## Attachment 1 Evaluation for LOCA Aging at 1880 MWt

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## **PURPOSE**

The purpose of this calculation is to evaluate specific environmentally qualified (EQ) equipment located in the Drywell for DBA LOCA accident aging at the Rerate power level of 1880 MWt in response to an NRC request for additional information to demonstrate margin. This will be accomplished by comparing the 1880 MWt DBA LOCA test profile to the test profile for the DG O'Brien containment penetrations and General Atomic Radiation monitors. These components were selected by the NRC for review based on meetings held at NRC headquarters in White Flint, MD on March 30, 1998.

## BACKGROUND

EQ components located in the containment are qualified for their required operating time, plus margin as required by 10 CFR 50.49. For those components with a short operating time, the test profile bounds the required operating time of the component and qualification is demonstrated. In the case of equipment with a longer operating time requirement, the qualification test duration may not envelope the required operating time. In some cases due to the methodology used during the testing of equipment, portions of the test profile may not bound the accident profile (see figures in attachment 2).

When required, component evaluations are made using the Arrhenius Methodology as provided in Reference 3. The Arrhenius Model establishes a correlation between thermal aging of different temperature time histories through consideration of material properties of the constituent components in an equipment item.

For this calculation, the following discussion is based on data appropriate for 1880 MWt with the use of the ANS 5.1 decay power time history as defined for the Power Rerate Program. For the DBA LOCA, at about 17 days it is expected that the drywell temperature will drop below 135°F [Ref. 6].

The limiting drywell parameters for the DBA LOCA for the first 24 hours are available in Reference 9, File 1880\_DBA. Drywell parameters for the DBA LOCA from 1 day through 180 days are provided in Reference 6. These curves provide the basis for the composite profile at the 1880 MWt conditions

The function of the General Atomic Radiation monitor and associated DG O'Brien electrical penetration is to provide high range monitoring of the dose rates inside containment post accident. This function is not required for breaks evaluated in SBA and IBA since under these conditions there is no fuel damage assumed and therefore no high radiation doses that would require monitoring. The monitoring function is required for the DBA LOCA since this accident provides the source for high dose rates.

To provide an evaluation of margin the test profiles for these devices will be compared to the 1880 MWt DBA LOCA profile and margin quantified and compared to the margin calculated in CA-98-105 "Qualified Life Evaluation For Containment EQ Components" Rev 1 Dated 3/28/98 [10]. This calculation used a profile which included conservative steps for thermal aging as shown in the figure in attachment 3. An evaluation will be performed to compare the results of the test profiles to the actual curve of the 1880 MWt profile and the stepped profile, to demonstrate the margin in this approach.

## METHODOLOGY

The bounding DBA LOCA accident profile for the 1880 MWt Rerate power level [Ref. 2] will be evaluated for the equivalent aging using the Arrhenius methodology [Ref. 3]. The equivalent aging for the 1880 MWt case will be compared to the test profile for the General Atomic Radiation monitor and associated DG O'Brien electrical penetration using the Arrhenius methodology. To demonstrate margin, the Arrhenius methodology will be applied to the DBA LOCA profile (Profile {2} in Table 1) using similar time steps to those used in calculation CA-98-105 [Ref. 10] and this will be compared to the results using the actual data time steps from the DBA profile (Profile {1} in Table 1). This will result in a more realistic value of aging based on the 1880 MWt DBA LOCA curve for comparison to the aging data from CA-98-105.

## ACCEPTANCE CRITERIA

The comparison of the 1880 MWt DBA LOCA profile to the test profiles must demonstrate that the test profile provides adequate margin between the accident profile and the test profile. This evaluation will be performed using an EXCEL spreadsheet in attachment 1. The margin calculated for the DBA LOCA curve at 1880 MWt must demonstrate an increase in margin over the value determined in CA-98-105 [Ref. 10].

## **INPUTS**

Inputs to this calculation are listed below:

- Output data from NSP calculation CA-97-176 "Equivalent Temperature Evaluation for EQ Equipment in Containment" Rev 2. [Ref. 2]
- DBA LOCA test data for the General Atomic Radiation monitor and associated DG O'Brien
  electrical penetration located in the MNGP containment as listed in the MNGP EQ Central
  File [Ref. 5].
- 3. Arrhenius methodology as defined in EWI 08.11.01 "Equipment Qualification User's Manual" [Ref. 3]
- Output of Calculation CA-97-197, Evaluation of Drywell Response to DBA LOCA for EQ, Rev. 0 [Ref. 6]

5. Output of Calculation CA-98-105 "Qualified Life Evaluation For Containment EQ Components" [Ref. 10]

## **ASSUMPTIONS**

1. Qualified life for EQ components is typically evaluated based on an average drywell temperature of 135°F over the life of the component prior to the accident. The mixed drywell temperature of 135°F is used as an initial assumption for primary containment accident response evaluations. Computer alarms along with administrative controls are established to insure appropriate actions are taken if this temperature is ever reached during normal plant operation. Therefore the use of 135° to evaluate aging of components while in service for the purposes of this calculation is an appropriate and conservative assumption.

## **ANALYSIS**

The Arrhenius Methodology was used for all calculations in Attachment 1 [Reference 3 and Reference 1]. Activation energies used in the analysis are from Reference 5. The equation used for calculations in Attachment 1 is based on the Arrhenius equation from Appendix 14.2 of Reference 3. The Arrhenius equation is:

$$t_a = t_t \exp \{(eV) \times 1.16 \times 10^4 (1/T_a - 1/T_t)\}$$

where:

t<sub>a</sub> is thermal aging life derived from the Arrhenius equation, exposure time limit at one specified temperature (T<sub>a</sub>)

eV is the activation energy

- t, is the test exposure time, or in this case the time spent at the accident temperature associated with this time step
- T<sub>t</sub> is the test temperature, or in this case the accident temperature
- T<sub>a</sub> is the specified temperature to which the Arrhenius equation is doing the comparison

The first column of each spreadsheet calculation shows time after the start of the LOCA test in seconds. The second column shows the temperature of the containment at the time shown for each associated test or accident time history. The third column shows the equivalent thermal life based on a reference temperature of 135°F for that time interval. The equation used for the tested accident profile evaluation with an activation energy given in the top cell in the third column is shown below:

$$=(B4-B3)*EXP((0.8*11600)*((1/330.372)-(1/(((C3-32)/1.8)+273.15))))$$

Where:

(B4-B3) is the time from the previous time step to the current time step \* is indication of multiplication EXP is indication of e raised to the power shown by the remaining equation 0.8 is the activation energy, i.e. 0.8 eV, which varies with component type 11600 is a conversion factor to convert eV to °K (Inverse of Boltzman's constant)

1/330.372 is 1 divided by 330.372°K or 135°F which is to determine the thermal aging life at this temperature

1/(((C3-32)/1.8)+273.15 is the test, or accident, temperature based on the value provided for the previous time step as shown in column 2

This results in evaluating accident aging by always maintaining the temperature at the higher temperature from the previous time step over the time from the previous time step to the current time step. This provides a conservative value for accident aging since the evaluation is essentially always done at values equal to or higher than the accident time history curve.

The test profile is evaluated by averaging the temperature of the previous and current time steps. This results in a conservatively lower value for temperature and therefore a more conservative evaluation of the test profile aging. This provides a conservative value for test aging since the evaluation is essentially done at values equal to or less than the aging time history curve.

## CONCLUSION

The following table provides a summary of the results of the comparison of the component specific test profile to the DBA LOCA accident profile for the 1880 MWt case, as well as the 1670 MWt and 1880 MWt composite profiles from Ref. 10.

Table 1 Aging Comparison

Accident Profile Case	General Atomic Radiation Monitor Aging / % Margin	DG O'Brien Ctmt Penetration Aging / % Margin
1670 MWt Composite [Ref 10]	0.42 Yr	0.13 Yr
1880 MWt Composite [Ref. 10]	1.17 Yr	0.24 Yr
Qualification Test Aging [Ref. 10] Test Profile	1.4 Yr	0.3 Yr
1880 MWt DBA LOCA {2} (with step curve function)	1.11 Yr /79.3%	0.238 Yr / 79.3%
1880 MWt DBA LOCA {1} (Actual profile)	0.34 Yr / 24.3%	0.14 Yr / 46.7%

The % Margin values given in the table above reflect the percent of total test profile aging that the accident profile represents. This value is derived by dividing the accident aging by the Qualification Test Aging.

above the test profile as demonstrated on figures in attachment 2. This does not impact the environmental qualification evaluation since the additional margin demonstrated in table 1 clearly shows that the test profile aging bounds the accident profile aging with significant margin.

The spreadsheet calculation as described in the Analysis section is provided as Attachment 1. A review of the aging results in table 1 shows that there is significant margin between the aging

defined for the test profile and the required accident aging for the 1880 MWt profile (2) above used for evaluation. Additionally, significant margin is demonstrated by a comparison of the test profile aging to the Arrhenius methodology applied to the actual DBA curve (1) above.

## **FUTURE NEEDS**

None identified.

## ATTACHMENTS

- 1. EXCEL Spreadsheet for Aging Analysis
- 2. Graphs showing linear and Log plots of accident and test temperature profiles
- 3. Graph showing Comparison on DBA LOCA profile at 1880 MW to the Step function profile
- 4. Verification Check List form 3495

## REFERENCES:

- Nuclear Power Plant Equipment Qualification Reference Manual, published by Electric Power Research Institute, Copyright 1992
- 2. CA-97-176 "Equivalent Temperature Evaluation for EQ Equipment in Containment" Rev 2
- 3. EWI 08.11.01 "Equipment Qualification Users Manual" Rev. 0
- Letter from NRC to R.O. Anderson, NSP, "Monticello Nuclear Generating Plant Request for Additional Information on License Amendment Request Entitled 'Supporting the Monticello Nuclear Generating Plant (MNGP) Power Rerate Program' (TAC No. M96238)" February 11, 1998
- 5. Monticello Nuclear Generating Plant (MNGP) EQ Central File
- 6. CA-97-197, "Evaluation of Drywell Response to DBA LOCA for EQ", Rev. 0
- 7. Containment Response Evaluation, August 1997, GE-NE-T2300731-1, DRF T23-00731
- AE-083-0983, "Monticello Nuclear Power Plant Extended Drywe: Temperature Analysis", October 1983
- 9. GE letter from P. T. Tran to S. J. Hammer, GLN-97-031, Suppression Pool Temperature Time Histories for 400 Days (Task 6.0), dated September 3, 1997
- CA-98-105 "Qualified Life Evaluation For Containment EQ Components" Rev 1 Dated 3/28/98

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Spread Sheets for Evaluation of Test Data

Confidential The data below is for the Accident aging for the Composite Accident profile developed in Calculation CA-97-176. This is the 1880 MWt bounding curve. DG OBRIEN GA RAD MON Time, sec CA-97-176 Accident Aging, sec Time, Sec CA-97-176 Accident Aging, Sec 0.1 335 0.1 335 300 300 335 2.49E+04 335 3.52E+05 330 8.30E+00 300 300 330 1.18E+02 330 2.29E+04 600 330 3.09E+05 600 600 285 0.00E+00 600 285 0.00E+00 1500 285 3.09E+04 1500 285 2.58E+05 55000 55000 230 1.84E+06 230 1.53E+07 432000 163 4.23E+06 432000 163 1.81E+07 1140480 163 1.56E+06 1140480 163 2.51E+06 Sum, sec 7.71E+06 Sum, sec | 3.68E+07 Sum, hr 2141 Sum, hr 10228 Sum, yr 0.24 Sum, yr 1.17 DG OBRIEN eV=0.5 GA RAD MON eV=0.8 AGING FOR DBA @1880 AGING FOR DBA @1880 Time, Sec Temp Accident Aging, Sec Time, Sec Temp Accident Aging, Sec 0.1 10299 0.1 85955 285 285 300 285 0 300 285 0 300 285 10302 300 285 85984 600 285 30907 600 257952 285 1500 285 1837233 1500 285 15333828 55000 285 55000 285 55000 228 4050161 55000 228 16832585 432000 228 0 432000 228 0 432000 163 1560222 432000 2505542 163 1140480 163 1140480 163 SUM, SEC 7499124 SUM, SEC 35101847 SUM, YR 0.237796 SUM, YR 1.113072 The data above is for the DBA LOCA 1880 MWt profile using the steps as evaluated in Calculations CA-97-197 and CA-97-176. This method of step function is used to evaluate the DBA LOCA profile in a conservative manner. This is presented visually in the graph in attachment 3.

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39514	232	12949	39514	232	56727
40618	231.7	12433	40618	231.7	54254
41685	231.4	13012	41685	231.4	56556
42809	231.1	12490	42809	231.1	54073
43895	230.8	12591	43895	230.8	54296
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	39514 40618 41685 42809 43895	8903       237.7         9453       236.4         10066       235.3         11117       234.2         12208       233.9         13273       234         14375       234.2         15459       234.5         16556       234.7         17627       234.8         18715       234.9         20894       234.9         21986       234.9         23072       234.9         24156       234.9         25241       234.9         25241       234.9         26337       234.7         27406       234.6         28495       234.5         29604       234.3         30684       234.1         31788       233.9         32907       233.6         33979       233.4         35092       233.1         36233       232.8         37292       232.5         38412       232.3         39514       232.         40618       231.7         41685       231.1         43895       230.8         44997 </td <td>8903       237.7       7298         9453       236.4       7910         10066       235.3       13243 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## List of Figures:

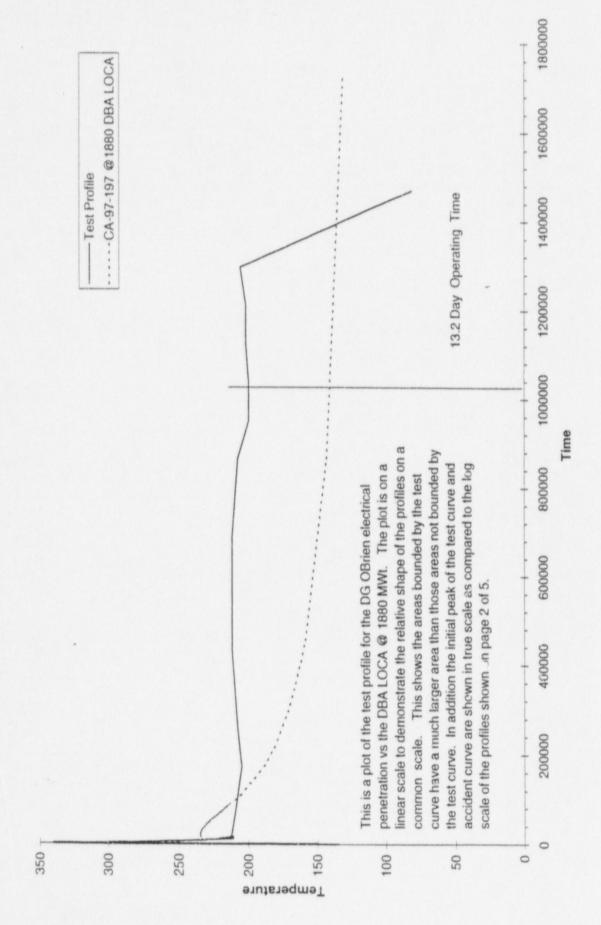
Figure 1 DG O'Brien vs DBA LOCA @ 1880 Mwt

Figure 2 DG O'Brien vs DBA LOCA @ 1880 Mwt

Figure 3 GA Rad Monitor vs DBA LOCA @1880 Mwt

Figure 4 GA Rad Monitor vs DBA LOCA @1880 MWt

## DG OBRIEN vs DBA LOCA @ 1880 MWt



## DG OBRIEN vs DBA LOCA @ 1880 MWt

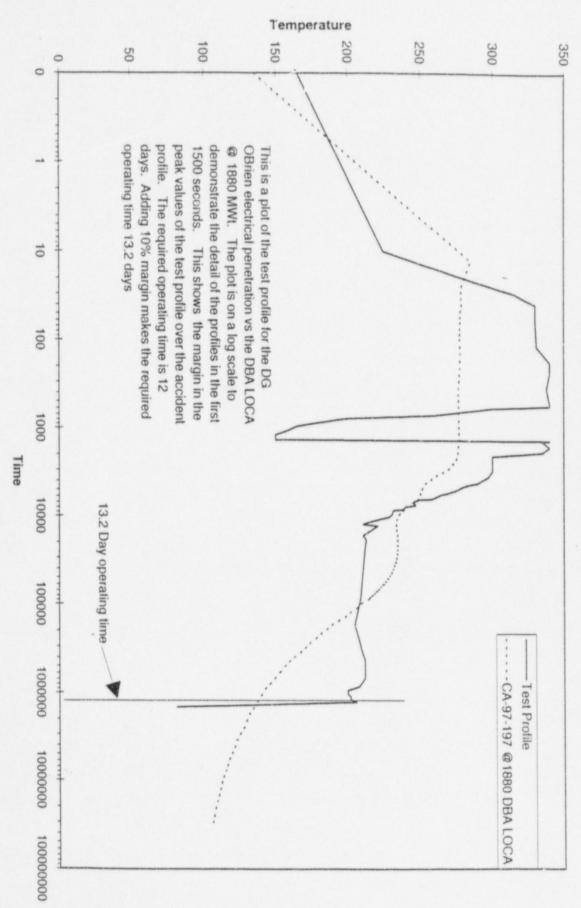
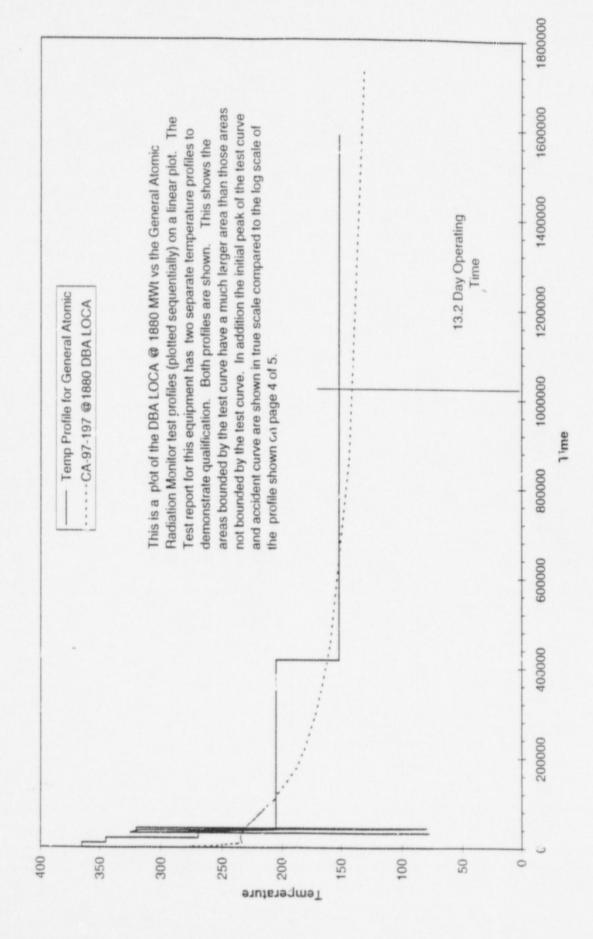


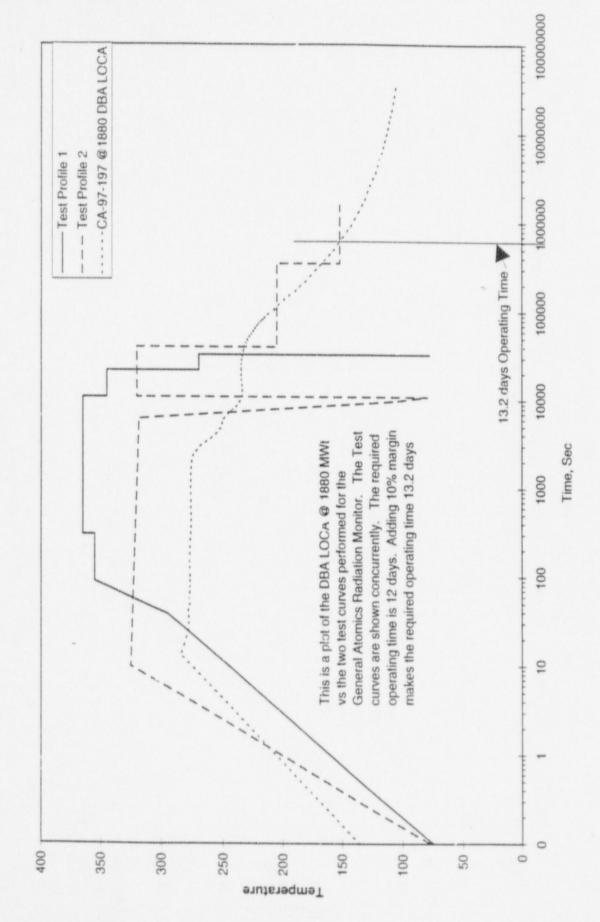
Figure 3

## Page 4 of 5

## GA Rad Monitor vs DBA LOCA @1880 MWt



# General Atomic RM vs DBA LOCA @ 1880 MWt

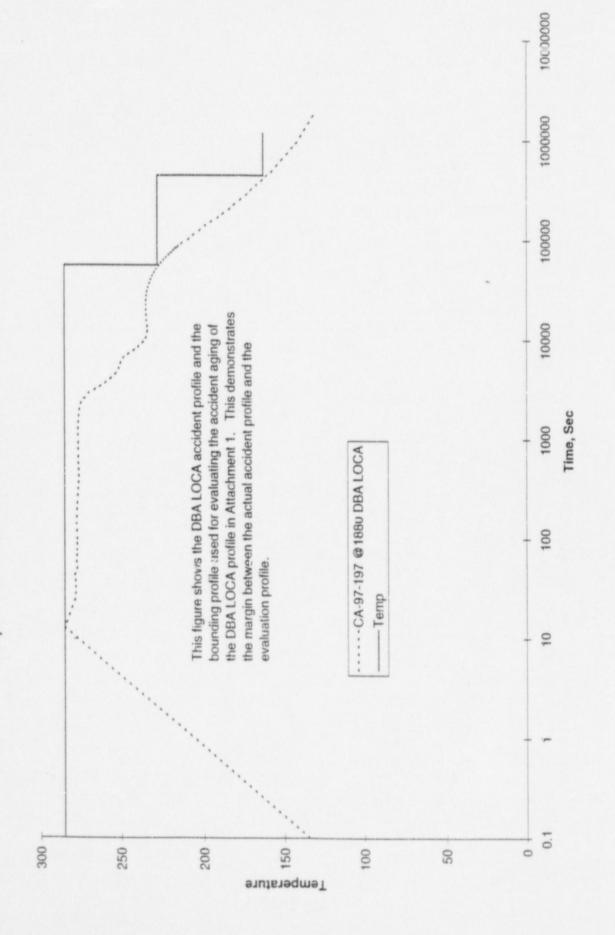


CA-98-106 Rev 1 Attachment 3 Page 1 of 2

List of Figures:

Figure 1 Comparison of DBA LOCA @ 1880 MWt to Evaluation Profile

# Comparison of 1880 MWt DBA LOCA to Evaluation Curve



## MONTICELLO NUCLEAR GENERATING PLANT 3495 CALCULATION/ANALYSIS VERIFICATION TITLE: Revision CHECKLIST Page 1 of 1 Place initial by items verified. CA -98 106 Attachment Page 1 2 31 REVIEW Verified 1. inputs correctly selected. 2. Assumptions described and reasonable. 3. Applicable codes, standards and regulations identified and met. 4. Appropriate method used. Mist 5. Applicable construction and operating experience considered. MSH 6. Applicable structure(s), system(s), and component(s) listed. MSG+ Formulas and equations documented, unusual symbols defined. Mist Detailed to allow verification without recourse to preparer. Met 9. Neat and legible, pages all correctly numbered. Micha 16. Signed by preparer. Myn-11. Interface requirements identified and satisfied. Met 12. Acceptance criteria identified, adequate and satisfied. Mar Result reasonable compared to inputs. Mign 14. Basis of all assumptions, acceptance criteria and inputs are identified. men 15. Conclusions not in conflict with previous analysis, USAR, Technical Specifications or NRC MSA Safety Evaluations. ALTERNATE CALCULATION Alternate calc results consistent with original. 17. Items 1-4 above verified. (Required by ANSI N.45.2.11) TESTING Testing requirements fully described and adequate. 19. Shows adequacy of tested feature at worst case conditions. 20. If test is for overall design adequacy, all operating modes considered in determining test conditions. 21. If model test, scaling laws and error analysis established. Results meet acceptance criteria, or documentation of acceptable resolution is attached. OTHER (Explain) FINAL DOCUMENTATION (Verify applicable items included) 23. Alternate or check calcs 24. Summary of test results.

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25. Comments (errors, discrepancies, recommendations).

26. Method of resolution of comparents

Completed By:

Complete 14 14

1. The purpose should address why these two components were used to demonstrate margin. It appears that the referenced components provided the slimmest margin in the CA-98-105 calculation. Is this information requested based on the CA-98-105 calculation?

Complete

 The activation energy stated in the analysis Arrhenius definition is inconsistent with that used in the sample equation. It may be better to not use an example activation energy (just use eV). This may be less confusing.

Committee

 Attachment No. 1 1880 MW DBA-calculation for aging should indicate Reference 9 in addition to Calculation CA-97-197. They are both required to build the curve presented. Calculation CA-97-176 could also be referenced in lieu of CA-97-197 and Reference 9.

Complete 414148

4. Add Venfication Checklist as Attachment 4.

## MONTICELLO NUCLEAR GENERATING PLANT 3495 TITLE: CALCULATION/ANALYSIS VERIFICATION Revision CHECKLIST Page 1 of 1 Place initial by items verified. CA -Attachment Page 1 REVIEW 4/4/48 Verified 1. inputs correctly selected. 2. Assumptions described and reasonable. 3. Applicable codes, standards and regulations identified and met. 4. Appropriate method used. 5. Application and operating experience considered. Applicable structure(s), system(s), and component(s) listed. 7. Formulas and equations documented, unusual symbols defined. 8. Detailed to allow verification without recourse to preparer. Neat and legible, pages all correctly numbered. 10. Signed by preparer. arn-11. Interface requirements identified and satisfied. Met 12. Acceptance criteria identified, adequate and satisfied. MEN Result reasonable compared to inputs. Myse 14. Basis of all assumptions, acceptance criteria and inputs are identified. MIST 15. Conclusions not in conflict with previous analysis, USAR, Technical Specifications or NRC Safety Evaluations. ALTERNATE CALCULATION Alternate calc results consistent with original. Items 1-4 above verified. (Required by ANSI N.45.2.11) TESTING Testing requirements fully described and adequate. 19. Shows adequacy of tested feature at worst case conditions. 20. If test is for overall design adequacy, all operating modes considered in determining test conditions. NX-11 SV 21. If model test, scaling laws and error analysis established. 1. hmgk Results meet acceptance criteria, or documentation of acceptable resolution is attached. NITTHE OTHER (Explain) FINAL DOCUMENTATION (Verify applicable items included) Alternate or check calcs Summary of test results. 25. Comments (errors, discrepancies, recommendations). 26. Method of resolution of comments. Completed By: 3087 (DOCUMENT CHANGE, HOLD AND COMMENT FORM) incorporated: AWI-05.01.25 FOR ADMINISTRATIVE Resp Supv: GSE-NG LASSOC Ref: Freq

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Attachment 2

MOV Information

1. What are NSP's improvement plans to address possible motor damage for MO-2034 and MO-4229 at rerate conditions?

## NSP Response

41

Prior to operation at rerate conditions, NSP will initiate a condition report to evaluate whether the subject valves are capable of allowing a subsequent operation after the required isolation safety functions are completed. This evaluation may include an examination of assumptions and methodologies, additional administrative controls, and modifications. The evaluation will be completed in order to institute the corrective actions, if any, by the end of the next scheduled refueling outage.

2. What are NSP's improvement plans regarding MOVs with relatively low capacity margin at rerate conditions?

## **NSP** Response

Of the five valves discussed with the staff, three valves now have acceptable excess capacity. These valves and the approximate margin values are listed below.

MO-2373 (Initial Margin 5%)
Actuator/Valve replaced this outage, now 32% margin.

MO-2015 (Initial Margin 6%)
Adjusted this outage to 9% based on rate of loading and full dp test.

MO-2006 (Initial Margin 6%) Adjusted this outage to 17%.

The remaining valves include MO-2398 (3%) and MO-2034 (6%). These margins will be evaluated by a method similar to that described for issue 1. above. Prior to operation at rerate conditions, NSP will initiate a condition report to evaluate the capacity margin of MO-2398 and MO-2034. This evaluation may include an examination of assumptions and methodologies, additional administrative controls, and modifications. The evaluation will be completed in order to institute the corrective actions, if any, by the end of the next scheduled refueling outage.

## Attachment 3

NSP Commitments for the Monticello Power Rerate

The following commitments apply to the implementation of the Monticello power rerate program.

. .. "

All plant changes described in Exhibit D of NSP's power rerate license amendment request dated December 4, 1997 will be completed prior to implementation of power rerate.

All commitments contained in Exhibit H of NSP's power rerate license amendment submittal dated December 4, 1997 will be completed as described therein.

Feedwater and Condensate System area ambient temperatures will be monitored at rerate conditions to confirm that design temperatures are not exceeded.

Feedwater and Condensate System testing will be conducted as described by NSP's response to Question 17 contained in NSP's power rerate submittal dated March 26, 1998.

The rerate startup test program will include a requirement to monitor moisture separator drain system stability.

The adequacy of the service water system will be confirmed by monitoring the system and its loads during the rerate startup testing program.

The final empirical relation between turbine 1st stage pressure and percent reactor power will be determined during the rerate startup testing program.