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U. S. Nuclear Regulatory Commission
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Subject: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Miscellaneous Information in Response to NRC Requests for Additional Information Regarding the ANO-2 Power Uprate License Application

Gentlemen:

Entergy Operations, Inc. submitted an "Application for License Amendment to Increase Authorized Power Level," on December 19, 2000 (2CAN120001). The purpose of this letter is to provide responses to three separate follow-up requests for additional information from the NRC staff. A separate attachment has been provided for each request.

Attachment 1 contains the staff's questions and Entergy's responses to the fourth request for additional information regarding probabilistic safety assessment. Three questions concerning shutdown risk management were received from the staff via telex on December 7, 2001.

Attachment 2 contains additional information requested by Reactor Systems Branch personnel regarding the long term cooling analysis performed at power uprate conditions. The boric acid precipitation evaluation model from CENPD-254-P-A, "Post-LOCA Long Term Cooling Evaluation Model," June 1980, is the methodology used for power uprate. During a teleconference on December 10, 2001, the staff expressed the need for additional information to substantiate that this methodology is conservative and bounding with respect to the analysis of record methodology. The long term cooling model has been discussed previously in several teleconferences and the response to NRC Question 18 in Entergy's letter to the NRC dated October 17, 2001 (2CAN100110) and in Attachment 5 of the letter dated October 31, 2001 (2CAN100102).

Attachment 3 contains excerpts from Appendices D and E of the radiological dose calculation, "ANO-2 Radiological Dose Analysis for RSG and Power Uprate." The staff requested this information during a teleconference on December 10, 2001, in order to complete a confirmatory calculation for their power uprate review. The appendix was not included when

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Entergy originally submitted this calculation to the staff on July 3, 2001 (2CAN070103), because only the sections consistent with the doses in the license application were submitted at that time. Appendix E provides doses consistent with a 60-minute operator response to the steam generator tube rupture analysis. The operator response time for this analysis was changed from 30 minutes to 60 minutes in response to NRC Question 11 in Entergy's letter to the NRC dated October 31, 2001 (2CAN100102). The excerpts from Appendix D and Appendix E regarding steam generator tube rupture dose calculations for the control room are not considered part of the licensing basis for ANO-2 or the license application. The maximum hypothetical accident control room doses are the bounding design basis considerations. The information in Attachment 3 is considered proprietary to Westinghouse Electric Company, LLC. A non-proprietary version of this information is provided in Attachment 4. Brackets are utilized to denote the removal of proprietary information.

An affidavit signed by Westinghouse, the owner of the proprietary information contained in Attachment 3, has already been submitted to the NRC. It was provided in the July 3, 2001, letter. Even though Appendices D and E were not included in the July 3, 2001, letter, the affidavit was written to address revision 004 of the entire calculation. The calculation has not been revised since July 3, 2001; therefore, the affidavit included in Attachment 4 of the July 3, 2001, letter remains applicable. For convenience, a photocopy of the affidavit is included as the first two pages of Attachment 3 of this letter.

The affidavit sets forth the basis on which the information may be withheld from public disclosure by the NRC and addresses the considerations listed in paragraph (b)(4) of Section 2.790 of the *Code of Federal Regulations* (10CFR2.790). Accordingly, it is respectfully requested that the information proprietary to Westinghouse be withheld from public disclosure in accordance with 10CFR2.790.

Correspondence regarding the proprietary aspects of the information contained in Attachment 3 should be addressed to Mehran Golbabai, Project Manager, ANO-2 Power Uprate, Westinghouse Electric Company LLC, 2000 Day Hill Road, Windsor, CT 06095.

This submittal contains no regulatory commitments.

I declare under penalty of perjury that the foregoing is true and correct. Executed on December 20, 2001.

Very truly yours,

Glenn R. Ashley

Glenn R. Ashley
Manager, Licensing

GRA/dwb
Attachments

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Attachment 1

Fourth Request for Additional Information on Probabilistic Safety Assessment and ANO Responses Regarding the ANO-2 Power Uprate License Application

Fourth Request for Additional Information on Probabilistic Safety Assessment and ANO Responses Regarding the ANO-2 Power Uprate License Application

NRC Question 1

How often do you determine the "time to boil" during an outage (e.g., once per shift)? Is the time to boil used only in the planning that goes into developing the shutdown operations protection plan, or is it done regularly during the outage to confirm that you have enough time to close containment before boiling with the planned breaches/activities?

ANO Response

The time to boil is calculated at least once per twelve (12) hours after the low temperature overpressure protection relief valves (LTOPs) are placed in service during cooldown. Time to boil calculations are not required while the head is removed and refueling canal is flooded above head removal level. Time to boiling is no longer calculated when the reactor coolant system overflows the vessel into the refueling canal during fill. This occurs at elevation 377 feet 10.5 inches or 105 inches above the bottom of the hot leg. The following instructions are included in revision 17 of Operations Administrative Procedure 1015.008, "Unit 2 SDC {Shutdown Cooling} Control" Attachment E, "Time to Boiling/Core Uncovery Estimate." A time to boil/uncovery estimate per this attachment is performed in accordance with the following:

- when LTOPs are placed in service during reactor coolant system (RCS) cooldown,
- approximately every twelve hours (triggered by Unit 2 Operations logs),
- prior to entering reduced inventory with fuel in the core,
- if an RCS draindown of greater than one foot is planned (perform calculation for final projected draindown level and use estimated time until level is stabilized),
- when RCS level has stabilized after draindown,
- if RCS level goes down more than one foot,
- when RCS temperature has stabilized after cooldown,
- during RCS heatup, perform for highest projected temperature (use this estimated time for the duration of the heatup),
- if unplanned RCS temperature change crosses a multiple of 10°F, or
- if the RCS status changes (i.e., intact to open, cold leg opening, etc.)

This calculation is NOT required for the following:

- when LTOPs are removed from service as part of RCS heatup,
- if Reactor Vessel Head removed and refueling canal above head removal level,
- during RCS fill (use the Time to Boiling/Core Uncovery Estimate for the level at which fill is started), or

- during initial RCS cooldown (use Time to Boiling/Core Uncovery Estimate performed when LTOPs were placed in service until the desired temperature is reached).

NRC Question 2

When in reduced inventory operations, you state that you have to have a second flow path in addition to a high pressure injection (HPI) flow path. Can this second flow path be a small charging pump that may not be able to keep the core covered following a loss of inventory event that includes a loss of HPI and residual heat removal (RHR)?

ANO Response

Two makeup sources are required while in reduced inventory operations. One of these must be a high pressure safety injection (HPSI) pump. The second source is required to have sufficient capacity to meet the required makeup rate calculated using the time to boiling calculation. This could be a charging pump(s) but only if the required makeup rate is within the capacity of available charging pumps.

NRC Question 3

If there is a loss of the HPI flow path, or a containment breach is discovered that cannot be closed within the calculated time to boil, it seems that the operations manager has discretion as to what to do. Is there any written guidance/standard considerations that the operations manager has in making this decision?

ANO Response

No discretion is afforded the operations manager regarding a loss of the HPSI flow path. Should the HPSI flow path be lost, restoration is required in accordance with the SDC Control procedure. During normal shutdown cooling operations, at least one operable means of adding inventory to the RCS is required. Prior to entering reduced inventory, two operable means of adding inventory to the RCS are required. These makeup systems are in addition to the pumps used for normal decay heat removal.

Regarding containment breaches, the SDC Control procedure provides general guidance for the operations manager to consider. Among the items that the manager would consider include, but would not be limited to, evolutions in progress, RCS water level, length of time the breach will be open, actual closure time and method, station personnel at the breach, aggregate impact of all breaches, and need for the breach. In any case, the breach must be capable of being closed in 45 minutes. As a general rule, the only exceptions are unintentional situations.

The following is an excerpt from Section 3.0 of 1015.008, "Unit 2 SDC Control":

> As general operating philosophy containment breaches should NOT be allowed. When maintenance is in progress at containment penetrations then additional measures are taken to ensure Containment Closure is set (i.e., installing Danger Tags, closing valves or installing blank flanges.) When a Containment breach is unavoidable, then closure materials will be prepared in advance and when possible, Containment Closure will be established from outside Containment. If a breach is required, then an individual working at the breach will be available with radio communication or with beeper. When a breach must be made at an Electrical Penetration, then the individual shall have a beeper.
>
> All Containment breaches will have the capability of being closed within 45 minutes and where possible within the estimated time to boiling. If the time for Containment Closure is greater than time to boiling, then approval is required from the Operations Manager or his designee prior to establishing the breach.

Attachment 2

Fifth Request for Additional Information from Reactor Systems Branch Personnel (Long Term Cooling Analysis Performed at Power Uprate Conditions)

Fifth Request for Additional Information from Reactor Systems Branch Personnel (Long Term Cooling Analysis Performed at Power Uprate Conditions)

NRC Question (paraphrased)

The boric acid precipitation evaluation model from CENPD-254-P-A, "Post-LOCA Long Term Cooling Evaluation Model," June 1980, is the methodology used for power uprate. Provide additional information to substantiate that this methodology is conservative and bounding.

ANO Response

The long term cooling model has been discussed previously in several teleconferences, in Entergy's response to NRC Question 18 in the letter dated October 17, 2001 (2CAN100110), and in Attachment 5 of the letter dated October 31, 2001 (2CAN100102). During a teleconference on December 10, 2001, the staff indicated that additional information was needed to substantiate that this methodology is conservative and bounding.

Section 7.1.5 of the Power Uprate Licensing Report (i.e., Enclosure 5 to letter 2CAN120001 dated December 19, 2000) describes the post-LOCA {loss of coolant accident} long term cooling analysis that was performed at power uprate conditions. The analysis consists of a boric acid precipitation analysis for a large cold leg break LOCA. The analysis uses the Westinghouse boric acid precipitation evaluation model for Combustion Engineering designed pressurized water reactors from CENPD-254-P-A, "Post LOCA Long Term Cooling Evaluation Model," June 1980. The CENPD-254 methodology uses the BORON computer code for calculating boric acid concentration in the core following a large break LOCA.

This is the first application of the BORON code to ANO-2. Prior to the power uprate effort, the long term cooling analysis in support of the emergency core cooling system design was performed by a method described in the Safety Analysis Report (SAR) and our April 5, 1978 letter (enclosed with letter 2CAN100110 dated October 17, 2001). The following three sections outline key changes from the original SAR analysis method and plant design to the power uprated conditions analyzed using the BORON code method.

Change from Cycle 1 Method to BORON Code Method

The implementation of the BORON code in the ANO-2 long term cooling analysis increases the conservatism in the analysis methodology relative to the original methods employed at ANO-2. To demonstrate this conservatism, the BORON code was run using input assumptions consistent with the Cycle 1 analysis and the same solubility limit of 32 weight percent. Figure 1 reflects the results of a comparison of the original Cycle 1 method to the CENPD-254 BORON code method. As indicated in the figure, application

of the BORON code increases operational restrictions. BORON code results indicate that the solubility limit is reached within 2.4 hours versus the 9.5 hours using the Cycle 1 methods. This change in methods has significantly enhanced the conservatism in the long term cooling analysis for ANO-2. This same level of conservatism exists in the power uprate analysis results using the BORON code versus the Cycle 1 method. If the power uprate effort had been performed using the Cycle 1 methods, a comparable level of conservatism would be demonstrated between the BORON results versus the results using the Cycle 1 method.

<u>Change in BAM Tank Concentration</u>

The second key change involves a reduction in the boric acid make-up (BAM) tank concentration. The maximum boric acid concentration in these tanks has been reduced from 12 weight percent to 3.5 weight percent by Amendment 82 to the ANO-2 Technical Specifications. This physical change to the operation of the plant significantly delays the onset of boric acid precipitation post-LOCA. A reduction in the BAM tank concentration increases the allowable operator response time. This is evidenced by the results presented in Section 7.1.5 of the license amendment request for power uprate which reflect a requirement that operators take action within 7.3 hours compared to the 2.4 hours presented above. The 7.3 hour value is based on a BORON code analysis consistent with the power uprate conditions and solubility limit while the 2.4 hour value is based on a BORON code analysis at the Cycle 1 conditions and solubility limit. While the change in operator response time from the Cycle 1 assessment is the result of various input parameter changes including power level, the most significant parameter change is the reduction in boric acid concentration in the BAM tanks. Since the BAM tank concentration change is conservative with respect to the long term cooling boric acid precipitation analysis considerations, no changes were made to the SAR results upon implementation.

The BORON code assumes that the inventory of the BAM tanks, which enters the vessel via the charging pumps, is deposited in the vessel before any consideration is given to other sources of boric acid being injected in the vessel. Appendix C of CENPD-254 discusses this assumption in more detail. This conservative treatment of the BAM tank inventory can be seen in BORON code results in Figure 1 as a sharp change in the slope of the line upon depletion of the BAM tank inventory. Reducing the BAM tank concentration from 12 weight percent to 3.5 weight percent reduces the slope of the line in Figure 7.1.5-2 of the license amendment request.

Comparing the results in Figure 1 to those in Section 7.1.5 of the power uprate amendment request demonstrates that plant changes made to decrease potential boric acid injection from the BAM tanks offset the impact due to power uprate and significantly increased the time available for operator action. This change in boric acid concentration has also offset most of the impact of changing from the Cycle 1 method to the more conservative BORON code method and solubility limit discussed below. For power uprate conditions, the change in operator response time has been reduced from 9.5 hours

in the SAR to 7.3 hours by using the more conservative BORON code in conjunction with the reduced boric acid concentration. If comparable BAM tank boric acid concentrations had been assumed for power uprate conditions using the BORON code alone (i.e., no credit for concentration reduction), a response time less than the 2.4 hours cited above would have been calculated.

Change in Solubility Limit

The third key change involves a change in the RCS boron precipitation solubility limit. The Cycle 1 method is based on a solubility limit of 32 weight percent. When the BORON code was applied as part of the power uprate effort, a more conservative solubility limit of 27.6 weight percent was applied. This more conservative solubility limit of 27.6 weight percent was used to calculate the 7.3-hour time discussed above. Using the solubility limit of 27.6 weight percent further demonstrates the conservatism in the power uprate analysis versus the Cycle 1 analysis.

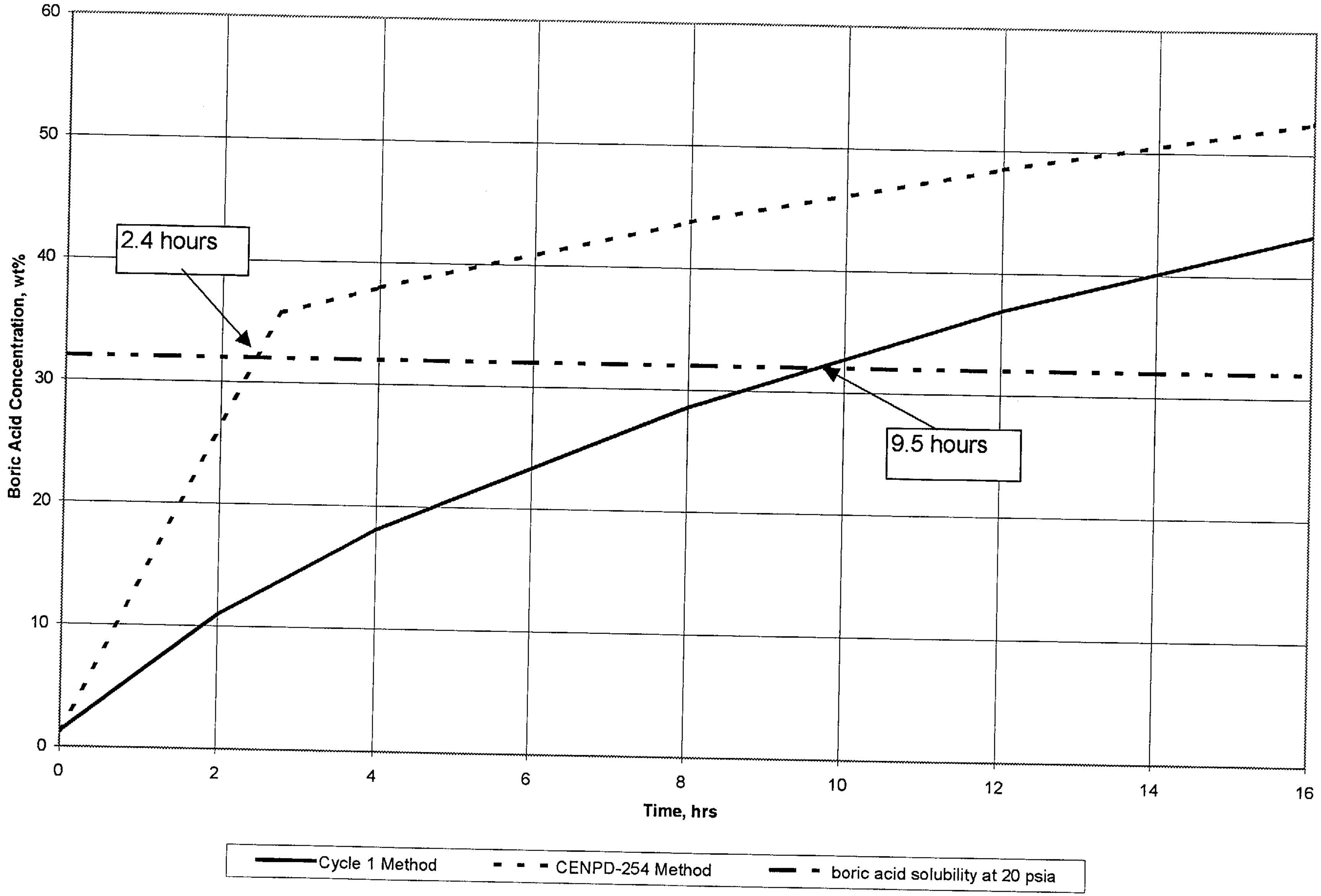
EOP Guidance

A current emergency operating procedure (EOP) requirement ensures hot leg injection is initiated between 2 and 4 hours. This EOP requirement is more conservative than the analysis assumption of 5 hours for initiation of hot leg injection. The analysis results in Section 7.1.5.3 of the license amendment request for power uprate indicate that if 250 gallons per minute simultaneous hot and cold leg injection is initiated at 5 hours post-LOCA, the maximum boric acid concentration in the core is 23.3 weight percent at 5.9 hours post-LOCA. This same analysis also indicates that the solubility limit of 27.6 weight percent is reached at 7.3 hours post-LOCA assuming no operator action. Therefore, the existing EOP requirement is acceptable for power uprate.

In conclusion:

- as illustrated above, the comparison of the Cycle 1 method to the BORON code method has demonstrated significant conservatism,
- this conservatism in methodology continues to exist under uprated conditions,
- the plant modification to the BAM tank concentration significantly delays the onset of boric acid precipitation post-LOCA,
- the solubility limit of 27.6 weight percent used in the power uprate assessment is more conservative than the 32 weight percent assumed in Cycle 1, and
- changes to the EOP requirements with respect to post-LOCA boric acid precipitation concerns are not required.

Figure 1


60
50
40
30
20
10
0
Boric Acid Concentration, wt%
0
2
4
6
8
10
12
14
16
Time, hrs
2.4 hours
9.5 hours
Cycle 1 Method
CENPD-254 Method
boric acid solubility at 20 psia

Attachment 4

Non Proprietary Version
Page D-16 through D-19 of Appendix D and Page E-1 through E-31 of Appendix E of ANO-2 Radiological Dose Analysis for RSG and Power Uprate

D.6 Steam Generator Tube Rupture

The Steam Generator Tube Rube Rupture (SGTR) event is a no fuel failure event. Thus, the three scenarios, no iodine spiking, PIS, and GIS are considered. Releases calculated in Section 4.3 are considered valid here. Factors listed in Section D.1 replace those used in Section 4.3 for Control Room doses.

This section is presenting the SGTR event Control Room Doses calculated with two different iodine Protection factors. Sub-section D.6.1 calculates the control room doses with new control room atmospheric dispersion factors (Table D.1-1) and an iodine Protection factor of 144. Sub-section D.6.2 calculates the control room doses with new control room atmospheric dispersion factors (Table D.1-1) and an iodine Protection factor of 2.95.

D.6.1 Iodine Protection Factor = 144

No Spiking

The thyroid calculation in Section 4.3.2.1 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Thyroid} = \left[\quad \right]$$

Control Room $D_{Thyroid}$ = [ ] = <0.1 rem

The whole body calculation in Section 4.3.2.2 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{WB} = \left[\quad \right]$$

Control Room D_{WB} = [ ] = <0.1 rem

The skin calculation in Section 4.3.2.3 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Skin} = [\quad]$$

Control Room D_{Skin} = [ ] = 0.3 rem

PIS

The thyroid calculation in Section 4.3.2.4 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Thyroid} = \left[\quad \right]$$

Control Room $D_{Thyroid}$ = 0.61 rem = **0.61 rem**

The whole body calculation in Section 4.3.2.5 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{WB} = \left[\quad \right]$$

Control Room D_{WB} = [ ] = <0.1 rem

The skin calculation in Section 4.3.2.6 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Skin} = \left[\quad \right]$$

Control Room D_{Skin} = [ ] = 0.3 rem

<u>GIS</u>

The thyroid calculation in Section 4.3.2.7 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Thyroid} = \left[\quad \right]$$

Control Room $D_{Thyroid}$ = [ ] = 0.2 rem

The whole body calculation in Section 4.3.2.8 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{WB} = \left[\quad \right]$$

Control Room D_{WB} = [ ] = <0.1 rem

The skin calculation in Section 4.3.2.9 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Skin} = \left[\quad \right]$$

Control Room D_{Skin} = [ ] = 0.3 rem

D.6.2 Iodine Protection Factor = 2.95

No Spiking

The thyroid calculation in Section 4.3.2.1 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Thyroid} = \left[\qquad \right]$$

Control Room $D_{Thyroid}$ =[ ]= 0.63 rem

The whole body calculation in Section 4.3.2.2 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{WB} = \left[\qquad \right]$$

Control Room D_{WB} = [ ] = <0.1 rem

The skin calculation in Section 4.3.2.3 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Skin} = \left[\qquad \right]$$

Control Room D_{Skin} = [ ] = 0.3 rem

PIS

The thyroid calculation in Section 4.3.2.4 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Thyroid} = \left[\qquad \right]$$

Control Room $D_{Thyroid}$ = [ ] = 29.8 rem

The whole body calculation in Section 4.3.2.5 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{WB} = \left[\qquad \right]$$

Control Room D_{WB} = [ ] = <0.1 rem

The skin calculation in Section 4.3.2.6 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Skin} = \left[\quad \right]$$

Control Room D_{Skin} = [ ] = 0.33 rem

GIS

The thyroid calculation in Section 4.3.2.7 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Thyroid} = \left[\quad \right]$$

Control Room $D_{Thyroid}$ = [ ] = 9.7 rem

The whole body calculation in Section 4.3.2.8 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{WB} = \left[\quad \right]$$

Control Room D_{WB} = [ ] = <0.1 rem

The skin calculation in Section 4.3.2.9 is repeated here, using the new control room atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Skin} = \left[\quad \right]$$

Control Room D_{Skin} = [ ] = 0.31 rem

Appendix E 1 hour SGTR with no Operator Action

E.1 Introduction

SGTR does not assume any fuel failure. The evaluation of the radiological doses associated with this event assumes no credit for operator action is taken in the first 60 minutes (1 hour); as opposed to Section 4.3 which only assumed 30 min (1/2 hour) of no operator action. In the first 60 minutes, steaming is conservatively assumed to occur only in the ruptured SG. This allows a greater release due to a flashing fraction of primary liquid being released at a DF of 1.0 instead of the normal DF of 100. At 60 minutes into the event, the operator isolates the ruptured unit. Only the unaffected steam generator is then used for the controlled 75 °F/hr cooldown (2 hour event) or 38 °F/hr cooldown (8 hour event) [see Section 2.2.11]. A primary to secondary leakage of 0.5 gpm to each generator was modified to 1.0 gpm to the intact SG for the cooldown stage.

A total primary to secondary mass transfer through the rupture of 120,400 lbm was assumed for the 1 hour. The mass transfer and flashing fractions were modeled at various intervals, Table E.1-1 shows the values that were used. [Refer to spreadsheet casea2c.xls for calculation of values.] Both the flashing fractions and mass transfer totals were considered conservative as they exceeded those calculated in the SGTR Analysis of Record. For the purposes of noble gas release, the 120,400 lbm is equivalent to a 15,170.4 g/s average leak rate. [120,400 lbm * 453.6 gram /lbm / 3600 sec]

A LOAC renders the main condenser unavailable. Thus, the entire cooldown must be performed by dumping steam to the atmosphere from the intact steam generator that is assumed to contain the maximum limit for steam generator activity. This bounds the no LOAC scenario. Since SGTR is not a fuel failure event, iodine spiking was considered.

[ ]

E.2 Offsite Dose

Offsite thyroid dose is given by:

$$D_{Thyroid} = \sum A_I \times BR \times \chi/Q \times DCF_{I\text{-}131}$$

where:

$D_{Thyroid}$ = Thyroid dose (rem)
A_I = Activity of iodine (Ci)
BR = Breathing Rate (m^3/s)
χ/Q = Atmospheric dispersion (s/m^3)
$DCF_{I\text{-}131}$ = Dose Conversion Factor of I-131 (rem/Ci)

Offsite whole body dose is given by:

$$D_{WB} = \left[\sum_i A_{I,i} \times DCF(\gamma+\beta)_{I,i} + A_N \times [\gamma+\beta]\right] \times \chi/Q$$

where:

D_{WB} = Whole body dose (rem)
$A_{I,i}$ = Activity of iodine isotope *i* (Ci)
$DCF(\gamma+\beta)_{I,i}$ = Gamma and Beta Dose Conversion Factor of iodine isotope *i* (rem-m^3/s-Ci)
A_N = Activity of noble gas (Ci)
$\gamma+\beta$ = Gamma and Beta conversion constant
= $(0.25 \times E_\gamma) + (0.23 \times E_\beta)$ rem-m^3/s-Ci
χ/Q = Atmospheric dispersion (s/m^3)

E.2.1 Offsite Thyroid – No Spiking

For activity release from the generator with the rupture, methodology from Section 2.2.22 was used, modified for leakage due to the ruptured SG tube. Activity release from this generator occurs for the first 60 minutes of the transient only through the main steam safety valves (MSSVs). After that, it is isolated by the operator. Steam generator time constants developed in Section 3.1.5 were utilized, corrected for the unaffected SG DF of 100. It is conservatively assumed that the following will occur. The flashing fraction portion of the rupture amount will immediately flash to steam and leave the SG, taking all primary activity with it. The non-flashing portion of the rupture amount will enter the generator and mix with the secondary fluid. Steam release from this unit will have a DF of 100. This is conservative in that it assumes no mixing of the flashing portion, hence no dilution of the activity carried from the primary side.

Assuming [ ] lbm was transferred in the first 60 seconds and a [ ] flashing fraction, [ ] will immediately flash to steam and escape through the safety valves. At an initial concentration of 1.0 μCi/g:

$$Activity, Flashing\,(Ci) = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{1.0\,\mu Ci}{g}$$

Activity, Flashing =[ ]

Subtracting the [ ] from the rupture amount in the first [ ] seconds leaves a non-flashing mass of [ ] lbm. A new rupture rate was calculated:

[ ]

Assuming [ ] lbm was transferred in the interval from [ ] seconds and an [ ] flashing fraction, [ ] lbm will immediately flash to steam and escape through the safety valves. At an initial concentration of 1.0 μCi/g:

$$Activity, Flashing\ (Ci) = [\quad] \times \frac{453.6\ g}{lbm} \times \frac{1.0\ \mu Ci}{g}$$

Activity, Flashing = [ ]

Subtracting the [ ] lbm from the rupture amount in the second interval leaves a non-flashing mass of [ ]. A new rupture rate was calculated:

[ ]

Assuming [ ] was transferred in the interval from [ ] seconds and a [ ] flashing fraction, [ ] lbm will immediately flash to steam and escape through the safety valves. At an initial concentration of 1.0 μCi/g:

$$Activity, Flashing\ (Ci) = [\quad] \times \frac{453.6\ g}{lbm} \times \frac{1.0\ \mu Ci}{g}$$

Activity, Flashing = [ ]

Subtracting the [ ] lbm from the rupture amount in the third interval leaves a non-flashing mass of [ ] lbm. A new rupture rate was calculated:

[ ]

Assuming [ ] was transferred in the interval from [ ] seconds and a [ ] flashing fraction, [ ] lbm will immediately flash to steam and escape through the safety valves. At an initial concentration of 1.0 μCi/g:

$$Activity, Flashing\ (Ci) = [\quad]$$

Activity, Flashing = [ ]

Subtracting the [ ] from the rupture amount in the fourth interval leaves a non-flashing mass of [ ]. A new rupture rate was calculated:

[ ]

Assuming [ ] was transferred in the interval from [ ] seconds and a [ ] flashing fraction, [ ] will immediately flash to steam and escape through the safety valves. At an initial concentration of 1.0 μCi/g:

$$\text{Activity, Flashing (Ci)} = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{1.0\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Subtracting the [ ] lbm from the rupture amount in the fifth interval leaves a non-flashing mass of [ ] lbm. A new rupture rate was calculated:

[ ]

Assuming [ ] lbm was transferred in the interval from [ ] seconds and a [ ] flashing fraction, [ ] lbm will immediately flash to steam and escape through the safety valves. At an initial concentration of 1.0 μCi/g:

$$\text{Activity, Flashing (Ci)} = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{1.0\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Subtracting the [ ] from the rupture amount in the sixth interval leaves a non-flashing mass of [ ]. A new rupture rate was calculated:

[ ]

Assuming [ ]was transferred in the interval from [ ]seconds and a [ ]flashing fraction, [ ] lbm will immediately flash to steam and escape through the safety valves. At an initial concentration of 1.0 μCi/g:

$$\text{Activity, Flashing (Ci)} = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{1.0\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Subtracting the [ ]from the rupture amount in the seventh interval leaves a non-flashing mass of [ ]. A new rupture rate was calculated:

[ ]

Assuming [ ] was transferred in the interval from [ ]seconds and a [ ]flashing fraction, [ ]lbm will immediately flash to steam and escape through the safety valves. At an initial concentration of 1.0 µCi/g:

$$Activity, Flashing\ (Ci) = [\quad] \times \frac{453.6\ g}{lbm} \times \frac{1.0\ \mu Ci}{g}$$

Activity, Flashing = [ ]

Subtracting the [ ]from the rupture amount in the eighth interval leaves a non-flashing mass of [ ]. A new rupture rate was calculated:

[ ]

Assuming [ ] was transferred in the interval from [ ] seconds and a [ ]flashing fraction, [ ]lbm will immediately flash to steam and escape through the safety valves. At an initial concentration of 1.0 µCi/g:

$$Activity, Flashing\ (Ci) = [\quad] \times \frac{453.6\ g}{lbm} \times \frac{1.0\ \mu Ci}{g}$$

Activity, Flashing = [ ]

Subtracting the [ ]from the rupture amount in the ninth interval leaves a non-flashing mass of [ ]. A new rupture rate was calculated:

[ ]

Assuming [ ]was transferred in the interval from [ ]seconds and a [ ]flashing fraction, [ ]will immediately flash to steam and escape through the safety valves. At an initial concentration of 1.0 µCi/g:

$$Activity, Flashing\ (Ci) = [\quad] \times \frac{453.6\ g}{lbm} \times \frac{1.0\ \mu Ci}{g}$$

Activity, Flashing = [ ]

Subtracting the [ ]from the rupture amount in the tenth interval leaves a non-flashing mass of [ ]. A new rupture rate was calculated:

[ ]

Assuming [ ]was transferred in the interval from [ ]seconds and a [ ]flashing fraction, [ ] will immediately flash to steam and escape through the safety valves. At an initial concentration of 1.0 μCi/g:

$$Activity, Flashing\,(Ci) = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{1.0\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Subtracting the [ ]from the rupture amount in the eleventh interval leaves a non-flashing mass of [ ]. A new rupture rate was calculated:

[ ]

Adding the activity released over these intervals yields a 60 minute total:

[ ]

Table E.2-1 charts the non-flashing release from the generator with the tube rupture over the first 60 minutes.

For activity release from the unaffected generator, methodology from Section 2.2.22 was also used. Steam generator time constants developed in Section 3.1.5 were utilized and corrected for the unaffected SG DF of 100. Table E.2-2 charts the release from the unaffected generator over a 2 hour time span. Table E.2-3 charts the release from the unaffected generator for the 8 hour event. Note, that since only the affected generator was assumed to steam the plant in the first 60 minutes, dose release from the unaffected SG in the first 60 minutes was ignored in the summation of releases.

Releases from both generators were added. The appropriate breathing rate and χ/Q from Section 2.2.7, and the DCF for I-131 for non-fuel failure from Section 2.2.1 were applied. For EAB dose (2 hour):

$$EAB\ D_{Thyroid} = [\quad]$$

EAB $D_{Thyroid}$ = [ ]= 1.41 rem

For LPZ boundary dose (8 hour):

$$LPZ\ \ Boundary\ \ D_{Thyroid} = [\quad]$$

LPZ Boundary $D_{Thyroid}$ [ ]= <0.1 rem

TABLE E.2-1
Ruptured Tube SG Release, No Iodine Spiking
First 60 Minutes

[ ]

TABLE E.2-2
Unaffected SG Release, No Iodine Spiking
2 Hour Event

[ ]

TABLE E.2-3
Unaffected SG Release, No Iodine Spiking
8 Hour Event

[ ]

E.2.2 Offsite Thyroid – PIS

A similar flashing calculation was performed for a PIS. Using the [ ] flashing fraction for the first [ ] second interval and an initial concentration of 60 μCi/g:

$$Activity,Flashing(Ci) = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{60\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the second interval and an initial concentration of 60 μCi/g:

$$Activity,Flashing(Ci) = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{60\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the third interval and an initial concentration of 60 μCi/g:

$$Activity,Flashing(Ci) = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{60\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the forth interval and an initial concentration of 60 μCi/g:

$$Activity,Flashing(Ci) = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{60\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the fifth interval and an initial concentration of 60 μCi/g:

$$Activity,Flashing(Ci) = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{60\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the sixth interval and an initial concentration of 60 μCi/g:

$$Activity,Flashing(Ci) = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{60\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the seventh interval and an initial concentration of 60 μCi/g:

$$Activity,Flashing(Ci) = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{60\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the eight interval and an initial concentration of 60 μCi/g:

$$Activity, Flashing(Ci) = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{60\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the ninth interval and an initial concentration of 60 μCi/g:

$$Activity, Flashing(Ci) = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{60\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the tenth interval and an initial concentration of 60 μCi/g:

$$Activity, Flashing(Ci) = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{60\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the eleventh interval and an initial concentration of 60 μCi/g:

$$Activity, Flashing(Ci) = [\quad] \times \frac{453.6\,g}{lbm} \times \frac{60\,\mu Ci}{g}$$

Activity, Flashing = [ ]

Adding the activity released over these intervals yields a 60 minute total:

[ ]

Table E.2-4 charts the non-flashing release from the generator with the tube rupture over the first 60 minutes.

For activity release from the unaffected generator, methodology from Section 2.2.22 was also used. Steam generator time constants developed in Section 3.1.5 were utilized and corrected for the unaffected SG DF of 100. Table E.2-5 charts the release from the unaffected generator over a 2 hour time span. Table E.2-6 charts the release from the unaffected generator for the 8 hour event. Note, that since only the affected generator was assumed to steam the plant in the first 60 minutes, dose release from the unaffected SG in the first 60 minutes was ignored in the summation of releases.

Releases from both generators were added. The appropriate breathing rate and χ/Q from Section 2.2.7, and the DCF for I-131 for non-fuel failure from Section 2.2.1 were applied. For EAB dose (2 hour):

$$EAB\ D_{Thyroid} = [\quad]$$

EAB $D_{Thyroid}$ = [ ] = 73.2 rem

For LPZ boundary dose (8 hour):

$$LPZ\ Boundary\ D_{Thyroid} = [\quad]$$

LPZ Boundary $D_{Thyroid}$ = [ ] = 3.6 rem

TABLE E.2-4
Ruptured Tube SG Release, PIS
First 60 Minutes

[ ]

TABLE E.2-5
Unaffected SG Release, PIS
2 Hour Event

[ ]

TABLE E.2-6
Unaffected SG Release, PIS
8 Hour Event

[ ]

E.2.3 Offsite Thyroid - GIS

A similar calculation was performed for a GIS. Iodine concentrations vary with time for a GIS. Section 3.5.2 calculated the RCS iodine concentration for 15 minute intervals. To apply these properly, the [ ] second interval was further broken down into segments. The 120,400 lbm primary to secondary transfer was also divided into parts for these intervals.

Using the [ ] flashing fraction for the first 60 second interval and an initial concentration of [ ] Ci/g:

$$Activity, Flashing\,(Ci) = \left[\qquad \right]$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the second interval and an initial concentration of [ ] Ci/g:

$$Activity, Flashing\,(Ci) = \left[\qquad \right]$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the third interval and an initial concentration of [ ] Ci/g:

$$Activity, Flashing\,(Ci) = \left[\qquad \right]$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the fourth interval and an initial concentration of [ ] Ci/g:

$$Activity, Flashing\,(Ci) = \left[\qquad \right]$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the fifth interval and an initial concentration of [ ] Ci/g:

$$Activity, Flashing\,(Ci) = \left[\qquad \right]$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the sixth interval and an initial concentration of [ ] Ci/g:

$$Activity, Flashing\,(Ci) = \left[\qquad \right]$$

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the seventh interval and an initial concentration of [ ] Ci/g:

Activity, Flashing (Ci) = [ ]

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the eighth interval and an initial concentration of [ ] Ci/g:

Activity, Flashing (Ci) = [ ]

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the ninth interval and an initial concentration of [ ] Ci/g:

Activity, Flashing (Ci) = [ ]

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the tenth interval and an initial concentration of [ ] Ci/g:

Activity, Flashing (Ci) = [ ]

Activity, Flashing = [ ]

Using an [ ] flashing fraction for the eleventh interval and an initial concentration of [ ] Ci/g:

Activity, Flashing (Ci) = [ ]

Activity, Flashing = [ ]

Adding the activity released over these intervals yields a 60 minute total:
[ ]

Table E.2-7 charts the non-flashing release from the generator with the tube rupture over the first 60 minutes.

For activity release from the unaffected generator, methodology from Section 2.2.22 was also used. Steam generator time constants developed in Section 3.1.5 were utilized and corrected for the unaffected SG DF of 100. Table E.2-8 charts the release from the unaffected generator over a 2 hour time span. Table E.2-9 charts the release from the unaffected generator for the 8 hour event. Note, that since only the affected generator was assumed to steam the plant in the first 60 minutes, dose release from the unaffected SG in the first 60 minutes was ignored in the summation of releases.

Releases from both generators were added. The appropriate breathing rate and χ/Q from Section 2.2.7, and the DCF for I-131 for non-fuel failure from Section 2.2.1 were applied. For EAB dose (2 hour):

$EAB\ \ D_{Thyroid}$ = [ ] .

EAB $D_{Thyroid}$ = [ ] = 29.994 rem

For LPZ boundary dose (8 hour):

$LPZ\ \ Boundary\ \ D_{Thyroid}$ = [ ]

LPZ Boundary $D_{Thyroid}$ = [ ] = 1.7 rem

TABLE E.2-7
Ruptured Tube SG Release, GIS
First 60 Minutes

[ ]

TABLE E.2-8
Unaffected SG Release, GIS
2 Hour Event

[ ]

TABLE E.2-9
Unaffected SG Release, GIS
8 Hour Event

[ ]

E.2.4 Offsite Whole Body – No Spiking

Table E.2-10 shows the breakdown of activity into individual iodine isotopes for a 2 hour event. The breakdown to individual isotopes was handled using the scaling factors from Section 3.5.2. Each isotope was then multiplied by its unique DCF. The sum of these terms is the contribution of whole body dose due to iodine.

TABLE E.2-10
Iodine Activity Distribution for a 2 Hour Event
No Iodine Spiking

[ ]

Table E.2-11 shows the breakdown of activity into individual iodine isotopes for an 8 hour event. The breakdown to individual isotopes was handled using the scaling factors from Section 3.5.2. Each isotope was then multiplied by its unique DCF. The sum of these terms is the contribution of whole body dose due to iodine.

TABLE E.2-11
Iodine Activity Distribution for an 8 Hour Event
No Iodine Spiking

[ ]

Noble gas contribution for cases with no fuel failure was found by taking the initial steady state RCS noble gas activity released over the course of 2 hours through 2 SGs, accounting for the rupture in the first 60 minutes, and applying the $\gamma + \beta$ factor.

For 0-60 minutes:

[ ]

For 60-120 minutes:

[ ]

For 2-8 hours:

[ ]

For the EAB dose (2 hour event):

$EAB\ D_{WB} = [$]

EAB D_{WB} = [ ] = 0.93 rem

For the LPZ boundary dose (8 hour event):

$LPZ\ Boundary\ D_{WB} = [$]

LPZ Boundary D_{WB} = [ ] = < 0.1 rem

E.2.5 Offsite Whole Body – PIS

Table E.2-12 shows the breakdown of activity into individual iodine isotopes for a 2 hour event. The breakdown to individual isotopes was handled using the scaling factors from Section 3.5.2. Each isotope was then multiplied by its unique DCF. The sum of these terms is the contribution of whole body dose due to iodine.

TABLE E.2-12
Iodine Activity Distribution for a 2 Hour Event
PIS

[ ]

Table E.2-13 shows the breakdown of activity into individual iodine isotopes for an 8 hour event. The breakdown to individual isotopes was handled using the scaling factors from Section 3.5.2. Each isotope was then multiplied by its unique DCF. The sum of these terms is the contribution of whole body dose due to iodine.

TABLE E.2-13
Iodine Activity Distribution for an 8 Hour Event
PIS

[ ]

Noble gas contributions are identical to those calculated for the no iodine spiking case.
For the EAB dose (2 hour event):

$EAB\ \ D_{WB} = [\qquad]$

EAB D_{WB} = [ ] = 1.24 rem

For the LPZ boundary dose (8 hour event):

$LPZ\ \ Boundary\ \ D_{WB} = [\qquad]$

LPZ Boundary D_{WB} = [ ] = < 0.1 rem

E.2.6 Offsite Whole Body – GIS

Table E.2-14 shows the breakdown of activity into individual iodine isotopes for a 2 hour event. The breakdown to individual isotopes was handled using the scaling factors from Section 3.5.2. Each isotope was then multiplied by its unique DCF. The sum of these terms is the contribution of whole body dose due to iodine.

TABLE E.2-14
Iodine Activity Distribution for a 2 Hour Event
GIS

[ ]

Table E.2-15 shows the breakdown of activity into individual iodine isotopes for an 8 hour event. The breakdown to individual isotopes was handled using the scaling factors from Section 3.5.2. Each isotope was then multiplied by its unique DCF. The sum of these terms is the contribution of whole body dose due to iodine.

TABLE E.2-15
Iodine Activity Distribution for an 8 Hour Event
GIS

[ ]

Noble gas contributions are identical to those calculated for the no iodine spiking case.
For the EAB dose (2 hour event):

$EAB\ D_{WB}$ = [ ]

EAB $\mathbf{D_{WB}}$ = 1.052 rem = **1.06 rem**

For the LPZ boundary dose (8 hour event):

$LPZ\ Boundary\ D_{WB}$ = [ ]

LPZ Boundary $\mathbf{D_{WB}}$ = 5.21E-02 rem = **< 0.1 rem**

E.3 Control Room Doses

Control Room thyroid dose is given by:

$$D_{Thyroid} = \sum A_I \times BR \times \chi/Q \times DCF_{I-131} \times 1/IPF$$

where:

$D_{Thyroid}$ = Thyroid dose (rem)
A_I = Activity of iodine (Ci)
BR = Breathing Rate (m^3/s)
χ/Q = Atmospheric dispersion (s/m^3)
DCF_{I-131} = Dose Conversion Factor of I-131 (rem/Ci)
IPF = Iodine Protection Factor (144)

Control Room whole body dose is given by:

$$D_{WB} = \left[\frac{1}{IPF} \times \frac{1}{GF} \times \sum_i A_{I,i} \times DCF(\gamma)_{I,i} + \frac{1}{GF} \times A_N \times \gamma\right] \times \chi/Q$$

where:

D_{WB} = Whole body dose (rem)
IPF = Iodine Protection Factor (144)
GF = Geometry Factor (32.24)
$A_{I,i}$ = Activity of iodine isotope *i* (Ci)
$DCF(\gamma)_{I,i}$ = Dose Conversion Factor of iodine isotope *i* (rem-m^3/s-Ci)
A_N = Activity of noble gas (Ci)
γ = Gamma conversion constant
= ($0.25 \times E_\gamma$) rem-m^3/s-Ci
χ/Q = Atmospheric dispersion (s/m^3)

Control Room skin dose is given by:

$$D_{Skin} = \left[\frac{1}{IPF} \times \sum_i \left[A_{I,i}\left[\frac{DCF(\gamma)_{I,i}}{GF} + DCF(\beta)_{I,i}\right]\right] + A_N\left[\frac{\gamma}{GF} + \beta\right]\right] \times \chi/Q$$

where:

D_{Skin} = Skin dose (rem)
IPF = Iodine Protection Factor (144)
$A_{I,i}$ = Activity of iodine isotope *i* (Ci)
$DCF(\gamma)_{I,i}$ = Gamma Dose Conversion Factor of iodine isotope *i* (rem-m^3/s-Ci)
$DCF(\beta)_{I,i}$ = Beta Dose Conversion Factor of iodine isotope *i* (rem-m^3/s-Ci)
GF = Geometry Factor (32.24)
A_N = Activity of noble gas (Ci)
γ = Gamma conversion constant
= ($0.25 \times E_\gamma$) rem-m^3/s-Ci
β = Beta conversion constant
= ($0.23 \times E_\beta$) rem-m^3/s-Ci
χ/Q = Atmospheric dispersion (s/m^3)

E.3.1 Table D.1-1 Control Room Atmospheric Dispersion Factors and Iodine Protection Factor = 144

E.3.1.1 Control Room Thyroid – No Spiking

The flashing and affected SG releases were assumed through the MSSVs in the first 60 minutes. The releases from the unaffected SG were broken down into 60-120 minutes and 2-8 hours for the purposes of applying the correct atmospheric dispersion factors:

$$Control\ \ Room\ \ D_{Thyroid} = \left[\qquad \qquad \right]$$

Control Room $D_{Thyroid}$ = [ ]= < 0.1 rem

E.3.1.2 Control Room Whole Body – No Spiking

For iodine contribution, TableE.3-16 follows identical methodology used in Table E.2-11. Only gamma DCFs are applied, however.

TABLE E.3-16
Iodine Activity Distribution for the Control Room
No Iodine Spiking

[ ]

Noble gas contribution for cases with no fuel failure was found by taking the initial steady state RCS noble gas activity released over the course of 8 hours through 2 SGs, accounting for the rupture, and applying the γ factor. It was necessary to break the 8 hour event into 0-60 minute, 60-120 minute, and 2-8 hour segments, to account for the different release paths of each SG and to facilitate using multiple atmospheric dispersion factors:

For 0-60 minutes:

[ ]

For 60-120 minutes:

[ ]

For 2-8 hours:

[ ]

The iodine releases were assumed at the most adverse atmospheric dispersion factor for convenience:

[ ]

Control Room D_{WB} = [ ] = < 0.1 rem

E.3.1.3 Control Room Skin – No Spiking

For iodine contribution, Table E.3-17 follows identical methodology used in Table E.2-11. However, the Geometry Factor is applied to the gamma DCF before it is added to the beta DCF.

TABLE E.3-17
Iodine Activity Distribution for the Control Room
No Iodine Spiking

[ ]

Noble gas contribution for cases with no fuel failure was found by taking the initial steady state RCS noble gas activity released over the course of 8 hours through 2 SGs, accounting for the rupture, and applying the γ/GF+ β factor. It was necessary to break the 8 hour event into 0-60 minute, 60-120 minute, and 2-8 hour segments, to account for the different release paths of each SG and to facilitate using multiple atmospheric dispersion factors.

For 0-60 minutes:

[ ]

For 60-120 minutes:

[ ]

For 2-8 hours:

[ ]

The iodine releases were assumed at the most adverse atmospheric dispersion factor for convenience:

$Control\,Room\,D_{Skin} = [$]

Control Room $\mathbf{D_{Skin}}$ = [ ]= 0.5 rem

E.3.1.4 Control Room Thyroid – PIS

The flashing and affected SG releases were assumed through the MSSVs in the first 60 minutes. The releases from the unaffected SG were broken down into 60-120 minutes and 2-8 hours for the purposes of applying the correct atmospheric dispersion factors:

$$Control\ Room\ D_{Thyroid} = \left[\quad\quad\right]$$

Control Room $D_{Thyroid}$ = [ ]= 0.7 rem

E.3.1.5 Control Room Whole Body – PIS

For iodine contribution, Table E.3-18 follows identical methodology used in Table E.2-13. Only gamma DCFs were applied, however.

TABLE E.3-18
Iodine Activity Distribution for the Control Room
PIS

[ ]

Noble gas contributions are identical to those calculated for the no iodine spiking case. The iodine releases were assumed at the most adverse atmospheric dispersion factor for convenience:

$$Control\ Room\ D_{WB} = \left[\quad\quad\right]$$

Control Room D_{WB} = [ ] = < 0.1 rem

E.3.1.6 Control Room Skin – PIS

For iodine contribution, Table E.3-19 follows identical methodology used in Table E.2-13. However, the Geometry Factor was applied to the gamma DCF before it was added to the beta DCF.

TABLE E.3-19
Iodine Activity Distribution for the Control Room
PIS

[ ]

Noble gas contributions are identical to those calculated for the no iodine spiking case. The iodine releases were assumed at the most adverse atmospheric dispersion factor for convenience:

$Control\ Room\ D_{Skin} = \left[\quad \right]$

Control Room D_{Skin} = [ ] rem = 0.5 rem

E.3.1.7 Control Room Thyroid – GIS

The flashing and affected SG releases were assumed through the MSSVs in the first 60 minutes. The releases from the unaffected SG were broken down into 60-120 minutes and 2-8 hours for the purposes of applying the correct atmospheric dispersion factors:

$$Control\ Room\ D_{Thyroid} = \left[\quad \right]$$

Control Room $D_{Thyroid}$ = [ ] = 0.3 rem

E.3.1.8 Control Room Whole Body – GIS

For iodine contribution, Table E.3-20 follows identical methodology used in Table E.2-15. Only gamma DCFs were applied, however.

TABLE E.3-20
Iodine Activity Distribution for the Control Room
GIS

[ ]

Noble gas contributions are identical to those calculated for the no iodine spiking case. The iodine releases were assumed at the most adverse atmospheric dispersion factor for convenience:

$$Control\ Room\ D_{WB} = \left[\quad \right]$$

Control Room D_{WB} = [ ] = < 0.1 rem

E.3.1.9 Control Room Skin – GIS

For iodine contribution, Table E.3-21 follows identical methodology used in Table E.2-15. However, the Geometry Factor was applied to the gamma DCF before it was added to the beta DCF.

TABLE E.3-21
Iodine Activity Distribution for the Control Room
GIS

[ ]

Noble gas contributions are identical to those calculated for the no iodine spiking case. The iodine releases were assumed at the most adverse atmospheric dispersion factor for convenience:

$$Control\ Room\ D_{Skin} = \left[\quad \right]$$

Control Room D_{Skin} = [ ] = 0.5 rem

E.3.2 Table D.1-1 Control Room Atmospheric Dispersion Factors and Iodine Protection Factor = 3.06

E.3.2.1 No Spiking

The thyroid calculation in Section E.3.1.1 is repeated here, using the new atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Thyroid} = \left[\qquad \right]$$

Control Room $D_{Thyroid}$ = [ ] = 0.63 rem

The whole body calculation in Section E.3.1.2 is repeated here, using the new atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{WB} = \left[\qquad \right]$$

Control Room D_{WB} = [ ] = <0.1 rem

The skin calculation in Section E.3.1.3 is repeated here, using the new atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Skin} = \left[\qquad \right]$$

Control Room D_{Skin} = [ ] = 0.50 rem

E.3.2.2 PIS

The thyroid calculation in Section E.3.1.4 is repeated here, using the new atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Thyroid} = \left[\qquad \right]$$

Control Room $D_{Thyroid}$ = [ ] = 29.98 rem

The whole body calculation in Section E.3.1.5 is repeated here, using the new atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{WB} = \left[\qquad \right]$$

Control Room D_{WB} = [ ] = <0.1 rem

The skin calculation in Section E.3.1.6 is repeated here, using the new atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Skin} = \left[\qquad\qquad\right].$$

Control Room D_{Skin} = [ ] = 0.53 rem

E.3.2.3 GIS

The thyroid calculation in Section E.3.1.7 is repeated here, using the new atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Thyroid} = \left[\qquad\qquad\right]$$

Control Room $D_{Thyroid}$ = [ ] = 12.9 rem

The whole body calculation in Section E.3.1.8 is repeated here, using the new atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{WB} = \left[\qquad\qquad\right]$$

Control Room D_{WB} = [ ] = <0.1 rem

The skin calculation in Section E.3.1.9 is repeated here, using the new atmospheric dispersion and iodine protection factors.

$$Control\ Room\ D_{Skin} = \left[\qquad\qquad\right]$$

Control Room D_{Skin} = [ ] = 0.51 rem

E.4 Appendix E Results

Dose limits were calculated in Sections E.2 and E.3. Offsite doses are summarized in Table E.4-1. Control Room doses are summarized in Table E.4-2.

TABLE E.4-1
Offsite Dose Consequence for SGTR event

Criteria: 300 rem for Thyroid, 25 rem for Whole Body					
		Thyroid Dose (rem)		Whole Body Dose (rem)	
Event	Criteria Fraction	EAB	LPZ	EAB	LPZ
30 min SGTR case results (Section 4.3)					
SGTR – No Spiking	0.10	1.4	<0.1	0.6	<0.1
SGTR – PIS	1.00	70.0	3.5	0.9	<0.1
SGTR – GIS	0.10	21.4	1.2	0.7	<0.1
60 min SGTR case results					
SGTR – No Spiking	0.10	1.41	<0.1	0.93	<0.1
SGTR – PIS	1.00	73.2	3.6	1.24	<0.1
SGTR – GIS	0.10	29.994	1.7	1.06	<0.1
EAB: Exclusionary Boundary (2 hour)		LPZ: Low Population Zone (8 hour)			

TABLE 5.1-2
Control Room Dose Consequence for Non-Fuel Failure Events

Criteria: 30 rem for Thyroid, 5 rem for Whole Body, and 75 rem for Skin			
	Dose (rem)		
Event	Thyroid	Whole Body	Skin
30 min SGTR old χ/Q and IPF = 144 (Section 4.3)			
SGTR – No Spiking	0.7	0.7	14.8
SGTR – PIS	29.8	0.7	14.8
SGTR – GIS	9.8	0.7	14.8
30 min SGTR new χ/Q and IPF = 144 (Appendix D, Section D.6.1)			
SGTR – No Spiking	<0.1	<0.1	0.3
SGTR – PIS	0.61	<0.1	0.3
SGTR – GIS	0.2	<0.1	0.3
30 min SGTR new χ/Q and IPF = 2.95 (Appendix D, Section D.6.2)			
SGTR – No Spiking	0.63	<0.1	0.3
SGTR – PIS	29.8	<0.1	0.33
SGTR – GIS	9.7	<0.1	0.31
60 min SGTR new χ/Q and IPF = 144 (Section E.3.1)			
SGTR – No Spiking	<0.1	<0.1	0.5
SGTR – PIS	0.7	<0.1	0.5
SGTR – GIS	0.3	<0.1	0.5
60 min SGTR new χ/Q and IPF = 3.06 (Section E.3.2			
SGTR – No Spiking	0.63	<0.1	0.50
SGTR – PIS	29.98	<0.1	0.53
SGTR – GIS	12.9	<0.1	0.51

Attachment 3

Photocopy of Affidavit Pursuant to 10CFR2.790 (2 pages)
and
Page D-16 through D-19 of Appendix D and Page E-1 through E-31 of Appendix E of ANO-2 Radiological Dose Analysis for RSG and Power Uprate

I, Philip W. Richardson, depose and say that I am the Licensing Project Manager, Windsor Nuclear Licensing, of Westinghouse Electric Company LLC (WEC), duly authorized to make this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and described below.

I am submitting this affidavit in conjunction with the application by Entergy Operations Incorporated and in conformance with the provisions of 10 CFR 2.790 of the Commission's regulations for withholding this information. I have personal knowledge of the criteria and procedures utilized by WEC in designating information as a trade secret, privileged, or as confidential commercial or financial information.

The information for which proprietary treatment is sought, and which document has been appropriately designated as proprietary, is contained in the following:

- A-AN-FE-0233, Rev. 004, (ANO-2 Document Number 98-E-0036-04), "ANO-2 Radiological Dose Analysis for RSG and Power Uprate," November 27, 2000

Pursuant to the provisions of Section 2.790(b)(4) of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information included in the document listed above should be withheld from public disclosure.

i. The information sought to be withheld from public disclosure is owned and has been held in confidence by WEC. It consists of information concerning the evaluation of radiological consequences associated with non – Loss of Coolant Accident transient analyses for Arkansas Nuclear One, Unit 2 (ANO-2).

ii. The information consists of test data or other similar data concerning a process, method or component, the application of which results in substantial competitive advantage to WEC.

iii. The information is of a type customarily held in confidence by WEC and not customarily disclosed to the public.

iv. The information is being transmitted to the Commission in confidence under the provisions of 10 CFR 2.790 with the understanding that it is to be received in confidence by the Commission.

v. The information, to the best of my knowledge and belief, is not available in public sources, and any disclosure to third parties has been made pursuant to regulatory provisions or proprietary agreements that provide for maintenance of the information in confidence.

vi. Public disclosure of the information is likely to cause substantial harm to the competitive position of WEC because:

   a. A similar product is manufactured and sold by major competitors of WEC.

   b. Development of this information by WEC required tens of thousands of dollars and hundreds of manhours of effort. A competitor would have to undergo similar expense in generating equivalent information. In order to acquire such information, a competitor would also require considerable time and inconvenience to develop radiological

consequences associated with non – Loss of Coolant Accident transient analyses for ANO-2.

c. The information consists of technical data and details concerning the development of radiological consequences associated with non – Loss of Coolant Accident transient analyses for ANO-2, the application of which provides WEC a competitive economic advantage. The availability of such information to competitors would enable them to design their product to better compete with WEC, take marketing or other actions to improve their product's position or impair the position of WEC's product, and avoid developing similar technical analysis in support of their processes, methods or apparatus.

d. In pricing WEC's products and services, significant research, development, engineering, analytical, manufacturing, licensing, quality assurance and other costs and expenses must be included. The ability of WEC's competitors to utilize such information without similar expenditure of resources may enable them to sell at prices reflecting significantly lower costs.

e. Use of the information by competitors in the international marketplace would increase their ability to market comparable analytical services by reducing the costs associated with their technology development. In addition, disclosure would have an adverse economic impact on WEC's potential for obtaining or maintaining foreign licenses.

Philip W. Richardson
Licensing Project Manager

Sworn to before me this 15th day of June, 2001.

Laurie J. White
Notary Public

My Commission expires: 8/31/04