Entergy

Entergy Nuclear Northeast
Entergy Nuclear Operations, Inc.
440 Hamilton Avenue
White Plains, NY 10601-1813
Tel 914 272 3500

June 7, 2002
JPN-02-016

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
11555 Rockville Pike
Rockville, MD 20852

SUBJECT: James A. FitzPatrick Nuclear Power Plant
Docket No. 50-333
Proposed License Amendment for a Limited Scope Application of the Alternate Source Term Guidelines in NUREG-1465 Related to the Re-evaluation of the Fuel Handling Dose Consequences

References:

1. NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants," February 1995.
2. USNRC Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accident at Nuclear Power Reactors," July 2000.
3. Entergy letter, T. A. Sullivan to USNRC (JAFP-02-0098) dated April 26, 2002 regarding "Revision J to Proposed Technical Specification Change (License Amendment) Conversion to Improved Standard Technical Specifications."
4. USNRC letter, D. S. Hood to G. Van Middlesworth, dated April 16, 2001 regarding "Duane Arnold Energy Center - Issuance of Amendment Regarding Secondary Containment Operability During Movement of Irradiated Fuel and Core Alterations (TAC No. MB1569)."

Dear Sir:

Pursuant to 10 CFR 50.90 and 50.67, Entergy Nuclear Operations, Inc. (ENO) hereby proposes to amend Appendix A (Technical Specifications) of the James A. FitzPatrick operating license to change the requirements associated with handling irradiated fuel and performing core alterations. Specifically, the changes would eliminate operability requirements for secondary containment when handling recently irradiated fuel and during core alterations. ENO is also proposing to revise the requirements associated with equipment whose performance is not credited in the new calculations.

A001

In support of these changes, ENO has completed new design-basis calculations using a selective implementation of alternate source term guidance for evaluating the potential dose consequences of a fuel handling accident. These calculations use the guidelines detailed in NUREG-1465 (Reference 1) and Regulatory Guide 1.183 (Reference 2). The calculations demonstrate that radiological doses at the exclusion area boundary (EAB), low population zone (LPZ) and in the control room (CR) are within allowable limits without crediting secondary containment integrity.

ENO has evaluated the proposed changes in accordance with 10CFR50.91(a)(1), using the criteria in 10CFR50.92(c) and has determined that this request involves no significant hazards considerations.

Attachment 1 describes and evaluates the proposed license change. Supporting radiological dose calculations are attachments 2, and 3. Attachment 4 provides marked-up pages of the technical specifications and technical specification bases to show the proposed changes. Attachment 5 summarizes ENO's commitments.

This proposed change is based on the final proposed technical specification conversion to Improved Standard Technical Specifications (ITS) documented in Reference 3. Approval of this proposed change is requested by September 9, 2002 (after approval of the ITS conversion amendment) to support the scheduled implementation date of October 2002 and to support the fall refuel outage scheduled for October 5, 2002. Upon issuance of the ITS amendment, ENO will provide an updated TS markup to support final NRC review of this proposed change.

To further limit the potential radiological consequences of a fuel handling accident, Entergy will revise the FitzPatrick guidelines for assessing systems removed from service during the handling of recently irradiated fuel assemblies or core alterations to implement the provisions of Section 11.3.6.5 of NUMARC 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," Revision 3.

Similar TS changes were approved by the NRC in Reference 4. In accordance with 10 CFR 50.91, a copy of this application and attachments has been provided to the designated New York State official.

If you have any questions, please contact Mr. Andrew Halliday at 315-349-6055.

I declare under penalty of perjury that the foregoing is true and correct.

Very truly yours,

J. Knubel
Vice President
Operations Support

Executed on June 7, 2002
(Date)

Attachments:

1. Description and Evaluation of the Proposed Changes to the FitzPatrick Technical Specifications regarding Proposed License Amendment for a Limited Scope Application of the Alternate Source Term Guidelines in NUREG-1465 Related to the Re-evaluation of the Fuel Handling Dose Consequences

2. Entergy Calculation No. JAF-CALC-RAD-04410, Rev. 0, "Fuel Handling Accident - AST Analysis for Relaxation of Secondary Containment Operability."

3. Entergy Calculation No. JAF-CALC-RAD-04409, Rev. 0, "CR X/Qs Using ARCON96 Code for Post-FHA Releases from RB Track Bay Door and RB Vent."

4. Proposed Changes to the FitzPatrick Technical Specifications regarding Proposed License Amendment for a Limited Scope Application of the Alternate Source Term Guidelines in NUREG-1465 Related to the Re-evaluation of the Fuel Handling Dose Consequences - Marked-Up Pages

5. Summary of Commitments

cc:

Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Mr. G. Vissing, Project Manager, Section 1
Project Directorate I-1
Division of Licensing Project Management
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Mail Stop: 8C2
Washington, DC 20555

Senior Resident Inspector
James A. FitzPatrick Nuclear Power Plant
U. S. Nuclear Regulatory Commission
P. O. Box 136
Lycoming, NY 13093

Mr. William M. Flynn
New York State Energy, Research and
Development Authority
Corporate Plaza West
286 Washington Ave Extension
Albany, NY 12203-6399

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

Subject: **Proposed License Amendment for a Limited Scope Application of the Alternate Source Term Guidelines in NUREG-1465 Related to the Re-evaluation of the Fuel Handling Dose Consequences**

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

List of Tables

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

INTRODUCTION

Pursuant to 10 CFR 50.90 and 50.67, Entergy Nuclear Operations, Inc. (ENO) hereby proposes to amend Appendix A (Technical Specifications) of the James A. FitzPatrick operating license to change the requirements for handling irradiated fuel and performing core alterations. Specifically, the changes would eliminate operability requirements for secondary containment when handling recently irradiated fuel and during core alterations. ENO is also proposing to revise the requirements associated with equipment whose performance is not credited in the new calculations.

The implementation of these changes could reduce the duration and cost of planned outages while maintaining an adequate safety margin. For example - moving large equipment into secondary containment in preparation for an outage must be coordinated with technical specification (TS) requirements for secondary containment operability. This limits how and when the equipment can be moved, which in turn, can result in delays to certain "critical path" activities and extend outage duration.

Another potential benefit involves the performance of maintenance or repair work on redundant "divisionalized" safety systems. This work is usually scheduled to ensure that one division is operable while work is performed on the other division. Unanticipated problems with the operable division could require the suspension of the movement of irradiated fuel or other core alterations, such as control rod drive testing, until the problem is corrected and the system returned to operable status. The proposed change could also facilitate maintenance or repairs on non-redundant portions of the control room emergency ventilation system without suspending refueling activities.

This document describes and evaluates the proposed license change. Other supporting documents provide marked-up pages of the technical specifications and technical specification bases to show the proposed changes, or detail supporting radiological dose calculations.

1.0 DESCRIPTION

FitzPatrick's TSs currently impose restrictions on plant operations when handling irradiated fuel assemblies or when performing core alterations. These restrictions require that certain structures, systems or components (SSCs) be operable. These restrictions assure that the radiological consequences of a fuel handling accident do not exceed those estimated in design-basis analyses.

The changes proposed in this application are consistent with TSTF-51 "Revise containment Requirements During Handling Irradiated Fuel and Core Alterations," (Reference 24). TSTF-51 removes TS requirements for engineered-safeguard features (ESF) (e.g., primary/secondary containment, standby gas treatment, isolation capability) to be operable after sufficient radioactive decay has occurred to ensure off-site doses remain below the standard review plan limits. TSTF-51 also deletes operability requirements during core alterations for ESF mitigation features.

A fuel handling accident (or refueling accident) is discussed in Sections 14.6.1.4, "Refueling Accident," and 14.8.2.1.4 "Refueling Accident" of the updated FitzPatrick Final Safety Analysis

Report (UFSAR). The design-basis scenario is when one fuel assembly falls onto the top of the reactor core.

Secondary containment, the standby gas treatment (SGT), and control room emergency ventilation air supply (CREVAS) filtration systems mitigate the potential effects of a fuel handling accident and are part of the primary success path for a design-basis FHA.

2.0 PROPOSED CHANGE

The proposed amendment would revise the Limiting Conditions for Operation (LCOs) in the FitzPatrick plant's TS to relax secondary containment operability requirements when handling recently irradiated fuel and during core alterations. The proposed revision would allow for more efficient performance of outage work while continuing to provide adequate controls against the release of fission product radioactivity to the outside atmosphere during core alterations or fuel handling activities inside containment.

Current Technical Specifications require secondary containment, together with other mitigating systems, to be operable:

(1) when handling irradiated fuel, or
(2) during core alterations or
(3) during operations with the potential for draining the reactor vessel (OPDRVs).

The changes proposed would relax, or eliminate, conditions (1) and (2). Specifically, condition number (1) would be relaxed to require secondary containment, and other select systems, to be operable only while handling recently irradiated fuel. Changes to the TS bases define what time period must elapse before fuel is considered recently irradiated. Changes are proposed to eliminate operability requirements during core alterations (condition 2) except for AC and DC electrical systems during shutdown conditions. No changes are proposed to requirements associated with operations with the potential for draining the reactor vessel (condition 3). The associated bases for each of these sections are also revised to reflect the proposed change. Table 1 summarizes the changes proposed.

The changes proposed do not alter operability requirements associated with core alterations and electrical power systems (AC, DC or distribution systems) while the plant is shutdown. This is to ensure that electrical power for certain systems (such as refueling interlocks or the Reactor Protection System) that could mitigate fuel-related accidents is available. Refueling interlocks impose restrictions on the movements of refueling equipment and control rods prevent an inadvertent criticality during refueling operations. The RPS can initiate a reactor scram in time to prevent fuel damage in the event of errors or malfunctions during criticality testing with the reactor vessel head off. (See UFSAR Section 14.6.1.4).

Section 9.9.3.11 ("Control and Relay Room Air Conditioning Systems") and Figure 9.9-5 ("Flow Diagram - Administration and Control Room Heating Vent and Air Conditioning") of the FitzPatrick UFSAR describes the FitzPatrick Control Room Ventilation System. Section 9.9.3.3 ("Reactor Building Ventilation System") and Figure 9.9-1 ("Reactor Building Ventilation System") of the UFSAR describe the Reactor Building ventilation system. Design-basis radiological analyses are described in Section 14.8.2 ("Uprate Power Level Radiological Analyses") of the

UFSAR. Fuel handling accident analyses are described in UFSAR Sections 14.6.1.4 ("Refueling Accident"), and 14.6.3 ("Reload Core"). A 1995 report (Reference 26) summarizes how the FitzPatrick control room ventilation system compares to the NRC staff guidance in Standard Review Plan 6.4.

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

TABLE 1 - Summary of Proposed Changes to the Technical Specifications

<table>
<tr><th>Section</th><th>Title</th><th>Add "recently" irradiated ?</th><th>Delete CORE ALTERATIONS ?</th><th>Delete Operations with a potential for Draining the Reactor Vessel (OPDRVs)</th></tr>
<tr><td>3.3.6.2</td><td>Isolation Actuation Instrumentation, (Table 3.3.6.2-1, Secondary Containment Isolation Instrumentation)</td><td rowspan="10">YES</td><td rowspan="7">YES</td><td rowspan="10">NO</td></tr>
<tr><td>3.3.7.1</td><td>Control Room Emergency Ventilation System Air Supply (CREVAS) System Instrumentation</td></tr>
<tr><td>3.6.4.1</td><td>Secondary Containment</td></tr>
<tr><td>3.6.4.2</td><td>Secondary Containment Isolation Valves (SCIVs)</td></tr>
<tr><td>3.6.4.3</td><td>Standby Gas Treatment (SGT) System</td></tr>
<tr><td>3.7.3</td><td>Control Room Emergency Ventilation Air Supply (CREVAS) System</td></tr>
<tr><td>3.7.4</td><td>Control Room Air Conditioning (AC) System</td></tr>
<tr><td>3.8.2</td><td>AC Sources - Shutdown</td><td rowspan="3">NO</td></tr>
<tr><td>3.8.5</td><td>DC Sources - Shutdown</td></tr>
<tr><td>3.8.8</td><td>Distribution Systems - Shutdown</td></tr>
</table>

3.0 BACKGROUND

In December 1999, the NRC issued a new regulation, 10 CFR 50.67, which provides a means for power reactor licensees to replace their existing accident source term with AST. Regulatory Guide 1.183 (Reference 2) provides guidance for the implementation of alternate source terms (ASTs). 10 CFR 50.67 requires licensees seeking to use AST to apply for a license amendment and include an evaluation of the consequences of the affected design-basis accidents. This application addresses these requirements by proposing to selectively use the AST described in RG 1.183 in evaluating the radiological consequences of an FHA. As part of the implementation of the AST, the total effective dose equivalent (TEDE) acceptance criterion of 10 CFR 50.67(b)(2) replaces the previous whole body and thyroid dose guidelines of 10 CFR 100.11 and GDC 19, 10 CFR 50, Appendix A.

4.0 TECHNICAL ANALYSIS

4.1 Alternate Source Term

ENO has completed two new calculations evaluating the potential dose consequences of the fuel handling accident. A copy of both of these calculations is included with the application package. These calculations use the alternate source term guidelines outlined in NUREG-1465 (Reference 1), Regulatory Guide 1.183 (Reference 2) and DG-1111 (Reference 21). These calculations demonstrate that radiological doses at the exclusion area boundary (EAB), low population zone (LPZ) and in the control room (CR) are within allowable limits without crediting secondary containment operability, control room emergency ventilation filtration or standby gas treatment.

4.2 Atmospheric Dispersion (X/Q)

Atmospheric dispersion factors (X/Q) at the normal (primary) FitzPatrick control room air intake were calculated using the ARCON96 (Atmospheric Relative CONcentrations in Building Wakes, Reference 20) computer code. Primary assumptions used in this analysis are summarized below:

- Reactor building refuel floor normal exhaust (NE corner of reactor building) and Reactor Building Track Bay Doors were evaluated as release points
- Release point treated as ground-level release
- 8 years (1985 - 1992) of FitzPatrick-specific meteorological data
- The doors located in the reactor building pressure boundary are airtight, are normally closed (except for passage of authorized personnel) for security purposes and are arranged in an "air lock" configuration that allows passage by opening only one door at a time. Since the doors are normally closed during refueling outages they are not considered as potential release paths.
- Vent release mode not used as per DG-1111 (Reference 21) for avoiding the use of the vent release model (mixed mode release) in design-basis accident applications

Table 2 summarizes the results of this calculation. A copy of the complete calculation is included as part of this submittal.

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

TABLE 2 - Atmospheric Dispersion Factors (X/Q)
for Control Room X/Q (s/m^3) from Reference 5

Time Interval (hrs.)	Reactor Building Vent	Reactor Building Track Bay Doors
0 - 2	3.52E-03	9.07E-04
2 - 8	3.31E-03	8.27E-04
8 - 24	1.43E-03	3.59E-04
24 - 96	7.73E-04	2.33E-04
96 - 720	6.07E-04	2.03E-04

As noted in the introduction of DG-1111 (Reference 21), many of the positions in the guide represent significant changes. ARCON96 implements an improved building wake dispersion algorithm; assessments of ground level, building vent, elevated and diffuse-source release models; use of hour-by-hour meteorological observations; sector averaging; and directional dependence of dispersion conditions. Therefore, no discussion of the comparison with current licensing basis X/Q values is presented.

4.3 Radiological Consequences of a Design-Basis Fuel Handling Accident

The radiological consequences of a design-basis FHA were analyzed using FitzPatrick-specific design inputs and assumptions. No specific ESF functions were credited in the analysis. The calculations assumed that the control room ventilation system remained in its normal (non-emergency) mode. Similarly, the standby gas treatment system was assumed not to be operating. Plant-specific design inputs were validated (See NEI 99-03, Reference 11) to ensure that they are representative of "as-built" plant design conditions.

Primary assumptions used in this analysis are summarized below:

- Alternate source terms used
- No credit taken for ESF systems (secondary containment operability, standby gas treatment system filtration or operation of the control room emergency ventilation air supply system)
- Analyses used guidance in Regulatory Guide 1.183, Appendix B
- Fuel decayed for a period of 96 hours
- 99% of the release occurred during a 2-hour period
- Credited scrubbing of the halogen activity by water over dropped assembly

Table 3 summarizes the key assumptions and design-basis parameters used in the development of the source term. The EAB, LPZ and CR TEDE doses were calculated using the post-FHA release through the reactor building vent for 0-2 hours using the newly calculated

X/Qs (Reference 5).

Appendix B to RG 1.183

Appendix B of Regulatory Guide 1.183 (Reference 2) outlines six groups of assumptions acceptable to the NRC staff for evaluating the radiological consequences of a design-basis fuel handling accident. The following sections will discuss these assumptions as they relate to the new analyses.

Source Term

The fractions of core inventory assumed to be in the gap for the various nuclides are taken from Table 3 "Non-LOCA Fraction of Fission Product Inventory in Gap" of Regulatory Guide 1.183. These release fractions were then applied to the core fission product inventory, a conservative estimate of 125 fuel damaged rods, and a maximum core radial peaking factor of 1.6, to produce the source term used in the analysis.

Water Depth

A decontamination factor (DF) of 200 was assumed for the scrubbing effects of water on halogen activity released. The DF was based on a minimum of 23 feet of water over the dropped assembly. While the minimum water depth above spent fuel assemblies in the spent fuel pool permitted by TS is less (21 ft. 7 in.), calculations show that as a result of a reduced drop height, an assembly dropped over the spent fuel pool would involve less energy and result in fewer damaged assemblies. Consequently, the radiological consequences of a FHA over the reactor vessel bound the consequences of a FHA over the spent fuel pool.

Noble Gases

A decontamination factor of 1 was used because the retention of noble gases in the water in the fuel pool or reactor cavity is negligible. Particulate radionuclides were assumed to be retained by the water in the fuel pool or reactor cavity (i.e., infinite decontamination factor).

Fuel Handling Accidents within the Fuel Building

This section of the regulatory guide is not applicable, as FitzPatrick does not have a separate fuel building.

Fuel Handling Accident within Containment

Entergy analyses assumed that the reactor building refuel floor ventilation system is functioning and the exhaust dampers are open during fuel handling operations. No credit has been taken for ESF actuation or manual actions to restore containment closure. Radioactive material that escapes from the spent fuel pool, or reactor cavity, is released to the environment over a 2-hour period.

Credit for dilution or mixing of the activity released from the reactor cavity by natural or forced convection inside the containment was not considered.

Core Inventory

The core inventory is based on a thermal power level of 1.02 times the maximum power level authorized by the FitzPatrick operating license (2536 X 1.02 = 2,586.5 ≈ 2,587 MW_t). A radial peaking factor of 1.6 was used instead of 1.5 as recommended in Regulatory Guide 1.183 to provide additional margin for future core reloads and different fuels. The isotopic activities released from the damaged fuel rods are calculated based on the number of rods failed during the FHA and core thermal power level to obtain the Ci/MW_t

Number of Fuel Rods Damaged

The analyses assumed that 125 fuel rods were damaged. This is the same number as was used in the current licensing basis FHA. See UFSAR Section 14.8.2.1.4 "Refueling Accident."

Assuming that all fuel is GE-8, there are 60 rods per assembly, and a total of 560 assemblies, there would be a total of 33,600 fuel rods in the core. However, FitzPatrick currently has fuel types other than GE-8 in the reactor core. Although the number of fuel rods damaged for other fuel types (such as GE-9, GE-10 or GE-11 fuel) would be greater in number that for GE-8 fuel, the use of a core inventory release fraction (125/33600 = 0.37%) based on a full inventory of GE-8 fuel bounds the other fuel types.

Refer to GNF report NEDE-31152P (Reference 18) and NEDE-24011-P-A-US-14 (Reference 19) for additional information.

Timing of Release Phase

Gap activity in the damaged rods was assumed to be released instantaneously. The analysis assumed that the release to the atmosphere would occur over a 2-hour period.

RADTRAD Computer Code

Dose calculations were performed using the RADTRAD (RADionuclide Transport and Removal and Dose Estimation) computer program, Version 3.02 (Reference 15). RADTRAD uses a combination of tables and numerical models of source term reduction phenomena to determine the time-dependent dose at a specified location. It also provides the inventory, decay chain and dose conversion factors needed for the dose analysis. The RADTRAD code was developed by Sandia National Laboratories, the NRC's technical contractor, for the staff to use in estimating fission product transport and removal, and in estimating radiological doses at selected receptors at nuclear power plants. The NRC has reviewed and approved other AST-based TS changes that used this same program (Reference 22).

Control Room Envelope In-leakage

Infiltration pathways, other than through the normal CR outside air intake, were not considered in this analysis because the control room ventilation system was assumed to operate in it's "normal" (non-emergency mode) without taking credit for emergency filtration systems or the effects of pressurizing or isolating the control room envelope.

Between 1993 and 2002, FitzPatrick's control room envelope has been the focus of engineering work to improve it's operation. By design, the control room emergency ventilation system (in the isolated mode) is capable of maintaining 0.125 inch water positive pressure with respect to all adjacent areas. As a result of this work, the differential pressure at the most conservative test point has increased by almost 150%.

An annual control room envelope "integrity" inspection is conducted of cable penetrations, conduit-ends, ducts, walls, structural steel intersections, floor and roof drains, piping penetrations and door weather stripping. Quarterly tests are conducted to confirm system operation and to identify performance trends.

Entergy believes that the effects of any additional unfiltered air intake as a result of in-leakage will not be significant although tests to quantify air leakage into the control room envelope have not been conducted. This is based on the result of evaluations conducted over the past several years and the conservation assumptions and models used in this analysis.

4.4 Results

The resulting doses at the EAB, LPZ and CR locations are compared with the regulatory allowable limits in Table 4. Table 5 compares these to current licensing basis (CLB) radiological doses for a refueling accident (or FHA). CLB doses are from Tables 14.8-8, -9, -10 and -11 of the FitzPatrick UFSAR. Radiological doses to Technical Support Center (TSC) personnel were not calculated because an engineering evaluation demonstrated that exposures for CR personnel bound the doses expected for the TSC.

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

TABLE 3 - Key Inputs for Fuel Handling Analysis

Parameter	Value	Notes
Reactor Power Level	2,587 MWt	1.02 times current licensed power level (2,536 MWt)
Radial Peaking Factor	1.6	Conservative value - greater than 1.5 value recommended by NRC Safety Guide 25.
Number of Fuel Rods Damaged	125	Based on GE-8 fuel and drop height over reactor core.
Fuel Decay Time	96 hours	Assumption.
Total Number of Fuel Rods in Core	33,600 (560 assemblies)	Based on GE-8 fuel
Core Radionuclide Inventory	See Attachment 2, (JAF-CALC-RAD-04410, Reference 5)	
	Gap Fractions	
• Alkali Metals	0.12	From Regulatory Guide 1.183, Regulatory Position 3.2, Table 3, "Non-LOCA Fraction of Fission Product Inventory in Gap"
• Iodine 131	0.08	
• Other Halogens	0.05	
• Kr-85	0.10	
• Noble Gases - Excluding Kr-85	0.05	
	Iodine Release Chemical Form	
• Elemental	57%	From RG 1.183, Appendix B, Section 2.
• Organic	43%	
Overall Effective Iodine Decontamination Factor	200	Based on 23 ft. water depth over reactor core.
Control Room Volume	101,000 cu. ft.	From FitzPatrick UFSAR Section 14.8, Table 14.8-6, "Control Room Characteristics and CREVASS Operating Conditions and Flows"
Control Room Fresh Air Makeup Rate	2, 112 cfm	From plant drawing 11825-FB-35C, Rev. 14.
Release Point	Reactor Building Vent	Limiting X/Q.
Reactor Building Volume	2.60E+06 cubic feet	Calculation assumes all airborne activity is released within 2 hours.

Parameter	Value	Notes
Reactor Building Ventilation Rate	99,800 cfm	See, JAF-CALC-RAD-04410, Section 7.3, "Post-FHA Release Rate"

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

TABLE 4 - Radiological Dose Effects of Fuel Handling Accident
Reactor Building Refueling Vent Release Point

	Receptor Location		
	Control Room	EAB	LPZ
Calculated TEDE Dose (rem)	4.67	0.265	0.0296
Allowable TEDE Limit (rem)	5.00	6.30	6.30

TABLE 5 - Comparison of Current Licensing Basis (CLB) and
Alternate Source Term (AST) Radiological Doses
as a result of a Fuel Handling Accident at FitzPatrick

	Site Boundary / Exclusion Area Boundary		**Low Populations Zone**		**Control Room**		**Technical Support Center**	
	CLB (Rem)	AST (TEDE)	CLB (Rem)	AST (TEDE)	CLB (Rem)[1]	AST (TEDE)[2]	CLB (Rem)[4]	AST (TEDE)
Thyroid	2.38	0.265	0.46	0.0296	9.2	4.67	25.8	Not Cal.[3]
Whole Body	0.15		0.05		0.5		3.5	
Skin	0.24		0.09		0.6		2.0	

Notes

1. Assumes control room ventilation system is pre-isolated during fuel handling operations.
2. No credit taken for control room ventilation filtration system.
3. Not calculated - CR doses bound TSC doses.
4. Assumes technical support center ventilation system is isolated 30 minutes after refueling accident.

5.0 REGULATORY SAFETY ANALYSIS

5.1 No Significant Hazards Consideration

ENO has evaluated whether or not a significant hazards consideration is involved with the proposed amendment by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of amendment," as discussed below:

1. *Does not involve a significant increase in the probability or consequences of an accident previously analyzed?*

Response: No.

The proposed TS changes do not modify the design or operation of equipment used to move spent fuel or to perform core alterations. Because the equipment affected by the change is not an initiator to any previously analyzed accident, the proposed change cannot increase the probability of any previously analyzed accident.

The conservative re-analysis of the fuel handling accident concludes that radiological consequences are within the acceptance criteria in Regulatory Guide 1.183 and 10 CFR 50.67. The results of the core alteration events, other than the fuel handling accident, remain unchanged from the original design-basis, which showed that these events do not result in fuel cladding damage or radioactive release. The radiological analysis uses the same FHA source activity previously accepted in the design-basis FHA analysis. The same source activity is used with the guidance in the Regulatory Guide 1.183, Appendix B and the passive release/transport path, which does not take the dose mitigation credit of engineered safeguards including secondary containment and CREVAS Systems.

Therefore, this proposed amendment does not involve a significant increase in the probability of occurrence or consequences of an accident previously analyzed.

2. *Does not create the possibility of a new or different kind of accident from any accident previously analyzed?*

Response: No

The proposed post-FHA activity transport path is passive in nature and it does not take the credit of dose mitigation functions previously credited in the design-basis FHA analysis. The proposed changes do not introduce any new modes of plant operation and do not involve physical modifications to the plant.

Therefore, this proposed amendment does not create the possibility of a new or different kind of accident from any previously analyzed.

3. *Does not involve a significant reduction in the margin of safety?*

Response: No

The proposed changes revise the FitzPatrick TS to establish operational conditions where specific activities represent situations during which significant radioactive releases can be postulated. These new operational conditions are consistent with the proposed design-basis accident analysis and are established such that the radiological consequences are less than the regulatory allowable limits. Safety margins and analytical conservatisms are retained to ensure that the analysis adequately bounds all postulated event scenarios. The selected assumptions and release models provide an appropriate and prudent safety margin against unpredicted events in the course of an accident and compensates for large uncertainties in facility parameters, accident progression, radioactive material transport and atmospheric dispersion. The proposed TS applicability statements continue to ensure that the TEDE at the control room and the exclusion area and low population zone boundaries are below the corresponding regulatory allowable limits in 10 CFR 50.67(b)(2).

Therefore, these changes do not involve a significant reduction in margin of safety.

Based on the above, ENO concludes that the proposed amendment presents no significant hazards consideration under the standards set forth in 10CFR50.92(c), and, accordingly, a finding of "no significant hazards consideration" is justified.

5.2 Applicable Regulatory Requirements/Criteria

This section describes how the proposed changes and ENO's technical analyses satisfy applicable regulatory requirements and acceptance criteria.

10 CFR 50, Appendix A, General Design Criterion 61, "Fuel Storage and Handling and Radiological Control"

The general design criteria (GDC) in place today became effective after the FitzPatrick construction permit was issued. A September 18, 1992 memorandum to the NRC EDO from the Secretary of the NRC summarized the results of a Commissioners vote in which the Commissioners instructed the NRC staff not to apply the GDC to plants with construction permits issued prior to May 21, 1971. FitzPatrick's construction permit was issued on May 20, 1970.

FitzPatrick's design and licensing basis for fuel storage and handling and radiological controls is detailed in the updated Final Safety Analysis Report (UFSAR), and other plant-specific licensing basis documents. Appendix H of the FitzPatrick operating license (OL) FSAR evaluated the FitzPatrick design against the GDC presented in 10 CFR 50, Appendix A, effective May 21, 1971.

10 CFR 50.67 "Accident Source Term"

10 CFR 50.67 permits licensees to voluntarily revise the accident source term used in design-basis radiological consequence analyses. This document is part of a 10 CFR 50.90 license amendment application and evaluates the

consequences of a design-basis fuel handling accident previously reported in the safety analysis report.

10 CFR 50.65 "Requirements for monitoring the effectiveness of maintenance at nuclear power plants"

10 CFR 50.65(a)(4) requires licensees to assess and manage changes in risk that result from taking risk-significant systems out-of-service or during certain maintenance activities. The NRC staff, in Regulatory Guide 1.182 (Reference 23) state that the methods detailed in Section 11 of NUMARC 93-01 (Reference 16) are acceptable for complying with the requirements of 10 CFR 50.65(a)(4). Section 11.3.6.5 "Containment - Primary (PWR)/Secondary (BWR)," of NUMARC 93-01 states:

> *Maintenance activities involving the need for open containment should include evaluation of the capability to achieve containment closure in sufficient time to mitigate potential fission product release. This time is dependent on a number of factors, including the decay heat level and the amount of RCS inventory available.*
>
> *For BWRs, technical specifications may require secondary containment to be closed under certain conditions, such as during fuel handling and operations with a potential to drain the vessel.*
>
> *In addition to the guidance in NUMARC 91-06, for plants which obtain license amendments to utilize shutdown safety administrative controls in lieu of Technical Specification requirements on primary or secondary containment operability and ventilation system operability during fuel handling or core alterations, the following guidelines should be included in the assessment of systems removed from service:*
>
> - *During fuel handling/core alterations, ventilation system and radiation monitor availability (as defined in NUMARC 91-06) should be assessed, with respect to filtration and monitoring of releases from the fuel. Following shutdown, radioactivity in the RCS decays fairly rapidly. The basis of the Technical Specifications operability is the reduction in doses due to such decay. The goal of maintaining ventilation system and radiation monitor availability is to reduce dose even further below that provided by the natural decay, and to avoid unmonitored releases.*
>
> - *A single normal or contingency method to promptly close primary or secondary containment penetrations should be developed. Such prompt methods need not completely block the penetration or be capable of resisting pressure. The purpose is to enable ventilation systems to draw the release from a postulated fuel handling accident in the proper direction such that it can be treated and monitored.*

To further limit the potential radiological consequences of a fuel handling accident at FitzPatrick, Entergy will revise the FitzPatrick guidelines for assessing systems removed from service during the handling of recently irradiated fuel assemblies or core alterations to implement the provisions of Section 11.3.6.5 of NUMARC 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," Revision 3. These new or revised guidelines will address the capabilities to promptly close secondary containment and will be completed prior to the implementation of this license amendment. (This commitment is also consistent with the NRC-approved generic TS change, TSTF-51 (Reference 24) regarding usage of the term "recently irradiated fuel assemblies.")

10 CFR 100, Paragraph 11, "Determination of Exclusion Area, Low Population Zone and Population Center Distance"

This paragraph provides criteria for evaluating the radiological aspects of reactor sites. A footnote to 10 CFR 100.11 states that the fission product release assumed in these evaluations should be based on a major accident involving substantial meltdown of the core with subsequent release of appreciable quantities of fission products. A similar footnote appears in 10 CFR 50.67.

In accordance with the provisions of 10 CFR 50.67(a), the radiation dose reference values in 10 CFR 50.67(b)(2) were used in these analyses in lieu of those prescribed in 10 CFR 100. (Refer to footnote 5 on page 1.183-7 of Regulatory Guide 1.183, dated July 2000.)

Regulatory Guide 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors"

Regulatory Guide 1.25 is not applicable to the application. Regulatory Guide 1.183 supersedes corresponding radiological assumptions provided in other regulatory guides and standard review plan chapters when used in conjunction with an approved alternate source term and the TEDE criteria provided in 10 CFR 50.67.

Regulatory Guide 1.183, "Alternative Radiological Source Terms for evaluating Design Basis Accidents at Nuclear Power Reactors", July 2000

This guide outlines acceptable applications of ASTs; the scope, nature and documentation of associated analyses and evaluations; consideration of impacts on analyzed risk; and content of submittals. It also establishes acceptable ASTs and identifies the attributes of ASTs acceptable to the NRC staff. This guide also identifies acceptable radiological analysis assumptions for use in conjunction with the AST.

Entergy used this regulatory guide extensively in the preparation of this "selective implementation" evaluation, the supported application and the supporting analyses. This application and the supporting analyses comply with this guidance to the extent practical.

NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants"

NUREG-1465 (Reference 1) provides more realistic estimates of "source term" releases into containment in terms of timing, nuclide types, quantities, and chemical form, given a severe core melt, than TID-14844 (Reference 17). NUREG-1465 provides much of the technical basis for the regulatory positions in Regulatory Guide 1.183.

NUREG-0800, Standard Review Plan, Section 15.7.4, "Radiological Consequences of Fuel Handling Accidents"

This SRP section covers the review of the radiological effects of a postulated fuel handling accident. Revision 1 does not reflect the guidance in Regulatory Guide 1.183 or the promulgation of 10 CFR 50.67.

5.3 Conclusion

The results of these analyses indicate that the dose at the exclusion area boundary (EAB) would be no more than 0.265 rem total effective dose equivalent (TEDE) and the dose at the low-population zone (LPZ) would be no more than 0.0296 rem TEDE. These results are less than the TEDE criteria of 6.3 rem set forth in Regulatory Guide 1.183 and are a small fraction of the dose criteria in 10 CFR 50.67(b)(2)(i) and (ii). The analyses also show that control room operators would receive no more than 4.67 rem TEDE. These doses are less than the TEDE limit of 5 rem contained in 10 CFR 50.67(b)(2)(iii) and GDC -19, "Control Room."

In conclusion, based on the considerations discussed above,

(1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner,
(2) such activities will be conducted in compliance with the Commission's regulations, and
(3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

Similar TS changes were approved by the NRC in Reference 4.

6.0 ENVIRONMENTAL CONSIDERATION

ENO has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, or would change an inspection or surveillance requirement. However, the proposed amendment does not involve

(i) a significant hazards consideration,
(ii) a significant change in the types or significant increase in the amounts of any

effluent that may be released offsite, or

(iii) a significant increase in individual or cumulative occupational radiation exposure.

Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

7.0 REFERENCES

1. NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants," L. Soffer et al., February 1995.

2. USNRC Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accident at Nuclear Power Reactors," July 2000.

3. Entergy letter, T. A. Sullivan to USNRC (JAFP-02-0098) dated April 26, 2002 regarding "Revision J to Proposed Technical Specification Change (License Amendment) Conversion to Improved Standard Technical Specifications."

4. USNRC letter, D. S. Hood to G. Van Middlesworth, dated April 16, 2001 regarding "Duane Arnold Energy Center - Issuance of Amendment Regarding Secondary Containment Operability During Movement of Irradiated Fuel and Core Alterations (TAC No. MB1569)."

5. FitzPatrick Calculation No. JAF-CALC-RAD-04409, Rev 0, "CR X/Qs Using ARCON96 Code for Post-FHA from RB Track Bay Door and RB Vent."

6. FitzPatrick Calculation No. JAF-CALC-RAD-04410, Rev. 0, "Fuel Handling Accident - AST Analysis for Relaxation of Secondary Containment Operability."

7. 10 CFR 50.67, "Accident Source Term"

8. GE letter to R. Chau (NYPA) from C. H. Stoll (GE plant performance engineering) dated May 2, 1991, regarding " J. A. FitzPatrick power uprate program – formal transmittal of final source term analysis results," Table 6.

9. USNRC Regulatory Guide 1.49, Rev. 1, "Power Levels for Nuclear Power Plants."

10. FitzPatrick Technical Specifications: Specification LCO 3.6.4.1, Secondary Containment; Bases 3.9.6, Reactor Pressure Vessel (RPV) Water Level; Specification LCO 3.7.7, Spent Fuel Pool Water Level; Specification 1.1, Definitions – Rated Thermal Power; Specification 4.2.1, Fuel Assemblies; TS Figure 4.1-1, Site and Exclusion Area Boundaries.

11. NEI 99-03, "Control Room Habitability Guidance."

12. GE Technical Report NEDO-20360, "Licensing Topical Report, General Electric Boiling Water Reactor, Generic Reload Application for 8x8 Fuel", Rev. 1, November 1974.

13. Global Nuclear Fuel, NEDE-31152P, Revision 8, Class III, April 2001, "General Electric Fuel Bundle Designs."

14. USNRC Safety Guide 25, "Assumptions Used For Evaluating The Potential Radiological Consequences Of A Fuel Handling Accident In The Fuel Handling and Storage Facility For Boiling and Pressurized Water Reactors," dated March 23, 1972.

15. S. L. Humphreys et al., "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation," NUREG/CR-6604, USNRC, April 1998.

16. NUMARC 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," Revision 3.

17. J. J. DiNunno et. al., "Calculation of Distance Factors for Power and Test Reactor Sites," USAEC TID-14844, U. S. Atomic Energy Commission (now USNRC), 1962.

18. Global Nuclear Fuel, NEDE-31152P, Revision 8, Class III, April 2001, "General Electric Fuel Bundle Designs."

19. General Electric, NEDE-24011-P-A--US-14, "General Electric Standard Application for Reactor Fuel (Supplement for United States)."

20. ARCON96 computer code described in NUREG/CR-6331, "Atmospheric Relative Concentrations in Building Wakes," Revision 1, May 1997.

21. USNRC Draft Regulatory Guide DG-1111, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants," December 2001.

22. USNRC letter, R. B. Ennis to H. W. Keiser, dated October 3, 2001 regarding "Hope Creek Generating Station - Issuance of Amendment Re: Increase in Allowable Main Steam Isolation Valve (MSIV) Leakage Rate and Elimination of MSIV Sealing System (TAC No. MB1970)."

23. USNRC Regulatory Guide 1.182, "Assessing and Managing Risk before Maintenance Activities at Nuclear Power Plants."

24. TSTF-51, Rev. 2 , "Revise Containment Requirements During Handling Irradiated Fuel and Core Alterations," Excel Services Corporation.

25. 10 CFR 100.11 "Determination of exclusion area, low population zone and population center distance."

26. NYPA letter, W. J. Cahill to USNRC dated March 2, 1995 (JPN-95-010) regarding "Response to NUREG-0737, Item III.D.3.4, Control Room Habitability."

Attachment 2 to JPN-02-016

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

Entergy Calculation No. JAF-CALC-RAD-04410, Rev. 0

"Fuel Handling Accident - AST Analysis for Relaxation of Secondary Containment Operability."

Entergy	CALCULATION CONTINUATION SHEET		SHEET No. 1 of 78	
	CALC. TITLE: Fuel Handling Accident – AST Analysis for Relaxation of Secondary Containment Operability			
	CALC. NO.: JAF-CALC-RAD-04410		REVISION NO.	0
	ORIGINATOR/DATE	G. Patel 05/23/02	REVIEWR/DATE	M. Drucker 05/24/02

CALCULATION COVER PAGE

☐ IP-2 ☐ IP-3 ☒ JAF ☐ PNPS

Calculation No.: JAF-CALC-RAD-04410	Revision 0	Sheet 1 of 78 (includes attachments)

Title:
Fuel Handling Accident – AST Analysis for Relaxation of Secondary Containment Operability

Status:
☐ Preliminary
☒ Pending
☐ As-Built
☐ Void
☐ Superceded

☒ QR ☐ NQR

Discipline: Radiological

Design Basis Calculation? ☒ Yes ☐ No

This calculation supersedes calculation N/A

Modification No./Task No/ER No: N/A

Software Used? ☒ Yes ☐ No (If Yes, include Computer Run Summary Sheet)

System No./Name: Secondary Containment / System 24

Component No./Name: N/A

(Attached additional pages if necessary)

Print/Sign	
Preparer: Gopal J. Patel NUCORE Consulting Services, Inc.	Date: 05/23/02
Reviewer/Design Verifier: Mark Drucker NUCORE Consulting Services, Inc. Mark F Drucker	Date: 05/24/02
Other Reviewer/Design Verifier: Gary C. Ré Gary C. Ré	Date: 5/29/02
Approver: Gary C. Ré Gary C. Ré	Date: 5/29/02

RECORD OF REVISIONS

Calculation Number: JAF-CALC-RAD-04410

Revision No.	Description of Change	Reason For Change
0	Original Issue	N/A

CALCULATION SUMMARY PAGE

Calculation No. JAF-CALC-RAD-04410 **Revision No. 0**

CALCULATION OBJECTIVE:

The purpose of this analysis is to determine the Exclusion Area Boundary (EAB), Low Population Zone (LPZ) and Control Room (CR) doses due to a Fuel Handling Accident (FHA) occurring in the reactor building (RB) without RB integrity (operability). The FHA analysis is performed using selective application of the Alternative Source Term (AST), the guidance in Regulatory Guide 1.183, Appendix B, and TEDE dose criteria.

This analysis provides a basis for relaxing JAF Technical Specification LCOs 3.6.4.1 through 3.6.4.3, 3.3.6.2, 3.7.3 and 3.3.7.1 applicability when irradiated fuel is being handled in the secondary containment (SC) and during core alterations.

CONCLUSIONS:

The results of the analysis, presented in Section 8, indicate that the EAB, LPZ and CR doses are within their respective allowable limits for a FHA occurring in the reactor building without secondary containment operability (i.e., with the containment RB vent opened). This analysis provides a basis for relaxation of the following JAF Technical Specification requirements:

After 96 hours of fission product decay:

1. Irradiated fuel assemblies can be moved and core alterations can be performed without secondary containment operability (Relaxation to Technical Specification LCO 3.6.4.1).
2. Secondary containment isolation valves (SCIVs) can be inoperable during movement of irradiated fuel in secondary containment and during core alterations (Relaxation to Technical Specification LCO 3.6.4.2).
3. Standby Gas Treatment System can be inoperable during movement of irradiated fuel in secondary containment and during core alterations (Relaxation to Technical Specification LCO 3.6.4.3).
4. The secondary containment isolation instrumentation for each function in Table 3.3.6.2-1 can be inoperable during movement of irradiated fuel in SC and during core alterations (Relaxation to Technical Specification LCO 3.3.6.2).
5. Two Control Room Emergency Ventilation Air Supply (CREVAS) subsystems can be inoperable during movement of irradiated fuel in secondary containment and during core alterations (Relaxation to Technical Specification LCO 3.7.3). This includes CREVAS system instrumentation (Relaxation to Technical Specification LCO 3.3.7.1)

ASSUMPTIONS:
The assumptions are listed in Section 4.0 of this calculation.

DESIGN INPUT DOCUMENTS:
The design inputs are listed in Section 5.0 of this calculation and supporting reference documents are listed in Section 6.0.

AFFECTED DOCUMENTS: PENDING

METHODOLOGY:
The calculation methodology complies with the guidance in Regulatory Guide 1.183, Appendix B and TEDE dose criteria in 10 CFR 50.67.

CALCULATION IMPACT REVIEW PAGE

Date: ____________ ☒ QR ☐ NQR

(Note: X indicates required distribution)

To:
- ___ Mechanical Engineering
- ___ I&C Engineering
- ___ Electrical Engineering
- ___ Civil Engineering
- _x_ System Engineering
- ___ Projects
- ___ Operations
- ___ Elect Maintenance
- ___ I&C Maintenance
- ___ Mech. Maintenance
- ___ Training
- ___ Computer Applications
- ___ Quality Assurance
- ___ Chemistry
- _x_ HP/Radiological
- ___ Procurement
- _x_ Rad Engineering
- _x_ Emergency Planning

From: ______________________________
(Print Name and Phone extension)

Calculation No.: JAF-CALC-RAD-04410 Revision No. 0

Title: Fuel Handling Accident – AST Analysis for Relaxation of Secondary Containment Operability

MESSAGE: Work organizations are requested to review the subject calculation (parts attached) to identify impacted calculations, procedures, Technical Specifications, FSAR sections, other design documents and other documents that must be updated because of the calculation results. Also, provide the name of the individual responsible for the action and the tracking number.

IMPACT REVIEW:

Procedures, Tech Specs, FSAR, System Design Basis Documents, Topical Design Basis Documents, Drawings, etc.	Responsible Individual	Action Tracking Number

Manager (or designee): ______________________________
Signature Date

Return the completed Calculation Impact Review to the originator.

Date Required: ____________

COMPUTER RUN SUMMARY SHEET

Calculation No. JAF-CALC-RAD-04410 Revision 0 Date 5/29/02

Sheet 5 of 78

Subject: Fuel Handling Accident – AST Analysis for Relaxation of Secondary Containment Operability

Code RADTRAD Catalog No. Pending Version 3.02

Run Title RADTRAD FHA INPUT/OUTPUT FILE

Run No. N/A Run Date 5/17/02 By NUCORE

Output Use:
- ☐ Variable Values as Noted
- ☐ Tape No. ______
- ☐ Disk
- ☐ Plot Attached
- ☒ File No. J16FHA96VT00.O0

Description Of Output See Attachment C

Comments ______

(Attached additional pages if necessary)

Review:
- ☒ Information Entered Above is Accurate
- ☒ Input Entry Accurate Based on Echo File Comparison to User Manual
- ☒ Code Properly Executed (Based on User Manual)
- ☒ Output Accurately Extracted or Location Specified

Reviewer Comments ______

GOPAL J. PATEL		Mark L. Drucker MARK DRUCKER	5/24/2002
Preparer (Print/Sign)	Date	Reviewer (Print/Sign)	Date

TABLE OF CONTENTS

1.0 BACKGROUND

1.1 Definitions

1.1.1 Containment Closure

The action to secure secondary containment (SC) and its associated structures, systems and components as a FUNCTIONAL barrier to fission product release under existing plant conditions is referred to as closure. Functional barriers prevent or minimize airflow between compartments, but are not necessarily airtight or able to withstand a pressure difference.

1.1.2 Operable – Operability

A structure, system and component shall be considered operable or be maintaining operability when it is capable of performing its specified safety function(s) (Ref. 6.6.4).

1.2 Maintaining Secondary Containment Operability

The duration of refueling outages continues to be shortened to reduce plant operating costs. Therefore, any disruptions to critical path work can be extremely costly. This analysis supports elimination of a potential critical path impediment, namely maintenance of secondary containment (SC) operability.

1.2.1 Primary Release Path

The reactor building (RB) vent is the normal release point for air exhausted from the refuel floor (RF) and below-RF ventilation systems. Inoperability of SC isolation systems could result in this vent remaining open for the duration of a postulated Fuel Handling Accident (FHA). Therefore, this analysis considers a RB vent release as a viable post-FHA release path when RB isolation systems are rendered inoperative.

1.2.2 Secondary Release Path

Moving large quantities of material, as well as oversized components, into and out of the reactor building (RB) under current Technical Specifications (CTS) requires the reactor building track bay (RBTB) doors (R-272/1 & R-272/2) to be used in airlock mode to maintain SC operability. The RBTB doors are at ground level on the south wall of the RB. They are the largest doors into the RB and are capable of accommodating very large items such as railcars, spent-fuel casks, etc. As such, open track bay doors are considered a viable release path for post-FHA releases and hence are evaluated in this analysis.

1.2.3 Secondary Containment Operability

Secondary containment and its associated systems' operability requirements are specified in TS LCO 3.6.4.1 through LCO 3.6.4.3 (Refs. 6.6.1, 6.6.7 & 6.6.8) and LCO 3.6.6.2 (Ref. 6.6.9). The proposed relaxation of SC operability allows the RB track bay (RBTB) doors (R-272/1 & R-272/2) and plant vent to remain open during refueling outages. It also allows the associated systems, which are normally required to maintain SC operability, to be unavailable during movement of irradiated fuel and core alterations. The Control Room Emergency Ventilation Air Supply (CREVAS) System also need not be operable, per LCO 3.7.3 and LCO 3.3.7.1 (Refs. 6.6.10 & 6.6.11).

1.3 Release Pathways - Details

The following release pathways are reviewed below to determine potential post-FHA release points:

1. Doors in the RB Pressure Boundary
2. RB Vent
3. RBTB Doors

1.3.1 Doors in the Reactor Building Pressure Boundary

The doors located in the RB pressure boundary (Ref. 6.21) are airtight (Ref. 6.10.9), are normally closed (except for passage of authorized personnel) for security purposes, and are arranged in an "air lock" configuration that allows passage by opening only one door at a time. Since the doors are normally closed during refueling outages they are not considered as potential release paths.

1.3.2 Reactor Building Vent

The air from the RF is exhausted through ducts, which are comprised of radiation monitoring systems, two independent exhaust trains and air-operated valves (AOVs) in series (Ref. 6.24). The arrangement of two parallel air-operated dampers (AODs) downstream of the exhaust fans and in series with the AOVs makes the RF exhaust system single failure proof. Should a FHA occur, the exhaust duct radiation monitors isolate the RB vent, which is followed by startup of the standby gas treatment system. RB air is then directed to the SGTS (Ref. 6.24), where it is filtered through charcoal filters and released to the environment via the main stack. This monitored release path is already analyzed in the CR habitability analysis in Reference 6.18 on pages 60 through 65 and the results are shown on pages 66 and 67. The worst-case CR thyroid and whole body doses are 24.86 rem and 0.01985 rem, respectively (Ref. 6.18, page 66, un-isolated CR). The corresponding CR TEDE dose is 0.767 rem (24.86 x 0.03 + 0.01985 = 0.767 rem) (Ref. 6.1, Section 1.3.4, Note 7).

With relaxation of SC and associated support-system operability during a refueling outage, the SGTS becomes inoperable, which makes available an unfiltered release path to the environment through the RB vent, should a FHA occur.

1.3.3 Reactor Building Track Bay Doors

The relaxation of SC containment operability allows the RBTB doors to remain open during refueling outages. The RBTB doors are a potential new path for the post-FHA release. Should a FHA occur, the activity contained in the RB volume from the damaged fuel could be released to the environment at ground level through the RBTB door.

1.3.4 Release Point Comparison

The atmospheric dispersion factors (χ/Qs) developed in Reference 6.5 for the post-FHA releases through the RB vent and RBTB doors are compared in the following table:

Time Interval (hr)	JAF CR Intake X/Qs (s/m^3)	
	RB Vent Release	RBTB Door Release
0-2	3.52E-03	9.07E-04
2-8	3.31E-03	8.27E-04
8-24	1.43E-03	3.59E-04
24-96	7.73E-04	2.33E-04
96-720	6.07E-04	2.03E-04

The comparison of χ/Qs in the above table shows that the post-FHA release through the RB vent is the most limiting for the CR doses. The post-FHA release through the RBTB doors is thus enveloped by the RB vent release (i.e., a post-FHA activity release through the RB vent to the CR has less atmospheric dispersion and more severe CR dose consequences than a release through the RBTB doors to the CR). Therefore, the post-FHA doses are analyzed using the RB vent release.

1.3.5 Technical Specification Requirements

The following technical specification requirements are addressed in this FHA analysis:

- Section 3.9.6: Reactor Pressure Vessel (RPV) Water Level

  RPV water level shall be ≥ 22 ft 2 inches above the top of the RPV flange (Ref. 6.6.2)

- Section 3.7.7: Spent Fuel Storage Pool Water Level

  The spent fuel storage pool water level shall be ≥ 21 ft 7 inches over the top of irradiated fuel assemblies seated in the spent fuel pool storage racks (Ref. 6.6.3).

- Section 1.1: Definitions – Rated Thermal Power (RTP)

  RTP shall be the total reactor core heat transfer rate to the reactor coolant of 2536 MW_{th} (Ref. 6.6.4).

- Section 4.2.1: Reactor Core Fuel Assemblies

  The reactor shall contain 560 fuel assemblies (Ref. 6.6.5)

- Figure 4.1-1: Site and Exclusion Area Boundaries

  See the Technical Specifications (Ref. 6.6.6) for this figure.

- Section 3.6.4.2 Secondary Containment Isolation Valves (SCIVs)

  Each SCIV shall be operable (Ref. 6.6.7)

- Section 3.6.4.3 Standby Gas Treatment (SGT) System

  Two SGT subsystems shall be operable (Ref. 6.6.8).

- Section 3.3.6.2.Secondary Containment Isolation Instrumentation

  Secondary containment isolation instrumentation for each function in Table 3.3.6.2-1 shall be operable (Ref. 6.6.9).

- Section 3.7.3 Control Room Emergency Ventilation Air Supply (CREVAS) System

  Two CREVAS subsystems shall be operable (Ref. 6.6.10).

- Section 3.3.7.1 Control Room Emergency Ventilation Air Supply (CREVAS) System Instrumentation

  The Control Room air inlet radiation-high channel shall be operable (Ref. 6.6.11)

2.0 PURPOSE

The purpose of this analysis is to determine the Exclusion Area Boundary (EAB), Low Population Zone (LPZ) and Control Room (CR) doses resulting from a Fuel Handling Accident (FHA) occurring in the reactor building (RB) without requiring SC operability. The FHA analysis is performed using selective application of the Alternative Source Term (AST), the guidance in Regulatory Guide 1.183, Appendix B, and TEDE dose criteria.

This analysis provides a basis for removing JAF Technical Specifications 3.6.4.1 through 3.6.4.3 (Refs. 6.6.1, 6.6.7, & 6.6.8), 3.3.6.2 (Ref. 6.6.9), 3.7.3 (Ref. 6.6.10) and 3.3.7.1 (Ref. 6.6.11) applicability when irradiated fuel is being handled in the secondary containment and during core alterations.

The Technical Support Center (TSC) air intakes are located 65 feet farther west of the primary CR air intakes (Ref. 6.10.12). The resulting TSC intake χ/Qs will be smaller than those for the CR air intakes. Therefore, the CR dose is bounding for the TSC dose.

3.0 METHOD OF ANALYSIS

The FHA is analyzed using RB-specific design inputs, which are compatible with the AST and TEDE dose criteria. Per NEI 99-03 (Ref. 6.11), all JAF plant-specific design inputs are validated to assure that they represent the as-built plant design conditions (Ref. 6.22). No specific ESF function is credited in the analysis except scrubbing of the halogen activity by the water column above the postulated damaged fuel assembly.

3.1 Halogen Decontamination Factor

A design-basis FHA postulates dropping a spent GE 8x8 fuel assembly over the reactor vessel, resulting in a total of 125 damaged fuel rods (Ref. 6.13). All activity released from the damaged rods passes through at least 23 feet of water before reaching the surface. Halogen activity scrubbing by the water column results in only 0.5% of the released halogens reaching the surface, which equates to a decontamination factor (DF) of 200 (Ref. 6.1, RGP B.2).

This is not the case for a FHA occurring in the spent fuel pool (SFP). The SFP water level is normally maintained at about 21 feet 7 inches over the top of irradiated fuel assemblies seated in the spent fuel pool storage racks (Ref. 6.6.3). The effective halogen DF for 21 feet 7 inches of water is 172.75, as calculated in Reference 6.17. However, an assembly dropped in the SFP travels a distance of only two (2) feet before being stopped by the stored assemblies. The reduced energy of impact results in 81 fuel rods being damaged (Ref. 6.12, page 10). This reduced source term more than offsets the increased halogen release from the water surface due to a reduced DF (Ref. 6.12, page 11). Therefore, an effective DF of 200 is used in this analysis based on a water depth of 23 feet (Ref. 6.1, RGP B.2).

3.2 FHA Source Term

The core inventory is obtained from Reference 6.3, which is calculated based on a thermal power level of 2,586.5 ≈ 2,587 MW_{th} (Refs. 6.3, 6.4, & 6.6.4). A radial peaking factor of 1.6 (Ref. 6.23) is conservatively used instead of 1.5 as recommended in Reference 6.15 (RGP C.1.e). The core inventory obtained from Reference 6.3 is listed in Design Input 5.3.1.2, Table 1.

The isotopic activities released from the damaged fuel rods are calculated in Table 8 based on 125 failed fuel rods (Ref. 6.13, Section 6.3.2.2.3.1) and core thermal power level of 2,587 MW_{th} to obtain the Ci/MW_{th}. The RADTRAD V3.02 default nuclide inventory file (NIF) Bwr_def.NIF is modified based on the normalized Ci/MW_{th}. The plant-specific NIF (J1.6FHA200_def) is further modified to include the isotopes Kr-83m, Br-83, Br-84. I-130, Xe-131m, Xe-133m, Xe-135m and Xe-138.

3.3 Dose Calculations

The RADTRAD3.02 dose conversion factor (DCF) file (Fgr11&12) is modified to include the DCFs for the added isotopes. The modified DCF file (JAFHA_FG11&12) is used in the FHA analysis. Since the DCFs for ground shine dose and dose rate are not used to evaluate the offsite and CR doses, they are set to zeros in the modified DCF file.

The CR TEDE dose is calculated using the post-FHA airborne radioactivity released through the RB vent for 0-2 hrs. The CR is maintained in the normal mode of operation for the entire duration of the accident without taking credit for the Control Room Emergency Ventilation Air Supply System (CREVASS). The activity release rate from the damaged fuel pins is postulated to release almost all radioactive material to the environment over a 2-hour period (Ref. 6.1, Regulatory Position 5.3).

The resulting doses at the EAB, LPZ and CR locations are compared in Section 8.1 with the regulatory allowable limits.

3.4 Atmospheric Dispersion

Newly calculated CR χ/Qs (Ref. 6.5) are used for the release through the RB vent.

Turbine building (TB) χ/Qs are used for calculating doses at the EAB and LPZ (Ref. 6.9, page 16). RB vent releases were not specifically calculated in Ref. 6.9 because design-basis accident releases are from either the stack (LOCA and FHA) or TB surfaces (CRDA and MSLBA). However, TB χ/Qs would bound those of the RB Vent for offsite receptors, as described below.

The shortest on-land site boundary distance for a TB release is 975 meters. This distance was used for all northern sectors leading to the shoreline (W to ESE), and is closer to the TB than the RB Vent (Ref. 6.9, page 50). In the southerly directions (SE to WSW), the distance from the TB to the site boundary varies from 1290 to 2240 meters. While these distances would be slightly lower for the RB Vent, the limiting TB to EAB distance would bound the PV χ/Qs.

3.5 Computer Code Verification

Post-LOCA containment leakage models for the CR, EAB and LPZ doses using the TID source terms are described in References 6.18 and 6.19, respectively. The same post-LOCA release model is recreated using the RADTRAD3.02 code to validate the code's ability to produce identical results for the same source terms, transport mechanisms, atmospheric dispersion, control room response and dose conversion factors. The results are compared in Section 8.2.

4.0 ASSUMPTIONS

The requirements in Regulatory Guide 1.183, Appendix B (Ref. 6.1) are adopted line-by-line as assumptions in this section. They are incorporated as design inputs along with other plant-specific as-built design parameters in Section 5.2. The assumptions in this section typically have been acceptable to the Staff for evaluating the radiological consequences of a FHA.

Source Term Assumptions

4.1 Per Reference 6.1, Regulatory Position 3.2, for non-LOCA events, the fractions of the core inventory assumed to be in the gap for the various radionuclides are given in Table 3 of RG 1.183. The release fractions from Table 3 are incorporated in Design Input 5.3.1.3 (Table 2) in conjunction with the core fission product inventory in Design Input 5.3.1.2 (Table 1) with the maximum core radial peaking factor of 1.60 (see Design Input 5.3.1.9).

4.2 Per Reference 6.1, Appendix B, Regulatory Position B.1.1, the number of fuel rods damaged during the accident should be based on a conservative analysis that considers the most limiting case. Per Reference 6.17, 125 fuel rods are assumed damaged in the DB-FHA, which considers a spent-fuel assembly dropped onto the core in the reactor vessel (see Design Input 5.3.1.5).

4.3 Core Inventory

Per Reference 6.1, Appendix B, Regulatory Position B.1.2, the fission product release from the breached fuel is based on the fraction of fission product inventory in the gap (RGP 3.2) and the estimated number of fuel rods breached (See Table 8).

The inventory of fission products in the reactor core that is available for gap release from damaged fuel is based on the maximum power level of 2,587 MW_{th}, which corresponds to current fuel enrichment and burnup and is 1.02 times the current licensed rated thermal power of 2,536 MW_{th} (Ref 6.6.4). The gap activity in the damaged rods is assumed to be released instantaneously. The fraction of the fission product inventory comprising the gap activity is shown in Design Input 5.3.1.3 (Table 2). It is further assumed that irradiated fuel is not removed from the reactor until the unit has been sub-critical for at least 96 hours (Design Input 5.3.1.8).

4.4 Timing of Release Phase

Per Reference 6.1, Regulatory Position 3.3, for non-LOCA DBAs in which fuel damage is projected, the release from the fuel gap and the fuel pellet is assumed to occur instantaneously with the onset of the projected damage.

4.5 Chemical Form

Per Reference 6.1, Appendix B, Regulatory Position B.1.3, the chemical form of radioiodine released from the fuel to the surrounding water is assumed to be 95 percent cesium iodide (CsI), 4.85 percent elemental iodine, and 0.15 percent organic iodide. The CsI released from the fuel is assumed to completely dissociate in the pool water. Because of the low pH of the pool water, the iodine re-evolves as elemental iodine. This is assumed to occur instantaneously.

4.6 Water Depth

The depth of water above the postulated damaged fuel is 23 feet or greater, thus the decontamination factors for the elemental and organic species are 500 and 1, respectively, giving an overall effective decontamination factor of 200 (i.e., 99.5% of the total iodine released from the damaged rods is retained by the water). This difference in decontamination factors for elemental (99.85%) and organic iodine (0.15%) species results in the iodine above the water being composed of 57% elemental and 43% organic species (Ref. 6.1, RGP B.2).

A FHA occurring in the SFP was considered because the depth of water above a postulated damaged fuel assembly is less than 23 feet. However, analysis shows that the smaller number of failed fuel rods postulated to fail in a SFP-FHA (81 instead of 125) conservatively compensates for the lesser water depth (23'-0" – 21'-7" = 1'-3). Therefore, a resulting overall effective DF of 200 is assumed per Reference 6.1, RGP B.2.

4.7 Noble Gases and Particulates

The retention of noble gases in the water in the fuel pool or reactor cavity is negligible (i.e., decontamination factor of 1). Particulate radionuclides are assumed to be retained by the water in the fuel pool or reactor cavity (i.e., infinite decontamination factor) (Ref. 6.1, RGP B.3).

Fuel Handling Accident within Secondary Containment

For fuel handling accidents postulated to occur within secondary containment, the following assumptions typically have been acceptable to the NRC staff (Ref. 6.1, RGP B.5).

4.8 If secondary containment is open during fuel handling operations, the radioactive material that escapes from the damaged fuel to the containment is released to the environment over a 2-hour period.

Offsite Dose Consequences

The following guidance is used in determining the TEDE for a maximum exposed individual at the EAB and LPZ locations:

4.9 The maximum EAB TEDE is determined for any two-hour period following the start of the radioactivity release and is used in determining compliance with the dose acceptance criteria in RG 1.183 (Ref. 6.1, RGP 4.4, Table 6).

EAB Dose Acceptance Criterion: 6.3 rem TEDE

4.10 The breathing rates for persons at offsite locations are given in Reference 6.1, RGP 4.1.3 and are incorporated in Design Input 5.5.4.

4.11 TEDE is determined for the most limiting receptor at the outer boundary of the low population zone (LPZ) and is used in determining compliance with the dose criteria in Reference 6.1, RGP 4.4 Table 6.

LPZ Dose Acceptance Criterion: 6.3 rem TEDE

4.12 No credit is taken for depletion of the effluent plume by deposition on the ground (Ref 6.1, RGP 4.1.7).

Control Room Dose Consequences

The following guidance is used in determining the TEDE for the maximum exposed individuals located in the control room:

4.13 The CR TEDE analysis considers the following sources of radiation that will cause exposure to control room personnel from a FHA (Ref 6.1, RGP 4.2.1):

- Contamination of the control room atmosphere through the air intake or infiltration of the radioactive material contained in the post-accident radioactive plume released from the facility (via normal CR unfiltered air intake),
- Contamination of the control room atmosphere through the air intake or infiltration of airborne radioactive material from areas and structures adjacent to the control room envelope (via normal CR unfiltered inleakage),
- Radiation shine from the external radioactive plume released from the facility (external airborne cloud),
- Radiation shine from radioactive material in secondary containment (containment shine dose),
- Radiation shine from radioactive material in systems and components inside or external to the control room envelope, e.g., radioactive material buildup in recirculation filters (CR filter shine dose).

Note: The containment shine dose due to a FHA is insignificant compared to that due to a LOCA (Section 7.4). Similarly, the external airborne cloud dose due to a FHA is insignificant (Section 7.4). There will be no CR filter shine dose because the CREVAS system is not credited in the analysis. If the CREVASS were activated, CR filter shine (iodines on filter behind concrete block shielding) would be less than CR immersion shine (iodines in CR air, no shielding), which is insignificant (Appendix C).

4.14 The radioactivity releases and radiation levels used in the control room dose analysis are determined using the same source term, transport and release assumptions used for determining the exclusion area boundary (EAB) and low population zone (LPZ) TEDE values (Ref 6.1, RGP 4.2.2).

4.15 The occupancy and breathing rates of the maximum exposed individuals present in the control room are incorporated in design inputs 5.4.3 & 5.4.4 (Ref. 6.1, RGP 4.2.6).

4.16 10 CFR 50.67 (Ref 6.20) establishes the radiological acceptance criterion for the control room.

CR Dose Acceptance Criterion: 5 rem TEDE (50.67(b)(2)(iii))

4.17 Credit for engineered safety features that mitigate airborne activity within the control room is not taken for the CREVAS system because the CR is maintained in a normal mode of operation.

4.18 No credit is taken for KI pills or respirators (Ref. 6.1, RGP 4.2.5).

5.0 INPUT AND DESIGN CRITERIA

5.1 General Considerations

5.1.1 Applicability of Prior Licensing Basis

The implementation of an AST is a significant change to the design basis of the facility as well as assumptions and design inputs used in the analyses. The characteristics of the AST and the revised TEDE dose calculation methodology may be incompatible with many of the assumptions and methods used in the facility's current design basis analyses.

The JAF plant-specific design inputs and assumptions used in the current FHA analyses were assessed for their validity to represent the as-built condition of the plant (Ref. 6.22) and evaluated for their compatibility to meet the AST and TEDE criteria. The analysis in this calculation ensures that assumptions, design inputs and methods are compatible with the AST and comply with RG 1.183, Appendix B requirements.

5.1.2 Credit for Engineered Safeguard Features

Credit should be taken only for accident mitigation features that are classified as safety-related, are required to be operable by technical specifications, are powered by emergency power sources, and are either automatically actuated or, in limited cases, have manual actuation requirements explicitly addressed in emergency operating procedures. No ESF functions are credited in the FHA analysis to mitigate the radiological consequences.

5.1.3 Assignment of Numeric Input Values

The numeric values that are chosen as inputs to the analyses required by 10 CFR 50.67 (Ref. 6.20) are compatible with AST and TEDE dose criteria and selected with the objective of producing conservative radiological consequences. As a conservative alternative, the limiting value applicable to each portion of the analysis is used in the evaluation of that portion. The inherent conservatisms in the radiological consequence analyses are demonstrated by use of the following:

- The normal CR mode of operation without taking credit for the CREVASS
- A higher radial peaking factor of 1.6 (instead of 1.5) (Table 8)
- The ground level χ/Qs for the RB vent release
- The release from the RB vent over 2 hours is not intervened

The key design input parameter values used in the analysis are those specified in the technical specifications (Ref. 6.6).

5.1.4 Meteorology Considerations

The control room atmospheric dispersion factors (χ/Qs) for the RB vent release are developed (Ref. 6.5) using the NRC-sponsored computer code ARCON96 and guidance provided in Draft Regulatory Guide DG-1111. The EAB and LPZ χ/Qs were selected for the ground level release from the turbine building (MSIV leakage path) from Reference 6.9, which uses the JAF plant specific 8-year meteorological data and appropriate regulatory guidance. The ground-level off-site χ/Qs in Reference 6.9 have been used in previous licensing proceedings.

5.2 Accident-Specific Design Inputs

The design inputs utilized in the EAB, LPZ and CR dose analyses are listed in the following sections, which incorporate the line-by-line regulatory requirements applicable to a FHA occurring in the reactor building (see Section 4.0). The design inputs are compatible with the AST and TEDE dose criteria. The design inputs and assumptions in the following sections represent the as-built design of the plant.

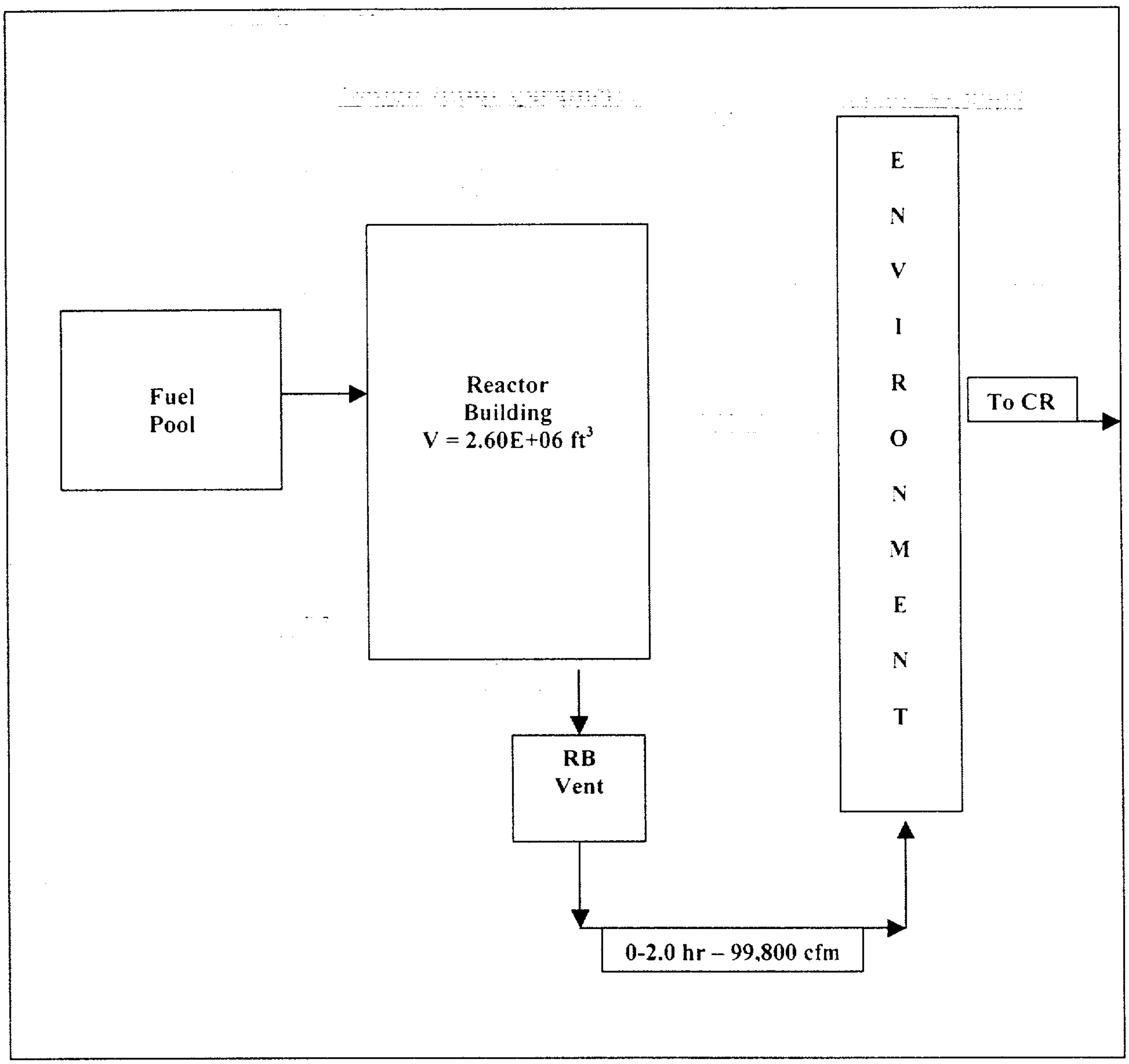

Figure 1: RADTRAD Nodalization for FHA Occurring in RB with RB Vent Release

5.3 FHA Occurring in Reactor Building - Design Input Parameters

5.3.1 Source Term

Design Input Parameter	Value Assigned	Reference
5.3.1.1 Core Power Level (MW_{th})	2,587 (2,536 x 1.2 = 2,586.5 ≈ 2,587)	6.6.4 & 6.4
5.3.1.2 Isotopic Core Inventory @ 2,586.5 MW_{th} (Table 1 below)		6.3, Table 6

Table 1: Core Inventory (Ci) at Shutdown

Isotope	Activity	Isotope	Activity	Isotope	Activity
Kr-83m	8.114E+06	I-130	2.705E+06	Xe-133	1.430E+08
Kr-85	7.798E+06	I-131	6.805E+07	Xe-133m	5.962E+06
Kr-85m	1.742E+07	I-132	9.945E+07	Xe-135	1.847E+07
Kr-87	3.342E+07	I-133	1.423E+08	Xe-135m	2.695E+07
Kr-88	4.733E+07	I-134	1.566E+08	Xe-138	1.192E+08
Br-83	8.078E+06	I-135	1.344E+08		
Br-84	1.432E+07	Xe-131m	4.092E+05		

5.3.1.3 Radionuclide Release Fractions (Table 2 below)

Table 2: Fraction of Fission Product Inventory in Gap

Group	Fraction	Reference
I-131	0.08	6.1, RGP 3.2, Table 3
Kr-85	0.10	
Other Noble Gases	0.05	
Other Halogens	0.05	
Alkali Metals	0.12	

Design Input Parameter	Value Assigned	Reference
5.3.1.4 Radionuclide Composition (Table 3 below)		
Table 3: Radionuclide Groups and Compositions		
Group	**Elements**	**Reference**
Noble Gases	Xe, Kr	6.1, RGP 3.4, Table 5
Halogens	I, Br	
Alkali Metals	Cs, Rb	
5.3.1.5 Damaged Fuel Rods	125(1)	6.13, Sec. 6.3.2.2.3.1, & 6.12
5.3.1.6 Total Number of Fuel Assemblies in Core	560	6.6.5 & 6.14, Table 3-1
5.3.1.7 Total Number of Fuel Rods in Fuel Assembly	60(2)	6.14, Sec. 2.1
5.3.1.8 Irradiated Fuel Decay Time (hrs)	96	Assumed
5.3.1.9 Radial Peaking Factor	1.5 1.60 (conservatively used in this analysis)	6.15, RGP 6.1.e 6.23
5.3.2 Activity Transport in Reactor Building		
5.3.2.1 Pool Water Depth (ft)	23	6.12
5.3.2.2 Reactor Building Volume (ft3)	2.60E+06	Assumed(3)
5.3.2.3 Decontamination Factors (DFs) for Iodines in Pool Water		
Elemental DF	500	6.1, RGP B.2
Organic DF	1	

Design Input Parameter	Value Assigned	Reference
5.3.2.4 Overall Effective DFs for Iodines in Pool Water		
Total Iodine DF	200	6.1, RGP B.2
5.3.2.5 Chemical Form of Iodine Released from Pool Water		
Elemental %	57.0	6.1, App. B.2
Organic %	43.0	
5.3.2.6 DF of Noble Gas	1	6.1, Appendix B.3
5.3.2.7 Duration of Release (hrs)	2	6.1, Appendix B.5.3
5.3.2.8 Fuel Peak Burnup (MWD/MTU)	< 62,000	6.3 & 6.1, Table 3, Note # 11
5.3.2.9 Maximum Linear Heat Generation Rate for Peak Rod (kw/ft)	< 6.3	6.1, Table 3, Note # 11
5.3.2.10 RB Vent Exhaust Rate (cfm)	99,800	See Section 7.3

5.4 Control Room Model Parameters

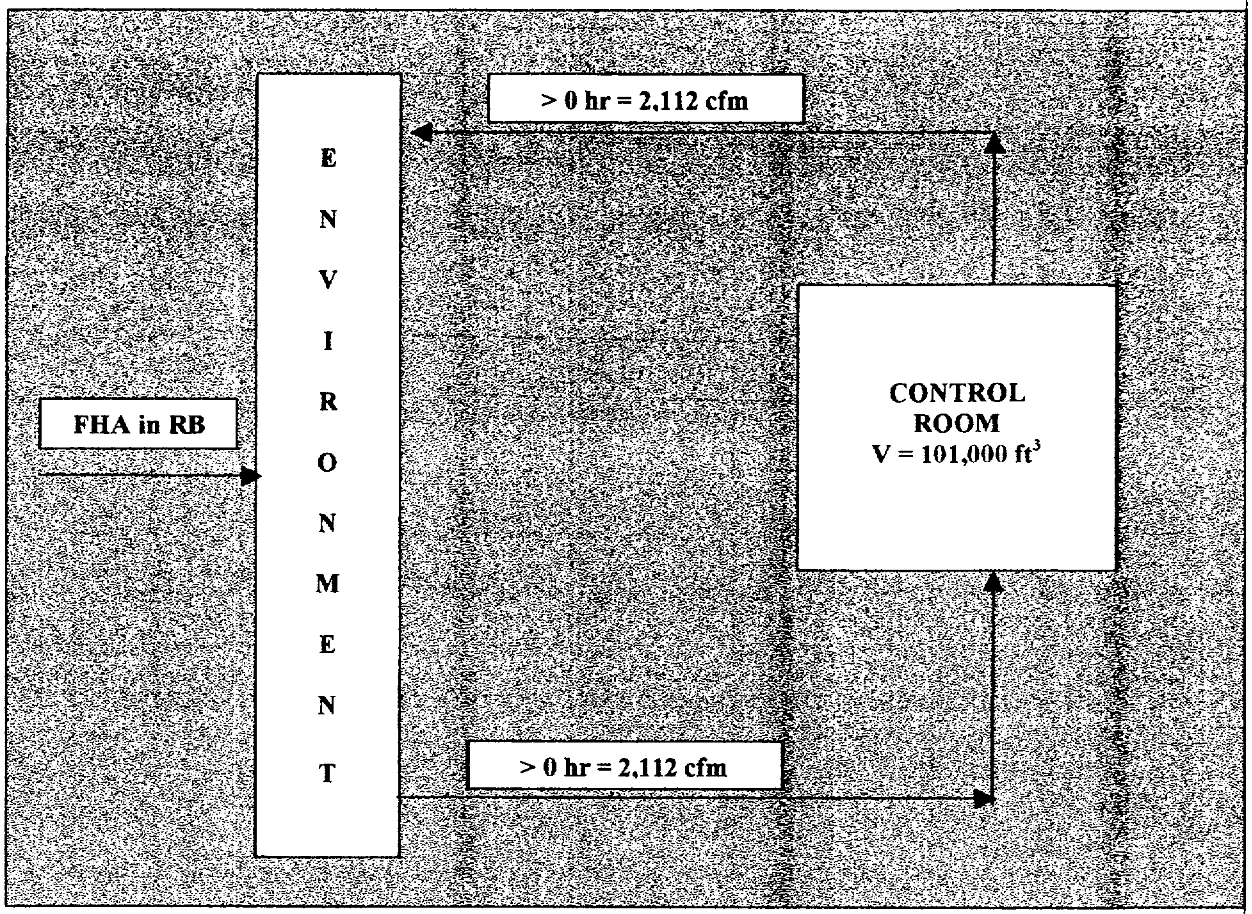

Figure 2 – JAF Control Room RADTRAD Nodalization

Design Input Parameter	Value Assigned	Reference
5.4.1 CR Volume (ft^3)	101,000	Assumed[3]
5.4.2 CR Normal Flow Rate (cfm)	2,112 (1.1 x 1,920)	6.10.4
5.4.3 CR Breathing Rate (m^3/sec)	3.5E-04	6.1, RGP 4.2.6

5.4.4 CR Occupancy Factors (Table 4 below)

Table 4: Control Room Occupancy Factors

Time (hrs)	Occupancy Factor (%)	Reference
0 - 24	100	6.1, RGP 4.2.6
24 - 96	60	
96 - 720	40	

5.4.5 CR Atmospheric Dispersion Factors (χ/Qs) for RB Vent Release (Table 5 below)

Table 5: Control Room χ /Qs for RB Vent Release

Time (hrs)	χ/Q (sec/m^3)	Reference
0 - 2	3.52E-03	6.5, Sec. 8.1
2 - 8	3.31E-03	
8 - 24	1.43E-03	
24 - 96	7.73E-04	
96-720	6.07E-04	

5.5 Site Boundary Release Model Parameters

Design Input Parameter	Value Assigned	Reference
5.5.1 EAB χ/Q (sec/m^3)	1.79E-04	6.9, Page 16

5.5.2 LPZ Atmospheric Dispersion Factors (χ/Qs) (Table 6 below)

Table 6: LPZ χ/Qs

Time (hrs)	χ/Q (sec/m^3)	Reference
0 - 8	2.00E-05	6.9, Page 16
8 - 24	1.34E-05	
24 - 96	5.59E-06	
96 - 720	1.60E-06	

Design Input Parameter	Value Assigned	Reference
5.5.3 EAB Breathing Rate (m3/sec)	3.5E-04	6.1, RGP 4.2.6
5.5.4 LPZ Breathing Rate (Table 7 below)		

Table 7: LPZ Breathing Rate (BR)

Time (hrs)	BR (m^3/sec)	Reference
0 - 8	3.5E-04	6.1, RGP 4.1.3
8 - 24	1.8E-04	
24 - 720	2.3E-04	

(1) Note: The accident involves a fuel assembly dropping from the maximum height allowed by the fuel handling equipment, resulting in the release of 0.37 percent of the core inventory. The fractional inventory released is based on rupturing 125 fuel rods in a standard GE 8x8 fuel assembly, based on information in Ref. 6.13, Sec. 6.3.2.2.3.1. The total number of fuel rods in a GE-8 core is equal to 33,600 (60 pins per assembly x 560 assemblies = 33,600 fuel pins). The fractional core inventory release is based on the ratio of the number of failed fuel pins to the total number of pins (125/33600 = 0.0037). It is noted that although the actual number of failed fuel rods would increase for GE-11 and other fuel types, the total number of fuel rods in the core also correspondingly increase. The fractional core inventory that is released however is bounded by the GE-8 analysis. Furthermore, the JAF core contains fuel of different fuel types (GE-11, GE-12, etc.) and the total numbers of fuel rods vary with core load. Use of the fractional core inventory release based on the GE-8 fuel type bounds the other fuel types.

(2) Note: Fuel bundles contain 60 fuel rods for 8x8 designs. The total number of fuel rods varies with each core load.

(3) Note: The RB and CR volumes are UFSAR values. The exact values of these parameters are not critical to the analysis. For example, the calculation models all of the RB airborne activity being released within the first two hours of the FHA event. Based on this criterion, an RB air exhaust rate is calculated. If a different RB volume is modeled, then the RB air exhaust rate will correspondingly change to maintain the two-hour criterion, and the dose results will remain the same.

Table 8

Post-FHA Undecayed Activity Released In Reactor Building Used In RADTRAD NIF

Isotope	Core Initial Inventory (Ci) A[1]	Radial Peaking Factor B	Total Number of Fuel Rod In Core C	Number of Fuel Rod Damaged D	Activity In Damaged Fuel Rods (Ci) E=A*B*D/C	DF F	Post-FHA Activity For RADTRAD Code Nuclide Inventory File (Ci) G=E/F	Post-FHA Activity For RADTRAD Code Nuclide Inventory File RADTRAD (Ci/MWt) H=G/2587
KR-83M	8.114E+06	1.60	33600	125	4.830E+04	1.0	4.830E+04	.1867E+02
KR-85[2]	1.600E+06	1.60	33600	125	9.524E+03	1.0	9.524E+03	.3681E+01
KR-85M	1.742E+07	1.60	33600	125	1.037E+05	1.0	1.037E+05	.4008E+02
KR-87	3.342E+07	1.60	33600	125	1.989E+05	1.0	1.989E+05	.7690E+02
KR-88	4.733E+07	1.60	33600	125	2.817E+05	1.0	2.817E+05	.1089E+03
KR-89	5.887E+07	1.60	33600	125	3.504E+05	1.0	3.504E+05	.1355E+03
BR-83	8.078E+06	1.60	33600	125	4.808E+04	200.0	2.404E+02	.9293E-01
BR-84	1.432E+07	1.60	33600	125	8.524E+04	200.0	4.262E+02	.1647E+00
I-130	2.705E+06	1.60	33600	125	1.610E+04	200.0	8.051E+01	.3112E-01
I-131[3]	1.089E+08	1.60	33600	125	6.482E+05	200.0	3.241E+03	.1253E+01
I-132	9.945E+07	1.60	33600	125	5.920E+05	200.0	2.960E+03	.1144E+01
I-133	1.423E+08	1.60	33600	125	8.470E+05	200.0	4.235E+03	.1637E+01
I-134	1.566E+08	1.60	33600	125	9.321E+05	200.0	4.661E+03	.1802E+01
I-135	1.344E+08	1.60	33600	125	8.000E+05	200.0	4.000E+03	.1546E+01
XE-131M	4.092E+05	1.60	33600	125	2.436E+03	1.0	2.436E+03	.9415E+00
XE-133	1.430E+08	1.60	33600	125	8.512E+05	1.0	8.512E+05	.3290E+03
XE-133M	5.962E+06	1.60	33600	125	3.549E+04	1.0	3.549E+04	.1372E+02
XE-135	1.847E+07	1.60	33600	125	1.099E+05	1.0	1.099E+05	.4250E+02
XE-135M	2.695E+07	1.60	33600	125	1.604E+05	1.0	1.604E+05	.6201E+02
XE-138	1.192E+08	1.60	33600	125	7.095E+05	1.0	7.095E+05	.2743E+03

(1) A from Reference 6.3 except noted as follows

(2) KR-85 activity is multiplied by a factor 2 (0.1/0.05) to account for additional fractional release.

(3) I-131 activity is multiplied by a factor 1.6 (0.08/0.05) to account for additional fractional release.

Isotope	Core Inventory (Ci) A	Core Activity	
		(Ci/MW_{th}) B=A/2586.5	RADTRAD Format (Ci/MW_{th}) C=B*1
KR-83M	8.114E+06	3.137E+03	.3137E+04
KR-85M	1.742E+07	6.735E+03	.6735E+04
KR-87	3.342E+07	1.292E+04	.1292E+05
KR-88	4.733E+07	1.830E+04	.1830E+05
I-131	6.805E+07	2.631E+04	.2631E+05
I-132	9.945E+07	3.845E+04	.3845E+05
I-133	1.423E+08	5.502E+04	.5502E+05
I-134	1.566E+08	6.055E+04	.6055E+05
I-135	1.344E+08	5.196E+04	.5196E+05
XE-131M	4.092E+05	1.582E+02	.1582E+03
XE-133	1.430E+08	5.529E+04	.5529E+05
XE-133M	5.962E+06	2.305E+03	.2305E+04
XE-135	1.847E+07	7.141E+03	.7141E+04
XE-135M	2.695E+07	1.042E+04	.1042E+05

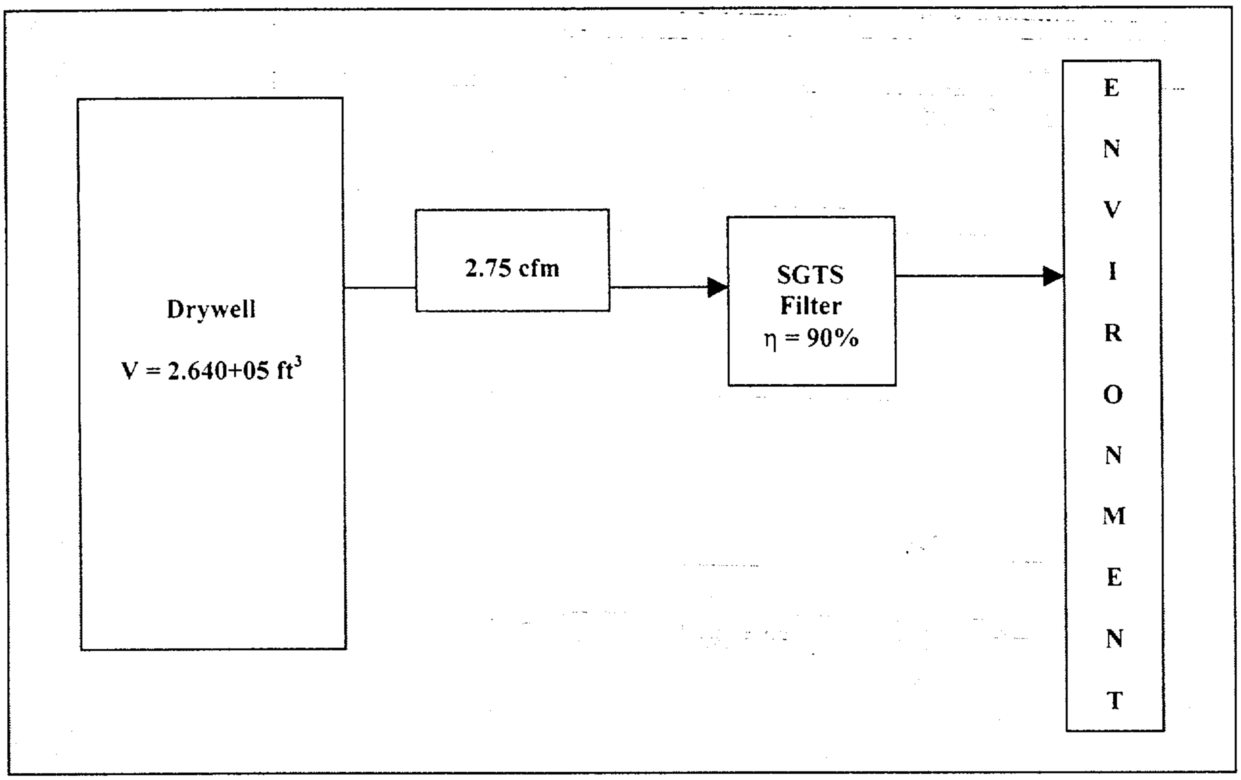

Figure 3: RADTRAD Nodalization of Post-LOCA Containment Leakage - TID

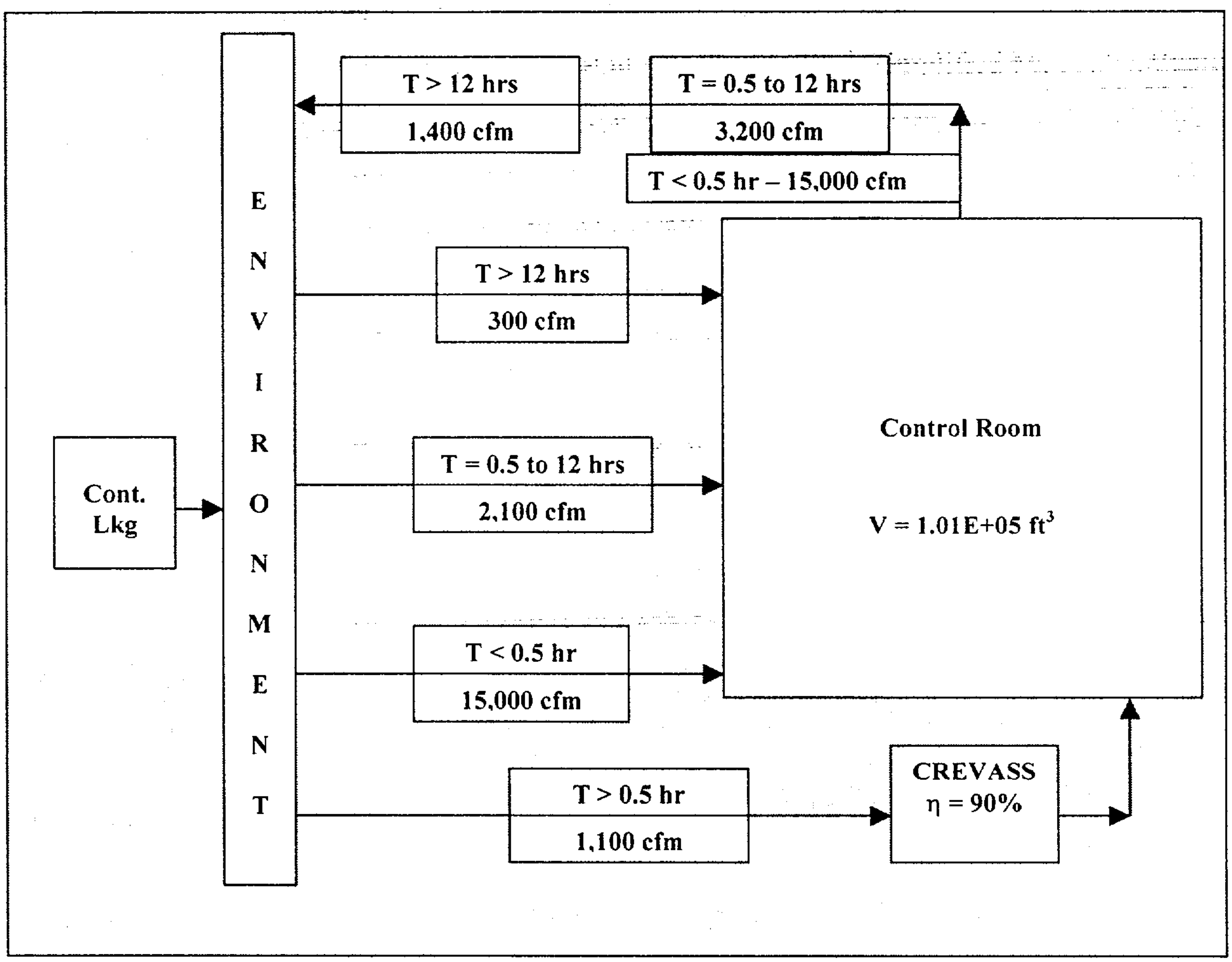

Figure 4: RADTRAD Nodalization of Post-LOCA Containment Leakage

TID CR Response

6.0 REFERENCES

1. U.S. NRC Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," July 2000.

2. S.L. Humphreys et al., "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation," NUREG/CR-6604, USNRC, April 1998.

3. GE letter addressed to Richard Chau, NYPA, from C. H. Stoll, GE plant performance engineering, "J. A. FITZPATRICK (JAFNPP) power uprate program – formal transmittal of final source term analysis results" (5/2/91), Table 6.
(Note: Full-core inventory provided in Table 6 is in units of Ci/MW_{th}. The final bundle exposure was approximately 29,000 MWD/MTU. The data in this table times 2586.5 MW_{th} gives the core inventory in Ci).

4. U.S. NRC Regulatory Guide 1.49, Rev 1, "Power Levels for Nuclear Power Plants."

5. JAF Calculation No. JAF-CALC-RAD-04409, Rev 0, "Control Room χ/Qs Using ARCON96 Code for Post-FHA Releases from RB Track Bay and Reactor Building Vent."

6. JAFNPP Technical Specifications:
   - 6.1 LCO 3.6.4.1, Secondary Containment Integrity
   - 6.2 LCO 3.9.6, Reactor Pressure Vessel (RPV) Water Level
   - 6.3 LCO 3.7.7, Spent Fuel Pool Water Level
   - 6.4 1.1, Definitions
   - 6.5 4.2.1, Fuel Assemblies
   - 6.6 Figure 4.1-1, Site and Exclusion Area Boundaries
   - 6.7 LCO 3.6.4.2, Secondary Containment Isolation Valves (SCIVs)
   - 6.8 LCO 3.6.4.3, Standby Gas Treatment System
   - 6.9 LCO 3.3.6.2, Secondary Containment Isolation Instrumentation
   - 6.10 LCO 3.7.3, Control Room Emergency Ventilation Air Supply (CREVAS) System
   - 6.11 LCO 3.3.7.1, Control Room Emergency Ventilation Air Supply (CREVAS) System Instrumentation

7. Federal Guidance Report 11, EPA-5201/1-88-020, Environmental Protection Agency.
8. Federal Guidance Report 12, EPA-402- R-93-081, Environmental Protection Agency.
9. JAF Calculation No. JAF-CALC-RAD-00007, Rev 2, "Onsite and Offsite Post-Accident Atmospheric Dispersion Factors."
10. JAFNPP Drawings:
    - 10.1 11825-FC-2A, Rev 6, Foundation Key Plant.
    - 10.2 11825-FC-29A, Rev 8, Rail Road & Track Port & Gas Treatment Bldg. Concrete Details – SH 1.
    - 10.3 11825-FC-29D, Rev 6, Rail Road & Track Port & Gas Treatment Bldg. Concrete Details – SH 4.
    - 10.4 11825-FB-35C, Rev 14, Equipment Room Heating, Vent & Air Conditioning Plan EL 300'-0"
    - 10.5 11825-FA-10A, Rev 10, Reactor BLDG – M.G. Sets Plans & Elevations.
    - 10.6 11825-FA-10B, Rev 6, Reactor BLDG, Plans, Elevations, Details Duct Enclosure
    - 10.7 11825-FA-10D, Rev 5, Reactor BLDG Roof Plan.
    - 10.8 11825-FA-11A, Rev 2, Reactor BLDG North and South Elevations.
    - 10.9 11825-FA-6E, Rev 18, Door Schedule Reactor BLDG.
    - 10.10 11825-FB-7A, Rev 16, Reactor Building Ventilation Arrangement.
    - 10.11 11825-FB-7B, Rev 9, Sheet 2, Reactor Building Ventilation Arrangement.
    - 10.12 11825-FA-16B, Rev 24, Administrative Building Floor & Roof Plans.
11. NEI 99-03, Control Room Habitability Guidance.
12. JAF Calculation No. JAF-CALC-MISC-04428, Rev 1, Number of Failed Fuel Rods Caused by Spent Fuel Pool Refueling Accident.
13. GE Technical Report NEDO-20360, "Licensing Topical Report, General Electric Boiling Water Reactor, Generic Reload Application for 8x8 Fuel", Rev. 1, November 1974.
14. GE Technical Report NEDE-31152P, "GE Fuel Bundle Designs," Rev. 8, April 2001.
15. U.S. NRC Safety Guide 25, 3/23/72, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors."

16. NUREG-1433, Rev 2, Volume 2, April 2001, Standard Technical Specifications General Electric Plants, BWR/4, Bases.

17. JAF Calculation No. JAF-CALC-RAD-04416, Rev 0, "Spent Fuel Iodine Decontamination Factor." Ref. 1 in this calculation is: Westinghouse Electric Corporation, "Radiological Consequences of a Fuel Handling Accident", Dec. 1971.

18. JAF Calculation No. JAF-CALC-RAD-00042, Rev 3 (including Addendum 3A and 3B), "Control Room Radiological Habitability under Power Uprate Conditions and CREVASS Reconfiguration."

19. JAF Calculation No. JAF-CALC-RAD-00048, Rev 2 (including Addendum 2A), "Power Uprate Project - Radiological Impact at Onsite and Offsite Receptor following Design Basis Accidents."

20. 10 CFR 50.67, "Alternate Source Term."

21. JAFNPP Machine Location Drawings:

    21.1 11825-FM-1A, Rev 12, Sheet 1, Plan EL 396'-0"

    21.2 11825-FM-1B, Rev 14, Sheet 2, Plan EL 344'-6"

    21.3 11825-FM-1C, Rev 11, Sheet 3, Plan EL 326'-9"

    21.4 11825-FM-1D, Rev 30, Sheet 4, Plan EL 300'-0"

    21.5 11825-FM-1E, Rev 28, Sheet 5, Plan EL 272'-0"

    21.6 11825-FM-1G, Rev 11, Sheet 7, Section 1-1

    21.7 11825-FM-1K, Rev 12, Sheet 10, Sections 4-4 & 5-5

22. Entergy Interface Control Document No. JAF-ICD-RAD-04414, Rev 0, "FHA AST Analyses – Secondary Containment Relaxation."

23. Entergy Memorandum to Gary Re' from George Rorke, Dated 03/07/2002, Subject: "James A FitzPatrick Nuclear Power Plant Estimate of Maximum Bundle Power for Use in Fuel Handling Accident Analysis."

24. JAFNPP Flow Diagrams:

    24.1 11825-FB-8A, Rev 27, Sheet 1 of 1, Reactor Building Vent & Cooling System 66.

    24.2 11825-FB-48A, Rev 28, Standby Gas Treatment System 01-125.

7.0 CALCULATIONS/ANALYSIS

7.1 Fuel Handling Accident in the Reactor Building with RB Vent Release

Activity released from the spent fuel pool is uniformly distributed in the entire volume of reactor building and released to the environment over a two-hour period such that 99% of the activity released from the damaged spent fuel assembly is released to the environment through the RB vent.

In this analysis, the activity is assumed to mix with the entire reactor building volume to calculate a hypothetical maximum release rate to remove almost the entire activity (99%) from the reactor building volume (see Section 7.3).

7.2 JAFNPP Plant Specific Nuclide Inventory File (NIF) for RADTRAD3.02 Input

The parameter Ci/MW_{th} in the RADTRAD3.02 default nuclide inventory file (Bwr_def_NIF) is dependent on the plant-specific core thermal power level, reload design, fuel burnup and fuel cycle. Therefore, the NIF is modified based on the plant-specific isotopic Ci/MW_{th} information developed in Table 8. The RADTRAD nuclide inventory file (J1.6FHA200_def) is shown in Attachment A and used in the analysis.

7.3 Post-FHA Release Rate

The total release rate from the reactor building to the environment is calculated such that 99% of the activity released into the reactor building is released to the environment in two hours. The equation used is:

$$A = A_0 e^{-\lambda t}$$

Where;

A_0 = Initial activity in source node

A = Final activity in source node

λ = Removal rate (vol/hr)

t = Removal time (hr) = 2.0 hr

Assuming that 99% of the activity is released into the environment, then

$A / A_0 = 1 - 0.99 = 0.01$

Therefore,

$A / A_0 = 0.01 = e^{-\lambda t}$

Solving for λ,

$\ln(0.01) = -2 \lambda \ln(e)$

$-4.605 = -2 \lambda$

$\lambda = -4.605 / -2 = 2.303$ volume/hr

The reactor building release rate thus becomes,

$= 2.303 \times 2{,}600{,}000\ ft^3/hr = 5{,}987{,}8000\ ft^3/hr \times 1/60\ hr/min$

$= \boxed{\mathbf{99{,}800\ ft^3/min}}$

7.4 Reactor Building Shine Dose and External Airborne Cloud Shine Dose to the Control Room

Post-LOCA 30-day cumulative shine dose from airborne radioactivity accumulated in the RB refueling level:

= 1.42E-02 rem (Ref. 6.18, Table 2.3).

Post-LOCA 30-day cumulative shine dose from external airborne cloud radioactivity:

= 1.34E-04 rem (Ref. 6.18, Table 2.3)

Ratio of rods damaged in a FHA to rods damaged in a LOCA:

= 125 / 33600 = 0.00372 = 0.372 %

Post-FHA 30-day cumulative shine dose from airborne radioactivity accumulated in the RB refueling level:

= 1.42E-02 rem x 0.00372

= $\boxed{\textbf{5.28E- 05 rem}}$

Post-FHA 30-day cumulative shine dose from external airborne cloud radioactivity:

= 1.34E-04 rem x 0.00372

= $\boxed{\textbf{4.99E- 07 rem}}$

8.0 RESULTS SUMMARY

8.1 FHA Analysis for Relaxation of SC Operability

The results of the FHA analysis, which establish the licensing basis for relaxing secondary containment operability, are summarized in the following table:

Release Location	Fuel Handling Accident Occurring in Reactor Building TEDE Dose (rem)		
	Receptor Location		
	Control Room	EAB	LPZ
RB Vent	4.67E+00	2.65E-01 (0.0 hr)*	2.96E-02
Allowable TEDE Limit	**5.00E+00**	**6.30E+00**	**6.30E+00**
RADTRAD Computer Run No.			
RB Vent	J16FHA96VT00	J16FHA96VT00	J16FHA96VT00

* Worst two-hour dose begins at time = 0.0 hr (i.e., 96 hours after reactor shutdown)

Significant assumptions used in this analysis:

- RB Vent remains open for the duration of the accident
- Post-FHA activity is released to the environment during 2 hours
- CR envelope is not pressurized. It remains in the normal mode of operation - the CREVASS is not credited during and after a FHA
- The reactor is assumed shutdown for 96 hours before SC operability is relaxed
- 125 fuel rods are damaged
- Spent fuel pool overall effective DF = 200
- Core thermal power = 2,587 MW_{th}
- Radial Peaking Factor = 1.60

8.2 Comparison of Results – RADTRAD3.02 vs. Current Analysis – Containment Leakage TID Source Term

The current post-LOCA containment leakage model is reanalyzed using the RADTRAD3.02 computer code, which is installed on the Microsoft Windows environment. The current CR, EAB and LPZ doses are compared in the following table with those calculated with RADTRAD3.02 to demonstrate the code's ability to produce almost identical results within a small percentage of variation.

	Receptor Location		
Analysis Information	**Control Room**	**Exclusion Area Boundary**	**Low Population Area**
Thyroid Dose (rem) Current Analysis	7.339E+00	5.820E+01	6.320E+01
Thyroid Dose (rem) RADTRAD Analysis	7.505E+00	5.894E+01	6.410E+01
Percentage Variation (RADTRAD / Current)	2.26	1.27	1.41
RADTRAD Run No.	FPTIDCL00	FPTIDCL00	FPTIDCL00
Current Analysis Reference	6.18, Page 18	6.19, Page 20	6.19, Page 21

9.0 CONCLUSIONS:

9.1 FHA Analysis for Relaxation of SC Operability

The results of analysis in Section 8.1 indicate that the EAB, LPZ and CR doses are within their allowable limits for a FHA occurring in the reactor building with a release through RB vent. The results demonstrate that the applicability of JAF Technical Specification 3.6.4.1, 3.6.4.2, 3.6.4.3, 3.3.6.2, 3.3.7.1 and 3.7.3 can be relaxed when irradiated fuel is being handled in the SC or the core is being altered.

Regulatory Exceptions

None

9.2 RADTRAD3.02 vs. Current Analysis – Containment Leakage TID Source Term

The current EAB, LPZ and CR doses due to post-LOCA containment leakage are compared in Section 8.2 with the corresponding doses calculated using the RADTRAD3.02 code. Results demonstrate that the RADTRAD3.02 code produces almost identical results with only minor variations. Therefore, the RADTRAD3.02 code is acceptable for radiological analyses and produces accurate and consistent results.

10.0 ATTACHMENTS

CD with the following electronic files:

JAF Calculation: JAF-CALC-RAD-04410, Rev 0

ATTACHMENT A – RADTRAD Nuclide Inventory File – J1.6FHA200_def
ATTACHMENT B – RADTRAD Dose Conversion Factor (DCF) File – JAFHA_FG11&12
ATTACHMENT C – RADTRAD FHA Input/Output File – J16FHA96VT00.O0
ATTACHMENT D – RADTRAD Nuclide Inventory File – JAFTIDLOCA_def
ATTACHMENT E – RADTRAD TID LOCA Input/Output File – FPTIDCL00.O0

Design Verification Comments

Release	RADTRAD3.02 Files			
Category	Name	Size	Date	Time
NIF AST Analyses	J1.6FHA200_def	9 KB	05/12/02	13:15:00
DCF File	JAFHA_FG11&12	49 KB	04/02/02	12:38:00
RB Vent Release	J16FHA96VT00.O0	38 KB	05/17/02	11:24:37
NIF TID Analysis	JAFTIDLOCA_def	3 KB	02/03/02	01:49:00
Cont. Leakage - TID	FPTIDCL00.O0	49 KB	04/01/02	11:28:00

Entergy	CALCULATION CONTINUATION SHEET		SHEET No. 43 of 78	
	CALC. TITLE: Fuel Handling Accident – AST Analysis for Relaxation of Secondary Containment Operability			
	CALC. NO.: JAF-CALC-RAD-04410		REVISION NO.	0
	ORIGINATOR/DATE	G. Patel 05/23/02	REVIEWR/DATE	M. Drucker 05/24/02

ATTACHMENT A
RADTRAD Nuclide Inventory File – J1.6FHA200_def

```
Name: J.A. Fitz Patrick FHA Core Inventory - DF = 200, PF = 1.6
Sample 3578 MWth BWR Core Inventory

Power Level:
 0.1000E+01
Nuclides:
 60
Nuclide 001:
Co-58
 7
 0.6117120000E+07
 0.5800E+02
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 002:
Co-60
 7
 0.1663401096E+09
 0.6000E+02
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 003:
Kr-83m
 1
 0.6588000000E+04
 0.8300E+02
 0.1867E+02
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 004:
Kr-85
 1
 0.3382974720E+09
 0.8500E+02
 0.3681E+01
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 005:
Kr-85m
 1
 0.1612800000E+05
 0.8500E+02
 0.4008E+02
Kr-85     0.2100E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 006:
Kr-87
 1
 0.4578000000E+04
 0.8700E+02
 0.7690E+02
Rb-87     0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 007:
Kr-88
 1
 0.1022400000E+05
 0.8800E+02
 0.1089E+03
Rb-88     0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 008:
Rb-86
 3
 0.1612224000E+07
 0.8600E+02
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 009:
Sr-89
 5
 0.4363200000E+07
 0.8900E+02
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 010:
Sr-90
 5
 0.9189573120E+09
 0.9000E+02
 0.0000E+00
Y-90      0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 011:
Sr-91
 5
 0.3420000000E+05
 0.9100E+02
 0.0000E+00
Y-91m     0.5800E+00
Y-91      0.4200E+00
none      0.0000E+00
Nuclide 012:
Sr-92
 5
 0.9756000000E+04
 0.9200E+02
 0.0000E+00
Y-92      0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 013:
Y-90
 9
 0.2304000000E+06
 0.9000E+02
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 014:
Y-91
 9
 0.5055264000E+07
 0.9100E+02
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 015:
Y-92
 9
 0.1274400000E+05
 0.9200E+02
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 016:
Y-93
 9
 0.3636000000E+05
 0.9300E+02
 0.0000E+00
Zr-93     0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 017:
Zr-95
 9
 0.5527872000E+07
 0.9500E+02
 0.0000E+00
Nb-95m    0.7000E-02
Nb-95     0.9900E+00
none      0.0000E+00
Nuclide 018:
Zr-97
 9
 0.6084000000E+05
 0.9700E+02
 0.0000E+00
Nb-97m    0.9500E+00
Nb-97     0.5300E-01
none      0.0000E+00
Nuclide 019:
Nb-95
```

```
 9
 0.3036960000E+07
 0.9500E+02
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 020:
Mo-99
 7
 0.2376000000E+06
 0.9900E+02
 0.0000E+00
Tc-99m    0.8800E+00
Tc-99     0.1200E+00
none      0.0000E+00
Nuclide 021:
Tc-99m
 7
 0.2167200000E+05
 0.9900E+02
 0.0000E+00
Tc-99     0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 022:
Ru-103
 7
 0.3393792000E+07
 0.1030E+03
 0.0000E+00
Rh-103m   0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 023:
Ru-105
 7
 0.1598400000E+05
 0.1050E+03
 0.0000E+00
Rh-105    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 024:
Ru-106
 7
 0.3181248000E+08
 0.1060E+03
 0.0000E+00
Rh-106    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 025:
Rh-105
 7
 0.1272960000E+06
 0.1050E+03
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 026:
Sb-127
 4
 0.3326400000E+06
 0.1270E+03
 0.0000E+00
Te-127m   0.1800E+00
Te-127    0.8200E+00
none      0.0000E+00
Nuclide 027:
Sb-129
 4
 0.1555200000E+05
 0.1290E+03
 0.0000E+00
Te-129m   0.2200E+00
Te-129    0.7700E+00
none      0.0000E+00
Nuclide 028:
Te-127
 4
 0.3366000000E+05
 0.1270E+03
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 029:
Te-127m
 4
 0.9417600000E+07
 0.1270E+03
 0.0000E+00
Te-127    0.9800E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 030:
Te-129
 4
 0.4176000000E+04
 0.1290E+03
 0.0000E+00
I-129     0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 031:
Br-83
 2
 0.8604040000E+04
 0.830E+02
 0.9293E-01
Kr-83m    1.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 032:
Br-84
 2
 0.1908000000E+04
 0.8400E+02
 0.1647E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 033:
I-130
 2
 0.4449600000E+05
 0.1300E+03
 0.3112E-01
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 034:
I-131
 2
 0.6946560000E+06
 0.1310E+03
 0.1253E+01
Xe-131m   0.1100E-01
none      0.0000E+00
none      0.0000E+00
Nuclide 035:
I-132
 2
 0.8280000000E+04
 0.1320E+03
 0.1144E+01
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 036:
I-133
 2
 0.7488000000E+05
 0.1330E+03
 0.1637E+01
Xe-133m   0.2900E-01
Xe-133    0.9700E+00
none      0.0000E+00
Nuclide 037:
I-134
 2
 0.3156000000E+04
 0.1340E+03
 0.1802E+01
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 038:
I-135
 2
 0.2379600000E+05
 0.1350E+03
 0.1546E+01
Xe-135m   0.1500E+00
Xe-135    0.8500E+00
none      0.0000E+00
Nuclide 039:
Xe-131m
 1
 0.1028160000E+07
 0.1310E+03
 0.9415E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 040:
Xe-133
 1
 0.4531680000E+06
 0.1330E+03
 0.3290E+03
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 041:
Xe-133m
 1
 0.1890432000E+06
 0.1330E+03
 0.1372E+02
Xe-133    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 042:
Xe-135
 1
 0.3272400000E+05
 0.1350E+03
 0.4250E+02
Cs-135    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 043:
Xe-135m
 1
 0.9174000000E+03
 0.1350E+03
 0.6201E+02
```

```
Xe-135    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 044:
Xe-138
 1
 0.8502000000E+03
 0.1380E+03
 0.2743E+03
Cs-138    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 045:
Cs-134
 3
 0.6507177120E+08
 0.1340E+03
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 046:
Cs-136
 3
 0.1131840000E+07
 0.1360E+03
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 047:
Cs-137
 3
 0.9467280000E+09
 0.1370E+03
 0.0000E+00
Ba-137m   0.9500E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 048:
Ba-139
 6
 0.4962000000E+04
 0.1390E+03
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 049:
Ba-140
 6
 0.1100736000E+07
 0.1400E+03
 0.0000E+00
La-140    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 050:
La-140
 9
 0.1449792000E+06
 0.1400E+03
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 051:
La-141
 9
 0.1414800000E+05
 0.1410E+03
 0.0000E+00
Ce-141    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 052:
La-142
 9
 0.5550000000E+04
 0.1420E+03
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 053:
Ce-141
 8
 0.2808086400E+07
 0.1410E+03
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 054:
Ce-143
 8
 0.1188000000E+06
 0.1430E+03
 0.0000E+00
Pr-143    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 055:
Ce-144
 8
 0.2456352000E+08
 0.1440E+03
 0.0000E+00
Pr-144m   0.1800E-01
Pr-144    0.9800E+00
none      0.0000E+00
Nuclide 056:
Pr-143
 9
 0.1171584000E+07
 0.1430E+03
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 057:
Nd-147
 9
 0.9486720000E+06
 0.1470E+03
 0.0000E+00
Pm-147    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 058:
Np-239
 8
 0.2034720000E+06
 0.2390E+03
 0.0000E+00
Pu-239    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 059:
Pu-241
 8
 0.4544294400E+09
 0.2410E+03
 0.0000E+00
U-237     0.2400E-04
Am-241    0.1000E+01
none      0.0000E+00
Nuclide 060:
Cm-242
 9
 0.1406592000E+08
 0.2420E+03
 0.0000E+00
Pu-238    0.1000E+01
none      0.0000E+00
none      0.0000E+00
End of Nuclear
Inventory File
```

ATTACHMENT B
RADTRAD Dose Conversion Factor (DCF) File – JAFHA_FG11&12

```
JAFHA_FGR11&12 added 8 nuclides; deleted Te129m,Te131m,Te132,Cm244,AM-242,Pu238-240 2/2001
Implicit daughter halflives (m) less than  90 and less than 0.100 of parent

         9 ORGANS DEFINED IN THIS FILE:
GONADS
BREAST
LUNGS
RED MARR
BONE SUR
THYROID
REMAINDER
EFFECTIVE
SKIN(FGR)
        60 NUCLIDES DEFINED IN THIS FILE:
Co-58     Y
Co-60     Y
Kr-83m            data entered by Gopal J. Patel NUCORE/10/08/2001
Kr-85
Kr-85m
Kr-87
Kr-88
Rb-86     D
Sr-89     Y
Sr-90     Y
Sr-91     Y      Including:Y-91m
Sr-92     Y
Y-90      Y
Y-91      Y
Y-92      Y
Y-93      Y
Zr-95     D
Zr-97     Y      Including:Nb-97m , Including:Nb-97
Nb-95     Y
Mo-99     Y
Tc-99m    D
Ru-103    Y      Including:Rh-103m
Ru-105    Y
Ru-106    Y      Including:Rh-106
Rh-105    Y
Sb-127    W
Sb-129    W
Te-127    W
Te-127m   W
Te-129    W
Br-83     D      data entered by Gopal J. Patel NUCORE/01/23/2002
Br-84     D      data entered by Gopal J. Patel NUCORE/01/23/2002
I-130     D      data entered by Gopal J. Patel NUCORE/01/23/2002
I-131     D
I-132     D
I-133     D
I-134     D
I-135     D      Including:Xe-135m
Xe-131m          data entered by Gopal J. Patel NUCORE/10/08/2001
Xe-133
Xe-133m          data entered by Gopal J. Patel NUCORE/10/08/2001
Xe-135
Xe-135m          data entered by Gopal J. Patel NUCORE/10/08/2001
Xe-138           data entered by Gopal J. Patel NUCORE/10/08/2001
Cs-134    D
Cs-136    D
Cs-137    D      Including:Ba-137m
Ba-139    D
Ba-140    D
La-140    W
La-141    D
La-142    D
Ce-141    Y
Ce-143    Y
Ce-144    Y      Including:Pr-144m, Including:Pr-144
Pr-143    Y
Nd-147    Y
Np-239    W
Pu-241    Y
Cm-242    W
          CLOUDSHINE  GROUND    GROUND    GROUND     INHALED   INHALED
INGESTION
                      SHINE 8HR SHINE 7DAY SHINE RATE ACUTE     CHRONIC
Co-58
GONADS     4.660E-14 2.867E-11 5.828E-10 9.970E-16-1.000E 6.170E-10 1.040E-09
```

```
BREAST      5.300E-14 2.737E-11 5.565E-10 9.520E-16-1.000E 9.370E-10 1.790E-10
LUNGS       4.640E-14 2.617E-11 5.319E-10 9.100E-16-1.000E 1.600E-08 8.530E-11
RED MARR    4.530E-14 2.671E-11 5.430E-10 9.290E-16-1.000E 9.230E-10 2.600E-10
BONE SUR    7.410E-14 3.795E-11 7.716E-10 1.320E-15-1.000E 6.930E-10 1.250E-10
THYROID     4.770E-14 2.720E-11 5.530E-10 9.460E-16-1.000E 8.720E-10 6.310E-11
REMAINDER   4.440E-14 2.585E-11 5.255E-10 8.990E-16-1.000E 1.890E-09 1.580E-09
EFFECTIVE   4.760E-14 2.732E-11 5.553E-10 9.500E-16-1.000E 2.940E-09 8.090E-10
SKIN(FGR)   5.580E-14 3.278E-11 6.664E-10 1.140E-15-1.000E 0.000E 0.000E
Co-60
GONADS      1.230E-13 7.056E-11 1.480E-09 2.450E-15-1.000E 4.760E-09 3.190E-09
BREAST      1.390E-13 6.739E-11 1.413E-09 2.340E-15-1.000E 1.840E-08 1.100E-09
LUNGS       1.240E-13 6.537E-11 1.371E-09 2.270E-15-1.000E 3.450E-07 8.770E-10
RED MARR    1.230E-13 6.710E-11 1.407E-09 2.330E-15-1.000E 1.720E-08 1.320E-09
BONE SUR    1.780E-13 8.956E-11 1.879E-09 3.110E-15-1.000E 1.350E-08 9.390E-10
THYROID     1.270E-13 6.480E-11 1.359E-09 2.250E-15-1.000E 1.620E-08 7.880E-10
REMAINDER   1.200E-13 6.508E-11 1.365E-09 2.260E-15-1.000E 3.600E-08 4.970E-09
EFFECTIVE   1.260E-13 6.768E-11 1.419E-09 2.350E-15-1.000E 5.910E-08 2.770E-09
SKIN(FGR)   1.450E-13 7.948E-11 1.667E-09 2.760E-15-1.000E 0.000E 0.000E
Kr-83m
GONADS      1.710E-18 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
BREAST      5.050E-18 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
LUNGS       1.640E-19 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
RED MARR    3.830E-19 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
BONE SUR    2.250E-18 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
THYROID     6.430E-19 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
REMAINDER   5.300E-19 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
EFFECTIVE   1.500E-18 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
SKIN(FGR)   3.560E-17 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
Kr-85
GONADS      1.170E-16 8.121E-14 1.704E-12 2.820E-18-1.000E 0.000E 0.000E
BREAST      1.340E-16 7.891E-14 1.656E-12 2.740E-18-1.000E 0.000E 0.000E
LUNGS       1.140E-16 7.056E-14 1.481E-12 2.450E-18-1.000E 0.000E 0.000E
RED MARR    1.090E-16 6.998E-14 1.469E-12 2.430E-18-1.000E 0.000E 0.000E
BONE SUR    2.200E-16 1.287E-13 2.702E-12 4.470E-18-1.000E 0.000E 0.000E
THYROID     1.180E-16 7.459E-14 1.565E-12 2.590E-18-1.000E 0.000E 0.000E
REMAINDER   1.090E-16 6.941E-14 1.457E-12 2.410E-18-1.000E 0.000E 0.000E
EFFECTIVE   1.190E-16 7.603E-14 1.596E-12 2.640E-18-1.000E 0.000E 0.000E
SKIN(FGR)   1.320E-14 2.304E-11 4.835E-10 8.000E-16-1.000E 0.000E 0.000E
Kr-85m
GONADS      7.310E-15 2.594E-12 3.653E-12 1.570E-16-1.000E 0.000E 0.000E
BREAST      8.410E-15 2.527E-12 3.560E-12 1.530E-16-1.000E 0.000E 0.000E
LUNGS       7.040E-15 2.379E-12 3.351E-12 1.440E-16-1.000E 0.000E 0.000E
RED MARR    6.430E-15 2.346E-12 3.304E-12 1.420E-16-1.000E 0.000E 0.000E
BONE SUR    1.880E-14 5.286E-12 7.446E-12 3.200E-16-1.000E 0.000E 0.000E
THYROID     7.330E-15 2.395E-12 3.374E-12 1.450E-16-1.000E 0.000E 0.000E
REMAINDER   6.640E-15 2.313E-12 3.257E-12 1.400E-16-1.000E 0.000E 0.000E
EFFECTIVE   7.480E-15 2.511E-12 3.537E-12 1.520E-16-1.000E 0.000E 0.000E
SKIN(FGR)   2.240E-14 2.247E-11 3.164E-11 1.360E-15-1.000E 0.000E 0.000E
Kr-87
GONADS      4.000E-14 4.962E-12 5.026E-12 7.610E-16-1.000E 0.000E 0.000E
BREAST      4.500E-14 4.740E-12 4.802E-12 7.270E-16-1.000E 0.000E 0.000E
LUNGS       4.040E-14 4.603E-12 4.663E-12 7.060E-16-1.000E 0.000E 0.000E
RED MARR    4.000E-14 4.708E-12 4.769E-12 7.220E-16-1.000E 0.000E 0.000E
BONE SUR    6.020E-14 6.514E-12 6.598E-12 9.990E-16-1.000E 0.000E 0.000E
THYROID     4.130E-14 4.473E-12 4.531E-12 6.860E-16-1.000E 0.000E 0.000E
REMAINDER   3.910E-14 4.590E-12 4.650E-12 7.040E-16-1.000E 0.000E 0.000E
EFFECTIVE   4.120E-14 4.773E-12 4.835E-12 7.320E-16-1.000E 0.000E 0.000E
SKIN(FGR)   1.370E-13 8.802E-11 8.916E-11 1.350E-14-1.000E 0.000E 0.000E
Kr-88
GONADS      9.900E-14 2.278E-11 2.655E-11 1.800E-15-1.000E 0.000E 0.000E
BREAST      1.110E-13 2.177E-11 2.537E-11 1.720E-15-1.000E 0.000E 0.000E
LUNGS       1.010E-13 2.139E-11 2.493E-11 1.690E-15-1.000E 0.000E 0.000E
RED MARR    1.000E-13 2.190E-11 2.552E-11 1.730E-15-1.000E 0.000E 0.000E
BONE SUR    1.390E-13 2.886E-11 3.363E-11 2.280E-15-1.000E 0.000E 0.000E
THYROID     1.030E-13 2.012E-11 2.345E-11 1.590E-15-1.000E 0.000E 0.000E
REMAINDER   9.790E-14 2.139E-11 2.493E-11 1.690E-15-1.000E 0.000E 0.000E
EFFECTIVE   1.020E-13 2.202E-11 2.567E-11 1.740E-15-1.000E 0.000E 0.000E
SKIN(FGR)   1.350E-13 5.607E-11 6.534E-11 4.430E-15-1.000E 0.000E 0.000E
Rb-86
GONADS      4.710E-15 2.788E-12 5.187E-11 9.740E-17-1.000E 1.340E-09 2.150E-09
BREAST      5.340E-15 2.662E-12 4.953E-11 9.300E-17-1.000E 1.330E-09 2.140E-09
LUNGS       4.710E-15 2.553E-12 4.750E-11 8.920E-17-1.000E 3.300E-09 2.140E-09
RED MARR    4.640E-15 2.619E-12 4.873E-11 9.150E-17-1.000E 2.320E-09 3.720E-09
BONE SUR    7.050E-15 3.635E-12 6.764E-11 1.270E-16-1.000E 4.270E-09 6.860E-09
THYROID     4.840E-15 2.599E-12 4.836E-11 9.080E-17-1.000E 1.330E-09 2.140E-09
REMAINDER   4.520E-15 2.542E-12 4.729E-11 8.880E-17-1.000E 1.380E-09 2.330E-09
EFFECTIVE   4.810E-15 2.665E-12 4.958E-11 9.310E-17-1.000E 1.790E-09 2.530E-09
SKIN(FGR)   4.850E-14 2.210E-10 4.111E-09 7.720E-15-1.000E 0.000E 0.000E
Sr-89
GONADS      7.730E-17 7.155E-14 1.436E-12 2.490E-18-1.000E 7.950E-12 8.050E-12
BREAST      9.080E-17 7.212E-14 1.447E-12 2.510E-18-1.000E 7.960E-12 7.980E-12
LUNGS       7.080E-17 5.689E-14 1.142E-12 1.980E-18-1.000E 8.350E-08 7.970E-12
RED MARR    6.390E-17 5.345E-14 1.073E-12 1.860E-18-1.000E 1.070E-10 1.080E-10
BONE SUR    1.940E-16 1.560E-13 3.131E-12 5.430E-18-1.000E 1.590E-10 1.610E-10
THYROID     7.600E-17 6.063E-14 1.217E-12 2.110E-18-1.000E 7.960E-12 7.970E-12
REMAINDER   6.710E-17 5.603E-14 1.124E-12 1.950E-18-1.000E 3.970E-09 8.250E-09
EFFECTIVE   7.730E-17 6.523E-14 1.309E-12 2.270E-18-1.000E 1.120E-08 2.500E-09
SKIN(FGR)   3.690E-14 1.914E-10 3.841E-09 6.660E-15-1.000E 0.000E 0.000E
Sr-90
GONADS      7.780E-18 9.590E-15 2.014E-13 3.330E-19-1.000E 2.690E-10 5.040E-11
BREAST      9.490E-18 1.008E-14 2.116E-13 3.500E-19-1.000E 2.690E-10 5.040E-11
LUNGS       6.440E-18 6.307E-15 1.324E-13 2.190E-19-1.000E 2.860E-06 5.040E-11
RED MARR    5.440E-18 5.558E-15 1.167E-13 1.930E-19-1.000E 3.280E-08 6.450E-09
BONE SUR    2.280E-17 2.393E-14 5.025E-13 8.310E-19-1.000E 7.090E-08 1.390E-08
THYROID     7.330E-18 7.171E-15 1.506E-13 2.490E-19-1.000E 2.690E-10 5.040E-11
REMAINDER   6.110E-18 6.422E-15 1.348E-13 2.230E-19-1.000E 5.730E-09 6.700E-09
EFFECTIVE   7.530E-18 8.179E-15 1.717E-13 2.840E-19-1.000E 3.510E-07 3.230E-09
SKIN(FGR)   9.200E-15 4.032E-12 8.465E-11 1.400E-16-1.000E 0.000E 0.000E
Sr-91
GONADS      4.819E-14 2.155E-11 5.062E-11 1.026E-15-1.000E 5.669E-11 2.520E-10
```

BREAST	5.477E-14	2.059E-11	4.838E-11	9.806E-16-1.000E	1.775E-11	3.676E-11
LUNGS	4.803E-14	1.970E-11	4.626E-11	9.376E-16-1.000E	2.170E-09	1.055E-11
RED MARR	4.691E-14	2.011E-11	4.722E-11	9.570E-16-1.000E	2.275E-11	5.659E-11
BONE SUR	7.674E-14	2.852E-11	6.709E-11	1.360E-15-1.000E	1.306E-11	2.070E-11
THYROID	4.938E-14	2.035E-11	4.782E-11	9.693E-16-1.000E	9.930E-12	1.968E-12
REMAINDER	4.610E-14	1.948E-11	4.573E-11	9.268E-16-1.000E	5.802E-10	2.557E-09
EFFECTIVE	4.924E-14	2.057E-11	4.832E-11	9.793E-16-1.000E	4.547E-10	8.455E-10
SKIN(FGR)	9.938E-14	1.748E-10	3.987E-10	8.080E-15-1.000E	0.000E	0.000E
Sr-92						
GONADS	6.610E-14	1.593E-11	1.830E-11	1.300E-15-1.000E	1.020E-11	8.180E-11
BREAST	7.480E-14	1.520E-11	1.745E-11	1.240E-15-1.000E	6.490E-12	1.700E-11
LUNGS	6.670E-14	1.483E-11	1.703E-11	1.210E-15-1.000E	1.050E-09	7.220E-12
RED MARR	6.620E-14	1.520E-11	1.745E-11	1.240E-15-1.000E	6.980E-12	2.290E-11
BONE SUR	9.490E-14	2.010E-11	2.308E-11	1.640E-15-1.000E	4.360E-12	8.490E-12
THYROID	6.820E-14	1.446E-11	1.661E-11	1.180E-15-1.000E	3.920E-12	1.300E-12
REMAINDER	6.450E-14	1.471E-11	1.689E-11	1.200E-15-1.000E	2.900E-10	1.720E-09
EFFECTIVE	6.790E-14	1.532E-11	1.759E-11	1.250E-15-1.000E	2.180E-10	5.430E-10
SKIN(FGR)	8.560E-14	2.280E-11	2.618E-11	1.860E-15-1.000E	0.000E	0.000E
Y-90						
GONADS	1.890E-16	1.586E-13	1.601E-12	5.750E-18-1.000E	5.170E-13	1.430E-14
BREAST	2.200E-16	1.578E-13	1.593E-12	5.720E-18-1.000E	5.170E-13	1.270E-14
LUNGS	1.770E-16	1.313E-13	1.326E-12	4.760E-18-1.000E	9.310E-09	1.260E-14
RED MARR	1.620E-16	1.261E-13	1.273E-12	4.570E-18-1.000E	1.520E-11	3.700E-13
BONE SUR	4.440E-16	3.228E-13	3.259E-12	1.170E-17-1.000E	1.510E-11	3.670E-13
THYROID	1.870E-16	1.385E-13	1.398E-12	5.020E-18-1.000E	5.170E-13	1.260E-14
REMAINDER	1.680E-16	1.291E-13	1.303E-12	4.680E-18-1.000E	3.870E-09	9.680E-09
EFFECTIVE	1.900E-16	1.468E-13	1.482E-12	5.320E-18-1.000E	2.280E-09	2.910E-09
SKIN(FGR)	6.240E-14	2.897E-10	2.924E-09	1.050E-14-1.000E	0.000E	0.000E
Y-91						
GONADS	2.560E-16	1.756E-13	3.546E-12	6.110E-18-1.000E	8.200E-12	3.540E-12
BREAST	2.930E-16	1.713E-13	3.459E-12	5.960E-18-1.000E	8.920E-12	5.540E-13
LUNGS	2.500E-16	1.526E-13	3.082E-12	5.310E-18-1.000E	9.870E-08	2.020E-13
RED MARR	2.410E-16	1.521E-13	3.070E-12	5.290E-18-1.000E	3.190E-10	6.590E-12
BONE SUR	4.560E-16	2.903E-13	5.862E-12	1.010E-17-1.000E	3.180E-10	6.130E-12
THYROID	2.600E-16	1.564E-13	3.157E-12	5.440E-18-1.000E	8.500E-12	1.290E-13
REMAINDER	2.390E-16	1.509E-13	3.047E-12	5.250E-18-1.000E	4.200E-09	8.570E-09
EFFECTIVE	2.600E-16	1.650E-13	3.332E-12	5.740E-18-1.000E	1.320E-08	2.570E-09
SKIN(FGR)	3.850E-14	1.989E-10	4.016E-09	6.920E-15-1.000E	0.000E	0.000E
Y-92						
GONADS	1.270E-14	3.855E-12	4.872E-12	2.650E-16-1.000E	2.610E-12	1.960E-11
BREAST	1.440E-14	3.680E-12	4.652E-12	2.530E-16-1.000E	1.500E-12	3.550E-12
LUNGS	1.270E-14	3.535E-12	4.468E-12	2.430E-16-1.000E	1.240E-09	1.390E-12
RED MARR	1.250E-14	3.608E-12	4.560E-12	2.480E-16-1.000E	2.070E-12	4.910E-12
BONE SUR	1.950E-14	5.091E-12	6.435E-12	3.500E-16-1.000E	1.510E-12	1.750E-12
THYROID	1.300E-14	3.579E-12	4.523E-12	2.460E-16-1.000E	1.050E-12	1.770E-13
REMAINDER	1.220E-14	3.506E-12	4.431E-12	2.410E-16-1.000E	2.030E-10	1.700E-09
EFFECTIVE	1.300E-14	3.680E-12	4.652E-12	2.530E-16-1.000E	2.110E-10	5.150E-10
SKIN(FGR)	1.140E-13	2.022E-10	2.556E-10	1.390E-14-1.000E	0.000E	0.000E
Y-93						
GONADS	4.670E-15	2.108E-12	4.989E-12	9.510E-17-1.000E	5.310E-12	2.200E-11
BREAST	5.300E-15	2.026E-12	4.794E-12	9.140E-17-1.000E	1.740E-12	3.130E-12
LUNGS	4.680E-15	1.937E-12	4.585E-12	8.740E-17-1.000E	2.520E-09	8.670E-13
RED MARR	4.580E-15	1.972E-12	4.669E-12	8.900E-17-1.000E	4.040E-12	4.930E-12
BONE SUR	7.580E-15	2.948E-12	6.977E-12	1.330E-16-1.000E	3.140E-12	1.730E-12
THYROID	4.790E-15	1.908E-12	4.516E-12	8.610E-17-1.000E	9.260E-13	1.260E-13
REMAINDER	4.510E-15	1.919E-12	4.543E-12	8.660E-17-1.000E	9.250E-10	4.090E-09
EFFECTIVE	4.800E-15	2.021E-12	4.784E-12	9.120E-17-1.000E	5.820E-10	1.230E-09
SKIN(FGR)	8.500E-14	2.726E-10	6.452E-10	1.230E-14-1.000E	0.000E	0.000E
Zr-95						
GONADS	3.530E-14	2.182E-11	4.421E-10	7.590E-16-1.000E	1.880E-09	8.160E-10
BREAST	4.010E-14	2.084E-11	4.223E-10	7.250E-16-1.000E	1.910E-09	1.050E-10
LUNGS	3.510E-14	1.989E-11	4.030E-10	6.920E-16-1.000E	2.170E-09	2.340E-11
RED MARR	3.430E-14	2.030E-11	4.112E-10	7.060E-16-1.000E	1.300E-08	2.140E-10
BONE SUR	5.620E-14	2.875E-11	5.824E-10	1.000E-15-1.000E	1.030E-07	4.860E-10
THYROID	3.610E-14	2.076E-11	4.205E-10	7.220E-16-1.000E	1.440E-09	8.270E-12
REMAINDER	3.360E-14	1.963E-11	3.978E-10	6.830E-16-1.000E	2.280E-09	2.530E-09
EFFECTIVE	3.600E-14	2.078E-11	4.211E-10	7.230E-16-1.000E	6.390E-09	1.020E-09
SKIN(FGR)	4.500E-14	2.561E-11	5.190E-10	8.910E-16-1.000E	0.000E	0.000E
Zr-97						
GONADS	4.331E-14	2.179E-11	7.799E-11	9.253E-16-1.000E	1.840E-10	6.228E-10
BREAST	4.928E-14	2.083E-11	7.455E-11	8.846E-16-1.000E	4.706E-11	8.137E-11
LUNGS	4.322E-14	1.992E-11	7.127E-11	8.456E-16-1.000E	4.108E-09	1.770E-11
RED MARR	4.224E-14	2.034E-11	7.279E-11	8.634E-16-1.000E	6.376E-11	1.302E-10
BONE SUR	6.897E-14	2.881E-11	1.031E-10	1.224E-15-1.000E	3.504E-11	4.558E-11
THYROID	4.443E-14	2.061E-11	7.377E-11	8.755E-16-1.000E	2.315E-11	2.671E-12
REMAINDER	4.139E-14	1.966E-11	7.035E-11	8.345E-16-1.000E	2.041E-09	6.990E-09
EFFECTIVE	4.432E-14	2.078E-11	7.438E-11	8.824E-16-1.000E	1.171E-09	2.283E-09
SKIN(FGR)	9.835E-14	2.281E-10	8.148E-10	9.587E-15-1.000E	0.000E	0.000E
Nb-95						
GONADS	3.660E-14	2.253E-11	4.435E-10	7.850E-16-1.000E	4.320E-10	8.050E-10
BREAST	4.160E-14	2.150E-11	4.231E-10	7.490E-16-1.000E	4.070E-10	1.070E-10
LUNGS	3.650E-14	2.055E-11	4.045E-10	7.160E-16-1.000E	8.320E-09	2.740E-11
RED MARR	3.560E-14	2.101E-11	4.135E-10	7.320E-16-1.000E	4.420E-10	1.990E-10
BONE SUR	5.790E-14	2.957E-11	5.819E-10	1.030E-15-1.000E	5.130E-10	2.940E-10
THYROID	3.750E-14	2.144E-11	4.220E-10	7.470E-16-1.000E	3.580E-10	1.180E-11
REMAINDER	3.490E-14	2.032E-11	4.000E-10	7.080E-16-1.000E	1.070E-09	1.470E-09
EFFECTIVE	3.740E-14	2.147E-11	4.226E-10	7.480E-16-1.000E	1.570E-09	6.950E-10
SKIN(FGR)	4.300E-14	2.598E-11	5.112E-10	9.050E-16-1.000E	0.000E	0.000E
Mo-99						
GONADS	7.130E-15	4.282E-12	4.403E-11	1.550E-16-1.000E	9.510E-11	2.180E-10
BREAST	8.130E-15	4.116E-12	4.233E-11	1.490E-16-1.000E	2.750E-11	3.430E-11
LUNGS	7.060E-15	3.867E-12	3.977E-11	1.400E-16-1.000E	4.290E-09	1.510E-11
RED MARR	6.820E-15	3.923E-12	4.034E-11	1.420E-16-1.000E	5.240E-11	8.320E-11
BONE SUR	1.240E-14	6.105E-12	6.278E-11	2.210E-16-1.000E	4.130E-11	6.320E-11
THYROID	7.270E-15	4.033E-12	4.147E-11	1.460E-16-1.000E	1.520E-11	1.030E-11
REMAINDER	6.740E-15	3.812E-12	3.920E-11	1.380E-16-1.000E	1.740E-09	4.280E-09
EFFECTIVE	7.280E-15	4.061E-12	4.176E-11	1.470E-16-1.000E	1.070E-09	1.360E-09
SKIN(FGR)	3.140E-14	1.039E-10	1.068E-09	3.760E-15-1.000E	0.000E	0.000E
Tc-99m						
GONADS	5.750E-15	2.334E-12	3.877E-12	1.240E-16-1.000E	2.770E-12	9.750E-12

```
BREAST     6.650E-15 2.258E-12 3.752E-12 1.200E-16-1.000E 2.150E-12 3.570E-12
LUNGS      5.490E-15 2.127E-12 3.533E-12 1.130E-16-1.000E 2.280E-11 3.140E-12
RED MARR   4.910E-15 2.070E-12 3.439E-12 1.100E-16-1.000E 3.360E-12 6.290E-12
BONE SUR   1.630E-14 5.383E-12 8.942E-12 2.860E-16-1.000E 2.620E-12 4.060E-12
THYROID    5.750E-15 2.145E-12 3.564E-12 1.140E-16-1.000E 5.010E-11 8.460E-11
REMAINDER  5.150E-15 2.070E-12 3.439E-12 1.100E-16-1.000E 1.020E-11 3.340E-11
EFFECTIVE  5.890E-15 2.277E-12 3.783E-12 1.210E-16-1.000E 8.800E-12 1.680E-11
SKIN(FGR)  7.140E-15 2.710E-12 4.502E-12 1.440E-16-1.000E 0.000E 0.000E
Ru-103
GONADS     2.191E-14 1.404E-11 2.783E-10 4.892E-16-1.000E 3.070E-10 5.720E-10
BREAST     2.512E-14 1.350E-11 2.677E-10 4.705E-16-1.000E 3.110E-10 1.200E-10
LUNGS      2.180E-14 1.273E-11 2.522E-10 4.432E-16-1.000E 1.561E-08 7.310E-11
RED MARR   2.100E-14 1.287E-11 2.551E-10 4.483E-16-1.000E 3.190E-10 1.660E-10
BONE SUR   3.892E-14 1.958E-11 3.882E-10 6.823E-16-1.000E 2.370E-10 9.631E-11
THYROID    2.241E-14 1.331E-11 2.639E-10 4.638E-16-1.000E 2.570E-10 6.250E-11
REMAINDER  2.080E-14 1.248E-11 2.472E-10 4.346E-16-1.000E 1.250E-09 2.110E-09
EFFECTIVE  2.251E-14 1.332E-11 2.641E-10 4.642E-16-1.000E 2.421E-09 8.271E-10
SKIN(FGR)  2.774E-14 1.785E-11 3.543E-10 6.229E-16-1.000E 0.000E 0.000E
Ru-105
GONADS     3.720E-14 1.327E-11 1.861E-11 8.070E-16-1.000E 1.590E-11 9.670E-11
BREAST     4.240E-14 1.271E-11 1.783E-11 7.730E-16-1.000E 6.610E-12 1.590E-11
LUNGS      3.700E-14 1.210E-11 1.697E-11 7.360E-16-1.000E 5.730E-10 6.210E-12
RED MARR   3.590E-14 1.230E-11 1.725E-11 7.480E-16-1.000E 7.700E-12 2.350E-11
BONE SUR   6.280E-14 1.809E-11 2.537E-11 1.100E-15-1.000E 4.620E-12 8.890E-12
THYROID    3.800E-14 1.260E-11 1.766E-11 7.660E-16-1.000E 4.150E-12 1.820E-12
REMAINDER  3.540E-14 1.189E-11 1.667E-11 7.230E-16-1.000E 1.610E-10 8.540E-10
EFFECTIVE  3.810E-14 1.265E-11 1.773E-11 7.690E-16-1.000E 1.230E-10 2.870E-10
SKIN(FGR)  6.730E-14 7.368E-11 1.033E-10 4.480E-15-1.000E 0.000E 0.000E
Ru-106
GONADS     1.010E-14 6.411E-12 1.340E-10 2.230E-16-1.000E 1.300E-09 1.640E-09
BREAST     1.160E-14 6.152E-12 1.286E-10 2.140E-16-1.000E 1.780E-09 1.440E-09
LUNGS      1.010E-14 5.836E-12 1.220E-10 2.030E-16-1.000E 1.040E-06 1.420E-09
RED MARR   9.750E-15 5.893E-12 1.232E-10 2.050E-16-1.000E 1.760E-09 1.460E-09
BONE SUR   1.720E-14 8.883E-12 1.856E-10 3.090E-16-1.000E 1.610E-09 1.430E-09
THYROID    1.030E-14 6.066E-12 1.268E-10 2.110E-16-1.000E 1.720E-09 1.410E-09
REMAINDER  9.630E-15 5.721E-12 1.196E-10 1.990E-16-1.000E 1.200E-08 2.110E-08
EFFECTIVE  1.040E-14 6.095E-12 1.274E-10 2.120E-16-1.000E 1.290E-07 7.400E-09
SKIN(FGR)  1.090E-13 4.082E-10 8.531E-09 1.420E-14-1.000E 0.000E 0.000E
Rh-105
GONADS     3.640E-15 2.127E-12 1.411E-11 7.980E-17-1.000E 2.110E-11 5.800E-11
BREAST     4.160E-15 2.063E-12 1.369E-11 7.740E-17-1.000E 5.610E-12 8.970E-12
LUNGS      3.570E-15 1.935E-12 1.284E-11 7.260E-17-1.000E 9.580E-10 3.860E-12
RED MARR   3.380E-15 1.946E-12 1.291E-11 7.300E-17-1.000E 7.770E-12 1.470E-11
BONE SUR   7.530E-15 3.332E-12 2.210E-11 1.250E-16-1.000E 4.460E-12 6.750E-12
THYROID    3.680E-15 1.983E-12 1.316E-11 7.440E-17-1.000E 2.880E-12 2.910E-12
REMAINDER  3.390E-15 1.885E-12 1.250E-11 7.070E-17-1.000E 4.530E-10 1.270E-09
EFFECTIVE  3.720E-15 2.031E-12 1.347E-11 7.620E-17-1.000E 2.580E-10 3.990E-10
SKIN(FGR)  1.070E-14 4.691E-12 3.112E-11 1.760E-16-1.000E 0.000E 0.000E
Sb-127
GONADS     3.260E-14 1.985E-11 2.441E-10 7.100E-16-1.000E 2.520E-10 6.140E-10
BREAST     3.720E-14 1.904E-11 2.341E-10 6.810E-16-1.000E 9.120E-11 7.600E-11
LUNGS      3.240E-14 1.809E-11 2.224E-10 6.470E-16-1.000E 6.940E-09 1.570E-11
RED MARR   3.140E-14 1.834E-11 2.255E-10 6.560E-16-1.000E 1.610E-10 1.330E-10
BONE SUR   5.520E-14 2.720E-11 3.345E-10 9.730E-16-1.000E 1.340E-10 5.240E-11
THYROID    3.330E-14 1.884E-11 2.317E-10 6.740E-16-1.000E 6.150E-11 4.640E-12
REMAINDER  3.090E-14 1.775E-11 2.183E-10 6.350E-16-1.000E 2.330E-09 5.870E-09
EFFECTIVE  3.330E-14 1.890E-11 2.324E-10 6.760E-16-1.000E 1.630E-09 1.950E-09
SKIN(FGR)  5.580E-14 7.967E-11 9.799E-10 2.850E-15-1.000E 0.000E 0.000E
Sb-129
GONADS     6.970E-14 2.336E-11 3.231E-11 1.440E-15-1.000E 2.150E-11 1.510E-10
BREAST     7.910E-14 2.222E-11 3.074E-11 1.370E-15-1.000E 1.280E-11 2.560E-11
LUNGS      6.980E-14 2.141E-11 2.962E-11 1.320E-15-1.000E 8.980E-10 9.390E-12
RED MARR   6.860E-14 2.190E-11 3.029E-11 1.350E-15-1.000E 1.700E-11 3.670E-11
BONE SUR   1.070E-13 3.033E-11 4.196E-11 1.870E-15-1.000E 1.460E-11 1.340E-11
THYROID    7.160E-14 2.174E-11 3.007E-11 1.340E-15-1.000E 9.720E-12 1.470E-12
REMAINDER  6.710E-14 2.125E-11 2.939E-11 1.310E-15-1.000E 1.870E-10 1.450E-09
EFFECTIVE  7.140E-14 2.238E-11 3.096E-11 1.380E-15-1.000E 1.740E-10 4.840E-10
SKIN(FGR)  1.050E-13 8.273E-11 1.144E-10 5.100E-15-1.000E 0.000E 0.000E
Te-127
GONADS     2.370E-16 1.191E-13 2.661E-13 5.480E-18-1.000E 2.020E-12 4.020E-12
BREAST     2.730E-16 1.158E-13 2.588E-13 5.330E-18-1.000E 1.880E-12 3.000E-12
LUNGS      2.320E-16 1.060E-13 2.370E-13 4.880E-18-1.000E 4.270E-10 2.890E-12
RED MARR   2.210E-16 1.058E-13 2.365E-13 4.870E-18-1.000E 4.090E-12 6.570E-12
BONE SUR   4.650E-16 1.862E-13 4.162E-13 8.570E-18-1.000E 4.090E-12 6.460E-12
THYROID    2.400E-16 1.106E-13 2.472E-13 5.090E-18-1.000E 1.840E-12 2.860E-12
REMAINDER  2.210E-16 1.036E-13 2.316E-13 4.770E-18-1.000E 1.110E-10 6.130E-10
EFFECTIVE  2.420E-16 1.125E-13 2.515E-13 5.180E-18-1.000E 8.600E-11 1.870E-10
SKIN(FGR)  1.140E-14 1.173E-11 2.622E-11 5.400E-16-1.000E 0.000E 0.000E
Te-127m
GONADS     1.900E-16 4.689E-13 9.642E-12 1.630E-17-1.000E 1.100E-10 1.250E-10
BREAST     2.690E-16 5.150E-13 1.059E-11 1.790E-17-1.000E 1.100E-10 9.740E-11
LUNGS      7.620E-17 1.602E-13 3.295E-12 5.570E-18-1.000E 3.340E-08 9.620E-11
RED MARR   6.430E-17 1.249E-13 2.567E-12 4.340E-18-1.000E 5.360E-09 5.430E-09
BONE SUR   3.940E-16 9.005E-13 1.852E-11 3.130E-17-1.000E 2.040E-08 2.070E-08
THYROID    1.500E-16 2.779E-13 5.714E-12 9.660E-18-1.000E 9.660E-11 9.430E-11
REMAINDER  8.640E-17 1.999E-13 4.111E-12 6.950E-18-1.000E 1.660E-09 2.980E-09
EFFECTIVE  1.470E-16 3.251E-13 6.684E-12 1.130E-17-1.000E 5.810E-09 2.230E-09
SKIN(FGR)  8.490E-16 1.496E-12 3.076E-11 5.200E-17-1.000E 0.000E 0.000E
Te-129
GONADS     2.710E-15 3.889E-13 3.922E-13 6.510E-17-1.000E 5.050E-13 1.590E-12
BREAST     3.120E-15 3.800E-13 3.832E-13 6.360E-17-1.000E 5.390E-13 6.050E-13
LUNGS      2.640E-15 3.298E-13 3.326E-13 5.520E-17-1.000E 1.530E-10 4.910E-13
RED MARR   2.540E-15 3.298E-13 3.326E-13 5.520E-17-1.000E 6.190E-13 7.640E-13
BONE SUR   4.880E-15 5.753E-13 5.802E-13 9.630E-17-1.000E 6.220E-13 5.400E-13
THYROID    2.740E-15 3.525E-13 3.555E-13 5.900E-17-1.000E 5.090E-13 3.360E-13
REMAINDER  2.520E-15 3.262E-13 3.289E-13 5.460E-17-1.000E 7.280E-12 1.790E-10
EFFECTIVE  2.750E-15 3.590E-13 3.621E-13 6.010E-17-1.000E 2.090E-11 5.450E-11
SKIN(FGR)  3.570E-14 3.429E-11 3.458E-11 5.740E-15-1.000E 0.000E 0.000E
Br-83
GONADS     3.740E-16 0.000E 0.000E 0.000E1.000E 3.280E-12 7.350E-12
```

```
BREAST      4.290E-16 0.000E 0.000E 0.000E1.000E 3.290E-12 7.340E-12
LUNGS       3.690E-16 0.000E 0.000E 0.000E1.000E 1.500E-10 7.350E-12
RED MARR    3.540E-16 0.000E 0.000E 0.000E1.000E 3.300E-12 7.350E-12
BONE SUR    6.750E-16 0.000E 0.000E 0.000E1.000E 3.200E-12 7.330E-12
THYROID     3.800E-16 0.000E 0.000E 0.000E1.000E 3.290E-12 7.330E-12
REMAINDER   3.520E-16 0.000E 0.000E 0.000E1.000E 1.130E-11 6.540E-11
EFFECTIVE   3.820E-16 0.000E 0.000E 0.000E1.000E 2.330E-11 2.470E-11
SKIN(FGR)   1.850E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
Br-84
GONADS      9.160E-14 0.000E 0.000E 0.000E1.000E 2.840E-12 6.750E-12
BREAST      1.020E-13 0.000E 0.000E 0.000E1.000E 3.310E-12 6.620E-12
LUNGS       9.270E-14 0.000E 0.000E 0.000E1.000E 1.560E-10 6.990E-12
RED MARR    9.260E-14 0.000E 0.000E 0.000E1.000E 3.270E-12 6.210E-12
BONE SUR    1.280E-13 0.000E 0.000E 0.000E1.000E 2.990E-12 5.560E-12
THYROID     9.500E-14 0.000E 0.000E 0.000E1.000E 3.120E-12 5.200E-12
REMAINDER   8.990E-14 0.000E 0.000E 0.000E1.000E 1.870E-11 1.480E-10
EFFECTIVE   9.410E-14 0.000E 0.000E 0.000E1.000E 2.610E-11 4.910E-11
SKIN(FGR)   1.880E-13 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
I-130
GONADS      1.010E-13 0.000E 0.000E 0.000E1.000E 2.810E-11 5.520E-11
BREAST      1.160E-13 0.000E 0.000E 0.000E1.000E 4.870E-11 7.320E-11
LUNGS       1.010E-13 0.000E 0.000E 0.000E1.000E 6.030E-10 7.180E-11
RED MARR    9.820E-14 0.000E 0.000E 0.000E1.000E 4.550E-11 6.740E-11
BONE SUR    1.680E-13 0.000E 0.000E 0.000E1.000E 4.030E-11 6.120E-11
THYROID     1.040E-13 0.000E 0.000E 0.000E1.000E 1.990E-08 3.940E-08
REMAINDER   9.660E-14 0.000E 0.000E 0.000E1.000E 8.020E-11 1.970E-10
EFFECTIVE   1.040E-13 0.000E 0.000E 0.000E1.000E 7.140E-10 1.280E-09
SKIN(FGR)   1.360E-13 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
I-131
GONADS      1.780E-14 1.119E-11 1.789E-10 3.940E-16-1.000E 2.530E-11 4.070E-11
BREAST      2.040E-14 1.082E-11 1.730E-10 3.810E-16-1.000E 7.880E-11 1.210E-10
LUNGS       1.760E-14 1.016E-11 1.626E-10 3.580E-16-1.000E 6.570E-10 1.020E-10
RED MARR    1.680E-14 1.022E-11 1.635E-10 3.600E-16-1.000E 6.260E-11 9.440E-11
BONE SUR    3.450E-14 1.675E-11 2.679E-10 5.900E-16-1.000E 5.730E-11 8.720E-11
THYROID     1.810E-14 1.053E-11 1.685E-10 3.710E-16-1.000E 2.920E-07 4.760E-07
REMAINDER   1.670E-14 9.908E-12 1.585E-10 3.490E-16-1.000E 8.030E-11 1.570E-10
EFFECTIVE   1.820E-14 1.067E-11 1.707E-10 3.760E-16-1.000E 8.890E-09 1.440E-08
SKIN(FGR)   2.980E-14 1.825E-11 2.920E-10 6.430E-16-1.000E 0.000E 0.000E
I-132
GONADS      1.090E-13 2.523E-11 2.771E-11 2.320E-15-1.000E 9.950E-12 2.330E-11
BREAST      1.240E-13 2.414E-11 2.652E-11 2.220E-15-1.000E 1.410E-11 2.520E-11
LUNGS       1.090E-13 2.305E-11 2.532E-11 2.120E-15-1.000E 2.710E-10 2.640E-11
RED MARR    1.070E-13 2.360E-11 2.592E-11 2.170E-15-1.000E 1.400E-11 2.460E-11
BONE SUR    1.730E-13 3.327E-11 3.655E-11 3.060E-15-1.000E 1.240E-11 2.190E-11
THYROID     1.120E-13 2.381E-11 2.616E-11 2.190E-15-1.000E 1.740E-09 3.870E-09
REMAINDER   1.050E-13 2.283E-11 2.509E-11 2.100E-15-1.000E 3.780E-11 1.650E-10
EFFECTIVE   1.120E-13 2.403E-11 2.640E-11 2.210E-15-1.000E 1.030E-10 1.820E-10
SKIN(FGR)   1.580E-13 8.199E-11 9.007E-11 7.540E-15-1.000E 0.000E 0.000E
I-133
GONADS      2.870E-14 1.585E-11 6.748E-11 6.270E-16-1.000E 1.950E-11 3.630E-11
BREAST      3.280E-14 1.519E-11 6.468E-11 6.010E-16-1.000E 2.940E-11 4.680E-11
LUNGS       2.860E-14 1.446E-11 6.156E-11 5.720E-16-1.000E 8.200E-10 4.530E-11
RED MARR    2.770E-14 1.466E-11 6.242E-11 5.800E-16-1.000E 2.720E-11 4.300E-11
BONE SUR    4.870E-14 2.161E-11 9.202E-11 8.550E-16-1.000E 2.520E-11 4.070E-11
THYROID     2.930E-14 1.502E-11 6.393E-11 5.940E-16-1.000E 4.860E-08 9.100E-08
REMAINDER   2.730E-14 1.418E-11 6.038E-11 5.610E-16-1.000E 5.000E-11 1.550E-10
EFFECTIVE   2.940E-14 1.509E-11 6.425E-11 5.970E-16-1.000E 1.580E-09 2.800E-09
SKIN(FGR)   5.830E-14 1.150E-10 4.897E-10 4.550E-15-1.000E 0.000E 0.000E
I-134
GONADS      1.270E-13 1.200E-11 1.202E-11 2.640E-15-1.000E 4.250E-12 1.100E-11
BREAST      1.440E-13 1.145E-11 1.147E-11 2.520E-15-1.000E 6.170E-12 1.170E-11
LUNGS       1.270E-13 1.100E-11 1.102E-11 2.420E-15-1.000E 1.430E-10 1.260E-11
RED MARR    1.250E-13 1.127E-11 1.129E-11 2.480E-15-1.000E 6.080E-12 1.090E-11
BONE SUR    1.960E-13 1.568E-11 1.571E-11 3.450E-15-1.000E 5.310E-12 9.320E-12
THYROID     1.300E-13 1.127E-11 1.129E-11 2.480E-15-1.000E 2.880E-10 6.210E-10
REMAINDER   1.220E-13 1.091E-11 1.093E-11 2.400E-15-1.000E 2.270E-11 1.340E-10
EFFECTIVE   1.300E-13 1.150E-11 1.152E-11 2.530E-15-1.000E 3.550E-11 6.660E-11
SKIN(FGR)   1.870E-13 4.477E-11 4.485E-11 9.850E-15-1.000E 0.000E 0.000E
I-135
GONADS      8.078E-14 3.113E-11 5.489E-11 1.599E-15-1.000E 1.700E-11 3.610E-11
BREAST      9.143E-14 2.971E-11 5.240E-11 1.526E-15-1.000E 2.340E-11 3.850E-11
LUNGS       8.145E-14 2.886E-11 5.089E-11 1.482E-15-1.000E 4.410E-10 3.750E-11
RED MARR    8.054E-14 2.965E-11 5.228E-11 1.523E-15-1.000E 2.240E-11 3.650E-11
BONE SUR    1.184E-13 3.983E-11 7.024E-11 2.046E-15-1.000E 2.010E-11 3.360E-11
THYROID     8.324E-14 2.852E-11 5.030E-11 1.465E-15-1.000E 8.460E-09 1.790E-08
REMAINDER   7.861E-14 2.883E-11 5.084E-11 1.481E-15-1.000E 4.700E-11 1.540E-10
EFFECTIVE   8.294E-14 2.989E-11 5.271E-11 1.535E-15-1.000E 3.320E-10 6.080E-10
SKIN(FGR)   1.156E-13 9.826E-11 1.733E-10 5.047E-15-1.000E 0.000E 0.000E
Xe-131m
GONADS      4.570E-16 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
BREAST      6.020E-16 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
LUNGS       2.670E-16 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
RED MARR    2.270E-16 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
BONE SUR    1.060E-15 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
THYROID     3.910E-16 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
REMAINDER   2.710E-16 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
EFFECTIVE   3.890E-16 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
SKIN(FGR)   4.820E-15 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
Xe-133
GONADS      1.610E-15 1.465E-12 2.052E-11 5.200E-17-1.000E 0.000E 0.000E
BREAST      1.960E-15 1.505E-12 2.107E-11 5.340E-17-1.000E 0.000E 0.000E
LUNGS       1.320E-15 1.045E-12 1.464E-11 3.710E-17-1.000E 0.000E 0.000E
RED MARR    1.070E-15 8.791E-13 1.231E-11 3.120E-17-1.000E 0.000E 0.000E
BONE SUR    5.130E-15 4.254E-12 5.958E-11 1.510E-16-1.000E 0.000E 0.000E
THYROID     1.510E-15 1.181E-12 1.653E-11 4.190E-17-1.000E 0.000E 0.000E
REMAINDER   1.240E-15 1.042E-12 1.460E-11 3.700E-17-1.000E 0.000E 0.000E
EFFECTIVE   1.560E-15 1.299E-12 1.819E-11 4.610E-17-1.000E 0.000E 0.000E
SKIN(FGR)   4.970E-15 1.953E-12 2.734E-11 6.930E-17-1.000E 0.000E 0.000E
Xe-133m
GONADS      1.420E-15 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
```

```
BREAST     1.700E-15 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
LUNGS      1.190E-15 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
RED MARR   1.100E-15 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
BONE SUR   3.230E-15 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
THYROID    1.360E-15 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
REMAINDER  1.150E-15 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
EFFECTIVE  1.370E-15 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
SKIN(FGR)  1.040E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
Xe-135
GONADS     1.170E-14 5.455E-12 1.194E-11 2.530E-16-1.000E 0.000E 0.000E
BREAST     1.330E-14 5.325E-12 1.166E-11 2.470E-16-1.000E 0.000E 0.000E
LUNGS      1.130E-14 4.959E-12 1.086E-11 2.300E-16-1.000E 0.000E 0.000E
RED MARR   1.070E-14 4.959E-12 1.086E-11 2.300E-16-1.000E 0.000E 0.000E
BONE SUR   2.570E-14 9.120E-12 1.997E-11 4.230E-16-1.000E 0.000E 0.000E
THYROID    1.180E-14 5.023E-12 1.100E-11 2.330E-16-1.000E 0.000E 0.000E
REMAINDER  1.080E-14 4.829E-12 1.058E-11 2.240E-16-1.000E 0.000E 0.000E
EFFECTIVE  1.190E-14 5.217E-12 1.142E-11 2.420E-16-1.000E 0.000E 0.000E
SKIN(FGR)  3.120E-14 4.506E-11 9.867E-11 2.090E-15-1.000E 0.000E 0.000E
Xe-135m
GONADS     2.000E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
BREAST     2.290E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
LUNGS      1.980E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
RED MARR   1.910E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
BONE SUR   3.500E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
THYROID    2.040E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
REMAINDER  1.890E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
EFFECTIVE  2.040E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
SKIN(FGR)  2.970E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
Xe-138
GONADS     5.590E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
BREAST     6.320E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
LUNGS      5.660E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
RED MARR   5.600E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
BONE SUR   8.460E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
THYROID    5.770E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
REMAINDER  5.490E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
EFFECTIVE  5.770E-14 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
SKIN(FGR)  1.070E-13 0.000E 0.000E 0.000E1.000E 0.000E 0.000E
Cs-134
GONADS     7.400E-14 4.607E-11 9.646E-10 1.600E-15-1.000E 1.300E-08 2.060E-08
BREAST     8.430E-14 4.406E-11 9.224E-10 1.530E-15-1.000E 1.080E-08 1.720E-08
LUNGS      7.370E-14 4.204E-11 8.802E-10 1.460E-15-1.000E 1.180E-08 1.760E-08
RED MARR   7.190E-14 4.262E-11 8.922E-10 1.480E-15-1.000E 1.180E-08 1.870E-08
BONE SUR   1.200E-13 6.105E-11 1.278E-09 2.120E-15-1.000E 1.100E-08 1.740E-08
THYROID    7.570E-14 4.377E-11 9.163E-10 1.520E-15-1.000E 1.110E-08 1.760E-08
REMAINDER  7.060E-14 4.147E-11 8.681E-10 1.440E-15-1.000E 1.390E-08 2.210E-08
EFFECTIVE  7.570E-14 4.377E-11 9.163E-10 1.520E-15-1.000E 1.250E-08 1.980E-08
SKIN(FGR)  9.450E-14 6.249E-11 1.308E-09 2.170E-15-1.000E 0.000E 0.000E
Cs-136
GONADS     1.040E-13 6.223E-11 1.102E-09 2.180E-15-1.000E 1.880E-09 3.040E-09
```

```
BREAST     1.180E-13 5.966E-11 1.056E-09 2.090E-15-1.000E 1.670E-09 2.650E-09
LUNGS      1.040E-13 5.710E-11 1.011E-09 2.000E-15-1.000E 2.320E-09 2.620E-09
RED MARR   1.010E-13 5.824E-11 1.031E-09 2.040E-15-1.000E 1.860E-09 2.950E-09
BONE SUR   1.660E-13 8.422E-11 1.491E-09 2.950E-15-1.000E 1.700E-09 2.710E-09
THYROID    1.070E-13 5.852E-11 1.036E-09 2.050E-15-1.000E 1.730E-09 2.740E-09
REMAINDER  9.950E-14 5.652E-11 1.001E-09 1.980E-15-1.000E 2.190E-09 3.520E-09
EFFECTIVE  1.060E-13 5.966E-11 1.056E-09 2.090E-15-1.000E 1.980E-09 3.040E-09
SKIN(FGR)  1.250E-13 7.251E-11 1.284E-09 2.540E-15-1.000E 0.000E 0.000E
Cs-137
GONADS     2.669E-14 1.669E-11 3.530E-10 5.840E-16-1.000E 8.760E-09 1.390E-08
BREAST     3.047E-14 1.596E-11 3.376E-10 5.585E-16-1.000E 7.840E-09 1.240E-08
LUNGS      2.649E-14 1.517E-11 3.209E-10 5.309E-16-1.000E 8.820E-09 1.270E-08
RED MARR   2.583E-14 1.542E-11 3.260E-10 5.394E-16-1.000E 8.300E-09 1.320E-08
BONE SUR   4.382E-14 2.238E-11 4.734E-10 7.832E-16-1.000E 7.940E-09 1.260E-08
THYROID    2.725E-14 1.588E-11 3.358E-10 5.556E-16-1.000E 7.930E-09 1.260E-08
REMAINDER  2.536E-14 1.490E-11 3.152E-10 5.215E-16-1.000E 9.120E-09 1.450E-08
EFFECTIVE  2.725E-14 1.585E-11 3.353E-10 5.546E-16-1.000E 8.630E-09 1.350E-08
SKIN(FGR)  4.392E-14 5.253E-11 1.110E-09 1.836E-15-1.000E 0.000E 0.000E
Ba-139
GONADS     2.130E-15 3.368E-13 3.429E-13 4.790E-17-1.000E 2.560E-12 1.560E-12
BREAST     2.450E-15 3.297E-13 3.357E-13 4.690E-17-1.000E 2.460E-12 5.170E-13
LUNGS      2.030E-15 3.002E-13 3.057E-13 4.270E-17-1.000E 2.530E-10 3.890E-13
RED MARR   1.870E-15 2.932E-13 2.985E-13 4.170E-17-1.000E 3.410E-12 8.590E-13
BONE SUR   5.290E-15 6.841E-13 6.965E-13 9.730E-17-1.000E 2.490E-12 4.380E-13
THYROID    2.130E-15 3.044E-13 3.100E-13 4.330E-17-1.000E 2.400E-12 2.660E-13
REMAINDER  1.920E-15 2.932E-13 2.985E-13 4.170E-17-1.000E 4.820E-11 3.570E-10
EFFECTIVE  2.170E-15 3.227E-13 3.286E-13 4.590E-17-1.000E 4.640E-11 1.080E-10
SKIN(FGR)  6.160E-14 7.241E-11 7.373E-11 1.030E-14-1.000E 0.000E 0.000E
Ba-140
GONADS     8.410E-15 5.451E-12 9.607E-11 1.910E-16-1.000E 4.300E-10 9.960E-10
BREAST     9.640E-15 5.280E-12 9.305E-11 1.850E-16-1.000E 2.870E-10 1.590E-10
LUNGS      8.270E-15 4.852E-12 8.550E-11 1.700E-16-1.000E 1.660E-09 6.630E-11
RED MARR   7.930E-15 4.880E-12 8.601E-11 1.710E-16-1.000E 1.290E-09 4.390E-10
BONE SUR   1.550E-14 8.020E-12 1.413E-10 2.810E-16-1.000E 2.410E-09 5.530E-10
THYROID    8.530E-15 5.109E-12 9.003E-11 1.790E-16-1.000E 2.560E-10 5.250E-11
REMAINDER  7.890E-15 4.766E-12 8.399E-11 1.670E-16-1.000E 1.410E-09 7.370E-09
EFFECTIVE  8.580E-15 5.137E-12 9.053E-11 1.800E-16-1.000E 1.010E-09 2.560E-09
SKIN(FGR)  2.520E-14 5.565E-11 9.808E-10 1.950E-15-1.000E 0.000E 0.000E
La-140
GONADS     1.140E-13 6.027E-11 4.425E-10 2.240E-15-1.000E 4.540E-10 1.340E-09
BREAST     1.290E-13 5.758E-11 4.228E-10 2.140E-15-1.000E 1.450E-10 1.800E-10
LUNGS      1.150E-13 5.596E-11 4.109E-10 2.080E-15-1.000E 4.210E-09 4.010E-11
RED MARR   1.140E-13 5.731E-11 4.208E-10 2.130E-15-1.000E 2.140E-10 2.810E-10
BONE SUR   1.690E-13 7.776E-11 5.709E-10 2.890E-15-1.000E 1.410E-10 9.770E-11
THYROID    1.180E-13 5.462E-11 4.010E-10 2.030E-15-1.000E 6.870E-11 6.400E-12
REMAINDER  1.110E-13 5.569E-11 4.089E-10 2.070E-15-1.000E 2.120E-09 6.260E-09
EFFECTIVE  1.170E-13 5.812E-11 4.267E-10 2.160E-15-1.000E 1.310E-09 2.280E-09
SKIN(FGR)  1.660E-13 2.217E-10 1.628E-09 8.240E-15-1.000E 0.000E 0.000E
La-141
GONADS     2.330E-15 7.315E-13 9.675E-13 4.740E-17-1.000E 1.010E-11 3.770E-12
```

```
BREAST     2.640E-15 7.007E-13 9.267E-13 4.540E-17-1.000E 9.840E-12 7.070E-13
LUNGS      2.340E-15 6.713E-13 8.879E-13 4.350E-17-1.000E 6.460E-10 2.720E-13
RED MARR   2.310E-15 6.852E-13 9.063E-13 4.440E-17-1.000E 2.930E-11 1.070E-12
BONE SUR   3.490E-15 9.923E-13 1.312E-12 6.430E-17-1.000E 1.200E-10 6.060E-13
THYROID    2.390E-15 6.590E-13 8.716E-13 4.270E-17-1.000E 9.400E-12 5.290E-14
REMAINDER  2.260E-15 6.682E-13 8.838E-13 4.330E-17-1.000E 2.280E-10 1.240E-09
EFFECTIVE  2.390E-15 7.007E-13 9.267E-13 4.540E-17-1.000E 1.570E-10 3.740E-10
SKIN(FGR)  6.580E-14 1.667E-10 2.204E-10 1.080E-14-1.000E 0.000E 0.000E
La-142
GONADS     1.400E-13 1.978E-11 2.034E-11 2.540E-15-1.000E 1.660E-11 6.990E-11
BREAST     1.570E-13 1.885E-11 1.938E-11 2.420E-15-1.000E 1.130E-11 1.540E-11
LUNGS      1.420E-13 1.846E-11 1.898E-11 2.370E-15-1.000E 3.010E-10 8.400E-12
RED MARR   1.420E-13 1.900E-11 1.954E-11 2.440E-15-1.000E 1.360E-11 1.930E-11
BONE SUR   1.950E-13 2.484E-11 2.554E-11 3.190E-15-1.000E 1.110E-11 7.400E-12
THYROID    1.450E-13 1.768E-11 1.818E-11 2.270E-15-1.000E 8.740E-12 1.160E-12
REMAINDER  1.380E-13 1.853E-11 1.906E-11 2.380E-15-1.000E 8.070E-11 5.200E-10
EFFECTIVE  1.440E-13 1.916E-11 1.970E-11 2.460E-15-1.000E 6.840E-11 1.790E-10
SKIN(FGR)  2.160E-13 9.111E-11 9.368E-11 1.170E-14-1.000E 0.000E 0.000E
Ce-141
GONADS     3.380E-15 2.213E-12 4.332E-11 7.710E-17-1.000E 5.540E-11 1.080E-10
BREAST     3.930E-15 2.170E-12 4.247E-11 7.560E-17-1.000E 4.460E-11 1.110E-11
LUNGS      3.170E-15 1.951E-12 3.820E-11 6.800E-17-1.000E 1.670E-08 1.430E-12
RED MARR   2.830E-15 1.860E-12 3.641E-11 6.480E-17-1.000E 8.960E-11 3.390E-11
BONE SUR   9.410E-15 5.166E-12 1.011E-10 1.800E-16-1.000E 2.540E-10 2.300E-11
THYROID    3.350E-15 2.003E-12 3.922E-11 6.980E-17-1.000E 2.550E-11 1.800E-13
REMAINDER  2.980E-15 1.894E-12 3.708E-11 6.600E-17-1.000E 1.260E-09 2.500E-09
EFFECTIVE  3.430E-15 2.118E-12 4.146E-11 7.380E-17-1.000E 2.420E-09 7.830E-10
SKIN(FGR)  1.020E-14 3.788E-12 7.416E-11 1.320E-16-1.000E 0.000E 0.000E
Ce-143
GONADS     1.280E-14 7.900E-12 4.958E-11 2.980E-16-1.000E 7.530E-11 2.120E-10
BREAST     1.470E-14 7.688E-12 4.825E-11 2.900E-16-1.000E 1.660E-11 2.320E-11
LUNGS      1.230E-14 6.893E-12 4.325E-11 2.600E-16-1.000E 3.880E-09 3.820E-12
RED MARR   1.170E-14 6.787E-12 4.259E-11 2.560E-16-1.000E 2.960E-11 5.070E-11
BONE SUR   2.520E-14 1.323E-11 8.302E-11 4.990E-16-1.000E 1.640E-11 1.610E-11
THYROID    1.280E-14 7.211E-12 4.525E-11 2.720E-16-1.000E 6.230E-12 4.350E-13
REMAINDER  1.170E-14 6.734E-12 4.226E-11 2.540E-16-1.000E 1.420E-09 3.890E-09
EFFECTIVE  1.290E-14 7.396E-12 4.642E-11 2.790E-16-1.000E 9.160E-10 1.230E-09
SKIN(FGR)  3.960E-14 1.058E-10 6.638E-10 3.990E-15-1.000E 0.000E 0.000E
Ce-144
GONADS     2.725E-15 6.328E-13 1.319E-11 6.088E-17-1.000E 2.390E-10 6.987E-11
BREAST     3.129E-15 6.274E-13 1.307E-11 5.922E-17-1.000E 3.480E-10 1.223E-11
LUNGS      2.639E-15 5.228E-13 1.089E-11 5.362E-17-1.000E 7.911E-07 6.551E-12
RED MARR   2.507E-15 4.755E-13 9.907E-12 5.247E-17-1.000E 2.880E-09 8.923E-11
BONE SUR   5.441E-15 1.646E-12 3.429E-11 1.127E-16-1.000E 4.720E-09 1.280E-10
THYROID    2.753E-15 5.529E-13 1.152E-11 5.418E-17-1.000E 2.920E-10 5.154E-12
REMAINDER  2.534E-15 5.086E-13 1.060E-11 5.283E-17-1.000E 1.910E-08 1.890E-08
EFFECTIVE  2.773E-15 5.909E-13 1.231E-11 5.766E-17-1.000E 1.010E-07 5.711E-09
SKIN(FGR)  8.574E-14 7.648E-13 1.594E-11 1.250E-14-1.000E 0.000E 0.000E
Pr-143
GONADS     2.130E-17 2.264E-14 4.032E-13 7.930E-19-1.000E 4.370E-18 8.990E-18
BREAST     2.550E-17 2.330E-14 4.149E-13 8.160E-19-1.000E 2.220E-18 1.090E-18
LUNGS      1.860E-17 1.642E-14 2.923E-13 5.750E-19-1.000E 1.330E-08 1.910E-19
RED MARR   1.620E-17 1.493E-14 2.659E-13 5.230E-19-1.000E 1.480E-11 1.030E-12
BONE SUR   5.930E-17 5.454E-14 9.711E-13 1.910E-18-1.000E 1.490E-11 1.030E-12
THYROID    2.050E-17 1.802E-14 3.208E-13 6.310E-19-1.000E 1.680E-18 2.660E-20
REMAINDER  1.760E-17 1.642E-14 2.923E-13 5.750E-19-1.000E 1.970E-09 4.220E-09
EFFECTIVE  2.100E-17 2.002E-14 3.564E-13 7.010E-19-1.000E 2.190E-09 1.270E-09
SKIN(FGR)  1.760E-14 5.711E-11 1.017E-09 2.000E-15-1.000E 0.000E 0.000E
Nd-147
GONADS     6.130E-15 4.218E-12 7.235E-11 1.480E-16-1.000E 8.410E-11 1.790E-10
BREAST     7.120E-15 4.132E-12 7.088E-11 1.450E-16-1.000E 3.450E-11 1.870E-11
LUNGS      5.820E-15 3.648E-12 6.257E-11 1.280E-16-1.000E 1.060E-08 2.440E-12
RED MARR   5.400E-15 3.505E-12 6.013E-11 1.230E-16-1.000E 9.190E-11 5.050E-11
BONE SUR   1.320E-14 8.265E-12 1.418E-10 2.900E-16-1.000E 3.260E-10 2.220E-11
THYROID    6.120E-15 3.876E-12 6.648E-11 1.360E-16-1.000E 1.820E-11 2.640E-13
REMAINDER  5.530E-15 3.562E-12 6.111E-11 1.250E-16-1.000E 1.760E-09 3.760E-09
EFFECTIVE  6.190E-15 3.961E-12 6.795E-11 1.390E-16-1.000E 1.850E-09 1.180E-09
SKIN(FGR)  1.950E-14 3.135E-11 5.377E-10 1.100E-15-1.000E 0.000E 0.000E
Np-239
GONADS     7.530E-15 4.691E-12 4.380E-11 1.710E-16-1.000E 7.450E-11 1.620E-10
BREAST     8.730E-15 4.636E-12 4.329E-11 1.690E-16-1.000E 1.630E-11 1.720E-11
LUNGS      7.180E-15 4.115E-12 3.842E-11 1.500E-16-1.000E 2.360E-09 2.400E-12
RED MARR   6.500E-15 4.005E-12 3.740E-11 1.460E-16-1.000E 2.080E-10 4.660E-11
BONE SUR   2.000E-14 1.001E-11 9.349E-11 3.650E-16-1.000E 2.030E-09 3.590E-11
THYROID    7.520E-15 4.197E-12 3.919E-11 1.530E-16-1.000E 7.620E-12 2.070E-13
REMAINDER  6.760E-15 4.005E-12 3.740E-11 1.460E-16-1.000E 9.590E-10 2.770E-09
EFFECTIVE  7.690E-15 4.471E-12 4.175E-11 1.630E-16-1.000E 6.780E-10 8.820E-10
SKIN(FGR)  1.600E-14 7.215E-12 6.737E-11 2.630E-16-1.000E 0.000E 0.000E
Pu-241
GONADS     7.190E-20 6.653E-17 1.396E-15 2.310E-21-1.000E 2.760E-07 5.660E-11
BREAST     8.670E-20 7.229E-17 1.517E-15 2.510E-21-1.000E 2.140E-11 2.790E-15
LUNGS      6.480E-20 4.090E-17 8.584E-16 1.420E-21-1.000E 3.180E-06 4.480E-15
RED MARR   5.630E-20 4.003E-17 8.403E-16 1.390E-21-1.000E 1.430E-06 2.780E-10
BONE SUR   2.190E-19 1.385E-16 2.908E-15 4.810E-21-1.000E 1.780E-05 3.480E-09
THYROID    6.980E-20 4.522E-17 9.491E-16 1.570E-21-1.000E 9.150E-12 1.010E-15
REMAINDER  6.090E-20 4.291E-17 9.007E-16 1.490E-21-1.000E 6.020E-07 1.850E-10
EFFECTIVE  7.250E-20 5.558E-17 1.167E-15 1.930E-21-1.000E 1.340E-06 2.070E-10
SKIN(FGR)  1.170E-19 2.033E-16 4.268E-15 7.060E-21-1.000E 0.000E 0.000E
Cm-242
GONADS     7.830E-18 4.893E-14 1.013E-12 1.700E-18-1.000E 5.700E-07 5.200E-09
BREAST     1.480E-17 6.159E-14 1.275E-12 2.140E-18-1.000E 9.440E-10 8.950E-12
LUNGS      1.130E-18 3.022E-15 6.257E-14 1.050E-19-1.000E 1.550E-05 8.840E-12
RED MARR   1.890E-18 6.562E-15 1.359E-13 2.280E-19-1.000E 3.900E-06 3.570E-08
BONE SUR   1.060E-17 4.231E-14 8.759E-13 1.470E-18-1.000E 4.870E-05 4.460E-07
THYROID    4.910E-18 1.261E-14 2.610E-13 4.380E-19-1.000E 9.410E-10 8.820E-12
REMAINDER  2.270E-18 1.079E-14 2.235E-13 3.750E-19-1.000E 2.450E-06 4.020E-08
EFFECTIVE  5.690E-18 2.751E-14 5.697E-13 9.560E-19-1.000E 4.670E-06 3.100E-08
SKIN(FGR)  4.290E-17 2.700E-13 5.589E-12 9.380E-18-1.000E 0.000E 0.000E
```

ATTACHMENT C
RADTRAD FHA Input/Output File – J16FHA96VT00.O0

```
##########################################################################
        RADTRAD Version 3.02 run on  5/17/2002  at 11:24:37
##########################################################################

##########################################################################
                     File information
##########################################################################

Plant file name           = C:\Radtrad\Accept\Fitz Patrick\J16FHA96VT00.psf
Inventory file name       = c:\radtrad\defaults\j1.6fha200_def.txt
Scenario file name        = C:\Radtrad\Accept\Fitz Patrick\J16FHA96VT00.psf
Release file name         = c:\radtrad\defaults\jafha_rft.rft
Dose conversion file name = c:\radtrad\defaults\jafha_fg11&12.txt

    #####    ####   #####     #  #     #  #####   #    #  #####
    #    #  #        #         #  ##    #  #    #  #    #    #
    #    #  #        #         #  # #   #  #    #  #    #    #
    #####    ####    ####      #  #  #  #  #####   #    #    #
    #            #   #         #  #   # #  #       #    #    #
    #            #   #         #  #    ##  #       #    #    #
    #        ####    #         #  #     #  #        ####     #


Radtrad 3.02 1/5/2000
JAF  FHA Occurring In Reactor Bldg With RB Vent Release, Pool DF = 200,
Peaking Factor = 1.6, Decay Time = 96 Hrs, CR Normal Flow Rate =2,112 cfm,
No SGTS Filtration, and Plant Vent Release @ 99,800 cfm
Nuclide Inventory File:
c:\radtrad\defaults\j1.6fha200_def.txt
Plant Power Level:
  2.5870E+03
Compartments:
  3
Compartment 1:
Reactor Building
  3
  2.6000E+06
  0
  0
  0
  0
  0
Compartment 2:
Environment
  2
  0.0000E+00
  0
  0
  0
  0
  0
Compartment 3:
Control Room
  1
  1.0100E+05
  0
  0
  0
  0
  0
Pathways:
  3
Pathway 1:
Reactor Building to Environment
  1
  2
  2
Pathway 2:
CR Air Intake
  2
  3
  2
Pathway 3:
CR Exhaust to Environment
  3
  2
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
```

```
1
1   1.0000E+00
c:\radtrad\defaults\jafha_fgl1&12.txt
c:\radtrad\defaults\jafha_rft.rft
 9.6000E+01
 0
 0.0000E+00   5.7000E-01   4.3000E-01   1.0000E+00
Overlying Pool:
 0
 0.0000E+00
 0
 0
 0
 0
Compartments:
 3
Compartment 1:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 2:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 3:
 1
 1
 0
 0
 0
 0
 0
 0
 0
Pathways:
 3
Pathway 1:
 0
 0
 0
 0
 0
 1
 3
 9.6000E+01   9.9800E+04   0.0000E+00   0.0000E+00   0.0000E+00
 9.8000E+01   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 8.1600E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 0
 0
 0
 0
 0
 0
Pathway 2:
 0
 0
 0
 0
 0
 1
 2
 9.6000E+01   2.1120E+03   0.0000E+00   0.0000E+00   0.0000E+00
 8.1600E+02   2.1120E+03   0.0000E+00   0.0000E+00   0.0000E+00
 0
 0
 0
 0
 0
 0
Pathway 3:
 0
 0
 0
 0
 0
 1
 2
 9.6000E+01   2.1120E+03   0.0000E+00   0.0000E+00   0.0000E+00
 8.1600E+02   2.1120E+03   0.0000E+00   0.0000E+00   0.0000E+00
 0
 0
 0
 0
 0
 0
Dose Locations:
 3
Location 1:
```

```
Exclusion Area Boundary
  2
  1
  2
  9.6000E+01   1.7900E-04
  8.1600E+02   0.0000E+00
  1
  2
  9.6000E+01   3.5000E-04
  8.1600E+02   0.0000E+00
  0
Location 2:
Low Population Zone
  2
  1
  5
  9.6000E+01   2.0000E-05
  1.0400E+02   1.3400E-05
  1.2000E+02   5.5900E-06
  1.9200E+02   1.6000E-06
  8.1600E+02   0.0000E+00
  1
  4
  9.6000E+01   3.5000E-04
  1.0400E+02   1.8000E-04
  1.2000E+02   2.3000E-04
  8.1600E+02   0.0000E+00
  0
Location 3:
Control Room
  3
  0
  1
  2
  9.6000E+01   3.5000E-04
  8.1600E+02   0.0000E+00
  1
  4
  9.6000E+01   1.0000E+00
  1.2000E+02   6.0000E-01
  1.9200E+02   4.0000E-01
  8.1600E+02   0.0000E+00
Effective Volume Location:
  1
  6
  9.6000E+01   3.5200E-03
  9.8000E+01   3.3100E-03
  1.0400E+02   1.4300E-03
  1.2000E+02   7.7300E-04
  1.9200E+02   6.0700E-04
  8.1600E+02   0.0000E+00
Simulation Parameters:
  6
  9.6000E+01   1.0000E-01
  9.8000E+01   5.0000E-01
  1.0400E+02   1.0000E+00
  1.2000E+02   2.0000E+00
  1.9200E+02   4.0000E+00
  8.1600E+02   0.0000E+00
Output Filename:
C:\Radtrad\Accept\Fitz Patrick\J16EHA96VT00.o0
  1
  1
  1
  0
  0
End of Scenario File
```

```
##########################################################################
          RADTRAD Version 3.02 run on  5/17/2002  at 11:24:37
##########################################################################

##########################################################################
                          Plant Description
##########################################################################

Number of Nuclides =  60

Inventory Power =    1.0000E+00 MWth
Plant Power Level =    2.5870E+03 MWth

Number of compartments    =    3

Compartment information

Compartment number  1  (Source term fraction =    1.0000E+00
)
Name: Reactor Building
Compartment volume =    2.6000E+06 (Cubic feet)
Pathways into and out of compartment  1
    Pathway to compartment number    2: Reactor Building to Environment

Compartment number  2
Name: Environment
Pathways into and out of compartment  2
    Pathway to compartment number    3: CR Air Intake
    Pathway from compartment number 1: Reactor Building to Environment
    Pathway from compartment number 3: CR Exhaust to Environment

Compartment number  3
Name: Control Room
Compartment volume =    1.0100E+05 (Cubic feet)
Pathways into and out of compartment  3
    Pathway to compartment number    2: CR Exhaust to Environment
    Pathway from compartment number 2: CR Air Intake

Total number of pathways =    3
```

```
##########################################################################
          RADTRAD Version 3.02 run on  5/17/2002  at 11:24:37
##########################################################################

##########################################################################
                          Scenario Description
##########################################################################

Time between shutdown and first release =    9.6000E+01 (Hours)

Radioactive Decay is enabled
RELEASE_NAME = RG-1.183, Tables 3 Section 3.2
Release Fractions and Timings
               GAP         EARLY IN-VESSEL
             0.0036 hrs     0.0000 hrs
NOBLES       5.0000E-02     0.0000E+00
IODINE       5.0000E-02     0.0000E+00
CESIUM       1.2000E-01     0.0000E+00
TELLURIUM    0.0000E+00     0.0000E+00
STRONTIUM    0.0000E+00     0.0000E+00
BARIUM       0.0000E+00     0.0000E+00
RUTHENIUM    0.0000E+00     0.0000E+00
CERIUM       0.0000E+00     0.0000E+00
LANTHANUM    0.0000E+00     0.0000E+00

Iodine fractions
     Aerosol     =    0.0000E+00
     Elemental   =    5.7000E-01
     Organic     =    4.3000E-01

COMPARTMENT DATA

Compartment number    1: Reactor Building

Compartment number    2: Environment

Compartment number    3: Control Room

PATHWAY DATA

Pathway number  1: Reactor Building to Environment

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate            Filter Efficiencies (%)
                        (cfm)       Aerosol     Elemental     Organic
      9.6000E+01    9.9800E+04   0.0000E+00   0.0000E+00   0.0000E+00
      9.8000E+01    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
```

```
     8.1600E+02     0.0000E+00    0.0000E+00    0.0000E+00    0.0000E+00

Pathway number  2: CR Air Intake

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate           Filter Efficiencies (%)
                        (cfm)        Aerosol      Elemental     Organic
       9.6000E+01     2.1120E+03    0.0000E+00    0.0000E+00    0.0000E+00
       8.1600E+02     2.1120E+03    0.0000E+00    0.0000E+00    0.0000E+00

Pathway number  3: CR Exhaust to Environment

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate           Filter Efficiencies (%)
                        (cfm)        Aerosol      Elemental     Organic
       9.6000E+01     2.1120E+03    0.0000E+00    0.0000E+00    0.0000E+00
       8.1600E+02     2.1120E+03    0.0000E+00    0.0000E+00    0.0000E+00

LOCATION DATA
     Location Exclusion Area Boundary      is in compartment   2

     Location X/Q Data
      Time (hr)          X/Q (s * m^-3)
       9.6000E+01          1.7900E-04
       8.1600E+02          0.0000E+00

     Location Breathing Rate Data
      Time (hr)          Breathing Rate (m^3 * sec^-1)
       9.6000E+01                 3.5000E-04
       8.1600E+02                 0.0000E+00
     Location Low Population Zone      is in compartment   2

     Location X/Q Data
      Time (hr)          X/Q (s * m^-3)
       9.6000E+01          2.0000E-05
       1.0400E+02          1.3400E-05
       1.2000E+02          5.5900E-06
       1.9200E+02          1.6000E-06
       8.1600E+02          0.0000E+00

     Location Breathing Rate Data
      Time (hr)          Breathing Rate (m^3 * sec^-1)
       9.6000E+01                 3.5000E-04
       1.0400E+02                 1.8000E-04
       1.2000E+02                 2.3000E-04
       8.1600E+02                 0.0000E+00
     Location Control Room      is in compartment   3

     Location X/Q Data
      Time (hr)          X/Q (s * m^-3)
       9.6000E+01          3.5200E-03
       9.8000E+01          3.3100E-03
       1.0400E+02          1.4300E-03
       1.2000E+02          7.7300E-04
       1.9200E+02          6.0700E-04
       8.1600E+02          0.0000E+00

     Location Breathing Rate Data
      Time (hr)          Breathing Rate (m^3 * sec^-1)
       9.6000E+01                 3.5000E-04
       8.1600E+02                 0.0000E+00

     Location Occupancy Factor Data
      Time (hr)          Occupancy Factor
       9.6000E+01             1.0000E+00
       1.2000E+02             6.0000E-01
       1.9200E+02             4.0000E-01
       8.1600E+02             0.0000E+00

USER SPECIFIED TIME STEP DATA - SUPPLEMENTAL TIME STEPS
     Time              Time step
       0.0000E+00        1.0000E-01
       2.0000E+00        5.0000E-01
       8.0000E+00        1.0000E+00
       2.4000E+01        2.0000E+00
       9.6000E+01        4.0000E+00
       7.2000E+02        0.0000E+00
```

```
########################################################################
      RADTRAD Version 3.02 run on   5/17/2002  at 11:24:37
########################################################################

########################################################################
          Dose, Detailed model and Detailed Inventory Output
########################################################################

Exclusion Area Boundary Doses:

Time (h) =   96.0036     Whole Body   Thyroid       TEDE
Delta dose (rem)          1.1581E-04  3.2527E-02  1.1070E-03
Accumulated dose (rem)    1.1581E-04  3.2527E-02  1.1070E-03

Low Population Zone Doses:

Time (h) =   96.0036     Whole Body   Thyroid       TEDE
Delta dose (rem)          1.2940E-05  3.6344E-03  1.2368E-04
Accumulated dose (rem)    1.2940E-05  3.6344E-03  1.2368E-04

Control Room Doses:

Time (h) =   96.0036     Whole Body   Thyroid       TEDE
Delta dose (rem)          1.6771E-07  1.1244E-03  3.4429E-05
Accumulated dose (rem)    1.6771E-07  1.1244E-03  3.4429E-05

Control Room Compartment Nuclide Inventory:

Time (h) =   96.0036        Ci           kg         Atoms         Bq
Kr-85                   6.8910E-03  1.7564E-08  1.2444E+17  2.5497E+08
Kr-85m                  2.6587E-08  3.2307E-18  2.2889E+07  9.8372E+02
I-130                   2.6760E-07  1.3721E-16  6.3559E+08  9.9011E+03
I-131                   1.6627E-03  1.3411E-11  6.1653E+13  6.1519E+07
I-133                   1.2510E-04  1.1043E-13  5.0003E+11  4.6287E+06
I-135                   1.2294E-07  3.5006E-17  1.5616E+08  4.5486E+03
Xe-131m                 1.3972E-03  1.6681E-11  7.6682E+13  5.1696E+07
Xe-133                  3.6328E-01  1.9408E-09  8.7877E+15  1.3441E+10
Xe-133m                 7.2382E-03  1.6131E-11  7.3041E+13  2.6781E+08
Xe-135                  5.2687E-05  2.0631E-14  9.2033E+10  1.9494E+06

Control Room Transport Group Inventory:

                                                          Overlying
Time (h) =   96.0036     Atmosphere     Sump          Pool
Noble gases (atoms)      1.3338E+17  0.0000E+00  0.0000E+00
Elemental I (atoms)      3.5428E+13  0.0000E+00  0.0000E+00
Organic I (atoms)        2.6726E+13  0.0000E+00  0.0000E+00
Aerosols (kg)            0.0000E+00  0.0000E+00  0.0000E+00

                         Deposition Recirculating
Time (h) =   96.0036      Surfaces     Filter
Noble gases (atoms)      0.0000E+00  0.0000E+00
Elemental I (atoms)      0.0000E+00  0.0000E+00
Organic I (atoms)        0.0000E+00  0.0000E+00
Aerosols (kg)            0.0000E+00  0.0000E+00

CR Air Intake Transport Group Inventory:

                           Pathway
Time (h) =   96.0036        Filter
Noble gases (atoms)      0.0000E+00
Elemental I (atoms)      0.0000E+00
Organic I (atoms)        0.0000E+00
Aerosols (kg)            0.0000E+00

CR Exhaust to Environment Transport Group Inventory:

                           Pathway
Time (h) =   96.0036        Filter
Noble gases (atoms)      0.0000E+00
Elemental I (atoms)      0.0000E+00
Organic I (atoms)        0.0000E+00
Aerosols (kg)            0.0000E+00

Exclusion Area Boundary Doses:

Time (h) =   98.0000     Whole Body   Thyroid       TEDE
Delta dose (rem)          2.7640E-02  7.7682E+00  2.6434E-01
Accumulated dose (rem)    2.7756E-02  7.8008E+00  2.6545E-01

Low Population Zone Doses:

Time (h) =   98.0000     Whole Body   Thyroid       TEDE
Delta dose (rem)          3.0883E-03  8.6796E-01  2.9536E-02
Accumulated dose (rem)    3.1012E-03  8.7160E-01  2.9659E-02

Control Room Doses:

Time (h) =   98.0000     Whole Body   Thyroid       TEDE
Delta dose (rem)          1.9116E-02  1.2836E+02  3.9302E+00
Accumulated dose (rem)    1.9116E-02  1.2836E+02  3.9302E+00
```

Control Room Compartment Nuclide Inventory:

Time (h) = 98.0000	Ci	kg	Atoms	Bq
Kr-85	2.6364E-01	6.7199E-07	4.7610E+18	9.7549E+09
Kr-85m	7.4690E-07	9.0759E-17	6.4301E+08	2.7635E+04
Kr-88	3.1970E-10	2.5496E-20	1.7448E+05	1.1829E+01
I-130	9.1538E-06	4.6934E-15	2.1742E+10	3.3869E+05
I-131	6.3159E-02	5.0945E-10	2.3420E+15	2.3369E+09
I-133	4.4782E-03	3.9532E-12	1.7900E+13	1.6569E+08
I-135	3.8150E-06	1.0863E-15	4.8460E+09	1.4116E+05
Xe-131m	5.3198E-02	6.3511E-10	2.9196E+15	1.9683E+09
Xe-133	1.3747E+01	7.3442E-08	3.3254E+17	5.0864E+11
Xe-133m	2.6973E-01	6.0113E-10	2.7219E+15	9.9800E+09
Xe-135	1.7311E-03	6.7788E-13	3.0239E+12	6.4052E+07

Control Room Transport Group Inventory:

Time (h) = 98.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	5.1030E+18	0.0000E+00	0.0000E+00
Elemental I (atoms)	1.3555E+15	0.0000E+00	0.0000E+00
Organic I (atoms)	1.0225E+15	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00	0.0000E+00

Time (h) = 98.0000	Deposition Surfaces	Recirculating Filter
Noble gases (atoms)	0.0000E+00	0.0000E+00
Elemental I (atoms)	0.0000E+00	0.0000E+00
Organic I (atoms)	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00

CR Air Intake Transport Group Inventory:

Time (h) = 98.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

CR Exhaust to Environment Transport Group Inventory:

Time (h) = 98.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Exclusion Area Boundary Doses:

Time (h) = 104.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.5322E-05	4.3247E-03	1.4709E-04
Accumulated dose (rem)	2.7771E-02	7.8051E+00	2.6560E-01

Low Population Zone Doses:

Time (h) = 104.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.7120E-06	4.8321E-04	1.6435E-05
Accumulated dose (rem)	3.1030E-03	8.7208E-01	2.9676E-02

Control Room Doses:

Time (h) = 104.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	3.6023E-03	2.4271E+01	7.4311E-01
Accumulated dose (rem)	2.2718E-02	1.5263E+02	4.6733E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 104.0000	Ci	kg	Atoms	Bq
Kr-85	1.4536E-04	3.7051E-10	2.6250E+15	5.3784E+06
Kr-85m	1.6276E-10	1.9778E-20	1.4012E+05	6.0222E+00
I-130	3.6051E-09	1.8485E-18	8.5628E+06	1.3339E+02
I-131	3.4082E-05	2.7491E-13	1.2638E+12	1.2610E+06
I-133	2.0217E-06	1.7847E-15	8.0809E+09	7.4803E+04
I-135	1.1212E-09	3.1928E-19	1.4242E+06	4.1486E+01
Xe-131m	2.8908E-05	3.4513E-13	1.5866E+12	1.0696E+06
Xe-133	7.3335E-03	3.9178E-11	1.7740E+14	2.7134E+08
Xe-133m	1.3740E-04	3.0621E-13	1.3865E+12	5.0838E+06
Xe-135	6.0406E-07	2.3654E-16	1.0552E+09	2.2350E+04

Control Room Transport Group Inventory:

Time (h) = 104.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	2.8137E+15	0.0000E+00	0.0000E+00
Elemental I (atoms)	7.4737E+11	0.0000E+00	0.0000E+00
Organic I (atoms)	5.6381E+11	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00	0.0000E+00

Time (h) = 104.0000	Deposition Surfaces	Recirculating Filter
Noble gases (atoms)	0.0000E+00	0.0000E+00
Elemental I (atoms)	0.0000E+00	0.0000E+00
Organic I (atoms)	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00

CR Air Intake Transport Group Inventory:

```
                        Pathway
Time (h) = 104.0000      Filter
Noble gases (atoms)     0.0000E+00
Elemental I (atoms)     0.0000E+00
Organic I (atoms)       0.0000E+00
Aerosols (kg)           0.0000E+00

CR Exhaust to Environment Transport Group Inventory:

                        Pathway
Time (h) = 104.0000      Filter
Noble gases (atoms)     0.0000E+00
Elemental I (atoms)     0.0000E+00
Organic I (atoms)       0.0000E+00
Aerosols (kg)           0.0000E+00

Exclusion Area Boundary Doses:

Time (h) = 120.0000     Whole Body   Thyroid      TEDE
Delta dose (rem)        8.1527E-09   2.3263E-06   7.9023E-08
Accumulated dose (rem)  2.7771E-02   7.8051E+00   2.6560E-01

Low Population Zone Doses:

Time (h) = 120.0000     Whole Body   Thyroid      TEDE
Delta dose (rem)        6.1031E-10   8.9561E-08   3.3388E-09
Accumulated dose (rem)  3.1030E-03   8.7208E-01   2.9676E-02

Control Room Doses:

Time (h) = 120.0000     Whole Body   Thyroid      TEDE
Delta dose (rem)        1.9173E-06   1.3059E-02   3.9975E-04
Accumulated dose (rem)  2.2720E-02   1.5264E+02   4.6737E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 120.0000      Ci           kg           Atoms        Bq
Kr-85                   2.8615E-13   7.2935E-19   5.1673E+06   1.0588E-02
Xe-133                  1.3220E-11   7.0628E-20   3.1980E+05   4.8915E-01

Control Room Transport Group Inventory:

                                                  Overlying
Time (h) = 120.0000     Atmosphere   Sump         Pool
Noble gases (atoms)     5.5395E+06   0.0000E+00   0.0000E+00
Elemental I (atoms)     1.4714E+03   0.0000E+00   0.0000E+00
Organic I (atoms)       1.1100E+03   0.0000E+00   0.0000E+00
Aerosols (kg)           0.0000E+00   0.0000E+00   0.0000E+00

                        Deposition Recirculating
Time (h) = 120.0000     Surfaces     Filter
Noble gases (atoms)     0.0000E+00   0.0000E+00
Elemental I (atoms)     0.0000E+00   0.0000E+00
Organic I (atoms)       0.0000E+00   0.0000E+00
Aerosols (kg)           0.0000E+00   0.0000E+00

CR Air Intake Transport Group Inventory:

                        Pathway
Time (h) = 120.0000      Filter
Noble gases (atoms)     0.0000E+00
Elemental I (atoms)     0.0000E+00
Organic I (atoms)       0.0000E+00
Aerosols (kg)           0.0000E+00

CR Exhaust to Environment Transport Group Inventory:

                        Pathway
Time (h) = 120.0000      Filter
Noble gases (atoms)     0.0000E+00
Elemental I (atoms)     0.0000E+00
Organic I (atoms)       0.0000E+00
Aerosols (kg)           0.0000E+00

Exclusion Area Boundary Doses:

Time (h) = 192.0000     Whole Body   Thyroid      TEDE
Delta dose (rem)        1.4703E-17   4.3148E-15   1.4612E-16
Accumulated dose (rem)  2.7771E-02   7.8051E+00   2.6560E-01

Low Population Zone Doses:

Time (h) = 192.0000     Whole Body   Thyroid      TEDE
Delta dose (rem)        4.5917E-19   8.8549E-17   3.1562E-18
Accumulated dose (rem)  3.1030E-03   8.7208E-01   2.9676E-02

Control Room Doses:

Time (h) = 192.0000     Whole Body   Thyroid      TEDE
Delta dose (rem)        3.0576E-15   2.1419E-11   6.5543E-13
Accumulated dose (rem)  2.2720E-02   1.5264E+02   4.6737E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 192.0000      Ci           kg           Atoms        Bq

Control Room Transport Group Inventory:

                                                  Overlying
Time (h) = 192.0000     Atmosphere   Sump         Pool
```

```
Noble gases (atoms)     3.4803E-33  0.0000E+00  0.0000E+00
Elemental I (atoms)     9.2444E-37  0.0000E+00  0.0000E+00
Organic I (atoms)       6.9739E-37  0.0000E+00  0.0000E+00
Aerosols (kg)           0.0000E+00  0.0000E+00  0.0000E+00

                        Deposition  Recirculating
Time (h) = 192.0000      Surfaces      Filter
Noble gases (atoms)     0.0000E+00  0.0000E+00
Elemental I (atoms)     0.0000E+00  0.0000E+00
Organic I (atoms)       0.0000E+00  0.0000E+00
Aerosols (kg)           0.0000E+00  0.0000E+00

CR Air Intake Transport Group Inventory:

                         Pathway
Time (h) = 192.0000       Filter
Noble gases (atoms)     0.0000E+00
Elemental I (atoms)     0.0000E+00
Organic I (atoms)       0.0000E+00
Aerosols (kg)           0.0000E+00

CR Exhaust to Environment Transport Group Inventory:

                         Pathway
Time (h) = 192.0000       Filter
Noble gases (atoms)     0.0000E+00
Elemental I (atoms)     0.0000E+00
Organic I (atoms)       0.0000E+00
Aerosols (kg)           0.0000E+00

Exclusion Area Boundary Doses:

Time (h) = 816.0000      Whole Body    Thyroid      TEDE
Delta dose (rem)          6.2186E-57  2.0827E-54  6.9629E-56
Accumulated dose (rem)    2.7771E-02  7.8051E+00  2.6560E-01

Low Population Zone Doses:

Time (h) = 816.0000      Whole Body    Thyroid      TEDE
Delta dose (rem)          5.5585E-59  1.2233E-56  4.2805E-58
Accumulated dose (rem)    3.1030E-03  8.7208E-01  2.9676E-02

Control Room Doses:

Time (h) = 816.0000      Whole Body    Thyroid      TEDE
Delta dose (rem)          1.4842E-54  1.1866E-50  3.6275E-52
Accumulated dose (rem)    2.2720E-02  1.5264E+02  4.6737E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 816.0000        Ci            kg            Atoms          Bq

Control Room Transport Group Inventory:

                                                      Overlying
Time (h) = 816.0000     Atmosphere     Sump             Pool
Noble gases (atoms)     0.0000E+00  0.0000E+00  0.0000E+00
Elemental I (atoms)     0.0000E+00  0.0000E+00  0.0000E+00
Organic I (atoms)       0.0000E+00  0.0000E+00  0.0000E+00
Aerosols (kg)           0.0000E+00  0.0000E+00  0.0000E+00

                        Deposition  Recirculating
Time (h) = 816.0000      Surfaces      Filter
Noble gases (atoms)     0.0000E+00  0.0000E+00
Elemental I (atoms)     0.0000E+00  0.0000E+00
Organic I (atoms)       0.0000E+00  0.0000E+00
Aerosols (kg)           0.0000E+00  0.0000E+00

CR Air Intake Transport Group Inventory:

                         Pathway
Time (h) = 816.0000       Filter
Noble gases (atoms)     0.0000E+00
Elemental I (atoms)     0.0000E+00
Organic I (atoms)       0.0000E+00
Aerosols (kg)           0.0000E+00

CR Exhaust to Environment Transport Group Inventory:

                         Pathway
Time (h) = 816.0000       Filter
Noble gases (atoms)     0.0000E+00
Elemental I (atoms)     0.0000E+00
Organic I (atoms)       0.0000E+00
Aerosols (kg)           0.0000E+00

    334
```

##

I-131 Summary

##

Time (hr)	Reactor Building I-131 (Curies)	Environment I-131 (Curies)	Control Room I-131 (Curies)
96.001	1.7705E+01	1.1329E-02	3.9740E-05
96.004	1.1433E+02	4.7460E-01	1.6627E-03
96.400	4.5819E+01	6.8921E+01	1.8314E-01
96.700	2.2936E+01	9.1837E+01	1.9111E-01
97.000	1.1481E+01	1.0334E+02	1.6393E-01
97.300	5.7471E+00	1.0912E+02	1.2892E-01
97.600	2.8768E+00	1.1203E+02	9.6702E-02
97.900	1.4401E+00	1.1349E+02	7.0491E-02
98.000	1.1434E+00	1.1380E+02	6.3159E-02
98.300	1.1422E+00	1.1382E+02	4.3355E-02
98.600	1.1410E+00	1.1383E+02	2.9761E-02
98.900	1.1397E+00	1.1384E+02	2.0429E-02
99.200	1.1385E+00	1.1384E+02	1.4023E-02
99.500	1.1373E+00	1.1385E+02	9.6262E-03
99.800	1.1361E+00	1.1385E+02	6.6078E-03
100.100	1.1348E+00	1.1385E+02	4.5359E-03
100.400	1.1336E+00	1.1386E+02	3.1136E-03
100.700	1.1324E+00	1.1386E+02	2.1373E-03
101.000	1.1312E+00	1.1386E+02	1.4672E-03
101.300	1.1299E+00	1.1386E+02	1.0071E-03
101.600	1.1287E+00	1.1386E+02	6.9133E-04
101.900	1.1275E+00	1.1386E+02	4.7456E-04
102.200	1.1263E+00	1.1386E+02	3.2576E-04
102.500	1.1251E+00	1.1386E+02	2.2362E-04
102.800	1.1239E+00	1.1386E+02	1.5350E-04
103.100	1.1227E+00	1.1386E+02	1.0537E-04
103.400	1.1215E+00	1.1386E+02	7.2329E-05
103.700	1.1202E+00	1.1386E+02	4.9650E-05
104.000	1.1190E+00	1.1386E+02	3.4082E-05
104.300	1.1178E+00	1.1386E+02	2.3379E-05
104.600	1.1166E+00	1.1386E+02	1.6037E-05
104.900	1.1154E+00	1.1386E+02	1.1001E-05
105.200	1.1142E+00	1.1386E+02	7.5460E-06
105.500	1.1130E+00	1.1386E+02	5.1762E-06
105.800	1.1118E+00	1.1386E+02	3.5507E-06
106.100	1.1106E+00	1.1386E+02	2.4356E-06
106.400	1.1094E+00	1.1386E+02	1.6707E-06
120.000	1.0565E+00	1.1386E+02	6.3351E-14
192.000	8.1575E-01	1.1386E+02	3.0731E-53
816.000	8.6712E-02	1.1386E+02	0.0000E+00

##

Cumulative Dose Summary

##

Time	Exclusion Area Bounda		Low Population Zone		Control Room	
(hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
96.001	7.7645E-04	2.6424E-05	8.6754E-05	2.9524E-06	5.3202E-06	1.6299E-07
96.004	3.2527E-02	1.1070E-03	3.6344E-03	1.2368E-04	1.1244E-03	3.4424E-05
96.400	4.7250E+00	1.6079E-01	5.2794E-01	1.7966E-02	2.2188E+01	6.7939E-01
96.700	6.2958E+00	2.1425E-01	7.0345E-01	2.3938E-02	4.9860E+01	1.5267E+00
97.000	7.0842E+00	2.4107E-01	7.9153E-01	2.6935E-02	7.5707E+01	2.3181E+00
97.300	7.4803E+00	2.5455E-01	8.3578E-01	2.8441E-02	9.6878E+01	2.9663E+00
97.600	7.6795E+00	2.6132E-01	8.5804E-01	2.9198E-02	1.1313E+02	3.4639E+00
97.900	7.7799E+00	2.6474E-01	8.6926E-01	2.9580E-02	1.2514E+02	3.8317E+00
98.000	7.8008E+00	2.6545E-01	8.7160E-01	2.9659E-02	1.2836E+02	3.9302E+00
98.300	7.8021E+00	2.6550E-01	8.7175E-01	2.9664E-02	1.3597E+02	4.1634E+00
98.600	7.8031E+00	2.6553E-01	8.7185E-01	2.9668E-02	1.4120E+02	4.3235E+00
98.900	7.8037E+00	2.6555E-01	8.7192E-01	2.9670E-02	1.4479E+02	4.4333E+00
99.200	7.8041E+00	2.6556E-01	8.7197E-01	2.9672E-02	1.4725E+02	4.5087E+00
99.500	7.8044E+00	2.6557E-01	8.7201E-01	2.9673E-02	1.4894E+02	4.5605E+00
99.800	7.8047E+00	2.6558E-01	8.7203E-01	2.9674E-02	1.5010E+02	4.5960E+00
100.100	7.8048E+00	2.6559E-01	8.7204E-01	2.9674E-02	1.5090E+02	4.6204E+00
100.400	7.8049E+00	2.6559E-01	8.7205E-01	2.9675E-02	1.5145E+02	4.6371E+00
100.700	7.8050E+00	2.6559E-01	8.7206E-01	2.9675E-02	1.5182E+02	4.6486E+00
101.000	7.8050E+00	2.6559E-01	8.7207E-01	2.9675E-02	1.5208E+02	4.6565E+00
101.300	7.8050E+00	2.6559E-01	8.7207E-01	2.9675E-02	1.5226E+02	4.6619E+00
101.600	7.8051E+00	2.6560E-01	8.7207E-01	2.9675E-02	1.5238E+02	4.6656E+00
101.900	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5246E+02	4.6681E+00
102.200	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5252E+02	4.6699E+00
102.500	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5256E+02	4.6711E+00
102.800	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5258E+02	4.6719E+00
103.100	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5260E+02	4.6725E+00
103.400	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5262E+02	4.6729E+00
103.700	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5262E+02	4.6732E+00
104.000	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5263E+02	4.6733E+00
104.300	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5263E+02	4.6735E+00
104.600	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5264E+02	4.6736E+00
104.900	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5264E+02	4.6736E+00
105.200	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5264E+02	4.6737E+00
105.500	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5264E+02	4.6737E+00
105.800	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5264E+02	4.6737E+00
106.100	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5264E+02	4.6737E+00
106.400	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5264E+02	4.6737E+00
120.000	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5264E+02	4.6737E+00
192.000	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5264E+02	4.6737E+00
816.000	7.8051E+00	2.6560E-01	8.7208E-01	2.9676E-02	1.5264E+02	4.6737E+00

```
####################################################################
                  Worst Two-Hour Doses
    Note: All of the dose locations are shown below but the
          worst two-hour dose is only meaningful for the EAB
          dose location.  Please disregard the two-hour worst
          doses for the other dose locations
####################################################################

Exclusion Area Boundary
   Time   Whole Body    Thyroid       TEDE
   (hr)     (rem)        (rem)        (rem)
   96.0  2.7753E-02   7.8000E+00   2.6542E-01

Low Population Zone
   Time   Whole Body    Thyroid       TEDE
   (hr)     (rem)        (rem)        (rem)
   96.0  3.1009E-03   8.7151E-01   2.9656E-02

Control Room
   Time   Whole Body    Thyroid       TEDE
   (hr)     (rem)        (rem)        (rem)
   96.0  1.9116E-02   1.2836E+02   3.9302E+00
```

ATTACHMENT D

RADTRAD Nuclide Inventory File – JAFTIDLOCA_def

```
Nuclide Inventory
Name: JAF TID Core
Inventory For LOCA
 TID-14844 Example
Normalized Core
Inventory
 Power Level:
  0.1000E+01
 Nuclides:
  14
 Nuclide 001:
 I-131
   2
  0.6946560000E+06
  0.1310E+03
  0.2631E+05
 Xe-131m  0.1100E-01
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 002:
 I-132
   2
  0.8280000000E+04
  0.1320E+03
  0.3845E+05
 none     0.0000E+00
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 003:
 I-133
   2
  0.7488000000E+05
  0.1330E+03
  0.5502E+05
 Xe-133m  0.2900E-01
 Xe-133   0.9700E+00
 none     0.0000E+00
 Nuclide 004:
 I-134
   2
  0.3156000000E+04
  0.1340E+03
  0.6055E+05
 none     0.0000E+00
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 005:
 I-135
   2
  0.2379600000E+05
  0.1350E+03
  0.5196E+05
 Xe-135m  0.1500E+00
 Xe-135   0.8500E+00
 none     0.0000E+00
 Nuclide 006:
 Xe-131m
   1
  0.1028160000E+07
  0.1310E+03
  0.1582E+03
 none     0.0000E+00
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 007:
 Xe-133m
   1
  0.1890432000E+06
  0.1330E+03
  0.2305E+04
 Xe-133   0.1000E+01
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 008:
 Xe-133
   1
  0.4531680000E+06
  0.1330E+03
  0.5529E+05
 none     0.0000E+00
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 009:
 Xe-135m
   1
  0.9174000000E+03
  0.1350E+03
  0.1042E+05
 Xe-135   0.1000E+01
 Cs-135   0.4500E-04
 none     0.0000E+00
 Nuclide 010:
 Xe-135
   1
  0.3272400000E+05
  0.1350E+03
  0.7141E+04
 Cs-135   0.1000E+01
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 011:
 Kr-83m
   1
  0.6588000000E+04
  0.8300E+02
  0.3137E+04
 none     0.0000E+00
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 012:
 Kr-85m
   1
  0.1612800000E+05
  0.8500E+02
  0.6735E+04
 Kr-85    0.2100E+00
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 013:
 Kr-87
   1
  0.4578000000E+04
  0.8700E+02
  0.1292E+05
 Rb-87    0.1000E+01
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 014:
 Kr-88
   1
  0.1022400000E+05
  0.8800E+02
  0.1830E+05
 Rb-88    0.1000E+01
 none     0.0000E+00
 none     0.0000E+00
End of Nuclear
Inventory File
```

Entergy	CALCULATION CONTINUATION SHEET		SHEET No. 65 of 78	
	CALC. TITLE: Fuel Handling Accident – AST Analysis for Relaxation of Secondary Containment Operability			
	CALC. NO.: JAF-CALC-RAD-04410		REVISION NO.	0
	ORIGINATOR/DATE	G. Patel 05/23/02	REVIEWR/DATE	M. Drucker 05/24/02

ATTACHMENT E
RADTRAD TID LOCA Input/Output File – FPTIDCL00.O0

```
######################################################################
          RADTRAD Version 3.02 run on  4/01/2002  at 11:28:46
######################################################################

######################################################################
                      File information
######################################################################

 Plant file name           = C:\Radtrad\Accept\Fitz Patrick\FPTIDCL00.psf
 Inventory file name       = C:\Radtrad\Defaults\JAFTIDLOCA_DEF.txt
 Scenario file name        = C:\Radtrad\Accept\Fitz Patrick\FPTIDCL00.psf
 Release file name         = c:\radtrad\defaults\tid_def.rft
 Dose conversion file name = c:\radtrad\defaults\tid_30.inp

     #####    ####   #####    #  #    #  #####  #    #  #####
     #    #  #       #        #  ##   #  #    # #    #    #
     #    #  #       #        #  # #  #  #    # #    #    #
     #####    ####   ####     #  #  # #  #####  #    #    #
     #            #  #        #  #   ##  #      #    #    #
     #            #  #        #  #    #  #      #    #    #
     #        ####   #        #  #    #  #       ####     #


Radtrad 3.02 1/5/2000
Fitz Patrick Cont Leakage=2.75 cfm TID Analysis, DMPR-105 Closes @ 12 Hrs
Nuclide Inventory File:
C:\Radtrad\Defaults\JAFTIDLOCA_DEF.txt
Plant Power Level:
 2.5870E+03
Compartments:
  3
Compartment 1:
Prim Cont
  3
 2.6400E+05
  0
  0
  0
  0
  0
Compartment 2:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Compartment 3:
Control Room
  1
 1.0100E+05
  0
  0
  0
  0
  0
Pathways:
  4
Pathway 1:
Prim Cont to Environment
  1
  2
  2
Pathway 2:
Environment to Control Room
  2
  3
  2
Pathway 3:
Environment Unfiltered to Control Room
  2
  3
  2
Pathway 4:
Control Room Ehaust to Environment
  3
  2
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\radtrad\defaults\tid_30.inp
c:\radtrad\defaults\tid_def.rft
  0.0000E+00
  0
```

```
 5.0000E-02   9.1000E-01   4.0000E-02   1.0000E+00
Overlying Pool:
 0
 0.0000E+00
 0
 0
 0
 0
Compartments:
 3
Compartment 1:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 2:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 3:
 1
 1
 0
 0
 0
 0
 0
 0
 0
Pathways:
 4
Pathway 1:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   2.7500E+00   9.0000E+01   9.0000E+01   9.0000E+01
 7.2000E+02   2.7500E+00   9.0000E+01   9.0000E+01   9.0000E+01
 0
 0
 0
 0
 0
 0
Pathway 2:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   1.5000E+04   0.0000E+00   0.0000E+00   0.0000E+00
 5.0000E-01   1.1000E+03   9.0000E+01   9.0000E+01   9.0000E+01
 7.2000E+02   1.1000E+03   9.0000E+01   9.0000E+01   9.0000E+01
 0
 0
 0
 0
 0
 0
Pathway 3:
 0
 0
 0
 0
 0
 1
 4
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 5.0000E-01   2.1000E+03   0.0000E+00   0.0000E+00   0.0000E+00
 1.2000E+01   3.0000E+02   0.0000E+00   0.0000E+00   0.0000E+00
 7.2000E+02   3.0000E+02   0.0000E+00   0.0000E+00   0.0000E+00
 0
 0
 0
 0
 0
 0
Pathway 4:
 0
 0
 0
 0
 0
 1
 4
 0.0000E+00   1.5000E+04   0.0000E+00   0.0000E+00   0.0000E+00
 5.0000E-01   3.2000E+03   0.0000E+00   0.0000E+00   0.0000E+00
 1.2000E+01   1.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
```

```
  7.2000E+02   1.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Dose Locations:
  3
Location 1:
Control Room
  3
  0
  1
  2
  0.0000E+00   3.4700E-04
  7.2000E+02   0.0000E+00
  1
  4
  0.0000E+00   1.0000E+00
  2.4000E+01   6.0000E-01
  9.6000E+01   4.0000E-01
  7.2000E+02   0.0000E+00
Location 2:
Exclusion Area Boundary
  2
  1
  2
  0.0000E+00   5.2400E-05
  2.0000E+00   0.0000E+00
  1
  2
  0.0000E+00   3.4700E-04
  2.0000E+00   0.0000E+00
  0
Location 3:
Low Population Zone
  2
  1
  6
  0.0000E+00   2.0400E-05
  4.0000E+00   2.1700E-06
  8.0000E+00   9.5300E-07
  2.4000E+01   3.9000E-07
  9.6000E+01   1.0800E-07
  7.2000E+02   0.0000E+00
  1
  4
  0.0000E+00   3.4700E-04
  8.0000E+00   1.7500E-04
  2.4000E+01   2.3200E-04
  7.2000E+02   0.0000E+00
  0
Effective Volume Location:
  1
  5
  0.0000E+00   9.2600E-07
  8.0000E+00   6.7500E-07
  2.4000E+01   3.3900E-07
  9.6000E+01   1.2600E-07
  7.2000E+02   0.0000E+00
Simulation Parameters:
  5
  0.0000E+00   1.0000E-01
  2.0000E+00   5.0000E-01
  8.0000E+00   1.0000E+00
  2.4000E+01   4.0000E+00
  7.4400E+02   0.0000E+00
Output Filename:
C:\Radtrad\Accept\Fitz Patrick\FPTIDCL00.o1
  1
  1
  1
  0
  0
End of Scenario File

#########################################################################
          RADTRAD Version 3.02 run on  4/01/2002  at 11:28:46
#########################################################################

#########################################################################
                        Plant Description
#########################################################################

Number of Nuclides =  14

Inventory Power =    1.0000E+00 MWth
Plant Power Level =    2.5870E+03 MWth

Number of compartments     =    3

Compartment information

Compartment number  1  (Source term fraction =    1.0000E+00
)
Name: Prim Cont
Compartment volume =    2.6400E+05 (Cubic feet)
Pathways into and out of compartment  1
    Pathway to compartment number   2: Prim Cont to Environment

Compartment number  2
Name: Environment
```

```
Pathways into and out of compartment  2
 Pathway to compartment number   3: Environment to Control Room
 Pathway to compartment number   3: Environment Unfiltered to Control Room
 Pathway from compartment number 1: Prim Cont to Environment
 Pathway from compartment number 3: Control Room Ehaust to Environment

Compartment number  3
Name: Control Room
Compartment volume =   1.0100E+05 (Cubic feet)
Pathways into and out of compartment  3
 Pathway to compartment number   2: Control Room Ehaust to Environment
 Pathway from compartment number 2: Environment to Control Room
 Pathway from compartment number 2: Environment Unfiltered to Control Room

Total number of pathways =   4
```

```
##################################################################
          RADTRAD Version 3.02 run on  4/01/2002  at 11:28:46
##################################################################

##################################################################
                    Scenario Description
##################################################################

Radioactive Decay is enabled
RELEASE_NAME = TID, TID-14844, Table IV., w/Reg Guide 1
Release Fractions and Timings,
                 GAP         EARLY IN-VESSEL
             0.0000 hrs      0.0000 hrs
NOBLES       1.0000E+00      0.0000E+00
IODINE       2.5000E-01      0.0000E+00
CESIUM       0.0000E+00      0.0000E+00
TELLURIUM    0.0000E+00      0.0000E+00
STRONTIUM    0.0000E+00      0.0000E+00
BARIUM       0.0000E+00      0.0000E+00
RUTHENIUM    0.0000E+00      0.0000E+00
CERIUM       0.0000E+00      0.0000E+00
LANTHANUM    0.0000E+00      0.0000E+00

Iodine fractions
     Aerosol      =    5.0000E-02
     Elemental    =    9.1000E-01
     Organic      =    4.0000E-02

COMPARTMENT DATA

Compartment number   1: Prim Cont

Compartment number   2: Environment

Compartment number   3: Control Room

PATHWAY DATA

Pathway number  1: Prim Cont to Environment

     Pathway Filter: Removal Data

       Time (hr)     Flow Rate          Filter Efficiencies (%)
                       (cfm)       Aerosol     Elemental     Organic
       0.0000E+00    2.7500E+00   9.0000E+01   9.0000E+01   9.0000E+01
       7.2000E+02    2.7500E+00   9.0000E+01   9.0000E+01   9.0000E+01

Pathway number  2: Environment to Control Room

     Pathway Filter: Removal Data

       Time (hr)     Flow Rate          Filter Efficiencies (%)
```

```
                  (cfm)       Aerosol     Elemental    Organic
0.0000E+00     1.5000E+04   0.0000E+00   0.0000E+00   0.0000E+00
5.0000E-01     1.1000E+03   9.0000E+01   9.0000E+01   9.0000E+01
7.2000E+02     1.1000E+03   9.0000E+01   9.0000E+01   9.0000E+01

Pathway number  3: Environment Unfiltered to Control Room

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                       (cfm)       Aerosol     Elemental    Organic
       0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
       5.0000E-01   2.1000E+03   0.0000E+00   0.0000E+00   0.0000E+00
       1.2000E+01   3.0000E+02   0.0000E+00   0.0000E+00   0.0000E+00
       7.2000E+02   3.0000E+02   0.0000E+00   0.0000E+00   0.0000E+00

Pathway number  4: Control Room Ehaust to Environment

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                       (cfm)       Aerosol     Elemental    Organic
       0.0000E+00   1.5000E+04   0.0000E+00   0.0000E+00   0.0000E+00
       5.0000E-01   3.2000E+03   0.0000E+00   0.0000E+00   0.0000E+00
       1.2000E+01   1.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
       7.2000E+02   1.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00

LOCATION DATA
     Location Control Room     is in compartment   3

     Location X/Q Data
      Time (hr)         X/Q (s * m^-3)
       0.0000E+00          9.2600E-07
       8.0000E+00          6.7500E-07
       2.4000E+01          3.3900E-07
       9.6000E+01          1.2600E-07
       7.2000E+02          0.0000E+00

     Location Breathing Rate Data
      Time (hr)         Breathing Rate (m^3 * sec^-1)
       0.0000E+00               3.4700E-04
       7.2000E+02               0.0000E+00

     Location Occupancy Factor Data
      Time (hr)         Occupancy Factor
       0.0000E+00          1.0000E+00
       2.4000E+01          6.0000E-01
       9.6000E+01          4.0000E-01
       7.2000E+02          0.0000E+00
     Location Exclusion Area Boundary     is in compartment   2

     Location X/Q Data
      Time (hr)         X/Q (s * m^-3)
       0.0000E+00          5.2400E-05
       2.0000E+00          0.0000E+00

     Location Breathing Rate Data
      Time (hr)         Breathing Rate (m^3 * sec^-1)
       0.0000E+00               3.4700E-04
       2.0000E+00               0.0000E+00
     Location Low Population Zone      is in compartment   2

     Location X/Q Data
      Time (hr)         X/Q (s * m^-3)
       0.0000E+00          2.0400E-05
       4.0000E+00          2.1700E-06
       8.0000E+00          9.5300E-07
       2.4000E+01          3.9000E-07
       9.6000E+01          1.0800E-07
       7.2000E+02          0.0000E+00

     Location Breathing Rate Data
      Time (hr)         Breathing Rate (m^3 * sec^-1)
       0.0000E+00               3.4700E-04
       8.0000E+00               1.7500E-04
       2.4000E+01               2.3200E-04
       7.2000E+02               0.0000E+00

USER SPECIFIED TIME STEP DATA - SUPPLEMENTAL TIME STEPS
     Time            Time step
      0.0000E+00      1.0000E-01
      2.0000E+00      5.0000E-01
      8.0000E+00      1.0000E+00
      2.4000E+01      4.0000E+00
      7.4400E+02      0.0000E+00
```

Entergy	CALCULATION CONTINUATION SHEET		SHEET No. 70 of 78	
	CALC. TITLE: Fuel Handling Accident – AST Analysis for Relaxation of Secondary Containment Operability			
	CALC. NO.: JAF-CALC-RAD-04410		REVISION NO.	0
	ORIGINATOR/DATE	G. Patel 05/23/02	REVIEWR/DATE	M. Drucker 05/24/02

```
##########################################################################
        RADTRAD Version 3.02 run on  4/01/2002  at 11:28:46
##########################################################################

     ####   #    #  #####  #####   #    #  #####
    #    #  #    #    #    #    #  #    #    #
    #    #  #    #    #    #    #  #    #    #
    #    #  #    #    #    #####   #    #    #
    #    #  #    #    #    #       #    #    #
    #    #  #    #    #    #       #    #    #
     ####    ####     #    #        ####     #

#######################################################################
        Dose, Detailed model and Detailed Inventory Output
#######################################################################
```

Control Room Doses:

Time (h) = 0.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.4966E-15	1.1795E-12	3.8345E-14
Accumulated dose (rem)	1.4966E-15	1.1795E-12	3.8345E-14

Exclusion Area Boundary Doses:

Time (h) = 0.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	4.5373E-07	1.4981E-05	9.2173E-07
Accumulated dose (rem)	4.5373E-07	1.4981E-05	9.2173E-07

Low Population Zone Doses:

Time (h) = 0.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.7664E-07	5.8322E-06	3.5884E-07
Accumulated dose (rem)	1.7664E-07	5.8322E-06	3.5884E-07

Control Room Compartment Nuclide Inventory:

Time (h) = 0.0000	Ci	kg	Atoms	Bq
I-131	3.4858E-09	2.8117E-17	1.2926E+08	1.2897E+02
I-132	5.0942E-09	4.9352E-19	2.2516E+06	1.8849E+02
I-133	7.2896E-09	6.4349E-18	2.9137E+07	2.6971E+02
I-134	8.0222E-09	3.0072E-19	1.3515E+06	2.9682E+02
I-135	6.8841E-09	1.9603E-18	8.7444E+06	2.5471E+02
Xe-131m	8.3839E-10	1.0009E-17	4.6013E+07	3.1021E+01
Xe-133m	1.2216E-08	2.7224E-17	1.2327E+08	4.5197E+02
Xe-133	2.9301E-07	1.5654E-15	7.0880E+09	1.0841E+04
Xe-135m	5.5221E-08	6.0621E-19	2.7042E+06	2.0432E+03
Xe-135	3.7844E-08	1.4819E-17	6.6106E+07	1.4002E+03
Kr-83m	1.6625E-08	8.0577E-19	5.8464E+06	6.1512E+02
Kr-85m	3.5693E-08	4.3371E-18	3.0728E+07	1.3206E+03
Kr-87	6.8470E-08	2.4173E-18	1.6732E+07	2.5334E+03
Kr-88	9.6982E-08	7.7343E-18	5.2928E+07	3.5883E+03

Control Room Transport Group Inventory:

Time (h) = 0.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	7.4323E+09	0.0000E+00	0.0000E+00
Elemental I (atoms)	1.5537E+08	0.0000E+00	0.0000E+00
Organic I (atoms)	6.8296E+06	0.0000E+00	0.0000E+00
Aerosols (kg)	1.8653E-18	0.0000E+00	0.0000E+00

Time (h) = 0.0000	Deposition Surfaces	Recirculating Filter
Noble gases (atoms)	0.0000E+00	0.0000E+00
Elemental I (atoms)	0.0000E+00	0.0000E+00
Organic I (atoms)	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00

Environment to Control Room Transport Group Inventory:

Time (h) = 0.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Environment Unfiltered to Control Room Transport Group Inventory:

Time (h) = 0.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Control Room Ehaust to Environment Transport Group Inventory:

Time (h) = 0.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Control Room Doses:

Time (h) = 0.5000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.3237E-04	2.0133E-01	6.5126E-03
Accumulated dose (rem)	2.3237E-04	2.0133E-01	6.5126E-03

Exclusion Area Boundary Doses:

Time (h) = 0.5000	Whole Body	Thyroid	TEDE
Delta dose (rem)	4.1818E-01	1.4926E+01	8.8389E-01
Accumulated dose (rem)	4.1819E-01	1.4926E+01	8.8389E-01

Low Population Zone Doses:

Time (h) = 0.5000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.6280E-01	5.8108E+00	3.4411E-01
Accumulated dose (rem)	1.6280E-01	5.8108E+00	3.4411E-01

Control Room Compartment Nuclide Inventory:

Time (h) = 0.5000	Ci	kg	Atoms	Bq
I-131	7.7171E-04	6.2247E-12	2.8615E+13	2.8553E+07
I-132	9.7178E-04	9.4145E-14	4.2951E+11	3.5956E+07
I-133	1.5900E-03	1.4036E-12	6.3554E+12	5.8830E+07
I-134	1.1982E-03	4.4916E-14	2.0186E+11	4.4334E+07
I-135	1.4488E-03	4.1255E-13	1.8403E+12	5.3606E+07
Xe-131m	1.8572E-04	2.2172E-12	1.0193E+13	6.8715E+06
Xe-133m	2.6914E-03	5.9981E-12	2.7159E+13	9.9582E+07
Xe-133	6.4807E-02	3.4623E-10	1.5677E+15	2.3979E+09
Xe-135m	3.1434E-03	3.4508E-14	1.5393E+11	1.1631E+08
Xe-135	8.0793E-03	3.1637E-12	1.4113E+13	2.9893E+08
Kr-83m	3.0510E-03	1.4788E-13	1.0729E+12	1.1289E+08
Kr-85m	7.3268E-03	8.9030E-13	6.3077E+12	2.7109E+08
Kr-87	1.1563E-02	4.0822E-13	2.8257E+12	4.2784E+08
Kr-88	1.9038E-02	1.5183E-12	1.0390E+13	7.0441E+08

Control Room Transport Group Inventory:

Time (h) = 0.5000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.6484E+15	0.0000E+00	0.0000E+00
Elemental I (atoms)	3.4459E+13	0.0000E+00	0.0000E+00
Organic I (atoms)	1.5147E+12	0.0000E+00	0.0000E+00
Aerosols (kg)	4.1370E-13	0.0000E+00	0.0000E+00

Time (h) = 0.5000	Deposition Surfaces	Recirculating Filter
Noble gases (atoms)	0.0000E+00	0.0000E+00
Elemental I (atoms)	0.0000E+00	0.0000E+00
Organic I (atoms)	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00

Environment to Control Room Transport Group Inventory:

Time (h) = 0.5000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Environment Unfiltered to Control Room Transport Group Inventory:

Time (h) = 0.5000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Control Room Ehaust to Environment Transport Group Inventory:

Time (h) = 0.5000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Control Room Doses:

Time (h) = 2.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	6.5586E-04	6.1447E-01	1.9740E-02
Accumulated dose (rem)	8.8823E-04	8.1580E-01	2.6253E-02

Exclusion Area Boundary Doses:

Time (h) = 2.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	9.1285E-01	4.4012E+01	2.2796E+00
Accumulated dose (rem)	1.3310E+00	5.8938E+01	3.1635E+00

Low Population Zone Doses:

Time (h) = 2.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	3.5539E-01	1.7135E+01	8.8747E-01
Accumulated dose (rem)	5.1819E-01	2.2945E+01	1.2316E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 2.0000	Ci	kg	Atoms	Bq
I-131	5.4931E-04	4.4308E-12	2.0369E+13	2.0324E+07
I-132	4.4254E-04	4.2872E-14	1.9559E+11	1.6374E+07
I-133	1.0824E-03	9.5551E-13	4.3265E+12	4.0049E+07
I-134	2.6192E-04	9.8183E-15	4.4125E+10	9.6911E+06
I-135	8.8594E-04	2.5227E-13	1.1253E+12	3.2780E+07
Xe-131m	1.8696E-04	2.2321E-12	1.0261E+13	6.9176E+06
Xe-133m	2.6660E-03	5.9415E-12	2.6903E+13	9.8642E+07
Xe-133	6.4941E-02	3.4694E-10	1.5709E+15	2.4028E+09
Xe-135m	5.3698E-05	5.8949E-16	2.6296E+09	1.9868E+06
Xe-135	7.2808E-03	2.8511E-12	1.2718E+13	2.6939E+08

Kr-83m	1.7465E-03	8.4651E-14	6.1419E+11	6.4621E+07
Kr-85m	5.8695E-03	7.1323E-13	5.0531E+12	2.1717E+08
Kr-87	5.1579E-03	1.8209E-13	1.2605E+12	1.9084E+08
Kr-88	1.3339E-02	1.0638E-12	7.2796E+12	4.9353E+08

Control Room Transport Group Inventory:

Time (h) = 2.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.6655E+15	0.0000E+00	0.0000E+00
Elemental I (atoms)	2.4661E+13	0.0000E+00	0.0000E+00
Organic I (atoms)	1.0840E+12	0.0000E+00	0.0000E+00
Aerosols (kg)	2.9607E-13	0.0000E+00	0.0000E+00

Time (h) = 2.0000	Deposition Surfaces	Recirculating Filter
Noble gases (atoms)	0.0000E+00	0.0000E+00
Elemental I (atoms)	0.0000E+00	0.0000E+00
Organic I (atoms)	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00

Environment to Control Room Transport Group Inventory:

Time (h) = 2.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	5.9754E+21
Organic I (atoms)	2.6266E+20
Aerosols (kg)	7.1738E-05

Environment Unfiltered to Control Room Transport Group Inventory:

Time (h) = 2.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Control Room Ehaust to Environment Transport Group Inventory:

Time (h) = 2.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Control Room Doses:

Time (h) = 4.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	5.5117E-04	7.0144E-01	2.2218E-02
Accumulated dose (rem)	1.4394E-03	1.5172E+00	4.8471E-02

Exclusion Area Boundary Doses:

Time (h) = 4.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	1.3310E+00	5.8938E+01	3.1635E+00

Low Population Zone Doses:

Time (h) = 4.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	3.0177E-01	2.2224E+01	9.8823E-01
Accumulated dose (rem)	8.1996E-01	4.5169E+01	2.2198E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 4.0000	Ci	kg	Atoms	Bq
I-131	5.3176E-04	4.2892E-12	1.9718E+13	1.9675E+07
I-132	2.3616E-04	2.2879E-14	1.0438E+11	8.7378E+06
I-133	9.8733E-04	8.7158E-13	3.9464E+12	3.6531E+07
I-134	5.2532E-05	1.9692E-15	8.8499E+09	1.9437E+06
I-135	7.0038E-04	1.9943E-13	8.8964E+11	2.5914E+07
Xe-131m	1.8595E-04	2.2200E-12	1.0205E+13	6.8801E+06
Xe-133m	2.5950E-03	5.7834E-12	2.6187E+13	9.6016E+07
Xe-133	6.4192E-02	3.4294E-10	1.5528E+15	2.3751E+09
Xe-135m	2.3289E-07	2.5566E-18	1.1405E+07	8.6168E+03
Xe-135	6.2473E-03	2.4464E-12	1.0913E+13	2.3115E+08
Kr-83m	8.1833E-04	3.9663E-14	2.8778E+11	3.0278E+07
Kr-85m	4.3049E-03	5.2310E-13	3.7061E+12	1.5928E+08
Kr-87	1.7329E-03	6.1179E-14	4.2348E+11	6.4118E+07
Kr-88	8.1821E-03	6.5252E-13	4.4654E+12	3.0274E+08

Control Room Transport Group Inventory:

Time (h) = 4.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.6645E+15	0.0000E+00	0.0000E+00
Elemental I (atoms)	2.4045E+13	0.0000E+00	0.0000E+00
Organic I (atoms)	1.0569E+12	0.0000E+00	0.0000E+00
Aerosols (kg)	2.8867E-13	0.0000E+00	0.0000E+00

Time (h) = 4.0000	Deposition Surfaces	Recirculating Filter
Noble gases (atoms)	0.0000E+00	0.0000E+00
Elemental I (atoms)	0.0000E+00	0.0000E+00
Organic I (atoms)	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00

Environment to Control Room Transport Group Inventory:

Time (h) = 4.0000	Pathway Filter

Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	1.3934E+22
Organic I (atoms)	6.1248E+20
Aerosols (kg)	1.6728E-04

Environment Unfiltered to Control Room Transport Group Inventory:

Time (h) = 4.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Control Room Ehaust to Environment Transport Group Inventory:

Time (h) = 4.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Control Room Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	5.8816E-04	1.3364E+00	4.1651E-02
Accumulated dose (rem)	2.0276E-03	2.8537E+00	9.0122E-02

Exclusion Area Boundary Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	1.3310E+00	5.8938E+01	3.1635E+00

Low Population Zone Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	3.4542E-02	4.5329E+00	1.7382E-01
Accumulated dose (rem)	8.5450E-01	4.9702E+01	2.3936E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 8.0000	Ci	kg	Atoms	Bq
I-131	5.2257E-04	4.2151E-12	1.9377E+13	1.9335E+07
I-132	7.0525E-05	6.8324E-15	3.1171E+10	2.6094E+06
I-133	8.6148E-04	7.6048E-13	3.4434E+12	3.1875E+07
I-134	2.2160E-06	8.3070E-17	3.7333E+08	8.1994E+04
I-135	4.5903E-04	1.3071E-13	5.8307E+11	1.6984E+07
Xe-131m	1.8370E-04	2.1931E-12	1.0082E+13	6.7967E+06
Xe-133m	2.4555E-03	5.4723E-12	2.4778E+13	9.0852E+07
Xe-133	6.2638E-02	3.3464E-10	1.5152E+15	2.3176E+09
Xe-135	4.5936E-03	1.7988E-12	8.0240E+12	1.6996E+08
Kr-83m	1.7942E-04	8.6959E-15	6.3094E+10	6.6384E+06
Kr-85m	2.3126E-03	2.8102E-13	1.9910E+12	8.5568E+07
Kr-87	1.9535E-04	6.8967E-15	4.7739E+10	7.2280E+06
Kr-88	3.0747E-03	2.4521E-13	1.6780E+12	1.1376E+08

Control Room Transport Group Inventory:

Time (h) = 8.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.6604E+15	0.0000E+00	0.0000E+00
Elemental I (atoms)	2.3972E+13	0.0000E+00	0.0000E+00
Organic I (atoms)	1.0537E+12	0.0000E+00	0.0000E+00
Aerosols (kg)	2.8779E-13	0.0000E+00	0.0000E+00

Time (h) = 8.0000	Deposition Surfaces	Recirculating Filter
Noble gases (atoms)	0.0000E+00	0.0000E+00
Elemental I (atoms)	0.0000E+00	0.0000E+00
Organic I (atoms)	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00

Environment to Control Room Transport Group Inventory:

Time (h) = 8.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	2.9821E+22
Organic I (atoms)	1.3108E+21
Aerosols (kg)	3.5802E-04

Environment Unfiltered to Control Room Transport Group Inventory:

Time (h) = 8.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Control Room Ehaust to Environment Transport Group Inventory:

Time (h) = 8.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Control Room Doses:

Time (h) 12.0000	Whole Body	Thyroid	TEDE

Delta dose (rem)	2.2714E-04	9.7248E-01	2.9971E-02
Accumulated dose (rem)	2.2547E-03	3.8262E+00	1.2009E-01

Exclusion Area Boundary Doses:

Time (h) = 12.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	1.3310E+00	5.8938E+01	3.1635E+00

Low Population Zone Doses:

Time (h) = 12.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	7.7057E-03	9.5464E-01	3.6902E-02
Accumulated dose (rem)	8.6220E-01	5.0657E+01	2.4305E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 12.0000	Ci	kg	Atoms	Bq
I-131	3.7462E-04	3.0218E-12	1.3891E+13	1.3861E+07
I-132	1.5364E-05	1.4884E-15	6.7905E+09	5.6846E+05
I-133	5.4833E-04	4.8404E-13	2.1917E+12	2.0288E+07
I-134	6.8194E-08	2.5563E-18	1.1488E+07	2.5232E+03
I-135	2.1946E-04	6.2492E-14	2.7877E+11	8.1202E+06
Xe-131m	1.3230E-04	1.5795E-12	7.2612E+12	4.8952E+06
Xe-133m	1.6939E-03	3.7751E-12	1.7093E+13	6.2675E+07
Xe-133	4.4562E-02	2.3807E-10	1.0779E+15	1.6488E+09
Xe-135	2.4625E-03	9.6426E-13	4.3014E+12	9.1111E+07
Kr-83m	2.8679E-05	1.3900E-15	1.0085E+10	1.0611E+06
Kr-85m	9.0577E-04	1.1006E-13	7.7978E+11	3.3513E+07
Kr-87	1.6055E-05	5.6682E-16	3.9235E+09	5.9405E+05
Kr-88	8.4237E-04	6.7179E-14	4.5973E+11	3.1168E+07

Control Room Transport Group Inventory:

Time (h) = 12.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.2075E+15	0.0000E+00	0.0000E+00
Elemental I (atoms)	1.7434E+13	0.0000E+00	0.0000E+00
Organic I (atoms)	7.6631E+11	0.0000E+00	0.0000E+00
Aerosols (kg)	2.0930E-13	0.0000E+00	0.0000E+00

Time (h) = 12.0000	Deposition Surfaces	Recirculating Filter
Noble gases (atoms)	0.0000E+00	0.0000E+00
Elemental I (atoms)	0.0000E+00	0.0000E+00
Organic I (atoms)	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00

Environment to Control Room Transport Group Inventory:

Time (h) = 12.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	4.5669E+22
Organic I (atoms)	2.0074E+21
Aerosols (kg)	5.4827E-04

Environment Unfiltered to Control Room Transport Group Inventory:

Time (h) = 12.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Control Room Ehaust to Environment Transport Group Inventory:

Time (h) = 12.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Control Room Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.7859E-04	1.2460E+00	3.8193E-02
Accumulated dose (rem)	2.5333E-03	5.0721E+00	1.5829E-01

Exclusion Area Boundary Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	1.3310E+00	5.8938E+01	3.1635E+00

Low Population Zone Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.1327E-02	2.6406E+00	9.1649E-02
Accumulated dose (rem)	8.7353E-01	5.3297E+01	2.5222E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 24.0000	Ci	kg	Atoms	Bq
I-131	1.5106E-04	1.2185E-12	5.6015E+12	5.5893E+06
I-132	1.7386E-07	1.6843E-17	7.6842E+07	6.4327E+03
I-133	1.5476E-04	1.3662E-13	6.1859E+11	5.7261E+06
I-135	2.6251E-05	7.4750E-15	3.3345E+10	9.7130E+05
Xe-131m	1.2758E-04	1.5231E-12	7.0017E+12	4.7203E+06
Xe-133m	1.4353E-03	3.1988E-12	1.4484E+13	5.3106E+07
Xe-133	4.1410E-02	2.2123E-10	1.0017E+15	1.5322E+09
Xe-135	9.7908E-04	3.8339E-13	1.7102E+12	3.6226E+07

Kr-83m	3.0230E-07	1.4652E-17	1.0631E+08	1.1185E+04
Kr-85m	1.4045E-04	1.7067E-14	1.2092E+11	5.1968E+06
Kr-87	2.3005E-08	8.1216E-19	5.6217E+06	8.5118E+02
Kr-88	4.4709E-05	3.5655E-15	2.4400E+10	1.6542E+06

Control Room Transport Group Inventory:

Time (h) = 24.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.1988E+15	0.0000E+00	0.0000E+00
Elemental I (atoms)	7.3396E+12	0.0000E+00	0.0000E+00
Organic I (atoms)	3.2262E+11	0.0000E+00	0.0000E+00
Aerosols (kg)	8.8115E-14	0.0000E+00	0.0000E+00

Time (h) = 24.0000	Deposition Surfaces	Recirculating Filter
Noble gases (atoms)	0.0000E+00	0.0000E+00
Elemental I (atoms)	0.0000E+00	0.0000E+00
Organic I (atoms)	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00

Environment to Control Room Transport Group Inventory:

Time (h) = 24.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	4.8791E+23
Organic I (atoms)	2.1447E+22
Aerosols (kg)	5.8576E-03

Environment Unfiltered to Control Room Transport Group Inventory:

Time (h) = 24.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Control Room Ehaust to Environment Transport Group Inventory:

Time (h) = 24.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	0.0000E+00
Organic I (atoms)	0.0000E+00
Aerosols (kg)	0.0000E+00

Control Room Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.3308E-04	1.5289E+00	4.6258E-02
Accumulated dose (rem)	2.7664E-03	6.6011E+00	2.0454E-01

Exclusion Area Boundary Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	1.3310E+00	5.8938E+01	3.1635E+00

Low Population Zone Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.1977E-02	6.4491E+00	2.0606E-01
Accumulated dose (rem)	8.8551E-01	5.9747E+01	2.7282E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 96.0000	Ci	kg	Atoms	Bq
I-131	5.5996E-05	4.5167E-13	2.0764E+12	2.0719E+06
I-133	6.7446E-06	5.9539E-15	2.6959E+10	2.4955E+05
I-135	6.6295E-09	1.8877E-18	8.4209E+06	2.4529E+02
Xe-131m	5.1431E-05	6.1403E-13	2.8227E+12	1.9030E+06
Xe-133m	2.6641E-04	5.9373E-13	2.6884E+12	9.8572E+06
Xe-133	1.3375E-02	7.1452E-11	3.2353E+14	4.9486E+08
Xe-135	1.9399E-06	7.5962E-16	3.3886E+09	7.1775E+04
Kr-85m	9.7927E-10	1.1900E-19	8.4306E+05	3.6233E+01

Control Room Transport Group Inventory:

Time (h) = 96.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	5.7556E+14	0.0000E+00	0.0000E+00
Elemental I (atoms)	3.5237E+12	0.0000E+00	0.0000E+00
Organic I (atoms)	1.5489E+11	0.0000E+00	0.0000E+00
Aerosols (kg)	4.2304E-14	0.0000E+00	0.0000E+00

Time (h) = 96.0000	Deposition Surfaces	Recirculating Filter
Noble gases (atoms)	0.0000E+00	0.0000E+00
Elemental I (atoms)	0.0000E+00	0.0000E+00
Organic I (atoms)	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00

Environment to Control Room Transport Group Inventory:

Time (h) = 96.0000	Pathway Filter
Noble gases (atoms)	0.0000E+00
Elemental I (atoms)	1.1553E+25
Organic I (atoms)	5.0780E+23
Aerosols (kg)	1.3869E-01

Environment Unfiltered to Control Room Transport Group Inventory:

```
                          Pathway
Time (h) =  96.0000        Filter
Noble gases (atoms)      0.0000E+00
Elemental I (atoms)      0.0000E+00
Organic I (atoms)        0.0000E+00
Aerosols (kg)            0.0000E+00

Control Room Ehaust to Environment Transport Group Inventory:

                          Pathway
Time (h) =  96.0000        Filter
Noble gases (atoms)      0.0000E+00
Elemental I (atoms)      0.0000E+00
Organic I (atoms)        0.0000E+00
Aerosols (kg)            0.0000E+00

Control Room Doses:

Time (h) = 720.0000      Whole Body   Thyroid      TEDE
Delta dose (rem)          9.2293E-05  9.0385E-01  2.7127E-02
Accumulated dose (rem)   2.8587E-03  7.5049E+00  2.3167E-01

Exclusion Area Boundary Doses:

Time (h) = 720.0000      Whole Body   Thyroid      TEDE
Delta dose (rem)          0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)   1.3310E+00  5.8938E+01  3.1635E+00

Low Population Zone Doses:

Time (h) = 720.0000      Whole Body   Thyroid      TEDE
Delta dose (rem)          5.3036E-03  4.3460E+00  1.3529E-01
Accumulated dose (rem)   8.9081E-01  6.4093E+01  2.8635E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 720.0000        Ci          kg         Atoms        Bq
I-131                  1.4979E-06  1.2082E-14  5.5542E+10  5.5421E+04
Xe-131m                2.8465E-06  3.3984E-14  1.5622E+11  1.0532E+05
Xe-133m                1.7750E-08  3.9559E-17  1.7912E+08  6.5676E+02
Xe-133                 1.0835E-04  5.7886E-13  2.6211E+12  4.0091E+06

Control Room Transport Group Inventory:

                                               Overlying
Time (h) = 720.0000     Atmosphere    Sump       Pool
Noble gases (atoms)     1.4484E+14  0.0000E+00  0.0000E+00
Elemental I (atoms)     8.8674E+11  0.0000E+00  0.0000E+00
Organic I (atoms)       3.8977E+10  0.0000E+00  0.0000E+00
Aerosols (kg)           1.0646E-14  0.0000E+00  0.0000E+00

                         Deposition Recirculating
Time (h) = 720.0000       Surfaces     Filter
Noble gases (atoms)      0.0000E+00  0.0000E+00
Elemental I (atoms)      0.0000E+00  0.0000E+00
Organic I (atoms)        0.0000E+00  0.0000E+00
Aerosols (kg)            0.0000E+00  0.0000E+00

Environment to Control Room Transport Group Inventory:

                          Pathway
Time (h) = 720.0000        Filter
Noble gases (atoms)      0.0000E+00
Elemental I (atoms)      8.9185E+25
Organic I (atoms)        3.9202E+24
Aerosols (kg)            1.0707E+00

Environment Unfiltered to Control Room Transport Group Inventory:

                          Pathway
Time (h) = 720.0000        Filter
Noble gases (atoms)      0.0000E+00
Elemental I (atoms)      0.0000E+00
Organic I (atoms)        0.0000E+00
Aerosols (kg)            0.0000E+00

Control Room Ehaust to Environment Transport Group Inventory:

                          Pathway
Time (h) = 720.0000        Filter
Noble gases (atoms)      0.0000E+00
Elemental I (atoms)      0.0000E+00
Organic I (atoms)        0.0000E+00
Aerosols (kg)            0.0000E+00

    315

#####################################################################
                          I-131 Summary
#####################################################################

               Prim Cont            Environment          Control Room
Time (hr)    I-131 (Curies)        I-131 (Curies)        I-131 (Curies)
   0.000       1.7016E+07            5.3175E-04            3.4858E-09
   0.400       1.6987E+07            4.2497E+02            7.5899E-04
   0.500       1.6980E+07            5.3110E+02            7.7171E-04
   0.800       1.6959E+07            8.4922E+02            6.6990E-04
   1.100       1.6937E+07            1.1669E+03            6.1211E-04
   1.400       1.6916E+07            1.4842E+03            5.7917E-04
   1.700       1.6894E+07            1.8012E+03            5.6028E-04
   2.000       1.6873E+07            2.1177E+03            5.4931E-04
   2.300       1.6852E+07            2.4338E+03            5.4282E-04
   2.600       1.6830E+07            2.7495E+03            5.3887E-04
```

2.900	1.6809E+07	3.0648E+03	5.3634E-04
3.200	1.6788E+07	3.3797E+03	5.3462E-04
3.500	1.6767E+07	3.6943E+03	5.3335E-04
3.800	1.6745E+07	4.0084E+03	5.3234E-04
4.000	1.6731E+07	4.2176E+03	5.3176E-04
4.300	1.6710E+07	4.5310E+03	5.3096E-04
4.600	1.6689E+07	4.8441E+03	5.3021E-04
4.900	1.6668E+07	5.1568E+03	5.2950E-04
5.200	1.6647E+07	5.4690E+03	5.2881E-04
5.500	1.6626E+07	5.7809E+03	5.2813E-04
5.800	1.6605E+07	6.0924E+03	5.2745E-04
6.100	1.6584E+07	6.4035E+03	5.2678E-04
6.400	1.6563E+07	6.7142E+03	5.2611E-04
6.700	1.6542E+07	7.0245E+03	5.2545E-04
7.000	1.6521E+07	7.3344E+03	5.2478E-04
7.300	1.6500E+07	7.6439E+03	5.2412E-04
7.600	1.6479E+07	7.9530E+03	5.2345E-04
7.900	1.6458E+07	8.2618E+03	5.2279E-04
8.000	1.6451E+07	8.3646E+03	5.2257E-04
8.300	1.6431E+07	8.6728E+03	4.6044E-04
8.600	1.6410E+07	8.9806E+03	4.2514E-04
8.900	1.6389E+07	9.2881E+03	4.0499E-04
9.200	1.6368E+07	9.5951E+03	3.9341E-04
9.500	1.6348E+07	9.9018E+03	3.8666E-04
9.800	1.6327E+07	1.0208E+04	3.8264E-04
10.100	1.6306E+07	1.0514E+04	3.8016E-04
10.400	1.6286E+07	1.0819E+04	3.7855E-04
12.000	1.6176E+07	1.2442E+04	3.7462E-04
24.000	1.5378E+07	2.4253E+04	1.5106E-04
96.000	1.1351E+07	8.3507E+04	5.5996E-05
720.000	8.1692E+05	2.3851E+05	1.4979E-06

##

Cumulative Dose Summary

##

	Control Room		Exclusion Area Bounda		Low Population Zone	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.000	1.1795E-12	3.8345E-14	1.4981E-05	9.2173E-07	5.8322E-06	3.5884E-07
0.400	1.4981E-01	4.8510E-03	1.1951E+01	7.1396E-01	4.6528E+00	2.7795E-01
0.500	2.0133E-01	6.5126E-03	1.4926E+01	8.8389E-01	5.8108E+00	3.4411E-01
0.800	3.4564E-01	1.1163E-02	2.3818E+01	1.3772E+00	9.2725E+00	5.3617E-01
1.100	4.7376E-01	1.5287E-02	3.2663E+01	1.8492E+00	1.2716E+01	7.1991E-01
1.400	5.9252E-01	1.9104E-02	4.1465E+01	2.3028E+00	1.6143E+01	8.9652E-01
1.700	7.0581E-01	2.2736E-02	5.0223E+01	2.7404E+00	1.9552E+01	1.0669E+00
2.000	8.1580E-01	2.6253E-02	5.8938E+01	3.1635E+00	2.2945E+01	1.2316E+00
2.300	9.2371E-01	2.9694E-02	5.8938E+01	3.1635E+00	2.6322E+01	1.3912E+00
2.600	1.0303E+00	3.3083E-02	5.8938E+01	3.1635E+00	2.9683E+01	1.5463E+00
2.900	1.1358E+00	3.6431E-02	5.8938E+01	3.1635E+00	3.3029E+01	1.6972E+00
3.200	1.2406E+00	3.9749E-02	5.8938E+01	3.1635E+00	3.6360E+01	1.8441E+00
3.500	1.3448E+00	4.3039E-02	5.8938E+01	3.1635E+00	3.9675E+01	1.987[illegible]E+00
3.800	1.4484E+00	4.6305E-02	5.8938E+01	3.1635E+00	4.2977E+01	2.1286E+00
4.000	1.5172E+00	4.8471E-02	5.8938E+01	3.1635E+00	4.5169E+01	2.2198E+00
4.300	1.6201E+00	5.1701E-02	5.8938E+01	3.1635E+00	4.5518E+01	2.2341E+00
4.600	1.7224E+00	5.4912E-02	5.8938E+01	3.1635E+00	4.5865E+01	2.2483E+00
4.900	1.8243E+00	5.8104E-02	5.8938E+01	3.1635E+00	4.6211E+01	2.2622E+00
5.200	1.9258E+00	6.1278E-02	5.8938E+01	3.1635E+00	4.6555E+01	2.2756E+00
5.500	2.0269E+00	6.4435E-02	5.8938E+01	3.1635E+00	4.6898E+01	2.289[illegible]E+00
5.800	2.1276E+00	6.7575E-02	5.8938E+01	3.1635E+00	4.7239E+01	2.3024E+00
6.100	2.2278E+00	7.0698E-02	5.8938E+01	3.1635E+00	4.7579E+01	2.3156E+00
6.400	2.3277E+00	7.3805E-02	5.8938E+01	3.1635E+00	4.7918E+01	2.3281E+00
6.700	2.4271E+00	7.6896E-02	5.8938E+01	3.1635E+00	4.8255E+01	2.3408E+00
7.000	2.5262E+00	7.9973E-02	5.8938E+01	3.1635E+00	4.8591E+01	2.3532E+00
7.300	2.6249E+00	8.3034E-02	5.8938E+01	3.1635E+00	4.8926E+01	2.3655E+00
7.600	2.7232E+00	8.6081E-02	5.8938E+01	3.1635E+00	4.9260E+01	2.3776E+00
7.900	2.8211E+00	8.9114E-02	5.8938E+01	3.1635E+00	4.9592E+01	2.3897E+00
8.000	2.8537E+00	9.0122E-02	5.8938E+01	3.1635E+00	4.9702E+01	2.3936E+00
8.300	2.9449E+00	9.2944E-02	5.8938E+01	3.1635E+00	4.9775E+01	2.3966E+00
8.600	3.0270E+00	9.5483E-02	5.8938E+01	3.1635E+00	4.9848E+01	2.3996E+00
8.900	3.1040E+00	9.7859E-02	5.8938E+01	3.1635E+00	4.9921E+01	2.4025E+00
9.200	3.1778E+00	1.0014E-01	5.8938E+01	3.1635E+00	4.9993E+01	2.4053E+00
9.500	3.2498E+00	1.0236E-01	5.8938E+01	3.1635E+00	5.0066E+01	2.4082E+00
9.800	3.3207E+00	1.0455E-01	5.8938E+01	3.1635E+00	5.0137E+01	2.4110E+00
10.100	3.3909E+00	1.0671E-01	5.8938E+01	3.1635E+00	5.0209E+01	2.4137E+00
10.400	3.4605E+00	1.0885E-01	5.8938E+01	3.1635E+00	5.0280E+01	2.4165E+00
12.000	3.8262E+00	1.2009E-01	5.8938E+01	3.1635E+00	5.0657E+01	2.4305E+00
24.000	5.0721E+00	1.5829E-01	5.8938E+01	3.1635E+00	5.3297E+01	2.5222E+00
96.000	6.6011E+00	2.0454E-01	5.8938E+01	3.1635E+00	5.9747E+01	2.7282E+00
720.000	7.5049E+00	2.3167E-01	5.8938E+01	3.1635E+00	6.4093E+01	2.8635E+00

```
####################################################################
                    Worst Two-Hour Doses
   Note: All of the dose locations are shown below but the
         worst two-hour dose is only meaningful for the EAB
         dose location.  Please disregard the two-hour worst
         doses for the other dose locations
####################################################################

Control Room
   Time   Whole Body    Thyroid        TEDE
   (hr)     (rem)        (rem)         (rem)
    0.0   8.8823E-04   8.1580E-01   2.6253E-02

Exclusion Area Boundary
   Time   Whole Body    Thyroid        TEDE
   (hr)     (rem)        (rem)         (rem)
    0.0   1.3310E+00   5.8938E+01   3.1635E+00

Low Population Zone
   Time   Whole Body    Thyroid        TEDE
   (hr)     (rem)        (rem)         (rem)
    0.0   5.1819E-01   2.2945E+01   1.2316E+00
```

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

Entergy Calculation No. JAF-CALC-RAD-04409, Rev. 0,

"CR X/Qs Using ARCON96 Code for Post-FHA Releases from RB Track Bay Door and RB Vent."

CALCULATION COVER PAGE

☐ IP-2 ☐ IP-3 ☒ JAF ☐ PNPS

Calculation No.: JAF-CALC-RAD-04409	Revision 0	Sheet 1 of 43 (Attachments included)

Title:
CR χ/Qs Using ARCON96 Code for Post-FHA Releases from RB Track Bay Door and RB Vent

Status:
☐ Preliminary
☒ Pending
☐ As-Built
☐ Void
☐ Superceded

☒ QR ☐ NQR

Discipline: Meteorology

Design Basis Calculation? ☒ Yes ☐ No

This calculation supersedes calculation ______

Modification No./Task No/ER No: N/A

Software Used? ☒ Yes ☐ No (If Yes, include Computer Run Summary Sheet)

System No./Name: N/A

Component No./Name: N/A

(Attached additional pages if necessary)

Print/Sign	
Preparer: Gopal J. Patel NUCORE Consulting Services, Inc.	Date: 05/23/2002
Reviewer/Design Verifier: Mark Drucker NUCORE Consulting Services, Inc. Mark Drucker	Date: 05/24/2002
Other Reviewer/Design Verifier: Gary C. Ré Gary C Ré	Date: 5/29/02
Approver: Gary C. Ré Gary C. Ré	Date: 5/29/02

RECORD OF REVISIONS

Calculation Number: JAF-CALC-RAD-04409

Revision No.	Description of Change	Reason For Change
0	Original Issue	N/A

CALCULATION SUMMARY PAGE

Calculation No. JAF-CALC-RAD-04409 **Revision No. 0**

CALCULATION OBJECTIVE:

The purpose of this calculation is to determine the 95% atmospheric dispersion factors (χ/Qs) (relative concentrations) at the James A. FitzPatrick Nuclear Power Plant (JAFNPP) control room (CR) air intake due to post–Fuel Handling Accident (FHA) releases from the Reactor Building Track Bay (RBTB) Doors (R-272/1) and RB Vent (RV).

The CR air intake χ/Qs are calculated using the NRC-sponsored computer code ARCON96 (Ref. 6.2) and 8-years of JAF plant-specific meteorological data (Ref. 6.1). The guidance provided in draft Regulatory Guide DG-1111 (Ref. 6.3) for use of the ARCON96 code and for avoiding the use of the Vent Release Model (mixed mode release) in design-basis accident applications, is incorporated in the assessment of χ/Q values. The RBTB doors and RV releases are treated as ground-level releases.

CONCLUSIONS:

The 95% atmospheric dispersion factors (χ/Qs) associated with the potential release paths for the design-basis FHA occurring in the reactor building are summarized in Section 8.0.

ASSUMPTIONS:

The assumptions are listed in Section 4.0 of this calculation.

DESIGN INPUT DOCUMENTS:

The design inputs are listed in Section 5.0 of this calculation and supporting reference documents are listed in Section 6.

AFFECTED DOCUMENTS:

Pending

METHODOLOGY:

The calculation methodology complies with the guidance in Draft Regulatory Guide DG-1111 and the ARCON96 code manual.

CALCULATION IMPACT REVIEW PAGE

Date: 5/28/02 ☒ QR ☐ NQR

(Note: X indicates required distribution)

To:
___ Mechanical Engineering
___ I&C Engineering
___ Electrical Engineering
___ Civil Engineering
___ System Engineering
___ Projects
___ Operations
___ Elect Maintenance
___ I&C Maintenance
___ Mech Maintenance
___ Training
___ Computer Applications
___ Quality Assurance
___ Chemistry
_x_ HP/Radiological
___ Procurement
_x_ Rad Engineering
_x_ Emergency Planning

From: ______________________________
(Print Name and Phone extension)

Calculation No.: JAF-CALC-RAD-04409 Revision No.: 0

Title: CR χ/Qs Using ARCON96 Code for Post-FHA Release from RB Track Bay Doors and RB Vent

MESSAGE: Work organizations are requested to review the subject calculation (parts attached) to identify impacted calculations, procedures, Technical Specifications, FSAR sections, other design documents and other documents that must be updated because of the calculation results. Also, provide the name of the individual responsible for the action and the tracking number.

IMPACT REVIEW:

Procedures, Tech Specs, FSAR, System Design Basis Documents, Topical Design Basis Documents, Drawings, etc.	Responsible Individual	Action Tracking Number

Manager (or designee): ______________________________
Signature Date

Return the completed Calculation Impact Review to the originator.

Date Required: ______________

COMPUTER RUN SUMMARY SHEET

Calculation No.: JAF-CALC-RAD-04409 Revision: 0 Date: 5/24/02

Sheet: 5 of 43

Subject: CR χ/Qs Using ARCON96 Code for Post-FHA Releases from RB Track Bay Doors and RB Vent

Code: ARCON96 Catalog No.: Pending Version: 1.0

Run No/Title/Date: (1) CR χ/Qs for RBTB Door Release (see Attachment A) 3/4/02

(2) CR χ/Qs for RV Door Release (see Attachment B) 5/7/02

(3) CR χ/Qs for TB Door Release (see Attachment C) 3/4/02

Run No.: See Above Run Date: See Above By: NUCORE

Output Use:
- ☒ Variable Values as Noted
- ☐ Plot Attached
- ☐ Tape No.: ____________
- ☐ File No.: ____________
- ☐ Disk

Description of Output: See Attachments

Comments: ____________

(Attached additional pages if necessary)

Review:
- ☒ Information Entered Above is Accurate
- ☒ Input Entry Accurate Based on Echo File Comparison to User Manual
- ☒ Code Properly Executed (Based on User Manual)
- ☒ Output Accurately Extracted or Location Specified

Reviewer Comments: ____________

GOPAL J. PATEL (signature) | Date | MARK DRUCKER (signature) | 5-24-2002

Preparer (Print/Sign) | Date | Reviewer (Print/Sign) | Date

TABLE OF CONTENTS

1.0 BACKGROUND

The doors and openings that constitute the reactor building (RB) pressure boundary are evaluated (Ref. 6.17) to determine the potential post-Fuel Handling Accident (FHA) atmospheric release paths. The proposed relaxation of secondary containment (SC) and associated support-system operability allows the equipment hatch at EL 369'-6" (Ref. 6.17.a) and RB track bay (RBTB) doors (R-272/1 / R-272/2) to remain open during refueling outages and other related systems (e.g.; Standby Gas Treatment System (SGTS)) to remain inoperable. Note that the RB is alternatively called secondary containment (SC).

The RBTB doors are at ground level on the south wall of the RB (see Figure 1). They are the largest doors into the RB and are capable of accommodating very large items such as railcars, spent-fuel casks, etc. The equipment hatch is a large opening in the floor of the refuel floor (RF). It also can accommodate very large items, such as spent fuel casks.

The air from the RF and the floors below the RF is exhausted to the environment via the RB vent (RV) during normal plant operations as well as refueling outages (Refs. 6.18 & 6.19). The Control Room (CR) doses are analyzed in Reference 6.15 for the post-FHA release through the RV, which takes credit for SGTS charcoal filtration. Since the SGTS becomes inoperable during a refueling outage due to the relaxation of SC and associated support-system operability, an unfiltered release path exists to the environment through the RV should a FHA occur.

In conclusion, should a FHA occur, the activity from the damaged fuel is postulated to release to the environment at ground level through the RBTB doors via the equipment hatch and/or the RV via the RB ventilation system. The values of the χ/Qs for these release paths are not readily available. Therefore, they are calculated in the following sections using the ARCON96 computer code.

2.0 PURPOSE

The purpose of this calculation is to determine the values of the atmospheric dispersion factors (χ/Qs) (relative concentrations) needed for analysis of post-accident radiological consequences at the James A. FitzPatrick Nuclear Power Plant (JAFNPP). Post-accident χ/Qs for the control room (CR) air intake are those that are not exceeded more than 5.0 percent of the total hours in the meteorological data set (i.e., 95th-percentile χ/Qs). These χ/Q values are determined for the post–FHA releases from the RBTB doors (Ref. 6.17.e) and RB Vent (RV) (Ref. 6.16.b).

The CR air intake χ/Qs are calculated using the NRC-sponsored computer code ARCON96 (Ref. 6.2) and 8-years (1985 to 1992) of JAF plant-specific meteorological data (Ref. 6.1). The recommendations provided in Draft Regulatory Guide DG-1111 (Ref. 6.3) for use of the ARCON96 dispersion model are incorporated (e.g., the Vent Release Model (mixed mode release) is not used in this analysis). The post-FHA releases through the RBTB doors and the RV are modeled as ground-level point sources.

The ARCON96 computer code is verified by running the code test cases and validated by comparing the results.

3.0 METHOD OF ANALYSIS

The ARCON96 computer code was developed for calculating the χ/Qs for use in control room habitability assessments. The ARCON96 code, in conjunction with the guidance in DG-1111 (Ref. 6.3), provides a method acceptable to the NRC staff for determining site-specific CR χ/Q values for radiological habitability assessments. ARCON96 implements improved building wake dispersion and low-wind-speed correction algorithms, use of hourly meteorological observations, sector averaging and directional-dependent dispersion conditions. CR χ/Qs are calculated for averaging periods ranging from one hour to 30 days in duration.

The location of the release point of interest is determined with respect to the primary CR air intake location based on the dimensions given in the building arrangement drawings (Ref. 6.5

through 6.9). The cross-sectional area of the structure controls the downwind distance of the building wake (see Figures 1, 2 & 3), which is calculated for the prevailing wind. Various receptor data (Ref. 6.2, pages 15 & 16) and source data (Ref. 6.2, pages 17 & 18) required for the ARCON96 χ/Q computations are established in Sections 7.4 through 7.6 based on the plant-specific configuration. The 8-year (1985-1992) JAF site-specific meteorological data files were formatted per the instruction format given in Table 1 of DG-1111 and used as ARCON96 meteorological data input. The required receptor and source input data are tabulated underneath the applicable figures (Figures 1, 2, and 3). The values of CR χ/Qs for the RBTB doors and RV are shown in Sections 8.1 and 8.2, respectively.

CR χ/Qs for turbine building releases are analyzed in Reference 6.14 using the Murphy/Campe model and the 8-year JAF site-specific meteorological data files. The same χ/Qs are reanalyzed using the ARCON96 code and the source/receptor geometry given in Reference 6.14, page 55. The results are compared in Section 8.3. The ARCON96 test case examples (1 through 4 and 5e) are executed in the Microsoft Windows based environment to demonstrate that the code produces the identical results as shown in Section 8.4.

4.0 ASSUMPTIONS

The regulatory requirements in Draft Regulatory Guide DG-1111 (Ref. 6.3) are adopted as assumptions in the following sections. They are incorporated as design inputs along with other plant-specific as-built design parameters provided in Section 5.0.

4.1 Meteorological Data Input – General Considerations

Design Input 5.1 - 8-years of JAF site-specific meteorological data - meets the following DG-1111 RGP 2.1 requirements:

1. The meteorological data were obtained from the Niagara Mohawk Power Corporation, Nine Mile Point Nuclear Generating Stations' (NMPNGSs) meteorological monitoring program, which provides the wind speed, wind direction and other measured parameters to determine atmospheric stability based on the guidance in Regulatory Guide 1.23 (Ref. 6.10 through 6.12). JAF and NMPNGS share a common site; therefore, NMPNGS' meteorological data are applicable to the JAF plant.
2. The meteorological data program includes quality assurance provisions consistent with Appendix B of 10 CFR Part 50 (Ref. 6.11).
3. Data are presented as hourly averages as defined in RG 1.23 (Ref. 6.12).
4. Data are representative of overall site conditions and are free from local effects such as building and cooling tower wakes, brush and vegetation, or terrain (Ref. 6.3).
5. The 8-years of data used in the χ/Q assessment are more than sufficient to reflect long-term site-specific meteorological trends.
6. The near-ground atmosphere stability classifications for the ground level release are determined based on the vertical temperature difference (ΔT) measured between the lower measurement point at 30 feet and intermediate measurement

point at 100 feet, using atmosphere stability classification criteria in RG 1.23 (Ref. 6.12 & 6.14, page 40).

7. The meteorological data are formatted in the text data files as shown in Table 1 of DG-1111. The unformatted meteorological data include the following information per line (Ref. 6.12, pages 34-36):

   - Identifier
   - Calendar year
   - Julian day (1 to 365/366 days)
   - Hour (24-hr clock, 0 to 23)
   - Upper measurement level (200.0 ft)
   - Wind direction (degrees)
   - Wind speed (mph)
   - Sigma theta (degrees)
   - Ambient temperature (deg. F)
   - Moisture (not available)
   - Similar information for the intermediate measurement level (100 ft)
   - Similar information for the lower measurement level (30.0 ft)
   - Temperature differences between various measurement levels (deg. F)
   - Precipitation (inches of water)
   - Solar radiation (not available)
   - Visibility (not available)
   - Barometric pressure (in of Hg)

   These unformatted data are formatted to include only the critical parameters needed as input to the ARCON96 code to calculate χ/Qs. The ARCON96 format is shown in Table 1 of DG–1111. The stability classifications were adopted from Reference 6.12 and the ARCON96 meteorological data files are compiled in Reference 6.1.

4.2 Determination of Source Characteristics

Design Input 5.2 – Source Data - meets the following DG-1111 RGP 2.2.1 requirement:

The post-FHA releases through the RBTB doors and RV are qualified to be ground-level point sources.

4.3 Determination of CR Intake (Receptor) Characteristics

Design Input 5.3 – Receptor Data - meets the following DG-1111 RGP 2.3 requirements:

1. Ventilation System Outside Air Intake

   RGP 2.3.1 requires that the CR ventilation system configuration and response should be evaluated during the accident condition to identify the CR outside air intakes for which χ/Q values are calculated. Since the CR envelope is not isolated during and following a FHA and the normal and emergency air intakes are at the same location (Ref. 6.9.b), the normal air supply flow rate is used with the most limiting air intake location (see the following section for determination of the most limiting air intake location).

2. Dual Ventilation Outside Air Intakes

   The requirements of RGP 2.3.2 to identify the limiting and favorable air intakes with regard to their χ/Q values are met as follows:

   The primary CR air intake is located on the roof of the administrative building at Row V and Column 9.6, approximately (Ref. 6.7.b). The roof elevation is 322'-0" (Ref. 6.7.b) and the CR normal air intake elevation is 326'-0" (Ref. 6.8.b). The secondary CR air intake is located on the west side of the administrative building at Row B and Column 9.7, approximately (Ref. 6.9.a). Due to its location, the potential concentration of post-FHA activity at the CR secondary air intake is expected to be lower than that at the primary intake. Therefore, per RGP 2.3.2, the outside air intake for the CR is assumed to be from the primary intake vent. This is based on its' distance being relatively closer to the source points than the secondary intake; also, it is in the same wind direction, experiences the same building wake and is supplied with the same air flow rate.

3. <u>Infiltration Pathways</u>

The typical infiltration pathways that need to be considered in establishing CR intake χ/Q values are listed in RGP 2.3.3 as follows:

- Control Room Envelope (CRE) doorway seals
- Personnel movement through CRE doors
- CRE outside air intake and exhaust isolation dampers
- Cable tray, conduit and piping penetrations in the CRE
- Penetrations in ductwork located outside of the CRE and subject to negative pressure (e.g. fan suctions)
- Ductwork that traverses the CRE and contains contaminated air
- Floor drains

The CR habitability analysis in Reference 6.15, Table 2.1, page 17 assumes an unfiltered air inleakage of 2,100 scfm through DMPR-105, which is located in the normal CR HVAC system and fails to close during CR isolation. The infiltration pathways listed in RGP 2.3.3 are not considered in this analysis for assessing CR χ/Q values for releases from the RBTB doors and RV. The reason is the CR envelope will be maintained in the normal mode of operation (without taking credit for the CR emergency filtration system) and DMPR-105 remains open to supply the normal airflow.

4.4 Source-Receptor Distance

Design Input 5.4 – Source-Receptor Distance – meets the DG-1111 RGP 2.4 requirement as follows:

The source-to-receptor distance is the shortest horizontal distance between the release point and intake. Therefore, the actual straight-line horizontal distances between the RBTB doors and RV centerlines and the CR intake are used (See Figures 1 and 2).

4.5 Source-Receptor Direction

Design Input 5.5 – Source-Receptor Direction – meets the DG-1111 RGP 2.4 requirement as follows:

Wind direction data are recorded as the direction from which the wind blows (e.g., a wind blowing out of the west is recorded with a direction of 270 degrees). The JAF facility "plant north" is the same as "true north" (Ref. 6.13). Therefore, the actual direction from the CR intake to the RBTB doors and RV are south (See Figures 1 & 2) and a south wind will carry the plume from the RBTB doors and RV release points to the primary CR air intake.

RGP 3 & 4 mainly discuss the alternative procedures for ground level releases and plume rise applications, which are not applicable to the evaluation of χ/Q values in this analysis. The qualification requirements of the site-specific experimental data in RGP 5 are redundant to those in RGP 2.1 and are incorporated into Assumption 4.1 above.

4.6 Building Area

Design Input 5.6 - ARCON96 uses the value of the building area in the high-wind speed adjustment for the ground level and vent release models. The actual reactor building vertical cross-sectional area, which is the area perpendicular to the south wind direction, is used in design input 5.6.

4.7 Release Height

Design Input 5.7 - ARCON96 uses the value of the release height to adjust the wind speed for the release height, determine the slant path for a ground-level release and correct the off-centerline data for elevated releases. The actual release heights, which are the centerline height of the RBTB doors and top elevation of the RV, are used in design input 5.7.

4.8 Intake Height

Design Input 5.8 - ARCON96 uses the value of the intake height to determine the slant path for a ground level release and correct the off-centerline data for the stack release model. The actual CR air intake centerline height is used in design input 5.8 for this analysis.

4.9 Surface Roughness Length

Design Input 5.9 - ARCON96 uses the value of this parameter in adjusting wind speeds to account for differences in meteorological instrumentation height and release height. A conservative value of 0.2 in lieu of the default value of 0.1 for most sites (Ref. 6.3, Table A-1) is used in design input 5.9.

4.10 Minimum Wind Speed

Design Input 5.10 - ARCON96 uses the value of this parameter to identify calm wind conditions. The code default wind speed of 0.5 m/s (Ref. 6.3, Table A-1) is used in design input 5.10. Consistent with DG-1111 Table A-1, use of the code default wind speed of 0.5 m/s is appropriate since the meteorological tower anemometer is capable of documenting wind speeds of less than 0.6 m/s (Ref. 6.1).

4.11 Average Sector Wind Constant

Design Input 5.11 - ARCON96 uses the value of this parameter to prevent inconsistencies between the centerline and sector average χ/Qs for wide plumes. Although the code default value is 4.0, a conservative value of 4.3 (Ref. 6.3, Table A-1) is used in design input 5.11.

4.12 Lower Measurement Height

Design Input 5.12 - ARCON96 uses the value of this parameter to adjust the wind speeds for the differences between the heights of the instrumentation and the release. The actual height of 30 feet is used for the lower instrumentation in design input 5.12.

4.13 Upper Measurement Height

Design Input 5.13 - ARCON96 uses the value of this parameter to adjust the wind speeds for the differences between the heights of the instrumentation and the release. The actual height of 100 feet is used for the upper instrumentation in design input 5.13. Calculation JAF-CALC-RAD-00007 (Ref. 6.14, page 40) determined that the 100-foot intermediate measurement point is appropriate for near-ground-level releases.

5.0 INPUT AND DESIGN CRITERIA

Parameter	Value	Reference
5.1 JAF Meteorological Data	1985–1992 Meteorological Data	6.1, 6.10, & 6.11
5.2 Source Data		
RBTB Door	See Figure 1	Section 7.4.1, Refs. 6.5 thru 6.7
RB Vent	See Figure 2	Section 7.4.2, Refs 6.5, 6.7, 6.8 & 6.16
Turbine Bldg	See Figure 3	Section 7.4.3, Ref. 6.14, P 46-47
5.3 CR Intake Receptor Data	See Figures 1, 2, & 3	Section 7.4.1, Ref. 6.5 thru 6.8
5.4 Source-Receptor Distance		
RBTB Door	73.55 m	Section 7.4.1, Refs. 6.5 thru 6.7
RB Vent	21.50 m	Section 7.4.2, Refs 6.5, 6.7, 6.8 & 6.16
Turbine Bldg	28.7 m	Section 7.4.3, Refs. 6.14, P 53-55
5.5 Source-Receptor Direction		
RBTB Door	172.2^0	Section 7.4.1, Refs. 6.5 thru 6.7
RB Vent	127.4^0	Section 7.4.2, Refs 6.5, 6.7, 6.8 & 6.16
Turbine Bldg	360^0	Section 7.4.3, Ref. 6.2
5.6 Building Wake Area		
RBTB Door	2,284.84 m^2	Section 7.4.1, Ref. 6.5
RB Vent	2,284.84 m^2	Section 7.4.2, Ref. 6.5
Turbine Bldg	1,305 m^2	Section 7.4.3, Ref. 6.5
5.7 Release Height		
RBTB Door	2.74 m	Section 7.4.1, Ref. 6.6b
RB Vent	52.03	Section 7.4.2, Ref.6.16.b
Turbine Bldg	32.9 m	Section 7.4.3, Ref. 6.5.b
5.8 Intake Height	16.46 m	Section 7.4.1, Ref. 6.5.b, 6.7.b, & 6.8.b
5.9 Surface Roughness Length	0.2 m	6.3, Table A-1

Parameter	Value	Reference
5.10 Minimum Wind Speed	0.5 m/s	6.3, Table A-1
5.11 Averaging Sector Width Constant	4.3	6.3, Table A-1
5.12 Lower Measurement Height for Meteorological Data	30 feet (9.1 m)	6.1 & 6.3, Table A-1
5.13 Intermediate Measurement Height for Meteorological Data	100 feet (30.49 m)	6.1 & 6.3, Table A-1

6.0 REFERENCES

1. J.A. FitzPatrick Nuclear Power Plant Meteorological Date Files (Attached CD)

2. NUREG/CR-6331 PNNL-10521, Rev 1, "Atmospheric Relative Concentration in Building Wakes", May 1997

3. U.S. NRC Draft Regulatory Guide DG-1111, December 2001, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants"

4. NEI 99-03, June 2001, Appendix D, Atmospheric Dispersion

5. JAF Nuclear Power Plant Drawings:

   a. 11825-FC-2A, Rev 6, Foundation Key Plan

   b. 11825-FA-2G, Rev 4, General Arrangement Elevations

6. JAF Nuclear Power Plant Reactor Building Drawings:

   a. 11825-FC-29A, Rev 8, SH 1, Rail Road & Truck Port & Gas Treatment Bldg Concrete Details

   b. 11825-FC-29D, Rev 6, SH 4, Rail Road & Truck Port & Gas Treatment Bldg Concrete Details

   c. 11825-FM-1E, Rev 28, SH 5, Machine Location – Reactor Building, Plan EL 272'-0"

   d. 11825-FM-100A, Rev 13, Equipment Arrangement – Aux Boiler Room, Stand-by Gas Treatment Area & Equipment Access Lock

7. JAF Nuclear Power Plant Admin Building Drawings:

   a. 11825-FA-16A, Rev 27, SH 1, Administration Bldg Floor Plans

   b. 11825-FA-16B, Rev 24, Administration Bldg Floor & Roof Plans

8. JAF Nuclear Power Plant Admin Building Drawings:

   a. 11825-FC-32C, Rev 10, Administration Building Plan-Floor Slab & Roof Details, ELs 300'-0" & 322'-0"

   b. 11825-FC-32N, Rev 5, Administration Building Details Roof Air Intake & Exhaust

9. JAF Nuclear Power Plant Admin Building HVAC Drawings:

   a. 11825-FB-32G, Rev 9, SH 7, Administrative Building Heating Vent & Air Conditioning

   b. 11825-FB-35C, Rev 14, Equipment Room Heating, Vent & Air Conditioning Plan EL 300'-0"

10. Niagara Mohawk Power Corporation, Nine-Mile Point Nuclear Station, Environmental Surveillance Procedure No. S-ENVSP-27, Rev. 3, "Site Weather Station Data Verification and Edit"

11. Niagara Mohawk Power Corporation, Nine-Mile Point Nuclear Station, Environmental Surveillance Procedure No. S-ENVSP-34, Rev. 1, "Meteorological Monitoring Program QA/QC"

12. NRC Regulatory Guide 1.23, "Onsite Meteorological Programs" (2/17/72)

13. JAF Nuclear Power Plant Admin Building HVAC Drawings:

   a. 11825-FC-6A

   b. 11825-FY-3B, Rev. 19, Sheet 1, "Grading, Roads and Walkways"

14. JAF Calculation No. JAF-CALC-RAD-00007, Rev 2, "Power Uprate Program – Onsite and Offsite Post-Accident Atmospheric Dispersion Factors"

15. JAF Calculation No.JAF-CALC-RAD-00042, Rev 3, "Control Room Radiological Habitability Under Power Uprate Conditions and CREVASS Reconfiguration"

16. JAFNPP Drawings:
    a. 11825-FA-10A, Rev 10, Reactor BLDG – M.G. Sets Plans & Elevations
    b. 11825-FA-10B, Rev 6, Reactor BLDG Plans, Elevations, & Details Duct Enclosure
    c. 11825-FA-10D, Rev 5, Reactor BLDG Roof Plan
    d. 11825-FA-11A, Rev 2, Reactor BLDG North & South Elevations
    e. 11825-FA-6E, Rev 18, Door Schedule Reactor BLDG
17. JAFNPP Machine Location Drawings:
    a. 11825-FM-1A, Rev 12, Sheet 1, Plan EL 396'-0"
    b. 11825-FM-1B, Rev 14, Sheet 2, Plan EL 344'-6"
    c. 11825-FM-1C, Rev 11, Sheet 3, Plan EL 326'-9"
    d. 11825-FM-1D, Rev 30, Sheet 4, Plan EL 300'-0"
    e. 11825-FM-1E, Rev 28, Sheet 5, Plan EL 272'-0"
18. JAFNPP Drawing No. FB-8A, Sheet 1 of 1, Rev 27, Flow Diagram Reactor Building Vent & Cooling System 66.
19. JAFNPP Drawing No. FB-7A, Rev 16, Reactor Building Ventilation Arrangement.

7.0 CALCULATION / ANALYSIS

7.1 Control Room Air Intake χ/Qs

7.1.1 Release through Reactor Building Track Bay (RBTB) Door (R-272/1)

The post-FHA activity is directly released to the environment when the RBTB doors are opened during the refueling outage. The track bay is located in the south wall of the Standby Gas Treatment Building (Ref. 6.5) (see Figure 1).

The south wind will carry the post-FHA activity plume from the outer RBTB door to the CR air intake. The south wind will be affected by the building wake of the reactor building. The cross-sectional area of the reactor building will contribute to the building wake diffusion. The south wall surface area of the RB above EL 272'-0' will determine the building wake (Ref 6.5 & 6.7). The ARCON96 essential design input parameters are calculated in Section 7.4.1. The ARCON96 input/output file for the RBTB door release χ/Qs is shown in Attachment A.

7.1.2 Release through RB Vent (RV)

The post-FHA unfiltered activity is directly released to the environment through the RV when the SGTS is not operable during the refueling outage. The RV is located at the northeast corner of the RB (Ref. 6.16.b) (see Figure 2).

The south wind will carry the post-FHA activity plume from the RV to the CR air intake. The south wind will be affected by the building wake of the reactor building. The cross-sectional area of the reactor building will contribute to the building wake diffusion. The south wall surface area of the RB above EL 272'-0' will determine the building wake (Ref 6.5 & 6.7). The ARCON96 essential design input parameters are calculated in Section 7.4.2. The ARCON96 input/output file for the RV release χ/Qs is shown in Attachment B.

7.2 Control Room Air Intake χ/Qs – Test Case

Release through Turbine Building (TB)(Test Case)

The CR intake χ/Qs are calculated for the TB release in Reference 6.14, page 16 using the Murphy/Campe model and 8-years (1985 to 1992) of JAF site-specific meteorological data. The same source/receptor geometry model shown in Figure 3 was analyzed using the ARCON96 code with the same 8-years of JAF site-specific meteorological data and the results compared in Section 8.3.

The north wind will carry the post-FHA activity plume from the TB to the CR air intake. The north wind will be affected by the building wake of the turbine building. The cross-sectional area of the turbine building will contribute to the building wake diffusion. The north wall surface area of the TB above EL 272'-0' will determine the building wake (Ref. 6.5). The ARCON96 essential design input parameters are calculated in Section 7.4.3. The ARCON96 input/output file for the TB release χ/Qs is shown in Attachment C.

7.3 Validation & Verification of ARCON96 Code

The test cases in the ARCON96 manual for Examples 1 through 4 and 5e are executed using the ARCON96 code. The calculated results are compared in Section 8.4 with those in the ARCON96 User's Manual to demonstrate the consistency of results and ability of the code to produce the same results in the different operating environments and configurations.

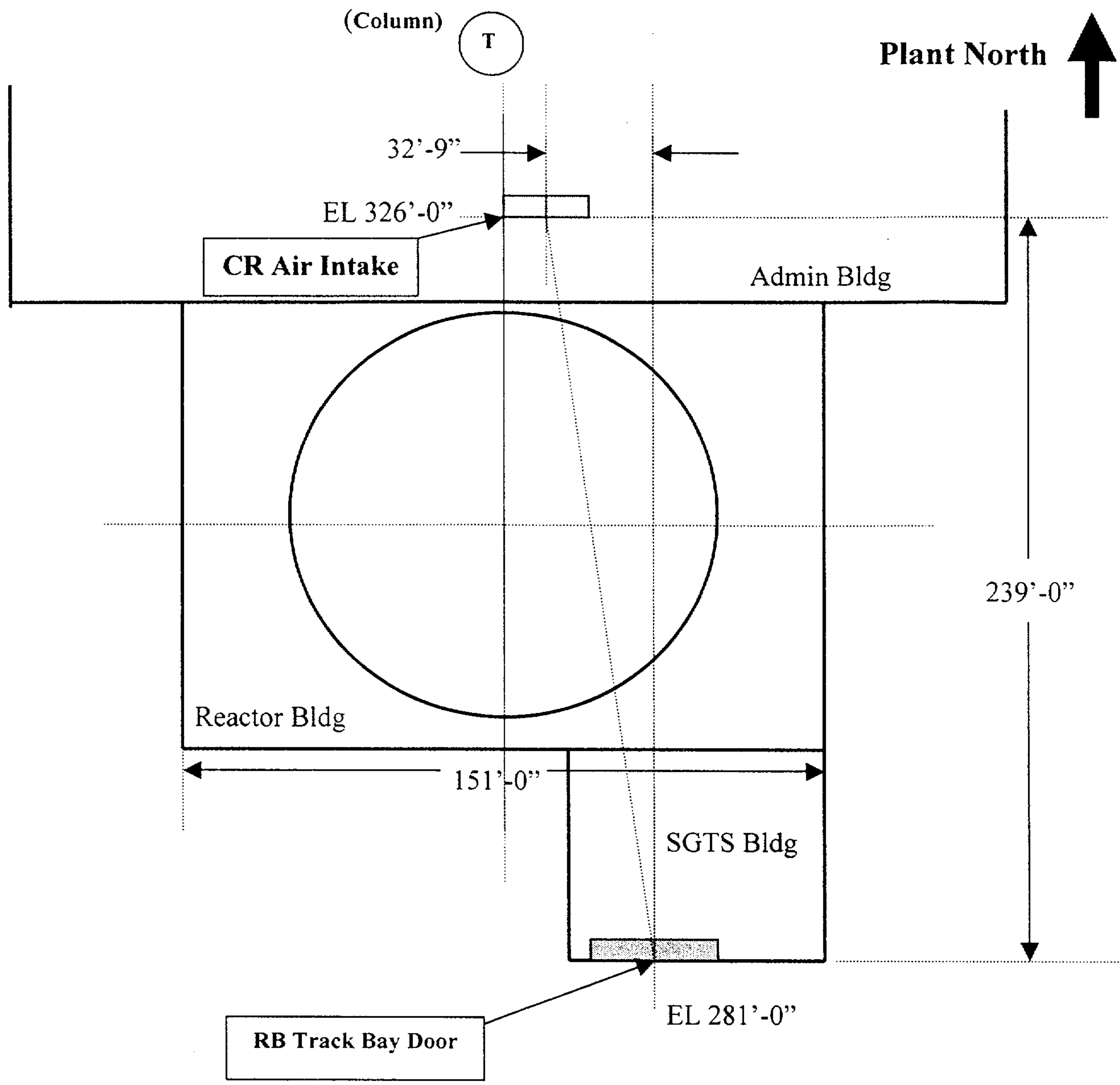

Figure 1: RBTB Door (Source) & CR Intake (Receptor) Geometry

Release Point	Distance to Receptor (feet)	Distance to Receptor (meters)	Release Point Height (feet)	Release Point Height (meters)	Direction to Source (degrees)	Wake Area ($meters^2$)	CR Intake Height (meters)
RBTB Doors	241.23	73.55	9.00	2.74	172.20	2284.84	16.46

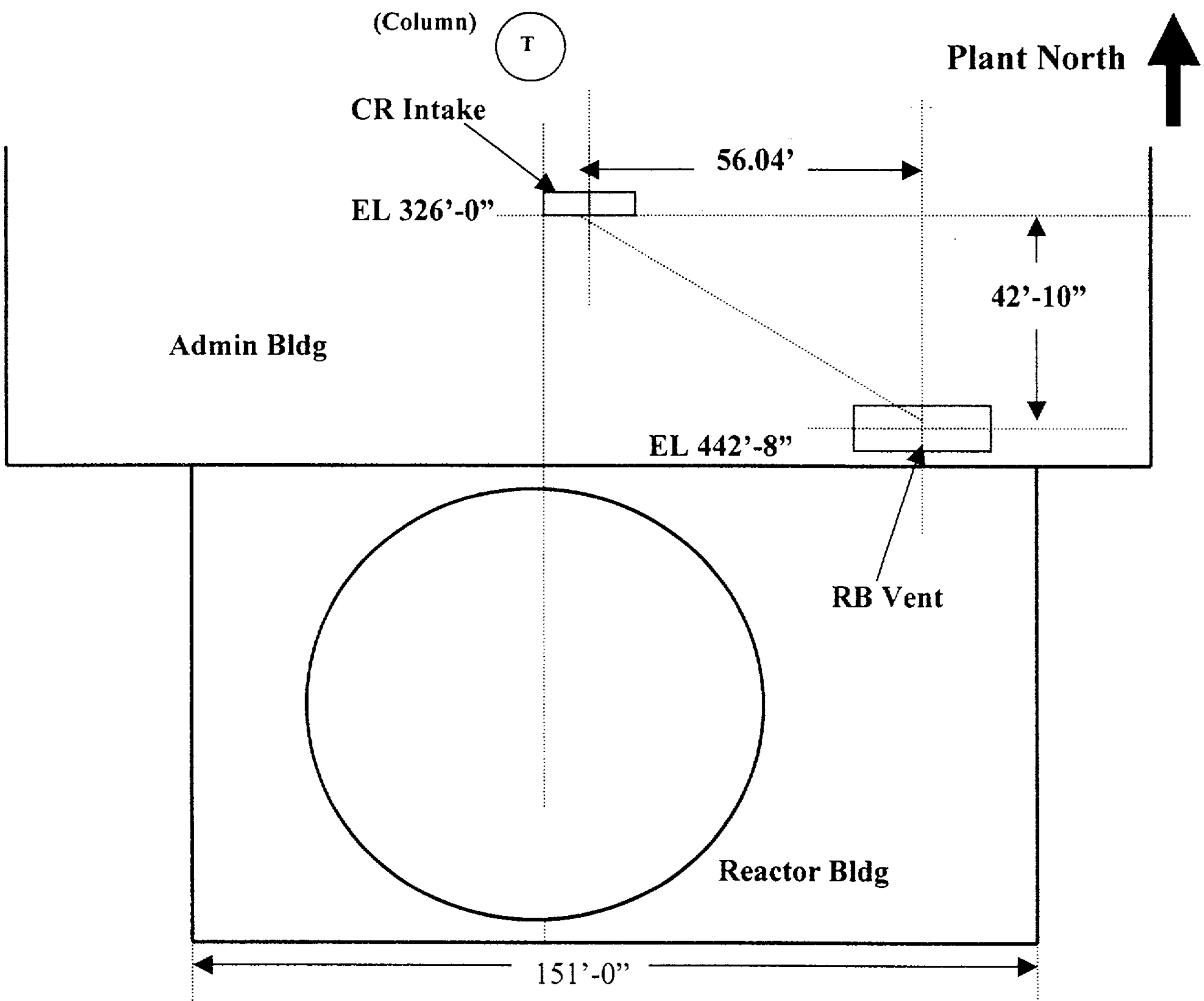

Figure 2: RV (Source) & CR Intake (Receptor) Geometry

Release Point	Distance to Receptor (feet)	Distance to Receptor (meters)	Release Point Height (feet)	Release Point Height (meters)	Direction to Source (degrees)	Wake Area ($meters^2$)	CR Intake Height (meters)
RV	70.53	21.50	170.67	52.03	127.4	2284.84	16.46

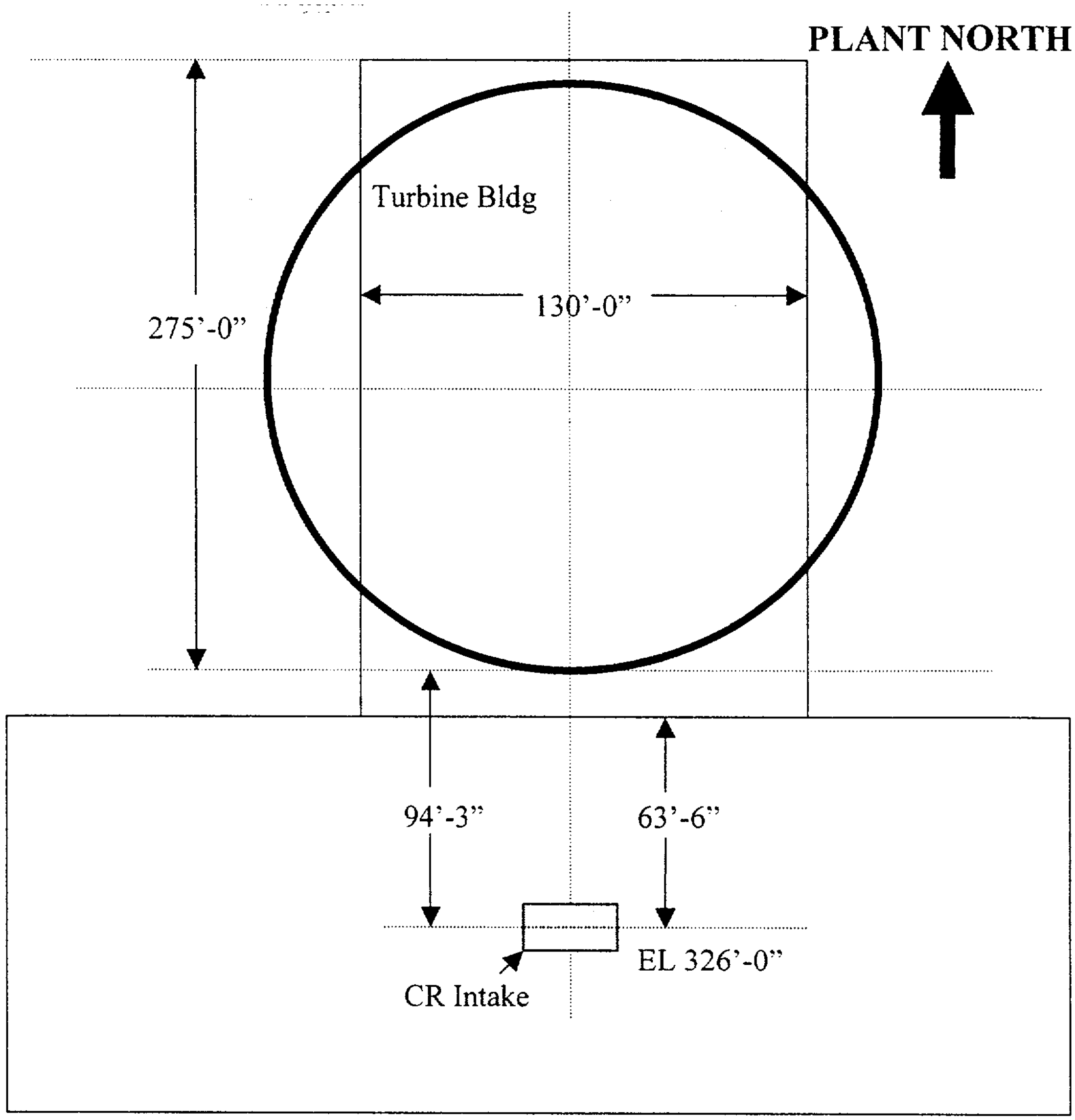

Figure 3: Turbine Bldg Surface (Source) & CR Intake (Receptor) Geometry (Test Case)

Release Point	Distance to Receptor		Release Point Height		Direction to Source	Wake Area	CR Intake Height
	(feet)	(meters)	(feet)	(meters)	(degrees)	$(meters^2)$	(meters)
Turbine Bldg	94.30	28.70	108.00	32.90	360.00	1305.00	16.46

7.4 Calculations

The source/receptor input parameters for the ARCON96 code are calculated in the following sections based on the geometry models in Figures 1 through 3 using the plant-specific as-built design information (Ref. 6.5 through 6.9).

7.4.1 Receptor/Intake Parameters for RBTB Door Release – CR Air Intake χ/Qs

The location of the outer RBTB door (R-272/1) with respect to the CR air intake is shown in Figure 1 (Refs. 6.5 through 6.9). The RBTB door location with respect to the CR air intake is such that the south wind will predominantly carry effluent from the RBTB door to the CR intake. Only the cross-sectional area perpendicular to the south wind is considered for the wake diffusion.

1. Total Cross-Sectional Area Perpendicular to South Wind:

= Surface area of South wall of RB

= 151'-0" (Ref. 6.5.b, South View) x (434'-9-1/2" – 272'-0") (Ref. 6.5.b, West View)

= 151' x 162.79' = 24,581.29 ft^2 = 2,284.84 m^2

= $\boxed{\mathbf{2{,}284.84\ m^2}}$

2. Straight Line Distance between RBTB Door and CR Air Intake:

Step 1: South-North Distance between Centerlines of RBTB Door and CR Primary Air Intake:

= Distance between RBTB Door and Column 1

+ Distance between Columns 1 and 8

+ Distance between Columns 8 and 9

+ Distance between Column 9 and Centerline of Conc. Hood

- Distance between Centerlines of Conc. Hood and CR South Air Intake

= 72'-6" (Ref. 6.5.b & 6.6.d) + 151'-0" (Ref. 6.5.a) + 3'-6" (Ref. 6.5.a) + 14'-7" (Ref. 6.7.b) – 2'-6" (Ref. 6.8.b, Plan View)

= 239'-1" ≈ 239'

Step 2: Net Distance of Centerline of RBTB Door and Centerline of Primary CR Air Intake:

East-West Distance between Centerline of RBTB Door and Centerline of RB (at Column T per Ref. 6.5.a)

= Distance between Centerline of Rail Road Track and Column W + Distance between Columns W and T

= 16'-9" (Ref. 6.6.a) + 20'-0" (Ref. 6.6.a) = 36'-9"

Distance of Centerline of Primary CR Air Intake from Centerline of RB

= 4'-0" (Ref. 6.7.b)

Net Distance of Centerline of RBTB Door and Centerline of Primary CR Air Intake

= 36'-9" - 4'-0" = 32'-9"

Step 3: Straight Line Distance between RBTB Door and CR Air Intake

= $[(32.75)^2 + (239)^2]^{-1/2}$ = 241.23 ft

= $\boxed{\textbf{73.55 m}}$

3. Direction (compass point in degrees) of Southerly Wind that Points Directly to the CR Air Intake from the RBTB Release Point:

Step 1: RBTB Direction with Respect to CR Intake

Height of CR Air Intake

= 326'-0" (Ref. 6.7.b & 6.8.b) – 272'-0" (Ref. 6.5b) = 54'-0"ft = 16.46 m

Height of RBTB Door = 18'-0" (Ref. 6.6.b)

Height of Centerline of RBTB Door = 18'-0"/2 = 9'-0" = 2.74 m

Height of Release Point = 2.74 m

RBTB Direction with Respect to CR Intake

Tan θ = 32.75/239 = 0.137, therefore θ = Tan^{-1} 0.137 =7.8^0

Step 2: Orientation of RBTB Release with Respect to CR Air Intake, Considering South Wind 180^0 and True North Wind 360^0 (Ref. 6.2, page 16) = 180^0 - 7.8^0

= $\boxed{\mathbf{172.2^0}}$

7.4.2 <u>Receptor/Intake Parameters for RV Release – CR Air Intake χ/Qs</u>

The location of the RV with respect to the CR air intake is shown in Figure 2 (Refs. 6.7.b & 6.16). The RV location with respect to the CR air intake is such that the south wind will predominantly carry effluent from the RV to the CR intake. Only the cross-sectional area perpendicular to the south wind is considered for the wake diffusion.

1. **Total Cross-Sectional Area Perpendicular to South Wind:**

= Surface Area of South Wall of RB

= 151'-0" (Ref. 6.5.b, South View) x (434'-9-1/2" – 272'-0") (Ref. 6.5.b, West View)

= 151' x 162.79' = 24,581.29 ft^2 = 2,284.84 m^2

= $\boxed{\mathbf{2,284.84\ m^2}}$

2. **Straight Line Distance between RV and CR Air Intake:**

Step 1: South-North Distance between Centerlines of RV and CR Primary Air Intake:

= Distance between Columns 6 and 7

- Distance between Column 6 and Centerline of RV

+ Distance between Columns 7 and 8

+ Distance between Columns 8 and 9

+ Distance between Column 9 and Centerline of Conc. Hood

- Distance between Centerlines of Conc. Hood and CR South Air Intake

= 18'-6" (Ref. 6.16.c) – (6'-3" + ½ (7'-0")) (Ref. 6.16.c) + 18'-6" (Ref. 6.16.c) + 3'-6" (Ref. 6.5.a) + 14'-7" (Ref. 6.7.b) – 2'-6" (Ref. 6.8.b, Plan View)

= 42'-10" = 42.83'

Step 2: Net Distance of Centerline of RV and Centerline of Primary CR Air Intake:

East-West Distance between Centerline of RV and Centerline of RB (at Column T per Ref. 6.5.a):

= (Distance between Columns T and W + Distance between Columns W and Y)

+ Distance between Columns Y and Y3/4

- (Distance between Column Y3/4 and Edge of RV Duct + ½ (Width of RV Duct))

= (20'-0" + 27'-9") (Ref. 6.16.b) + 16'-3-1/2" (Ref. 6.16.b) – (6" + ½ (7'-0")) (Ref. 6.16.b) = 47'-9" + 16'-3-1/2" – 4'-0" = 60'-1/2" = 60.04'

Distance of Centerline of Primary CR Air Intake from Centerline of RB

= 4'-0" (Ref. 6.7.b)

Net Distance of Centerline of RV and Centerline of Primary CR Air Intake

= 60.04 - 4'-0" = 56.04'

Step 3: Straight Line Distance between RBTB Door and CR Air Intake

= $[(42.83)^2 + (56.04)^2]^{-1/2}$ = 70.53 ft

= $\boxed{\textbf{21.5 m}}$

3. Direction (compass point in degrees) of Southerly Wind that Points Directly to the CR Air Intake from the RV Release Point:

Step 1: RV Direction with Respect to CR Intake

Height of CR Air Intake

= 326'-0" (Ref. 6.7.b & 6.8.b) – 272'-0" (Ref. 6.5b) = 54'-0"ft = 16.46 m

Elevation of RV = 442'-8" (Ref. 6.16.b, North Elevation View)

Height of RV Release Point = 442'-8" – 272'-0" (Ref. 6.5b) = 170'-8" = 52.03 m

RV Direction with Respect to CR Intake

Tan θ = 56.04/42.83 = 1.308, therefore θ = Tan^{-1} 1.308 = 52.6^0

Step 2: Orientation of RV Release with Respect to CR Air Intake, Considering South Wind 180^0 and True North Wind 360^0 (Ref. 6.2, page 16) = $180^0 – 52.6^0$

= $\boxed{\mathbf{127.4^0}}$

7.4.3 <u>Wake Area for Turbine Building Release χ/Qs – CR Air Intake (Test Case)</u>

The location of the turbine building with respect to the CR air intake is shown in Figure 3 (Ref. 6.14, pages 46, 47 & 55). The TB location with respect to the CR air intake is such that the wind from the north will predominantly carry effluent from the TB to the CR air intake. Only the cross-sectional area perpendicular to wind from the north is considered for the wake diffusion.

1. Total Cross-Sectional Area Perpendicular to Wind from the North

= Surface area of North wall of TB

= 130'-0" (Ref. 6.5a [Column B to C])
x (380'-0" – 272'-0") (Ref. 6.5.b, West View)

= 130' x 108' = 14,040 ft2 = 1,305 m2

= $\boxed{\mathbf{1{,}305\ m^2}}$

2. Shortest Distance between TB Release Point and CR Intake

The rectangular turbine building was converted into a cylinder with the same cross-sectional area for use in the Murphy/Campe dispersion model in JAF-CALC-RAD-00007 (Ref. 6.14, pages 43 and 53) and the equivalent diameter was determined. The source/receptor geometry shown in Figure 3 is the same as that shown in Ref. 6.14, page 55.

Shortest Distance between TB Cylindrical Surface and CR Intake = 94.3' (Ref. 6.14, pages 54 & 55)

= $\boxed{\textbf{28.7 m}}$

3. Direction (compass point in degrees) of Northerly Wind that Points Directly to the CR Air Intake from the TB Release Point:

Height of CR Air Intake

= 326'-0" (Ref. 6.7.b & 6.8.b) – 272'-0" (Ref. 6.5.b) = 54'-0"ft = 16.46 m

Elevation of TB Roof = 380'-0" (Ref. 6.5.b)

Height of TB = 380'-0" – 272'-0" = 108'-0" = 32.9 m

Height of Release Point = 32.9 m

Orientation of TB Release with Respect to CR Air Intake, Considering South Wind 180^0 and True North Wind 360^0 (Ref. 6.2, page 16)

= $\boxed{\mathbf{360^0}}$

8.0 RESULTS SUMMARY

8.1 Control Room χ/Qs for Reactor Building Track Bay Door Release

The 95% control room air intake χ/Qs for the RBTB door release are summarized in the following table:

CR 95% χ/Qs for RBTB Door Release	
Time Interval (hrs)	CR χ/Q (s/m^3)
0 - 2	9.07E-04
2 - 8	8.27E-04
8 - 24	3.59E-04
24 - 96	2.33E-04
96 - 720	2.03E-04

8.2 Control Room χ/Qs for RB Vent Release

The 95% control room air intake χ/Qs for the RV release are summarized in the following table:

CR 95% χ/Qs for RB Vent Release	
Time Interval (hrs)	CR χ/Q (s/m^3)
0 - 2	3.52E-03
2 - 8	3.31E-03
8 - 24	1.43E-03
24 - 96	7.73E-04
96 - 720	6.07E-04

8.3 Control Room χ/Qs for Turbine Building Release (Test Case)

The existing 95% control room air intake χ/Qs for the Turbine Building release are obtained from Reference 6.14, page 16 and compared with the newly developed ARCON96 χ/Qs in the following table:

CR 95% χ/Qs for TB Release		
Time Interval	Control Room Intake	
	ARCON96 χ/Q	Existing χ/Q
(hrs)	(s/m^3)	(s/m^3)
0 - 2	4.69E-03	
2 - 8	4.02E-03	
0 - 8*	4.19E-03	3.29E-03
8 - 24	1.43E-03	2.81E-03
24 - 96	9.36E-04	2.00E-03
96 - 720	7.12E-04	1.22E-03

* 0 - 8 hr ARCON96 χ/Q
= [(4.69E-03 x 2) + (4.02E-03 x 6)] / 8 = 4.19E-03

8.4 Comparison of Results - ARCON96 Test Cases vs. V&V Cases

The ARCON96 test case examples are re-executed after installing ARCON96 on the Microsoft Windows-based computer. In the following table, the results are compared with those in the ARCON96 User's Manual to demonstrate the code's ability to produce consistent results.

Comparison of ARCON96 Test Cases vs. V&V Cases

Example No.	Release Category	Case Analyzed	Time Interval (hrs) X/Q Values (s/m^3)				
			0-2	2-8	8-24	24-96	96-720
1	Ground	Test	1.43E-03	1.04E-03	5.46E-04	4.49E-04	3.75E-04
EX1VV_96	Level	V&V	1.43E-03	1.04E-03	5.46E-04	4.49E-04	3.75E-04
2	Uncapped	Test	1.94E-03	1.71E-03	7.74E-04	5.37E-04	2.74E-04
EX2VV_96	Vent	V&V	1.94E-03	1.71E-03	7.74E-04	5.37E-04	2.74E-04
3	Capped	Test	1.04E-02	8.12E-03	4.00E-03	3.03E-03	1.82E-03
EX3VV_96	Vent	V&V	1.04E-02	8.12E-03	4.00E-03	3.03E-03	1.82E-03
4	Stack	Test	1.53E-05	1.61E-05	3.67E-06	3.71E-06	3.55E-06
EX4VV_96		V&V	1.53E-05	1.61E-05	3.67E-06	3.71E-06	3.55E-06
5e	Multiple	Test	6.73E-04	4.43E-04	1.40E-04	1.60E-04	1.38E-04
ex5ev_96	Vent	V&V	6.73E-04	4.43E-04	1.40E-04	1.60E-04	1.38E-04

9.0 CONCLUSIONS/RECOMMENDATIONS

9.1 Control Room χ/Qs for Reactor Building Track Bay Door and RB Vent Releases

The 95% atmospheric dispersion factors (χ/Qs) for the post-FHA release through the RBTB doors and RV are summarized in Sections 8.1 and 8.2 respectively. The RBTB door and RV releases are assumed to be ground-level release. These χ/Qs should be used for the design basis FHA occurring in the reactor building with the releases from the RBTB doors and RV.

Regulatory Exceptions

NONE

9.2 Control Room χ/Qs for Turbine Building Release (Test Case)

The existing 95% control room air intake χ/Qs for the Turbine Building release are compared with the newly developed ARCON96 χ/Qs in Section 8.3. The slight differences in the results are due to the ARCON96 code treatment.

9.3 ARCON96 Test Cases vs. V&V Cases

The results of selected ARCON96 test cases are compared in Section 8.4. They demonstrate that the ARCON96 code produces identical results for the test cases.

10.0 ATTACHMENTS

CD with the following electronic files:

- JAF Calculation: JAF-CALC-RAD-04409, Rev 0
- ATTACHMENT A - ARCON96 Input/Output File – Control Room χ/Qs for RBTB Door Release
- ATTACHMENT B - ARCON96 Input/Output File – Control Room χ/Qs for RV Release
- ATTACHMENT C - ARCON96 Input/Output File – Control Room χ/Qs for TB Release
- Electronic Files for ARCON96 Test Case Examples 1 through 4 & 5e:
- ARCON96 Input/Output File – ARCON96 Code Test Example 1 V&V Case
- ARCON96 Input/Output File – ARCON96 Code Test Example 2 V&V Case
- ARCON96 Input/Output File – ARCON96 Code Test Example 3 V&V Case
- ARCON96 Input/Output File – ARCON96 Code Test Example 4 V&V Case
- ARCON96 Input/Output File – ARCON96 Code Test Example 5e V&V Case
- Meteorological Data Files – 1985 through 1992
- Design Verification Comments

Release Category	ARCON96 File			
	Name	Size	Date	Time
RBTB Door	JRBTB.log	6 KB	3/4/02	22:51:29
Plant Vent	JRBVENT.log	6 KB	5/7/02	07:19:28
Turbine Bldg	JCRTB30.log	6 KB	3/4/02	23:28:28
Ground Level	EX1VV_96.log	5 KB	3/3/02	10:45:06
Uncapped Vent	EX2VV_96.log	5 KB	3/3/02	10:45:33
Capped Vent	EX3VV_96.log	5 KB	3/3/02	10:45:52
Stack Release	EX4VV_96.log	5 KB	3/3/02	10:46:24
Multiple Vent	ex5ev_96.log	5 KB	3/3/02	10:59:25

ATTACHMENT A

ARCON96 Input/Output File – Control Room χ/Qs for RBTB Door Release

Program Title: ARCON96.

Developed For: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: June 25, 1997 11:00 a.m.

NRC Contacts: J. Y. Lee Phone: (301) 415 1080, e-mail: jyl1@nrc.gov
J. J. Hayes Phone: (301) 415 3167, e-mail: jjh@nrc.gov
L. A Brown Phone: (301) 415 1232, e-mail: lab2@nrc.gov

Code Developer: J. V. Ramsdell Phone: (509) 372 6316, e-mail: j_ramsdell@pnl.gov

Code Documentation: NUREG/CR-6331 Rev. 1

The program was prepared for an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibilities for any third party's use, or the results of such use, of any portion of this program or represents that its use by such third party would not infringe privately owned rights.

Program Run 3/ 4/2002 at 22:51:29

******* ARCON INPUT **********

Number of Meteorological Data Files = 8
Meteorological Data File Names
C:\ARCON96\FITZ100\FITZ3085.MET
C:\ARCON96\FITZ100\FITZ3086.MET
C:\ARCON96\FITZ100\FITZ3087.MET
C:\ARCON96\FITZ100\FITZ3088.MET
C:\ARCON96\FITZ100\FITZ3089.MET
C:\ARCON96\FITZ100\FITZ3090.MET
C:\ARCON96\FITZ100\FITZ3091.MET
C:\ARCON96\FITZ100\FITZ3092.MET

Height of lower wind instrument (m) = 9.1
Height of upper wind instrument (m) = 30.5
Wind speeds entered as miles per hour
Ground-level release
Release height (m) = 2.7
Building Area (m^2) = 2284.8
Effluent vertical velocity (m/s) = .00
Vent or stack flow (m^3/s) = .00

Vent or stack radius (m) = .00

Direction .. intake to source (deg) = 172

Wind direction sector width (deg) = 90

Wind direction window (deg) = 127 - 217

Distance to intake (m) = 73.6

Intake height (m) = 16.5

Terrain elevation difference (m) = .0

Output file names

JRBTB30.log

JRBTB30.cdf

Minimum Wind Speed (m/s) = .5

Surface roughness length (m) = .20

Sector averaging constant = 4.3

Initial value of sigma y = .00

Initial value of sigma z = .00

Expanded output for code testing not selected

Total number of hours of data processed = 70128

Hours of missing data = 1826

Hours direction in window = 22527

Hours elevated plume w/ dir. in window = 0

Hours of calm winds = 2293

Hours direction not in window or calm = 43482

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	24820.	28186.	32997.	39852.	45462.	54928.	65665.	65193.	64453.	64219.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	43482.	39910.	34710.	27109.	21792.	12046.	379.	1.	0.	0.
TOTAL X/Qs	68302.	68096.	67707.	66961.	67254.	66974.	66044.	65194.	64453.	64219.
% NON ZERO	36.34	41.39	48.73	59.52	67.60	82.01	99.43	100.00	100.00	100.00

95th PERCENTILE X/Q VALUES

9.07E-04 9.00E-04 8.82E-04 8.47E-04 7.07E-04 5.22E-04 3.05E-04 2.63E-04 2.33E-04 2.17E-04

95% X/Q for standard averaging intervals

0 to 2 hours	9.07E-04
2 to 8 hours	8.27E-04
8 to 24 hours	3.59E-04
1 to 4 days	2.33E-04
4 to 30 days	2.03E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	1.24E-03	3.20E-04
SECTOR-AVERAGE	7.24E-04	1.87E-04

NORMAL PROGRAM COMPLETION

ATTACHMENT B

ARCON96 Input/Output File – Control Room χ/Qs for RV Release

Program Title: ARCON96.

Developed For: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: June 25, 1997 11:00 a.m.

NRC Contacts: J. Y. Lee Phone: (301) 415 1080
e-mail: jyl1@nrc.gov
J. J. Hayes Phone: (301) 415 3167
e-mail: jjh@nrc.gov
L. A Brown Phone: (301) 415 1232
e-mail: lab2@nrc.gov

Code Developer: J. V. Ramsdell Phone (509) 372 6316
e-mail: j_ramsdell@pnl.gov

Code Documentation: NUREG/CR-6331 Rev. 1

The program was prepared for an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibilities for any third party's use, or the results of such use, of any portion of this program or represents that its use by such third party would not infringe privately owned rights.

Program Run 5/ 7/2002 at 07:19:28

******* ARCON INPUT **********

Number of Meteorological Data Files = 8
Meteorological Data File Names
C:\ARCON96\FITZ100\FITZ3085.MET
C:\ARCON96\FITZ100\FITZ3086.MET
C:\ARCON96\FITZ100\FITZ3087.MET
C:\ARCON96\FITZ100\FITZ3088.MET
C:\ARCON96\FITZ100\FITZ3089.MET
C:\ARCON96\FITZ100\FITZ3090.MET
C:\ARCON96\FITZ100\FITZ3091.MET
C:\ARCON96\FITZ100\FITZ3092.MET

Height of lower wind instrument (m) = 9.1
Height of upper wind instrument (m) = 30.5
Wind speeds entered as miles per hour

Ground-level release
Release height (m) = 52.0
Building Area (m^2) = 2284.8
Effluent vertical velocity (m/s) .00

Entergy	CALCULATION CONTINUATION SHEET		SHEET No. 41 of 43	
	CALC. TITLE: CR χ/Qs Using ARCON96 Code for Post-FHA Releases from RB Track Bay Door and RB Vent			
	CALC. NO.: JAF-CALC-RAD-04409		REVISION NO.	0
	ORIGINATOR/DATE	G. Patel 05/24/02	REVIEWR/DATE	M. Drucker 05/25/02

Vent or stack flow (m^3/s) = .00

Vent or stack radius (m) = .00

Direction .. intake to source (deg) = 127

Wind direction sector width (deg) = 90

Wind direction window (deg) = 082 - 172

Distance to intake (m) = 21.5

Intake height (m) = 16.5

Terrain elevation difference (m) = .0

Output file names

JRBVENT.log

JRBVENT.cdf

Minimum Wind Speed (m/s) = .5

Surface roughness length (m) = .20

Sector averaging constant = 4.3

Initial value of sigma y = .00

Initial value of sigma z = .00

Expanded output for code testing not selected

Total number of hours of data processed = 70128

Hours of missing data = 1826

Hours direction in window = 16285

Hours elevated plume w/ dir. in window = 0

Hours of calm winds = 2388

Hours direction not in window or calm = 49629

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	18673.	21150.	24895.	30544.	35497.	45787.	64517.	65141.	64453.	64219.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	49629.	46946.	42812.	36417.	31757.	21187.	1527.	53.	0.	0.
TOTAL X/Qs	68302.	68096.	67707.	66961.	67254.	66974.	66044.	65194.	64453.	64219.
% NON ZERO	27.34	31.06	36.77	45.61	52.78	68.37	97.69	99.92	100.00	100.00

95th PERCENTILE X/Q VALUES

3.52E-03 3.51E-03 3.47E-03 3.36E-03 2.80E-03 2.08E-03 1.10E-03 9.16E-04 7.54E-04 6.72E-04

95% X/Q for standard averaging intervals

0 to 2 hours	3.52E-03
2 to 8 hours	3.31E-03
8 to 24 hours	1.43E-03
1 to 4 days	7.73E-04
4 to 30 days	6.07E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	4.54E-03	6.26E-04
SECTOR-AVERAGE	2.65E-03	3.65E-04

NORMAL PROGRAM COMPLETION

ATTACHMENT C

ARCON96 Input/Output File – Control Room χ/Qs for TB Release

Program Title: ARCON96.

Developed For: U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

Division of Reactor Program Management

Date: June 25, 1997 11:00 a.m.

NRC Contacts: J. Y. Lee Phone: (301) 415 1080, e-mail: jyl1@nrc.gov

J. J. Hayes Phone: (301) 415 3167, e-mail: jjh@nrc.gov

L. A Brown Phone: (301) 415 1232, e-mail: lab2@nrc.gov

Code Developer: J. V. Ramsdell Phone: (509) 372 6316, e-mail: j_ramsdell@pnl.gov

Code Documentation: NUREG/CR-6331 Rev. 1

The program was prepared for an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibilities for any third party's use, or the results of such use, of any portion of this program or represents that its use by such third party would not infringe privately owned rights.

Program Run 3/ 4/2002 at 23:28:28

******* ARCON INPUT **********

Number of Meteorological Data Files 8

Meteorological Data File Names

C:\ARCON96\FITZ100\FITZ3085.MET

C:\ARCON96\FITZ100\FITZ3086.MET

C:\ARCON96\FITZ100\FITZ3087.MET

C:\ARCON96\FITZ100\FITZ3088.MET

C:\ARCON96\FITZ100\FITZ3089.MET

C:\ARCON96\FITZ100\FITZ3090.MET

C:\ARCON96\FITZ100\FITZ3091.MET

C:\ARCON96\FITZ100\FITZ3092.MET

Height of lower wind instrument (m) = 9.1

Height of upper wind instrument (m) = 30.5

Wind speeds entered as miles per hour

Ground-level release

Release height (m) 32.9

Building Area (m^2) = 1305.0

Effluent vertical velocity (m/s) = .00

Vent or stack flow (m^3/s) = .00

Vent or stack radius (m) = .00

Direction .. intake to source (deg) = 360

Wind direction sector width (deg) = 90

Wind direction window (deg) = 315 - 045

Distance to intake (m) = 28.7

Intake height (m) = 16.5

Terrain elevation difference (m) = .0

Output file names

JCRTB30.log

JCRTB30.cdf

Minimum Wind Speed (m/s) = .5

Surface roughness length (m) = .20

Sector averaging constant = 4.3

Initial value of sigma y = .00

Initial value of sigma z = .00

Expanded output for code testing not selected

Total number of hours of data processed = 70128

Hours of missing data = 1826

Hours direction in window = 13154

Hours elevated plume w/ dir. in window = 0

Hours of calm winds = 2490

Hours direction not in window or calm = 52658

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVER. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0	0.
IN RANGE	15644.	18255.	22309.	28298.	33336.	44011.	63579.	64990.	64453.	64219.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	81.	0.	0.
ZERO	52658.	49841.	45398.	38663.	33918.	22963.	2465.	123.	0.	0
TOTAL X/Qs	68302.	68096.	67707.	66961.	67254.	66974.	66044.	65194.	64453.	64219.
% NON ZERO	22.90	26.81	32.95	42.26	49.57	65.71	96.27	99.81	100.00	100.00

95th PERCENTILE X/Q VALUES

4.69E-03 4.65E-03 4.52E-03 4.19E-03 3.38E-03 2.35E-03 1.29E-03 1.07E-03 8.74E-04 7.89E-04

95% X/Q for standard averaging intervals

0 to 2 hours	4.69E-03
2 to 8 hours	4.02E-03
8 to 24 hours	1.43E-03
1 to 4 days	9.36E-04
4 to 30 days	7.12E-04

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	7.10E-03	5.98E-04
SECTOR-AVERAGE	4.14E-03	3.49E-04

NORMAL PROGRAM COMPLETION

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

Proposed Changes to the FitzPatrick Technical Specifications regarding Proposed License Amendment for a Limited Scope Application of the Alternate Source Term Guidelines in NUREG-1465 Related to the Re-evaluation of the Fuel Handling Dose Consequences

Marked-Up Pages

Attachment 4 to JPN-02-016

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

The following Technical Specifications are affected by this change request.

Technical Specification Section[1]	Page(s)	New ITS[2] Page Number
3.3.6.2	3.3-61	3.3.6.2-4
3.3.7.1	3.3-62	3.3.7.1-1
3.6.4.1	3.6-37	3.6.4.1-1
	3.6-38	3.6.4.1-2
3.6.4.2	3.6-39	3.6.4.2-1
	3.6-41	3.6.4.2-3
3.6.4.3	3.6-43	3.6.4.3-1
	3.6-44	3.6.4.3-2
3.7.3	3.7-7	3.7.3-1
	3.7-8	3.7.3-2
	3.7-9	3.7.3-3
3.7.4	3.7-11	3.7.4-1
	3.7-12	3.7.4-2
	3.7-13	3.7.4-3
3.8.2	3.8-12	3.8.2-1
	3.8-13	3.8.2-2
	3.8-14	3.8.2-3
3.8.5	3.8-22	3.8.5-1
3.8.8	3.8-30	3.8.8-1
B 3.3.6.2	B 3.3-191	B 3.3.6.2-6
B 3.3.7.1	B 3.3-200	B 3.3.7.1-3
B 3.6.4.1	B 3.6-84	B 3.6.4.1-1
	B 3.6-85	B 3.6.4.1-2
	B 3.6-86	B 3.6.4.1-3
	B 3.6-87	B 3.6.4.1-4
B 3.6.4.2	B 3.6-90	B 3.6.4.2-1
	B 3.6-92	B 3.6.4.2-3
	B 3.6-94	B 3.6.4.2-5
	B 3.6-95	B 3.6.4.2-6
B 3.6.4.3	B 3.6-98	B 3.6.4.3-2
	B 3.6-99	B 3.6.4.3-3
	B 3.6-100	B 3.6.4.3-4
	B 3.6-101	B 3.6.4.3-5
B 3.7.3	B 3.7-16	B 3.7.3-2
	B 3.7-17	B 3.7.3-3
	B 3.7-19	B 3.7.3-5
	B 3.7-20	B 3.7.3-6
	B 3.7-21	B 3.7.3-7
B 3.7.4	B 3.7-25	B 3.7.4-3
	B 3.7-26	B 3.7.4-4
	B 3.7-27	B 3.7.4-5
B 3.8.2	B 3.8-27	B 3.8.2-1
	B 3.8-29	B 3.8.2-3

Attachment 4 to JPN-02-016

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

Technical Specification Section[1]	Page(s)	New ITS[2] Page Number
	B 3.8-30	B 3.8.2-4
	B 3.8-31	B 3.8.2-5
B 3.8.5	B 3.8-54	B 3.8.5-1
	B 3.8-55	B 3.8.5-2
	B 3.8-56	B 3.8.5-3
	B 3.6-57	B 3.8.5-4
B 3.8.8	B 3.8-74	B 3.8.8-1
	B 3.8-75	B 3.8.8-2
	B 3.8-76	B 3.8.8-3

Notes:

1. Changed Bases pages are included for information only.
2. Page numbers will change as a result of ITS repagination. This column cross-references the pages number in this submittal and the repaginated version.

Attachment 4 to JPN-02-016

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

Table of Text Inserts

Insert A (page B 3.3-191)

Due to radioactive decay, the Function is only required to isolate secondary containment during fuel handling accidents involving handling recently irradiated fuel (i.e., fuel that has occupied part of a critical reactor core within the previous 96 hours.)

Insert B (page B.3.3-200)

Also due to radioactive decay, this Function is only required to initiate the CREVAS System during fuel handling accidents involving handling recently irradiated fuel (i.e., fuel that has occupied part of a critical reactor core within the previous 96 hours.)

Insert C (pages B 3.6-84, B 3.6-90, B 3.6-98 and B 3.7-16)

involving handling recently irradiated fuel (i.e., fuel that has occupied part of a critical reactor core within the previous 96 hours)

Insert D (page B 3.6-85)

Due to radioactive decay, secondary containment is only required to be OPERABLE during fuel handling involving handling recently irradiated fuel (i.e., fuel that has occupied part of a critical reactor core within the previous 96 hours).

Insert E (page B 3.6-92)

Due to radioactive decay, SCIVs are only required to be OPERABLE during fuel handling involving handling recently irradiated fuel (i.e., fuel that has occupied part of a critical reactor core within the previous 96 hours).

Insert F (page B 3.6-99)

Due to radioactive decay, the SGT system is only required to be OPERABLE during fuel handling involving handling recently irradiated fuel (i.e., fuel that has occupied part of a critical reactor core within the previous 96 hours).

Insert G (page B 3.7-17)

Due to radioactive decay, the CREVAS system is only required to be OPERABLE during fuel handling involving handling recently irradiated fuel (i.e., fuel that has occupied part of a critical reactor core within the previous 96 hours).

Insert H (page B 3.7-25)

Due to radioactive decay, the Control Room AC system is only required to be OPERABLE during fuel handling involving handling recently irradiated fuel (i.e., fuel that has occupied part of a critical reactor core within the previous 96 hours).

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

Insert I (page B 3.8-27)

involving handling recently irradiated fuel. Due to radioactive decay, AC electrical power is only required to mitigate fuel handling accidents involving handling recently irradiated fuel (i.e., fuel that has occupied part of a critical reactor core within the previous 96 hours).

Insert J (page B 3.8-29, B 3.8-55 and B 3.8-75)

involving handling recently irradiated fuel

Insert K (page B 3.8-30 and B 3.8-56)

involving handling recently irradiated fuel (i.e., fuel that has occupied part of a critical reactor core within the previous 96 hours).

Insert L (page B 3.8-54 and B 3.8-75)

involving handling recently irradiated fuel. Due to radioactive decay, DC electrical power is only required to mitigate fuel handling accidents involving handling recently irradiated fuel (i.e., fuel that has occupied part of a critical reactor core within the previous 96 hours).

Insert M (page B 3.8-74)

involving handling recently irradiated fuel. Due to radioactive decay, AC and DC electrical power is only required to mitigate fuel handling accidents involving handling recently irradiated fuel (i.e., fuel that has occupied part of a critical reactor core within the previous 96 hours).

Table 3.3.6.2-1 (page 1 of 1)
Secondary Containment Isolation Instrumentation

FUNCTION	APPLICABLE MODES OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER TRIP SYSTEM	SURVEILLANCE REQUIREMENTS	ALLOWABLE VALUE
1. Reactor Vessel Water Level - Low (Level 3)	1,2,3, (a)	2	SR 3.3.6.2.1 SR 3.3.6.2.2 SR 3.3.6.2.4 SR 3.3.6.2.5 SR 3.3.6.2.6	≥ 177 inches
2. Drywell Pressure - High	1,2,3	2	SR 3.3.6.2.1 SR 3.3.6.2.2 SR 3.3.6.2.4 SR 3.3.6.2.5 SR 3.3.6.2.6	≤ 2.7 psig
3. Reactor Building Exhaust Radiation - High	1,2,3, (a),(b)	1	SR 3.3.6.2.1 SR 3.3.6.2.3 SR 3.3.6.2.6	≤ 24,800 cpm
4. Refueling Floor Exhaust Radiation - High	1,2,3, (a),(b)	1	SR 3.3.6.2.1 SR 3.3.6.2.3 SR 3.3.6.2.6	≤ 24,800 cpm

(a) During operations with a potential for draining the reactor vessel.

(b) During ~~CORE ALTERATIONS and during~~ movement of recently irradiated fuel assemblies in secondary containment.

3.3 INSTRUMENTATION

3.3.7.1 Control Room Emergency Ventilation Air Supply (CREVAS) System Instrumentation

LCO 3.3.7.1 The Control Room Air Inlet Radiation – High channel shall be OPERABLE.

recently

APPLICABILITY: MODES 1, 2 and 3,
During movement of irradiated fuel assemblies in the secondary containment,
~~During CORE ALTERATIONS,~~ e
During operations with a potential for draining the reactor vessel.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Channel inoperable.	A.1 Place the CREVAS System in the isolate mode of operation. OR A.2 Declare both CREVAS subsystems inoperable.	1 hour 1 hour

3.6 CONTAINMENT SYSTEMS

3.6.4.1 Secondary Containment

LCO 3.6.4.1 The secondary containment shall be OPERABLE.

recently

APPLICABILITY: MODES 1, 2, and 3,
During movement of irradiated fuel assemblies in the secondary containment,
~~During CORE ALTERATIONS,~~
During operations with a potential for draining the reactor vessel (OPDRVs).

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. Secondary containment inoperable in MODE 1, 2, or 3.	A.1	Restore secondary containment to OPERABLE status.	4 hours
B. Required Action and associated Completion Time of Condition A not met.	B.1	Be in MODE 3.	12 hours
	AND		
	B.2	Be in MODE 4.	36 hours
C. Secondary containment inoperable during movement of irradiated fuel assemblies in the secondary containment, ~~during CORE ALTERATIONS,~~ or during OPDRVs. recently	C.1	--------NOTE-------- LCO 3.0.3 is not applicable. ------------------- Suspend movement of irradiated fuel assemblies in the secondary containment.	Immediately
	AND		

(continued)

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. (continued)	~~C.2 Suspend CORE ALTERATIONS.~~	~~Immediately~~
	~~AND~~	
	C.~~3~~ 2 Initiate action to suspend OPDRVs.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.6.4.1.1	Verify secondary containment vacuum is ≥ 0.25 inch of vacuum water gauge.	24 hours
SR 3.6.4.1.2	Verify all secondary containment equipment hatches are closed and sealed.	31 days
SR 3.6.4.1.3	Verify one secondary containment access door in each access opening is closed.	31 days
SR 3.6.4.1.4	Verify the secondary containment can be maintained ≥ 0.25 inch of vacuum water gauge for 1 hour using one SGT subsystem at a flow rate ≤ 6000 cfm.	24 months on a STAGGERED TEST BASIS for each SGT subsystem

TSTF-322, R2

3.6 CONTAINMENT SYSTEMS

3.6.4.2 Secondary Containment Isolation Valves (SCIVs)

LCO 3.6.4.2 Each SCIV shall be OPERABLE.

APPLICABILITY: MODES 1, 2, and 3,
During movement of recently irradiated fuel assemblies in the secondary containment,
~~During CORE ALTERATIONS,~~ e
During operations with a potential for draining the reactor vessel (OPDRVs).

ACTIONS

NOTES

1. Penetration flow paths may be unisolated intermittently under administrative controls.
2. Separate Condition entry is allowed for each penetration flow path.
3. Enter applicable Conditions and Required Actions for systems made inoperable by SCIVs.

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. One or more penetration flow paths with one SCIV inoperable.	A.1	Isolate the affected penetration flow path by use of at least one closed and de-activated automatic valve, closed manual valve, or blind flange.	8 hours
	AND		
			(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 in the secondary containment, ~~during CORE ALTERATIONS,~~ or during OPDRVs. recently	D.1	--------NOTE-------- LCO 3.0.3 is not applicable. -------------------- Suspend movement of irradiated fuel assemblies in the secondary containment.	Immediately
	AND		
	~~D.2~~	~~Suspend CORE ALTERATIONS.~~	~~Immediately~~
	~~AND~~		
	D.~~3~~ 2	Initiate action to suspend OPDRVs.	Immediately

3.6 CONTAINMENT SYSTEMS

3.6.4.3 Standby Gas Treatment (SGT) System

LCO 3.6.4.3 Two SGT subsystems shall be OPERABLE.

recently

APPLICABILITY: MODES 1, 2, and 3,
During movement of irradiated fuel assemblies in the secondary containment,
~~During CORE ALTERATIONS,~~ e
During operations with a potential for draining the reactor vessel (OPDRVs).

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One SGT subsystem inoperable.	A.1 Restore SGT subsystem to OPERABLE status.	7 days
B. Required Action and associated Completion Time of Condition A not met in MODE 1, 2, or 3.	B.1 Be in MODE 3. AND B.2 Be in MODE 4.	12 hours 36 hours
C. Required Action and associated Completion Time of Condition A not met during movement of recently irradiated fuel assemblies in the secondary containment, ~~during CORE ALTERATIONS,~~ e or during OPDRVs.	------------NOTE------------ LCO 3.0.3 is not applicable. ---------------------------- C.1 Place OPERABLE SGT subsystem in operation. OR	 Immediately (continued)

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
C. (continued) recently	C.2.1	Suspend movement of irradiated fuel assemblies in secondary containment.	Immediately
	~~AND~~		
	~~C.2.2~~	~~Suspend CORE ALTERATIONS.~~	~~Immediately~~
	AND		
	C.2.~~3~~ 2	Initiate action to suspend OPDRVs.	Immediately
D. Two SGT subsystems inoperable in MODE 1, 2, or 3.	D.1	Enter LCO 3.0.3.	Immediately
E. Two SGT subsystems inoperable during movement of recently irradiated fuel assemblies in the secondary containment, ~~during CORE ALTERATIONS,~~ or during OPDRVs.	E.1	--------NOTE-------- LCO 3.0.3 is not applicable. -------------------- Suspend movement of recently irradiated fuel assemblies in secondary containment.	Immediately
	AND		
	~~E.2~~	~~Suspend CORE ALTERATIONS.~~	~~Immediately~~
	~~AND~~		
	E.~~3~~ 2	Initiate action to suspend OPDRVs.	Immediately

J

3.7 PLANT SYSTEMS

3.7.3 Control Room Emergency Ventilation Air Supply (CREVAS) System

LCO 3.7.3 Two CREVAS subsystems shall be OPERABLE.

---------------------------NOTE---------------------------
The control room boundary may be opened intermittently under administrative control.

APPLICABILITY: MODES 1, 2, and 3,
During movement of recently irradiated fuel assemblies in the secondary containment,
~~During CORE ALTERATIONS,~~
During operations with a potential for draining the reactor vessel (OPDRVs).

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One CREVAS subsystem inoperable.	A.1 Restore CREVAS subsystem to OPERABLE status.	7 days
B. Two CREVAS subsystems inoperable due to inoperable control room boundary in MODE 1, 2, or 3.	B.1 Restore control room boundary to OPERABLE status.	24 hours
C. Required Action and associated Completion Time of Condition A or B not met in MODE 1, 2, or 3.	C.1 Be in MODE 3. <u>AND</u> C.2 Be in MODE 4.	12 hours 36 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. Required Action and associated Completion Time of Condition A not met during movement of recently irradiated fuel assemblies in the secondary containment, ~~during CORE ALTERATIONS,~~ or during OPDRVs.	------------NOTE------------ LCO 3.0.3 is not applicable. ----------------------------	
	D.1 Place OPERABLE CREVAS subsystem in isolate mode.	Immediately
	<u>OR</u>	
	D.2.1 Suspend movement of recently irradiated fuel assemblies in the secondary containment.	Immediately
	~~AND~~	
	~~D.2.2 Suspend CORE ALTERATIONS.~~	~~Immediately~~
	<u>AND</u>	
	D.2.~~3~~ 2 Initiate action to suspend OPDRVs.	Immediately
E. Two CREVAS subsystems inoperable in MODE 1, 2, or 3 for reasons other than Condition B.	E.1 Enter LCO 3.0.3.	Immediately

(continued)

TSTF-287

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
F. Two CREVAS subsystems inoperable during movement of recently irradiated fuel assemblies in the secondary containment, ~~during CORE ALTERATIONS~~, or during OPDRVs.	------------NOTE------------ LCO 3.0.3 is not applicable. ----------------------------	
	F.1 Suspend movement of recently irradiated fuel assemblies in the secondary containment.	Immediately
	~~AND~~	
	~~F.2 Suspend CORE ALTERATIONS.~~	~~Immediately~~
	AND	
	F.~~3~~ 2 Initiate action to suspend OPDRVs.	Immediately

TSTF-287

3.7 PLANT SYSTEMS

3.7.4 Control Room Air Conditioning (AC) System

LCO 3.7.4 Two control room AC subsystems shall be OPERABLE.

APPLICABILITY: MODES 1, 2, and 3,
During movement of recently irradiated fuel assemblies in the secondary containment.
~~During CORE ALTERATIONS.~~
During operations with a potential for draining the reactor vessel (OPDRVs).

I

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One control room AC subsystem inoperable.	A.1 Restore control room AC subsystem to OPERABLE status.	30 days
B. Required Action and associated Completion Time of Condition A not met in MODE 1, 2, or 3.	B.1 Be in MODE 3. AND B.2 Be in MODE 4.	12 hours 36 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
C. Required Action and associated Completion Time of Condition A not met during movement of recently irradiated fuel assemblies in the secondary containment, ~~during CORE ALTERATIONS~~, or during OPDRVs.	-----------NOTE----------- LCO 3.0.3 is not applicable.		
	C.1	Place OPERABLE control room AC subsystem in operation.	Immediately
	<u>OR</u>		
	C.2.1	Suspend movement of irradiated fuel assemblies in the secondary containment.	Immediately
	~~<u>AND</u>~~		
	~~C.2.2~~	~~Suspend CORE ALTERATIONS.~~	~~Immediately~~
	<u>AND</u>		
	C.2.~~3~~ 2	Initiate action to suspend OPDRVs.	Immediately
D. Two control room AC subsystems inoperable in MODE 1, 2, or 3.	D.1	Enter LCO 3.0.3.	Immediately

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
E. Two control room AC subsystems inoperable during movement of recently irradiated fuel assemblies in the secondary containment, ~~during CORE ALTERATIONS,~~ or during OPDRVs. recently	-----------NOTE------------ LCO 3.0.3 is not applicable. ---------------------------		
	E.1	Suspend movement of recently irradiated fuel assemblies in the secondary containment.	Immediately
	~~AND~~		
	~~E.2~~	~~Suspend CORE ALTERATIONS.~~	~~Immediately~~
	AND		
	E.~~3~~ 2	Initiate action to suspend OPDRVs.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.7.4.1	Verify each control room AC subsystem has the capability to remove the assumed heat load.	24 months

3.8 ELECTRICAL POWER SYSTEMS

3.8.2 AC Sources - Shutdown

LCO 3.8.2 The following AC electrical power sources shall be OPERABLE:

a. One qualified circuit between the offsite transmission network and one division of the plant Class 1E AC electrical power distribution subsystem(s) required by LCO 3.8.8, "Distribution Systems - Shutdown"; G

b. One qualified circuit, which maybe the same circuit required by LCO 3.8.2.a, between the offsite transmission network and the other division of the plant Class 1E AC electrical power distribution subsystem(s), when a second division is required by LCO 3.8.8; and G

c. One emergency diesel generator (EDG) subsystem capable of supplying one division of the plant Class 1E AC electrical power distribution subsystem(s) required by LCO 3.8.8.

RAI 3.8.2-1

APPLICABILITY: MODES 4 and 5,
During movement of recently irradiated fuel assemblies in the secondary containment.

ACTIONS

-----------------------------------NOTE-----------------------------------
LCO 3.0.3 is not applicable.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or both required offsite circuits inoperable.	------------NOTE------------ Enter applicable Condition and Required Actions of LCO 3.8.8, when any required division is de-energized as a result of Condition A. ----------------------------	
	A.1 Declare affected required feature(s), with no offsite power available, inoperable. OR	Immediately
	A.2.1 Suspend CORE ALTERATIONS. AND	Immediately
recently	A.2.2 Suspend movement of irradiated fuel assemblies in the secondary containment. AND	Immediately
	A.2.3 Initiate action to suspend operations with a potential for draining the reactor vessel (OPDRVs). AND	Immediately
		(continued)

RAI 3.8.2-1 1 (G)

1 (G)

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. (continued)	A.2.4	Initiate action to restore required offsite power circuit(s) to OPERABLE status.	Immediately
B. One required EDG subsystem inoperable.	B.1	Suspend CORE ALTERATIONS.	Immediately
	<u>AND</u>		
recently	B.2	Suspend movement of irradiated fuel assemblies in secondary containment.	Immediately
	<u>AND</u>		
	B.3	Initiate action to suspend OPDRVs.	Immediately
	<u>AND</u>		
	B.4	Initiate action to restore required EDG subsystem to OPERABLE status.	Immediately

3.8 ELECTRICAL POWER SYSTEMS

3.8.5 DC Sources – Shutdown

LCO 3.8.5 One 125 VDC electrical power subsystem shall be OPERABLE to support one division of the plant Class IE DC Electrical Power Distribution System required by LCO 3.8.8, "Distribution Systems – Shutdown." 1B

recently

APPLICABILITY: MODES 4 and 5,
During movement of irradiated fuel assemblies in the secondary containment.

ACTIONS

---------------------------------NOTE---------------------------------
LCO 3.0.3 is not applicable.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Required DC electrical power subsystem inoperable.	A.1 Declare affected required feature(s) inoperable.	Immediately
	OR	
	A.2.1 Suspend CORE ALTERATIONS.	Immediately
	AND	
recently	A.2.2 Suspend movement of irradiated fuel assemblies in the secondary containment.	Immediately
	AND	
		(continued)

3.8 ELECTRICAL POWER SYSTEMS

3.8.8 Distribution Systems - Shutdown

LCO 3.8.8 The necessary portions of the AC and 125 VDC electrical power distribution subsystems shall be OPERABLE to support equipment required to be OPERABLE.

APPLICABILITY: MODES 4 and 5,
During movement of recently irradiated fuel assemblies in the secondary containment.

ACTIONS

-----------------------------------NOTE-----------------------------------
LCO 3.0.3 is not applicable.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more required AC or 125 VDC electrical power distribution subsystems inoperable.	A.1 Declare associated supported required feature(s) inoperable.	Immediately
	<u>OR</u>	
	A.2.1 Suspend CORE ALTERATIONS.	Immediately
	<u>AND</u>	
	A.2.2 Suspend movement of recently irradiated fuel assemblies in the secondary containment.	Immediately
	<u>AND</u>	
		(continued)

BASES

APPLICABLE SAFETY ANALYSES, LCO, and APPLICABILITY

3, 4. Reactor Building and Refueling Floor Ventilation Exhaust Radiation - High (continued)

exhaust piping coming from the reactor building and the refueling floor zones. The signal from each detector is input to an individual monitor whose trip outputs are assigned to an isolation channel. Two channels of Reactor Building Ventilation Exhaust Radiation - High Function and two channels of Refueling Floor Ventilation Exhaust Radiation - High Function are available and are required to be OPERABLE to ensure that no single instrument failure can preclude the isolation function. J

The Allowable Values are chosen to promptly detect gross failure of the fuel cladding and are set in accordance with the ODCM.

The Reactor Building and Refueling Floor Ventilation Exhaust Radiation - High Functions are required to be OPERABLE in MODES 1, 2, and 3 where considerable RCS energy exists; thus, there is a probability of pipe breaks resulting in significant releases of radioactive steam and gas. In MODES 4 and 5, the probability and consequences of these events are low due to the RCS pressure and temperature limitations of these MODES; thus, these Functions are not required. In addition, the Functions are also required to be OPERABLE during ~~CORE ALTERATIONS,~~ OPDRVs, and movement of recently irradiated fuel ~~assemblies in the~~ secondary containment, because the capability of detecting radiation releases due to fuel failures (due to fuel uncovery or dropped fuel assemblies) must be provided to ensure that offsite and control room dose limits are not exceeded. INSERT A

ACTIONS

A Note has been provided to modify the ACTIONS related to secondary containment isolation instrumentation channels. Section 1.3, Completion Times, specifies that once a Condition has been entered, subsequent divisions, subsystems, components, or variables expressed in the Condition, discovered to be inoperable or not within limits, will not result in separate entry into the Condition. Section 1.3 also specifies that Required Actions of the Condition continue to apply for each additional failure, with Completion Times based on initial entry into the Condition. However, the Required Actions for inoperable secondary containment isolation instrumentation channels

(continued)

BASES

LCO (continued)

A high radiation level may pose a threat to control room personnel; thus, an alarm is provided in the control room so that the CREVAS System can be placed in the isolate mode of operation. 1 (J)

APPLICABILITY

The Control Room Air Inlet Radiation—High Function is required to be OPERABLE in MODES 1, 2, and 3 and during ~~CORE ALTERATIONS,~~ OPDRVs, and movement of recently irradiated fuel assemblies in the secondary containment, to ensure that control room personnel are protected during a LOCA, fuel handling event, or vessel draindown event. During MODES 4 and 5, when these specified conditions are not in progress (e.g., ~~CORE ALTERATIONS~~), the probability of a LOCA ~~or fuel damage~~ is low; thus, the Function is not required. 1 (J)

OPDRVs

INSERT B

ACTIONS

A.1 and A.2

With the Control Room Air Inlet Radiation—High Function inoperable one CREVAS subsystem must be placed in the isolate mode of operation per Required Action A.1 to ensure that control room personnel will be protected in the event of a Design Basis Accident. Alternately, if it is not desired to start a CREVAS subsystem, the CREVAS System must be declared inoperable within 1 hour. 1 (B)

The 1 hour Completion Time is intended to allow the operator time to place the CREVAS subsystem in operation. The 1 hour Completion Time is acceptable because it minimizes risk while allowing time for restoration of the channel, for placing one CREVAS subsystem in operation, or for entering the applicable Conditions and Required Actions for two inoperable CREVAS subsystems.

SURVEILLANCE REQUIREMENTS

The Surveillances are modified by a Note to indicate that when a channel is placed in an inoperable status solely for performance of required Surveillances, entry into associated Conditions and Required Actions may be delayed for up to 6 hours. Upon completion of the Surveillance, or expiration

(continued)

B 3.6 CONTAINMENT SYSTEMS

B 3.6.4.1 Secondary Containment

BASES

BACKGROUND

The function of the secondary containment is to contain, dilute, and hold up fission products that may leak from primary containment following a Design Basis Accident (DBA). In conjunction with operation of the Standby Gas Treatment (SGT) System and closure of certain valves whose lines penetrate the secondary containment, the secondary containment is designed to reduce the activity level of the fission products prior to release to the environment and to isolate and contain fission products that are released during certain operations that take place inside primary containment, when primary containment is not required to be OPERABLE, or that take place outside primary containment.

The secondary containment is a structure that surrounds the primary containment and is designed to provide secondary containment for postulated loss-of-coolant accidents inside the primary containment. The Secondary Containment also surrounds the refueling facilities and is designed to provide primary containment for the postulated refueling accident. This structure forms a control volume that serves to hold up and dilute the fission products. It is possible for the pressure in the control volume to rise relative to the environmental pressure (e.g., due to pump and motor heat load additions). To prevent ground level exfiltration while allowing the secondary containment to be designed as a conventional structure, the secondary containment requires support systems to maintain the control volume pressure at less than the external pressure. Requirements for these systems are specified separately in LCO 3.6.4.2, "Secondary Containment Isolation Valves (SCIVs)," and LCO 3.6.4.3, "Standby Gas Treatment (SGT) System."

APPLICABLE SAFETY ANALYSES

INSERT C

There are two principal accidents for which credit is taken for secondary containment OPERABILITY. These are a loss of coolant accident (LOCA) (Ref. 1) and a refueling accident inside secondary containment (Ref. 2). The secondary containment performs no active function in response to each of these limiting events; however, its leak tightness is required to ensure that fission products entrapped within

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

the secondary containment structure will be treated by the SGT System prior to discharge to the environment.

Secondary containment satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii) (Ref. 3).

LCO

An OPERABLE secondary containment provides a control volume into which fission products that leak from primary containment, or are released from the reactor coolant pressure boundary components located in secondary containment, or are released directly to the secondary containment as a result of a refueling accident, can be processed prior to release to the environment. For the secondary containment to be considered OPERABLE, it must have adequate leak tightness to ensure that the required vacuum can be established and maintained.

APPLICABILITY

In MODES 1, 2, and 3, a LOCA could lead to a fission product release to primary containment that leaks to secondary containment. Therefore, secondary containment OPERABILITY is required during the same operating conditions that require primary containment OPERABILITY.

In MODES 4 and 5, the probability and consequences of the LOCA are reduced due to the pressure and temperature limitations in these MODES. Therefore, maintaining secondary containment OPERABLE is not required in MODE 4 or 5 to ensure a control volume, except for other situations for which significant releases of radioactive material can be postulated, such as during operations with a potential for draining the reactor vessel (OPDRVs), ~~during CORE ALTERATIONS,~~ or during movement of recently irradiated fuel assemblies in the secondary containment. INSERT D

ACTIONS

A.1

If secondary containment is inoperable, it must be restored to OPERABLE status within 4 hours. The 4 hour Completion Time provides a period of time to correct the problem that is commensurate with the importance of maintaining secondary

(continued)

BASES

ACTIONS

A.1 (continued)

containment during MODES 1, 2, and 3. This time period also ensures that the probability of an accident (requiring secondary containment OPERABILITY) occurring during periods where secondary containment is inoperable is minimal.

B.1 and B.2

If secondary containment cannot be restored to OPERABLE status within the required Completion Time, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 12 hours and to MODE 4 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.

C.1, C.2, and ~~C.3~~

recently

Movement of recently irradiated fuel assemblies in the secondary containment, ~~CORE ALTERATIONS,~~ and OPDRVs can be postulated to cause significant fission product release to the secondary containment. In such cases, the secondary containment is the only barrier to release of fission products to the environment. ~~CORE ALTERATIONS and~~ Therefore, movement of recently irradiated fuel assemblies must be immediately suspended if the secondary containment is inoperable.

Suspension of ~~these~~ this activit~~ies~~y shall not preclude completing an action that involves moving a component to a safe position. Also, action must be immediately initiated to suspend OPDRVs to minimize the probability of a vessel draindown and subsequent potential for fission product release. Actions must continue until OPDRVs are suspended.

LCO 3.0.3 is not applicable in MODES 4 or 5. However, since recently irradiated fuel assembly movement can occur in MODE 1, 2, or 3, Required Action C.1 has been modified by a Note stating that LCO 3.0.3 is not applicable. If moving recently irradiated fuel assemblies while in MODE 4 or 5, LCO 3.0.3 would not specify any action. If moving recently irradiated fuel assemblies while in

recently

(continued)

BASES

ACTIONS

C.1, C.2, and C.3 (continued)

MODE 1, 2, or 3, the fuel movement is independent of reactor operations. Therefore, in either case, inability to suspend movement of recently irradiated fuel assemblies would not be a sufficient reason to require a reactor shutdown.

SURVEILLANCE REQUIREMENTS

SR 3.6.4.1.1

This SR ensures that the secondary containment boundary is sufficiently leak tight to preclude exfiltration under expected wind conditions. Momentary transients on the installed instrumentation due to gusty wind conditions are considered acceptable and not cause for failure of this SR. The 24 hour Frequency of this SR was developed based on operating experience related to secondary containment vacuum variations during the applicable MODES and the low probability of a DBA occurring between surveillances.

Furthermore, the 24 hour Frequency is considered adequate in view of other indications available in the control room, including alarms, to alert the operator to an abnormal secondary containment vacuum condition.

SR 3.6.4.1.2 and SR 3.6.4.1.3

Verifying that secondary containment equipment hatches and one access door in each access opening are closed ensures that the infiltration of outside air of such a magnitude as to prevent maintaining the desired negative pressure does not occur. Verifying that all such openings are closed provides adequate assurance that exfiltration from the secondary containment will not occur. SR 3.6.4.1.2 also requires equipment hatches to be sealed. In this application, the term "sealed" has no connotation of leak tightness. Maintaining secondary containment OPERABILITY requires verifying one door in the access opening is closed. An access opening contains one inner and one outer door. In some cases, secondary containment access openings are shared such that a secondary containment barrier may have multiple outer doors. The intent is to not breach the secondary containment at any time when secondary containment is required. This is achieved by maintaining the inner or

(continued)

B 3.6 CONTAINMENT SYSTEMS

B 3.6.4.2 Secondary Containment Isolation Valves (SCIVs)

BASES

BACKGROUND

The function of the SCIVs, in combination with other accident mitigation systems, is to limit fission product release during and following postulated Design Basis Accidents (DBAs) (Refs. 1 and 2). Secondary containment isolation within the time limits specified for those isolation valves designed to close automatically ensures that fission products that leak from primary containment following a DBA, or that are released during certain operations when primary containment is not required to be OPERABLE or take place outside primary containment, are maintained within the secondary containment boundary.

The OPERABILITY requirements for SCIVs help ensure that an adequate secondary containment boundary is maintained during and after an accident by minimizing potential paths to the environment. These isolation devices consist of either passive devices or active (automatic) devices. Manual valves, de-activated automatic valves secured in their closed position (including check valves with flow through the valve secured), and blind flanges are considered passive devices.

Automatic SCIVs close on a secondary containment isolation signal to establish a boundary for untreated radioactive material within secondary containment following a DBA or other accidents.

Other penetrations are isolated by the use of valves in the closed position or blind flanges.

APPLICABLE SAFETY ANALYSES

The SCIVs must be OPERABLE to ensure the secondary containment barrier to fission product releases is established. The principal accidents for which the secondary containment boundary is required are a loss of coolant accident (Ref. 1) and a refueling accident ~~inside secondary containment~~ (Ref. 2). The secondary containment

INSERT C

(continued)

BASES

APPLICABILITY (continued)

OPERABLE is not required in MODE 4 or 5, except for situations under which significant radioactive releases can be postulated, such as during operations with a potential for draining the reactor vessel (OPDRVs), ~~during CORE ALTERATIONS,~~ or during movement of irradiated fuel assemblies in the secondary containment. Moving irradiated fuel assemblies in the secondary containment may also occur in MODES 1, 2, and 3. INSERT E recently

RAI 3.6.4.2-4

ACTIONS

The ACTIONS are modified by three Notes. The first Note allows penetration flow paths to be unisolated intermittently under administrative controls. These controls consist of stationing a dedicated operator, who is in continuous communication with the control room, at the controls of the isolation device. In this way, the penetration can be rapidly isolated when a need for secondary containment isolation is indicated.

The second Note provides clarification that, for the purpose of this LCO, separate Condition entry is allowed for each penetration flow path. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory actions for each inoperable SCIV. Complying with the Required Actions may allow for continued operation, and subsequent inoperable SCIVs are governed by subsequent Condition entry and application of associated Required Actions.

The third Note ensures appropriate remedial actions are taken, if necessary, if the affected system(s) are rendered inoperable by an inoperable SCIV.

A.1 and A.2

In the event that there are one or more penetration flow paths with one SCIV inoperable, the affected penetration flow path(s) must be isolated. The method of isolation must include the use of at least one isolation barrier that cannot be adversely affected by a single active failure.

(continued)

BASES

ACTIONS

B.1

With two SCIVs in one or more penetration flow paths inoperable, the affected penetration flow path must be isolated within 4 hours. The method of isolation must include the use of at least one isolation barrier that cannot be adversely affected by a single active failure. Isolation barriers that meet this criterion are a closed and de-activated automatic valve, a closed manual valve, and a blind flange. The 4 hour Completion Time is reasonable considering the time required to isolate the penetration and the probability of a DBA, which requires the SCIVs to close, occurring during this short time, is very low.

The Condition has been modified by a Note stating that Condition B is only applicable to penetration flow paths with two isolation valves. This clarifies that only Condition A is entered if only one SCIV is inoperable in multiple penetrations.

C.1 and C.2

If any Required Action and associated Completion Time cannot be met, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 12 hours and to MODE 4 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, D.2, and ~~D.3~~

If any Required Action and associated Completion Time are not met, the plant must be placed in a condition in which the LCO does not apply. If applicable, ~~CORE ALTERATIONS and~~ the movement of recently irradiated fuel assemblies in the secondary containment must be immediately suspended. Suspension of this ~~these~~ activity ~~ies~~ shall not preclude completion of movement of a component to a safe position. Also, if applicable, actions must be immediately initiated to suspend OPDRVs in order to minimize the probability of a vessel draindown and the subsequent potential for fission product release. Actions must continue until OPDRVs are suspended.

(continued)

BASES (continued)

ACTIONS

D.1, D.2, and D.3 (continued)

recently

LCO 3.0.3 is not applicable while in MODE 4 or 5. However, since irradiated fuel assembly movement can occur in MODE 1, 2, or 3, Required Action D.1 has been modified by a Note stating that LCO 3.0.3 is not applicable. If moving irradiated fuel assemblies while in MODE 4 or 5, LCO 3.0.3 would not specify any action. If moving fuel while in MODE 1, 2, or 3, the fuel movement is independent of reactor operations. Therefore, in either case, inability to suspend movement of irradiated fuel assemblies would not be a sufficient reason to require a reactor shutdown. TSTF-45, R2

SURVEILLANCE REQUIREMENTS

SR 3.6.4.2.1

This SR verifies that each secondary containment manual isolation valve and blind flange that is not locked, sealed, or otherwise secured and is required to be closed during accident conditions is closed. The SR helps to ensure that post accident leakage of radioactive fluids or gases outside of the secondary containment boundary is within design limits. This SR does not require any testing or valve manipulation. Rather, it involves verification that those SCIVs in secondary containment that are capable of being mispositioned are in the correct position.

Since these SCIVs are readily accessible to personnel during normal operation and verification of their position is relatively easy, the 31 day Frequency was chosen to provide added assurance that the SCIVs are in the correct positions. This SR does not apply to valves that are locked, sealed, or otherwise secured in the closed position, since these were verified to be in the correct position upon locking, sealing, or securing. TSTF-45, R2

Two Notes have been added to this SR. The first Note applies to valves and blind flanges located in high radiation areas and allows them to be verified by use of administrative controls. Allowing verification by administrative controls is considered acceptable, since access to these areas is typically restricted during MODES 1, 2, and 3 for ALARA reasons. Therefore, the probability of misalignment of these SCIVs, once they have been verified to be in the proper position, is low. RAI 3.6.4.2-5

(continued)

BASES

BACKGROUND (continued)

d. A high efficiency particulate air (HEPA) filter;

e. A charcoal adsorber; and

f. A second HEPA filter.

The SGT System equipment and components are sized to reduce and maintain the secondary containment at a negative pressure of 0.25 inches water gauge when the system is in operation under neutral wind conditions and the SGT fans exhausting at a rate of 6,000 cfm. 1 J

The demister is provided to remove entrained water in the air, while the electric heater reduces the relative humidity of the airstream to less than 70% (Ref. 2). The prefilter removes large particulate matter, while the HEPA filter removes fine particulate matter and protects the charcoal from fouling. The charcoal adsorber removes gaseous elemental iodine and organic iodides, and the final HEPA filter collects any carbon fines exhausted from the charcoal adsorber.

The SGT System automatically starts and operates in response to actuation signals indicative of conditions or an accident that could require operation of the system. Following initiation, both SGT subsystem fans start. Upon verification that both subsystems are operating, one subsystem is normally shut down.

APPLICABLE SAFETY ANALYSES

INSERT C

The design basis for the SGT System is to mitigate the consequences of a loss of coolant accident and refueling accidents (Ref. 3). For all events analyzed, the SGT System ~~is shown~~ to be automatically initiated to reduce, via filtration and adsorption, the radioactive material released to the environment.

The SGT System satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii) (Ref. 4).

(continued)

BASES (continued)

LCO

Following a DBA, a minimum of one SGT subsystem is required to maintain the secondary containment at a negative pressure with respect to the environment and to process gaseous releases. Meeting the LCO requirements for two OPERABLE subsystems ensures operation of at least one SGT subsystem in the event of a single active failure. An OPERABLE SGT subsystem consists of a demister, heater, prefilter, HEPA filter, charcoal adsorber, a final HEPA filter, centrifugal fan, and associated ductwork, dampers, valves and controls.

APPLICABILITY

In MODES 1, 2, and 3, a DBA could lead to a fission product release to primary containment that leaks to secondary containment. Therefore, SGT System OPERABILITY is required during these MODES.

In MODES 4 and 5, the probability and consequences of these events are reduced due to the pressure and temperature limitations in these MODES. Therefore, maintaining the SGT System in OPERABLE status is not required in MODE 4 or 5, except for other situations under which significant releases of radioactive material can be postulated, such as during operations with a potential for draining the reactor vessel (OPDRVs)~~, during CORE ALTERATIONS,~~ or during movement of recently irradiated fuel assemblies in the secondary containment. INSERT F

RAI 3.6.4.3-8

ACTIONS

A.1

With one SGT subsystem inoperable, the inoperable subsystem must be restored to OPERABLE status in 7 days. In this Condition, the remaining OPERABLE SGT subsystem is adequate to perform the required radioactivity release control function. However, the overall system reliability is reduced because a single failure in the OPERABLE subsystem could result in the radioactivity release control function not being adequately performed. The 7 day Completion Time is based on consideration of such factors as the availability of the OPERABLE redundant SGT subsystem and the low probability of a DBA occurring during this period.

(continued)

BASES

ACTIONS (continued)

B.1 and B.2

If the SGT subsystem cannot be restored to OPERABLE status within the required Completion Time in MODE 1, 2, or 3, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 12 hours and to MODE 4 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.

C.1, C.2.1, C.2.2, and ~~C.2.3~~

recently

During movement of irradiated fuel assemblies in the secondary containment~~, during CORE ALTERATIONS,~~ or during OPDRVs, when Required Action A.1 cannot be completed within the required Completion Time, the OPERABLE SGT subsystem should immediately be placed in operation. This action ensures that the remaining subsystem is OPERABLE, that no failures that could prevent automatic actuation have occurred, and that any other failure would be readily detected.

a significant amount of

An alternative to Required Action C.1 is to immediately suspend activities that represent a potential for releasing radioactive material to the secondary containment, thus placing the plant in a condition that minimizes risk. If applicable, ~~CORE ALTERATIONS and~~ movement of irradiated fuel assemblies must immediately be suspended. Suspension of ~~these activities~~ must not preclude completion of movement of a component to a safe position. Also, if applicable, actions must immediately be initiated to suspend OPDRVs in order to minimize the probability of a vessel draindown and subsequent potential for fission product release. Actions must continue until OPDRVs are suspended.

this activity

LCO 3.0.3 is not applicable in MODE 4 or 5. However, since irradiated fuel assembly movement can occur in MODE 1, 2, or 3, the Required Actions of Condition C have been modified by a Note stating that LCO 3.0.3 is not applicable. If moving irradiated fuel assemblies while in MODE 4 or 5, LCO 3.0.3 would not specify any action. If moving irradiated fuel assemblies while in MODE 1, 2, or 3, the fuel movement is independent of reactor operations. Therefore, in either

(continued)

BASES

ACTIONS

C.1, C.2.1, C.2.2, and ~~C.2.3~~ (continued) recently

case, inability to suspend movement of irradiated fuel assemblies would not be a sufficient reason to require a reactor shutdown.

D.1

If both SGT subsystems are inoperable in MODE 1, 2, or 3, the SGT System may not be capable of supporting the required radioactivity release control function. Therefore, action is required to enter LCO 3.0.3 immediately.

E.1, E.2, and ~~E.3~~ recently

When two SGT subsystems are inoperable, if applicable, ~~CORE ALTERATIONS and~~ movement of irradiated fuel assemblies in secondary containment must immediately be suspended. Suspension of ~~these activities~~ shall not preclude completion of movement of a component to a safe position. Also, if applicable, actions must immediately be initiated to suspend OPDRVs in order to minimize the probability of a vessel draindown and subsequent potential for fission product release. Actions must continue until OPDRVs are suspended.

this activity

LCO 3.0.3 is not applicable in MODE 4 or 5. However, since irradiated fuel assembly movement can occur in MODE 1, 2, or 3, Required Action E.1 has been modified by a Note stating that LCO 3.0.3 is not applicable. If moving irradiated fuel assemblies while in MODE 4 or 5, LCO 3.0.3 would not specify any action. If moving irradiated fuel assemblies while in MODE 1, 2, or 3, the fuel movement is independent of reactor operations. Therefore, in either case, inability to suspend movement of irradiated fuel assemblies would not be a sufficient reason to require a reactor shutdown.

recently

SURVEILLANCE REQUIREMENTS

SR 3.6.4.3.1

Operating each SGT subsystem fan for ≥ 10 continuous hours ensures that both subsystems are OPERABLE and that all associated controls are functioning properly. It also ensures that blockage, fan or motor failure, or excessive

(continued)

BASES

BACKGROUND (continued)

The CREVAS System is designed to maintain the control room environment for a 31 day continuous occupancy after a DBA without exceeding 5 rem whole body dose or its equivalent to any part of the body. A single CREVAS subsystem will pressurize the control room to ≥ 0.125 inches water gauge above the Turbine Building and outside atmosphere to prevent infiltration of air from surrounding buildings, since these are the only adjacent areas to the control room that could be directly contaminated by a design basis accident. CREVAS System operation in maintaining control room habitability is discussed in the UFSAR, Sections 9.9.3.11 and 14.8.2, (Refs. 1 and 2, respectively).

APPLICABLE SAFETY ANALYSES

The ability of the CREVAS System to maintain the habitability of the control room is an explicit assumption for the safety analyses presented in the UFSAR, Chapters 6 and 14 (Refs. 3 and 4, respectively). The isolate mode of the CREVAS System is assumed to operate following a loss of ~~coolant accident, refueling accident,~~ main steam line break, and control rod drop ~~accident, as~~ discussed in the UFSAR, Section 14.8.2 (Ref. 2). The radiological doses to control room personnel as a result of the various DBAs are summarized in Reference 2.

INSERT C

The CREVAS System satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii) (Ref. 5).

LCO

Two redundant subsystems of the CREVAS System are required to be OPERABLE to ensure that at least one is available, assuming a single failure disables the other subsystem. Total system failure could result in exceeding a dose of 5 rem to the control room operators in the event of some DBAs.

The CREVAS System is considered OPERABLE when the individual components necessary to control operator exposure are OPERABLE in both subsystems. A subsystem is considered OPERABLE when its associated:

a. Fans are OPERABLE (i.e., one control room emergency air supply fan, one air handling unit fan, one recirculation exhaust fan);

(continued)

BASES

LCO (continued)

b. A prefilter, two HEPA filters and charcoal adsorbers are not excessively restricting flow and are capable of performing their filtration functions; and

c. Ductwork, valves, and dampers are OPERABLE, and air circulation can be maintained.

In addition, the control room boundary must be maintained, including the integrity of the walls, floors, ceilings, ductwork, and access doors such that the pressurization limit of SR 3.7.3.3 can be met. However, it is acceptable for access doors to be open for normal control room entry and exit, and not consider it to be a failure to meet the LCO.

The LCO is modified by a Note allowing the control room boundary to be opened intermittently under administrative controls. For entry and exit through doors the administrative control of the opening is performed by the person(s) entering or exiting the area. For other openings, these controls 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.

APPLICABILITY

In MODES 1, 2, and 3, the CREVAS System must be OPERABLE to control operator exposure during and following a DBA, since the DBA could lead to a fission product release.

In MODES 4 and 5, the probability and consequences of a DBA are reduced because of the pressure and temperature limitations in these MODES. Therefore, maintaining the CREVAS System OPERABLE is not required in MODE 4 or 5, except for the following situations under which significant radioactive releases can be postulated:

a. During operations with potential for draining the reactor vessel (OPDRVs); and

~~b. During CORE ALTERATIONS;~~

b ~~c.~~ During movement of recently irradiated fuel assemblies in the secondary containment.

INSERT G

(continued)

BASES

ACTIONS (continued)

C.1 and C.2

In MODE 1, 2, or 3, if the inoperable CREVAS subsystem or control room boundary cannot be restored to OPERABLE status within the associated Completion Time, the plant must be placed in a MODE that minimizes risk. To achieve this status, the plant must be placed in at least MODE 3 within 12 hours and in MODE 4 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, D.2.1, D.2.2, and ~~D.2.3~~

recently

LCO 3.0.3 is not applicable when in MODE 4 or 5. However, since irradiated fuel assembly movement can occur in MODE 1, 2, or 3, the Required Actions of Condition D are modified by a Note indicating that LCO 3.0.3 does not apply. If moving irradiated fuel assemblies while in MODE 1, 2, or 3, the fuel movement is independent of reactor operations. Therefore, inability to suspend movement of irradiated fuel assemblies is not sufficient reason to require a reactor shutdown.

During movement of irradiated fuel assemblies in the secondary containment~~, during CORE ALTERATIONS,~~ or during OPDRVs, if the inoperable CREVAS subsystem cannot be restored to OPERABLE status within the required Completion Time, the OPERABLE CREVAS subsystem may be placed in the isolate mode. This action ensures that the remaining subsystem is OPERABLE, and that any active failure will be readily detected.

An alternative to Required Action D.1 is to immediately suspend activities that present a potential for releasing radioactivity that might require isolation of the control room. This places the plant in a condition that minimizes risk.

(continued)

BASES

TSTF-287

ACTIONS

D.1, D.2.1, D.2.2, and ~~D.2.3~~ (continued)

recently

If applicable, ~~CORE ALTERATIONS and~~ movement of irradiated fuel assemblies in the secondary containment must be suspended immediately. Suspension of ~~these activities~~ shall not preclude completion of movement of a component to a safe position. Also, if applicable, action must be initiated immediately to suspend OPDRVs to minimize the probability of a vessel draindown and the subsequent potential for fission product release. Action must continue until the OPDRVs are suspended.

this activity

E.1

If both CREVAS subsystems are inoperable in MODE 1, 2, or 3 for reasons other than an inoperable control room boundary (i.e., Condition B), the CREVAS System may not be capable of performing the intended function and the plant is in a condition outside the accident analyses. Therefore, LCO 3.0.3 must be entered immediately.

F.1, F.2, and ~~F.3~~

LCO 3.0.3 is not applicable when in MODE 4 or 5. However, since irradiated fuel assembly movement can occur in MODES 1, 2, or 3, the Required Actions of Condition F are modified by a Note indicating that LCO 3.0.3 does not apply. If moving irradiated fuel assemblies while in MODE 1, 2, or 3, the fuel movement is independent of reactor operations. Therefore, inability to suspend movement of irradiated fuel assemblies is not sufficient reason to require a reactor shutdown.

recently

During movement of irradiated fuel assemblies in the secondary containment ~~during CORE ALTERATIONS~~ or during OPDRVs, with two CREVAS subsystems inoperable, action must be taken immediately to suspend activities that present a potential for releasing radioactivity that might require isolation of the control room. This places the plant in a condition that minimizes risk.

(continued)

TSTF-287

BASES

ACTIONS

F.1, F.2, and ~~F.3~~ (continued)

If applicable, ~~CORE ALTERATIONS and~~ movement of recently irradiated fuel assemblies in the secondary containment must be suspended immediately. Suspension of ~~these activities~~ this activity shall not preclude completion of movement of a component to a safe position. If applicable, action must be initiated immediately to suspend OPDRVs to minimize the probability of a vessel draindown and subsequent potential for fission product release. Action must continue until the OPDRVs are suspended.

SURVEILLANCE REQUIREMENTS

SR 3.7.3.1

This SR verifies that a subsystem in a standby mode starts on demand and continues to operate. These subsystems should be checked periodically to ensure that they start and function properly. As the environmental and normal operating conditions of this system are not severe, testing each subsystem once every three months provides an adequate check on this system. Since the CREVAS System does not contain heaters, it need only be operated for ≥ 15 minutes to demonstrate the function of the system. The 92 day Frequency is based on the known reliability of the equipment and the two subsystem redundancy available.

SR 3.7.3.2

TSTF-362

This SR verifies that the required CREVAS testing is performed in accordance with the Ventilation Filter Testing Program (VFTP). The VFTP includes testing HEPA filter performance, charcoal adsorber efficiency, minimum system flow rate, and the physical properties of the activated charcoal (general use and following specific operations). Specific test frequencies and additional information are discussed in detail in the VFTP.

(continued)

BASES (continued)

APPLICABILITY

In MODE 1, 2, or 3, the Control Room AC System must be OPERABLE to ensure that the control room temperature will not exceed equipment OPERABILITY limits following control room isolation.

In MODES 4 and 5, the probability and consequences of a Design Basis Accident are reduced due to the pressure and temperature limitations in these MODES. Therefore, maintaining the Control Room AC System OPERABLE is not required in MODE 4 or 5, except for the following situations under which significant radioactive releases can be postulated:

a. During operations with a potential for draining the reactor vessel (OPDRVs);

~~b. During CORE ALTERATIONS;~~ and

b ~~c~~. During movement of recently irradiated fuel assemblies in the secondary containment. INSERT H

ACTIONS

A.1

With one control room AC subsystem inoperable, the inoperable control room AC subsystem must be restored to OPERABLE status within 30 days. With the plant in this condition, the remaining OPERABLE control room AC subsystem is adequate to perform the control room air conditioning function. However, the overall reliability is reduced because a single active component failure in the OPERABLE subsystem could result in loss of the control room air conditioning function. The 30 day Completion Time is based on the low probability of an event occurring requiring control room isolation, the consideration that the remaining subsystem can provide the required protection, and the availability of alternate safety and nonsafety cooling methods.

B.1 and B.2

In MODE 1, 2, or 3, if the inoperable control room AC subsystem cannot be restored to OPERABLE status within the associated Completion Time, the plant must be placed in a

(continued)

BASES

ACTIONS

B.1 and B.2 (continued)

MODE that minimizes risk. To achieve this status, the plant must be placed in at least MODE 3 within 12 hours and in MODE 4 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.

C.1, C.2.1, C.2.2, and ~~C.2.3~~

LCO 3.0.3 is not applicable while in MODE 4 and 5. However, since recently irradiated fuel assembly movement can occur in MODES 1, 2, or 3 the Required Actions of Condition C are modified by a Note indicating that LCO 3.0.3 does not apply. If moving recently irradiated fuel assemblies while in MODE 1, 2, or 3, the fuel movement is independent of reactor operations. Therefore, inability to suspend movement of recently irradiated fuel assemblies is not sufficient reason to require a reactor shutdown.

During movement of recently irradiated fuel assemblies in the secondary containment ~~during CORE ALTERATIONS,~~ or during OPDRVs, if Required Action A.1 cannot be completed within the required Completion Time, the OPERABLE control room AC subsystem may be placed immediately in operation. This action ensures that the remaining subsystem is OPERABLE, that no failures that would prevent actuation will occur, and that any active failure will be readily detected.

An alternative to Required Action C.1 is to immediately suspend activities that present a potential for releasing radioactivity that might require isolation of the control room. This places the plant in a condition that minimizes risk.

If applicable, ~~CORE ALTERATIONS and~~ movement of recently irradiated fuel assemblies in the secondary containment must be suspended immediately. Suspension of ~~these activities~~ this activity shall not preclude completion of movement of a component to a safe position. Also, if applicable, action must be initiated immediately to suspend OPDRVs to minimize the probability of a vessel draindown and subsequent potential for fission product release. Action must continue until the OPDRVs are suspended.

(continued)

BASES

ACTIONS (continued)

D.1

If both control room AC subsystems are inoperable in MODE 1, 2, or 3, the Control Room AC System may not be capable of performing the intended function. Therefore, LCO 3.0.3 must be entered immediately.

E.1, E.2, and ~~E.3~~

recently

LCO 3.0.3 is not applicable when in MODE 4 or 5. However, since irradiated fuel assembly movement can occur in MODE 1, 2, or 3 the Required Actions of Condition E are modified by a Note indicating that LCO 3.0.3 does not apply. If moving irradiated fuel assemblies while in MODE 1, 2, or 3, the fuel movement is independent of reactor operations. Therefore, inability to suspend movement of irradiated fuel assemblies is not a sufficient reason to require a reactor shutdown.

During movement of irradiated fuel assemblies in the secondary containment, ~~during CORE ALTERATIONS,~~ or during OPDRVs, with two control room AC subsystems inoperable, action must be taken immediately to suspend activities that present a potential for releasing radioactivity that might require isolation of the control room. This places the plant in a condition that minimizes risk.

If applicable, ~~CORE ALTERATIONS and~~ handling of irradiated fuel in the secondary containment must be suspended immediately. Suspension of ~~these activities~~ shall not preclude completion of movement of a component to a safe position. Also, if applicable, action must be initiated immediately to suspend OPDRVs to minimize the probability of a vessel draindown and subsequent potential for fission product release. Action must continue until the OPDRVs are suspended.

this activity

SURVEILLANCE REQUIREMENTS

SR 3.7.4.1

This SR verifies that the heat removal capability of the system is sufficient to remove the control room heat load assumed in the safety analyses with ESW providing water to the cooling coils of the air handling units. The SR consists of a combination of testing and calculation. It is

(continued)

B 3.8 ELECTRICAL POWER SYSTEMS

B 3.8.2 AC Sources - Shutdown

BASES

BACKGROUND

A description of the AC sources is provided in the Bases for LCO 3.8.1, "AC Sources - Operating." In addition to the reserve AC sources described in LCO 3.8.1, during plant shutdown with the main generator off line, the plant emergency buses may be supplied using the 345 kV (backfeed) AC source. The 345 kV backfeed requires removing the main generator disconnect links that tie the main generator to the 24 kV bus, and providing power from the 345 kV transmission network to energize the main transformers (T1A and T1B), 24 kV bus, normal station service transformer (NSST) 71T-4, and subsequent 4.16 kV distribution and emergency buses. However, the backfeed AC Source is not considered a qualified offsite circuit. 1 J

APPLICABLE SAFETY ANALYSES

The OPERABILITY of the minimum AC sources during MODES 4 and 5 and during movement of recently irradiated fuel assemblies in the secondary containment ensures that:

a. The facility can be maintained in the shutdown or refueling condition for extended periods;

b. Sufficient instrumentation and control capability is available for monitoring and maintaining the plant status; and

c. Adequate AC electrical power is provided to mitigate events postulated during shutdown, such as an inadvertent draindown of the vessel or a fuel handling accident. INSERT I

In general, when the plant is shutdown the Technical Specifications requirements ensure that the plant has the capability to mitigate the consequences of postulated accidents. However, assuming a single active component failure and concurrent loss of all offsite or loss of all onsite power is not required. The rationale for this is based on the fact that many Design Basis Accidents (DBAs) that are analyzed in MODES 1, 2, and 3 have no specific analyses in MODES 4 and 5.

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

The AC sources satisfy Criterion 3 of 10 CFR 50.36(c)(2)(ii) (Ref. 1).

LCO

One qualified offsite circuit capable of supplying one division of the plant Class 1E AC power distribution subsystem(s) of LCO 3.8.8, "Distribution Systems – Shutdown," and one qualified offsite circuit, which may be the same circuit required above, capable of supplying the other division of the plant Class 1E AC power distribution subsystem(s) when a second division is required by LCO 3.8.8, ensures that all required loads are powered from offsite power. An OPERABLE EDG subsystem, associated with a 4.16 kV emergency bus required OPERABLE by LCO 3.8.8, ensures that a diverse power source is available for providing electrical power support assuming a loss of the offsite circuit. Together, OPERABILITY of the required offsite circuit and EDG subsystem ensures the availability of sufficient AC sources to operate the plant in a safe manner and to mitigate the consequences of postulated events during shutdown (e.g., fuel handling accidents and reactor vessel draindown). Automatic initiation of the required EDG during shutdown conditions is specified in LCO 3.3.5.1, "ECCS Instrumentation," and LCO 3.3.8.1, "LOP Instrumentation."

INSERT J

The qualified offsite circuit(s) must be capable of maintaining rated frequency and voltage while connected to its respective 4.16 kV emergency bus(es), and of accepting required loads during an accident. Qualified offsite circuits are those that are described in LCO 3.8.1 Bases and the UFSAR and are part of the licensing basis for the plant. However, since the plant is shutdown, when two offsite circuits are required, they may share one of the incoming switchyard breakers provided the North and South bus disconnect is closed. Also, while in this condition, the automatic opening feature of the disconnect is not required to be OPERABLE. This is allowed since the two offsite circuits are not required to be independent while shutdown.

The required EDG subsystem must be capable of starting, accelerating to rated speed and voltage, force paralleling, and connecting to its respective emergency bus on detection of bus undervoltage. This sequence must be accomplished within 11 seconds. The required EDG subsystem must also be capable of accepting required loads within the assumed loading sequence intervals, and must continue to operate until offsite power can be restored to the emergency buses. These capabilities are required to be met with the EDG subsystem in standby condition.

(continued)

BASES

LCO (continued)

Proper sequencing of loads, including tripping of nonessential loads, is a required function for EDG subsystem OPERABILITY. The necessary portions of the Emergency Service Water System and Ultimate Heat Sink are also required to provide appropriate cooling to the required EDG subsystem. In addition, proper sequence operation is an integral part of offsite circuit OPERABILITY since its inoperability impacts the ability to start and maintain energized loads required OPERABLE by LCO 3.8.8. 1B

No automatic transfer capability is required for offsite circuits to be considered OPERABLE. 1C

APPLICABILITY

recently

The AC sources are required to be OPERABLE in MODES 4 and 5 and during movement of irradiated fuel assemblies in the secondary containment to provide assurance that:

a. Systems providing adequate coolant inventory makeup are available for the irradiated fuel assemblies in the core in case of an inadvertent draindown of the reactor vessel;

b. Systems needed to mitigate a fuel handling accident are available; INSERT K

c. Systems necessary to mitigate the effects of events that can lead to core damage during shutdown are available; and

d. Instrumentation and control capability is available for monitoring and maintaining the plant in a cold shutdown condition or refueling condition.

AC power requirements for MODES 1, 2, and 3 are covered in LCO 3.8.1.

ACTIONS

LCO 3.0.3 is not applicable while in MODE 4 or 5. However, since irradiated fuel assembly movement can occur in MODE 1, 2, or 3, the ACTIONS have been modified by a Note stating that LCO 3.0.3 is not applicable. If moving irradiated fuel

recently

(continued)

BASES

ACTIONS (continued)

assemblies while in MODE 4 or 5, LCO 3.0.3 would not specify any action. If moving irradiated fuel assemblies while in MODE 1, 2, or 3, the fuel movement is independent of reactor operations. Entering LCO 3.0.3, while in MODE 1, 2, or 3 would require the unit to be shutdown unnecessarily. RAI 3.8.2-7

recently

A.1

An offsite circuit is considered inoperable if it is not available to one required 4.16 kV emergency bus. If two 4.16 kV emergency buses are required per LCO 3.8.8, one division with offsite power available may be capable of supporting sufficient required features to allow continuation of CORE ALTERATIONS, fuel movement, and operations with a potential for draining the reactor vessel. By the allowance of the option to declare required features inoperable with no offsite power, appropriate restrictions can be implemented in accordance with the affected required feature(s) LCOs' ACTIONS. RAI 3.8.2-6

recently irradiated

A.2.1, A.2.2, A.2.3, A.2.4, B.1, B.2, B.3, and B.4

With an offsite circuit not available to all required 4.16 kV emergency buses, the option still exists to declare all required features inoperable per Required Action A.1. Since this option may involve undesired administrative efforts, the allowance for sufficiently conservative actions is made. With the required EDG subsystem inoperable, the minimum required diversity of AC power sources is not available. It is, therefore, required to suspend CORE ALTERATIONS, movement of irradiated fuel assemblies in the secondary containment, and activities that could result in inadvertent draining of the reactor vessel. RAI 3.8.2-7

Suspension of these activities shall not preclude completion of actions to establish a safe conservative condition. These actions minimize the probability of the occurrence of postulated events. It is further required to immediately initiate action to restore the required AC sources and to continue this action until restoration is accomplished in order to provide the necessary AC power to the plant safety systems.

(continued)

B 3.8 ELECTRICAL POWER SYSTEMS

B 3.8.5 DC Sources - Shutdown

BASES

BACKGROUND

A description of the DC sources is provided in the Bases for LCO 3.8.4, "DC Sources - Operating."

APPLICABLE SAFETY ANALYSES

The initial conditions of Design Basis Accident and transient analyses in the UFSAR, Chapter 6 (Ref. 1) and Chapter 14 (Ref. 2), assume that Engineered Safeguards systems are OPERABLE. The DC electrical power system provides normal and emergency DC electrical power for the emergency diesel generators (EDGs), emergency auxiliaries, and control and switching during all MODES of operation and during movement of recently irradiated fuel assemblies in the secondary containment.

The OPERABILITY of the DC subsystems is consistent with the initial assumptions of the accident analyses and the requirements for the supported systems' OPERABILITY.

The OPERABILITY of the minimum DC electrical power sources during MODES 4 and 5 and during movement of recently irradiated fuel assemblies in the secondary containment ensures that:

a. The facility can be maintained in the shutdown or refueling condition for extended periods:

b. Sufficient instrumentation and control capability is available for monitoring and maintaining the plant status; and

c. Adequate DC electrical power is provided to mitigate events postulated during shutdown, such as an inadvertent draindown of the vessel or a refueling accident. INSERT L

In general, when the unit is shutdown, the Technical Specifications requirements ensure that the unit has the capability to mitigate the consequences of postulated accidents. However, assuming a single failure and concurrent loss of all offsite or all onsite power is not required. The rationale for this is based on the fact that many Design Basis Accidents (DBAs) that are analyzed in MODES 1, 2, and 3 have no specific analyses in MODES 4 and 5. Worst case bounding events are deemed not credible in 1(J)

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

Worst case bounding events are deemed not credible in MODES 4 and 5 because the energy contained within the reactor pressure boundary, reactor coolant temperature and pressure, and the corresponding stresses result in the probabilities of occurence being significantly reduced or eliminated, and in minimal consequences. These deviations from DBA analysis assumptions and design requirements during shutdown conditions are allowed by the LCO for required systems.

The shutdown Technical Specification requirements are designed to ensure that the unit has the capability to mitigate the consequences of certain postulated accidents. Worst case Design Basis Accidents which are analyzed for operating MODES are generally viewed not to be a significant concern during shutdown MODES due to the lower energies involved. The Technical Specifications therefore require a lesser complement of electrical equipment to be availabe during shutdown than is required during operating MODES. More recent work completed on the potential risks associated with shutdown, however, have found significant risk associated with certain shutdown evolutions. As a result, in addition to the requirements established in the Technical Specifications, the industry has adopted NUMARC 91-06, "Guidelines for Industry Actions to Assess Shutdown Management," as an Industry initiative to manage shutdown tasks and associated electrical support to maintain risk at an acceptable low level. This may require the availability of additional equipment beyond that required by the shutdown Technical Specifications.

The DC sources satisfy Criterion 3 of 10 CFR 50.36(c)(2)(ii) (Ref. 3).

LCO

One 125 VDC electrical power subsystem consisting of one 125 V battery, one battery charger, and the corresponding control equipment and interconnecting cabling supplying power to the associated bus is required to be OPERABLE to support one DC distribution subsystem required OPERABLE by LCO 3.8.8, "Distribution Systems – Shutdown." This requirement ensures the availability of sufficient DC electrical power sources to operate the plant in a safe manner and to mitigate the consequences of postulated events during shutdown (e.g., refueling accidents, and inadvertent reactor vessel draindown).

INSERT J

(continued)

BASES (continued)

APPLICABILITY

The DC electrical power sources required to be OPERABLE in MODES 4 and 5 and during movement of irradiated fuel assemblies in the secondary containment provide assurance that:

recently

a. Required features to provide adequate coolant inventory makeup are available for the irradiated fuel assemblies in the core in case of an inadvertent draindown of the reactor vessel;

b. Required features needed to mitigate a fuel handling accident are available;

INSERT K

c. Required features necessary to mitigate the effects of events that can lead to core damage during shutdown are available; and

d. Instrumentation and control capability is available for monitoring and maintaining the plant in a cold shutdown condition or refueling condition.

The DC electrical power requirements for MODES 1, 2, and 3 are covered in LCO 3.8.4.

ACTIONS

LCO 3.0.3 is not applicable while in MODE 4 or 5. However, since irradiated fuel assembly movement can occur in MODE 1, 2 or 3, the ACTIONS have been modified by a Note stating that LCO 3.0.3 is not applicable. If moving irradiated fuel assemblies while in MODE 4 or 5, LCO 3.0.3 would not specify any action. If moving irradiated fuel assemblies while in MODE 1, 2, or 3, the fuel movement is independent of reactor operations. Entering LCO 3.0.3, while in MODE 1, 2, or 3 would require the unit to be shutdown unnecessarily.

recently

<u>A.1, A.2.1, A.2.2, A.2.3, and A.2.4</u>

By allowance of the option to declare required features inoperable with the associated DC electrical power subsystem inoperable, appropriate restrictions are implemented in accordance with the affected system LCOs' ACTIONS. However in many instances, this option may involve undesired administrative efforts. Therefore, the allowance for

(continued)

BASES

ACTIONS

A.1, A.2.1, A.2.2, A.2.3, and A.2.4 (continued)

sufficiently conservative actions is made (i.e., to suspend CORE ALTERATIONS, movement of recently irradiated fuel assemblies in the secondary containment, and any activities that could result in inadvertent draining of the reactor vessel).

Suspension of these activities shall not preclude completion of actions to establish a safe conservative condition. These actions minimize the probability of the occurrence of postulated events. It is further required to immediately initiate action to restore the required DC electrical power subsystem and to continue this action until restoration is accomplished in order to provide the necessary DC electrical power to the plant safety systems.

The Completion Time of immediately is consistent with the required times for actions requiring prompt attention. The restoration of the required DC electrical power subsystems should be completed as quickly as possible in order to minimize the time during which the plant safety systems may be without sufficient power.

SURVEILLANCE REQUIREMENTS

SR 3.8.5.1

SR 3.8.5.1 requires performance of all Surveillances required by SR 3.8.4.1 through SR 3.8.4.4. Therefore, see the corresponding Bases for LCO 3.8.4 for a discussion of each SR.

This SR is modified by a Note. The reason for the Note is to preclude requiring the OPERABLE DC electrical power subsystem from being discharged below their capability to provide the required power supply or otherwise rendered inoperable during the performance of SRs. It is the intent that these SRs must still be capable of being met, but actual performance is not required.

REFERENCES

1. UFSAR, Chapter 6.
2. UFSAR, Chapter 14.
3. 10 CFR 50.36(c)(2)(ii).

B 3.8 ELECTRICAL POWER SYSTEMS

B 3.8.8 Distribution Systems – Shutdown

BASES

BACKGROUND

A description of the AC and 125 VDC electrical power distribution system is provided in the Bases for LCO 3.8.7, "Distribution Systems – Operating."

APPLICABLE SAFETY ANALYSES

The initial conditions of Design Basis Accident and transient analyses in the UFSAR, Chapter 6 (Ref. 1) and Chapter 14 (Ref. 2), assume Engineered Safeguards systems are OPERABLE. The AC and 125 VDC electrical power distribution systems are designed to provide sufficient capacity, capability, redundancy, and reliability to ensure the availability of necessary power to Engineered Safeguards systems so that the fuel, Reactor Coolant System, and containment design limits are not exceeded.

The OPERABILITY of the AC and 125 VDC electrical power distribution systems is consistent with the initial assumptions of the accident analyses and the requirements for the supported systems' OPERABILITY.

The OPERABILITY of the minimum AC and 125 VDC electrical power sources and associated power distribution subsystems during MODES 4 and 5, and during movement of recently irradiated fuel assemblies in the secondary containment ensures that:

a. The facility can be maintained in the shutdown or refueling condition for extended periods;

b. Sufficient instrumentation and control capability is available for monitoring and maintaining the plant status; and

c. Adequate power is provided to mitigate events postulated during shutdown, such as an inadvertent draindown of the vessel or a fuel handling accident &

The AC and 125 VDC electrical power distribution systems satisfy Criterion 3 of 10 CFR 50.36(c)(2)(ii) (Ref. 3).

INSERT M

(continued)

BASES (continued)

LCO

Various combinations of subsystems, equipment, and components are required OPERABLE by other LCOs, depending on the specific plant condition. Implicit in those requirements is the required OPERABILITY of necessary support required features. This LCO explicitly requires energization of the portions of the electrical distribution system necessary to support OPERABILITY of Technical Specification required systems, equipment, and components – both specifically addressed by their own LCO, and implicitly required by the definition of OPERABILITY.

Maintaining these portions of the distribution system energized ensures the availability of sufficient power to operate the plant in a safe manner to mitigate the consequences of postulated events during shutdown (e.g., fuel handling accidents INSERT J and inadvertent reactor vessel draindown).

APPLICABILITY

The AC and 125 VDC electrical power distribution subsystems required to be OPERABLE in MODES 4 and 5 and during movement of recently irradiated fuel assemblies in the secondary containment provide assurance that:

a. Systems to provide adequate coolant inventory makeup are available for the irradiated fuel in the core in case of an inadvertent draindown of the reactor vessel;

b. Systems needed to mitigate a fuel handling accident INSERT K are available;

c. Systems necessary to mitigate the effects of events that can lead to core damage during shutdown are available; and

d. Instrumentation and control capability is available for monitoring and maintaining the plant in a cold shutdown condition or refueling condition.

The AC, and 125 VDC electrical power distribution subsystem requirements for MODES 1, 2, and 3 are covered in LCO 3.8.7.

(continued)

BASES (continued)

ACTIONS

LCO 3.0.3 is not applicable while in MODE 4 or 5. However, since irradiated fuel assembly movement can occur in MODE 1, 2, or 3, the ACTIONS have been modified by a Note stating that LCO 3.0.3 is not applicable. If moving irradiated fuel assemblies while in MODE 4 or 5, LCO 3.0.3 would not specify any action. If moving irradiated fuel assemblies while in MODE 1, 2, or 3, the fuel movement is independent of reactor operations. Entering LCO 3.0.3, while in MODE 1, 2, or 3 would require the unit to be shutdown unnecessarily.

recently

<u>A.1, A.2.1, A.2.2, A.2.3, A.2.4, and A.2.5</u>

recently irradiated

Although redundant required features may require redundant divisions of electrical power distribution subsystems to be OPERABLE, one OPERABLE distribution subsystem division may be capable of supporting sufficient required features to allow continuation of CORE ALTERATIONS, fuel movement, and operations with a potential for draining the reactor vessel. By allowing the option to declare required features associated with an inoperable distribution subsystem inoperable, appropriate restrictions are implemented in accordance with the affected distribution subsystem LCO's Required Actions. In many instances this option may involve undesired administrative efforts. Therefore, the allowance for sufficiently conservative actions is made, (i.e., to suspend CORE ALTERATIONS, movement of irradiated fuel assemblies in the secondary containment, and any activities that could result in inadvertent draining of the reactor vessel).

Suspension of these activities shall not preclude completion of actions to establish a safe conservative condition. These actions minimize the probability of the occurrence of postulated events. It is further required to immediately initiate action to restore the required AC and 125 VDC electrical power distribution subsystems and to continue this action until restoration is accomplished in order to provide the necessary power to the plant safety systems.

Not withstanding performance of the above conservative Required Actions, a required residual heat removal-shutdown cooling (RHR-SDC) subsystem may be inoperable. In this case, Required Actions A.2.1 through A.2.4 do not adequately address the concerns relating to coolant circulation and heat removal. Pursuant to LCO 3.0.6, the RHR-SDC ACTIONS would not be entered. Therefore, Required Action A.2.5 is 1(I)

(continued)

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant
Proposed Amendment to the Technical Specifications

Summary of Commitments

Commitment ID	Description	Due Date
JPN-02-016 -01	Entergy will revise the FitzPatrick guidelines for assessing systems removed from service during the handling of irradiated fuel assemblies or core alterations to implement the provisions of Section 11.3.6.5 of NUMARC 93-01, Revision 3.	Completed prior to the implementation of this license amendment.
JPN-02-016-02	Revise FitzPatrick UFSAR to reflect revised fuel handling analyses and alternate source term.	Completed in accordance with next scheduled FSAR update after approval of this application.
JPN-02-016-03	Submit to the NRC updated technical specification marked-up pages for relaxed secondary containment changes.	30 days after NRC approval of ITS.

PACKAGE DIVIDER

DRP-003