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RECIP.NAME RECIPIENT AFFILIATION
JOHNSON,A.R. Project Directorate I-3

SUBJECT: Forwards response to request for addl info contained in NRC SER of station blackout analysis,dtd 920130,in response to NRC 920204 ltr transmitting findings from TAC M68458 & Procedure ST-89.02, "Control Bldg Heat Generation...."

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April 6, 1992

U. S. Nuclear Regulatory Commission
Document Control Desk
Attn: Allen R. Johnson
Project Directorate I-3
Washington, D.C. 20555

Subject: 10 CFR §50.63, *Loss Of All Alternating Current Power*
60-Day Response To TAC M68548
R. E. Ginna Nuclear Power Plant
Docket No. 50-244

Dear Mr. Johnson,

On February 4, 1992, Rochester Gas And Electric Corporation received correspondence from you transmitting the US NRC Staff's findings from TAC M68458, *R. E. Ginna Nuclear Power Plant Station Blackout Analysis*, dated January 30, 1992. The Safety Evaluation Report (SER) attached to that correspondence contained 14 recommendations from the USNRC Staff; five of those recommendations contained requirements for RG&E to provide additional information for USNRC Staff review within 60 days of the receipt of the referenced correspondence. RG&E's responses to those five requests are attached.

Very truly yours,

Robert C. Mecredy

Subscribed and sworn to before me
on this 6th day of April, 1992

Deborah A. Piperni
Notary Public

DEBORAH A. PIPERNI
Notary Public in the State of New York
ONTARIO COUNTY
Commission Expires Nov. 23, 1993

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Enclosures

xc: Mr. Allen R. Johnson (Mail Stop 14D1)
Project Directorate I-3
Washington, D.C. 20555

United States Nuclear Regulatory Commission
Region I
475 Allendale Road
King Of Prussia, PA 19406

Ginna Senior Resident Inspector

9204150124

1) Section 2.2.4.1, Page 6 (1)

Recommendation: The licensee should reevaluate and provide the results for Staff review of the temperature rise in the control room using a conservative initial temperature corresponding to the Technical Specification temperature limits or the maximum value allowed under the administrative procedures, and using conservative parameters as described in the Science Applications International Corporation (SAIC) Technical Evaluation Report for the heat up calculations. If the licensee's administrative procedures do not specify an operating temperature limit, the licensee should establish administrative procedures or revise existing procedures to maintain the control room temperature at or below the initial room temperature used in the heat up analysis.

Response: According to NUMARC 87-00, Revision 1, Baseline Assumption 2.2.1 (2),

> *Immediately prior to the postulated station blackout event, the reactor and supporting systems are within normal operating ranges for pressure, temperature, and water level. All plant equipment is either normally operating or available from the standby state.*

NUMARC 87-00, Revision 1, Baseline Assumption 2.7.1 (3) deals with control room habitability. Its basis is,

> *(i) Before station blackout, it is assumed that the control room is at 78°F and about 35% relative humidity.*

RG&E believes, therefore, that NUMARC 87-00, Revision 1, allows licensees to reasonably assume that control room HVAC is operating normally to maintain an environment of 78°F and about 35% relative humidity prior to the onset of the station blackout event.

Studies such as NUREG-1032 and NUREG/CR-3226 that have been conducted in support of the station blackout rule making process consistently applied engineering judgement to dismiss highly unlikely events such as the simultaneous occurrence of a station blackout and an earthquake. This approach is consistent with the concept of reasonable assurance. In particular, NUREG-1032 was based on best estimate analyses, evaluations and results. Using the highest design temperature of 104°F as the starting point for the control room heatup calculations does not represent a best estimate for the likely initial environmental conditions experienced during normal operations.

The calculations submitted to the NRC assumed an initial control room temperature of 77°F. RG&E does not believe that the results of the heatup calculations would be substantially changed by substituting the NUMARC 87-00 assumption of 78°F.

RG&E utilizes Ginna Administrative Procedure A-52.12, *Inoperability Of Equipment Important To Safety*, to track the operating status of equipment that is important to plant safety but is not addressed in Technical Specifications. This procedure calls for repairing and returning such equipment to service in an expeditious manner. Ginna Administrative Procedure A-52.12 will be

modified to include the system that provides HVAC to the control room within the time frame of 10 CFR §50.63 (c)(3), following notification of NRC approval.

2) Section 2.2.4.1, Page 6 (2)

Recommendation: The licensee should provide for Staff review detailed information about the test performed to measure the heat loads in the control room and verify that these heat loads were correctly / conservatively measured.

Response: The requested information on the control room heat load test is included in Enclosure 1. If requested, we would be willing to discuss details of this test with the NRC staff and contractors.

The following information deals with specific concerns raised about this test in the SAIC TER:

2.1) **SAIC TER:** The licensee did not state when the test was performed nor what the atmospheric conditions were at the time of the test.

RG&E RESPONSE: The HVAC tests performed on the control building were accomplished in February of 1990. The battery rooms were tested from 1700 hours on 2/8/90 to 2358 hours on 2/9/90. The relay room was tested from 1600 hours on 2/13/90 to 1608 hours on 2/14/90. The control room was tested from 1615 hours on 2/15/90 to 0936 hours on 2/17/90. The atmospheric conditions were documented by the RG&E consultant only on a limited scale because RG&E was measuring control building **internal** heat loads. The outside air temperature did not exceed 51°F. Also, because it was February, the sun did not significantly affect the possible solar gain effects that may occur in the summer time. The computer model was developed assuming that no heat was added to the room due to solar effects during the control building tests. The solar heat loads were added to the computer model with the relationship *q=UxAxCLTD* for an event occurring on a 91°F August design day at noon, which allows for additional conservatism in that the maximum heat input experienced to the control building areas occur during the time of day when the air temperature is greater. The *ASHRAE Handbook 1985 Fundamentals SI Edition* (ASHRAE, Atlanta, GA) was used for this analysis.

2.2) **SAIC TER:** The calculated heat load in the control room is 14.25 kW. The licensee stated that the two inverters of 7.5 Kw each are fully loaded during normal plant operation. Therefore, it appears that the calculated heat load is low.

RG&E Response: The calculated heat load in the control room was 14.25 kW. The 7.5 kW inverters are located in the battery rooms, not in the control room. The 48610 BTU/HR (14.25 kW) heat load from the control room appears to be reasonable and conservative. The computer model assumes the control room equipment heat loads remain constant and that power is not lost to any of those loads. RG&E believes that this is a conservative value.

2.3) **SAIC TER:** The licensee first made an assumption that the area between the drop ceiling tiles and the control room ceiling, or the "truss area," receives the cooled air first and then the air passes through holes to the area below, i.e. operating area. At the end of the calculation the licensee identifies a need for removing the ceiling tiles, but did not indicate when nor which tiles should be removed. Removal of the tiles needs to be performed in the first 30 minutes of the event.

RG&E Response: When plant is operating normally (i.e. when the control room HVAC equipment is operating normally) the "truss area" is acting as ductwork or a plenum. The cooled air normally blows into the control room from the "truss area". The control room HVAC equipment does not operate during a station blackout event. When no air is being forced through the "truss area", the tiles tend to restrict the natural air circulation to cool the control room. The tiles and the air space they create in the control room both act as insulators and slow down heat transfer through the control room ceiling to the outside environment.

RG&E is evaluating two alternatives that would address this concern: Modifying the station blackout procedure to instruct the operators to remove as many tiles as possible (at least 10% of all tiles) within 30 minutes; or, replacing at least 10% of the existing ceiling tiles with open grids. As stated in RG&E's previous submittals on 10 CFR §50.63, this procedure change or modification will be completed within the timeframe of 10 CFR §50.63 (c)(3), following notification of NRC approval.

3) Section 2.2.4.2, Page 7 (1)

Recommendation: The licensee should reevaluate and provide the results for staff review of the temperature rise in the relay room and battery rooms A and B using conservative initial temperatures, corresponding to the Technical Specifications temperature limits or the maximum values allowed under administrative procedures, and using conservative parameters as described in the SAIC Technical Evaluation Report for the heat up calculations. If the licensee's administrative procedures do not specify an operating temperature limit for each of these rooms, the licensee should establish administrative procedures or revise the existing procedures to maintain the room temperatures at or below the initial room temperatures used in the heat up analyses.

Response: For the reasons stated in response to Section 2.2.4.1, Page 6 (1), RG&E feels that the use of normal operating temperatures for these areas at the start of the station blackout event is appropriate. The following information deals with other specific areas of concern raised in the SAIC TER:

RG&E utilizes Ginna Administrative Procedure A-52.12, *Inoperability Of Equipment Important To Safety*, to track the operating status of equipment that is important to plant safety but is not addressed in Technical Specifications. This procedure calls for repairing and returning such equipment to service in an expeditious manner. Ginna Administrative Procedure A-52.12 will be modified to include the system that provides HVAC to the control room within the time frame of 10 CFR §50.63 (c)(3), following notification of NRC approval.

3.1) SAIC TER: It appears that the licensee has used all surface areas (i.e., side walls, floor, and ceiling) in each room as heat sink. Since the battery room, relay room, and control room are at different elevations, the ceiling for one room is the floor for the next room. It is not clear how the licensee modeled this dependency. Our understanding of the calculation is that the licensee used a one dimensional heat transfer code which assumes the surrounding room temperatures to remain unchanged during the analysis. This approach will result in underestimating the final temperatures of the individual rooms if the dependency is ignored. Other factors that effect heat-up calculations are the outside ambient air temperature, heat transfer coefficient, and thermo-physical properties of the materials considered in the analysis. Without this information we unable to concur with the licensee's findings.

RG&E Response: There were two separate and distinct basic steps of this analysis. The first was to collect test data of the individual rooms. The second was to develop a model of the system using conservative values. The first step individually looked at three volumes: The control room, relay room and battery rooms (both A and B battery rooms), to collect temperature profiles. The primary objective was to determine the heat generation rate during operating conditions for each of the three volumes. The heat generation rate for the three volumes was then conservatively calculated

by the computer model from the test data. The computer model then treated the three volumes as one connected system, such that the floor of an upper room was the same surface as the ceiling of a lower room. The computer code assumed that the three room volumes were connected and thermally influenced by each others temperatures. Conservative assumptions were made, which consisted of high design day outdoor temperatures, large solar gain effects and high ground temperatures (initially 75°F).

The heat transfer coefficients that were generated within the computer model, however, are not included in the program's standard output. The structural boundaries thermo-physical property values were generated within the computer model, however, were not formally printed out. The RG&E contractor who did the testing and the computer model was unable to give RG&E verification calculations which contained heat transfer coefficient data and thermo-physical property values of the materials used, since the consultant considered such information to be proprietary. Since this was a 10 CFR §50 Appendix B calculation, it is available for review at the consultant's offices, if necessary.

<u>4) Section 2.2.4.2, Page 7 (2)</u>

Recommendation: The licensee should provide the detailed information about the tests performed to measure the heat loads in these (the relay room and battery rooms A and B) rooms and verify that these heat loads were correctly / conservatively measured.

Response: The requested information on the control room heat load test is included in Enclosurer 1.

<u>5) Section 2.2.4.3, Page 8, Item (1)</u>

Recommendation: The licensee should evaluate and provide results for Staff review of the temperature rise in the AFW pump room using conservative assumptions (see SAIC's Technical Evaluation Report) and assess the effect of the higher temperature on the equipment required to respond to an station blackout event in the AFW pump room.

Response: The following information addresses the specific concerns raised in the SAIC TER:

5.1) **SAIC TER:** The licensee used the surrounding walls as heat sinks, and neglected the floor, which is the basement, and the ceiling surface area. The licensee claimed that these assumptions make the calculation conservative. Our review of the licensee's calculations indicates that the ceiling, which is constructed of corrugated metal attached to the 5 inch poured concrete slab, could be at a temperature higher than the 104°F assumed for all the walls except that of the containment.

RG&E Response: RG&E maintains that the AFW room SBO heat up calculations are conservative. The AFW room ceiling is being heated by both the ARV and AFW rooms, and storing that energy in the metal and concrete during a SBO. The calculated numbers given by the SAIC TER of 123°F ceiling temperature and a final room temperature of 152°F with the doors open, were incorrect, since they apparently did not take into account the different heights of the ARV and AFW rooms and did not use the correct area in the NUMARC 87-00 correlations. The effect of not considering the AFW ceiling as a heat sink may not have been readily apparent, however the calculations below will add more detail to prove that the existing calculations are conservative. These calculations are preliminary, but we expect to formalize them approximately one month following the 1992 refueling outage, and will submit them at that time. The correlations obtained from NUMARC 87-00 are used assuming that the wall areas (A_w) and temperatures (T_w) mentioned can be used for heat sink locations, consisting of walls, ceilings and floors (A and T_{AVE}). The sections 7F and 7G use the above assumption.

A) Determine heat from ARV room to the floor.

Q_{ARV} = 112198 W (from page 10 of the 4/9/91 Devonrue Calculation(4/9C))

A = [97.93 m(wall per.)][6.1 m(ARV room height)] from page 14 (4/9C)

Conservatively assume no contribution from the floor or ceiling to this area initially, since T_∞ would be higher; consequently, Q into the floor would be lower.

A = $597.37\ m^2$

T_i = 40°C = 104°F = 313°K

T_∞ = $T_i + [Q / A]^{.75}$

T_∞ = $313°K + (112198\ W/597.37\ m^2)^{.75}$

$T_\infty =$ 363.7°K

$T_{film} = (T_\infty + T_s)/2 = (363.7°K + 313°K)/2 = 338.35°K$

$\beta =$ $1/T_{film} = 1/338.35°K = .002956°K^{-1}$

$L =$ 3.4 m (Value from page 17 of (4/9C))

$\alpha =$ $28.18 \times 10^{-6}\ m^2/s$ (Value interpolated from Incropera and DeWitt reference)

$\nu =$ $19.75 \times 10^{-6}\ m^2/s$ (Value interpolated from Incropera and DeWitt reference)

$Ra =$ $[g\beta(T_s - T_\infty)L^3] / \nu\alpha$

$$Ra = \frac{(9.8\ m/s^2)(.002956°K^{-1})(313°K - 363.7°K)(3.4\ m)^3}{(19.75 \times 10^{-6}\ m^2/s)(28.18 \times 10^{-6}\ m^2/s)}$$

$Ra =$ -1.037×10^{11} (The negative sign means that the air is heating up the ARV floor surface)

For the condition where the lower surface gets heated, even though the normal range for an equation like this is $10^5 \lesssim Ra_L \lesssim 10^{10}$ (Close, so it will be used here).

$Nu_L = .27\ Ra_L^{.25} = .27(1.037 \times 10^{11})^{.25}$

$Nu_L = 153.2$

$k =$ .02914 W/m°K (Interpolated from the Incropera and DeWitt reference)

$h_c =$ $k(Nu_L)/L = (.02914\ W/m°K)(153.2)/(3.4\ m)$

$h_c =$ $1.313\ W/m^2{}°K$

$Q =$ $h_c A \Delta T = (1.313\ W/m^2{}°K)(333\ m^2)(363.7°K - 313°K)$

$Q =$ 22168 W into the floor of the ARV room

B) Determine heat flow from the AFW room into the ceiling.

A_{WALLS} = (Per.)(ht.) = (97.93 m - 33.33 m)(7.57 m)

A_{WALLS} = 489.02 m^2

$A_{CONTAINMENT}$ = (33.33 m)(7.57 m) = 252.31 m^2

$A_{CEILING}$ = 333.1 m^2

$A_{TOTAL} = A_{WALLS} + A_{CONTAINMENT} + A_{CEILING}$

A_{TOTAL} = 489.02 m^2 + 252.31 m^2 + 333.1 m2

A_{TOTAL} = 1074.4 m^2

$A_{CEILING}/A_{TOTAL}$ = 333.1 m^2 / 1074.4 m^2 = .310

Q_{AFW} = 63105 W (From page 11 of the 5/28/90 Devonrue Limited *Calculation on the Ginna TDAFW Pump Area Ambient Temperature Rise* (5/28C))

Q = (.310)(63105 W)

Q = 19564 W

C) Determine the heat entering the common slab from the ARV and AFW rooms.

Q_{SLAB} = 22168 W + 19564 W = 41732 W

D) Determine the increase in temperature of the common slab.

Assume that the size and construction of the ARV ceiling is the same as the floor.

ρ = 147.4 lbm/ft^3 from page 20 of (4/9C)

c_p = .1557 Btu/lbm°F (from page 20 of (4/9C))

V_{TOTAL} = 1504.3 ft^3 (from page 20 of (4/9C))

Δt = 4 hours (length of SBO analyzed)

Q = 41732 W ((1 Btu/hr)/(.2931 W)) = 142381 Btu/hr

$Q = \rho\, c_p\, V\, \Delta T / \Delta t$

or

$\Delta T = Q\, \Delta t / \rho\, c_p\, V$

$$\Delta T = \frac{(142381\ \text{Btu/hr})(4\ \text{hr})}{(147.4\ \text{lbm/ft}^3)(.1557\ \text{Btu/lbm°F})(1504.3\ \text{ft}^3)}$$

ΔT = 16.5 °F

T_{SLAB} @ 4 HOURS = 104°F + 16.5°F = 120.5°F

The 120.5°F will conservatively be used as the AFW room ceiling temperature throughout the SBO transient, even though the correct temperature to use is somewhere between 104°F and 120.5°F, probably closer to 114°F.

E) Determine the average wall and ceiling temperature.

$A_{CONTAINMENT}/A_{TOTAL}$ = 252.31 m^2 / 1074.4 m^2 = .235

A_{WALLS}/A_{TOTAL} = 489.02 m^2 / 1074.4 m^2 = .455

$T_{CONTAINMENT}$ = .5 (104°F + 120°F) = 112 °F

T_{AVE} = .310(120.5°F) + .235(112°F) + .455(104°F)

T_{AVE} = 111.0 °F = 43.89 °C = 316.9 °K

F) Determine AFW room temperature with the doors closed.

A = Total surface area of walls and ceilings acting as heat sinks. Note that the more conservative area as noted on page 14 of (4/9C) should be used here of 244 m^2 due to the area being in the denominator of the equation, and hence showing a larger temperature increase.

$A = 1074.4\ m^2 + 244\ m^2 - 333.1\ m^2 = 985.3\ m^2$

$Q = 63105\ W$

$T_{air} = T_{AVE} + [Q/A]^{.75}$ (NUMARC 87-00 Correlation)

$T_{air} = 316.9\ °K + [(63105\ W)/(985.3\ m^2)]^{.75}$

$T_{air} = 339.5\ °K = 66.54\ °C = 151.8\ °F$

G) Determine the AFW room temperature with the doors open.

F = 7.58 (From page 12 of (5/28C))

$T_{air} = \quad 4 + T_{AVE} + \{Q^{.75}/[A^{.75} + (16.18)F^{.8653}]\}$ (NUMARC 87-00 Correlation)

$T_{air} = \quad 4 + 316.9\ °K + \{(63105\ W)^{.75}/[(985.3\ m^2)^{.75} + 16.18(7.58)^{.8653}]\}$

$T_{air} = 335.7\ °K = 62.7\ °C = 144.9\ °F$

Enclosures: Station Blackout Control Building Internal Heat Load Analyses

Enclosure 1 - copy of RG&E procedure ST-89.02, Control Building Heat Generation Rate Testing, Revision 0, which was used to conduct the subject tests.

Enclosure 2 - copies of photographs which show the locations of various thermocouples used for the tests.

Enclosure 3 - data sheets showing the temperatures recorded by thermocouples during the test.

Enclosure 4 - listing of thermocouples vs. recorder point.

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NRC NOTES: TAC M68548 is correct.

NAME: Sue Fridley PHONE: 504 2066

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REVISION 1, 7/13/88