RS-19-093 Enclosure A

DRE19-0015, Revision 0a

Dresden Units 2 & 3 Secondary Containment Drawdown Analysis

Design Analysis Cover Sheet Form

Page 1

Design Analysis		**Last Page No.** ⁶	39, G2
Analysis No.: ¹	DRE19-0015	**Revision:** ²	0A Major ☐ Minor ☒
Title: ³	Dresden Units 2 & 3 Secondary Containment Drawdown Analysis		
EC No.: ⁴	628318	**Revision:** ⁵	0

		Component(s): ¹⁴	
Station(s): ⁷	Dresden	N/A	
Unit No.: ⁸	2, 3		
Discipline: ⁹	MEDC		
Descrip. Code/Keyword: ¹⁰	N02		
Safety/QA Class: ¹¹	Safety-Related		
System Code: ¹²	01, 75		
Structure: ¹³	N/A		

CONTROLLED DOCUMENT REFERENCES ¹⁵

Document No.:	From/To	Document No.:	From/To
See Section 4			
DRE05-0048	To		

Is this Design Analysis Safeguards Information? ¹⁶ Yes ☐ No ☒ If yes, see SY-AA-101-106

Does this Design Analysis contain Unverified Assumptions? ¹⁷ Yes ☐ No ☒ If yes, ATI/AR#:

This Design Analysis SUPERCEDES: ¹⁸ **in its entirety.**

Description of Revision (list changed pages when all pages of original analysis were not changed): ¹⁹
Updated Attachment E to Revision 1 of TODI 19-007. Affected pages: 1-5, 15, 39, all pages of Attachment E.

	Print Name	Sign Name	Date
Preparer: ²⁰	John Wright (ENERCON)	John Wright	10/17/19

Method of Review: ²¹ **Detailed Review** ☒ **Alternate Calculations (attached)** ☐ **Testing** ☐

	Print Name	Sign Name	Date
Reviewer: ²²	Guy Spikes (ENERCON)	Guy Spikes	10-17-19

Review Notes: ²³ Independent review ☒ Peer review ☐

The document has been reviewed in its entirety and found to be acceptable. All recommended changes were discussed, accepted, and incorporated into the final document. The review was performed by the preparer's supervisor. The supervisor is the only technically qualified person available. The need to use the supervisor was approved by the supervisor's manager.

	Print Name	Sign Name	Date
(For External Analyses Only) **External Approver:** ²⁴	Jeffrey Head (ENERCON)	Jeffrey Head	10/17/19
Exelon Reviewer: ²⁵	Dan Lee	Dan K Lee	10/17/19

Independent 3rd Party Review Reqd? ²⁶ Yes ☐ No ☒

	Print Name	Sign Name	Date
Exelon Approver: ²⁷	Brian T. Madderom		10/18/19

Attachment 2
Owner's Acceptance Review checklist for External Design Analysis
Page 1 of 3

Design Analysis No.: DRE19-0015 Rev: 0A Page 2
Contract #: 597114 Release #: 151

No	Question	Instructions and Guidance	Yes / No / N/A
1	Do assumptions have sufficient documented rationale?	All Assumptions should be stated in clear terms with enough justification to confirm that the assumption is conservative. For example, 1) the exact value of a particular parameter may not be known or that parameter may be known to vary over the range of conditions covered by the Calculation. It is appropriate to represent or bound the parameter with an assumed value. 2) The predicted performance of a specific piece of equipment in lieu of actual test data. It is appropriate to use the documented opinion/position of a recognized expert on that equipment to represent predicted equipment performance. Consideration should also be given as to any qualification testing that may be needed to validate the Assumptions. Ask yourself, would you provide more justification if you were performing this analysis? **If** yes, the rationale is likely incomplete.	☒ ☐ ☐
2	Are assumptions compatible with the way the plant is operated and with the licensing basis?	Ensure the documentation for source and rationale for the assumption supports the way the plant is currently or will be operated post change and they are not in conflict with any design parameters. If the Analysis purpose is to establish a new licensing basis, this question can be answered yes, if the assumption supports that new basis.	☒ ☐ ☐
3	Do all unverified assumptions have a tracking and closure mechanism in place?	**If** there are unverified assumptions without a tracking mechanism indicated, **then** create the tracking item either through an ATI or a work order attached to the implementing WO. Due dates for these actions need to support verification prior to the analysis becoming operational or the resultant plant change being op authorized.	☐ ☐ ☒
4	Do the design inputs have sufficient rationale?	The origin of the input, or the source should be identified and be readily retrievable within Exelon's documentation system. If not, then the source should be attached to the analysis. Ask yourself, would you provide more justification if you were performing this analysis? **If** yes, the rationale is likely incomplete.	☒ ☐ ☐
5	Are design inputs correct and reasonable with critical parameters identified, if appropriate?	The expectation is that an Exelon Engineer should be able to clearly understand which input parameters are critical to the outcome of the analysis. That is, what is the impact of a change in the parameter to the results of the analysis? If the impact is large, then that parameter is critical.	☒ ☐ ☐
6	Are design inputs compatible with the way the plant is operated and with the licensing basis?	Ensure the documentation for source and rationale for the inputs supports the way the plant is currently or will be operated post change and they are not in conflict with any design parameters.	☒ ☐ ☐

Attachment 2
Owner's Acceptance Review checklist for External Design Analysis
Page 2 of 3

Design Analysis No.: DRE19-0015 Rev: 0A Page 3

No	Question	Instructions and Guidance	Yes / No / N/A
7	Are Engineering Judgments clearly documented and justified?	See Section 2.13 in CC-AA-309 for the attributes that are sufficient to justify Engineering Judgment. Ask yourself, would you provide more justification if you were performing this analysis? **If** yes, the rationale is likely incomplete.	☒ ☐ ☐
8	Are Engineering Judgments compatible with the way the plant is operated and with the licensing basis?	Ensure the justification for the engineering judgment supports the way the plant is currently or will be operated post change and is not in conflict with any design parameters. **If** the Analysis purpose is to establish a new licensing basis, **then** this question can be answered yes, if the judgment supports that new basis.	☒ ☐ ☐
9	Do the results and conclusions satisfy the purpose and objective of the Design Analysis?	Why was the analysis being performed? Does the stated purpose match the expectation from Exelon on the proposed application of the results? **If** yes, **then** the analysis meets the needs of the contract.	☒ ☐ ☐
10	Are the results and conclusions compatible with the way the plant is operated and with the licensing basis?	Make sure that the results support the UFSAR defined system design and operating conditions, or they support a proposed change to those conditions. If the analysis supports a change, are all of the other changing documents included on the cover sheet as impacted documents?	☒ ☐ ☐
11	Have any limitations on the use of the results been identified and transmitted to the appropriate organizations?	Does the analysis support a temporary condition or procedure change? Make sure that any other documents needing to be updated are included and clearly delineated in the design analysis. Make sure that the cover sheet includes the other documents where the results of this analysis provide the input.	☐ ☐ ☒
12	Have margin impacts been identified and documented appropriately for any negative impacts (Reference ER-AA-2007)?	Make sure that the impacts to margin are clearly shown within the body of the analysis. If the analysis results in reduced margins ensure that this has been appropriately dispositioned in the EC being used to issue the analysis.	☐ ☐ ☒
13	Does the Design Analysis include the applicable design basis documentation?	Are there sufficient documents included to support the sources of input, and other reference material that is not readily retrievable in Exelon controlled Documents?	☒ ☐ ☐
14	Have all affected design analyses been documented on the Affected Documents List (ADL) for the associated Configuration Change?	Determine if sufficient searches have been performed to identify any related analyses that need to be revised along with the base analysis. It may be necessary to perform some basic searches to validate this.	☒ ☐ ☐
15	Do the sources of inputs **and** analysis methodology used meet committed technical and regulatory requirements?	Compare any referenced codes and standards to the current design basis and ensure that any differences are reconciled. If the input sources **or** analysis methodology are based on an out-of-date methodology or code, additional reconciliation may be required if the site has since committed to a more recent code	☒ ☐ ☐

Attachment 2
Owner's Acceptance Review checklist for External Design Analysis
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Design Analysis No.: DRE19-0015 Rev: 0A Page 4

No	Question	Instructions and Guidance	Yes / No / N/A
16	Have vendor supporting technical documents and references (including GE DRFs) been reviewed when necessary?	Based on the risk assessment performed during the pre-job brief for the analysis (per HU-AA-1212), ensure that sufficient reviews of any supporting documents not provided with the final analysis are performed.	☒ ☐ ☐
17	Do operational limits support assumptions and inputs?	Ensure the Tech Specs, Operating Procedures, etc. contain operational limits that support the analysis assumptions and inputs.	☒ ☐ ☐
18.	List the critical characteristics of the product, and validate those critical characteristics. Rx Building modelling, SBGT and Drywell spray performance		

Create an SFMS entry as required by CC-AA-4008. SFMS Number: 66007

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A. GOTHIC Model Schematic Diagram	1 page
B. GOTHIC input File for Case 1 and Changes for Cases 2, 3, and 4	46 pages
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1. PURPOSE

The purpose of this analysis is to determine the Reactor Building (RB) pressure response following a design basis loss of coolant accident (LOCA) with a coincident loss of offsite power (LOOP) at Dresden Nuclear Power Station Units 2 and 3.

The Reactor Building forms part of the Secondary Containment (SC). (Ref. 12.a) The Reactor Building is normally maintained at a slight negative gauge pressure by the Reactor Building Ventilation system. Following an accident, the Reactor Building Ventilation system isolates and the Standby Gas Treatment (SGT) system is initiated. The heatup of the Reactor Building after isolation causes the RB pressure to increase until the SGT system capacity is sufficient to overcome the expansion of the RB air volume and subsequently reduce the RB pressure. If the RB pressure is positive with respect to the outside air pressure, then any leakage from the Reactor Building is out-leakage. NRC Regulatory Guide (RG) 1.183 Appendix A paragraph 4.2 (Ref. 1) states that leakage from Primary Containment is assumed to be released directly to the environment as a ground-level release during any period in which the Secondary Containment does not have a negative pressure as defined in the Technical Specifications. RG 1.183 also states that the effect of high wind speeds on the ability of the secondary containment to maintain a negative pressure should be evaluated on an individual case basis. RG 1.183 also states that ambient temperature used in these assessments should be conservative for the intended use, e.g. high temperatures if limiting. Therefore, RB pressures will be calculated for both summer and winter conditions to determine the most limiting conditions. RB pressures will also be calculated for calm conditions and at the maximum assumed wind speed. The time duration after the LOCA occurs that the RB/SC pressure, measured with respect to the external ambient pressure, is greater than Dresden Technical Specification (TS) value of -0.25 inwg, as defined by TS SR 3.6.4.1.3, is referred to as the drawdown time in this analysis.

2. INPUTS

1. The Reactor Building geometry and heat loads are specified in Exelon calculation DRE97-0214. (Ref. 2) The Reactor Building volumes, wall dimensions, opening areas, and post LOCA heat loads are listed in Appendices A and D and Tables F1 and I6 of Ref. 2.

2. One SGT subsystem can maintain the Secondary Containment at a minimum vacuum pressure of 0.25 inwg with a maximum flow rate of 4000 cfm under calm wind conditions. (Refs. 10.c, 10.e, 12.a, 13)

3. The maximum SGT pressure drop is 16.2 inwg at a flow rate of 4000 cfm. (Ref. 9.a)

4. The SGT fan capacity is 3975 cfm at a static pressure of 16 inwg. (Ref. 9.b)

5. The primary SGT subsystem is initiated on a SC isolation signal after a LOCA. (Refs. 10.e, 12.a, 12.b, 17)

6. The failure of the primary SGT subsystem to start within 20 seconds will initiate the automatic start and alignment of the standby SGT subsystem. (Ref. 10.e, 12.b, 18)

7. The two normally closed SGT isolation valves in each subsystem (2/3-7505A/B and 2/3 - 7507A/B) have maximum opening times of 67 and 14.7 seconds, respectively. (Refs. 19, 43)

8. The SGT systems take suction from all elevations of the Reactor Building via the RB ventilation system. (Ref. 22, 23, 24) The SGT system discharges via the top of the 310 ft SGT exhaust stack at an elevation of 827' 6". (Refs. 12.a, 21, 22)

9. The RB ventilation fans trip and RB ventilation isolation valves begin closing in both units immediately after a LOCA initiation signal, i.e. high drywell pressure, low reactor water level or high drywell radiation. (Refs. 12.a, 12.d, 15, 17, 43)

10. The maximum closing time of the normally open RB ventilation supply and exhaust SC isolation valves is 300 seconds. (Refs. 10.d, 11, 23, 24)

11. The RB ventilation supply intake louvers are located at an elevation of 581'4" and the RB ventilation exhaust stack discharges at an elevation of 676' 4 ½". (Ref. 21, 25, 26) The unit 2 intake is located on the east side of the Reactor Building and the unit 3 intake on the west side.

3. ASSUMPTIONS

RG 1.183 states that assumptions regarding the occurrence and timing of a loss of offsite power (LOOP) should be selected with the objective of maximizing the postulated radiological consequences. Therefore, LOOP or no/LOOP conditions are conservatively utilized for the individual assumptions to maximize the drawdown time: LOOP conditions are assumed for SGT operation (see Assumption 29) and Suppression Pool temperature response (Assumption 14) while no LOOP conditions are assumed for the Reactor Building heat loads. (Assumption 19) Therefore, separate cases for LOOP and no LOOP conditions are not required to determine which condition provides the limiting drawdown time. However, this added conservatism does not result in excessive margin in the limiting drawdown time.

1. The outside air temperature is assumed to remain constant at the summer design temperature of 93 ^{o}F during summer conditions and at -6 ^{o}F during winter conditions. (Ref. 12.d) Per RG 1.183 (Ref. 1), the ambient temperature should be the 1-hour average value that is exceeded only 5% (for summer conditions) and 95% (for winter conditions) of the total number of hours in the data set. The assumed temperatures conservatively bound the summer 1% and winter 99% exceedance values of 91 ^{o}F and 0 ^{o}F, respectively, in the vicinity of Dresden (i.e. West Chicago, Illinois) from Reference 38 Chapter 26 Tables 1A and 1B.

2. The outside air relative humidity is 0%, which results in the highest air density at a given temperature (Ref. 38 Chapter 6 Table 2). This will conservatively provide the maximum mass of air in-leakage into the Reactor Building and will result in the highest wind pressures.

3. The outside air pressure is 14.7 psia at the Dresden RB ground floor elevation of 517' 6". (Ref. 21)

4. The initial temperature of the Reactor Building is maintained at 103 °F during summer conditions and 65 °F during winter conditions. These correspond to the maximum and minimum design temperatures for the RB ventilation system. (Ref. 12.d, 3)

5. The initial relative humidity in the Reactor Building is at the minimum of 20% during normal conditions. (Ref. 3) Moist air has a lower density than dry air at a given temperature (Ref. 38 Chapter 6 Table 2) and results in the minimum mass of air removed from the Reactor Building during SGT operation. However, dry air has a much lower enthalpy than moist air and results in the fastest room heat-up rates. The minimum initial relative humidity of 20% will be assumed for this analysis since this results in a slightly longer limiting drawdown time for Dresden. (see Attachment G)

6. All the equipment hatches in the Reactor Building floors from the Mezzanine level up to the Reactor level are assumed to be open, consistent with Appendix F of Reference 2. The equipment hatches in the Refueling floor are also assumed to be open in this analysis. The hatch in the Refueling floor at the 613' elevation is normally open and only closed/tarped during an outage. (Refs. 16, 43, Attachment E) Therefore, both these hatches will be open since both units are assumed to be in normal operation prior to the LOCA. (Assumption 19)

7. A door is open between Units 2 and 3 on the ground floor elevation, consistent with Appendix F of Reference 2 and Attachment E. (Ref. 43)

8. The area of stairwells between RB levels and other penetrations between levels and units will be conservatively neglected in calculating the Reactor Building flow areas to maximize the pressure difference between RB volumes.

9. Each of the RB openings is assumed to have a loss coefficient of 2.85 to maximize the pressure difference between volumes. This corresponds to the maximum loss coefficient for a wall opening per Diagram 4-18 of Ref. 41. Friction losses in the RB internal flow paths are negligible compared to the assumed loss coefficient.

10. Heat transfer from external Reactor Building walls to adjacent areas and to the external environment will be conservatively neglected, other than heat transfer from the Main Steam Tunnel and from the refueling floor walls and roof to the outside air. Although the Diesel Generator (DG) Room temperature from Table 2 of Ref. 2 is higher than the initial Reactor Building temperature, heat transfer from this room would be offset by heat losses to other adjacent areas due to the relatively small surface area of the DG Room wall (Ref. 2 Appendix A and D). However, heat transfer from the Reactor Building to the internal surfaces of the exterior walls will be included, but with an insulated (adiabatic) boundary condition on the outer surface to prevent heat transfer from this surface to the adjacent areas.

11. Heat transfer to internal RB walls between interior areas of the Reactor Building, other than the walls to the drywell (DW), spent fuel pool (SFP), floors between elevations and internal walls between the two units, will be conservatively neglected.

12. Suppression Pool (SP) and DW temperatures of 98 ^{o}F and 150 ^{o}F, respectively, will be assumed constant for the non-LOCA unit and as initial conditions for the LOCA unit for both summer and winter conditions. These correspond to the maximum initial temperatures used in the Reference 6 containment analysis. The DW temperature equals the corresponding TS limit while the SP temperature conservatively bounds the corresponding TS limit. (Ref. 10.a, 10.b)

13. The DW temperature in the LOCA unit is conservatively assumed to increase immediately to a constant temperature of 290 ^{o}F after the LOCA occurs, which is consistent with the maximum DW temperature from Reference 8 and conservatively bounds the assumed long term temperature of 275 ^{o}F from Reference 43. (Attachment E)

14. The bounding LOCA SP temperature profile for EPU conditions from the Reference 6 containment analysis will be conservatively used for the LOCA unit for both summer and winter conditions. This conservatively assumes LOCA/LOOP conditions and maximum initial and cooling water temperatures.

15. The compressive effect of primary containment expansion on the secondary containment pressurization is negligible. The RB (secondary containment) volume is relatively large compared to the primary containment volume. Therefore, any SC pressurization due to reduction in secondary containment volume from expansion of the primary containment would be negligible.

16. A constant SFP temperature of 125 ^{o}F will be assumed for both the LOCA and non-LOCA units consistent with Ref. 2. The SFP temperature is normally maintained below 125 ^{o}F during normal operation. (Ref. 12.c, 14, 43)

17. The effects of solar heat gain on the RB roof is accounted for by assuming constant sol-air temperatures of 127 ^{o}F and 28 ^{o}F on the outer surface of the roof for summer and winter conditions, respectively. These values were obtained by adjusting the maximum sol-air temperature of 130 ^{o}F from Ref. 5 Appendix C, calculated using a maximum outdoor air temperature of 96 ^{o}F, to the assumed summer and winter outdoor air temperatures of 93 and -6 ^{o}F, respectively, from Assumption 1. This is conservative since the sol-air temperature varies with time and is lower than the maximum value during most of the day. This is also conservative for winter conditions since the assumed value implicitly assumes the same solar heat gain as was used for summer conditions. Solar heat gain from the walls is neglected since the average sol-air temperature for the walls is less than the assumed maximum outdoor air temperature per Ref. 5 Appendix C.

18. Unit 2 is assumed to be the LOCA unit and Unit 3 is the non-LOCA unit for consistency with Reference 2. However, the units are similar in geometry and equipment configuration, so the results are applicable to either unit.

19. The heat loads are conservatively based on no concurrent LOOP with Unit 3 remaining in normal operation immediately after the LOCA. This will maximize the heat loads in the Reactor Building and is consistent with the Reference 2 heat loads. The normal heat loads are also appropriate for LOOP heat loads since, although much of the equipment would not

be operating after a LOOP, the residual heat loads from the deenergized equipment and associated piping would not significantly decay during the relatively short drawdown period.

20. Reactor Building heat loads, including the decaying heat loads in the RWCU rooms, pipe chases and from the Main Steam Tunnel and time-dependent heat loads in other areas, are conservatively assumed to remain constant at the initial heat load after LOCA occurs. The increased heat load in the Shutdown Cooling (SDC) pump room after shutdown of the non-LOCA unit (see Table I6 Ref. 2) occurs well after the drawdown time calculated by this analysis. The heat load for the RWCU heat exchanger (HX) room on the 545' elevation of the LOCA unit is conservatively assumed to be equal to the RWCU HX room heat load in the non-LOCA unit since this also accounts for the heat load of the RWCU piping and heat exchanger in this room.

21. Heat loads from insulated ECCS pipes will be conservatively modeled as uninsulated pipes.

22. ECCS pump room cooler heat removal capacities are consistent with Table 4 of Reference 2. These represent the individual cooler capacities in each of the pump rooms in the RB basement, i.e. two LPCI pump room coolers and one HPCI pump room cooler in each unit, consistent with Appendix A of Ref. 2. Because they are based on non-winter conditions, these cooler capacities are conservative for winter conditions since the cooling water temperature supplied to the coolers will be lower, increasing the cooler heat removal capacity at a given room temperature. No credit for room cooler heat removal will be conservatively assumed for room temperatures below 104 ^{o}F, the minimum temperature listed in Table 4 of Ref. 2. This is conservatively higher than the temperature switch setpoints that initiate the room coolers (Ref. 43). The cooler heat removal is also conservatively assumed to be constant for room temperatures above 150 ^{o}F, the maximum temperature listed in Table 4 of Ref. 2.

23. The total heat removal of the ECCS pump room coolers in the RB basement of the LOCA unit is equal to the heat removal of a single LPCI room cooler. The heat removal by the HPCI room cooler and the other LPCI room cooler in the LOCA unit will be conservatively neglected. The ECCS pumps in the second LPCI room and HPCI are not operational for the assumed scenario per Ref. 2, resulting in lower room heat loads and temperatures and correspondingly lower heat removal by these room coolers. Although ECCS pumps in these rooms could be operating, the increased heat load would be offset by the increased heat removal of the additional room coolers. No credit is assumed for heat removal by the pump coolers in the non-LOCA unit.

24. The total Reactor Building in-leakage is based on one air change of the RB volume per day at a 0.25 inwg vacuum RB pressure. (Refs. 42, 43, Attachment E)

25. All RB in-leakage is assumed to be on the refueling floor elevation consistent with Ref. 2 and the in-leakage is assumed to be distributed on each side of the Reactor Building based on the wall surface area. This is a reasonable assumption since the Reactor Building is concrete from the basement up to the 613' Refueling floor elevation while the refueling floor walls are constructed of insulated metal siding (Ref. 2). The RB airlock access doors and RB penetrations on other elevations are other potential in-leakage locations (Ref. 12.a, 43,

Attachment E). However, the assumed in-leakage locations have a relatively minor effect on the drawdown time since the Reactor Building is relatively open and the drawdown time is dominated by the total in-leakage rate and not the assumed in-leakage location.

26. No credit is taken for secondary containment out-leakage (per NRC Standard Review Plan (SRP) 6.2.3., Ref. 42).

27. A maximum wind speed of 24 mph will be assumed for the analysis. Per RG 1.183 (Ref. 1), the wind speed to be assumed is the 1-hour average value that is exceeded only 5% of the total number of hours in the data set. From the wind data in Attachment G of Ref. 4, a wind speed of 24 mph is exceeded less than 5% of the time at elevations of 35 ft and 150 ft, which bound the height of the Reactor Building. The assumed wind speed is conservative compared to the 5% wind speed of 19 mph for West Chicago, Illinois from Reference 38.

28. The wind will be assumed to be from the south. This will result in the highest RB pressurization due to wind effects since the wind pressures will be highest on the RB wall with the largest exposed surface area. Therefore, a south or north wind will introduce higher in-leakage rates than an east or west wind since the north and south walls are longer than the east and west walls. (Ref. 20)

29. A 13-second delay will be conservatively assumed for loading the primary SGT fan onto the diesel generator (DG) bus after the LOCA occurs (Ref. 10.f, 12.e, 43). This conservatively assumes LOOP conditions for starting the SGT system while no LOOP conditions are conservatively assumed for the RB heat loads per Assumption 19.

30. The primary SGT fan fails to start after the LOCA and the standby SGT fan starts after a 20-second time delay (Inputs 5 and 6). The secondary SGT subsystem, which is operating during the LOCA for this scenario, is assumed to be located in LOCA Unit 2. The Dresden SGT system takes suction from all levels of the Reactor Building. Therefore, this will result in the minimum mass of air removed by the operating SGT system (and therefore the longest drawdown times) since the LOCA unit has higher RB temperatures than the non-LOCA unit.

31. The SGT isolation valves in the standby unit start to open immediately after the standby fan starts and are fully open after a stroke time of 67 seconds. (Input 7) Using the maximum stroke time of the two isolation valves in each SGT system conservatively results in the lowest flow rate during opening of the isolation valves and the longest time before full SGT flow is achieved.

32. The SGT system flow rate is controlled to a maximum flow rate of 3975 cfm through the operating unit, which conservatively corresponds to the flow rate with dirty filters. (Refs. 9.b, 12.a, 17)

33. The static head delivered by the SGT fan is constant at flow rates below 3975 cfm. This will conservatively result in lower SGT flow rates during opening of the SGT isolation valves since the static head of the SGT fan is higher at flow rates below 3975 cfm. (Ref. 9.b)

34. The RB building pressure has a negligible effect on the SGT flow rate. This is conservative during RB pressurization after the LOCA since positive RB pressures will tend to decrease the static head required by the fan and increase the SGT flow rates. The vacuum pressure developed by wind blowing across the outlet of the SGT exhaust stack will also tend to increase the SGT flow. However, the vacuum pressures developed by wind effects at outlet of the SGT exhaust stack and the negative RB pressures developed after the period of RB pressurization are small compared to the static head delivered by the SGT fan and will therefore have a negligible effect on the SGT flow rate. This assumption is only used for calculating the SGT flow rates during opening of the SGT isolation valves since the flow rate is controlled to a maximum of 3975 cfm after the isolation valves are open per Assumption 33.

35. Two RB ventilation supply and exhaust fans are operating in each unit prior to the LOCA. (Refs. 23, 24)

36. The RB ventilation supply and exhaust fan flow rates are equal to the flow rates of 50,000 and 55,000 cfm, respectively, from References 23 and 24. The pressure loss in the RB ventilation system is assumed to be equal to the rated pressure of 9.7 inwg of the RB ventilation supply and exhaust fans at a flow rate of 41,750 cfm (Attachment E, Ref. 43). Using this pressure loss will conservatively result in larger RB ventilation system loss coefficients since the fan pressure actually decreases at higher flow rates.

37. The normal RB ventilation flow rates supplied to and exhausted from each elevation of the Reactor Building are as shown on References 23 and 24.

38. The initial RB/SC pressure prior to the LOCA is at the vacuum pressure of 0.25 inwg vacuum maintained by the RB ventilation systems during normal operation (Ref. 10.c, 12.a, 12.d, 15). This is the minimum negative internal RB pressure measured by four differential pressure sensors located at the 613’ refueling floor elevation. (Ref. 12.a, 31, 43)

39. The SGT isolation valve position during opening is linear with time, which is reasonable for the stroke of a motor operated valve.

40. A linear flow characteristic is conservatively assumed for the RB ventilation isolation valves. This will conservatively allow more flow through the valve during closure than would the actual flow characteristics of a butterfly valve.

41. There are backdraft dampers on the RB ventilation supply and exhaust fans that will automatically close after the fans are tripped (Refs. 23, 24, 43, Attachment E). Therefore, no flow out of the Reactor Building through the RB ventilation system will be credited after the LOCA to maximize the RB pressures, which is consistent with Assumption 26.

4. REFERENCES

1. NRC Regulatory Guide 1.183, Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors, July 2000.

2. Exelon calculation DRE97-0214, "Reactor Building Post-LOCA Temperature Analysis", Rev. 1C.

3. Exelon calculation DRE01-0041, Updated EQ Zone Parameter Tables Following Implementation of Extended Power Update, Rev. 03.

4. Exelon calculation DRE04-0030, Atmospheric Dispersion Factors (X/Qs) for Accident Release, Rev. 2.

5. Exelon calculation DRE05-0073, "Impact on Reactor Building Post-LOCA Temperatures Due to Tarping the Equipment Hatches", Rev. 0.

6. General Electric Project Task Report GE-NE-A22-00103-08-01, Dresden and Quad Cities Extended Power Uprate Evaluation, Task T0400, Containment System Response, Rev. 1A.

7. General Electric Project Task Report GE-NE-A22-00103-55-01, Dresden and Quad Cities Extended Power Uprate Evaluation, Task T0610, Power-Dependent HVAC, Rev. 1A.

8. General Electric Project Task Report GE-NE-0000-0056-9883-R0, LAMB and M3CPT3 Data to Exelon and Additional Containment Assessment for Dresden 2 and 3 New Steam Dryer, Rev. 0A.

9. Sargent and Lundy calculations

    a. VG-05, SBGT System Pressure Drop Calculation, Rev. 1.

    b. VG-06, SBGT System Fan Performance Evaluation, Rev. 1.

10. Dresden Technical Specifications and Bases, through Amendment 260/253.

    a. 3.6.1.5 Drywell Air Temperature

    b. 3.6.2.1 Suppression Pool Average Temperature

    c. 3.6.4.1 Secondary Containment

    d. 3.6.4.2 Secondary Containment Isolation Valves

    e. 3.6.4.3 Standby Gas Treatment (SGT) System

    f. 3.8.1 AC Sources - Operating

11. Dresden Technical Requirements Manual (TRM) Table B-1, Secondary Containment Isolation Valves, Rev. 86.

12. Dresden Updated Final Safety Analysis Report (UFSAR), Rev. 13.

    a. Section 6.2.3, Secondary Containment Functional Design

    b. Section 6.5.3, Fission Product Control Systems

    c. Section 9.1.3, Spent Fuel Pool Cooling and Cleanup System

    d. Section 9.4.5, Reactor Building Ventilation System

    e. Section 8.3.1.5, Standby Diesel Generator Systems

13. Procedure DOS 1600-32, Secondary Containment Leak Rate Test, Rev. 18.

14. Procedure DOA 1900-01, Loss of Spent Fuel Pool Cooling, Rev. 30.

15. Procedure DOP 5750-02, Reactor Building Ventilation, Rev. 48.

16. Procedure DMP 5700-05, Outage Adjustment to Refuel Floor Ventilation and Control of Equipment Hatches, Rev. 10.

17. Procedure DOP 7500-01, Standby Gas Treatment System Operation, Rev. 39.

18. Procedure DIS 7500-01, Unit 2/3 SBGT Auto-Actuation and Secondary Containment Isolation System Logic System Functional Test, Rev. 28.

19. Procedure DOS 7500-02, SBGT System Surveillance and IST Test, Rev. 57.

20. General Arrangement Floor Plan Drawings

    a. Drawing M-2, Main Floor Plan, Rev. P.

    b. Drawing M-3, Mezzanine Floor Plan, Rev. Z.

    c. Drawing M-4, Ground Floor Plan, Rev. AJ.

    d. Drawing M-5, Basement Floor Plan, Rev. N.

    e. Drawing M-6, Reactor Floor Plans, Rev. I.

21. General Arrangement Section Drawings

    a. Drawing M-7, Section A-A and B-B, Rev. D.

    b. Drawing M-8, Section C-C and D-D, Rev. C.

22. Drawing M-49, Diagram of Standby Gas Treatment, Rev. RB.
23. Drawing M-269, Diagram Reactor Building Ventilation, Sheet 1, Rev. K and Sheet 2, Rev. F.
24. Drawing M-529, Diagram of Reactor Building Ventilation, Sheet 1, Rev. N and Sheet 2, Rev. O.
25. Drawing M-278, Turbine & Reactor Bldg Vent Fan Floor Plan El 601’-4” and 581’-4”, Rev. O.
26. Drawing M-279, Vent Fan Floors - Sections, Turbine and Reactor Building, Rev. M.
27. Drawing M-286, Reactor Building Ventilation Plans, EL 613’-0” & 589’-0”, Rev. G.
28. Drawing M-287, Reactor Building Ventilation Plans, EL 570-0” & 545-6”, Rev. R.
29. Drawing M-288, Reactor Building Ventilation Plans, EL 517’-6” & 476’-”, Rev. S.
30. Drawing M-289, Reactor Building Ventilation Sections, Rev. J.
31. Drawing M-526, Pneumatic Diagram of Reactor Building Ventilation System, Sheet 1, Rev. O.
32. Drawing B-333, Door & Hardware Schedule, Rev. BP.
33. Drawing B-335, Window and Louver Schedules and Details, Rev. J.
34. Drawing B-412, Reactor Building Ground Floor Plan South Area elevation 517’-6”, Rev. H.
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42. Standard Review Plan (SRP) 6.2.3, Secondary Containment Functional Design, from NUREG-0800: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition, Revision 3, March 2007.
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5. COMPUTER PROGRAMS

GOTHIC version 8.2 (Ref. 36, 37) is used to calculate the Reactor Building temperature and pressure response for the assumed scenario. GOTHIC is an EPRI-sponsored general purpose thermal-hydraulics code approved for design, licensing, and safety analysis of nuclear power plant containments and confinement buildings. GOTHIC is used per EXELON DTSQA program requirements. GOTHIC error notices pertaining to version 8.2 were reviewed and none were identified which are applicable to the model used in this analysis.

6. METHOD OF ANALYSIS

The Dresden post-LOCA secondary containment drawdown analysis is based on the requirements of NRC RG 1.183 (Ref. 1) and guidance of SRP 6.2.3 (Ref. 42). The Dresden post LOCA Reactor Building heatup model from Reference 2 was used as the basis for the Reactor Building geometry and heat loads. The Reactor Building geometry and heat loads from Reference 2 were consolidated to use fewer volumes and fewer corresponding inputs. These were then used to construct a corresponding GOTHIC model with control volumes, internal RB flow paths, thermal conductors, heaters and coolers. Inputs were updated for EPU conditions and to match the inputs and assumptions used in this calculation. Volumes, boundary conditions, flow paths, and fan and valve components were then added to the GOTHIC model to simulate the SGT system, RB ventilation system, Reactor Building leakage and SFP evaporation necessary to model the building pressure response after a LOCA. Attachment A shows a schematic of the GOTHIC model used in this analysis. GOTHIC thermal conductors are not shown on this schematic for clarity. The following sections discuss the modeling approach and Section 7 develops the inputs that are used in the GOTHIC model.

Four LOCA cases were analyzed with the GOTHIC model to envelope the assumed environmental conditions: 1 - summer with no wind, 2 – summer with wind, 3 - winter with no wind, and 4 – winter with wind. (Attachment B shows the GOTHIC input file for Case 1 and the changes for Cases 2, 3, and 4.) The following sequence of major events is postulated for this calculation:

1. The units are initially both in normal operation with the RB ventilation system maintaining the specified RB vacuum pressure.

2. At time zero, a DBA LOCA is assumed to occur with a concurrent LOOP. (Note: Reactor Building heat loads are conservatively based on non-LOOP conditions to maximize the heat loads. See Assumption 19.)

3. The secondary containment is isolated by closing the RB ventilation system isolation valves and the RB ventilation system fans are tripped. The RB ventilation system isolation valves are fully closed after 300 seconds. (Input 10)

4. The diesel generators start and the primary SGT fan is loaded onto DG bus at 13 seconds after the LOCA occurs. (Assumption 29)

5. The primary SGT fan fails to start after being loaded onto the DG bus and the standby SGT fan starts and the isolation valves begin to open after a 20 second time delay. (Assumption 30)

6. The SGT system flow rate is controlled to a maximum of 3975 cfm (Assumption 32) after the SGT isolation valves open at 67 seconds after the standby SGT fan starts. (Input 7)

RB Control Volumes

The Reactor Building GOTHIC model is divided into eleven (11) GOTHIC control volumes, one for each level in each unit from the basement up to the Reactor level and a combined volume for the Refueling floor since this is common to both units. (CV# 1-11 in Attachment A) The volume for each control volume consists of the volume for each of the rooms on the corresponding level from Ref. 2. The height of each control volume below the refueling floor is calculated as the elevation difference between levels and the height of the refueling floor is calculating using the RB roof elevation. The hydraulic diameter of each control volume is calculated using Eqn. 11.1 of Ref. 36.

RB Flow Paths

Each of the GOTHIC control volumes are connected by flow paths to model the flow between levels and between the two units. (FP# 1-14 in Attachment A) The dimensions and flow areas used for each of the flow paths are from Reference 2. To provide greater model flexibility for evaluating future changes, flow paths are also included in the model for some RB openings that are normally closed per Reference 2. A very small flow area is used for these closed flow paths to prevent flow though the opening. The hydraulic diameter for each flow path is calculated using Eqn. 12.1 of Ref. 36. The center to center distance between connecting control volumes is used as the inertia length, consistent with guidance provide in Ref. 36. A loss coefficient of 2.85 is used for each RB flow path per assumption 9.

RB Thermal Conductors

GOTHIC thermal conductors (TC) were used to model heat transfer to the RB walls. The common RB wall areas from Reference 2 between identical areas were combined to reduce the number of thermal conductors in the GOTHIC model. Internal RB walls, other than the walls to the drywell (DW), spent fuel pool (SFP), floors between levels, and internal walls between the two units, were conservatively neglected per Assumption 11. Heat transfer from the Reactor Building to adjacent areas and to the outside air, other than the Refueling floor walls and roof, was conservatively neglected by modeling the outer surface of these walls as an insulated boundary condition. (Assumption 10) Thermal conductors for the suppression pool and ECCS pipes were also included in the LOCA unit to model the heat transfer from these surfaces to the Reactor Building. (TC # 36-40 in Attachment B)

RB Heat Loads

GOTHIC heaters are used to represent the electrical and mechanical heat loads in the Reactor Building. A single GOTHIC heater component is used in each of the RB control volumes.

(Heater# 1H-11H in Attachment A) The total heat load for each control volume consists of the heat load from each of the rooms on the corresponding level. The total heat loads from Table I6 of Reference 2 are used for each area. A GOTHIC trip is used to turn the heaters on when the LOCA occurs.

RB Coolers

A single GOTHIC cooler (Cooler# 12C in Attachment A) is used in the basement control volume of the LOCA unit to represent the heat removal of a single LPCI pump room cooler in this unit. (Assumption 23) The heat removal of the cooler component is specified as a function of the torus area control volume temperature by use of a GOTHIC function. A GOTHIC trip is used to turn the cooler on when the LOCA occurs.

External Environment

Five GOTHIC control volumes connected to boundary conditions with flow paths are used to represent the external environment: one on each face of the Reactor Building and one for the exhaust of the SGT and RB ventilation systems. (BC# 1P, 2F, 3P, 4F, 5P, 6F, 9P, 10F, 11P, 12F, CV# 12-14 and 19-20, and FP# 21-26 and 59-62 in Attachment A) Separate environmental control volumes are used since the external pressure varies based on the assumed wind direction due to the different building pressure coefficients on each surface of the Reactor Building. The pressure used for the boundary condition is calculated as a function of the wind speed and the temperature and relative humidity are set equal to the assumed summer conditions of 93 ^{o}F with 0% humidity or the assumed winter conditions of -6 ^{o}F with 0% humidity. (Assumptions 1 and 2)

RB Leakage

Four flow paths, one on each wall of the refueling floor are used for the RB leakage and to measure the differential pressures between the RB refueling floor and the external environment. (FP# 57, 58, 63, 64 in Attachment A) The total leakage area for the RB leakage flow paths is calculated based on based on one air change of the RB volume per day and is distributed among the four leakage flow paths on the refueling floor. (Assumptions 24 and 25) Additional flow paths, with no leakage, are used to determine the differential pressure between the Unit 2 RB levels below the refueling floor and the external environment. (FP# 65-69 in Attachment A) GOTHIC control variables are used to convert the differential pressure across the leakage paths from units of psi to inwg and to calculate the average RB pressure differential on the refueling floor.

SGT

Two GOTHIC flow paths connected from the Reactor Building exhuast control volumes in each unit to the external environment control volume for the exhaust stacks are used to represent each of the two SGT trains. (FP# 15 and 16 in Attachment A) The loss coefficient for these flow paths is calculated using the pressure loss across the SGT system from Ref. 9.a. A GOTHIC constant volume fan is used in each flow path to represent the SGT exhaust flow. (Fan# 1Q and 2Q in Attachment A) The flow rate of the failed primary SGT fan (Assumption 30) is set equal to zero. The flow rate thru the standby SGT fan is calculated using the SGT system resistance as a function of time during opening of the isolation valves but is limited to the maximum SGT flow rate of 3975 cfm. (Assumption 32) A GOTHIC function is used to apply this time dependent flow rate to the standby SGT fan component.

RB Ventilation System

Four GOTHIC control volumes (CV# 15-18 in Attachment A) are used to represent the RB ventilation supply and exhaust ducts for each unit that are located outside of the Reactor Building. (Ref. 23, 24, 25, 26) These RB ventilation system control volumes are connected with GOTHIC flow paths (FP# 31-54 in Attachment A) to the control volumes for each level of the Reactor Building in the respective unit. (Note: Part of the multiple exhaust flow paths from the RB levels to the RB ventilation system exhaust control volumes are shown as a single line on the GOTHIC model schematic in Attachment A due to space limitations.) Each of the RB ventilation supply and exhaust control volumes are also connected to the corresponding ambient air control volumes with two flow paths. (FP# 17-20, 27-30 in Attachment A) A constant volume fan component representing the RB ventilation supply or exhaust fans is used on one of these flow paths. (Fan# 3Q-6Q in Attachment A) A valve component representing the RB ventilation supply or exhaust isolation valves is used on the second of these flow paths. (Valve# 1V-4V in Attachment A) (Note: Two flow paths are necessary between the each of the RB ventilation system and outside air control volumes since the flow rate in the fan flow path is forced to zero by the constant volume fan component during isolation valve closure.) The flow rate of the RB exhaust fan components is controlled with GOTHIC trips to maintain the assumed average initial RB pressure on the Refueling floor. GOTHIC trips are also used to trip the RB supply and exhaust fan components when the LOCA occurs. The position of the RB supply and exhaust isolation valve components is controlled via the use of a GOTHIC function.

SFP Evaporation

SFP evaporation was modeled by adding flow boundary conditions for the SFP evaporation rate from the SFP in each unit. (BC# 7F and 8F in Attachment A) These flow boundary conditions were connected to the refueling floor control volume with GOTHIC flow paths. (FP# 55 and 56 in Attachment A) The SFP evaporation rate was determined using an ASHRAE equation for pool evaporation. Internal thermal conductors connected to the refueling floor elevation were also used to model the natural convection heat transfer from the fuel pool surface. (TC# 52 and 53 in Attachment B)

Time Domains

Three time domains were specified for the solution. The first two time domains are used to stabilize initial conditions before the LOCA occurs. The first time domain before the LOCA was used to initialize the room pressures and the second was used to initialize the conductor temperatures. The third time domain is used to represent the time after the postulated LOCA occurs.

GOTHIC trips and functions are used in the model to control the time dependent aspects of the model. During the first two initial time domains, GOTHIC trips and functions are used to maintain the Reactor Building at the assumed initial pressure, temperature and humidity. During this time, the initial RB room and humidity temperature is used for the outside air temperature and humidity, heat transfer to the RB thermal conductors was set to zero and the RB volume heater components, ECCS room cooler components and SFP evaporation are turned off to maintain the assumed initial conditions. The initial RB pressure is maintained by cycling the RB ventilation exhaust fan components with GOTHIC trips to control the RB exhaust flow. A large value of the DT ratio is used for the second time domain to initialize the conductor temperatures. A short time increment is also used for the second time domain to prevent the room temperatures from changing due to heat transfer to or from the thermal conductors. During third LOCA time domain, the outside air temperature and humidity is set equal to the assumed outdoor air conditions, heat transfer to the conductors and SFP evaporation is initialized and the RB volume heater and ECCS room cooler components were turned on.

7. NUMERIC ANALYSIS

The calculations for the GOTHIC version 8.2 inputs are outlined in the following sections. Many of the calculations are performed in Attachment C and the GOTHIC input file is shown in Attachment B.

RB Control Volumes

The results of the computations for each of the RB control volumes are shown in Table 1 of Attachment C. The volumes from the table on page D-39 of Ref. 2 are used to calculate the volume of each RB control volume. These correspond to the PCFLUD volumes from Attachment A of Ref. 2 except the PCFLUD volumes are rounded. The total volume of each control volume includes the volume for each of the rooms on the corresponding level in each unit. One of the rooms in the basement (476'-6" elevation) of Unit 3 is slightly smaller than the corresponding room in Unit 2. Therefore, different volumes are used for the two GOTHIC control volumes (CV#1 and 6) representing this elevation in Units 2 and 3. The volumes for the RWCU demin area on the 570' elevation and the 545'-6" and 570' elevation pipe chases from page D-39 of Ref. 2are also conservatively included in the Gothic volume calculations even though these volumes are not included in the PCFLUD volumes from Attachment A of Ref. 2. The heights of the control volumes are calculated using the elevation difference between levels. The height of the refueling floor control volume is calculating using a roof elevation of 658'6". (Ref. 21) The hydraulic diameter of each control volume is calculated using Eqn. 11.1 of Ref. 36 using the total volume and the sum of the conductor wall surface areas for each control volume from Attachment C. The total wetted surface area for each control volume used to calculate the hydraulic diameter also includes the floor area (i.e., the ceiling area of the elevation below) of each volume and the area of internal walls for each volume listed in Table 3 of Attachment C, even though these were not included as thermal conductors in the GOTHIC model, based on guidance on the use of Eqn. 11.1 from Ref. 36.

RB Flow Paths

The dimensions and flow areas for each of the RB flow paths are from Table F1 of Reference 2. The elevations of the flow paths are based on the corresponding floor elevations. A height of 7 ft is used for the height of the door openings between the two units. A height of 1 ft is used for the flow paths between elevations is based on a floor thickness of 1 ft since this will have a negligible effect on the analysis. The flow areas and the results of the computations of the hydraulic diameter and hydraulic diameter for each of the RB flow paths are shown in Table 2 of Attachment C. Only the flow area of open equipment hatches between levels and open doors between units is credited consistent with assumptions 6 and 7. The flow areas for the closed flow paths (doors between units on the Main, Mezzanine and Reactor levels, FP# 12-14) are set to a small value in GOTHIC to prevent flow through these flow paths. A loss coefficient of 2.85 is used for each of the RB flow paths per assumption 9 and the friction length is set equal to zero since the friction losses are negligible. The center to center distance between connecting control volumes is used as the RB flow path inertia length per Ref. 36. The volume heights from Table 1 of Attachment C are used to calculate the inertia lengths of the flow paths between elevations and the center to center distance between units (Ref. 20) is used for the flow paths between units. The hydraulic diameter of each flow path is calculated using Eqn. 12.1 of Ref. 36 using the opening dimensions from Table F1 of Reference 2. There are two 4 ft square hatch openings in the floor between the ground level and torus area of each unit that are credited in this analysis. Therefore, the area and wetted perimeter used to calculate the hydraulic diameter of these flow paths is twice that of a single hatch opening.

RB Thermal Conductors

Table 3 of Attachment C shows the results of the computations for each of the RB GOTHIC thermal conductors, except for the SFP thermal conductors on the refueling floor (TC# 52, 53), which are discussed later in the SFP evaporation section. The surface area of each conductor is the sum of the common RB wall surfaces areas between identical areas from Appendix A of Reference 2. The minimum wall thickness of the common conductors was used to conservatively minimize the thermal mass of the walls. (Wall thicknesses were rounded off to the nearest 0.25 ft to minimize the number of thermal conductor types required except for the DW wall thicknesses, which were rounded off to the next lower whole number.) All the external concrete walls to adjacent areas were combined into a single thermal conductor for each volume with a wall thickness of 1.5 ft, which bounds the thickness of the external walls. Internal RB walls, other than the walls to the drywell (DW), spent fuel pool (SFP) and internal walls between the two units, were conservatively neglected per Assumption 11. Thermal conductors for the suppression pool and ECCS pipes were also included in the LOCA unit control volumes. The PCFLUD model from Ref. 2 included thermal conductors (TC# 148 and 149) for the RWCU pipes and heat exchanger in the RWCU HX room of the LOCA unit to account for the decaying heat load from these hot pipes. However, thermal conductors for the RWCU pipes and HX were not included in the GOTHIC model since this was accounted for by using a constant heat load for these components instead of a decaying heat load per Assumption 20. The thermal properties from Section 4.6 of Ref. 2 were used for each of the thermal conductors. The walls of the Refueling floor are 1-1/4” thick insulated metal siding per Section 4.2 of Ref. 2 and the RB roof consists of built up roofing over 1” of rigid insulation on 3.5” concrete roof slabs. A 1” thickness is used for the built-up roofing consistent with Appendix A of Ref. 2. The initial RB temperature is used for each of the thermal conductors. This is acceptable since an initial time period is used during the solution procedure to initialize the temperature profile in the thermal conductors prior to the LOCA as described in the Run Control section.

The heat transfer coefficients for the sides of RB thermal conductors exposed to the RB internal environment are calculated using the GOTHIC natural convection correlations and include the effect of radiation heat transfer to the secondary containment environment. As described in the Run Control section, heat transfer from these surfaces is prevented to maintain the assumed RB initial temperatures during the initial two time domains by specifying a zero heat transfer coefficient via use of a GOTHIC function. The assumed outside air and sol-air temperatures from assumptions 1 and 17 are used for the external surfaces of the refueling floor walls and floor, respectively. The outside surface of external concrete walls to adjacent areas below the refueling floor was conservatively modeled as an insulated boundary condition to prevent heat transfer to the adjacent areas. (Assumption 10) The assumed DW and SP temperatures are conservatively used as specified temperatures on the side of the respective thermal conductors exposed to the primary containment atmosphere. This implicitly assumes the most conservative, i.e. infinite, heat transfer coefficients between the conductor and the primary containment atmosphere. A specified temperature boundary condition is also used for the SFP thermal conductors. Constant DW temperatures of 150 ^{o}F and 290 ^{o}F are used for non-LOCA unit 3 and LOCA unit 2, respectively, and a constant SFP temperature of 125 ^{o}F is used for both units per assumptions 12, 13 and 16. A constant SP temperature of 98 ^{o}F is used for non-LOCA unit 3 and the time dependent SP temperatures from Tables 3-5 and 3-6 of Ref. 6 are used for LOCA unit 2 via a GOTHIC forcing function per Assumption 14.

RB Heat Loads

Table 4 of Attachment C shows the results of the heat load computations for each of the GOTHIC heaters used in each of the RB control volumes. The total heat load for each control volume consists of the heat load in each of the rooms on the corresponding level. The LOCA total heat loads from Table I6 of Reference 2 are used for the Unit 2 volumes and the non-LOCA heat loads are used for the Unit 3 volumes. The initial heat load from Table I6 is used for each of the rooms since the RB heat loads are assumed to be constant per Assumption 20. The heat load for the heater component in the Refueling floor control volume is the combined refueling floor heat load for both units. The non-LOCA heat load for the RWCU HX room on the 545' elevation is also conservatively used for the LOCA heat load for this room instead of modeling this as a decaying heat load, i.e. with a thermal conductor, per Assumption 20. A GOTHIC trip is used to turn the heater components on when the LOCA occurs.

RB Coolers

Table 5 of Attachment C shows the heat removal capacity of the LPCI and HPCI pump room coolers from Table 4 of Reference 2. Only the heat removal capacity of a single LPCI pump room cooler is used for the total heat removal capability for the GOTHIC cooler component in the basement of the LOCA unit per Assumptions 22 and 23. The heat removal of the other LPCI pump room cooler and the HPCI room cooler is conservatively neglected per Assumption 23. A GOTHIC function is used to control the cooler heat removal capacity as a function of the room temperature of the LOCA unit basement control volume. The cooler capacity is zero for room temperatures below 104 ^{o}F and constant for room temperatures above 150 ^{o}F. (Assumption 22) A GOTHIC trip is used to turn the ECCS cooler component on when the LOCA occurs.

RB Leakage

From Table 1 of Attachment C, the total free volume of the Reactor Building is 3.509E6 ft^3. Therefore, the total RB in-leakage, based on based on one air change of the RB volume per day per Assumption 24, is:

$$Q = \frac{3.509E6\ ft^3/day}{(24\frac{hr}{day})(60\frac{min}{hr})} = 2437\ cfm$$

The total RB leakage area is calculated using Eqns. 9 and 29 from Chapter 32 of Ref. 38:

$$A = \left(\frac{Q}{4005}\right)\sqrt{\frac{K}{\Delta P}} = \left(\frac{2437}{4005}\right)\sqrt{\frac{2.85}{0.25}} = 2.055\ ft^2$$

Where:

A = leakage area, ft^2
Q = flow rate = 2437 cfm
ΔP = pressure difference = 0.25 inwg (Assumption 24)
K = assumed loss coefficient = 2.85 (Assumption 9)

The RB leakage is calculated with the loss coefficient of 2.85 assumed for the RB openings (Assumption 9). However, the loss coefficient used to calculate the leakage is inconsequential if the leakage area is consistent with the loss coefficient used in the GOTHIC model since the leakage only depends on the ratio of the area to the loss coefficient. The leakage area is divided among the four walls on the refueling floor based on the area of each wall, i.e. the leakage area for the north and south wall of the refueling floor is 294'/117.5' = 2.5 times that of the east and west walls since these walls span both units. (Refs. 20.e. and 21, Assumption 25) Therefore, leakage areas of 2.055/7 = 0.294 ft^2 are used for the flow paths on the east and west walls (FP# 57, 58) and 2.055*2.5/7 = 0.734 ft^2 for the flow paths on the north and south walls. (FP# 63, 64) An elevation of 621' is used for the elevation of each leakage flow path since this corresponds to the elevation of the four RB differential pressure sensors on the refueling floor elevation. (Ref. 31, 43) A reverse loss coefficient of 2.85 is used for each flow path consistent with the assumed value used to calculate the leakage area. However, a large value is used for the forward loss coefficient of the leakage flow paths, i.e. the flow direction corresponding to out-leakage from the Reactor Building, to prevent out-leakage from the Reactor Building per Assumption 26. A friction length of zero is used for the leakage flow paths since the flow areas were calculated solely based on the assumed form coefficient of 2.85. Assumed values are used for the height of the flow path, the hydraulic diameter and the inertia length are inconsequential to the analysis. A small area is used for the flow paths used to measure the RB differential pressures below the refueling floor to prevent any flow in these flow paths. (FP# 65-69)

External Environment

A large volume was used for each of the five GOTHIC control volumes representing the external environment. (CV# 12-14 and 19-20) The elevation of each was set equal to the RB ground level elevation of 517’6” ft and the height was set equal to 400 ft to bound the height of the SGT exhaust stack. The elevation of each environment boundary condition (BC# 1P-4F and 9P-12F) was also set equal to the RB ground level elevation of 517’6” ft. The temperature and relative humidity of the environment boundary conditions are controlled via the use of forcing functions. These are set equal to the assumed Reactor Building initial conditions prior to the LOCA to prevent RB temperature and humidity changes during the stabilization period prior to the LOCA. After the LOCA occurs, these values are set equal to the assumed outdoor air conditions for summer or winter conditions. A large value is used for the volumetric flow rate of the flow boundary conditions so that the conditions in the environment control volumes change rapidly to maintain the assumed outdoor air conditions. The pressure used for each of the environment boundary conditions is equal to the assumed atmospheric pressure plus the surface pressure on the RB surface corresponding to the boundary condition. The surface pressure is calculated as a function of the wind speed using Eqn. 3 from Chapter 15 and Eqn. 8 from Chapter 32 of Ref. 38:

$$P_s = C_p P_v = C_p \rho \left(\frac{U}{1097}\right)^2$$

Where:

P_s = surface pressure difference = inwg
P_v = velocity pressure = inwg
C_p = pressure coefficient
U = wind velocity = 24 mph*5280/60 = 2112 fpm (Assumption 27)
ρ = air density = 0.0718 lb/ft^3 at 93 ^{o}F, 0 % RH summer conditions
= 0.0875 lb/ft^3 at -6 ^{o}F, 0% RH winter conditions
(Assumptions 1 and 2, Ref. 38 Chapter 6 Table 2)

Ref. 38 defines P_s as the difference between the pressure on the building surface and the local outdoor atmospheric pressure at the same level in an undisturbed wind approaching the building. Therefore, the surface pressure difference P_s is converted from inwg to psi by dividing by the conversion factor of 27.7 (Ref. 38 Chapter 35 Table 2) and added to the atmospheric pressure of 14.7 psia (assumption 3) to give the pressure for each environment boundary condition. A south wind is assumed for this analysis to maximize RB pressurization effects due to the wind. (Assumption 28) Building pressure coefficients of 0.8 and -0.43 will be used for the upwind (south), and downwind (north) sides of the Reactor Building and a value of -0.4 will be used for the sides parallel to the wind (east and west). These represent the maximum and minimum pressures coefficients at the locations of the RB pressure sensors on the refueling floor elevation. (Ref. 38 Chapter 15 Figure 5) Table 6 of Attachment C calculates the wind pressures and corresponding atmospheric pressures used for each of the environment boundary conditions (BC# 1P-4F and 9P-12F) at both summer and winter conditions. The pressure for the exhaust stack environment boundary condition is set equal to the assumed atmospheric pressure of 14.7 psia since the exhaust stacks are located above the elevation of the Reactor

Building and will not be influenced by building wind effects. Parameters were chosen for the flow paths (FP# 21-26 and 59-62) connecting the environment control volumes to boundary conditions so that they do not influence the results of the analysis.

<u>SGT</u>

The inlet elevation of each SGT flow path is set equal to the Reactor Building exhaust duct elevation of 581’4” and the outlet elevation to the SGBTS exhaust stack elevation of 827’6”. (Ref. 12.a, 20) A height and hydraulic diameter of 2 ft and a flow area of 3.14 ft^2 corresponding to the 2 ft diameter of the SGT isolation valves are used for the SGT flow paths. (Refs. 9.a, 22) The total pressure loss of the SGT system is 16.2 inwg with dirty filters at the rated SGT flow of 4000 cfm. (Ref. 9) Therefore, the total SGT system resistance is calculated using Eqns. 9 and 29 from Chapter 32 of Ref. 38:

$$K = \left(\frac{4005A}{Q}\right)^2 \Delta P = \left(\frac{4005 * 3.14}{4000}\right)^2 16.2 = 160.1$$

Where:

K = SGT loss coefficient
Q = SGT rated flow rate = 4000 cfm (Ref. 9.a)
A = SGT flow area = 3.14 ft^2 based on 2 ft diameter isolation valve size (Ref. 9.a)
ΔP = SGT pressure loss = 16.2 inwg (Ref. 9.a)

(Note: The SGT loss coefficient is calculated based on area of the isolation valves for consistency.) The above value is used for the forward loss coefficient of the SGT flow paths. However, a large reverse loss coefficient is used for the SGT flow paths to prevent reverse flow in the flow path due to the backflow dampers on the SGT fan discharge. (Ref. 22) The friction length is set equal to zero since all the pressure loss is accounted for the by the loss coefficient and an inertia length of 1 ft is used for these flow paths since it has no effect on the analysis results.

The flow rate of the failed primary SGT fan component is set equal to zero. (Assumption 30) The flow rate of the standby SGT fan component is controlled using a GOTHIC function. The flow rate of the standby SGT fan is set equal to zero up until the time that the standby fan starts at 33 seconds after the LOCA, i.e. 13 seconds to load the primary SGT onto the DG and an additional 20 seconds for the standby SGT to start after the primary SGT is assumed to fail. (Assumptions 29 and 30) The flow rate after the subsequent 67 second SGT valve opening time is set equal to a maximum SGT flow rate of 3975 cfm. (Assumptions 31, 32)

The flow rate during opening of the SGT isolation valves is calculated using the total pressure losses across the SGT isolation valves and the rest of the SGT system. The SGT pressure loss is equal to the static pressure of the SGT fan. Therefore, the SGT flow rate during valve opening is calculated using the same equation as was used above to calculate the SGT loss coefficient but is rearranged to solve for the flow rate and setting the SGT pressure loss equal to the fan static pressure:

$$Q = 4005A\sqrt{\frac{\Delta P}{K}}$$

Where:

Q = SGT flow rate, cfm
ΔP = SGT pressure loss = SGT fan static pressure
= 16.0 inwg (Ref.9.b, Assumption 33)
K = total SGT loss coefficient = 160.1 = 159.7 + 2*K_v
K_v = SGT valve loss coefficient = 0.19 (Ref. 9.a)
A = SGT flow area = 3.14 ft^2 based on 2 ft diameter valve and duct size

The total SGT loss coefficient is the sum of the loss coefficients for the two butterfly isolation valves and that for the remainder of the SGT system from the RB ventilation system to the exhaust stack. The SGT isolation valves are 24" diameter butterfly valves with a fully open loss coefficient of 0.19. (Refs. 9.a) Subtracting the loss coefficient of two fully open isolation butterfly valves (0.19 each) gives the loss coefficient of 159.7 for the remainder of the SGT system. The SGT flow rate as a function of time during valve opening is calculated in Table 7 of Attachment C. The valve loss coefficient as a function of valve position is from Table 6-14A of Ref. 40. The fan static pressure is conservatively assumed to remain constant and the valve position is linear with time over the 67 second opening time. (Assumptions 33, 39) The SGT flow calculated using this equation is limited to a maximum flow of 3975 cfm per Assumption 32. The SGT flow rate is approximately linear during the initial opening of the isolation valves and reaches 3400 cfm at approximately 30 seconds after the isolation valves begins to open. The rate of the SGT flow rate increase slows after 30 seconds and reaches the assumed maximum flow rate of 3975 cfm after the SGT valves are fully open at 67 seconds. Therefore, the SGT flow will be assumed to increase linearly from zero from the time that the standby SGT fan starts at 13 + 20 = 33 seconds after the LOCA until the time that the SGT flow reaches 3400 cfm at 13 + 20 + 30 = 63 seconds after the LOCA. The SGT flow rate will also be conservatively be modeled as linearly increasing from 3400 cfm at 63 seconds after the LOCA to 3975 cfm when the SGT valves are fully open at 13 + 20 + 67 = 100 seconds after the LOCA. The SGT flow rate then remains constant at 3975 cfm after 100 seconds. This SGT flow rate is applied standby SGT fan component via a GOTHIC forcing function.

<u>RB Ventilation System</u>

A volume of 1000 ft^3 is used for each of the RB ventilation supply and exhaust control volumes to approximate the volume between the isolation valves and Reactor Building. (Refs. 25, 26) (Note: The exact value used for this volume is not critical since it is negligible compared to the total RB volume.) The 581'4" elevation of the fan rooms is used for the elevation of these control volumes and 6 ft is used for the height and hydraulic diameter, corresponding to the diameter of the RB ventilation isolation valves. (Ref. 25, 26) The inlet and exit elevations of the RB ventilation supply flow paths from the environment to the RB ventilation supply isolation valves is also set equal the inlet elevation of 581'4". This value is also used for the inlet elevations of the RB ventilation exhaust flow paths to the environment from the RB ventilation exhaust isolation valves, but the exit elevation is set equal the RB ventilation exhaust stack outlet elevation 676’ 4 ½”. A value of 6 ft is also used for the height and hydraulic diameter of all these flow paths and the flow area is set equal to a corresponding value of 28.3 ft^2. The RB ventilation isolation valves are butterfly valves, which have a fully open loss coefficient of 0.19. (Ref. 9.a) Therefore, a value of 0.38, corresponding to two butterfly valves in series, is used for the forward loss coefficient of the supply valve flow paths and the reverse loss coefficient of the exhaust valve flow paths. A large value is used for the reverse flow coefficient of the supply valve flow paths and the forward loss coefficient of the exhaust valve flow paths to prevent flow out of the Reactor Building through these flow paths. (Assumption 41) The friction length for these flow paths is set equal to zero since all the pressure loss is accounted for the by the loss coefficient.

The inlet elevation of each RB ventilation supply flow paths and outlet elevations of exhaust flow paths to the individual RB levels is set equal to the 581’4” elevation of the RB ventilation supply and exhaust control volumes. The outlet elevation of the supply flow paths and outlet elevation of exhaust flow paths is set equal to the corresponding RB floor elevation. The ventilation supply and exhaust ducts in the Reactor Building have a wide variety of sizes and lengths. (Ref. 27, 28, 29) Therefore, an arbitrary height and hydraulic diameter of 1 ft and an area of 28.3 ft^2, consistent with the isolation valve area, are used for these flow paths since these values are not critical to the analysis. The friction length for each of the flow paths is set equal to zero and the loss coefficients are calculated using the RB supply/exhaust fan static pressure and the flow rate supplied to the corresponding level during normal operation. (Ref. 23, 24) The pressure loss across each flow path during normal operation is the fan static pressure minus the pressure loss across the isolation valves. The pressure loss across the two RB supply isolation valves in series is calculated using Eqns. 9 and 29 from Chapter 32 of Ref. 38:

$$\Delta P = K\left(\frac{Q}{4005A}\right)^2 = 0.38\left(\frac{100000}{4005*28.3}\right)^2 = 0.30 \text{ inwg}$$

Where:

ΔP = pressure loss across supply isolation valves, inwg
K_v = RB isolation valve loss coefficient = 0.38 for two butterfly valves in series
Q = normal RB ventilation supply flow rate = 100,000 cfm (Ref. 23, 24)
A = valve area = 28.3 ft^2 based on 6 ft diameter isolation valve size

The corresponding pressure loss across the two RB exhaust isolation valves is 0.36 inwg at the exhaust flow rate 110,000 cfm with two RB exhaust fans in parallel. The pressure loss across two fully open isolation valves in series is subtracted from the fan static pressure to give the pressure loss in each of the supply and exhaust flow paths at the assumed flow rates. Therefore, the corresponding pressure loss in each of the RB ventilation supply and exhaust flow paths is 9.4 and 9.34 inwg using the supply and exhaust fan static pressures of 9.7 inwg from Assumption 36. The pressure loss for each of the supply and exhaust flow paths is calculated in in Table 8 of Attachment C using the approximate supply and exhaust flow rates for each elevation from References 23 and 24. The total exhaust flow rate is less than the total exhaust fan flow rate of 110,000 cfm since the exhaust fans are sized for 10,000 cfm of infiltration. (Ref. 23, 24)

The flow rate for each of the RB ventilation fan components is set equal to the total flow rate of 100,000 cfm for two RB ventilation supply fans operating in parallel and 110,000 cfm for two RB ventilation exhaust fans operating in parallel up until the time of the LOCA and is set to zero thereafter using a GOTHIC trip. Trips are used to control the exhaust fan components to give an minimum initial RB internal pressure of 0.25 inwg vacuum (calculated by GOTHIC control variable 4C for the North RB wall) prior to the LOCA. (Assumption 38) The position of the RB ventilation isolation valve components is also specified as a function of time. The valves are initially closed (valve position of zero) in the GOTHIC model up until the time that the LOCA occurs since the RB ventilation flows are being supplied by through the fan components. The valves are then immediately opened at the time of the LOCA. The valves position is then linear with time until the valves are closed at 300 seconds after the LOCA. (Assumption 39) A linear valve characteristic is used for the valve components used on RB ventilation flow paths. (Assumption 40)

SFP Evaporation

The evaporation rate from the SFP pool was calculated using Eqn. 1 from Chapter 4 of Ref. 39:

$$W_{SFP} = \frac{A}{h_{fg}}(P_w - P_a)(95 + 0.425V) = \frac{1353}{1022.3}(3.96 - 0)(95 + 0.425 * 0)$$
$$= 497.9\ lb/hr$$

Where:

W_{SFP} = SFP evaporation rate, lb/hr
A = SFP surface area = 33’ x 41’= 1353 ft^2 (Ref. 2 pg. I-5, Ref. 35 pg. 3-45)
h_{fg} = latent heat of evaporation at SFP temperature
= 1022.3 BTU/lb at 125 ^{0}F (Table 3 Ref. 38 Chapter 6)
P_w = saturation vapor pressure at SFP temperature
= 3.96 inHg at 125 ^{0}F (Table 3 Ref. 38 Chapter 6)
P_a = saturation pressure at room air dew point = 0 inHg (assumed 0% RH)
V = air velocity over water surface = 0 fpm with no forced air circulation after LOCA

The SFP evaporation rate was conservatively calculated assuming zero humidity on the refueling floor, i.e. $P_a = 0$. The evaporation rate calculated above multiplied by an activity factor of 0.5 (Ref. 39 page 4.6) to account for the quiescent pool surface conditions and was converted to lb/s to give a flow rate of 0.07 lb/s for the GOTHIC flow boundary condition. The SFP temperature of 125 ^{0}F and corresponding saturation pressure of 1.945 psia were also used for this boundary condition along with a steam volume fraction of 1. (Table 3 Ref. 38 Chapter 6)

The SFP area of 1353 ft^2 and a hydraulic diameter 36.6 ft, calculated using Eqn. 12.1 of Ref. 36 with the SFP dimensions (33’ x 41’) from Reference 35, were used for the flow paths (FP# 55 and 56) connecting the SFP flow boundary conditions to the refueling floor control volume. Assumed values are used for the remaining SFP flow path parameters; these have no effect on the results of the analysis since the SFP evaporation flow rate is prescribed by the boundary condition.

The area of the thermal conductors added to model natural convection heat transfer from SFP to the refueling floor (TC# 52, 53) were set equal to the SFP surface area of 1353 ft^2. The heat transfer coefficient for natural convection from a floor was used for one side of the conductor and the other side of the conductor was set equal to the specified SFP temperature of 125 ^{o}F. (Assumption 16) The conductor itself was modeled as a thin layer of water in order to minimize the temperature difference across the conductor and to minimize the thermal capacitance of the conductor.

Initial Conditions

The same initial conditions were used for all the control volumes used in the model. The initial temperature for each of the volume is 103 ^{o}F for summer conditions and 65 ^{o}F for winter conditions per assumption 4 and the initial relative humidity is 20% per assumption 5. The outside air pressure of 14.7 psia from assumption 3 is used as the initial pressure for each of the rooms even though the RB is maintained at a slight negative pressure per assumption 38. This is acceptable since an additional time is included in the GOTHIC model to allow the pressures in the RB to adjust an equilibrium steady state conditions with the assumed initial RB (minimum Refueling floor) pressure of -0.25 inwg before the assumed LOCA occurs.

Time Domains

An interval of 999.9 seconds was used for the initial time domain to stabilize the RB pressures and an interval of 0.1 seconds was used for the second time domain to initialize the thermal conductors. Therefore, the LOCA is assumed to occur at 1000 seconds into the solution. A third time domain with an interval of 3600 seconds from 1000 to 4600 seconds was used after the LOCA occurs.

GOTHIC Input Files

The GOTHIC input file for the Case 1 (summer conditions, no wind) and the changes for Cases 2, 3, and 4 are shown in Attachment B. The inputs for the ambient air temperature, sol-air temperature, initial RB temperature, wind speed and corresponding wind pressures are the only differences in the other cases. The values used for each case are shown in Table 1 below. The values for the atmospheric wind pressures are from Table 6 of Attachment C. Table 2 lists the GOTHIC input files used for each of the cases. (Note: The test case is described in Attachment F and the sensitivity cases in Attachment G.)

Table 1: Input Parameters for Drawdown Cases

Variable	Case 1	Case 2	Case 3	Case 4
Description	Summer, No Wind	Summer, with Wind	Winter, No Wind	Winter, with Wind
Outside Air Temperature (^oF)	93	93	-6	-6
Sol-Air temperature (^oF)	127	127	28	28
Initial Reactor Building Temperature (^oF)	103	103	65	65
Wind Speed (mph)	0	24	0	24
Wind Pressure, South Face (psia)	14.7	14.7077	14.7	14.7094
Wind Pressure, North Face (psia)	14.7	14.6959	14.7	14.6950
Wind Pressure, East and West Faces (psia)	14.7	14.6962	14.7	14.6953

Table 2: GOTHIC Input Files

Input Filename	Description	GOTHIC Checksum Value
DRE Drawdown Case1.GTH	Summer Conditions with No Wind	17954
DRE Drawdown Case2.GTH	Summer Conditions with 24 Mph Wind	30914
DRE Drawdown Case3.GTH	Winter Conditions with No Wind	58110
DRE Drawdown Case4.GTH	Winter Conditions with 24 Mph Wind	51162
DRE Drawdown Sens1.GTH	Case 1 sensitivity with 90% initial humidity	18009
DRE Drawdown Sens2.GTH	Case 2 sensitivity with 90% initial humidity	41310
DRE Drawdown Sens3.GTH	Case 3 sensitivity with 90% initial humidity	7106
DRE Drawdown Sens4.GTH	Case 4 sensitivity with 90% initial humidity	58560
DRE Drawdown Test Case.GTH	Test Conditions (see Attachment F)	40269

8. RESULTS

The results for each of the cases is shown in Attachment D. The LOCA occurs at 1000 seconds on each of these plots. Figures 1 through 6 below summarize the pertinent results from the various cases. (Note: The results in Figures 1 through 6 are on an adjusted time scale with time zero equal to 1000 seconds from the GOTHIC results, i.e. coincident with the time that the LOCA is assumed to occur.) The RB temperature profiles for summer conditions from Case 1 shown in Figure 1 are similar to those from Reference 2, which indicates that the RB heatup after the LOCA is being correctly modeled. Figures 2 and 3 show the pressures and differential pressures with respect to atmospheric pressure for the various levels of the Reactor Building. The RB pressures and differential pressures increase rapidly when the RB ventilation system trips after the LOCA and the RB temperatures begin to increase. The minimum differential pressure between the refueling floor and outside ambient is maintained at -0.25 inwg prior to the LOCA but becomes positive quickly after the RB ventilation system trips. The RB pressures and differential pressures begin to decrease after the SGT fan starts and exhausts air from the Reactor Building as shown in Figure 4, and eventually drop below the local outside air pressure, i.e. a negative pressure differential. Figure 4 also shows the total RB leakage, i.e. the sum of the leakage from all four sides of the building. RB out-leakage is indicated as a positive flow and in-leakage as a negative flow, consistent with the direction used for the GOTHIC flow paths. The leakage is zero while the RB building is at a positive pressure, consistent with the no out-leakage assumption (Assumption 26). RB in-leakage begins after the RB pressure becomes negative.

As shown in Figure 3, the differential pressures for the lower elevations of the Reactor Building are lower (more negative) than those on the refueling floor. Therefore, the limiting average differential pressure for the refueling floor elevation is used to determine the drawdown times. For the cases with no wind (Cases 1 and 3), all the differential pressures on the refueling floor are identical. However, for the cases with wind (Cases 2 and 4), the differential pressures vary on the different walls of the refueling floor due to the different wind surface pressures. Figure 5 shows the differential pressures on the refueling floor for Case 2. The differential pressures are lowest, i.e. most negative, on the south (upwind) wall due to the assumed southerly wind and are highest on the north (downwind) side of the Reactor Building. Figure 6 shows the average differential pressures on the refueling floor for each of the cases. The winter cases (Cases 3 and 4) result in the highest positive pressure differential due to the higher outside air density than for the summer cases and take slightly longer for the average differential pressure to become negative. However, all the cases examined reach an average differential pressure of -0.25 inwg at approximately the same time.

The following table compares the drawdown times for each of the cases. The average differential pressure of the refueling floor elevation is used to determine the drawdown times since this is consistent with the bases for the SGT system and for the Technical Specification criteria of -0.25 inwg (Ref. 10.c, 10.e, 12.a, 13). The drawdown time is determined from the time that GOTHIC control variable 5C reduces below -0.25 inwg after the LOCA occurs at 1000 seconds in the analysis and subtracting 1000 seconds used in the analysis for the time period before the LOCA occurs. The drawdown time is slightly longer for the cases with wind (Cases 2 and 4) than the corresponding cases with no wind (Cases 1 and 3, respectively). However, the difference between the minimum and maximum drawdown times for all the cases examined is only about 60 seconds. The limiting drawdown time corresponding with the summer conditions with wind (Case 2) is 1334 seconds. Therefore, the design basis SC drawdown time is 1334 seconds, or approximately 22.2 minutes.

Table 3: Reactor Building Drawdown Times

	Case 1	Case 2	Case 3	Case 4
Description	Summer, No Wind	Summer, with Wind	Winter, No Wind	Winter, with Wind
Drawdown Time (s)	1286	1334	1272	1284

Figure 1: Unit 2 Temperatures for Case 1

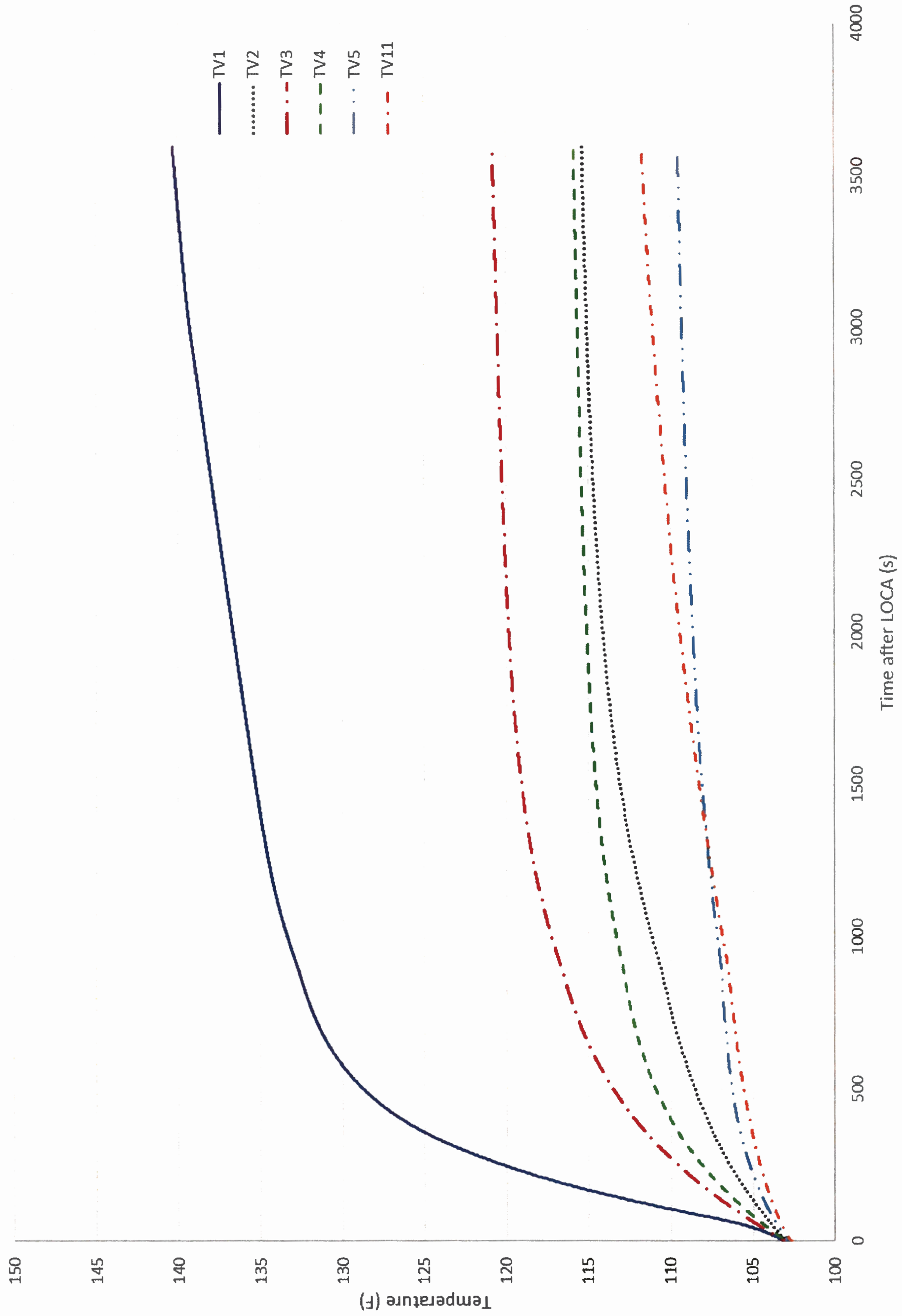


Figure 2: Unit 2 Pressures for Case 1

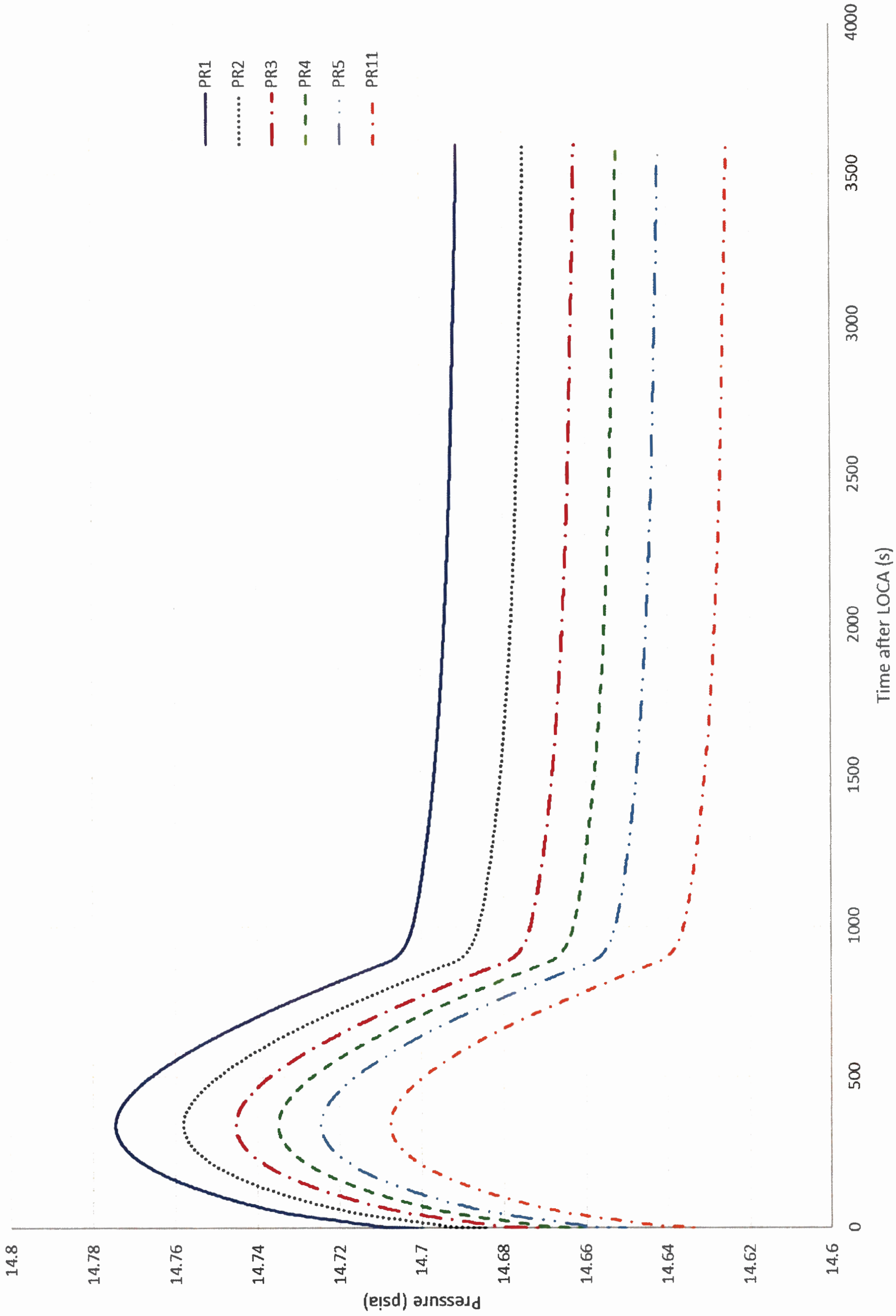


Figure 3: U2 Differential Pressures for Case 1

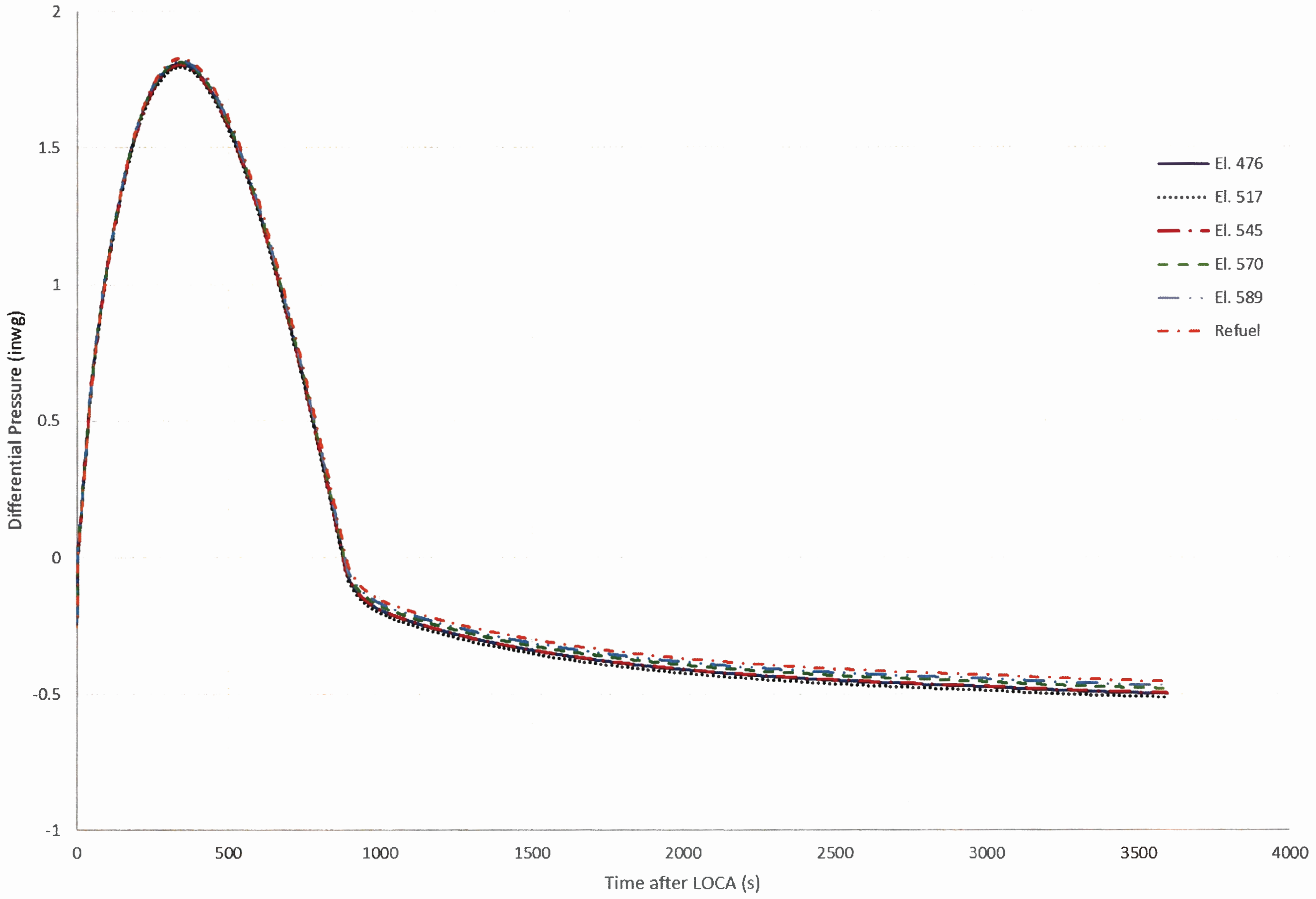


Figure 4: Leakage and SGT Flows for Case 1

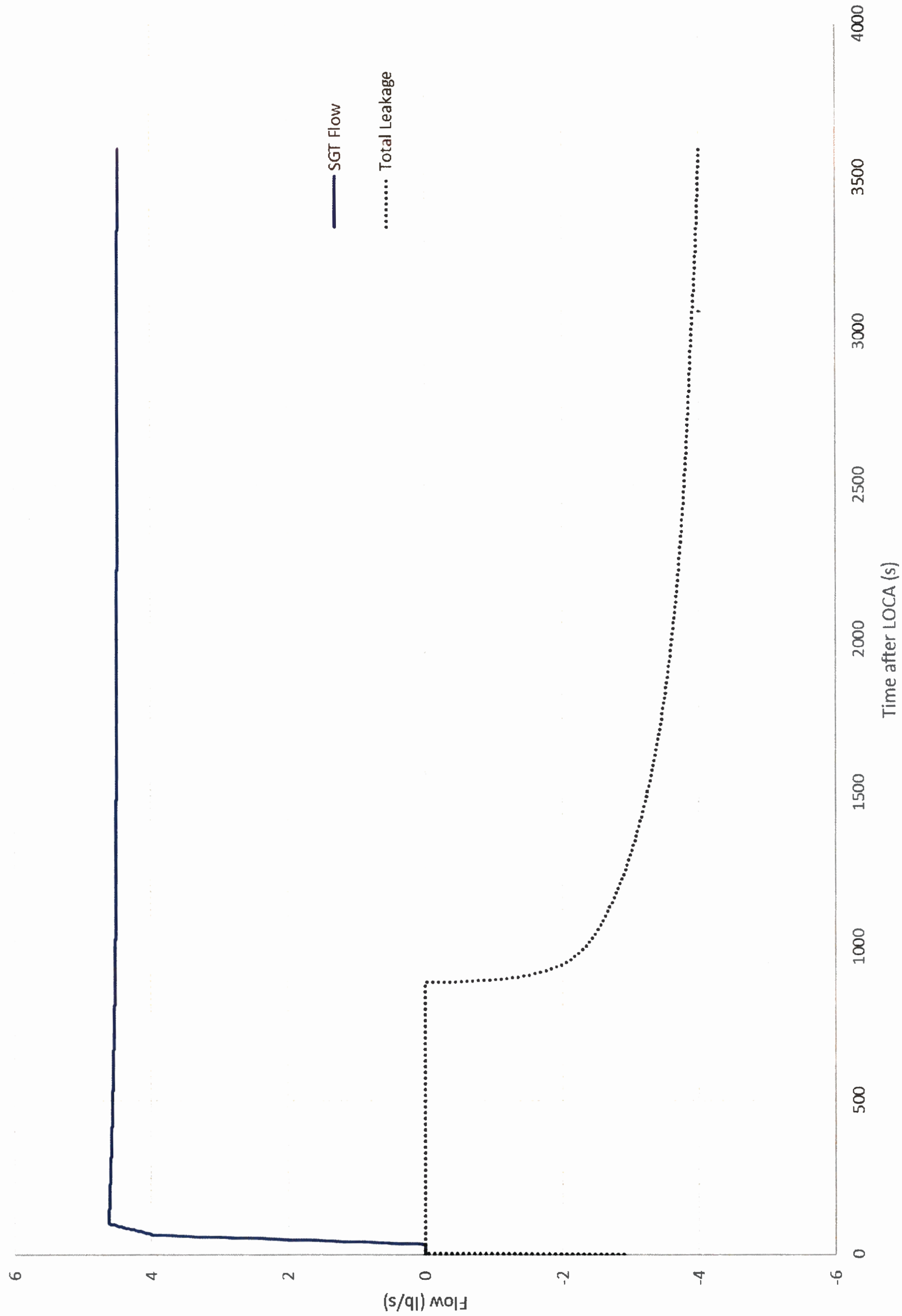


Figure 5: Refueling Floor Differential Pressures for Case 2

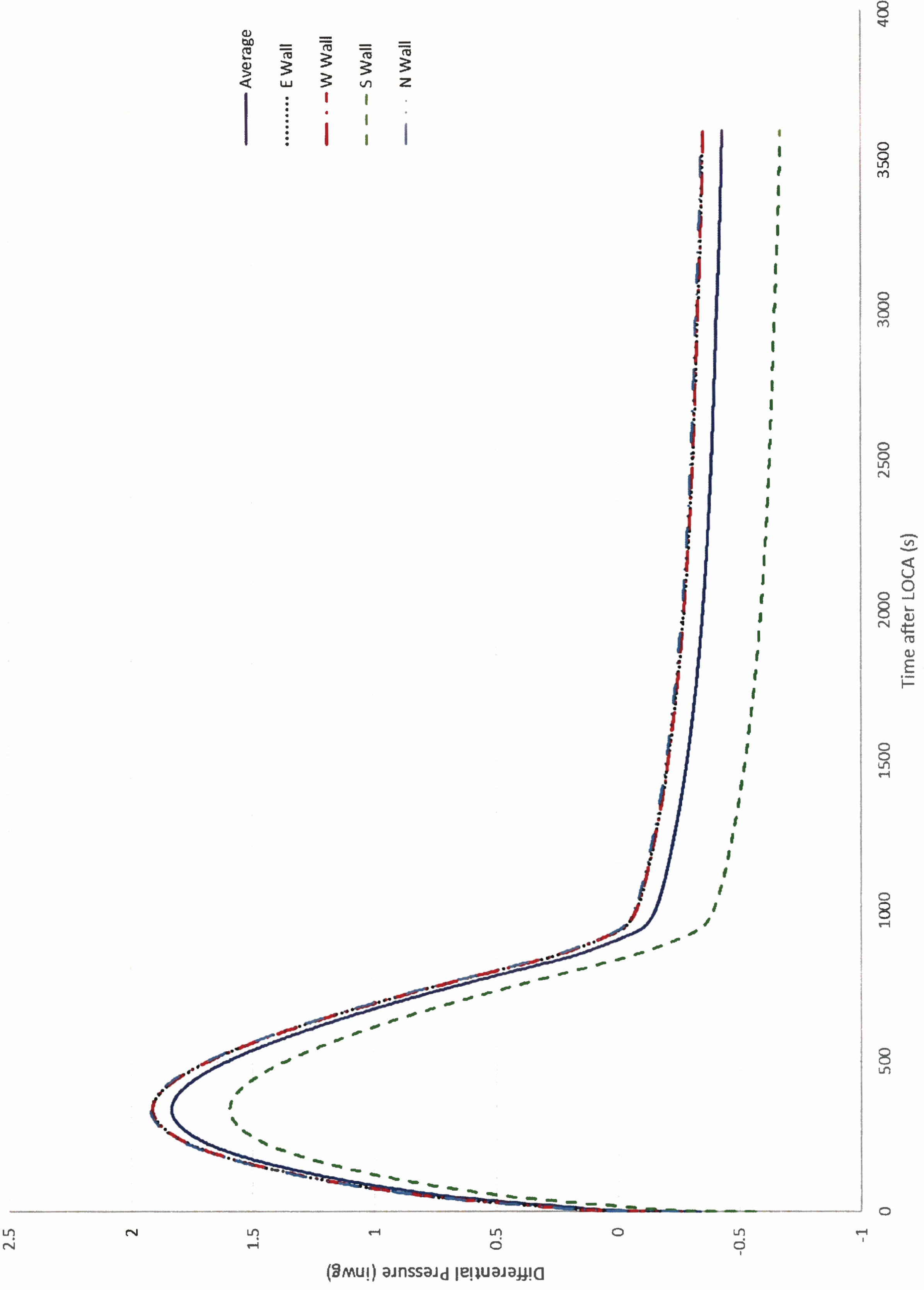
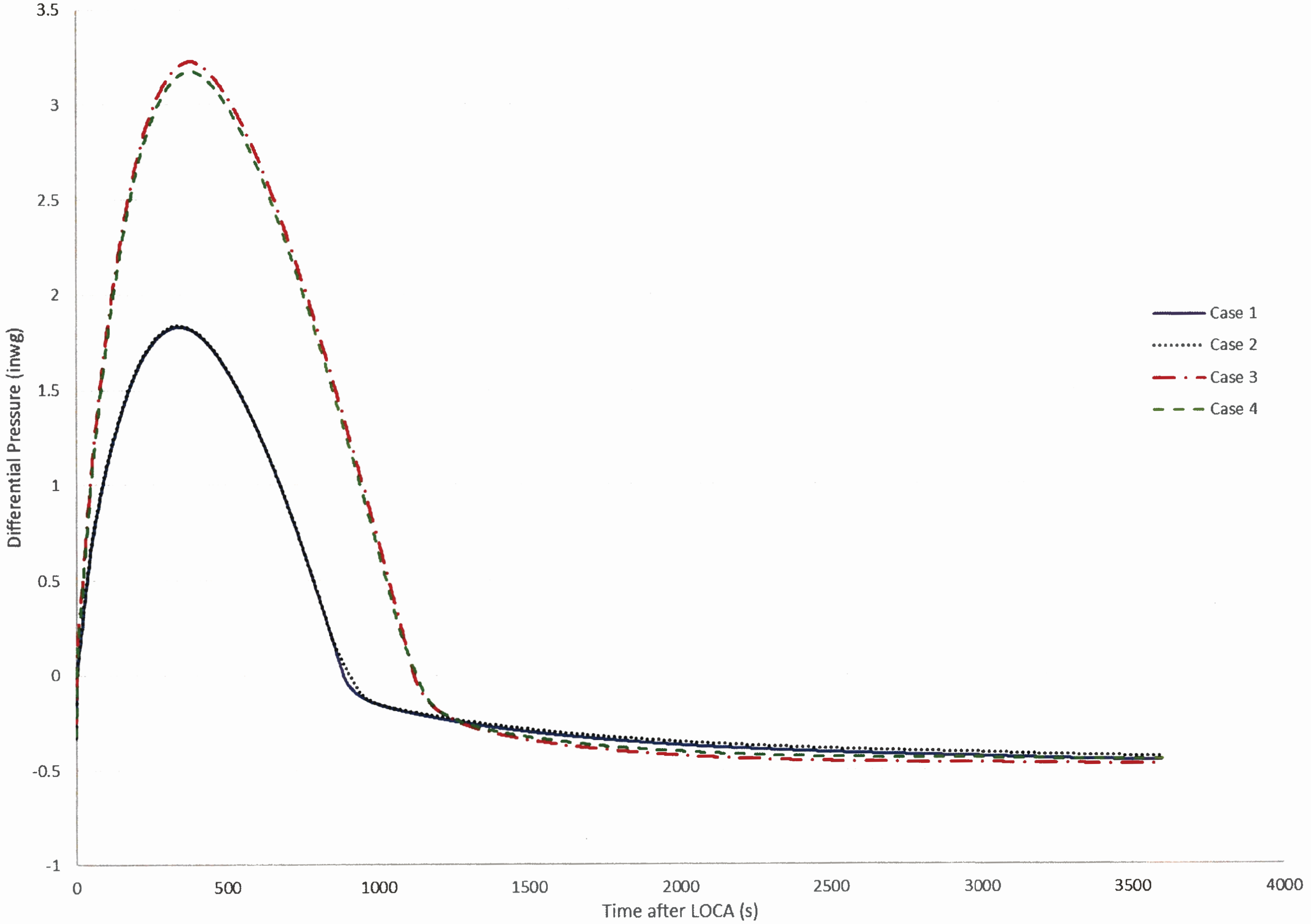


Figure 6: Average Refueling Floor Differential Pressures for Each Case



9. CONCLUSION

The differential pressure inside the Dresden Reactor Building after a design basis LOCA will be less than the Technical Specification criteria of -0.25 inwg with respect to the outside air pressure after a drawdown time of 1334 seconds (22.2 minutes) under the limiting outside air temperature and wind conditions conforming with the RG 1.183 guidance. This insures that there will be no unfiltered exfiltration from the Reactor Building after the drawdown time under these conditions.

An additional case to simulate RB isolation during normal operation, documented in Attachment F, was performed to estimate the drawdown time during test conditions. A drawdown time of 11.4 minutes, to reach an average RB pressure of -0.25 inwg, was calculated for the test conditions assumed in Attachment F.

10. ATTACHMENTS

A. GOTHIC Model Schematic Diagram

B. GOTHIC input File for Case 1 and Changes for Cases 2, 3, and 4

C. Calculation of GOTHIC Inputs

D. GOTHIC Results

E. Exelon TODI No. (DRE) TODI-19-007, Rev. 1.

F. Drawdown Test Case

G. Initial Reactor Building Humidity Sensitivity Study

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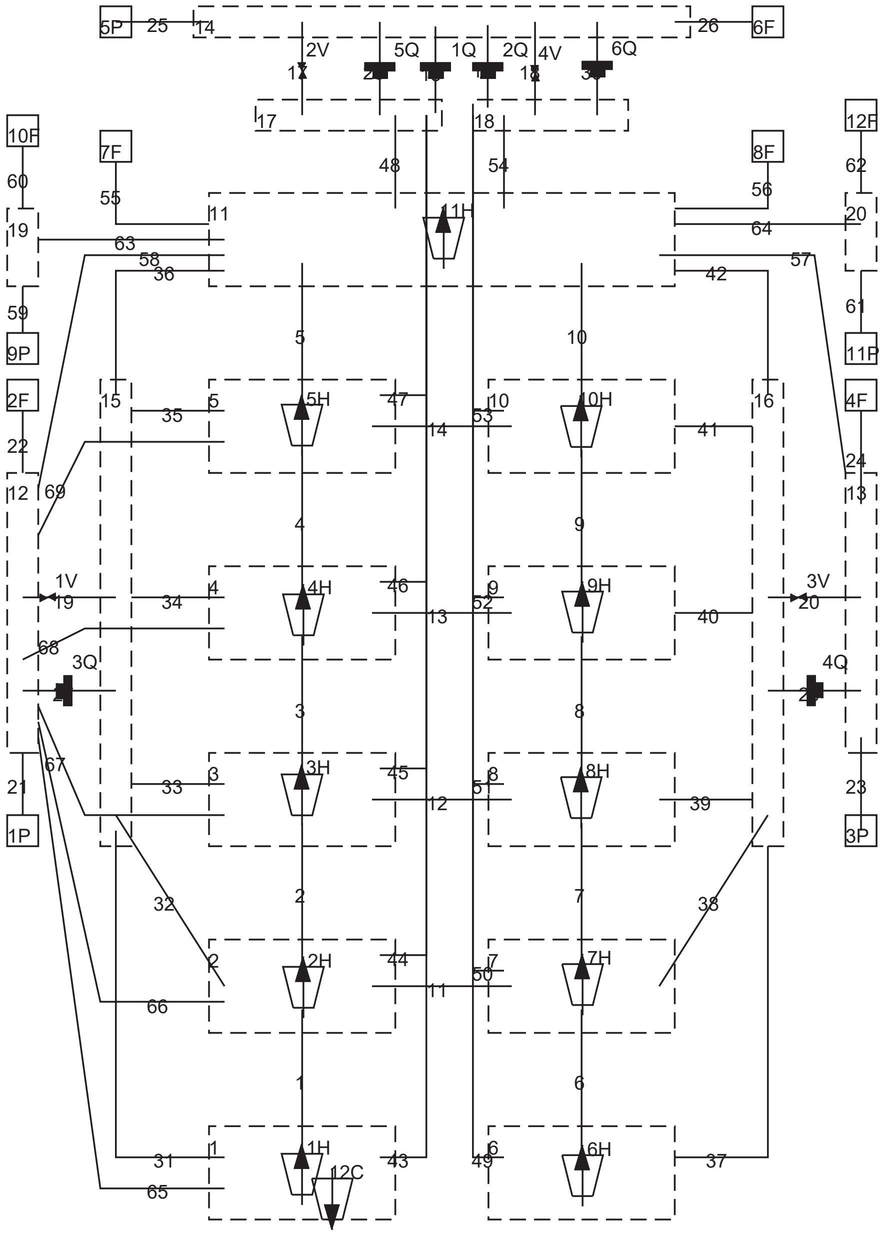

Control Volume Parameters

Vol #	Description	Vol (ft3)	Elev (ft)	Ht (ft)	Hyd. D. (ft)	L/V IA (ft2)	SA FF	Min Film (ft)	Min Film FF
1	U2 Basement 476	283359.	476.5	41.	10.8	DEFAULT		DEFAULT	
2	U2 Ground 517	278726.	517.5	28.	26.5	DEFAULT		DEFAULT	
3	U2 Mezz 545	221360.	545.5	24.5	21.1	DEFAULT		DEFAULT	
4	U2 Main 570	174898.	570.	19.	22.6	DEFAULT		DEFAULT	
5	U2 Reactor 589	187986.	589.	24.	21.1	DEFAULT		DEFAULT	
6	U3 Basement 476	277635.	476.5	41.	10.6	DEFAULT		DEFAULT	
7	U3 Ground 517	278726.	517.5	28.	26.5	DEFAULT		DEFAULT	
8	U3 Mezz 545	221360.	545.5	24.5	21.1	DEFAULT		DEFAULT	
9	U3 Main 570	174898.	570.	19.	22.6	DEFAULT		DEFAULT	
10	U3 Reactor 589	187986.	589.	24.	21.1	DEFAULT		DEFAULT	
11	Refueling 613	1222452.	613.	45.5	60.7	DEFAULT		DEFAULT	
12	E Wall Ambient	1e+10	517.5	400.	1e+06	DEFAULT		DEFAULT	
13	W Wall Ambient	1e+10	517.5	400.	1e+06	DEFAULT		DEFAULT	
14	Exhaust Ambient	1e+10	517.5	400.	1e+06	DEFAULT		DEFAULT	
15	U2 HVAC Supply	1000.	581.33	6.	6.	DEFAULT		DEFAULT	
16	U3 HVAC Supply	1000.	581.33	6.	6.	DEFAULT		DEFAULT	
17	U2 HVAC Exhaust	1000.	581.33	6.	6.	DEFAULT		DEFAULT	
18	U3 HVAC Exhaust	1000.	581.33	6.	6.	DEFAULT		DEFAULT	
19	S Wall Ambient	1e+10	517.5	400.	1e+06	DEFAULT		DEFAULT	
20	N Wall Ambient	1e+10	517.5	400.	1e+06	DEFAULT		DEFAULT	

Control Volume Options

Vol #	S Wave Damper	Pool HMT Mult	Pool Opt	Pool Pres. Correction	Pool Dp. FF	Gas Tracking	Burn Opt	ICIP Drag
1	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
2	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
3	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
4	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
5	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
6	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
7	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
8	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
9	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
10	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
11	1.	DEFAULT	LOCAL	ON		ON	NONE	ON

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Control Volume Options (cont.)

Vol #	S Wave Damper	Pool HMT Mult	Pool Opt	Pool Pres. Correction	Pool Dp. FF	Gas Tracking	Burn Opt	ICIP Drag
12	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
13	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
14	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
15	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
16	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
17	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
18	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
19	1.	DEFAULT	LOCAL	ON		ON	NONE	ON
20	1.	DEFAULT	LOCAL	ON		ON	NONE	ON

Laminar Leakage

Vol #	Lk Rate Factor (%/hr)	Ref Press (psia)	Ref Temp (F)	Ref Humid (%)	Sink or Src	Model Option	Rep Wall	Subvol Option	Leak Area (ft2)
1	0.					CNST T		UNIFORM	DEFAULT
2	0.					CNST T		UNIFORM	DEFAULT
3	0.					CNST T		UNIFORM	DEFAULT
4	0.					CNST T		UNIFORM	DEFAULT
5	0.					CNST T		UNIFORM	DEFAULT
6	0.					CNST T		UNIFORM	DEFAULT
7	0.					CNST T		UNIFORM	DEFAULT
8	0.					CNST T		UNIFORM	DEFAULT
9	0.					CNST T		UNIFORM	DEFAULT
10	0.					CNST T		UNIFORM	DEFAULT
11	0.					CNST T		UNIFORM	DEFAULT
12	0.					CNST T		UNIFORM	DEFAULT
13	0.					CNST T		UNIFORM	DEFAULT
14	0.					CNST T		UNIFORM	DEFAULT
15	0.					CNST T		UNIFORM	DEFAULT
16	0.					CNST T		UNIFORM	DEFAULT
17	0.					CNST T		UNIFORM	DEFAULT
18	0.					CNST T		UNIFORM	DEFAULT
19	0.					CNST T		UNIFORM	DEFAULT
20	0.					CNST T		UNIFORM	DEFAULT

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Turbulent Leakage

Vol #	Lk Rate Factor (%/hr)	Ref Press (psia)	Ref Temp (F)	Ref Humid (%)	Sink or Src	Model Option	Rep Wall	Subvol Option	Leak Area (ft2)	fL/D
1	0.					CNST T		UNIFORM	DEFAULT	
2	0.					CNST T		UNIFORM	DEFAULT	
3	0.					CNST T		UNIFORM	DEFAULT	
4	0.					CNST T		UNIFORM	DEFAULT	
5	0.					CNST T		UNIFORM	DEFAULT	
6	0.					CNST T		UNIFORM	DEFAULT	
7	0.					CNST T		UNIFORM	DEFAULT	
8	0.					CNST T		UNIFORM	DEFAULT	
9	0.					CNST T		UNIFORM	DEFAULT	
10	0.					CNST T		UNIFORM	DEFAULT	
11	0.					CNST T		UNIFORM	DEFAULT	
12	0.					CNST T		UNIFORM	DEFAULT	
13	0.					CNST T		UNIFORM	DEFAULT	
14	0.					CNST T		UNIFORM	DEFAULT	
15	0.					CNST T		UNIFORM	DEFAULT	
16	0.					CNST T		UNIFORM	DEFAULT	
17	0.					CNST T		UNIFORM	DEFAULT	
18	0.					CNST T		UNIFORM	DEFAULT	
19	0.					CNST T		UNIFORM	DEFAULT	
20	0.					CNST T		UNIFORM	DEFAULT	

Discrete Burn Parameters

Vol #	Min H2 Frac	Min O2 Frac	Max H2O Frac	Burn Length (ft)	Flame Speed (ft/s)	Burn Rate FF	Un Burn Frac	Burn Opt
1	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
2	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
3	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
4	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
5	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
6	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
7	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
8	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
9	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
10	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
11	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
12	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
13	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
14	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
15	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR

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Discrete Burn Parameters (cont.)

Vol #	Min H2 Frac	Min O2 Frac	Max H2O Frac	Burn Length (ft)	Flame Speed (ft/s)	Burn Rate FF	Un Burn Frac	Burn Opt
16	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
17	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
18	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
19	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR
20	0.07	0.05	0.55	DEFAULT	DEFAULT		DEFAULT	FBR

Continuous Burn Parameters

Vol Vol #	Min H2 Flow (lbm/s)	Min O2 Frac	Max H2O Frac	Max H2O/H2 Ratio	Burn Frac
1	0.	0.05	0.55	1000.	1.
2	0.	0.05	0.55	1000.	1.
3	0.	0.05	0.55	1000.	1.
4	0.	0.05	0.55	1000.	1.
5	0.	0.05	0.55	1000.	1.
6	0.	0.05	0.55	1000.	1.
7	0.	0.05	0.55	1000.	1.
8	0.	0.05	0.55	1000.	1.
9	0.	0.05	0.55	1000.	1.
10	0.	0.05	0.55	1000.	1.
11	0.	0.05	0.55	1000.	1.
12	0.	0.05	0.55	1000.	1.
13	0.	0.05	0.55	1000.	1.
14	0.	0.05	0.55	1000.	1.
15	0.	0.05	0.55	1000.	1.
16	0.	0.05	0.55	1000.	1.
17	0.	0.05	0.55	1000.	1.
18	0.	0.05	0.55	1000.	1.
19	0.	0.05	0.55	1000.	1.
20	0.	0.05	0.55	1000.	1.

Mechanistic Burn Rate Parameters

Vol #	Min H2 Frac	Min O2 Frac	Max H2O Frac	Da No.	Lam Burn Rate (lbm/ft3-s)	FF	Burn Temp Limit (F)	FF	Turb Burn Opt	Turb Burn FF
1	0.	0.	1.	1.	DEFAULT		350.		EDIS	

Mechanistic Burn Rate Parameters (cont.)

Vol #	Min H2 Frac	Min O2 Frac	Max H2O Frac	Da No.	Lam Burn Rate (lbm/ft3-s)	FF	Burn Temp Limit (F)	FF	Turb Burn Opt	Turb Burn FF
2	0.	0.	1.	1.	DEFAULT		350.		EDIS	
3	0.	0.	1.	1.	DEFAULT		350.		EDIS	
4	0.	0.	1.	1.	DEFAULT		350.		EDIS	
5	0.	0.	1.	1.	DEFAULT		350.		EDIS	
6	0.	0.	1.	1.	DEFAULT		350.		EDIS	
7	0.	0.	1.	1.	DEFAULT		350.		EDIS	
8	0.	0.	1.	1.	DEFAULT		350.		EDIS	
9	0.	0.	1.	1.	DEFAULT		350.		EDIS	
10	0.	0.	1.	1.	DEFAULT		350.		EDIS	
11	0.	0.	1.	1.	DEFAULT		350.		EDIS	
12	0.	0.	1.	1.	DEFAULT		350.		EDIS	
13	0.	0.	1.	1.	DEFAULT		350.		EDIS	
14	0.	0.	1.	1.	DEFAULT		350.		EDIS	
15	0.	0.	1.	1.	DEFAULT		350.		EDIS	
16	0.	0.	1.	1.	DEFAULT		350.		EDIS	
17	0.	0.	1.	1.	DEFAULT		350.		EDIS	
18	0.	0.	1.	1.	DEFAULT		350.		EDIS	
19	0.	0.	1.	1.	DEFAULT		350.		EDIS	
20	0.	0.	1.	1.	DEFAULT		350.		EDIS	

Mechanistic Burn Propagation Parameters

Vol #	Unburned H2 Frac	FF	Burned H2 Frac	FF	CC Flow Vel (ft/s)	FF	Flame Thick (ft)	FF	Ig Min H2 Frac	Ig Min O2 Frac	Ig Max Steam Frac	Auto Ig Temp (F)	FF
1	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
2	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
3	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
4	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
5	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
6	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
7	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
8	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
9	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
10	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
11	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
12	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
13	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
14	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
15	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
16	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	

Mechanistic Burn Propagation Parameters (cont.)

Vol #	Unburned H2 Frac	FF	Burned H2 Frac	FF	CC Flow Vel (ft/s)	FF	Flame Thick (ft)	FF	Ig Min H2 Frac	Ig Min O2 Frac	Ig Max Steam Frac	Auto Ig Temp (F)	FF
17	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
18	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
19	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	
20	0.04		0.001		DEFAULT		0.164		0.04	0.05	0.55	DEFAULT	

Fluid Boundary Conditions - Table 1

BC#	Description	Press. (psia)	FF	Temp. (F)	FF	Flow (lbm/s)	FF	S P	J O	ON Trip	OFF Trip	Elev. (ft)
1P	E Wall Ambient	14.7		1	2T			N	N			517.5
2F	E Wall Ambient	14.7		1	2T	v1e10		N	N			517.5
3P	W Wall Ambient	14.7		1	2T			N	N			517.5
4F	W Wall Ambient	14.7		1	2T	v1e10		N	N			517.5
5P	Exhaust Ambient	14.7		1	2T			N	N			517.5
6F	Exhaust Ambient	14.7		1	2T	v1e10		N	N			517.5
7F	U2 SFP Evap	1.945		125		0.07	8T	N	N			613.
8F	U3 SFP Evap	1.945		125		0.07	8T	N	N			613.
9P	S Wall Ambient	14.7		1	2T			N	N			517.5
10F	S Wall Ambient	14.7		1	2T	v1e10		N	N			517.5
11P	N Wall Ambient	14.7		1	2T			N	N			517.5
12F	N Wall Ambient	14.7		1	2T	v1e10		N	N			517.5

Fluid Boundary Conditions - Table 2

BC#	Liq. V. Frac.	FF	Stm. V. Frac.	FF	Drop D. (in)	FF	Drop GSD	Drop Frac.	FF	Cpld BC#	Flow Frac.	FF	Heat (Btu/s)	FF	Outlet Quality	FF
1P			H100	9T	NONE		1.								DEFAULT	
2F			H100	9T	NONE		1.								DEFAULT	
3P			H100	9T	NONE		1.								DEFAULT	
4F			H100	9T	NONE		1.								DEFAULT	
5P			H100	9T	NONE		1.								DEFAULT	
6F			H100	9T	NONE		1.								DEFAULT	
7F			1		NONE		1.								DEFAULT	
8F			1		NONE		1.								DEFAULT	
9P			H100	9T	NONE		1.								DEFAULT	
10F			H100	9T	NONE		1.								DEFAULT	
11P			H100	9T	NONE		1.								DEFAULT	
12F			H100	9T	NONE		1.								DEFAULT	

Fluid Boundary Conditions - Table 3
Volume Fractions

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

Fluid Boundary Conditions - Table 4
Volume Fractions

BC#	Gas 5	FF	Gas 6	FF	Gas 7	FF	Liquid Comp. Set	FF
1P								
2F								
3P								
4F								
5P								
6F								
7F								
8F								
9P								
10F								
11P								
12F								

Flow Paths - Table 1

F.P. #	Description	Vol A	F	Elev (ft)	Ht (ft)	Vol B	F	Elev (ft)	Ht (ft)	Tilt (deg)	Rot. (deg)
1	U2 Basement-Grd	1	-	516.5	1.	2	-	517.5	1.		
2	U2 Ground-Mezz	2	-	544.5	1.	3	-	545.5	1.		
3	U2 Mezz-Main	3	-	569.	1.	4	-	570.	1.		

Flow Paths - Table 1 (cont.)

F.P. #	Description	Vol A	F	Elev (ft)	Ht (ft)	Vol B	F	Elev (ft)	Ht (ft)	Tilt (deg)	Rot. (deg)
4	U2 Main-Reactor	4	-	588.	1.	5	-	589.	1.		
5	U2 Reactor-Refu	5	-	612.	1.	11	-	613.	1.		
6	U3 Basement-Grd	6	-	516.5	1.	7	-	517.5	1.		
7	U3 Ground-Mezz	7	-	544.5	1.	8	-	545.5	1.		
8	U3 Mezz-Main	8	-	569.	1.	9	-	570.	1.		
9	U3 Main-Reactor	9	-	588.	1.	10	-	589.	1.		
10	U3 Reactor-Refu	10	-	612.	1.	11	-	613.	1.		
11	U3-U2 Grnd Flr	2	-	517.5	7.	7	-	517.5	7.		
12	U3-U2 Mezzanine	3	-	545.5	7.	8	-	545.5	7.		
13	U3-U2 Main Flr	4	-	570.	7.	9	-	570.	7.		
14	U3-U2 Reactor F	5	-	589.	7.	10	-	589.	7.		
15	U2 Primary SGT	17	-	581.33	2.	14	-	827.5	2.		
16	U3 Standby SGT	18	-	581.33	2.	14	-	827.5	2.		
17	U2 Exhaust Vlv	17	-	581.33	6.	14	-	676.38	6.		
18	U3 Exhaust Vlvt	18	-	581.33	6.	14	-	676.38	6.		
19	U2 Supply Vlv	12	-	581.33	6.	15	-	581.33	6.		
20	U3 Supply Vlv	13	-	581.33	6.	16	-	581.33	6.		
21	E Wall Ambient	12	-	517.5	1.	1P	-	517.5	1.		
22	E Wall Ambient	12	-	517.5	1.	2F	-	517.5	1.		
23	W Wall Ambient	13	-	517.5	1.	3P	-	517.5	1.		
24	W Wall Ambient	13	-	517.5	1.	4F	-	517.5	1.		
25	Exhaust Ambient	14	-	517.5	1.	5P	-	517.5	1.		
26	Exhaust Ambient	14	-	517.5	1.	6F	-	517.5	1.		
27	U2 Supply Fan	12	-	581.33	6.	15	-	581.33	6.		
28	U2 Exhaust Fan	17	-	581.33	6.	14	-	676.38	6.		
29	U3 Supply Fan	13	-	581.33	6.	16	-	581.33	6.		
30	U3 Exhaust Fan	18	-	581.33	6.	14	-	676.38	6.		
31	U2 Torus Supply	1	-	476.5	1.	15	-	581.33	1.		
32	U2 517 Supply	2	-	517.5	1.	15	-	581.33	1.		
33	U2 545 Supply	3	-	545.5	1.	15	-	581.33	1.		
34	U2 570 Supply	4	-	570.	1.	15	-	581.33	1.		
35	U2 589 Supply	5	-	589.	1.	15	-	581.33	1.		
36	U2 Refuel Suppl	11	-	613.	1.	15	-	581.33	1.		
37	U3 Torus Supply	6	-	476.5	1.	16	-	581.33	1.		
38	U3 517 Supply	7	-	517.5	1.	16	-	581.33	1.		
39	U3 545 Supply	8	-	545.5	1.	16	-	581.33	1.		
40	U3 570 Supply	9	-	570.	1.	16	-	581.33	1.		
41	U3 589 Supply	10	-	589.	1.	16	-	581.33	1.		
42	U3 Refuel Sup	11	-	613.	1.	16	-	581.33	1.		
43	U2 Torus Exh	1	-	476.5	1.	17	-	581.33	1.		
44	U2 517 Exhaust	2	-	517.5	1.	17	-	581.33	1.		
45	U2 545 Exhaust	3	-	545.5	1.	17	-	581.33	1.		
46	U2 570 Exhaust	4	-	570.	1.	17	-	581.33	1.		
47	U2 589 Exhaust	5	-	589.	1.	17	-	581.33	1.		
48	U2 Refuel Exh	11	-	613.	1.	17	-	581.33	1.		

Flow Paths - Table 1 (cont.)

F.P. #	Description	Vol A	F	Elev (ft)	Ht (ft)	Vol B	F	Elev (ft)	Ht (ft)	Tilt (deg)	Rot. (deg)
49	U3 Torus Exh	6	-	476.5	1.	18	-	581.33	1.		
50	U3 517 Exhaust	7	-	517.5	1.	18	-	581.33	1.		
51	U3 545 Exhaust	8	-	545.5	1.	18	-	581.33	1.		
52	U3 570 Exhaust	9	-	570.	1.	18	-	581.33	1.		
53	U3 589 Exhaust	10	-	589.	1.	18	-	581.33	1.		
54	U3 Refuel Exh	11	-	613.	1.	18	-	581.33	1.		
55	U2 SFP Evap	11	-	613.	1.	7F	-	613.	1.		
56	U3 SFP Evap	11	-	613.	1.	8F	-	613.	1.		
57	W Refuel Wall	11	-	621.	1.	13	-	621.	1.		
58	E Refuel Wall	11	-	621.	1.	12	-	621.	1.		
59	S Wall Ambient	19	-	517.5	1.	9P	-	517.5	1.		
60	S Wall Ambient	19	-	517.5	1.	10F	-	517.5	1.		
61	N Wall Ambient	20	-	517.5	1.	11P	-	517.5	1.		
62	N Wall Ambient	20	-	517.5	1.	12F	-	517.5	1.		
63	S Refuel Wall	11	-	621.	1.	19	-	621.	1.		
64	N Refuel Wall	11	-	621.	1.	20	-	621.	1.		
65	U2 476 DP	1	-	516.5	1.	12	-	517.5	1.		
66	U2 517 DP	2	-	517.5	1.	12	-	517.5	1.		
67	U2 545 DP	3	-	545.5	1.	12	-	545.5	1.		
68	U2 570 DP	4	-	570.	1.	12	-	570.	1.		
69	U2 589 DP	5	-	589.	1.	12	-	589.	1.		

Flow Paths - Table 2

Flow Path #	Flow Area (ft2)	Hyd. Diam. (ft)	Inertia Length (ft)	Friction Length (ft)	Relative Rough- ness	Lam Geom Fact	Dep Bend (deg)	Mom Trn Opt	Strat Flow Opt
1	32.	4.	34.5			DEFA	0.	-	NONE
2	380.	19.5	26.25			DEFA	0.	-	NONE
3	380.	19.5	21.75			DEFA	0.	-	NONE
4	130.	9.7	21.5			DEFA	0.	-	NONE
5	380.	19.5	35.625			DEFA	0.	-	NONE
6	32.	4.	34.5			DEFA	0.	-	NONE
7	380.	19.5	26.25			DEFA	0.	-	NONE
8	380.	19.5	21.75			DEFA	0.	-	NONE
9	130.	9.7	21.5			DEFA	0.	-	NONE
10	380.	19.5	35.625			DEFA	0.	-	NONE
11	35.	5.8	147.			DEFA	0.	-	NONE
12	1e-06	4.2	147.			DEFA	0.	-	NONE
13	1e-06	4.2	147.			DEFA	0.	-	NONE
14	1e-06	4.2	147.			DEFA	0.	-	NONE
15	3.14	2.	1.			DEFA	0.	-	NONE

Flow Paths - Table 2 (cont.)

Flow Path #	Flow Area (ft2)	Hyd. Diam. (ft)	Inertia Length (ft)	Friction Length (ft)	Relative Rough-ness	Lam Geom Fact	Dep Bend (deg)	Mom Trn Opt	Strat Flow Opt
16	3.14	2.	1.			DEFA	0.	-	NONE
17	28.3	6.	1.			DEFA	0.	-	NONE
18	28.3	6.	1.			DEFA	0.	-	NONE
19	28.3	6.	1.			DEFA	0.	-	NONE
20	28.3	6.	1.			DEFA	0.	-	NONE
21	1e+10	1e+10	1.			DEFA	0.	-	NONE
22	1e+10	1e+10	1.			DEFA	0.	-	NONE
23	1e+10	1e+10	1.			DEFA	0.	-	NONE
24	1e+10	1e+10	1.			DEFA	0.	-	NONE
25	1e+10	1e+10	1.			DEFA	0.	-	NONE
26	1e+10	1e+10	1.			DEFA	0.	-	NONE
27	28.3	6.	1.			DEFA	0.	-	NONE
28	28.3	6.	1.			DEFA	0.	-	NONE
29	28.3	6.	1.			DEFA	0.	-	NONE
30	28.3	6.	1.			DEFA	0.	-	NONE
31	28.3	6.	1.			DEFA	0.	-	NONE
32	28.3	6.	1.			DEFA	0.	-	NONE
33	28.3	6.	1.			DEFA	0.	-	NONE
34	28.3	6.	1.			DEFA	0.	-	NONE
35	28.3	6.	1.			DEFA	0.	-	NONE
36	28.3	6.	1.			DEFA	0.	-	NONE
37	28.3	6.	1.			DEFA	0.	-	NONE
38	28.3	6.	1.			DEFA	0.	-	NONE
39	28.3	6.	1.			DEFA	0.	-	NONE
40	28.3	6.	1.			DEFA	0.	-	NONE
41	28.3	6.	1.			DEFA	0.	-	NONE
42	28.3	6.	1.			DEFA	0.	-	NONE
43	28.3	6.	1.			DEFA	0.	-	NONE
44	28.3	6.	1.			DEFA	0.	-	NONE
45	28.3	6.	1.			DEFA	0.	-	NONE
46	28.3	6.	1.			DEFA	0.	-	NONE
47	28.3	6.	1.			DEFA	0.	-	NONE
48	28.3	6.	1.			DEFA	0.	-	NONE
49	28.3	6.	1.			DEFA	0.	-	NONE
50	28.3	6.	1.			DEFA	0.	-	NONE
51	28.3	6.	1.			DEFA	0.	-	NONE
52	28.3	6.	1.			DEFA	0.	-	NONE
53	28.3	6.	1.			DEFA	0.	-	NONE
54	28.3	6.	1.			DEFA	0.	-	NONE
55	1353.	36.6	1.			DEFA	0.	-	NONE
56	1353.	36.6	1.			DEFA	0.	-	NONE
57	0.294	1.	1.			DEFA	0.	-	NONE
58	0.294	1.	1.			DEFA	0.	-	NONE
59	1e+10	1e+10	1.			DEFA	0.	-	NONE

Flow Paths - Table 2 (cont.)

Flow Path #	Flow Area (ft2)	Hyd. Diam. (ft)	Inertia Length (ft)	Friction Length (ft)	Relative Rough- ness	Lam Geom Fact	Dep Bend (deg)	Mom Trn Opt	Strat Flow Opt
60	1e+10	1e+10	1.			DEFA	0.	-	NONE
61	1e+10	1e+10	1.			DEFA	0.	-	NONE
62	1e+10	1e+10	1.			DEFA	0.	-	NONE
63	0.734	1.	1.			DEFA	0.	-	NONE
64	0.734	1.	1.			DEFA	0.	-	NONE
65	1e-12	1.	1.			DEFA	0.	-	NONE
66	1e-12	1.	1.			DEFA	0.	-	NONE
67	1e-12	1.	1.			DEFA	0.	-	NONE
68	1e-12	1.	1.			DEFA	0.	-	NONE
69	1e-12	1.	1.			DEFA	0.	-	NONE

Flow Paths - Table 3

Flow Path #	Fwd. Loss Coeff.	FF	Rev. Loss Coeff.	FF	Comp. Opt.	Critical Flow Model	Exit Loss Coeff.	Drop Breakup Model	Homog. Flow Opt.
1	2.85		2.85		OFF	OFF	0.	OFF	OFF
2	2.85		2.85		OFF	OFF	0.	OFF	OFF
3	2.85		2.85		OFF	OFF	0.	OFF	OFF
4	2.85		2.85		OFF	OFF	0.	OFF	OFF
5	2.85		2.85		OFF	OFF	0.	OFF	OFF
6	2.85		2.85		OFF	OFF	0.	OFF	OFF
7	2.85		2.85		OFF	OFF	0.	OFF	OFF
8	2.85		2.85		OFF	OFF	0.	OFF	OFF
9	2.85		2.85		OFF	OFF	0.	OFF	OFF
10	2.85		2.85		OFF	OFF	0.	OFF	OFF
11	2.85		2.85		OFF	OFF	0.	OFF	OFF
12	2.85		2.85		OFF	OFF	0.	OFF	OFF
13	2.85		2.85		OFF	OFF	0.	OFF	OFF
14	2.85		2.85		OFF	OFF	0.	OFF	OFF
15	160.1		1e+60		OFF	OFF	0.	OFF	OFF
16	160.1		1e+60		OFF	OFF	0.	OFF	OFF
17	1e+60		0.38		OFF	OFF	0.	OFF	OFF
18	1e+60		0.38		OFF	OFF	0.	OFF	OFF
19	0.38		1e+60		OFF	OFF	0.	OFF	OFF
20	0.38		1e+60		OFF	OFF	0.	OFF	OFF
21	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
22	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
23	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
24	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
25	1e-60		1e-60		OFF	OFF	0.	OFF	OFF

Flow Paths - Table 3 (cont.)

Flow Path #	Fwd. Loss Coeff.	FF	Rev. Loss Coeff.	FF	Comp. Opt.	Critical Flow Model	Exit Loss Coeff.	Drop Breakup Model	Homog. Flow Opt.
26	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
27	1e-20		1e-20		OFF	OFF	0.	OFF	OFF
28	1e-20		1e-20		OFF	OFF	0.	OFF	OFF
29	1e-20		1e-20		OFF	OFF	0.	OFF	OFF
30	1e-20		1e-20		OFF	OFF	0.	OFF	OFF
31	345.5		345.5		OFF	OFF	0.	OFF	OFF
32	683.		683.		OFF	OFF	0.	OFF	OFF
33	240.8		240.8		OFF	OFF	0.	OFF	OFF
34	714.8		714.8		OFF	OFF	0.	OFF	OFF
35	2091.6		2091.6		OFF	OFF	0.	OFF	OFF
36	193.3		193.3		OFF	OFF	0.	OFF	OFF
37	345.5		345.5		OFF	OFF	0.	OFF	OFF
38	683.		683.		OFF	OFF	0.	OFF	OFF
39	240.8		240.8		OFF	OFF	0.	OFF	OFF
40	714.8		714.8		OFF	OFF	0.	OFF	OFF
41	2091.6		2091.6		OFF	OFF	0.	OFF	OFF
42	193.3		193.3		OFF	OFF	0.	OFF	OFF
43	343.2		343.2		OFF	OFF	0.	OFF	OFF
44	516.		516.		OFF	OFF	0.	OFF	OFF
45	260.8		260.8		OFF	OFF	0.	OFF	OFF
46	678.5		678.5		OFF	OFF	0.	OFF	OFF
47	19201.8		19201.8		OFF	OFF	0.	OFF	OFF
48	141.7		141.7		OFF	OFF	0.	OFF	OFF
49	343.2		343.2		OFF	OFF	0.	OFF	OFF
50	516.		516.		OFF	OFF	0.	OFF	OFF
51	260.8		260.8		OFF	OFF	0.	OFF	OFF
52	678.5		678.5		OFF	OFF	0.	OFF	OFF
53	19201.8		19201.8		OFF	OFF	0.	OFF	OFF
54	141.7		141.7		OFF	OFF	0.	OFF	OFF
55	1e-10		1e-10		OFF	OFF	0.	OFF	OFF
56	1e-10		1e-10		OFF	OFF	0.	OFF	OFF
57	1e+20		2.85		OFF	OFF	0.	OFF	OFF
58	1e+20		2.85		OFF	OFF	0.	OFF	OFF
59	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
60	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
61	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
62	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
63	1e+20		2.85		OFF	OFF	0.	OFF	OFF
64	1e+20		2.85		OFF	OFF	0.	OFF	OFF
65	2.85		2.85		OFF	OFF	0.	OFF	OFF
66	2.85		2.85		OFF	OFF	0.	OFF	OFF
67	2.85		2.85		OFF	OFF	0.	OFF	OFF
68	2.85		2.85		OFF	OFF	0.	OFF	OFF
69	2.85		2.85		OFF	OFF	0.	OFF	OFF

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Flow Paths - Table 4

	Forward			Reverse					
Flow Path #	Min H2 Frac	Min O2 Frac	Max H2O Frac	Min H2 Frac	Min O2 Frac	Max H2O Frac	Burn Time Frac	Prop With Zero Flow	Prop Opt
1	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
2	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
3	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
4	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
5	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
6	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
7	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
8	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
9	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
10	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
11	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
12	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
13	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
14	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
15	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
16	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
17	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
18	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
19	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
20	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
21	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
22	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
23	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
24	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
25	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
26	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
27	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
28	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
29	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
30	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
31	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
32	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
33	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
34	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
35	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
36	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
37	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
38	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
39	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
40	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
41	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
42	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
43	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW

Flow Paths - Table 4 (cont.)

Flow Path #	Min H2 Frac	Forward Min O2 Frac	Max H2O Frac	Min H2 Frac	Reverse Min O2 Frac	Max H2O Frac	Burn Time Frac	Prop With Zero Flow	Prop Opt
44	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
45	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
46	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
47	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
48	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
49	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
50	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
51	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
52	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
53	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
54	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
55	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
56	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
57	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
58	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
59	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
60	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
61	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
62	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
63	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
64	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
65	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
66	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
67	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
68	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW
69	0.06	0.05	0.55	0.06	0.05	0.55	0.5	NO	COFLOW

Thermal Conductors

Cond #	Description	Vol A	Srf Opt	Vol B	Srf Opt	Cond Type	S. A. (ft2)	Init. T.(F)	I/X	Grp #
1	U2 Base - 517	1	2	2	3	5	11539.	103.	X	
2	U2 517 - 545	2	2	3	3	2	11641.	103.	X	
3	U2 545 - 570	3	2	4	3	4	9799.	103.	X	
4	U2 570- 589	4	2	5	3	1	8801.	103.	X	
5	U2 589 - Refuel	5	2	11	3	5	10064.	103.	X	
6	U3 Base - 517	6	2	7	3	5	11539.	103.	X	
7	U3 517 - 545	7	2	8	3	2	11642.	103.	X	
8	U3 545 - 570	8	2	9	3	4	9799.	103.	X	
9	U3 570- 589	9	2	10	3	1	8801.	103.	X	

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Thermal Conductors (cont.)

Cond #	Description	Vol A	Srf Opt	Vol B	Srf Opt	Cond Type	S. A. (ft2)	Init. T.(F)	I/X	Grp #
10	U3 589 - Refuel	10	2	11	3	5	10064.	103.	X	
11	U2 - U3 Base	1	1	6	1	8	6124.	103.	X	
12	U2 - U3 517	2	1	7	1	6	3000.	103.	X	
13	U2 - U3 545	3	1	8	1	5	2574.	103.	X	
14	U2 - U3 570	4	1	9	1	5	1188.	103.	X	
15	U2 - U3 589	5	1	10	1	7	1917.	103.	X	
16	U2 Base - Adj	1	1	1	4	3	36519.	103.	I	
17	U2 517 - Adj	2	1	2	4	3	9698.	103.	I	
18	U2 545 - Adj	3	1	3	4	3	9217.	103.	I	
19	U2 570 - Adj	4	1	4	4	3	5220.	103.	I	
20	U2 589 - Adj	5	1	5	4	3	8031.	103.	I	
21	U3 Base - Adj	6	1	6	4	3	35021.	103.	I	
22	U3 517 - Adj	7	1	7	4	3	9698.	103.	I	
23	U3 545 - Adj	8	1	8	4	3	9217.	103.	I	
24	U3 570 - Adj	9	1	9	4	3	5220.	103.	I	
25	U3 589 - Adj	10	1	10	4	3	8031.	103.	I	
26	U2 Base - DW	1	1	1	8	9	9068.	103.	I	
27	U2 517 - DW	2	1	2	8	11	4842.	103.	I	
28	U2 545 - DW	3	1	3	8	12	3382.	103.	I	
29	U2 570 - DW	4	1	4	8	11	1657.	103.	I	
30	U2 589 - DW	5	1	5	8	10	1838.	103.	I	
31	U3 Base - DW	6	1	6	11	9	9068.	103.	I	
32	U3 517 - DW	7	1	7	11	11	4842.	103.	I	
33	U3 545 - DW	8	1	8	11	12	3382.	103.	I	
34	U3 570 - DW	9	1	9	11	11	1657.	103.	I	
35	U3 589 - DW	10	1	10	11	10	1838.	103.	I	
36	U2 Base - Torus	1	5	1	7	15	32000.	103.	I	
37	U2 Base - Pipes	1	6	1	7	16	5152.	103.	I	
38	U2 517 - Pipes	2	6	2	7	16	793.	103.	I	
39	U2 545 - Pipes	3	6	3	7	16	445.	103.	I	
40	U3 Base - Torus	6	5	6	10	15	1e-06	103.	I	
41	U2 545 - SFP	3	2	3	9	11	2008.	103.	I	
42	U2 570 - SFP	4	1	4	9	11	2942.	103.	I	
43	U2 589 - SFP	5	1	5	9	11	5064.	103.	I	
44	U3 545 - SFP	8	2	8	12	11	2008.	103.	I	
45	U3 570 - SFP	9	1	9	12	11	2942.	103.	I	
46	U3 589 - SFP	10	1	10	12	11	5064.	103.	I	
47	Refuel - U2 DW	11	3	11	8	12	1452.	103.	I	
48	Refuel - U3 DW	11	3	11	11	12	1452.	103.	I	
49	Refuel - TB	11	1	11	13	13	662.	103.	I	
50	Refuel -Outside	11	1	11	14	13	22830.	103.	I	
51	Refuel - Roof	11	2	11	15	14	34000.	103.	I	
52	U2 SFP - Refuel	11	3	11	9	17	1353.	103.	I	
53	U3 SFP - Refuel	11	3	11	12	17	1353.	103.	I	

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Thermal Conductors - Radiation Parameters

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

Thermal Conductors - Radiation Parameters (cont.)

Cond #	Therm. Rad. Side A	Emiss. Side A	Therm. Rad. Side B	Emiss. Side B	Scope
46	No		No		FULL
47	No		No		FULL
48	No		No		FULL
49	No		No		FULL
50	No		No		FULL
51	No		No		FULL
52	No		No		FULL
53	No		No		FULL

Conductor Surface Options - Table 1

Surf Opt #	Description	Heat Transfer Option	Nominal Value	FF	Cnd/ Cnv Opt	Cnd Opt	Sp Cnv HTC	Nat Cnv Opt	For Cnv Opt
1	Interior Wall	Direct		3T		DLM-FM		VERT SURF	OFF
2	Int Ceiling	Direct		3T		DLM-FM		FACE DOWN	OFF
3	Int Floor	Direct		3T		DLM-FM		FACE UP	OFF
4	Insulated	Sp Heat	0.						
5	Torus	Direct		3T		DLM-FM		HORZ CYL	OFF
6	Pipes	Direct		3T		DLM-FM		HORZ CYL	OFF
7	LOCA SP Temp	Sp Temp	1.	6T					
8	LOCA DW Temp	Sp Temp	1.	7T					
9	LOCA SFP Temp	Sp Temp	125.						
10	Normal SP Temp	Sp Temp	98.						
11	Normal DW Temp	Sp Temp	150.						
12	Normal SFP Temp	Sp Temp	125.						
13	Turbine Bldg	Sp Heat	0.						
14	Outside Air	Sp Temp	93.						
15	Roof Sol-Air T	Sp Temp	127.						

Conductor Surface Options - Table 2

Surf Opt #	Phase Opt	Min Liq Fract	Max Liq Fract	Convection Bulk Temp Model	FF	Condensation Bulk Temp Model	FF	Rad to Steam Emissivity Dry	Rad to Steam Emissivity Wet
1	VAP			Tg-Tf		Tb-Tw		DEFAULT	DEFAULT
2	VAP			Tg-Tf		Tb-Tw		DEFAULT	DEFAULT
3	VAP			Tg-Tf		Tb-Tw		DEFAULT	DEFAULT
4									

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Conductor Surface Options - Table 2 (cont.)

Surf Opt #	Phase Opt	Min Liq Fract	Max Liq Fract	Convection Bulk Temp Model	FF	Condensation Bulk Temp Model	FF	Rad to Steam Emissivity Dry	Wet
5	VAP			Tg-Tf		Tb-Tw		DEFAULT	DEFAULT
6	VAP			Tg-Tf		Tb-Tw		DEFAULT	DEFAULT
7									
8									
9									
10									
11									
12									
13									
14									
15									

Conductor Surface Options - Table 3

Surf Opt #	Char. Length (ft)	Nom Vel (ft/s)	Vel FF	Minimum Conv HTC (B/h-f2-F)	Char. Height (ft)	Cond. Length (ft)
1				DEFAULT	DEFAULT	DEFAULT
2				DEFAULT	DEFAULT	DEFAULT
3				DEFAULT	DEFAULT	DEFAULT
4						
5				DEFAULT	DEFAULT	DEFAULT
6				DEFAULT	DEFAULT	DEFAULT
7						
8						
9						
10						
11						
12						
13						
14						
15						

Conductor Surface Options - Table 4

Surf Opt #	Const CT	Total Heat (Btu)	Peak Time (sec)	Exp XT	Initial Value (B/h-f2-F)	BD Exp yt	Post-BD Exp xt	Post-BD Direct FF
1								

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Conductor Surface Options - Table 4 (cont.)

Surf Opt #	Const CT	Total Heat (Btu)	Peak Time (sec)	Exp XT	Initial Value (B/h-f2-F)	BD Exp yt	Post-BD Exp xt	Post-BD Direct FF
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

Conductor Surface Options - Forced Convection Variables
htc = (k/l) * (A + B*Re**C*Pr**D)

Surf Opt #	Conv Var A Nom.	Conv Var A FF	Conv Var B Nom.	Conv Var B FF	Conv Var C Nom.	Conv Var C FF	Conv Var D Nom.	Conv Var D FF
1	0.		0.023		0.8		0.4	
2	0.		0.023		0.8		0.4	
3	0.		0.023		0.8		0.4	
4	0.		0.023		0.8		0.4	
5	0.		0.023		0.8		0.4	
6	0.		0.023		0.8		0.4	
7	0.		0.023		0.8		0.4	
8	0.		0.023		0.8		0.4	
9	0.		0.023		0.8		0.4	
10	0.		0.023		0.8		0.4	
11	0.		0.023		0.8		0.4	
12	0.		0.023		0.8		0.4	
13	0.		0.023		0.8		0.4	
14	0.		0.023		0.8		0.4	
15	0.		0.023		0.8		0.4	

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Conductor Surface Options - Natural Convection Variables
htc = (k/l) * (A + B*Gr**C*Pr**D)

Surf Opt #	Conv Var A Nom.	Conv Var A FF	Conv Var B Nom.	Conv Var B FF	Conv Var C Nom.	Conv Var C FF	Conv Var D Nom.	Conv Var D FF
1	0.		0.59		0.25		0.25	
2	0.		0.59		0.25		0.25	
3	0.		0.59		0.25		0.25	
4	0.		0.59		0.25		0.25	
5	0.		0.59		0.25		0.25	
6	0.		0.59		0.25		0.25	
7	0.		0.59		0.25		0.25	
8	0.		0.59		0.25		0.25	
9	0.		0.59		0.25		0.25	
10	0.		0.59		0.25		0.25	
11	0.		0.59		0.25		0.25	
12	0.		0.59		0.25		0.25	
13	0.		0.59		0.25		0.25	
14	0.		0.59		0.25		0.25	
15	0.		0.59		0.25		0.25	

Thermal Conductor Types

Type #	Description	Geom	Thick. (in)	O.D. (in)	Regions	Heat (Btu/ft3-s)	Heat FF
1	1’ Wall	WALL	12.	0.	1	0.	
2	1.25’ Wall	WALL	15.	0.	1	0.	
3	1.5’ Wall	WALL	18.	0.	1	0.	
4	1.75’ Wall	WALL	21.	0.	1	0.	
5	2’ Wall	WALL	24.	0.	1	0.	
6	2.25’ Wall	WALL	27.	0.	1	0.	
7	2.5’ Wall	WALL	30.	0.	1	0.	
8	3’ Wall	WALL	36.	0.	1	0.	
9	4’ Wall	WALL	48.	0.	1	0.	
10	5’ Wall	WALL	60.	0.	1	0.	
11	6’ Wall	WALL	72.	0.	1	0.	
12	8’ Wall	WALL	96.	0.	1	0.	
13	Refuel Wall	WALL	1.25	0.	1	0.	
14	Refuel Ceiling	WALL	5.5	0.	3	0.	
15	Torus	WALL	0.5	0.	1	0.	
16	Pipe	WALL	0.12	0.	1	0.	
17	SFP Surface	WALL	0.001	0.	1	0.	

Thermal Conductor Type
1
1’ Wall

Region	Mat. #	Bdry. (in)	Thick (in)	Sub- regs.	Heat Factor
1	1	0.	12.	10	0.

Thermal Conductor Type
2
1.25’ Wall

Region	Mat. #	Bdry. (in)	Thick (in)	Sub- regs.	Heat Factor
1	1	0.	15.	10	0.

Thermal Conductor Type
3
1.5’ Wall

Region	Mat. #	Bdry. (in)	Thick (in)	Sub- regs.	Heat Factor
1	1	0.	18.	10	0.

Thermal Conductor Type
4
1.75’ Wall

Region	Mat. #	Bdry. (in)	Thick (in)	Sub- regs.	Heat Factor
1	1	0.	21.	10	0.

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Thermal Conductor Type
5
2’ Wall

Region	Mat. #	Bdry. (in)	Thick (in)	Sub- regs.	Heat Factor
1	1	0.	24.	10	0.

Thermal Conductor Type
6
2.25’ Wall

Region	Mat. #	Bdry. (in)	Thick (in)	Sub- regs.	Heat Factor
1	1	0.	27.	10	0.

Thermal Conductor Type
7
2.5’ Wall

Region	Mat. #	Bdry. (in)	Thick (in)	Sub- regs.	Heat Factor
1	1	0.	30.	10	0.

Thermal Conductor Type
8
3’ Wall

Region	Mat. #	Bdry. (in)	Thick (in)	Sub- regs.	Heat Factor
1	1	0.	36.	10	0.

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Thermal Conductor Type
9
4’ Wall

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	48.	10	0.

Thermal Conductor Type
10
5’ Wall

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	60.	10	0.

Thermal Conductor Type
11
6’ Wall

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	72.	10	0.

Thermal Conductor Type
12
8’ Wall

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	1	0.	96.	10	0.

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Thermal Conductor Type
13
Refuel Wall

Region	Mat. #	Bdry. (in)	Thick (in)	Sub- regs.	Heat Factor
1	3	0.	1.25	6	0.

Thermal Conductor Type
14
Refuel Ceiling

Region	Mat. #	Bdry. (in)	Thick (in)	Sub- regs.	Heat Factor
1	1	0.	3.5	5	0.
2	4	3.5	1.	5	0.
3	5	4.5	1.	5	0.

Thermal Conductor Type
15
Torus

Region	Mat. #	Bdry. (in)	Thick (in)	Sub- regs.	Heat Factor
1	2	0.	0.5	10	0.

Thermal Conductor Type
16
Pipe

Region	Mat. #	Bdry. (in)	Thick (in)	Sub- regs.	Heat Factor
1	2	0.	0.12	5	0.

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Thermal Conductor Type
17
SFP Surface

Region	Mat. #	Bdry. (in)	Thick (in)	Sub-regs.	Heat Factor
1	6	0.	0.001	1	0.

Cooler/Heater

Heater Cooler #	Description	Vol. #	On Trip #	Off Trip #	Flow Rate (CFM)	Flow Rate FF	Heat Rate (Btu/s)	Heat Rate FF	Phs Opt	Ctrlr Loc
1H	U2 Basement	1	1				145.		VTI	1
2H	U2 Ground Flr	2	1				42.4		VTI	2
3H	U2 Mezzanine	3	1				95.4		VTI	3
4H	U2 Main Flr	4	1				59.2		VTI	4
5H	U2 Reactor Fl	5	1				20.8		VTI	5
6H	U3 Basement	6	1				17.3		VTI	6
7H	U3 Ground Flr	7	1				41.2		VTI	7
8H	U3 Mezzanine	8	1				126.		VTI	8
9H	U3 Main Flr	9	1				69.6		VTI	9
10H	U3 Reactor Fl	10	1				20.8		VTI	10
11H	Refueling Flr	11	1				61.5		VTI	11
12C	Pump Rm Coole	1	1				1.	4T	VTE	1

Volumetric Fan - Table 1

Vol Fan #	Description	Flow Path #	On Trip #	Off Trip #	Min DP (psi)	Max DP (psi)
1Q	U2 Standby SGT	15			DEFAULT	DEFAULT
2Q	U3 Primary SGT	16			DEFAULT	DEFAULT
3Q	U2 RB Supply	27		1	DEFAULT	DEFAULT
4Q	U3 RB Supply	29		1	DEFAULT	DEFAULT
5Q	U2 RB Exhaust	28	4	3	DEFAULT	DEFAULT
6Q	U3 RB Exhaust	30	4	3	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	1.	1T	Time			14
2Q	Time	1e-06	1T	Time			14
3Q	Time	100000.		Time			15
4Q	Time	100000.		Time			16
5Q	Time	110000.		Time			14
6Q	Time	110000.		Time			14

Valves & Doors

Valve #	Description	Flow Path #	Open Trip #	Close Trip #	Valve Type #	Disch. Vol.
1V	U2 RB Supply	19	2		1	15
2V	U2 RB Exhaust	17	2		1	14
3V	U3 RB Supply	20	2		1	16
4V	U3 RB Exhaust	18	2		1	14

Valve/Door Types

Valve Type #	Description	Valve Option	F Open Area (ft2)	Opn Trv Crv	Cls Trv Crv	Full Open Cd	Flow Char Coef A	Flow Char Coef B	Flow Char Coef C	Flow Char Exp	Cd Mult Crv
1	RB isolation	T OPEN	28.3	5T		1.	1.				BLTN

Volume Initial Conditions

Vol #	Total Pressure (psia)	Vapor Temp. (F)	Liquid Temp. (F)	Relative Humidity (%)	Liquid Volume Fract.	Liq. Comp. Set	Vapor Tracer Set	Liquid Tracer Set
def	14.7	103.	103.	20.	0.	NONE	NONE	NONE

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Initial Volume Fractions							
Vol #	Air Gas 1	Gas 2	Gas 3	Gas 4	Gas 5	Gas 6	Gas 7
def	1.	0.	0.	0.	0.	0.	0.

Drop Fields - Physical Parameters				
Field No.	Description	Dnom (in)	Geom Std Dev	Min V Frac
1	Default	0.00393	1.	1e-10

Drop Fields - General Options				
Field No.	Unfm Dist	Temp Equil	Velocity Equil	Entrain-ment
1	YES	NO	NO	YES

Drop Fields - Agglomeration Options								
Field No.	Inter-field	Intra-field	Therm Diff	FF	Turb Diff	FF	Grav Coll	FF
1	YES	YES	YES		YES		YES	

Drop Fields - Deposition Options												
Field No.	Impac-tion	FF	Grav Settle	FF	Therm Diff	FF	Turb Diff	FF	Thermo-phoresis	FF	Diffusio-phoresis	FF
1	YES		YES		YES		YES		NO		NO	

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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 No.	Cp Tmin (R)	Equation Tmax (R)	(Required) Cp (Btu/lbm-R)	Visc. Tmin (R)	Equation Tmax (R)	(Optional) Viscosity (lbm/ft-hr)
1	200.	3000.	0.2889163+5.130			

Materials			
Type #	Description	Gap	Tracer Tracking
1	Concrete	NO	NO
2	Steel	NO	NO
3	Siding Insulation	NO	NO
4	Roof Insulation	NO	NO
5	Built Up Roofing	NO	NO
6	Water	NO	NO

Material Type 1 Concrete			
Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
	143.	0.92	0.21

Material Type
2
Steel

Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
	490.	25.	0.11

Material Type
3
Siding Insulation

Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
	2.	0.02	0.2

Material Type
4
Roof Insulation

Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
	4.5	0.02	0.4

Material Type
5
Built Up Roofing

Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
	70.	0.1	0.35

Material Type
6
Water

Temp. (F)	Density (lbm/ft3)	Cond. (Btu/hr-ft-F)	Sp. Heat (Btu/lbm-F)
	62.32	0.348	0.999

Component Trips

Trip #	Description	Sense Variable	Sensor 1 Loc.	Sensor 2 Loc.	Var. Limit	Set Point	Delay Time	Rset Trip	Cond Trip	Cond Type
1	LOCA Start	TIME			GE	1000.	0.			AND
2	Initial	TIME			GE	0.	0.			AND
3	RB Fan Off	CONT VAR	4C		LT	-0.251	0.	4	1	OR
4	RB Fan On	CONT VAR	4C		GT	-0.249	0.	3	5	AND
5	LOCA Time	CONT VAR	6C		LT	0.	0.			AND

Forcing Function Tables

FF#	Description	Ind. Var.	Dep. Var.	Points
0	Constant	-	-	0
1T	SGT Flow	Ind. Var.	Dep. Var.	6
2T	OA Temperature	Ind. Var.	Dep. Var.	4
3T	Cond HTC Coefs	Ind. Var.	Dep. Var.	4
4T	Pump Rm Cooler	Ind. Var.	Dep. Var.	13
5T	RB Valve Positi	Ind. Var.	Dep. Var.	5
6T	LOCA SP Temp	Ind. Var.	Dep. Var.	19
7T	LOCA DW Temp	Ind. Var.	Dep. Var.	4
8T	SFP Evaporation	Ind. Var.	Dep. Var.	4
9T	OA Humidity	Ind. Var.	Dep. Var.	4

Function
1T
SGT Flow
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	1000.	0.

Function (cont.)
1T
SGT Flow
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
1033.	0.	1063.	3400.
1100.	3975.	1e+06	3975.

Function
2T
OA Temperature
Ind. Var.: Ind. Var.
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	103.	1000.	103.
1000.01	93.	1e+06	93.

Function
3T
Cond HTC Coefs
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	999.9	0.
999.91	1.	1e+06	1.

Function
4T
Pump Rm Cooler
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
-100.	0.	104.	0.
104.01	19.4	110.	32.1
115.	42.6	120.	53.

Function (cont.)
4T
Pump Rm Cooler
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
125.	63.3	130.	73.5
135.	83.6	140.	93.6
145.	103.5	150.	113.3
500.	113.3		

Function
5T
RB Valve Positionpen
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	1000.	0.
1000.1	1.	1300.	0.
1e+06	0.		

Function
6T
LOCA SP Temp
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	98.	1000.	98.
1074.	147.4	1106.	148.9
1156.	153.7	1203.	156.1
1309.	161.3	1406.	163.8
1510.	165.9	1600.	167.5
2065.	172.	3954.	182.8
5996.	189.1	11083.	196.9
16006.	200.1	21027.	201.1
26125.	201.	31020.	200.4
41000.	197.8		

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Function
7T
LOCA DW Temp
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	150.	1000.	150.
1000.1	290.	1e+06	290.

Function
8T
SFP Evaporation
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	1000.	0.
1000.1	1.	1e+10	1.

Function
9T
OA Humidity
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.2	1000.	0.2
1000.01	0.	1e+06	0.

Control Variables

CV #	Description	Func. Form	Initial Value	Coeff. G	Coeff. a0	Min	Max	Upd. Int. Mult.
1C	DP E side	mult	0.	27.7	0.	-1e+32	1e+32	0.
2C	DP W side	mult	0.	27.7	0.	-1e+32	1e+32	0.
3C	DP S Side	mult	0.	27.7	0.	-1e+32	1e+32	0.
4C	DP N Side	mult	0.	27.7	0.	-1e+32	1e+32	0.
5C	Avg DP Refuel	sum	0.	1.	0.	-1e+32	1e+32	0.
6C	Time After LO	sum	0.	1.	-1000.	-1e+32	1e+32	0.

Control Variables (cont.)

CV #	Description	Func. Form	Initial Value	Coeff. G	Coeff. a0	Min	Max	Upd. Int. Mult.
7C	DP 476	mult	0.	27.7	0.	-1e+32	1e+32	0.
8C	DP 517	mult	0.	27.7	0.	-1e+32	1e+32	0.
9C	DP 545	mult	0.	27.7	0.	-1e+32	1e+32	0.
10C	DP 570	mult	0.	27.7	0.	-1e+32	1e+32	0.
11C	DP 589	mult	0.	27.7	0.	-1e+32	1e+32	0.
12C	Total Leakage	sum	0.	1.	0.	-1e+32	1e+32	0.

Function Components
Control Variable 1C
DP E side: G=27.7 a0=0. min=-1.e32 max=1.e32
mult
Y=G*(a1X1*a2X2*...*anXn), a0 unused

#	X: Gothic_s Name	X: Variable location	a: Mult. coef.	Min. Value	Max Value
1	Dpjnc	cJ58	1.	-1e+32	1e+32

Function Components
Control Variable 2C
DP W side: G=27.7 a0=0. min=-1.e32 max=1.e32
mult
Y=G*(a1X1*a2X2*...*anXn), a0 unused

#	X: Gothic_s Name	X: Variable location	a: Mult. coef.	Min. Value	Max Value
1	Dpjnc	cJ57	1.	-1e+32	1e+32

Function Components
Control Variable 3C
DP S Side: G=27.7 a0=0. min=-1.e32 max=1.e32
mult
Y=G*(a1X1*a2X2*...*anXn), a0 unused

#	X: Gothic_s Name	X: Variable location	a: Mult. coef.	Min. Value	Max Value
1	Dpjnc	cJ63	1.	-1e+32	1e+32

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Function Components
Control Variable 4C
DP N Side: G=27.7 a0=0. min=-1.e32 max=1.e32
mult
Y=G*(a1X1*a2X2*...*anXn), a0 unused

#	X: Gothic_s Name	X: Variable location	a: Mult. coef.	Min. Value	Max Value
1	Dpjnc	cJ64	1.	-1e+32	1e+32

Function Components
Control Variable 5C
Avg DP Refuel: G=1.0 a0=0. min=-1.e32 max=1.e32
sum
Y=G*(a0+a1X1+a2X2+...+anXn)

#	X: Gothic_s Name	X: Variable location	a: Mult. coef.	Min. Value	Max Value
1	Cvval(0)	cv1C	0.25	-1e+32	1e+32
2	Cvval(0)	cv2C	0.25	-1e+32	1e+32
3	Cvval(0)	cv3C	0.25	-1e+32	1e+32
4	Cvval(0)	cv4C	0.25	-1e+32	1e+32

Function Components
Control Variable 6C
Time After LOCA: G=1.0 a0=-1000 min=-1.e32 max=1.e32
sum
Y=G*(a0+a1X1+a2X2+...+anXn)

#	X: Gothic_s Name	X: Variable location	a: Mult. coef.	Min. Value	Max Value
1	Etime	cM	1.	-1e+32	1e+32

Function Components
Control Variable 7C
DP 476: G=27.7 a0=0. min=-1.e32 max=1.e32
mult
Y=G*(a1X1*a2X2*...*anXn), a0 unused

#	X: Gothic_s Name	X: Variable location	a: Mult. coef.	Min. Value	Max Value
1	Dpjnc	cJ65	1.	-1e+32	1e+32

Function Components
Control Variable 8C
DP 517: G=27.7 a0=0. min=-1.e32 max=1.e32
mult
Y=G*(a1X1*a2X2*...*anXn), a0 unused

#	X: Gothic_s Name	X: Variable location	a: Mult. coef.	Min. Value	Max Value
1	Dpjnc	cJ66	1.	-1e+32	1e+32

Function Components
Control Variable 9C
DP 545: G=27.7 a0=0. min=-1.e32 max=1.e32
mult
Y=G*(a1X1*a2X2*...*anXn), a0 unused

#	X: Gothic_s Name	X: Variable location	a: Mult. coef.	Min. Value	Max Value
1	Dpjnc	cJ67	1.	-1e+32	1e+32

Function Components
Control Variable 10C
DP 570: G=27.7 a0=0. min=-1.e32 max=1.e32
mult
Y=G*(a1X1*a2X2*...*anXn), a0 unused

#	X: Gothic_s Name	X: Variable location	a: Mult. coef.	Min. Value	Max Value
1	Dpjnc	cJ68	1.	-1e+32	1e+32

Function Components
Control Variable 11C
DP 589: G=27.7 a0=0. min=-1.e32 max=1.e32
mult
Y=G*(a1X1*a2X2*...*anXn), a0 unused

#	X: Gothic_s Name	X: Variable location	a: Mult. coef.	Min. Value	Max Value
1	Dpjnc	cJ69	1.	-1e+32	1e+32

Function Components
Control Variable 12C
Total Leakage: G=1.0 a0=0. min=-1.e32 max=1.e32
sum
Y=G*(a0+a1X1+a2X2+...+anXn)

#	X: Gothic_s Name	X: Variable location	a: Mult. coef.	Min. Value	Max Value
1	Wjncc	cJ57	1.	-1e+32	1e+32
2	Wjncc	cJ58	1.	-1e+32	1e+32
3	Wjncc	cJ63	1.	-1e+32	1e+32
4	Wjncc	cJ64	1.	-1e+32	1e+32

Time Domain Data (Seconds)

Time Dom	DT Min	DT Max	DT Ratio	End Time	Print Int	Graph Int	Gas Error Relax T	Dump Int	Ph Chng T Scale	L Flow Shutoff
1	0.001	1.	1.	999.9	100.	2.	DEFAULT	0.	DEFAULT	DEFAULT
2	0.001	1.	1e+20	1000.	50.	2.	DEFAULT	0.	DEFAULT	DEFAULT
3	0.001	0.1	1.	4600.	50.	2.	DEFAULT	0.	DEFAULT	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.
2	SEMI-IMP	0.	1	DIRECT	0.	1	FOUP	0.
3	SEMI-IMP	0.	1	DIRECT	0.	1	FOUP	0.

Jul/18/2019 10:33:42
GOTHIC Version 8.2(QA) - Oct 2016
File: C:\Users\jlwright\Documents\Exelon AST\Dresden Drawdown\Gothic\Final\DRE Drawdown Case1.GTH

Control Limits

Time Dom	Tot. Pres. Change (psia)	Stm. Enth. Change (Btu/lbm)	Domain End Dt Controls	--V Interface HT Shutoff-- Start V Frac	End V Frac	Ramp Exp
1	DEFAULT	DEFAULT	ON	DEFAULT	DEFAULT	DEFAULT
2	DEFAULT	DEFAULT	ON	DEFAULT	DEFAULT	DEFAULT
3	DEFAULT	DEFAULT	ON	DEFAULT	DEFAULT	DEFAULT

Run Options

Option	Setting
Restart Option	NONE
Start Time (sec)	0.0
Parallel Processes	1
Preprocessor Multithreading	YES
Revaporization Fraction	DEFAULT
Maximum Mist Density (lbm/ft3)	DEFAULT
Drop Diam. From Mist (in)	DEFAULT
Minimum HT Coeff. (B/h-ft2-F)	0.0
Reference Pressure (psia)	IGNORE
Maximum Pressure (psia)	DEFAULT
Forced Ent. Drop Diam. (in)	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
Debug Starting Time Step	0
Debug Time Step Frequency	1
Restart Dump on CPU Interval (sec)	3600.
Pressure Initialization Iteration	0
Pressure Initialization Convergenc	1.0e-6
Solver Command Line Options	

Restart Options

Option	Setting
Restart Data File	

Restart Options (cont.)	
Option	Setting
Graphics Data File	
Restart Time Step #	0
Restart Time Control	NEW

Graphs							
Graph			Curve	Number			Curve
#	Description	1	2	3	4	5	Ops
0	M & E Imbalance	EM	EE				
1	U2 Temperatures	TV1	TV2	TV3	TV4	TV5	
2	U3 Temperatures	TV6	TV7	TV8	TV9	TV10	
3	Refuel Floor Te	TV11					
4	U2 Pressures	PR1	PR2	PR3	PR4	PR5	
5	U3 Pressures	PR6	PR7	PR8	PR9	PR10	
6	Refuel Floor Pr	PR11					
7	Refuel Floor Di	cv1C	cv2C	cv3C	cv4C	cv5C	
8	U2 Differential	cv7C	cv8C	cv9C	cv10C	cv11C	
9	Leakage Flows	FV57	FV58	FV63	FV64		
10	SBGTS and Total	FV15	FV16	cv12C			

Data Files						
File #	Name	Type	Inter- polate	Output Files	Detail Level	Format Option
1	DRE Drawdown Ca	TIME	YES	SINGLE	FULL	

Table List	
Entry	Description
1	Flow Paths - Table 1
2	Flow Paths - Table 2
3	Flow Paths - Table 3

File Comparison: Double entries indicate differences.
/ Current File: C:\Users\jlwright\Documents\Exelon AST\Dresden Drawdown\Gothic\Final\DRE Drawdown Case2.GTH
\ Compare File: C:\Users\jlwright\Documents\Exelon AST\Dresden Drawdown\Gothic\Final\DRE Drawdown Case1.GTH
Jul/18/2019 10:41:28
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Data Files

File #	Name	Type	Inter-polate	Output Files	Detail Level	Format Option
1	/DRE Drawdown Ca \DRE Drawdown Ca	TIME	YES	SINGLE	FULL	

Fluid Boundary Conditions - Table 1

BC#	Description	Press. (psia)	FF	Temp. (F)	FF	Flow (lbm/s)	FF	S P	J O	ON Trip	OFF Trip	Elev. (ft)
1P	E Wall Ambient	/14.6962 \14.7		1	2T			N	N			517.5
2F	E Wall Ambient	/14.6962 \14.7		1	2T	v1e10		N	N			517.5
3P	W Wall Ambient	/14.6962 \14.7		1	2T			N	N			517.5
4F	W Wall Ambient	/14.6962 \14.7		1	2T	v1e10		N	N			517.5
5P	Exhaust Ambient	14.7		1	2T			N	N			517.5
6F	Exhaust Ambient	14.7		1	2T	v1e10		N	N			517.5
7F	U2 SFP Evap	1.945		125		0.07	8T	N	N			613.
8F	U3 SFP Evap	1.945		125		0.07	8T	N	N			613.
9P	S Wall Ambient	/14.7077 \14.7		1	2T			N	N			517.5
10F	S Wall Ambient	/14.7077 \14.7		1	2T	v1e10		N	N			517.5
11P	N Wall Ambient	/14.6959 \14.7		1	2T			N	N			517.5
12F	N Wall Ambient	/14.6959 \14.7		1	2T	v1e10		N	N			517.5

Thermal Conductors

Cond #	Description	Vol A	Srf Opt	Vol B	Srf Opt	Cond Type	S. A. (ft2)	Init. T.(F)	I/X	Grp #
1	U2 Base - 517	1	2	2	3	5	11539.	/65. \103.	X	
2	U2 517 - 545	2	2	3	3	2	11641.	/65. \103.	X	
3	U2 545 - 570	3	2	4	3	4	9799.	/65. \103.	X	
4	U2 570- 589	4	2	5	3	1	8801.	/65. \103.	X	
5	U2 589 - Refuel	5	2	11	3	5	10064.	/65. \103.	X	
6	U3 Base - 517	6	2	7	3	5	11539.	/65. \103.	X	
7	U3 517 - 545	7	2	8	3	2	11642.	/65. \103.	X	
8	U3 545 - 570	8	2	9	3	4	9799.	/65. \103.	X	
9	U3 570- 589	9	2	10	3	1	8801.	/65. \103.	X	
10	U3 589 - Refuel	10	2	11	3	5	10064.	/65. \103.	X	
11	U2 - U3 Base	1	1	6	1	8	6124.	/65. \103.	X	
12	U2 - U3 517	2	1	7	1	6	3000.	/65. \103.	X	
13	U2 - U3 545	3	1	8	1	5	2574.	/65. \103.	X	
14	U2 - U3 570	4	1	9	1	5	1188.	/65. \103.	X	
15	U2 - U3 589	5	1	10	1	7	1917.	/65. \103.	X	
16	U2 Base - Adj	1	1	1	4	3	36519.	/65. \103.	I	
17	U2 517 - Adj	2	1	2	4	3	9698.	/65. \103.	I	
18	U2 545 - Adj	3	1	3	4	3	9217.	/65. \103.	I	
19	U2 570 - Adj	4	1	4	4	3	5220.	/65. \103.	I	
20	U2 589 - Adj	5	1	5	4	3	8031.	/65. \103.	I	
21	U3 Base - Adj	6	1	6	4	3	35021.	/65. \103.	I	
22	U3 517 - Adj	7	1	7	4	3	9698.	/65. \103.	I	
23	U3 545 - Adj	8	1	8	4	3	9217.	/65. \103.	I	
24	U3 570 - Adj	9	1	9	4	3	5220.	/65. \103.	I	
25	U3 589 - Adj	10	1	10	4	3	8031.	/65. \103.	I	
26	U2 Base - DW	1	1	1	8	9	9068.	/65. \103.	I	
27	U2 517 - DW	2	1	2	8	11	4842.	/65. \103.	I	
28	U2 545 - DW	3	1	3	8	12	3382.	/65. \103.	I	
29	U2 570 - DW	4	1	4	8	11	1657.	/65. \103.	I	
30	U2 589 - DW	5	1	5	8	10	1838.	/65. \103.	I	
31	U3 Base - DW	6	1	6	11	9	9068.	/65. \103.	I	
32	U3 517 - DW	7	1	7	11	11	4842.	/65. \103.	I	
33	U3 545 - DW	8	1	8	11	12	3382.	/65. \103.	I	
34	U3 570 - DW	9	1	9	11	11	1657.	/65. \103.	I	
35	U3 589 - DW	10	1	10	11	10	1838.	/65. \103.	I	
36	U2 Base - Torus	1	5	1	7	15	32000.	/65. \103.	I	
37	U2 Base - Pipes	1	6	1	7	16	5152.	/65. \103.	I	
38	U2 517 - Pipes	2	6	2	7	16	793.	/65. \103.	I	
39	U2 545 - Pipes	3	6	3	7	16	445.	/65. \103.	I	
40	U3 Base - Torus	6	5	6	10	15	1e-06	/65. \103.	I	
41	U2 545 - SFP	3	2	3	9	11	2008.	/65. \103.	I	
42	U2 570 - SFP	4	1	4	9	11	2942.	/65. \103.	I	
43	U2 589 - SFP	5	1	5	9	11	5064.	/65. \103.	I	
44	U3 545 - SFP	8	2	8	12	11	2008.	/65. \103.	I	

Thermal Conductors (cont.)

Cond #	Description	Vol A	Srf Opt	Vol B	Srf Opt	Cond Type	S. A. (ft2)	Init. T.(F)	I/X	Grp #
45	U3 570 - SFP	9	1	9	12	11	2942.	**/65. \103.**	I	
46	U3 589 - SFP	10	1	10	12	11	5064.	**/65. \103.**	I	
47	Refuel - U2 DW	11	3	11	8	12	1452.	**/65. \103.**	I	
48	Refuel - U3 DW	11	3	11	11	12	1452.	**/65. \103.**	I	
49	Refuel - TB	11	1	11	13	13	662.	**/65. \103.**	I	
50	Refuel -Outside	11	1	11	14	13	22830.	**/65. \103.**	I	
51	Refuel - Roof	11	2	11	15	14	34000.	**/65. \103.**	I	
52	U2 SFP - Refuel	11	3	11	9	17	1353.	**/65. \103.**	I	
53	U3 SFP - Refuel	11	3	11	12	17	1353.	**/65. \103.**	I	

Volume Initial Conditions

Vol #	Total Pressure (psia)	Vapor Temp. (F)	Liquid Temp. (F)	Relative Humidity (%)	Liquid Volume Fract.	Liq. Comp. Set	Vapor Tracer Set	Liquid Tracer Set
def	14.7	**/65. \103.**	**/65. \103.**	20.	0.	NONE	NONE	NONE

Data Files

File #	Name	Type	Inter-polate	Output Files	Detail Level	Format Option
1	**/DRE Drawdown Ca \DRE Drawdown Ca**	TIME	YES	SINGLE	FULL	

Conductor Surface Options - Table 1

Surf Opt #	Description	Heat Transfer Option	Nominal Value	FF	Cnd/ Cnv Opt	Cnd Opt	Sp Cnv HTC	Nat Cnv Opt	For Cnv Opt
1	Interior Wall	Direct		3T		DLM-FM		VERT SURF	OFF
2	Int Ceiling	Direct		3T		DLM-FM		FACE DOWN	OFF
3	Int Floor	Direct		3T		DLM-FM		FACE UP	OFF
4	Insulated	Sp Heat	0.						
5	Torus	Direct		3T		DLM-FM		HORZ CYL	OFF
6	Pipes	Direct		3T		DLM-FM		HORZ CYL	OFF
7	LOCA SP Temp	Sp Temp	1.	6T					
8	LOCA DW Temp	Sp Temp	1.	7T					

Conductor Surface Options - Table 1 (cont.)

Surf Opt #	Description	Heat Transfer Option	Nominal Value	FF	Cnd/ Cnv Opt	Cnd Opt	Sp Cnv HTC	Nat Cnv Opt	For Cnv Opt
9	LOCA SFP Temp	Sp Temp	125.						
10	Normal SP Temp	Sp Temp	98.						
11	Normal DW Temp	Sp Temp	150.						
12	Normal SFP Temp	Sp Temp	125.						
13	Turbine Bldg	Sp Heat	0.						
14	Outside Air	Sp Temp	/-6. \93.						
15	Roof Sol-Air T	Sp Temp	/28. \127.						

Function
2T
OA Temperature
Ind. Var.: Ind. Var.
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	/65. \103.	1000.	/65. \103.
1000.01	/-6. \93.	1e+06	/-6. \93.

File Comparison: Double entries indicate differences.
/ Current File: C:\Users\jlwright\Documents\Exelon AST\Dresden Drawdown\Gothic\Final\DRE Drawdown Case4.GTH
\ Compare File: C:\Users\jlwright\Documents\Exelon AST\Dresden Drawdown\Gothic\Final\DRE Drawdown Case1.GTH
Jul/18/2019 11:02:58
GOTHIC Version 8.2(QA) - Oct 2016

Thermal Conductors

Cond #	Description	Vol A	Srf Opt	Vol B	Srf Opt	Cond Type	S. A. (ft2)	Init. T.(F)	I/X	Grp #
1	U2 Base - 517	1	2	2	3	5	11539.	/65. \103.	X	
2	U2 517 - 545	2	2	3	3	2	11641.	/65. \103.	X	
3	U2 545 - 570	3	2	4	3	4	9799.	/65. \103.	X	
4	U2 570- 589	4	2	5	3	1	8801.	/65. \103.	X	
5	U2 589 - Refuel	5	2	11	3	5	10064.	/65. \103.	X	
6	U3 Base - 517	6	2	7	3	5	11539.	/65. \103.	X	
7	U3 517 - 545	7	2	8	3	2	11642.	/65. \103.	X	
8	U3 545 - 570	8	2	9	3	4	9799.	/65. \103.	X	
9	U3 570- 589	9	2	10	3	1	8801.	/65. \103.	X	
10	U3 589 - Refuel	10	2	11	3	5	10064.	/65. \103.	X	
11	U2 - U3 Base	1	1	6	1	8	6124.	/65. \103.	X	
12	U2 - U3 517	2	1	7	1	6	3000.	/65. \103.	X	
13	U2 - U3 545	3	1	8	1	5	2574.	/65. \103.	X	
14	U2 - U3 570	4	1	9	1	5	1188.	/65. \103.	X	
15	U2 - U3 589	5	1	10	1	7	1917.	/65. \103.	X	
16	U2 Base - Adj	1	1	1	4	3	36519.	/65. \103.	I	
17	U2 517 - Adj	2	1	2	4	3	9698.	/65. \103.	I	
18	U2 545 - Adj	3	1	3	4	3	9217.	/65. \103.	I	
19	U2 570 - Adj	4	1	4	4	3	5220.	/65. \103.	I	
20	U2 589 - Adj	5	1	5	4	3	8031.	/65. \103.	I	
21	U3 Base - Adj	6	1	6	4	3	35021.	/65. \103.	I	
22	U3 517 - Adj	7	1	7	4	3	9698.	/65. \103.	I	
23	U3 545 - Adj	8	1	8	4	3	9217.	/65. \103.	I	
24	U3 570 - Adj	9	1	9	4	3	5220.	/65. \103.	I	
25	U3 589 - Adj	10	1	10	4	3	8031.	/65. \103.	I	
26	U2 Base - DW	1	1	1	8	9	9068.	/65. \103.	I	
27	U2 517 - DW	2	1	2	8	11	4842.	/65. \103.	I	
28	U2 545 - DW	3	1	3	8	12	3382.	/65. \103.	I	
29	U2 570 - DW	4	1	4	8	11	1657.	/65. \103.	I	
30	U2 589 - DW	5	1	5	8	10	1838.	/65. \103.	I	
31	U3 Base - DW	6	1	6	11	9	9068.	/65. \103.	I	
32	U3 517 - DW	7	1	7	11	11	4842.	/65. \103.	I	
33	U3 545 - DW	8	1	8	11	12	3382.	/65. \103.	I	
34	U3 570 - DW	9	1	9	11	11	1657.	/65. \103.	I	
35	U3 589 - DW	10	1	10	11	10	1838.	/65. \103.	I	
36	U2 Base - Torus	1	5	1	7	15	32000.	/65. \103.	I	
37	U2 Base - Pipes	1	6	1	7	16	5152.	/65. \103.	I	
38	U2 517 - Pipes	2	6	2	7	16	793.	/65. \103.	I	
39	U2 545 - Pipes	3	6	3	7	16	445.	/65. \103.	I	
40	U3 Base - Torus	6	5	6	10	15	1e-06	/65. \103.	I	
41	U2 545 - SFP	3	2	3	9	11	2008.	/65. \103.	I	
42	U2 570 - SFP	4	1	4	9	11	2942.	/65. \103.	I	
43	U2 589 - SFP	5	1	5	9	11	5064.	/65. \103.	I	
44	U3 545 - SFP	8	2	8	12	11	2008.	/65. \103.	I	

File Comparison: Double entries indicate differences.
/ Current File: C:\Users\jlwright\Documents\Exelon AST\Dresden Drawdown\Gothic\Final\DRE Drawdown Case4.GTH
\ Compare File: C:\Users\jlwright\Documents\Exelon AST\Dresden Drawdown\Gothic\Final\DRE Drawdown Case1.GTH
Jul/18/2019 11:02:58
GOTHIC Version 8.2(QA) - Oct 2016

Thermal Conductors (cont.)

Cond #	Description	Vol A	Srf Opt	Vol B	Srf Opt	Cond Type	S. A. (ft2)	Init. T.(F)	I/X	Grp #
45	U3 570 - SFP	9	1	9	12	11	2942.	/65. \103.	I	
46	U3 589 - SFP	10	1	10	12	11	5064.	/65. \103.	I	
47	Refuel - U2 DW	11	3	11	8	12	1452.	/65. \103.	I	
48	Refuel - U3 DW	11	3	11	11	12	1452.	/65. \103.	I	
49	Refuel - TB	11	1	11	13	13	662.	/65. \103.	I	
50	Refuel -Outside	11	1	11	14	13	22830.	/65. \103.	I	
51	Refuel - Roof	11	2	11	15	14	34000.	/65. \103.	I	
52	U2 SFP - Refuel	11	3	11	9	17	1353.	/65. \103.	I	
53	U3 SFP - Refuel	11	3	11	12	17	1353.	/65. \103.	I	

Volume Initial Conditions

Vol #	Total Pressure (psia)	Vapor Temp. (F)	Liquid Temp. (F)	Relative Humidity (%)	Liquid Volume Fract.	Liq. Comp. Set	Vapor Tracer Set	Liquid Tracer Set
def	14.7	/65. \103.	/65. \103.	20.	0.	NONE	NONE	NONE

Data Files

File #	Name	Type	Inter-polate	Output Files	Detail Level	Format Option
1	/DRE Drawdown Ca \DRE Drawdown Ca	TIME	YES	SINGLE	FULL	

Fluid Boundary Conditions - Table 1

BC#	Description	Press. (psia)	FF	Temp. (F)	FF	Flow (lbm/s)	FF	S P	J O	ON Trip	OFF Trip	Elev. (ft)
1P	E Wall Ambient	/14.6953 \14.7		1	2T			N	N			517.5
2F	E Wall Ambient	/14.6953 \14.7		1	2T	v1e10		N	N			517.5
3P	W Wall Ambient	/14.6953 \14.7		1	2T			N	N			517.5
4F	W Wall Ambient	/14.6953 \14.7		1	2T	v1e10		N	N			517.5
5P	Exhaust Ambient	14.7		1	2T			N	N			517.5
6F	Exhaust Ambient	14.7		1	2T	v1e10		N	N			517.5
7F	U2 SFP Evap	1.945		125		0.07	8T	N	N			613.
8F	U3 SFP Evap	1.945		125		0.07	8T	N	N			613.
9P	S Wall Ambient	/14.7094 \14.7		1	2T			N	N			517.5

Fluid Boundary Conditions - Table 1 (cont.)

BC#	Description	Press. (psia)	FF	Temp. (F)	FF	Flow (lbm/s)	FF	S P	J O	ON Trip	OFF Trip	Elev. (ft)
10F	S Wall Ambient	/14.7094 \14.7		1	2T	v1e10		N	N			517.5
11P	N Wall Ambient	/14.695 \14.7		1	2T			N	N			517.5
12F	N Wall Ambient	/14.695 \14.7		1	2T	v1e10		N	N			517.5

Conductor Surface Options - Table 1

Surf Opt #	Description	Heat Transfer Option	Nominal Value	FF	Cnd/ Cnv Opt	Cnd Opt	Sp Cnv HTC	Nat Cnv Opt	For Cnv Opt
1	Interior Wall	Direct		3T		DLM-FM		VERT SURF	OFF
2	Int Ceiling	Direct		3T		DLM-FM		FACE DOWN	OFF
3	Int Floor	Direct		3T		DLM-FM		FACE UP	OFF
4	Insulated	Sp Heat	0.						
5	Torus	Direct		3T		DLM-FM		HORZ CYL	OFF
6	Pipes	Direct		3T		DLM-FM		HORZ CYL	OFF
7	LOCA SP Temp	Sp Temp	1.	6T					
8	LOCA DW Temp	Sp Temp	1.	7T					
9	LOCA SFP Temp	Sp Temp	125.						
10	Normal SP Temp	Sp Temp	98.						
11	Normal DW Temp	Sp Temp	150.						
12	Normal SFP Temp	Sp Temp	125.						
13	Turbine Bldg	Sp Heat	0.						
14	Outside Air	Sp Temp	/-6. \93.						
15	Roof Sol-Air T	Sp Temp	/28. \127.						

Function
2T
OA Temperature
Ind. Var.: Ind. Var.
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	/65. \103.	1000.	/65. \103.
1000.01	/-6. \93.	1e+06	/-6. \93.

Table 1: Reactor Building Volumes

	PCFLUD				Gothic						
Elev (ft)	Vol No. U2	U3	Description	Volume (ft^3)	CV No. U2	U3	Description	Volume (ft^3)	Height (ft)	Aw (ft^2)	Dh (ft)
476.5	1	21	Torus Room	206852	1		Basement	283359	41	105025	10.8
	2	22	U2 NW Corner (U3 NE)	9724		6		277635	41	105025	10.6
	3	n/a	U2 SW Corner	20342							
	4	23	U2 SE Corner (U3 SW)	20961							
	n/a	24	U3 SE Corner	14618							
	20	39	HPCI Room	25480							
517.5	5	25	517 GFA	235289	2	7	Ground Flr	278726	28	42124	26.5
	6	26	517 SDC Pump	13437							
	13	29	MST	30000							
545.5	7	27	545 RWCU HX	24354	3	8	Mezzanine	221360	24.5	41930	21.1
	8	28	545 GFA	154616							
	10	30	545 SD HX	31356							
	n/a	n/a	545 Pipe Chase	4346							
	11	31	545 Equipment Hatch	6688							
570	14	34	570 GFA	139676	4	9	Main Floor	174898	19	31024	22.6
	n/a	n/a	570 Pipe Chase	4955							
	n/a	n/a	570 RWCU Demin Area	24795							
	15	35	570 Equipment Hatch	5472							
589	16	36	589 GFA S	123638	5	10	Reactor Flr	187986	24	35715	21.1
	17	37	589 GFA N	57508							
	18	38	589 Equipment Hatch	6840							
613	19		613 Refuel	1222452	11		Refuel Floor	1222452	45.5	80524	60.7
658.5			Roof								
Total				3509386				3509386			

Notes:

1 - PCFLUD volumes from Page D-39 of Ref. 2.

2 - 613' elevation refueling floor volume is combined total for both units.

Table 2: Reactor Building Flow Paths

FP Description	FP #	Vol 1	Vol 2	W (ft)	H or L (ft)	A (ft^2)	Dh (ft)	L1 (ft)	L2 (ft)	Inertia L (ft)	Notes
U2 Basement - Ground	1	1	2	4	4	32	4	41	28	34.5	1
U2 Ground - Mezzanine	2	2	3	19	20	380	19.5	28	24.5	26.25	
U2 Mezzanine - Main	3	3	4	19	20	380	19.5	24.5	19	21.75	
U2 Main - Reactor	4	4	5	6.8	20	130	9.7	19	24	21.5	
U2 Reactor - Refuel	5	5	11	19	20	380	19.5	24	47.25	35.625	2
U3 Basement - Ground	6	6	7	4	4	32	4	41	28	34.5	1
U3 Ground - Mezzanine	7	7	8	19	20	380	19.5	28	24.5	26.25	
U3 Mezzanine - Main	8	8	9	19	20	380	19.5	24.5	19	21.75	
U3 Main - Reactor	9	9	10	6.8	20	130	9.7	19	24	21.5	
U3 Reactor - Refuel	10	10	11	19	20	380	19.5	24	47.25	35.625	2
U2- U3 Ground Floor	11	2	7	5	7	35	5.8	147	147	147	
U2 - U3 Mezzanine	12	3	8	3	7	21	4.2	147	147	147	3
U2 - U3 Main Floor	13	4	9	3	7	21	4.2	147	147	147	3
U2 - U3 Reactor Level	14	5	10	3	7	21	4.2	147	147	147	3

Notes:

1 - There are two 4' x 4' hatch openings between the basement and ground floor.

2 - These flow paths are assumed open based on Assumption 6.

3 - These doors are normally closed so a small flow area is used in the Gothic model to prevent flow through these openings.

4 - Flow path dimensions are from Table F1 of Ref. 2. H is height of vertical openings and L is horizontal length of horizontal openings.

Table 3: Reactor Building Thermal Conductors

PCFLUD							Gothic				
No.	Description	Vol 1	Vol 2	A (ft^2)	t (ft)	htc	TC #	Vol 1	Vol 2	A (ft^2)	t (ft)
7	U2 torus - 517 GFA	1	2	9491	2	ceiling	1	1	2	11539	2
8	U2 torus - 517 SD	1	2	646	2	ceiling					
18	U2 SW - 517	1	2	717	2	ceiling					
21	U2 SE - 517	1	2	685	2.75	ceiling					
2	U2 torus - U3 torus	1	6	2321	3	wall	11	1	6	6124	3
14	U2 NW - U3 NE	1	6	476	3	wall					
17	U2 SW - U3 SE	1	6	1414	3	wall					
81	U2 HPCI - U3 SE	1	6	613	3	wall					
82	U2 HPCI - U3 HPCI	1	6	1300	3	wall					
9	U2 torus - TB	1	adj - TB	2186	2	ceiling	16	1	1	36519	1.5
15	U2 NW - TB	1	adj - TB	795	2.5	ceiling					
83	U2 HPCI - DG	1	adj - DG	1274	3	ceiling					
1	U2 torus - ground	1	adj -gr	22137	3.6	wall					
13	U2 NW corner - ground	1	adj -gr	1378	3.5	wall					
16	U2 SW - ground	1	adj -gr	2104	3.4	wall					
20	U2 SE - ground	1	adj -gr	3458	3.3	wall					
80	U2 HPCI - ground	1	adj -gr	3187	3.4	wall					
6	U2 torus - DW	1	DW2	9068	4	wall	26	1	1	9068	4
3	U2 torus - U2 NW Corner	1	int	883	3.5	wall	internal walls not modeled			4623	
4	U2 torus - U2 SE Corner	1	int	1809	3.5	wall					
5	U2 torus - U2 SW Corner	1	int	1931	3.5	wall					
10	U2 torus - SP	1	SP2	32000		SP	36	1	1	32000	0
11	U2 torus - pipes	1	SP2	3560		pipe	37	1	1	5152	0
12	U2 torus- ins pipes	1	SP2	92		pipe					
19	U2 SW - pipes	1	SP2	1500		pipe					
22	U2 SE - pipes	1	SP2	0.001		pipe					
29	U2 517 - 545	2	3	8577	1.3	ceiling	2	2	3	11641	1.25
30	U2 517 - 545 SD HX	2	3	850	3.2	ceiling					
34	U2 517 SDC - 545	2	3	209	2	ceiling					
35	U2 517 SDC - 545 SD HX	2	3	520	2	ceiling					

PCFLUD							Gothic				
No.	Description	Vol 1	Vol 2	A (ft^2)	t (ft)	htc	TC #	Vol 1	Vol 2	A (ft^2)	t (ft)
28	U2 517 - 545 RWCU	2	3	1485	1.2	ceiling					
25	U2 517 - U3 517	2	7	3000	2.3	wall	12	2	7	3000	2.25
24	U2 517 - outside	2	adj - OA	6793	2.5	wall	17	2	2	9698	1.5
23	U2 517 - TB	2	adj - TB	2073	4	wall					
32	U2 517 SD - TB	2	adj - TB	832	4	wall					
27	U2 517 - DW	2	DW2	4113	6	wall	27	2	2	4842	6
33	U2 517 SD - DW	2	DW2	729	6	wall					
31	U2 517 - pipes	2	SP2	665		pipe	38	2	2	793	0
36	U2 517 SD - pipes	2	SP2	128		pipe					
26	U2 517 - 517 SD	2	int	611	2	wall	internal walls not modeled			611	
40	U2 545 RWCU - 570	3	4	1462	4	ceiling	3	3	4	9799	1.75
46	U2 545 - 570	3	4	6781	1.8	ceiling					
51	U2 545 SD - 570	3	4	1556	3	ceiling					
43	U2 545 - U3 545	3	8	2574	2	wall	13	3	8	2574	2
42	U2 545- outside	3	adj - OA	6043	1.7	wall	18	3	3	9217	1.5
49	U2 545 SD - TB	3	adj - TB	2093	4	wall					
41	U2 545 - TB	3	adj - TB	1081	4	wall					
38	U2 545 RWCU - DW	3	DW2	652	8	wall	28	3	3	3382	8
45	U2 545 - DW	3	DW2	1494	8	wall					
50	U2 545 SD - DW	3	DW2	1236	8	wall					
47	U2 545 - SFP	3	SFP2	2008	6.25	ceiling	41	3	3	2008	6
39	U2 545 RWCU - 545	3	int	1538	3.2	wall	internal walls not modeled			2864	
37	U2 545 RWCU - 545 SD HX	3	int	313	2	wall					
44	U2 545 SD - 545	3	int	1013	2.5	wall					
48	U2 545 - pipes	3	SP2	370		pipe	39	3	3	445	0
52	U2 SD 545 - pipes	3	SP2	75		pipe					
148	U2 545 RWCU - pipe	3	heat load	446		pipe	modeled as heat load			503	
149	U2 545 RWCU - RWCU HX	3	heat load	57		pipe					
59	U2 570 - 589	4	5	6869	1	ceiling	4	4	5	8801	1
60	U2 570 - 589	4	5	1932	3	ceiling					
56	U2 570 - U3 570	4	9	1188	2	wall	14	4	9	1188	2
55	U2 570 - outside	4	adj - OA	3773	1.6	wall	19	4	4	5220	1.5

PCFLUD							Gothic				
No.	Description	Vol 1	Vol 2	A (ft^2)	t (ft)	htc	TC #	Vol 1	Vol 2	A (ft^2)	t (ft)
54	U2 570 - TB	4	adj - TB	1447	1.5	wall					
57	U2 570 - DW	4	DW2	1657	6.5	wall	29	4	4	1657	6
53	U2 FD - 570	4	int	1417	2	wall	internal walls not modeled			1417	
61	U2 570 - D/S pool	4	SFP2	740	5	ceiling	42	4	4	2942	6
58	U2 570 - SFP	4	SFP2	2202	6	wall					
63	U2 589 - U3 589	5	10	1253	2.5	wall	15	5	10	1917	2.5
70	U2 589 - U3 589	5	10	664	2.5	wall					
67	U2 589 - refuel	5	11	6869	1.5	ceiling	5	5	11	10064	1.5
74	U2 589 - refuel	5	11	3195	1.5	ceiling					
62	U2 589 - outside	5	adj - OA	4330	1.6	wall	20	5	5	8031	1.5
68	U2 589 - TB	5	adj - TB	2205	1.5	wall					
69	U2 589 - outside	5	adj- OA	1496	1.5	wall					
64	U2 589 - DW	5	DW2	926	5	wall	30	5	5	1838	5
71	U2 589 - DW	5	DW2	912	5	wall					
66	U2 589 - D/S pool	5	SFP2	1159	3	wall	43	5	5	5064	6
73	U2 589 - D/S pool	5	SFP2	1159	3	wall					
65	U2 589 - SFP	5	SFP2	1373	6	wall					
72	U2 589 - SFP	5	SFP2	1373	6	wall					
90	U3 torus - 517	6	7	9491	2	ceiling	6	6	7	11539	2
91	U3 torus - 517 SDC	6	7	646	2	ceiling					
96	U3 SW - 517	6	7	685	2.75	ceiling					
99	U3 SE - 517	6	7	717	2	ceiling					
84	U3 torus - ground	6	adj - gr	21480	3.3	wall	21	6	6	35021	1.5
93	U3 NE - ground	6	adj - gr	1378	3.5	wall					
95	U3 SW - ground	6	adj - gr	3458	3.3	wall					
97	U3 SE - ground	6	adj - gr	652	3.4	wall					
144	U3 HPCI - ground	6	adj - gr	3187	3.4	wall					
85	U3 torus - DG	6	adj - DG	201	3	wall					
98	U3 SE - DG	6	adj - DG	410	3	wall					
92	U3 torus - TB	6	adj - TB	2186	2	ceiling					
94	U3 NE - TB	6	adj - TB	795	2.5	ceiling					
147	U3 HPCI - DG	6	adj - DG	1274	3	ceiling					

PCFLUD							Gothic				
No.	Description	Vol 1	Vol 2	A (ft^2)	t (ft)	htc	TC #	Vol 1	Vol 2	A (ft^2)	t (ft)
89	U3 torus - DW	6	DW3	9068	4	wall	31	6	6	9068	4
86	U3 torus - NE	6	int	883	3.5	wall	internal walls not modeled			5235	
87	U3 torus -SE	6	int	1931	3.5	wall					
88	U3 torus - SW	6	int	1809	3.5	wall					
145	U3 HPCI - SE	6	int	156	3	wall					
146	U3 HPCI - torus	6	int	456	3	wall					
105	U3 517 - 545 RWCU	7	8	1485	1.2	ceiling	7	7	8	11642	1.25
106	U3 517 - 545	7	8	8577	1.3	ceiling					
107	U3 517 - 545 SD HX	7	8	851	3.2	ceiling					
110	U3 517 SDC - 545	7	8	209	2	ceiling					
111	U3 517 SDC - 545 SD HX	7	8	520	2	ceiling					
102	U3 517 - DG	7	adj - DG	416	1.5	wall	22	7	7	9698	1.5
101	U3 517 - outside	7	adj - OA	6377	2.6	wall					
108	U3 517 SDC - TB	7	adj - TB	832	4	wall					
100	U3 517 - TB	7	adj - TB	2073	4	wall					
104	U3 517 - DW	7	DW3	4113	6	wall	32	7	7	4842	6
109	U3 517 SDC - DW	7	DW3	729	6	wall					
103	U3 517 - SDC	7	int	611	2	wall	internal walls not modeled			611	
115	U3 545 RWCU - 570	8	9	1462	4	ceiling	8	8	9	9799	1.75
120	U3 545 - 570	8	9	6781	1.8	ceiling					
124	U3 545 SD HX - 570	8	9	1556	3	ceiling					
117	U3 545 -outside	8	adj - OA	6043	1.7	wall	23	8	8	9217	1.5
122	U3 545 SD -TB	8	adj - TB	2093	4	wall					
116	U3 545 - TB	8	adj - TB	1081	4	wall					
113	U3 545 RWCU - DW	8	DW3	652	8	wall	33	8	8	3382	8
123	U3 545 SD HX - DW	8	DW3	1236	8	wall					
119	U3 545 - DW	8	DW3	1494	8	wall					
114	U3 545 RWCU - 545	8	int	1538	3.2	wall	internal walls not modeled			2864	
118	U3 545 - SD HX	8	int	1013	2.5	wall					
112	U3 545 RWCU - 545 SD HX	8	int	313	3	wall					
121	U3 545 -SFP	8	SFP3	2008	6.25	ceiling	44	8	8	2008	6
130	U3 570 - 589	9	10	6869	1	ceiling	9	9	10	8801	1

PCFLUD							Gothic				
No.	Description	Vol 1	Vol 2	A (ft^2)	t (ft)	htc	TC #	Vol 1	Vol 2	A (ft^2)	t (ft)
131	U3 570 - 589	9	10	1932	3	ceiling					
127	U3 570 - outside	9	adj - OA	3773	1.6	wall	24	9	9	5220	1.5
126	U3 570 - TB	9	adj - TB	1447	1.5	wall					
128	U3 570 - DW	9	DW3	1657	6.5	wall	34	9	9	1657	6
125	U3 570 RWCU - 570	9	int	1447	1	wall	internal walls not modeled			1447	
132	U3 570 - D/S pool	9	SFP3	740	5	ceiling	45	9	9	2942	6
129	U3 570 - SFP	9	SFP3	2202	6	wall					
137	U3 589 - refuel	10	11	6869	1.5	ceiling	10	10	11	10064	1.5
143	U3 589 - refuel	10	11	3195	1.5	ceiling					
133	U3 589 - outside	10	adj - OA	4330	1.6	wall	25	10	10	8031	1.5
139	U3 589 - outside	10	adj - OA	1496	1.5	wall					
138	U3 589 - TB	10	adj - TB	2205	1.5	wall					
134	U3 589 - DW	10	DW3	926	5	wall	35	10	10	1838	5
140	U3 589 - DW	10	DW3	912	5	wall					
136	U3 589 - D/S pool	10	SFP3	1159	3	wall	46	10	10	5064	6
142	U3 589 - D/S pool	10	SFP3	1159	3	wall					
135	U3 589 - SFP	10	SFP3	1373	6	wall					
141	U3 589 - SFP	10	SFP3	1373	6	wall					
75	Refuel - outside	11	adj - OA	22830	0.25	wall	50	11	11	22830	0
79	Refuel - outside	11	adj - OA	34000	0.25	ceiling	51	11	11	34000	0
76	Refuel - TB	11	adj - TB	662	0.25	wall	49	11	11	662	0
78	Refuel - U3 DW	11	DW3	1452	8.75	floor	47	11	11	1452	8
77	Refuel - U2 DW	11	DW2	1452	8.75	floor	48	11	11	1452	8

Note: PCFLUD wall thickness and surface area from Appendix A of Ref. 2.

Table 4: Reactor Building Heat Loads

	PCFLUD			Gothic			
		Total Heat Load (BTU/s)		U2	Heat Load	U3	Heat Load
Elev	Room	LOCA	nonLOCA	Volume	BTU/s	Volume	BTU/s
476	Torus	8.5	8.5	1	145.0	6	17.3
	U2 NW (U3 NE)	1.5	2.4				
	U2 SW (U3 SE)	123.4	1.9				
	U2 SE (U3 SW)	7.6	3.2				
	HPCI	4.0	1.3				
517	GFA	39.6	38.4	2	42.4	7	41.2
	SDC	2.8	2.8				
545	RWCU HX	23.4	23.4	3	95.4	8	126
	GFA	63.5	94.1				
	SD HX	8.5	8.5				
570	GFA	59.2	69.6	4	59.2	9	69.6
589	GFA E	14.1	14.1	5	20.8	10	20.8
	GFA W	6.7	6.7				
613	Refuel	30.75	30.75	11	61.50		

Note: PCFLUD heat loads from Table I6 of Ref. 2

Table 5: ECCS Room Cooler Heat Removal Capacity

	Cooler Capacity (BTU/s)		
Inlet T (F)	LPCI	HPCI	Combined
104	19.4	8	46.8
110	32.1	15	79.2
115	42.6	19.8	105.0
120	53	24.7	130.7
125	63.3	29.5	156.1
130	73.5	34.2	181.2
135	83.6	38.9	206.1
140	93.6	43.5	230.7
145	103.5	48.1	255.1
150	113.3	52.7	279.3

Notes:

1 - Individual cooler capacities from Table 4 of Ref. 2.

2 - HPCI cooler capacity at 104 F conservatively based on capacity at 103 F from Ref. 2.

3 - Combined cooler capacity is for one unit with 2 LPCI and 1 HPCI room cooler.

Table 6: Surface and Atmospheric Pressures Due To Wind

Parameter		Summer Conditions		Winter Conditions	
Wind speed		24	mph	24	mph
		2112	fpm	2112	fpm
Air density		0.0718	lb/ft3	0.0875	lb/ft3
Velocity P (Pv)		0.2662	inwg	0.3244	inwg
		0.0096	psi	0.0117	psi
Face	Cp	Surface P Ps (inwg)	Atm P P (psi)	Surface P Ps (inwg)	Atm P P (psi)
S	0.8	0.2130	14.7077	0.2595	14.7094
N	-0.43	-0.1145	14.6959	-0.1395	14.6950
E/W	-0.4	-0.1065	14.6962	-0.1298	14.6953

Table 7: SBGTS Flow Rate During Valve Opening

Ksbgts	160.1	
Kvlv	0.19	
Dpfan	16	inwg
Avlv	3.14	ft^2
tvlv	67	s

open angle degrees	Kvlv	Ktot	V (fpm)	t (s)	Q (cfm)
0	1.0E+100	2.0E+100	1E-46	0.0	0.0
30	108	375.7	826.5	22.3	2595.1
40	29	217.7	1085.7	29.8	3409.1
50	11	181.7	1188.4	37.2	3731.6
60	4.5	168.7	1233.3	44.7	3872.7
70	1.5	162.7	1255.9	52.1	3943.4
80	0.52	160.8	1263.5	59.6	3967.4
90	0.19	160.1	1266.1	67.0	3975.5

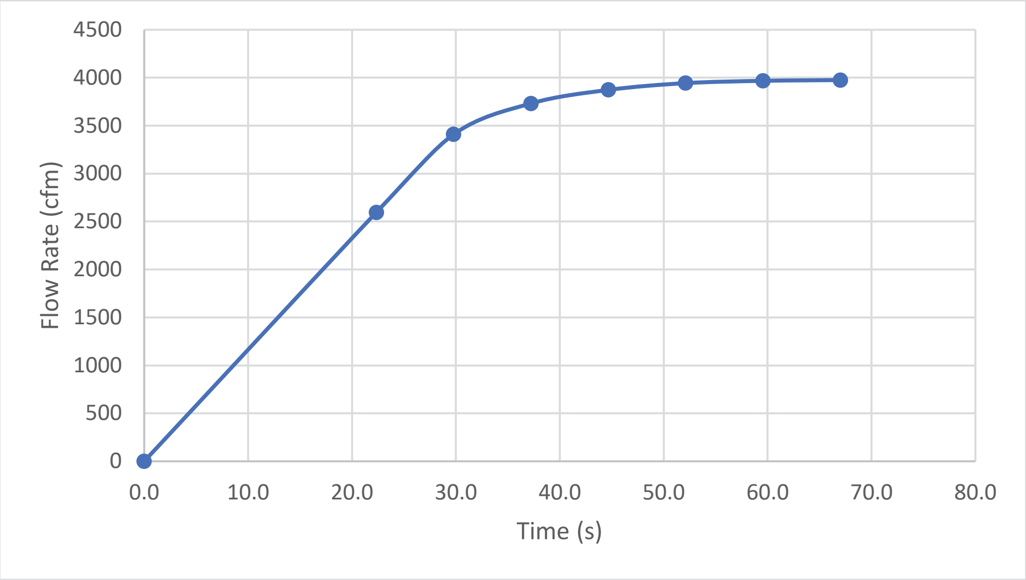

Table 8: RB Ventilation System Loss Coefficients

	Supply		Exhaust	
Fan Flow	100000	cfm	110000	cfm
Fan SP	9.7	inwg	9.7	inwg
Vlv K	0.38		0.38	
Vlv A	28.3	ft^2	28.3	ft^2
Vlv DP	0.30	inwg	0.36	inwg
Duct DP	9.40	inwg	9.34	inwg
Duct A	28.3	ft^2	28.3	ft^2

Elev ft	Branch Flows cfm	Total Flow cfm	Loss Coef K
613	9500 15500	25000	193.3
589	4100 3500	7600	2091.6
570	11800 1200	13000	714.8
545	9400 8000 5000	22400	240.8
517	13300 -4800 4800	13300	683.0
476	13900 4800	18700	345.5
Total	100000	100000	

Elev ft	Branch Flows cfm	Total Flow cfm	Loss Coef K
613	11690 17410	29100	141.7
589	2500	2500	19201.8
570	8200 2200 2100 800	13300	678.5
545	12000 1000 8450	21450	260.8
517	14900 -8450 4400 4400	15250	516.0
476	24100 -4400 -1000	18700	343.2
Total	100300	100300	

Notes:

1 - Negative flows indicate branch flows supplied to other elevations

2 - Exhaust flow fan rate greater than total exhaust flows due to infiltration

3 - Total exhaust flow less than total supply flow since flows are approximate per references

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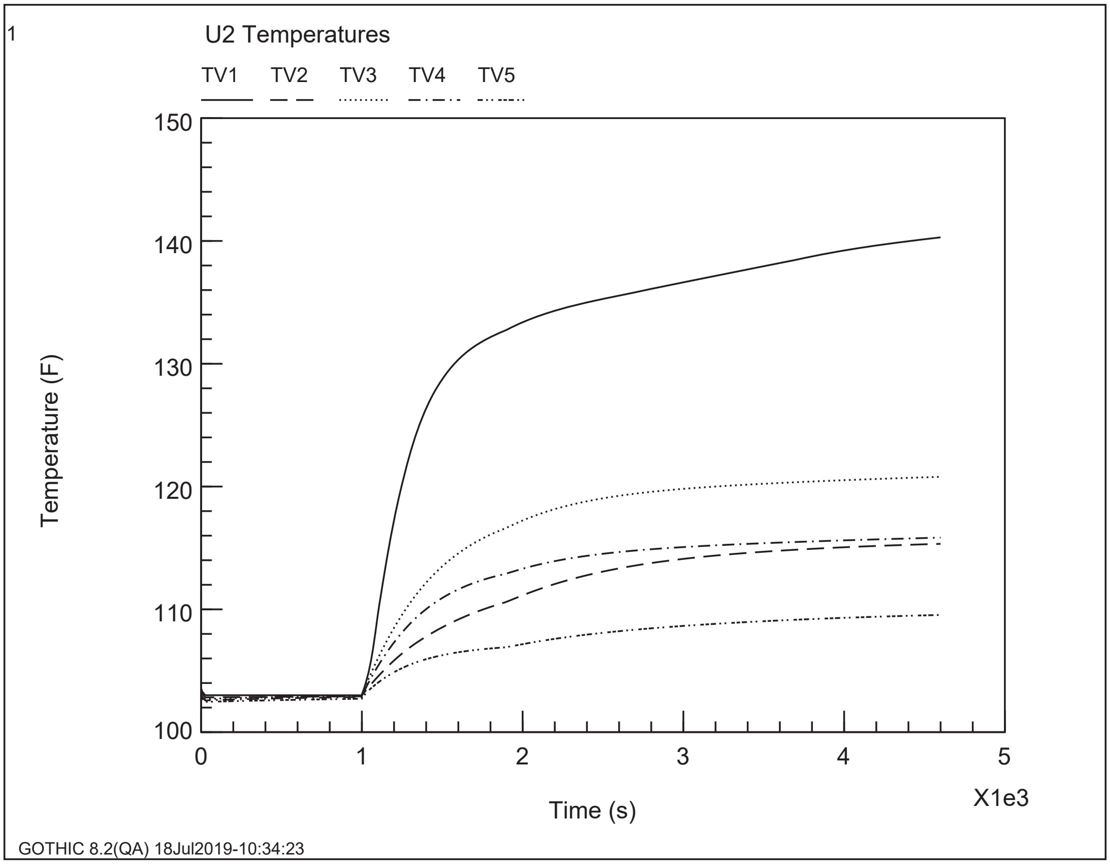

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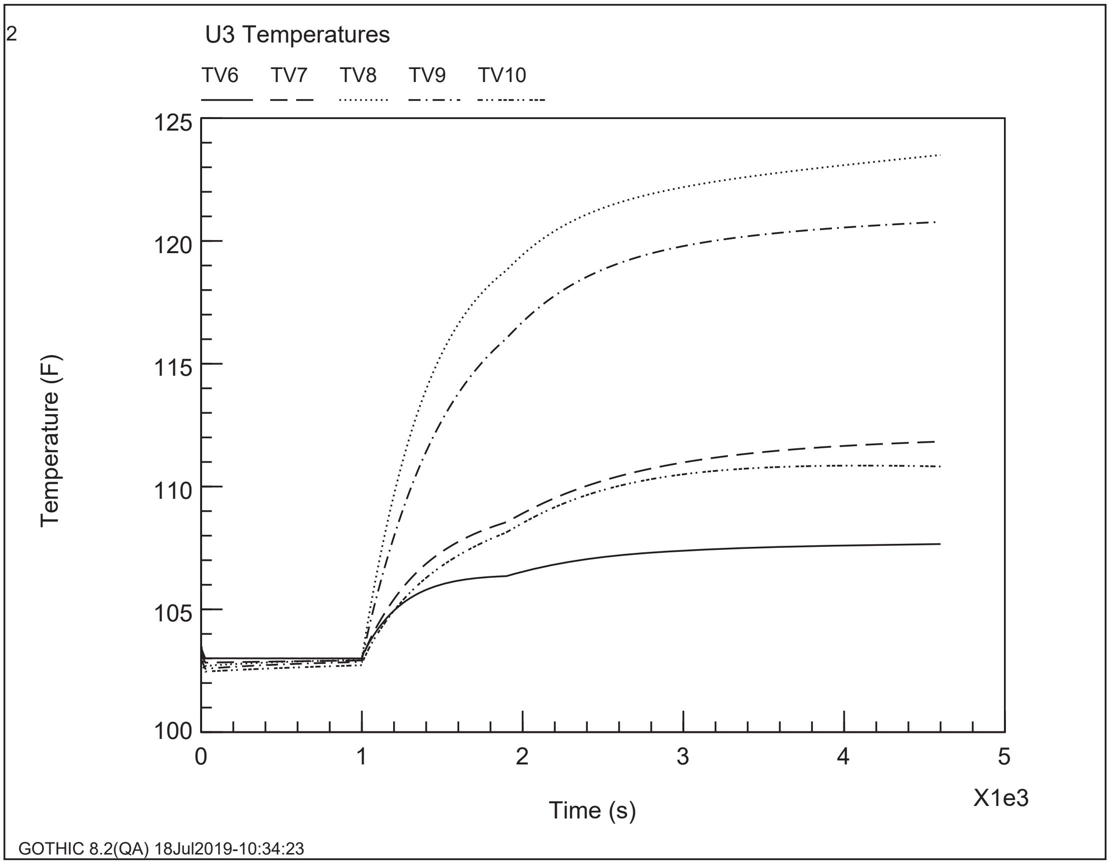

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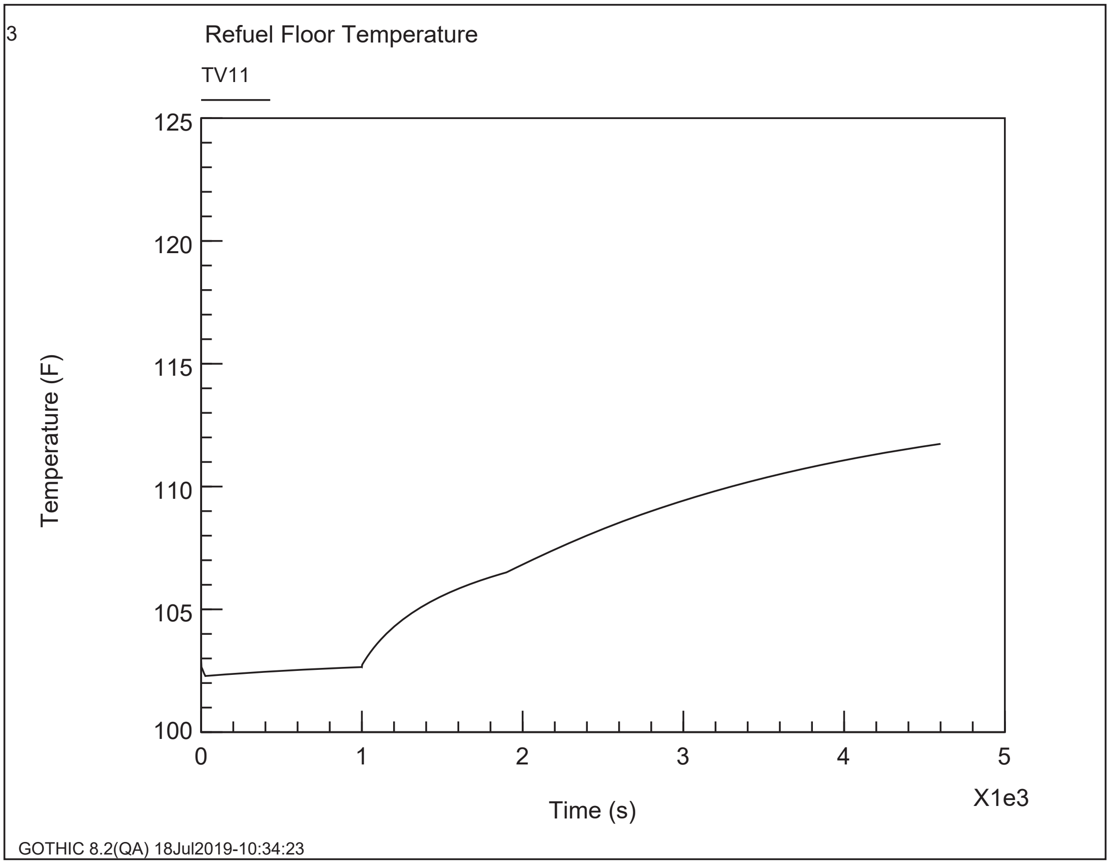

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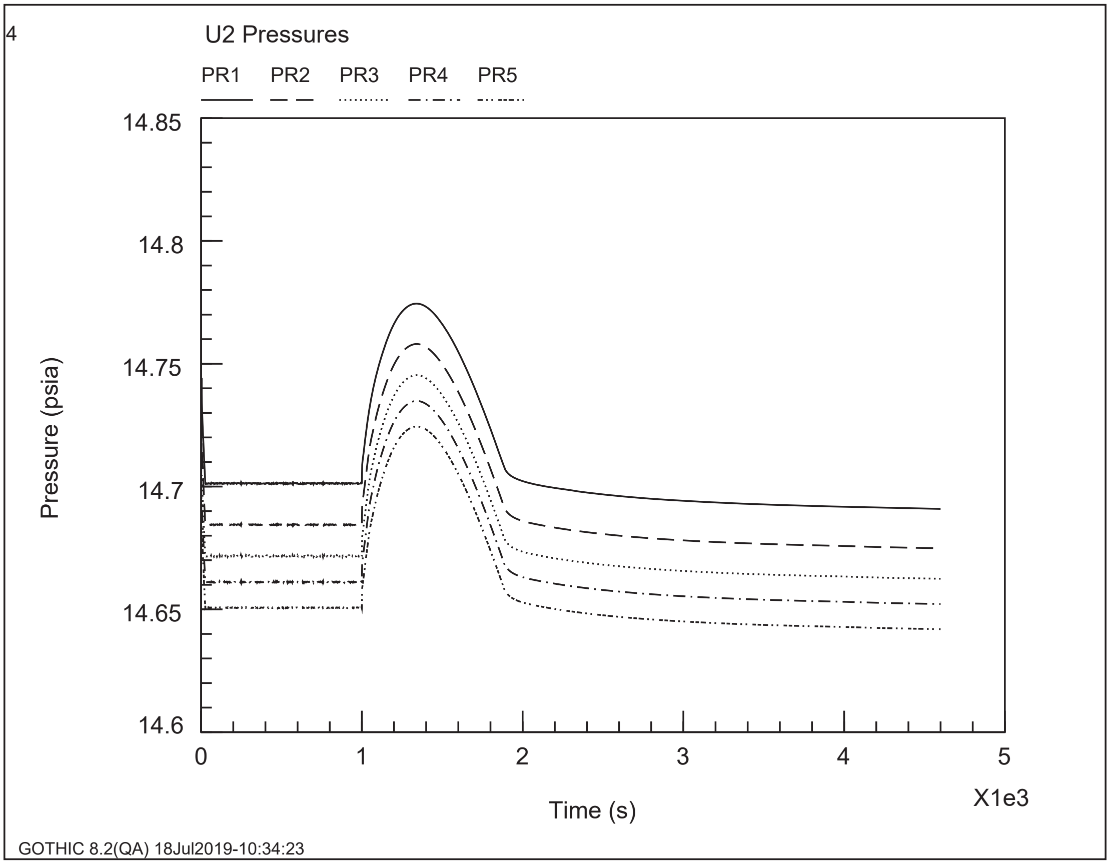

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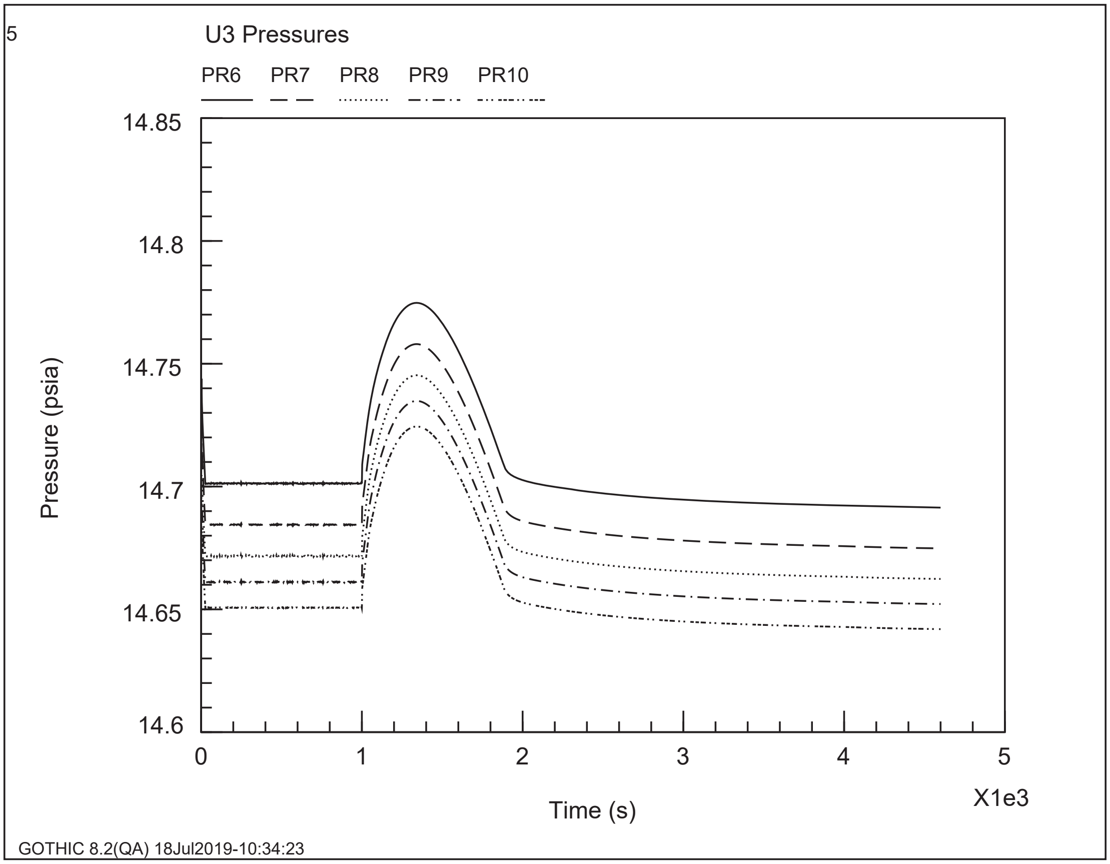

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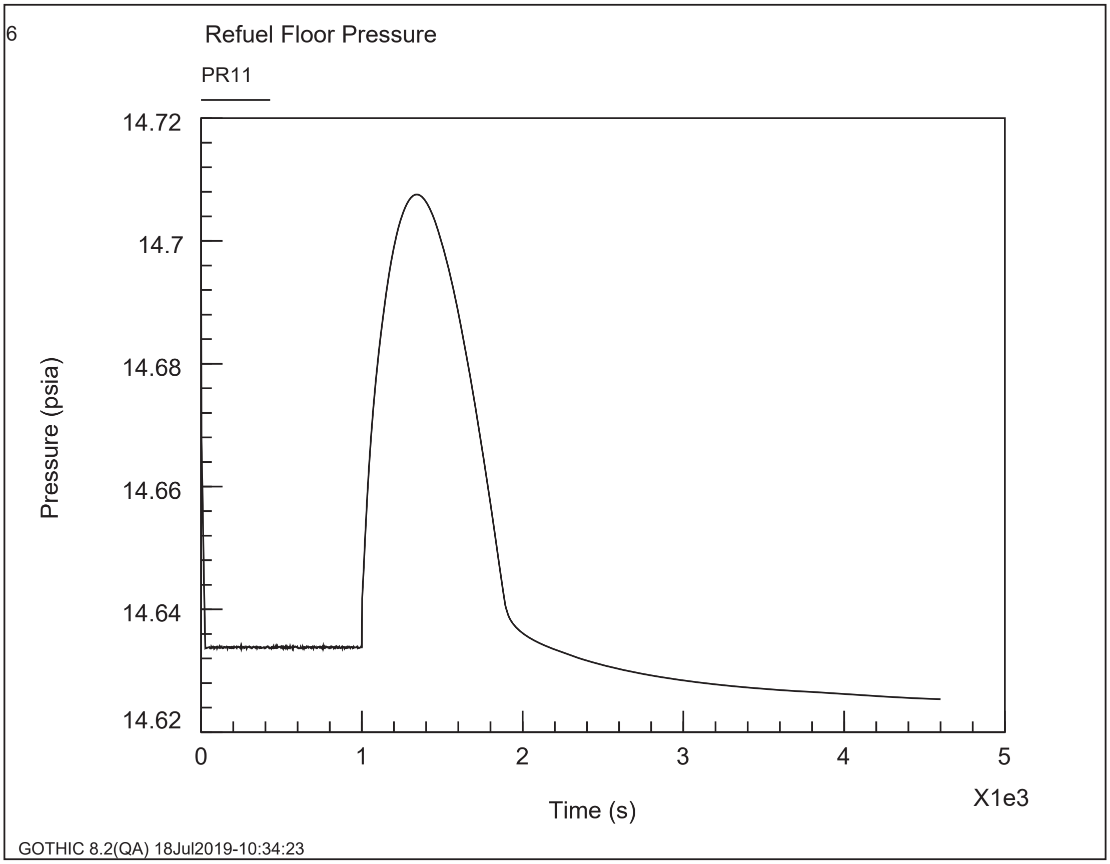

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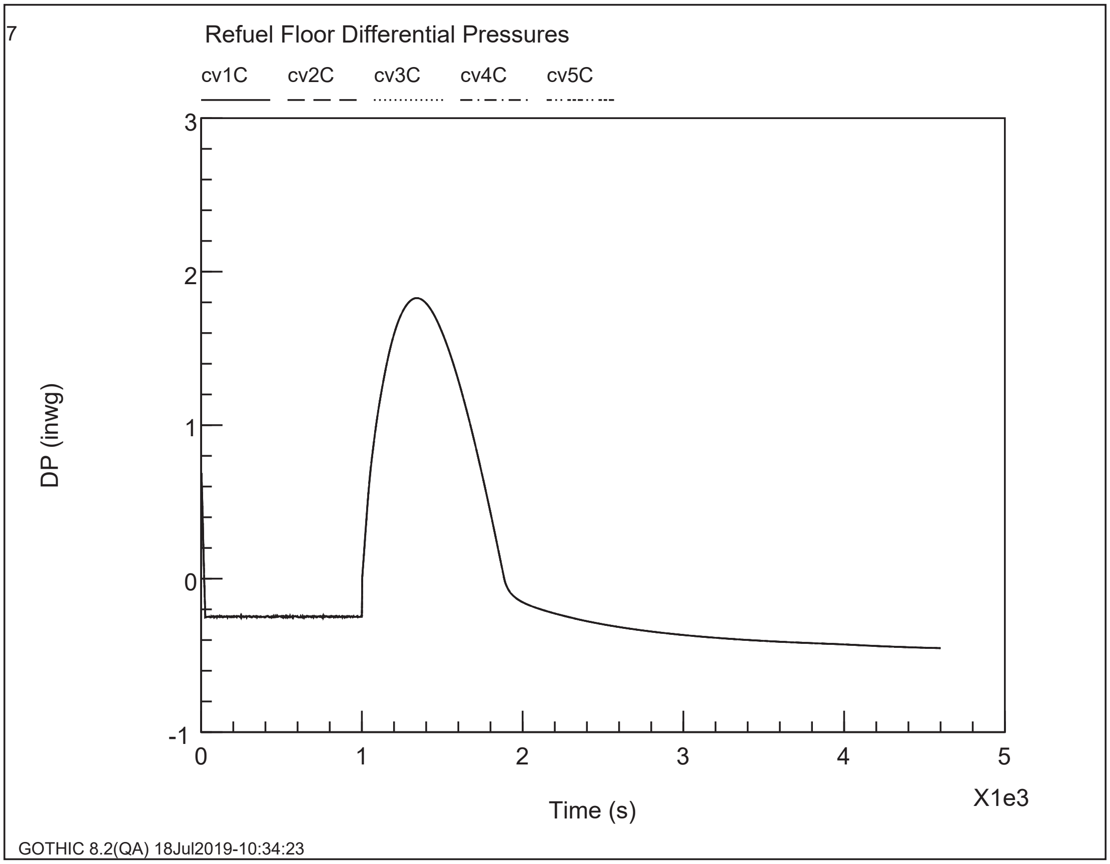

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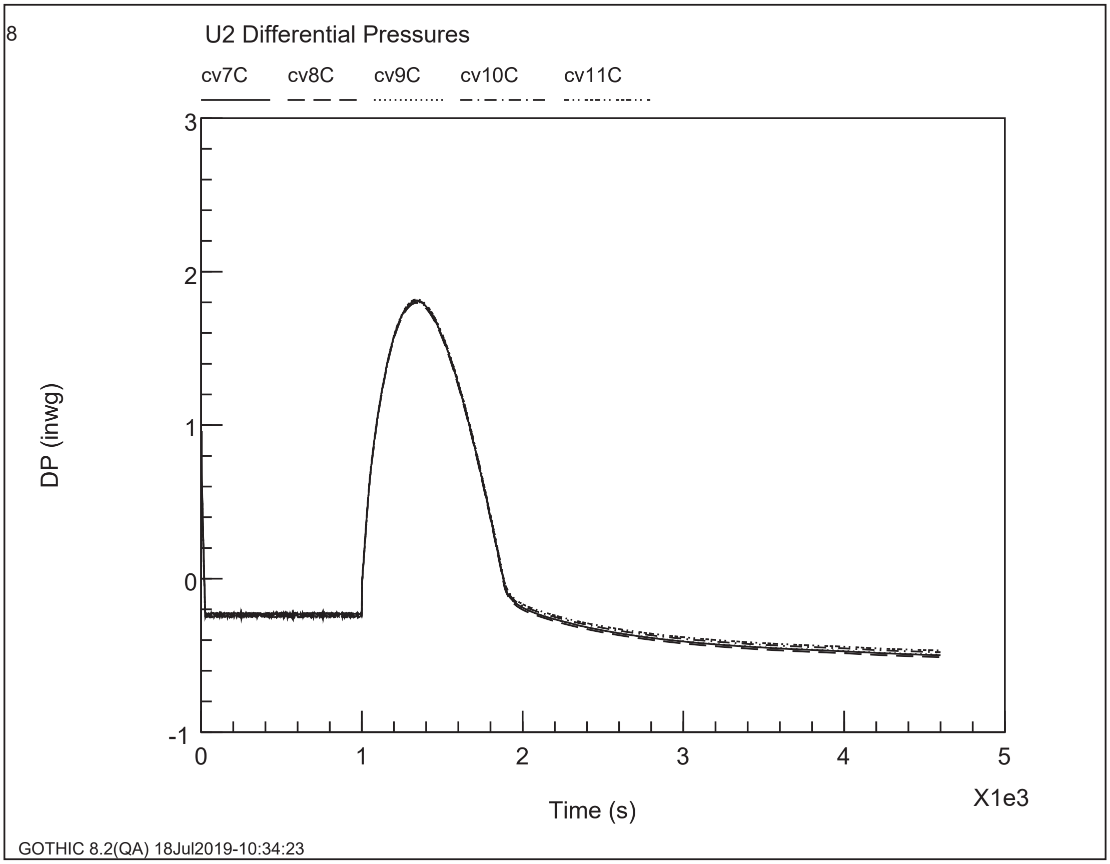

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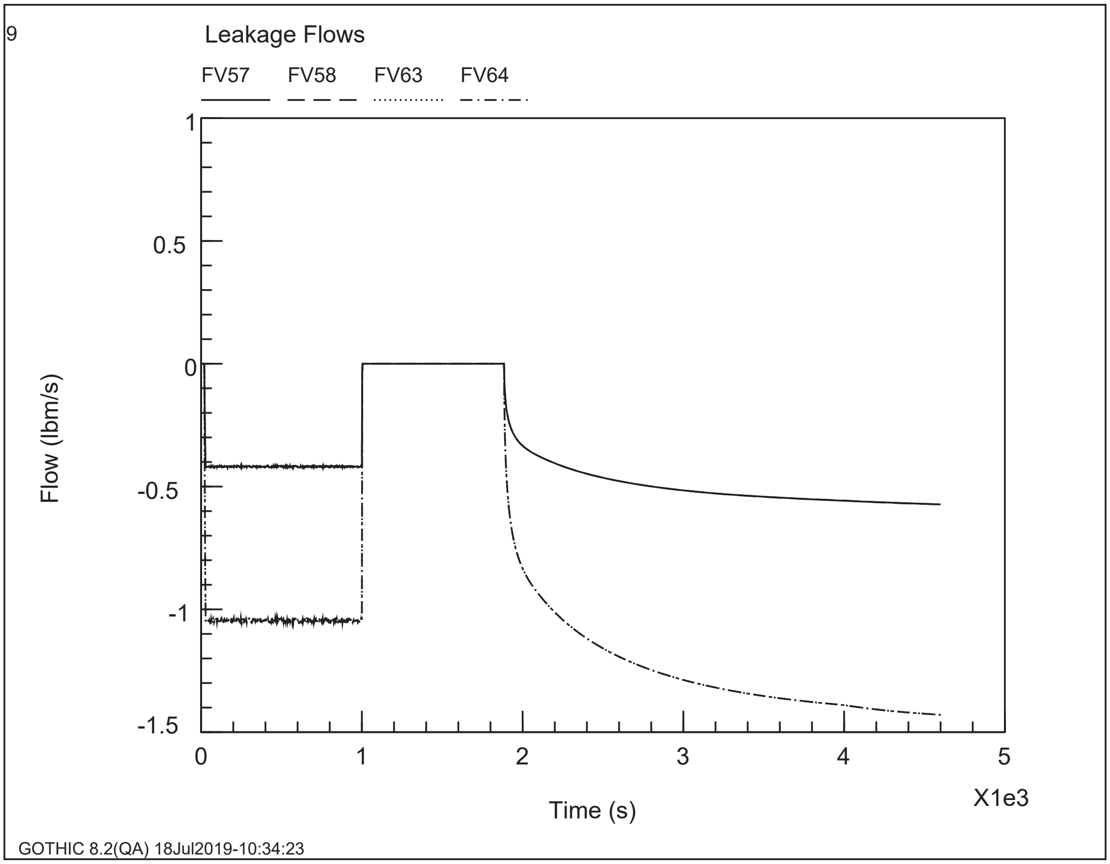

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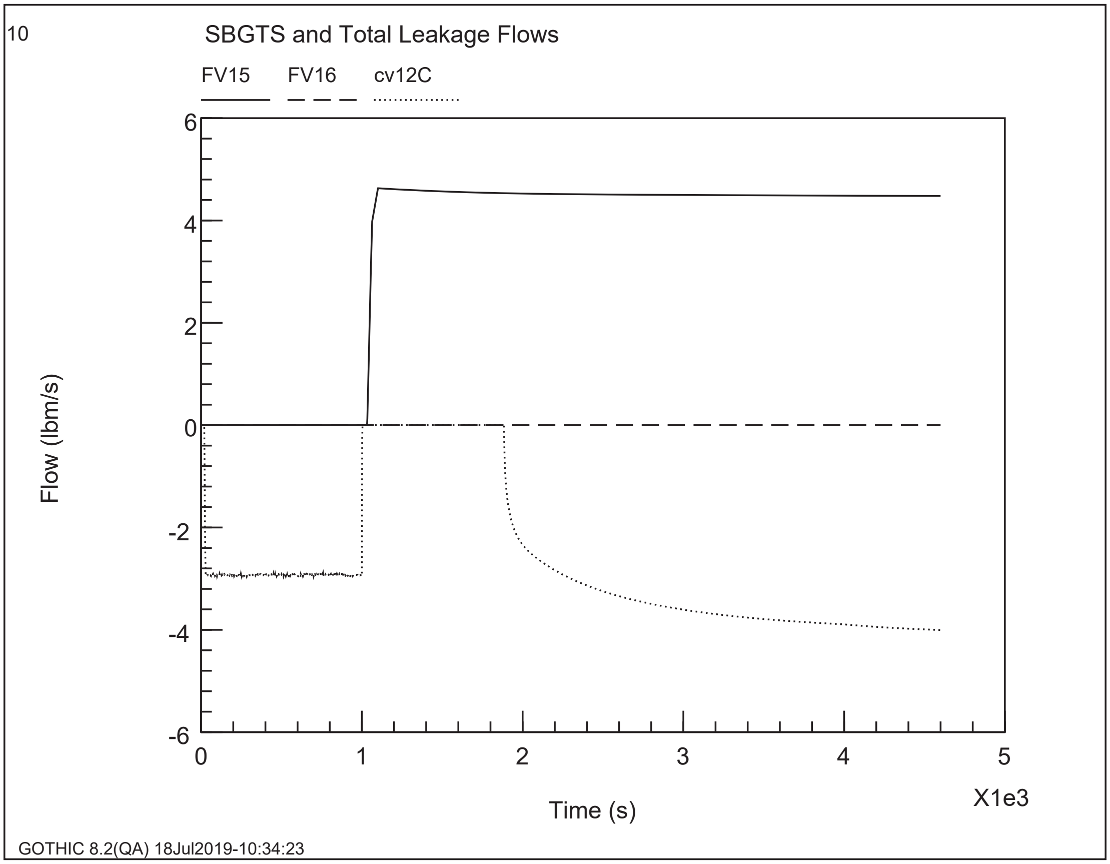

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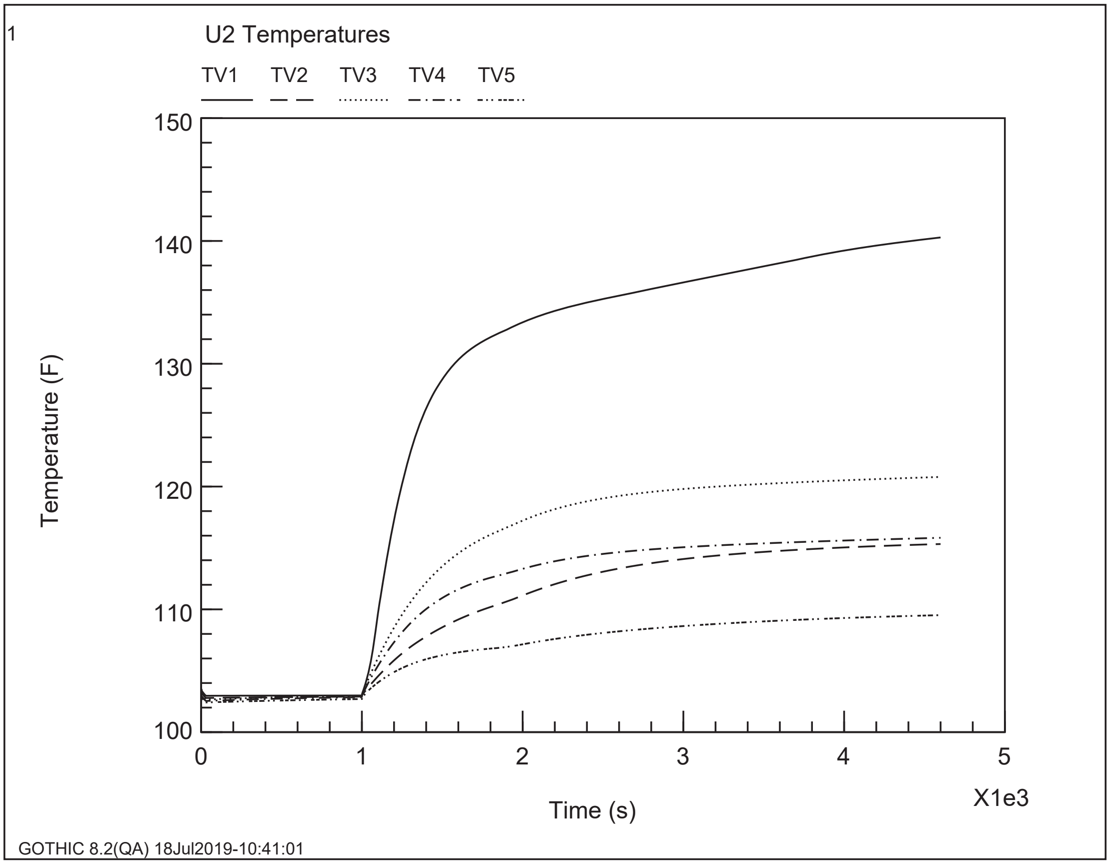

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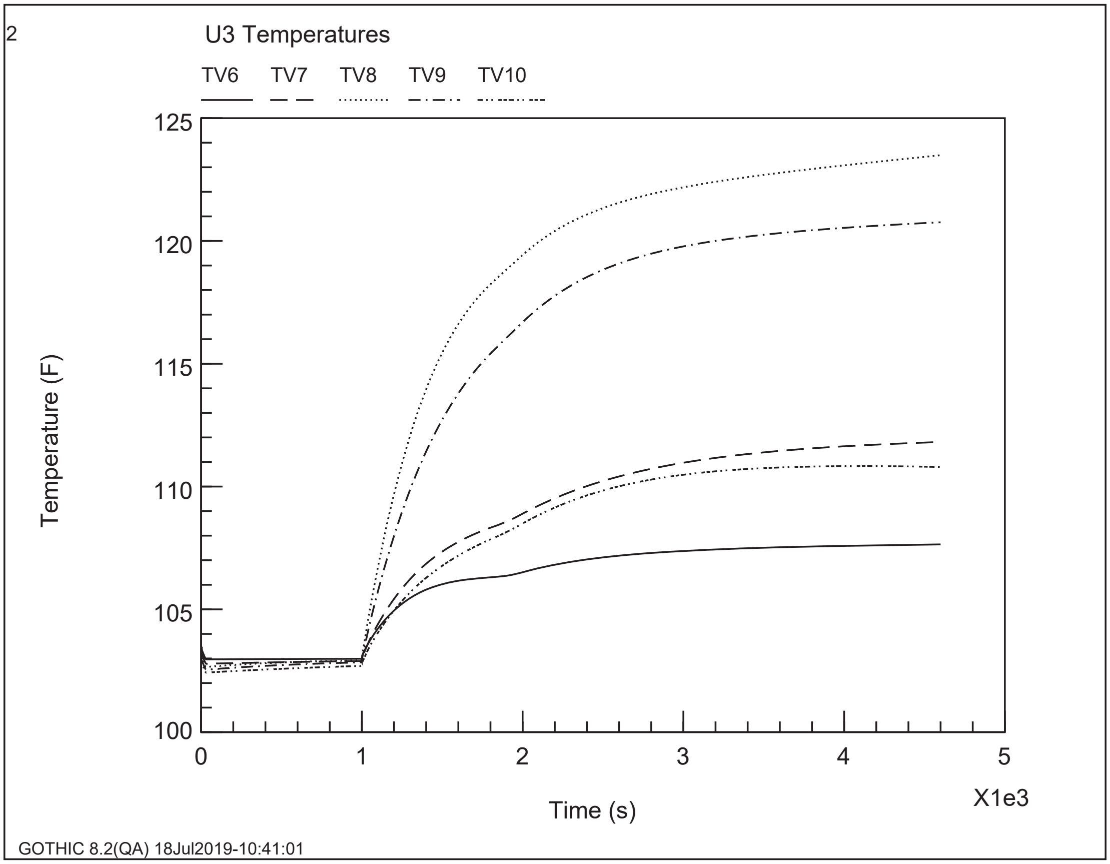

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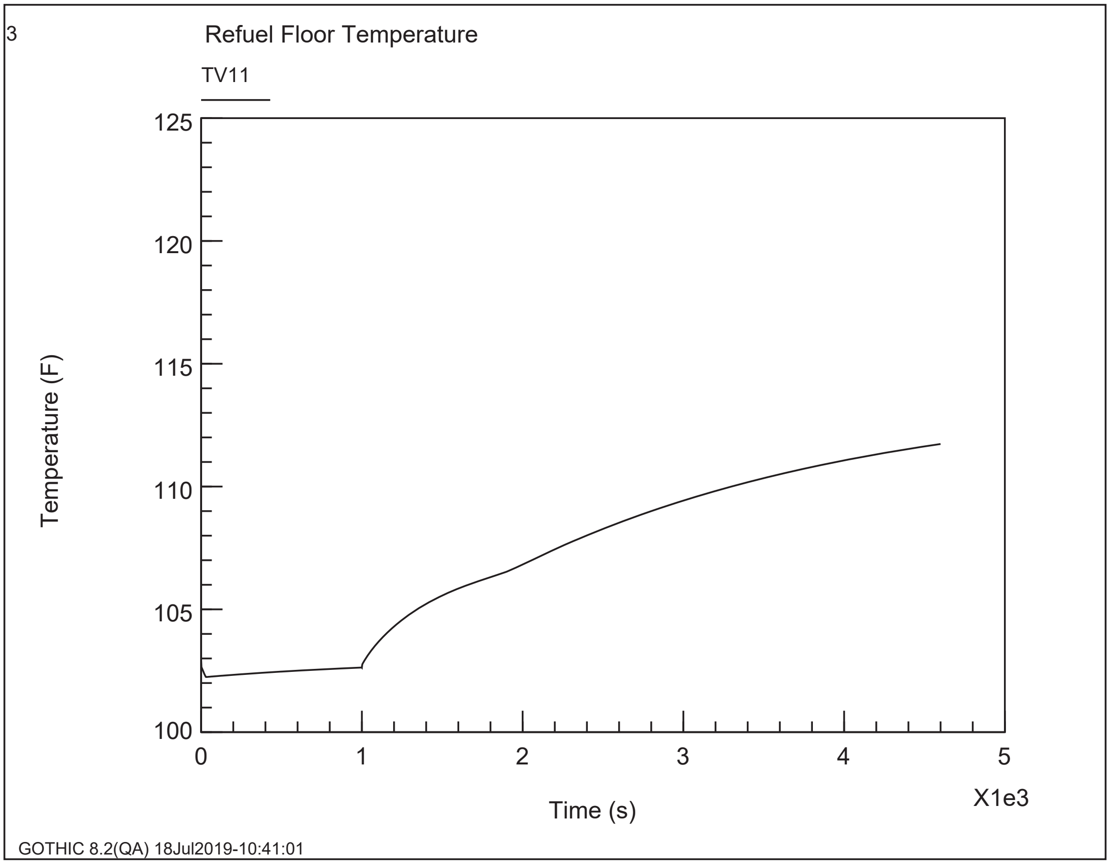

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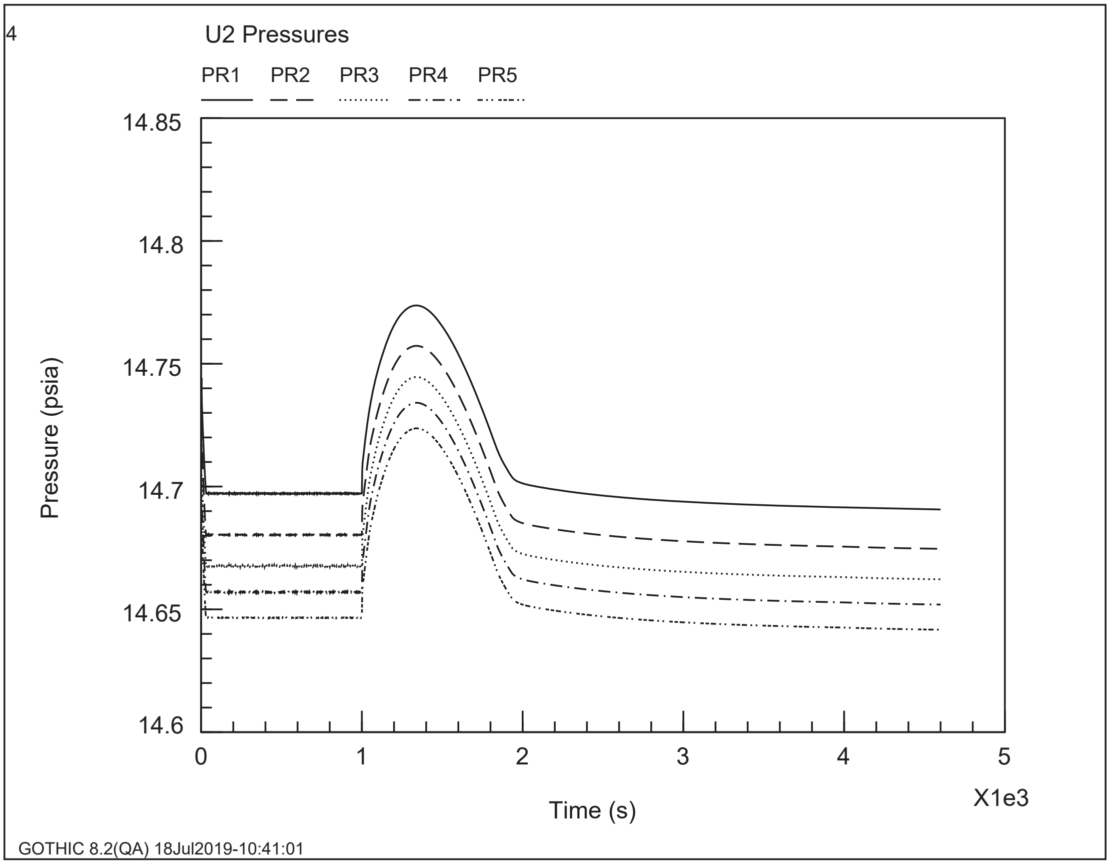

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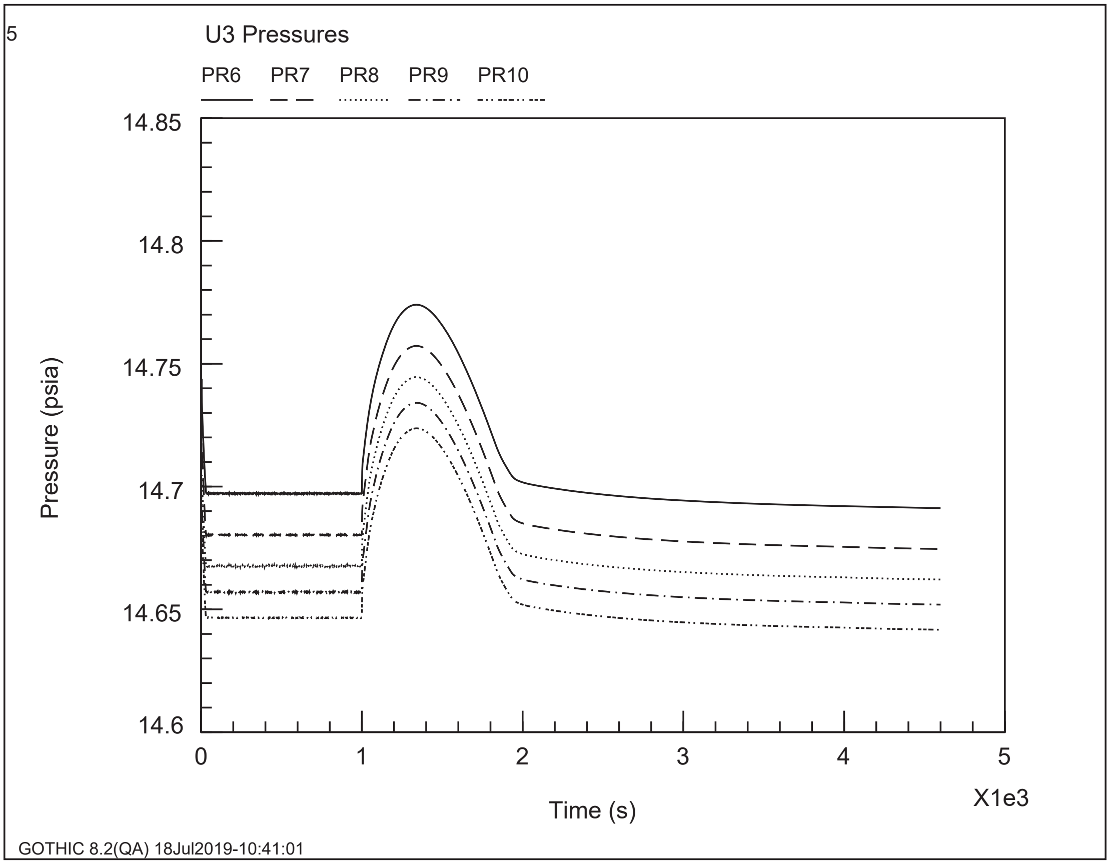

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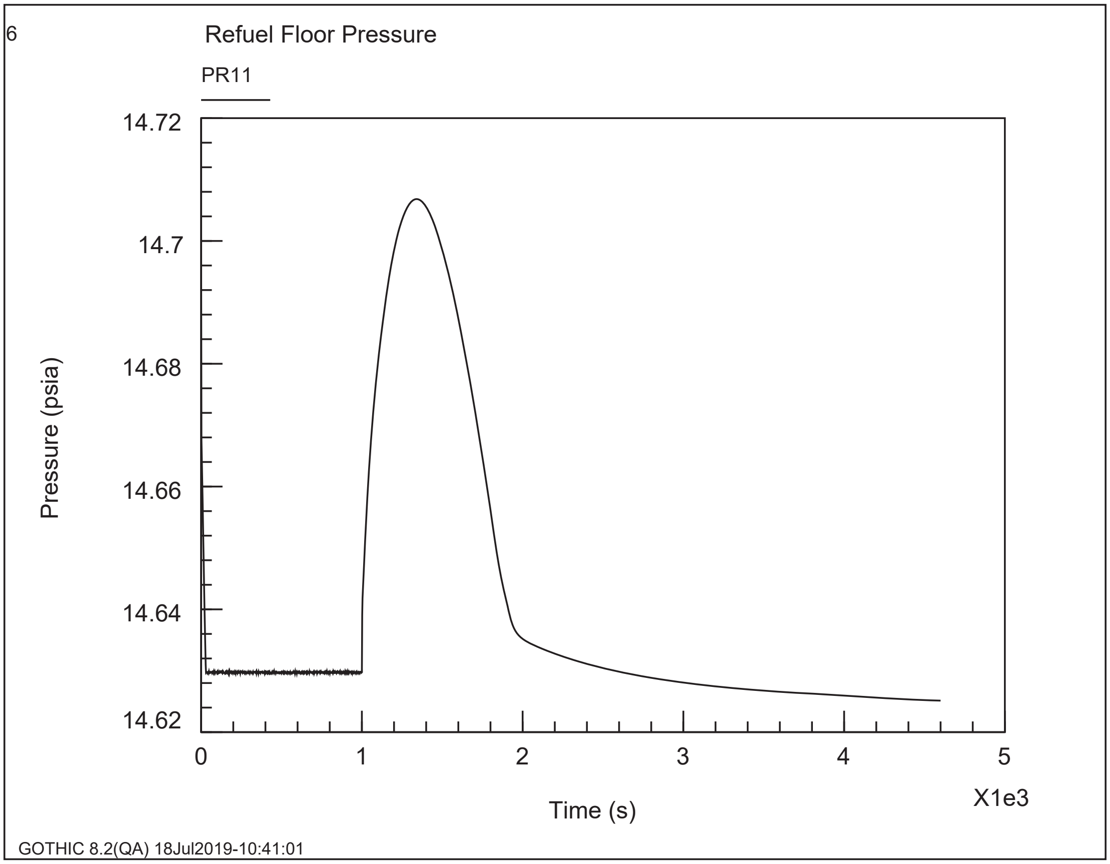

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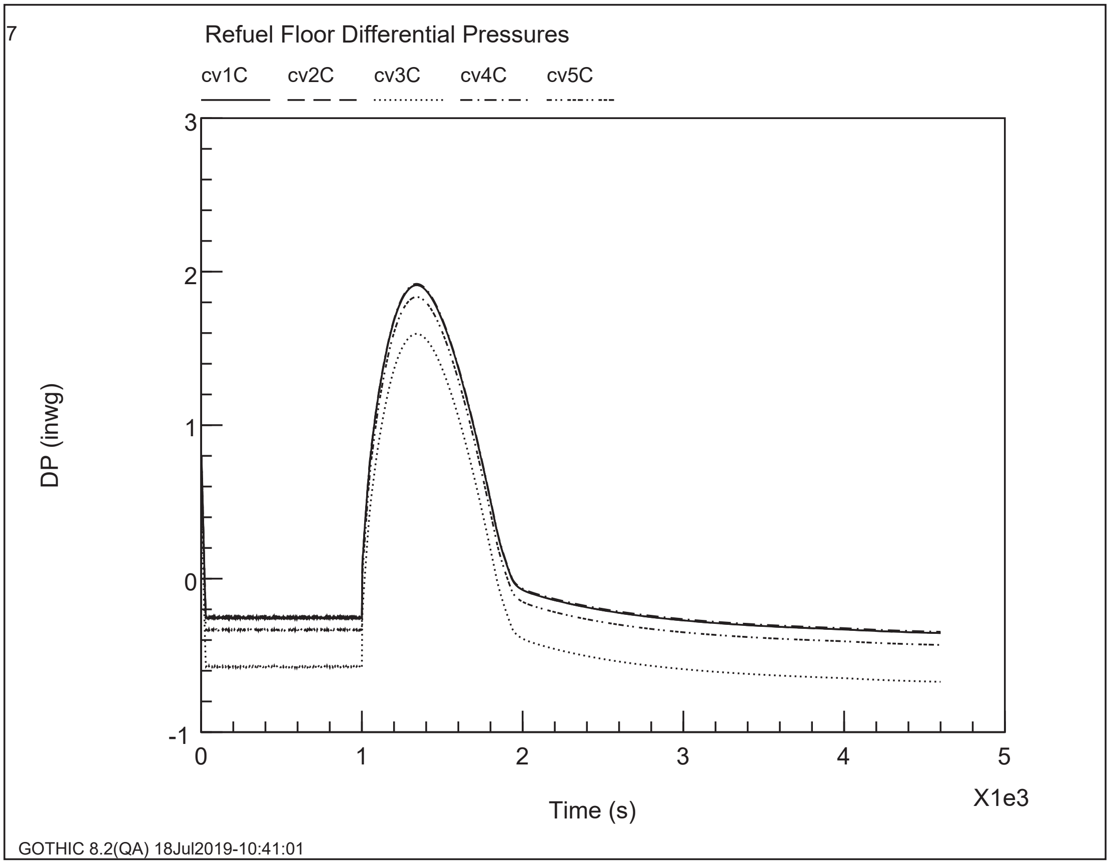

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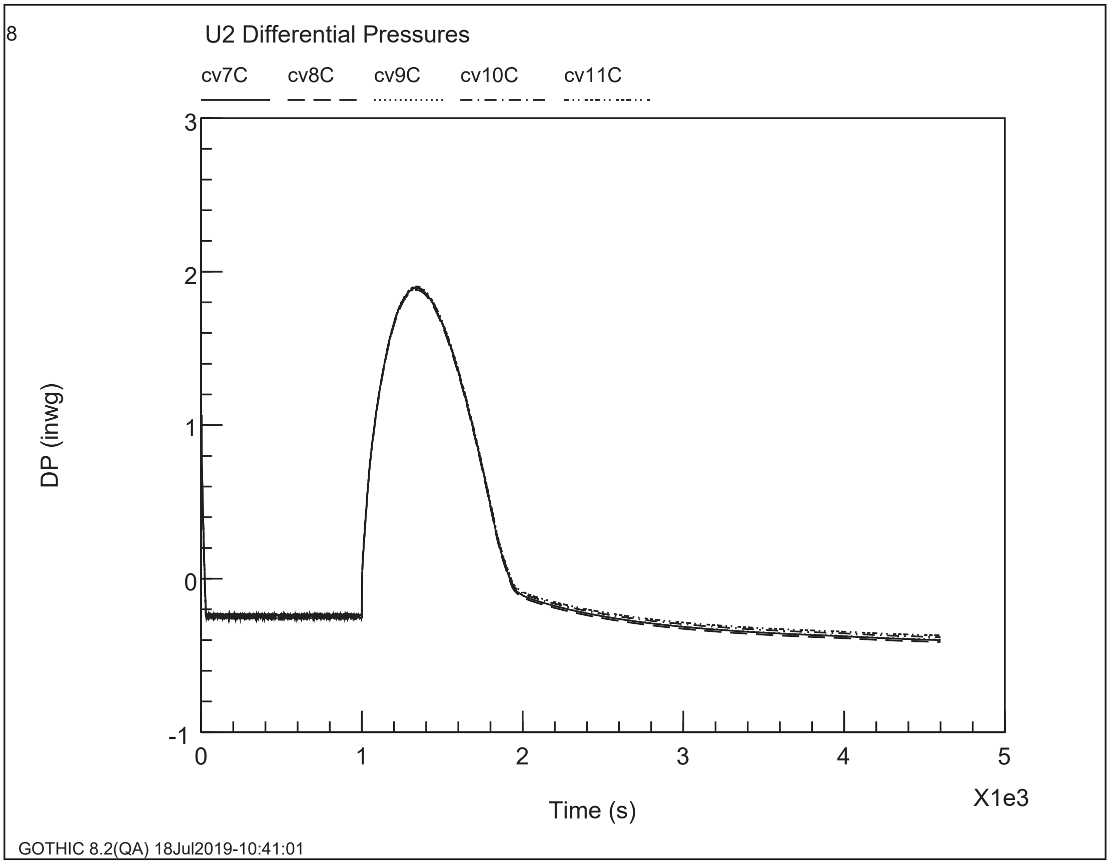

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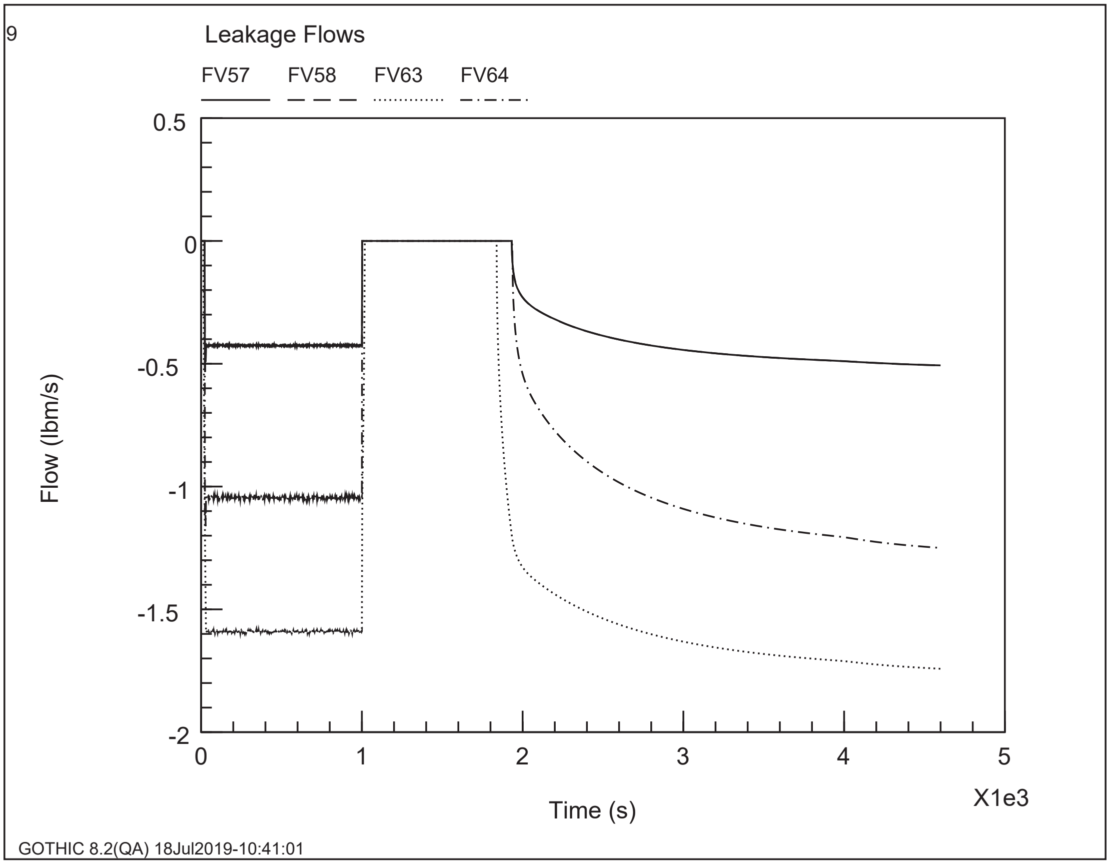

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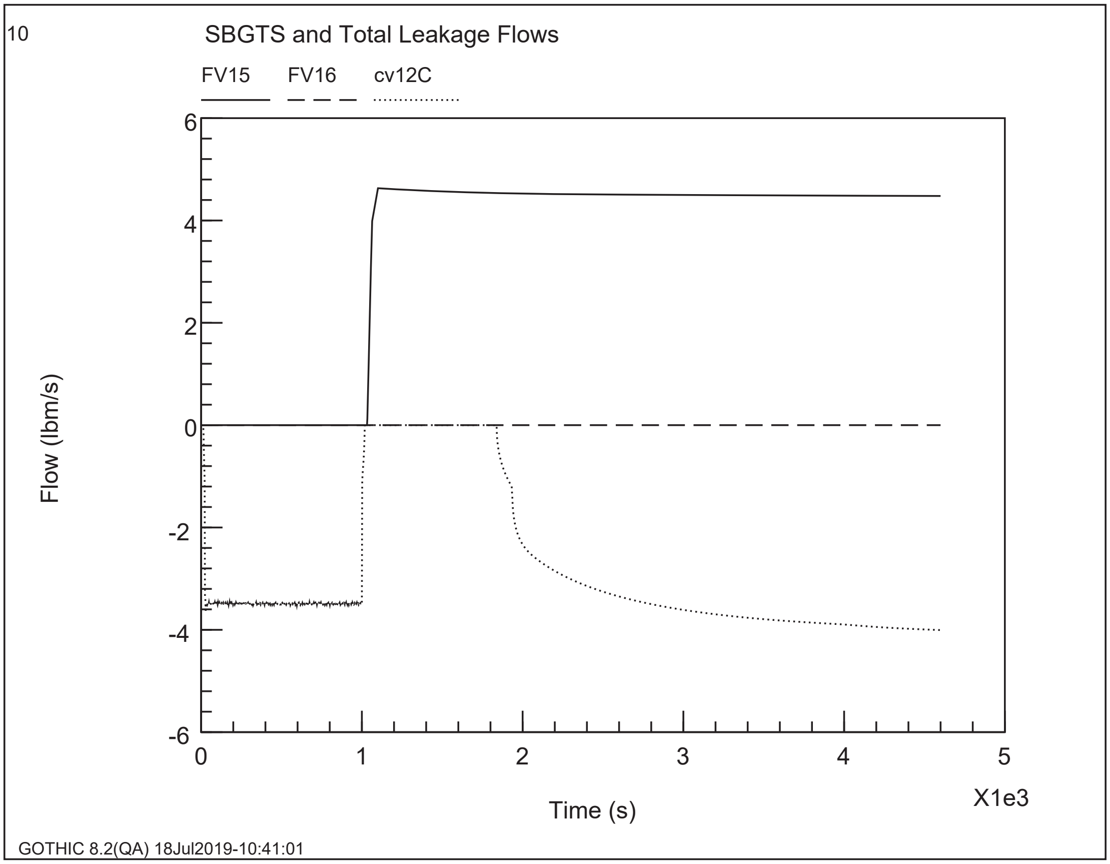

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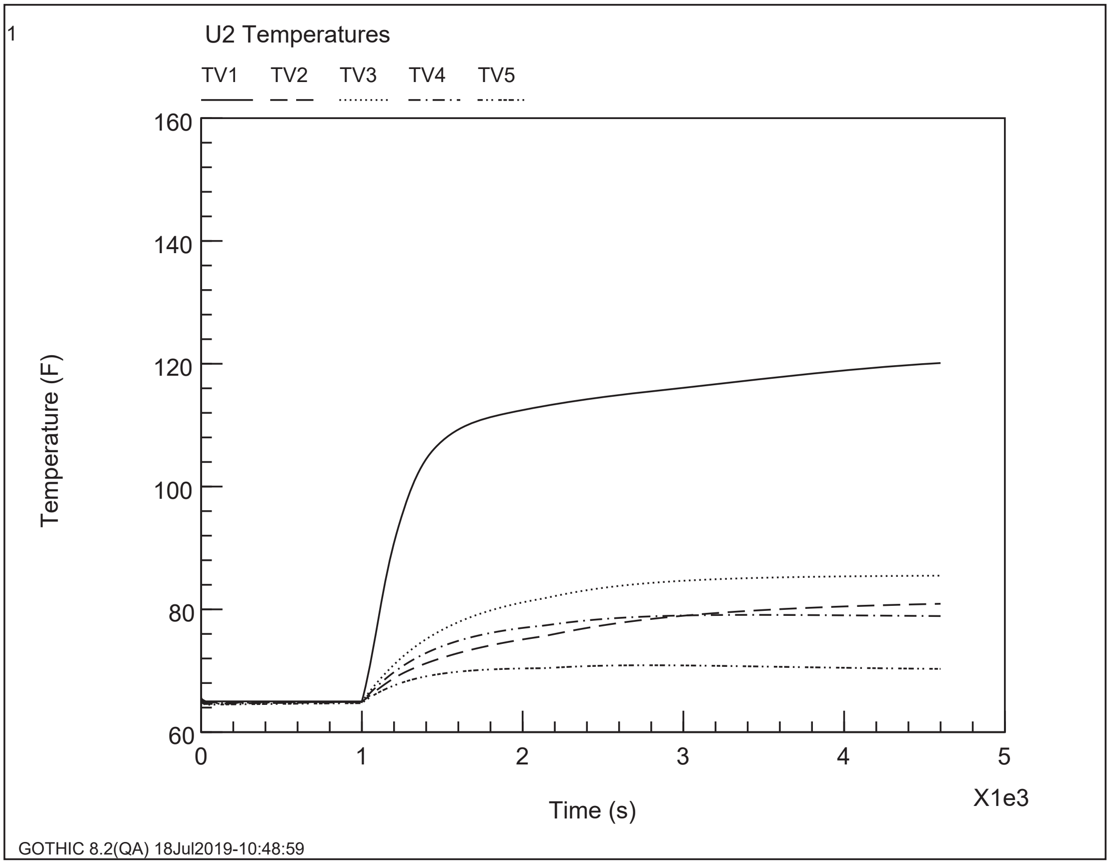

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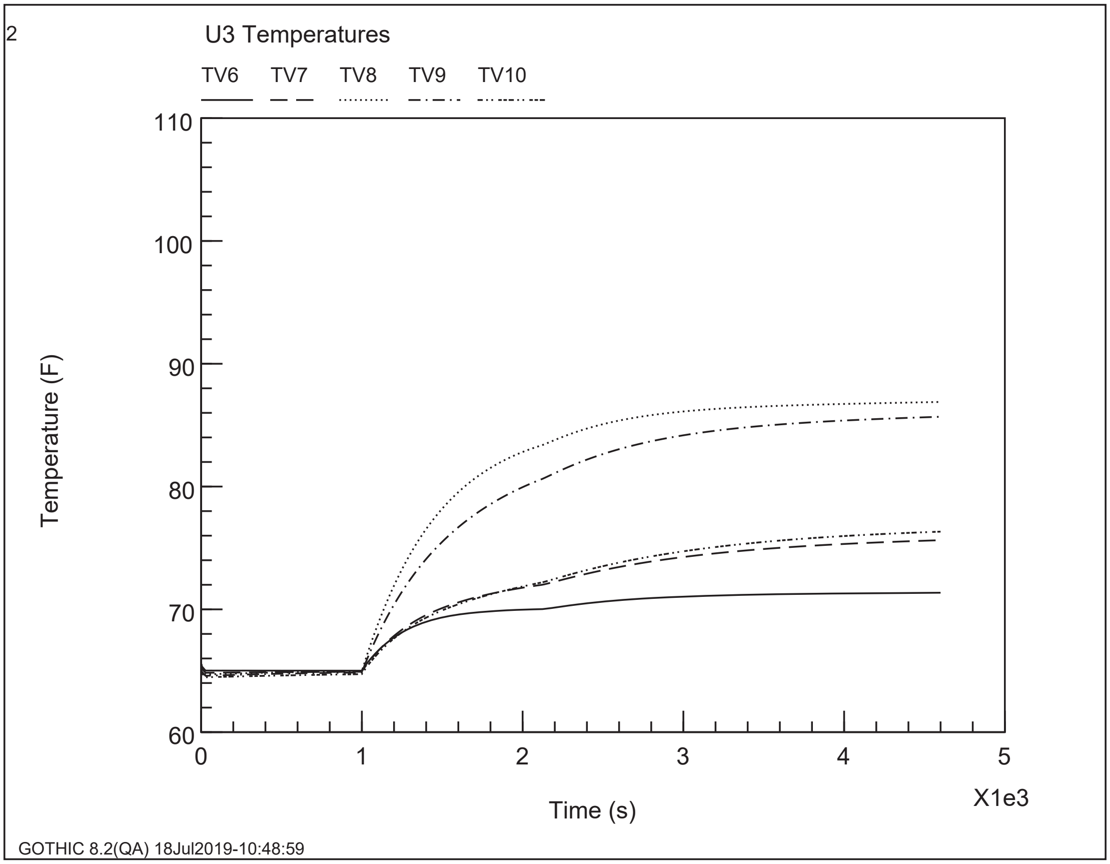

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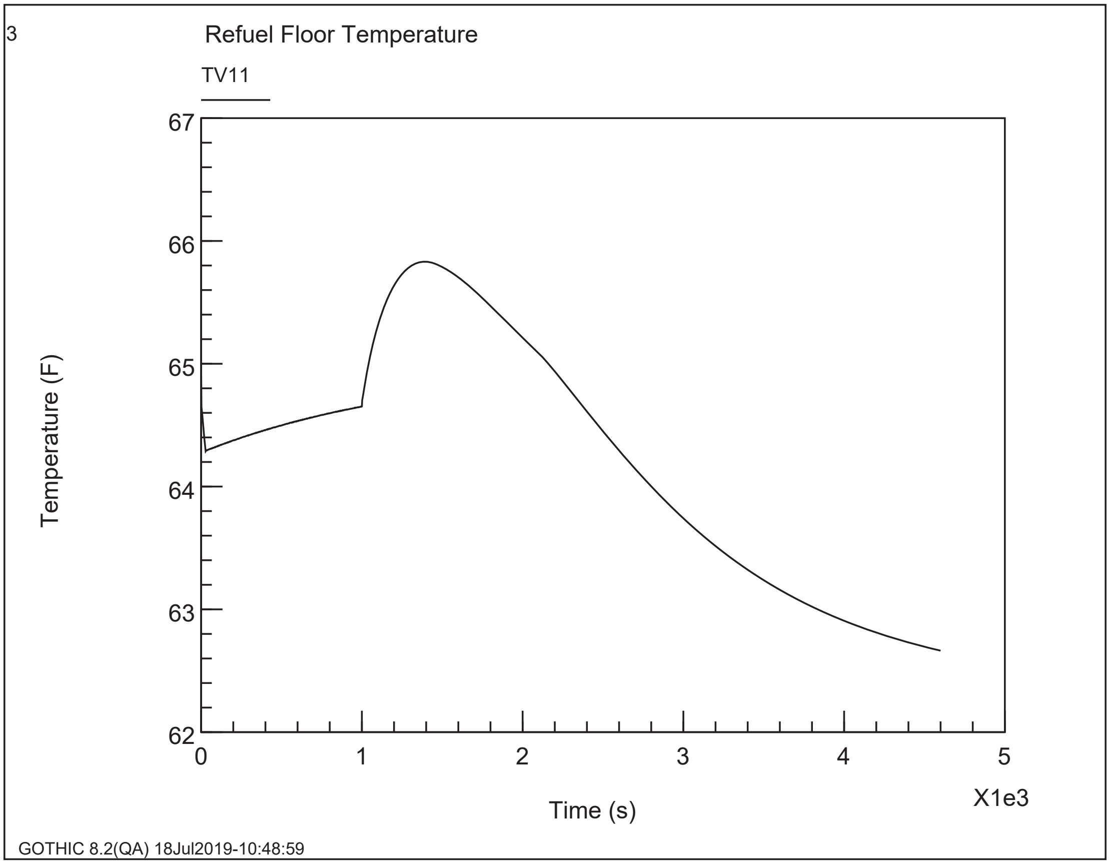

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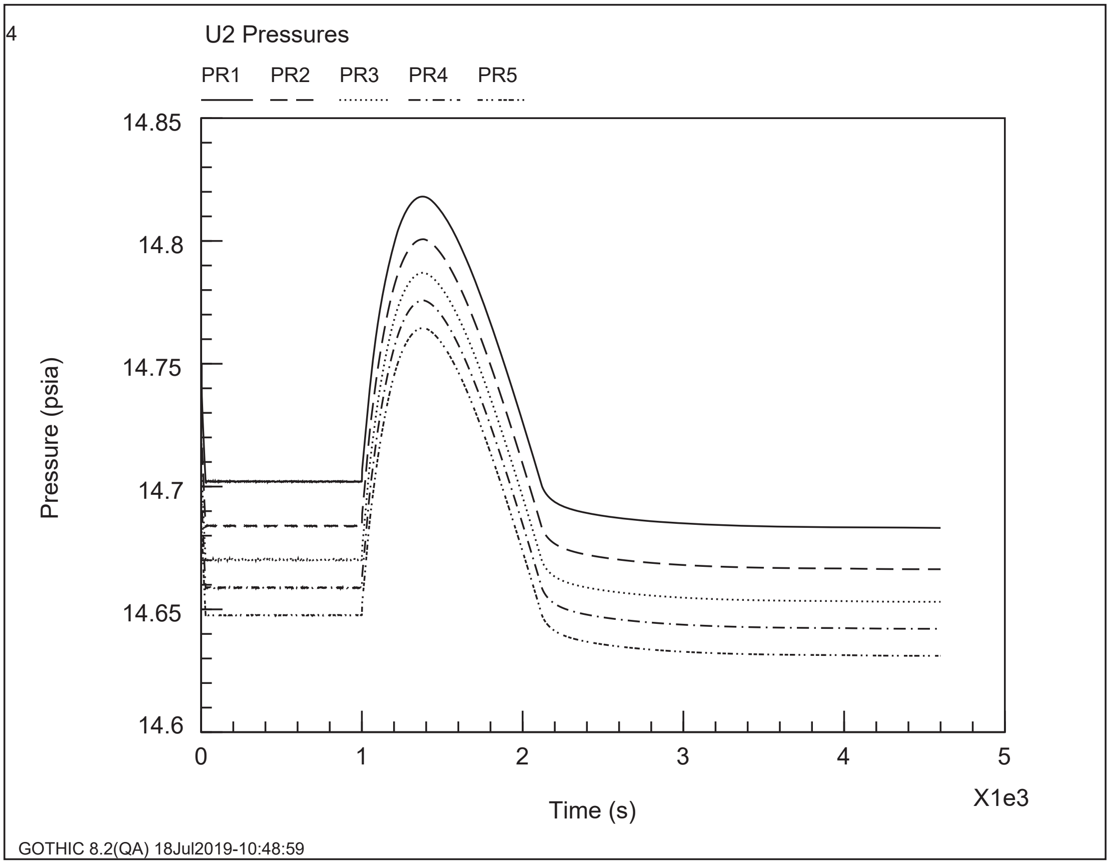

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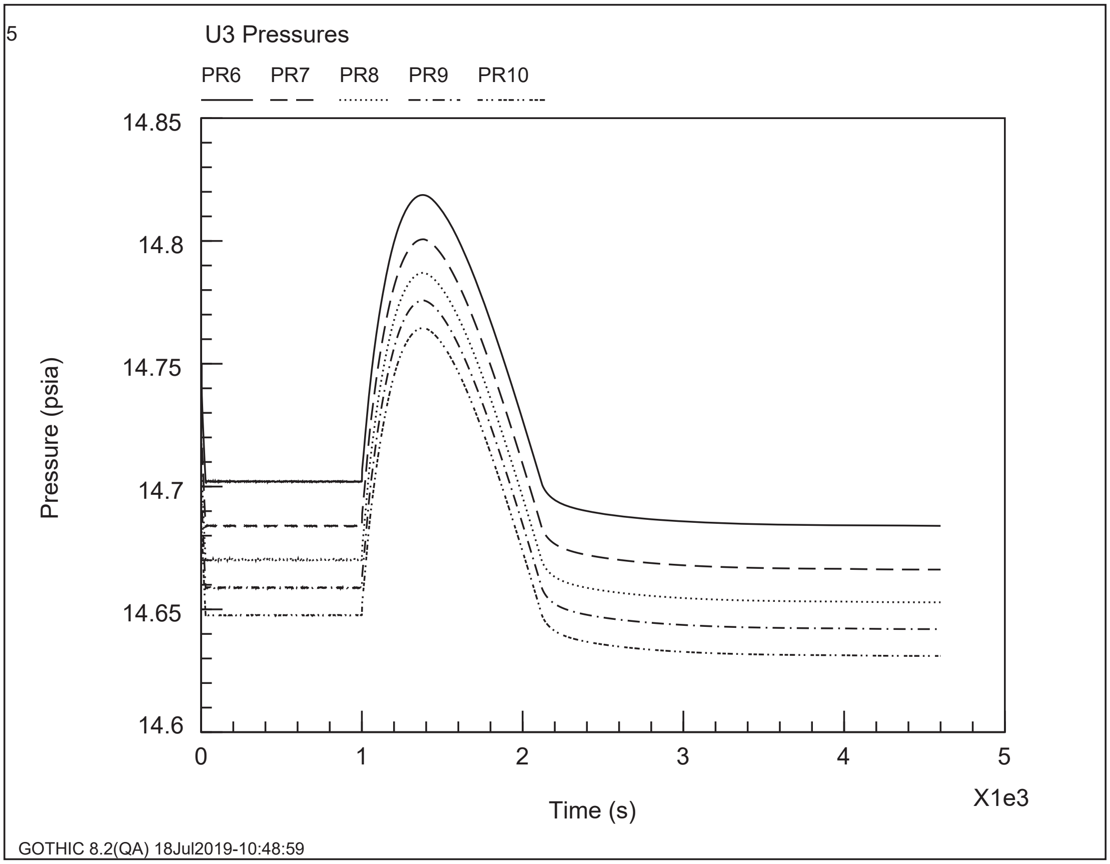

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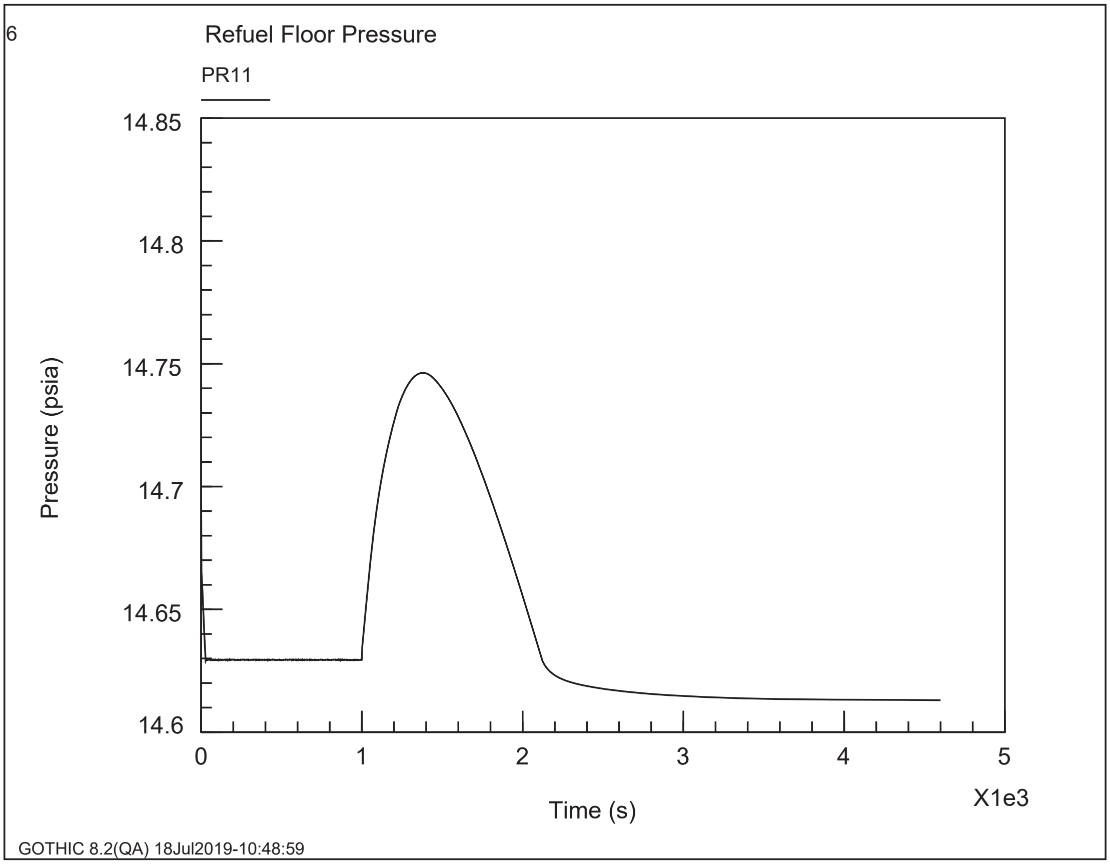

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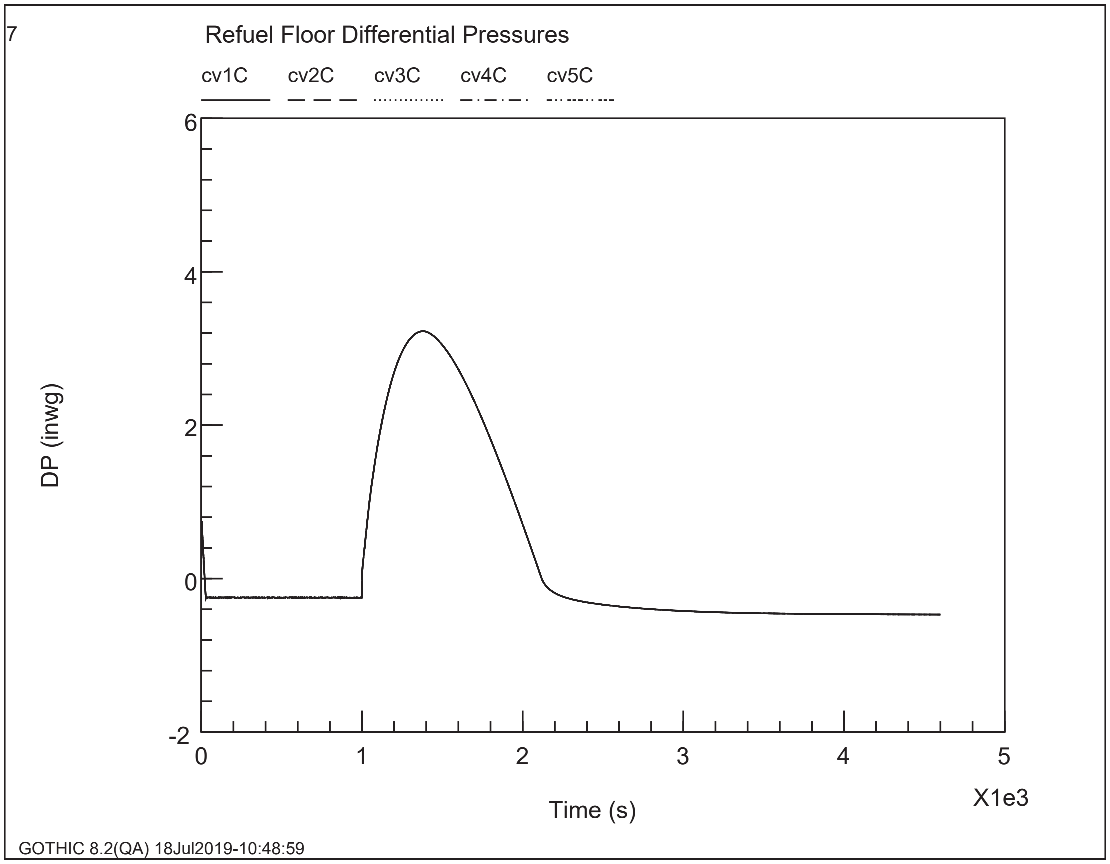

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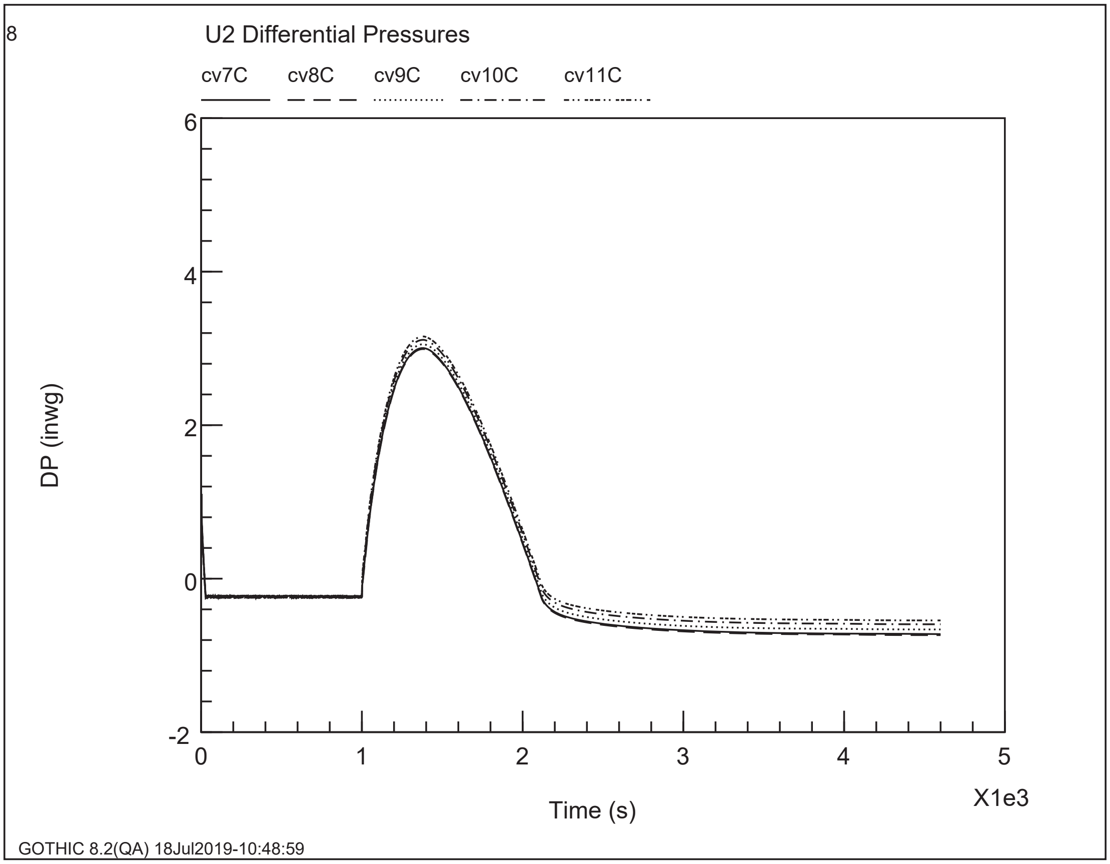

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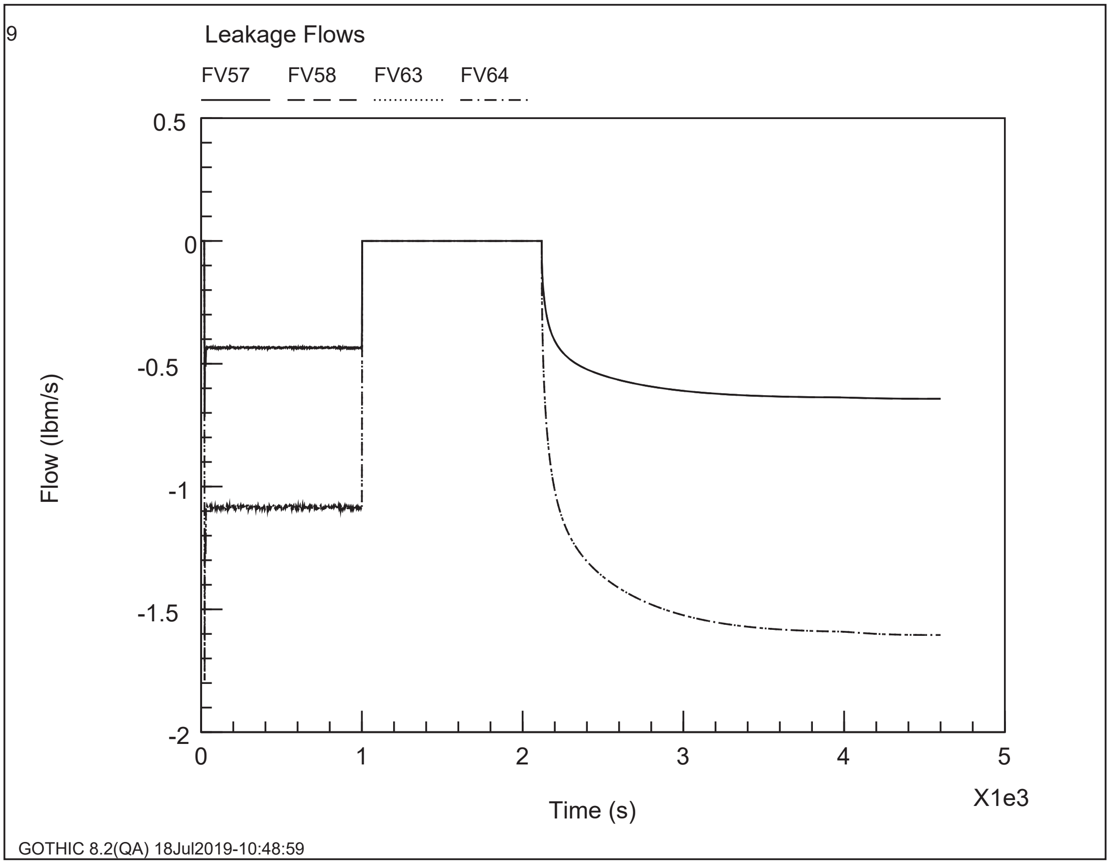

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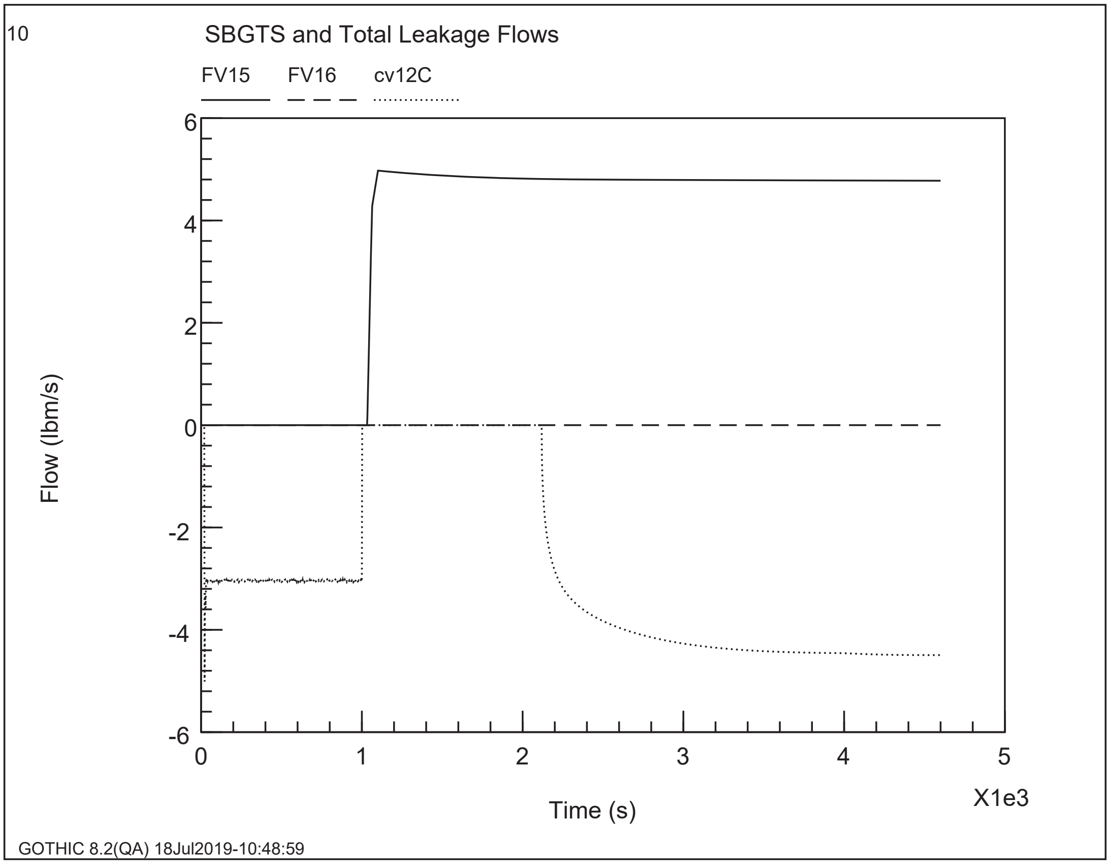

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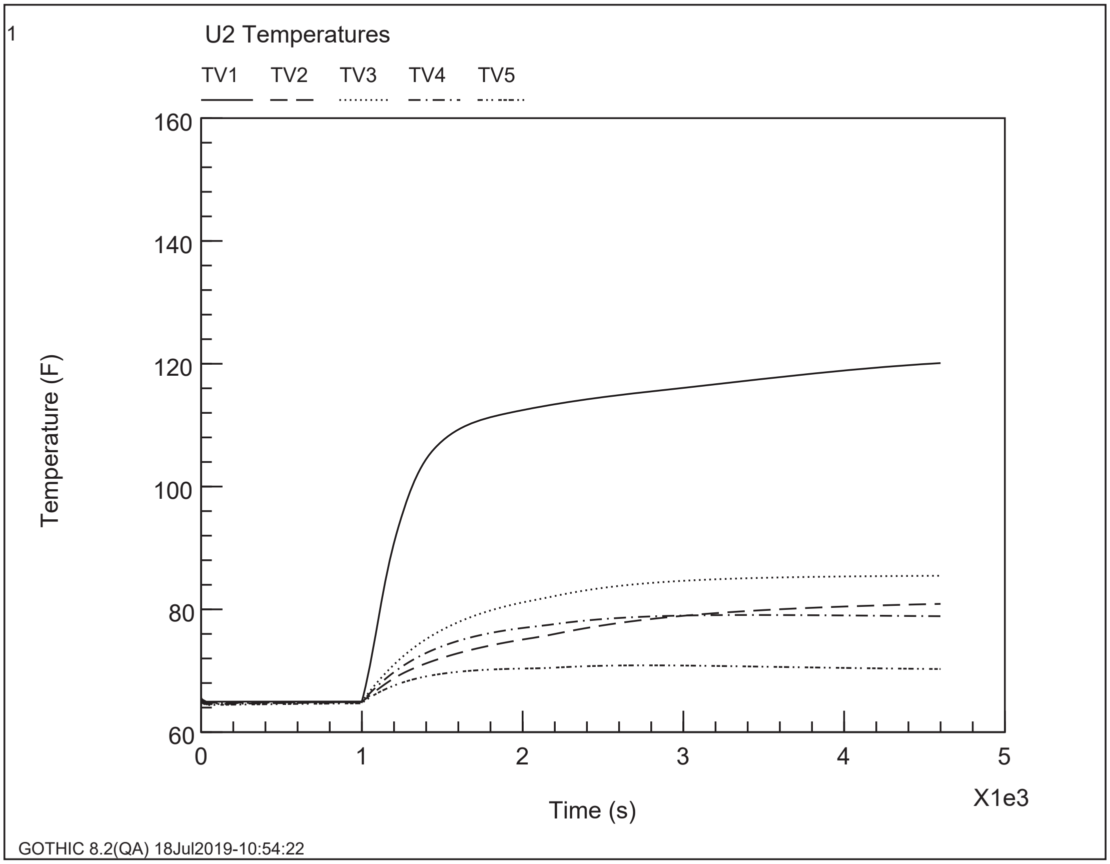

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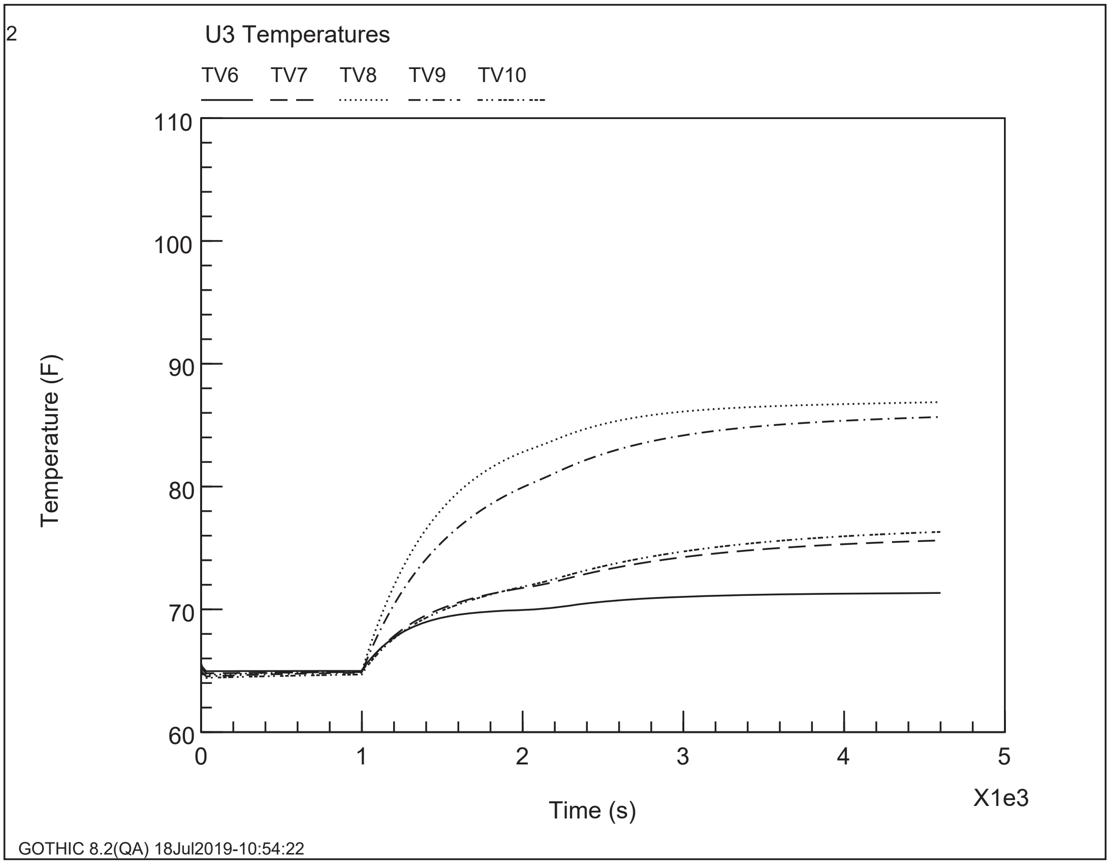

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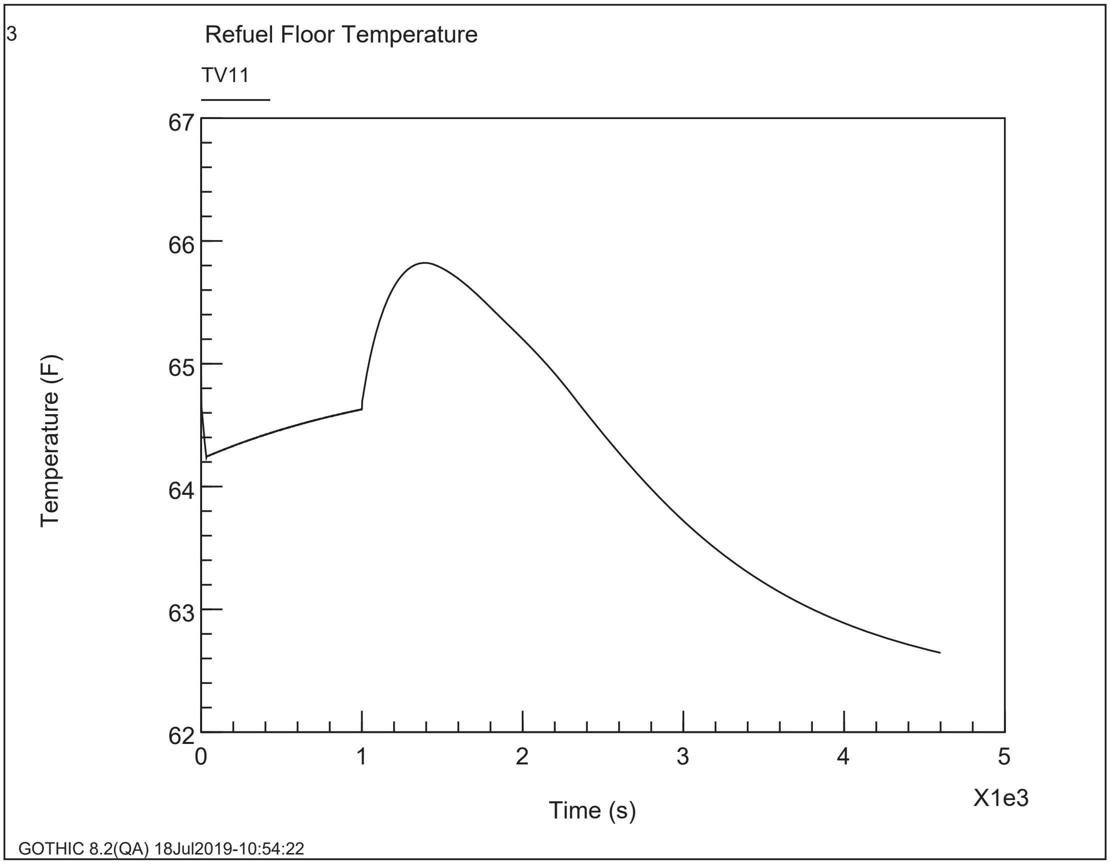

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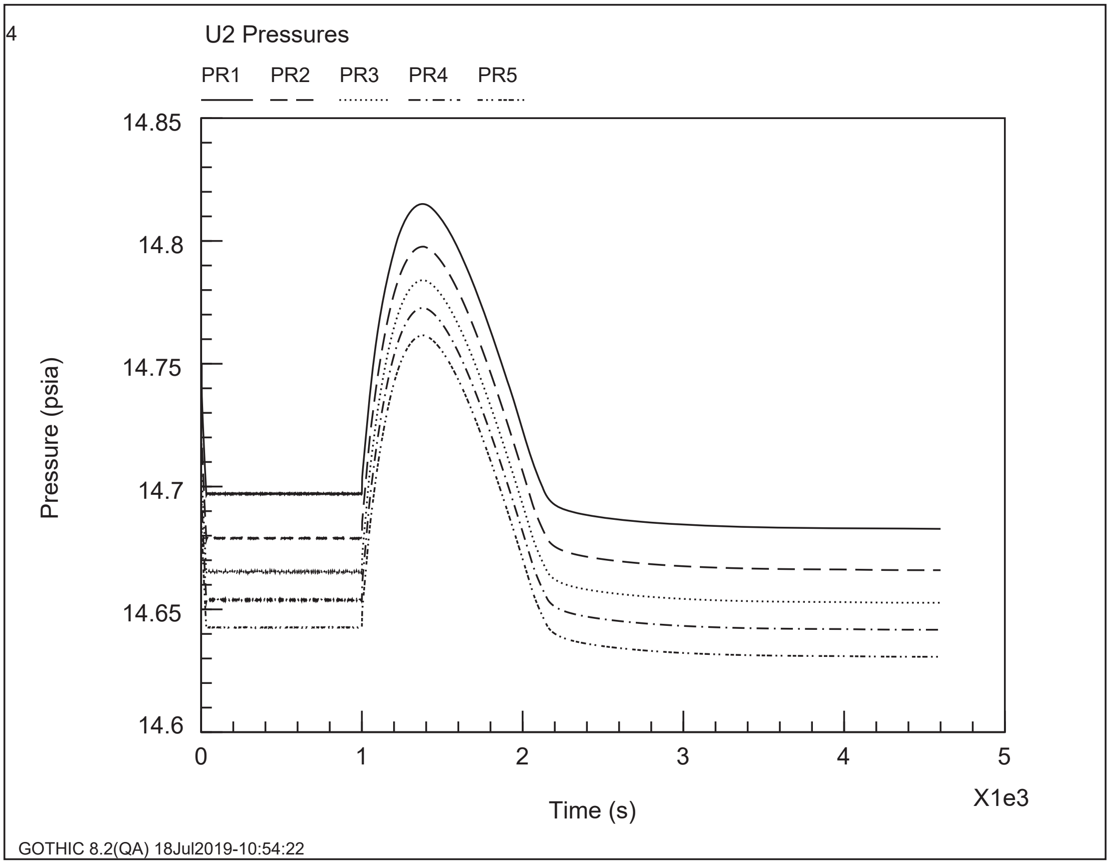

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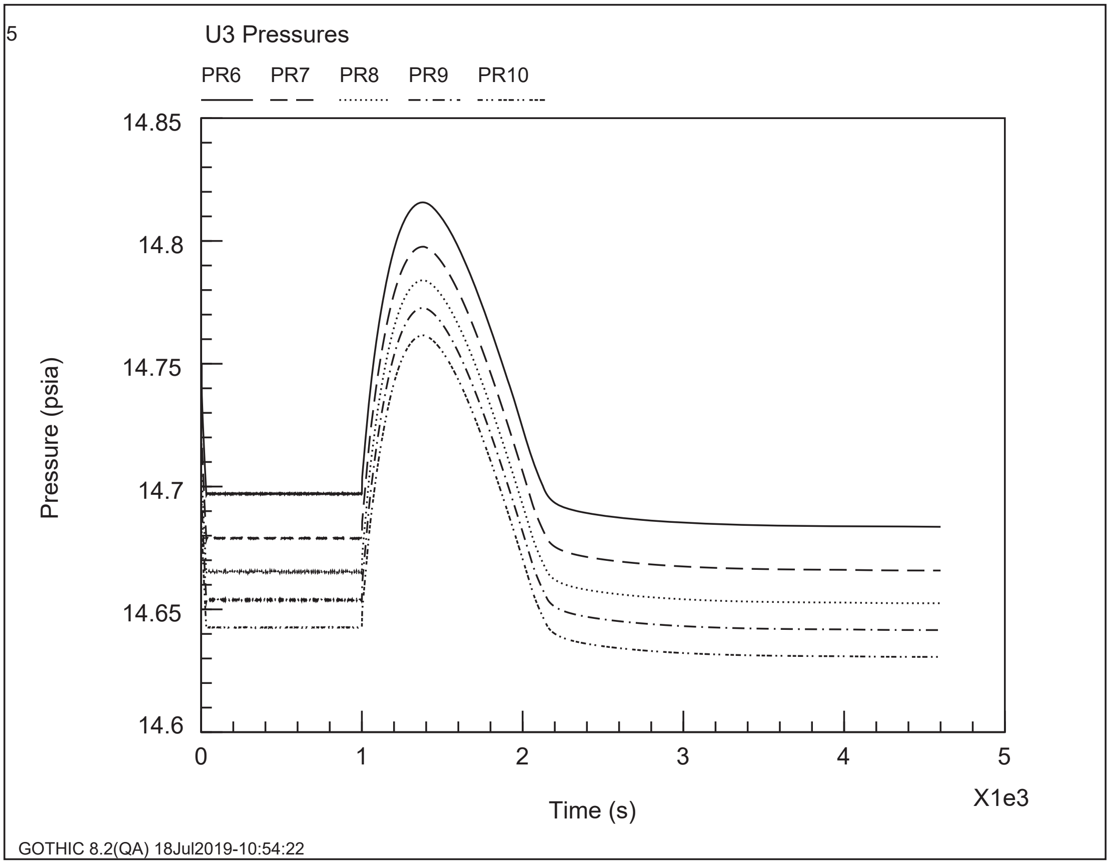

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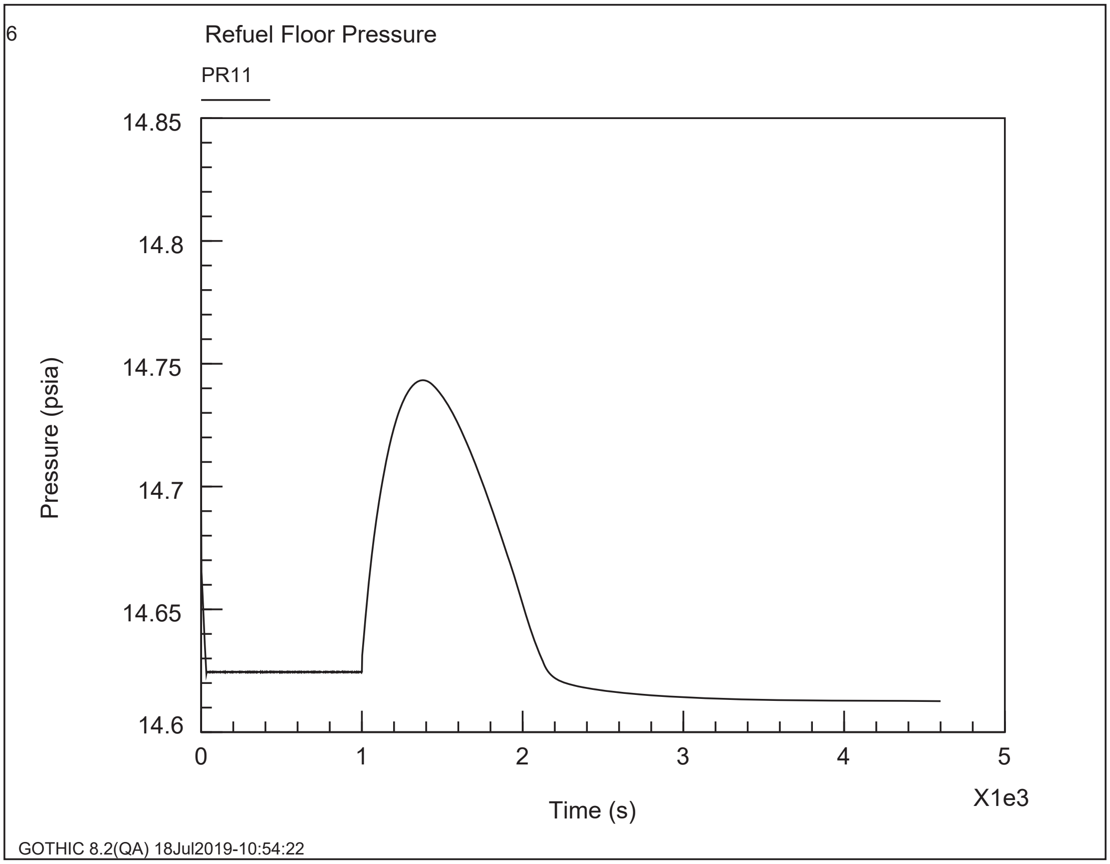

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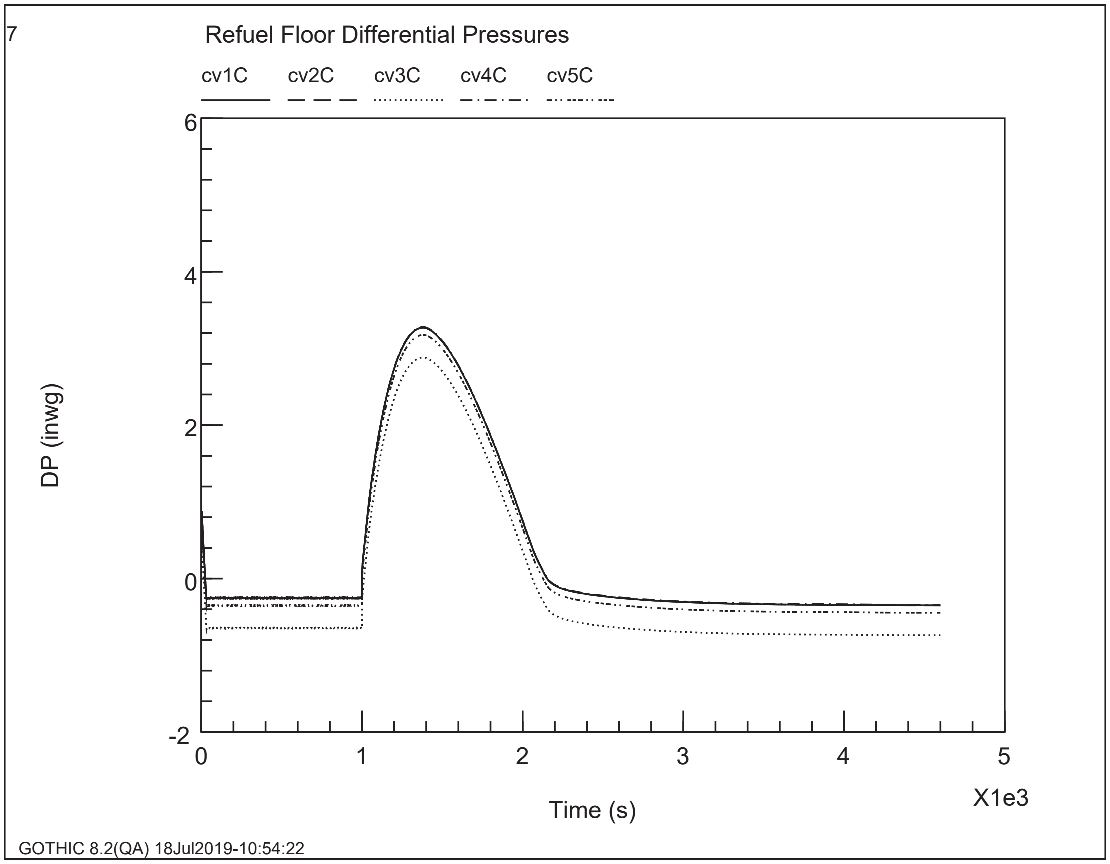

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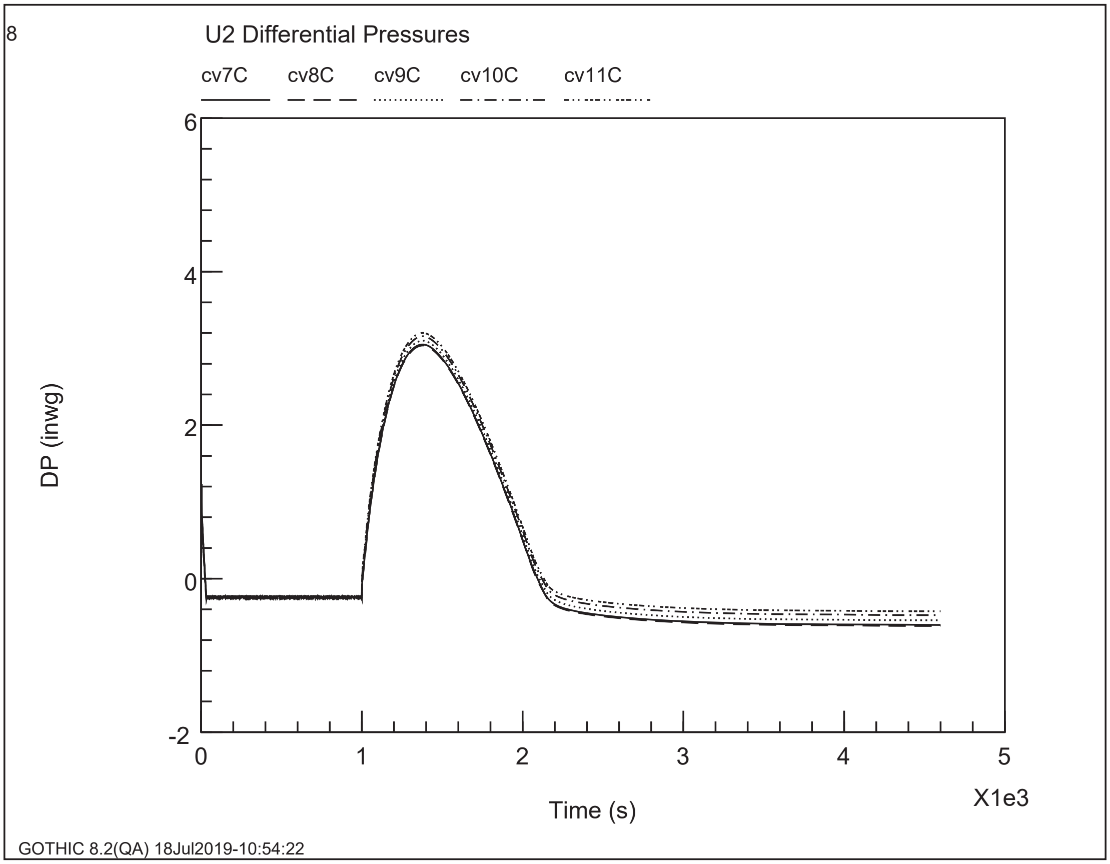

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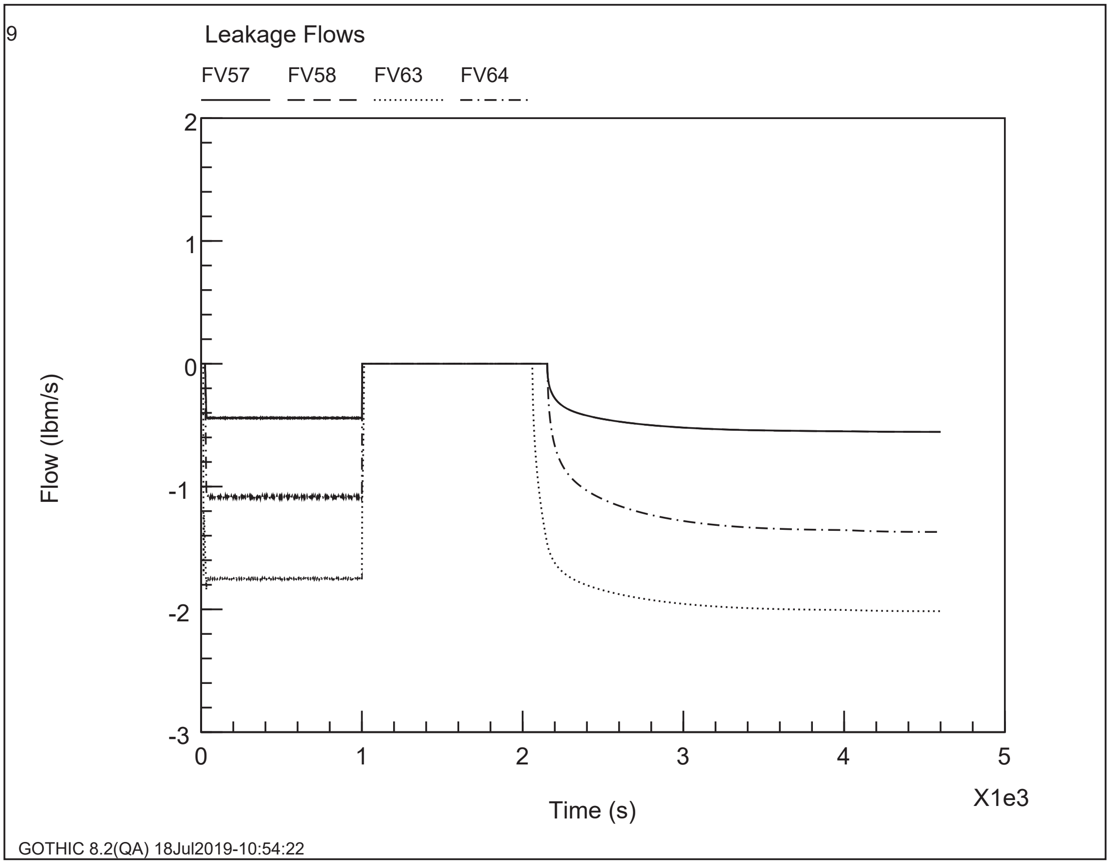

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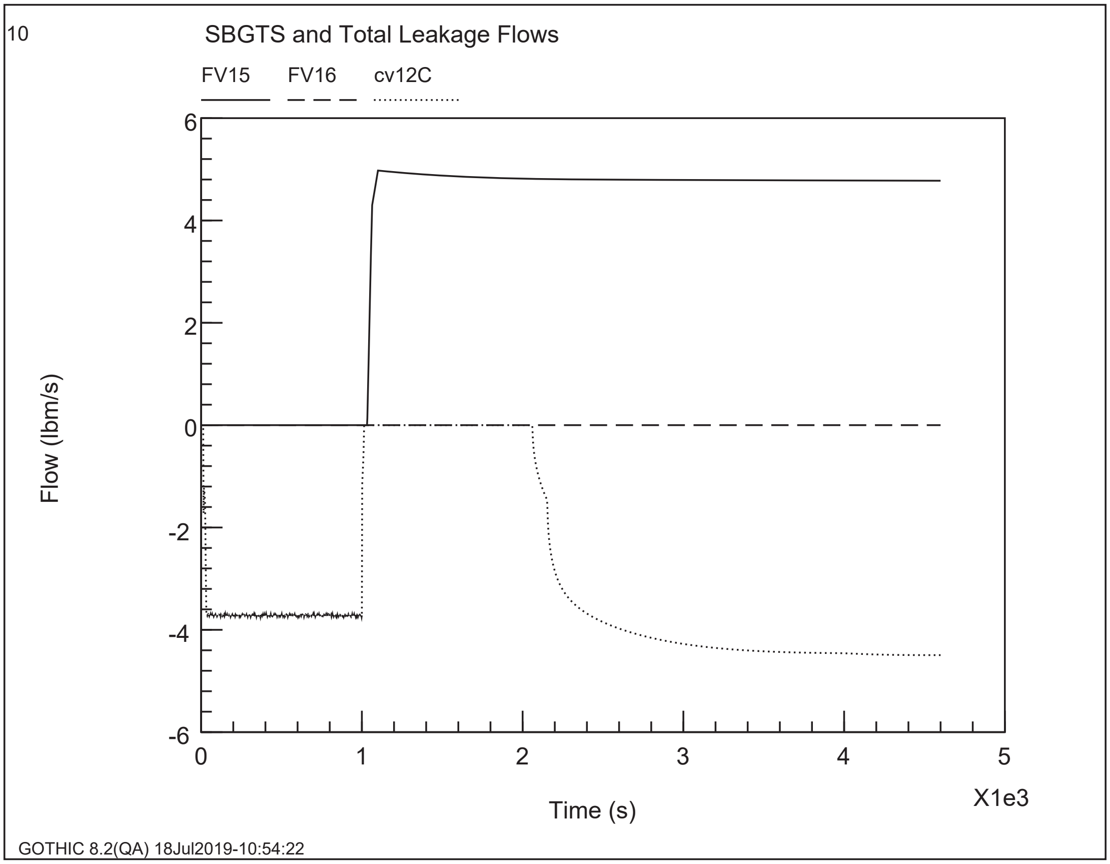


EXELON TRANSMITTAL OF DESIGN INFORMATION

☒ SAFETY-RELATED ☐ NON-SAFETY-RELATED ☐ REGULATORY RELATED	Originating Organization ☒ Exelon ☐Other (Specify)	TODI No. (DRE) TODI 19-007 Rev. 01
Station: Dresden Unit (s): 02 / 03 System Designation: SBGT/Secondary Containment		Page 1 of 5 To: John Wright (Enercon) jlwright@enercon.com

Subject: MSIV Leakage Rate Optimization – Input data request for RB Drawdown Analysis

Dan Lee — Preparer — Dan K Lee — Preparer's Signature — 10/16/2019 — Date

Brian Madderom — Approver — Approver's Signature — 10/16/2019 — Date

Status of Information: X Approved for Use __Unverified

Method and Schedule of Verification for Unverified TODIs: NA

Description of Information:

Reactor Building ventilation system, SBGT system, and building configuration parameters

Rev. 01 is to Remove Att. A and revise Att. B to remove the inserted pages taken from vendor proprietary documents.

Purpose of Issuance:

Input Parameters for Dresden Units 2&3 Secondary Containment Drawdown Analysis

Limitations: Only for use with project CORP 17-0070, BWR MSIV Optimization, associated with DCR 628316, Increase MSIV Limit, and calculation DRE19-0015.

References: Provide within TODI information

Distribution: Dresden Record Management, John Wright (Enercon)

Item #	Parameter Description	Value	Reference/Comment
1	Reactor Bldg. Geometry	Inputs data can be obtained the following calculations / sources • DRE97-0214 Rev. 001 • DRE05-0073 Rev. 000 • Dresden Drawing M-2 thru M-8 (latest revisions) • The HPCI and LPCI room coolers will auto start at high area temperature as detected by (temperature switches) TS 2/3-5746-A/B (set point 97+/- 1°F) and TS 2/3-5747 (set point 100+/- 2°F).	• Copy of source document can be download from EDMS. • Copy of DRE97-00214 Rev.001 has been transmitted via. E-mails on 5/20/2019 • Drawings 12E-2393 Rev. AH, 12E-3394 Rev. AB. • Passport D030 data panel.
2	Reactor Bldg. Heat Loads		
3	ECCS Room Cooler Heat Removal Capacity		
4	Drywell Temperature (LOCA)	Maxmixum LOCA Drywell temperature is 290.0 °F at time 7.56 seconds. Note: Assume drywell temperature remains unchanged after 29.62 seconds @ 274.9°F.	• Calc. GE-NE-0000-0056-9883-R0, Rev.0 • Report GE-NE-0000-0043-9608-R0
5	Suppression Pool Temperature (LOCA)	See Attachment B	• Analysis GE-NE-A22-00103-08-01, Rev. 1
6	Spent Fuel Pool Temperature (LOCA)	≤ 125 F	• Calc. DRE97-0214 Rev. 001A • Proc. DOA 1900-01
7	RB/SC In-Leakage	1 RB volume/day	• NUREG-0800 SRP 6.2.3
8	RB/SC In-Leakage Locations	RB siding, RB access doors, penetrations	• UFSAR 6.2.3.3
9	RB Pressure (Normal)	≥ 0.25 inch vacuum.	• TS SR 3.6.4.1.1 • Drawings M-526 Sht.1 Rev O, 12E2399C Rev. Y

		Controlled by using the lowest differential pressure from the four DPTs (see item 11) to two Differential Pressure Controllers (DPC 2/3-5703-7C/7F).	• UFSAR 6.2.3.3
10	RB Pressure (LOCA)	≥ 0.25 inch vacuum (with SBGT ≤ 4000 CFM). Average value measured by four (4) dP gauges located on the four walls of the refuel floor @ Elev. 613’	• TS SR 3.6.4.1.3 • Proc. DOS 1600-32
11	Location and number of RB Differential Pressure Sensors	Atmospheric pressure is sensed by four pressure sensors located through each exterior wall of the Reactor Building @ Elev. Above the refuel floor. Building pressure is sensor by two pressure sensors located on the wall of both Unit 2 and Unit 3 refuel floors @ Elev. 621’. The measured atmospheric and building pressures are supplied to four Differential Pressure Transmitters (dPT 2/3-5703-7A1/7B1/7C1/7D1) which determine the building to atmospheric D/P.	• Drawing M-526 Sht. 1 Rev. O • UFSAR 6.2.3.3
12	Wind Speed	24 mph (1-hour average value exceeded only 5% of the total number of hours in the data set - per RG 1.183)	• Wind speed that is only exceeded less than 5% of the time based on Elev 35’ and 150’ wind speed from Attachment G of DRE 04-0030 Rev 02
13	RB HVAC SC Isolation Valve Closure Time	300 seconds	• TRM Appendix B Table B-1 • Proc. DOS 1600-3, -5
14	SGTS Capacity	4000 cfm design flow nominal	• UFSAR 6.5.3.1 • TS SR 3.6.4.1.3
15	SGTS Flow Control Method	Flow Indication Controller is used to throttle the position of the fan suction valve to control the flow to 4000 cfm +/- 10% on the operating train. FCI 2/3-7451-28A/28B	• UFSAR 6.5.3.2 • Proc. DOP 7500-01 • Drawing M-49 Rev RB

16	SBGT Pressure Loss at Design Flow	16.2 inwg at 4000 cfm (w/ dirty filter)	• Calc. VG-05 Rev. 0
17	SBGT Fan Performance	16.0 inwg at 3975 cfm (w/ dirty filter)	• Calc. VG-06 Rev. 0
18	SBGT Suction Location(s) for LOCA conditions	From all levels of Reactor Bldg (see Dwgs M-269, sht2 and M-529 Sht 2).	• M-49 Rev RB • M-269 Sht 2 Rev F • M-529 Sht 2 Rev H
19	SBGT Delay time to load onto DG after LOCA/LOOP	13 seconds to close DG breakers; SGTS loaded when breakers close	• TS SR 3.8.1.8 • UFSAR 8.3.15 • UFSAR Figures 8.3-4 & 8.3-5
20	Delay time to start Secondary SGTS if Primary SGTS fails	20 seconds	• TS B3.6.4.3 • Proc. DIS 7500-1
21	SBGT Isolation Valve Opening Time (Max)	See Attachment C	• Proc. DOS 7500-2 • IST Acceptance Criteria Manual-Valve Test Acceptance Criteria Sheet for DOS 7500-2, dated 8/12/2011
22	Normal RB Ventilation Flow Rates	As shown on drawings M-269 and M-529	• M-269 Sht 2 Rev F • M-529 Sht 2 Rev H
23	RB Ventilation Fan Pressures or System Pressure Losses	See Attachment E for RB supply and exhaust Fan data / Fan curve.	• VETIP D1506
24	Time Delay to Trip RB Ventilation Fans and Start Isolation Valve Closure after LOCA	There is no time delay on tripping the RB ventilation supply and exhaust fans and closing the isolation valves (dampers) upon receiving a secondary containment isolation signals.	• Per drawings 12E-2399A Rev. 3, 12E-2399C Rev. Y, there is no delay timer/relays shown on the drawings

25	Are Backdraft Dampers Installed on Discharge of RB Ventilation Fans	The supply fan isolation valves 2/3-5741-A, 2/3-5741-B and exhaust fan isolation valves 2/3-5742-A, 2/3-5742-B will automatically close when the fans are tripped (See item 24 response). There are also backdraft dampers on both the supply fan (AO 2/3-5772-15A/B/C) and exhaust fan (AO 2/3-5772-16A/B/C) that will also close upon fan trip.	• Drawings M-269 Sht 1 Rev. K, M-529 Sht 1 Rev. N.
26	RB Hatches Open/Closed Between Levels	The equipment hatch (on both Units) is normally open from the ground floor (Elev. 571') all the way up to the refuel floor. Both Unit 2 &3 hatch opening on the refuel floor will be covered up with tarps during refueling outage time for contamination control.	• Drawing M-4 Rev. AJ. • Proc. DMP 5700-05
27	RB Doors Open Between Units	The Roll-up fire door #57 (2/3-4100-57) between Unit 2 and Unit RB is normally open. The door will auto close upon a fire alarm actuation on either unit.	• Drawings B-333 Rev. BP, B-412 Rev. H
28	SFP Temperature for Test Case	See Attachment D for SBGT test data and fuel pool temperature.	

Attachment A not use. Leave Blank

Post LOCA Suppression Pool Temperature

Time (sec)	Pool Temperature (°F)
0	98
106.	148.9
203	156.1
406	163.8
600	167.5
2954	182.8
10,083	196.9
20,027	201.1
30,020	200.4

Valve Test Acceptance Criteria Sheet

Procedure DOS 7500-02

Page 1 of 1

Valve EPN	Stroke Direction	Reference Value	Acceptable Range	Alert Range	Required Action Range	Measured Value
2/3-7504A MO	Open	50.9	43.3 to 58.5	Hi: >58.5 to 63.6 Low: <43.3	Hi: > 63.6 N/A	
2/3-7504A MO	Closed	51.1	43.5 to 58.7	Hi: >58.7 to 63.8 Low: <43.5	Hi: > 63.8 N/A	
2/3-7505-A MO	Open	52.5	44.7 to 60.3	Hi: >60.3 to 65.6 Low: <44.7	Hi: > 65.6 N/A	
2/3-7505-A MO	Closed	53	45.1 to 60.9	Hi: >60.9 to 66.2 Low: <45.1	Hi: > 66.2 N/A	
2/3-7507-A MO	Open	9.7	7.3 to 12.1	Hi: >12.1 to 14.5 Low: <7.3	Hi: > 14.5 N/A	
2/3-7507-A MO	Closed	10.1	8.6 to 11.6	Hi: >11.6 to 12.6 Low: <8.6	Hi: > 12.6 N/A	
2/3-7504B MO	Open	49.3	42 to 56.6	Hi: >56.6 to 61.6 Low: <42	Hi: > 61.6 N/A	
2/3-7504B MO	Closed	49.8	42.4 to 57.2	Hi: >57.2 to 62.2 Low: <42.4	Hi: > 62.2 N/A	
2/3-7505-B MO	Open	53.6	45.6 to 61.6	Hi: >61.6 to 67 Low: <45.6	Hi: > 67. N/A	
2/3-7505-B MO	Closed	54.5	46.4 to 62.6	Hi: >62.6 to 68.1 Low: <46.4	Hi: > 68.1 N/A	
2/3-7507-B MO	Open	9.8	7.4 to 12.2	Hi: >12.2 to 14.7 Low: <7.4	Hi: > 14.7 N/A	
2/3-7507-B MO	Closed	9.7	7.3 to 12.1	Hi: >12.1 to 14.5 Low: <7.3	Hi: > 14.5 N/A	

Prepared by: D. Oakly 8/14/11
IST Program Engineer Date

Reviewed by: 8/14/11
Engineering Programs Manager Date

From: Franzen, Bruce D:(GenCo-Nuc)
To: Lee, Daniel K:(GenCo-Nuc)
Subject: Re: RX Bldg D/P data during RBV Auto Isolations - SBGT Starts during DIS 7500-01
Date: Thursday, December 13, 2018 7:53:40 AM

Yes I see your question. Should be -.81.

Get Outlook for iOS

From: Franzen, Bruce D:(GenCo-Nuc) <bruce.franzen@exeloncorp.com>
Sent: Thursday, December 13, 2018 7:52 AM
To: Lee, Daniel K:(GenCo-Nuc)
Subject: Re: RX Bldg D/P data during RBV Auto Isolations - SBGT Starts during DIS 7500-01

It looks like both tests show it going negative approx 9 seconds after the trip. My guess is the timing between fan trips and damper closing.

Get Outlook for iOS

From: Lee, Daniel K:(GenCo-Nuc) <danielk.lee@exeloncorp.com>
Sent: Thursday, December 13, 2018 7:32 AM
To: Franzen, Bruce D:(GenCo-Nuc); Simpson, Patrick R.:(GenCo-Nuc)
Subject: RE: RX Bldg D/P data during RBV Auto Isolations - SBGT Starts during DIS 7500-01

Bruce,

Thanks for getting the test data. For the 2nd test, it shows the “D/P trended negative and peaked at -.081” nine seconds after the RBV trip – 2/3B SBGT Auto Start”, should it be -0.81” ?

Dan Lee

From: Franzen, Bruce D:(GenCo-Nuc)
Sent: Thursday, December 13, 2018 6:46 AM
To: Lee, Daniel K:(GenCo-Nuc) <danielk.lee@exeloncorp.com>; Simpson, Patrick R.:(GenCo-Nuc) <patrick.simpson@exeloncorp.com>
Subject: Fwd: RX Bldg D/P data during RBV Auto Isolations - SBGT Starts during DIS 7500-01

Fyi
Get Outlook for iOS

From: Gallagher, Richard P:(GenCo-Nuc) <rick.gallagher@exeloncorp.com>
Sent: Thursday, December 13, 2018 4:43 AM
To: Franzen, Bruce D:(GenCo-Nuc)
Cc: Netemeyer, Katharine A:(GenCo-Nuc); Passmore, Adam:(GenCo-Nuc); Griffith, Thomas James:

(GenCo-Nuc); Ciko, Michael A.:(GenCo-Nuc); Haarhoff, Patrick B:(GenCo-Nuc)
Subject: RX Bldg D/P data during RBV Auto Isolations - SBGT Starts during DIS 7500-01

Bruce,

Here is the data I got for the 2 RBV auto isolations and SBGT starts:

Observed the following RB D/P trends during DIS 7500-01
U2 and U3 Rx Bldg Vent trip with 2/3A SBGT Auto Start
Initial D/P before transient: -0.62”
D/P trended negative and peaked at -.81” ten seconds after the RBV trip – 2/3A SBGT Auto Start
60 sec: -0.37” trending positive
120 sec: -0.30” trending positive
163 sec: -0.28” peak
180 sec: -.030” trending negative
240 sec: -0.33” tending negative
300 sec: -0.41” stable
U2 and U3 Rx Bldg Vent trip with 2/3B SBGT Auto Start
Initial D/P before transient: -0.65”
D/P trended negative and peaked at -.081” nine seconds after the RBV trip – 2/3B SBGT Auto Start
60 sec: -0.37” trending positive
120 sec: -0.30” trending positive
163 sec: -0.28” peak
180 sec: -.029” trending negative
240 sec: -0.31” tending negative
300 sec: -0.35” trending negative
360 sec: -0.37” trending negative
420 sec: -0.37” trending positive very slowly
600 sec -0.38” stable

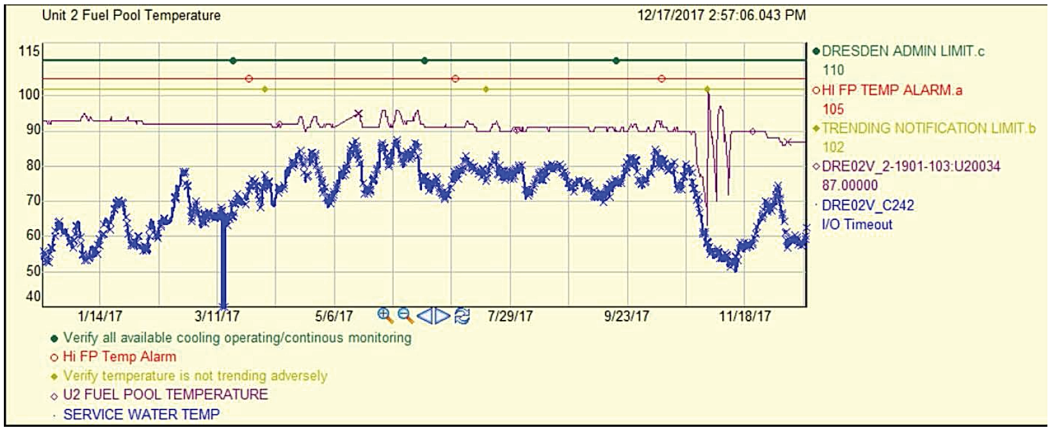
If you want more data, shift 2 has 2 more DIS 7500-01 auto isolations on days.

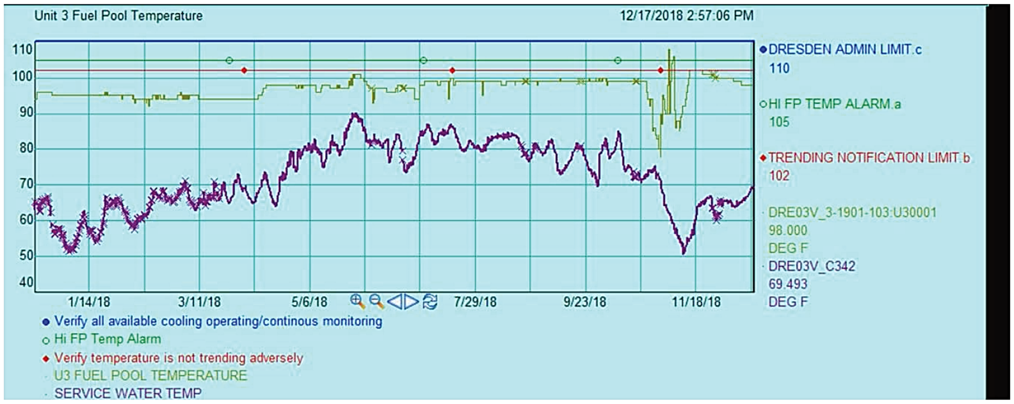
-Rick Gallagher

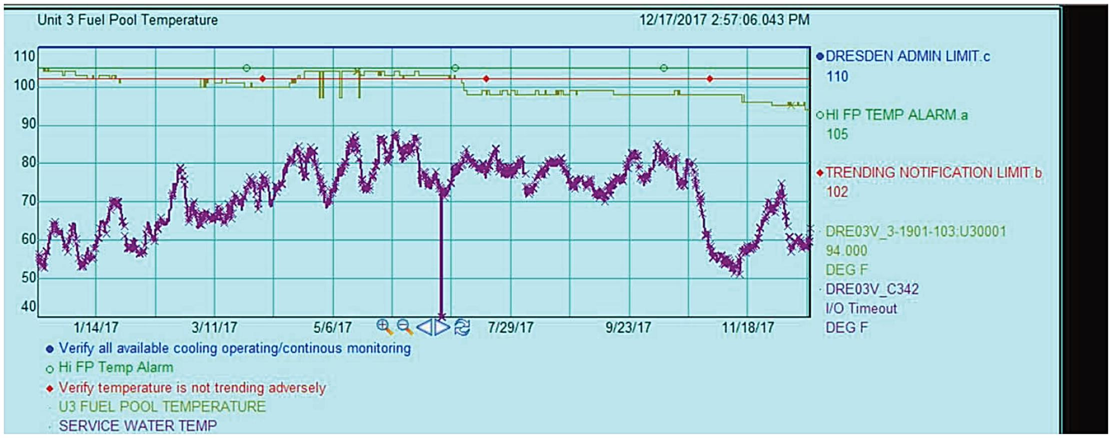
From: Campbell, Michael:(GenCo-Nuc)
To: Hawman, Jason Owen:(GenCo-Nuc); ZHOU, CHONG:(GenCo-Nuc); Lee, Daniel K:(GenCo-Nuc); Gardner, Shane R:(GenCo-Nuc)
Subject: RE: FYI - possible change to get drawdown data at Dresden today
Date: Monday, December 17, 2018 3:02:25 PM
Attachments: image009.png
image010.png
image011.png
image012.png

Here is some data include fuel offload – alarm at 105F
Summer
both pools at 100F

Outage
one pool at 90F and other potentially is 105F







From: Hawman, Jason Owen:(GenCo-Nuc)
Sent: Monday, December 17, 2018 2:56 PM
To: Campbell, Michael:(GenCo-Nuc) <Michael.Campbell3@exeloncorp.com>; ZHOU, CHONG:(GenCo-Nuc) <CHONG.ZHOU@exeloncorp.com>; Lee, Daniel K:(GenCo-Nuc) <danielk.lee@exeloncorp.com>; Gardner, Shane R:(GenCo-Nuc) <shane.gardner@exeloncorp.com>
Subject: RE: FYI - possible change to get drawdown data at Dresden today

Do you have access to the System Engineer Notebook for SFP? He has spreadsheets and tracking of actual temperatures.

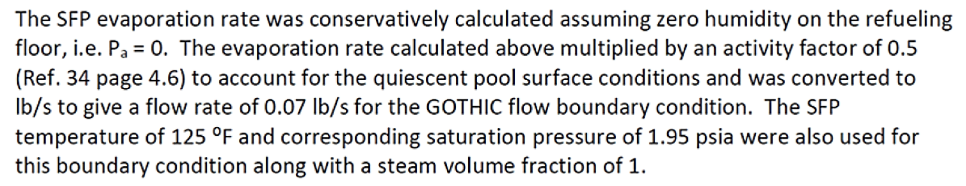
Jason Hawman
Mechanical Design Engineer
Quad Cities Nuclear Generating Station
22710 206th Avenue North
Cordova, IL 61242-9740
(309)227-3943

From: Campbell, Michael:(GenCo-Nuc)
Sent: Monday, December 17, 2018 2:54 PM
To: ZHOU, CHONG:(GenCo-Nuc) <CHONG.ZHOU@exeloncorp.com>; Hawman, Jason Owen:(GenCo-Nuc) <JasonOwen.Hawman@exeloncorp.com>; Lee, Daniel K:(GenCo-Nuc) <danielk.lee@exeloncorp.com>; Gardner, Shane R:(GenCo-Nuc) <shane.gardner@exeloncorp.com>
Subject: RE: FYI - possible change to get drawdown data at Dresden today

Let me figure out what the actual pool temperatures are.

From: ZHOU, CHONG:(GenCo-Nuc)
Sent: Monday, December 17, 2018 2:50 PM
To: Campbell, Michael:(GenCo-Nuc) <Michael.Campbell3@exeloncorp.com>; Hawman, Jason Owen:(GenCo-Nuc) <JasonOwen.Hawman@exeloncorp.com>; Lee, Daniel K:(GenCo-Nuc) <danielk.lee@exeloncorp.com>; Gardner, Shane R:(GenCo-Nuc) <shane.gardner@exeloncorp.com>
Subject: RE: FYI - possible change to get drawdown data at Dresden today

Basically yes, 940 CFM is for both pools. The equaiton calculated the evaporate rate for each pool (33'x41' surface area), but later applied another 0.5 factor to account for the quiescent pool surface. So to account for both pools, you have to multiply by 2 so the factor is canceled out.


The SFP evaporation rate was conservatively calculated assuming zero humidity on the refueling floor, i.e. $P_a = 0$. The evaporation rate calculated above multiplied by an activity factor of 0.5 (Ref. 34 page 4.6) to account for the quiescent pool surface conditions and was converted to lb/s to give a flow rate of 0.07 lb/s for the GOTHIC flow boundary condition. The SFP temperature of 125 ^{o}F and corresponding saturation pressure of 1.95 psia were also used for this boundary condition along with a steam volume fraction of 1.

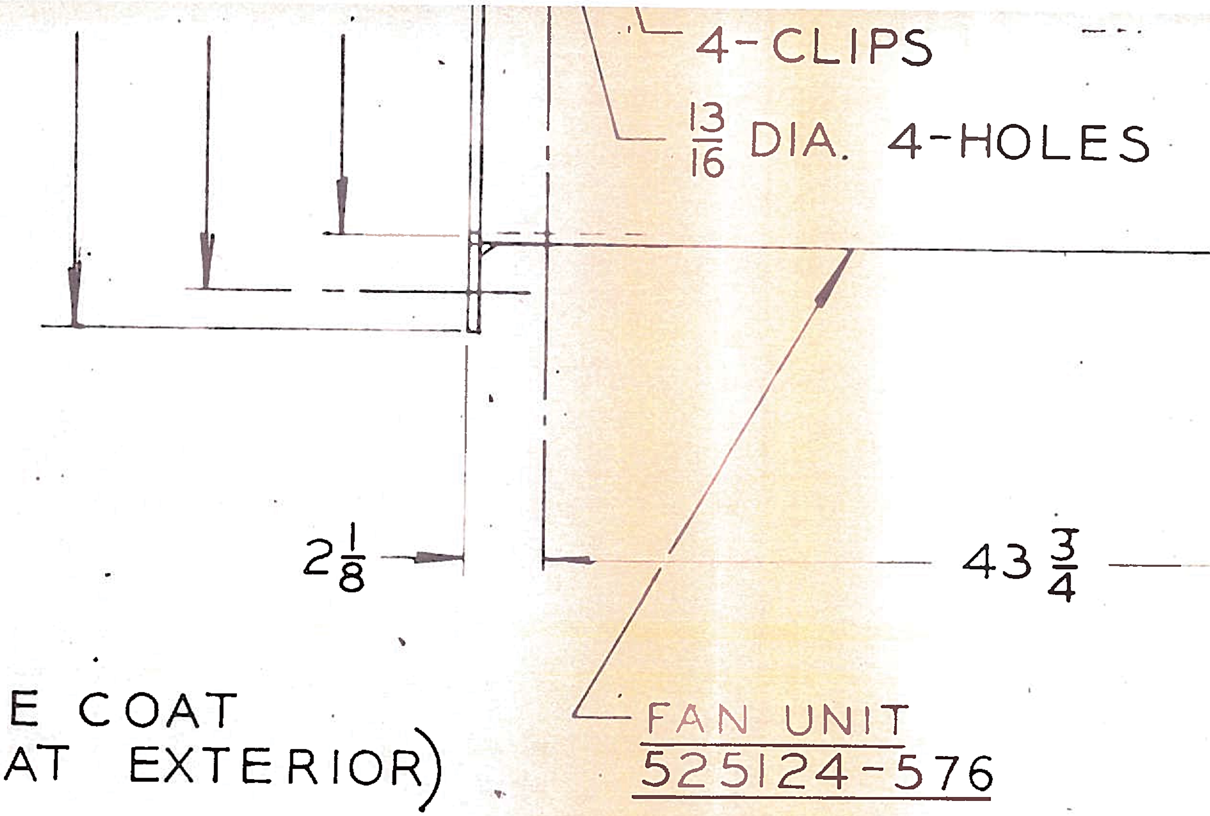
From: Campbell, Michael:(GenCo-Nuc)
Sent: Monday, December 17, 2018 2:45 PM
To: ZHOU, CHONG:(GenCo-Nuc) <CHONG.ZHOU@exeloncorp.com>; Hawman, Jason Owen:(GenCo-Nuc) <JasonOwen.Hawman@exeloncorp.com>; Lee, Daniel K:(GenCo-Nuc) <danielk.lee@exeloncorp.com>; Gardner, Shane R:(GenCo-Nuc) <shane.gardner@exeloncorp.com>
Subject: RE: FYI - possible change to get drawdown data at Dresden today

Is that both pools? That seems high.

I will look for the book.

From: ZHOU, CHONG:(GenCo-Nuc)
Sent: Monday, December 17, 2018 1:44 PM
To: Campbell, Michael:(GenCo-Nuc) <Michael.Campbell3@exeloncorp.com>; Hawman, Jason Owen:(GenCo-Nuc) <JasonOwen.Hawman@exeloncorp.com>; Lee, Daniel K:(GenCo-Nuc) <danielk.lee@exeloncorp.com>; Gardner, Shane R:(GenCo-Nuc) <shane.gardner@exeloncorp.com>
Subject: RE: FYI - possible change to get drawdown data at Dresden today

Following is the equation used by Enercon to calculate the SFP evaporation. It comes from HVAC Applications Handbook, ASHRAE, 1999. Mike, do you have this book?



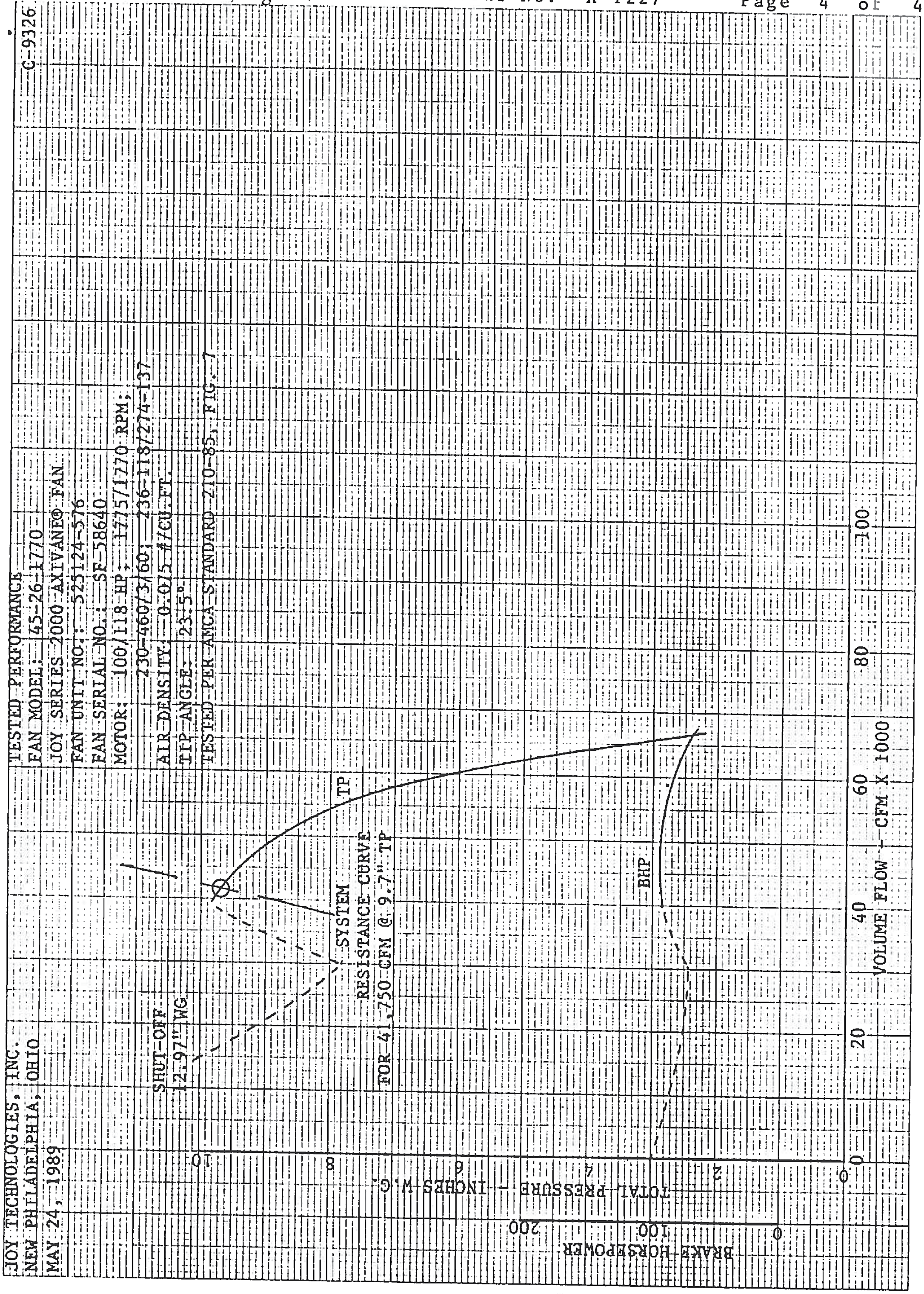
FINISH

1. JOY ORANGE (ONE COAT INTERIOR, ONE COAT EXTERIOR)

FAN DATA	
MODEL. 45-26-1770	SERIES. 2000
SERIAL NO. SF 58640 THRU SF 58646	
CFM 41,750	
STATIC PRESSURE INCHES H_2O	
TOTAL PRESSURE INCHES H_2O	9.7
BLADE SETTING	3 1/2
DENSITY LB/FT^3	.075

MOTOR DATA	
MOTOR PART NO.	600263-08
BHP	
NOMINAL HP	100
FRAME	405 TCZ
ENCLOSURE	T. E. A. O.
TYPE INSULATION	F
MAIN — VOLTS 460 PH 3	

ENG. ORDER NCP 13	REVISIONS	NCP 296


G-9326
TESTED PERFORMANCE
FAN MODEL: 45-26-1770
JOY SERIES 2000 AXIVANE® FAN
FAN UNIT NO.: 525124-576
FAN SERIAL NO.: SF-58640
MOTOR: 100/118 HP; 1775/1770 RPM;
230-460/3/60; 236-118/274-137
AIR DENSITY: 0.075 #/CU.FT.
TIP ANGLE: 23.5°
TESTED PER AMCA STANDARD 210-85, FIG. 7
JOY TECHNOLOGIES, INC.
NEW PHILADELPHIA, OHIO
MAY 24, 1989
SHUT-OFF
12.97" WG
SYSTEM
RESISTANCE CURVE
FOR 41,750 CFM @ 9.7" TP
TP
BHP
0
20
40
60
80
100
VOLUME FLOW - CFM X 1000
10
8
6
4
2
0
TOTAL PRESSURE - INCHES W.G.
200
100
0
BRAKE HORSEPOWER

DRAWDOWN TEST CASE

1. PURPOSE

The purpose of this attachment is to determine the Reactor Building (RB) pressure response following a RB isolation during normal operation at Dresden and the resulting drawdown time for test conditions.

2. INPUTS

The inputs used in this attachment are the same as those from Section 2 in the body of the calculation except input 6 is not used since no failure of the primary SGT system is assumed for the test case.

3. ASSUMPTIONS

The following are the assumptions from the body of the calculation which are modified for the test case to minimize the drawdown time calculated for test conditions during normal operation:

1. The outside air temperature, initial RB temperature and wind speed are equal to the conditions for LOCA Case 1, i.e. 93 ^{o}F outside air temperature, 103 ^{o}F initial RB temperature and no wind. The drawdown times for all of the Dresden LOCA cases are within a one minute range, so the outside air conditions used for the test case will have minor effect on the drawdown time.

2. Normal operating heat loads are assumed for both units since both units are assumed to be in normal operation prior to and during the test.

3. No credit is assumed for ECCS pump room cooler heat removal in either unit since the ECCS pumps would not be operating during normal operation, which is consistent with the normal operation heat loads assumed above.

4. The primary SGT fan starts immediately after RB ventilation system isolation occurs with no time delay. There is no time delay to load the primary SGT system onto the DG bus since no LOOP is assumed for the test case and there is no time delay to start the standby SGT system since no failure of the primary SGT system is assumed for the test case. The SGT fan in Unit 2 is assumed to be operating for the test case but the results are also applicable to the SGT fan in Unit 3 due to the similarities between the two units.

5. Credit is assumed for secondary containment out-leakage during periods of positive RB pressurization since this will reduce the RB pressurization and result in a shorter drawdown time.

6. Heat transfer from external Reactor Building walls to adjacent areas and to the external environment will be credited since this will reduce the drawdown time. The temperature adjacent areas will be assumed equal to the outside air temperature.

7. The effect of solar heat gain on the RB roof is neglected since this may not be present during test conditions.

8. Constant SP and DW temperatures of 98 ^{o}F and 150 ^{o}F, respectively, are assumed for both units. These SP and DW temperatures are consistent with the 103 ^{o}F, initial RB temperature assumed above.

9. Evaporation from the SFP for the test case will be calculated based on an assumed SFP temperature of 100 ^{o}F (Ref. 43) and a RB relative humidity (RH) of 50%. The SFP temperature during normal operation would typically be lower than the 125 ^{o}F assumed for LOCA conditions and the RB relative humidity greater than the 0% RH used to calculate the LOCA evaporation rate, resulting in a lower SFP evaporation rate and shorter drawdown time.

4. REFERENCES

The references are the same as those used in the body of the calculation.

5. METHOD OF ANALYSIS

The Case 1 GOTHIC model for LOCA conditions was modified for the assumptions from Section 3 of this attachment for the assumed test conditions during normal operation. The following sections describe the changes made for the test case model and the changes made to the GOTHIC model are shown in Appendix F1.

RB Flow Paths

The forward loss coefficients of the RB leakage flow paths (FP# 57, 58, 63, and 64) are set equal to the assumed loss coefficient of 2.85 used for the reverse loss coefficient to allow out-leakage during periods of positive RB pressurization. (Assumption 5)

RB Thermal Conductors

Conductor surface options 4 and 13 were modified to use a specified temperature equal to the Case 1 outside air temperature of 93 ^{o}F instead of a specified heat flow of zero, i.e. an insulated boundary condition, to allow heat transfer from the Reactor Building to adjacent areas and to the external environment. (Assumption 6) Conductor surface options 7, 8 and 15 were modified to use constant temperatures of 98, 150, and 93 ^{o}F, respectively. (Assumptions 7 and 8) The surface area of conductor 40 for the torus in the Unit 3 basement was also set equal to the surface area of conductor 36 for the torus in the Unit 2 basement. A small value was used for the surface area of conductor 40 in the Case 1 LOCA model to conservatively prevent heat transfer to the cooler torus in non-LOCA Unit 3.

RB Heat Loads

The heat rate for GOTHIC heaters H1 through H5 were modified to use the corresponding Unit 3 heat loads from Table 4 of Attachment C since these represent the normal operating heat loads. (Assumption 2)

RB Coolers

The heat removal rate for GOTHIC cooler 12C was set equal to zero to prevent heat removal by the ECCS pump room coolers. (Assumption 3)

SGT

GOTHIC forcing function 1T was modified so that the SGT flow increases from zero immediately after RB isolation at 1000 seconds to 3975 cfm at 67 seconds after isolation. (Assumption 4)

SFP Evaporation

Evaporation from the SFP for the test case will be calculated based on an assumed SFP temperature of 100 ^{o}F and a RB relative humidity (RH) of 50%. (Assumption 9) At these conditions, the SFP evaporation rate at the initial RB temperature of 103 ^{o}F is:

$$W_{SFP} = \frac{A}{h_{fg}}(P_w - P_a)(95 + 0.425V) = \frac{1353}{1036.67}(1.935 - 0.5 * 2.12)(95 + 0.425 * 0)$$
$$= 108.5\ lb/hr$$

Where:

W_{SFP} = SFP evaporation rate, lb/hr
A = SFP surface area = 33’ x 41’= 1353 ft^2 (Ref. 2 pg. I-5, Ref. 35 pg. 3-45)
h_{fg} = latent heat of evaporation at SFP temperature
= 1036.67 BTU/lb at 100 ^{o}F (Table 3 Ref. 38 Chapter 6)
P_w = saturation vapor pressure at SFP temperature
= 1.935 inHg at 100 ^{o}F (Table 3 Ref. 38 Chapter 6)
P_a = saturation pressure at room air dew point
= 0.5*2.12 = 1.06 inHg at 103 ^{o}F with 50% RH (Table 3 Ref. 38 Chapter 6)
V = air velocity over water surface = 0 fpm assuming no forced air circulation

Multiplying the evaporation rate calculated above multiplied by an activity factor of 0.5 (Ref. 39 page 4.6) to account for the quiescent pool surface conditions and converting to lb/s gives a flow rate of 0.015 lb/s for the SFP flow boundary conditions. (BC# 7F and 8F) The assumed SFP temperature of 100 ^{o}F and corresponding saturation pressure of 0.95 psia were also used for these boundary conditions and the SFP conductor temperatures in the test case.

6. RESULTS

The GOTHIC results for the test case are shown in Appendix F2. RB isolation occurs at 1000 seconds on each of these plots. Figure F1 below shows the average differential pressures on the refueling floor for the test case. The differential pressure increases rapidly from the initial RB pressure of -0.25 inwg and becomes positive. However, the positive RB pressure increases to less than 0.05 inwg under the assumed test conditions and again becomes negative after about 300 seconds. The RB pressure reaches -0.25 inwg at 682 seconds and continues to decrease, reaching a relatively constant value of -0.56 inwg at 3600 seconds after RB isolation.

7. CONCLUSION

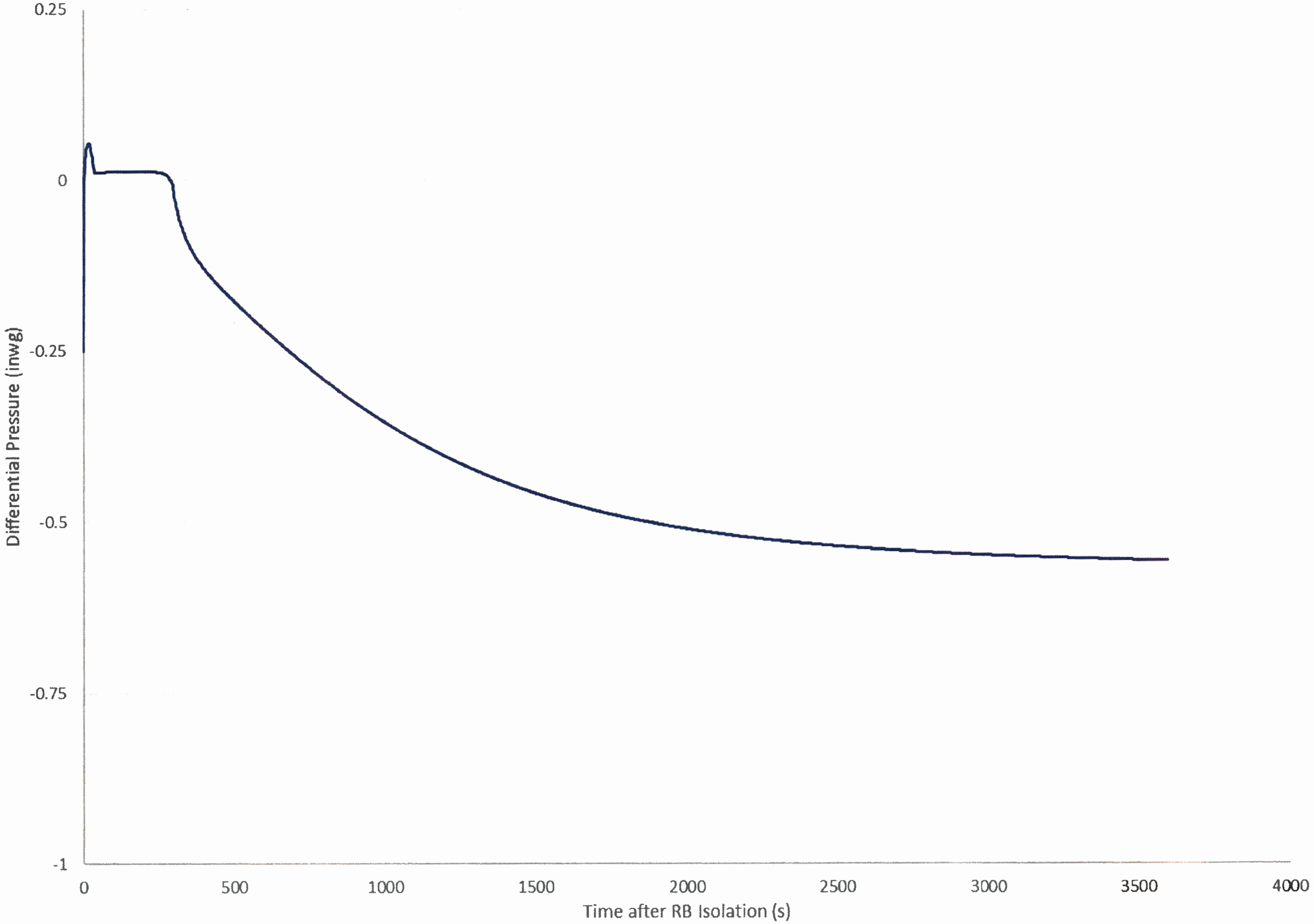
The differential pressure inside the Dresden Reactor Building predicted by the GOTHIC model after RB isolation during normal operation, will be less than -0.25 inwg with respect to the outside air pressure after a drawdown time of 682 seconds (11.4 minutes) under the assumed test conditions and with the assumed RB in-leakage.

8. APPENDICIES

F.1 GOTHIC Input File Changes for Test Case

F.2 GOTHIC Results for Test Case

Figure F1: Refueling Floor Differential Pressure for Test Case



File Comparison: Double entries indicate differences.
/ Current File: C:\Users\jlwright\Documents\Exelon AST\Dresden Drawdown\Gothic\Final\DRE Drawdown Test Case.GTH
\ Compare File: C:\Users\jlwright\Documents\Exelon AST\Dresden Drawdown\Gothic\Final\DRE Drawdown Case1.GTH
Jul/18/2019 11:04:47
GOTHIC Version 8.2(QA) - Oct 2016

Flow Paths - Table 3

Flow Path #	Fwd. Loss Coeff.	FF	Rev. Loss Coeff.	FF	Comp. Opt.	Critical Flow Model	Exit Loss Coeff.	Drop Breakup Model	Homog. Flow Opt.
1	2.85		2.85		OFF	OFF	0.	OFF	OFF
2	2.85		2.85		OFF	OFF	0.	OFF	OFF
3	2.85		2.85		OFF	OFF	0.	OFF	OFF
4	2.85		2.85		OFF	OFF	0.	OFF	OFF
5	2.85		2.85		OFF	OFF	0.	OFF	OFF
6	2.85		2.85		OFF	OFF	0.	OFF	OFF
7	2.85		2.85		OFF	OFF	0.	OFF	OFF
8	2.85		2.85		OFF	OFF	0.	OFF	OFF
9	2.85		2.85		OFF	OFF	0.	OFF	OFF
10	2.85		2.85		OFF	OFF	0.	OFF	OFF
11	2.85		2.85		OFF	OFF	0.	OFF	OFF
12	2.85		2.85		OFF	OFF	0.	OFF	OFF
13	2.85		2.85		OFF	OFF	0.	OFF	OFF
14	2.85		2.85		OFF	OFF	0.	OFF	OFF
15	160.1		1e+60		OFF	OFF	0.	OFF	OFF
16	160.1		1e+60		OFF	OFF	0.	OFF	OFF
17	1e+60		0.38		OFF	OFF	0.	OFF	OFF
18	1e+60		0.38		OFF	OFF	0.	OFF	OFF
19	0.38		1e+60		OFF	OFF	0.	OFF	OFF
20	0.38		1e+60		OFF	OFF	0.	OFF	OFF
21	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
22	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
23	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
24	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
25	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
26	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
27	1e-20		1e-20		OFF	OFF	0.	OFF	OFF
28	1e-20		1e-20		OFF	OFF	0.	OFF	OFF
29	1e-20		1e-20		OFF	OFF	0.	OFF	OFF
30	1e-20		1e-20		OFF	OFF	0.	OFF	OFF
31	345.5		345.5		OFF	OFF	0.	OFF	OFF
32	683.		683.		OFF	OFF	0.	OFF	OFF
33	240.8		240.8		OFF	OFF	0.	OFF	OFF
34	714.8		714.8		OFF	OFF	0.	OFF	OFF
35	2091.6		2091.6		OFF	OFF	0.	OFF	OFF
36	193.3		193.3		OFF	OFF	0.	OFF	OFF
37	345.5		345.5		OFF	OFF	0.	OFF	OFF
38	683.		683.		OFF	OFF	0.	OFF	OFF
39	240.8		240.8		OFF	OFF	0.	OFF	OFF
40	714.8		714.8		OFF	OFF	0.	OFF	OFF
41	2091.6		2091.6		OFF	OFF	0.	OFF	OFF
42	193.3		193.3		OFF	OFF	0.	OFF	OFF
43	343.2		343.2		OFF	OFF	0.	OFF	OFF

Flow Paths - Table 3 (cont.)

Flow Path #	Fwd. Loss Coeff.	FF	Rev. Loss Coeff.	FF	Comp. Opt.	Critical Flow Model	Exit Loss Coeff.	Drop Breakup Model	Homog. Flow Opt.
44	516.		516.		OFF	OFF	0.	OFF	OFF
45	260.8		260.8		OFF	OFF	0.	OFF	OFF
46	678.5		678.5		OFF	OFF	0.	OFF	OFF
47	19201.8		19201.8		OFF	OFF	0.	OFF	OFF
48	141.7		141.7		OFF	OFF	0.	OFF	OFF
49	343.2		343.2		OFF	OFF	0.	OFF	OFF
50	516.		516.		OFF	OFF	0.	OFF	OFF
51	260.8		260.8		OFF	OFF	0.	OFF	OFF
52	678.5		678.5		OFF	OFF	0.	OFF	OFF
53	19201.8		19201.8		OFF	OFF	0.	OFF	OFF
54	141.7		141.7		OFF	OFF	0.	OFF	OFF
55	1e-10		1e-10		OFF	OFF	0.	OFF	OFF
56	1e-10		1e-10		OFF	OFF	0.	OFF	OFF
57	/2.85 \1e+20		2.85		OFF	OFF	0.	OFF	OFF
58	/2.85 \1e+20		2.85		OFF	OFF	0.	OFF	OFF
59	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
60	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
61	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
62	1e-60		1e-60		OFF	OFF	0.	OFF	OFF
63	/2.85 \1e+20		2.85		OFF	OFF	0.	OFF	OFF
64	/2.85 \1e+20		2.85		OFF	OFF	0.	OFF	OFF
65	2.85		2.85		OFF	OFF	0.	OFF	OFF
66	2.85		2.85		OFF	OFF	0.	OFF	OFF
67	2.85		2.85		OFF	OFF	0.	OFF	OFF
68	2.85		2.85		OFF	OFF	0.	OFF	OFF
69	2.85		2.85		OFF	OFF	0.	OFF	OFF

Thermal Conductors

Cond #	Description	Vol A	Srf Opt	Vol B	Srf Opt	Cond Type	S. A. (ft2)	Init. T.(F)	I/X	Grp #
1	U2 Base - 517	1	2	2	3	5	11539.	103.	X	
2	U2 517 - 545	2	2	3	3	2	11641.	103.	X	
3	U2 545 - 570	3	2	4	3	4	9799.	103.	X	
4	U2 570- 589	4	2	5	3	1	8801.	103.	X	
5	U2 589 - Refuel	5	2	11	3	5	10064.	103.	X	
6	U3 Base - 517	6	2	7	3	5	11539.	103.	X	
7	U3 517 - 545	7	2	8	3	2	11642.	103.	X	
8	U3 545 - 570	8	2	9	3	4	9799.	103.	X	
9	U3 570- 589	9	2	10	3	1	8801.	103.	X	
10	U3 589 - Refuel	10	2	11	3	5	10064.	103.	X	

Thermal Conductors (cont.)

Cond #	Description	Vol A	Srf Opt	Vol B	Srf Opt	Cond Type	S. A. (ft2)	Init. T.(F)	I/X	Grp #
11	U2 - U3 Base	1	1	6	1	8	6124.	103.	X	
12	U2 - U3 517	2	1	7	1	6	3000.	103.	X	
13	U2 - U3 545	3	1	8	1	5	2574.	103.	X	
14	U2 - U3 570	4	1	9	1	5	1188.	103.	X	
15	U2 - U3 589	5	1	10	1	7	1917.	103.	X	
16	U2 Base - Adj	1	1	1	4	3	36519.	103.	I	
17	U2 517 - Adj	2	1	2	4	3	9698.	103.	I	
18	U2 545 - Adj	3	1	3	4	3	9217.	103.	I	
19	U2 570 - Adj	4	1	4	4	3	5220.	103.	I	
20	U2 589 - Adj	5	1	5	4	3	8031.	103.	I	
21	U3 Base - Adj	6	1	6	4	3	35021.	103.	I	
22	U3 517 - Adj	7	1	7	4	3	9698.	103.	I	
23	U3 545 - Adj	8	1	8	4	3	9217.	103.	I	
24	U3 570 - Adj	9	1	9	4	3	5220.	103.	I	
25	U3 589 - Adj	10	1	10	4	3	8031.	103.	I	
26	U2 Base - DW	1	1	1	8	9	9068.	103.	I	
27	U2 517 - DW	2	1	2	8	11	4842.	103.	I	
28	U2 545 - DW	3	1	3	8	12	3382.	103.	I	
29	U2 570 - DW	4	1	4	8	11	1657.	103.	I	
30	U2 589 - DW	5	1	5	8	10	1838.	103.	I	
31	U3 Base - DW	6	1	6	11	9	9068.	103.	I	
32	U3 517 - DW	7	1	7	11	11	4842.	103.	I	
33	U3 545 - DW	8	1	8	11	12	3382.	103.	I	
34	U3 570 - DW	9	1	9	11	11	1657.	103.	I	
35	U3 589 - DW	10	1	10	11	10	1838.	103.	I	
36	U2 Base - Torus	1	5	1	7	15	32000.	103.	I	
37	U2 Base - Pipes	1	6	1	7	16	5152.	103.	I	
38	U2 517 - Pipes	2	6	2	7	16	793.	103.	I	
39	U2 545 - Pipes	3	6	3	7	16	445.	103.	I	
40	U3 Base - Torus	6	5	6	10	15	/32000. \1e-06	103.	I	
41	U2 545 - SFP	3	2	3	9	11	2008.	103.	I	
42	U2 570 - SFP	4	1	4	9	11	2942.	103.	I	
43	U2 589 - SFP	5	1	5	9	11	5064.	103.	I	
44	U3 545 - SFP	8	2	8	12	11	2008.	103.	I	
45	U3 570 - SFP	9	1	9	12	11	2942.	103.	I	
46	U3 589 - SFP	10	1	10	12	11	5064.	103.	I	
47	Refuel - U2 DW	11	3	11	8	12	1452.	103.	I	
48	Refuel - U3 DW	11	3	11	11	12	1452.	103.	I	
49	Refuel - TB	11	1	11	13	13	662.	103.	I	
50	Refuel -Outside	11	1	11	14	13	22830.	103.	I	
51	Refuel - Roof	11	2	11	15	14	34000.	103.	I	
52	U2 SFP - Refuel	11	3	11	9	17	1353.	103.	I	
53	U3 SFP - Refuel	11	3	11	12	17	1353.	103.	I	

Forcing Function Tables

FF#	Description	Ind. Var.	Dep. Var.	Points
0	Constant	-	-	0
1T	SGT Flow	Ind. Var.	Dep. Var.	/5 \6
2T	OA Temperature	Ind. Var.	Dep. Var.	4
3T	Cond HTC Coefs	Ind. Var.	Dep. Var.	4
4T	Pump Rm Cooler	Ind. Var.	Dep. Var.	13
5T	RB Valve Positi	Ind. Var.	Dep. Var.	5
6T	LOCA SP Temp	Ind. Var.	Dep. Var.	19
7T	LOCA DW Temp	Ind. Var.	Dep. Var.	4
8T	SFP Evaporation	Ind. Var.	Dep. Var.	4
9T	OA Humidity	Ind. Var.	Dep. Var.	4

Data Files

File #	Name	Type	Inter- polate	Output Files	Detail Level	Format Option
1	/DRE Drawdown Te \DRE Drawdown Ca	TIME	YES	SINGLE	FULL	

Fluid Boundary Conditions - Table 1

BC#	Description	Press. (psia)	FF	Temp. (F)	FF	Flow (lbm/s)	FF	S P	J O	ON Trip	OFF Trip	Elev. (ft)
1P	E Wall Ambient	14.7		1	2T			N	N			517.5
2F	E Wall Ambient	14.7		1	2T	v1e10		N	N			517.5
3P	W Wall Ambient	14.7		1	2T			N	N			517.5
4F	W Wall Ambient	14.7		1	2T	v1e10		N	N			517.5
5P	Exhaust Ambient	14.7		1	2T			N	N			517.5
6F	Exhaust Ambient	14.7		1	2T	v1e10		N	N			517.5
7F	U2 SFP Evap	/0.95 \1.945		/100 \125		/0.015 \0.07	8T	N	N			613.
8F	U3 SFP Evap	/0.95 \1.945		/100 \125		/0.015 \0.07	8T	N	N			613.
9P	S Wall Ambient	14.7		1	2T			N	N			517.5
10F	S Wall Ambient	14.7		1	2T	v1e10		N	N			517.5
11P	N Wall Ambient	14.7		1	2T			N	N			517.5
12F	N Wall Ambient	14.7		1	2T	v1e10		N	N			517.5

Cooler/Heater

Heater Cooler #	Description	Vol. #	On Trip #	Off Trip #	Flow Rate (CFM)	Flow Rate FF	Heat Rate (Btu/s)	Heat Rate FF	Phs Opt	Ctrlr Loc
1H	U2 Basement	1	1				/17.3 \145.		VTI	1
2H	U2 Ground Flr	2	1				/41.2 \42.4		VTI	2
3H	U2 Mezzanine	3	1				/126. \95.4		VTI	3
4H	U2 Main Flr	4	1				/69.6 \59.2		VTI	4
5H	U2 Reactor Fl	5	1				20.8		VTI	5
6H	U3 Basement	6	1				17.3		VTI	6
7H	U3 Ground Flr	7	1				41.2		VTI	7
8H	U3 Mezzanine	8	1				126.		VTI	8
9H	U3 Main Flr	9	1				69.6		VTI	9
10H	U3 Reactor Fl	10	1				20.8		VTI	10
11H	Refueling Flr	11	1				61.5		VTI	11
12C	Pump Rm Coole	1	1				/0. \1.	4T	VTE	1

Conductor Surface Options - Table 1

Surf Opt #	Description	Heat Transfer Option	Nominal Value	FF	Cnd/ Cnv Opt	Cnd Opt	Sp Cnv HTC	Nat Cnv Opt	For Cnv Opt
1	Interior Wall	Direct		3T		DLM-FM		VERT SURF	OFF
2	Int Ceiling	Direct		3T		DLM-FM		FACE DOWN	OFF
3	Int Floor	Direct		3T		DLM-FM		FACE UP	OFF
4	Insulated	/Sp Temp \Sp Heat	/93. \0.						
5	Torus	Direct		3T		DLM-FM		HORZ CYL	OFF
6	Pipes	Direct		3T		DLM-FM		HORZ CYL	OFF
7	LOCA SP Temp	Sp Temp	/98. \1.	/ \6T					
8	LOCA DW Temp	Sp Temp	/150. \1.	/ \7T					
9	LOCA SFP Temp	Sp Temp	/100. \125.						
10	Normal SP Temp	Sp Temp	98.						
11	Normal DW Temp	Sp Temp	150.						
12	Normal SFP Temp	Sp Temp	/100. \125.						
13	Turbine Bldg	/Sp Temp \Sp Heat	/93. \0.						
14	Outside Air	Sp Temp	93.						
15	Roof Sol-Air T	Sp Temp	/93. \127.						

Function
1T
SGT Flow
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	0.	1000.	0.
/1030. \1033.	/3400. \0.	/1067. \1063.	/3975. \3400.
/1e+06 \1100.	3975.	/ \1e+06	/ \3975.

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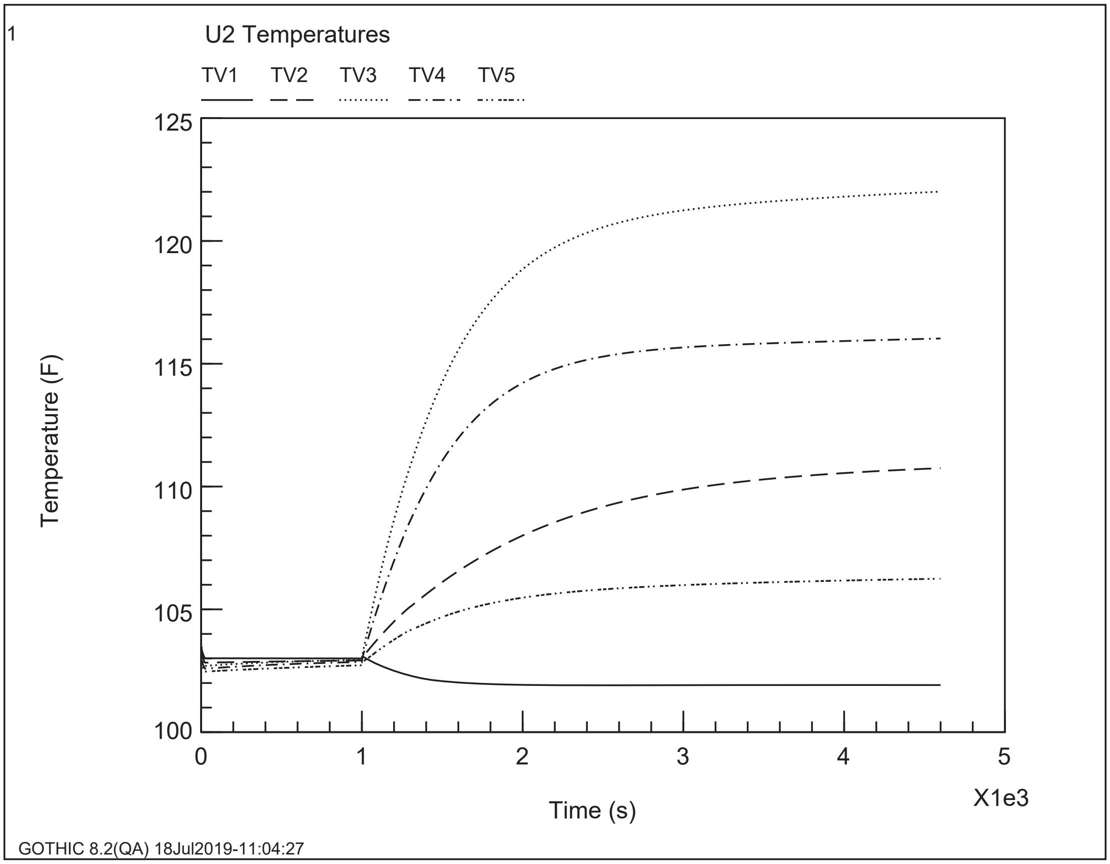

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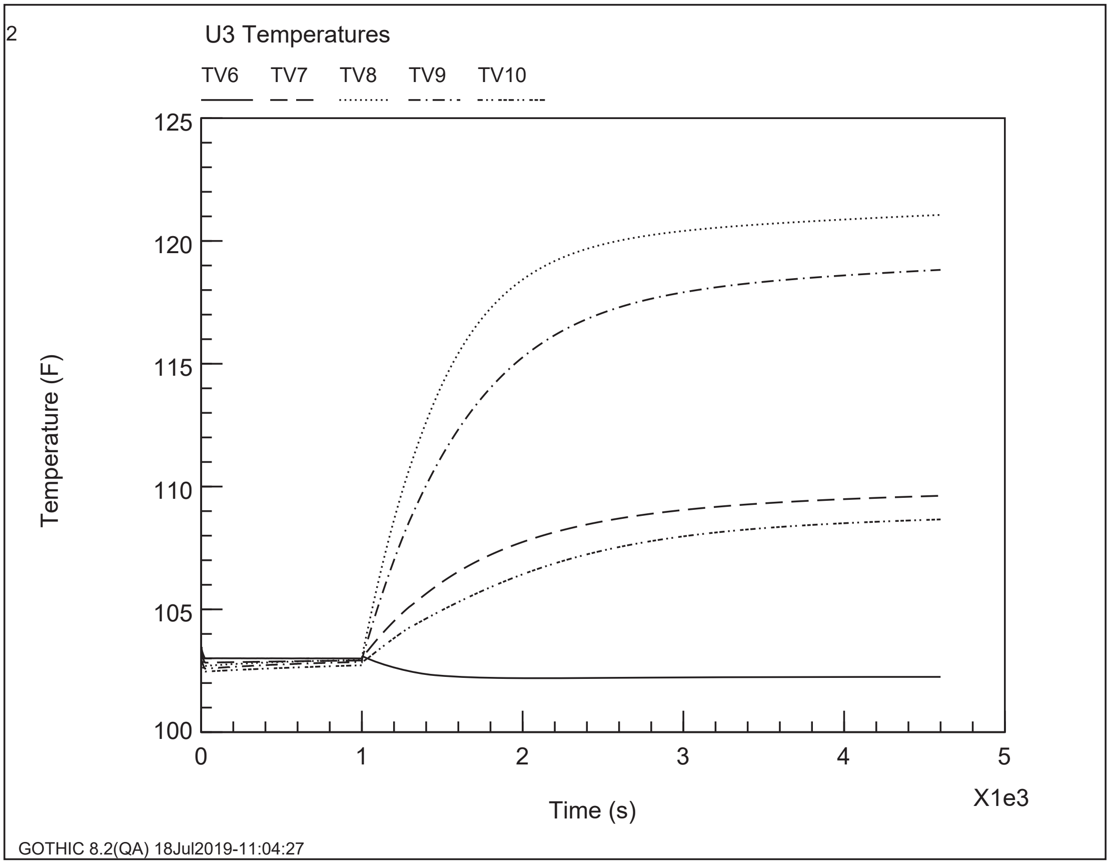

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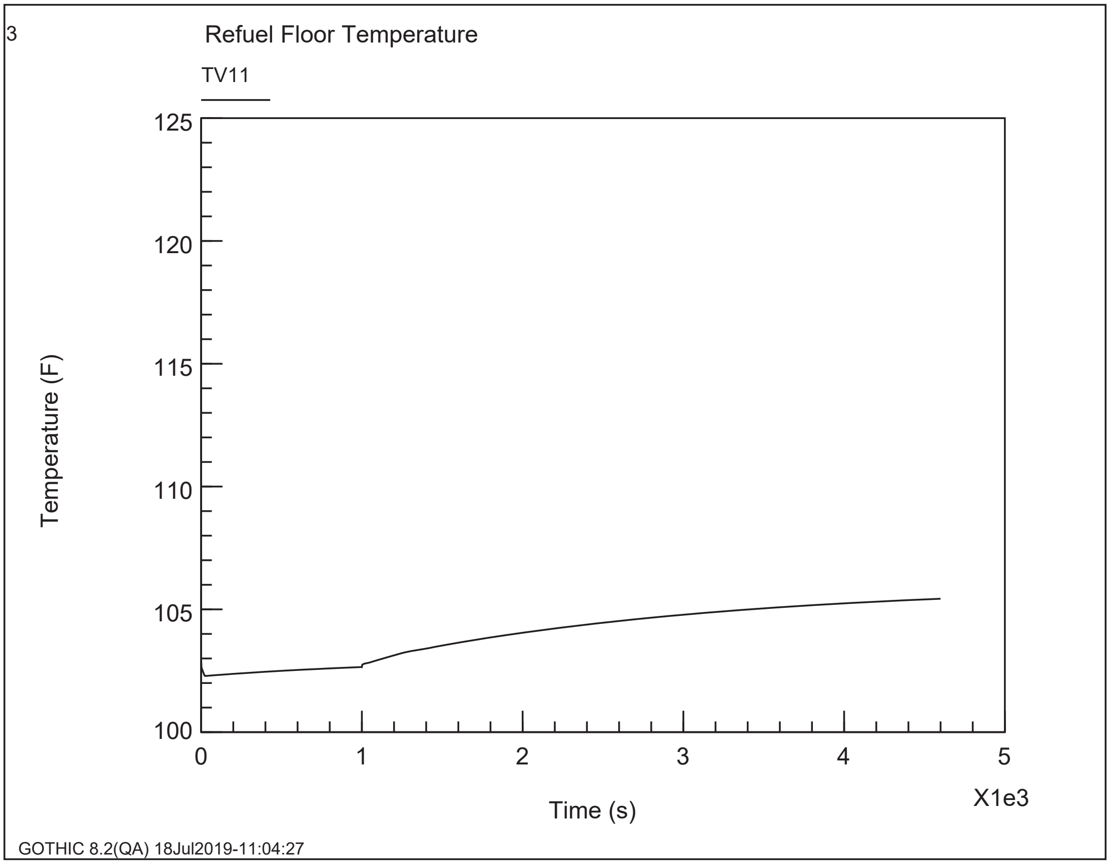

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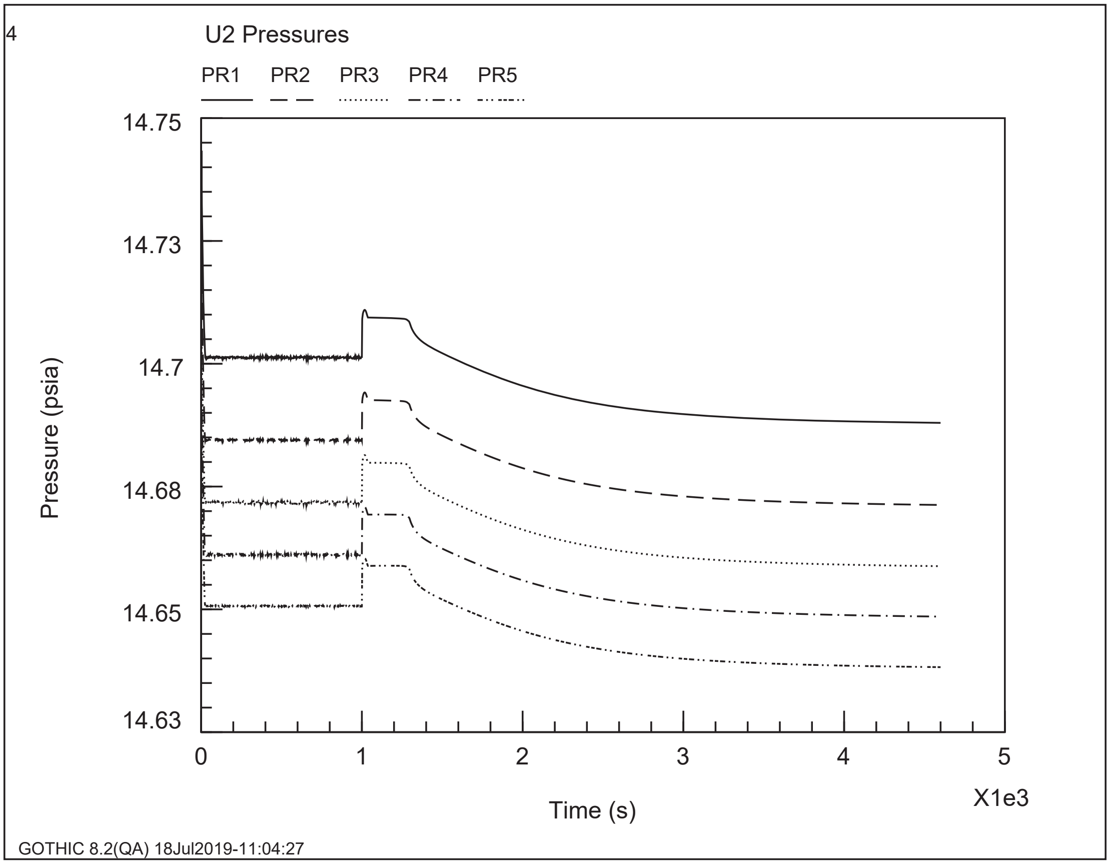

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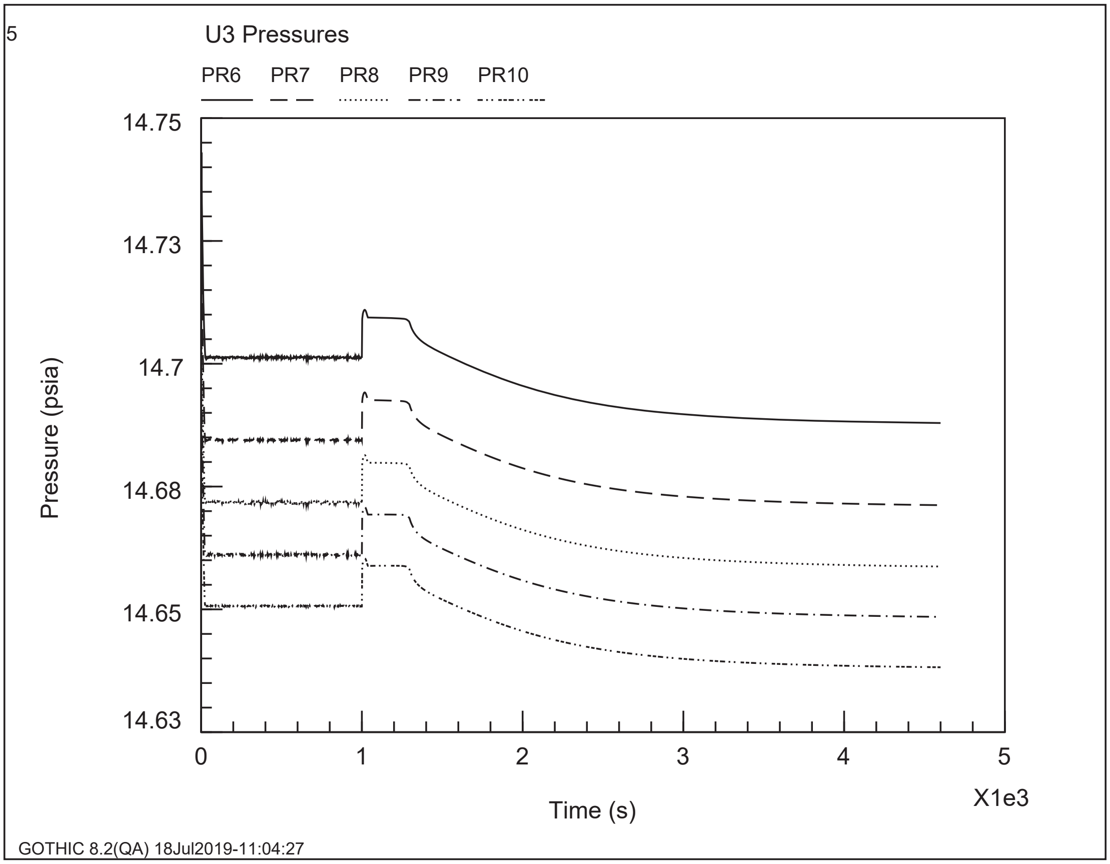

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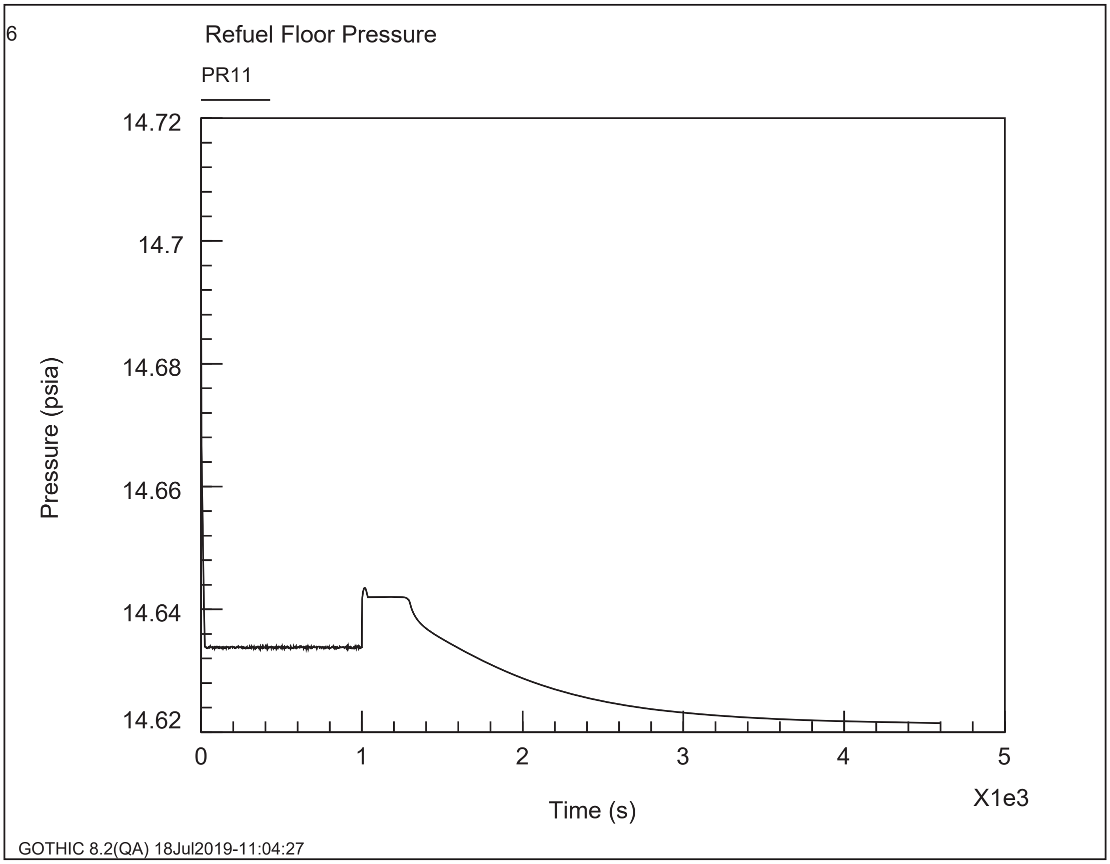

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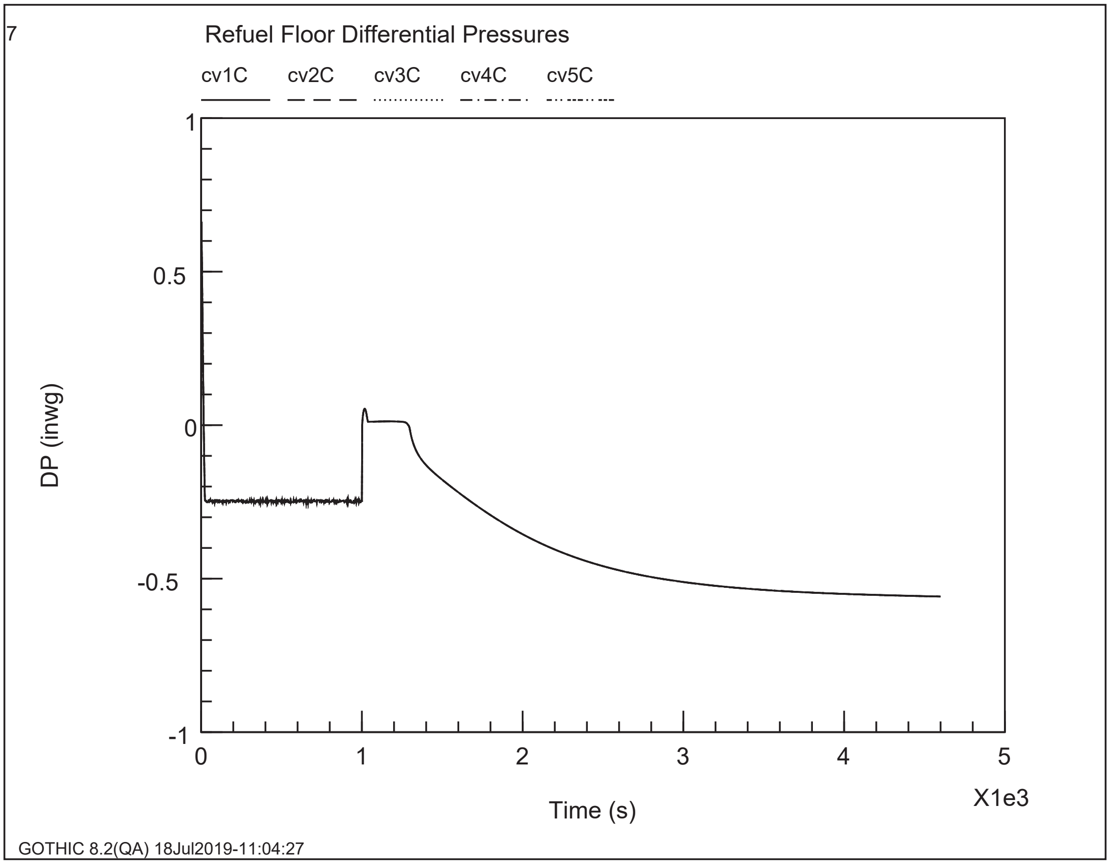

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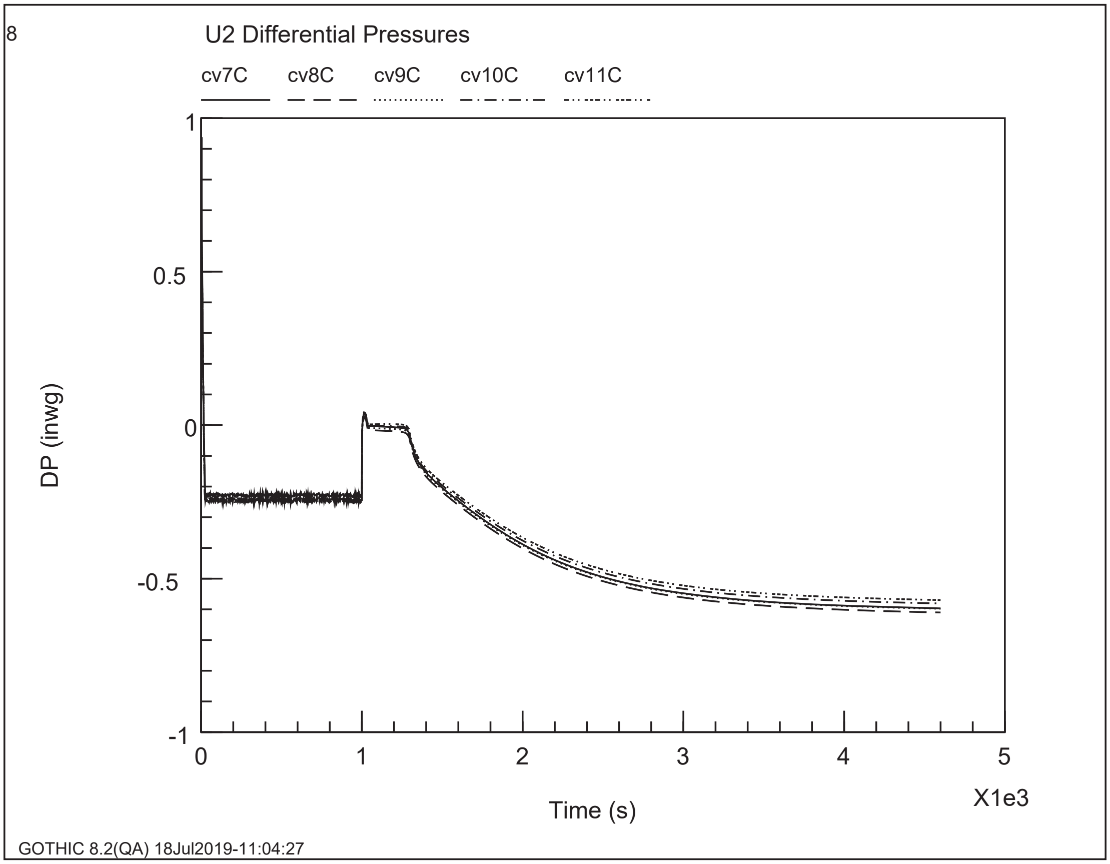

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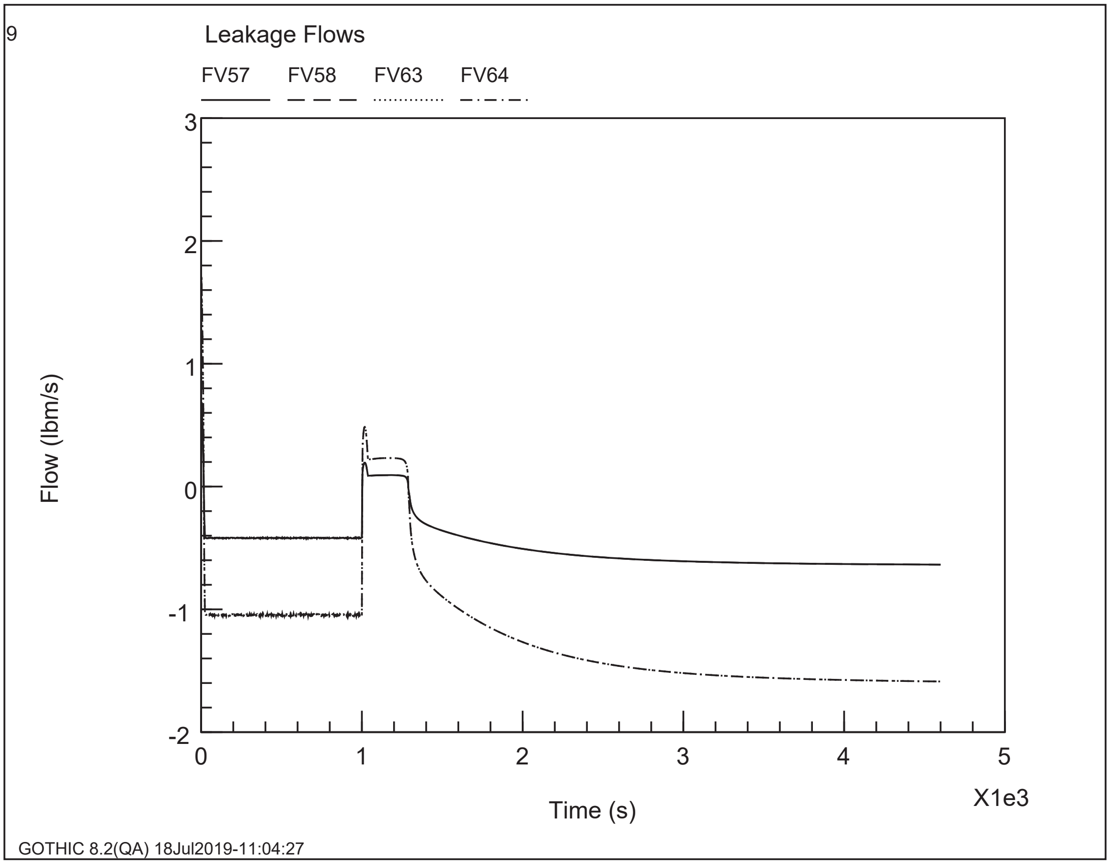

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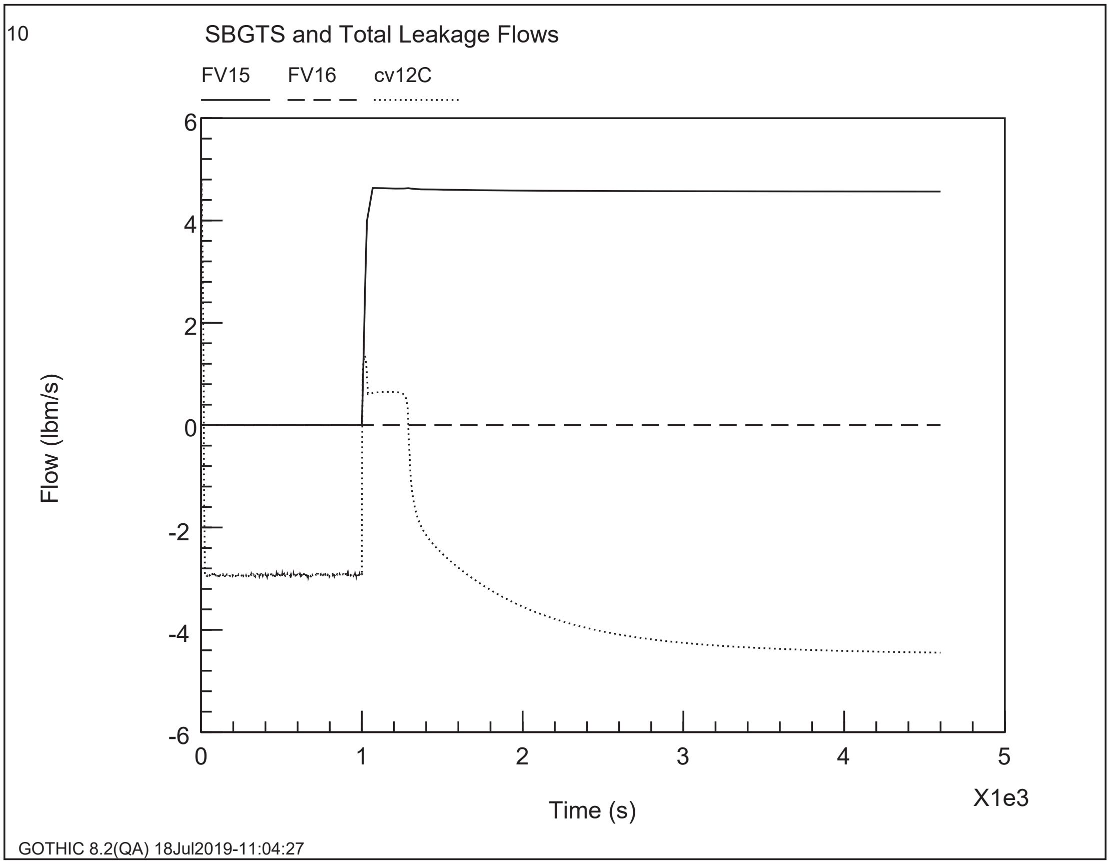

INITIAL REACTOR BUILDING HUMIDITY SENSITIVITY STUDY

1. PURPOSE

The purpose of this attachment is to determine the sensitivity of the Dresden Secondary Containment drawdown time to the initial Reactor Building humidity.

2. INPUTS

The inputs used in this attachment are the same as those from Section 2 in the body of the calculation.

3. ASSUMPTIONS

The only assumption from the body of the calculation modified for this sensitivity case is the use of the maximum humidity of 90% during normal conditions (Ref. 3) for the initial relative humidity in the Reactor Building instead of the minimum humidity of 20% from Assumption 5.

4. REFERENCES

The references are the same as those used in the body of the calculation.

5. METHOD OF ANALYSIS

The GOTHIC models for each of the four cases from the body of the calculation were modified to incorporate an initial RB relative humidity of 90%. The only changes made to the Gothic models are the humidity value used in the initial conditions table and the table used for Function 9T. These changes are show in the tables below. Function 9T specifies the outside air humidity in terms of a ratio, which is then multiplied by the relative humidity of 100% specified for the outside air boundary conditions. (The outside air boundary conditions are used to maintain the initial RB conditions in the GOTHIC model during the first 1000 seconds prior to the LOCA.)

Volume Initial Conditions

Vol #	Total Pressure (psia)	Vapor Temp. (F)	Liquid Temp. (F)	Relative Humidity (%)	Liquid Volume Fract.	Liq. Comp. Set	Vapor Tracer Set	Liquid Tracer Set
def	14.7	103.	103.	/90. \20.	0.	NONE	NONE	NONE

Function 9T
OA Humidity
Ind. Var.:
Dep. Var.:

Ind. Var.	Dep. Var.	Ind. Var.	Dep. Var.
0.	/0.9 \0.2	1000.	/0.9 \0.2
1000.01	0.	1e+06	0.

6. RESULTS

The results for each of the sensitivity cases with a 90% initial RB humidity are shown in the following table along with the results from Table 3 in the body of the calculation for a 20% initial RB humidity. The drawdown times increase for all of the cases with a lower initial relative humidity, although the increase is relatively small for the two winter cases (Cases 3 and 4) and is larger for the two summer cases. (Case 1 and 2) The limiting drawdown time increases from 1268 seconds for Case 4 with a 90% initial RB humidity to 1334 seconds for Case 2 with a 20% initial RB humidity, a difference of 66 seconds.

Table G1: Reactor Building Drawdown Times

Initial RB Humidity	Case 1	Case 2	Case 3	Case 4
	Summer, No Wind	Summer, with Wind	Winter, No Wind	Winter, with Wind
20%	1286	1334	1272	1284
90 %	1130	1168	1258	1268

7. CONCLUSION

The Dresden drawdown times are longer with an initial Reactor Building humidity of 20% than with an initial humidity of 90%. Therefore, the drawdown time is conservatively based on the 20% initial RB relative humidity cases. However, the limiting drawdown time with a 20% initial RB relative humidity is only slightly longer, i.e. about one minute.