Entergy

Entergy Operations, Inc.
River Bend Station
5485 U.S. Highway 61N
St. Francisville, LA 70775
Tel 225-381-4177

Joseph A. Clark
Manager, Regulatory Assurance

March 24, 2016

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

RBG-47668
RBF1-16-0038

Subject: Submittal of Regulatory Conference Documents
River Bend Station – Unit 1
Docket No. 50-458
License No. NPF-47

Reference: NRC Letter to Entergy, dated February 16, 2016, NRC Inspection Report 5000458/2015010; and Preliminary White Finding

Entergy Letter to NRC, dated February 25, 2016, Response to Preliminary White Finding

In NRC Inspection Report to River Bend Station (RBS), dated February 16, 2016, the NRC identified a preliminary white finding for failure to adequately consider control room cooling in assessing the risk of maintenance activities on the control building chilled water system chillers in various single-failure vulnerable configurations. On February 25, 2016, RBS submitted a letter to the NRC documenting the option to attend a Regulatory Conference. The NRC has scheduled a Regulatory Conference for April 4, 2016.

RBS agrees with the violation as characterized in NRC's inspection report. RBS concludes; however, using best estimate realistic conditions that the risk deficit associated with each of the 2014 HVK/HVC divisional outages represented very low risk in accordance with Manual Chapter 0609, Appendix K, "Maintenance Risk Assessment and Risk Management Significance Determination Process". Information that supports this conclusion is summarized in Attachment 1 to this letter. Attachments 2 through 11 contain the technical documents referenced in Attachment 1. This information will be discussed further in the Regulatory Conference on April 4, 2016.

RBS appreciates the opportunity to further discuss the details surrounding this preliminary white finding at the upcoming Regulatory Conference. Should you have any questions regarding the information presented in this letter, please contact Joey Clark at (225) 381-4177.

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NRR

Attachments:

1. Evaluation Summary
2. Engineering Report No. RBS-ME-16-00003, Evaluation of Main Control Room Realistic Heat Load Based on Measured Data
3. Engineering Report No. RBS-ME-16-00002, Main Control Room Heat-up Analysis During Loss of HVAC Conditions for 24 hours
4. Calculation No. ENTR-078-CALC-003, Attachment 22, Heat Load Sensitivity with HVC-ACU1A(B) Aligned to SWP
5. Calculation Report No. ENTR-078-CALC-003, Attachment 5, Heat Load Sensitivities
6. Engineering Report No. RBS-ME-15-00036, Main Control Room (MCR) Operator Habitability under Beyond Design Basis Loss of HVAC Conditions
7. Evaluation of RBS Remote Shutdown Panel Rooms following a Loss of Control Building HVAC
8. PRA Model Changes to Include Control Room Cooling
9. Potential Greater than Green (a)(4) Violation – River Bend
10. Response to NRC Concern with Temperature Effects on Safety-Related Electronics in Main Control Room
11. Technical Paper on Loss of AC Bus Initiator for RBS

cc: U.S. Nuclear Regulatory Commission
Region IV
1600 E. Lamar Blvd.
Arlington, TX 76011-4511

NRC Resident Inspector
PO Box 1050
St. Francisville, LA 70775

Central Records Clerk
Public Utility Commission of Texas
1701 N. Congress Ave.
Austin, TX 78711-3326

Ms. Andrea E. George, Project Manager
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

Attachment 1 to RBS-47668

Evaluation Summary

Attachment 1
Evaluation Summary

This attachment provides a detailed summary of evaluations conducted by River Bend Station (RBS) that are associated with the March 9, 2015, loss of Control Building ventilation and the subsequent NRC Inspection Report 50000458/2015010.

Table of Contents:

A. Main Control Room (MCR) Operator Response on March 9, 2015

RBS has determined that the actions taken by the MCR operators on March 9, 2015 were appropriate. Since the actual temperature conditions remained moderate during the period without cooling, reaching only the low 70°F's, the decision to not align Service Water to MCR air conditioning unit (ACU) was appropriate. This is particularly the case because the Maintenance and Engineering department personnel reported that the return to service of a Control Building Chilled Water System (HVK) chiller was imminent. The HVK chiller was returned to service approximately 220 minutes after the Loss of Control Building Ventilation. During that time period, when cooling was not available, MCR temperature rose from approximately 65°F to 72°F.

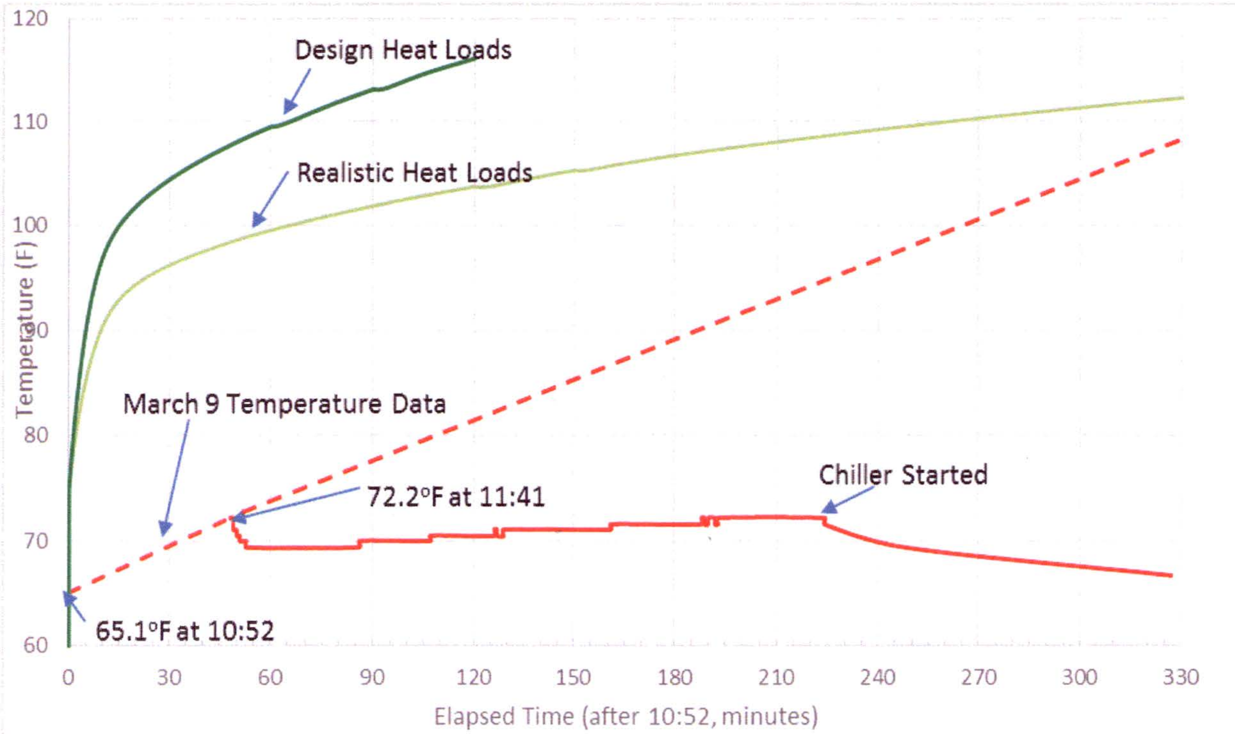
B. Introduction to the Engineering Analyses Performed

RBS has determined that the success paths below preclude electrical equipment failure and establish temperature control were available to allow the MCR to remain habitable and functional in the event of a sustained Loss of Control Building Ventilation. These include:

- The preferred method of aligning Service Water to one of the two MCR air conditioning units (ACU).
- A secondary method of using the installed Smoke Removal Fan to draw-in fresh air and exhaust it to outside and removing the MCR ceiling tiles to allow the hotter air to rise.

Calculations have been performed based upon both design heat loads and realistic heat loads for the MCR to determine heatup rates and the effectiveness of the mitigation actions. The results of these calculations are shown in Figure 1.

Figure 1
Summary of MCR Average Temperature for
Design, Realistic and March 9, 2015 Heat Loads



C. Analysis of March 9, 2015, Loss of Control Building Ventilation and Resulting MCR Temperature

Attachment 10.1 of Engineering Report RBS-ME-16-00003 (Reference 1) contains a detailed discussion of the indicated MCR temperature.

RBS's continuing investigation into the event determined that the HVCTA01 computer point was not indicative of MCR temperature for the initial period of the event, when there was no HVAC flow. Computer point HVCTA01 temperatures shown on Figure 2 were previously provided to the NRC inspectors in response to a request for MCR temperature indications from March 9, 2015. This point is normally used to monitor MCR temperature; the associated temperature instrument is located in the return air duct several feet below the MCR floor.

This computer point, HVCTA01, was the only available recorded information. It was not known at the time that this temperature did not correspond to the actual MCR temperature response without a MCR ACU in operation. Investigation has determined that the maximum MCR temperature during the initial time when there was no airflow from the MCR HVAC system was about 70°F. The maximum temperature of 91.4°F, previously reported to the NRC, was not representative of the actual MCR temperature. This was additionally validated by discussions with Operators who indicated that the temperature was above the 65°F normal MCR temperature, however, not hot.

The initiator of the March 9, 2015 event was the Division I ECCS test. Equipment failures led to the failure of the 1C chiller and 1A ACU to successfully restart once the

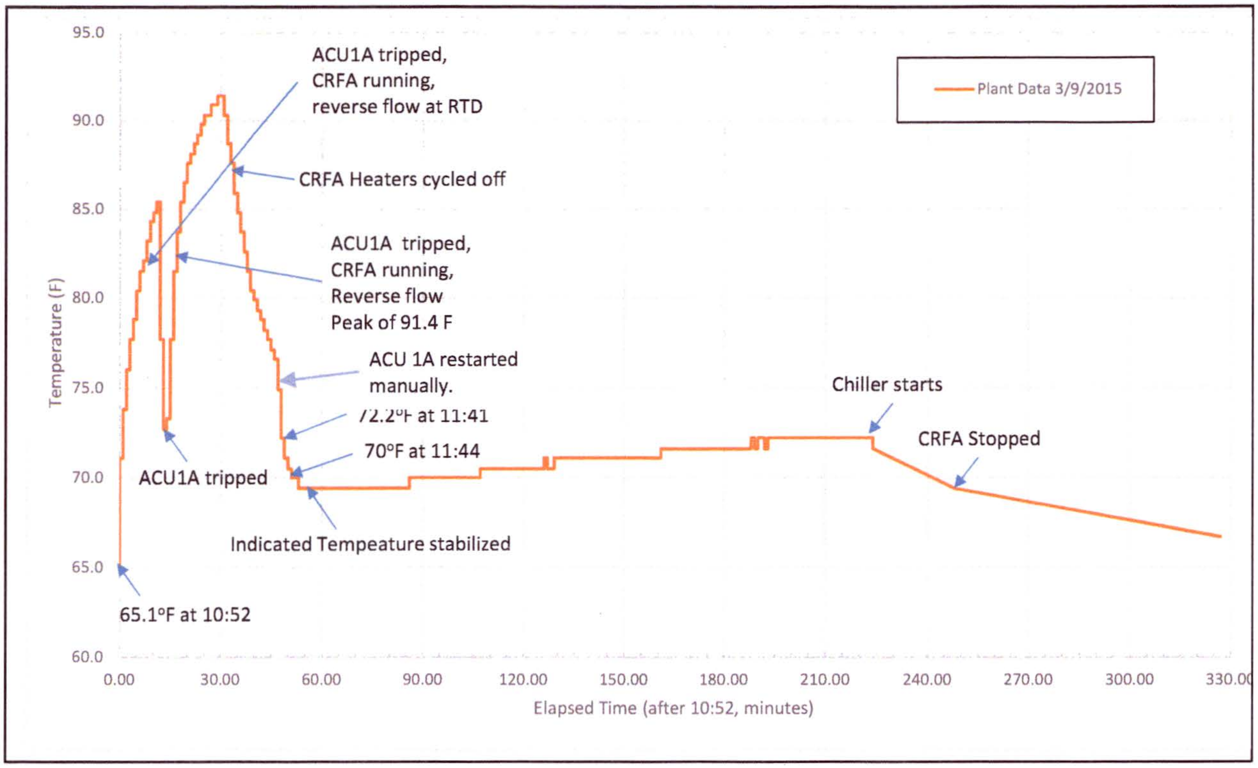
Diesel Generator repowered the Division 1 safety bus. The Control Room Fresh Air (CRFA) system was initiated by this test signal. The CRFA filter train includes a heater that heats the airflow. The CRFA flow path to the MCR is through the ACUs. However, due to chiller trips, the CRFA flow path through the ACUs, to the MCR was isolated. There was no path to the MCR through the Supply Duct. This resulted in diverting some of the heated CRFA flow to a reverse path to the area above the MCR false ceiling through the Return Air Duct, as well as to a mechanical equipment area. Thus, the maximum temperature indication of 91.4°F was driven by the heated CRFA backflow and did not indicate actual MCR temperature. The high temperatures indicated by this instrument on March 9, 2015 were due to a small backflow through the Return Duct into the upper volume, above the false ceiling, of the MCR.

As shown in Figure 2, the temperature while an ACU was not running rose from ~64.5°F to ~70°F. A best estimate interpretation is that the endpoint is 70.0°F at 11:44, a 4.9°F heatup over 52 minutes for a heatup rate of 5.7°F/hour. A worst case interpretation of the data shows the MCR heated from 65.1°F at 10:52 to no more than 72.2°F at 11:41, thus at a rate of 8.7°F/hour over this 49 minute span. The temperature initially stabilized and then increased at a lower rate due to the thermal inertia of the quiescent cold chilled water in the ACU coils. At this conservative rate, it would have taken ~4.5 hours to reach 104°F. This is considerably less than the calculated one-hour heatup of 34.5°F using design heat loads (Reference 2), and less than the 24.6°F heatup calculated using the realistic heat load (Reference 4) measured on February 2, 2016.

The lowering temperature after about 30 minutes was a result of the CRFA heater cycling off.

In conclusion, the actual heat up of the MCR ambient temperature on March 9, 2015 was not accurately represented by the indicated temperature from computer point HVCTA01 while there was no HVAC flow. The recorded temperature changes from computer point HVCTA01 while there was no HVAC flow are explained by the back flow of heated outside air from the CRFA system. This explains why the actual heatup of the MCR on March 9, 2015 was lower than initially reported.

Figure 2
Temperatures Recorded by HVCTA01
During the March 9, 2015 Loss of Main Control Room Cooling Event



D. Evaluation of Realistic MCR Heat Loads

Engineering Report RBS-ME-16-00003 (Reference 1) contains a detailed discussion of the methods and evaluation used to develop the actual MCR heat load.

MCR temperature data was taken during November 2015 using handheld temperature instruments. Based upon a heat balance, this data indicated actual MCR heat loads were substantially smaller than the design heat loads.

Based on the November measurements and the March 9, 2015 observations, RBS proceeded to take detailed measurements of MCR airflow and temperature. This was done on February 2, 2016 in conjunction with a performance of surveillance test STP-402-4203, "HVC-ACU1A Performance Monitoring". The measured MCR heat load from this test was 59,871 watts, 56.7% of the electrical heat load based on design and vendor information used in GOTHIC MCR heatup calculation ENTR-078-CALC-004 (Reference 2). Calibrated high accuracy M&TE equipment was used for the February 2, 2016 detailed measurements. While not as accurate, a similar but slightly higher heat load, of 64% was measured in November 2015. The heatup rate observed during the March 9, 2015 event was also indicative of a lower heat load than measured in either February or November. Thus, it is concluded that realistic MCR heat loads are substantially less (56.7%) than the heat loads derived from design information used in the GOTHIC heatup calculations.

E. RBS Response to GOTHIC Calculation Issues Identified by the NRC

RBS provided the NRC with calculation ENTR-078-CALC-003, Revision 0, a 24-hour heatup calculation for the MCR using the GOTHIC thermal-hydraulic analysis code, in mid-August, 2015. Condition Report CR-RBS-2015-7237 was written on October 7, 2015, to document NRC issues reported to RBS concerning the calculation. These issues included:

1. Steel Heat Capacity: The calculation used a higher value of steel heat capacity than considered appropriate. This was determined to be an erroneous value in a Mechanical Engineering handbook. This issue was documented in CR-RBS-2015-7034. Calculation ENTR-078-CALC-003 was revised (rev.3) to correct the heat capacity value. This revision also credited additional metal heat sinks in the MCR which had been previously identified but had not been previously credited in the calculation. The resulting maximum bulk average MCR temperature increased from 114.7°F to 117.6°F.

2. Concrete density: NRC questioned the use of a lower concrete density than what they considered typical. RBS reviewed the information and concluded the concrete density being used was appropriate. A sensitivity calculation was subsequently performed which showed this difference made only a 0.3°F difference in temperature at 24 hours into the event, a non-limiting time in the transient. There was no calculated difference at the time of peak temperature. Increased concrete density is potentially non-conservative, especially early in a heatup event, due to increasing heat absorption.

3. Main Control Room Floor Modeling: The NRC questioned the approach used in modeling the raised MCR floor. Specifically, the NRC was concerned that neglecting the floor covering (carpet) in this model could result in the floor acting as a heat sink during the heatup event and thus lower the MCR temperature. A sensitivity calculation was subsequently performed assuming a worst case configuration of the MCR floor, which showed only a 0.2°F impact on peak MCR temperatures.

   The MCR Floor Modeling has since been updated based on observations and walk downs to conservatively reflect the actual floor construction. The aluminum honeycomb support structure included in the previous modeling was replaced with a less thermally conductive wood material representing the removable hardwood floor tiles. This current model was subjected to third party reviews by Numerical Applications Inc. (NAI) and MPR Associates as part of the model refinement for the new streamlined MCR temperature calculation documented in ENTR-078-CALC-004 (Entergy report RBS-ME-16-00002), Reference 2.

4. Volume Mesh Size (subdivided volume): NRC questioned the use of a 4x2x2 mesh in the subdivided MCR GOTHIC model. A previous sensitivity calculation had shown a 0.6°F impact of increasing the mesh size to 16x8x2.

   For development of the updated GOTHIC model used in calculation ENTR-078-CALC-004 (Reference 2), a 16x8x3 mesh has been incorporated into the model for the lower MCR volume; a 16x8x2 mesh is used for the upper MCR region, above the false ceiling. Significant effort was expended to determine localized heat loads for this finer mesh, which includes 384 subvolumes in the lower MCR.

5. Momentum Transport: The NRC noted that the GOTHIC modeling did not include any momentum transport through flow paths between subdivided volumes. Sensitivity analyses, which included the appropriate momentum transport option in these flow paths, were conducted and showed no impact on peak temperatures. Crediting momentum transport, as suggested by NRC, resulted in very small decreases in long-term maximum temperatures, well after the time of peak bulk and local temperatures. The ENTR-078-CALC-004 (Reference 2) model specifies use of Momentum Transport; this had also been previously incorporated in the ENTR-078-CALC-003 Rev. 3 model.

6. Solar heating effects: NRC questioned the impact of solar heat flux on the MCR temperature response. A sensitivity study was performed which conservatively included the effects of solar heat flux on both the roof and all four walls of the MCR. This study showed there was no impact (0.0°F) on calculated maximum temperature, which occurs early in the event. A minimal 0.5°F increase was shown in the non-limiting 24-hour average temperature.

   Solar heating effects have been fully incorporated into the ENTR-078-CALC-004 (Reference 2) MCR model; this had also been previously incorporated in the ENTR-078-CALC-003 Rev. 3 model.

7. Panel Surface Temperatures: NRC questioned the initial temperatures of the thermal conductors representing the metal control panels or electrical cabinets in the MCR. The electrical equipment in the MCR is predominately located in the electrical cabinets and these cabinets are represented in the GOTHIC model by thermal conductors (i.e., heat sinks) contained entirely within the room volume. They were modeled as having initial surface temperatures equal to the room temperature consistent with typical GOTHIC modeling practice. Since the panels have electrical heat loads within the enclosure, the panel temperatures are expected to be initially somewhat higher than the surrounding ambient temperature prior to opening the panel doors.

   The modeling of the control panels was revised in the ENTR-078-CALC-004 (Reference 2) MCR model. The revised modeling conservatively initializes the panel conductors at approximately 85°F, which is over 5°F greater than panel surface temperatures measured by thermography during a MCR walk down. The revised control panel modeling was the subject of extensive third party review by NAI and MPR and this conservative, bounding model resulted from their review and comment. A sensitivity case was subsequently performed which assumed a Zero MCR heat loading, which showed the current model of control panels and MCR walls in ENTR-078-CALC-004 results in a 8°F MCR temperature rise upon a loss of HVAC with a zero heat load. This is considered a bounding conservative model, and the difference in observed heatup on the March 9, 2015, event and calculations is partially attributed to this conservatism.

Shortly after NRC closeout of inspection activities in early October, Revision 3 to calculation ENTR-078-CALC-003 was issued, which corrected the steel heat capacity condition of CR-RBS-2015-7034. That revision also incorporated Momentum Transport and accounted for solar heat flux. Additional MCR heat sinks which had been previously identified during MCR walk downs but had not been previously credited were incorporated into the model during this revision.

In conclusion, RBS has responded to each of these issues as described above. The MCR heatup calculation has been appropriately revised to incorporate changes. As discussed

in Section D, the resulting temperature response, including maximum values, based on design heat loads continue to demonstrate similar temperature responses.

F. Evaluation of MCR Heatup

Calculation ENTR-078-CALC-004 (Reference 2) provides the updated calculation of MCR heatup using the developed design heat loads. This streamlined calculation was initiated to address the GOTHIC issues raised by the NRC, discussed above. The calculation enhanced and refined the ENTR-078-CALC-003 model and incorporated additional modeling suggested from third party reviews by MPR Associates and by Numerical Applications Inc. (NAI), the GOTHIC code developer. A draft of this calculation, which incorporated all the items discussed by the NRC except for mesh size, was provided to the NRC on November 4, 2015. Work continued on the mesh size modeling, including heat load distribution definition, after that data was incorporated into the approved Revision 0 of ENTR-078-CALC-004 (Reference 2).

The MCR heatup calculations contain the analyses of these three primary cases:

Case A: This case represents the preferred mitigation action of lining up Service Water flow to Control Building Chilled Water System (HVK) piping to provide cooling to MCR ACUs per AOP-0060, "Loss of Control Building Ventilation", Rev. 9.

This case uses a conservative assumption of only one Service Water Pump providing flow at the design post-LOCA service water temperature of 95°F. Without such a transient, a realistic service water temperature would be less than the Standby Service Water Technical Specification temperature limit of 88°F. Thus, realistic service water conditions, even during summer months, would result in greater cooling than presented for this case in the various calculation revisions. Also, realistically, both pumps per Service Water train would be available, resulting in a further increase in cooling capacity.

This Case assumes Offsite Power is available. It bounds the case of Loss of Offsite Power where MCR heat loads are reduced.

In the event that Service Water cooling of HVC-ACU units is not available, the MCR heatup calculations evaluate two secondary cases, which credit different mitigating actions depending on the availability of offsite power.

Case B: Offsite Power Available:
If offsite power is available, the MCR smoke removal fan (HVC-FN9) is available as a means of MCR ventilation. The Offsite Power Available case credits this action and the removal of MCR false ceiling tiles for temperature control in the event that the Service Water crosstie to the HVK is not successful.

MCR heat loads are highest for cases with Offsite Power Available. Heat loads in the MCR are due to computer heat loads, lighting, normally energized logic relays, and controls and indications in MCR panels. These heat loads do not vary significantly with plant conditions, other than if power supplies are out of service. For example, the latest full revision of the calculation for MCR electrical heat loads show a MCR heat load of 112,679 watts for Normal Conditions; the corresponding heat load for a LOCA with Offsite Power available is slightly less, 107,880 watts, due to assumptions of certain equipment being deactivated due to LOCA signals. Certain lighting and panel

heat loads are not powered or have short duration battery power under Loss of Offsite Power (LOOP) conditions, thus MCR heat loads under LOOP conditions are non-limiting.

Case C: Loss of Offsite Power case:
This is a non-limiting heatup case but is presented since the smoke removal fan is not available. The only operator action which has been credited in the analysis, if the Service Water crosstie is unsuccessful, is the removal of the ceiling tiles.

RBS determined that it was necessary to investigate the localized heat load distribution below the MCR ceiling. This further investigation showed that there was a need to further subdivide the MCR model. The MCR subdivided volume model representing below the MCR ceiling was changed from a 4x2x2 mesh to a much finer 16x8x3 mesh, for an increase from 16 subvolumes to 384 subvolumes. The subdivided volume representing the upper MCR (region above the false ceiling) as changed from a 4x2x2 mesh to a 16x8x2 mesh (256 subvolumes). Additional information on heat load distribution in the MCR was developed as the previous design heat load information only provided a total heat load for the entire collection of MCR panels. RBS determined localized MCR panel heat loads for input to the heatup calculation. During this work, Condition Report CR-RBS-2015-8967 was written to document discrepancies in heat load values in design basis Electrical Heat Load calculation E-226. These discrepancies included a legacy error in lighting heat loads, differences in computer heat loads, as well as discrepancies in control panel heat loads discovered in the effort to determine heat load distribution. Investigation documented in Engineering Change EC 61975 concluded the electrical heat loads for the MCR with Offsite Power available were 105,637 watts, a slight reduction from the previous E-226 rev.5 value of 112,679 watts. CR-RBS-2015-8967 also reported that non-limiting heat loads for Loss of Offsite Power conditions increased due to failure of E-226 to account for battery powered loads and due to not considering all diesel heat loads; these issues did not impact the limiting case of Offsite Power available. The results of EC 61975 are used as input to the MCR heatup calculations based on design heat loads in calculation ENTR-078-CALC-004 (Reference 2).

Additional GOTHIC cases using the measured heat load documented in report RBS-ME-16-00003 (Reference 1) have been run, to determine the corresponding MCR temperature response to realistic heat loads. The use of realistic vice design heat loads results in a significantly longer time being available for operator action to establish MCR temperature control and mitigate the MCR temperature rise after a loss of MCR cooling.

GOTHIC calculations have been performed using the realistic heat loads of Reference 1. Attachments 22 and 5 to calculation ENTR-078-CALC-003, Revision 4 (Reference 3 & 4) contain the detailed results of the calculated MCR temperature response to a loss of MCR cooling using realistic heat loads. The attachments respectively credit use of Service Water cooling (Att.22) and the crediting of the Smoke Removal Fan and removal of ceiling tiles (Att.5) for mitigating the MCR temperature rise.

Table 1 below compares the peak average and maximum local temperatures from the normal operations heat load (offsite power available) cases and the LOOP cases using the various GOTHIC models. The offsite power available cases assume the alternative mitigating action of starting the Smoke Removal Fan and removing MCR ceiling tiles. Operator action is assumed at 2 hours for design heat load cases and at 6 hours for realistic heat load cases.

Table 1
Calculation Results

	Offsite Power Available Peak Average MCR Temperature	Offsite Power Available Max Local MCR Temperature	Loss of Offsite Power Peak Average MCR Temperature
Design Heat Loads			
ENTR-078-CALC-003 rev. 0/1/2	114.7°F at 2 hours	118.3°F	104.7°F
ENTR-078-CALC-003 rev.3	117.6°F at 2 hours	120.3°F	105.9°F
ENTR-078-CALC-004 (Nov. 4, 2015, draft provided to NRC)	115.1°F at 2 hours	121.8°F	107.6°F
ENTR-078-CALC-004 rev.0	116.1°F at 2 hours	121.8°F	111.4°F
Realistic Heat Loads			
ENTR-078-CALC-003 Rev.4 Attachment 5	113.1°F at 6 hours	117.2°F at 6 hours	Not analyzed (data not available)

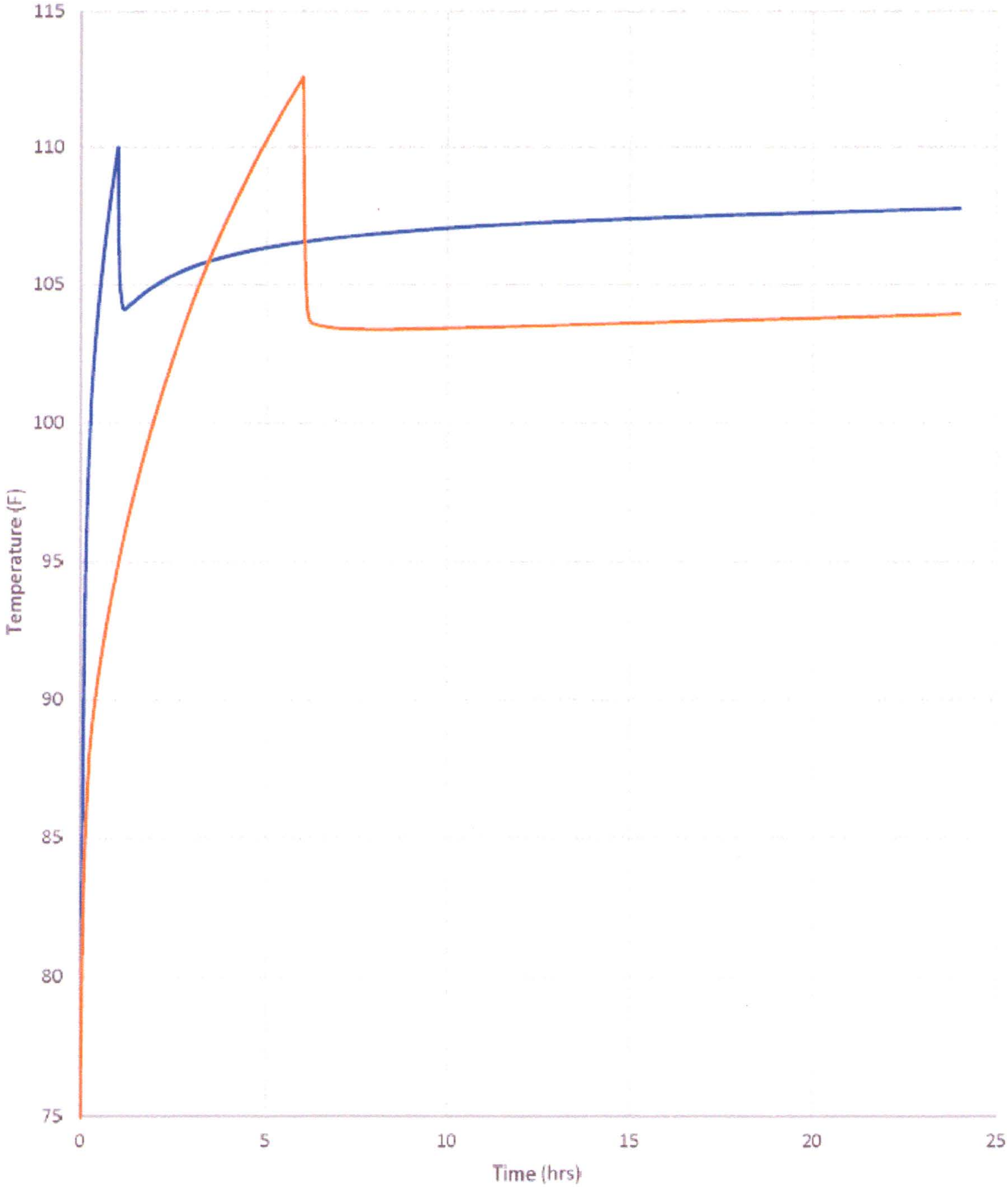
The temperature responses for the cases based on design heat loads all show a similar temperature response. This includes accounting for the issues raised by the NRC concerning these calculations.

The GOTHIC calculations also provide MCR relative humidity results, Figures 5 and 6 below. High initial relative humidity assumptions will reduce heatup slightly due to higher vapor heat capacity, thus cases were run for both minimum and maximum initial relative humidity. The GOTHIC code does not account for the contribution from operator perspiration and breathing but evaluations performed in conjunction with habitability studies demonstrate this had a minimal impact for cases where MCR ventilation (e.g., the ACU using Service Water or the Smoke Removal Fan) is restored.

For the preferred mitigating action of aligning service water, the MCR temperature response would be reduced by considering a more realistic Service Water temperature and flow. For the backup cooling method, cooler outside air than worst case summer 96°F temperatures would result in lower temperature air being introduced to the Main Control Room and thus lower long-term MCR temperatures.

Figure 3 below compares the average MCR temperature based on realistic heat loads and design heat loads. The graphs show a significantly slower heatup assuming realistic heat loads versus design heat loads. While the realistic case shows 6 hours is an acceptable time for temperature control, operators would be expected to respond as quickly as possible to this event. This graph assumes operator action to provide MCR cooling with Service Water at 1 hour for the design heat load case and at 6 hours for the realistic heat load case.

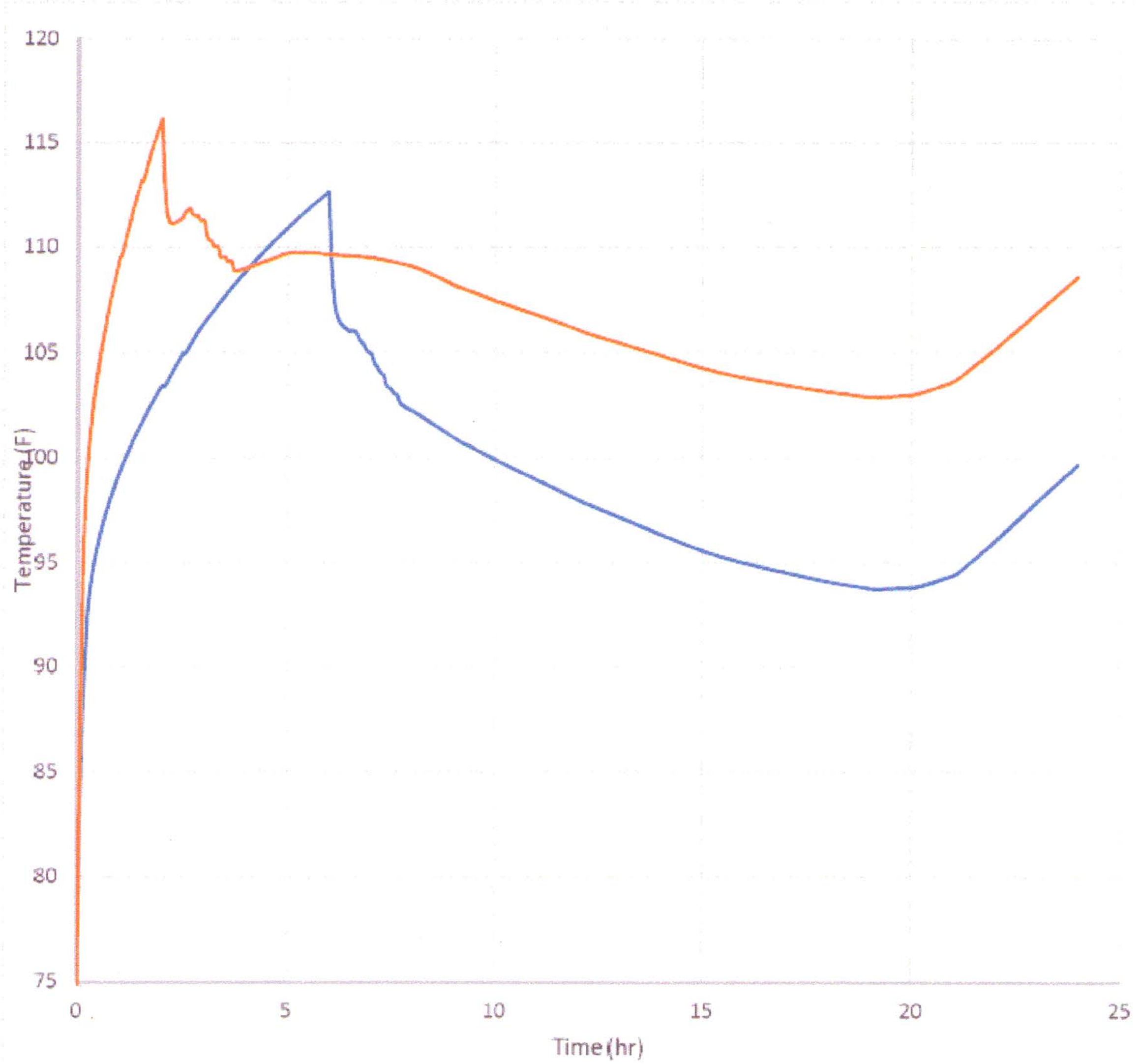
Figure 3
Design and Realistic Temperature Response with Service Water



95°F Service Water temperature assumed
96°F Outside Air temperature assumed (diurnal variation)

In the event Service Water cooling for the MCR was not available, Figure 4 below shows the significantly slower heatup assuming realistic heat loads vice design heat loads for the backup alternative of using the Smoke Removal Fan and removing MCR ceiling tiles:

Figure 4
Design and Realistic Response with Smoke Removal Fan and Ceiling Tile Removal



96°F outside air temperature assumed (diurnal variation)

Figure 5 below shows the calculated Relative Humidity for both design heat loads and realistic heat loads. This graph assumes operator action to provide MCR cooling with Service Water at 1 hour for the design heat load case and at 6 hours for the realistic heat load case.

These cases assume an initial relative humidity of 70%, the maximum specified per the River Bend Environmental Design Criteria. The response is relatively similar other than the difference in assumed operator action times.

Figure 5
Design and Realistic Relative Humidity with Service Water

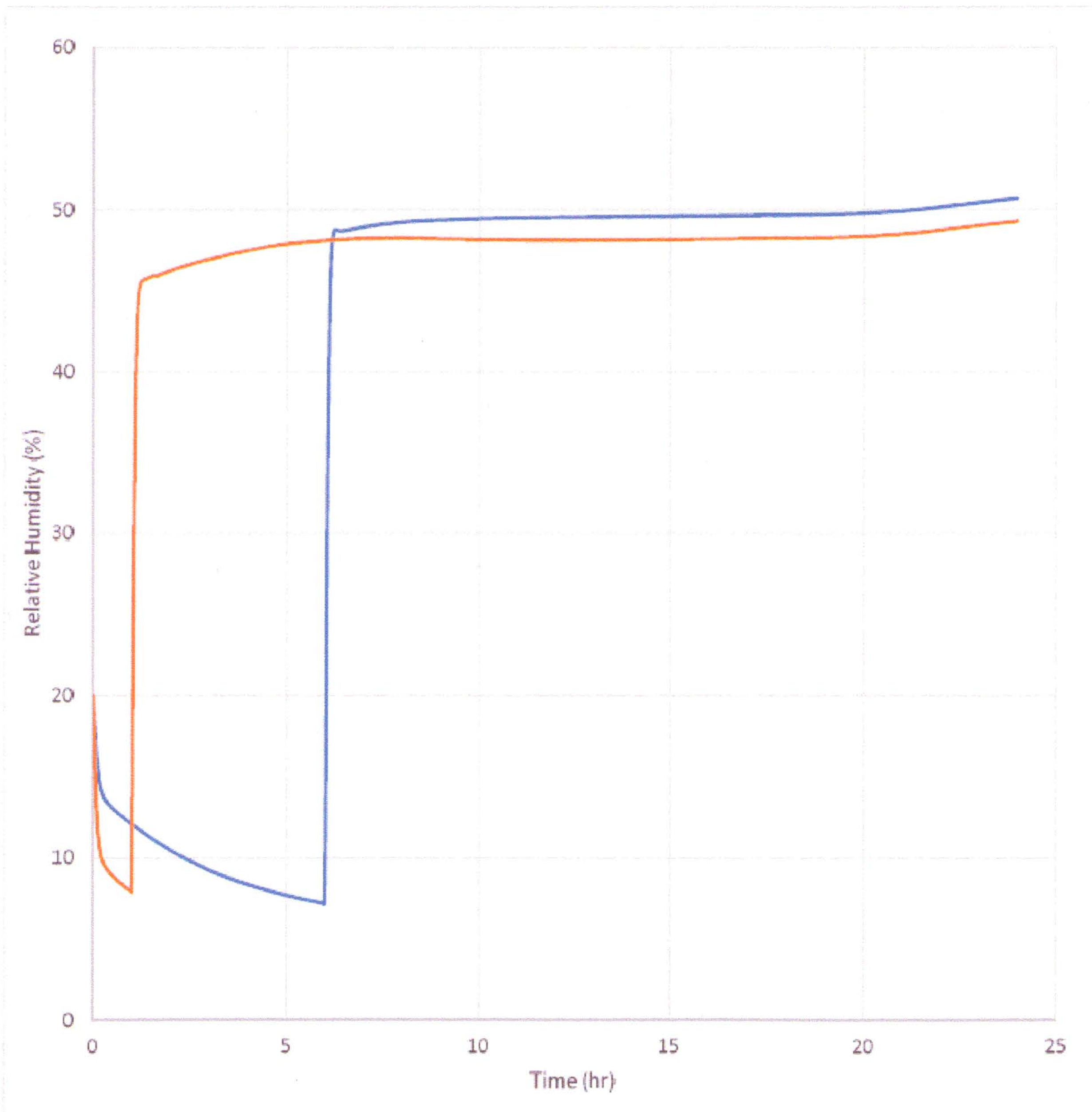
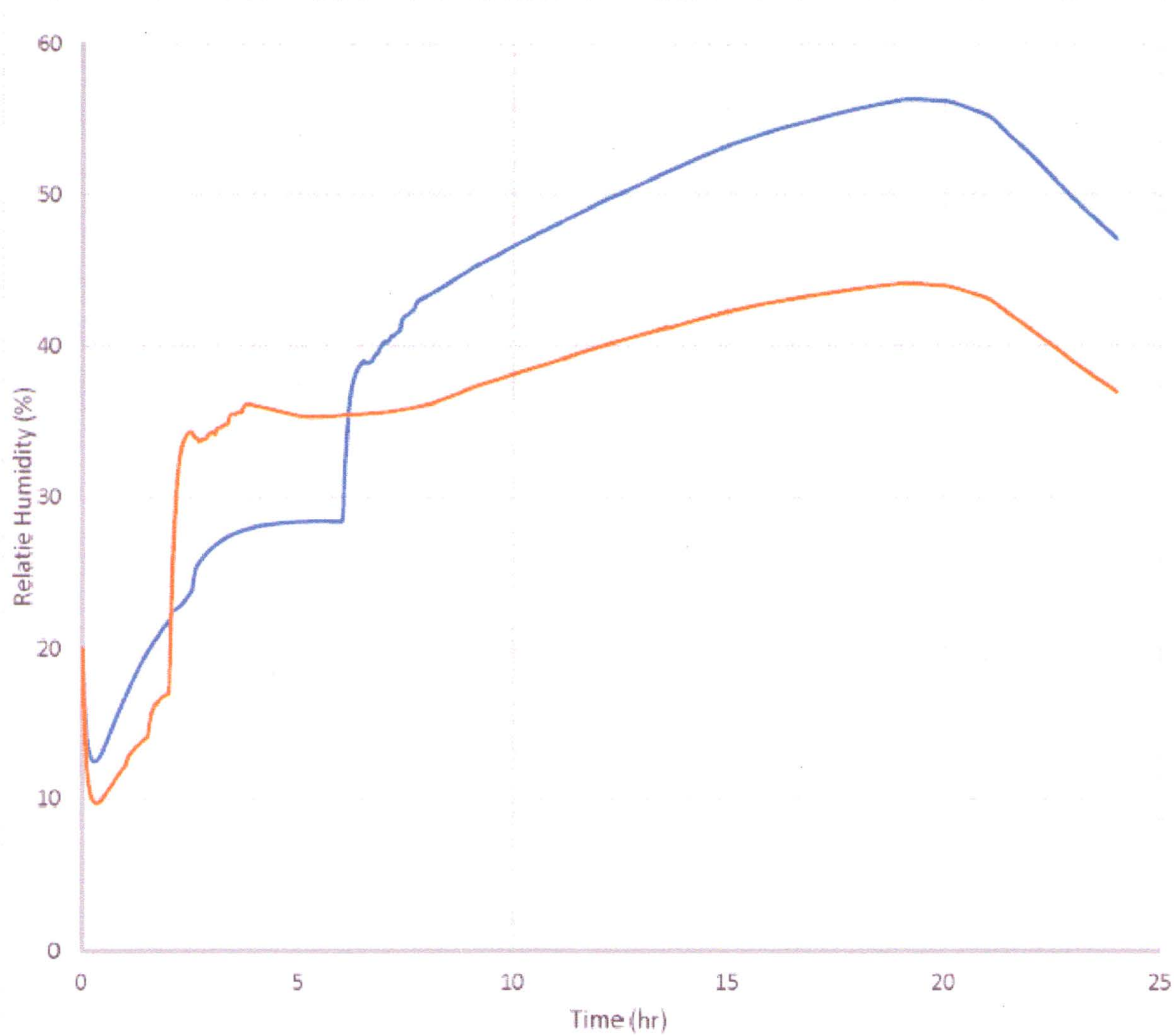


Figure 6 below shows the calculated MCR relative humidity for both design heat loads and realistic heat loads for the case where Service Water cooling for the MCR was not available, using the secondary method based on the Smoke Removal Fan and removing MCR ceiling tiles:

Figure 6
Design and Realistic Relative Humidity with Smoke Removal Fan and Ceiling Tile Removal



The long term relative humidity for the realistic heat load case is higher than for the design heat load case due to lower temperatures.

Relative humidity remains below the 70% maximum allowed value per the RBS Environmental Design Criteria for all these cases presented.

Improvements in plant procedures for responding to a Loss of MCR cooling since the March 9, 2015 event would result in more timely operator action than has been assumed in these retrospective calculations. Based on these procedure improvements and increased knowledge of MCR heatup, operator response to any future loss of MCR cooling would be improved compared to the calculation assumptions.

G. MCR Habitability

Report RBS-ME-15-00036, Revision 0 (Reference 5), prepared by MPR Associates, evaluates the impact of environmental conditions in the MCR upon operators, including an assessment against Entergy's procedure for exposure to temperature, EN-IS-108, "Working in Hot Environments." The calculation contains evaluations based upon both realistic heat loads and design heat loads for the MCR. RBS will provide additional information on stay times for realistic heat load cases with operator action at 6 hours for the Regulatory Conference.

Using the industry standard Wet Bulb Globe Temperature (WBGT)[1] parameter, even for the design heat load case, worst case WBGT values are considerably less than those discussed in the NRC inspection report, and stay times, when required, are considerably longer than discussed in the inspection report.

* No operator stay time would be required for WBGT values below 90°F.

* Maximum WBGT for the case of design heat loads is 93.6°F. The corresponding Operations stay time is 195 minutes.

* Based on design heat loads, the maximum long-term WBGT is 91°F when cooling is provided by Service Water, only 1°F over the limit for no operator stay times. This corresponds to a 230 minute stay-time per EN-IS-108. Consideration of realistic heat loads, maximum normal service water temperature of 88°F, and the unlikelihood of a service water pump failure led to the conclusion that no long term stay times are realistically required for this case.

* Based on design heat loads and assuming backup cooling with the Smoke Removal Fan and removing ceiling tiles, stay times over the 24 hour PRA mission time would be either 195 minutes, 230 minutes, or not required, per EN-IS-108.

* With realistic heat loads, no stay time would be needed after operator mitigating actions (Service Water alignment for MCR cooling, or the backup action of smoke removal fans and ceiling tiles) to terminate the rising temperature.

* For realistic heat loads, if (as expected) Operators take these mitigating actions earlier in the event (around 4 hours), then no stay times would be required.

* Strategies are available for Operator response to conditions meeting EN-IS-108 stay time criteria, including rotation of onshift personnel with minimum in-MCR staffing and callout of on-call Operations personnel.

The WBGT tends to be considerably less than the calculated dry bulb temperature from heatup calculations. Figure 8 below shows these three temperature parameters for the

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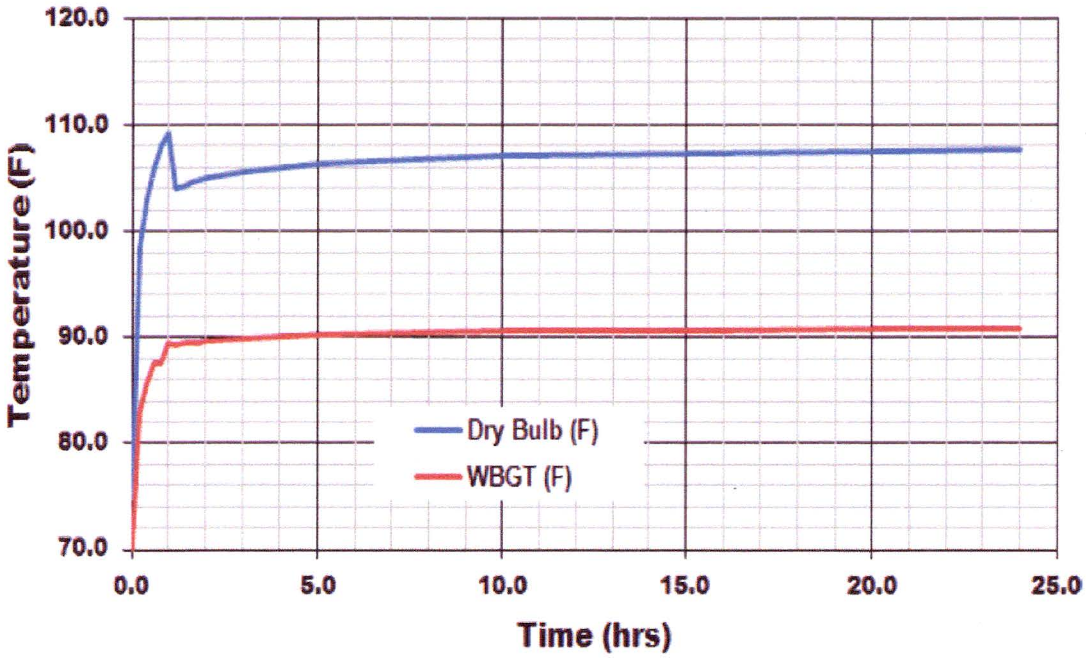
[1] $WBGT = 0.7 \times T_{wet\ bulb} + 0.3 \times T_{dry\ bulb}$

case crediting removal of ceiling tiles and operation of the smoke removal fan with design heat loads.

The WBGT results, based upon design heat loads, demonstrate manageable stay time requirement. Figure 7 below shows the WBGT results crediting Service Water cooling for the MCR after one hour. The corresponding WBGT is between 90°F and 91°F beyond 4 hours, within one degree of the value where there are no stay times per EN-IS-108. The heat removal for service water in this case is conservatively based on maximum post-accident temperature of 95°F and assumes only one of two service water pump is running. Consideration of realistic heat loads, a maximum normal temperature of 88°F, and assuming no pump failure so that both pumps are running, no stay times would be required for the long-term response crediting Service Water cooling.

Figure 7
Design Heat Loads
Offsite power available, Service Water for MCR cooling



Operator response for the design heat load case would be the same as shown for the secondary case (smoke removal fan and removal of ceiling tiles) in Figure 8 below for operator mitigation actions at 2 hours. Figure 7 above shows the long-term response based on design heat loads. Consideration of the conservatism with using design vice realistic heat loads, and the conservatism in the calculation of the effectiveness of service water to provide MCR cooling, support the conclusion that no long-term stay times are required under those conditions.

Figure 8 below shows dry bulb, wet bulb, and WBGT temperatures for the secondary case crediting use of the Smoke Removal Fan and removing ceiling tiles for MCR temperature control. Design heat loads are assumed in this graph.

Figure 8
Design Heat Loads
Offsite Power Available, Smoke Removal Fan, and Ceiling Tiles

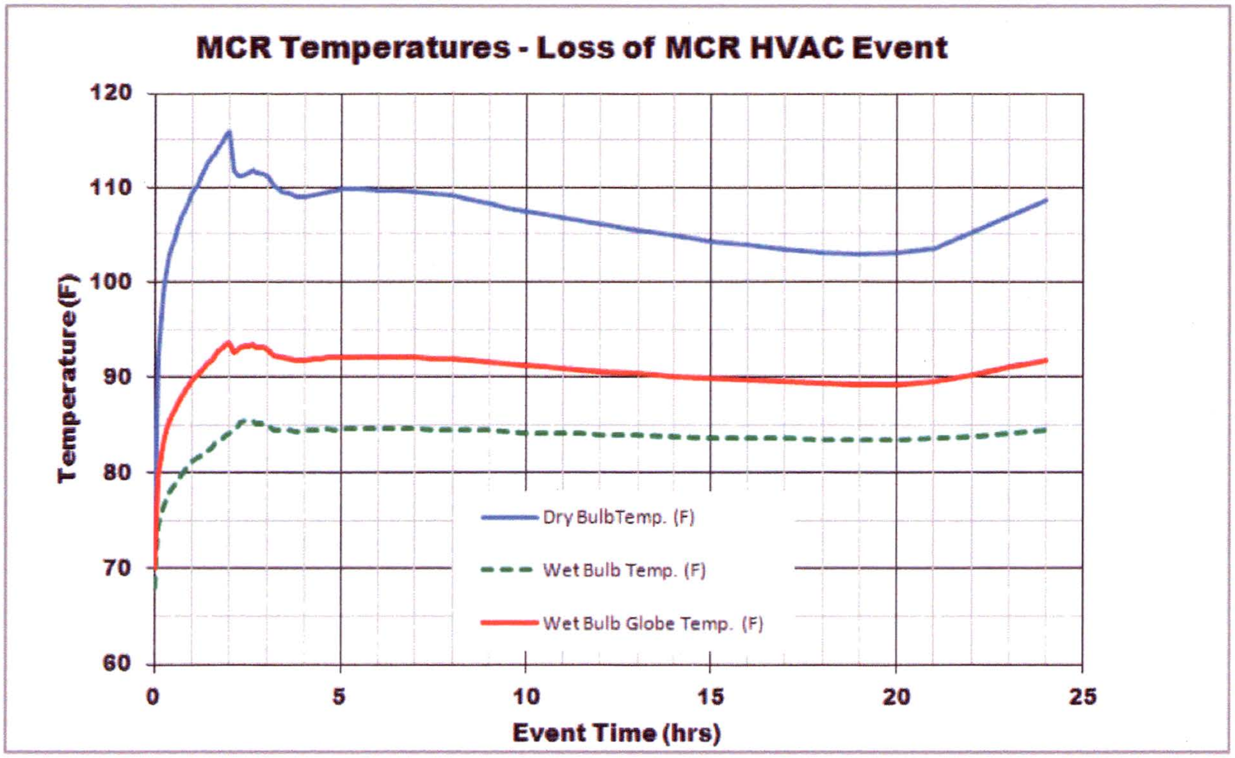
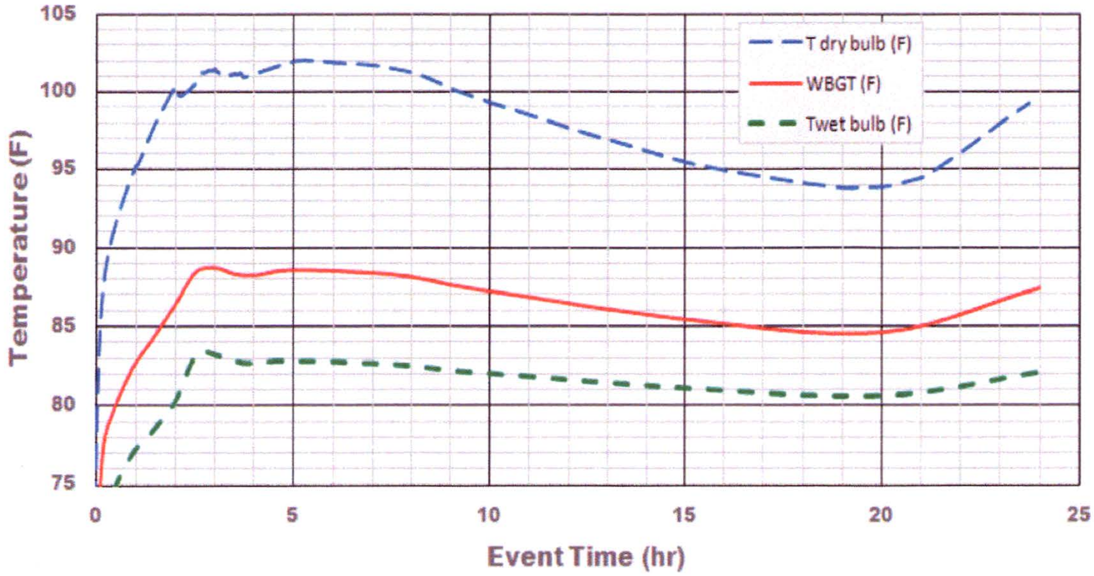


Figure 8 shows the WBGT is typically about 15°F less than the dry bulb temperature calculated in the GOTHIC MCR Heatup calculations. A maximum initial relative humidity of 70% is assumed for all WBGT calculations.

Stay times for Operations would only apply for a WBGT of 90°F or more. The maximum WBGT of about 93°F for this design heat load case occurs near the time of the maximum temperature. The minimum low demand stay time for operators is 195 minutes.

If the same case is considered for realistic heat loads as shown in Figure 9 below, the maximum WBGT would be 88°F and no Operator stay times would apply per EN-IS-108. (This case assumes operator actions at 2 hours into the event and demonstrates the long term WBGT response does not meet the criteria for applying stay times.)

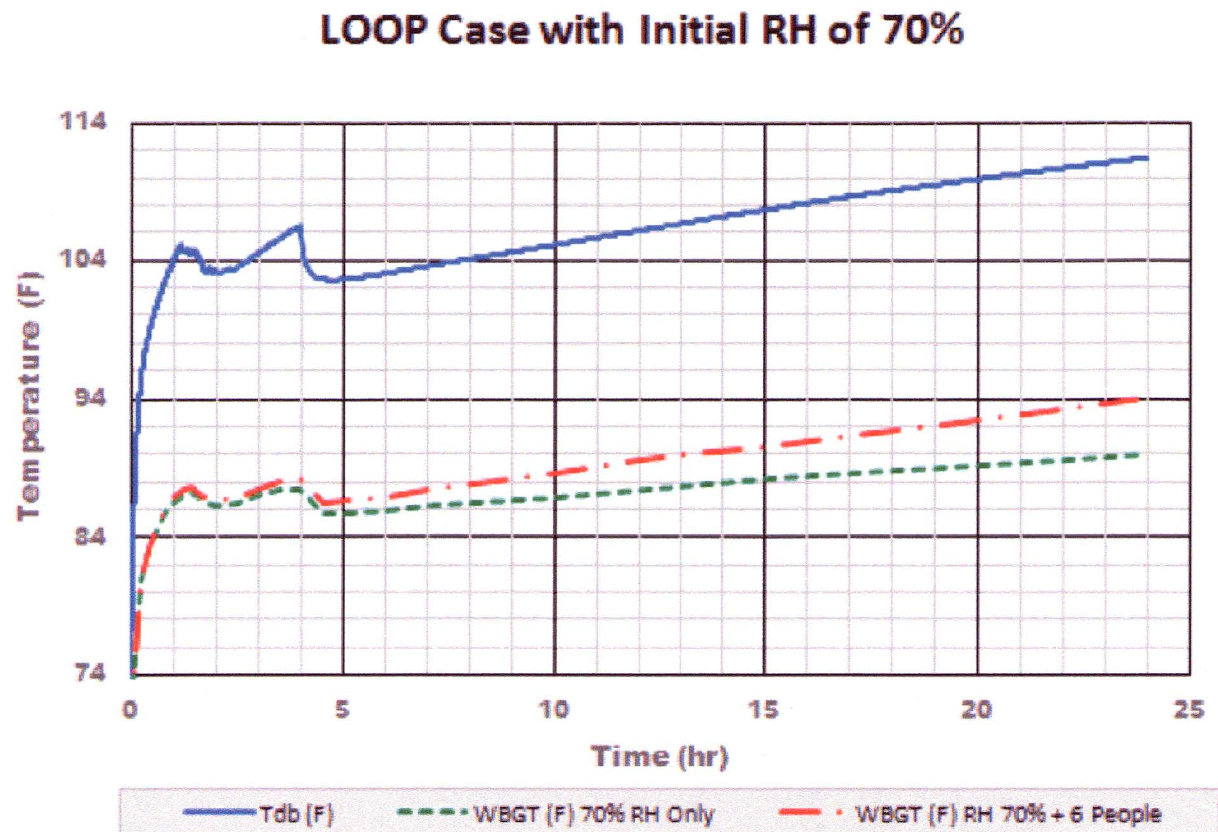
Figure 9
Realistic Heat Loads, Action at 2 hours
Offsite power available, backup case (ceiling tiles, smoke removal fan



For both methods of long-term MCR temperature control (Service Water alignment for MCR cooling, or the backup action of smoke removal fans and ceiling tiles), ventilation is provided for the main control room. This ventilation would prevent any buildup of additional humidity from operator perspiration or breath.

Buildup of water vapor from operator perspiration or breath is only of concern for the backup cooling case for Loss of Offsite Power (LOOP) conditions as shown in Figure 10. Accounting for this contribution, WBGT would rise above 90°F about 12 hours into the event.

Figure 10
Design Heat Loads
Backup LOOP case crediting only ceiling tile removal



This is a function of both buildup of water vapor and slowly increasing temperature as this case was calculated assuming no ventilation, only the removal of ceiling tiles to allow mixing with the larger volume of unheated air above the ceiling. Operators would reasonably take actions to install portable fans under these circumstances. Note orders had been given to obtain the FLEX portable fans for the MCR during the short duration of the March 9, 2015 event. These fans have been available onsite since November, 2014. A high capacity gas-powered smoke removal fan is also available from the fire brigade van. Installation of such fans would have occurred long term and their ventilation would have provided mitigation for both heatup and buildup of water vapor for this backup LOOP case.

H. Evaluation of Electrical Equipment Survivability under Loss of MCR HVAC Conditions

A Technical Paper (Reference 9) was prepared to document the review of USNRC Information Notice 85-89, NUREG/CR-6479, ENTR-078-CALC-004, and USNRC Inspection Report 05000458/2015010, Attachment 3. It concludes that USNRC Information Notice 85-89 and NUREG/CR-6479 do not identify any previously unevaluated risk factors for reliability of electronic equipment in the RBS MCR during a loss of cooling event because:

- Mitigating actions will be performed within 30 minutes to provide natural circulation to the MCR panels resulting in a different outcome than that presented in USNRC Information Notice 85-89. Also noted, prior to the described event the subject equipment had experienced issues at normal MCR temperatures due to high internal cabinet temperature. RBS has not experienced similar occurrences with MCR equipment. Per NUMARC 87-00 opening panel doors allows adequate air mixing and internal panel temperatures will be in equilibrium with MCR ambient air temperature.

- The review of USNRC Inspection Report 05000458/2015010 also revealed the application of an incorrect maximum design temperature of 104°F. The temperature of 104°F is the maximum ambient temperature for MCR equipment assuming closed control panel doors. Per GE-22A3888, Rev. 3, MCR equipment is designed to operate at temperatures up to 122°F. Assuming control panel doors are open, the ambient temperature and internal panel temperatures will reach equilibrium. Lack of clarity in RBS FSAR Section 6.4.1 has been documented in our corrective action program and corrective actions are being taken to clarify that 104°F is a maximum MCR ambient temperature which supports the 122°F equipment design temperature. MCR equipment is not expected to exceed its maximum design temperature. In addition, operating temperatures for instruments providing MCR indications fall within the design temperature rating of 122°F for all instruments in the GE specification.

- The MCR humidity is not expected to exceed the River Bend Environmental Design Criteria maximum relative humidity of 70%. Without a high humidity environment, there is no synergistic effect between high temperature and high humidity and, per NUREG/CR-6479; risk effects from high temperature alone are insignificant.

I. Risk Aggregation

A Technical Paper (Reference 8) was prepared to evaluate the appropriateness of aggregating the risk impact from individual maintenance configurations during 2014 to develop an overall significance of the violation. This type of aggregation is inappropriate with respect to the intent of 10CFR50.65 (a)(4) and is not supported by the Significance Determination Process (SDP) developed for (a)(4) violations. Applying the SDP as described in MC 0609, Appendix K to the individual configurations and using the associated unavailability times as listed in the inspection report, results in the worst case risk being only a fraction of the improperly aggregated risk.

For any performance deficiency associated with paragraph (a)(4), the determination of the significance is aligned to a specific configuration. In particular, the evaluations that are performed to develop the significance of (a)(4) performance deficiencies use the Zero-Maintenance PRA model as opposed to the average availability Test and Maintenance PRA model used in the development of risk metrics associated with other aspects of the Reactor Oversight Process defined by IMC 0308 and implemented in IMC 0609. This concept of being aligned to a configuration is repeated throughout the process including the parameter definitions used in this significance determination process. The determination of any metric associated with an inadequate risk assessment is clearly tied to a specific configuration and not to an aggregated condition. There are no provisions, as defined in IMC 0308 or as implemented in IMC 0609, for the aggregation of different configurations into an overall significance determination.

Comparing the aggregate risk deficit over a year to the 1E-6 Incremental Core Damage Probability (ICDP) allowed for a single maintenance configuration is inconsistent.

For this issue, the NRC has identified a number of specific maintenance configurations of various chillers being unavailable for which risk assessment and/or risk management was not adequate. Per IMC 0308 and IMC 0609, each of these specific maintenance configurations must be assessed independently to determine the significance of the inadequate risk assessment for that configuration.

J. Evaluation of NRC's inclusion of fire risk in a Maintenance Rule (a)(4) violation

During 2014, RBS implemented their proceduralized risk management actions in accordance with ADM-0096, "Risk Management Program Implementation and On-Line Maintenance Risk Assessment" during Divisional HVK chiller outages. These actions are consistent with industry practice and meet the NRC-endorsed guidance of NUMARC 93-01, Rev 4a. RBS believes it is not appropriate to add external event fire risks in this assessment. This is also discussed in Reference 8.

K. Evaluation of Loss of Medium Voltage Bus Initiating Event

The RBS PRA Models have never included an Initiating Event for a loss of a safety-related 4160 volt bus. Reference 10 is a Technical Paper that evaluates the inclusion of this initiator in the NRC's RBS SPAR model. The RBS SPAR model includes an Initiating Event of a Loss of Medium Volt Bus (i.e., ENS-SWG1A(B) 4160 volt busses). This initiator does not have a significant risk importance as per the RBS Plant Risk Information e-Book issued by the NRC (dated 4/18/12) and as such, is not included in the RBS PRA model. This was because a review of RBS loads powered by the 4KV buses has confirmed that the loads that are lost with such an event would not lead to an automatic or immediate manual plant scram. Such a situation would put the plant into a 12-hour Technical Specification LCO. This is documented in the screening of Initiating Events for the RBS PRA.

Thus, RBS does not believe that the Loss of Medium Voltage Bus initiating event should be included in the SPAR model.

L. PRA Evaluation of risk associated with MCR Heatup

RBS has performed new engineering analyses, research and testing to incorporate more realism into the modeling of control building cooling into the RBS PRA. This effort has demonstrated that the R5 EOOS model currently in use and used throughout 2014 is very conservative with regard to control building cooling. The PRA model was revised (revision R5-RHU) to account for improved Control Building heatup calculations and detailed equipment survivability studies. These modifications incorporated in the R5-RHU model significantly reduced the contribution of risk from loss of control building cooling to the AC switchgear, DC equipment and battery rooms. Conservative modeling for MCR cooling and the impact on operator actions modeled in the PRA were subsequently added to the model for revision R5-RHU-MCR. The addition of conservative modeling for cooling to the MCR in R5-RHU-MCR resulted in a relatively insignificant increase in CDF due to MCR heatup when compared to the R5-RHU model. A third party review of the R5-RHU-MCR model was performed by a recognized expert in the PRA community.

The use of the new models also has demonstrated that the risk of HVK outages during 2014 is of very low significance. Calculated risk deficit against the Revision 5 PRA model in use for Maintenance Rule configuration risk management is -4.39E-07, which means actual risk was bounded by calculated risk in the R5 EOOS Model. Using the R5-RHU PRA that account for refined Control Building heatup calculations and improved electrical equipment survivability studies, the calculated risk deficit is a small value, <<E-9. These results are consistent with the industry consensus that MCR HVAC is a small contributor to risk. RBS concludes that risk assessments of HVK outages performed with the R5-EOOS model during 2014 have been demonstrated to be conservative.

Table 2 provides a summary of the results for the risk deficit if the 2014 HVK Divisional Outage impacts were aggregated.

Table 2
Summary of Risk Deficit Calculations

	Risk Deficit	
	R5 vs. R5-RHU-MCR	**R5-RHU vs. R5-RHU-MCR**
Combined 2014 HVK Outages (consistent with NRC Inspection Report)	-4.39E-07	<<E-9

M. Remote Shutdown Room Heatup

Information on heatup of the rooms containing the Remote Shutdown Panels is included in calculation G13.18.12.3*161, the calculation for Switchgear Area heatup as of the March 2015 Special Inspection. That calculation showed temperatures for the Remote Shutdown Rooms of about 170°F for Division 1 and about 130°F for Division 2 at 24 hours into an event. However, those temperatures were calculated assuming that the doors to those rooms remained closed for the entire 24 hours.

RBS subsequently performed an evaluation (Reference 6) of the temperature response for the Remote Shutdown Rooms based upon realistic heat loads in these rooms. This evaluation estimated that the rooms would only heat up to 114.2°F in 2 hours or 118.7°F in 6 hours, thus equipment in those rooms would have remained available and functional and would not have been damaged by high temperature if operators relocated to the Remote Shutdown Panel at that time.

The Remote Shutdown Panels are not credited in any of the RBS evaluations provided. However, this evaluation shows they would realistically be available before MCR temperature would reach 122°F.

References:

1. RBS Engineering Report RBS-ME-16-00003 (STP / heat load measurement report)
2. Enercon calculation ENTR-078-CALC-004 (RBS Engineering Report RBS-ME-16-00002)
   (MCR heatup calculation using design heat loads)

3. Attachment 22 to Enercon calculation ENTR-078-CALC-003 revision 4 (RBS vendor document 4216.110-996-004)
   (MCR heatup calculation using realistic heat loads)
4. Attachment 5 to Enercon calculation ENTR-078-CALC-003 revision 4 (RBS vendor document 4216.110-996-004)
   (MCR heatup calculation using realistic heat loads)
5. MCR Operator Habitability Report
6. Remote Shutdown Panel Room Heatup Evaluation
7. PRA Model Changes to Include Control Room Cooling
8. Risk Aggregation per IMC 0609 Appendix K
9. Response to NRC Concern with Temperature Effects on Safety-Related Electronics in Main Control Room
10. White Paper on Loss of Medium Voltage AC Bus Initiator for RBS PRA

Attachment 4
to RBS-47668

Calculation No. ENTR-078-CALC-003, Attachment 22, Heat Load Sensitivity with HVC-ACU1A(B) Aligned to SWP

Attachment 22: Heat Load Sensitivity with HVC-ACU1A(B) Aligned to SWP

The actual Main Control Room (MCR) heat load was determined in RBS-ME-16-00003 (Reference 8.26) as 59,871 Watts. The total normal operations heat load used in ENTR-078-CALC-004 (Reference 8.25) (excluding operator heat load) is 105,637 Watts. The heat load from Reference 8.25 is highly conservative as it results in a significantly faster MCR heat-up transient than was observed on the 3/9/2015 event. This is due to the fact that the heat load in Reference 8.25 is a design heat load; in reality the heat generating equipment would not be operating at 100% capacity for the duration of the transient. The heat load developed in Reference 8.26 is divided by the heat load used in ENTR-078-CALC-004 to determine a reduction factor that is applied to the heat loads for Attachment 1 case in ENTR-078-CALC-004. This reduction factor is determined below. The reduction factor is applied evenly to all of the heat loads in this analysis except for operator heat loads, which are kept the same.

$$Heat\ Load\ Reduction = \frac{59{,}871\ Watts}{105{,}637\ Watts} = 0.567$$

The sensitivity in this attachment evaluates the effect of this lower actual heat load on the MCR heatup transient on the Attachment 1 case from Reference 8.25. Additionally the assumed time to re-start HVC-ACU1A(B) aligned to the service water system (SWP) is delayed from one hour to six hours. The internal heat rate in the control panel thermal conductors is turned off to provide a more realistic heat-up transient. The internal heat rate in the control panel thermal conductors was used to initialize these conductors to a high temperature so that the sensible heat that would potentially be released to the MCR from these conductors is included. Based on the fact that this sensible heat from the control panels would be released during steady-state period, the measurements recorded in RBS-ME-16-00003 would include this heat load as part of the total heat load. Therefore, initializing these control panel thermal conductors to an elevated temperature would be redundant in terms of addressing the heat from the control panels. Additionally, no loads are shed throughout the analysis and the heat rate to the air from electrical equipment is constant. The results of the sensitivity are compared to the results from Attachment 1 of Reference 8.25 in the table below.

Case	1 hr T_{avg} (°F)	2 hr T_{avg} (°F)	4 hr T_{avg} (°F)	24 hr T_{avg} (°F)	Maximum T_{avg} (°F)	Maximum Cell Temp (°F)
ENTR-078-CALC-004, Attachment 1	110.0	105.0	106.1	107.8	110.0 (1 hr)	115.1 (1 hr)
Attachment 22	95.2	100.6	107.9	104.0	113.1 (6 hr)	117.2 (6 hr)

Figure 1 and 2 compare the average and maximum local temperature of the lower MCR for this sensitivity to Attachment 1 of Reference 8.25. Figure 1 and 2 show that the heat-up transient is slower for this sensitivity due to the reduced heat load. The maximum average and maximum local temperature are greater in this sensitivity due to the 5 hour delay in re-starting HVC-ACU1A(B) aligned to SWP (from one hour to six hours). After HVC-ACU1A(B) is started, the average temperature is approximately 4°F less than the average temperature in Attachment 1 case of Reference 8.26, reflecting the effects of the lower MCR heat loads. Figure 3 compares the relative humidity in the horseshoe area of the MCR to Attachment 1 of Reference 8.25. The relative humidity is slightly higher for this sensitivity due to the reduced temperature.

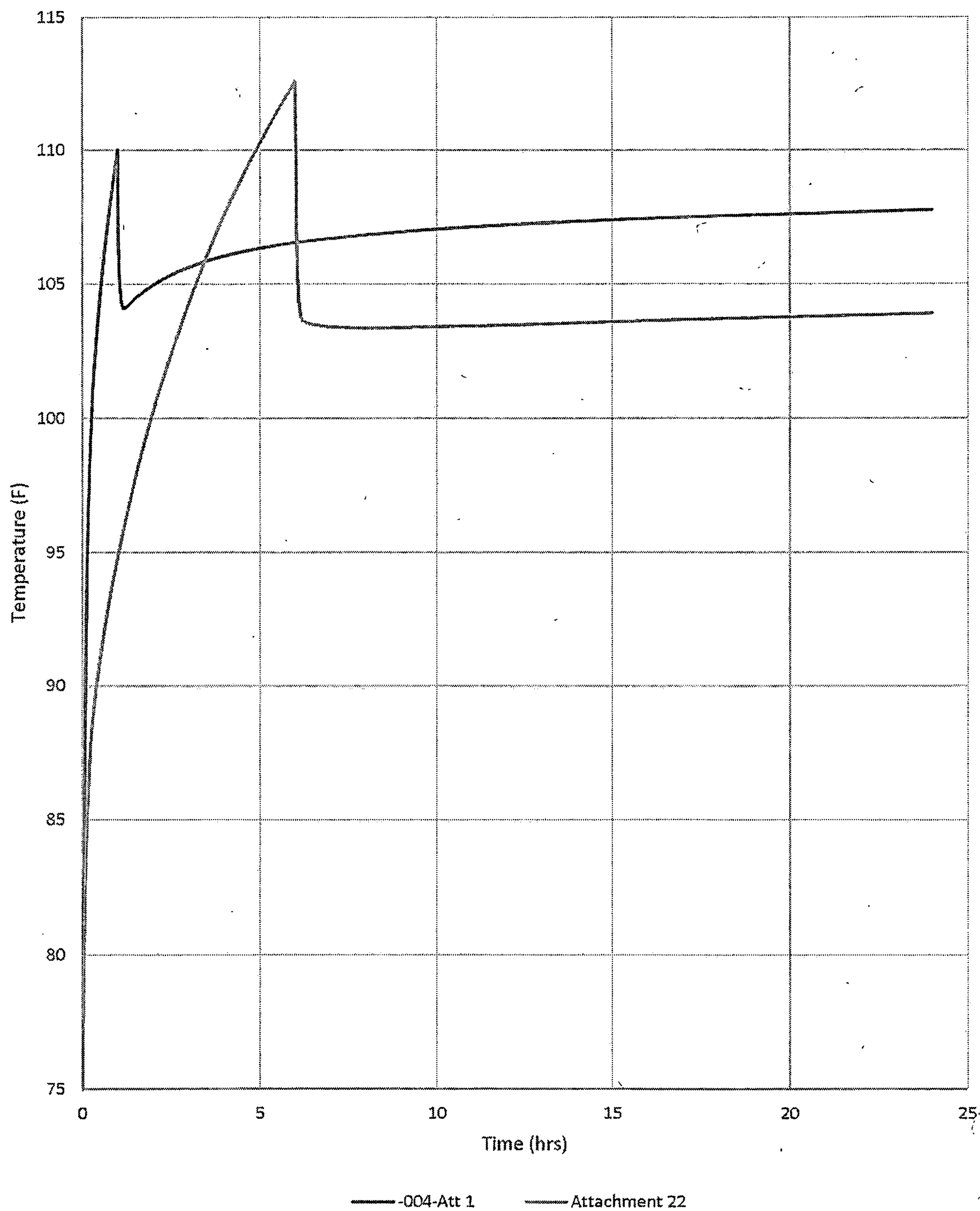


Figure 1: Average Temperature of the MCR for Attachment 22

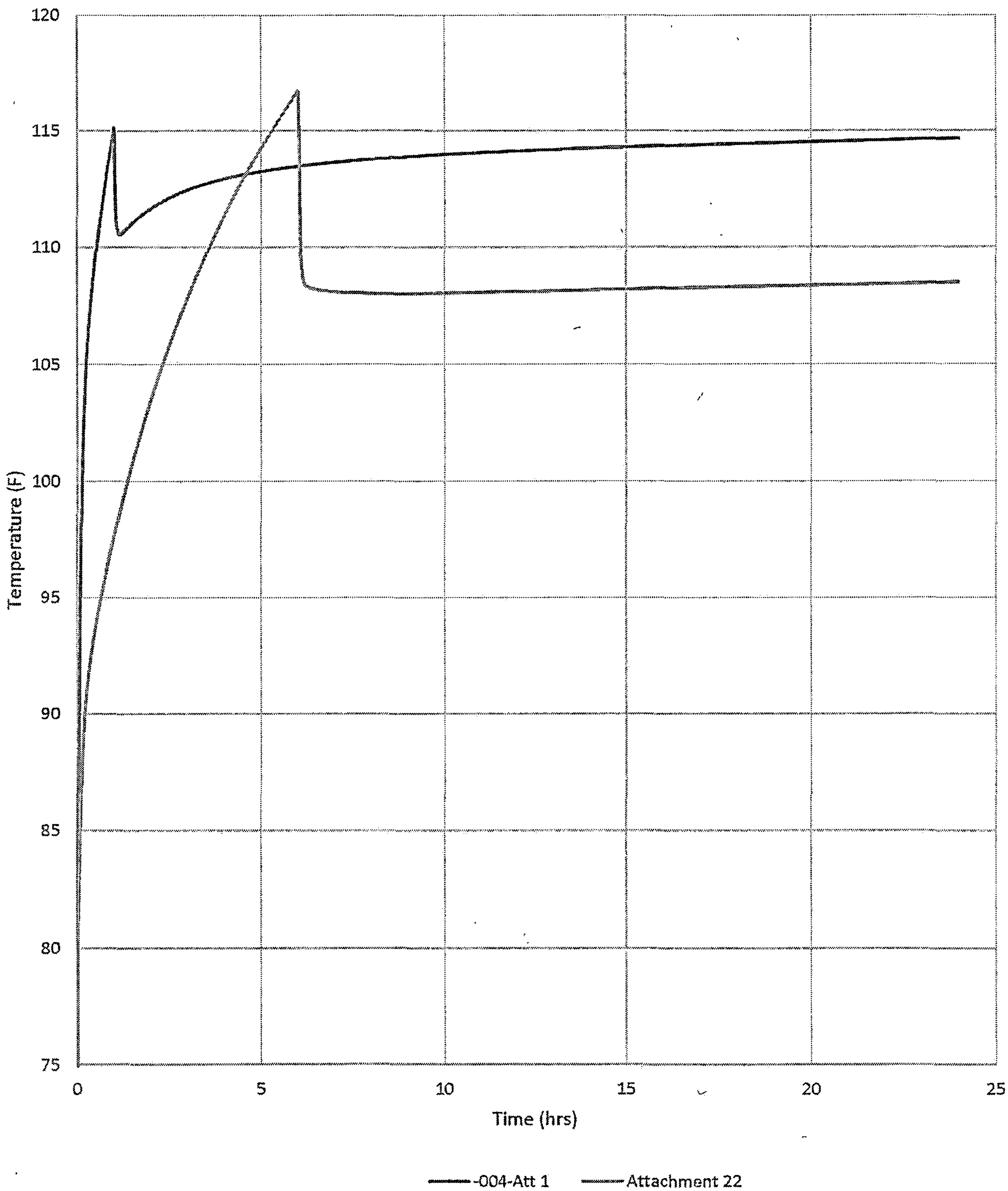


Figure 2: Maximum Local Temperature of the MCR for Attachment 22

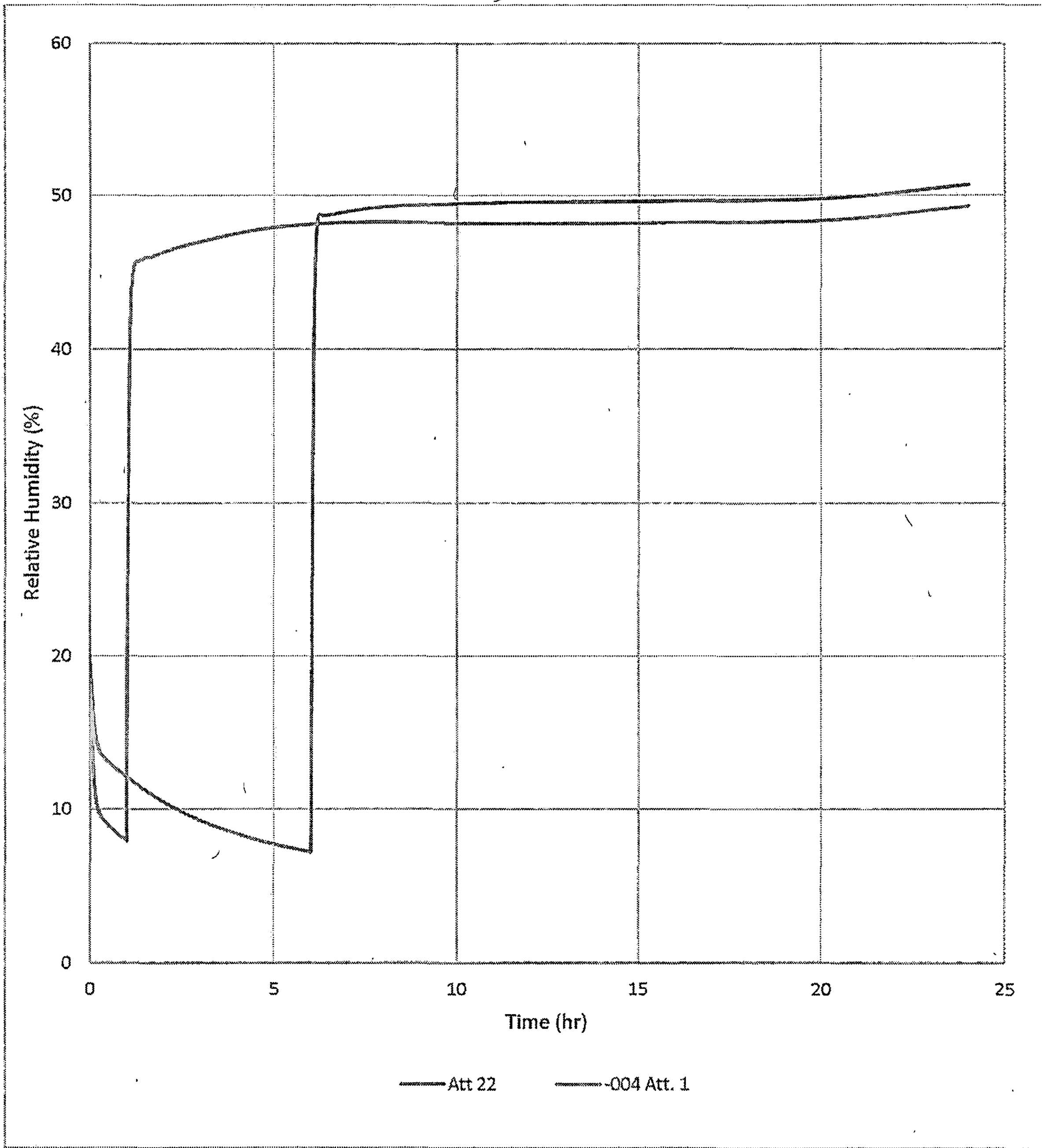


Figure 3: Relative Humidity of the MCR for Attachment 22

Attachment 5
to RBS-47668

Calculation Report No. ENTR-078-CALC-003, Attachment 5, Heat Load Sensitivities

Attachment 5: Heat Load Sensitivities

The actual Main Control Room (MCR) heat load was determined in RBS-ME-16-00003 (Reference 8.26) as 59,871 Watts assuming the Environmental Design Criteria (EDC) maximum humidity of 70%. Assuming the EDC maximum humidity conservatively maximizes the heat load compared to using 0% humidity as the air is denser at higher relative humidifies. The heat load in Reference 8.26 is calculated based on a heat balance using the recorded HVC-ACU1A(B) flow rate, and the measured inlet and outlet temperatures in the MCR. The total normal operations heat load used in ENTR-078-CALC-004 (Reference 8.25) (excluding operator heat load) is 105,637 Watts. The heat load from Reference 8.25 is highly conservative as it results in a significantly faster MCR heat-up transient than was observed on the 3/9/2015 event. This is due to the fact that the heat load in Reference 8.25 is a design heat load; in reality the heat generating equipment would not be operating at 100% capacity for the duration of the transient. The sensitivity cases in this attachment evaluate the effect of this lower actual heat load on the MCR heatup transient. The heat load developed in Reference 8.26 is divided by the heat load used in ENTR-078-CALC-004 to determine a reduction factor that is applied to the heat loads for the normal operations cases in ENTR-078-CALC-004. This reduction factor is determined below. The reduction factor is applied evenly to all of the heat loads in this analysis except for operator heat loads, which are kept the same.

$$Heat\ Load\ Reduction = \frac{59{,}871\ Watts}{105{,}637\ Watts} = 0.567$$

Four sensitivities are evaluated in this attachment:

- Case A: Heat load reduction is applied to Case 2 from ENTR-078-CALC-004 (20% initial relative humidity). The internal heat rate in the control panel thermal conductors is turned off to provide a more realistic heat-up transient. The internal heat rate in the control panel thermal conductors was used to initialize these conductors to a high temperature so that the sensible heat that would potentially be released to the MCR from these conductors is included. Based on the fact that this sensible heat from the control panels would be released during steady-state period, the measurements recorded in RBS-ME-16-00003 would include this heat load as part of the total heat load. Therefore, initializing these control panel thermal conductors to an elevated temperature would be redundant in terms of addressing the heat from the control panels. Additionally, no loads are shed throughout the analysis and the heat rate to the air from electrical equipment is constant. During a LOOP scenario this internal heat generation rate would be more realistic as loads are shed, and there would be stored energy in the panels not accounted for by the base heat loads.
- Case B: Heat load reduction is applied to the Case in Attachment 2 (70% initial relative humidity) of ENTR-078-CALC-004. The internal heat rate in the control panel thermal conductors is turned off to provide a more realistic heatup.
- Case C: Same as Case A, except that the timing for operator actions is delayed as follows:

  1. The operator action to open the MCR door is delayed from one hour to two hours.
  2. The operator action to stage the portable fan is delayed from 1.5 hours to 2.5 hours.
  3. The operator action to start the smoke removal fan is delayed from 2 hours to 6 hours.
  4. The operator action to initiate removal of ceiling tiles is delayed from 2.5 hours to 6.5 hours.

- Case D: Same as Case C, except the control panel thermal conductors are conservatively initialized with an internal heat rate to elevate the initial temperature of these conductors.

The results of the temperature transient are compared to the results of Case 2 from ENTR-078-CALC-004 in the table below. The heat load reduction is shown to have approximately a 15°F reduction in

temperature for the first two hours before the smoke removal fan is started for Case A and B. After the smoke removal fan is started, the difference in the MCR temperature is 8-9°F for Case A and B. The results for Case D show that using the internal heat rate for the control panel thermal conductors increase the temperature in the MCR during the initial periods, compared to Case C. The sensitivity to the internal generating heat rate at 24 hours is shown to be negligible. The results for Case C and D show that the action to turn on the smoke removal fan could potentially be delayed to over 6 hours.

Case	1 hr T_{avg} (°F)	2 hr T_{avg} (°F)	4 hr T_{avg} (°F)	24 hr T_{avg} (°F)	Maximum T_{avg} (°F)	Maximum Local Temp (°F)
ENTR-078-CALC-004: Case 2	109.5	116.1	109.0	108.6	116.1 (2.0 hrs)	121.8 (2.02 hrs)
Attachment 5-Case A	95.2	100.4	101.1	99.7	102.0 (5.2 hrs)	107.2 (6.8 hrs)
Attachment 5-Case B	95.2	100.4	101.1	99.7	102.0 (5.2 hrs)	107.2 (6.8 hrs)
Attachment 5-Case C	95.2	100.4	107.2	99.8	111.7 (6 hrs)	115.7 (6 hours)
Attachment 5-Case D	99.6	103.8	109.2	99.9	113.1 (6 hrs)	117.2 (6 hrs)

The temperature transient for Case A is shown in Figure 1 and 2. The temperature transient for Case B is not shown as it is nearly identical to Case A. The relative humidity transient for Case B is shown in Figure 3. The Case A relative humidity transient is not shown as it is bounded by the relative humidity in Case B. The temperature transient for Case C is shown in Figure 4 and 5. The relative humidity for Case C is shown in Figure 6. The temperature transient for Case D is shown in Figure 7 and 8. The relative humidity for Case D is shown in Figure 9.

Figure 1 compares the average temperature of the MCR for Case A to the average temperature of the MCR for Case 2 from ENTR-078-CALC-004. The average temperature of the MCR for Case A increases to 100.4 °F at two hours immediately before the smoke removal fan is started. Starting the smoke removal fan results in a brief reduction in temperature. The temperature increases again while the ceiling tile removal action is taken reaching an overall maximum of approximately 102.0°F at 5.2 hours. The temperature then decreases due to the diurnal change in outside air temperature. The MCR average temperature is 99.7°F at 24 hours.

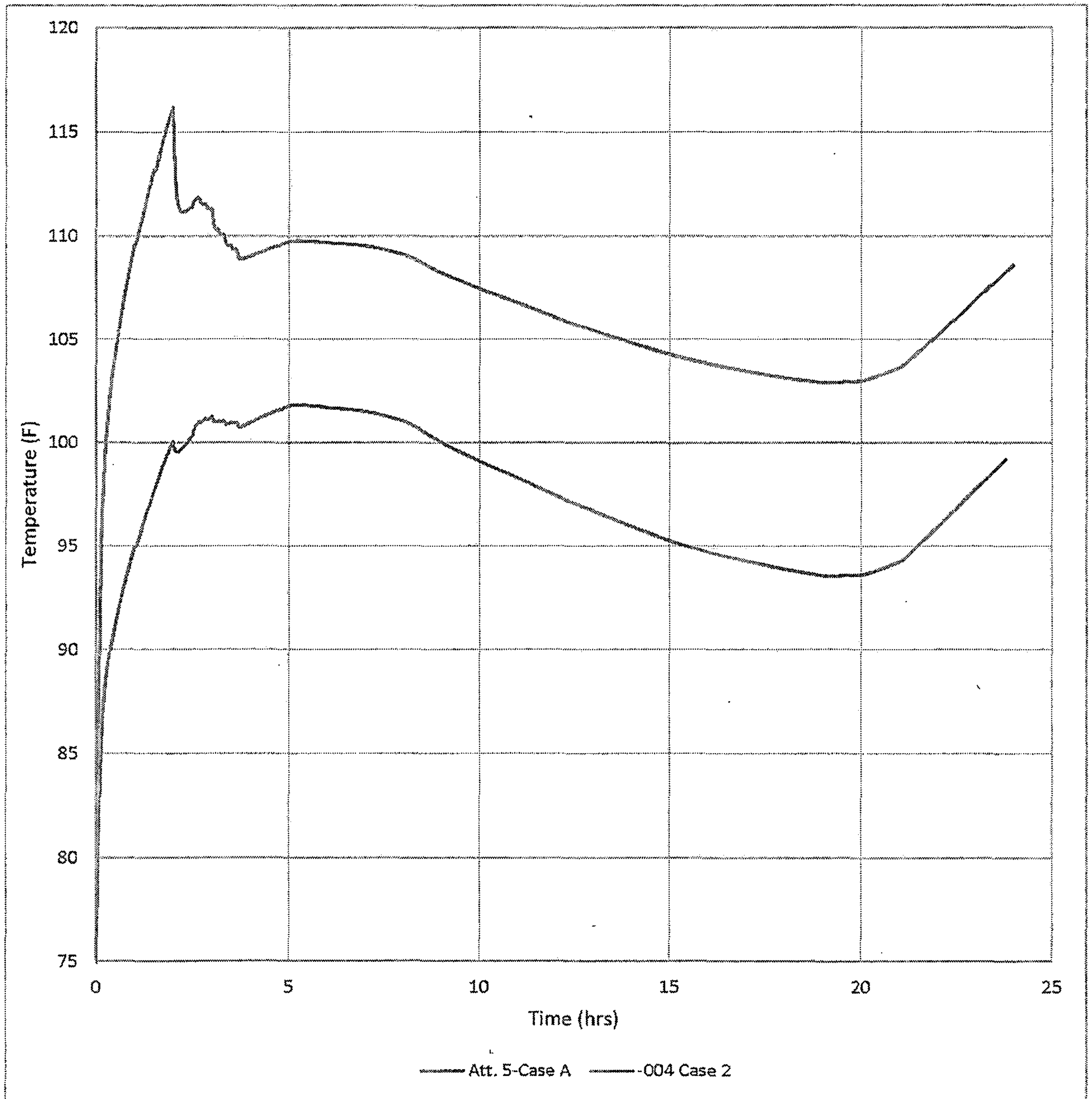


Figure 1: Average Temperature of the MCR for Case A

Figure 2 compares the maximum local temperature of the MCR for Case A to the maximum local temperature from Case 2 of ENTR-078-CALC-004. The maximum local temperature for Case A increases to 103.4°F at 2 hours immediately before the smoke removal fan is started. Starting the smoke removal fan results in a brief reduction in temperature. The temperature continues to increase until 2.5 hours when the ceiling tile removal is started, which briefly decreases the temperature before reaching the maximum local temperature of 107.2°F at approximately 6.8 hours. The temperature then decreases due to the diurnal change in outside air temperature and at 24 hours, the maximum local temperature is approximately 105.2°F.

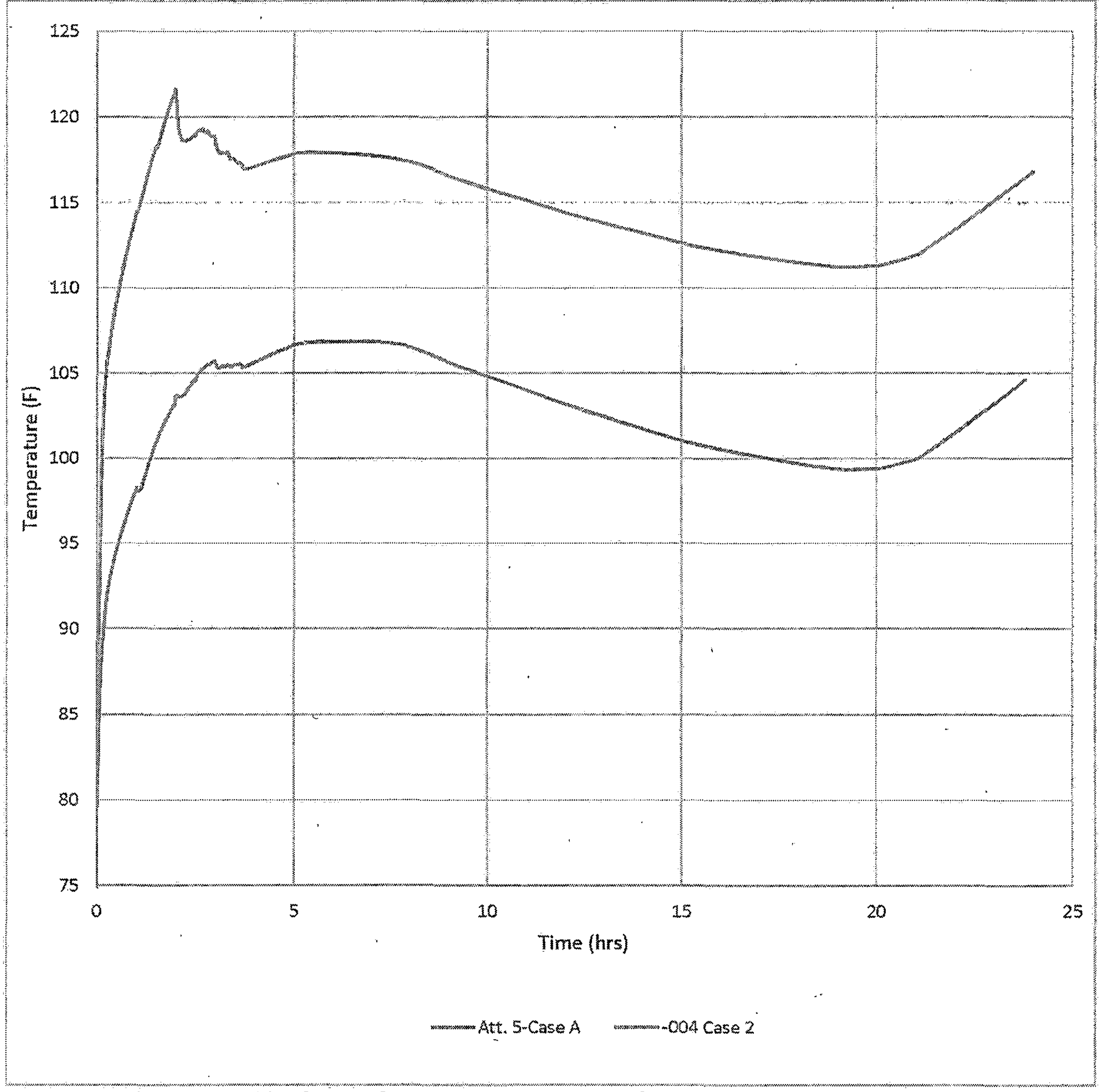


Figure 2: Maximum Local Temperature of the MCR for Case A

Figure 3 compares the relative humidity in the horseshoe area of the MCR for Case B to the relative humidity in the horseshoe area of the MCR from Attachment 2 of ENTR-078-CALC-004. The initial relative humidity for Case B is 70% and decreases initially due to the rising MCR temperature. At 2 hours the relative humidity increases to approximately 49% due to the smoke removal fan starting and drawing in outside air. The relative humidity then fluctuates between 45% and 60% for the remainder of the transient due to the diurnal change in outside air temperature. The relative humidity is approximately 10-15% higher through the transient for Case B compared to the case in Attachment 2 of ENTR-078-CALC-004 due to the reduced temperature for Case B.

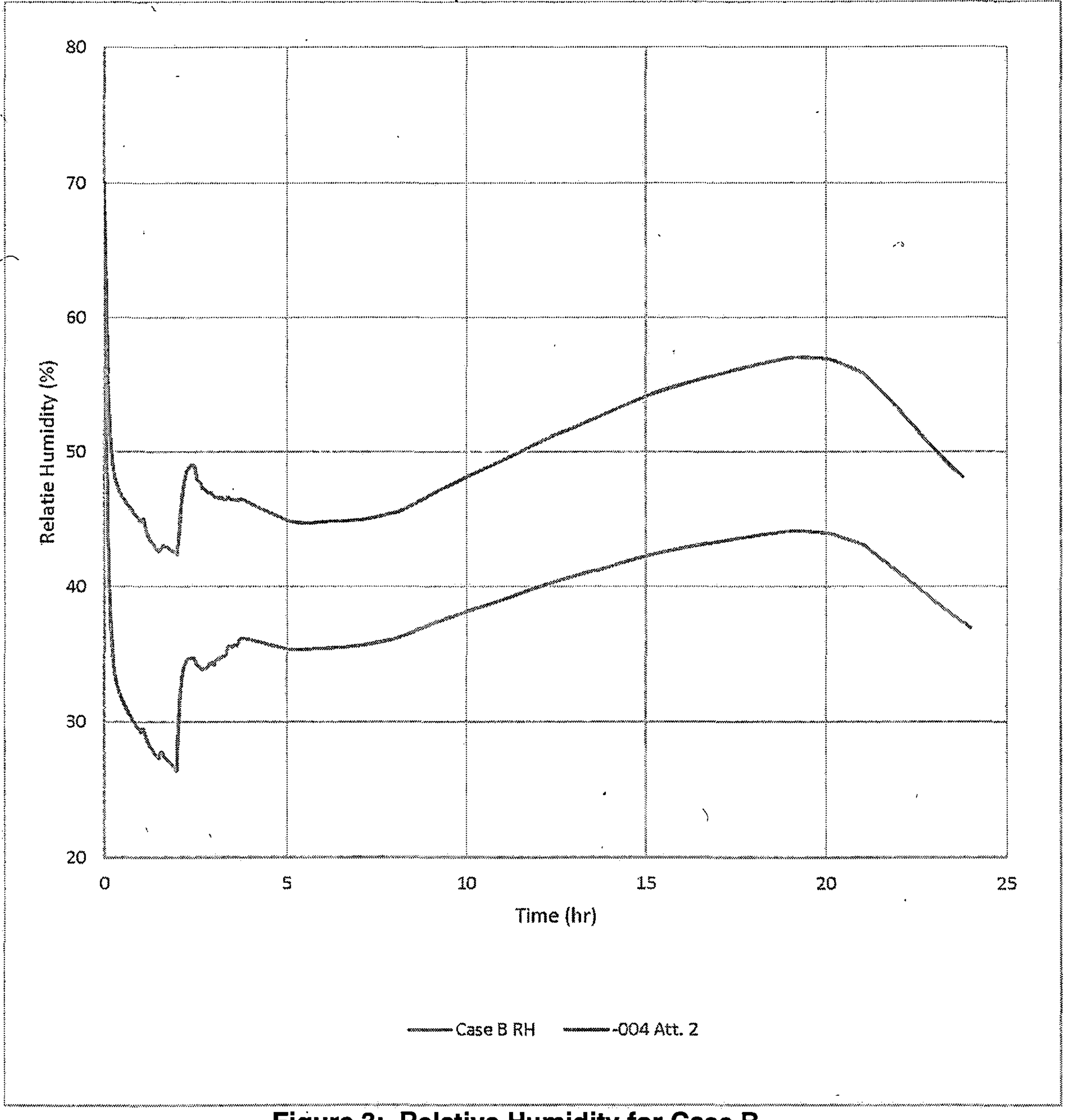


Figure 3: Relative Humidity for Case B

Figure 4 shows the average temperature of the MCR for Case C. The average temperature increases to the maximum value of 111.7°F at 6 hours immediately before the smoke removal fan is started at six hours. Starting the smoke removal fan decreases the average temperature to approximately 106°F. Ceiling tile removal further decreases the average temperature. The average temperature then fluctuates due to the diurnal change in temperature and at 24 hours is 99.8°F. The four hour delay in starting the smoke removal fan results in approximately a 10°F increase in the maximum average temperature compared to Case A and B. However, the maximum average temperature remains below the Case 2 results, due to the lower MCR heat loads.

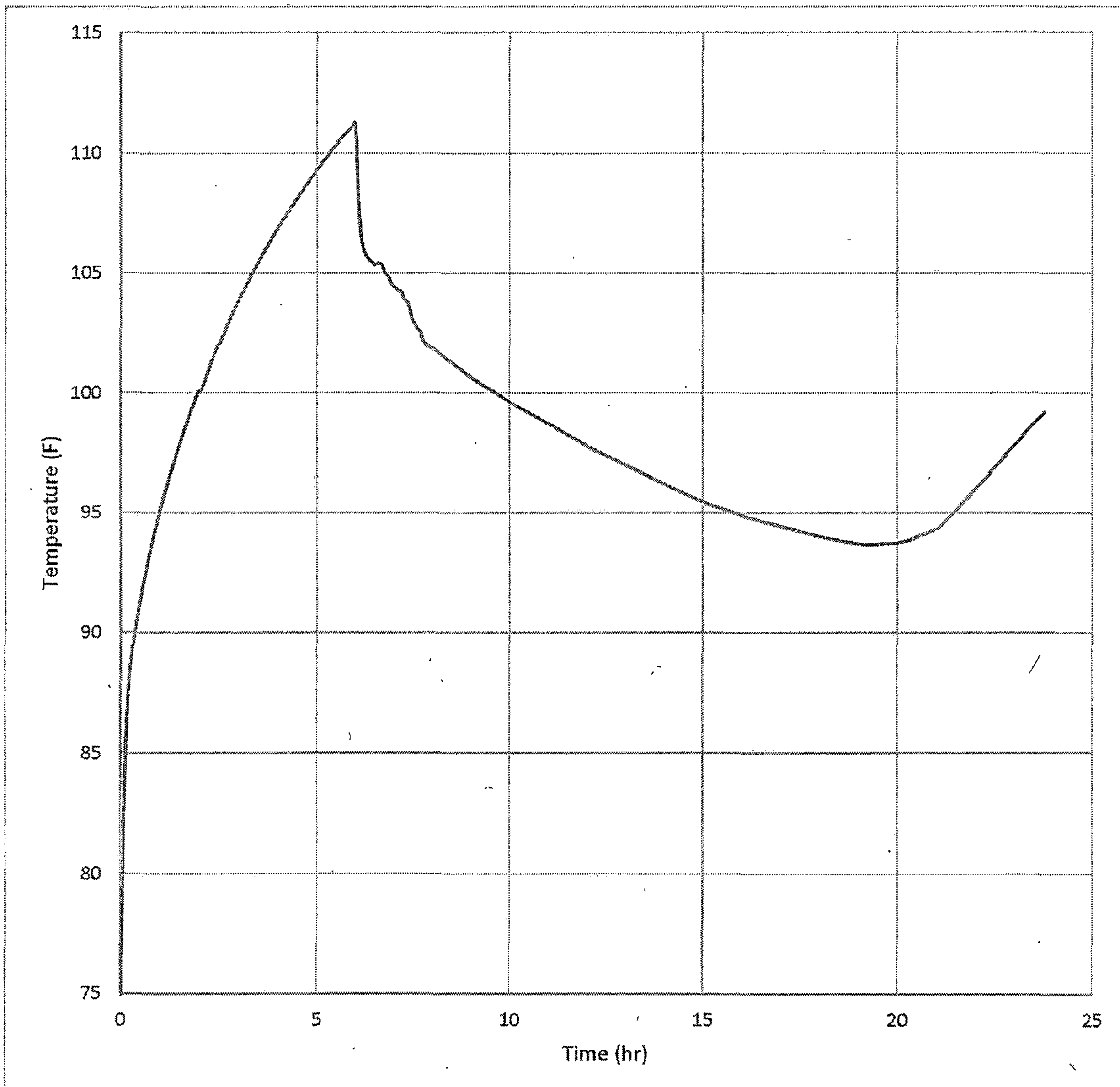


Figure 4: Average Temperature of the MCR for Case C

Figure 5 shows the maximum local temperature of the MCR for Case C. The maximum local temperature increases to the maximum of 115.7°F immediately before the smoke removal fan is started at six hours. Starting the smoke removal fan decreases the maximum local temperature to approximately 111°F. Ceiling tile removal further decreases the maximum local temperature. The maximum local temperature fluctuates due to the diurnal change in outside air temperature and at 24 hours is 105.1°F. The four hour delay in starting the smoke removal fan results in approximately an 8.5°F increase in the maximum local temperature compared to Case A and B. The results of Case C show that the timing of the operator action to start the smoke removal fan and initiate ceiling tile removal could be delayed greater than four hours past the time assumed in ENTR-078-CALC-004, Case 2.

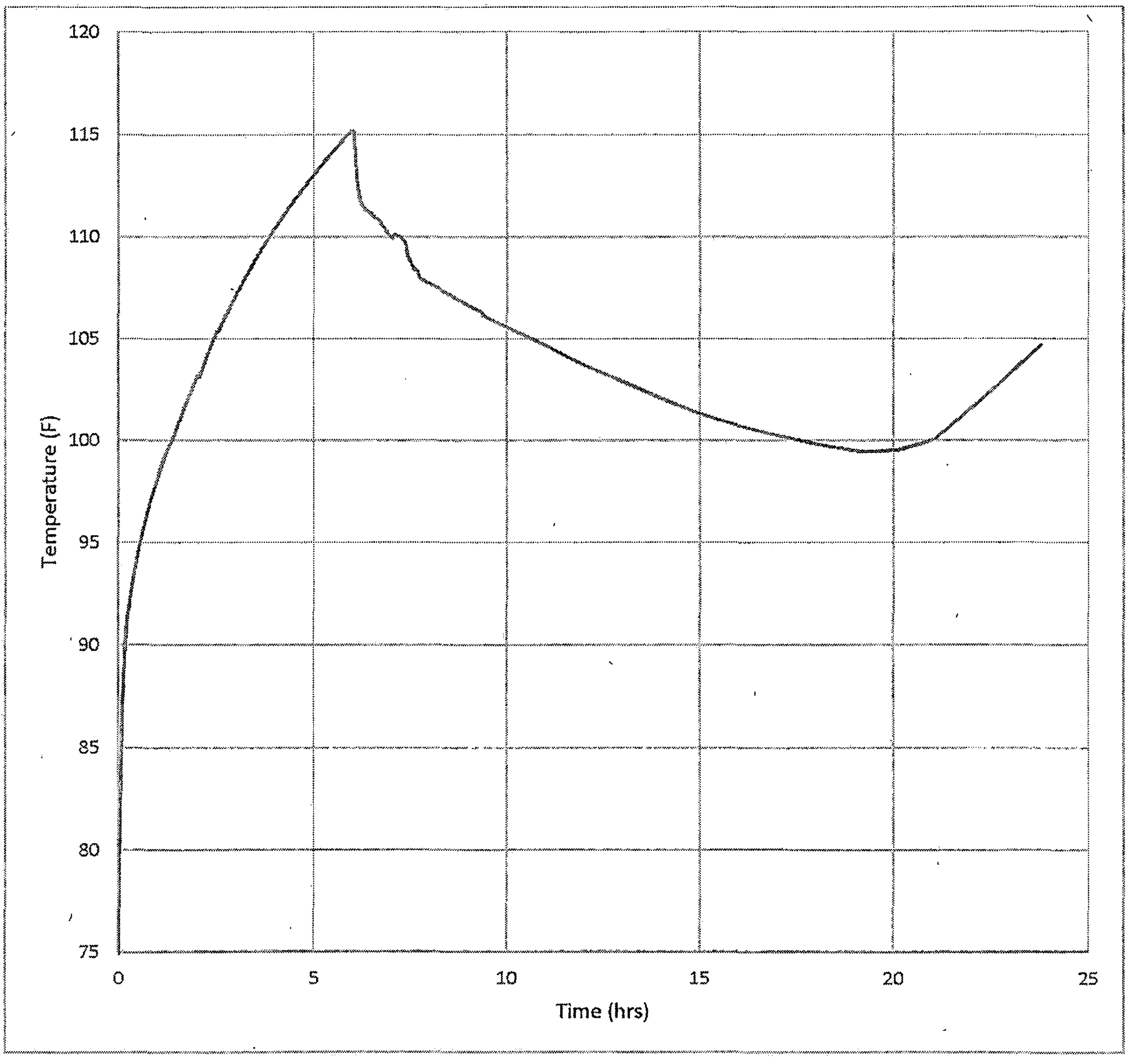


Figure 5: Maximum Local Temperature of the MCR for Case C

Figure 6 shows the relative humidity in the horseshoe area of the MCR for Case C. The relative humidity decreases initially due to the rising temperature, and then begins to increase due to the outside air introduced through the toilet/kitchen fan. The relative humidity increases from 30% to 40% at 6 hours due to the smoke removal fan being started and drawing in outside air. The relative humidity then fluctuates between 40% and 55% for the rest of the transient due to the diurnal change in outdoor air temperature.

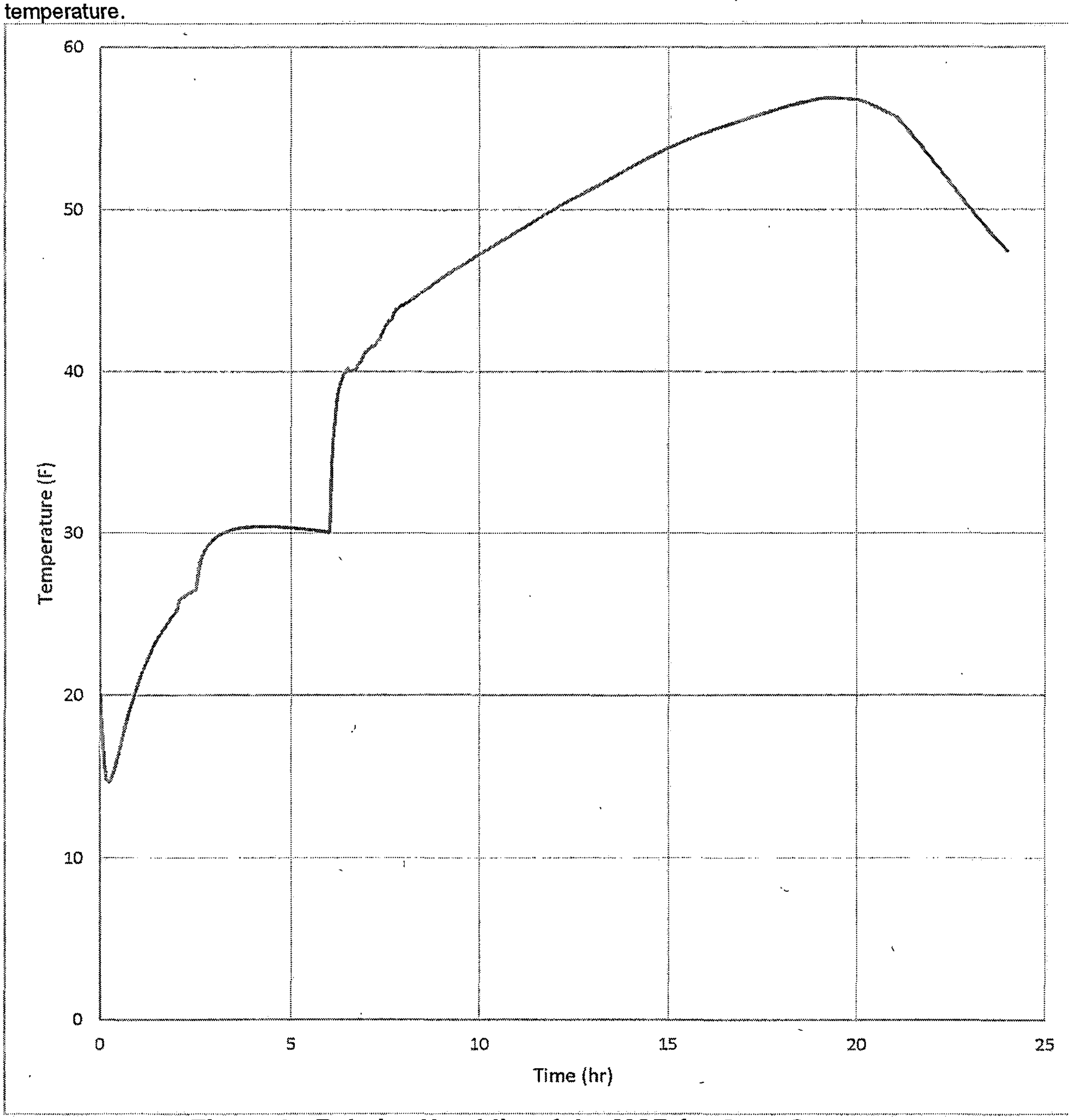


Figure 6: Relative Humidity of the MCR for Case C

Figure 7 shows the average temperature of the MCR for Case D. The average temperature increases to the maximum value of 113.1°F at 6 hours immediately before the smoke removal fan is started at six hours. Starting the smoke removal fan decreases the average temperature to approximately 106°F. Ceiling tile removal further decreases the average temperature. The average temperature then fluctuates due to the diurnal change in temperature and at 24 hours is 99.9°F. The four hour delay in starting the smoke removal fan results in approximately an 11°F increase in the maximum average temperature compared to Case A and B. However, the maximum average temperature remains below the Case 2 results, due to the lower MCR heat loads.

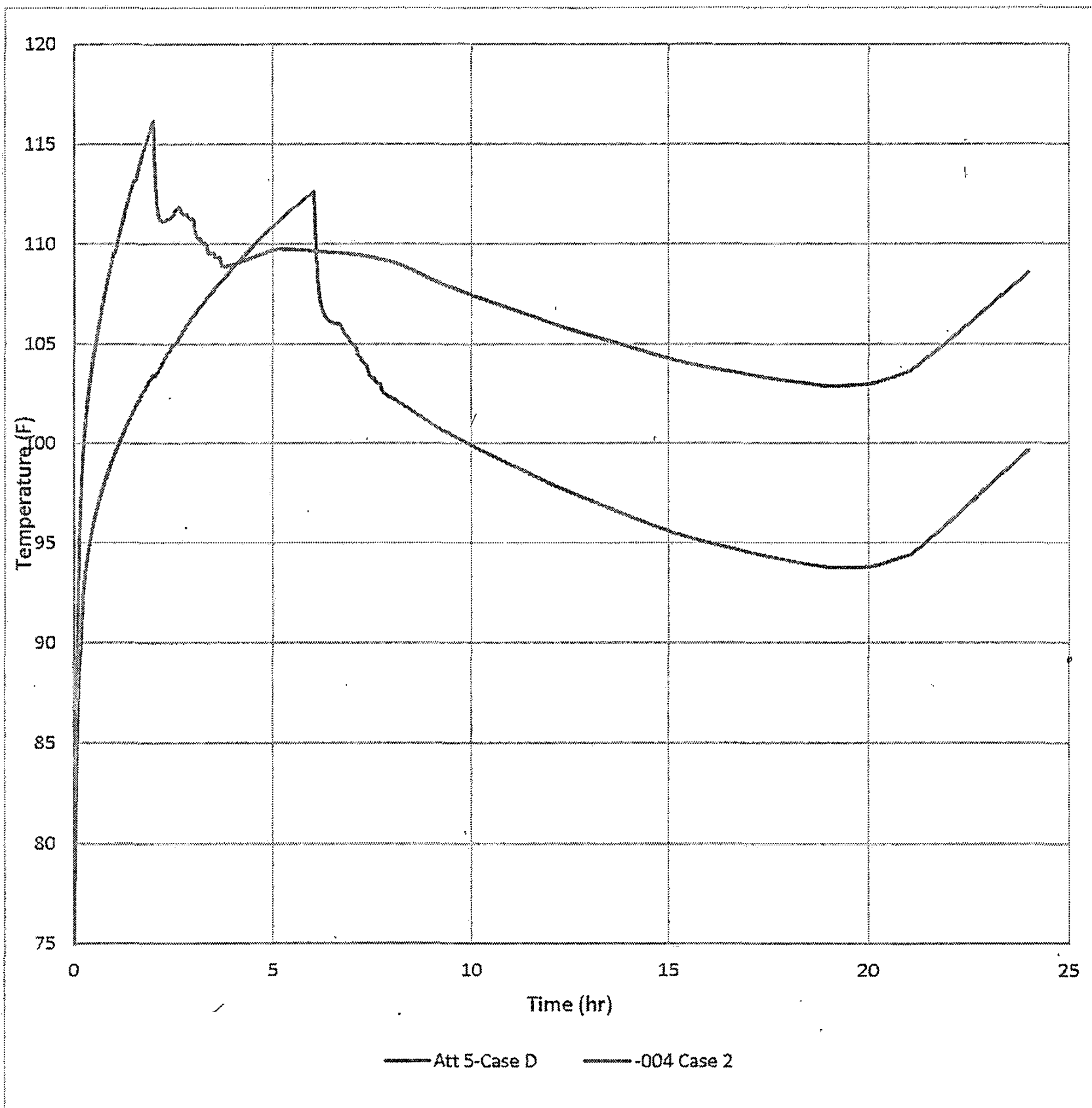


Figure 7: Average Temperature of the MCR for Case D

Figure 8 shows the maximum local temperature of the MCR for Case D. The maximum local temperature increases to the maximum of 117.2°F immediately before the smoke removal fan is started at six hours. Starting the smoke removal fan decreases the maximum local temperature to approximately 112°F. Ceiling tile removal further decreases the maximum local temperature. The maximum local temperature fluctuates due to the diurnal change in outside air temperature and at 24 hours is 105.1°F. The four hour delay in starting the smoke removal fan results in approximately an 8.5°F increase in the maximum local temperature compared to Case A and B. The results of Case D show that the timing of the operator action to start the smoke removal fan and initiate ceiling tile removal could be delayed greater than four hours past the time assumed in ENTR-078-CALC-004, Case 2.

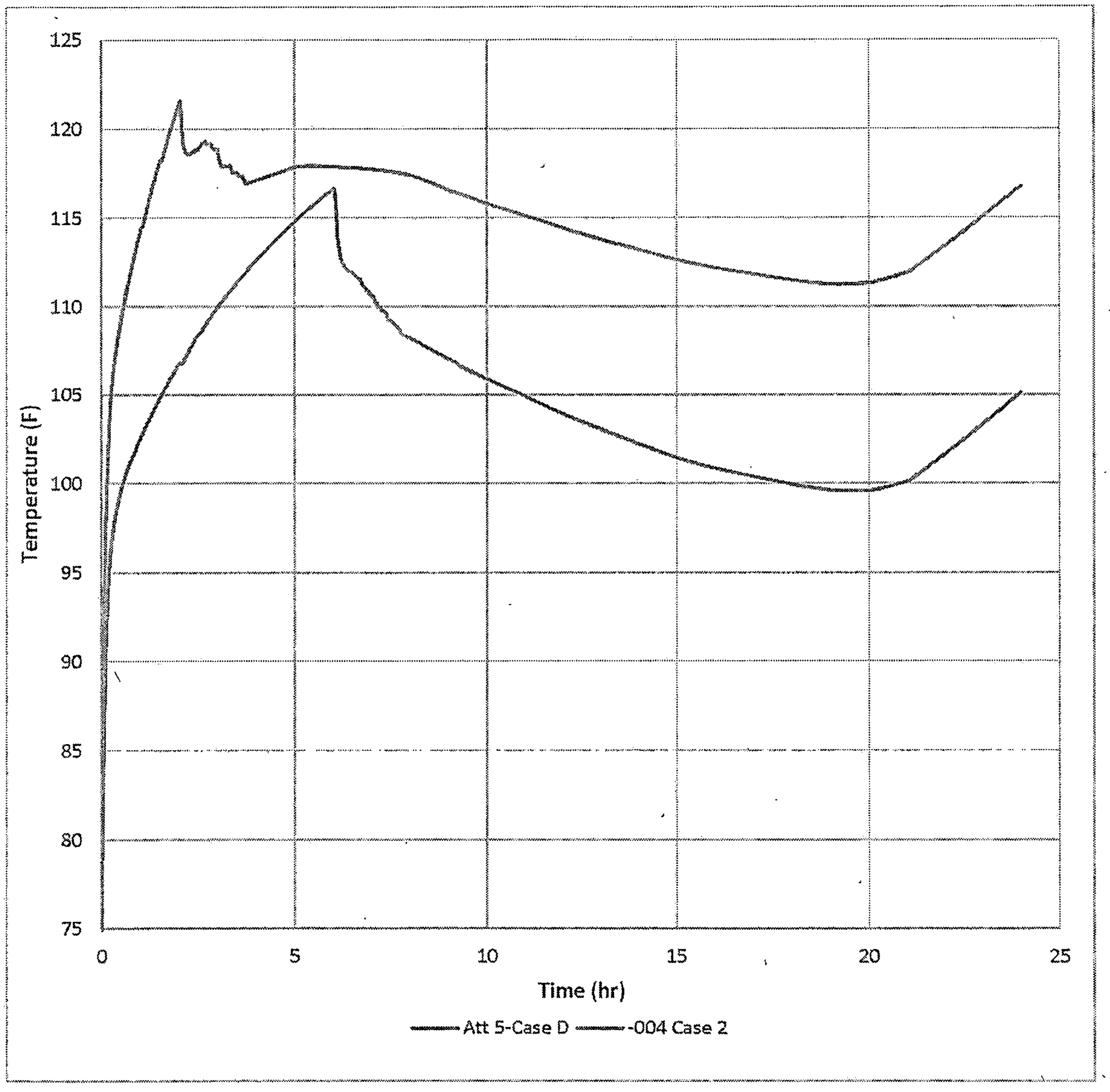


Figure 8: Maximum Local Temperature of the MCR for Case D

Figure 9 shows the relative humidity in the horseshoe area of the MCR for Case D. The relative humidity decreases initially due to the rising temperature, and then begins to increase due to the outside air introduced through the toilet/kitchen fan. The relative humidity increases from approximately 25% to 40% at 6 hours due to the smoke removal fan being started and drawing in outside air. The relative humidity then fluctuates between approximately 40% and 55% for the rest of the transient due to the diurnal change in outdoor air temperature. Once the smoke removal fan is started, the relative humidity for Case D is approximately 10-15% greater than Case 2 of Reference 8.25 due to the reduced temperature.

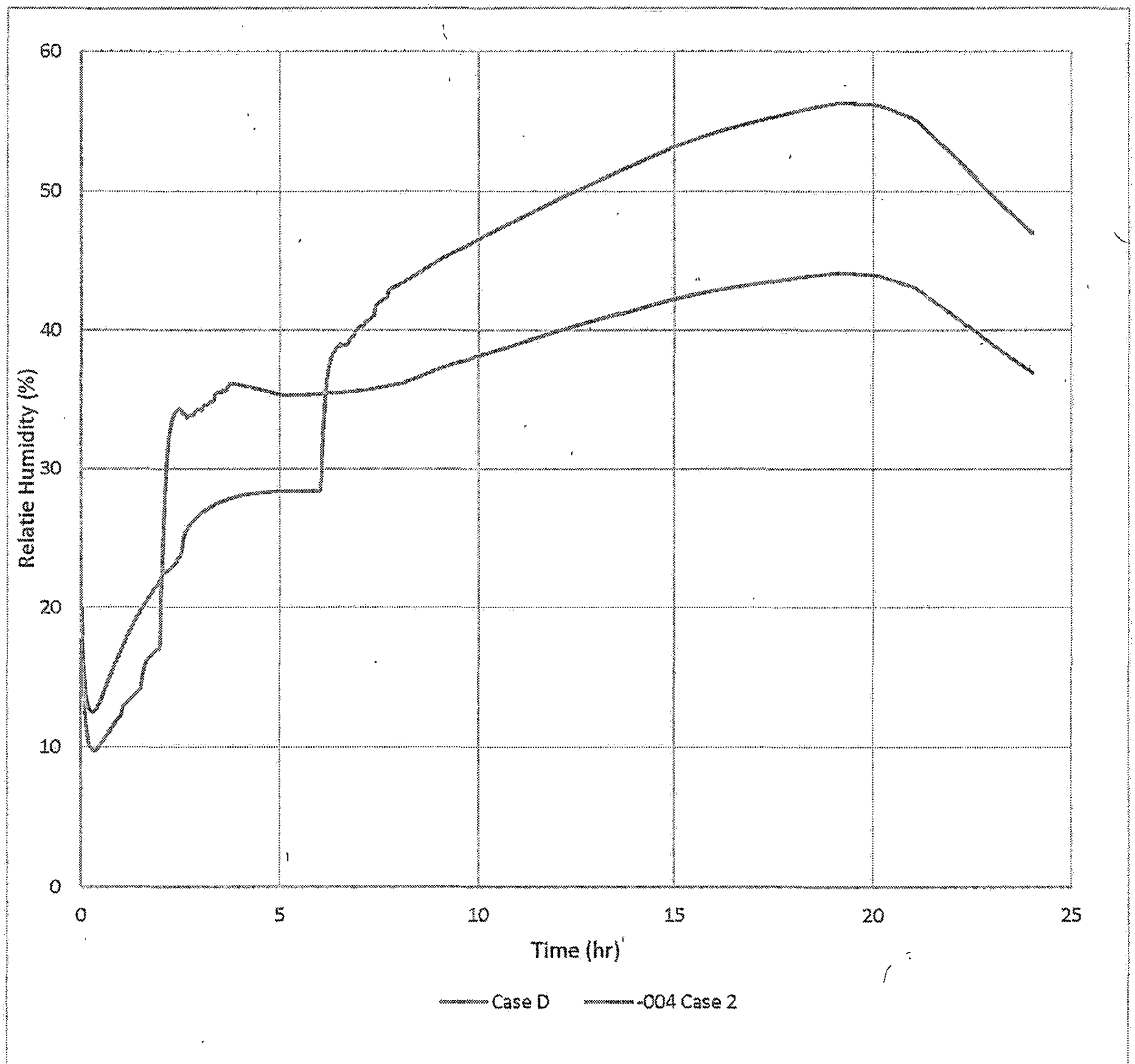


Figure 9: Relative Humidity of the MCR for Case D

Attachment 7
to RBS-47668

Evaluation of RBS Remote Shutdown Panel Rooms following a Loss of Control Building HVAC

Evaluation of RBS Remote Shutdown Panel Rooms following a Loss of Control Building HVAC

Purpose

Evaluate the temperatures in the Remote Shutdown Panel rooms (Division 1 and Division 2 RSS) following a loss of Control Building HVAC.

Background

On March 9, 2015, during a scheduled refueling outage, RBS experienced a temporary loss of Control Building and Main Control Room (MCR) cooling due to trip of the associated chilled water system (HVK). The NRC has raised concerns regarding the reliability of electrical equipment and the long-term habitability of the Main Control Room (MCR) following a loss of cooling. RBS has developed detailed GOTHIC thermal-hydraulic models of the RBS Main Control Room and Control Building and evaluated the MCR heat-up following a loss of all cooling assuming various mitigating actions (References 1, 2, and 6). The MCR heat-up evaluations include cases with design basis normal operating MCR heat loads (Ref. 3) and with measured heat loads determined from a steady-state MCR heat balance performed during normal operations (Ref. 4). The measured heat loads are 57% of the design normal operating heat load. The MCR heat-up evaluations show that the MCR average temperature reaches 116°F within two hours of a loss of HVAC with design heat loads. However, using the actual, measured heat loads, the MCR temperature remains below 113°F for six hours following a loss of HVAC. Should mitigating actions to provide cooling to the MCR prove unsuccessful and the environmental conditions in the MCR worsen such that operator habitability is challenged, operators could evacuate to the Division 1 or Division 2 Remote Shutdown (RSS) rooms and shutdown the plant from the remote shutdown panels. This evaluation determines if the Division 1 and Division 2 RSS rooms will remain habitable and equipment remain available during a loss of control building HVAC event.

Conclusions

Both the Division 1 and Division 2 RSS rooms would remain habitable and equipment would remain available following a loss of HVAC in the control building. Should the MCR be abandoned due to a loss of control building HVAC, operators would open the doors to the RSS rooms to allow access. Opening of these doors would provide mixing via natural circulation with the air in the adjacent control building rooms. As shown in Reference 6, the Control Building Switchgear Area heat loads under a LOCA-LOOP condition is lower than the heat loads for a LOCA with offsite power, which would reduce the temperatures in the RSS rooms. Page 167 of Reference 7 shows that the heatup for these rooms is minimal under LOOP conditions. The MCR heat-up calculations show that the MCR would remain habitable for at least 6 hours assuming measured heat loads and 2 hours assuming design heat loads. Without taking credit for metal heat sinks in the RSS rooms, temperatures in the most limiting RSS room are expected to remain below 108°F during the first 2 hours and below 114°F at 6 hours. Therefore, in the unlikely event of a rapid MCR heat-up requiring early MCR evacuation (within 2 hours), the temperature in the limiting RSS room after opening doors is

expected to be less than 108°F. For the slower MCR heat up using measured heat loads, MCR evacuation is less likely due to the increased time (6 hours) available to implement mitigating actions. However, if evacuation to the RSS rooms occurs at 6 hours, the temperature in the limiting RSS room after opening doors is expected to be less than 114°F. The temperatures predicted for the RSS rooms are lower than the values reported in G13.18.12.3*161 (Reference 7), due to the refined heat loads and modeling techniques applied in ENTR-078-CALC-001 (Reference 6) and this evaluation.

Evaluation

RSS Room Description

The Division 1 (CB098-11) and Division 2 (CB098-13) RSS rooms are located on the 98 foot elevation of the control building. The volume of the Division 1 RSS is approximately 971 ft^3 while the Division 2 RSS is approximately 1626 ft^3. The control panels in these rooms as listed in the tables below provide a substantial amount of steel mass that would act as a heat sink during heat up of the rooms following a loss of HVAC. The Division 1 RSS room includes a single door that opens to the general area of the 98 foot elevation (CB098-10). The Division 2 RSS room includes two doors that open to the Standby Switch Gear Room 1B (CB098-12).

Division 1 RSS Heat Loads

The E-226 R5 calculation (Ref. 5, pg. 44) provides the following heat loads for the Division 1 RSS (note that normal heat loads and LOCA with offsite power are identical).

Table 1: Div. 1 RSS E-226 Heat Loads

Div. 1 Equipment	Heat Load	
	Normal (Watts)	LOCA with Offsite Power (Watts)
C61-PNLP001	200	200
RSS-PNL101	540	540
Lighting (5)	480	480
TOTAL	1220	1220

A review of the panels and walk downs were performed to evaluate the panels and lighting to ensure that the heat loads documented in the E-226 R5 calculation were accurate. The panel review was performed by reviewing ESK-4RSS101. The individual parts and components of the RSS-PNL101 were reviewed in ESK-4RSS101 and the heat load of the heat generating components was determined based on the wattage rating of each item. The total heat load for RSS-PNL101 is found by summing up the heat loads of the individual components. The lighting review was performed by walk downs. The Div. 1 RSS room contained 4 light fixtures with each fixture containing two 40W light bulbs. Based on the review, the revised heat loads are presented in Table 2.

Table 2: Div. 1 RSS Revised Heat Loads

Div. 1 Equipment	Heat Load	
	LOCA with Offsite Power (Watts)	Reduction (%)
C61-PNLP001	200	0%
RSS-PNL101	180	67%
Lighting (4)	320	33%
TOTAL	**700**	**43%**

Division 2 RSS Heat Loads

The E-226 R5 calculation (Ref. 5, pg. 44) provides the following heat loads for the Division 2 RSS (note that normal heat loads and LOCA with offsite power are identical).

Table 3: Div. 2 RSS E-226 Heat Loads

Div. 2 Equipment	Heat Load	
	Normal (Watts)	LOCA with Offsite Power (Watts)
RSS-PNL102	540	540
Lighting (2)	192	192
TOTAL	732	732

A review of the panels and walk downs were performed to evaluate the panels and lighting to ensure that the heat loads documented in the E-226 R5 calculation were accurate. The panel review was performed by reviewing ESK-4RSS102. The individual parts and components of the RSS-PNL102 were reviewed in ESK-4RSS102 and the heat load of the heat generating components was determined based on the wattage rating of each item. The total heat load for RSS-PNL102 is found by summing up the heat loads of the individual components. The lighting review was performed by walk downs. The Division 2 RSS room contained 2 light fixtures with each fixture containing two 34W light bulbs. Based on the review, the revised heat loads are presented in Table 4.

Table 4: Div. 2 RSS Revised Heat Loads

Div. 2 Equipment	Heat Load	
	LOCA with Offsite Power (Watts)	Reduction (%)
RSS-PNL102	200	63%
Lighting (2)	136	29%
TOTAL	**336**	**54%**

RSS Room Temperatures Following Loss of HVAC

The temperatures in the Division 1 and 2 RSS rooms following a loss of HVAC were calculated using the Control Building (GOTHIC) model that opens the doors in the Control Building at 30 minutes developed in Reference 6. The temperatures of the RSS rooms did not change at 2 and 6 hours for the case with no doors opened from Reference 6. The control building heat loads for the LOCA with offsite power case were used as they result in the bounding heat loads for LOCA and non-LOCA cases. The revised heat loads from Table 2 and 4 are used in the RSS rooms. The model does not credit metal heat sinks in the RSS rooms which would reduce the temperature in these rooms. The model also does not consider opening the doors to these rooms, which would allow mixing with the adjacent rooms. The case with inverters operating in the Standby Switchgear Rooms is selected to conservatively maximize the temperature in Standby Switchgear Room 1B located outside the Division 2 RSS room.

Table 5 shows the temperatures in the RSS rooms and adjacent rooms outside the Division 1 RSS room (98 foot General Area, CB098-10) and the Division 2 RSS room (Standby Switchgear room 1B, CB098-12) at 2 and 6 hours. The temperatures in the Division 1 RSS rooms remain below 115°F at 2 hours and below 119°F at 6 hours. Temperatures in the Division 2 RSS room remain below 100°F at 2 and 6 hours. The temperature outside the Division 1 RSS room is 97.2°F at 2 hours and 101.8°F at 6 hours. The temperature in the Standby Switchgear Room outside the Division 2 RSS room is 108.5°F at 2 hours and 114.4°F at 6 hours. Should the MCR be abandoned, operators would open the doors to the RSS rooms to allow access. Due to the small size of these rooms, opening the room doors would be a highly effective means of providing mixing of the room air with the larger adjacent rooms. The RSS rooms would be expected to stabilize at a temperature within a few degrees of the temperature of the area outside the room. Therefore, the temperature in the Division 1 RSS room will decrease after the door is opened for operator access and is estimated to be no more than 100°F at 2 hours and 110°F at 6 hours. The temperature in the Division 2 RSS room will increase after the door is opened for operator access. The temperature would be no more than 108°F at 2 hours and 114°F at 6 hours.

Table 5: RSS and Adjacent Room Temperatures

Room	Temperature (°F)	
	2 hours	6 Hours
Div 1 RSS (CB098-11)	114.2	118.7
General Area (CB098-10)	97.2	101.8
Div 2 RSS (CB098-13)	97.8	99.7
Stby SG Room 1B (CB098-12)	108.5	114.4

References

1. Calculation ENTR-078-CALC-003, Rev. 4, "Main Control Room Heat-Up Under Loss of HVAC Conditions for 24 Hours."
2. RBS-ME-16-00002, Rev. 0 (ENTR-078-CALC-004, Rev. 0), "Main Control Room Heat-Up Analysis During Loss of HVAC Conditions for 24 Hours."
3. EC61975, "References for E-226 Calculation Revision."
4. RBS-ME-16-00003, Rev. 0, "Evaluation of Main Control Room Heat-up on Loss of HVAC Based on Empirical Temperature and Flow Data."
5. Calculation E-226, Rev. 5, "Control Building Electrical Equipment Heat Release During LOCA Condition With Off Site Power Available and Also Control Building Electrical Heat Release During LOCA Condition Without Offsite Power (LOOP and with EGS-EG1B Diesel Generator Not Responding."
6. Calculation ENTR-078-CALC-001, Rev. 1, "Control Building Heatup Analysis Following Loss of HVAC."
7. Calculation G13.18.12.3*161, Rev. 2, "Standby Switchgear Room Temperatures following Loss of Offsite Power and Loss of HVAC".

Attachment 8 to RBS-47668

PRA Model Changes to Include Control Room Cooling

PRA Model Changes to Include Control Room Cooling

The RBS EOOS tool is used to assess the risk of maintenance in accordance with the Maintenance Rule (10 CFR 50.65 (a)(4)). It quantifies and displays the risk of a specific plant configuration in terms of Plant Safety Index (PSI). PSI is defined as 10 X (log of configuration specific annual CDF) / (log of the Zero Test and Maintenance (ZTM) Baseline CDF). Therefore the PSI of the ZTM configuration is 10. The CDF values calculated by EOOS can also be used to calculate Incremental Condition Core Damage Probability (ICDP), which is equal to the delta CDF (configuration CDF – ZTM CDF) divided by 8760 hours per year times the number of hours that the specific configuration exists. This is another measure used to determine the risk of maintenance.

EOOS R5 PRA Model

During 2014 and until the present the EOOS model has been based on PRA Revision 5 which was peer reviewed in April 2011 against the ASME Standard. This model only considers the impact of HVK/HVC relative to the Control Building Switchgear room (SWGR) cooling and does not explicitly consider Main Control Room (MCR) cooling as a safety function. There were no findings in the Peer Review related to lack of MCR cooling in the PRA. This is consistent with industry practice which considers loss of MCR cooling a low risk contributor due to presence of operators in the MCR who would respond to increasing temperature and take appropriate actions. The low risk associated with loss of control room HVAC has been recognized by the NRC. As an example, per NRC-EPRI presentations at joint NRC-EPRI Fire PRA workshops, the slow effects of a loss of MCR HVAC are easily identified and recoverable before plant operation is adversely affected, making a loss of HVAC an initiator which does not need to be included in PRA models.

This model also did not credit the use of the service water (SWP) to directly cool the Control Building ACUs if HVK was lost even though it was included in the loss of control building ventilation procedure. It is noted that the MCR air conditioning units (HVC-ACU1A(B)) are modeled only for their impact on running chillers, since their failure will trip the chillers through interlocks in the control logic. However, the risk associated with MCR heat-up is highly correlated with the logic for Switchgear Room area heat-up due to commonalities in equipment and the modeling of HVC-ACU1A(B) MCR HVAC units.

R5-RHU Model

In response to March 2015 Special Inspection, RBS developed a revised model (PRA R5-RHU), based on newly developed Control Building (CB) heat-up calculations and detailed equipment survivability studies to develop more realistic (versus the conservative design basis) PRA success criteria for cooling of electrical switchgear (SWGR) equipment. The survivability studies demonstrated that the electrical equipment would survive and continue to operate at temperatures higher than their conservative design temperature limits. The heat-up calculations used refined equipment heat loads and more realistic heat sinks along with the survivability temperatures to establish the time from loss of cooling that the most limiting equipment in a specific room would fail. This model addressed dependencies and developed revised human failure estimates for actions needed to ensure SWGR cooling. Specifically, the changes made included:

- Added modeling for direct SW cooling to HVC-ACUs as a success path to restore SWGR cooling.

- Added human failure event (HFE) to open Div. 1 and Div. 2 AC switchgear room doors within 4 hours (analyses determined 4 hours were available instead of 1 hour).
- Removed the requirement for portable fans to ensure 24-hour long-term cooling of Div. 1/2 SWGR rooms. The portable fans were not that effective for risk mitigation since they relied on offsite power and were removed from the PRA model because room heat-up analyses determined that opening SWGR doors at 4 hours would ensure success for the mission time without any other action.
- Div. 3 AC switchgear room dependency on room cooling removed (analyses determined that equipment in room would survive the expected conditions without restoring cooling or opening doors).
- Added event to open Div. 1 and Div. 2 DC switchgear rooms in 30 min (per AOP-0060)
- Div. 1 and Div. 2 battery room dependency on room cooling removed (analyses determined that the batteries would survive the expected conditions without restoring cooling or opening doors).

As a result of these changes PRA R5-RHU demonstrated significantly lower risk with a single Division of Chillers (HVK system) out of service due to realistic treatment of equipment survivability and actions to recover switchgear room cooling. A comparison of risk results, quantified at a truncation of 1E-11/yr, for the R5-RHU to those of the R5 EOOS model is provided in Table 1.

R5-RHU-MCR Model

As indicated above, neither the RBS R5 EOOS nor the R5-RHU models include modeling of cooling to the MCR. The initial RBS effort to address MCR cooling issues focused on development of realistic GOTHIC heat-up calculations to determine the potential impact of higher temperatures on MCR equipment and, subsequently, operator performance. When it became clear that the NRC was interested in the risk associated with loss of MCR cooling RBS decided to incorporate modeling of MCR cooling into the R5-RHU model in order to assess the risk associated with loss of MCR cooling. This effort was started about the time the NRC closed their inspection activities in early October. The RBS-RHU model was revised to account for the realistic GOTHIC calculations and incorporate actions that were proceduralized prior to March 2015 to provide temporary cooling of the MCR. Most importantly, this model also conservatively accounts for the potential impact on operator MCR actions if cooling was not restored. The revised model, R5-RHU-MCR, was reviewed by a recognized industry expert, Mr. Gareth Parry, who has significant experience in PRA and Human Reliability Analysis. His conclusion was that, while it was not considered industry standard practice to model MCR HVAC in PRA models, the RBS approach was acceptable. Specifically, the changes made included:

- Identified existing HFEs potentially impacted by loss of MCR cooling. Impacted HFEs that are those performed in the MCR after 1 hour following a loss of MCR cooling. This assumption is conservative because not all actions would fail due to high temperature and many of the actions can be performed at local panels.
- Added fault tree logic and HFE basic events to account for operator actions to restore cooling. The human reliability analyses (HRAs) for HFEs used in this model were developed assuming 1 hour time frame from loss of MCR HVAC to take action. The time frame is based on initial GOTHIC calculations using the design heat loads, and is conservative even for that assumption.

This assumption is very conservative since actual heat loads are less than 60% of the design heat loads and new Gothic calculations indicate that up to 6 hours is available. Added HFEs include:

- HFE to open MCR cabinet doors in accordance with the Loss of Control Building Ventilation procedure, AOP-0060.
- HFE to remove MCR ceiling tiles during loss of offsite power (LOOP). This action allows hot air to rise into the normally stagnant upper volume of the MCR in accordance with Station Blackout procedure AOP-0050.
- HFE to start the installed MCR smoke removal fan for non-LOOP transient initiators, which along with opening the MCR doors and adjoining doors in the SW stair tower, would allow fresh air into the MCR. This HFE also includes task of removing MCR ceiling tiles.

- Added loss of MCR HVAC logic (via "OR" gate) to impacted HFEs to model failure of the HFE when MCR cooling and cooling recovery actions fail.

As shown in Table 1, quantification of the R5-RHU-MCR model demonstrates that the impact of loss of MCR cooling is relatively insignificant for the cases with a division of HVK/HVC out of service based on the zero maintenance model. The increase in CDF over that of the R5-RHU model is approximately 1E-08/yr for the zero maintenance cases. More realistic modeling of the loss of MCR cooling would result in even lower results.

Table 1 Comparison of R5 EOOS, R5-RHU Model and R5-RHU-MCR Results

Configuration*	R5 EOOS Model CDF	R5-RHU Model CDF	R5-RHU-MCR Model CDF
ZTM (No Maintenance)	8.64E-07	7.48E-07	7.59E-07
	Delta CDF Increase Over ZTM		
Div 1 HVK OOS (Trains A and C)	6.45E-06	4.04E-11	3.21E-10
Div 2 HVK OOS (Trains B and D)	6.37E-06	1.40E-10	1.61E-10
Div. 1 HVK & B OOS (Trains A, C & D)	6.84E-06	4.04E-11	3.48E-10
Div. 2 HVK & A OOS (Trains B, D & A)	6.73E-06	1.40E-10	1.88E-10

*Quantification preformed assuming normal weather, default system alignments (defined in PSA-RB-01-002S10, Revision 1) and truncation of 1E-11/year.

As indicated above, the added R5-RHU-MCR model HFEs were conservatively assessed assuming one hour was available to perform the actions. However, Gothic calculations utilizing realistic MCR heat loads show that at least 6 hours is available to perform the tasks for controlling MCR temperature. RBS has completed additional engineering evaluations and testing to develop best estimate realistic MCR heat loads. The results indicate that the realistic heat loads are about 56.7% of that based on equipment design heat loads. This lower heat load significantly slows MCR heat-up and delays the peak temperatures before operator action is taken. Refer to the graphs of MCR temperature in calculation ENTR-078-CALC-003 Rev.4 Attachment 5. Consideration of this additional time will significantly reduce the failure probability of the HFEs and therefore, further reduce the significance of loss of MCR room cooling. If this additional time available based on this new information was applied to the R5-RHU-MCR:

- The operator actions to restore cooling would be more likely to succeed. It is estimated that with the realistic heat loads the operator time to take action to either align SW and start the ACU or to remove the ceiling tiles and start the smoke removal fan could be increased from 1

hour to 6 hours. This would significantly reduce the failure probability of these HFEs. For example, the failure probability of aligning SW to the ACUs is 6.3E-02 in R5-RHU-MCR. Using SPAR HRA methodology and assuming only 4 hours are available, the failure probability would be 7E-04. Accounting for the extra time would significantly reduce the already very low contribution of risk from loss of MCR cooling.

- The assumption that the impacted human actions in the MCR would fail after 1 hour following the loss of MCR cooling can also be extended to 6 hours. This significantly increases the likelihood that the unit would be in a stable condition when the MCR became uninhabitable since most of the important HFEs would have been performed prior to that time, even if cooling is not restored.

Risk Deficit Calculations for Selected HVK Outages During 2014

The NRC uses the risk deficit parameter to determine the risk of a flawed assessment of maintenance risk performed per Maintenance Rule (MR) (a)(4). IMC0609 Appendix K defines risk deficit (ICDPD) as actual incremental core damage probability ($ICDP_{actual}$) – the flawed incremental core damage probability ($ICDP_{flawed}$) where the actual ICDP is the correct risk assessment and the flawed ICDP is incorrect. ICDP is calculated as the product of the incremental CDF (ICDF) of a configuration and the annualized fraction of the duration of the configuration (ICDP = ICDF X duration, hrs / 8760 hrs per reactor year). Incremental core damage frequency (ICDF) is equal to the configuration CDF – zero maintenance CDF. Therefore, ICDPD = $ICDP_{actual}$ – $ICDP_{flawed}$.

As a result of a Special Inspection performed March 2015, the NRC identified a finding for "Failure to Adequately Assess Risk During Chiller Unavailability." The following describes risk deficit calculations performed by RBS to determine the risk deficit of selected HVK divisional outages. (i.e., the longest outage during 2014 for each of the two Divisions).

Risk assessments originally performed for the HVK outages in 2014 were performed using the RBS R5 EOOS model. Since this model does not include MCR cooling and does not explicitly assess risk of loss of MCR cooling, risk assessments of HVK unavailability using the R5 EOOS model are considered "flawed" assessments per Appendix K. Risk assessments performed with the more realistic R5-RHU model would also be considered "flawed" as this model does not include MCR cooling. The "actual" assessment is performed with model RBS R5-RHU-MCR which incorporates MCR cooling. The only difference between the R5-RHU and R5-RHU-MCR models is the modeling of MCR cooling. As previously indicated including MCR cooling in nuclear plant PRA is not standard practice in the industry.

The risk assessments with each model were quantified assuming zero maintenance or only the identified maintenance/work activity in place, normal weather, default system alignments (defined in PRA-RB-01-002S10, Revision 1) and truncation of 1E-11/year. Note that the values for CDF_{Config} – CDF_{ZTM} used to calculate ICDP below are from Table 1.

- **Division 1, HVK A/C, Outage 10-23-2014 20:13 to 10-29-2014 9:17 (133hr 4min)**

Since both the R5 EOOS and R5-RHU model assessment are considered flawed, ICDPD will be determined for this configuration with the R5-RHU-MCR used to determine the actual ICDP.

EOOS R5 ICDP

$ICDP_{EOOS\ R5}$ = ($CDF_{Config} - CDF_{ZTM}$) X 133.07 / 8760
= (6.45E-06) X 133.07 / 8760
= 9.80E-08

R5-RHU ICDP

$ICDP_{R5\text{-}RHU}$ = ($CDF_{Config} - CDF_{ZTM}$) X 133.07 / 8760
= (4.04E-11) X 133.07 / 8760
= 6.13E-13

R5-RHU-MCR ICDP

$ICDP_{R5\text{-}RHU\text{-}MCR}$ = ($CDF_{Config} - CDF_{ZTM}$) X 133.07 / 8760
= (3.21E-10) X 133.07 / 8760
= 4.88E-12

Risk Deficit for R5-RHU-MCR compared to EOOS R5

$ICDPD_{EOOS\text{-}R5}$ = $ICDP_{R5\text{-}RHU\text{-}MCR} - ICDP_{EOOS\ R5}$
= 4.88E-12 – 9.8E-08
= -9.8E-08

Risk Deficit for R5-RHU-MCR compared to R5-RHU

$ICDPD_{EOOS\text{-}R5}$ = $ICDP_{R5\text{-}RHU\text{-}MCR} - ICDP_{R5\text{-}RHU}$
= 4.88E-12 – 6.13E-13
= 4.26E-12

- **Division 2, HVK B/D, Outage 04-21-14 1:00 to 04-24-14 4:07 (75hr 7min)**

During the HVK B/D outage time frame there was also "light" switchyard work (EOOS category Switchyard Other) performed from 04-22-14 09:18 to 11:07 (total of 1hr 49min). Because these activities were concurrent for a short period time, the ICDP is calculate separately for each configuration and then added together for the total ICDP for the duration of the HVK B/D outage. Therefore the total HVK B/D OOS only time is 73hr 18min (75hr 7min - 1hr 49 in) during this period and both HVK B/D and Switchyard Other work occur concurrently for 1hr 49.

EOOS R5 ICDP

$ICDP_{EOOS\ R5}$ = ($CDF_{HVK\ A/B} - CDF_{ZTM}$) X 73.3 / 8760 + ($CDF_{HVK\ A/B\ \&\ SW\ Other} - CDF_{ZTM}$) X 1.82 / 8760
= (6.37E-06) X 73.3 / 8760 + (3.63E-05 – 8.64E-07) X 1.82 / 8760
= 5.33E-08 + 7.34E-9
= 6.07E-08

R5-RHU ICDP

$ICDP_{R5\text{-}RHU}$ = ($CDF_{HVK\ A/B} - CDF_{ZTM}$) X 73.3 / 8760 + ($CDF_{HVK\ A/B\ \&\ SW\ Other} - CDF_{ZTM}$) X 1.82 / 8760
= (1.40E-10) X 73.3 / 8760 + (3.05E-06 – 7.48E-07) X 1.82 / 8760
= 1.17E-12 + 4.775E-10
= 4.787E-10

R5-RHU-MCR ICDP

$ICDP_{R5\text{-}RHU\text{-}MCR}$ = ($CDF_{HVK\ A/B} - CDF_{ZTM}$) X 73.3 / 8760 + ($CDF_{HVK\ A/B\ \&\ SW\ Other} - CDF_{ZTM}$) X 1.82 / 8760
= (1.61E-10) X 73.3 / 8760 + (3.06E-06 – 7.59E-07) X 1.82 / 8760
= 1.35E-12 + 4.778E-10

$= 4.791E-10$

<u>Risk Deficit for R5-RHU-MCR compared to EOOS R5</u>

$ICDPD_{EOOS\text{-}R5} = ICDP_{R5\text{-}RHU\text{-}MCR} - ICDP_{EOOS\ R5}$
$= 4.79E-10 - 6.07E-08$
$= -6.02E-08$

<u>Risk Deficit for R5-RHU-MCR compared to R5-RHU</u>

$ICDPD_{R5\text{-}RHU} = ICDP_{R5\text{-}RHU\text{-}MCR} - ICDP_{R5\text{-}RHU}$
$= 4.791E-10 - 4.787E-10$
$= 4.56E-13$

A summary of the risk deficit calculation results is provided in Table 2. The use of the more realistic PRA models, R5-RHU and R5-RHU-MCR, result in lower ICDP values for the above plant configurations compared to the RBS R5 EOOS model. As a result, the risk deficit based upon the R5 model in use for (a)(4) Configuration Risk Management during 2014 results in negative risk deficits. The risk deficit from the R5-RHU and R5-RHU-MCR models is entirely due to the risk of MCR cooling and is extremely small.

Table 2 Summary of Risk Deficit Calculations

2014 Outages	Risk Deficit	
	R5 vs. R5-RHU-MCR	R5-RHU vs. R5-RHU-MCR
Division 1 – HVK A/C		
10-23-2014 20:13 to 10-29-2014 9:17	-9.8E-08	4.26E-12
Division 2 – HVK B/D		
04-21-14 1:00 to 04-24-14 4:07*	-6.02E-08	4.56E-13

*This time period also includes concurrent Switchyard work.

<u>Risk Deficit Calculations for All HVK Outages During 2014</u>

While not normal practice for assessing MR(a)(4) risk, the following calculations calculate the ICDPs for all the total time that the following configurations were in place during 2014: HVK A/C OOS, HVK B/D, HVK A/C & D, and HVK B/D & A. This will be used to evaluate the HVK outage configurations (includes same outage times) that were evaluated in the NRC Special Inspection report with each of the PRA models so ICDPD can be calculated. Note that the delta CDF values are from Table 1

Table 3 EOOS R5 ICPD for Combined 2014 HVK Outages

HVK Division Configuration	Time OOS (hrs)	Delta CDF	ICDP
Div 1 (HVK-A/C) (excludes below)	343.8	6.45E-06	2.53E-07
Div 2 (HVK-B/D) (excludes below)	135.7	6.37E-06	9.87E-08
Div 1 (HVK-A/C) + HVK-D	18.13	6.84E-06	1.42E-08
Div 2 (HVK-B/D) + HVK-A	94.33	6.73E-06	7.25E-08
		EOOS R5 Total 2014 HVK ICDP	**4.39E-07**

Table 4 R5-RHU ICPD for Combined 2014 HVK Outages

HVK Division Configuration	Time OOS (hrs)	Delta CDF	ICDP
Div 1 (HVK-A/C) (excludes below)	343.8	4.04E-11	1.58E-12
Div 2 (HVK-B/D) (excludes below)	135.7	1.40E-10	2.17E-12
Div 1 (HVK-A/C) + HVK-D	18.13	4.04E-11	8.35E-14
Div 2 (HVK-B/D) + HVK-A	94.33	1.40E-10	1.51E-12
		R5-RHU Total 2014 HVK ICDP	**5.35E-12**

Table 5 R5-RHU-MCR ICPD for Combined 2014 HVK Outages

HVK Division Configuration	Time OOS (hrs)	Delta CDF	ICDP
Div 1 (HVK-A/C) (excludes below)	343.8	3.21E-10	1.26E-11
Div 2 (HVK-B/D) (excludes below)	135.7	1.61E-10	2.49E-12
Div 1 (HVK-A/C) + HVK-D	18.13	3.48E-10	7.20E-13
Div 2 (HVK-B/D) + HVK-A	94.33	1.88E-10	2.02E-12
		R5-RHU-MCR Total 2014 HVK ICDP	**1.78E-11**

<u>2014 Risk Deficit for R5-RHU-MCR compared to EOOS R5</u>

$ICDPD_{2014\ EOOS\text{-}R5} = ICDP_{2014\ R5\text{-}RHU\text{-}MCR} - ICDP_{2014\ EOOS\ R5}$

= 1.78E-11 – 4.39E-07

= -4.39E-07

<u>Risk Deficit for R5-RHU-MCR compared to R5-RHU</u>

$ICDPD_{2014\ R5\text{-}RHU} = ICDP_{2014\ R5\text{-}RHU\text{-}MCR} - ICDP_{2014\ R5\text{-}RHU}$

= 1.78E-11 – 5.35E-12

= 1.25E-11

A summary of the risk deficit calculation results for the combined 2014 HVK outages is provided in Table 6. As in the in the previous evaluations, use of the more realistic PRA models, R5-RHU and R5-RHU-MCR, result in lower ICDP values compared to the RBS R5 EOOS model. Therefore, the risk deficit based upon the R5 model for the combined 2014 outages results in a negative risk deficit. The risk deficit from the R5-RHU and R5-RHU-MCR models is entirely due to the risk of MCR cooling and is extremely small.

Table 6 Summary of Risk Deficit Calculations

	Risk Deficit	
	R5 vs. R5-RHU-MCR	**R5-RHU vs. R5-RHU-MCR**
Combined 2014 HVK Outages	-4.39E-07	1.25E-11

<u>RBS Review of the NRC's SPAR Model</u>

Based on discussions with the NRC Region IV SRA, RBS understands that the SPAR model was used to calculate annual CDF increases for only the impact on CB SWGR cooling for each configuration of HVK OOS. These annual CDF increase included the chance that operators failed to: opened the SWGR doors,

aligned SW to and restart SWGR air conditioning units (HVC-ACU2A(B) and recovered an HVK chiller. Then this annual SWGR CDFs were divided by the chance that the operator failed to open the SWGR room doors to estimate the chance that CR cooling would be lost. RBS generated the following summary of NRC Risk assessment associated with the 2014 HVK Divisional Outages, based on information discussed with the SRA.

Loss of CB Vent Frequency 1.0	Failure to Recover a Train of Cooling	Use of SW Cooling	Alternate Ventilation in CB 4 Hours	Probability given a Loss of CB Ventilation that:
				OK
	2.53E-01			OK
		5.06E-01		MCR Heats Up 1.28E-01
			2.10E-04	SWGR Heats Up and Fails 2.69E-05

Based in this input RBS endeavored to use the RBS SPAR model Revision 8.20 and SAPHIRE 8.0.1 to recreate the NRC's cutsets, relative to the impact of Division I and Division II HVK OOS on SWGR cooling. Model changes were needed to address the power supplies to the HVK/HVC equipment similar to those made by the SRA. Once these results were generated RBS reviewed the dominant core damage sequences and cutsets with the NRC, confirming that they matched the NRC's results. RBS identified the following:

- The dominant contributor was a loss of medium voltage bus (LOMVB) 4160 Safety-related Division I bus initiating event.
  - The Division 2 OOS configuration were over four times as risk significant as Division 1 OOS configuration. This appeared to be due to how the SPAR model only assumed the loss of the Division I safety related bus as an initiator. Thus it appeared that for the Division 2 HVK OOS configurations the LOMVB initiating event would directly result in a loss of all remaining HVK chillers due to loss of power to the running Division I HVK train.
  - If the SPAR model was reconfigured to align the LOMBV initiating event to the Division 2 bus, vice Division I and the Division 1 HVK OOS configuration run the results would be essentially the same for each division.
  - The IE-LOMVB frequency was doubled since it was simplistically modeled on only one division.
- The other contributors were Transients and Losses of the Condenser heat sink initiating events, with the subsequent failure of an ACU or the loss of the 4160 AC bus over the 24 hour period.
  - RBS did note that for each of these initiating events there were cutsets that included failures of the ACU to start. This appeared to be an error in NRC's modeling as the

running ACU would continue to run following these initiating events and has been discussed with the NRC.

The LOMVB initiating event is not modeled in the RBS PRA, because a loss of a 4160 volt AC bus will not cause an automatic reactor SCRAM nor will it force the operators into inserting a manual SCRAM rapidly after the loss of the bus.

Summary

RBS has expended significant effort in new engineering analyses, research and testing to incorporate more realism into the modeling of control building cooling into the RBS PRA. This effort has demonstrated that the R5 EOOS model currently in use and throughout 2014, is very conservative with regard to control building cooling. Modifications incorporated in the R5-RHU model significantly reduced the contribution of risk from loss of control building cooling to the AC switchgear, DC equipment and battery rooms. The addition of conservative modeling for cooling to the MCR in R5-RHU-MCR resulted in a relatively insignificant increase in CDF compared to the R5-RHU model. A third party review of this model was performed by Dr. Gareth Parry, a recognized expert in the PRA community. The use of the new models also has demonstrated that the risk of HVK outages during 2014 is not significant. Calculated risk deficit against the Revision 5 PRA model in use for Maintenance Rule configuration risk management is -4.39E-07, a negative risk deficit. Using the Revision R5-RHU PRA that accounts for refined control building heat-up calculations and improved electrical equipment survivability studies, the calculated risk deficit is the small value of 1.25E-11. The risk deficits for individual maintenance outages is smaller in magnitude. For the worst case Division 1 HVK outage, the risk deficit is -9.8E-08 using the Rev.5 model and 4.26E-12 using the R5-RHU model. For the worst case Division 2 HVK outage, the risk deficit is -6.02E-08 using the Rev.5 model and 4.56E-13 using the R5-RHU model. These results are consistent with the industry consensus that control room HVAC is a small contributor to risk. RBS has also concluded that risk assessments of HVK outages performed with the R5-EOOS model during 2014 have been demonstrated to be conservative.

Attachment 9
to RBS-47668

Potential Greater than Green (a)(4) Violation – River Bend

Potential Greater Than Green (a)(4) Violation – River Bend

The purpose of this paper is to provide a discussion on various aspects of the regulatory risk assessment performed to determine the significance of an (a)(4) performance deficiency at River Bend station. The details of the performance deficiency are documented in NRC Inspection Report 05000458/2015010, dated February 16, 2016. The specific attributes of the assessment to be discussed below are:

- Risk Aggregation
- Selection of the Exposure time
- Adequacy of Fire Risk Management Actions (RMAs)

Risk Aggregation

The risk assessment prepared for the performance deficiency performs an aggregation of the risk impact from the individual maintenance configurations to develop an overall significance of the violation. This type of aggregation is inappropriate and is not supported by the Significance Determination Process (SDP) developed for (a)(4) violations. Applying the SDP as described in IMC 0609, Appendix K to the specific individual maintenance configurations and using the associated specific configuration unavailability times, results in the significance of each configuration being only a fraction of the improperly aggregated risk.

As stated in IMC 0308, Attachment 3, Appendix K, "Technical Basis Document: Maintenance Risk Assessment and Risk Management Significance Determination Process":

> *"The intent of paragraph (a)(4) is to have licensees appropriately assess the risks of proposed maintenance activities that will (1) directly, or may inadvertently, result in equipment being taken out of service, (2) involve temporary alterations or modifications that could impact structure, system, or component (SSC) operation or performance, (3) be affected by other maintenance activities, plant conditions, or evolutions, and/or (4) be affected by external events, internal flooding, or containment integrity. Paragraph (a)(4) requires management of the resultant risk using insights from the assessment. Therefore, licensee risk assessments should properly determine the risk impact of* ***planned maintenance configurations*** *to allow effective implementation of RMAs to limit any potential risk increase when maintenance activities are actually being performed. Although the level of complexity in an assessment would be expected to differ from plant to plant, as well as from configuration to configuration within a given plant, it is expected that licensee risk assessments would provide insights for identifying risk-significant activities and minimizing their durations." (emphasis added)*

For any performance deficiency associated with paragraph (a)(4), the determination of the significance is aligned to a specific configuration. In particular, the evaluations that

are performed to develop the significance of (a)(4) performance deficiencies use the Zero-Maintenance PRA model as opposed to the average Test and Maintenance PRA model used in the development of risk metrics associated with other aspects of the Reactor Oversight Process defined by IMC 0308 and implemented in IMC 0609. This concept of being aligned to a configuration is repeated throughout the process including the parameter definitions used in this significance determination process.

From IMC 0308, Section IV (emphasis added):

> Incremental Core Damage Frequency (ICDF). The ICDF is the difference between the actual (adequately/accurately assessed) maintenance risk *(configuration-specific CDF)* and the zero-maintenance CDF. The *configuration-specific CDF* or ICDF is the annualized risk estimate with the out-of-service or otherwise affected SSCs considered unavailable.
>
> Incremental Core Damage Probability (ICDP). The ICDP is the product of the incremental CDF and the annual fraction of the duration of the *configuration* [i.e., ICDP = ICDF x (duration in hours)÷(8760 hours per reactor year)].
>
> Incremental Core Damage Frequency Deficit (ICDFD). The ICDFD is that portion of the ICDF defined as the difference between the actual *maintenance-configuration-specific CDF* (called $ICDF_{actual}$ for purposes of this definition) and the maintenance-related ICDF as originally and inadequately assessed (flawed) by the licensee ($ICDF_{flawed}$).
>
> Incremental Core Damage Probability Deficit (ICDPD). The ICDPD is the product of the ICDFD and the Exposure (i.e., the annual fraction of the duration of the unassessed or inadequately assessed *configuration*, or that portion of the annual fraction of the duration of the *maintenance configuration* during which its risk remained unassessed or inadequately assessed). Thus the ICDPD = ICDFD x (exposure in hours) ÷ (8760 hours per reactor-year).

The above definitions are graphically represented in Figures 1 and 2 below. These figures are taken from IMC 0609, Appendix K.

The determination of any metric associated with an inadequate risk assessment is clearly tied to a specific configuration and not to an aggregated condition.

There are no provisions, as defined in IMC 0308 or as implemented in IMC 0609, for the aggregation of different configurations into an overall significance determination. There is no known precedent associated with this aggregation process associated with (a)(4) issues.

For this issue, the NRC has identified a number of specific maintenance configurations of various chillers being unavailable (and associated unavailability durations) for which the risk assessment and/or risk management was not adequate. Per IMC 0308 and

IMC 0609, each of these individual maintenance configurations must be assessed independently to determine the significance of the inadequate risk assessment for that configuration.

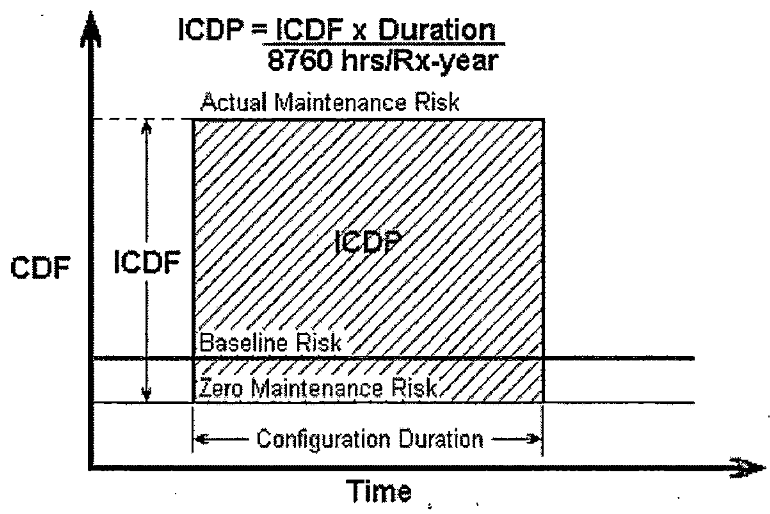


Figure 1 - Relationship of ICDF to ICDP

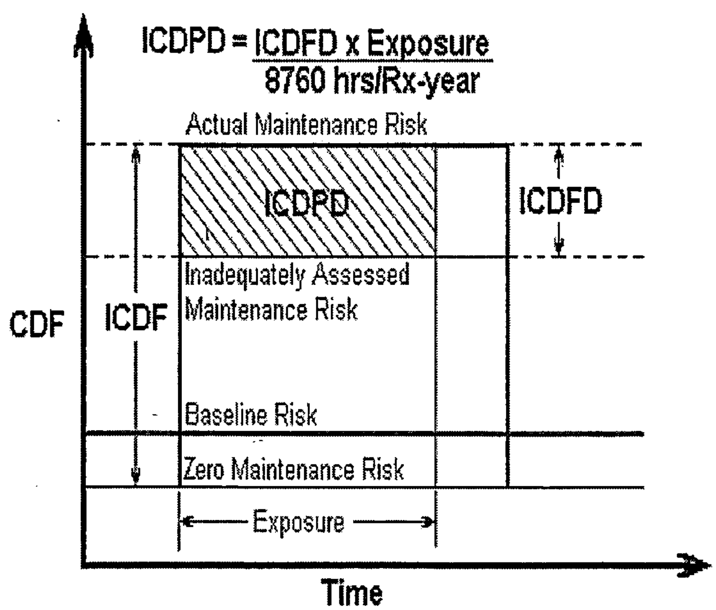


Figure 2 - Relationship of ICDFD to ICDPD

Selection of the Exposure Time

To evaluate the significance of an (a)(4) related performance deficiency, the following information is required:

- The Base Zero Maintenance CDF (LERF)
- The actual Maintenance Configuration CDF (LERF)
- The duration ("Exposure") of the Maintenance Configuration

As defined in IMC 0308 and implemented in IMC 0609, the determination of the Incremental Core Damage Probability Deficit (ICDPD) is based on the difference between the actual configuration risk and the inadequately assessed risk and the "...Exposure (i.e., the annual fraction of the duration of the unassessed or inadequately assessed *configuration*, or that portion of the annual fraction of the duration of the *maintenance configuration* during which its risk remained unassessed or inadequately assessed)." (emphasis added)

For this performance deficiency, the inspection report identifies that an exposure time of one year was used for the regulatory assessment. This is inappropriate since none of the specific maintenance configurations listed have unavailability times of that magnitude individually. The Maintenance Rule is a performance based, risk informed rule. When there is a performance deficiency, the significance of the deficiency is aligned to the configuration duration associated with the deficiency, not to the process duration.

When the applicable maintenance configuration exposure times and the associated configuration delta CDF values (Actual Configuration Risk – Assessed Configuration Risk) are used, the realistic significance of this performance deficiency is only a fraction of the risk impact developed using the inappropriate Exposure time (aggregating the times of the individual and independent maintenance configurations).

Adequacy of Fire Risk Management Actions (RMAs)

The concept associated with Fire RMAs is different than that for RMAs developed as part of the Internal Events portion of the CRM process. Fire RMAs are directed at reducing the likelihood of a fire or at minimizing the consequences of a fire in the important fire areas. For any given Fire important component that is unavailable and for which Fire RMAs are desired, the main focus of those Fire RMAs is to protect the ability for the function to be successful. This aspect of the RMA development is similar to the internal events RMA development. Due to the spatial nature of fire events, the protection is aligned to the fire events in the areas that would result in the loss of the function.

The following guidance is provided in NUMARC 93-01, Revision 4A on the considerations associate with Fire RMA development:

11.3.7.5 Fire Risk Management Actions

If the evaluation described in Section 11.3.7.3 indicates risk management actions are appropriate, the following actions should be considered:

1. Primary action: Coordinate activities within the plant that could involve increased fire risk with those maintenance activities involving removal from service of mitigation equipment important for fire risk. This involves coordination of fire protection personnel with maintenance rule (a)(4) personnel. Based on this coordination, evaluate appropriate risk management actions as discussed in Section 11.3.7.4.

2. Additional risk management actions specific to fire could include:
   - Re-scheduling activities that involve increased fire likelihood in fire areas where the out of service core damage mitigation equipment would be relied upon in the event of a fire
   - Increased fire watches in fire areas where the out of service core damage mitigation equipment would be relied upon in the event of a fire
   - Confirm the availability of an alternate success path for safe shutdown should it be needed. These could include alternative success paths excluded from design basis evaluations (e.g., Bleed & Feed Cooling (PWRs), Containment Venting (BWRs))

Entergy procedure ADM-0096, "RISK MANAGEMENT PROGRAM IMPLEMENTATION AND ON-LINEMAINTENANCE RISK ASSESSMENT" provides the station specific guidance on Fire RMAs and aligns well with the endorsed guidance in NUMARC 93-01. Table 1 below lists the Fire RMAs contained in ADM-0096 that were developed to satisfy the guidance in NUMARC 93-01 and the corresponding attribute associated with either reducing the likelihood of a fire or reducing the magnitude of a fire should it occur.

Table 1: Comparison of River Bend Fire RMAs and NUMARC 93-01 Recommendations

RMA #	RMA Description	NUMARC 93-01 Attribute
1	Make a Main Control Room narrative log entry documenting the completion of the following: • Brief Fire Brigade and Operations on Fire Areas w/o credited SSD success path • Identify Risk Mitigation equipment OOS • Identify current success path for SSD • Fire Fighting strategies for affected area(s)	Provides increased awareness and control
2	Identify Fire Areas w/o credited success path in POD & T-6 and T-2 Meetings	Provides increased awareness and control
3	Limit/minimize combustibles in affected areas – walkdown to confirm	Reduces magnitude of a potential fire
4	Prohibit Hot Work in affected areas – notify all Hot Work Supervisors	Reduces likelihood of a potential fire
5	Confirm availability of fire detection and/or suppression in affected areas or adequacy of comp. measures	Reduces magnitude of a potential fire

Table 1: Comparison of River Bend Fire RMAs and NUMARC 93-01 Recommendations		
RMA #	**RMA Description**	**NUMARC 93-01 Attribute**
6	Confirm no impaired barriers in affected area or adequate comp. measures in place	Reduces magnitude of a potential fire
7	Prohibit/minimize electrical switching at panels in subject areas	Reduces likelihood of a potential fire
8	Work Fire Risk Mitigation equipment on an accelerated schedule	Reduces magnitude of the potential risk increase
9	Evaluate/Reschedule surveillances/PM that could affect FP equipment in area	Reduces magnitude of a potential fire
10	Evaluate work in the affected area for compensatory measures	Reduces magnitude of a potential fire
11	Determine if alternate or contingent SSD success path can be established	Reduces magnitude of the potential risk increase

Based on this review, the Fire RMAs developed in Entergy procedure ADM-0096 are aligned with the endorsed guidance in NUMARC 93-01 and are adequate to meet the intent of managing the increase in risk from the performance of maintenance activities.

Attachment A – Background Information

Background

For the succeeding 15 years, US utilities have implemented the requirements of 10CFR50.65, paragraph (a)(4) through a process referred to as Configuration Risk Management (CRM). This process, as required by paragraph (a)(4), assesses and manages the increase in risk from the performance of maintenance activities. And as noted by the name itself, the process evaluates the risk impact and provides insights associated with a specific configuration. If the configuration is changed, then the risk impact and associated insights are changed.

Risk Assessment of the Configuration

As noted above, assessing the risk impact is performed on a configuration by configuration basis. Figure A below represents a set of maintenance configurations of unavailable equipment as follows:

- Configuration 1 – Component A unavailable
- Configuration 2 – Components A and B unavailable
- Configuration 3 – Components A, B and C unavailable
- Configuration 4 – Components A and C unavailable
- Configuration 5 – Component C unavailable

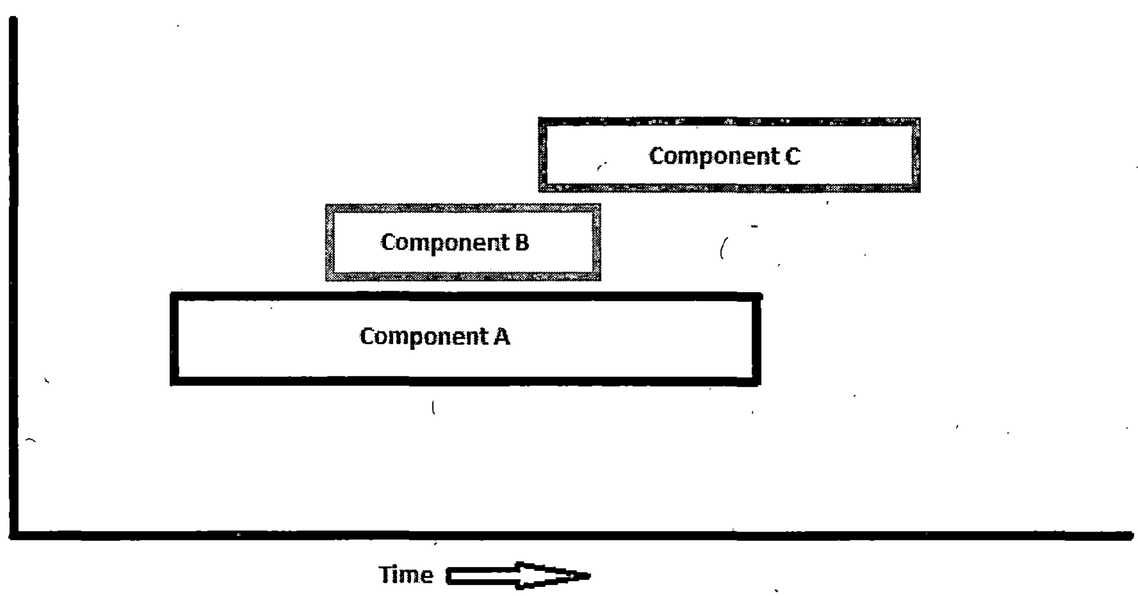


Figure A

Each of these configurations is assessed independently of each other to generate a risk impact and associated insights that are used to manage the increase in risk from the

planned (or emergent) maintenance activities. Note that there is no configuration of maintenance unavailability where Component B is the only unavailable component.

Determining Significance of a Performance Deficiency Associated with CRM

NRC Manual Chapter 0609, Appendix K provides guidance on how to evaluate the significance of a performance deficiency associated with the Configuration Risk Management process. This process develops a risk deficit for the deficient condition that takes into account the base level of risk, the risk impact from the configuration and the duration that the configuration was in existence. This is shown graphically in Figures 1 and 2 of IMC 0609, Appendix A and repeated below.

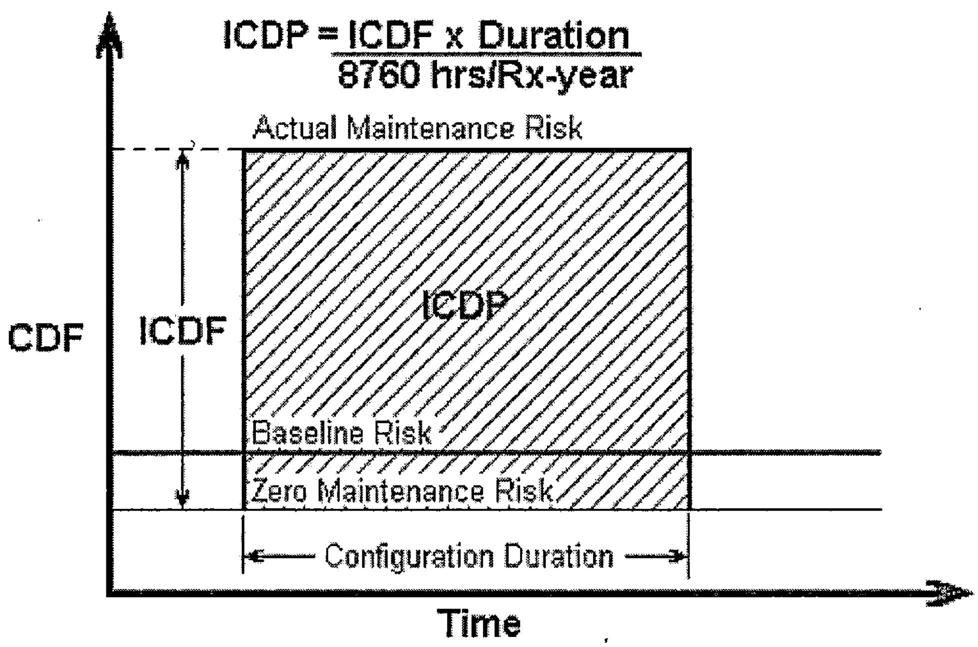


Figure 1 - Relationship of ICDF to ICDP

Figure 1 shows the three pieces of information needed to develop an ICDP for a Maintenance configuration:

- Zero-Maintenance Risk
- Actual Maintenance Risk
- Configuration Duration ("Exposure")

Figure 2 from Appendix K provides the graphical representation of how the risk deficit is determined for an inadequate risk assessment. Using Figure A as an example, assume that the configuration of Components A and C (Configuration 4) was never assessed as

part of the CRM process for that work week, only Configuration 5, Component C by itself, was assessed. A determination of the risk impact would look similar to Figure 2 from IMC 0609, Appendix K (repeated below). In this case, the line labeled "Inadequately Assessed Maintenance Risk" is associated with the risk impact from Component C being unavailable by itself as this was the configuration assessed. The line labeled "Actual Maintenance Risk" represents the risk impact from Components A and C being unavailable. The width of the column, defined as "Exposure", is the duration of time that the configuration of Components A and C were unavailable concurrently. The significance of the performance deficiency is associated with the Incremental Code Damage Probability Deficit (ICDPD). This represents the difference in the CDF between the "Actual Maintenance Risk" and the "Inadequately Assessed Maintenance Risk" times the "Exposure" divided by the number of hours in a year (8760 hours). This is the fraction of a year that the configuration existed.

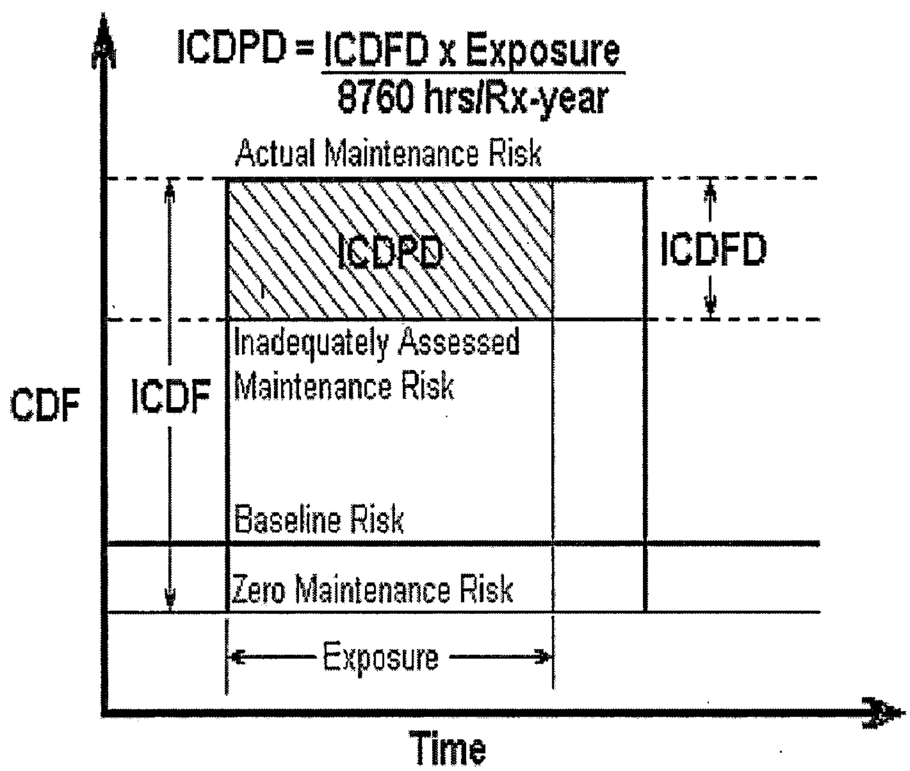


Figure 2 - Relationship of ICDFD to ICDPD

Attachment 10
to RBS-47668

Response to NRC Concern with Temperature Effects on Safety-Related Electronics in Main Control Room

RESPONSE TO NRC CONCERN WITH TEMPERATURE EFFECTS ON SAFETY-RELATED ELECTRONICS IN MAIN CONTROL ROOM

PURPOSE

In a recent NRC Inspection Exit Meeting and USNRC Inspection Report 05000458/2015010, Attachment 3, a concern was expressed by the NRC that the evaluation of the Loss of HVAC in the Main Control Room does not appear to be conservative with respect to the potential impact on safety-related electronic components. Two documents were cited as a basis for this concern:

- USNRC Information Notice 85-89, "Potential Loss of Solid-State Instrumentation Following Failure of Control Room Cooling"
- NUREG/CR-6479, "Technical Basis for Environmental Qualification of Microprocessor-Based Safety-Related Equipment in Nuclear Power Plants"

The purpose of this document is to evaluate the information presented in these documents, as well as the inspection report, and determine if the NRC cited documents and concerns identify any unevaluated risks to reliable operation of Main Control Room safety-related electronic equipment with regard to elevated temperature effects.

Additionally, Attachment 1 to this document provides a summary of the evaluations and analyses performed over the past year to address River Bend Station's loss of Control Building HVAC.

SCOPE

The scope of this evaluation is limited to the potential adverse effect of elevated temperatures on Main Control Room safety-related electronic equipment as discussed in USNRC Information Notice 85-89, NUREG/CR-6479, and USNRC Inspection Report 05000458/2015010, Attachment 3.

METHODOLOGY

Review NRC Inspection Report 05000458/2015010, Attachment 3.

Review the NRC cited documents and applicable analysis to determine the applicability of USNRC Information Notice 85-89 and NUREG/CR-6470 to the River Bend Main Control Room.

Review GE document 22A3888, Rev. 3 "Main Control Room Panels (NSSS) Design Specification" (Reference 7) for Main Control Room design temperatures.

Review the GOTHIC model (Reference 5) for Case 1 and Case 2. Case 1 is Loss of Offsite Power (LOOP) with mitigating actions. Case 2 is normal operation with mitigating actions. The model was developed to determine Main Control Room temperatures and humidity changes on a loss of Main Control Room cooling. Attachment 1 of Reference 5 models a scenario developed from Case 2 in which HVC-ACU1 is aligned to the service water system one hour following the start of the event (Case 2 demonstrates that the acceptable temperature control for the Main Control Room). Because Case 2 results in higher temperatures that bound the Attachment 1 temperatures, only Case 2 will be referenced.

Average temperature and humidity curves from the GOTHIC model are provided in Figures 1 through 3 for Case 1 and Figures 4 through 6 for Case 2. Figure 7 shows the maximum local relative humidity. Figures 8 and 9 show the temperature and humidity curves for subvolume 171, which is the subvolume that contains safety related electronic equipment with the highest peak temperature.

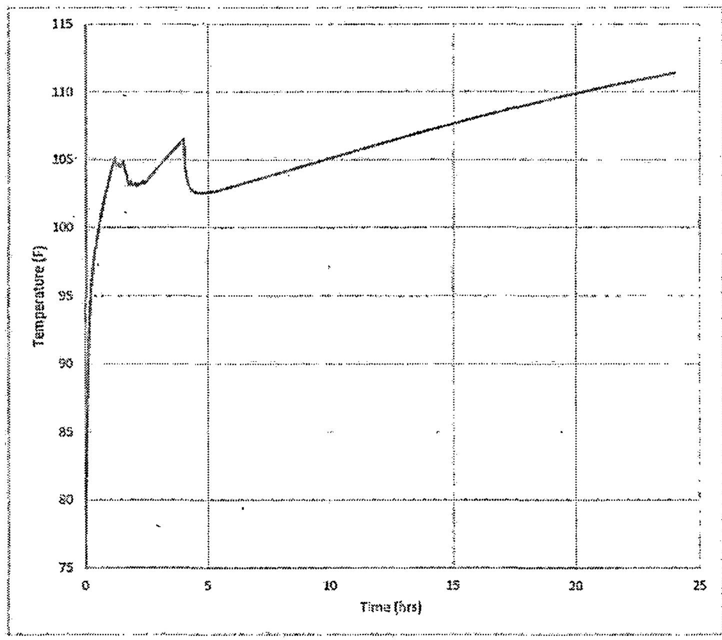


Figure 1: Average MCR Temperature for Case 1

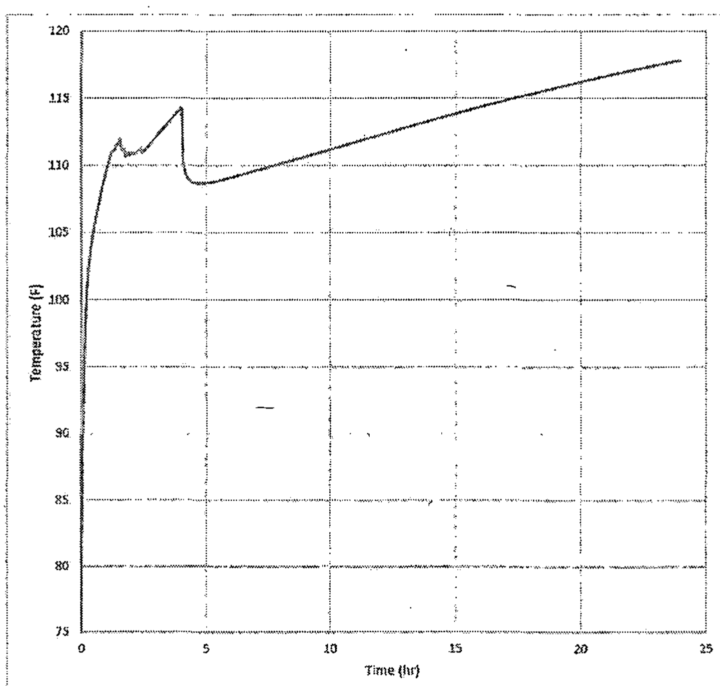


Figure 2: Maximum Local MCR Temperature for Case 1

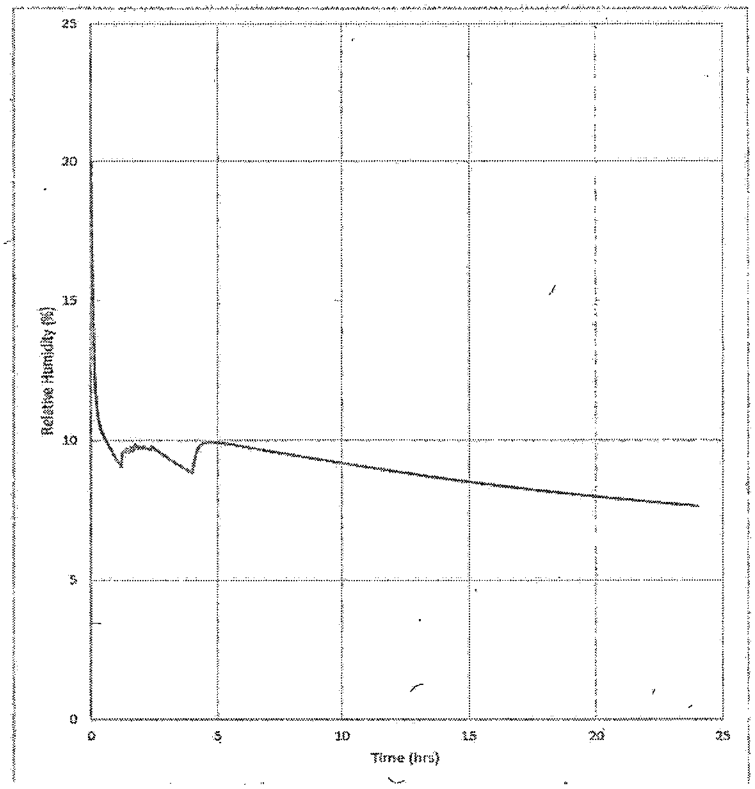


Figure 3: Relative Humidity in the Horseshoe Area for Case 1

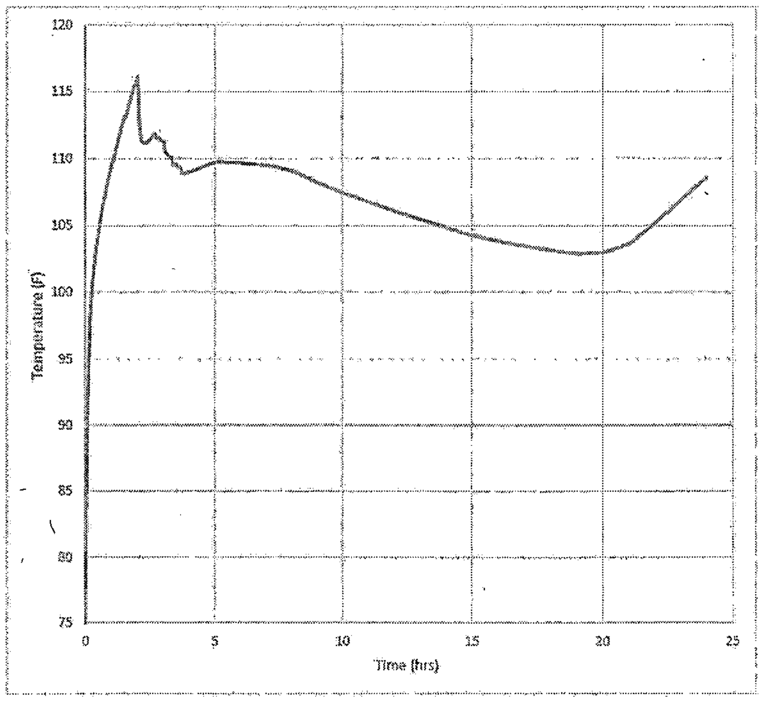


Figure 4: Average MCR Temperature for Case 2

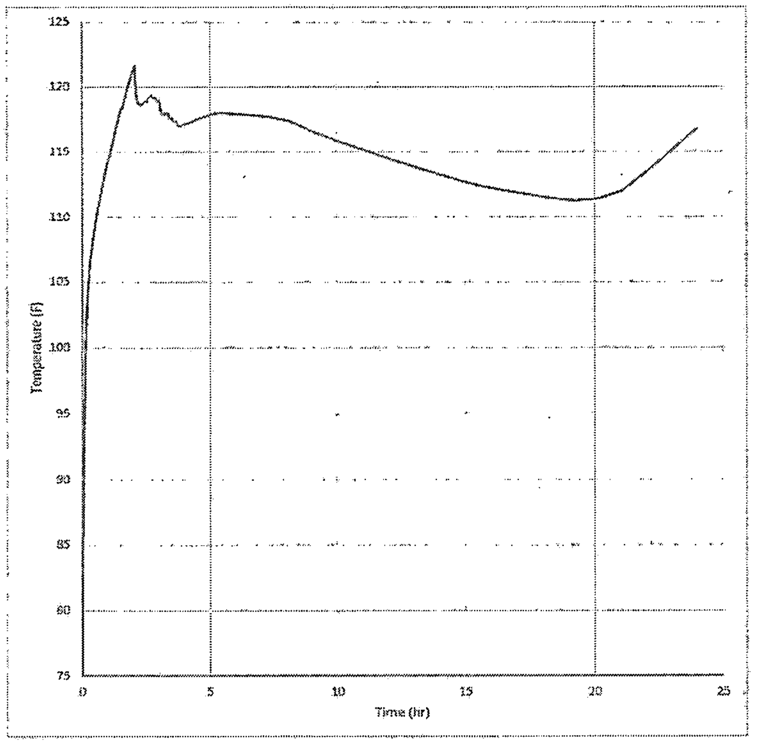


Figure 5: Maximum Local MCR Temperature for Case 2

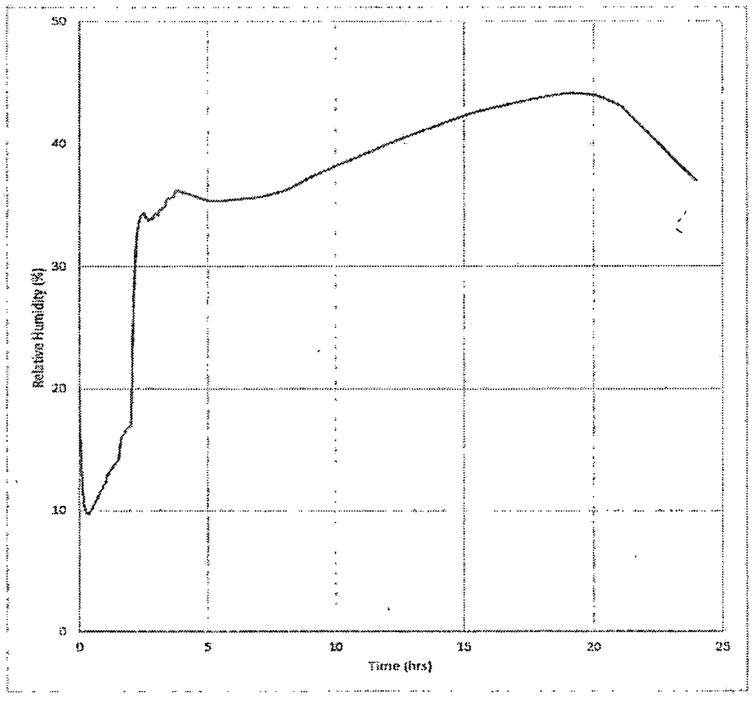


Figure 6: Relative Humidity in the Horseshoe Area for Case 2

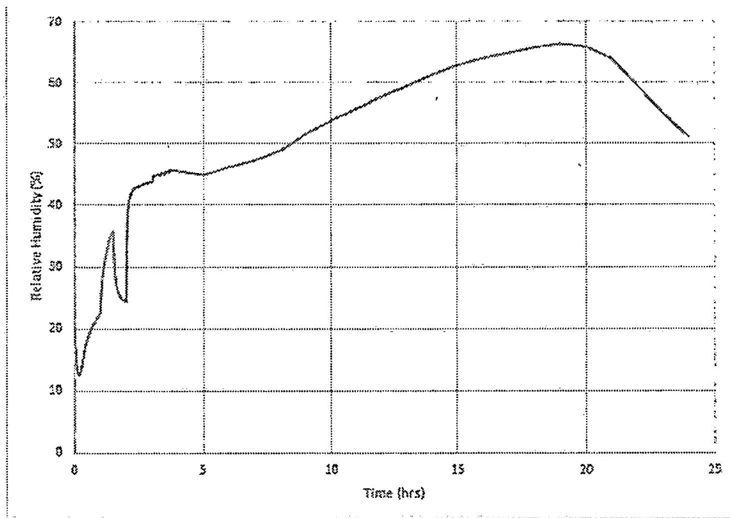


Figure 7: Maximum Local Relative Humidity (Just Inside MCR Door)

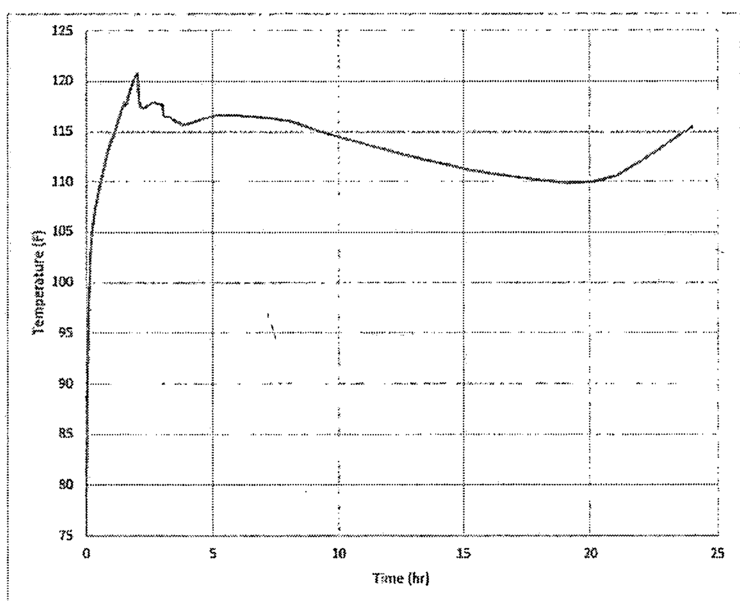


Figure 8: Temperature in Subvolume 171 for Case 2

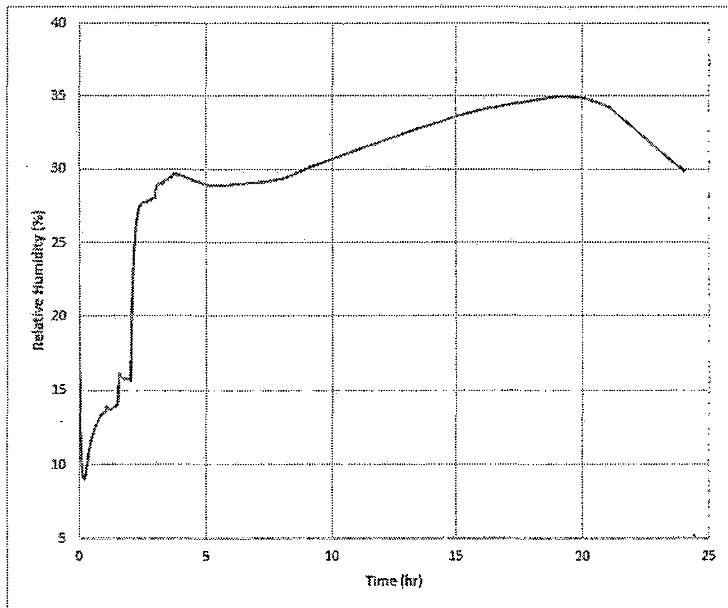


Figure 9: Relative Humidity in Subvolume 171 for Case 2

DISCUSSION

USNRC Information Notice 85-89

Information Notice 85-89 presents an event that occurred at McGuire Nuclear Station in June 1984 in which the station experienced a total loss of Main Control Room cooling and entered a Technical Specification Required Action to reduce power. As control room temperatures increased, several spurious alarms from the safety-related Westinghouse Process Control 7300 System (PCS) began coming in after about 43 minutes. Approximately 2 hours into the event, ventilation and temporary cooling was provided to the PCS 7300 cabinets causing the spurious alarms to stop.

Prior to the June 1984 event, McGuire experienced numerous card failures which they attributed to the elevated temperature conditions in and around the PCS 7300 cabinets. Their basis for this conclusion was the actual ambient air temperature measurement taken (72°F) and internal cabinet temperatures (max reading 125°F) after the event.

River Bend Station Main Control Room is a GE design and does not use Westinghouse PCS 7300 cabinets. GE document 22A3888, Rev. 3 "Main Control Room Panels (NSSS) Design Specification" (Reference 7) states:

> "Apparatus shall be suitable for continuous operation within the panels, or benchboard with a normal and abnormal maximum ambient air inlet temperature as specified in the BWR Equipment Environmental Interface Data Specification (A62-4270). Allowance shall be made for the temperature rise in the cubicle due to heat given off by other equipment in the same cubicle, when considering individual components the maximum temperature in a panel, or benchboard shall not exceed 122°F (50°C) under the above conditions."

Per the GOTHIC model (Reference 5), the average ambient temperature in the Main Control Room in the 24 hours following a loss of HVAC is 111.4°F for Case 1 and 116.1°F for Case 2. The maximum local/subvolume temperature in the Main Control Room in the 24 hours following a loss of HVAC is 118.7°F for Case 1 and 121.8°F for Case 2. This maximum temperature in both cases is in subvolume 187 around panel H13-P630, Annunciator Logic Cabinet, which contains non-safety related electronic equipment. The peak temperature occurs 2.02 hours following the start of the event; for less than 30 minutes of the entire 24-hour event, subvolume 187 has a temperature above 120°F. For the remainder of the event, subvolume 187 experiences temperatures below 120°F.

The subvolume with the highest temperature (120.8°F) that contains safety related equipment is subvolume 171 surrounding panel H13-P694, Reactor Protection System Logic Div D (Figure 8). The peak temperature occurs 2.02 hours following the start of the event; for less than 11 minutes of the entire 24-hour event, subvolume 171 has a temperature above 120°F. For the remainder of the event, subvolume 171 experiences temperatures below 120°F.

AOP-0060, Rev. 9, "Loss of Control Building Ventilation" (Reference 6) was effective on 6/17/2014 and was the current revision during the Loss of HVAC in the Main Control Room on 3/9/2015. Procedure AOP-0060, Rev. 9, step 5.1.4 instructs operators "At Main Control Room, open all back panel doors" within 30 minutes of the start of the event. Per the Main Control Room Operator's dayshift log from the 3/9/2015 event (Reference 9), operators performed AOP-0060, Rev. 9, step 5.1.4 within 23 minutes of entering AOP-0060.

NUREG/CR-4942 (Reference 3) states, in part on page 12, "...if a closed cabinet can be opened allowing virtually unrestricted air circulation inside of it, then the electrical components inside the cabinet are probably acceptable if they can be shown to survive the maximum ambient or room temperatures..."

NUMARC 87-00 (Reference 4) states, on page 2-10, "Equipment located in Condition 1 rooms are considered to be of low concern with respect to elevated temperature effects and will likely require no special actions to assure operability for a 4-hour station blackout. This condition is defined by a steady state temperature of 120°F." The document goes on to say, on page 2-10, "By opening cabinet doors, adequate air mixing is achieved to maintain internal cabinet temperatures in equilibrium with the control room temperatures. Therefore, cabinets containing instrumentation and controls required for achieving and maintaining safe shutdown in a station blackout are considered to be in Condition 1. As such, additional cooling may be provided in a station blackout by opening cabinet doors within 30 minutes of the event's onset."

The Farley Response to NFPA-805 RAI (Reference 10) states, on page 12 of Attachment 2, "From reviews of WCAP 8687 accelerating [sic] thermal aging tests...it was found that components in typical electrical/electronic equipment [sic] (including solid sates [sic] components) in nuclear power plants do not fail immediately when exposed to a temperature as high as 105°C (221°F) but can survive up to a year at such high temperature (for brand new components). Considering a localized temperature inside a cabinet with limited ventilation may be about 20°C (36°F) higher than outside ambient temperature (another insight), the above statement may be restated as that all electrical/electronic components in cabinets can survive up to a year at an elevated outside cabinet ambient temperature of 85°C (185°F). A simulation using Arrhenius model showed a similar result."

With average Main Control Room temperatures never exceeding 116.1°F, maximum local cell/subvolume temperatures never exceeding 120.8°F for safety related electronic equipment, and the Main Control Room back panel doors all being opened, the design temperature of the safety-related electronic equipment is reasonably assured to not be exceeded. Additionally, considering the information presented in the Farley Response to NFPA-805 RAI (Reference 10), WCAP 8687 accelerated thermal aging tests shows electrical/electronic equipment can survive up to a year at elevated ambient temperatures up to 185°F.

Therefore, the NRC's reference to Information Notice 85-89 does not identify any previously unevaluated risk factors to electronic equipment during the loss of Main Control Room cooling event at River Bend Station.

NUREG/CR-6479

NUREG/CR-6479 is a generic guidance document not specific to River Bend Station or any specific locations in the plant, but rather the qualification testing of microprocessor based electrical equipment. The document also presents studies to provide a technical basis for environmental qualification of computer-based safety equipment in nuclear power plants. The studies addressed:

(1) Adequacy of present test methods for qualification of digital instrumentation and control (I&C) systems

(2) Preferred (i.e., Regulatory Guide-endorsed) standards

(3) Recommended stressors to be included in the qualification process during type-testing

(4) Resolution of the need for accelerated aging for equipment to be located in a benign environment

(5) Determination of an appropriate approach for addressing the impact of smoke in digital equipment qualification programs.

The significant conclusions of the studies were:

(1) Type testing should continue to be the preferred test method for safety-related I&C systems.

(2) The "state of the art" does not warrant any changes to be made with regard to aging methodologies for digital systems in nuclear power plants.

(3) A stressor not previously considered for analog safety system qualification is smoke exposure.

(4) The synergistic effect of high temperature in combination with high relative humidity is potentially risk-significant to digital I&C.

(5) Based on comparative analysis of IEEE 323-1974 and IEEE 323-1983, it is recommended that IEEE 323-1983 be endorsed.

(6) Dynamic response of a *distributed* system under environmental stress should be considered during type-testing.

(7) There is a need for electromagnetic compatibility standard(s) for the nuclear power plant environment.

(8) The nuclear industry should adopt a new philosophy of qualification, in which the assurance that safety-related equipment will perform properly is "built-in" as well as being "tested-in."

The NRC inspection concerns the event that occurred at River Bend Station on 3/9/2015 in which there was a loss of cooling to the Main Control Room. Because of this, conclusions (1), (2), and (5) through (8) are not considered due to their focus on qualification testing of new microprocessor based electronic equipment. Therefore, the only conclusions from NUREG/CR-6479 considered are (3) and (4), which concern environmental stressors.

Concerning smoke as a significant environmental stressor, the scenarios modeled in the GOTHIC model (Reference 5) do not assume smoke to be present in the River Bend Main Control Room or a smoke/fire source anywhere in the Control Building that would affect the environmental conditions of the Main Control Room. Case 2 of the GOTHIC model (Reference 5) credits the use of smoke removal fans for air circulation purposes only. Therefore, with respect to River Bend Station's loss of Control Building HVAC, smoke as a significant environmental stressor is not applicable.

Concerning the synergistic, or combined, effect of high temperature and high humidity, the GOTHIC model (Reference 5) shows that temperature will not exceed 122°F. The highest cell/subvolume temperature for the cases considered is 121.8°F in subvolume 187 at 2.02 hours into the event. Subvolume 187 contains panel H13-P630 which is a non-safety related annunciator logic cabinet. Relative humidity is expected to be ~65% RH (in the subvolume around the Main Control Room door into the southwest stairwell), which is not high and within the maximum relative humidity of 70% specified in the River Bend Environmental Design Criteria for the Main Control Room.

- Per NUREG/CR-6479, page 26, "Under these conditions, semiconductors are not likely to exhibit significant failure mechanisms because of temperature...High humidity (~85%) is unlikely to be a problem unless it is accompanied by high temperature."
- Per NUREG/CR-6479, page 72, "With regard to temperature and humidity, the study found that the combination of high temperature at high relative humidity was the condition to affect the [experimental digital safety channel] EDSC, rather than temperature acting alone."
- Per NUREG/CR-6479, pages 62 and 63, "For the levels of stressors analyzed, risk effects from temperature in digital I&C equipment locations, and that from assumed levels of vibration, appear to be insignificant."

Because humidity is not expected to be high (~65% RH per Figure 7) and temperature alone appears to have "insignificant" risk effects, any risk to microprocessor based safety-related equipment is low. Therefore, the NRC's reference to NUREG/CR-6479 does not identify any previously unevaluated risk factors to electronic equipment during the loss of Main Control Room cooling event at River Bend Station.

USNRC Inspection Report 05000458/2015010

The inspection report (Reference 11) documents the special inspection performed on River Bend Station following the 3/9/2015 event where River Bend Station lost Control Building cooling. Attachment 3 of the report (River Bend Station Control Building Ventilation Risk Assessment Detailed Evaluation) documents the assumptions and facts used to evaluate risk significance of the event.

Page A3-5 states:

> "Enercon Calculation ENTR-078-CALC-002, 'Main Control Room Heat-Up under Loss of HVAC Conditions,' Revision 0, dated June 29, 2015, showed the control room reaching 104-108°F in one hour. Design Basis Calculation G.13.18.12.4*027, 'Control Room Temperature during Station Blackout,' Revision 2, dated December 12, 2012, concluded that control room temperature will reach approximately 120°F in 4 hours under blackout conditions. NRC inspectors determined that each of these calculations had limitations, conservatisms, and non-conservatisms when attempting to determine control room temperature. In response to NRC inspectors' questioning, the licensee performed Calculation ENTR-078-CALC-003, 'Main Control Room Heat-up Under Loss of HVAC Conditions for 24 hours,' Revision 0, to predict control room temperature during several conditions and made this calculation available to the inspectors on August 3, 2015. The inspectors again determined that the licensee's analysis contained several non-conservatisms, including assumptions of a wrong initial cabinet material temperature, not fully including the effects of sunshine warming the external concrete of the control building, dividing the control room into large sub-volumes for GOTHIC analysis, inadequate floor modelling, and inaccurate momentum transport. Sensitivities were run on Calculation ENTR-078-CALC-003 resulting in Revision 1, dated August 27, 2015, and Revision 2, dated September 10, 2015, being issued. The sensitivities run for each of the licensee errors were determined to have less than 1°F rise each in the control room. These non-conservatisms were never aggregated by the licensee to produce a cumulative effect on control room temperature.
>
> The inspectors found an incorrect value for the specific heat capacity of steel in Calculation ENTR-078-CALC-003 in September 2015. The licensee used a value of 0.16 BTU/lbm-°F, where a more appropriate value of 0.116 BTU/lbm-°F should have been used. The correct value resulted in a 14°F increase in control room temperature. The licensee then performed another analysis using the correct heat capacity of steel and added more steel (heat sink) at the same time. The licensee reported that they added the steel to the analysis to account for steel identified in the control room during a walkdown performed in July 2015. The effect of using the appropriate heat capacity of steel with these added steel heat sinks produced a final control room temperature of 119.9°F. This value of 119.9°F included use of the service water contingency to the coils of the air handling units within 2 hours. If the service water contingency is not credited, the main control room temperature rises above 120°F. This analysis did not include the several non-conservatisms described above. The inspectors determined that the control room would exceed 120°F during a loss of control building cooling event, given the non-conservatisms in the licensee's analysis, and the high failure probability of the service water contingency."

Response to A3-5 statement:

Calculation ENTR-078-CALC-004 was prepared to specifically address the NRC's concerns regarding techniques used in the development of previous GOTHIC models in calculations ENTR-078-CALC-002 and ENTR-078-CALC-003. MPR and NAI performed separate and independent third party reviews of these calculations and their comments and recommendations have been incorporated into ENTR-078-CALC-004. Listed below are the NRC concerns and the changes incorporated into calculation ENTR-078-CALC-004 to address those concerns. The sections and tables referred to are from ENTR-078-CALC-004.

1. Heat capacity of structural steel: Calculations ENTR-078-CALC-002 and ENTR-078-CALC-003 incorporated an incorrect value for the specific heat of structural steel. A corrected value of 0.116 Btu/lbm-°F was used in ENTR-078-CALC-004. This value was verified through two independent references (Section 3.15 and Table 2). As demonstrated in Attachment 9 of ENTR-078-CALC-003, the effects of the incorrect steel specific heat value was an under prediction of the average Main Control Room (MCR) temperature of 6.6°F in the limiting case. When combined with the addition of steel heat sinks identified during a MCR walkdown conducted in July, 2015 and with the effects of solar heating on the external surfaces of the MCR envelope (see Item 6 below), the effect of use of the incorrect steel heat capacity was an approximately 3°F under prediction of average temperature.
2. Density of concrete: The value used for the density of concrete (131.5 lb/ft^3) in all calculations was questioned as being about 2% lower than the "commonly accepted value" (140 lb/ft^3). In preparing calculation ENTR-078-CALC-004, this value was reviewed and verified, together with the other concrete thermal properties (specific heat and thermal conductivity), to be appropriate for this application. The verification was based on values from two independent references (Section 3.15, Table 2).
3. The control room floor modeling: The modeling of the MCR raised floor has been reviewed and revised, removing any credit for the aluminum honeycomb support structure and including modeling of the hardwood floor tiles (Section 3.5 and Figure 1, 2 and 3, Section 4.10).
4. Subvolume size: Calculations ENTR-078-CALC-002 and ENTR-078-CALC-003 employed MCR subdivided volumes of the upper and lower main control rooms based on a 4 (x direction) x 2 (y direction) x 2 (z-direction) grid, resulting in relatively large subvolumes. The mesh size of the GOTHIC subdivided volumes representing the upper and lower main control room regions has been increased to 16 (x-direction) and 8 (y-direction) nodes. The lower main control room subvolumes have also been increased to 3 (z-direction) nodes (Section 6.1). This change results in a significant reduction in the size of each subvolume.
5. Momentum Transport: Appropriate momentum transport options are now included in flow paths between subvolumes and between a subvolume and lumped volume or boundary condition (Section 6.6).
6. Solar heating: The effects of solar incidence (heating) on the MCR are included in the thermal conductors representing the control room external walls and roof in all GOTHIC models (Section 6.3).

7. Control Cabinet Temperatures: The NRC questioned the initial temperature of the thermal conductors representing the control panel (cabinet) material in the control room. The cabinets were previously modeled as passive heat sinks (thermal conductors) with initial surface temperature equal to the MCR temperature. Calculation ENTR-078-CALC-004 revises the conductors to include an initial control panel internal heat rate equal to the electrical heat load within the enclosure. With this approach, the initial temperature of the panel conductors is greater than 85°F; significantly above measured control panel temperatures. Since the panel doors are opened early in the transient (within the first 30 minutes), the cabinet heat load is input into the room using heater components. Therefore, the internal heat rate in the control panel thermal conductors is shut off after the first time step so that any residual heat in the panels is released to the MCR.

In addition to the above changes, calculation ENTR-078-CALC-004 also incorporates revised MCR heat loads. These heat loads are distributed in the MCR subvolumes based on their actual location in order to model the effects of localized heating.

Some other discrepancies in the NRC's reasoning should be noted:

- Changing to the correct value for the specific heat of steel did not result in a 14°F increase in control room temperature- the increase was approximately 7°F (see Item 1 above). After this was found, known heat sinks that were conservatively not credited in previous analysis were added in to mitigate this increase, which resulted in an MCR temperature of less than 120°F.
- ENTR-078-CALC-003 and ENTR-078-CALC-004 also evaluated another method of cooling the main control room if the service water contingency fails, specifically running the smoke removal fan, opening the MCR doors and staging a small portable fan, and opening ceiling tiles.

Page A3-6 states:

1. "Also on March 9, 2015, the plant was in a condition where the reactor cavity was flooded up in cold shutdown with lower electrical loads (heat sources)."
2. "When requested, the licensee could not provide the NRC a detailed analysis of the equipment survivability of control room equipment at the temperatures which would be expected to be experienced during a postulated heat-up scenario. The licensee instead provided analyses to indicate the control room would never reach 120°F, a temperature at which they assumed equipment would not be affected."
3. "When asked by inspectors about the basis of 104°F, the licensee cited section 6.4 of their Final Safety Analysis Report and stated 104°F was the maximum temperature limit main control room equipment was designed to operate."
4. "The analyst considered use of the guidance of Section 3.0, 'Failure Modeling,' of Volume 1, 'Internal Events,' of the Risk Assessment Standardization Project (RASP) Manual. Section 3.2 states, 'no credit should be taken for component operability beyond its design or rated capabilities unless supported by an appropriate combination of test or operational data, engineering analysis, or expert judgment.' Use of this provision would have control room components fail at 104°F"

Response to A3-6 statements:

1. Electrical loads in the Main Control Room are relatively constant because the loads consist primarily of lighting heat loads, computer heat loads, and control panel heat loads. Panel heat loads are due to indication and control power, and therefore, have very little variation for the differences in at-power conditions and cold shutdown conditions. Thus, the Main Control Room heat load for shutdown conditions is essentially equivalent for at-power conditions. Case 2 of the GOTHIC model (Reference 5) models a loss of Main Control Room cooling with normal at-power loads.

2. Design temperature of the Main Control Room equipment will not be exceeded, therefore a detailed analysis of the equipment survivability is not required. GE-22A3888, Rev. 3 (Reference 7) provides a design temperature of 122°F for the Main Control Room equipment. AOP-0600, Rev. 9 (Reference 6), in step 5.1.4 instructs Operators to open the control panel doors. Per NUMARC 87-00 (Reference 4), opening panel doors allows adequate air mixing and internal panel temperatures will be in equilibrium with Main Control Room ambient air temperature. The GOTHIC Model (Reference 5) shows Main Control Room temperature will not exceed 122°F (temperature will peak at 120.8°F around Safety Related control panel H13-P694 and remains above 120°F for only 11 minutes).

3. The temperature of 104°F is the maximum ambient temperature for control room equipment assuming closed control panel doors. Per GE-22A3888, Rev. 3 (Reference 7), the equipment is designed to operate at temperatures up to 122°F. Assuming the control panel doors are open, the ambient temperature and internal panel temperatures will reach equilibrium. Ambient temperature, and therefore internal panel temperatures, will not exceed 122°F per the GOTHIC model (Reference 5).

4. GE-22A3888, Rev. 3 (Reference 7) provides a design temperature of 122°F for the Main Control Room equipment. Therefore, the NRC's use of the provision in Section 3.2, of Volume 1, "Internal Events," of the RASP Manual should apply the design temperature of 122°F and assume failure of components at or above 122°F.

Page A3-7 states:

1. "The analyst reviewed the River Bend Updated Final Safety Analysis Report to determine the expected temperature range that control room equipment would experience during events. Table 9.4-1, 'Environmental and System Design Parameters for HVAC,' listed 65-80°F as the range with the highest temperature for control room equipment. This range is typically used for application of instrument inaccuracies in plant calculations. Operation at elevated control room temperatures, as would have occurred from the finding, would place instruments above the 80°F temperature value and likely affect instrument readings. The use of erroneous instrument readings during response to the event initiators and during the technical specification required shutdown of the plant would complicate operator response and lead to potential improper operation of systems."

2. "NUREG 1.115, 'Station Blackout,' describes that NUMARC 8700, 'Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors,' provided guidance acceptable to the NRC for meeting the requirements of 10 CFR 50.63, Station Blackout'. NUMARC-8700 discusses that maintaining a temperature below 120°F in the control room would assure proper functioning of equipment for up to four hours. For this case, most scenarios would last greater than four hours which exceeds the premises of NUMARC-8700. The NRC therefore qualitatively considered effects beyond four hours as described below.

   The use of the 120°F value from NUMARC-8700 for control room equipment functionality was less conservative than other approaches outline in various NRC documents, and would provide lower increases in core damage frequency. The analyst noted that NRC Information Notice 85-89, Potential Loss of Solid-State Instrumentation Following a Loss of Control Room Cooling,' discussed an event where solid-state instrumentation in the control failed at an ambient temperature of 90°F and described that the failure rate of instrumentation can be expected to increase as the control room temperature increases. Also, NUREF/CR-6479, 'Technical Basis for Environmental Qualification of Microprocessor-Based Safety-Related Equipment in Nuclear Power Plants,' described that the failure rate of instrumentation and combination with high humidity was potentially safety significant to digital instrumentation and control equipment as it recounted a test of some instrumentation and control equipment which failed 20°F below the equipment's maximum rated operating value.

   Accounting for all inputs, the NRC considered that the licensee's posture of ensuring the control room was maintained less than 120°F would only be acceptable for scenarios which would only result in elevated temperatures up to four hours and only if they also demonstrated that humidity did not rise appreciably in those four hours."

Response to A3-7 statements:

1. **Temperature Effect on Nominal Trip Setpoints (NTSP)**

   A review of forty-six (46) G13.18.6.1 instrument setpoint calculations critical to plant operations was performed to determine the effect of elevated temperatures (120°F max) in main control room on nominal trip setpoints. Thirty-one of the instrument loops evaluated use Rosemount 510DU or 710DU trip units to perform the trip function. Other instrument loops use a variation of Bailey model 745, NUS Model A076PA, or GE 184C5988 trip units. In each of the loops evaluated at an increased temperature of 120°F, the procedural as left band was greater than the loop reference accuracy (RA) and therefore, per reference EN-IC-S-007, the RA of each individual device is set to zero for the remainder of the calculation. In that scenario, the zero RA is not used when calculating the nominal trip point (NTSP). The conclusions in the associated calculations were not affected and the calculated NTSPs do not change. Therefore, it can be concluded that the elevated temperature evaluated has no adverse effect on the aforementioned instruments.

   Temperature Effect on Control Room Indicators

   Some of the indicators/recorders found to be in the main control room are GE 180 edgewise meters and Bailey, Westronics, and Yokogawa recorders. A review of the referenced

documentation concerning these devices indicate the following operating temperatures and temperature effects:

Instrument	Operating Temperature /Temperature Effect	Reference
Bailey 771/772	40 to 120°F Temperature Effect = ± 0.4% span/10°F (above 80°F)	B045-0134
Westronics M5E/M11E	Rated: 59 to 104°F Extreme: 15.8 to 122°F	3242.414-000-012G
Yokogawa DX200, DX364, DX2000	32 to 122°F Temperature Effect = ± (0.1% reading + 1 digit)/18°F (above 77°F)	Y006-0162, 0164, 229
GE 180 Edgewise Meters	-4 to 150°F No Temperature Effect specified	7242.433-000-003A

Although there is some operating temperature data given for a sampling of indicating instruments used in the main control room, there are no known accuracy requirements for indicating instruments. GE Specification GE-22A3888, Rev. 3 (0242.411-000-009), provides a design temperature of 122°F for all instruments within control room panels. The operating temperatures given for the indicating instruments reviewed fall within the design temperatures given in the GE specification for control room instruments. Therefore, it is concluded that the elevated control room temperatures as modeled in the GOTHIC calculation (Reference 5) will not cause erroneous instrument readings during a response to an event and during the technical specification required shutdown of the plant that would complicate operator response and lead to potential improper operation of plant safety system instruments.

2. Per GE-22A3888, Rev. 3 (Reference 7):
   "Apparatus shall be suitable for continuous operation within the panels, or benchboard with a normal and abnormal maximum ambient air inlet temperature as specified in the BWR Equipment Environmental Interface Data Specification (A62-4270). Allowance shall be made for the temperature rise in the cubicle due to heat given off by other equipment in the same cubicle, when considering individual components the maximum temperature in a panel, or benchboard shall not exceed 122°F (50°C) under the above conditions."

   Allowance is made for temperature rise (up to 18°F, i.e., up to the 122 °F design temperature) in the panel assuming an ambient air temperature of 104°F. This assumption is based on a panel being in operation with the doors closed. Opening the panel doors will allow the temperature inside the panel to reach equilibrium with the ambient air temperature (per NUMARC 87-00). Per AOP-0060, Rev. 9, "Loss of Control Building Ventilation" (Reference 6), step 5.1.4 operators will open the panel doors within 30 minutes of a loss of Control Building cooling. Additionally, per Reference 9 (River Bend Station Main Control Room Dayshift Log for 3/9/2015) step 5.1.4 was successfully completed 23 minutes into the event.

The control room equipment is designed for a maximum temperature of 122°F. The GOTHIC model (Reference 5) shows that ambient air temperatures will not exceed the equipment design maximum temperature of 122°F. Additionally, Figures 3, 6, 7, and 9 show that humidity will remain low and within the Main Control Room's Environmental Design Criteria. Therefore, the 4-hour limit is not applicable to River Bend Station Main Control Room.

CONCLUSION

A review of USNRC Information Notice 85-89, NUREG/CR-6479, ENTR-078-CALC-004, and USNRC Inspection Report 05000458/2015010, Attachment 3 concludes USNRC Information Notice 85-89 and NUREG/CR-6479 do not identify any previously unevaluated risk factors for reliability to the electronic equipment in the River Bend Station Main Control Room during the loss of cooling event because:

- Mitigating actions will be performed within 30 minutes (per Reference 6) to provide ventilation to the Main Control Room panels resulting in a different outcome than that presented in USNRC Information Notice 85-89.
- Per the GOTHIC model (Reference 5), the Main Control Room humidity is expected not to be high (maximum local of ~65% RH). Without a high humidity environment, there is no synergistic effect between high temperature and high humidity and, per NUREG/CR-6479, risk effects from high temperature alone are insignificant.

The review of USNRC Inspection Report 05000458/2015010, Attachment 3 also revealed the application of an incorrect maximum design temperature of 104°F. GE-22A3888, Rev. 3, (Reference 7) shows a maximum design temperature of 122°F for the Main Control Room equipment. Application of the correct maximum design temperature alters some conclusions of the USNRC inspection report, as detailed previously, and shows the Main Control Room equipment will not be challenged by the elevated temperatures cause by a loss of Main Control Room cooling event.

REFERENCES

1. USNRC Information Notice 85-89, "Potential Loss of Sold-State Instrumentation Following Failure of Control Room Cooling"
2. NUREG/CR-6479, "Technical Basis for Environmental Qualification of Microprocessor-Based Safety-Related Equipment in Nuclear Power Plants"
3. NUREG/CR-4942, "Equipment Operability During Station Blackout Events"
4. NUMARC 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors"
5. ENTR-078-CALC-004, Rev. 0, "Main Control Room Heat-Up Analysis During Loss of HVAC Conditions for 24 Hours"
6. AOP-0060, Rev. 9, "Loss of Control Building Ventilation" (effective 6/17/2014)
7. GE-22A3888, Rev. 3, "Design Specification Main Control Room Panels" (eB doc. 0242.411-000-009)
8. 215.150, Rev. 6, "Environmental Design Criteria"
9. River Bend Station Main Control Room Dayshift Log for 3/9/2015
10. ADAMS ML14038A019, "Joseph M. Farley Nuclear Plant Response to Request for Additional Information Regarding License Amendment Request for Transition to 10 CFR 50.48(c) – NFPA 805 Performance Based Standard for Fire Protection for Light Water Reactor Generating Plants"
11. USNRC Inspection Report 05000458/2015010, "River Bend Station – NRC Special Inspection Report 0500458/2015010 and Preliminary White Finding"

ATTACHMENT 1 – NRC Inspection Support Deliverables

1. Calculation G13.18.2.3-426, Standby Switchgear Room Temperature Sensitivity with Service Water Aligned to the HVK System
2. Calculation G13.18.4.0-063, Cooling Capacity of the Standby Service Water System to the Control Building Air Handling Units
3. 4216.110-996-001, Rev. 1, Control Building Heat Up Analysis following a Loss of HVAC
4. 4216.110-996-002, Rev. 0, Main Control Room Heat Up under Loss of HVAC Conditions
5. 4216.110-996-004, Rev. 3, Main Control Room Heat Up under Loss of HVAC Conditions for 24 Hours
6. RBS-ME-16-0002, Main Control Room Heat Up Analysis during Loss of HVAC Conditions for 24 Hours
7. Calculation ENTR-078-CALC-005 [in progress], Effectiveness of Ventilation with No Chilled Water
8. Engineering Report PSA-RBS-08-04, PRA Analyses supporting March 2015 NRC Special Inspection Issues (HVK Chillers, CR-RBS-2014-6284 Masterpact Breakers)

9. Engineering Report PSA-RBS-08-05, PRA Main Control Room Analysis following Loss of Control Building HVAC
10. Engineering Report PSA-RBS-08-03, Control Building Equipment Survivability Report
11. Engineering Report RBS-ME-15-00034, Vibration And Mechanical Design Evaluation for Aligning Service Water to Control Building Chilled Water (HVK) per AOP-0060 For Control Building Loss of Cooling / Loss of HVAC
12. Engineering Report RBS-NE-15-0001, Notice of Enforcement Discretion (NOED) Template and Typical Analysis for Control Building Cooling Systems (HVC, HVK)
13. Engineering Report RBS [in progress], Main Control Room Heat Load Assessment based on data obtained 2/11/16 during the performance of STP 402-4203
14. MPR Engineering Report 2062-1502-05-01, Rev. 1, January 5, 2016, Survey of US Nuclear Plants for Main Control Room Temperature Data
15. MPR Calculation CALC 2062-0005-0001, Rev. 0, February 12, 2016, Steady-state Analysis and Benchmark of River Bend Station Main Control Room GOTHIC Model
16. RBS-ME-15-00036, February 11, 2016, Main Control Room (MCR) Operator Habitability under Beyond-Design Basis Loss of HVAC Condition

Attachment 11
to RBS-47668

Technical Paper on Loss of AC Bus Initiator for RBS

Technical Paper on Loss of AC Bus Initiator for RBS

Background

The NRC has sent RBS an Inspection Report (EA-15-140 dated February 16, 2016). This inspection report refers to use of a SPAR model for RBS used by the NRC in performing their risk analysis. This SPAR model has a Loss of 4KV Bus initiating event whereas the RBS plant specific PRA model does not have this Loss of 4KV Bus as an initiator. The objective of this paper is to investigate this difference and develop and provide a basis for Entergy's position on this issue as part of the HVC/HVK regulatory conference scheduled with the NRC on April 3, 2016.

Discussion

RBS IPE

Attachment 1 has the Table of initiators modeled in the RBS IPE model. Per the Report EA-RA-91-0004-MP, rev 0, Pages 63 and 64, the Loss of AC Bus initiator was considered but not included in the model as a review of bus loads indicated that it does not cause a plant scram. However, the plant would have to proceed to a manual shutdown either on loss of drywell cooling or Tech Spec LCO entry within 8 hours.

RBS Latest Model (Rev 5)

The RBS PRA model does not model the loss of 4KV bus event as an initiator because a review of the loads impacted by the loss of these buses has been found to not cause a plant scram. This detailed review is available in Attachment 11 of the RBS Rev 4 PRA Initiating Event calculation and is reproduced in Attachment 2.

Given that GGNS has it in their Rev 4 model, a review was performed for the basis for inclusion of that event at GGNS. The loss of AC power procedure at GGNS provides clear direction to proceed to shutdown should there be a loss of a 4 KV bus. The equivalent RBS procedure does not have a similar procedural direction. This combined with the fact that at RBS a loss of 4 KV bus does not cause a plant scram is used to base the RBS PRA position that the loss of 4KV AC bus event need not be included in the RBS PRA model as a special initiator.

Other BWR/6 Info

GGNS

NUREG/CR-4550 (GGNS)

The Loss of AC bus was screened out. Basis: no plant scram found to be caused by loss of the 4KV bus initiator.

IPE

The Loss of AC bus was included based on Instrument Air isolation caused by failing the AC bus. (Since then the GGNS Instrument Air/Plant Air design has been modified so that this isolation will not occur).

Latest Model (Rev 4 Draft)

The loss of AC bus initiator is conservatively included in the model even though it no longer causes a loss of instrument air and an automatic plant scram. This is based on GGNS Procedure for "Loss of AC Power", Section 3.1 for Loss of Div 1 OR Div 2 ESF Buses (15AA OR 16AB de-energized). Step 3.1.3 in this procedure states: " IF it is obvious the affected bus CANNOT be immediately energized, THEN INITIATE a manual scram." Therefore, this event is considered conservatively to be an initiator in the GGNS Rev 4 draft PRA model (note that this model is currently undergoing closure of F&Os from the recent BWROG RG 1.200 Peer Review).

Perry

Loss of 4KV AC Bus is not in the Perry model, as it does not cause a plant scram.

Clinton

The Clinton PRA model does not have a Loss of 4KV AC Bus initiator. They do have an impact on Instrument Air from such a loss of bus as was evident from a recent plant event and they are planning to add this initiator to the model at the next periodic model revision to address this issue.

Conclusions

The RBS Plant Specific PRA Rev 5 does not model the loss of 4 KV. This is based on a detailed review of plant loads fed by the 4KV AC buses as well as the procedural directions in the AOP-0004 (loss of Offsite Power). No other procedures were found that deal with the loss of a 4KV Bus. Therefore, it is believed that the RBS PRA model appropriately treats the loss of 4KV bus event without a special initiator for it.

Attachment 1: Table with List of Initiators in RBS IPE Calculation

A	Large Loss of Coolant Accident (LOCA)	1.00E-4
S1	Intermediate LOCA	3.00E-4
S2	Small LOCA	3.00E-3
S3	Small-Small LOCA (Recirc pump seal LOCA)	3.00E-2
T1	Loss of Offsite Power Transient	0.1
T2	Transient With Loss of PCS	1.66
$T3_A$	Transient With PCS Available	4.5
$T3_B$	Loss of Feedwater Transient	0.76
$T3_C$	Inadvertent SRV Opening Transient	0.14
TB	Station Blackout - Not a Separate Initiator but a Sequence of Concern That Could Result From Other Initiators	
TDCI	Loss of DC Division I Transient	5.0E-3
TDCII	Loss of DC Division II Transient	5.0E-3
TNSW	Loss of Normal Service Water Transient	2.0E-3
TCCS	Loss of Turbine Plant Component Cooling Water Transient	2.0E-3
TCCP	Loss of Reactor Plant Component Cooling Water Transient	2.0E-3
TIAS	Loss of Instrument Air Transient	8.0E-4

Attachment 2 – Review of Loads Impacted by a Loss of 4 KV Bus Event at RBS

Table 1: Normally Running Class 1E Loads and Non-Class 1E Equipment Supplied from Class 1E Buses

Load	Description	Class 1E Bus	Impact to Scram due to Loss of Associated Emergency AC Bus
ENB-CHGR1A	Emergency battery charger (Battery ENB-BAT01A)	ENS-SWG1A	ENB-CHGR1A is used to power safety related 125 VDC bus ENB-SWG1A and charge ENB-BAT01A. Failure of the charger would not result in an automatic scram, but would result in 2 hour shutdown LCO. If the charger is not restored within 2 hours, the plant must be in Mode 3 within 12 hours and Mode 4 within 24 hours.
ENB-CHGR1B	Emergency battery charger (Battery ENB-BAT01B)	ENS-SWG1B	ENB-CHGR1B is used to power safety related 125 VDC bus ENB-SWG1B and charge ENB-BAT01B. Failure of the charger would not result in an automatic scram, but would result in 2 hour shutdown LCO. If the charger is not restored within 2 hours, the plant must be in Mode 3 within 12 hours and Mode 4 within 24 hours.
E22-S001CGR	Emergency battery charger (Battery E22-S001BAT)	E22-S002	E22-S001CGR is used to power safety relater 125 VDC bus E22-S001 and charge E22-S001BAT. Failure of the charger would not result in an automatic scram.
HVR-UC1A	Containment Unit Cooler	ENS-SWG2A	Each containment unit cooler can remove 50% of rated heat load during normal operation. If division I power is lost, HVR-UC1C would be needed to remove the heat generated and maintain containment temperatures below 90°F. If containment temperature cannot be maintained below 90°F, the plant would enter an 8-hour shutdown LCO. If the temperature is not restored within 8 hours, the plant must be in Mode 3 within 12 hours and Mode 4 within 36 hours.
HVR-UC1B, HVR-UC1C	Containment Unit Coolers	ENS-SWG2B	Each containment unit cooler can remove 50% of rated heat load during normal operation. If division II power is lost, two of the three containment unit coolers would be inoperable. Therefore, the plant would enter an 8-hour LCO. If one of the two unit coolers is not restored within 8 hours, the plant must be in Mode 3 within 12 hours and Mode 4 within 36 hours.
Division I Control Building HVAC components (ACUs, Fans, AODs, Chillers)	Various equipment required to run to provide cooling to the Control Room, Switchgear Rooms, Battery Rooms, etc.	ENS-SWG1A, EHS-MCC14A	Each Control building HVAC subsystem can remove 100% of the rated heat load during normal operation. Each HVK Chiller can remove 100% of rated heat load. Therefore, failure of the Division I HVC/HVK system would not impact power operation as long as the area temperatures remain below the setpoints in TR 3.7.10.
Division II Control Building HVAC components (ACUs, Fans,	Various equipment required to run to provide cooling to the Control Room, Switchgear Rooms, Battery Rooms, etc.	EJS-SWG1B, EHS-MCC14B	Each Control building HVAC subsystem can remove 100% of the rated heat load during normal operation. Each HVK Chiller can remove 100% of rated heat load. Therefore, failure of the Division II HVC/HVK system would not impact power operation as long as the area temperatures remain below

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AODs, Chillers)			the setpoints in TR 3.7.10.
BYS-CHGR1A	Normal battery charger (Battery BYS-BAT01A)	EJS-SWG1A	BYS-CHGR1A is used to power non-safety related 125 VDC bus BYS-SWG1A and charge BYS-BAT01A. The batteries have a 2550 amp-hour rating and can supply to the bus for at least 2 hours. Backup charger BYS-CHGR1D can be used to supply power to the bus if this charger failed. No scram would occur due to loss of the normal battery charger
BYS-CHGR1B	Normal battery charger (Battery BYS-BAT01B)	ENS-SWG1B	BYS-CHGR1B is used to power non-safety related 125 VDC bus BYS-SWG1B and charge BYS-BAT01B The batteries have a 2550 amp-hour rating and can supply to the bus for at least 2 hours. Backup charger BYS-CHGR1D can be used to supply power to the bus if this charger failed. No scram would occur due to loss of the normal battery charger
IHS-CHGR1D	Information handling system battery charger (battery IHS-BAT01D)	EJS-SWG2B	IHS-CHGR1D is used to power non-safety related 125 VDC bus IHS-SWG01D and charge IHS-BAT01D. The batteries have a 2550 amp-hour rating. IHS-SWG01D supplies power to IHS-INV01 which is used to power security and information handling. The primary source of power to the inverter is not lost due to loss of the emergency AC bus. Therefore, there is no impact to plant operation.
NHS-MCC101	Normal motor control center for turbine mezzanine level and auxiliary building	ENS-SWG1B	See impact due to failure of the loads listed below.
LPM-1-LPM-6 TGOP MSOP SOVP VXM MSP TGM PBM SCA-PNL101	Bearing Lift Pumps Turning gear oil pump motor H2 main seal oil pump motor H2 seal oil vacuum pump motor Vapor Extraction Tank motor Motor oil suction pump motor Turning gear motor Turning gear piggyback motor Turbine building distribution panel	NHS-MCC101	Most of these pumps are only required for startup and shutdown operations. Therefore, there is no impact due to these pump motors. The main seal oil pump would receive backup from the Emergency Booster Oil Pump (DC Driven). The EBOP is not impacted by loss of ENS-SWG1B. If H2 Seal Oil Vacuum Pump is lost, no vacuum pretreatment is available. Therefore, the generator must be supplied with clean hydrogen to maintain purity. Plant shutdown is not required.
NHS-MCC102A	Normal motor control center for auxiliary and turbine buildings	ENS-SWG2A	See impact due to failure of the loads listed below.
DRS-UC1A,C,E SLP-1	Drywell unit coolers Surveillance light	NHS-MCC102A	Drywell UCs are used for drywell heat removal during operation. Each of the drywell UCs are sized for 25% capacity. Two from each division are normally running. A total loss of one division of AC power would reduce the capacity to 50% and a low flow alarm would annunciate in the control

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			room. The operator could start the standby unit on the available division, resulting in 75% capacity. A slow heatup and pressurization of the drywell could occur. Power reduction might be needed to reduce the heat load in the drywell. However, Technical Specifications requirements for high drywell containment differential pressure (+1.2 psid) and high drywell temperature (145°F) would ultimately force a controlled shutdown before a scram would occur.
NHS-MCC102B	Normal motor control center for auxiliary and turbine buildings	ENS-SWG2B	See impact due to failure of the loads listed below.
DRS-UC1B,D,F CPP-FN1 SLP-2	Drywell unit coolers Hydrogen purge fan Surveillance light	NHS-MCC102B	Drywell UCs are used for drywell heat removal during operation. Each of the drywell UCs are sized for 25% capacity. Two from each division are normally running. A total loss of one division of AC power would reduce the capacity to 50% and a low flow alarm would annunciate in the control room. The operator could start the standby unit on the available division, resulting in 75% capacity. A slow heatup and pressurization of the drywell could occur. Power reduction might be needed to reduce the heat load in the drywell. However, Technical Specifications requirements for high drywell containment differential pressure (+1.2 psid) and high drywell temperature (145°F) would ultimately force a controlled shutdown before a scram would occur. The hydrogen purge fan is not required to operate during normal operation.
Various	Unqualified heaters furnished with Class 1E MOVs	Various 120V	MOV heaters are not required to function for the Class 1E MOVs to function.
C71-P001	RPS bus	RPS-XRC10A1	Loss of power to a RPS bus will result in a half scram and a half MSIV isolation. However, loss of a RPS bus will not result in an automatic scram unless test or maintenance activities on the other division is in process which would cause a half scram on the other division.
C71-P002	RPS bus	RPS-XRC10B1	Loss of power to a RPS bus will result in a half scram and a half MSIV isolation. However, loss of a RPS bus will not result in an automatic scram unless test or maintenance activities on the other division is in process which would cause a half scram on the other division.
IHA-PNL1	Control Building data acquisition system	EHS-MCC8A	Loss of this panel causes loss of monitoring to status of HVK chilled water pumps (A,C) and HVK flow switches (A). This would not result in a plant trip.
IHA-PNL1	Control Building data acquisition system	EHS-MCC8B	Loss of this panel causes loss of monitoring to status of HVK chilled water

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			pumps (B,D) and HVK flow switches (B).). This would not result in a plant trip.
IHA-PNL1	Control Building data acquisition system	SCV-PNL8A1	Loss of this panel causes loss of monitoring to status of HVK chilled water pumps (A,C) and HVK flow switches (A). This would not result in a plant trip.
IHA-PNL1	Control Building data acquisition system	SCV-PNL8B1	Loss of this panel causes loss of monitoring to status of HVK chilled water pumps (B,D) and HVK flow switches (B).). This would not result in a plant trip.
LAC-XLC9	Main Control Room lighting system transformer	EHS-MCC14A	To furnish 20% lighting in the main control room upon loss of non-Class 1E sources of power to remaining 80%. No impact on plant operation.
LAC-XLC9	Main Control Room lighting system transformer	EHS-MCC14B	To furnish 20% lighting in the main control room upon loss of non-Class 1E sources of power to remaining 80%. No impact on plant operation.
MHR-CRN1	Polar crane - Reactor Building	EJS-LDC2A	Used for maintenance. No impact on plant operation.
MHW-CRN2A	Monorail – Standby Cooling Tower	EHS-MCC16A	Used for maintenance. No impact on plant operation.
MHW-CRN2B	Monorail – Standby Cooling Tower	EHS-MCC16B	Used for maintenance. No impact on plant operation.
Various	Non-Class 1E slide wire transducers	Various control circuits	Valve position indication on selected RHR valves. No impact on plant operation.
Various	Non-Class 1E limit switches	Various control circuits	Valve position indication. No impact on plant operation.
SWP-P2AH	Non-Class 1E motor heater	SCV-PNL14A1	Humidity control. No impact on plant operation.
SWP-P2BH	Non-Class 1E motor heater	SCV-PNL14B1	Humidity control. No impact on plant operation.
SWP-P2CH	Non-Class 1E motor heater	SCV-PNLS002	Humidity control. No impact on plant operation.
SWP-P2DH	Non-Class 1E motor heater	SCV-PNL14B1	Humidity control. No impact on plant operation.
SWP-SOV600A	Control solenoid for SWP-AOV599	VBS-PNL01A	Energize to close valve SWP-AOV599. SWP-AOV599 closed during power operation. Valve open logic is not made.
SWP-SOV600B	Control solenoid for SWP-AOV599	VBS-PNL01A	Energize to close valve SWP-AOV599. See SWP-SOV600A
SWP-SOV601	Control solenoid for SWP-AOV599	VBS-PNL01A	Energize to open valve SWP-AOV599. See SWP-SOV600A
SWP-SOV602A	Control solenoid for SWP-AOV599	EHS-MCC16A	De-energize when Division I is not available to auto open valve SWP-AOV599. See SWP-SOV600A
SWP-SOV602B	Control solenoid for SWP-AOV599	EHS-MCC16B	De-energize when Division II is not available to auto open valve SWP-AOV599. See SWP-SOV600A
SWP-SOV602C	Control solenoid for SWP-AOV599	E22-S002	Energize when valve SWP-MOV40C is open to auto open valve SWP-AOV599. See SWP-SOV600A
RPS-PNL2B	RPS-EPA Monitoring	EHS-MCC14B	Monitoring voltage and frequency. No impact on plant scram.

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E31-TDSR608	Leak detection area ambient temperature recorder	VBS-PNL01A	Records ambient temperature in various areas of the plant and provides a high temperature alarm. No impact on plant scram.
E31-TDSR611	Leak detection area differential temperature recorder	VBS-PNL01A	Records the temperature difference between the inlet and outlet air temperature of various areas of the plant and provides an alarm on high differential temperature. No impact on plant scram.
C11-TRR018	CRD Temperature recorder	VBS-PNL01A	Records CRD temperatures and provides common high temperature alarm in the main control room. No impact on plant scram..
JRB-DRA1	Upper containment airlock	EHS-MCC2K	Access to containment. No impact to plant operation.
JRB-DRA2	Lower containment airlock	EHS-MCC8B	Access to containment. No impact to plant operation.
E31-FYN021-1 and E31-FTN021	Drywell cooler condensate drain flow transmitter	SCV-PNL2B1	Power drywell cooler condensate flow element E31-FYN021-1 and E31-FTN021. No impact on plant scram.