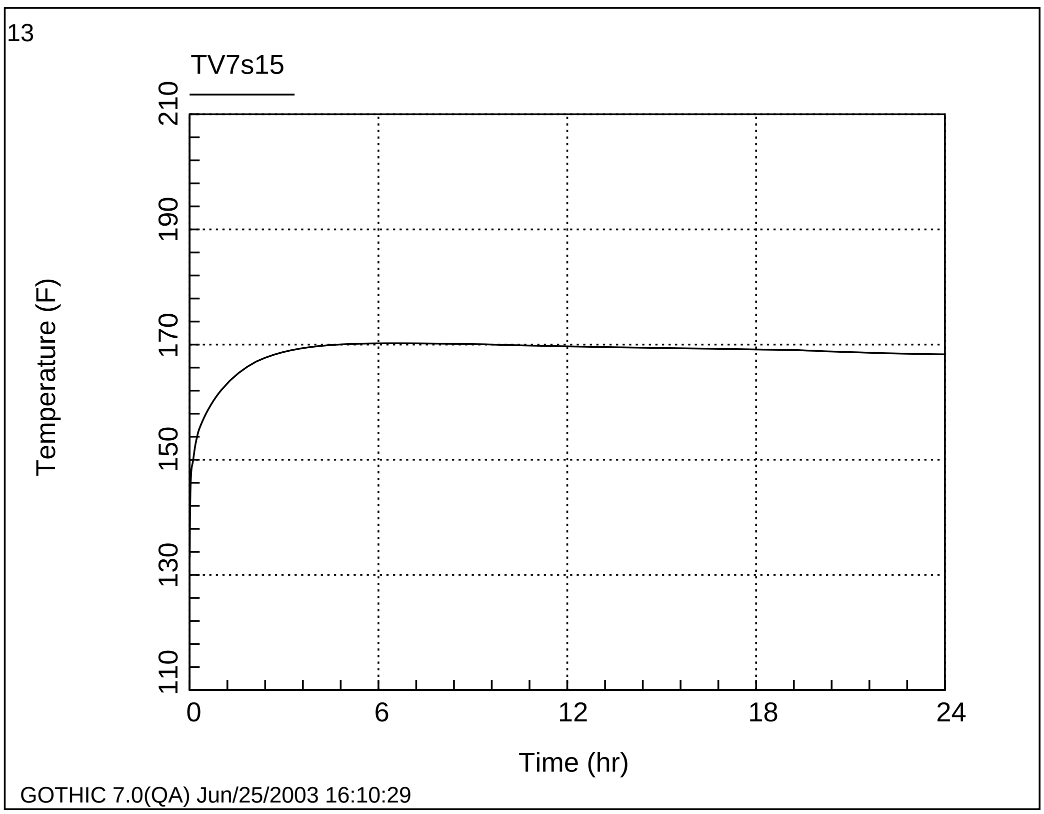
GOTHIC Sub-Volume V7s15

Maximum temperature realized – 171°F after 6 hrs 50 min 30 sec

Time required to reach 145°F – 1 min 56 sec

Time required to reach 160°F – 40 min 43 sec

Leak Location 1 – Summer (Fan Modification)
19.68 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 170.2°F after 6 hrs 33 min 40 sec

Time required to reach 145°F – 1 min 43 sec

Time required to reach 160°F – 43 min 47 sec

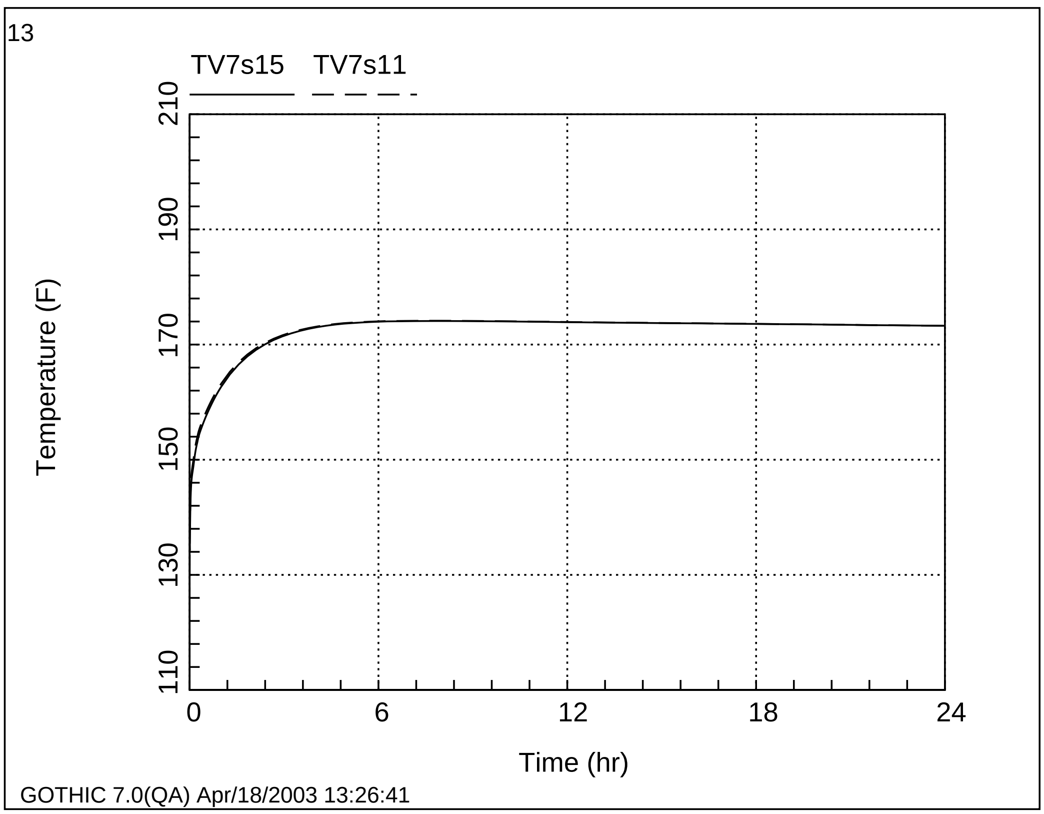
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 2 – Summer (No Fans)
19.68 Lb_m/sec Leak Rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 174.1°F after 7 hrs 57 min 0 sec

Time required to reach 145°F – 2 min 37 sec

Time required to reach 160°F – 43 min 42 sec

FirstEnergy

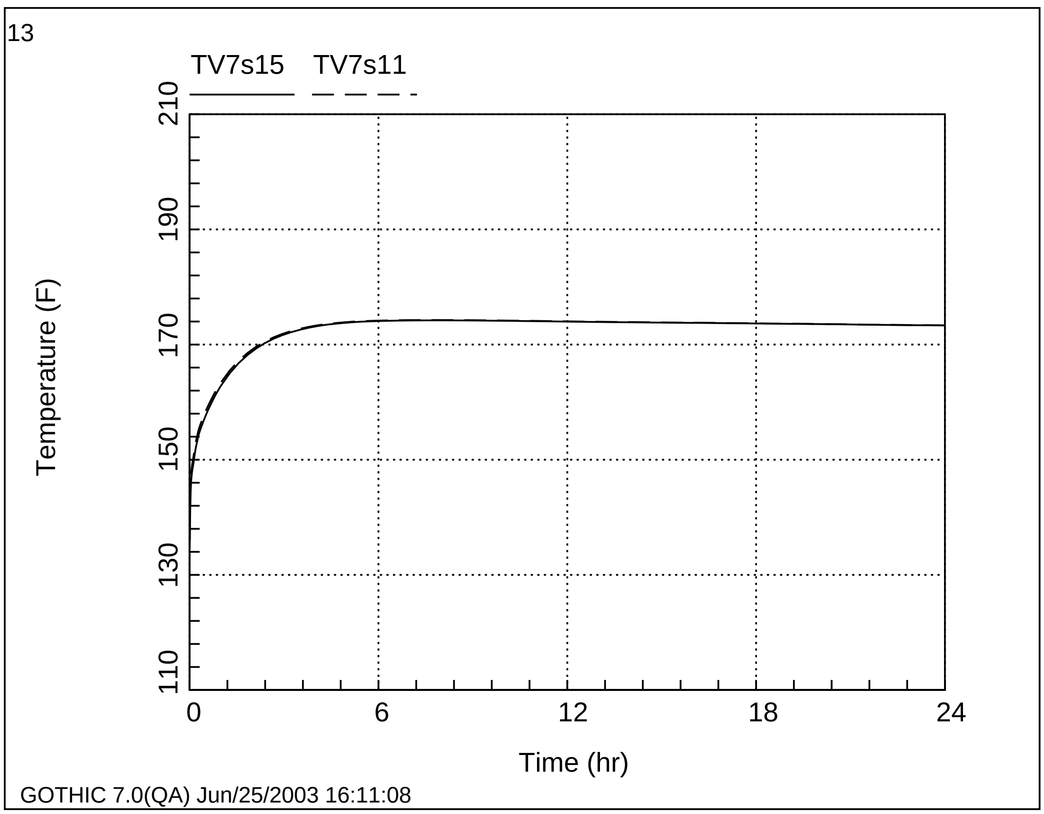
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 2 – Summer (Fan Modification)
19.68 Lb_m/sec Leak Rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 174.2°F after 7 hrs 40 min 10 sec

Time required to reach 145°F – 2 min 16 sec

Time required to reach 160°F – 42 min 20 sec

FirstEnergy

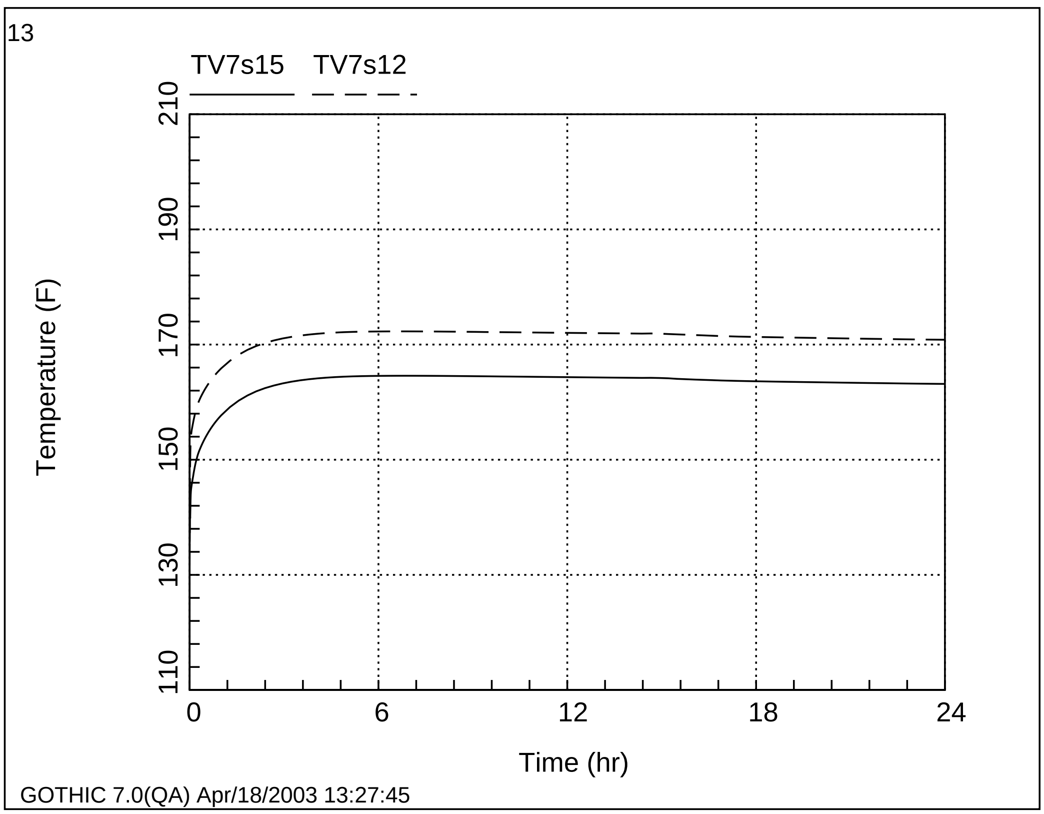
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 3 – Summer (No Fans)
19.68 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 164.6°F after 6 hrs 51 min 0 sec

Time required to reach 145°F – 3 min 0 sec

Time required to reach 160°F – 1 hr 29 min 42 sec

FirstEnergy

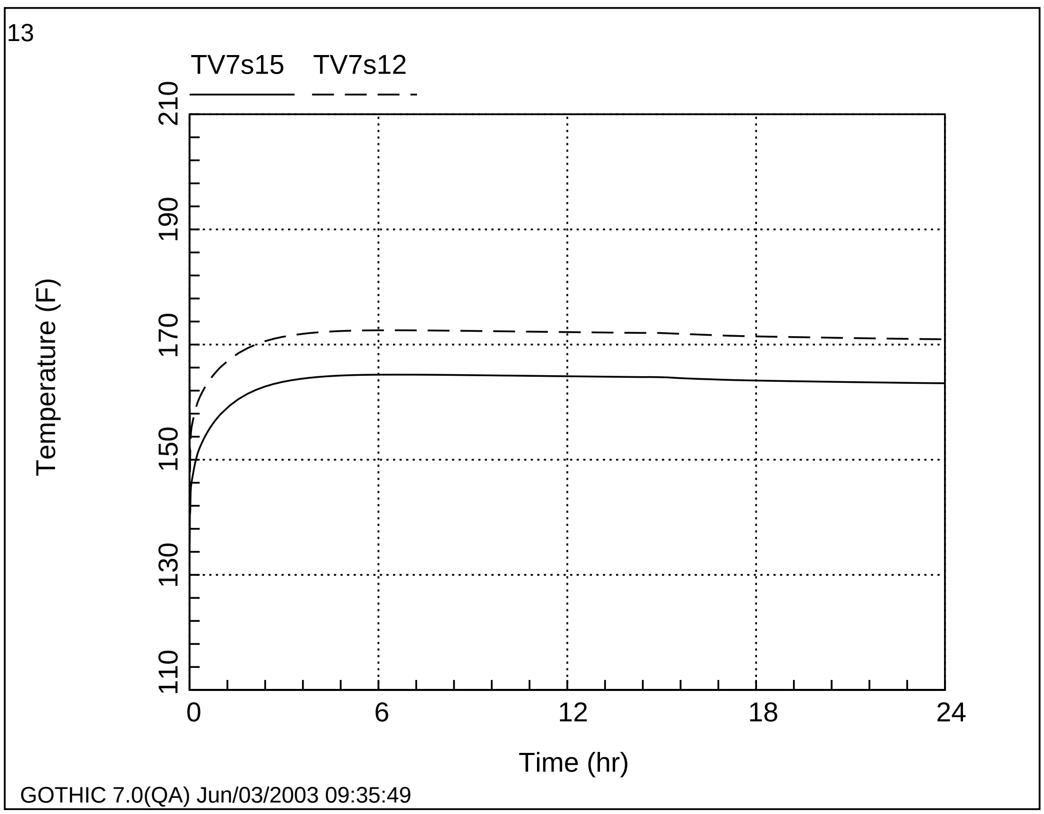
CALCULATION ADDENDUM

NOP-CC-3002-02 Rev. 00

INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Leak Location 3 – Summer (Fan Modification)
19.68 Lb_m/sec leak rate



GOTHIC Sub-Volume V7s15

Maximum temperature realized – 164.8°F after 6 hrs 34 min 10 sec

Time required to reach 145°F – 2 min 22 sec

Time required to reach 160°F – 1 hr 25 min 20 sec

FirstEnergy	CALCULATION ADDENDUM NOP-CC-3002-02 Rev. 00		
INITIATING DOCUMENT TM-1-03-011	CALCULATION NO. 2.4.6.14	CALCULATION REV. 0	ADDENDUM NO. A-01
TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks			

Table 3 – Time Required to Reach 145°F at the Thermocouples

	Summer (No Fans)	Summer (Fan Modification)	Difference Due to Fans
32.90 Lb_m/sec	Leak 1 - 57 sec Leak 2 - 1 min 16 sec Leak 3 - 1 min 2 sec	Leak 1 - 51 sec Leak 2 - 1 min 10 sec Leak 3 - 56 sec	Leak 1 - 6 sec less Leak 2 - 6 sec less Leak 3 - 6 sec less
19.68 Lb_m/sec	Leak 1 - 1 min 56 sec Leak 2 - 2 min 37 sec Leak 3 - 3 min 0 sec	Leak 1 - 1 min 43 sec Leak 2 - 2 min 16 sec Leak 3 - 2 min 22 sec	Leak 1 - 13 sec less Leak 2 - 21 sec less Leak 3 - 38 sec less

Table 4 – Time Required to Reach 160°F at the Thermocouples

	Summer (No Fans)	Summer (Fan Modification)	Difference Due to Fans
32.90 Lb_m/sec	Leak 1 - 4 min 35 sec Leak 2 - 6 min 49 sec Leak 3 - 7 min 2 sec	Leak 1 - 4 min 29 sec Leak 2 - 6 min 38 sec Leak 3 - 6 min 48 sec	Leak 1 - 6 sec less Leak 2 - 11 sec less Leak 3 - 14 sec less
19.68 Lb_m/sec	Leak 1 - 40 min 43 sec Leak 2 - 43 min 42 sec Leak 3 - 1 hr 29 min 42 sec	Leak 1 - 43 min 47 sec Leak 2 - 42 min 20 sec Leak 3 - 1 hr 25 min 20 sec	Leak 1 - 3 min 4 sec more Leak 2 - 1 min 22 sec less Leak 3 - 4 min 22 sec less

FirstEnergy	CALCULATION ADDENDUM NOP-CC-3002-02 Rev. 00		
INITIATING DOCUMENT TM-1-03-011	CALCULATION NO. 2.4.6.14	CALCULATION REV. 0	ADDENDUM NO. A-01
TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks			

Conclusions

Part 1

The analysis indicates that a steam leak rate of 32.90 Lb_m/sec will result in elevated temperatures of 145°F and 160°F near the E31 thermocouples well within the acceptable time limit of 1 hr 11 min 46 sec.

Part 2

Comparing the results of the GOTHIC model, before and after the addition of the fans, reveals minor yet generally consistent effects. The time required to reach a setpoint of 145°F is decreased in all six cases by adding the fans. Also, a lower leak rate resulted in the fans having a larger effect for each case. The time required to reach a setpoint of 160°F is decreased in 5 out of 6 cases. Again, except in the case of Leak Location #1 during summer conditions, a lower leak rate resulted in the fans having a greater effect in their ability to decrease the time required for detection. The reason behind Summer Leak Location #1 not performing in line with the other cases can only be conjectured. It is assumed that because Leak Location #1 lies in the same subvolume as the thermocouples, air is being directed via the fans from a cooler sub-volume towards the thermocouples, while the leaking steam is being forced out of the vicinity of the thermocouples where it originates. Over the longer period of time it takes to reach 160°F vs. 145°F, the region surrounding the thermocouples is allowed to be homogenized to a greater extent with the surrounding cooler air. Beyond this special case, the results are consistent in predicting that the fans will help to homogenize the volumes and decrease the time for detection. Even in the instance that the time required is increased, all of the detection times still remain well within the acceptance criteria.

Note: Two anomalies have been identified in the final results represented in this Addendum to Calculation 2.4.6.14. The first anomaly is that there is no definining trend on when a specific leak location is the limiting leak location for a given set of cases/scenarios. The reason for this is not readily apparent. There are many potentially contributing factors to this anomaly that are taken into account in the GOTHIC model, such as the leak rate and location, outdoor temperature, ventilation into the room, forced convection by fans, flow paths into adjacent zones, and the fact that the leaks are being directed away from the thermocouples allowing greater mixing. This complex set of factors results in GOTHIC treating each specific case in an individualistic manner, thus creating a set of solutions in which intuitive trends can sometimes not be found.

The second anomaly is that, according to the graphical results, once it appears that steady-state has been reached in some cases, there is a slight decline in temperature over time. It is conjectured that the reason for this is due to thick concrete walls surrounding the control volume in which the steam leaks and thermocouples reside. Once the concrete walls are heated up to a certain threshold temperature, they are able to begin radiating heat to their surroundings, thus conducting heat away from the control volume in question. Verifying this reasoning would require additional GOTHIC models to be created and executed outside the scope of this calculation.

CALCULATION ADDENDUM

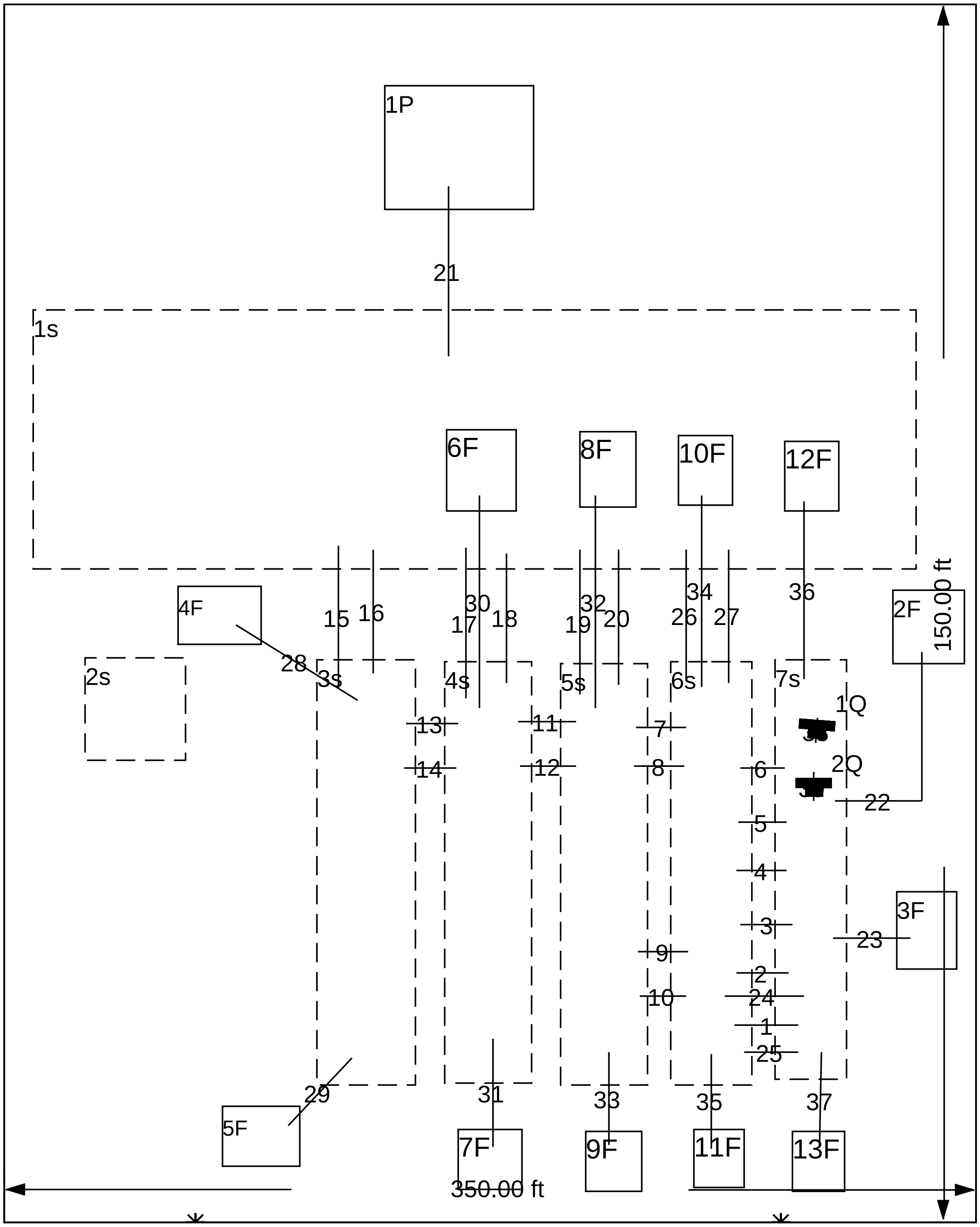
NOP-CC-3002-02 Rev. 00

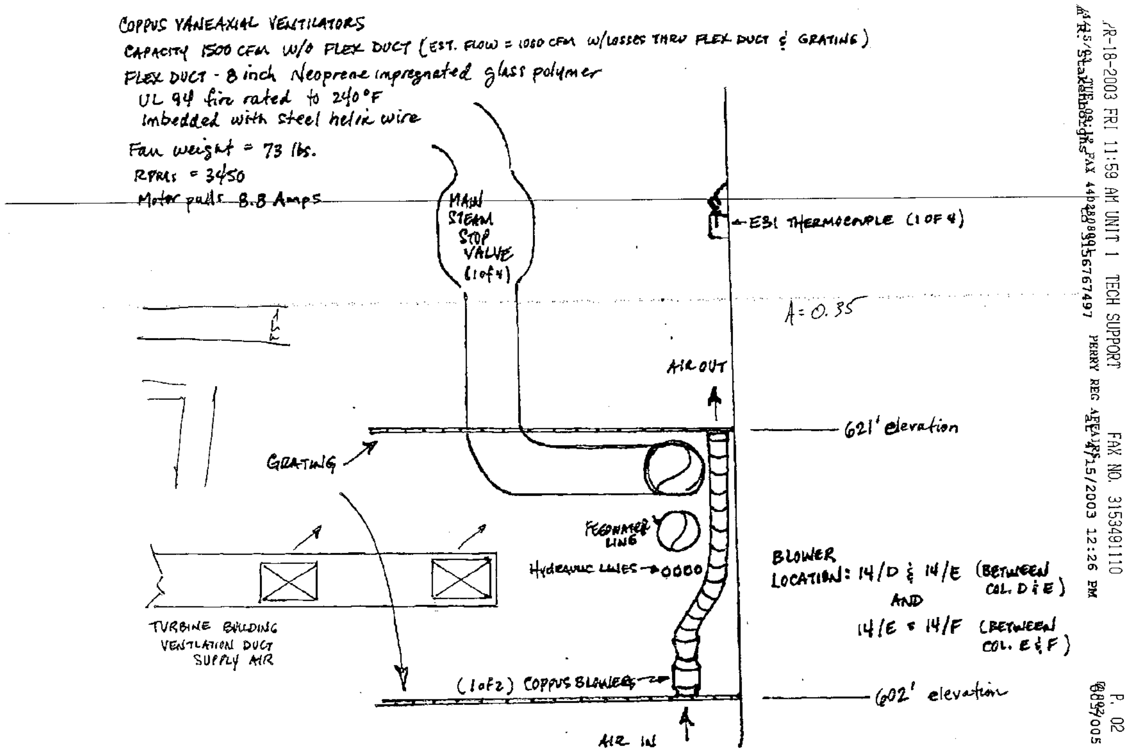
INITIATING DOCUMENT	CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
TM-1-03-011	2.4.6.14	0	A-01

TITLE/SUBJECT: Turbine Building Temperature Response to Steam Leaks

Attachments

Attachment A: GOTHIC-generated model layout (Part 2)	1 page
Attachment B: Fan and Associated Hydraulic Line Location Diagram (Part 2)	1 page
Attachment C: GOTHIC Input File (Part 2)	26 pages
Attachment D: GOTHIC Output Data for 32.90 Lbm/sec Leak (Part 1)	82 pages


1P
21
1s
6F
8F
10F
12F
4F
15
16
30
17
18
32
19
20
34
26
27
36
2F
150.00 ft
28
2s
3s
4s
5s
6s
7s
1Q
13
11
7
14
12
8
6
2Q
22
5
4
3F
3
23
9
2
10
24
1
25
29
31
33
35
37
5F
7F
9F
11F
13F
350.00 ft


COPPUS VANEAXIAL VENTILATORS
CAPACITY 1500 CFM W/O FLEX DUCT (EST. FLOW = 1060 CFM W/LOSSES THRU FLEX DUCT & GRATING)
FLEX DUCT - 8 inch Neoprene impregnated glass polymer
UL 94 fire rated to 240°F
imbedded with steel helix wire
Fan weight = 73 lbs.
RPMs = 3450
Motor pulls 8.8 Amps
MAIN STEAM STOP VALVE (1 of 4)
EBI THERMOCOUPLE (1 OF 4)
A = 0.35
AIR OUT
621' elevation
GRATING
FEEDWATER LINE
Hydraulic LINES
BLOWER LOCATION: 14/D & 14/E (BETWEEN COL. D & E) AND 14/E & 14/F (BETWEEN COL. E & F)
TURBINE BUILDING VENTILATION DUCT SUPPLY AIR
(1 of 2) COPPUS BLOWERS
602' elevation
AIR IN
APR-18-2003 FRI 11:59 AM UNIT 1 TECH SUPPORT
FAX NO. 3153491110
P. 02

PNPP Turbine Building GOTHIC Model[7]

[7] This particular input file represents the Summer – Leak #1 – 32.90 Lb_m/sec case. The required changes for all other cases are noted in this attachment.

Control Volumes

Vol #	Description	Vol (ft3)	Elev (ft)	Ht (ft)	Hyd. D. (ft)	L/V IA (ft2)	Burn Opt
1s	Operating Floor	3452000.	647.5	67.2	183.2	DEFAULT	NONE
2s	TB1-TB4/620.5'	304471.	620.5	27.5	104.8	DEFAULT	NONE
3s	TB9-TB10	264000.	577.5	70.	52.7	DEFAULT	NONE
4s	TB10-TB11	284000.	577.5	70.	55.7	DEFAULT	NONE
5s	TB11-TB12	279500.	577.5	70.	55.1	DEFAULT	NONE
6s	TB12-TB13	270500.	577.5	70.	53.7	DEFAULT	NONE
7s	TB13-TB14	284000.	577.5	70.	55.7	DEFAULT	NONE

Laminar Leakage

Vol #	Lk Rate Factor (%/hr)	Ref Press (psia)	Ref Temp (F)	Ref Humid (%)	Sink /Src BC	Model Option	Rep Wall	Subvol Option	Leak Area (ft2)
1s	0.					CNST	T	UNIFORM	DEFAULT
2s	0.					CNST	T	UNIFORM	DEFAULT
3s	0.					CNST	T	UNIFORM	DEFAULT
4s	0.					CNST	T	UNIFORM	DEFAULT
5s	0.					CNST	T	UNIFORM	DEFAULT
6s	0.					CNST	T	UNIFORM	DEFAULT
7s	0.					CNST	T	UNIFORM	DEFAULT

Turbulent Leakage

Vol #	Lk Rate Factor (%/hr)	Ref Press (psia)	Ref Temp (F)	Ref Humid (%)	Sink /Src BC	Model Option	Rep Wall	Subvol Option	Leak Area (ft2)	fL/D
1s	0.					CNST	T	UNIFORM	DEFAULT	
2s	0.					CNST	T	UNIFORM	DEFAULT	
3s	0.					CNST	T	UNIFORM	DEFAULT	
4s	0.					CNST	T	UNIFORM	DEFAULT	
5s	0.					CNST	T	UNIFORM	DEFAULT	
6s	0.					CNST	T	UNIFORM	DEFAULT	
7s	0.					CNST	T	UNIFORM	DEFAULT	

X-Direction Noding
Volume 1s

Cell Plane	Distance (ft)	Width (ft)
1	0.	85.
2	85.	71.
3	156.	71.
4	227.	218.

Y-Direction Noding
Volume 1s

Cell Plane	Distance (ft)	Depth (ft)
1	0.	38.
2	38.	39.
3	77.	38.

Z-Direction Noding
Volume 1s

Cell Plane	Distance (ft)	Height (ft)
1	0.	27.

```
2     27.         40.2

Cell Blockages
Volume 1s
   Bl                              Coord       (ft)         (ft)
No.    Typ       X1     Y1     Z1     X2     Y2     Z2     X3     Y3     Z3     L
           B   N

X-Direction Cell Face Variations
Volume 1s
Cell     Blockage Area     Hyd. Dia. Loss     Drop De-ent.
No.      No.      Fraction (ft)      Coeff.   Factor
def      0        1.       183.2     0.       0.

Y-Direction Cell Face Variations
Volume 1s
Cell     Blockage Area     Hyd. Dia. Loss     Drop De-ent.
No.      No.      Fraction (ft)      Coeff.   Factor
def      0        1.       183.2     0.       0.

Z-Direction Cell Face Variations
Volume 1s
Cell     Blockage Area     Hyd. Dia. Loss     Drop De-ent.
No.      No.      Fraction (ft)      Coeff.   Factor
def      0        1.       183.2     0.       0.
1s1      0        1.       1000000.  0.       0.
1s2      0        1.       1000000.  0.       0.
1s3      0        1.       1000000.  0.       0.
1s4      0        1.       1000000.  0.       0.
1s5      0        1.       1000000.  0.       0.
1s6      0        1.       1000000.  0.       0.
1s7      0        1.       1000000.  0.       0.
1s8      0        1.       1000000.  0.       0.
1s9      0        1.       1000000.  0.       0.
1s10     0        1.       1000000.  0.       0.
1s11     0        1.       1000000.  0.       0.
1s12     0        1.       1000000.  0.       0.
1s13     0        1.       1000000.  0.       0.
1s14     0        1.       1000000.  0.       0.
1s15     0        1.       1000000.  0.       0.
1s16     0        1.       1000000.  0.       0.
1s17     0        1.       1000000.  0.       0.
1s18     0        1.       1000000.  0.       0.
1s19     0        1.       1000000.  0.       0.
1s20     0        1.       1000000.  0.       0.
1s21     0        1.       1000000.  0.       0.
1s22     0        1.       1000000.  0.       0.
1s23     0        1.       1000000.  0.       0.
1s24     0        1.       1000000.  0.       0.

Volume Variations
Volume 1s
Cell     Blockage Volume   Hyd. Dia.
No.      No.      Porosity (ft)
def      0        1.       183.2
1s1      0        1.       1000000.
1s2      0        1.       1000000.
```

1s3	0	1.	1000000.
1s4	0	1.	1000000.
1s5	0	1.	1000000.
1s6	0	1.	1000000.
1s7	0	1.	1000000.
1s8	0	1.	1000000.
1s9	0	1.	1000000.
1s10	0	1.	1000000.
1s11	0	1.	1000000.
1s12	0	1.	1000000.
1s13	0	1.	1000000.
1s14	0	1.	1000000.
1s15	0	1.	1000000.
1s16	0	1.	1000000.
1s17	0	1.	1000000.
1s18	0	1.	1000000.
1s19	0	1.	1000000.
1s20	0	1.	1000000.
1s21	0	1.	1000000.
1s22	0	1.	1000000.
1s23	0	1.	1000000.
1s24	0	1.	1000000.

Boundary Slip Conditions
Volume 1s

North	South	East	West	Top	Bottom
SLIP	SLIP	SLIP	SLIP	SLIP	SLIP

X-Direction Noding
Volume 2s

Cell Plane	Distance (ft)	Width (ft)
1	0.	48.
2	48.	48.

Y-Direction Noding
Volume 2s

Cell Plane	Distance (ft)	Depth (ft)
1	0.	38.
2	38.	39.
3	77.	38.

Z-Direction Noding
Volume 2s

Cell Plane	Distance (ft)	Height (ft)
1	0.	27.5

Cell Blockages
Volume 2s

Bl No.	Typ		X1	Y1	Z1	Coord X2	Y2	(ft) Z2	X3	(ft) Y3	Z3	L
	B	N										

X-Direction Cell Face Variations
Volume 2s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	104.8	0.	0.

Y-Direction Cell Face Variations
Volume 2s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	104.8	0.	0.

Z-Direction Cell Face Variations
Volume 2s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	104.8	0.	0.

Volume Variations
Volume 2s

Cell No.	Blockage No.	Volume Porosity	Hyd. Dia. (ft)
def	0	1.	104.8

Boundary Slip Conditions
Volume 2s

North	South	East	West	Top	Bottom
SLIP	SLIP	SLIP	SLIP	SLIP	SLIP

X-Direction Noding
Volume 3s

Cell Plane	Distance (ft)	Width (ft)
1	0.	17.
2	17.	17.

Y-Direction Noding
Volume 3s

Cell Plane	Distance (ft)	Depth (ft)
1	0.	38.
2	38.	39.
3	77.	38.

Z-Direction Noding
Volume 3s

Cell Plane	Distance (ft)	Height (ft)
1	0.	12.
2	12.	30.5
3	42.5	27.5

Cell Blockages
Volume 3s

Bl No.	Typ	X1	Y1	Z1	Coord X2	(ft) Y2	Z2	(ft) X3	Y3	Z3	L
	B N										

X-Direction Cell Face Variations

Volume 3s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	52.7	0.	0.

Y-Direction Cell Face Variations
Volume 3s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	52.7	0.	0.

Z-Direction Cell Face Variations
Volume 3s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	52.7	0.	0.
3s1	0	1.	1000000.	0.	0.
3s2	0	1.	1000000.	0.	0.
3s3	0	1.	1000000.	0.	0.
3s4	0	1.	1000000.	0.	0.
3s5	0	1.	1000000.	0.	0.
3s6	0	1.	1000000.	0.	0.
3s7	0	1.	1000000.	0.	0.
3s8	0	1.	1000000.	0.	0.
3s9	0	1.	1000000.	0.	0.
3s10	0	1.	1000000.	0.	0.
3s11	0	1.	1000000.	0.	0.
3s12	0	1.	1000000.	0.	0.
3s13	0	1.	1000000.	0.	0.
3s14	0	1.	1000000.	0.	0.
3s15	0	1.	1000000.	0.	0.
3s16	0	1.	1000000.	0.	0.
3s17	0	1.	1000000.	0.	0.
3s18	0	1.	1000000.	0.	0.

Volume Variations
Volume 3s

Cell No.	Blockage No.	Volume Porosity	Hyd. Dia. (ft)
def	0	1.	52.7
3s1	0	1.	1000000.
3s2	0	1.	1000000.
3s3	0	1.	1000000.
3s4	0	1.	1000000.
3s5	0	1.	1000000.
3s6	0	1.	1000000.
3s7	0	1.	1000000.
3s8	0	1.	1000000.
3s9	0	1.	1000000.
3s10	0	1.	1000000.
3s11	0	1.	1000000.
3s12	0	1.	1000000.
3s13	0	1.	1000000.
3s14	0	1.	1000000.
3s15	0	1.	1000000.
3s16	0	1.	1000000.
3s17	0	1.	1000000.

3s18	0	1.	1000000.

Boundary Slip Conditions
Volume 3s

North	South	East	West	Top	Bottom
SLIP	SLIP	SLIP	SLIP	SLIP	SLIP

X-Direction Noding
Volume 4s

Cell Plane	Distance (ft)	Width (ft)
1	0.	18.5
2	18.5	18.5

Y-Direction Noding
Volume 4s

Cell Plane	Distance (ft)	Depth (ft)
1	0.	38.
2	38.	39.
3	77.	38.

Z-Direction Noding
Volume 4s

Cell Plane	Distance (ft)	Height (ft)
1	0.	12.
2	12.	30.5
3	42.5	27.5

Cell Blockages
Volume 4s

Bl No.	Typ	X1	Y1	Z1	Coord X2	Y2	(ft) Z2	X3	(ft) Y3	Z3	L	B	N

X-Direction Cell Face Variations
Volume 4s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	55.7	0.	0.

Y-Direction Cell Face Variations
Volume 4s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	55.7	0.	0.

Z-Direction Cell Face Variations
Volume 4s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	55.7	0.	0.
4s1	0	1.	1000000.	0.	0.

4s2	0	1.	1000000.	0.	0.
4s3	0	1.	1000000.	0.	0.
4s4	0	1.	1000000.	0.	0.
4s5	0	1.	1000000.	0.	0.
4s6	0	1.	1000000.	0.	0.
4s7	0	1.	1000000.	0.	0.
4s8	0	1.	1000000.	0.	0.
4s9	0	1.	1000000.	0.	0.
4s10	0	1.	1000000.	0.	0.
4s11	0	1.	1000000.	0.	0.
4s12	0	1.	1000000.	0.	0.
4s13	0	1.	1000000.	0.	0.
4s14	0	1.	1000000.	0.	0.
4s15	0	1.	1000000.	0.	0.
4s16	0	1.	1000000.	0.	0.
4s17	0	1.	1000000.	0.	0.
4s18	0	1.	1000000.	0.	0.

Volume Variations
Volume 4s

Cell No.	Blockage No.	Volume Porosity	Hyd. Dia. (ft)
def	0	1.	55.7
4s1	0	1.	1000000.
4s2	0	1.	1000000.
4s3	0	1.	1000000.
4s4	0	1.	1000000.
4s5	0	1.	1000000.
4s6	0	1.	1000000.
4s7	0	1.	1000000.
4s8	0	1.	1000000.
4s9	0	1.	1000000.
4s10	0	1.	1000000.
4s11	0	1.	1000000.
4s12	0	1.	1000000.
4s13	0	1.	1000000.
4s14	0	1.	1000000.
4s15	0	1.	1000000.
4s16	0	1.	1000000.
4s17	0	1.	1000000.
4s18	0	1.	1000000.

Boundary Slip Conditions
Volume 4s

North	South	East	West	Top	Bottom
SLIP	SLIP	SLIP	SLIP	SLIP	SLIP

X-Direction Noding
Volume 5s

Cell Plane	Distance (ft)	Width (ft)
1	0.	18.
2	18.	18.

Y-Direction Noding
Volume 5s

Cell	Distance	Depth

Plane	(ft)	(ft)
1	0.	38.
2	38.	39.
3	77.	38.

Z-Direction Noding
Volume 5s

Cell Plane	Distance (ft)	Height (ft)
1	0.	12.
2	12.	30.5
3	42.5	27.5

Cell Blockages
Volume 5s

Bl No.	Typ	X1	Y1	Z1	Coord X2	Y2	(ft) Z2	X3	(ft) Y3	Z3	L
	B N										

X-Direction Cell Face Variations
Volume 5s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	55.1	0.	0.

Y-Direction Cell Face Variations
Volume 5s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	55.1	0.	0.

Z-Direction Cell Face Variations
Volume 5s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	55.1	0.	0.
5s1	0	1.	1000000.	0.	0.
5s2	0	1.	1000000.	0.	0.
5s3	0	1.	1000000.	0.	0.
5s4	0	1.	1000000.	0.	0.
5s5	0	1.	1000000.	0.	0.
5s6	0	1.	1000000.	0.	0.
5s7	0	1.	1000000.	0.	0.
5s8	0	1.	1000000.	0.	0.
5s9	0	1.	1000000.	0.	0.
5s10	0	1.	1000000.	0.	0.
5s11	0	1.	1000000.	0.	0.
5s12	0	1.	1000000.	0.	0.
5s13	0	1.	1000000.	0.	0.
5s14	0	1.	1000000.	0.	0.
5s15	0	1.	1000000.	0.	0.
5s16	0	1.	1000000.	0.	0.
5s17	0	1.	1000000.	0.	0.
5s18	0	1.	1000000.	0.	0.

Volume Variations
Volume 5s

Cell No.	Blockage No.	Volume Porosity	Hyd. Dia. (ft)
def	0	1.	55.1
5s1	0	1.	1000000.
5s2	0	1.	1000000.
5s3	0	1.	1000000.
5s4	0	1.	1000000.
5s5	0	1.	1000000.
5s6	0	1.	1000000.
5s7	0	1.	1000000.
5s8	0	1.	1000000.
5s9	0	1.	1000000.
5s10	0	1.	1000000.
5s11	0	1.	1000000.
5s12	0	1.	1000000.
5s13	0	1.	1000000.
5s14	0	1.	1000000.
5s15	0	1.	1000000.
5s16	0	1.	1000000.
5s17	0	1.	1000000.
5s18	0	1.	1000000.

Boundary Slip Conditions
Volume 5s

North	South	East	West	Top	Bottom
SLIP	SLIP	SLIP	SLIP	SLIP	SLIP

X-Direction Noding
Volume 6s

Cell Plane	Distance (ft)	Width (ft)
1	0.	17.5
2	17.5	17.5

Y-Direction Noding
Volume 6s

Cell Plane	Distance (ft)	Depth (ft)
1	0.	38.
2	38.	39.
3	77.	38.

Z-Direction Noding
Volume 6s

Cell Plane	Distance (ft)	Height (ft)
1	0.	12.
2	12.	30.5
3	42.5	27.5

Cell Blockages
Volume 6s

Bl No.	Typ		X1	Y1	Z1	X2 Coord	Y2	Z2 (ft)	X3	Y3 (ft)	Z3	L
	B	N										

X-Direction Cell Face Variations
Volume 6s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	53.7	0.	0.

Y-Direction Cell Face Variations
Volume 6s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	53.7	0.	0.

Z-Direction Cell Face Variations
Volume 6s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	53.7	0.	0.
6s1	0	1.	1000000.	0.	0.
6s2	0	1.	1000000.	0.	0.
6s3	0	1.	1000000.	0.	0.
6s4	0	1.	1000000.	0.	0.
6s5	0	1.	1000000.	0.	0.
6s6	0	1.	1000000.	0.	0.
6s7	0	1.	1000000.	0.	0.
6s8	0	1.	1000000.	0.	0.
6s9	0	1.	1000000.	0.	0.
6s10	0	1.	1000000.	0.	0.
6s11	0	1.	1000000.	0.	0.
6s12	0	1.	1000000.	0.	0.
6s13	0	1.	1000000.	0.	0.
6s14	0	1.	1000000.	0.	0.
6s15	0	1.	1000000.	0.	0.
6s16	0	1.	1000000.	0.	0.
6s17	0	1.	1000000.	0.	0.
6s18	0	1.	1000000.	0.	0.

Volume Variations
Volume 6s

Cell No.	Blockage No.	Volume Porosity	Hyd. Dia. (ft)
def	0	1.	53.7
6s1	0	1.	1000000.
6s2	0	1.	1000000.
6s3	0	1.	1000000.
6s4	0	1.	1000000.
6s5	0	1.	1000000.
6s6	0	1.	1000000.
6s7	0	1.	1000000.
6s8	0	1.	1000000.
6s9	0	1.	1000000.
6s10	0	1.	1000000.
6s11	0	1.	1000000.
6s12	0	1.	1000000.
6s13	0	1.	1000000.

6s14	0	1.	1000000.
6s15	0	1.	1000000.
6s16	0	1.	1000000.
6s17	0	1.	1000000.
6s18	0	1.	1000000.

Boundary Slip Conditions
Volume 6s

North	South	East	West	Top	Bottom
SLIP	SLIP	SLIP	SLIP	SLIP	SLIP

X-Direction Noding
Volume 7s

Cell Plane	Distance (ft)	Width (ft)
1	0.	19.
2	19.	19.

Y-Direction Noding
Volume 7s

Cell Plane	Distance (ft)	Depth (ft)
1	0.	38.
2	38.	39.
3	77.	38.

Z-Direction Noding
Volume 7s

Cell Plane	Distance (ft)	Height (ft)
1	0.	12.
2	12.	30.5
3	42.5	27.5

Cell Blockages
Volume 7s

Bl No.	Typ	X1	Y1	Z1	Coord X2	Y2	(ft) Z2	X3	(ft) Y3	Z3	L
	B N										

X-Direction Cell Face Variations
Volume 7s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	55.7	0.	0.
7s1	0	1.	56.8	0.	0.
7s2	0	1.	56.8	0.	0.
7s3	0	1.	56.8	0.	0.
7s4	0	1.	56.8	0.	0.
7s5	0	1.	56.8	0.	0.
7s6	0	1.	56.8	0.	0.
7s7	0	1.	56.8	0.	0.
7s8	0	1.	56.8	0.	0.
7s9	0	1.	56.8	0.	0.
7s10	0	1.	56.8	0.	0.
7s11	0	1.	56.8	0.	0.
7s12	0	1.	56.8	0.	0.

7s13	0	1.	56.8	0.	0.
7s14	0	1.	56.8	0.	0.
7s15	0	1.	56.8	0.	0.
7s16	0	1.	56.8	0.	0.
7s17	0	1.	56.8	0.	0.
7s18	0	1.	56.8	0.	0.

Y-Direction Cell Face Variations
Volume 7s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	55.7	0.	0.
7s1	0	1.	56.8	0.	0.
7s2	0	1.	56.8	0.	0.
7s3	0	1.	56.8	0.	0.
7s4	0	1.	56.8	0.	0.
7s5	0	1.	56.8	0.	0.
7s6	0	1.	56.8	0.	0.
7s7	0	1.	56.8	0.	0.
7s8	0	1.	56.8	0.	0.
7s9	0	1.	56.8	0.	0.
7s10	0	1.	56.8	0.	0.
7s11	0	1.	56.8	0.	0.
7s12	0	1.	56.8	0.	0.
7s13	0	1.	56.8	0.	0.
7s14	0	1.	56.8	0.	0.
7s15	0	1.	56.8	0.	0.
7s16	0	1.	56.8	0.	0.
7s17	0	1.	56.8	0.	0.
7s18	0	1.	56.8	0.	0.

Z-Direction Cell Face Variations
Volume 7s

Cell No.	Blockage No.	Area Fraction	Hyd. Dia. (ft)	Loss Coeff.	Drop De-ent. Factor
def	0	1.	55.7	0.	0.
7s1	0	1.	1000000.	0.	0.
7s2	0	1.	1000000.	0.	0.
7s3	0	1.	1000000.	0.	0.
7s4	0	1.	1000000.	0.	0.
7s5	0	1.	1000000.	0.	0.
7s6	0	1.	1000000.	0.	0.
7s7	0	1.	1000000.	0.	0.
7s8	0	1.	1000000.	0.	0.
7s9	0	1.	1000000.	0.	0.
7s10	0	1.	1000000.	0.	0.
7s11	0	1.	1000000.	0.	0.
7s12	0	1.	1000000.	0.	0.
7s13	0	1.	1000000.	0.	0.
7s14	0	1.	1000000.	0.	0.
7s15	0	1.	1000000.	0.	0.
7s16	0	1.	1000000.	0.	0.
7s17	0	1.	1000000.	0.	0.

7s18	0	1.	1000000.	0.	0.

Volume Variations
Volume 7s

Cell No.	Blockage No.	Volume Porosity	Hyd. Dia. (ft)
def	0	1.	55.7
7s1	0	1.	1000000.
7s2	0	1.	1000000.
7s3	0	1.	1000000.
7s4	0	1.	1000000.
7s5	0	1.	1000000.
7s6	0	1.	1000000.
7s7	0	1.	1000000.
7s8	0	1.	1000000.
7s9	0	1.	1000000.
7s10	0	1.	1000000.
7s11	0	1.	1000000.
7s12	0	1.	1000000.
7s13	0	1.	1000000.
7s14	0	1.	1000000.
7s15	0	1.	1000000.
7s16	0	1.	1000000.
7s17	0	1.	1000000.
7s18	0	1.	1000000.

Boundary Slip Conditions
Volume 7s

North	South	East	West	Top	Bottom
SLIP	SLIP	SLIP	SLIP	SLIP	SLIP

Turbulence Parameters

Vol #	Molec Diff.	Turb. Model	Liquid Mix.L. (ft)	Vapor Mix.L (ft)	Liquid Pr/Sc No.	Vapor Pr/Sc No.	Phase Option
1s	NO	NONE			1.	1.	VAPOR
2s	NO	NO			1.	1.	VAPOR
3s	NO	NO			1.	1.	VAPOR
4s	NO	NO			1.	1.	VAPOR
5s	NO	NO			1.	1.	VAPOR
6s	NO	NO			1.	1.	VAPOR
7s	NO	NO			1.	1.	VAPOR

Turbulence Sources

Vol #	Type	Phase	Kinetic Energy (ft2/s2)[*lbm/s]	FF	Dissipation (ft2/s3)[*lbm/s]	FF

Fluid Boundary Conditions - Table 1

BC#	Description	Press. (psia)	FF	Temp. (F)	FF	Flow (lbm/s)	FF	ON Trip	OFF Trip
1P	Outdoors	14.7		104					
2F	Break Source	1100.		e1190.4		**32.9**	1		
3F	steam tunnel	14.7		121		v41.67	0		
4F	ventilation 1	14.7		63		v103.33	0		
5F	ventilation 2	14.7		63		v105	0		
6F	ventilation 3	14.7		63		v218.33	0		

Leak Flow Rate

7F	ventilation 4	14.7	63	v140	0
8F	ventilation 5	14.7	63	v208.33	0
9F	ventilation 6	14.7	63	v155	0
10F	ventilation 7	14.7	63	v150	0
11F	ventilation 8	14.7	63	v150	0
12F	ventilation 9	14.7	63	v158.33	0
13F	ventilation 10	14.7	63	v160	0

Fluid Boundary Conditions - Table 2

BC#	Liq. V Frac.	FF	Stm. P.R.	FF	Drop D (in)	FF	Cpld BC#	Flow Frac.	FF	Heat (Btu/s)	FF	Outlet Quality	FF
1P	0.		h100		NONE							DEFAULT	
2F	0.		1		NONE							DEFAULT	
3F	0.		h20		NONE							DEFAULT	
4F	0.		h55		NONE							DEFAULT	
5F	0.		h55		NONE							DEFAULT	
6F	0.		h55		NONE							DEFAULT	
7F	0.		h55		NONE							DEFAULT	
8F	0.		h55		NONE							DEFAULT	
9F	0.		h55		NONE							DEFAULT	
10F	0.		h55		NONE							DEFAULT	
11F	0.		h55		NONE							DEFAULT	
12F	0.		h55		NONE							DEFAULT	
13F	0.		h55		NONE							DEFAULT	

Fluid Boundary Conditions - Table 3
Gas Pressure Ratios

BC#	Air Gas 1	FF	Gas 2	FF	Gas 3	FF	Gas 4	FF
1P	1.							
2F	1.							
3F	1.							
4F	1.							
5F	1.							
6F	1.							
7F	1.							
8F	1.							
9F	1.							
10F	1.							
11F	1.							
12F	1.							
13F	1.							

Fluid Boundary Conditions - Table 4
Gas Pressure Ratios

BC#	Gas 5	FF	Gas 6	FF	Gas 7	FF	Gas 8	FF
1P								
2F								
3F								
4F								
5F								
6F								
7F								
8F								
9F								
10F								

11F
12F
13F

Flow Paths - Table 1

F.P. #	Description	Vol A	Elev (ft)	Ht (ft)	Vol B	Elev (ft)	Ht (ft)
1	TB13/N/B	7s8	589.51	30.48	6s7	589.51	30.48
2	TB13/N/T	7s14	620.01	19.48	6s13	620.01	19.48
3	TB13/C/B	7s10	589.51	30.48	6s9	589.51	30.48
4	TB13/C/T	7s16	620.01	19.48	6s15	620.01	19.48
5	TB13/S/B	7s12	589.51	30.48	6s11	589.51	30.48
6	TB13/S/T	7s18	620.01	19.48	6s17	620.01	19.48
7	TB12/N/T	6s14	624.5	13.	5s13	624.5	13.
8	TB12/S/T	6s18	624.5	13.	5s17	624.5	13.
9	TB12/N/B	6s2	577.51	10.	5s1	577.51	10.
10	TB12/S/B	6s6	577.51	10.	5s5	577.51	10.
11	TB11/N/T	5s14	624.5	13.	4s13	624.5	10.
12	TB11/S/T	5s18	624.5	13.	4s17	624.5	10.
13	TB10/N/T	4s14	624.5	13.	3s13	624.5	13.
14	TB10/S/T	4s18	624.5	13.	3s17	624.5	13.
15	3/1N	3s13	647.4	0.01	1s3	647.51	0.1
16	3/1S	3s17	647.4	0.01	1s11	647.51	0.1
17	4/1N	4s13	647.4	0.01	1s3	647.51	0.1
18	4/1S	4s17	647.4	0.01	1s11	647.51	0.1
19	5/1N	5s13	647.4	0.01	1s2	647.51	0.1
20	5/1S	5s17	647.4	0.01	1s10	647.51	0.1
21	leakage path	1s19	714.	0.1	1P	714.	0.1
22	pipe break	**7s15**	**624.**	0.01	2F	**624.**	0.01
23	steam tunnel	7s17	620.5	23.	3F	620.5	23.
24	TB13/N/D	7s2	577.51	7.	6s1	577.51	7.
25	TB13/S/D	7s6	577.51	7.	6s5	577.51	7.
26	6/1N	6s13	647.4	0.01	1s2	647.51	0.1
27	6/2S	6s17	647.4	0.01	1s10	647.51	0.1
28	vent1	3s7	616.25	3.	4F	616.25	3.
29	vent2	3s17	624.6	3.	5F	624.6	3.
30	vent3	4s7	592.	3.	6F	592.	3.
31	vent4	4s17	624.6	3.	7F	624.6	3.
32	vent5	5s7	595.5	3.	8F	595.5	3.
33	vent6	5s17	624.6	3.	9F	624.6	3.
34	vent7	6s7	595.5	3.	10F	595.5	3.
35	vent8	6s11	615.	3.	11F	615.	3.
36	vent9	7s7	595.5	3.	12F	595.5	3.
37	vent10	7s11	607.75	3.	13F	607.75	3.
38	**coppus1**	7s9	602.	0.1	7s15	621.	0.1
39	**coppus2**	7s9	602.	0.1	7s15	621.	0.1

Leak Locations:
Leak #1 = 7s15
Leak #2 = 7s11
Leak #3 = 7s12

Leak Elevation:
Leak #1 = 624'
Leak #2 = 592'
Leak #3 = 592'

Hydraulic Lines for the Two Fans

Flow Paths - Table 2

Flow Path #	Flow Area (ft2)	Hyd. Diam. (ft)	Inertia Length (ft)	Friction Length (ft)	Relative Rough-ness	Dep Bend (deg)	Mom Trn Opt	Strat Flow Opt
1	915.	20.	30.	1.		0.	-	NONE
2	585.	20.	30.	1.		0.	-	NONE
3	793.	20.	30.	1.		0.	-	NONE
4	507.	20.	30.	1.		0.	-	NONE
5	915.	20.	30.	1.		0.	-	NONE
6	585.	20.	30.	1.		0.	-	NONE

7	390.	20.	30.	1.		0.	-	NONE
8	390.	20.	30.	1.		0.	-	NONE
9	40.	20.	30.	1.		0.	-	NONE
10	40.	20.	30.	1.		0.	-	NONE
11	390.	20.	30.	1.		0.	-	NONE
12	390.	20.	30.	1.		0.	-	NONE
13	390.	20.	30.	1.		0.	-	NONE
14	390.	20.	30.	1.		0.	-	NONE
15	242.	0.1	30.	1.		0.	-	NONE
16	242.	0.1	30.	1.		0.	-	NONE
17	242.	0.1	30.	1.		0.	-	NONE
18	242.	0.1	30.	1.		0.	-	NONE
19	242.	0.1	30.	1.		0.	-	NONE
20	242.	0.1	30.	1.		0.	-	NONE
21	10.	10.	30.	1.		0.	-	NONE
22	0.001	0.001	0.1	0.1		0.	-	NONE
23	500.	20.	70.	1.		0.	-	NONE
24	21.	3.	30.	1.		0.	-	NONE
25	21.	3.	30.	1.		0.	-	NONE
26	115.	5.	30.	1.		0.	-	NONE
27	115.	5.	30.	1.		0.	-	NONE
28	15.	4.	1.	1.		0.	-	NONE
29	15.	4.	1.	1.		0.	-	NONE
30	24.	4.	1.	1.		0.	-	NONE
31	20.	4.	1.	1.		0.	-	NONE
32	32.	4.	1.	1.		0.	-	NONE
33	24.	4.	1.	1.		0.	-	NONE
34	24.	4.	1.	1.		0.	-	NONE
35	24.	4.	1.	1.		0.	-	NONE
36	20.	4.	1.	1.		0.	-	NONE
37	24.	4.	1.	1.		0.	-	NONE
38	**0.35**	**0.67**	**1.**	**1.**			-	NONE
39	**0.35**	**0.67**	**1.**	**1.**			-	NONE

Hydraulic Line Characteristics

Flow Paths - Table 3

Flow Path #	Fwd. Loss Coeff.	Rev. Loss Coeff.	Comp. Opt.	Critical Flow Model	Exit Loss Coeff.	Drop Breakup Model
1	2.78	2.78	OFF	OFF	0.	OFF
2	2.78	2.78	OFF	OFF	0.	OFF
3	2.78	2.78	OFF	OFF	0.	OFF
4	2.78	2.78	OFF	OFF	0.	OFF
5	2.78	2.78	OFF	OFF	0.	OFF
6	2.78	2.78	OFF	OFF	0.	OFF
7	2.78	2.78	OFF	OFF	0.	OFF
8	2.78	2.78	OFF	OFF	0.	OFF
9	2.78	2.78	OFF	OFF	0.	OFF
10	2.78	2.78	OFF	OFF	0.	OFF
11	2.78	2.78	OFF	OFF	0.	OFF
12	2.78	2.78	OFF	OFF	0.	OFF
13	2.78	2.78	OFF	OFF	0.	OFF
14	2.78	2.78	OFF	OFF	0.	OFF
15	2.78	2.78	OFF	OFF	0.	OFF
16	2.78	2.78	OFF	OFF	0.	OFF
17	2.78	2.78	OFF	OFF	0.	OFF
18	2.78	2.78	OFF	OFF	0.	OFF
19	2.78	2.78	OFF	OFF	0.	OFF

20	2.78	2.78	OFF	OFF	0.	OFF
21	2.78	2.78	OFF	OFF	0.	OFF
22	2.78	2.78	ON	TABLES	1.	OFF
23	2.78	2.78	OFF	OFF	0.	OFF
24	2.78	2.78	OFF	OFF	0.	OFF
25	2.78	2.78	OFF	OFF	0.	OFF
26	2.78	2.78	OFF	OFF	0.	OFF
27	2.78	2.78	OFF	OFF	0.	OFF
28			OFF	OFF	0.	OFF
29			OFF	OFF	0.	OFF
30			OFF	OFF	0.	OFF
31			OFF	OFF	0.	OFF
32			OFF	OFF	0.	OFF
33			OFF	OFF	0.	OFF
34			OFF	OFF	0.	OFF
35			OFF	OFF	0.	OFF
36			OFF	OFF	0.	OFF
37			OFF	OFF	0.	OFF
38			OFF	OFF	0.	OFF
39			OFF	OFF	0.	OFF

Thermal Conductors - Table 1

Cond #	Description	Vol A	HT Co	Vol B	HT Co	Cond Type	S. A. (ft2)	Init. T.(F)	Or
1s	east wall	7s6-8	1	7s6-8	7	2	4824.	110.	I
2s	north wall	7s1-8	1	7s1-8	7	2	1700.	110.	I
3s	south wall	7s6-11	1	7s6-11	7	2	1700.	110.	I
4s	north wall	6s1-8	1	6s1-8	7	2	1488.	110.	I
5s	south wall	6s6-11	1	6s6-11	7	2	1488.	110.	I
6s	floor	7s2-5	2	7s2-5	7	2	4370.	110.	I
7s	floor	6s2-5	2	6s2-5	7	2	4024.	110.	I
8s	floor	5s5-2	2	5s5-2	7	2	4140.	110.	I
9s	floor	4s5-2	2	4s5-2	7	2	4255.	110.	I
10s	floor	3s5-2	2	3s5-2	7	2	3910.	110.	I
11s	north wall	5s1-8	1	5s1-8	7	2	1537.	110.	I
12s	south wall	5s6-11	1	5s6-11	7	2	1537.	110.	I
13s	north wall	4s1-8	1	4s1-8	7	2	1562.	110.	I
14s	south wall	4s6-11	1	4s6-11	7	2	1562.	110.	I
15s	north wall	3s1-8	1	3s1-8	7	2	1551.	110.	I
16s	south wall	3s6-11	1	3s6-11	7	2	1551.	110.	I
17s	north wall	1s1-4	1	1s1-4	5	2	12015.	110.	I
18s	south wall	1s9-12	1	1s9-12	5	2	12015.	110.	I
19s	east wall	1s1-5	1	1s1-5	5	2	3105.	110.	I
20s	west wall	1s12-4	1	1s12-4	5	2	3105.	110.	I
21s	roof	1s21-1	5	1s21-1	4	3	51175.	120.	I
22s	N upper wall	1s16-2	1	1s16-2	5	3	17889.	120.	I
23s	S upper wall	1s13-2	1	1s13-2	5	3	17889.	120.	I
24s	E upper wall	1s16-1	1	1s16-1	5	3	4623.	120.	I
25s	W upper wall	1s24-2	1	1s24-2	5	3	4623.	120.	I
26s	V1 heat	1s24-1	1	1s24-1	8	4	10000.	120.	I
27s	V3 heat	3s18-1	1	3s18-1	8	4	10000.	120.	I
28s	V4 heat	4s18-1	1	4s18-1	8	4	10000.	120.	I
29s	V5 heat	5s18-1	1	5s18-1	8	4	10000.	120.	I
30s	V6 heat	6s18-1	1	6s18-1	8	4	10000.	120.	I
31s	V7 heat	7s18-1	1	7s18-1	8	4	10000.	120.	I
32s	CV3 steel	3s1-18	1	3s1-18	1	5	14770.	120.	I
33s	CV4 steel	4s1-18	1	4s1-18	1	5	16256.	120.	I

34s	CV5 steel	5s1-18	1	5s1-18	1	5	16121.	120.	I
35s	CV6 steel	6s1-18	1	6s1-18	1	8	29621.	120.	I
36s	CV7 steel	7s1-18	1	7s1-18	1	9	37221.	120.	I
37s	east upper wall	7s14-1	1	7s14-1	5	2	3121.	120.	I
38s	north upper wal	7s13-1	1	7s13-1	5	2	1100.	120.	I
39s	south upper wal	7s17-1	1	7s17-1	5	2	1100.	120.	I
40s	north upper wal	6s13-1	1	6s13-1	5	2	962.	120.	I
41s	south upper wal	6s17-1	1	6s17-1	5	2	962.	120.	I
42s	north upper wal	5s13-1	1	5s13-1	5	2	995.	120.	I
43s	south upper wal	5s17-1	1	5s17-1	5	2	995.	120.	I
44s	north upper wal	4s14-1	1	4s14-1	5	2	1011.	120.	I
45s	south upper wal	4s17-1	1	4s17-1	5	2	1011.	120.	I
46s	north upper wal	3s13-1	1	3s13-1	5	2	1004.	120.	I
47s	south upper wal	3s17-1	1	3s17-1	5	2	1004.	120.	I

Thermal Conductors - Table 2

Cond #	Therm. Rad. Side A	Emiss. Side A	Therm. Rad. Side B	Emiss. Side B
1s	No		No	
2s	No		No	
3s	No		No	
4s	No		No	
5s	No		No	
6s	No		No	
7s	No		No	
8s	No		No	
9s	No		No	
10s	No		No	
11s	No		No	
12s	No		No	
13s	No		No	
14s	No		No	
15s	No		No	
16s	No		No	
17s	No		No	
18s	No		No	
19s	No		No	
20s	No		No	
21s	No		No	
22s	No		No	
23s	No		No	
24s	No		No	
25s	No		No	
26s	No		No	
27s	No		No	
28s	No		No	
29s	No		No	
30s	No		No	
31s	No		No	
32s	No		No	
33s	No		No	
34s	No		No	
35s	No		No	
36s	No		No	
37s	No		No	

38s	No	No
39s	No	No
40s	No	No
41s	No	No
42s	No	No
43s	No	No
44s	No	No
45s	No	No
46s	No	No
47s	No	No

Heat Transfer Coefficient Types - Table 1

Type #	Heat Transfer Option	Nominal Value	FF	Cnd Cnv Opt	Cnd Opt	Sp Cnv HTC	Nat Cnv Opt	For Cnv Opt	Rad Opt
1	Direct			ADD	MAX		VERT SURF	PIPE FLOW	ON
2	Direct			ADD	MAX		FACE UP	PIPE FLOW	ON
3	Sp Heat	0.							
4	Direct			ADD	MAX		FACE DOWN	PIPE FLOW	ON
5	Sp Ambie	104.				6			
6	Sp Conv	1.46							ON
7	Sp Temp	53.							
8	Sp Heat	155.	2						

Heat Transfer Coefficient Types - Table 2

Type #	Phase Opt	Min Liq Fract	Max Liq Fract	Convect Bulk T Model	FF	Condensa Bulk T Model	FF
1	VAP			Tg-Tf		Tb-Tw	
2	VAP			Tg-Tf		Tb-Tw	
3							
4	VAP			Tg-Tf		Tb-Tw	
5							
6	VAP			Tg-Tw			
7							
8							

Heat Transfer Coefficient Types - Table 3

Type #	Char. Length (ft)	Nat Coef FF	Exp FF	For Coef FF	Exp FF	Nom Vel (ft/s)	Vel FF	Minimum Conv HTC (B/h-f2-F)
1								DEFAULT
2								DEFAULT
3								
4								DEFAULT
5								
6								
7								
8								

HTC Types - Table 4

Type #	Total Heat (Btu)	Peak Time (sec)	Initial Value (B/h-f2-F)	Post-BD Direct FF
1				
2				
3				

4
5
6
7
8

Thermal Conductor Types

Type #	Description	Geom	Thick. (in)	O.D. (in)	Regions	Heat (Btu/ft3-s)	Heat FF
1	insul concrete	WALL	12.	0.	7	0.	
2	cond concrete	WALL	36.	0.	16	0.	
3	sheet metal	WALL	0.1	0.	2	0.	
4	area heat	WALL	0.5	0.	1	0.	0
5	Zone 3 steel	WALL	0.17	0.	7	0.	
6	Zone 4 steel	WALL	0.5	0.	10	0.	
7	Zone 5 steel	WALL	0.49	0.	10	0.	
8	Zone 6 steel	WALL	0.15	0.	7	0.	
9	Zone 7 steel	WALL	0.16	0.	7	0.	

Thermal Conductor Type
1
insul concrete

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.12	1	0.
2	1	0.12	0.24	1	0.
3	1	0.36	0.48	1	0.
4	1	0.84	0.96	1	0.
5	1	1.8	1.92	1	0.
6	1	3.72	4.140001	1	0.
7	1	7.860001	4.139999	1	0.

Thermal Conductor Type
2
cond concrete

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.12	1	0.
2	1	0.12	0.24	1	0.
3	1	0.36	0.48	1	0.
4	1	0.84	0.96	1	0.
5	1	1.8	1.92	1	0.
6	1	3.72	3.84	1	0.
7	1	7.56	7.68	1	0.
8	1	15.24	5.190001	1	0.
9	1	20.43	5.19	1	0.
10	1	25.62	3.329996	1	0.
11	1	28.95	3.329993	1	0.
12	1	32.27999	1.920005	1	0.
13	1	34.2	0.960003	1	0.
14	1	35.16	0.480000	1	0.
15	1	35.64	0.240000	1	0.
16	1	35.88	0.119998	1	0.

Thermal Conductor Type
3
sheet metal

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	0.05	1	0.
2	1	0.05	0.05	1	0.

Thermal Conductor Type
4
area heat

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	2	0.	0.5	1	0.

Thermal Conductor Type
5
Zone 3 steel

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	2	0.	0.0132	1	0.
2	2	0.0132	0.0264	1	0.
3	2	0.0396	0.0326	1	0.
4	2	0.0722	0.0326	1	0.
5	2	0.1048	0.026	1	0.
6	2	0.1308	0.026	1	0.
7	2	0.1568	0.0132	1	0.

Thermal Conductor Type
6
Zone 4 steel

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	2	0.	0.0132	1	0.
2	2	0.0132	0.0264	1	0.
3	2	0.0396	0.0528	1	0.
4	2	0.0924	0.1056	1	0.
5	2	0.198	0.0755	1	0.
6	2	0.2735	0.0755	1	0.
7	2	0.349	0.0557	1	0.
8	2	0.4047	0.0557	1	0.
9	2	0.4604	0.0264	1	0.
10	2	0.4868	0.0132	1	0.

Thermal Conductor Type
7
Zone 5 steel

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	2	0.	0.0132	1	0.
2	2	0.0132	0.0264	1	0.
3	2	0.0396	0.0528	1	0.
4	2	0.0924	0.1056	1	0.
5	2	0.198	0.073	1	0.
6	2	0.271	0.073	1	0.
7	2	0.344	0.0532	1	0.
8	2	0.3972	0.0532	1	0.
9	2	0.4504	0.0264	1	0.
10	2	0.4768	0.0132	1	0.

Thermal Conductor Type
8
Zone 6 steel

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	2	0.	0.0132	1	0.
2	2	0.0132	0.0264	1	0.
3	2	0.0396	0.0276	1	0.
4	2	0.0672	0.0276	1	0.
5	2	0.0948	0.021	1	0.
6	2	0.1158	0.021	1	0.
7	2	0.1368	0.0132	1	0.

Thermal Conductor Type
9
Zone 7 steel

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	2	0.	0.0132	1	0.
2	2	0.0132	0.0264	1	0.
3	2	0.0396	0.0301	1	0.
4	2	0.0697	0.0301	1	0.
5	2	0.0998	0.0235	1	0.
6	2	0.1233	0.0235	1	0.
7	2	0.1468	0.0132	1	0.

Volumetric Fan - Table 1

Vol Fan #	Description	Flow Path #	On Trip #	Off Trip #	Min DP (psi)	Max DP (psi)
1Q	coppus1	38			DEFAULT	DEFAULT
2Q	coppus2	39			DEFAULT	DEFAULT

Volumetric Fan - Table 2

Vol Fan #	Flow Option	Flow Rate (CFM)	Flow Rate FF	Heat Option	Heat Rate (Btu/s)	Heat Rate FF	Disch Vol
1Q	Time	**1000.**		Time			**7s15**
2Q	Time	**1000.**		Time			**7s15**

Fan Flow Rate

Fan Discharge Location

Volume Initial Conditions

Vol #	Pressure (psia)	Vapor Temp. (F)	Liquid Temp. F	Relative Humidity (%)	Liquid Volume Fractio	Ice Volume Fract.	Ice Surf.A. (ft2)
def	14.7	80.	80.	60.	0.	0.	0.
1s	14.7	130.	130.	90.	0.	0.	0.
2s	14.7	105.	105.	50.	0.	0.	0.
3s	14.7	130.	130.	90.	0.	0.	0.
4s	14.7	130.	130.	90.	0.	0.	0.
5s	14.7	130.	130.	90.	0.	0.	0.
6s	14.7	130.	130.	90.	0.	0.	0.
7s	14.7	130.	130.	90.	0.	0.	0.

Initial Gas Pressure Ratios

Vol #	Air Gas 1	Gas 2	Gas 3	Gas 4	Gas 5	Gas 6	Gas 7	Gas 8
def	1.	0.	0.	0.	0.	0.	0.	0.

1s	1.	0.	0.	0.	0.	0.	0.	0.
2s	1.	0.	0.	0.	0.	0.	0.	0.
3s	1.	0.	0.	0.	0.	0.	0.	0.
4s	1.	0.	0.	0.	0.	0.	0.	0.
5s	1.	0.	0.	0.	0.	0.	0.	0.
6s	1.	0.	0.	0.	0.	0.	0.	0.
7s	1.	0.	0.	0.	0.	0.	0.	0.

Noncondensing Gases

Gas No.	Description	Symbol	Type	Mol. Weight	Lennard-Jones Diameter (Ang)	Parameters e/K (K)
1	Air	Air	POLY	28.97	3.617	97.

Noncondensing Gases - Cp/Visc. Equations

Gas	Cp Equation (Required)			Visc. Equation (Optional)		
No.	Tmin (R)	Tmax (R)	Cp (Btu/lbm-R)	Tmin (R)	Tmax (R)	Viscosity (lbm/ft-hr)
1	360.	2280.	0.238534-6.2006			

Materials

Type #	Description
1	concrete
2	steel

Material Type
1
concrete

Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
0.	140.	1.	0.2
1000.	140.	1.	0.2

Material Type
2
steel

Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
0.	490.	11.	0.11
5000.	490.	11.	0.11

Ice Condenser Parameters

Initial Temp. (F)	Bulk Density (lbm/ft3)	Surface Area Multiplier Function	Heat Transfer Option
15.	33.43		UCHIDA

Functions

FF#	Description	Ind. Var.	Dep. Var.	Points
0	Constant	-	-	0
1	break flow rati	Ind. Var.	Dep. Var.	4
2	heat rate	Ind. Var.	Dep. Var.	3

Function
1

break flow ratio
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	3600.	0.
3601.	1.	1000000.	1.

Function
2
heat rate
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.7	1000.	1.
1000000.	1.		

FPDOSE Control

Options	Setting	Units
Generate FPDOSE Input	NO	
Transfer Time Interval	0.0	s
Isolation Valve #	-	
Washout Factor	0.0	
Containment Leak Rate/Pressure	0.0	%/hr-psig
Vacuum Bldg Leak Rate/Pressure	0.0	%/hr-psig

FPDOSE Volume Types

Vol #	Type	FP Transfer Option	Transfer Vol. Frac.
1s	NORMAL	NORMAL	0.
2s	NORMAL	NORMAL	0.
3s	NORMAL	NORMAL	0.
4s	NORMAL	NORMAL	0.
5s	NORMAL	NORMAL	0.
6s	NORMAL	NORMAL	0.
7s	NORMAL	NORMAL	0.

Run Control Parameters (Seconds)

Time Dom	DT Min	DT Max	DT Ratio	End Time	Print Int	Graph Int	Max CPU	Dump Int	Phs Chng Time Scale
1	1e-008	10.	1e+009	10.	10.	1.	1e+006	0.	DEFAULT
2	1e-008	20.	1.	7200.	7200.	20.	1e+006	0.	DEFAULT
3	1e-008	20.	1.	90000.	90000.	1000.	1e+006	0.	DEFAULT

Solution Options

Time Dom	Solution Method	Imp Conv Limit	Imp Iter Limit	Pres Sol Method	Pres Conv Limit	Pres Iter Limit	Differ Scheme	Burn Sharp
1	SEMI-IMP	0.	1	DIRECT	0.	1	FOUP	0.0
2	SEMI-IMP	0.	1	DIRECT	0.	1	FOUP	0.0
3	SEMI-IMP	0.	1	DIRECT	0.	1	FOUP	0.0

Run Options

Options	Setting
Restart Time (sec)	0.0
Restart Time Step #	0
Restart Time Control	NEW
Revaporization Fraction	DEFAULT
Fog Model	OFF

Maximum Mist Density	DEFAULT
Drop Diam. From Mist	DEFAULT
Minimum HT Coeff.	0.0
Reference Pressure	IGNORE
Forced Ent. Drop Diam.	DEFAULT
Vapor Phase Head Correction	INCLUDE
Kinetic Energy	IGNORE
Vapor Phase	INCLUDE
Liquid Phase	INCLUDE
Drop Phase	INCLUDE
Force Equilibrium	IGNORE
Drop-Liq. Conversion	INCLUDE
QA Logging	OFF
Debug Output Level	0
Restart Dump on CPU Interval (sec)	3600.

Graphs

Graph #	Title	Mon	Curve Number 1	2	3	4	5
1			TV7s16	TV6s15	TV1s19	TV7s15	
2			TV4s14	TV4s8	TV4s2		
3			PR7s16	PR1s7			
4			1R7s15	SR7s15			
5			TV6s15	TV5s15	TV4s15	TV3s15	
6			FV21	FV23	FV22	FL22	FD22
7			FV15	FV16	FV17	FV18	FV19
8			LL7s3	LL6s3			
9			TV7s15	TV7s12			
10			TP1s8t1				
11			TL7s3				
12			TV6s11	TV7s16	TV7s18	TV7s13	
13			**TV7s15**				
14			TP6s1t1	TP6s1t1	TP6s1t4	TP6s1t8	
15			TP36s1t	TP36s1t	TP36s1t	TP36s1t	TP36s1t
16			TP31s1t	TP31s1t	TP31s1t	TP31s1t	
17			RH7s15				
18			AL7s3				

Leak Location:
Leak #1 = V7s15
Leak #2 = V7s11
Leak #3 = V7s12

Envelope Sets

Set No.	Set Type	Description	No. Items

GOTHIC Output Data for 32.90 Lb_m/sec Leak