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PY-CEI/NRR-2796L

United States Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Perry Nuclear Power Plant
Docket No. 50-440
Response to Second Request for Additional Information Regarding License Amendment Request to Increase Main Steam Line Turbine Building High Temperature Trip Setpoint Allowable Value, TAC No. MC0342

Ladies and Gentlemen:

This letter provides responses to the Nuclear Regulatory Commission Request for Additional Information dated March 31, 2004 pertaining to the Perry Nuclear Power Plant License Amendment Request (LAR) submitted on August 14, 2003 (PY-CEI/NRR-2675L). This LAR increases the Analytical Limit and the resulting Technical Specification Allowable Value related to the setpoint for the Main Steam Line Turbine Building Temperature – High system isolation function. This letter supplements the August 14, 2003 LAR and the January 22, 2004 (PY-CEI/NRR-2754L) FirstEnergy Nuclear Operating Company letter that provided responses to previous NRC questions on the subject LAR.

The enclosed responses are being submitted promptly to allow NRC review and approval before June 1, 2004 as requested in the August 14, 2003 letter.

There are no regulatory commitments contained in this letter or its attachments. If you have questions or require additional information, please contact Mr. Vernon K. Higaki, Manager - Regulatory Affairs, at (440) 280-5294.

Very truly yours,

Attachments:

1. Notarized Affidavit
2. Response to Request for Additional Information

cc: Joseph J. Hagan
NRC Project Manager
NRC Resident Inspector
NRC Region III
State of Ohio

A001

I, William R. Kanda, hereby affirm that (1) I am Vice President – Perry, of the FirstEnergy Nuclear Operating Company, (2) I am duly authorized to execute and file this certification as the duly authorized agent for The Cleveland Electric Illuminating Company, Toledo Edison Company, Ohio Edison Company, and Pennsylvania Power Company, and (3) the statements set forth herein are true and correct to the best of my knowledge, information and belief.

William R. Kanda

Subscribed to and affirmed before me, the 6th day of May, 2004

Brenda Alvord
My commission expires 8-15-06

The following are responses to the March 31, 2004 Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) pertaining to the August 14, 2003 (PY-CEI/NRR-2675L) Perry Nuclear Power Plant (PNPP) License Amendment Request (LAR). The subject LAR increases the Analytical Limit and the resulting Technical Specification Allowable Value related to the setpoint for the Main Steam Line Turbine Building Temperature – High system isolation function. Each specific NRC question and the corresponding PNPP response are provided below. This letter supplements the August 14, 2003 LAR and the January 22, 2004 RAI response letter.

To support the responses to the NRC questions, several sensitivity cases were developed using the inputs of the GOTHIC analysis that was completed to support the subject LAR. These sensitivity studies start with the GOTHIC preprocessor file W-3-33, which was the temperature response of interest for the proposed new leak rate. For the W-3-33 case, the time to reach the proposed Analytical Limit of 155°F is estimated to be 1004 seconds.

Each individual sensitivity case revises only the input in question (unless otherwise noted). The time to reach the temperature of interest is read from the *.got file, which is generated every time the user requests that the GOTHIC graphics processor replace graph data. Time-temperature plots are included for some cases but not for those in which the change in results is too small to make a visually distinguishable difference.

Within this document the words "setpoint," "Analytical Limit" and "temperature of interest" are used interchangeably. Also, within the following discussion of the sensitivity studies, an input to the model is considered conservative if the variation of its value used in the sensitivity case results in a shorter time to reach the temperature of interest than what is seen in the original analysis. Conversely, an input to the model is considered nonconservative if the variation of its value used in the sensitivity case results in a longer time to reach the temperature of interest than what is seen in the original analysis. Those inputs identified as nonconservative should not be considered incorrect or inappropriate for the original analysis that supports the proposed LAR. The label of nonconservative is simply used as a means to categorize the trend of the results when the input is varied. After each individual sensitivity case was run, a final sensitivity case was run that varied all of the inputs that are considered nonconservative to determine the cumulative effect. Those variations in input that would decrease the time to the Analytical Limit were not considered.

NRC REQUEST

1) It is stated that the GOTHIC subdivided volume model is used for cases where buoyancy-induced flow is expected to be the primary means of mass transport or, for this case, when the steam line break is small and there exists the possibility of a localized temperature response (CN 2.4.6.14 Rev 0, page 3 of 51). In the GOTHIC qualification manual two studies are presented which appear to be related to this LAR. One is standard problem 13 which shows thermal stratification for a 3x3 subdivided model, however, the results are not qualified and there is only a single control volume (1,000 ft^3). The other is an HDR study which supports the need for consistent vertical modeling, as used in the LAR model, however, the HDR is not on a scale similar to the turbine building. (a) Is there any data or comparisons to other computer programs (for example those used to evaluate building HVAC and contaminate transport) which can be used to assess or confirm the LAR model? (b) Have there been any "loss of ventilation" events at Perry which could be used to benchmark the model?

RESPONSE

1a) Comparisons to other computer programs are not available; however, the following sensitivity study provides evidence to confirm the adequacy of the model. The GOTHIC model that supports the proposed LAR was originally created with the existing subdivided control volumes to determine the Turbine Building temperature response to a steam line leak of approximately 3 lb_m/s (25 gpm). The minimum steam line break flowrate was subsequently increased to approximately 33 lb_m/s (280 gpm), yet the same subdivided model was used to determine the temperature response. A larger steam flow indicates that the subdivisions may not be required since the possibility of localized temperature increase diminishes as the mass flowrate increases. To test this hypothesis, the subdivisions for Control Volume 7 were removed. Figure 1 indicates the resultant temperature.

The Analytical Limit of 155°F is reached at 587 seconds. Comparing this to the subdivided case, in which it takes 1004 seconds to reach the Analytical Limit, indicates that the subdivisions are conservative since the subdivided case takes longer to reach the temperature of interest.

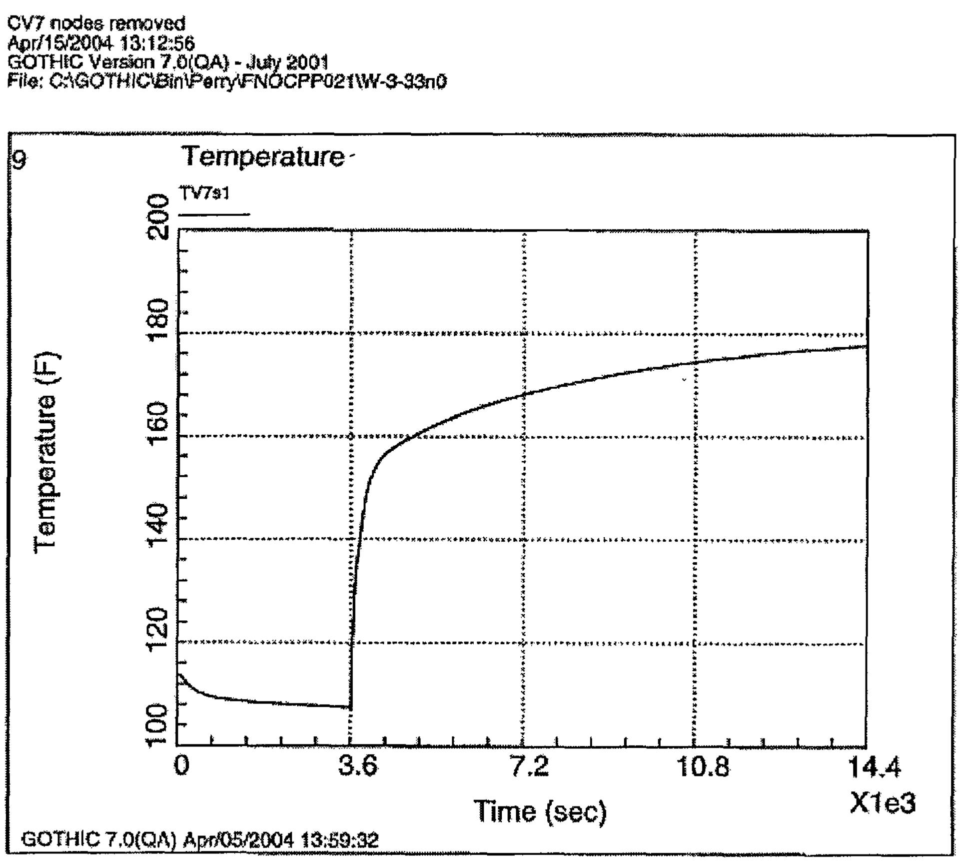

Figure 1

1b) There have been no complete loss of Turbine Building ventilation events at PNPP, which would be useful to benchmark for the GOTHIC model that supports the proposed LAR.

NRC REQUEST

2) A "steady-state" run, for a period of one hour, is performed before the transient starts. During this run the "steady-state" circulation flows are established based on the initial conditions and the modeling (flow paths, heat sinks and sources). During this time period the temperatures in the model decrease, with, for example, the fluid and heat sinks in control volume (CV) 1 reaching about 84.4° F (starting at 110° F). While this could be characterized as a conservative aspect of the model, it would take longer to heat up the cooled down fluid and structures, it would appear that the results may be influenced by the nodalization. (a) Are the conditions at the end of the "steady-state" run the expected conditions at the time of the leak? (Note, for other cases, summer and average, the results are different.) (b) Have nodalization studies, changes in the number of subdivided volumes per control volume and number of control volumes, been performed to support the LAR model? (c) The heat sources and boundary conditions (fixed heat fluxes) should be re-evaluated to provide a better "steady-state," or additional justification for the current model is needed.

RESPONSE

2a,c) The steady state conditions within subvolume V7s15 (the subvolume which contains the temperature sensors) are those expected at the time of the steam leak. Figure 2 indicates several CV7 subvolume temperatures from 1 to 2 hours with no break energy entering the control volume. The temperature at the end of the steady state run for whichever case, i.e., summer, winter or average, is the same as expected at the time of the leak. The design temperature for winter conditions is 113°F and the steady state achieved by the model is about 112.5°F. Due to the subdivisions within the model, it would be virtually impossible to normalize all subvolumes at the same temperature. Therefore, a heat load was inserted which would create the desired temperature within the subvolume of interest: V7s15. Other representative subvolume temperatures are indicated on Figure 2 and, as expected, their temperature does not coincide with that of V7s15. Most importantly, however, the break subvolume (V7s12) initial temperature is 106F, which creates a conservative model since a portion of the steam break energy at the onset of the steam leak is expended on increasing the break subvolume temperature to the theoretical starting temperature rather than increasing the temperature of the sensor subvolume (V7s15). Consequently, the predicted temperature rise in the sensor subvolume is delayed because the total quantity of break energy is not immediately available to produce a temperature increase at the sensors.

2b) Please see the response to 1a.

steady state - no break
Apr/15/2004 13:55:26
GOTHIC Version 7.0(QA) - July 2001
File: C:\GOTHIC\Bin\Perry\FNOCPP021\W-3-33ss

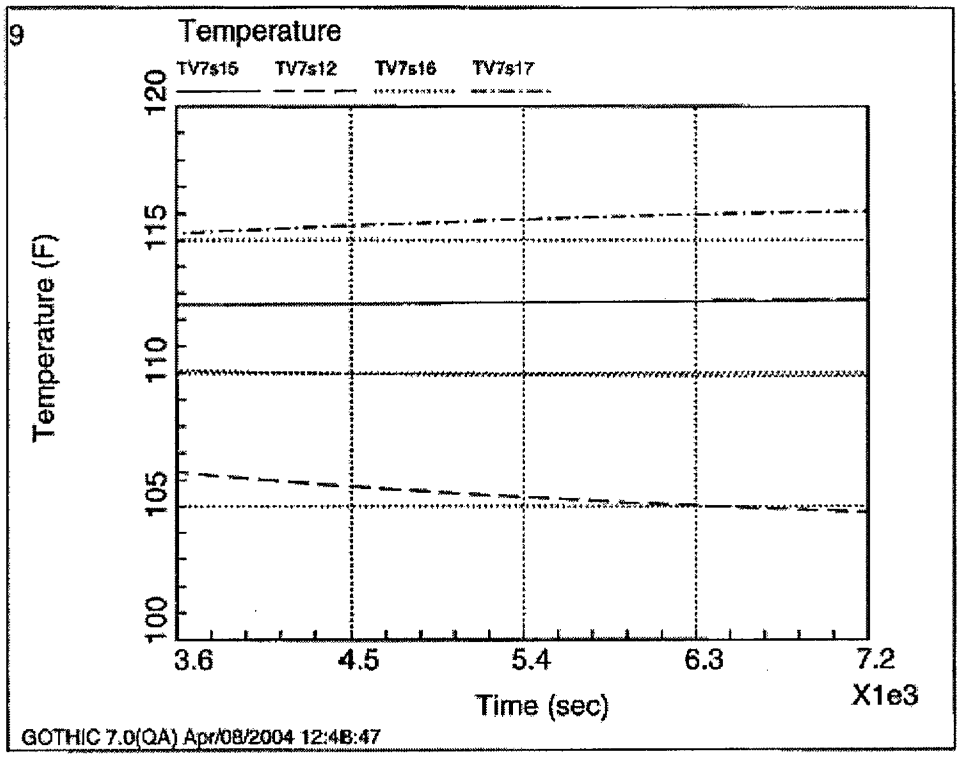

Figure 2

NRC REQUEST

3) The intent of the environmental boundary condition, BC 1P, is to maintain the pressure in the lower elevations in the turbine building at near atmospheric pressure, with the area of flow path (FP) 21 set large enough to allow the air to be driven to the outside atmosphere. It would therefore be expected that the various CVs in the model would remain at, or near, about 14.7 psia. However, during the "steady-state" portion of the transient, the pressure rises to about 15.3 psia. Following the start of the leak the pressure increases to about 15.92 psia, in 14 minutes, and settles down to about 15.8 psia. This could be characterized as non-conservative, it would not take as long to heat up the fluid and structures at the higher pressure. (a) Are the conditions at the end of the "steady-state" run the expected conditions at the time of the leak? (Note, for other cases, summer and average, the results are different.) (b) FP21 should be re-evaluated (area, hydraulic diameter) to provide a means to maintain the pressure near atmospheric or the current model needs additional justification.

RESPONSE

3a,b) Flowpath 21 represents the Turbine Building exhaust paths, which are provided by a series of ventilation fans. This flowpath was assigned a loss coefficient of 2.78, which created an artificial pressure increase in the Turbine Building (Figure 3).

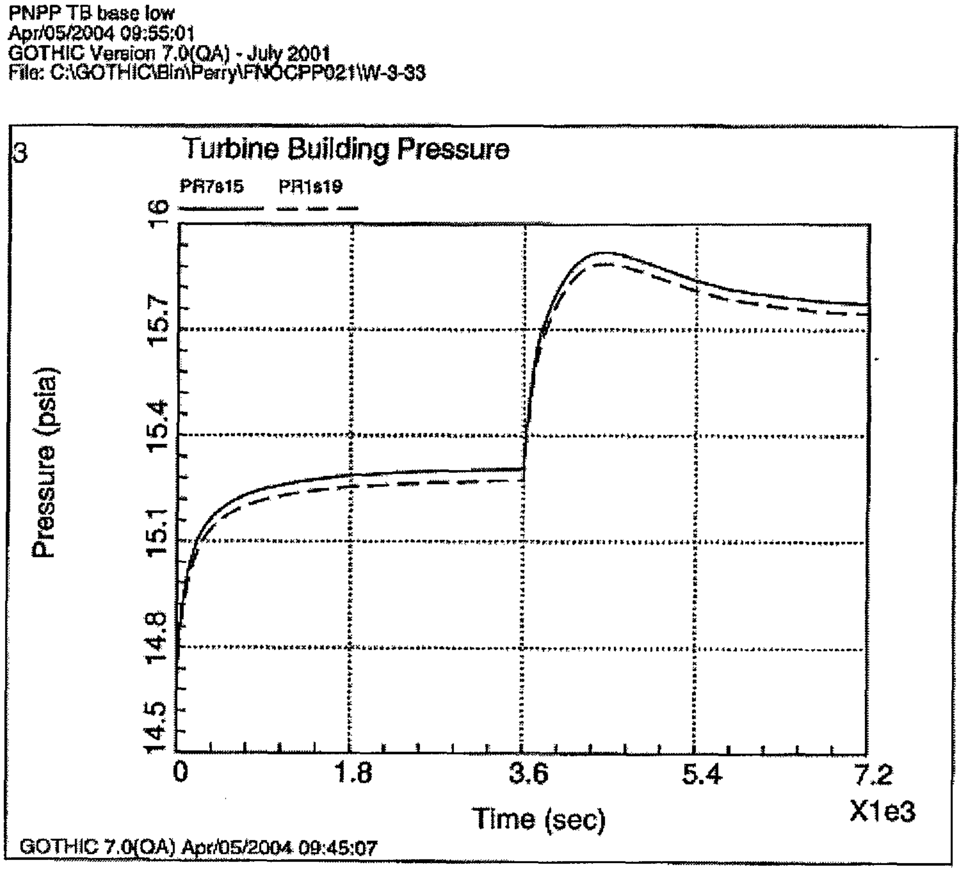

Figure 3

A loss coefficient should not have been assigned to this flowpath because the flow is driven by exhaust fans and there is no net pressure loss across the exhaust ductwork. Removing the loss coefficient creates a steady atmospheric pressure (Figure 4) during the steam blowdown (as is intuitively expected) and increases the time to 155°F from 1004 to 1133 seconds due to the loss of the temperature-increasing pressure effect. The existing model is not conservative in this respect, but the change in the time to the analytical value is relatively small (a little more than 2 minutes). However, the original analysis will be revised to reflect the elimination of a loss coefficient for Flowpath 21. The net effect of eliminating the Flowpath 21 loss coefficient is an increase in the mass release to 37,276 lb_m and the resulting radiological release remains a fraction (26%) of the limiting main steam line break release. Therefore, the radiological consequences of the proposed LAR remain acceptable.

FP21 K=0
Apr/22/2004 09:20:23
GOTHIC Version 7.0(QA) - July 2001
File: C:\GOTHIC\Bin\Perry\FNOCPP021\W-3-33FP21a

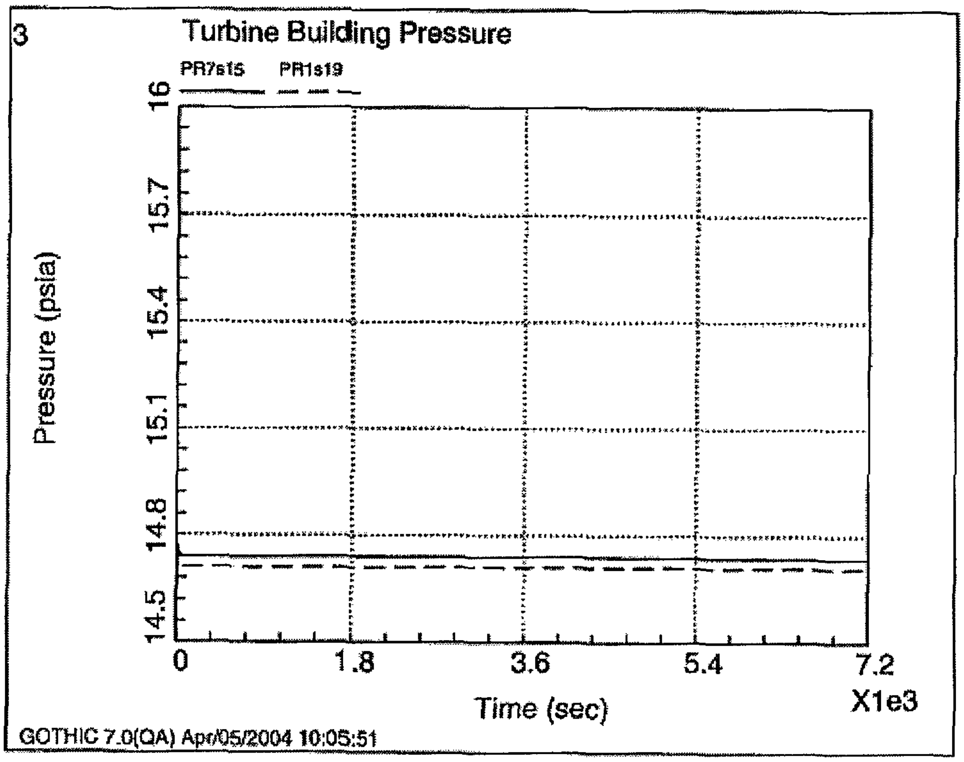

Figure 4

NRC REQUEST

4) Based on guidance in the GOTHIC User Guide (for a sharp-edged orifice in a wall that is much larger than the orifice - as discussed in Section 21.6.3 “Doorways”), a forward and reverse non-recoverable loss coefficient of 2.78 is used in all FPs. It is not clear that FPs with areas on the order of 100 to 900 ft^2 would be covered by this guidance. The effective CV areas are on the order of 1,000 to 8,000 ft^2, before subdividing into smaller interfaces. Consider FP5 with an area of 915 ft^2, connecting CV 7s12 to CV 6s11. The subdivided volume interface area is about 1,200 ft^2 (39 ft by 30.5 ft), with a total side area of 8,050 ft^2 (115 ft by 70 ft). The total FP area between CV7 and CV6 is over 4,300 ft^2. (a) Provide justification for the value used for the loss coefficient, including reference to appropriate data. (b) Have any studies been performed to assess the importance of this assumption? (c) Is the geometry and forced circulation closer to the case where the value should be 1.0?

RESPONSE

4a) The GOTHIC Users Manual modeling guide suggests the use of 2.78 for sharp-edged orifices in a wall that is much larger than the orifice opening. Missing from this suggestion is a guide as to just what exactly "much larger" means. One of the references for this value is Idelchik's "Handbook of Hydraulic Resistance." This reference does not give any guidelines for how much larger the wall should be compared to the orifice, but it does suggest values in the range of 2.78 as appropriate for this application based on wall thickness to hydraulic diameter ratio.

4b,c) The lowest value for a simple opening in a wall is 1.5, which is the combination of an entrance loss of 0.5 and an exit loss of 1.0. Although values closer to 2.78 are appropriate for many of the junctions used in this model, a sensitivity study changing all junction losses to 1.5 increases the time to 155°F from 1004 to 2147 seconds (Figure 5).

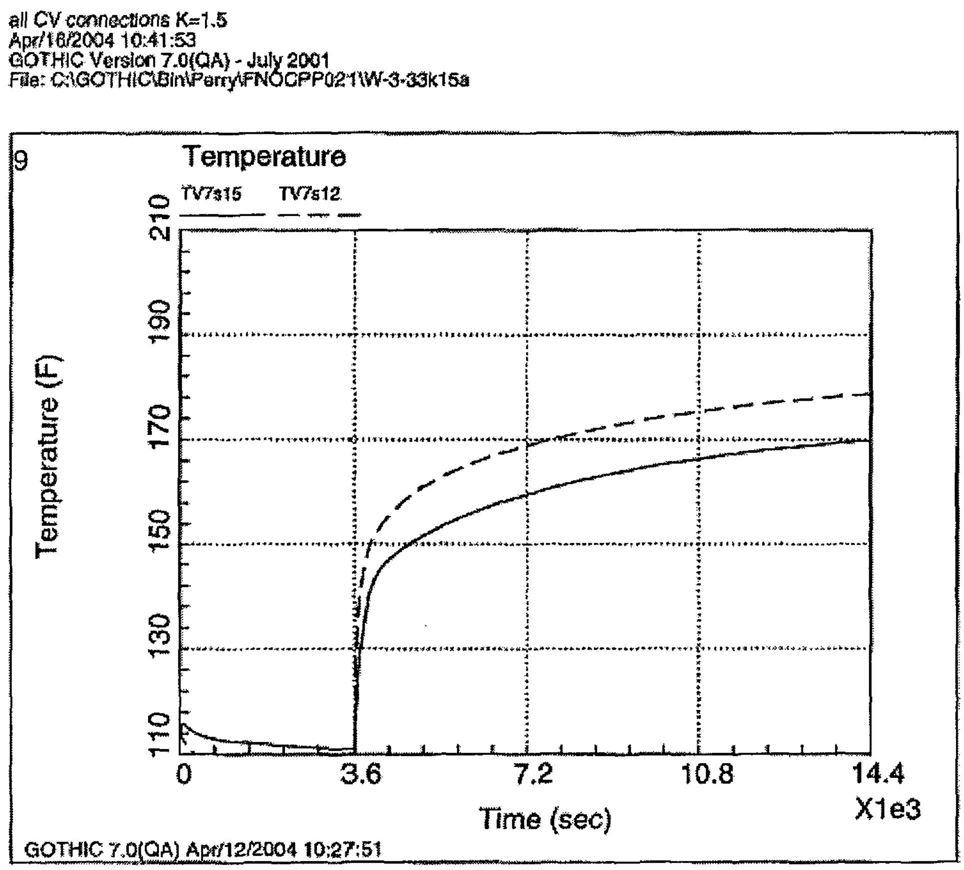

Figure 5

Although this is a significant increase, there are two mitigating factors. The first is that using a loss coefficient of 1.5 for all flowpaths is highly conservative and tends to be unrealistic. Most of the flowpaths will, in actuality, have a loss coefficient somewhere between 1.5 and 2.78, with some at the maximum of 2.78.

The lower resistance values increase the time to the setpoint by allowing more steam flow to the adjacent control volumes, away from the temperature sensor subvolume. The second mitigating factor is that the revised loss coefficients cause the start temperature to decrease by about 1.5°F. Adjusting the setpoint temperature accordingly to 153.5°F yields a total time to setpoint of 1796 seconds.

NRC REQUEST

5) It appears that only CV7 includes modeling of X-direction and Y-direction cell face variations, in addition to the Z-direction (elevation). (a) Why is this appropriate, should the other CVs include these variations? (b) What does GOTHIC assume if the information is not provided, is the (default) "def" value used throughout?

RESPONSE

5a) Cell face variations were added to CV7 during a sensitivity study requested by the calculation design verifier (see Calculation 2.4.6.14, Rev. 0, Attachment E, Page 12). The sensitivity study varied the cell face hydraulic diameter between the default value (which is the control volume hydraulic diameter) and 1,000,000 feet. The study indicated that changes in this value have a negligible effect on the results, thus the values last entered into the input deck were left as-is. In order to confirm these results, two new studies were prepared. The first study set all subvolume face hydraulic diameters to the default value and the second study set this parameter to 1,000,000 feet. The default values yielded a time to setpoint of 982 seconds, while a value of 1,000,000 feet yielded 994 seconds. The 12 second difference indicates that the value used for this input is not critical to the model accuracy.

5b) GOTHIC uses the control volume hydraulic diameter (which must be input by the user) as the default value for the subvolume cell face hydraulic diameters.

NRC REQUEST

6) In developing the flow path modeling, it is assumed that the volume-to-volume flow velocities are relatively small and a constant flow path inertia length (30 ft) is used for all volume-to-volume connections (FP23 used 70 ft) and the flow path friction length is set to a small constant value (1.0 ft). It is further stated that the friction length is only important for thermally or buoyancy driven flows and the LAR case is driven by the forced ventilation system (CN 2.4.6.14 Rev 0, page 7 of 51), that is this length is unimportant. It also appears that the hydraulic diameters are assumed to be constant for large or small areas, and that for FPs 15 to 20 they represent some type of flow restriction. (a) Have any studies been performed to assess the importance of these assumptions? (b) Have the results been assessed to verify these assumptions? (c) Explain the apparent inconsistency between the statements on pages 3 (See (1) above) and 7 of CN 2.4.6.14 Rev 0. (d) Provide the rationale for the selection of the hydraulic diameters and assess their importance.

RESPONSE

6a, b) The values used for the friction length, inertia length, and hydraulic diameters were originally chosen based on the general dimensions within and between Turbine Building control volumes. The sensitivity studies of these inputs indicates that they are not critical to the accuracy of the model. Varying the inertia length of all flowpaths (except the break junction, FP22, and the forced ventilation flowpaths, FP28-FP37) between 1 foot and 100 feet resulted in times to the 155°F setpoint of 1056 and 986 seconds, respectively.

The friction length was set to 1 foot for all flowpaths (except the break junction, FP22) to approximate the thickness of the walls and floors through which they pass. A sensitivity study changing the friction length for these junctions to 3 feet and 10 feet decreases the time to 155°F from 1004 to 963 seconds and 855 seconds, respectively. This is most likely due to the increased restrictions preventing the steam flow from leaving CV7 as easily as before.

6c) The statement on page three: "where buoyancy-induced flow is the primary means of mass transport or, as in this case, a steam line leak is small and there exists the possibility of only localized temperature increases" conflicts with the statement on page seven: "in this case, air movement is driven by forced convection (i.e. the ventilation system)." The first statement (from page three) is an anachronism and should have been revised as the original model was refined by adding the ventilation system and increasing the steam leak flowrate. Therefore, in the current model, air movement is primarily created by forced rather than natural convection, and the statement on page seven is correct.

6d) The hydraulic diameters that are used are loosely based on the actual dimensions of the openings that the flowpaths represent. In the case of Flowpaths 15 through 20, the hydraulic diameter was set to a small number because these are grated floor panels. Two sensitivity studies for this input set the hydraulic diameter of all flowpaths (except the steam break flowpath) to 1 foot and 100 feet. The 1 foot value increases the time to 155°F from 1004 to 1023 seconds. A hydraulic diameter of 100 feet increases the time to 155°F from 1004 to 1014 seconds.

NRC REQUEST

7) Scoping studies (attempting to address the above issues) performed by the staff, using GOTHIC 7.0, indicate that there is a large uncertainty in the time to reach the proposed high temperature trip setpoint, ranging from about 8 minutes to 48 minutes to reach 155° F. The initial and boundary conditions address seasonal changes and are reasonable. How should uncertainties in developing the model (nodalization, flow path characterization and heat sources/sinks) be considered in establishing the setpoint?

RESPONSE

7) The previous six questions reveal some current inputs that may be considered to be nonconservative (though not necessarily incorrect). These nonconservative inputs may be evaluated by creating a file, which incorporates all of the inputs, which were determined to be more conservative. These inputs are (see the related question number for details of changes):

- Flow Path 21 loss coefficient changed from 2.78 to 0 (3b).
- All other Flow Path loss coefficients changed from 2.78 to 1.5 (4b, c).
- All Flow Path inertia lengths set to 1 foot (6a, b).
- All Flow Path hydraulic diameters set to 1 foot (6d).

These cumulative changes to the model create a time to 155°F of 2215 seconds (Figure 6), which is more than twice as long as that of the original. This result is somewhat mitigated by the slightly lower starting temperature of 110.5°F, which is 2.0°F lower than the original start temperature of 112.5°F. Adjusting the setpoint temperature accordingly (153.0°F) yields a total time of 1779 seconds.

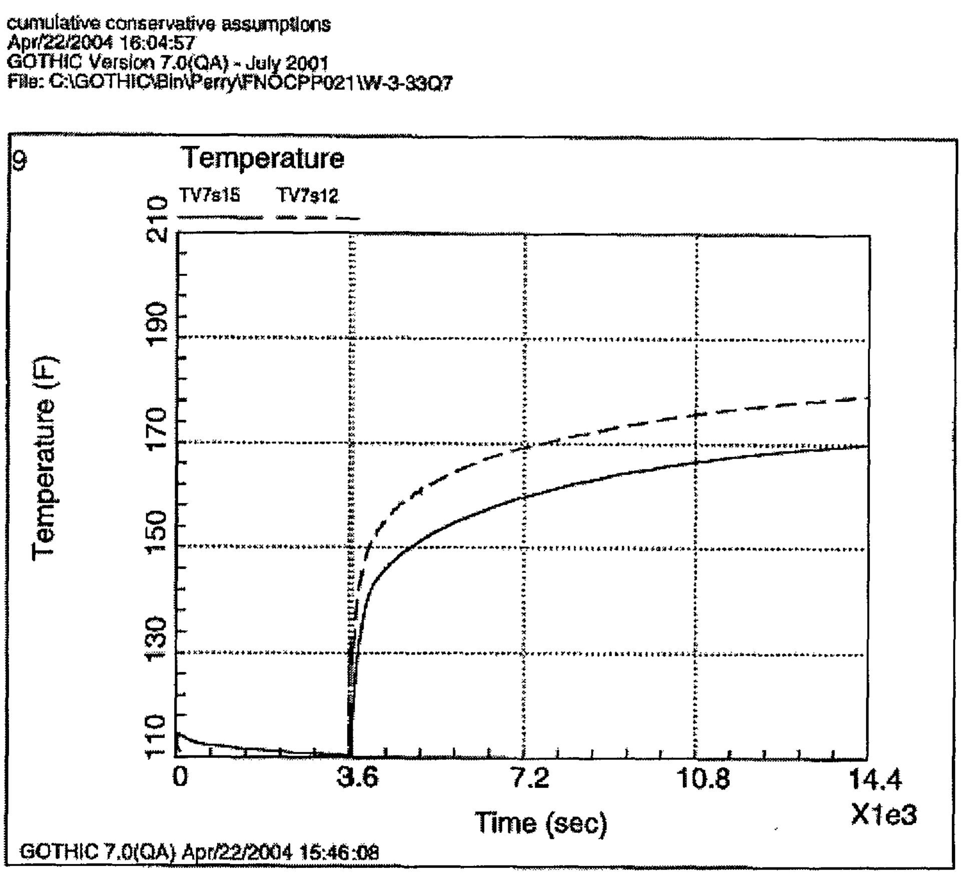

Figure 6

While the sensitivity case used to investigate the cumulative effect of the nonconservative inputs results in a longer time to reach the Analytical Limit than the original analysis, the time still remains significantly less than the limiting value of 4306 seconds. The variations made to these nonconservative inputs are considered to be taken to an extreme limit of the input value and are not as realistic as the inputs used in the original model. However, the model produces acceptable results even when the values used are not representative of the analyzed configuration for those inputs categorized as nonconservative. It is concluded that the original inputs are reasonable and therefore the original model is appropriate and provides an acceptable model of the Turbine Building temperature response. However, as noted in the response to Question 3, to produce a slightly more conservative model of the Turbine Building temperature response, the original analysis will be revised to reflect the elimination of a loss coefficient for Flowpath 21.

NRC REQUEST

8) The submittal states that with a leak of 280 gpm, the Main Steam system will isolate in about 17.5 minutes to limit the impact of the leak. The submittal does not discuss leaks of <280 gpm but >25gpm. The staff is concerned that a lesser but still substantial leak could go undetected for an extended period of time with unanalyzed consequences. The licensee needs to provide an analysis that addresses the impact of leaks between 25 and 280 gpm.

RESPONSE

8) Please refer to the January 22, 2004 letter (PY-CEI/NRR-2754L), which addressed the first set of NRC questions on the subject LAR for the response to this question.

NRC REQUEST

9) On Page 3 of 7 of the technical analysis, item 3 states that: "The leak will be detected before the leakage could increase a level beyond the capability of the makeup system." What is the approximate leak rate outside containment during normal operation? How much leakage can be compensated by the excess capacity of the feedwater system? How much CRD flow will also compensate for the leak? The present allowable leakage rate of 25 gpm is made up by the above systems. Please confirm that the proposed 280 gpm leakage rate can be made-up by those systems.

RESPONSE

9) Steam leaks in general are not tolerated at PNPP. However, generally most leaks do not originate from pressure boundary or piping breaches but are either from valve packing or at bolted flanges at the gasket to flange face interface. The new maximum equivalent mass steam leakage value proposed by the LAR within the Turbine Building to be detected by the associated Leakage Detection instruments is 280 gpm. The makeup capability of the Feedwater system is more than adequate to accommodate this leakage since 280 gpm is insignificant compared to the Feedwater supply capacity.

As documented in the Feedwater System Operating Instruction, the maximum suction flow for one turbine driven reactor Feedwater pump is approximately 23,000 gpm and the motor driven Feedwater pump is 8,000 gpm. During normal operation, PNPP uses two turbine driven reactor Feedwater pumps, thus the available feed flow would be approximately 46,000 gpm. A leak in the Turbine Building of 280 gpm is insignificant (0.6%) in relation to the total Feedwater flow capacity. Therefore, Feedwater system makeup would not be a concern along with adequate Control Rod Drive (CRD) flow with the proposed LAR.

REQUEST

10) On Page 5 of 7 – Leakage Shall not Exceed Makeup Capability "GE establishes the Loss of Coolant Accident limit as an equivalent 2-inch diameter schedule 80 pipe break based on the normal capability, which is approximately an equivalent mass Main Steam System leakage value of 383 gpm." Please clarify whether 383 gpm is at the upstream or downstream of the break.

RESPONSE

10) The Loss Of Coolant Accident (LOCA) 2-inch pipe equivalent mass steam leakage value of 383 gpm is downstream of the break. The method of calculating the mass flow rate assumes that the vapor reaches sonic velocity at the outlet of the crack and is exhausted to atmospheric pressure.