Florida Power
A Progress Energy Company

Crystal River Unit 3
Docket No. 50-302
Operating License No. DPR-72

Ref: 10 CFR 50.90

June 14, 2001
3F0601-03

Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Crystal River Unit 3 - License Amendment Request #262, Revision 1, and Response to NRC Request for Additional Information RE: License Amendment Request #262, Revision 0, "Alternative Source Term and Control Room Emergency Ventilation System" (TAC No. MB0241)

Reference: NRC to FPC letter, 3N0501-09, dated May 24, 2001. "Crystal River Unit 3 – Request for Additional Information RE: Proposed License Amendment Request No. 262, Revision 0, Alternative Source Term and Control Room Emergency Ventilation System" (TAC No. MB0241)

Dear Sir:

Florida Power Corporation (FPC) hereby submits License Amendment (LAR) #262, Revision 1, and the response to the NRC request for additional information (RAI) regarding LAR #262, Revision 0, forwarded by the referenced letter. LAR #262, Revision 0, requested full implementation of an alternative source term for Crystal River Unit 3 (CR-3) and proposed changes to Improved Technical Specifications (ITS) 3.7.12, "Control Room Emergency Ventilation System (CREVS)," ITS 5.6.2.12, "Ventilation Filter Testing Program," ITS 3.3.16, "Control Room Isolation – High Radiation," and ITS 3.7.18, "Control Complex Cooling System."

LAR #262, Revision 1, revises ITS 3.7.12 in accordance with Item 11 of the RAI. The changes to ITS 3.7.12 proposed by this submittal revise the wording and format of the specification proposed in LAR #262, Revision 0, in order to match the guidance for the Control Room Emergency Ventilation System contained in NUREG-1430, "Standard Technical Specifications: Babcock and Wilcox Plants," Revision 2. These changes do not alter the intent of the changes to ITS 3.7.12 proposed by LAR #262, Revision 0, and do not impact the technical justification for the changes provided in the original submittal. FPC has concluded that these changes do not affect the previous conclusions or the bases for the conclusions in the No Significant Hazards Consideration and Environmental Impact Evaluation provided in LAR #262, Revision 0, in accordance with 10 CFR 50.92(c) and 51.22(c), respectively. Consequently, FPC does not consider that additional public notice in accordance with 10 CFR 50.91(a)(2) is required.

This revision to LAR #262 continues to propose removal of the Control Complex integrated leakage test as a surveillance requirement. Additional justification for removal of this requirement is provided in the response to Item 10 of the RAI. FPC is closely monitoring NRC

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and industry progress in developing a consensus guidance document (currently NEI 99-03) for assessing the adequacy of control room habitability programs. FPC supports the industry position that habitability envelope integrity verification should be based on an individual plant's design features, and the margin between assumed or measured leak rates and the actual leak rate that would cause dose limits to be exceeded. Based on this principle, periodic leak rate testing may not be required to assure continued envelope integrity at all plants.

FPC has conducted two integrated leak rate tests of the CR-3 habitability envelope (1997 and 1999) with very consistent results at approximately 523 cfm. CR-3 dose calculations verify compliance with GDC 19 dose limits assuming 1000 cfm of leakage. We consider that the robust design of the CR-3 habitability envelope, the strong administrative controls established for maintenance and control of the habitability boundary, and the significant margin available in the dose calculations provide adequate assurance of continued control room operator protection. FPC therefore proposes to discontinue the biennial integrated leak rate test now contained in the CR-3 ITS. When guidance on habitability envelope integrity monitoring and verification has been approved by the NRC, FPC commits to apply that guidance for habitability envelope integrity monitoring and verification at CR-3, including proposal of ITS changes if appropriate.

In LAR #262, Revision 0, FPC stated that it was currently implementing modifications to reduce the existing toxic gas sources at the Crystal River Energy Complex. These modifications eliminate the potential for any toxic gas release that requires automatic isolation of the CR-3 control complex by the toxic gas detectors. This effort, which was completed in May 2001, is discussed in the revised Control Room Habitability Report provided as Appendix A to this submittal.

As a result of questions raised by the RAI, a number of the Appendices submitted as part of LAR #262 have been revised. These revisions are provided as Appendices A through G of this submittal as replacement pages for the original Appendices.

The CR-3 Plant Nuclear Safety Committee has reviewed this submittal and recommended it for approval.

Attachment G lists the regulatory commitments established by this submittal.

If you have any questions regarding this submittal, please contact Mr. Sid Powell, Supervisor, Licensing and Regulatory Programs at (352) 563-4883.

Sincerely,

Dale E. Young

Dale E. Young
Vice President, Crystal River Nuclear Plant

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Attachments:

A. Response to NRC Request for Additional Information
B. Description of Proposed Changes, Reason for Request, and Evaluation of Request
C. Proposed Revised Improved Technical Specifications and Bases Change Pages - Strikeout / Shadowed Format
D. Proposed Revised Improved Technical Specifications and Bases Change Pages - Revision Bar Format
E. Calculation Number M97-0137, Revision 4
F. Control Room Emergency Ventilation System – Flow Diagrams and Differential Pressure Data
G. List of Regulatory Commitments

Appendices:

A. Revised Crystal River Unit 3 Control Room Habitability Report
B. Revised Summary of Radiological Analyses for FSAR Chapter 14 Accidents
C. Revised Control Rod Ejection Accident Containment Release RADTRAD Inputs
D. Revised Control Rod Ejection Accident Secondary Side Release RADTRAD Inputs
E. Revised LOCA ECCS Leakage RADTRAD Inputs
F. Revised LOCA Containment Leakage RADTRAD Inputs
G. Revised LOCA Hydrogen Purge RADTRAD Inputs

xc: Regional Administrator, Region II
Senior Resident Inspector
NRR Project Manager

STATE OF FLORIDA

COUNTY OF CITRUS

Dale E. Young states that he is the Vice President, Crystal River Nuclear Plant for Progress Energy; that he is authorized on the part of said company to sign and file with the Nuclear Regulatory Commission the information attached hereto; and that all such statements made and matters set forth therein are true and correct to the best of his knowledge, information, and belief.

Dale E. Young

Dale E. Young
Vice President
Crystal River Nuclear Plant

The foregoing document was acknowledged before me this 14th day of June, 2001, by Dale E. Young.

Charlene Miller

Signature of Notary Public
State of Florida

Charlene Miller
Commission # CC 979312
Expires Nov. 4, 2004
Bonded Thru
Atlantic Bonding Co., Inc.

(Print, type, or stamp Commissioned Name of Notary Public)

Personally Known ✓ -OR- Produced Identification ______

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50 - 302 / LICENSE NUMBER DPR - 72

ATTACHMENT A

LICENSE AMENDMENT REQUEST #262, REVISION 1
Alternative Source Term and
Control Room Emergency Ventilation System

Response to NRC Request for Additional Information

Response to NRC Request for Additional Information

1. **NRC Request:**

There appears to be a discrepancy between the atmospheric dispersion values (x/Q) used for the main steamline break, steam generator tube rupture, and waste gas decay tank analyses and those stated in Table 14-23 of the CR-3 Final Safety Analysis Report (FSAR). In your letter of November 7, 1997, the response to staff question #7 states that the values in FSAR Table 14-23 are to be used for assessing these events. While the values used in the analysis are more conservative for the 0-to-8-hour period than the values provided in Table 14-23, they are not consistent with the design basis. Please identify whether or not it is your intent to revise the current design basis to use the more conservative values.

FPC Response:

The x/Q values in FSAR Table 14-23 were based on 1972 data. The x/Q values in FSAR Table 2-18 are based on 1975 data and models more acceptable to the NRC than the models used for Table 14-23. In February 2000, the steamline break, steam generator tube rupture and waste gas decay tank rupture accidents were reanalyzed using the x/Q's from Table 2-18. An FSAR change was approved that eliminated Table 14-23. This change will be incorporated in the next FSAR revision to be submitted to the NRC. It is FPC's intent to use the x/Q's in Table 2-18 for all Chapter 14 radiological dose analyses. Therefore, the Table 2-18 x/Q's were used for all of the Alternative Source Term analyses.

2. **NRC Request:**

Your analyses have used a single set of x/Q values for assessing control room dose from all analyzed accidents. Please explain why these values are bounding for each of the combinations of release points and control room intakes, given differences in the intervening distances and in wind direction frequency.

FPC Response:

The CR-3 Control Complex x/Q's are not based on detailed computer models such as PAVAN or ARCON. The 0-2 hour x/Q was based on the methodology specified in CR-3's letter to the NRC dated May 23, 1988, "NUREG-0737, Item III.D.3.4, Request for Additional Information" specifically, Response No. 10, which was approved by the NRC by letter dated May 25, 1989, "Crystal River Unit 3 – Control Room Habitability Evaluation (NUREG-0737 Item III.D.3.4)." The x/Q value was based on a very simplistic and conservative methodology. Due to the close distance from the containment to the control complex, the horizontal and vertical dispersion factors were neglected. The x/Q was therefore only a function of the building wake correction factor for the containment and the wind speed. In determining the 5% wind speed (which was calculated to be 1.2 m/sec), all wind directions from the SSE sector, clockwise to the NNW sector, were considered. As can be seen in Figure 1, these wind direction sectors would encompass all potential release points. The control complex would also be in the containment building wake from any of these release points.

3. NRC Request:

In several locations, you have stated that an analysis assumption or input was based on Draft Regulatory Guide (DG)-1081 or on NUREG-1465. In some of these occurrences, you have stated that the DG-1081 values are more conservative than those in Regulatory Guide (RG) 1.183. Except where explicitly identified in this Request for Additional Information (RAI), the staff agrees with your position that the current analyses are adequate for this amendment request and need not be re-analyzed. However, the staff does not believe that it is appropriate to reference DG-1081 and NUREG-1465 in the CR-3 design basis. DG-1081 is a draft document that was revised in response to public comments. The official agency guidance is provided in RG 1.183. While NUREG-1465 was the source of some of the guidance provided in RG 1.183, the staff has not endorsed NUREG-1465 as an acceptable approach to demonstrating compliance to 10 CFR 50.67. Please provide a commitment that the applicable assumptions of RG 1.183 will constitute the CR-3 design basis and that future revisions to these analyses will utilize the applicable guidance in RG 1.183 or acceptable alternatives thereto.

FPC Response:

CR-3 commits to using the applicable assumptions of Regulatory Guide 1.183, Rev. 0, or acceptable alternatives thereto in future revisions to the design basis public and control room dose assessments. The response to other questions in this RAI necessitated the recalculation of the doses from the LOCA and Control Rod Ejection. These revised calculations were performed in accordance with Regulatory Guide 1.183. The attached revised Appendices related to these accidents have deleted any reference to DG-1081 and NUREG-1465.

4. NRC Request:

In Appendix I to your application, you have described your analysis of the consequences of emergency core cooling system (ECCS) leakage, assuming, in part, a 50-gallon per minute release lasting 30 minutes from passive failure of ECCS piping at 24-hours post accident. This analysis requirement of DG-1081 was deleted from RG 1.183. Your assumption does result in separate maximum 2-hour doses for each release path. Instead of conservatively summing the projected doses, you have considered only the ECCS leakage that occurs in the 0.8 to 2.8 hour maximum dose period for containment leakage dose. You state that this is appropriate since "It can be assumed that the population at the exclusion area boundary (EAB) would have been evacuated by 24 hours . . . ." The staff cannot accept this rationale in a design basis accident assessment. The language of the dose criterion addresses the maximum exposure to any individual at any point on the boundary of the EAB for any 2-hour period. There is a presumption that an individual is present for the entire exposure period. The decision to actually implement the evacuation rests with the elected state and local officials. While it may be reasonable to presume that these officials will respond appropriately in emergency preparedness space, CR-3 cannot control whether or not an evacuation will occur. Please revise your analysis and submittal or provide additional justification for your position.

FPC Response:

The LOCA analysis has been revised to incorporate the assumptions of Regulatory Guide 1.183 in lieu of Draft Guide 1081. In updating to RG 1.183, the assumption of a 50 gpm leak for 30 minutes at 24 hours has been eliminated. Therefore, the maximum EAB dose 2 hour window remains the period from 0.8 to 2.8 hours. The only other assumption that required revision in updating to RG 1.183 was the determination of the cutoff times for spray removal coefficients, based on a revised definition of 'maximum' in RG 1.183 compared to DG-1081. Additionally, with changes to the LOCA and Control Rod Ejection accident, the Control Rod Ejection is now the limiting accident for control room dose. Therefore, the control complex breach margin determination has been eliminated from the LOCA dose analysis and added to the Control Rod Ejection dose analysis. The revised Assumptions and Results for the LOCA have been incorporated into the attached revisions to Appendices B, I, J, and K from the October 3, 2000 submittal.

5. **NRC Request:**

The control-rod-ejection accident used in your analysis was based on the core average source term used in RADTRAD. Since the fuel clad breach is limited to only 14% of the core, the source term needs to be adjusted for the radial peaking factor. See Regulatory Position 3.1 of RG 1.183. You used a peaking factor of 1.8 in the fuel-handling accident (FHA) analysis. The staff analysis assuming a radial peaking factor of 1.8 projected doses within acceptance criteria, but with a control dose greater than that for the loss-of-coolant accident (LOCA). Please revise your analysis and submittal or provide additional justification for your position.

FPC Response:

The Control Rod Ejection Accident analysis has been revised to include the radial peaking factor of 1.8. In revising this calculation, the following changes were also incorporated:

- The assumed time to isolate the steam generators and switch to decay heat system cooling was revised from a non-mechanistically assumed conservative value of 14 days, to a time of 72 hours based on existing Thermal Hydraulic calculations.
- The fraction of activity in the fuel rod gap was revised from the values in Table 3 of Draft Guide 1081 to the values in Appendix H of Regulatory Guide 1.183.
- A determination of Control Complex breach margin was added, as the Control Rod Ejection (secondary side release path) is now the limiting accident for Control Room Habitability.

The revised Assumptions and Results for the Control Rod Ejection have been incorporated into the attached revisions to Appendices B, G, and H from the October 3, 2000 submittal.

6. NRC Request:

For the iodine spiking releases shown in the tables in Attachment 2 to Appendix E and in Attachment 2 to Appendix L, your submittal explains that they were generated by a thermohydraulic code. Page 8 of Appendix B does explain some of the basis of this determination for the letdown break. Please provide a brief description of the calculational algorithm used by this code. Also provide the volume or mass of primary and secondary releases for the four time periods. These data are needed to assess the acceptability of your assumed releases.

FPC Response:

The thermal-hydraulic code used for both the Letdown Line Rupture and the Steam Generator Tube Rupture was the RELAP5/MOD2-B&W code. This code has been reviewed and approved by the NRC for use at B&W plants (B&W Topical Reports BAW-10164P-A, April 1991 and BAW-10192P, February 1994).

The calculated mass releases are variable over the very small time increments calculated by RELAP5, but can be approximated by the following averages over the time periods used in the dose assessments as follows:

- Letdown Line Rupture – primary side mass release:

  0 - 0.033 hrs – 110 lbm/sec
  0.033 – 0.1 hrs – 100 lbm/sec
  0.1 - 0.22 hrs – 95 lbm/sec
  0.22 - 0.325 hrs – 95 lbm/sec

  Total release over entire 0.325 hrs was 114,000 lbm

- Steam Generator Tube Rupture (SGTR) – primary to secondary side mass release:

  The primary to secondary mass flow rates for the SGTR are shown in Figure 2. Average rates for each of the 4 time periods are approximated as follows:

  0-0.13 hrs – 33 lbm/sec (note – releases over this time period are to the condenser and are reduced by a factor of 100)
  0.13 - 0.63 hrs – 36 lbm/sec – released directly to atmosphere with no decontamination factor (DF)
  0.63-1.8 hrs – 30 lbm/sec – released directly to atmosphere with no DF
  1.8 - 8 hrs – Although Figure 2 shows a primary to secondary mass flow for this time period, this flow is into the affected generator, which is isolated at 1.8 hours. Hence, activity in this flow will not be released. The activity being released during this period is only from the assumed 150 gallons/day primary to secondary leak in the unaffected generator, which is assumed to be released directly to atmosphere with no DF.

- Steam Generator Tube Rupture – secondary side mass releases:

  The secondary side mass releases are not used in the dose analysis for CR-3 as the activity passing to the secondary side from the primary side was assumed to be released directly to the environment with no holdup or removal in the secondary side. (Except for the first 0.13 hour time step when the condenser was still available and a DF of 100 for the condenser was assumed). Additionally, CR-3 has a very restrictive Technical Specification secondary side activity limit of 4.5E-4 μCi/gm Dose Equivalent I-131. Therefore, releases of any activity assumed to be in the secondary side prior to the tube rupture are considered insignificant.

7. NRC Request:

In your application, you propose a breach margin of 50 square inches. The derivation of this breach size is provided on page 7 of Appendix B as being based on the margin between the 4.29 roentgen equivalent man (rem) LOCA result and the 5-rem dose criterion. However, page 4 of the same appendix indicates that the dose due to an FHA is 4.43 rem. This information is also tabulated in the control room habitability report, which treats the LOCA as the maximum hypothetical accident (MHA). Please explain why the FHA is not the MHA with regard to control room habitability since the projected dose is greater and why the FHA is not being used as the basis for the breach margin. Please confirm that the results of the control-rod-ejection accident which you are re-assessing in response to the earlier RAI does not establish the control room envelope (CRE) as the MHA.

FPC Response:

The Fuel Handling Accident was not considered the limiting accident for determination of breach margin, as the calculated dose of 4.43 REM for the FHA is based on taking no credit for the Control Complex Habitability Envelope or Control Room Emergency Ventilation System. The FHA calculation assumed continuous operation in the normal makeup mode to the control complex of 5700 cfm of unfiltered intake. While operating in the normal ventilation mode, the inleakage rate through CCHE breaches is not applicable.

As discussed in the responses to Questions 4 and 5 above, due to the changes made to the LOCA and Control Rod Ejection accidents, the limiting accident for determination of the CCHE breach margin is now the Control Rod Ejection – secondary side release pathway. The attached revision to Appendix H includes the breach assessment determination for the Control Rod Ejection accident. The assessment demonstrates that a breach margin of 50 in^2 is still appropriate. A revision to Bases Section B 3.7.12 of License Amendment Request #262 has been made to change the reference calculation for the breach margin from the LOCA dose calculation N-00-0002 to the CRE dose calculation N-00-0006, Revision 1.

8. NRC Request:

CR-3, in their submittal dated October 3, 2000, provided no basis for the acceptability of equating their unfiltered in-leakages inside the control complex habitability envelope (CCHE) with a conversion factor of "8.02 cfm for one square inch breach." Also, CR-3 provided no information regarding the margin of errors associated with this approximation. In addition, CR-3 did not provide an explanation for why the conversion factor of "8.02 cfm [cubic feet per minute] for one square inch breach" is valid for various hole sizes and/or multiple holes, which add up to the aggregate in-leakage as specified in the proposed TS Bases. Appendix B, page 7 of 9 to your submittal, refers to 8.02 cfm for 1 square inch breach, based on 0.2-inch water gauge (WG) pressure differential between CRE and auxiliary building. In order to assess compliance with the requirements of 10 CFR 50, Appendix A, General Design Criterion 19 and/or 10 CFR 50.67, please provide the following:

a. CREVS flow diagram showing flow and pressure data serving the CCHE.

b. Bases and assumptions made in the calculation of the conversion factor of 8.02 cfm for 1 square inch breach, and the margin of errors associated with it. Also, provide Calculation Number M97-0137, Revision 4.

c. A detailed explanation stating why the conversion factor of 8.02 cfm for 1 square inch breach is valid for the various hole sizes and/or multiple holes which add up to an aggregate hole size of 50 square inches for the aggregate leak rate of 400 cfm as specified in the proposed ITS Bases.

d. Please number the separate locations where the actual pressure differentials were measured during the tracer gas testing. Also, describe where these measurements were taken with respect to the CCHE and state if they were of the same value.

e. Basis for the extrapolation methodology used to determine the unfiltered in leakages at the worst-case pressure differential of 0.2-inch WG from the actual test results at lower pressure differentials (i.e., 513 cfm at 0.2-inch WG corresponds to the actual measured leak rate of 443$\pm$20 at 0.171-inch WG and 503 cfm at 0.2-inch WG corresponds to the actual measured leak rate of 450$\pm$13 cfm at 0.176-inch WG).

FPC Response:

a. The requested flow diagrams are provided in Attachment F. As previously discussed with NRC staff members, these diagrams do not include pressure data.

b. Attachment E provides six pages from Calculation M-97-0137, Rev. 4, that are related to the evaluation of building inleakage. The 2 pages of Attachment M from M-97-0137 explain how a flow of 5.912 cfm was calculated for a 1 in^2 opening with a pressure differential of 0.125 in. WG. This was based on an equation from Crane for compressible flow through an orifice, with a small pressure differential. Pages 22 and 23 of M-97-0137 explain how this was extrapolated to 8.02 cfm based on a pressure differential of 0.2 in. WG. Pages 8 and 9 of M-97-0137 explain the use of the exponent of 0.65 used in the extrapolation on Page 23.

c. The formula from Crane in Appendix M to the attached pages from Calculation M-97-0137, as discussed above, is linear with the assumed hole size. For example, a 10 in^2 hole would have 10 times the calculated flow as a 1 in^2 hole. With the very small pressure differential, considerations of choke, or sonic flow would not apply, and the linear relationship is considered appropriate. The estimated flow per in^2 based on a 1 in^2 hole is likely conservative for a larger size hole, such as a full 50 in^2 breach size hole in one location, as with a larger hole it would be more difficult to maintain a 0.2 in. WG. differential pressure across the boundary in the immediate area of the hole.

d. Testing performed in 1997 measured differential pressures on the 108, 124, 134, and 164-foot elevations of the control complex. The sensing points used for the measurements are indicated on the CCHE exploded view drawing included as part of Attachment F. Testing performed in 1999 measured differential pressures on the 108 and 124-foot elevations of the control complex using the same sensing points as the 1997 tests. The 1997 and 1999 test results are included as part of Attachment F.

The exploded view shows dampers and a penetration on the 164-foot elevation that were permanently closed by a modification completed after the 1997 test. The ventilation drawings provided with this submittal show the current configuration.

e. The basis is provided on Pages 8 and 9 of Calculation M-97-0137, which are provided in Attachment E.

9. NRC Request:

Appendix A, Section III.2, page 6 to your submittal states that "The maximum differential across the CCHE occurs when there is no loss of offsite power. In this case, the auxiliary building exhaust fans would remain on and the supply fans would trip on high radiation. This results in a negative pressure in the auxiliary building and hence a higher differential pressure across the CCHE of 0.2-inch WG." Does this consider the worst-case alignment of the other adjacent ventilation systems? Provide the bases for why the pressure differential of 0.2-inch WG is the maximum expected pressure differential during all accident conditions.

FPC Response:

Testing conducted in 1997 measured a maximum differential pressure of 0.201 in. WG across the CCHE with the auxiliary building supply fans secured. Validation of these test results was performed in 1999 and documented in the interoffice correspondence provided as part of Attachment F. The information in the attached letter, which includes consideration of adjacent ventilation system alignments, provides the basis for why a differential pressure of 0.2 in. WG is the maximum expected during all accident conditions.

10. NRC Request:

Appendix A, Section III.2, page 7 to your submittal states that "The 1999 test results were essentially equal to the 1997 results, thus demonstrating that the CCHE boundary is not degrading with the time." Provide your reasoning why two tracer tests conducted during a 2-year period (1997 through 1999) demonstrate that the CCHE will not degrade over a longer period.

FPC Response:

The cited statement was not intended to imply that components that make up the CCHE are not susceptible to degradation, but rather to demonstrate the effectiveness of the administrative, surveillance and maintenance procedures CR-3 has implemented to ensure the continued integrity of the CCHE through the timely identification and correction of minor expected component degradations.

The design and construction of the CR-3 Control Complex limits the number of potential CCHE in-leakage paths. The building is a six floor Class 1 structure designed to withstand accident loads due to tornados, tornado missiles, main turbine missiles, and earthquakes. The exterior walls, which are constructed of poured concrete, are two feet thick. The roof is also constructed of concrete.

The penetrations/potential in-leakage paths in the Control Complex consist of doors, cable and conduit penetrations, and piping penetrations. There are no other components, such as paneling sections, that create interfaces that could develop in-leakage. Many of the piping and conduit penetrations are sealed by grout to the Control Complex walls.

The Control Room Emergency Ventilation System (CREVS) is completely enclosed within the Control Complex, and no other ventilation system ducts penetrate the Control Complex boundary. These features eliminate a potentially significant source of leakage that has typically been problematic within the industry.

Prior to the performance of the 1997 CCHE in-leakage test, CR-3 completed a number of significant modifications to improve the integrity of the CCHE. These included the replacement of single CREVS isolation dampers with redundant bubble-tight dampers in series, and the installation of loop seals on small-bore drain pipes penetrating the CCHE. In addition, CCHE penetrations were surveilled and sealed as required to minimize leakage. In 1998, a modification was initiated to apply sealant between the individual cables in cable trays penetrating the CCHE in order to further improve CCHE integrity. Due to power cable ampacity concerns, this application of sealant was confined to a limited number of control and instrument cables. With the exception of that effort, CCHE integrity was maintained between 1997 and the performance of the 1999 in-leakage test entirely through the application of routine administrative controls associated with the tracking and controlling of CCHE breaches, and the performance of routine surveillance and maintenance activities related to the inspection and repair of CCHE penetrations, fire doors, loop seals and dampers. A detailed discussion of these controls and procedures was provided to the NRC by FPC letter, 3F0597-11, dated May 15, 1997. The effectiveness of these activities in identifying and correcting minor, expected degradations of the CCHE is indicated by the 1999 in-leakage test results, which were essentially the same as the 1997 test results.

As discussed in LAR #262, the CCHE in-leakage rate assumed in the alternative source term dose calculations is 1000 cfm, which is approximately twice the 1997 and 1999 measured CCHE in-leakage values. With the extensive and effective CCHE boundary preventative maintenance program that exists at CR3, it is not considered likely that the CCHE boundary would degrade to the point where an in-leakage rate greater than 1000 cfm would be exceeded.

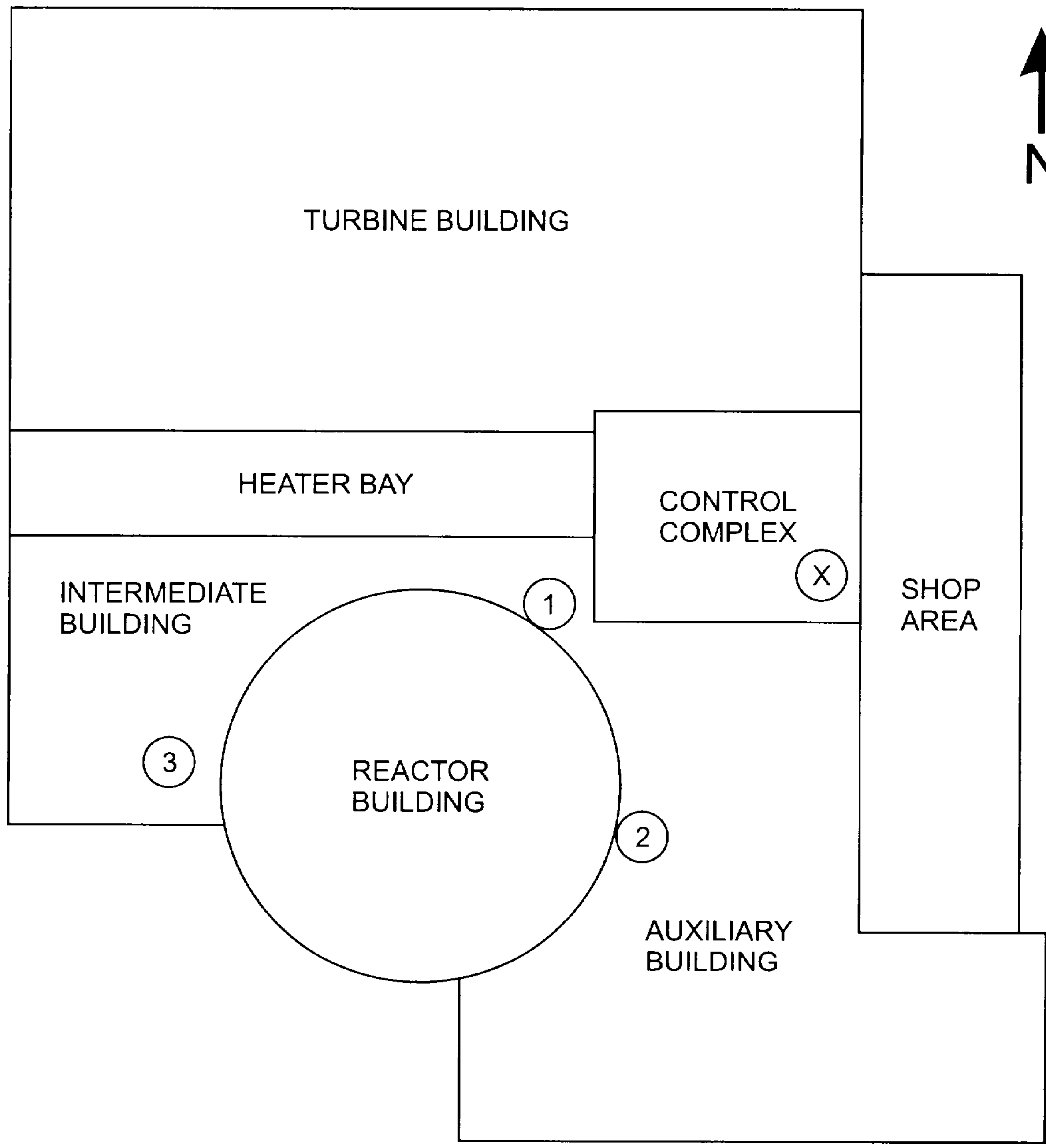
As also stated in LAR #262, FPC will continue to apply current administrative controls for identifying, tracking, and closing CCHE breaches, and continue to perform required inspection and maintenance activities for CREVS dampers, CCHE doors, penetration seals, and floor drains to ensure that margin is maintained between actual in-leakage and the 1000 cfm value assumed in the dose calculations.

11. NRC Request:

The proposed ITS 3.7.12, "CONDITION A," allows the restoring of the CCHE boundary, due to a breach or breaches in excess of the limit, within "COMPLETION TIME" of "24 hours." This reflects the concept of Technical Specification Task Force (TSTF)-287, but not in its format or wording. In order for the Nuclear Regulatory Commission (NRC) staff to find the requested "24-hour completion time" acceptable, the licensee needs to provide a formal submittal request in accordance with the TSTF-287 requirements, which has been generically approved by the NRC staff.

FPC Response:

ITS 3.7.12 has been reformatted and reworded to reflect the guidance for the Control Room Emergency Ventilation System provided in NUREG-1430, "Standard Technical Specifications: Babcock and Wilcox Plants," Revision 2. A description and evaluation of the reformatted/reworded ITS 3.7.12 are provided in Attachment B, and revised ITS and Bases pages in strikeout/shadowed format and revision bar formats are provided in Attachments C and D, respectively.



X CONTROL COMPLEX SUPPLY INTAKE

1 CONTAINMENT SURFACE*

2 RB/AB VENTILATION STACK*

3 MAIN STEAM SAFETIES AND ATMOSPHERIC DUMPS*

*POTENTIAL RELEASE POINTS

Figure 1

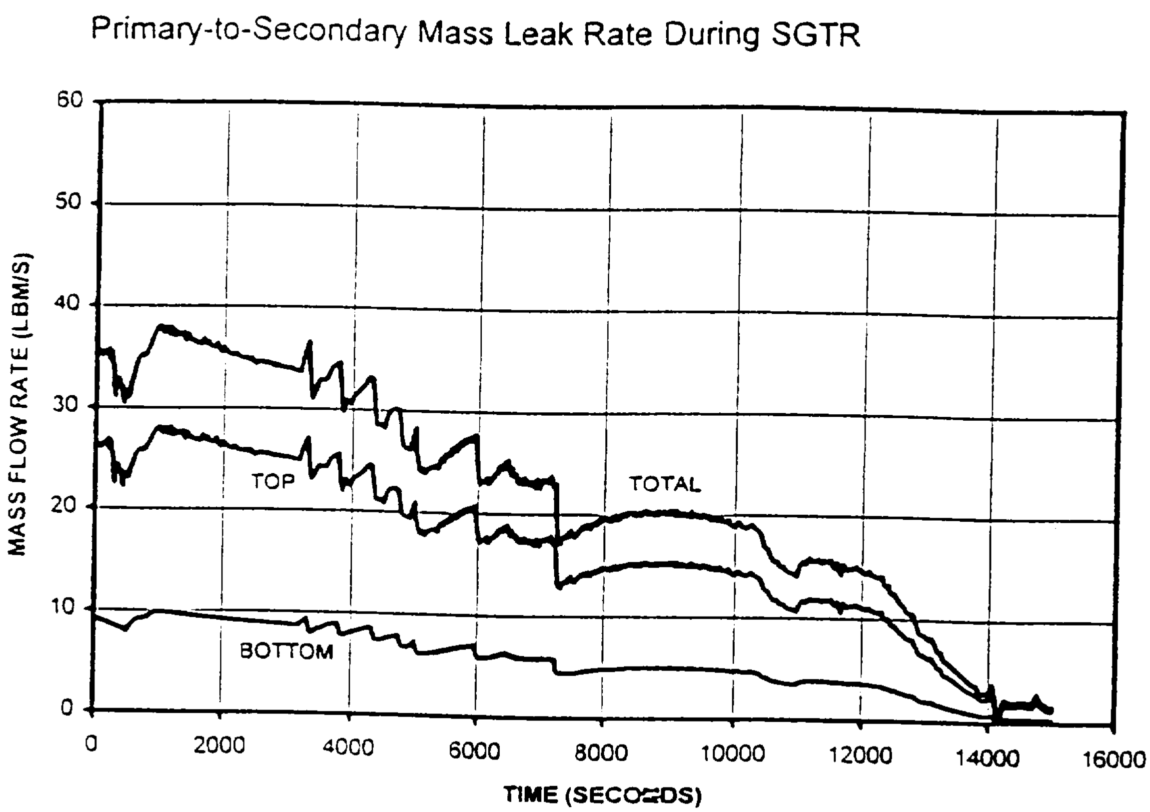

Primary-to-Secondary Mass Leak Rate During SGTR
MASS FLOW RATE (LBM/S)
60
50
40
30
20
10
0
TOP
TOTAL
BOTTOM
0
2000
4000
6000
8000
10000
12000
14000
16000
TIME (SECONDS)

Figure 2

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50 - 302 / LICENSE NUMBER DPR - 72

ATTACHMENT B

LICENSE AMENDMENT REQUEST #262, REVISION 1
Alternative Source Term and
Control Room Emergency Ventilation System

Description of Proposed Changes, Reason for Request and
Evaluation of Request

LICENSE AMENDMENT REQUEST NO. #262, REVISION 1
ALTERNATIVE SOURCE TERM AND CONTROL ROOM EMERGENCY VENTILATION SYSTEM

Description of Proposed Changes

Crystal River Unit 3 (CR-3) proposes the following changes to the Improved Technical Specifications (ITS) 3.7.12, "Control Room Emergency Ventilation System (CREVS)," submitted by LAR #262, Revision 0:

1. The following Note will be added: "The control complex habitability envelope (CCHE) boundary may be opened intermittently under administrative control."

2. Condition A, renumbered as Condition B, will be changed from "CCHE inoperable due to a breach or breaches in excess of the limit." to "Two CREVS trains inoperable due to inoperable CCHE boundary." Required Action B.1 will be changed from "Restore CCHE boundary." to "Restore CCHE boundary to OPERABLE status."

3. Condition B, renumbered as Condition A, will be changed from "One CREVS train inoperable for reasons other than Condition A." to "One CREVS train inoperable."

4. Condition D will be changed from "Two CREVS trains inoperable for reasons other than Condition A." to "Two CREVS trains inoperable for reasons other than Condition B."

Bases Section B 3.7.12 will be revised to reflect the above listed changes. Bases Section 3.7.12 will also be revised to indicate that the Control Rod Ejection accident is the limiting accident for the Control Room Emergency Ventilation System at CR-3.

The above changes are reflected in the Strikeout/Shadowed pages and Revision Bar pages provided in Attachments C and D, respectively. These pages replace the associated pages of LAR #262, Revision 0, previously submitted.

Reason For Request

By letter dated May 24, 2001, the NRC provided a request for additional information (RAI) regarding License Amendment Request (LAR) #262. Item 11 of the RAI included a discussion of the changes to ITS 3.7.12 Condition A proposed by LAR #262, Revision 0, and indicated that the proposed changes reflected the concept of Technical Specification Task Force (TSTF)-287 but not the format or wording. The RAI further stated that in order for the NRC staff to find the proposed 24 hour completion time for ITS 3.7.12 Condition A acceptable, FPC would need to provide a formal submittal request in accordance with the TSTF-287 requirements. This Attachment, together with Attachments C and D, constitute the formal submittal of LAR #262, Revision 1, as discussed in the RAI.

Evaluation of Request

The changes to ITS 3.7.12 described in this attachment do not alter the intent of the changes to ITS 3.7.12 proposed by LAR #262, Revision 0, and do not impact the technical justification for the changes provided in the original submittal. The changes revise the wording and format of the proposed ITS 3.7.12 submitted by LAR #262, Revision 0, to more closely match the wording and format of ITS 3.7.10, "Control Room Emergency Ventilation System," contained in NUREG–1430. This guidance, which was developed for NUREG-1430, Revision 2, as part of TSTF-287, has been generically approved by the NRC staff.

Condition B of ITS 3.7.10 in NUREG-1430 allows the CCHE boundary to be inoperable for up to 24 hours. As discussed in the associated Bases Section B 3.7.10, the acceptability of allowing an unlimited breach for up to 24 hours is based on the low probability of a design basis accident (DBA) during this time period and the existence of preplanned compensatory measures during the time that the CCHE is inoperable. A "Reviewer's Note" in Bases Section B.3.7.10 under ACTION B.1 states: "Adoption of Condition B is dependent on a commitment from the licensee to have written procedures available describing compensatory measures to be taken in the event of an intentional or unintentional entry into Condition B." At CR-3, the guidance provided in CP-147, "Control Complex Habitability Envelope Breaches," ensures this condition is satisfied. CP-147 includes instructions for personnel discovering a CCHE breach, planning for activities that will cause a breach in the CCHE (including requirements for preplanned compensatory actions), and for documenting and tracking breaches. Continued application of the guidance provided in CP-147 was identified as an FPC commitment in Appendix F of LAR #262, Revision 0.

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302 / LICENSE NUMBER DPR - 72

ATTACHMENT C

LICENSE AMENDMENT REQUEST #262, REVISION 1
Alternative Source Term and
Control Room Emergency Ventilation System

Proposed Revised Improved Technical Specifications and Bases
Change Pages

Strikeout / Shadow Format

~~Strikeout Text~~	Indicates deleted text
Shadowed text	Indicates added text

3.7 PLANT SYSTEMS

3.7.12 Control Room Emergency Ventilation System (CREVS)

LCO 3.7.12 Two CREVS trains ~~and the Control Complex Habitability Envelope (CCHE)~~ shall be OPERABLE.

NOTE
The control complex habitability envelope (CCHE) boundary may be opened intermittently under administrative control.

APPLICABILITY: MODES 1, 2, 3, and 4.~~,~~
~~During movement of irradiated fuel assemblies.~~

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One CREVS train inoperable.	A.1 Restore CREVS train to OPERABLE status.	7 days
B. **Two CREVS trains inoperable due to** inoperable CCHE **boundary.** ~~due to a breach or breaches in excess of the limit~~ ~~AND~~ ~~less than or equal to 1 square foot in excess of the limit.~~	B.1 Restore CCHE boundary **to OPERABLE status.**	**24**~~7~~ **hours**~~days~~ ~~NOTE~~ ~~NOTE~~
C. Required Action and associated Completion Time of Condition A or B not met. ~~in MODE 1, 2, 3 or 4.~~	C.1 Be in MODE 3. AND C.2 Be in MODE 5.	6 hours 36 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME	
~~D. Required Action and associated Completion Time of Condition A or B not met during movement of irradiated fuel assemblies.~~	~~-----------NOTE-----------~~ ~~Place in emergency recirculation mode if automatic transfer to emergency recirculation mode is inoperable.~~ ~~---------------------------~~		~~NOTE~~ ~~NOTE~~
	~~D.1 Place OPERABLE CREVS train in emergency recirculation mode.~~ ~~OR~~	~~Immediately~~	~~NOTE~~
	~~D.2 Suspend movement of irradiated fuel assemblies.~~	~~Immediately~~	~~NOTE~~
~~E~~D. Two CREVS trains inoperable **for reasons other than** ~~or breaches exist in the CCHE that exceed~~ Condition B. ~~during MODE 1, 2, 3, or 4.~~	~~E~~D.1 Enter LCO 3.0.3.	Immediately	~~NOTE~~
~~F. Two CREVS trains inoperable or breaches exist in the CCHE that exceed Condition B during movement of irradiated fuel assemblies.~~	~~F.1 Suspend movement of irradiated fuel assemblies.~~	~~Immediately~~	~~NOTE~~

BASES

APPLICABLE SAFETY ANALYSIS

During emergency operations the design basis of the CREVS and the CCHE is to provide radiation protection to the control room operators. The limiting accident which may threaten the habitability of the control room (i.e., accidents resulting in release of airborne radioactivity) is the postulated ~~maximum hypothetical accident (MHA)~~**Control Rod Ejection accident.**~~, which is assumed to occur while in MODE 1.~~ The consequences of this event ~~in MODE 1 envelope the results for MODES 2, 3, and 4, and~~ results~~s~~ in the limiting radiological source term for the control room habitability evaluation (Ref. 2). ~~A fuel handling accident (FHA) may also result in a challenge to control room habitability, and may occur in any MODE. However, due to the severity of the MHA and the MODES in which the postulated MHA can occur, the FHA is the limiting radiological accident in MODES 5 and 6 only.~~ The CREVS and the CCHE ensures that the control room will remain habitable following all postulated design basis events, maintaining exposures to control room operators within the limits of GDC 19 of 10 CFR 50 Appendix A (Ref. 3).

The CREVS is not in the primary success path for any accident analysis. However, the Control Room Emergency Ventilation System meets Criterion 3 of the NRC Policy Statement since long term control room habitability is essential to mitigation of accidents resulting in atmospheric fission product release.

LCO

Two trains of the control room emergency ventilation system are required to be OPERABLE to ensure that at least one is available assuming a single failure disabling the other train. Failure to meet the LCO could result in the control room becoming uninhabitable in the unlikely event of an accident.

The required CREVS trains must be independent to the extent allowed by the design which provides redundant components for the major equipment as discussed in the BACKGROUND section of this bases. OPERABILITY of the CREVS requires the following as a minimum:

a. A Control Complex Emergency Duty Supply Fan is OPERABLE;

(continued)

BASES

LCO (continued)

b. A Control Complex Return Fan is OPERABLE;

c. HEPA filter and charcoal adsorber are not excessively restricting flow, and are capable of performing their filtration functions;

d. Ductwork and dampers are OPERABLE, and air circulation can be maintained; and

e. The CCHE is intact as discussed below.

The CCHE boundary including the integrity of the doors, walls, roof, floors, floor drains, penetration seals, and ventilation isolation dampers must be maintained within the assumptions of the design calculations. Breaches in the CCHE must be controlled to provide assurance that the CCHE remains capable of performing its function.

If the total open breach area in the CCHE exceeds the limit determined in approved design analyses (Reference 2), currently 350~~.5~~ square inches, the CCHE is rendered inoperable and entry into LCO Condition B is required. ~~The upper bound of the breach area for the LCO is the sum of the breach area limit plus one square foot (144 square inches).~~ If the Required Action of LCO Condition B is not met within the respective Completion Time, then Condition C ~~or D, as applicable,~~ must be entered. ~~NOTE~~

The LCO is modified by a Note allowing the CCHE boundary to be opened intermittently under administrative controls. Routine opening and closing of CCHE doors for personnel passage and movement of equipment is accounted for in the design calculations. A continuous leakage of 10 cubic feet per minute is assumed to account for this. Holding or blocking doors open for short periods of time does not constitute a breach of the CCHE as long as the doors could be closed upon notification of a radiological or toxic gas release. The administrative controls for other openings in the CCHE boundary consist of stationing a dedicated individual at the opening who is in continuous communication with the control room. This individual will have a method to rapidly close the opening when a need for control room isolation is indicated.

The ability to maintain temperature in the Control Complex is addressed in Technical Specification 3.7.18.

APPLICABILITY

In MODES 1, 2, 3, and 4, the CREVS must be OPERABLE to ensure that the CCHE will remain habitable during and following a postulated accident. ~~During movement of irradiated fuel assemblies, the CREVS must be OPERABLE to cope with a release due to a fuel handling accident.~~

(continued)

BASES

ACTIONS

A.1

With one CREVS train inoperable, action must be taken to restore the train to OPERABLE status within 7 days. In this Condition, the remaining OPERABLE CREVS train is adequate to perform the radiation protection function for control room personnel. However, the overall reliability is reduced because a failure in the OPERABLE CREVS train could result in loss of CREVS function. The 7 day Completion Time is based on the low probability of an accident occurring during this time period, and ability of the remaining train to provide the required capability.

B.1

With the CCHE inoperable due to breaches in excess of approved design calculations, **the CREVS trains cannot perform their intended functions. Actions must be taken to restore an OPERABLE CCHE boundary within 24 hours.** ~~but within the criteria stated, operation may continue for 7 days.~~ **During the time frame that the CCHE boundary is inoperable, appropriate compensatory measures (consistent with the intent of GDC 19) should be utilized to protect control room operators from potential hazards such as radiation, toxic chemicals and smoke.** Restoration of excess breaches is not limited to returning the opening to its pre-breached condition, but can also be accomplished using temporary sealing measures as described in plant procedures and/or work instructions.

Condition B will permit opening breaches in the CCHE to support maintenance and modification to the habitability envelope boundary. It also will establish an allowance for the discovery of breaches during routine operation, and provide the opportunity to repair the breach in a time frame consistent with the low safety significance of small breaches in the CCHE. **Preplanned measures should be available to address these concerns for intentional and unintentional entry into the condition. The 24 hour completion time is reasonable based on the low probability of a significant release occurring during this time and the use of compensatory measures.** ~~to protect the control room operators from potential hazards such as radiation, toxic chemicals and smoke.~~ ~~NOTE~~

~~Condition B also provides an opportunity, following an unsuccessful CCHE leak rate test, to determine the cause for excessive leakage, correct it, and perform a re-test. Excessive leakage measured during an integrated leak test can be converted to an equivalent breach size in accordance with approved design calculations. If the calculated breach size is less than or equal to 179.5 square inches then operation may continue while locating the source of the leakage and performing a re-test.~~

(continued)

BASES

~~SURVEILLANCE REQUIREMENTS (continued)~~

~~SR 3.7.12.4~~

~~This SR verifies the integrity of the CCHE and the assumed inleakage rates of potentially contaminated air. During the emergency mode of operation, the CCHE is designed to be a closed environment having limited air exchange with its surroundings. Performance of a periodic leak test verifies the continuing integrity of the CCHE. The Frequency of 24 months is consistent with the typical fuel cycle length.~~

~~The design of the CCHE precludes performance of the commonly applied leak test characterized by pressurization to a nominal value and measurement of the make up air required to maintain pressurization. The test for CR-3 is performed by operating CREVS in the emergency recirculation mode with the Auxiliary Building Ventilation System operating to maintain a differential pressure between the CCHE and the Auxiliary Building. The Auxiliary Building will be at least 1/8 inch water gauge negative relative to the CCHE. Tracer gas will be used to determine the leakage rate. The acceptance criteria for the test is a leakage rate that would not result in control room personnel exceeding dose limits described in Reference 3 following the most limiting accident. A detailed description of the conditions for conduct of the test are provided in Reference 2.~~

~~NOTE~~

REFERENCES

1. FSAR, Section 9.7.2.1.g.
2. ~~CR-3 Control Room Habitability Report, dated July 30, 1998~~**FPC Calculation N-00-0006 Revision 1**.
3. 10 CFR 50, Appendix A, GDC 19.
4. Regulatory Guide 1.52, Rev. 2, 1978.

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

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ATTACHMENT D

LICENSE AMENDMENT REQUEST #262, REVISION 1
Alternative Source Term and
Control Room Emergency Ventilation System

Proposed Revised Improved Technical Specifications and Bases
Change Pages

Revision Bar Format

3.7 PLANT SYSTEMS

3.7.12 Control Room Emergency Ventilation System (CREVS)

LCO 3.7.12 Two CREVS trains shall be OPERABLE.

---------------------------NOTE---------------------------
The control complex habitability envelope (CCHE) boundary may be opened intermittently under administrative control.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One CREVS train inoperable.	A.1 Restore CREVS train to OPERABLE status.	7 days
B. Two CREVS trains inoperable due to inoperable CCHE boundary.	B.1 Restore CCHE boundary to OPERABLE status.	24 hours
C. Required Action and associated Completion Time of Condition A or B not met.	C.1 Be in MODE 3. <u>AND</u> C.2 Be in MODE 5.	6 hours 36 hours
D. Two CREVS trains inoperable for reasons other than Condition B.	D.1 Enter LCO 3.0.3.	Immediately

BASES

APPLICABLE SAFETY ANALYSIS

During emergency operations the design basis of the CREVS and the CCHE is to provide radiation protection to the control room operators. The limiting accident which may threaten the habitability of the control room (i.e., accidents resulting in release of airborne radioactivity) is the postulated Control Rod Ejection accident. The consequences of this event result in the limiting radiological source term for the control room habitability evaluation (Ref. 2). The CREVS and the CCHE ensures that the control room will remain habitable following all postulated design basis events, maintaining exposures to control room operators within the limits of GDC 19 of 10 CFR 50 Appendix A (Ref. 3).

The CREVS is not in the primary success path for any accident analysis. However, the Control Room Emergency Ventilation System meets Criterion 3 of the NRC Policy Statement since long term control room habitability is essential to mitigation of accidents resulting in atmospheric fission product release.

LCO

Two trains of the control room emergency ventilation system are required to be OPERABLE to ensure that at least one is available assuming a single failure disabling the other train. Failure to meet the LCO could result in the control room becoming uninhabitable in the unlikely event of an accident.

The required CREVS trains must be independent to the extent allowed by the design which provides redundant components for the major equipment as discussed in the BACKGROUND section of this bases. OPERABILITY of the CREVS requires the following as a minimum:

a. A Control Complex Emergency Duty Supply Fan is OPERABLE;

b. A Control Complex Return Fan is OPERABLE;

c. HEPA filter and charcoal adsorber are not excessively restricting flow, and are capable of performing their filtration functions;

d. Ductwork and dampers are OPERABLE, and air circulation can be maintained; and

(continued)

BASES

LCO (continued)

e. The CCHE is intact as discussed below.

The CCHE boundary including the integrity of the doors, walls, roof, floors, floor drains, penetration seals, and ventilation isolation dampers must be maintained within the assumptions of the design calculations. Breaches in the CCHE must be controlled to provide assurance that the CCHE remains capable of performing its function.

If the total open breach area in the CCHE exceeds the limit determined in approved design analyses (Reference 2), currently 50 square inches, the CCHE is rendered inoperable and entry into LCO Condition B is required. If the Required Action of LCO Condition B is not met within the respective Completion Time, then Condition C must be entered.

The LCO is modified by a Note allowing the CCHE boundary to be opened intermittently under administrative controls. Routine opening and closing of CCHE doors for personnel passage and movement of equipment is accounted for in the design calculations. A continuous leakage of 10 cubic feet per minute is assumed to account for this. Holding or blocking doors open for short periods of time does not constitute a breach of the CCHE as long as the doors could be closed upon notification of a radiological or toxic gas release. The administrative controls for other openings in the CCHE boundary consist of stationing a dedicated individual at the opening who is in continuous communication with the control room. This individual will have a method to rapidly close the opening when a need for control room isolation is indicated.

The ability to maintain temperature in the Control Complex is addressed in Technical Specification 3.7.18.

APPLICABILITY

In MODES 1, 2, 3, and 4, the CREVS must be OPERABLE to ensure that the CCHE will remain habitable during and following a postulated accident.

ACTIONS

A.1

With one CREVS train inoperable, action must be taken to restore the train to OPERABLE status within 7 days. In this Condition, the remaining OPERABLE CREVS train is adequate to perform the radiation protection function for control room personnel. However, the overall reliability is reduced because a failure in the OPERABLE CREVS train could result

(continued)

BASES

ACTIONS (continued)

A.1 (continued)

in loss of CREVS function. The 7 day Completion Time is based on the low probability of an accident occurring during this time period, and ability of the remaining train to provide the required capability.

B.1

With the CCHE inoperable due to breaches in excess of approved design calculations, the CREVS trains cannot perform their intended functions. Actions must be taken to restore an OPERABLE CCHE boundary within 24 hours. During the time frame that the CCHE boundary is inoperable, appropriate compensatory measures (consistent with the intent of GDC 19) should be utilized to protect control room operators from potential hazards such as radiation, toxic chemicals and smoke. Restoration of excess breaches is not limited to returning the opening to its pre-breached condition, but can also be accomplished using temporary sealing measures as described in plant procedures and/or work instructions.

Condition B will permit opening breaches in the CCHE to support maintenance and modification to the habitability envelope boundary. It also will establish an allowance for the discovery of breaches during routine operation, and provide the opportunity to repair the breach in a time frame consistent with the low safety significance of small breaches in the CCHE. Preplanned measures should be available to address these concerns for intentional and unintentional entry into the condition. The 24 hour completion time is reasonable based on the low probability of a significant release occurring during this time and the use of compensatory measures.

C.1 and C.2

In MODE 1, 2, 3, or 4, if the inoperable CREVS train cannot be restored to OPERABLE status, or breaches in the CCHE which exceed allowable limits cannot be closed within the associated Completion Time, the plant must be placed in a MODE in which the LCO does not apply. To achieve this status, the plant must be placed in at least MODE 3 within 6 hours, and in MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems.

D.1

If both CREVS trains are inoperable the CREVS may not be capable of performing the intended function and the plant is in a condition outside the accident analysis. Therefore, LCO 3.0.3 must be entered immediately.

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.7.12.1

Standby systems should be checked periodically to ensure that they function properly. Since the environment and normal operating conditions on this system are not severe, testing each train once every month adequately checks proper function of this system. Systems such as the CR-3 design without heaters need only be operated for ≥ 15 minutes to demonstrate the function of the system. The 31 day Frequency is based on the known reliability of the equipment and the two train redundancy available.

SR 3.7.12.2

This SR verifies that the required CREVS testing is performed in accordance with the Ventilation Filter Testing Program (VFTP). The CREVS filter tests are in accordance with Regulatory Guide 1.52, (Ref. 4) as described in the VFTP Program description (FSAR, Section 9.7.4). The VFTP includes testing HEPA filter performance, charcoal absorber efficiency, minimum system flow rate, and the physical properties of the activated charcoal. Specific test frequencies and additional information are discussed in detail in the VFTP.

SR 3.7.12.3

This SR verifies that each CREVS train actuates to place the control complex into the emergency recirculation mode on an actual or simulated actuation signal. The Frequency of 24 months is consistent with the typical fuel cycle length.

REFERENCES

1. FSAR, Section 9.7.2.1.g.
2. FPC Calculation N-00-0006, Revision 1.
3. 10 CFR 50, Appendix A, GDC 19.
4. Regulatory Guide 1.52, Rev. 2, 1978.

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

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ATTACHMENT E

Calculation Number M97-0137, Revision 4

Considering that the Activity in the TB, A_{TB}, is a function of the χ/Q for the TB, $(\chi/Q)_{TB}$, the activity in the Primary, A_P, the Primary release rate, λ_P, and the flow into the TB, Q_{TB}, the above representation can be revised as follows:

$$A_{inCR} = f\left(A_P \; \lambda_P \; (\chi/Q)_{TB} \; \frac{Q_{TB}}{V_{TB}} \; Q_{CR}\right) \tag{2}$$

For the "secondary containment" model (as shown in Figure 3), the rate of activity entering into the Control Complex is a function of the Activity in the Primary, the primary release rate, the secondary release rate, the χ/Q for the Control Complex, and the flow into the Control Complex. The activity entering the Control Complex in this model is as follows:

$$A_{inCR} = f\left(A_P \; \lambda_P \; (\chi/Q)_{CR} \; \lambda_S \; Q_{CR}\right) \tag{3}$$

Considering that the release rate for the secondary, λ_S, in the above equation is equal to the Turbine Building ventilation rate, Q_{TB}, divided by the TB volume, V_{TB}, the activity in the Control Complex can be expressed as given in equation (2) above. Therefore, the models will yield the same results provided the same χ/Q's are used. Therefore, the treatment of the Turbine Building as a Secondary Containment is technically correct and will yield identical results.

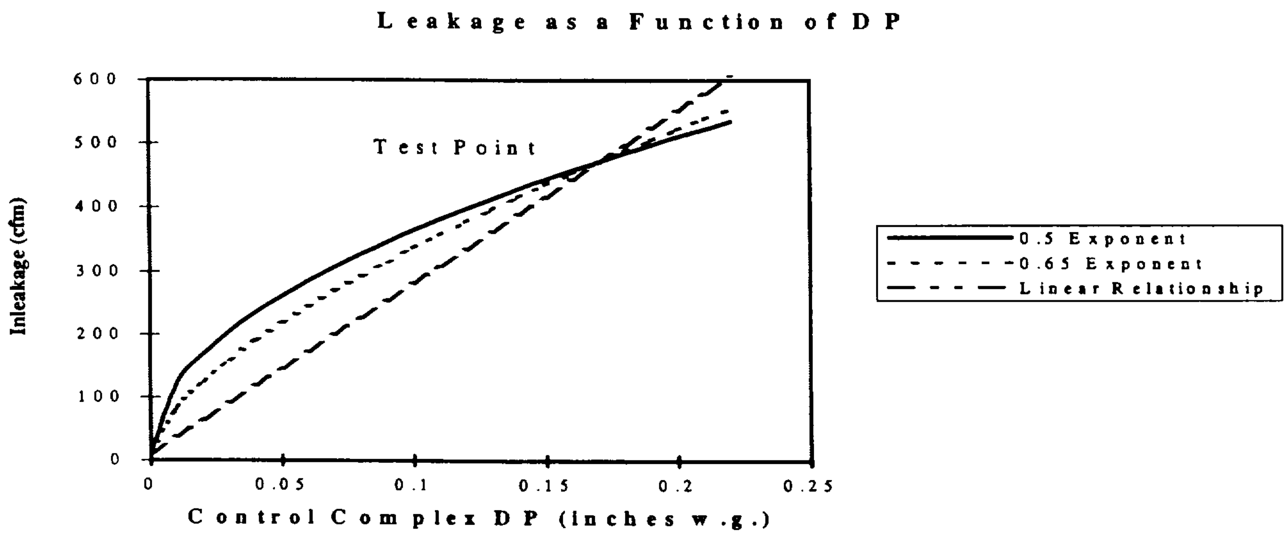
<u>Building Leakage</u>

With the design basis scenario analyzed in Reference 3.1, the leakage into the Control Complex is based on the differential pressure created by the wind speeds that corresponds to the analysis assumptions of the Murphy/Campe paper (Reference 3.10). Specifically, for the first 8 hours the wind speed is very low and increases with time through the duration of the accident, thereby crediting additional dispersion. The equation from reference 3.1 shows the correlation between leakage and differential pressure is as follows:

$$Leakage\ (cfm) = 463(DP / 0.171)^{0.5} + 10$$

This equation was derived from measuring the leakage with a differential pressure of 0.171 inches w.g. between the Auxiliary Building and the Turbine Building (the same mechanism that will cause leakage for the LOCA without LOOP scenario). For the LOCA with LOOP analysis, the above equation was modified to consider the "stack effect" and "<u>local</u> differential pressure effect" at low DPs. These factors do not need to be applied to this analysis since the test was performed at essentially the same conditions as the scenario being analyzed.

The 0.5 exponent was conservatively assigned in the above equation since it overestimates the leakage for differential pressures less than the test pressure. However, for this scenario, the differential pressure will be above the test pressure used to develop the above equation. With the differential pressure above the test pressure, the use of an exponent of 0.5 could be considered non-conservative. Therefore, an exponent of 0.65 will conservatively be used based on the discussions in ASHRAE, which conclude that whole building pressurization test data generally with an exponent between 0.6 and 0.7 (page 23.13 of Reference 3.11). The relationship between leakage and flow exponent is shown on the following graph.



As can be seen from the above curves, a linear assumption would be the most conservative where as a square root function would be the least conservative (only if the actual differential pressure is above the test pressure of 0.171 inches w.g.). The analysis will use an average exponent in the range defined in ASHRAE.

Turbine Building Air Change Rate

This analysis evaluates the impact of on the Control Room operator in the event that the Auxiliary Building exhaust fans are in operation and the Turbine Building ventilation fans are in operation. The Turbine Building has a total of 9 supply fans with a nominal capacity of 50,000 cfm that could be operating during a design basis LOCA. Three of the supply fans are in the middle of the Turbine Building and three fans are at each end of the Turbine Building (i.e., opposite ends). The analysis will consider the impact on the Control Room dose as a function of Turbine-Building air exchange rate. The Turbine Building volume is approximated at 5 million cubic feet and the flow rate of each fan is approximated at 50,000 cfm (as can be seen in the output, the results are not very sensitive to these values, for example. at 30,000,000 cfm exchange vs. 300,000 cfm the, dose is only 14% higher).

Using Cycle 11 Source Terms

At an infiltration rate of 523 cfm, the 30-day thyroid dose for the LOCA without LOOP is calculated in Attachments O at a Turbine Building exchange rate of 300,000 cfm and is follows:

	Contain. Contrib.	ECCS Contrib.	Direct Gamma Dose	Total
300.000 cfm	**Attachment O**	**Attachment N**	Section 5.4	
thyroid	21.1 rem	0.77 rem		21.87 rem
wholebody	0.46 rem	0.004 rem	.067 rem	0.531 rem
beta	13.6 rem	0.12 rem		13.72 rem

5.7 Breach Margin with No Hydrogen Purging

To determine the breach margin, the AXIDENT code was run at various inleakage rates until the total 30-day thyroid dose was determined to be close to 26.5 rem (current calculated limit) and close to 30 rem.

Using TID-14844 Source Terms

Attachment K determines the dose at 734 cfm infiltration and at a Turbine Building exchange rate of 300,000 cfm and is as follows:

300,000 cfm   26.4 rem + 0.68 rem (734/523) = 27.4 rem

Since the dose is linear over this inleakage range, the allowable inleakage to get close to 26.5 is estimated at (26.5/27.4)(734) = 710 cfm

Attachment L determines the dose at 815 cfm infiltration and at a Turbine Building exchange rate of 300,000 cfm and is as follows:

300,000 cfm   29.2 rem + 0.68 rem (815/523) = 30.26 rem

Since the dose is linear over this inleakage range, the allowable inleakage to get close to 29.5 is estimated at (30/30.26)(815) = 808 cfm

The breach margin can be calculated using the methodology in Attachment M. The breach margin in Attachment M was calculated at 0.125 inches w.g. and was divided in two since it was arrived at by using the Murphy/Campe methodology (pressurize the entire area to 0.125 and divide by two). At 0.20 inches w.g., the breach margin (cfm leakage per square inch) is as follows (in Attachment M, the leakage rate at 0.125 inches w.g. is 5.912 cfm):

$$= 5.912\ cfm\left(\frac{0.20}{0.125}\right)^{0.65} = 8.02\ cfm$$

The above equation, however, was modified to based on the assumption that the leakage is a function of an exponent of 0.65.

Therefore, the available breach margin at 26.5 rem = (710 - 523)/8.02 = 23.3 square inches

Therefore, the available breach margin at 30 rem = (808 - 523)/8.02 = 35.5 square inches

Using Cycle 11 Source Terms

Attachment P determines the dose at 717 cfm infiltration and at a Turbine Building exchange rate of 300,000 cfm and is as follows:

300,000 cfm   28.7 rem + 0.77 rem (717/523) = 29.75 rem

Since the dose is linear over this inleakage range, the allowable inleakage to get 30 rem is estimated at (30/29.75)(717) = 723 cfm

The allowable inleakage which results in a dose close to 26.5 is estimated at (26.5/29.75)(717) = 638 cfm

Therefore, the available breach margin at 26.5 rem = (638 - 523)/8.02 = 14.3 square inches

Therefore, the available breach margin at 30 rem = (723 - 523)/8.02 = 24.9 square inches

5.8 Effect of Changing the Spray Removal Factor in the Containment from 20.46 to 20.00

In order to assess the effect of changing the spray removal factor in the containment from 20.46 to 20.00 on the Control Room post-accident doses, the calculation presented in Attachment K was repeated with the new factor. The results did not change up to three significant figures. Therefore, the results presented in previous revisions are considered unchanged with the correction of this factor.

ATTACHMENT M

M-97-0137. Rev. 4

Gilbert Commonwealth Engineers & Consultants
Green Hills Corporate Center, Rt. 10 & Pheasant Rd. Reading, PA 19607

April 25, 1995

FCS-14520
W.O. 04-5525-002
Small Account #00010
Contract N00812AD, WA #002

Mr. W. W. Nisula
Contract Manager
Florida Power Corporation
P. O. Box 14042/C2I
St. Petersburg, Florida 33733

Attention: Mr. J. A. Lese

Re: Crystal River Unit 3
Control Room Habitability - Inleakage

Ref: Small Account Request #2-10

Action By: N/A

Dear Mr. Nisula:

Per your request the following provides details of the derivation of the 2.96 cfm/in^2 value used in the determination of the control room habitability envelope allowable inleakages presented in Attachment 1 to FCS-13509, page 3 of 21.

The value was conservatively developed using equation 3-22 for compressible flow through an orifice from CRANE Technical Paper No. 410, 25th printing-1991.

$$q_m = 412 [Y d^2 C / S_g] [\Delta P \rho]^{½}$$

where

q_m	=	rate of flow in cfm
Y	=	net expansion factor
d	=	diameter in inches
C	=	discharge coefficient
ΔP	=	differential pressure in psi
ρ	=	fluid density in lbs/ft^3
S_g	=	specific gravity relative to air = 1.0

for a 1 square inch opening d^2 is:

$$d^2 = 4 * Area / \pi \text{ or } 1.27324$$

per CRANE for a small pressure ratio:

C = 0.6 (page A-20, square edge orifice)
Y = 1.0 (page A-21)

Gilbert/Commonwealth engineers and consultants
P.O. Box 1498, Reading, PA 19603 • Tel: 610/775-2600 • Fax: 610/775-2670 • Telex 173-229

M97-0137, Rev. 4

per definition ΔP = 1/8 in. w.g. or 0.0045115 psi where the conversion factor of 0.036092 psi/in. w. g. is taken from page B-11 of CRANE.

per page A-10 of CRANE ρ is given as 0.0782 lbs./ft³ where a temperature of 50 °F was conservatively used in FCS-13509 to maximize the inleakage for a given area. The 50 °F value was based on the daily minimum normal temperature listed in Table 2-5 of the CR3 FSAR.

Therefore,

$$q_m = 412\ [1.0 * 1.27324 * 0.6/1.0]\ [0.0045115 * 0.0782]^{1/2}$$

$$= 5.912 \text{ cfm}$$

In accordance with the criteria specified in USNRC Standard Review Plan 6.4 (page 6.4-8), for a zone isolation design with filtered recirculated air the infiltration rate into the control room is equal to one-half of the value calculated when the control room is pressurized to 1/8 inch w.g. Therefore, the above value is further divided by a factor of two resulting in a leakage per square inch area of 2.96 cfm.

Should you have any questions, or would like any additional information, please call.

Very truly yours,

M. M. Waselus
Applied Engineering Analysis

R. E. Vaughn
Project Manager

MMW/REV:mlh

cc: W. W. Nisula
J. A. Lese
FPC Records Management (CL Only)
R. E. Vaughn (2)
P. L. Bunker

ANALYSIS/CALCULATION
DOC ID # I-92-001 ATT # 'F'
REV 1 SHEET 2 OF 2

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50 - 302 / LICENSE NUMBER DPR - 72

ATTACHMENT F

Control Room Emergency Ventilation System Flow Diagrams and Differential Pressure Data

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED: FD-302-753, REV. 38, Sheet 1 of 4: F.D. AIR HANDLING BUILDING SEVICE CONTROL COMPLEX

WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DRAWING NUMBER: FD-302-753, REV. 38, Sheet 1 of 4

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

FD-302-753, REV. 18, Sheet 2 of 4: BUILDING SEVICE FLOW DIAGRAM CONTROL COMPLEX VENTILATION EL. 164'-0" & 145'-0"

WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DRAWING NUMBER: FD-302-753, REV. 18, Sheet 2 of 4

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

FD-302-753, REV. 16, Sheet 3 of 4:
BUILDING SEVICE FLOW DIAGRAM
CONTROL COMPLEX VENTILATION
EL. 134'-0", 124'-0" & 108'-0"

WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DRAWING NUMBER:

FD-302-753, REV. 16, Sheet 3 of 4

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

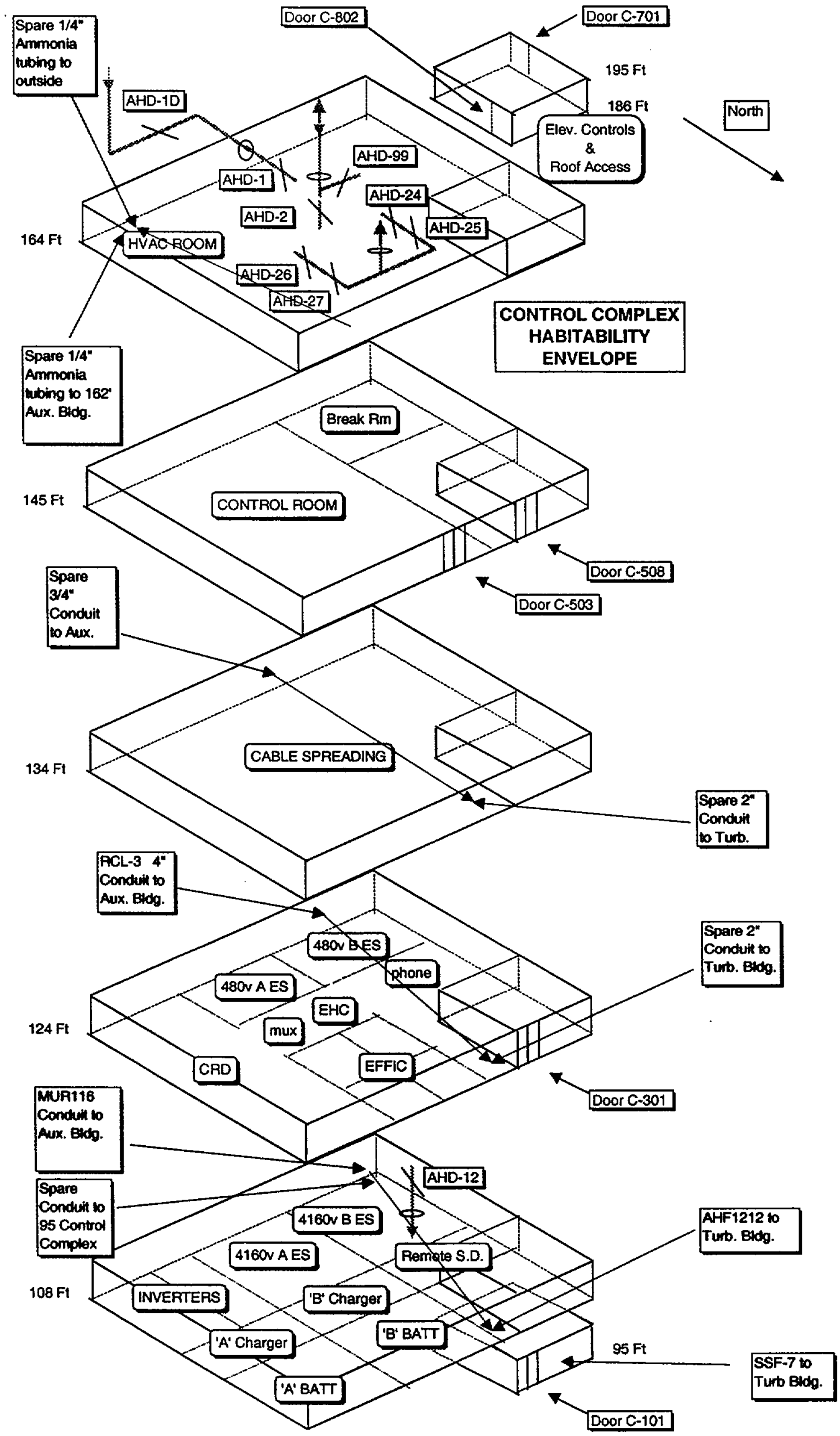
FD-302-753, REV. 16, Sheet 4 of 4: BUILDING SEVICE FLOW DIAGRAM CONTROL COMPLEX VENTILATION EL. 95'-0"

WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DRAWING NUMBER:

FD-302-753, REV. 16, Sheet 4 of 4

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

[1997 Testing]



Tracer Gas Test Differential Pressure Results

1997 Toxic Gas

Elevation	Turbine to Auxiliary Bldg DP
108	0.178
124	0.166
134	0.160
164	0.161
Average	**0.166**

1999 Toxic Gas

Elevation	Turbine to Auxiliary Bldg DP
108	0.165
124	0.140
Average	**0.152**

1997 High Rad

Elevation	Turbine to Auxiliary Bldg DP
108	0.188
124	0.176
134	0.148
164	0.171
Average	**0.171**

1999 High Rad

Elevation	Turbine to Auxiliary Bldg DP
108	0.191
124	0.161
Average	**0.176**

Readings are provided in inches of water gauge

INTEROFFICE CORRESPONDENCE

Florida Power CORPORATION

System Engineering	PA3A	240-3510
OFFICE	MAC	TELEPHONE

9101

SUBJECT: **Maximum Turbine to Auxiliary Building Differential Pressure**

TO: **S. C. Powell**

DATE: **September 23,1999**
SE99-0195

System Engineering has validated the 1997 finding that the maximum Turbine to Auxiliary Building differential pressure for use in the CCHE dose calculations is 0.2" w.c. A discussion of the validation follows.

Background:

The radiological dose calculations for control room habitability were updated in 1997 and 1998. These calculations evaluated a number of different accidents: MHA (Maximum Hypothetical Accident which is a Large Break LOCA with severe core damage) with a LOOP, the MHA without a LOOP, a letdown line rupture with a LOOP, a letdown line rupture without a LOOP, a SGTR, and a FHA. The limiting scenario is the MHA without LOOP. This analysis assumes that the Auxiliary Building (AB) ventilation system responds as-designed to a high radiation signal from RM-A2 and takes the AB to its maximum negative pressure by tripping the supply fans. This produces a differential pressure across the CCHE, from the atmospheric pressure in the Turbine Building to the negative pressure in the Auxiliary Building. The pressure gradient induces the leakage across the CCHE that produces the limiting thyroid dose to the operators. The post-accident leakage rates are calculated by extrapolating the tracer gas leakage rate, at test differential pressure, up to the post RM-A2 trip differential pressures.

The post RM-A2 trip AB pressure is determined primarily by the system flow characteristics (the supply fans simply trip). Theoretically, the position of the make-up damper (AHD-37) could also have a small impact on the post-LOCA Auxiliary Building pressure. AHD-37 is in "auto" both before and after a RM-A2 trip. In the "auto" mode, AHD-37 admits a controlled amount of air into the ducting between the charcoal filters and the exhaust fans. The control system modulates AHD-37 open, should the total flow from the exhaust fans go below its set point. Opening AHD-37 is intended to protect the exhaust fans but could also result in a small increase in AB pressure. As AHD-37 opens, more outside air is admitted to the exhaust fan suctions and AB pressure could become less negative. The most negative building pressure is theoretically created when AHD-37 is shut. In the normal and post RM-A2 trip ventilation line-ups, AHD-37 is in "auto" and may be partially open. AHD-37 is air to close / spring to open design.

Note: The original plant design did control the AB pressure by modulating two inlet dampers (AHD-34 & 35) on the inlet side of the charcoal filters. MAR 90-12-07-01 eliminated this control and locked AHD-34 & 35 fully open in 1991. Since this modification, the AB pressure is established as discussed above.

The Turbine Building pressure will be essentially atmospheric. The Turbine building is a large open building, with a normally open roll-up door, windows, and roof vents.

The best way to determine the post accident differential pressure across the CCHE is to actually place the AB ventilation system into its high radiation response line up and measure the resulting pressure. This test was performed in 1997, and the averaged differential pressure was found to be 0.2" w.c.

<u>1999 Validation:</u>

Methodology:The first part of the validation consisted of a review of the 1997 records to ensure that there were no errors in the test line ups or data transcriptions. The second part of the review consisted of comparing the differential pressures measured in 1997 to those found in 1999 for similar ventilation configurations. This approach provides reasonable assurance that the 1997 maximum differential pressure test produced valid results.

<u>1997 Records Review:</u>

FPC calculation M-97-0137, Rev. 4, Control Room Habitability Analysis Considering a LOCA without LOOP, references letter number NOE97-2610.
NOE97-2610, last paragraph reads:

"...During a simulated trip of RM-A2 the averaged differential pressure across the Control Complex was 0.201" w.c. This information was taken from data taken on 11/3/97 under WR 347634. Pressure data sheets, graphs and completed MP-531 are included in the work package..."

A copy of WR 347634 was obtained from Records Management. Our review found that the MP-531, enclosures 1 and 2, dated 11/3/97 placed the Control Complex into recirculation, secured all three Auxiliary Building Supply fans (AHD-37 was in its normal post RM-A2 trip mode: "auto"), and left at least one of the nine turbine building supply fans running. The differential pressure across the control complex was measured at the 108', 124' and 134' elevations using the same data acquisition system used for the tracer gas test. (The instrumentation at the 164' could not be used due to installation of a loop seal where it penetrated the Turbine Building). The averaged differential pressure reading was 0.201" w.c.

Our review identified one possible non-conservatism with the ventilation configuration used in the 1997 test: It may be possible to slightly pressurize the Turbine Building by running all nine supply fans. The 1997 test did not run all of the Turbine Building supply fans.

This concern was resolved by:
On 9/21/99, the Control Complex was placed into recirculation and one Auxiliary Building Supply fan was secured in preparation for the tracer gas test. All nine of the Turbine Building Supply fans were operating. The data acquisition system was used to collect differential pressure data. All nine of the Turbine Building Supply fans were then secured. The differential pressure data showed no change in the average differential pressures across the control complex. This confirms that the operation of the Turbine Building Supply fans does not affect the differential pressure and the data from the 1997 maximum dP test was not influenced by how many Turbine Building Supply fans were operating.

1997 to 1999 dP Comparisons
The 1997 averaged differential pressures are essentially equal to those measured in 1999 (as discussed below). This is considered excellent repeatability for a tracer gas test on a five story building with a free volume of 364,922 cubic feet.

The maximum dP, and tracer gas inleakage dP, used in the 1998 CCHE dose calculations are an average of the dPs recorded from several instruments over the duration of the test. These values do not include the instrument string uncertainty. This is appropriate for the CCHE dose calculations due to the gross conservatisms already present in the analysis. However, instrument uncertainty should be considered when determining if a change in the biannual measurement is due to "data scatter" or due to some physical phenomena. The string uncertainty is being evaluated under EEI-99-0004, but preliminary information is that it will be around ±0.79% of full scale. The full scale is –0.5" to +0.5" w.c. so the approximate uncertainty becomes ±0.008" w.c. for the differential pressure reading taken across one elevation. The test instrumentation is temporary. The instrumentation was calibrated and installed just prior to the 1997 and 1999 tests. Each instrument string has an uncertainty of ±0.008" w.c. Thus, there could be as much as ±0.016" w.c. difference between the 1997 and 1999 dP measurements just due to instrumentation repeatability.

Comparison of the High Radiation mode tracer gas dP tests:

- The 1997 tracer gas test was conducted with the CREVS "A" train in filtered recirculation, one of the Auxiliary Building supply fans secured with AHD-37 in its normal ("auto") control mode. The averaged differential pressure reading across the CCHE was 0.171" w.c.

- The 1999 tracer gas test was conducted with the CREVS "A" train in filtered recirculation, one of the Auxiliary Building supply fans secured with AHD-37 in the shut position. The averaged differential pressure reading across the CCHE was 0.176" w.c.
- The 1999 test had a 0.005" higher averaged nominal dP than the 1997 test which is less than the ±0.016" w.c. deviation attributed instrument repeatability.

<u>**Comparison of the Toxic Gas mode tracer gas dP tests:**</u>

- The 1997 tracer gas test was conducted with the CREVS "B" train in unfiltered recirculation, one of the Auxiliary Building supply fans secured with AHD-37 in its normal ("auto") control mode. The averaged differential pressure reading across the CCHE was 0.166" w.c.

- The 1999 tracer gas test was conducted with the CREVS "B" train in unfiltered recirculation, one of the Auxiliary Building supply fans secured with AHD-37 in the shut position. The averaged differential pressure reading across the CCHE was 0.152" w.c.

- The 1999 averaged differential pressure was .014" w.c. less than the 1997 test which is less than the ±0.016" w.c. deviation attributed instrument repeatability.

The 1997 averaged differential pressures are essentially equal to those measured in 1999, even though AHD-37 was shut during the 1999 testing. This shows that the 1997 testing was conservative enough to envelope this off-normal condition. However, to better understand this observation, we evaluated AHD-37's impact on the Auxiliary Building's ventilation system, as discussed below.

<u>**AHD-37's Impact on AB Pressure**</u>

When one or more AB supply fans are secured, the AB pressure decreases until the ventilation system reaches a new balance. If AHD-37 is not allowed to modulate (i.e. not in "auto"), then equilibrium is achieved at lowered AB pressure and AB exhaust flow rate. If AHD-37 is in "auto" then equilibrium is achieved at a lowered AB pressure but AHD-37's modulation may keep the AB exhaust flow rate closer to its original value. Examining the changes in total AB exhaust flow, with AHD-37 shut (not modulating), will bound AHD-37's impact on the final AB exhaust flow rate.

During the 1999 tracer gas testing, AHD-37 was in the shut position. REDAS data (computer point W351) shows that the Auxiliary Building's total exhaust flow was about 146,000 to 148,000 cfm in its normal operating condition. Securing one supply fan reduced the total exhaust flow by ≈1,000 cfm. If AHD-37 had been allowed to modulate (as in the 1997 test), then the maximum possible impact on exhaust flow rate would have been about 1,000 cfm out of 147,000 cfm or less than 1% of the total exhaust flow.

On 9/13/99, AHD-37 was in the shut position and all of the supply fans were secured. REDAS data (computer point W351) shows that the Auxiliary Building's total exhaust flow was initially ≈149,000 cfm and decreased about 2,000 cfm due to securing all of the supply fans. If AHD-37 had been allowed to modulate, then the maximum possible impact on exhaust flow rate would have been about 2,000 cfm out of 149,000 cfm or about 1.3% of the total exhaust flow.

Changing AHD-37 from "auto" to shut has a minimal impact on the AB exhaust flow rates attained during tracer gas testing. Thus, the impact on differential pressure is very small and masked by other factors such as instrument repeatability. This explains why the 1997 averaged differential pressures are essentially equal to those measured in 1999, even though AHD-37 was shut during the 1999 testing.

Conclusion:

Our review of the 1997 maximum differential pressure test conducted under WR 347634 finds that it used a valid test technique and the test results were properly transcribed into the calculations. The additional testing performed in 1999 adds further support to the 1997 test results. Therefore, it is concluded that the 1997 maximum differential pressure test produced a valid result that can be used in the CCHE dose calculations.

M. Clary

M. D. Clary, Nuclear Staff Engineer
System Engineering

xc: M. W. Donovan
K. L. Anderson
K. D. Ward
R. A. Crandall
R. L. Muzzi
[Records Management]

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302 / LICENSE NUMBER DPR - 72

ATTACHMENT G

List of Regulatory Commitments

List of Regulatory Commitments

The following table identifies those actions committed to by Florida Power Corporation (FPC) in this document. Any other actions discussed in the submittal represent intended or planned actions by FPC. They are described to the NRC for the NRC's information and are not regulatory commitments. Please notify the Supervisor, Licensing and Regulatory Programs of any questions regarding this document or any associated regulatory commitments.

Commitment	Due Date
CR-3 commits to using the applicable assumptions of Regulatory Guide 1.183, Rev. 0 or acceptable alternatives thereto in future revisions to the design basis public and control room dose assessments.	Following NRC approval of LAR #262.
FPC commits to apply NRC approved guidance for habitability envelope integrity monitoring and verification at CR-3, including proposal of ITS changes if appropriate.	Following NRC approval of guidance on habitability envelope integrity monitoring and verification.

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302 / LICENSE NUMBER DPR - 72

APPENDIX A

Revised CR-3 Control Room Habitability Report
(Appendix A of LAR #262, Revision 0)

Control Room

Habitability Report

Florida Power Corporation

Crystal River – Unit 3

June 2001

Control Room Habitability Report
Florida Power Corporation
Crystal River 3

Table of Contents

I. Introduction and Summary

The Crystal River, Unit 3 (CR-3) Operating License contains a requirement to maintain control room habitability as specified in the post-Three Mile Island (TMI) requirements of NUREG-0737. Control Room Habitability analyses were performed during the 1980's to demonstrate compliance with NUREG-0737. System Readiness Reviews conducted in 1997 identified several issues that potentially impacted control room habitability. The primary issue identified was the inability of the Control Complex Habitability Envelope (CCHE) to maintain unfiltered inleakage to a value less than assumed in the 1980's Control Room Habitability analyses.

A number of modifications were made in 1997 to significantly improve the level of protection provided for the control room operator. For example, redundant bubble-tight dampers were installed in system connections that penetrate the boundary of the Control Complex. A more detailed discussion of all the improvements can be found in the 1998 version of the Control Room Habitability Report (submitted in letter 3F0798-15). After the modifications were completed, a 1997 tracer gas test was performed to determine the inleakage rate.

The unfiltered inleakage rate still exceeded the design basis value. The February 1998 startup was allowed with a JCO in effect. The JCO included compensatory actions, such as the maintenance of KI tablets for distribution to control room operators. The control room operator dose calculations were revised in 1998 to align inputs and assumptions with plant design and measured inleakage rates. Additionally, the control room dose was calculated for a number of accidents other than the LOCA. These other accidents included the Steam Generator Tube Rupture (SGTR), Letdown Line Rupture and Fuel Handling Accident. The LOCA remained the bounding accident.

Based on these revised habitability analyses, License Amendment Request #222 was submitted on July 30, 1998 (FPC Letter 3F0798-15). The 1998 version of the Control Room Habitability Report was attached to the LAR submittal. On August 23, 1999 (NRC Letter 3N0899-13), the NRC issued License Amendment 185 related to control room habitability. A number of the revised Technical Specification sections were approved for only one operating cycle (Cycle 12). Additionally, the NRC noted in its SER, that although the Technical Specification changes were approved, the Control Room Habitability Report was still under review. The NRC specified that the compensatory actions specified in the JCO must remain in place.

On October 28, 1999 (FPC Letter 3F1099-18), FPC withdrew the request for the NRC to review the 1998 Control Room Habitability Report. FPC noted that a subsequent LAR was anticipated to replace the ITS changes that were approved for one cycle. It was expected that this subsequent LAR would include a revised Control Room Habitability Report based on analyses using the Alternative Source Term.

A September 2000 version of the Control Room Habitability Report updated the report to present the results of the revised control room habitability analyses performed using the Alternative Source Term (10CFR50.67 and Regulatory Guide 1.183). That version was submitted with License Amendment Request 262 on October 3, 2000 (Ref. 16).

In May 2001, FPC received a Request For Additional Information from the NRC regarding LAR 262. Based on the NRC comments, some modifications were made to the Alternative Source Term analyses. This June 2001 version of the Control Room Habitability Report incorporates those changes and will be submitted to the NRC with the responses to the RAI for LAR 262.

Upon NRC approval of the License Amendment Request, anticipated by the end of Cycle 12, the JCO will be closed.

This report will be a living document and will be referenced in the UFSAR. If any changes are made to the plant design or procedures that affect the assumptions or evaluations in this report, the report will be revised. Since this report will be referenced in the UFSAR, any changes to this report will require an evaluation per 10CFR50.59, unless revised as part of a License Amendment Request. .

II. Control Room Emergency Ventilation System Description

A simplified schematic of the CREVS is provided as Figure 1. The CREVS consists of two independent safety-related air recirculation trains that, in addition to the cooling capability, have the ability to divert 100% of the recirculation flow through an Emergency Filter Unit. Each Emergency Filter Unit contains, in the direction of flow, a roughing filter, a HEPA filter, 2-inch activated carbon filter bank, and a safety-related recirculation booster fan. The Emergency Filter Units do not include means to lower the humidity of the air as it enters the adsorber bank, such as electric heating coils. Heaters are not required since the system only operates in a recirculation mode. The emergency recirculation fans are powered by separate safety-related power sources. The CREVS processes and filters air from the top five levels of the control complex.

Upon detection of either high reactor building pressure or high radiation in normal Control Room ventilation ductwork, as detected by RMA-5, the redundant, bubble-tight boundary isolation dampers are automatically closed. The operation of the emergency fans and filters are manually initiated by the operator. The calculations conservatively assume 30 minutes for the time of manual initiation of the filters.

The redundant, bubble-tight boundary isolation dampers are also automatically closed as a result of a Loss of Offsite Power (LOOP). The operation of the CREVS during a LOOP is manually initiated by the operators. Although the diesel loading would allow starting of the CREVS well before 30 minutes, the operation of the CREVS is conservatively not credited for 30 minutes.

The CREVS provides environmental control for personnel comfort and equipment operation and protection of control room personnel during radiological and toxic gas events. It provides habitability via zone isolation with filtered recirculation. The control complex is not pressurized to limit inleakage. Leak tightness and filtration capability provide the necessary level of protection for the control room operator to ensure that exposure limits associated with DBAs and toxic gas events are not exceeded.

III. Control Complex Habitability Envelope (CCHE)

III.1 General Description

The CCHE is the physical barrier that separates the control room environment from the external environment. The integrity of the CCHE barriers (walls, doors, ceilings, floors, sealed penetrations, ventilation penetrations, etc.) directly affects the inleakage of radiation sources associated with Design Basis Accidents (DBAs).

The Control Complex is a six floor building located between the auxiliary building and the turbine building as shown in Figure 2. The CCHE is the top five floors of the Control Complex. The lower floor is isolated from the CCHE under accident conditions. The top floor of the CCHE contains the control complex ventilation equipment, thus it is all internal to the CCHE. The control room is one floor below the ventilation equipment room. The CCHE, along with CREVS are designed to protect the operator in case of a radiological or toxic gas release.

As is noted in the diagram in Figure 2, the only open surfaces to the environment are the upper levels of the east and west walls, which have no penetrations, and the roof. The north wall adjoins the turbine building and has a number of penetrations through the CCHE and the south wall adjoins the auxiliary building and contains a number of penetrations. Thus, the CCHE is not subject to significant inleakage due to wind induced effects. This is due both to the fact that it is fairly well surrounded by higher structures which should minimize wind loading and because the open surfaces contain a limited number of penetrations. Most inleakage would be expected to occur from penetrations in the turbine building wall due to negative pressure in the auxiliary building providing a motive force for flow from the turbine building through the CCHE and the into the auxiliary building. Inleakage rates are discussed below.

III.2 CCHE Inleakage Rates

The infiltration of unfiltered air into a control room boundary results from three paths: (1) through the zone boundary; (2) through the system components located outside of the emergency zone; and (3) through backflow at the zone boundary doors as a result of personnel access or egress.

With respect to component leakage, all of the CREVS components and ductwork at CR-3 are contained within the CCHE boundary and as such do not contribute as an inleakage source. With respect to backflow through the zone boundary doors, it has been assumed that an additional 10 scfm of infiltration is induced by the opening and closing of doors, as recommended by SRP 6.4. The inleakage through the zone boundary has been determined by testing.

Following the 1997 improvements to the CCHE boundary, the boundary performance was measured using tracer gas tests. The tests were performed by engineers from FPC and Lagus Applied Technology. The tracer gas test procedure was based on ASTM Standard E741-93, "Standard Test Method for Determining Air Change Rate in a Single Zone by Means of a Tracer Gas Dilution." The tests were accomplished using an electronegative gas, sulfur hexafluoride (SF_6), as a tracer. Although not prescribed by regulatory guidance, application of tracer gas technology is recognized as a means to accurately measure building inleakage. By using tracer gas test methods, it is possible to measure inleakage under conditions which are representative of a specific postulated scenario. The 1997 test results gave a measured leak rate of 443 ± 20 cfm at a differential pressure across the CCHE of 0.171" water gauge.

The results of the 1997 tracer gas inleakage test measurements were used in the 1998 control room habitability dose calculations. Different inleakage rates were used for different dose calculations depending on the assumed ventilation alignments, wind speeds and potential differential pressure across the CCHE. The maximum differential pressure across the CCHE occurs when there is no Loss of Offsite Power. In this case, the Auxiliary Building Exhaust fans would remain on and the supply fans would trip on high radiation. This results in a negative pressure in the Auxiliary Building and hence a higher differential pressure across the CCHE of 0.2" water gauge. The measured results were extrapolated up to this higher differential pressure, resulting in a maximum potential inleakage rate of 513 cfm. The 10 cfm assumed inleakage from ingress/egress was added, giving a total maximum inleakage of 523 cfm. The value of 523 cfm was used in the applicable dose calculations. For the dose calculations for scenarios that involved a Loss of Offsite Power, lower inleakage rates were used based on extrapolation of the measured results to pressure differentials across the CCHE based on meteorological conditions.

Approximately 2 years later, in 1999, a subsequent CCHE tracer gas inleakage test was performed. The same methods as noted above were used. The test results were essentially identical. The 1999 measured leak rate was 450 ± 13 cfm at a differential pressure across the CCHE of 0.176" water gauge. This extrapolates to a leak rate at the maximum expected pressure differential of 0.2" water gauge of 503 cfm. Adding the 10 cfm from ingress/egress gives a maximum leak rate of 513 cfm. Revised dose calculations were unnecessary as the measured rates were within the assumed rates.

The Alternative Source Term dose calculations performed in 2000 for the proposed license amendment request used an unfiltered inleakage rate assumption of 1000 cfm under all conditions (the assumed 10 cfm for ingress/egress is included in this 1000 cfm). This value was chosen to provide sufficient margin above the measured inleakage rate. The value is approximately 2 times the expected inleakage rate under the worst possible pressure differential conditions. It would provide even greater margin under other conditions, such as Loss of Offsite Power scenarios, where the pressure differential across the CCHE is less.

The use of 1000 cfm as the assumed inleakage rate provides part of the justification for the license amendment request to eliminate the requirement for subsequent tracer gas inleakage measurements. The deletion of this requirement is based on:

- 1000 cfm is twice the maximum expected leak rate based on previous tracer gas tests. This provides significant margin for CCHE boundary degradation before the dose calculation assumptions would be challenged.
- The 1999 test results were essentially equal to the 1997 results, thus demonstrating that the CCHE boundary is not degrading to any significant degree with time.
- The most likely sites for CCHE inleakage and boundary degradation (dampers and door seals) will continue to be inspected and maintained in good condition.

IV. Technical Specification Requirements

Improved Technical Specifications (ITS) Sections 3.7.12 and 5.6.2.12 specify operability and surveillance requirements for CREVS and the CCHE. Currently CREVS and the CCHE must be operable during Modes 1-4 and during movement of irradiated fuel assemblies. The proposed LAR will delete the operability requirement during movement of irradiated fuel based on the revised assessment of the Fuel Handling accident.

The Surveillance Requirements to demonstrate CREVS operability, include the following criteria:

- operating each CREVS train for at least 15 minutes each month
- satisfying the CREVS ventilation filter testing program

- verifying that each CREVS train actuates to the emergency recirculation mode on an actual or simulated actuation signal every 24 months.

The second criterion refers to the requirements of the ventilation filter test program defined in ITS Section 5.6.2.12. ITS Section 5.6.2.12 defines requirements pertaining to the Ventilation Filter Testing Program at CR-3 and requires that the CREVS filtration units meet minimum performance standards regarding penetration, bypass, and adsorption. The Alternative Source Term dose calculations are also being used to justify a reduction in the ITS specified adsorption efficiency of the CREVS charcoal filters.

Section 5.6.2.12 also contains requirements for the Auxiliary Building Exhaust filters. The Auxiliary Building filters were taken credit for in the 1998 control room dose assessments. The Alternative Source Term dose calculations take no credit for the Auxiliary Building filters for the dose to either the public or the control room. Therefore, the license amendment is requesting removal of the AB filter test requirements from the ITS.

Section 3.7.12 contains requirements related to the CCHE. One requirement specifies that the CCHE be declared inoperable if breaches in the boundary exceed predetermined limits. The license amendment request is requesting some modifications to the specific wording related to breaches. A surveillance requirement also specifies that an integrated CCHE leak test be performed once per 24 months. The use of a high inleakage rate assumption in the dose calculations, combined with the consistent results from the two tests already completed, is being used to justify the elimination of this test requirement.

V. Radiological Evaluations

In the 1998 Control Room Habitability Report, details were included on the assumptions and results for the control room dose assessments performed for the LOCA, the SGTR, the LLR and the FHA. In 1998, only the control room doses were being reanalyzed. For this 2000 license amendment request, CR3 is submitting a full implementation of the Alternative Source Term rule, 10CFR50.67. Therefore, dose analyses are required for not only the control room, but also for the public for each applicable FSAR Chapter 14 accident.

Appendices B through M were included in the license amendment request package to fully describe the radiological evaluation input assumptions and results for each applicable accident. The NRC developed RADTRAD code was used to perform the control room radiological evaluations. The detailed inputs to RADTRAD are provided. Since RADTRAD calculates both the public dose and the control room dose as part of the same computer run, the inputs provided in Appendices B through M also apply to this control room habitability section. The information is not repeated here. (The control room dose assessment information will be incorporated into the controlled, living version of this Control Room Habitability Report maintained at Crystal River Unit 3). The control room dose was calculated for the LOCA, SGTR, LLR, FHA and Control Rod Ejection Accident. Note that the Control Rod Ejection has been added to the list of accidents evaluated for control room dose.

Based on the NRC May 2001 Request for Additional Information, the LOCA and Control Rod Ejection Accidents were reanalyzed in June 2001.

The results of these radiological analyses are as follows:

Control Room TEDE –

- LOCA – 2.30 REM
- SGTR – (pre-accident spike) – 1.19 REM
- SGTR – (post-accident spike) – 0.365 REM
- FHA – 4.43 REM – Note – takes no credit for CCHE or CREVS
- LLR – (LOOP, pre-accident spike) – 0.895 REM
- LLR – (LOOP, post-accident spike) – 0.06 REM
- LLR – (no LOOP, pre-accident spike) – 3.24 REM
- LLR – (no LOOP, post-accident spike) – 0.339 REM
- CREA – (Containment release) – 0.75 REM
- CREA – (Secondary side release) – 3.49 REM

All results are within the 5 REM TEDE criteria specified in 10CFR50.67. Note that the dose from a fuel handling accident is within the 5 REM limit taking no credit for the CCHE boundary, nor CREVS recirculation. Normal ventilation, with an unfiltered intake of 5700 cfm is assumed to continue for the course of the accident. Therefore, operability of CCHE and CREVS is unnecessary for moving irradiated fuel.

Also, none of the above analyses take credit for isolation of the normal ventilation based on a high radiation signal from the control complex ventilation radiation monitor (RMA-5). This provides justification for removal of the radiation monitor requirements of RMA-5 from the ITS. The monitor and its auto-isolation function will remain in service for defense in depth.

The Control Room Habitability analyses summarized in License Amendment Request 262, including the response to the Request for Additional Information, will supersede the analyses contained in previous submittals upon NRC approval.

The analyses consider the concept of "breach margin." The breach margin is the area that can be opened in the CCHE envelope and still result in 30-day post accident doses within the limits. The breaches are controlled and logged to ensure that the integrity of the CCHE is maintained within the limits through normal operation. The bounding analysis (CRE-secondary side pathway) calculates an allowable breach area of 50 in^2 in addition to that area that would result in 1000 cfm inleakage.

VI. Hazardous Chemical Evaluation

CCHE integrity is also required to provide protection to the control room operator in the event of a toxic gas accident. Regulatory Guide 1.78 provides information and assumptions for assessing toxic gas accidents with regard to control room habitability. From this document comes the basic criteria that, in the event of a toxic gas accident, appropriate toxicity limits not be exceeded in the control room two minutes after initial detection in order to allow the operator adequate time to take action (i.e., don an air pack) prior to being overcome. The Regulatory Guide allows for detection to be accomplished by personal means (nasal detection) or with automatic detection equipment. CREVS isolation, if required, can be attained either by operator action or by an automatic signal from toxic gas detectors. At CR-3, procedures provide the appropriate instructions for the operator in the event of a toxic gas accident and for the use of air packs.

Based on previous evaluations, the locations and quantities of toxic gas storage sites at the Crystal River site that posed a potential liability to CR-3 control room habitability are listed below:

Toxic Gas container Size and Location

Toxic Gas	Helper Cooling Towers	CR-1/CR-2	CR-4/ CR-5
Chlorine -- Cl_2	17 tons	none	1 ton cylinders
Sulfur Dioxide --SO_2	50 tons	45 tons	1 ton cylinders

The most limiting source of toxic gas was an SO_2 tank at CR-1, which had been administratively limited to storage of 30 tons. Automatic detection and isolation was required as a result of that tank. That tank has been replaced with a system that uses solid pellets, which are converted to SO_2 as needed. The tank has been emptied of its contents and will no longer be used. As such, it is no longer the limiting source.

The next most limiting toxic gas source is the Helper Cooling Towers. Currently, there is no SO_2 or Cl_2 stored at this location. If chemicals were stored at this location, administrative controls are in place to limit the Helper Cooling Towers to 3 tons of Cl_2 and 17 tons of SO_2. FPC has used revised calculations to evaluate the lower quantities: 3 tons of Cl_2 and 17 tons of SO_2. This analysis concludes that CREVS could remain in its normal alignment (i.e., no CCHE isolation required) without exceeding Control Room toxicity limits within 2 minutes of nasal detection.

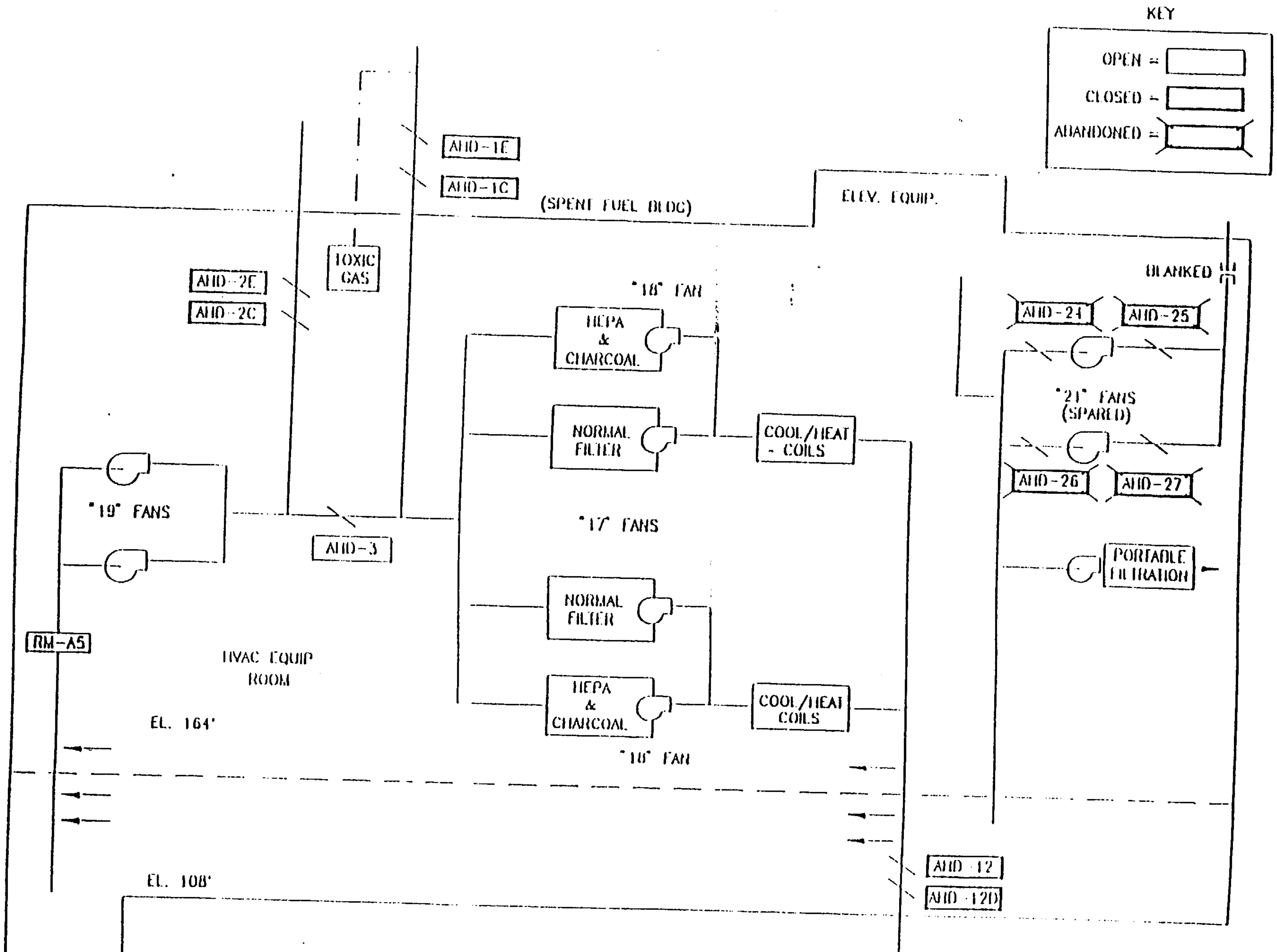
In May 2001, all potentially significant sources of gaseous Cl_2 and SO_2 were removed from CR Units 4/5. CR Units 4/5 now have a system that uses sodium hypochlorite and sodium bisulfite. This also eliminated any frequent transport of toxic chemicals to the site.

Based on the removal of all significant sources of toxic gas, and the administrative controls on the quantity allowed at the Helper Cooling Towers, the CR3 control room SO_2 detectors and their auto-isolation functions have been removed and the chlorine detectors and their isolation functions are in the process of being removed.

References

1. FPC Calculation No. M97-0109 R/1 (SL-9929-M-0008 R/1), Toxic Gas Analysis
2. FPC Calculation No. N-00-0001 – Public and Control Room Dose from a Fuel Handling Accident Using the Alternative Source Term
3. FPC Calculation No. N-00-0002, Rev. 1 – Public and Control Room Dose from a LOCA Using the Alternative Source Term
4. FPC Calculation No. N-00-0003 – Public and Control Room Dose from a Letdown Line Rupture Using the Alternative Source Term
5. FPC Calculation No. N-00-0004 – Public and Control Room Dose from a Steam Generator Tube Rupture Using the Alternative Source Term
6. FPC Calculation No. N-00-0006, Rev. 1 – Public and Control Room Dose from a Control Rod Ejection Accident Using the Alternative Source Term
7. Deleted
8. Regulatory Guide 1.183 – Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors, July 2000
9. Code of Federal Regulations 10CFR50.67
10. FPC Letter 3F0798-15, License Amendment Request #222, Revision 1 – Control Room Emergency Ventilation System and Ventilation Filter Test Program, July 30, 1998
11. NRC Letter 3N0899-13, Crystal River Unit 3 – Issuance of Amendment Regarding Control Room Emergency Ventilation System and Ventilation Filter Testing Program, August 23, 1999
12. FPC Letter 3F1099-18, Withdrawal of Request for Review of the Crystal River Unit 3 Control Room Habitability Report, October 28, 1999
13. FPC letter 3F0198-26, dated 01/14/98 Fm M.W. Rencheck (FPC) To NRC Doc. Control Desk
14. NRC Letter 3N0298-04, Crystal River Nuclear Generating Plant Unit 3 - Control Complex Habitability Envelope Justification for Continued Operation – Interim Assessment Results, February 3, 1998
15. Condition Resolution Report/Justification for Continued Operation 97-4355, Revision 7
16. FPC Letter 3F1000-08, dated October 3, 2000, License Amendment Request #262, Rev. 0, Alternative Source Term and Control Room Emergency Ventilation System

Figure 1



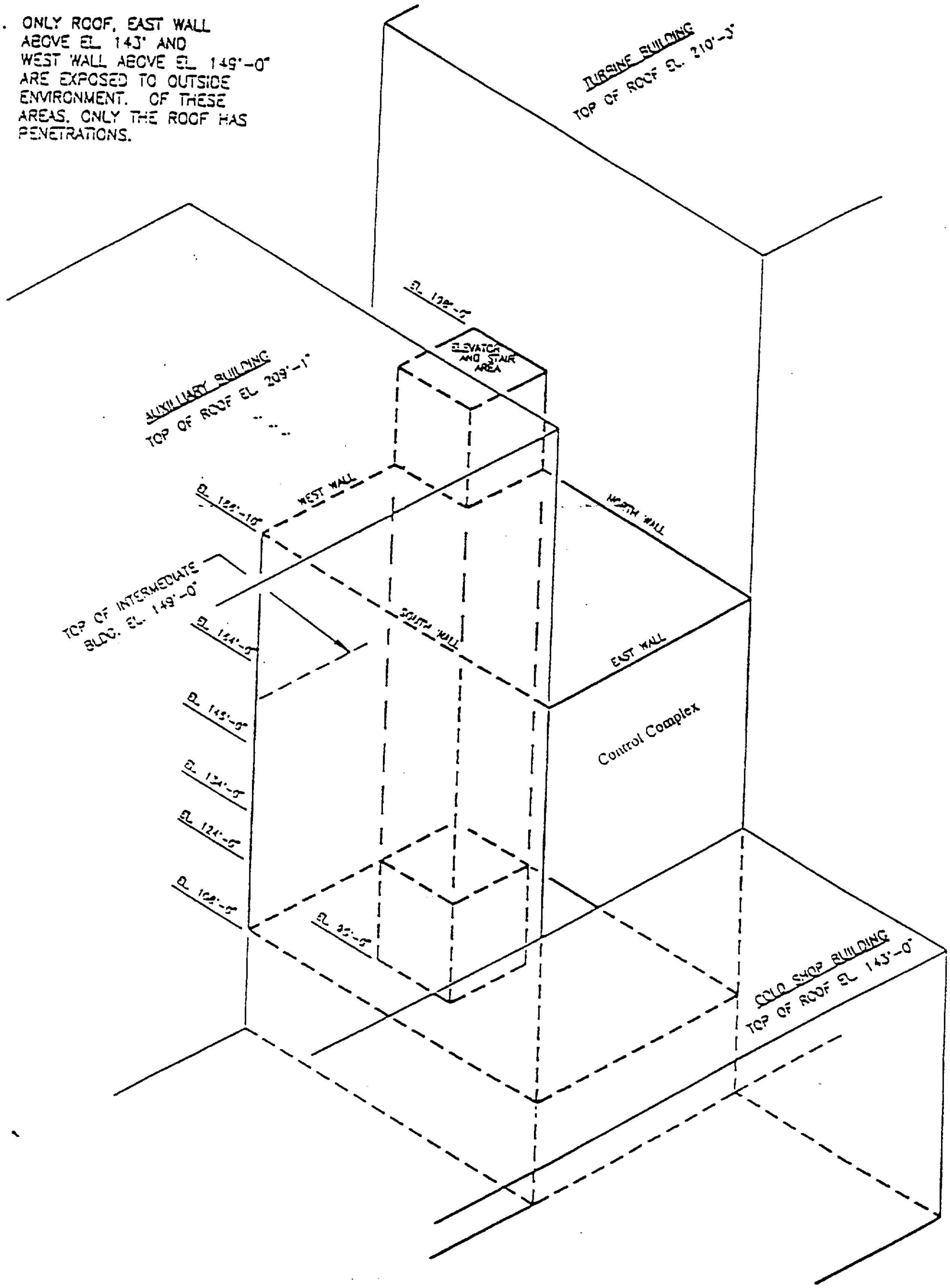
CONTROL COMPLEX VENTILATION SYSTEM
POST-MARs 97-07-05-01/02
SHOWN IN THE RECIRCULATION LINE-UP

Control Room Habitability Report
Florida Power Corporation
Crystal River 3

Figure 2

NOTES:

1. ONLY ROOF, EAST WALL ABOVE EL. 143' AND WEST WALL ABOVE EL. 149'-0" ARE EXPOSED TO OUTSIDE ENVIRONMENT. OF THESE AREAS, ONLY THE ROOF HAS PENETRATIONS.



FLORIDA POWER CORPORATION

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APPENDIX B

Revised Summary of Radiological Analyses
For FSAR Chapter 14 Accidents
(Appendix B of LAR #262, Revision 0)

Summary of Radiological Analyses for FSAR Chapter 14 Accidents

Each of the Design Basis Accidents in Chapter 14 that had a quantified calculation of the dose consequences was recalculated using the Alternative Source Term where applicable. All dose results are expressed in terms of TEDE for comparison with the limits of 10CFR50.67. Unless noted, the accident consequences were calculated to both the Control Room Operator and the public at the Exclusion Area Boundary (EAB) and the Low Population Zone (LPZ). The primary method used for these analyses was the NRC developed code, RADTRAD, Version 3.02.

The following is a summary of the scenario, analysis and results for each of the accidents. The detailed inputs to the calculation and their bases are provided in a format consistent with the order in which they are entered into the RADTRAD input files. This input information is provided as individual Appendices in this submittal.

1. Main Steam Line Break – FSAR Section 14.2.2.1

   Scenario – For the purpose of radiological analysis, this accident is assumed to involve the rupture of a main steam line outside containment, but upstream of the MSIV's. The release consists of complete loss of the secondary coolant plus additional feedwater from the affected generator, secondary coolant from the unaffected generator, and a continuing primary to secondary leak in the affected generator of 1 gpm for 85 hours. The reactor coolant activity is based on steady state operation with 1% degraded fuel cladding. No spiking is assumed. This concentration is higher than allowed by Technical Specifications. There is no calculated fuel damage as a result of the accident.

   Analysis - There are no changes to the plant design or procedures associated with this license amendment request that would affect the current dose assessment. There are no aspects of the source term specified in Regulatory Guide 1.183 that would affect the existing dose calculation, as there is no fuel damage associated with this accident. The only aspect of the current Chapter 14 analysis affected by 10CFR50.67 and CR-3's intent to apply a Full Application of the Alternative Source term is the requirement to express the dose results of the existing calculation in terms of TEDE. This is required to demonstrate compliance with the limits of 10CFR50.67. Therefore, a new RADTRAD analysis for this accident was not required. A calculation was performed using the dose conversion factors in RADTRAD to convert the current dose results to TEDE results. Appendix C provides the inputs used in the current analysis and the conversion to TEDE results.

   Results:

   EAB TEDE = 0.0047 REM (0-2 hr is worst 2 hr period)
   LPZ TEDE = 0.0031 REM

The releases for this accident are significantly less than for a Steam Generator Tube Rupture (SGTR). Therefore, a control room dose assessment was not performed for this accident, as it would be bounded by the SGTR.

2. Steam Generator Tube Rupture – FSAR Section 14.2.2.2

Scenarios - There are two scenarios analyzed for the SGTR. They are the licensing basis analysis for public dose and the informational Standard Review Plan analysis performed for control room habitability.

The licensing basis scenario for public dose assumes no single failure and no Loss of Offsite Power (LOOP). Without a LOOP, the condenser remains available and iodine releases are significantly reduced. No iodine spike cases are analyzed. Significant conservatism is applied to the assumed release from the primary side, as discussed below.

In response to a request for additional information from the NRC related to control room habitability, in 1998, CR-3 analyzed the control room dose for a SGTR scenario consistent with the guidelines of the Standard Review Plan (Iodine spiking, LOOP, single failure).

The assumed licensing basis scenario is:

T=0 – Tube rupture. The primary to secondary break flow is conservatively calculated to be 60.5 lbm/sec (includes an existing 1 gpm primary to secondary leak) and is assumed to continue for the entire 8 hours of the event.

T= 8 min – the reactor trips. Until this time, all releases are via the condenser. With the reactor/turbine trip, a fraction of the steam is released via the atmospheric dumps and main steam safeties. The fraction of steam that is released directly to atmosphere from 8 minutes to 9 minutes is 0.55.

T= 9 minutes – steam flow is such that the dumps and safeties are closed. All releases for the remainder of the accident are via the condenser. The assumed reduction of iodine in the condenser is a factor of 10,000. In regard to noble gas releases, the release path doesn't matter. All noble gases released from the primary side are assumed to be instantaneously released to the environment.

T= 8 hours – the plant has been cooled to the point where both steam generators are isolated and heat removal is via the Decay Heat system. This terminates the release.

The reactor coolant activity for the licensing basis scenario is based on steady state operation with 1% degraded fuel cladding. No spiking is assumed. This concentration is higher than allowed by Technical Specifications. Releases of secondary side activity are not included in the calculation due to their insignificance compared to the primary side releases.

The control room dose SRP-like analysis considers a LOOP, the most-limiting single failure, and both a pre-existing iodine spike at the maximum value allowed in the Technical Specification (60 μCi/gm dose equivalent I-131) and an iodine spike 500 times the equilibrium release rate coincident with the operation value of 1 μCi/gm dose equivalent I-131. Credit is taken for some non-safety-related components, specifically, the analysis credits the use of the ADVs for cooldown, and the use of the PORV for depressurization.

The sequence of events for the SRP-like SGTR analysis, including control room assumptions, is as follows:
T = 0 - Tube Rupture
T = 8 min. - Rx trip, LOOP, loss of condenser, isolation of CCHE with LOOP
T = 38 min. - CR ventilation on recirculation 30 min. after LOOP
T = 53 min. - Operators initiate cooldown with ADV's – ADV fails on unaffected generator
T = 55 min. - Initiate RCS depressurization with PORV's
T = 78 min. - Manually open failed ADV
T = 108 min. - Isolate affected OTSG
T = 8 hrs - Terminate release from unaffected generator

The analysis conservatively considered a LOOP coincident with the reactor trip. The limiting single failure is the failure of the Atmospheric Dump Valve (ADV) on the unaffected steam generator to automatically open in response to the post-trip pressure control signal. This forces the operator to cool down using the affected generator's ADV until the unaffected steam generator's ADV can be opened. This results in an extended cooldown time and hence time until the affected generator can be isolated.

Analysis - For the Chapter 14 licensing basis assessment, there are no changes to the plant design or procedures associated with the planned Alternative Source Term license amendment request that would affect the current dose assessment. There are no aspects of the source term specified in Reg. Guide 1.183 that would affect the existing dose calculation, as there is no fuel damage associated with this accident. The only aspect of the current Chapter 14 analysis affected by 10CFR50.67 and CR-3's intent to apply a Full Application of the Alternative Source term is the requirement to express the dose results of the existing calculation in terms of TEDE dose. This is required to demonstrate compliance with the limits of 10CFR50.67. A calculation was performed using the dose conversion factors in RADTRAD to convert the current dose results to TEDE results. Appendix D provides the inputs used in the current analysis and the conversion to TEDE results.

For the SRP-like SGTR analysis of control room dose, there are changes associated with the proposed license amendment that will affect the calculation of control room dose. Therefore, a reanalysis of the control room dose using RADTRAD has been performed. For informational purposes, the public dose results will also be presented for the SRP-like scenario. Appendix E presents the RADTRAD inputs and their bases.

Results:

Chapter 14 Design Basis Assumptions
EAB TEDE – 0.139 REM (0-2 hr is worst 2 hour period)
LPZ TEDE – 0.0455 REM

SRP Assumptions
EAB TEDE -Pre-accident spike – 5.98 REM
EAB TEDE -Post-accident spike – 2.40 REM
LPZ TEDE - Pre-accident spike – 0.523 REM
LPZ TEDE - Post-accident spike – 0.210 REM
Control Room TEDE -Pre-accident spike – 1.19 REM
Control Room TEDE -Post-accident spike – 0.365 REM

3. Fuel Handling Accident – FSAR Section 14.2.2.3

Scenario - The gap activity is conservatively assumed to be released from all fuel pins in one fuel assembly. The gap fractions from Regulatory Guide 1.183 are used. A reduction factor for iodine is applied for removal by the water in the reactor cavity or spent fuel pool. No credit is taken for either building isolation or release pathway filters. As such, the calculation of a FHA in the spent fuel pool area will be exactly the same as for an accident in the Reactor Building. Hence, only one calculation is performed. All the activity is conservatively assumed to be released within the first few minutes. The control complex is assumed to be in the normal ventilation mode. No credit is taken for automatic isolation by the control room ventilation radiation monitor (RM-A5) or for manual isolation by the operator. No credit is taken for control complex recirculation filters. If the radiation monitor or operator did isolate the control complex and place the ventilation in filtered recirculation, the doses would be less than the results of this calculation.

Analysis – The doses were calculated using RADTRAD. Appendix F presents the RADTRAD inputs and their bases.

Results:

EAB TEDE (0-2 hr is worst 2 hour period) - 0.83 REM
LPZ TEDE - 0.073 REM
Control Room TEDE - 4.43 REM

4. Control Rod Ejection Accident – FSAR Section 14.2.2.4.

Scenario - There are two cases analyzed for the Control Rod Ejection (CRE). The first case assumes that all the activity released from the failed fuel is released directly to the containment and then leaks from the containment to the environment. The second case assumes that all the activity released from the fuel is dispersed in the reactor coolant and then is released to the environment via primary to secondary leakage.

Thermal hydraulic calculations determined that 14% of the fuel is assumed to experience clad damage (FTI 51-1172602-00). (This was very conservatively determined by assuming that any core area experiencing DNB resulted in clad damage). No fuel was calculated to experience fuel melt. Gap activity is assumed to be released from this 14% of the fuel. The gap activity is taken from Reg. Guide 1.183, Appendix H as 10% of the iodines and noble gases. Since less than 100% of the core is affected, the activity is multiplied by the maximum allowed radial peaking factor of 1.8. Normal coolant activity is insignificant compared to the activity from the 14% of the fuel that fails and hence the normal coolant activity is not included in the calculation.

For the first case, all the activity released from the fuel is instantaneously dispersed to the containment. There is no credit taken for removal by sprays. No immediate plateout is assumed. The only removal mechanisms assumed are natural deposition for the aerosol iodine and decay for all nuclides. The containment is assumed to leak at the Technical Specification leak rate limit for 24 hours and at one half that limit for the remaining 29 days.

For the second case, all the activity released from the fuel is instantaneously dispersed in the reactor coolant. The reactor coolant is assumed to leak at 150 gpd in each steam generator (300 gpd total). All activity released to the secondary side is assumed to be immediately released to the environment. It is assumed that there is a loss of offsite power and hence the condenser is not available. There is no credit assumed for any partitioning factor or removal of iodine or other nuclides in the secondary side. It is also conservatively assumed that the plant continues to cool down by steaming through the steam generators for 72 hours prior to going on the Decay Heat System.

Analysis – The doses were calculated using RADTRAD. Appendix G, Rev. 1 presents the RADTRAD inputs and their bases for the containment release scenario. Appendix H, Rev. 1 presents the RADTRAD inputs and their bases for the secondary side release scenario.

Results:

Containment Release
- EAB TEDE – 1.03 REM (0-2hr is worst 2 hours)
- LPZ TEDE – 0.288 REM
- Control Room TEDE – 0.754 REM

Secondary Side Release
- EAB TEDE – 2.10 REM (0-2hr is worst 2 hours)
- LPZ TEDE – 0.819 REM
- Control Room TEDE – 3.49 REM

Additionally, the CRE, secondary side release, is the bounding dose for CCHE/CREVS operability. Therefore, the margin between the CRE dose and the 10CFR50.67 limit of 5 REM TEDE will be used to establish the new breach margin for the CCHE.

Controlled breaches are allowed to be opened in the Control Complex Habitability Envelope to a size that would ensure that the dose remains within the 5 REM TEDE acceptance criterion. The margin to this acceptance criterion based on the results below is 5.0 – 3.49 = 1.51 REM.

RADTRAD runs were made varying the control complex inleakage until a total dose of 5 REM was achieved. These calculations determined that an additional 400 cfm from controlled breaches would be acceptable. Calculation M-97-0137, Rev. 4 presented information on the inleakage rate as a function of breach size. Page 23 of that calculation concludes that at the maximum delta p expected across the CCHE boundary (0.2 " w.g.), there is 8.02 cfm of inleakage per in^2 of opening.

Therefore, the 400 cfm allowed breach inleakage corresponds to a breach size of: 400/8.02 = 50 in^2.

5. LOCA – FSAR Section 14.2.2.5

Scenario/Analysis - There are a number of different contributors to the LOCA dose assessment. They are:

- The dose from leakage of recirculated ECCS water. This source is considered for both the public and control room operator. Appendix I presents the input assumptions for this analysis. The calculations are performed using the NRC Code RADTRAD.
- The dose from leakage of containment atmosphere. This source is considered for both the public and control room operator. Appendix J presents the input assumptions for this analysis. The calculations are performed using the NRC Code RADTRAD.
- The dose from an assumed containment purge at 14 days into the accident for hydrogen control. This source is considered for both the public and control room operator. Appendix K presents the input assumptions for this analysis. The calculations are performed using the NRC Code RADTRAD
- Direct doses from containment shine, charcoal filters in the Control Complex and the plume outside the control room. These direct doses are considered in the control room dose analysis and are discussed below.

The control room dose from sources outside the control room will all be direct gamma dose and hence will be a Deep Dose Equivalent (DDE). Therefore, the calculated dose can be added directly to the TEDE from activity inside the control room to get a total TEDE.

The dose due to the plume outside the control room was calculated in M-97-0110, Rev 4 to be 0.01 REM. Based on the reduced magnitude and delayed timing of the AST compared to the TID-14844 source term, the plume dose rate will be less for the AST. Assumptions such as the containment leak rate have not been changed that would affect this conclusion. It is therefore conservative to assume that the direct dose in the control room from the plume shine from outside the control room is the same as calculated in M-97-0110, or 0.01 REM.

The dose from containment shine was calculated in M-97-0110 to be 0.03 REM. Since the plume whole body dose from containment leakage is directly related to the containment airborne concentration, the above logic is also applicable to this source. The TID contribution from containment shine will be greater than the AST contribution. Therefore, it is conservative to use the dose of 0.03 REM as calculated in M-97-0110 for this AST analysis.

The dose from the control complex charcoal filters was calculated in M-97-0110 to be 0.026 REM. In this case, a number of changes have been made to assumptions that affect the amount of iodines and particulates taken into the control complex (e.g.- control complex inleakage rate). The changes are such that the integrated activity taken into the control complex is greater for the AST analysis. Therefore, it is not conservative to use the dose from M-97-0110. An approximate measure of the integrated activity in the control complex over 30 days, and hence eventually on the control complex filters, can be determined by evaluating the 30 day thyroid dose. For the TID analysis in M-97-0110, the 30 day operator thyroid dose is approximately 19 REM. For the AST analysis, the thyroid dose is approximately 47.4 REM, or approximately 2.5 times greater. Other factors, such as the effects of other particulates besides iodine can also have an effect. However, the calculation of direct dose from the filters in M-97-0110 is very conservative as it only used a concrete thickness of 1 foot between the filters on the 164' level of the control complex and the control room on the 145' level. The actual shielding thickness is a minimum of 2 feet of concrete. This extra foot of concrete would reduce the dose by at least a factor of 10. This factor of 10 would more than compensate for the effects of other nuclides or other minor differences. Therefore, the direct dose from the filters for the AST case will conservatively be estimated as 2.5 x 0.026 REM = 0.07 REM.

Results:

EAB TEDE – 7.59 REM (0.8 to 2.8 hrs is worst 2 hour period)
LPZ TEDE = 1.07 REM
Control Room TEDE = 2.30 REM

6. Letdown Line Rupture – FSAR Section 14.2.2.6

Scenario - At time zero, the letdown line outside containment is postulated to break releasing primary coolant in the Auxiliary Building. For the first six minutes, control room personnel try to keep the reactor at full power. During this time period, the control room is still assumed to be in normal makeup, with 5700 cfm of outside air. No credit is taken for the automatic radiation monitor isolation. No credit is taken for the Auxiliary Building filters in reducing the release to the environment.

At approximately six minutes, the reactor trips. At this time, there are two scenarios analyzed. The first assumes that with the reactor trip, simultaneously, there is a Loss Of Offsite Power (LOOP). As a result of the LOOP, control room ventilation trips resulting in no makeup or recirculation of the air within the control room. Because there is a LOOP, the Auxiliary Building Ventilation System loses power, however, this does not factor into the dose scenarios as no credit had been assumed for the Auxiliary Building filters. At this time, unfiltered inleakage into the control room begins.

The second scenario assumes that with the reactor trip at approximately 6 minutes, there is no simultaneous LOOP. Therefore, the control room ventilation continues to operate with a normal makeup of 5700 cfm. The Auxiliary Building ventilation would continue to operate, however, this does not factor into the dose scenarios as no credit had been assumed for the Auxiliary Building filters.

The accident continues with these conditions until 19.5 minutes. At this time, control room personnel recognize and isolate the letdown line break ending the release.

For the scenario with the LOOP, it was assumed that the control room recirculation filters are started 30 minutes after the LOOP; therefore, at 36 minutes into the accident, the control room filtered recirculation is started. From this time, all conditions remain the same until the end of the dose calculation scenario (30 days). For the scenario without the LOOP, the control room is assumed to operate in the normal ventilation mode (5700 cfm intake, no recirculation filters) until the end of the dose calculation period (30 days).

The release rate calculations evaluated two scenarios in accordance with Standard Review Plan 15.6.2. The two scenarios are the accident initiated spike and the pre-accident spike cases. Therefore, there are a total of four scenarios:

Case 1 – LOOP / Pre-accident spike
Case 2 – LOOP / Post-accident spike
Case 3 – No LOOP / Pre-accident spike
Case 4 – No LOOP / Post-accident spike

The activity release rate into the auxiliary building was calculated by FTI and presented in FTI Document 86-1266335-00, "CR-3 Letdown Line Break SRP Activities." The activity release rates are based on the following:

- The thermal hydraulic calculations of M-96-0043 for the break flow rates.
- For the post-accident spike case - an equilibrium reactor coolant concentration of noble gases and iodines corresponding to the Technical Specification limit of 1 μCi/gm Dose Equivalent I-131, followed by a spike factor of 500 in the steady state iodine release rate from the fuel.
- For the pre-accident spike case – a reactor coolant iodine concentration corresponding to the Technical Specification short-term concentration limit of 60

μCi/gm Dose Equivalent I-131 and a noble gas concentration corresponding to the 1 μCi/gm Dose Equivalent I-131 limit.

- An assumed carryover fraction from the RCS liquid to the Auxiliary Building atmosphere of 100% of the noble gases and 10% of the iodines.

Analysis – The analysis was performed with RADTRAD. Appendix L presents the input assumptions and their bases.

Results:

EAB TEDE (0-2 hr is worst 2 hour period)
Pre-accident spike – 0.614 REM
Post-accident spike – 0.078 REM

LPZ TEDE
Pre-accident spike – 0.054 REM
Post-accident spike – 0.0068 REM

Control Room TEDE – LOOP – CR Isolation/Filtration
Pre-accident spike – 0.895 REM
Post-accident spike – 0.060 REM

Control Room TEDE – no LOOP – no CR Isolation/Filtration
Pre-accident spike – 3.24 REM
Post-accident spike – 0.339 REM

7. Waste Gas Decay Tank Rupture – FSAR Section 14.2.2.8

Scenario - The entire contents of all three waste gas decay tanks is assumed to be released. Each tank is assumed to be at its maximum allowed activity as specified in the Offsite Dose Calculation Manual. This is a very conservative assumption, as the activity in two tanks would have significantly decayed while the third tank was being filled. Additionally, the tanks are isolated from each other and it is only credible to fail one tank. The activity released from the tanks is assumed to be released to the environment instantaneously. There is no credit for mitigation features such as filters.

Analysis – The dose to the public was analyzed using RADTRAD. The input assumptions and their bases are provided in Appendix M. The releases from this accident are small compared to other accidents, so the control room dose is not analyzed.

Results:

EAB TEDE – 0.125 REM (0-2 hr is worst 2 hr period)
LPZ TEDE – 0.011 REM

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APPENDIX C

**Revised Control Rod Ejection Accident
Containment Release RADTRAD Inputs
(Appendix G of LAR #262, Revision 0)**

RADTRAD Inputs for the Control Rod Ejection Accident Containment Releases

A. Compartments

1. Containment –This run is calculating the dose from the assumed releases into the containment. A separate run is made for releases via the secondary side.

    a. Compartment type – Other – since it is not the environment or control room.
    b. Volume – 2.0 E6 ft^3 – This is the free air volume of the containment per calculation M-98-0010, Rev. 0
    c. Source term fraction – 1 – The fraction of core inventory released into the containment will be accounted for in the release fraction table. Therefore, this value is 1 as this run assumes all activity is released to the containment.
    d. Compartment features – Natural Deposition is selected. No credit for sprays is taken in the CRE, as the spray activation setpoint may not be reached. Credit can be taken for natural deposition per Reg. Guide 1.183, Appendix H.
    e. Natural Deposition Panel – "Powers Containment" option is selected. In Appendix A of Reg. Guide 1.183, it states that the Power's model (NUREG/CR-6189) is an acceptable model for deposition.
    f. Powers Aerosol Panel – The 10% uncertainty model is chosen. This is the most conservative choice and hence would be acceptable. PWR design basis accident is also chosen.
    g. Elemental iodine panel – no credit is taken for elemental iodine deposition – conservative assumption. Therefore, all values are 0.

2. Environment

    a. Compartment type – Environment - This defeats all other input parameters.

3. Control Room

    a. Compartment type – Control Room
    b. Volume - 3.649E+05 ft^3 – Note that this is the volume of the Control Complex Habitability Envelope (i.e. – all levels of the Control Complex except the 95' level). This value must be used as this is the volume into which any activity input will be dispersed and the volume that is processed by the recirculation filters. However, since the control room is a subset of this volume, use of this volume will underestimate the finite cloud correction factor for noble gas submersion. This could be adjusted by hand in the calculation, however, for this analysis the TEDE contribution from the noble gas submersion is so small that no adjustment was made.
    c. Compartment Features – Recirculating Filters is turned on.

d. Recirculating Filters – Forced flow rate – 3.78E+04 cfm – this is the lower end of the acceptance criteria for the filter system flow testing in the Technical Specifications.
e. Recirculating Filters – Filter efficiencies
Time 0 – all filter efficiencies are 0% as emergency recirculation through filters is not automatically initiated.
Time = 0.5 hours – filter efficiency for iodine chemical forms is assumed to be 95% for aerosols and 90% for elemental and organic iodine. These are the values justified per the revised test acceptance criteria in the License Amendment Request. The operator is assumed to manually lineup the emergency filters at 30 minutes. These efficiencies apply until the end of the accident at 30 days.

B. Transfer Pathways

1. Leak to environment

a. From Compartment 1 – Containment
b. To Compartment 2 – Environment
c. Transfer mechanism – "Air Leakage" selected – Although containment leakage may be filtered, it can not be assured, hence all leakage is assumed to be unfiltered air leakage. The air leakage panel allows input in terms of %/day, consistent with the units for the Containment leak rate limit.
d. Air Leakage Panel – The leak rate is 0.25%/day for 0 to 24 hours and one-half of that, or 0.125%/day for 24 to 720 hours. The 0.25%/day is the ITS limit. The value is reduced by one-half at 24 hours per Reg. Guide 1.183.
e. Active Pathway – Yes

2. Unfiltered inflow

a. From Compartment 2 – Environment
b. To Compartment 3 – Control Room
c. Transfer mechanism – Filter is selected – Although the inleakage will not be filtered, filter is selected for ease of input. The filter panel allows rates to be input as cfm. The air leakage panel requires input in percent per day. Since the CR3 inleakage rates are in cfm, the filter panel is easier to use. The filter efficiencies will be set to zero to account for the fact that the inleakage will be unfiltered.
d. Filter Efficiency Panel – Flow Rate – 1000 cfm – this is the assumed inleakage rate for the entire course of the accident – based on being approximately 2 times the worst case tracer gas measurement results. The control complex would isolate on RB isolation prior to plume arrival. Therefore, the only intake will be the assumed inleakage. The use of 1000 cfm will be justified in the proposed license amendment request.
e. Filter efficiencies – 0% - as noted above this is unfiltered inleakage.
f. Active Pathway - Yes

3. Exhaust

   a. From Compartment 3 – Control Room
   b. To Compartment 2 – Environment
   c. Transfer mechanism – Filter is selected – Although the exhaust will not be filtered, filter is selected for ease of input. The filter panel allows rates to be input as cfm. The air leakage panel requires input in percent per day. Since the CR3 inleakage rates are in cfm, the filter panel is easier to use. The exhaust rate will be assumed to be equal to the inleakage rate. The filter efficiencies will be set to zero to account for the fact that the exhaust will be unfiltered.
   d. Filter Efficiency Panel – Flow Rate – 1000 cfm – this is the assumed inleakage rate for the entire course of the accident – based on tracer gas measurements. The exhaust rate is assumed equal to the intake rate.
   e. Filter efficiencies – 0% - as noted above this is unfiltered exhaust.
   f. Active Pathway – Yes

C. Dose Locations

1. Exclusion Area Boundary

   a. In Compartment 2 – Environment
   b. Breathing Rate Default – not checked
   c. X/Q – 1.60E-04 sec/m^3 – this is the 0-2 hr accident X/Q for CR3. (NUS-1753) This value is entered from time 0 to the end of the accident. There is no point in reducing the value with time as only the maximum 2 hour dose will be used. The value is left at the 0-2hr X/Q value to ensure the maximum release period occurs with the maximum X/Q.
   d. Breathing Rate – 3.47E-04 m^3/sec – this is the Reg. Guide specified breathing rate for the public (Reg. Guide 1.4). This value is entered from time 0 to the end of the accident. There is no point in reducing the value with time as only the maximum 2 hour dose will be used. The value is left at the 0-2hr breathing rate value to ensure the maximum release period occurs with the maximum breathing rate.

2. Low Population Zone

   a. In Compartment 2 – Environment
   b. Breathing Rate Default – not checked
   c. X/Q – 1.40E-05 sec/m^3 for the period 0 to 8 hours, 1.50E-06 sec/m^3 for the period 8 hours to 24 hours, 7.7E-07 sec/m^3 for the period 24 hours to 96 hours and 4.5E-07 sec/m^3 for the period 96 hours to 30 days. These are the LPZ accident X/Q's for CR3 (NUS-1753).
   d. Breathing Rate – 3.47E-04 m^3/sec for the period 0 to 8 hours, 1.75E-04 m^3/sec for the period 8 hours to 24 hours and 2.32E-04 m^3/sec for the period 24 hours

to 30 days– these are the Reg. Guide specified breathing rates (Reg. Guide 1.4).

3. Control Room

   a. In Compartment 3 – Control Room
   b. Breathing Rate Default – not checked
   c. X/Q – 9.0E-04 sec/m^3 for the 0-8 hr time period, 5.31E-04 sec/m^3 for the 8 to 24 hour period, 3.38E-04 sec/m^3 for the 24-96 hour period, and 1.49E-04 sec/m^3 for the 96-720 hour period. These are the accident X/Q's for the CR3 control complex from Letter 3F0588-10. They are not adjusted for occupancy time as the occupancy times will be entered separately.
   d. Breathing Rate – 3.47E-04 m^3/sec – this is the Reg. Guide specified breathing rate. This value is entered from time 0 to the end of the accident.
   e. Occupancy Factor – 1.0 for the first 24 hours, 0.6 for the subsequent 72 hours and then 0.4 for the remainder of the accident. These are the standard values from Murphy and Campe.

D. Source Term

1. Nuclide Inventory

   a. Default PWR is checked.
   b. Plant Power – 2619 MWt – this is the potential licensed power plus 2% for instrument uncertainty.
   c. NIF file – this is automatically entered as PWR_def.nif by the code when Default PWR is selected. It is not edited.
   d. Decay and No Daughter products is selected. This matches standard methods.
   e. Iodine Chemical Fractions – AST is selected. This automatically enters values of 0.95 for aerosol, 0.0485 for elemental, and 0.0015 for organic. They are not edited as this is consistent with the mix specified in Regulatory Guide 1.183.

2. Release Fractions and Timing

   a. User RFT file is selected. The file to be selected is crer1_def.rft. This file has the following values:
   Duration = 0.1E-05 hrs. Unlike the delayed source term for a LOCA, the clad damage in this case is due to the reactivity excursion with the rod ejection. Therefore, all the activity is assumed to be released instantaneously. The value of 0.1E-05 is a nominal value to ensure all activity is released to the containment within 1 second.
   Fraction of noble gases and iodines released during first time interval = 0.252E-01. This value is based on:
   0.14 is the fraction of fuel assumed to experience clad damage (Reference 11)
   0.10 is the assumed fraction of core inventory in the gap for the noble gases and iodines per Appendix H of Reg. Guide 1.183. The combined fraction is

0.014. This value is multiplied by 1.8, the licensed maximum radial peaking factor (Ref. 17). Reg. Guide 1.183 (Section 3.1) specifies the use of a radial peaking factor if only a fraction of the core experienced fuel damage. This is very conservatively used in this case, as the value of 1.8 is the maximum for any one fuel pin and is applied to all 14% of the fuel pins assumed to fail in this calculation. The resulting fraction is 0.014 x 1.8 = 0.0252.
All other values in the rft file are 0 as there are no additional releases over time and no other nuclides assumed to be in the gap. There is no calculated fuel melt for this event at CR-3.

b. Delay(hours) – 0. Release will occur at the time of rod ejection.
c. Decay and No Daughter products – automatically set the same as the previous panel
d. Iodine chemical fractions - automatically set the same as the previous panel

3. Dose Conversion Factors

   a. MACSS 60 (FGR 11& 12) is selected. This automatically selects the file to be used as fgr11&12.inp. This is the default dose factor file to be used with the AST source term.
   b. Decay and No Daughter products – automatically set the same as the previous panel
   c. Iodine chemical fractions - automatically set the same as the previous panel

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APPENDIX D

Revised Control Rod Ejection Accident
Secondary Side Release RADTRAD Inputs
(Appendix H of LAR #262, Revision 0)

RADTRAD Inputs
for the
Control Rod Ejection Accident
Secondary Side Releases

A. Compartments

1. Reactor coolant –This run is calculating the dose from the assumed releases into the reactor coolant and then to the secondary side via primary to secondary leakage. A separate run is made for releases via primary containment leakage. The first compartment selected is the Reactor Coolant as that is where the activity released from the fuel is dispersed. There is no compartment required for the secondary side as the calculation conservatively assumes that all activity released from the primary side to the secondary side is immediately released to the environment, with no removal mechanisms.

    a. Compartment type – Other – since it is not the environment or control room.
    b. Volume – 8162 ft^3 – This is the reactor coolant cold volume per FTI Document 86-1266341-00. The cold volume is used since the samples for primary to secondary leakage determination are cold water samples.
    c. Source term fraction – 1 – The fraction of core inventory released into the reactor coolant will be accounted for in the release fraction table. Therefore, this value is 1 as this run assumes all activity is released to the coolant.
    d. Compartment features – None selected. There are no removal mechanisms assumed in either the primary or secondary sides.

2. Environment

    a. Compartment type – Environment - This defeats all other input parameters.

3. Control Room

    a. Compartment type – Control Room
    b. Volume - 3.649E+05 ft^3 – Note that this is the volume of the Control Complex Habitability Envelope (i.e. – all levels of the Control Complex except the 95' level). This value must be used as this is the volume into which any activity input will be dispersed and the volume that is processed by the recirculation filters. However, since the control room is a subset of this volume, use of this volume will underestimate the finite cloud correction factor for noble gas submersion. This could be adjusted by hand in the calculation, however, for this analysis the TEDE contribution from the noble gas submersion is so small that no adjustment was made.
    c. Compartment Features – Recirculating Filters is turned on.

d. Recirculating Filters – Forced flow rate – 3.78E+04 cfm – this is the lower end of the acceptance criteria for the filter system flow testing in the Technical Specifications.
e. Recirculating Filters – Filter efficiencies
Time 0 – all filter efficiencies are 0% as emergency recirculation through filters is not automatically initiated.
Time = 0.5 hours – filter efficiency for iodine chemical forms is assumed to be 95% for aerosols and 90% for elemental and organic iodine. These are the values justified per the revised test acceptance criteria in the License Amendment Request. The operator is assumed to manually lineup the emergency filters at 30 minutes. These efficiencies apply until the end of the accident at 30 days.

B. Transfer Pathways

1. Leak to environment

a. From Compartment 1 – Reactor Coolant
b. To Compartment 2 – Environment
c. Transfer mechanism – "Air Leakage" selected – although this is water and not air, the input units are %/day and hence the medium is not important.
d. Air Leakage Panel – The leak rate is 0.5%/day for the first 72 hours. The rate is then changed to 0 for the remainder of the accident. This value is based on the following:
The Technical Specification limit for primary to secondary leakage is 150 gpd. Since there are 2 steam generators, there could be a total of 300 gpd. The total RCS cold volume is:
8162 ft^3 x 7.48 gal/ft^3 = 61,000 gal
The percentage of the RCS cold volume represented by 300 gpd is:
(300 gpd/61000g) x 100% = 0.5%/day
The time period of 72 hours is based on FPC Calculation F-97-0010. This calculation determined that the time required to cooldown using natural circulation to where switchover to the Decay Heat system can occur was 57 hours. The results were conservatively increased to 72 hours, which is the acceptance criteria for reaching cold shutdown for an Appendix R, natural circulation cooldown.
e. Active Pathway – Yes

2. Unfiltered inflow

a. From Compartment 2 – Environment
b. To Compartment 3 – Control Room
c. Transfer mechanism – Filter is selected – Although the inleakage will not be filtered, filter is selected for ease of input. The filter panel allows rates to be input as cfm. The air leakage panel requires input in percent per day. Since the CR3 inleakage rates are in cfm, the filter panel is easier to use. The filter

efficiencies will be set to zero to account for the fact that the inleakage will be unfiltered.

d. Filter Efficiency Panel – Flow Rate – 1000 cfm – this is the assumed inleakage rate for the entire course of the accident – based on being approximately 2 times the worst case tracer gas measurement results. The control complex would isolate on the loss of offsite power prior to arrival of any plume with significant activity (prior to the LOOP the condenser would be available and the iodine releases would be insignificant). Therefore, the LOOP is assumed to occur at T=0 to maximize releases. Therefore, the only intake will be the assumed inleakage. The use of 1000 cfm will be justified in the proposed license amendment request.
e. Filter efficiencies – 0% - as noted above this is unfiltered inleakage.
f. Active Pathway - Yes

3. Exhaust

a. From Compartment 3 – Control Room
b. To Compartment 2 – Environment
c. Transfer mechanism – Filter is selected – Although the exhaust will not be filtered, filter is selected for ease of input. The filter panel allows rates to be input as cfm. The air leakage panel requires input in percent per day. Since the CR3 inleakage rates are in cfm, the filter panel is easier to use. The exhaust rate will be assumed to be equal to the inleakage rate. The filter efficiencies will be set to zero to account for the fact that the exhaust will be unfiltered.
d. Filter Efficiency Panel – Flow Rate – 1000 cfm – this is the assumed inleakage rate for the entire course of the accident – based on tracer gas measurements. The exhaust rate is assumed equal to the intake rate.
e. Filter efficiencies – 0% - as noted above this is unfiltered exhaust.
f. Active Pathway – Yes

C. Dose Locations

1. Exclusion Area Boundary

a. In Compartment 2 – Environment
b. Breathing Rate Default – not checked
c. X/Q – 1.60E-04 sec/m^3 – this is the 0-2 hr accident X/Q for CR3. (NUS-1753) This value is entered from time 0 to the end of the accident. There is no point in reducing the value with time as only the maximum 2 hour dose will be used. The value is left at the 0-2hr X/Q value to ensure the maximum release period occurs with the maximum X/Q.
d. Breathing Rate – 3.47E-04 m^3/sec – this is the Reg. Guide specified breathing rate for the public (Reg. Guide 1.4). This value is entered from time 0 to the end of the accident. There is no point in reducing the value with time as only the maximum 2 hour dose will be used. The value is left at the 0-2hr breathing

rate value to ensure the maximum release period occurs with the maximum breathing rate.

2. Low Population Zone

   a. In Compartment 2 – Environment
   b. Breathing Rate Default – not checked
   c. X/Q – 1.40E-05 sec/m^3 for the period 0 to 8 hours, 1.50E-06 sec/m^3 for the period 8 hours to 24 hours, 7.7E-07 sec/m^3 for the period 24 hours to 96 hours and 4.5E-07 sec/m^3 for the period 96 hours to 30 days. These are the LPZ accident X/Q's for CR3 (NUS-1753).
   d. Breathing Rate – 3.47E-04 m^3/sec for the period 0 to 8 hours, 1.75E-04 m^3/sec for the period 8 hours to 24 hours and 2.32E-04 m^3/sec for the period 24 hours to 30 days– these are the Reg. Guide specified breathing rates (Reg. Guide 1.4).

3. Control Room

   a. In Compartment 3 – Control Room
   b. Breathing Rate Default – not checked
   c. X/Q – 9.0E-04 sec/m^3 for the 0-8 hr time period, 5.31E-04 sec/m^3 for the 8 to 24 hour period, 3.38E-04 sec/m^3 for the 24-96 hour period, and 1.49E-04 sec/m^3 for the 96-720 hour period. These are the accident X/Q's for the CR3 control complex from Letter 3F0588-10. They are not adjusted for occupancy time as the occupancy times will be entered separately.
   d. Breathing Rate – 3.47E-04 m^3/sec – this is the Reg. Guide specified breathing rate. This value is entered from time 0 to the end of the accident.
   e. Occupancy Factor – 1.0 for the first 24 hours, 0.6 for the subsequent 72 hours and then 0.4 for the remainder of the accident. These are the standard values from Murphy and Campe.

D. Source Term

1. Nuclide Inventory

   a. Default PWR is checked.
   b. Plant Power – 2619 MWt – this is the potential licensed power plus 2% for instrument uncertainty.
   c. NIF file – this is automatically entered as PWR_def.nif by the code when Default PWR is selected. It is not edited.
   d. Decay and No Daughter products is selected. This matches standard methods.
   e. Iodine Chemical Fractions – The values entered are 0 for Aerosol, 0.97 for Elemental and 0.03 for Organic. These are based on Reg. Guide 1.183, Appendix H.

2. Release Fractions and Timing

a. User RFT file is selected. The file to be selected is crer1_def.rft. This file has the following values:
Duration = 0.1E-05 hrs. Unlike the delayed source term for a LOCA, the clad damage in this case is due to the reactivity excursion with the rod ejection. Therefore, all the activity is assumed to be released instantaneously. The value of 0.1E-05 is a nominal value to ensure all activity is released to the coolant within 1 second.
Fraction of noble gases and iodines released during first time interval = 0.252E-01. This value is based on:
0.14 is the fraction of fuel assumed to experience clad damage (Reference 11)
0.10 is the assumed fraction of core inventory in the gap for the noble gases and iodines per Appendix H of Reg. Guide 1.183. The combined fraction is 0.014. This value is multiplied by 1.8, the licensed maximum radial peaking factor (Ref. 17). Reg. Guide 1.183 (Section 3.1) specifies the use of a radial peaking factor if only a fraction of the core experienced fuel damage. This is very conservatively used in this case, as the value of 1.8 is the maximum for any one fuel pin and is applied to all 14% of the fuel pins assumed to fail in this calculation. The resulting fraction of noble gases and iodines released during the first time interval is 0.014 x 1.8 = 0.0252.
All other values in the rft file are 0 as there are no additional releases over time and no other nuclides assumed to be in the gap. There is no calculated fuel melt for this event at CR-3.
b. Delay (hours) – 0. Release will occur at the time of rod ejection.
c. Decay and No Daughter products – automatically set the same as the previous panel
d. Iodine chemical fractions - automatically set the same as the previous panel

3. Dose Conversion Factors

a. MACSS 60 (FGR 11& 12) is selected. This automatically selects the file to be used as fgr11&12.inp. This is the default dose factor file to be used with the AST source term.
b. Decay and No Daughter products – automatically set the same as the previous panel
c. Iodine chemical fractions - automatically set the same as the previous panel

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APPENDIX E

Revised LOCA ECCS Leakage RADTRAD Inputs
(Appendix I of LAR #262, Revision 0)

RADTRAD Code Inputs for the LOCA
ECCS Leakage

This run calculates the dose from continuous ECCS leakage. Revision 0 had assumed a 30 minute release of 50 gpm at 24 hours in addition to the continuous release. However, the need for this assumed leak at 24 hours was eliminated in Regulatory Guide 1.183. Therefore, Revision 1 of this calculation no longer assumes the 30 minute release at 24 hours. Containment leakage is addressed in a separate RADTRAD run.

A. Compartments

1. Sump

   a. Compartment type – Other – since it is not the environment or control room.
   b. Volume – 4.537E4 ft^3 – this is the minimum possible volume of recirculated sump water from Calculation M-95-0007, "BWST Level for Adequate RB Inventory". The actual value entered in this input parameter will not figure in the calculation as the release rate will be input in %/day. However, this value will be used in determining the %/day.
   c. Source term fraction – 1.0 – Per Reg. Guide 1.183 all of the activity released from the core is released to the sump for this analysis.
   d. Compartment features – None selected as there are no removal mechanisms.

2. Auxiliary Building – the ECCS systems would leak into the Auxiliary Building.

   a. Compartment type – Other – since it is not the environment or control room.
   b. Volume – 1 ft^3 – since no holdup is being assumed in the AB, an arbitrary low volume is used, which when combined with an arbitrary high release rate of 1000 cfm below results in the assumption that all activity leaking from the sump water is immediately released to the environment.
   c. Source term fraction – 0 – The activity released from the core is released to the sump water. There will be a transfer rate to the AB.
   d. Compartment features – Nothing is selected since there is no credit for any removal mechanisms. (Flash fraction will be addressed in a subsequent input parameter).

3. Environment

   Compartment type – Environment - This defeats all other input parameters.

4. Control Room

   a. Compartment type - Control Room

b. Volume - 3.649E+05 ft^3 – Note that this is the volume of the Control Complex Habitability Envelope (i.e. – all levels of the Control Complex except the 95' level). Basis – S&L Design Input Transmittal DIT-CR-0044, "Control Complex Volume" 10/1/97. This value must be used as this is the volume into which any activity input will be dispersed and the volume that is processed by the recirculation filters. However, since the control room is a subset of this volume, use of this volume will underestimate the finite cloud correction factor for noble gas submersion. This could be adjusted by hand in the calculation, but will not be for this analysis due to the small contribution from submersion DDE.
c. Compartment Features – Recirculating Filters is turned on.
d. Recirculating Filters – Forced flow rate – 3.78E+04 cfm – this is the lower end of the acceptance criteria for the filter system flow testing in the Technical Specifications.
e. Recirculating Filters – Filter efficiencies
Time 0– all filter efficiencies are 0% as emergency recirculation through filters is not required and is not automatically initiated.
Time = 0.5 hours – filter efficiency is assumed to be 95% for aerosols and 90% for elemental and organic iodine, as the operator is assumed to manually lineup the emergency filters at 30 minutes. (AP-250) These efficiencies apply until the end of the accident at 30 days. These efficiencies are based on the revised test criteria being submitted in the LAR.

B. Transfer Pathways

1. Sump to Auxiliary Building.

a. From Compartment 1 – Sump
b. To Compartment 2 – Auxiliary Building
c. Transfer mechanism – Air Leakage – even though it's water, this is the best choice. The units are percent/day and it is really an indication of the fraction of the radionuclide activity transferred per day. Hence the medium doesn't matter.
d. Air Leakage Tab – Edit Rates - Leakage Rate is determined as follows:
Continuous leakage – proposed leakage test acceptance criteria – 0.02 gal/min. Calculation assumed leakage = two times surveillance acceptance criteria, or 0.04 gal/min. Converting to percent per day for code input, using the sump volume of 45,370 ft^3 we get:

$$(0.04 \text{ gal/min} \times 0.134 \text{ ft}^3\text{/gal} \times 1440 \text{ min/day} \times 100\%) / 45{,}370 \text{ ft}^3 = 0.017 \text{ \%/day}$$

This value is entered from T=0 to T=720 hours.

2. Auxiliary Building to Environment

a. From Compartment 2 – Auxiliary Building
b. To Compartment 3 – Environment

c. Transfer mechanism – Filter is checked. There will be no credit taken for the auxiliary building filters. However, this is the location in the code where credit will be taken for the flash fraction of 10%.
d. Filter Tab – Edit Efficiencies. A flow of 1000 cfm is entered. As noted above, this is an arbitrary value, which when combined with the low building volume assumed, ensures an immediate release of all airborne iodine. A filter efficiency of 90% is entered for all forms of iodine. This is based upon incorporation of the flash fraction of 10% (M-97-0137).

3. Filtered Inflow

   a. From Compartment 3 – Environment
   b. To Compartment 4 – Control Room
   c. Transfer mechanism- Filter
   d. Filter Tab – Edit Efficiencies – All values are entered as 0. This transfer pathway was established for the previous LOCA analyses, which had a filtered inleakage component. No filtered inleakage is assumed in this analysis. The pathway was left in the model for consistency, but has no effect since 0 flows are assumed. The code does not allow deletion of the pathway once established.

4. Unfiltered inflow

   a. From Compartment 3 – Environment
   b. To Compartment 4 – Control Room
   c. Transfer mechanism – Filter is selected – Although the inleakage will not be filtered, filter is selected for ease of input. The filter panel allows rates to be input as cfm. The air leakage panel requires input in percent per day. Since the CR3 inleakage rates are in cfm, the filter panel is easier to use. The filter efficiencies will be set to zero to account for the fact that the inleakage will be unfiltered.
   d. Filter Efficiency Panel – Flow Rate – 1000 cfm – this is the assumed inleakage rate for the entire course of the accident – The value is approximately two times the maximum expected inleakage based on tracer gas measurements. Since the control complex isolates with high RB pressure before the plume arrives, the only input is the inleakage.
   e. Filter efficiencies – 0% - as noted above this is unfiltered inleakage.
   f. Active Pathway – Yes

5. Exhaust

   a. From Compartment 4 – Control Room
   b. To Compartment 3 – Environment
   c. Transfer mechanism – Filter is selected – Although the exhaust will not be filtered, filter is selected for ease of input. The filter panel allows rates to be input as cfm. The air leakage panel requires input in percent per day. Since the CR3 inleakage rates are in cfm, the filter panel is easier to use. The exhaust rate will be

assumed to be equal to the inleakage rate. The filter efficiencies will be set to zero to account for the fact that the exhaust will be unfiltered.

d. Filter Efficiency Panel – Flow Rate – 1000 cfm – this is the assumed inleakage rate for the entire course of the accident – based on a two factor margin above tracer gas measurements. The exhaust rate is assumed equal to the intake rate.
e. Filter efficiencies – 0% - as noted above this is unfiltered exhaust
f. Active Pathway – Yes

C. Dose Locations

1. Exclusion Area Boundary

a. In Compartment 3 – Environment
b. Breathing Rate Default – not checked
c. X/Q – 1.60E-04 sec/m^3 – this is the 0-2 hr accident X/Q for CR3. (NUS-1753) This value is entered from time 0 to the end of the accident to ensure the worst meteorology occurs simultaneous with the worst release. Under Control Options we will ask the code to print the EAB dose for this case for a number of time periods between 0 and 3 hours as that is the time period over which the worst two hours from containment leakage will occur.
d. Breathing Rate – 3.47E-04 m^3/sec - This is the Reg. Guide specified breathing rate for 0 to 8 hours. (Reg. Guide 1.4) Only the 0-8 hr value is used for the EAB dose to ensure the maximum breathing rate coincides with the maximum two hour release period.

2. Low Population Zone

a. In Compartment 3 – Environment
b. Breathing Rate Default – not checked
c. X/Q – 1.40E-05 sec/m^3 for 0 to 8 hours, 1.50E-06 sec/m^3 for 8 to 24 hours, 7.70E-07 sec/m^3 for 24 to 96 hours and 4.50E-07 sec/m^3 for 96 to 720 hours– these are the accident X/Q's at the LPZ for CR3 (NUS-1753).
d. Breathing Rate – 3.47E-04 m^3/sec for 0 to 8 hours, 1.75E-04 m^3/sec for 8 to 24 hours and 2.32E-04 m^3/sec for 24 to 720 hours– these are the Reg. Guide specified breathing rates (Reg. Guide 1.4).

3. Control Room

a. In Compartment 4 – Control Room
b. Breathing Rate Default – not checked
c. X/Q – 9.0E-04 sec/m^3 for the 0-8 hr period, 5.31E-04 for 8 hrs to 24 hrs, 3.38E-04 for 24 hrs to 96 hrs, and 1.49E-04 for 96 hrs to 720 hrs. These are the accident X/Q's for the CR3 control complex based on an FPC letter 3F0588-10 and Murphy and Campe.
d. Breathing Rate – 3.47E-04 m^3/sec – this is the Murphy and Campe specified breathing rate. This value is entered from time 0 to the end of the accident.

e. Occupancy Factor – 1.0 for the first 24 hours, 0.6 for the subsequent 72 hours and 0.4 for the remainder of the accident. These are the occupancy factors from Murphy and Campe.

D. Source Term

1. Nuclide Inventory

a. Default PWR is checked.
b. Plant Power – 2619 MWt – this is the potential licensed power plus 2% for instrument uncertainty.
c. NIF file – this is automatically entered by the code when Default PWR is selected. The file used is "pwr_def.nif". It is not edited.
d. Decay and No Daughter products is selected. This is the standard method used.
e. Iodine Chemical Fractions – 0% aerosol, 97% elemental and 3% organic. These are the fractions specified in Reg. Guide 1.183.

2. Release Fractions and Timing

a. User RFT button is checked.
b. Delay (hours) – 0 hrs – This is the standard industry assumption. Although ECCS sump recirculation would not start for many minutes post-LOCA, it is conservatively assumed to exist from T=0.
c. RFT file – the file that has been created for ECCS leakage is "eccsast.rft". This file specifies release fractions only for iodines based on Reg. Guide 1.183, Appendix A. The file specifies a release fraction of 0.05 for the first period, which has a duration of 0.5 hours, and a release fraction of 0.35 for the second time period, which has a duration of 1.3 hours. These values are from Tables 2 and 4 of Reg. Guide 1.183.
d. Decay and No Daughter products – automatically set the same as the previous panel
e. Iodine chemical fractions – automatically set the same as the previous panel

3. Dose Conversion Factors

a. MACCS 60 (FGR 11&12) is selected. This automatically selects the file to be used as fgr11&12.inp. These are dose factors to be used with the PWR alternative source term.
b. Decay and No Daughter products – automatically set the same as the previous panel.
c. Iodine chemical fractions – automatically set the same as the previous panel.

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APPENDIX F

Revised LOCA Containment Leakage RADTRAD Inputs (Appendix J of LAR #262, Revision 0)

RADTRAD Code Inputs for the LOCA Containment Leakage

This run is for the containment leakage contribution to the LOCA dose. ECCS leakage is addressed in a separate RADTRAD run.

A. Compartments

1. Sprayed Region - the containment is divided into two nodes, the sprayed region and the unsprayed region.

a. Compartment type – Other – since it is not the environment or control room.
b. Volume – 1.304E6 ft^3 – Based on calculation I-86-0001, Rev 0, "Containment Sprayed/Unsprayed Volumes 2/6/86 - the sprayed volume constitutes 65.2% of the containment free air volume. This value is 65.2% of the containment volume of 2E6 ft^3. (M-98-0010, Rev. 0 provides the containment volume)
c. Source term fraction – 0.652 – The activity released from the core is assumed to be homogeneously mixed in the containment atmosphere. Therefore, the fraction in the sprayed region is equal to the fraction of the volume sprayed.
d. Compartment features – "Sprays" selected since this is the sprayed region. "Natural deposition" is not selected. Natural deposition does not significantly affect the results and hence is not assumed.
e. Sprays Tab – "User Defined Coefficients is checked. The intent is to use the spray removal coefficients as calculated in I-86-0002.
f. User Defined Coefficient Tab - All removal factors are 0 until 0.0344 hrs. This corresponds to 124 seconds, which is the time at which sprays are delivering full flow. At 0.0344 hrs, the Aerosol removal coefficient is 1.98 hr^{-1} and the elemental removal coefficient is 19.81 hr^{-1}. This is based on Calculation I-86-0002 for a minimum spray flow (injection or recirculation mode) of 1000 gal/min.

   In accordance with NRC guidance (SRP 6.5.2 – Ref. 21), the elemental spray removal coefficient should be terminated when the elemental iodine DF is 200. A special RADTRAD run was made with all elemental iodine to determine the time to a 200 factor reduction using the iodine removal coefficients and mixing rates consistent with this calculation. The elemental removal coefficient is changed to 0 when a DF of 200 is achieved at 3.3 hours.

   In accordance with NRC guidance (SRP 6.5.2 – Ref. 21), the particulate spray removal coefficient should be reduced by a factor of 10 when the particulate iodine DF is 50. A special RADTRAD run was made with all particulate iodine to determine the time to a 50 factor reduction using the iodine removal coefficients and mixing rates consistent with this calculation. The particulate removal coefficient is changed to 0.198 at 4.8 hours.

   Organic iodine removal factors are assumed to be 0 at all times.

2. Unsprayed region – the containment is divided into two nodes, the sprayed region and the unsprayed region.

a. Compartment type – Other – since it is not the environment or control room.
b. Volume – 6.96E5 ft^3 – Based on calculations, the unsprayed volume constitutes 34.8% of the containment free air volume. (I-86-001, Rev. 0) This value is 34.8% of the containment volume of 2E6 ft^3.
c. Source term fraction – 0.348 – The activity released from the core is assumed to be homogeneously mixed in the containment atmosphere. Therefore, the fraction in the unsprayed region is equal to the fraction of the volume unsprayed.
d. Compartment features – Nothing is selected since this is the unsprayed region. No deposition removal factors are used.

3. Environment

Compartment type – Environment - This defeats all other input parameters.

4. Control room

a. Compartment type - Control Room
b. Volume - 3.649E+05 ft^3 – Basis – S&L Design Input Transmittal DIT-CR-0044, "Control Complex Volume 10/1/97. Note that this is the volume of the Control Complex Habitability Envelope (i.e. – all levels of the Control Complex except the 95' level). This value must be used as this is the volume into which any activity input will be dispersed and the volume that is processed by the recirculation filters. However, since the control room is a subset of this volume, use of this volume will underestimate the finite cloud correction factor for noble gas submersion. This can be adjusted by hand in the calculation.
c. Compartment Features – Recirculating Filters is turned on.
d. Recirculating Filters – Forced flow rate – 3.78E+04 cfm – this is the lower end of the acceptance criteria for the filter system flow testing in the Technical Specifications.
e. Recirculating Filters – Filter efficiencies
   Time 0– all filter efficiencies are 0% as emergency recirculation through filters is not required and is not automatically initiated.
   Time = 0.5 hours – filter efficiency is assumed to be 95% for aerosols and 90% for elemental and organic iodine, as the operator is assumed to manually lineup the emergency filters at 30 minutes. (AP-250) These efficiencies apply until the end of the accident at 30 days. These efficiencies are based on the revised test criteria being submitted in the LAR.

B. Transfer Pathways

1. Sprayed Region to Unsprayed Region

a. From Compartment 1 – Sprayed region

b. To Compartment 2 – Unsprayed region
c. Transfer mechanism – Air Leakage
d. Air Leakage Tab – Edit Rates - Leakage Rate is 2562%/day from T=0 to end of accident. This is based on 2 turnovers of the Unsprayed volume per hour. (SRP 6.5.2) This gives:
   6.96E5 ft^3 x 2/hr x 24 hr/day x 100% / 1.304E6 ft^3= 2562%/day

2. Unsprayed Region to Sprayed Region

a. From Compartment 2 – Unsprayed region
b. To Compartment 1 – Sprayed region
c. Transfer mechanism – Air Leakage
d. Air Leakage Tab – Edit Rates - Leakage Rate is 4800%/day from T=0 to end of accident. This is based on the Standard Review Plan assumption of 2 turnovers of the Unsprayed volume per hour. This gives:
   6.96E5 ft^3 x 2/hr x 24 hr/day x 100% / 6.96E5 ft^3= 4800%/day

3. Sprayed Region to Environment

a. From Compartment 1 – Sprayed region
b. To Compartment 3 – Environment
c. Transfer mechanism – Air Leakage
d. Air Leakage Tab – Edit Rates - Leakage Rate is 0.25%/day from T=0 to 24 hours. Then it is 0.125%/day from 24 hours to the end of the accident (720 hours). This is based on the Technical Specification Containment leak rate limit of 0.25%/day and the Reg. Guide 1.183 assumption that the leakage is one half of the limit after 24 hours. Containment leakage is assumed to come from the unsprayed and sprayed region at the same percentage rate.

4. Unsprayed Region to Environment

a. From Compartment 2 – Unsprayed region
b. To Compartment 3 – Environment
c. Transfer mechanism – Air Leakage
d. Air Leakage Tab – Edit Rates - Leakage Rate is 0.25%/day from T=0 to 24 hours. Then it is 0.125%/day from 24 hours to the end of the accident (720 hours). This is based on the Technical Specification Containment leak rate limit of 0.25%/day and the Reg. Guide 1.183 assumption that the leakage is one half of the limit after 24 hours. Containment leakage is assumed to come from the unsprayed and sprayed region at the same percentage rate.

5. Filtered Inflow

a. From Compartment 3 – Environment
b. To Compartment 4 – Control Room
c. Transfer mechanism- Filter

d. Filter Tab – Edit Efficiencies – All values are entered as 0. This transfer pathway was established for the previous LOCA analyses, which had a filtered inleakage component. No filtered inleakage is assumed in this analysis. The pathway was left in the model for consistency, but has no effect since 0 flows are assumed. The code does not allow deletion of the pathway once established.

6. Unfiltered inflow

a. From Compartment 3 – Environment
b. To Compartment 4 – Control Room
c. Transfer mechanism – Filter is selected – Although the inleakage will not be filtered, filter is selected for ease of input. The filter panel allows rates to be input as cfm. The air leakage panel requires input in percent per day. Since the CR3 inleakage rates are in cfm, the filter panel is easier to use. The filter efficiencies will be set to zero to account for the fact that the inleakage will be unfiltered.
d. Filter Efficiency Panel – Flow Rate – 1000 cfm – this is the assumed inleakage rate for the entire course of the accident – The value is approximately two times the maximum expected inleakage based on tracer gas measurements. Since the control complex isolates with high RB pressure before the plume arrives, the only input is the inleakage.
e. Filter efficiencies – 0% - as noted above this is unfiltered inleakage.
f. Active Pathway – Yes

7. Exhaust

a. From Compartment 4 – Control Room
b. To Compartment 3 – Environment
c. Transfer mechanism – Filter is selected – Although the exhaust will not be filtered, filter is selected for ease of input. The filter panel allows rates to be input as cfm. The air leakage panel requires input in percent per day. Since the CR3 inleakage rates are in cfm, the filter panel is easier to use. The exhaust rate will be assumed to be equal to the inleakage rate. The filter efficiencies will be set to zero to account for the fact that the exhaust will be unfiltered.
d. Filter Efficiency Panel – Flow rate - 1000 cfm – this is the assumed inleakage rate for the entire course of the accident – based on a two factor margin above tracer gas measurements. The exhaust rate is assumed equal to the intake rate.
e. Filter efficiencies – 0% - as noted above this is unfiltered exhaust
f. Active Pathway – Yes

C. Dose Locations

1. Exclusion Area Boundary

a. In Compartment 3 – Environment
b. Breathing Rate Default – not checked

c. X/Q – 1.60E-04 sec/m^3 – this is the 0-2 hr accident X/Q for CR3. (NUS-1753) This value is entered from time 0 to the end of the accident. Although only a 2 hour EAB dose is calculated, per the new acceptance criteria of 10CFR50.67, it must be the worst 2 hour period. By keeping the X/Q at the 0-2 hr X/Q value, it ensures the bounding release period matches up with the bounding meteorology.
d. Breathing Rate – 3.47E-04 m^3/sec – this is the Reg. Guide specified breathing rate for the EAB. (Reg. Guide 1.4) This value is entered from time 0 to the end of the accident, again to ensure the bounding breathing rate matches up with the bounding 2 hour release period.

2. Low Population Zone

a. In Compartment 3 – Environment
b. Breathing Rate Default – not checked
c. X/Q – 1.40E-05 sec/m^3 for 0 to 8 hours, 1.50E-06 sec/m^3 for 8 to 24 hours, 7.70E-07 sec/m^3 for 24 to 96 hours and 4.50E-07 sec/m^3 for 96 to 720 hours– these are the accident X/Q's at the LPZ for CR3. (NUS-1753)
d. Breathing Rate – 3.47E-04 m^3/sec for 0 to 8 hours, 1.75E-04 m^3/sec for 8 to 24 hours and 2.32E-04 m^3/sec for 24 to 720 hours– these are the Reg. Guide specified breathing rates for the LPZ. (Reg. Guide 1.4)

3. Control Room

a. In Compartment 4 – Control Room
b. Breathing Rate Default – not checked
c. X/Q – 9.0E-04 sec/m^3 for the 0-8 hr period, 5.31E-04 for 8 hrs to 24 hrs, 3.38E-04 for 24 hrs to 96 hrs, and 1.49E-04 for 96 hrs to 720 hrs. These are the accident X/Q's for the CR3 control complex based on FPC Letter 3F0588-10 and Murphy and Campe.
d. Breathing Rate – 3.47E-04 m^3/sec – this is the Murphy and Campe specified breathing rate. This value is entered from time 0 to the end of the accident.
e. Occupancy Factor – 1.0 for the first 24 hours, 0.6 for the subsequent 72 hours and 0.4 for the remainder of the accident. These are the occupancy factors from Murphy and Campe.

D. Source Term

1. Nuclide Inventory

a. Default PWR is checked.
b. Plant Power – 2619 MWt – this is the potential licensed power plus 2% for instrument uncertainty.
c. NIF file – this is automatically entered as PWR_def.nif by the code when Default PWR is selected. It is not edited.

d. Decay and No Daughter products is selected. This matches the standard method used.
e. Iodine Chemical Fractions –When default PWR is chosen above, this automatically enters values into the boxes for each chemical form. The standard PWR assumption is that 4.85% is elemental, 95% is particulate and 0.15% is organic.

2. Release Fractions and Timing

a. PWR-DBA button is checked.
b. Delay (hours) – 0 hrs – This is the standard industry assumption. The delay in the timing of the release is built into the PWR-DBA library.
c. RFT file – this is automatically entered as pwr_dba.rft when the PWR-DBA button is selected. It is not edited.
d. Decay and No Daughter products – automatically set the same as the previous panel
e. Iodine chemical fractions – automatically set the same as the previous panel

3. Dose Conversion Factors

a. MACCS60/FGR 11&12 is selected. This automatically selects the file to be used as fgr11&12.inp. These are dose factors to be used with the TID source term.
b. Decay and No Daughter products – automatically set the same as the previous panel.
c. Iodine chemical fractions – automatically set the same as the previous panel.

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APPENDIX G

Revised LOCA Hydrogen Purge RADTRAD Inputs
(Appendix K of LAR #262, Revision 0)

RADTRAD Code Inputs for the LOCA Hydrogen Purge

This run is for the containment hydrogen purge contribution to the LOCA dose. Since the purge will occur many days into the accident, it will not contribute to the 2 hour EAB dose. Therefore, only the dose to the LPZ and control room is calculated.

A. Compartments

1. Sprayed Region - the containment is divided into two nodes, the sprayed region and the unsprayed region.

a. Compartment type – Other – since it is not the environment or control room.
b. Volume – 1.304E6 ft^3 – Based on calculation I-86-0001, Rev 0, "Containment Sprayed/Unsprayed Volumes 2/6/86 - the sprayed volume constitutes 65.2% of the containment free air volume. This value is 65.2% of the containment volume of 2E6 ft^3. (M-98-0010, Rev. 0 provides the containment volume)
c. Source term fraction – 0.652 – The activity released from the core is assumed to be homogeneously mixed in the containment atmosphere. Therefore, the fraction in the sprayed region is equal to the fraction of the volume sprayed.
d. Compartment features – "Sprays" selected since this is the sprayed region. "Natural deposition" is not selected. Natural deposition does not significantly affect the results and hence is not assumed.
e. Sprays Tab – "User Defined Coefficients is checked. The intent is to use the spray removal coefficients as calculated in I-86-0002.
f. User Defined Coefficient Tab - All removal factors are 0 until 0.0344 hrs. This corresponds to 124 seconds, which is the time at which sprays are delivering full flow. At 0.0344 hrs, the Aerosol removal coefficient is 1.98 hr^{-1} and the elemental removal coefficient is 19.81 hr^{-1}. This is based on Calculation I-86-0002 for a minimum spray flow (injection or recirculation mode) of 1000 gal/min.

   In accordance with NRC guidance (SRP 6.5.2), the elemental spray removal coefficient should be terminated when the elemental iodine DF is 200. A special RADTRAD run was made with all elemental iodine to determine the time to a 200 factor reduction using the iodine removal coefficients and mixing rates consistent with this calculation. The elemental removal coefficient is changed to 0 at 3.3 hours.

   In accordance with NRC guidance (SRP 6.5.2 – Ref. 21), the particulate spray removal coefficient should be reduced by a factor of 10 when the particulate iodine DF is 50. A special RADTRAD run was made with all particulate iodine to determine the time to a 50 factor reduction using the iodine removal coefficients and mixing rates consistent with this calculation. The particulate removal coefficient is changed to 0.198 at 4.8 hours.

   Organic iodine removal factors are assumed to be 0 at all times.

2. Unsprayed region – the containment is divided into two nodes, the sprayed region and the unsprayed region.

a. Compartment type – Other – since it is not the environment or control room.
b. Volume – 6.96E5 ft^3 – Based on calculations, the unsprayed volume constitutes 34.8% of the containment free air volume. (I-86-001, Rev. 0) This value is 34.8% of the containment volume of 2E6 ft^3.
c. Source term fraction – 0.348 – The activity released from the core is assumed to be homogeneously mixed in the containment atmosphere. Therefore, the fraction in the unsprayed region is equal to the fraction of the volume unsprayed.
d. Compartment features – Nothing is selected since this is the unsprayed region. No deposition removal factors are used.

3. Environment

Compartment type – Environment - This defeats all other input parameters.

4. Control room

a. Compartment type - Control Room
b. Volume - 3.649E+05 ft^3 – Basis – S&L Design Input Transmittal DIT-CR-0044, "Control Complex Volume 10/1/97. Note that this is the volume of the Control Complex Habitability Envelope (i.e. – all levels of the Control Complex except the 95' level). This value must be used, as this is the volume into which any activity input will be dispersed and the volume that is processed by the recirculation filters. However, since the control room is a subset of this volume, use of this volume will underestimate the finite cloud correction factor for noble gas submersion. This can be adjusted by hand in the calculation.
c. Compartment Features – Recirculating Filters is turned on.
d. Recirculating Filters – Forced flow rate – 3.78E+04 cfm – this is the lower end of the acceptance criteria for the filter system flow testing in the Technical Specifications.
e. Recirculating Filters – Filter efficiencies
   Time 0– all filter efficiencies are 0% as emergency recirculation through filters is not required and is not automatically initiated.
   Time = 0.5 hours – filter efficiency is assumed to be 95% for aerosols and 90% for elemental and organic iodine, as the operator is assumed to manually lineup the emergency filters at 30 minutes. (AP-250) These efficiencies apply until the end of the accident at 30 days. These efficiencies are based on the revised test criteria being submitted in the LAR.

B. Transfer Pathways

1. Sprayed Region to Unsprayed Region

a. From Compartment 1 – Sprayed region

b. To Compartment 2 – Unsprayed region
c. Transfer mechanism – Air Leakage
d. Air Leakage Tab – Edit Rates - Leakage Rate is 2562%/day from T=0 to end of accident. This is based on 2 turnovers of the Unsprayed volume per hour. (SRP 6.5.2) This gives:
   6.96E5 ft^3 x 2/hr x 24 hr/day x 100% / 1.304E6 ft^3= 2562%/day

2. Unsprayed Region to Sprayed Region

a. From Compartment 2 – Unsprayed region
b. To Compartment 1 – Sprayed region
c. Transfer mechanism – Air Leakage
d. Air Leakage Tab – Edit Rates - Leakage Rate is 4800%/day from T=0 to end of accident. This is based on the Standard Review Plan assumption of 2 turnovers of the Unsprayed volume per hour. This gives:
   6.96E5 ft^3 x 2/hr x 24 hr/day x 100% / 6.96E5 ft^3= 4800%/day

3. Sprayed Region to Environment

a. From Compartment 1 – Sprayed Region
b. To Compartment 3 – Environment
c. Transfer Mechanism – Filter
d. Filter Tab – Edit Rates – The release rate at T=0 is 0. At T= 336 hrs, the release rate is 65.2 cfm. This rate is continued until 720 hours. Based on Calculation M-85-1004, Rev. 3, "Hydrogen Generation", 9/2/98 a hydrogen purge could occur as early as 14.8 days. It was conservatively assumed the purge begins at 14.0 days, or 336 hours. The required purge rate per M-85-1004, Rev. 3 will be in the range of 50 cfm at 14.8 days. Considering instrument uncertainty for the purge flow meter, the actual purge flow could be approximately 60 cfm. Conservatively, this calculation assumes a purge flow of 100 cfm is established and continues for the remainder of the accident. The fraction of the 100 cfm from the sprayed region is assumed to be the same as the fractional volume of the containment, or 0.652. Therefore, the flow from the sprayed region is assumed to be 65.2 cfm. The purge is through the RB filters which are tested to 95 % efficiency. Therefore, an efficiency of 90% is assumed.

4. Unsprayed Region to Environment

a. From Compartment 2 – Unsprayed region
b. To Compartment 3 – Environment
c. Transfer mechanism – Filter
d. Filter Tab – Edit Rates - The release rate at T=0 is 0. At T= 336 hrs, the release rate is 34.8 cfm. This rate is continued until 720 hours. Based on Calculation M-85-1004, Rev. 3, "Hydrogen Generation", 9/2/98 a hydrogen purge could occur as early as 14.8 days. It was conservatively assumed the purge begins at 14.0 days, or 336 hours. The required purge rate per M-85-1004, Rev. 3 will be in the range of 50 cfm at 14.8 days.

Considering instrument uncertainty for the purge flow meter, the actual purge flow could be approximately 60 cfm. Conservatively, this calculation assumes a purge flow of 100 cfm is established and continues for the remainder of the accident. The fraction of the 100 cfm from the unsprayed region is assumed to be the same as the fractional volume of the containment, or 0.348. Therefore, the flow from the unsprayed region is assumed to be 34.8 cfm. The purge is through the RB filters which are tested to 95 % efficiency. Therefore, an efficiency of 90% is assumed.

5. Filtered Inflow

a. From Compartment 3 – Environment
b. To Compartment 4 – Control Room
c. Transfer mechanism- Filter
d. Filter Tab – Edit Efficiencies – All values are entered as 0. This transfer pathway was established for the previous LOCA analyses, which had a filtered inleakage component. No filtered inleakage is assumed in this analysis. The pathway was left in the model for consistency, but has no effect since 0 flows are assumed. The code does not allow deletion of the pathway once established.

6. Unfiltered inflow

a. From Compartment 3 – Environment
b. To Compartment 4 – Control Room
c. Transfer mechanism – Filter is selected – Although the inleakage will not be filtered, filter is selected for ease of input. The filter panel allows rates to be input as cfm. The air leakage panel requires input in percent per day. Since the CR3 inleakage rates are in cfm, the filter panel is easier to use. The filter efficiencies will be set to zero to account for the fact that the inleakage will be unfiltered.
d. Filter Efficiency Panel – Flow Rate – 1000 cfm – this is the assumed inleakage rate for the entire course of the accident – The value is approximately two times the maximum expected inleakage based on tracer gas measurements. Since the control complex isolates with high RB pressure before the plume arrives, the only input is the inleakage.
e. Filter efficiencies – 0% - as noted above this is unfiltered inleakage.
f. Active Pathway – Yes

7. Exhaust

a. From Compartment 4 – Control Room
b. To Compartment 3 – Environment
c. Transfer mechanism – Filter is selected – Although the exhaust will not be filtered, filter is selected for ease of input. The filter panel allows rates to be input as cfm. The air leakage panel requires input in percent per day. Since the CR3 inleakage rates are in cfm, the filter panel is easier to use. The exhaust rate will be assumed to be equal to

the inleakage rate. The filter efficiencies will be set to zero to account for the fact that the exhaust will be unfiltered.

d. Filter Efficiency Panel – Flow rate - 1000 cfm – this is the assumed inleakage rate for the entire course of the accident – based on a two factor margin above tracer gas measurements. The exhaust rate is assumed equal to the intake rate.
e. Filter efficiencies – 0% - as noted above this is unfiltered exhaust
f. Active Pathway – Yes

C. Dose Locations

1. Exclusion Area Boundary

a. In Compartment 3 – Environment
b. Breathing Rate Default – not checked
c. X/Q – 0. This value is entered from time 0 to the end of the accident. The hydrogen purge will not occur during the worst two hour period at the EAB (0.8 to 2.8 hours). Therefore, no contribution from the hydrogen purge will be added to the EAB dose. Hence, 0 was used as the X/Q.
d. Breathing Rate – 0. This value is entered from time 0 to the end of the accident. The hydrogen purge will not occur during the worst two hour period at the EAB (0.8 to 2.8 hours). Therefore, no contribution from the hydrogen purge will be added to the EAB dose. Hence, 0 was used as the breathing rate.

2. Low Population Zone

a. In Compartment 3 – Environment
b. Breathing Rate Default – not checked
c. X/Q – 1.40E-05 sec/m^3 for 0 to 8 hours, 1.50E-06 sec/m^3 for 8 to 24 hours, 7.70E-07 sec/m^3 for 24 to 96 hours and 4.50E-07 sec/m^3 for 96 to 720 hours– these are the accident X/Q's at the LPZ for CR3. (NUS-1753)
d. Breathing Rate – 3.47E-04 m^3/sec for 0 to 8 hours, 1.75E-04 m^3/sec for 8 to 24 hours and 2.32E-04 m^3/sec for 24 to 720 hours– these are the Reg. Guide specified breathing rates for the LPZ. (Reg. Guide 1.4)

3. Control Room

   a. In Compartment 4 – Control Room
   b. Breathing Rate Default – not checked
   c. X/Q – 9.0E-04 sec/m^3 for the 0-8 hr period, 5.31E-04 for 8 hrs to 24 hrs, 3.38E-04 for 24 hrs to 96 hrs, and 1.49E-04 for 96 hrs to 720 hrs. These are the accident X/Q's for the CR3 control complex based on FPC letter 3F0588-10 and Murphy and Campe.
   d. Breathing Rate – 3.47E-04 m^3/sec – this is the Murphy and Campe specified breathing rate. This value is entered from time 0 to the end of the accident.

e. Occupancy Factor – 1.0 for the first 24 hours, 0.6 for the subsequent 72 hours and 0.4 for the remainder of the accident. These are the occupancy factors from Murphy and Campe.

D. Source Term

1. Nuclide Inventory

a. Default PWR is checked.
b. Plant Power – 2619 MWt – this is the potential licensed power plus 2% for instrument uncertainty.
c. NIF file – this is automatically entered as PWR_def.nif by the code when Default PWR is selected. It is not edited.
d. Decay and No Daughter products is selected. This matches the standard method used.
e. Iodine Chemical Fractions –When default PWR is chosen above, this automatically enters values into the boxes for each chemical form. The standard PWR assumption is that 4.85% is elemental, 95% is particulate and 0.15% is organic.

2. Release Fractions and Timing

a. PWR-DBA button is checked.
b. Delay (hours) – 0 hrs – This is the standard industry assumption. The delay in the timing of the release is built into the PWR-DBA library.
c. RFT file – this is automatically entered as pwr_dba.rft when the PWR-DBA button is selected. It is not edited.
d. Decay and No Daughter products – automatically set the same as the previous panel
e. Iodine chemical fractions – automatically set the same as the previous panel

3. Dose Conversion Factors

a. MACCS60/FGR 11&12 is selected. This automatically selects the file to be used as fgr11&12.inp. These are dose factors to be used with the alternative source term. |
b. Decay and No Daughter products – automatically set the same as the previous panel.
c. Iodine chemical fractions – automatically set the same as the previous panel.