FENOC

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February 11, 2002
PY-CEI/NRR-2609L

United States Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Perry Nuclear Power Plant
Docket No. 50-440
License Amendment Request Pursuant to 10 CFR 50.90: Alternative Source Term Update of a Previous License Amendment which Adopted Shutdown Safety Administrative Controls During Fuel Movement.

Ladies and Gentlemen:

A license amendment is requested to the Technical Specifications for the Perry Nuclear Power Plant (PNPP). The requested change utilizes Alternative Source Term radiological calculations to update and expand upon License Amendments 102 and 103, issued in March 1999. Amendment 102 introduced the concept of utilizing Shutdown Safety administrative controls in place of Technical Specifications to provide defense in depth during fuel handling activities. Amendment 103 was a pilot plant application of an Alternative Source Term for a loss of coolant accident. New fuel handling accident calculations performed for PNPP will no longer credit OPERABILITY of filtration systems or the Containment/Fuel Handling buildings. As a result, the 10 CFR 50.36 criteria that specify the items that must remain in Technical Specifications no longer apply to these buildings and filtration systems during fuel handling activities, since they are no longer part of the "primary success path" for the Fuel Handling Accident. Shutdown Safety administrative controls over filtration system availability and building closure will be used in place of Technical Specifications to provide defense in depth during fuel handling activities. Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors" was utilized in the development of this application.

Approval is requested by December 14, 2002, to support preparations for the ninth refueling outage. This application is considered a cost beneficial licensing change due to anticipated cost savings on outage duration. If you have questions or require additional information, please contact Mr. Gregory A. Dunn, Manager - Regulatory Affairs, at (440) 280-5305.

Very truly yours,

Enclosures:

1. Notarized Affidavit
2. Evaluation of the changes, including a Summary, Description of the Changes, Background, Technical Analysis, Regulatory Analysis/Commitments, and Environmental Consideration
3. Significant Hazards Consideration
4. Proposed Technical Specification Changes (mark-up)
5. Dose Calculation entitled "Fuel Handling Accident Using Alternative Source Term"
6. Information copy of Technical Specification Table of Contents and Bases (mark-up)
7. Information copy of proposed USAR changes (mark-up)

cc: NRC Project Manager
NRC Resident Inspector
NRC Region III
State of Ohio

I, Guy G. Campbell, hereby affirm that (1) I am Vice President - Perry, of the FirstEnergy Nuclear Operating Company, (2) I am duly authorized to execute and file this certification as the duly authorized agent for The Cleveland Electric Illuminating Company, Toledo Edison Company, Ohio Edison Company, and Pennsylvania Power Company, and (3) the statements set forth herein are true and correct to the best of my knowledge, information and belief.

Guy G. Campbell

Subscribed to and affirmed before me, the 11th day of February, 2002

Jane E Mott

JANE E. MOTT
Notary Public, State of Ohio
My Commission Expires Feb. 20, 2005
(Recorded in Lake County)

Summary

The changes proposed to the Perry Nuclear Power Plant (PNPP) Technical Specifications are based on a new dose analysis for the design basis Fuel Handling Accident, using an Alternative Source Term (AST). Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors" was utilized in the development of this application.

Although it is not physically possible for the process of plant cooldown and vessel disassembly to be completed to the point of handling fuel within only one day (three days is the current best estimate), the analysis assumes the event occurs after only one day (24 hours) of radiological decay, rather than seven days as was assumed in License Amendment 102 (issued in March 1999). Even with this 24-hour assumption, the doses from such an event remain within regulatory acceptance limits, even without credit for OPERABILITY of filtration systems or the Containment/Fuel Handling Building. Since the filtration systems and Containment/Fuel Handling Buildings are no longer credited as part of the "primary success path" for the Fuel Handling Accident, the 10 CFR 50.36 criteria for including items within Technical Specifications are no longer applicable to these filtration systems and buildings during fuel handling activities. The Technical Specification requirements on OPERABILITY of various buildings and filtration systems during fuel handling are therefore being replaced with Shutdown Safety administrative controls, which maintain closure controls for buildings and availability (rather than OPERABILITY) for ventilation systems. In keeping with this concept, a commitment is included to the recently published Nuclear Energy Institute (NEI) guidance on assessing systems removed from service during the handling of irradiated fuel assemblies.

Description of the Changes

As a result of the new design basis calculation, a number of Specifications are deleted or revised. Since the only Applicability statement in the Fuel Handling Building (FHB) Specification and the FHB Ventilation Exhaust System Specification was "During movement of recently irradiated fuel in the FHB", these two Specifications would be removed from the Technical Specifications in their entirety. Also, in a number of specifications, various buildings/systems would now only be required to be OPERABLE when the plant is pressurized (MODE 1, 2 and 3), or during Operations with a Potential for Draining the Reactor Vessel (OPDRVs). The APPLICABILITY of these specifications would no longer include "During movement of recently irradiated fuel...". Finally, references to the FHB Ventilation System would be removed from the Ventilation Filter Testing Program in the Administrative Controls portion of the Specifications. The FHB Ventilation System would no longer be classified as an Engineered Safety Feature (ESF) system.

Specifically, the first change is to remove the following two Specifications in their entirety because they were only applicable during movement of recently irradiated fuel in the FHB:

Specification	Specification Name
3.7.8	Fuel Handling Building
3.7.9	Fuel Handling Building Ventilation Exhaust System

The second change is to delete references to "movement of recently irradiated fuel assemblies" in the Primary Containment and/or the Fuel Handling Building from the APPLICABILITY statements and ACTIONS of the following Specifications:

Specification	Specification Name
3.3.6.1	Primary Containment and Drywell Isolation Instrumentation
3.3.7.1	Control Room Emergency Recirculation (CRER) System Instrumentation
3.6.1.2	Primary Containment Air Locks
3.6.1.3	Primary Containment Isolation Valves (PCIVs)
3.6.1.10	Primary Containment – Shutdown

3.6.1.11	Containment Vacuum Breakers
3.6.1.12	Containment Humidity Control
3.6.4.1	Secondary Containment
3.6.4.2	Secondary Containment Isolation Valves (SCIVs)
3.6.4.3	Annulus Exhaust Gas Treatment (AEGT) System
3.7.3*	Control Room Emergency Recirculation (CRER) System
3.7.4*	Control Room Heating, Ventilating, and Air Conditioning (HVAC) System
3.8.2*	AC Sources – Shutdown (Applicability during MODES 4 & 5 remains)
3.8.5*	DC Sources – Shutdown (Applicability during MODES 4 & 5 remains)
3.8.8*	Distribution Systems – Shutdown (Applicability during MODES 4 & 5 remains)

* The NOTE's in these five specifications which state "LCO 3.0.3 is not applicable" are also being deleted. LCO 3.0.3 is a "shutdown statement" which only applies in MODES 1, 2, and 3. The purpose of the "LCO 3.0.3 is not applicable " note was to make it clear that if irradiated fuel was being handled in the Fuel Handling Building fuel pool during a period when the plant was pressurized (MODE 1, 2, or 3), there was no need to shut down the plant if a problem occurred with a system credited with mitigating a Fuel Handling Accident. As a result of the Fuel Handling Accident AST calculations, these systems are no longer credited in the design basis analyses. Since the APPLICABILITY statements for the above specifications will no longer include "movement of recently irradiated fuel assemblies", there is no need for this "LCO 3.0.3 is not applicable" note to remain.

Finally, reference to the Fuel Handling Building Ventilation System is removed from Administrative Control 5.5.7 "Ventilation Filter Testing Program (VFTP)", subsections a, b, c, d and e.

The annotated pages are provided in Enclosure 4. Also included for NRC information in Enclosures 6 and 7 are annotated Technical Specification Bases pages and a sampling of Updated Safety Analysis Report (USAR) pages, respectively.

Background

In a Federal Register Notice dated December 23, 1999, the Nuclear Regulatory Commission (NRC) published a new regulation, 10 CFR 50.67, providing a mechanism for licensed power reactors to replace the traditional accident source term used in design basis accident analyses with Alternative Source Terms (ASTs). Regulatory guidance for the implementation of these ASTs is provided in Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors", dated July 2000. 10 CFR 50.67(b) states that licensees who seek to revise their current accident source term in design basis radiological consequence analyses should apply for a license amendment under 10 CFR 50.90.

Two previous PNPP license amendments have laid the groundwork for the current license amendment request. License Amendment 102, issued in March 1999, introduced the concept that Shutdown Safety administrative controls can be utilized in lieu of Technical Specification controls during fuel handling, once the dose calculations demonstrate that regulatory limits for the Fuel Handling Accident can be met without credit for filtration systems and the Containment/Fuel Handling Buildings. License Amendment 103, also issued in March 1999, involved a pilot plant application of an alternative source term for a design basis Loss Of Coolant Accident (LOCA). Subsequent to March of 1999, significant consideration was given to the characteristics of the AST for a Fuel Handling Accident (FHA), which is different from a LOCA. The results of these considerations were published in Regulatory Guide 1.183, which is the primary regulatory basis document for the currently proposed change. This current request therefore applies the AST characteristics of a Fuel Handling Accident to the PNPP radiological calculations, to show that Shutdown Safety administrative controls can be applied to handling of fuel that has been subcritical for at least 24 hours.

Technical Analysis

The following table summarizes conformance to Regulatory Guide 1.183, to ensure the guidance is adequately addressed. This supplements the actual calculation, which is included as Enclosure 5.

Regulatory Guide 1.183 Guidance	Degree of Conformance
Section 1 Implementation of AST *1.1.1 Safety Margins* "The proposed uses of an AST and the associated proposed facility modifications and changes to procedures should be evaluated to determine whether the proposed changes are consistent with the principle that sufficient safety margins are maintained, including a margin to account for analysis uncertainties. The safety margins are products of specific values and limits contained in the technical specifications (which cannot be changed without NRC approval) and other values, such as assumed accident or transient initial conditions or assumed safety system response times. Changes, or the net effects of multiple changes, that result in a reduction in safety margins may require prior NRC approval. Once the initial AST implementation has been approved by the staff and has become part of the facility design basis, the licensee may use 10 CFR 50.59 and its supporting guidance in assessing safety margins related to subsequent facility modifications and changes to procedures."	Sufficient safety margins are maintained with the Alternative Source Term analyses. There are a number of conservatisms in the calculations, which account for analysis uncertainties. The primary uncertainties in the calculation consist of the inventory released from the fuel, the scrubbing of the nuclides from the water pool over the fuel, the efficiency of filtration provided by plant structures and systems, and dispersion of the release as it travels away from the plant. The inventory available in the fuel is determined using an NRC accepted code (see Section 3.1 below) which is conservative enough to address uncertainties in the inventory, and in the radiological decay process. The fraction of that inventory which is available in the gap of the fuel rods is assumed to be the same as provided in Regulatory Guide 1.183 (see Section 3.2 below), which addresses uncertainties in the gap fraction. The uncertainties of the scrubbing provided by the water is addressed by using the overall decontamination factor (DF) of 200 documented in Regulatory Guide 1.183. This is a conservative value. Several plants that have submitted Alternative Source Term analyses have shown that the overall DF provided by the water over the fuel is actually greater than the 200 value. The requirements for water coverage over the fuel in the Technical Specifications remain unchanged by this proposal. The uncertainties in the efficiency of filtration systems to treat the release are addressed by assuming there are no Containment or Fuel Handling Buildings or ventilation/filtration systems present, and the release from the pool to the environment is an instantaneous, undiluted, and unfiltered release. The release is then dispersed by Chi/Q values previously approved by the NRC, which were considered to adequately address uncertainties in the actual dispersion of the release. Taking no credit for the Containment or Fuel Handling Buildings or ventilation/filtration systems is a significant penalty, since as detailed below for Item 1.1.2 "Defense in Depth", buildings and filtration systems such as the Fuel Handling Building

Regulatory Guide 1.183 Guidance	Degree of Conformance
	Ventilation System will remain available (note: the USAR name for this system uses the word "Area" rather than "Building"). One other significant item that the calculation does not fully credit is the amount of radiological decay that the available inventory would undergo before the point in the outage when it is physically possible to be handling fuel and have the accident occur. The calculation only assumes 24-hours of decay. It is not physically possible to begin handling of irradiated fuel, or any loads over irradiated fuel, within 24 hours. It takes substantially longer than 24 hours to drain and decontaminate the upper cavity, remove the Drywell and reactor vessel heads, and remove the steam separators and dryers. An estimate of the best time that can be expected at a plant with PNPP's design features is 3 days (72 hours). The best time that has been achieved to date at PNPP was 79 hours, in a planned mid-cycle fuel replacement outage that was dedicated only to fuel movement. Since radiological decay is a natural process, it is 100% reliable in its reduction of the source term available for release. Therefore assuming only 1 day instead of 3 days of decay is a significant penalty, since crediting the 2 additional days of decay in the calculation would result in a lower source term and lower resultant doses. The 24 hour value is enforced in the PNPP Operational Requirements Manual (ORM), in the Decay Time specification (a copy is included at the beginning of Enclosure 6). The Decay Time specification was relocated to the ORM as part of the improved Technical Specifications. The NRC Safety Evaluation for Amendment 69 still holds true, where it stated: "Although Criterion 2 of the Final Policy Statement would require [the Decay Time specification] to be retained in the improved TS, the requirement for a 24 hour decay time following subcriticality before commencing movement of irradiated fuel in the reactor vessel will always be met for a refueling outage. ...Therefore, the requirement is unnecessary and has been relocated from the specifications to the ORM." The dose calculation results remain below the limits of 10 CFR 50.67. Table 7 of Enclosure 5 presents the results of the base calculation (Table 8 presents sensitivities), along with the applicable dose limits: **TABLE 7 RESULTS** (Control Room / EAB / LPZ) RADTRAD Results (rem): 1.03 / 1.44 / 0.161 Regulatory limit (rem): 5 / 6.3 / 6.3

TABLE 7 RESULTS

	Control Room	EAB	LPZ
RADTRAD Results (rem)	1.03	1.44	0.161
Regulatory limit (rem)	5	6.3	6.3

Regulatory Guide 1.183 Guidance	Degree of Conformance
1.1.2 Defense in Depth "The proposed uses of an AST and the associated proposed facility modifications and changes to procedures should be evaluated to determine whether the proposed changes are consistent with the principle that adequate defense in depth is maintained to compensate for uncertainties in accident progression and analysis data. Consistency with the defense-in-depth philosophy is maintained if system redundancy, independence, and diversity are preserved commensurate with the expected frequency, consequences of challenges to the system, and uncertainties. In all cases, compliance with the General Design Criteria in Appendix A to 10 CFR Part 50 is essential. Modifications proposed for the facility generally should not create a need for compensatory programmatic activities, such as reliance on manual operator actions. ...	Adequate defense in depth is maintained through the use of Shutdown Safety administrative controls over building closure and filtration system availability, in addition to the natural defenses of radiological decay over time (which reduces the magnitude of any release) and the scrubbing effect of the water pool over the fuel (which is not being changed as a result of this amendment). As noted above, the radiological calculations show that Fuel Handling Accident doses remain within regulatory acceptance limits. Therefore, there are no requirements for Engineered Safety Feature (ESF) grade ventilation systems or Technical Specification controls over Containment/Fuel Handling Building or ventilation system OPERABILITY. However, monitoring and filtration of releases from the plant, even following postulated accidents, is still necessary to ensure compliance with: ♦ 10 CFR 20 and 10CFR 50 Appendix I requirements on effluents to unrestricted areas ♦ Technical Specification 5.5.4 "Radioactive Effluent Controls Program" ♦ Technical Specification 5.6.3 "Radioactive Effluent Release Report" ♦ GDC 61"Fuel Storage and Handling and Radioactivity Control" ♦ GDC 63 "Monitoring Fuel and Waste Storage" ♦ GDC 64 "Monitoring Radioactivity Releases" Due to the above requirements, although the Fuel Handling Building Ventilation Exhaust System will no longer be classified as an ESF system, and the Technical Specification controls will be removed, Shutdown Safety administrative controls will still remain in place. As part of the Nuclear Regulatory Commission (NRC) resolution of the proposed Shutdown Rule (1997), the Maintenance Rule, 10 CFR 50.65, was revised to require licensees to assess the impact on shutdown safety before removing equipment from service for maintenance. The industry, through the Nuclear Energy Institute (NEI), developed guidance to implement this new requirement. A recently approved Revision 3 to NUMARC 93-01, Section 11.3.6.5, contains the final approved wording on how the industry is addressing Containment during plant shutdown periods. License Amendment 102 (March 1999), which provided the original approval of handling irradiated fuel under Shutdown Safety controls rather than Technical Specifications at PNPP, contained a commitment to the draft version of this NUMARC (now NEI) document. With this new letter, this commitment is updated to commit to Revision 3 of NUMARC 93-01,

Regulatory Guide 1.183 Guidance	Degree of Conformance
Proposed modifications that seek to downgrade or remove required engineered safeguards equipment should be evaluated to be sure that the modification does not invalidate assumptions made in facility PRAs and does not adversely impact the facility's severe accident management program."	Section 11.3.6.5. This ensures that a building closure plan is in effect and ventilation systems remain available to monitor and filter a release from a Fuel Handling Accident. [See Commitment 1 at the end of this Enclosure.] In order to be sure the Technical Specification modifications and the downgrade of the Fuel Handling Building Ventilation System to a non-ESF do not invalidate assumptions in the PNPP Probabilistic Safety Analysis (PSA), and does not adversely impact the facility's Severe Accident Management (SAM) program, this submittal was reviewed by subject matter experts for both the above areas. The conclusion was that neither the PSA nor the SAM guidelines were invalidated or adversely affected.
1.1.3 Integrity of Facility Design Basis "...Although a complete re-assessment of all facility radiological analyses would be desirable, the NRC staff determined that recalculation of all design analyses would generally not be necessary. Regulatory Position 1.3 of this guide provides guidance on which analyses need updating as part of the AST implementation submittal and which may need updating in the future as additional modifications are performed. This approach would create two tiers of analyses, those based on the previous source term and those based on an AST. ... In either case, the facility design bases should clearly indicate that the source term assumptions and radiological criteria in these affected analyses have been superseded and that future revisions of these analyses, if any, will use the updated approved assumptions and criteria. ..."	See further discussion under Regulatory Position 1.3 below, and see the markups of the Updated Safety Analysis Report (USAR) in Enclosure 7. These note that this application is considered to be a selective application of the AST. The USAR markups note that the source term assumptions and radiological criteria in the previous Fuel Handling Accident analyses have been superceded by the new analyses, and future revisions of Fuel Handling Accident analyses will use the updated source term assumptions and radiological criteria.
1.1.4 Emergency Preparedness Applications "...The AST is not representative of the wide spectrum of possible events that make up the planning basis of emergency preparedness. Therefore, the AST is insufficient by itself as a basis for requesting relief from the emergency preparedness requirements of 10 CFR 50.47 and Appendix E to 10 CFR Part 50. This guidance does not, however, preclude the appropriate use of the insights of the AST in establishing emergency response procedures such as those associated with emergency dose projections, protective measures, and severe accident management guides."	No relief is being requested from emergency planning provisions. Procedures are already in place for responding to a fuel handling accident using administrative controls for building closure, as a result of License Amendment 102.
1.2.1 Full Implementation	This application is not considered to be a full implementation. See Section 1.2.2 below.
1.2.2 Selective Implementation "Selective implementation is a modification of the facility design basis that (1) is based on one or	This application entails re-evaluation of a limited subset of the design basis radiological analyses,

Regulatory Guide 1.183 Guidance	Degree of Conformance
more of the characteristics of the AST or (2) entails re-evaluation of a limited subset of the design basis radiological analyses. The NRC staff will allow licensees flexibility in technically justified selective implementations provided a clear, logical, and consistent design basis is maintained. An example of an application of selective implementation would be ... a request to remove the charcoal filter media from the spent fuel building ventilation exhaust. For the latter, the licensee may only need to re-analyze DBAs that credited the iodine removal by the charcoal media. Additional analysis guidance is provided in Regulatory Position 1.3 of this guide. NRC approval for the AST (and the TEDE dose criterion) will be limited to the particular selective implementation proposed by the licensee. The licensee would be able to make subsequent modifications to the facility and changes to procedures based on the selected AST characteristics incorporated into the design basis under the provisions of 10 CFR 50.59. However, use of other characteristics of an AST or use of TEDE criteria that are not part of the approved design basis, and changes to previously approved AST characteristics, would require prior staff approval under 10 CFR 50.67..."	specifically the Fuel Handling Accident. There are no physical design modifications to the plant being performed in concert with this amendment. The only "modifications" being proposed are to replace the Technical Specification controls on OPERABILITY of ventilation/filtration systems and the Containment/Fuel Handling Buildings during fuel handling with Shutdown Safety controls, and declassification of the Fuel Handling Building Ventilation Exhaust System to a non-ESF status. In order to accomplish this, the only DBA that needs to be reanalyzed is the Fuel Handling Accident. The descriptions of how the design basis for this event is being maintained are included in the sample USAR markups in Enclosure 7. It is understood that since this is a selective application of the AST for the Fuel Handling Accident, NRC approval will be limited to this event. Use of AST to change the design basis for other events such as the Control Rod Drop Accident or the Main Steam Line Break Outside Containment, or changes to the approved AST characteristics, would require prior staff approval under 10 CFR 50.67.
1.3.1 Design Basis Radiological Analyses "There are several regulatory requirements for which compliance is demonstrated, in part, by the evaluation of the radiological consequences of design basis accidents. These requirements include, but are not limited to, the following. ♦ Environmental Qualification of Equipment (10 CFR 50.49) ♦ Control Room Habitability (GDC-19 of Appendix A to 10 CFR Part 50) ♦ Emergency Response Facility Habitability (Paragraph IV.E.8 of Appendix E to 10 CFR Part 50) ♦ Alternative Source Term (10 CFR 50.67) ♦ Environmental Reports (10 CFR Part 51) ♦ Facility Siting (10 CFR 100.11) There may be additional applications of the accident source term identified in the Technical Specification bases and in various licensee commitments. These include, but are not limited to, the following from Reference 2, NUREG-0737. ♦ Post-Accident Access Shielding (NUREG-0737, II.B.2) ♦ Post-Accident Sampling Capability (NUREG-0737, II.B.3) ♦ Accident Monitoring Instrumentation (NUREG-0737, II.F.1)	**10 CFR 50.49 Environmental Qualification of Equipment** – No credit is taken for filtration system OPERABILITY (or OPERABILITY of any other system) in the design basis calculations for the Fuel Handling Accident. Therefore, there is not a concern that some aspect of the alternative source term could make such systems unable to perform a "credited" safety function. **GDC 19 Control Room Habitability** – For a Fuel Handling Accident, a design basis dose calculation for the Control Room was performed. The base calculation showed that doses remained less than the 5 rem Total Effective Dose Equivalent (TEDE) limit in GDC-19 and 10 CFR 50.67, even assuming no Containment or FHB integrity, or filtration system OPERABILITY. **10 CFR 50 Appendix E Emergency Response Facility Habitability** – The proposed changes do not result in changes to Emergency Response Facility Habitability. 10 CFR 50 Appendix E does not contain habitability criteria, however NUREG-0737 Supplement 1 does. The only facility with a specific dose criterion is the Technical Support Center (TSC). The dose limit in Supplement 1 for this facility is 5 rem whole body, or its equivalent. The "or equivalent" for this evaluation is considered to be 5 rem TEDE.

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♦ Leakage Control (NUREG-0737, III.D.1.1) ♦ Emergency Response Facilities (NUREG-0737, III.A.1.2) ♦ Control Room Habitability (NUREG-0737, III.D.3.4)."	Although the TSC has essentially no response function for a Fuel Handling Accident, a scoping study for the TSC was performed. The ventilation intakes for the TSC are farther away from the containment structure and from ventilation system release points than the Control Room intakes, and the TSC intake is at a lower elevation by more than 60 feet. Since the dispersion of a plume for an intake at a greater distance and lower elevation would be correspondingly better, the scoping evaluation concluded that the 5 rem TEDE limit would be met for the TSC as well. The regulatory guidance does not include specific dose limits for Emergency Operations Facility (EOF) and backup EOF habitability. For the same reasons as discussed for the TSC, these facilities are also considered to not be adversely affected as a result of this change in the source term assumptions. **10 CFR 50.67 Accident Source Term** – The acceptance criteria of 10 CFR 50.67 and the attributes of an acceptable alternative source term as described in Regulatory Guide 1.183 are being utilized in this application. **10 CFR Part 51 Environmental Protection Regulations** – See the section of this letter entitled "Environmental Consideration" below. **10 CFR 100.11 Facility Siting** – As noted in Footnote 5 of Reg. Guide 1.183, the dose guidelines of 10 CFR 100 are superceded by 10 CFR 50.67 for applications implementing an alternative source term such as this. **NUREG-0737 Item II.B.2 Post-Accident Access Shielding** – There are no design basis actions credited outside the Control Room for a Fuel Handling Accident. TSC access/dose was addressed above. **NUREG-0737 Item II.B.3 Post-Accident Sampling Capability** – No post-accident sampling inside the Containment is required for a Fuel Handling Accident. **Accident Monitoring Instrumentation (NUREG-0737, II.F.1)** - No post-accident monitors are required to respond to a Fuel Handling Accident. **NUREG-0737 Item III.D.1.1 Leakage Control** – No post-accident leakage control is required for a Fuel Handling Accident. **NUREG-0737 Item III.A.1.2 Emergency Response Facilities** – Item III.A.1.2 is unaffected, since no dose protection or habitability guidance is included in this TMI item. See discussions above on Emergency Response Facilities. **NUREG-0737, Item III.D.3.4 Control Room Habitability** – Control Room habitability was

Regulatory Guide 1.183 Guidance	Degree of Conformance
	analyzed and determined to be acceptable, by meeting the radiological dose limits of 10 CFR 50.67. The proposed amendment does not affect protection from toxic gases. No additional applications of the accident source term for a Fuel Handling Accident were identified in the Technical Specification Bases or in licensee commitments.
1.3.2 Re-Analysis Guidance "Any implementation of an AST, full or selective, and any associated facility modification should be supported by evaluations of all significant radiological and non-radiological impacts of the proposed actions. This evaluation should consider the impact of the proposed changes on the facility's compliance with the regulations and commitments listed above as well as any other facility-specific requirements. These impacts may be due to (1) the associated facility modifications or (2) the differences in the AST characteristics. The scope and extent of the re-evaluation will necessarily be a function of the specific proposed facility modification and whether a full or selective implementation is being pursued. The NRC staff does not expect a complete recalculation of all facility radiological analyses, but does expect licensees to evaluate all impacts of the proposed changes and to update the affected analyses and the design bases appropriately. An analysis is considered to be affected if the proposed modification changes one or more assumptions or inputs used in that analysis such that the results, or the conclusions drawn on those results, are no longer valid. Generic analyses, such as those performed by owner groups or vendor topical reports, may be used provided the licensee justifies the applicability of the generic conclusions to the specific facility and implementation. Sensitivity analyses, discussed below, may also be an option. If affected design basis analyses are to be re-calculated, all affected assumptions and inputs should be updated and all selected characteristics of the AST and the TEDE criteria should be addressed. The license amendment request should describe the licensee's re-analysis effort and provide statements regarding the acceptability of the proposed implementation, including modifications, against each of the applicable analysis requirements and commitments identified in Regulatory Position 1.3.1 of this guide. ..."	As noted above, there are no design changes being made in conjunction with this proposal. The buildings and ventilation/filtration systems are not being physically modified. The Technical Specification controls during handling of fuel are being replaced with Shutdown Safety administrative controls, since the design basis calculations no longer need to credit the Containment/Fuel Handling Building integrity or ventilation system effectiveness. The Fuel Handling Building Ventilation System will continue to be available as a non-ESF system, similar to other non-ESF ventilation systems at PNPP, which are maintained/tested consistent with guidance in Regulatory Guide 1.140. Compliance with various regulations and commitments were addressed in items above. The design basis FHA calculation has been updated and is included in Enclosure 5 for NRC review. This selective implementation is solely for the Fuel Handling Accident, since fuel handling is the activity that is being removed from the Applicability of the various Technical Specifications. Other design basis calculations were determined to not be affected by this proposed Technical Specification change. Draft Bases and USAR markups are also provided for information in Enclosures 6 and 7. In the calculation, all affected assumptions and inputs were updated to address AST and TEDE, and all selected characteristics of the AST and the TEDE criteria are addressed. Statements regarding the acceptability of the proposed Technical Specification changes against each of the applicable items identified in Regulatory Position 1.3.1 of the Reg. Guide were provided above. The above discussion addressed radiological impact of the proposed changes. Since there are no physical design changes being made in conjunction with this proposal, there are also no non-radiological impacts as a result of the proposed changes.

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1.3.3 Use of Sensitivity or Scoping Analyses "It may be possible to demonstrate by sensitivity or scoping evaluations that existing analyses have sufficient margin and need not be recalculated. As used in this guide, a sensitivity analysis is an evaluation that considers how the overall results vary as an input parameter (in this case, AST characteristics) is varied. A scoping analysis is a brief evaluation that uses conservative, simple methods to show that the results of the analysis bound those obtainable from a more complete treatment. Sensitivity analyses are particularly applicable to suites of calculations that address diverse components or plant areas but are otherwise largely based on generic assumptions and inputs. Such cases might include post-accident vital area access dose calculations, shielding calculations, and equipment environmental qualification (integrated dose). It may be possible to identify a bounding case, re-analyze that case, and use the results to draw conclusions regarding the remainder of the analyses. It may also be possible to show that for some analyses the whole body and thyroid doses determined with the previous source term would bound the TEDE obtained using the AST. Where present, arbitrary "designer margins" may be adequate to bound any impact of the AST and TEDE criteria. If sensitivity or scoping analyses are used, the license amendment request should include a discussion of the analyses performed and the conclusions drawn. Scoping or sensitivity analyses should not constitute a significant part of the evaluations for the design basis exclusion area boundary (EAB), low population zone (LPZ), or control room dose."	No sensitivity evaluations that varied AST characteristics were performed. However, several sensitivity evaluations were performed which varied Control Room ventilation assumptions to show doses remained acceptable. In the base case, normal ventilation continues to operate throughout the event, which initially brings the undiluted, unfiltered source term directly into the Control Room without any isolation protection. This case takes no credit for the Control Room Area Radiation Monitor or the Emergency Recirculation (filtration) system, showing that they do not need to be in the Technical Specifications during fuel handling. This serves as the basis for the removal of the Technical Specification Applicability of "During movement of recently irradiated fuel..." from several Control Room related specifications. Two other calculation sensitivity cases were also run, which isolated the control room at the worst possible time, after the source term available at the intake is introduced into the Control Room. For these two cases, the isolation exists for 2 hours, and then was followed by either a subsequent re-initiation of the normal intake flow, or the use of the filtration system. Each case produced an acceptable result, showing that following a Fuel Handling Accident, the operators have flexibility on how to operate their ventilation systems without exceeding the radiological acceptance criteria. The base case shows that filtration systems are not required. The two sensitivity cases show that ventilation/filtration systems can be effectively used to reduce doses to the Control Room operators in the event that the radiation monitor isolates the Control Room intake at the worst possible time after available activity is taken into the Control Room. A scoping evaluation is also used to show that the TSC doses would be lower than the Control Room doses since the TSC inlet is farther away from the plant vents and the Containment itself than the Control Room inlets are, and is lower on the buildings by more than 60 feet, so the dispersion factors would be better than the previously NRC-approved dispersion factors for the Control Room intakes.
1.3.4 Updating Analyses Following Implementation "Full implementation of the AST replaces the previous accident source term with the approved AST and the TEDE criteria for all design basis radiological analyses. ... Since [for a full implementation] the AST and the TEDE criteria are	This is a selective implementation rather than a full implementation. Since the USAR discussions of the Fuel Handling Accident will include the AST and TEDE criteria (see

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part of the approved design basis for the facility, use of the AST and TEDE criteria in new applications at the facility do not constitute a change in analysis methodology that would require NRC approval. This guidance is also applicable to selective implementations to the extent that the affected analyses are within the scope of the approved implementation as described in the facility design basis. In these cases, the characteristics of the AST and TEDE criteria identified in the facility design basis need to be considered in updating the analyses. Use of other characteristics of the AST or TEDE criteria that are not part of the approved design basis, and changes to previously approved AST characteristics, requires prior NRC staff approval under 10 CFR 50.67."	Enclosure 7), future updates to Fuel Handling Accident calculations will continue to use the characteristics of the AST and TEDE under the provisions of 10 CFR 50.59.
1.3.5 Equipment Environmental Qualification "Current environmental qualification (EQ) analyses may be impacted by a proposed plant modification associated with the AST implementation. The EQ analyses that have assumptions or inputs affected by the plant modification should be updated to address these impacts. The NRC staff is assessing the effect of increased cesium releases on EQ doses to determine whether licensee action is warranted. ..."	There are no physical plant modifications associated with this AST implementation. There are also no increased EQ requirements as a result of this proposed Technical Specification change and declassification of the Fuel Handling Building Ventilation Exhaust System from an ESF status. Further details on EQ are provided in Section 6. The cesium issue discussed in this section of the Regulatory Guide is associated with a LOCA and is unrelated to a Fuel Handling Accident.
1.4 Risk Implications "The use of an AST changes only the regulatory assumptions regarding the analytical treatment of the design basis accidents. The AST has no direct effect on the probability of the accident. Use of an AST alone cannot increase the core damage frequency (CDF) or the large early release frequency (LERF). However, facility modifications made possible by the AST could have an impact on risk. If the proposed implementation of the AST involves changes to the facility design that would invalidate assumptions made in the facility's PRA, the impact on the existing PRAs should be evaluated. Consideration should be given to the risk impact of proposed implementations that seek to remove or downgrade the performance of previously required engineered safeguards equipment on the basis of the reduced postulated doses. The NRC staff may request risk information if there is a reason to question adequate protection of public health and safety. The licensee may elect to use risk insights in support of proposed changes to the design basis that are not addressed in currently approved NRC staff positions. ..."	The Technical Specification changes constitute the proposed "modifications", along with the declassification of the Fuel Handling Building Ventilation Exhaust System to a non-ESF status. Shutdown Safety administrative controls over building closure and filtration system availability (rather than OPERABILITY) will replace the Technical Specification controls. Even without credit for the Containment or Fuel Handling Building integrity or the ventilation/filtration systems, the dose calculations continue to meet the regulatory acceptance criteria. Therefore, there is not an impact on the Large Early Release Frequency as a result of the proposed changes. Probabilistic Safety Analysis personnel reviewed this submittal to determine the impact on the existing PSA. They concluded that the change did not invalidate assumptions made in the PSA. Although risk insights are not being used to support this change, some risk insights were utilized in NRC approval of License Amendment 102, which remain applicable to this proposed change.
1.5 Submittal Requirements " ... The NRC staff's finding that the amendment	The dose analysis calculation is being provided for

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may be approved must be based on the licensee's analyses, since it is these analyses that will become part of the design basis of the facility. The amendment request should describe the licensee's analyses of the radiological and nonradiological impacts of the proposed modification in sufficient detail to support review by the NRC staff. The staff recommends that licensees submit affected FSAR pages annotated with changes that reflect the revised analyses or submit the actual calculation documentation. If the licensee has used a current approved version of an NRC-sponsored computer code, the NRC staff review can be made more efficient if the licensee identifies the code used ...."	NRC review as Enclosure 5. Additional detail on how the NRC guidance in Regulatory Guide 1.183 is being met is provided in this table format. A draft of a USAR change package, which includes examples of the types of changes that will be made, is also included for information as Enclosure 7. The Code used in the analysis was RADTRAD 3.02, January 5, 2000.
1.6 FSAR Requirements " ... The regulations in 10 CFR 50.71(e) require that the FSAR be updated to include all changes made in the facility or procedures described in the FSAR.... The affected radiological analysis descriptions in the FSAR should be updated to reflect the replacement of the design basis source term by the AST. The analysis descriptions should contain sufficient detail to identify the methodologies used, significant assumptions and inputs, and numeric results. ... The descriptions of superseded analyses should be removed from the FSAR in the interest of maintaining a clear design basis.	A draft USAR change package is provided for information in Enclosure 7, which provides examples of how the licensing basis will be revised as a result of this proposed amendment.
Section 2 Attributes Of An Acceptable AST "...Regulatory Position 3 of this guide identifies an AST that is acceptable to the NRC staff for use at operating power reactors. A substantial effort was expended by the NRC, its contractors, various national laboratories, peer reviewers, and others in performing severe accident research and in developing the source terms provided in NUREG-1465 (Ref. 5). However, future research may identify opportunities for changes in these source terms. The NRC staff will consider applications for an AST different from that identified in this guide."...	This application uses the characteristics of the source term outlined in Regulatory Position 3 of Reg. Guide 1.183. Therefore the rest of Section 2 is considered to be not applicable, since no attempt is made to define different source term characteristics from those provided in the Reg. Guide.
Section 3 Accident Source Term *3.1 Fission Product Inventory* "The inventory of fission products in the reactor core and available for release to the containment should be based on the maximum full power operation of the core with, as a minimum, current licensed values for fuel enrichment, fuel burnup, and an assumed core power equal to the current licensed rated thermal power times the ECCS evaluation uncertainty. The period of irradiation should be of sufficient duration to allow the activity of dose-significant radionuclides to reach equilibrium or to reach maximum values. The core inventory should be determined using an	General Electric (GE) used the computer code ORIGEN 2 to determine the core inventory for a Fuel Handling Accident. This input was originally developed to support the power uprate and 24-month operating cycle amendments (License Amendments 112 and 115). The core inventory provided by GE was performed in Curies per megawatt (Ci/MW). The inventory was adjusted by an additional 2% to account for evaluation uncertainty. The fission product inventory of each of the fuel rods was determined by dividing the total core inventory by the number of fuel rods in the core. To

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appropriate isotope generation and depletion computer code such as ORIGEN 2 (Ref. 17) or ORIGEN-ARP (Ref. 18). ... For DBA events that do not involve the entire core, the fission product inventory of each of the damaged fuel rods is determined by dividing the total core inventory by the number of fuel rods in the core. To account for differences in power level across the core, radial peaking factors from the facility's core operating limits report (COLR) or technical specifications should be applied in determining the inventory of the damaged rods. ... For events postulated to occur while the facility is shutdown, e.g., a fuel handling accident, radioactive decay from the time of shutdown may be modeled."	account for differences in power level across the core, a radial peaking factor of 2.0 was applied. This simulates that the rods in the bundle being dropped and the struck bundles would be the highest inventory rods in the core. This maximum core wide radial peaking factor of 2.0 is being added into the list of reload analysis parameters that must be re-verified each cycle. [See Commitment 2] For the Fuel Handling Accident analyses performed for this submittal, radioactive decay from the time of shutdown was modeled.
3.2 Release Fractions " ... 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. The release fractions from Table 3 are used in conjunction with the fission product inventory calculated with the maximum core radial peaking factor." [An applicable footnote is linked to Table 3. Footnote 11 states "The release fractions listed here have been determined to be acceptable for use with currently approved LWR fuel with a peak burnup up to 62,000 MWD/MTU provided that the maximum linear heat generation rate does not exceed 6.3 kw/ft peak rod average power for burnups exceeding 54 GWD/MTU. As an alternative, fission gas release calculations performed using NRC-approved methodologies may be considered on a case-by-case basis. To be acceptable, these calculations must use a projected power history that will bound the limiting projected plant-specific power history for the specific fuel load. ..."]	Table 3 fractions were applied to the fission product inventory determined as described above for the rods with the maximum core radial peaking factor. These fractions are 8% of I-131, 10% of Kr-85, 5% of the other Noble Gases, 5% of the other Halogens, and 12% of the Alkali Metals. For footnote 11, which applies to Table 3, the provisions in the first sentence of the footnote are met at PNPP. The fuel in use at PNPP is NRC approved fuel, and the average exposure of the peak fuel rod is maintained below 62,000 MWD/MTU (= 62 GWD/MTU). Also, the maximum linear heat generation rate for the fuel that could exceed 54 GWD/MTU by the end of the cycle is maintained at or below 6.3 kw/ft (in other words, the higher burnup fuel is moved to lower power portions of the core such as the periphery). The burnup limit of 62 GWD/MTU on the average exposure of the peak rod, and the LHGR limit of 6.3 kw/ft peak rod average power for the higher burnup fuel (> 54 GWD/MTU), are both being added into the list of reload analysis parameters that must be re-verified each cycle. [See Commitment 3]
3.3 Timing of Release Phases "... For non-LOCA DBAs in which fuel damage is projected, the release from the fuel gap and the fuel pellet should be assumed to occur instantaneously with the onset of the projected damage. ..."	For the Fuel Handling Accident, the release from the fuel gap is assumed to occur instantaneously with the impact of the fuel bundle.
3.4 Radionuclide Composition Table 5 lists the elements in each radionuclide group that should be considered in design basis analyses. **Table 5** Radionuclide Groups **Group** — **Elements** Noble Gases — Xe, Kr Halogens — I, Br Alkali Metals — Cs, Rb	This guidance is generic for all events. More specific guidance for a Fuel Handling Accident is provided in Appendix B to Reg. Guide 1.183. In summary, only the first three groups in this table are considered to be available in the gap for immediate release (the Noble Gases, the Halogens, and the Alkali Metals). However, the Alkali Metals (Cesium and Rubidium) are particulates that have an infinite

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Tellurium Group — Te, Sb, Se, Ba, Sr Noble Metals — Ru, Rh, Pd, Mo, Tc, Co Lanthanides — La, Zr, Nd, Eu, Nb, Pm, Pr Sm, Y, Cm, Am Cerium — Ce, Pu, Np	decontamination factor (i.e., they are fully retained by the water in the fuel pool or reactor cavity). Twenty of the most significant Noble Gases and Halogens are used in the calculation for a Fuel Handling Accident (see Enclosure 5). The other nuclides in these groups were not included because their core activity was less than 1E-9 Ci/MWt, and were considered insignificant.
3.5 Chemical Form " ... The accident-specific appendices to this Regulatory Guide provide additional details."	Specific details on Chemical Form for Fuel Handling Accidents are in the Appendix B discussions below.
3.6 Fuel Damage in Non-LOCA DBAs " ... The amount of fuel damage caused by a FHA is addressed in Appendix B of this guide.	See the fuel pin failure discussion below for the Appendix B items.
Section 4 Dose Calculational Methodology "The NRC staff has determined that there is an implied synergy between the ASTs and total effective dose equivalent (TEDE) criteria, and between the TID-14844 source terms and the whole body and thyroid dose criteria, and therefore, they do not expect to allow the TEDE criteria to be used with TID-14844 calculated results. The guidance of this section applies to all dose calculations performed with an AST pursuant to 10 CFR 50.67."	The Total Effective Dose Equivalent (TEDE) criteria are utilized in this AST application, which is performed pursuant to 10 CFR 50.67.
4.1 Offsite Dose Consequences "...*4.1.1* ... TEDE is the sum of the committed effective dose equivalent (CEDE) from inhalation and the deep dose equivalent (DDE) from external exposure. The calculation of these two components of the TEDE should consider all radionuclides, including progeny from the decay of parent radionuclides, that are significant with regard to dose consequences and the released radioactivity."	The TEDE dose calculations considered the radionuclides, including progeny from the decay of parent radionuclides, which are significant with regard to dose consequences and the released radioactivity. All the isotopes of bromine, iodine, krypton, and xenon with core activity greater than 1E-9 Ci/MWt (a total of 20) and their daughters, i.e., an additional three isotopes of cesium and rubidium, were used.
4.1.2 The exposure-to-CEDE factors for inhalation of radioactive material should be derived from the data provided in ICRP Publication 30, "Limits for Intakes of Radionuclides by Workers" (Ref. 19). Table 2.1 of Federal Guidance Report 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion" (Ref. 20), provides tables of conversion factors acceptable to the NRC staff. The factors in the column headed "effective" yield doses corresponding to the CEDE.	The conversion factors utilized for the CEDE inhalation component (of TEDE) were obtained from the 1989 printing of Federal Guidance Report 11.
4.1.3 For the first 8 hours, the breathing rate of persons offsite should be assumed to be 3.5×10^{-4} cubic meters per second. From 8 to 24 hours following the accident, the breathing rate should be assumed to be 1.8×10^{-4} cubic meters per second. After that and until the end of the accident, the rate	The recommended offsite Exclusion Area Boundary (EAB) and Low Population Zone (LPZ) breathing rates were used, however, considering that the release would occur instantaneously, the effective breathing rate used was 3.5E-4 m^3/s.

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should be assumed to be 2.3 x 10^{-4} cubic meters per second."	
4.1.4 The DDE should be calculated assuming submergence in semi-infinite cloud assumptions with appropriate credit for attenuation by body tissue. The DDE is nominally equivalent to the effective dose equivalent (EDE) from external exposure if the whole body is irradiated uniformly. Since this is a reasonable assumption for submergence exposure situations, EDE may be used in lieu of DDE in determining the contribution of external dose to the TEDE. Table III.1 of Federal Guidance Report 12, "External Exposure to Radionuclides in Air, Water, and Soil" (Ref. 21), provides external EDE conversion factors acceptable to the NRC staff. The factors in the column headed "effective" yield doses corresponding to the EDE.	The conversion factors utilized for the DDE/EDE external component (of TEDE) were obtained from the MACCS2 computer code, which uses the 1993 version of Federal Guidance Report 12.
4.1.5 ... The maximum EAB TEDE for any two-hour period following the start of the radioactivity release should be determined ... by calculating the postulated dose for a series of small time increments and performing a "sliding" sum over the increments for successive two-hour periods. The maximum TEDE obtained is submitted. ... (see also Table 6).	The activity is conservatively assumed to be immediately released (a puff release rather than a 2-hour period). Atmospheric dispersion of radioactivity during transport was accounted for by using the PNPP dispersion factors (Chi/Q), but the release was transported to the EAB and the LPZ immediately, without delay or deposition on the ground. Therefore, it was not necessary to perform sliding sums. Table 6 of Reg. Guide 1.183 identifies the FHA analysis release duration as 2 hours. The puff release replaced that assumption, and is considered conservative.
4.1.6 TEDE should be determined for the most limiting receptor at the outer boundary of the low population zone (LPZ) and should be used in determining compliance with the dose criteria in 10 CFR 50.67.	The TEDE dose was determined for the most limiting receptor at the outer boundary of the LPZ. The results, and the 10 CFR 50.67 limits, are presented in Table 7 of Enclosure 5.
4.1.7 No correction should be made for depletion of the effluent plume by deposition on the ground."	No credit was taken in the calculations for deposition of the radionuclides on the ground.
4.2 Control Room Dose Consequences "*...4.2.1* The TEDE analysis should consider all sources of radiation that will cause exposure to control room personnel. The applicable sources will vary from facility to facility, but typically will include: ♦ Contamination of the control room atmosphere by the intake or infiltration of the radioactive material contained in the radioactive plume released from the facility, ♦ Contamination of the control room atmosphere by the intake or infiltration of airborne radioactive material from areas and structures adjacent to the control room envelope,	All the radioactivity released from the pool is assumed to be immediately transported outside of the Containment without dilution. Contamination of the Control Room atmosphere by the intake of the available radioactive material contained in the radioactive plume was modeled. Infiltration in addition to the 6600 cfm of unfiltered intake was not incorporated, since there are no in-plant pathways that can transport activity to within the Control Room as effectively as via the outside air intake (additional information is provided in Section 3.14.1.2 of the calculation in Enclosure 5). In the

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♦ Radiation shine from the external radioactive plume released from the facility, ♦ Radiation shine from radioactive material in the reactor containment, ♦ 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.	event that the Control Room intake isolates and the activity is trapped in the Control Room, assuming lesser quantities of infiltration is conservative, since subsequent inleakage would dilute/purge the trapped activity. Due to shielding of the Control Room, radiation shine from a Fuel Handling Accident is considered to be a negligible dose contributor. More details on the various assumptions for radiation sources and the shielding available to the Control Room is provided in the calculation, Section 3.14.
4.2.2 The radioactive material releases and radiation levels used in the control room dose analysis should be determined using the same source term, transport, and release assumptions used for determining the EAB and the LPZ TEDE values, unless these assumptions would result in non-conservative results for the control room.	The radioactive material releases and radiation levels used in the Control Room dose analysis were determined using the same source term, transport, and release assumptions used for determining the EAB and the LPZ TEDE values. Control Room Chi/Q values were utilized.
4.2.3 The models used to transport radioactive material into and through the control room, and the shielding models used to determine radiation dose rates from external sources, should be structured to provide suitably conservative estimates of the exposure to control room personnel.	The RADTRAD computer code was used to model transport of radioactive material into and through the Control Room. This modeling provides suitably conservative estimates of the exposure to Control Room personnel.
4.2.4 Credit for engineered safety features that mitigate airborne radioactive material within the control room may be assumed. Such features may include control room isolation or pressurization, or intake or recirculation filtration. ... In most designs, control room isolation is actuated by engineered safeguards feature (ESF) signals or radiation monitors (RMs). In some cases, the ESF signal is effective only for selected accidents, placing reliance on the RMs for the remaining accidents. Several aspects of RMs can delay the control room isolation, including the delay for activity to build up to concentrations equivalent to the alarm setpoint and the effects of different radionuclide accident isotopic mixes on monitor response.	The base calculation takes no credit for Control Room engineered safety features or isolations, i.e., no credit for the Control Room radiation monitor that can isolate the intake, or for any filtration on the intake flows. Since no credit was taken for isolation of the intake by the radiation monitor, the issue of whether this monitor might be delayed in responding to the radiation is not a concern. Sensitivity studies were performed to examine the flexibility the Control Room operators have in using ventilation, to ensure there were no dose outliers. The studies evaluated what steps could be taken even if the radiation monitor was to isolate the intake at the worst possible time (after all of the available activity from the plume had been introduced into the Control Room). The sensitivity studies showed that even if the operators take two hours to take action, they can then either purge or use ventilation filters to remove the activity, and neither method resulted in excessive doses. Procedural guidance for response to a Fuel Handling Accident will be updated to recommend that the operators evaluate what dose minimization method for the Control Room is best suited for the case at hand (filtration or re-initiation of normal intake), then take the appropriate ventilation

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	measures to minimize dose. [See Commitment 4].
4.2.5 Credit should generally not be taken for the use of personal protective equipment or prophylactic drugs. Deviations may be considered on a case-by-case basis.	No credit was taken for the use of personal protective equipment or prophylactic drugs.
4.2.6 The dose receptor for these analyses is the hypothetical maximum exposed individual who is present in the control room for 100% of the time during the first 24 hours after the event, 60% of the time between 1 and 4 days, and 40% of the time from 4 days to 30 days. For the duration of the event, the breathing rate of this individual should be assumed to be 3.5 x 10 –4 cubic meters per second.	The dose receptor for these analyses was the hypothetical maximum exposed individual, who is present in the Control Room for 100% of the time during the first 24 hours after the event, 60% of the time between 1 and 4 days, and 40% of the time from 4 days to 30 days. For the duration of the event, the breathing rate of this individual was assumed to be 3.5 x 10^{-4} cubic meters per second.
4.2.7 Control room doses should be calculated using dose conversion factors identified in Regulatory Position 4.1 above for use in offsite dose analyses. The DDE from photons may be corrected for the difference between finite cloud geometry in the control room and the semi-infinite cloud assumption used in calculating the dose conversion factors. The following expression may be used to correct the semi-infinite cloud dose, DDE_{∞}, to a finite cloud dose ..."	The Control Room doses were calculated using the same dose conversion factors as identified in Regulatory Position 4.1 for use in offsite dose analyses. Also, the RADTRAD computer code uses the equation provided in Section 4.2.7 for correcting the finite versus semi-infinite cloud assumptions.
4.3 Other Dose Consequences "The guidance provided in Regulatory Positions 4.1 and 4.2 should be used, as applicable, in re-assessing the radiological analyses identified in Regulatory Position 1.3.1, such as those in NUREG-0737 (Ref. 2). Design envelope source terms provided in NUREG-0737 should be updated for consistency with the AST. In general, radiation exposures to plant personnel identified in Regulatory Position 1.3.1 should be expressed in terms of TEDE. Integrated radiation exposure of plant equipment should be determined using the guidance of Appendix I of this guide."	See Section 1.3.1 above for the responses to each of those items. "Design envelope source terms" are not being changed by the Fuel Handling Accident dose re-calculation. Radiation exposure estimates to plant personnel for many of the NUREG–0737 considerations are also not affected by a Fuel Handling Accident. The Technical Support Center doses were addressed through a scoping study comparison to the Control Room. Equipment qualification requirements for plant equipment in the Fuel Handling Building are not being revised as a result of the new Fuel Handling Accident calculation, consistent with guidance in Regulatory Guide 1.183, Section 1.3.5. In the Containment, the Fuel Handling Accident doses are not bounding for EQ purposes, so the design basis integrated exposure values are unaffected.
4.4 Acceptance Criteria "The radiological criteria for the EAB, the outer boundary of the LPZ, and for the control room are in 10 CFR 50.67. These criteria are stated for evaluating reactor accidents of exceedingly low probability of occurrence and low risk of public exposure to radiation, e.g., a large-break LOCA. The control room criterion applies to all accidents. For events with a higher probability of occurrence,	The 5 rem TEDE Control Room dose criterion from 10 CFR 50.67 is used. For EAB and LPZ, the 6.3 rem TEDE dose criterion from Table 6 of Regulatory Guide 1.183 is used (~25% of the 10 CFR 50.67 criterion). The NUREG-0737 item potentially affected by a Fuel Handling Accident is TSC dose (if the TSC is activated for such an

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postulated EAB and LPZ doses should not exceed the criteria tabulated in Table 6. The acceptance criteria for the various NUREG-0737 (Ref. 2) items generally reference General Design Criteria 19 (GDC 19) from Appendix A to 10 CFR Part 50 or specify criteria derived from GDC-19. These criteria are generally specified in terms of whole body dose, or its equivalent to any body organ. For facilities applying for, or having received, approval for the use of an AST, the applicable criteria should be updated for consistency with the TEDE criterion in 10 CFR 50.67(b)(2)(iii)."	event), which is estimated by a scoping study to be well within the 5 rem TEDE dose. The USAR markup provided in Enclosure 7 shows how the new dose criteria are being updated. RG 1.183 Table 6 also shows an "analysis release duration" of 2 hours. Instead of the 2-hour release duration, the calculation conservatively used an instantaneous release assumption.
Section 5. Analysis Assumptions and Methodology ***5.1 General Considerations*** *5.1.1 Analysis Quality* "The evaluations required by 10 CFR 50.67 ... should be prepared, reviewed, and maintained in accordance with quality assurance programs that comply with Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50. These design basis analyses were structured to provide a conservative set of assumptions to test the performance of one or more aspects of the facility design. Many physical processes and phenomena are represented by conservative, bounding assumptions rather than being modeled directly. The staff has selected assumptions and models that provide an appropriate and prudent safety margin against unpredicted events in the course of an accident and compensate for large uncertainties in facility parameters, accident progression, radioactive material transport, and atmospheric dispersion. Licensees should exercise caution in proposing deviations based upon data from a specific accident sequence since the DBAs were never intended to represent any specific accident sequence -- the proposed deviation may not be conservative for other accident sequences."	The revised Fuel Handling Accident calculations were prepared under a 10 CFR 50 Appendix B quality assurance program. The conservative, bounding characteristics of the AST that the NRC staff chose to present in Regulatory Guide 1.183 are used in the calculations. Therefore there are no proposed deviations from the AST characteristics that are based on specific accident sequences that would require additional justification to prove they are conservative for other accident sequences.
5.1.2 Credit for Engineered Safeguard Features "Credit may be taken 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 actuation requirements explicitly addressed in emergency operating procedures. The single active component failure that results in the most limiting radiological consequences should be assumed. Assumptions regarding the occurrence and timing of a loss of offsite power should be selected with the objective of maximizing the postulated radiological consequences."	No credit for ESF systems or components is taken in the base calculation, which produced acceptable results. The normal ventilation system is considered to continue to run throughout the event. Since the base case shows that no credit for isolation or filtration is necessary during fuel handling, the Technical Specification controls on mitigating systems are being replaced with Shutdown Safety administrative controls.

Regulatory Guide 1.183 Guidance	Degree of Conformance
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 should be selected with the objective of determining a conservative postulated dose. In some instances, a particular parameter may be conservative in one portion of an analysis but be nonconservative in another portion of the same analysis. For example, assuming minimum containment system spray flow is usually conservative for estimating iodine scrubbing, but in many cases may be nonconservative when determining sump pH. Sensitivity analyses may be needed to determine the appropriate value to use. As a conservative alternative, the limiting value applicable to each portion of the analysis may be used in the evaluation of that portion. A single value may not be applicable for a parameter for the duration of the event, particularly for parameters affected by changes in density. For parameters addressed by technical specifications, the value used in the analysis should be that specified in the technical specifications. ..."	Conservative assumptions were utilized in the analyses. As described above, one area in which sensitivity studies were completed is with the Control Room dose. The base case assumes the normal ventilation system continues to run. This ensures the intake of activity into the Control Room is maximized, and ensures no credit is taken for active functions such as isolations from the radiation monitor or activation of the Emergency Recirculation system. This base case conservatively assumed intake flow 10% above nominal in order to maximize the amount of activity that enters the Control Room, then conservatively assumed exhaust flow 10% below nominal after the activity has been introduced into the Control Room. The sensitivity studies examined actions the operators could take after a period of time in an isolated, non-filtered mode (2 hours after all the activity is introduced into the Control Room in the studies), to ensure that their choice of action would not result in a dose outlier. The sensitivities studied the effects of turning on the filtration system, with low filter efficiency (50%), or re-establishing the normal system intake, effectively purging the Control Room. Both cases provided doses within the dose limits.
5.1.4 Applicability of Prior Licensing Basis "The NRC staff considers the implementation of an AST to be a significant change to the design basis of the facility that is voluntarily initiated by the licensee. In order to issue a license amendment authorizing the use of an AST and the TEDE dose criteria, the NRC staff must make a current finding of compliance with regulations applicable to the amendment. The characteristics of the ASTs and the revised dose calculational methodology may be incompatible with many of the analysis assumptions and methods currently reflected in the facility's design basis analyses. The NRC staff may find that new or unreviewed issues are created by a particular site-specific implementation of the AST, warranting review of staff positions approved subsequent to the initial issuance of the license. This is not considered a backfit as defined by 10 CFR 50.109, "Backfitting." However, prior design bases that are unrelated to the use of the AST, or are unaffected by the AST, may continue as the facility's design basis. Licensees should ensure that analysis assumptions and methods are compatible with the ASTs and the TEDE criteria.	Two items may be considered to be "retained items" from the current licensing basis. The first is the allowance that the water level above the reactor vessel flange may be 22 feet 9 inches, less than the standard 23 foot value. This has been previously reviewed and approved by the NRC based on the fact that there is actually no fuel stored at the level of the flange (there is more than 51 feet of coverage over the top of the fuel that is down in the reactor vessel itself). Technical Specification 3.9.6 requires the 22 foot 9 inch height over the flange of the reactor vessel. As explained in the Bases, a dropped bundle would not be striking another fuel bundle at this level where less than 23 feet of coverage exists. This limits the potential damage from the strike at this elevation to the pins in just one bundle rather than the two or more bundles that are involved in the bounding calculation (where a strike occurs in the core with 51 feet of coverage). By itself, this single versus multiple bundle damage limits the release at this height, and more than compensates for the coverage being less than 23 feet. Also, a bundle dropped at this elevation is falling less than 2 feet, rather than the drop of 34

Regulatory Guide 1.183 Guidance	Degree of Conformance
	feet assumed in the evaluation that determines the number of fuel pins that might be damaged by a drop. As already explained in the Technical Specification 3.9.6 Bases, the reduction in this water level over the flange is acceptable. To validate this conclusion, a separate calculation was performed (and is included as Appendix A to Enclosure 5) for the drop of a bundle that strikes the refueling shield. The refueling shield, which sets on the reactor vessel flange during the refueling process, is the highest horizontal surface that a fuel bundle could strike if dropped in the reactor cavity area. As expected, the resultant doses were bounded by the analyses where a dropped bundle hit multiple other bundles (the doses from the drop onto the refueling shield would be less than 75% of the design basis cases). Therefore, despite the water level being less than 23 feet, this does not represent the limiting case. Further details on the drop onto the refueling shield are contained in Appendix A to Enclosure 5. The second item is that the "Decay Time" specification was relocated out of the Technical Specifications as part of Amendment 69, the improved Technical Specifications. The Decay Time specification is located in the PNPP Operational Requirements Manual (ORM), and it requires that the plant be subcritical for at least 24 hours before movement of irradiated fuel may begin. As described more fully in Section 1.1.1 of this matrix above, it is proposed that this control remain in the ORM, since it is physically impossible to disassemble the vessel, remove all the reactor internals, and move fuel within 24 hours.
5.2 Accident-Specific Assumptions "The appendices to this regulatory guide provide accident-specific assumptions that are acceptable to the staff for performing analyses that are required by 10 CFR 50.67. ... Licensees should analyze the DBAs that are affected by the specific proposed applications of an AST. The NRC staff has determined that the analysis assumptions in the appendices to this guide provide an integrated approach to performing the individual analyses and generally expects licensees to address each assumption or propose acceptable alternatives. Such alternatives may be justifiable on the basis of plant-specific considerations, updated technical analyses, or, in some cases, a previously approved licensing basis consideration. The assumptions in the appendices are deemed consistent with the AST identified in Regulatory Position 3 and internally consistent with each other. Although	Reg. Guide 1.183 Appendix B is the applicable appendix for a Fuel Handling Accident. Each assumption in that guidance is addressed below. Except for the 23 feet of water over the vessel flange issue discussed above, and the instantaneous puff release, also discussed above, alternatives to the assumptions in Appendix B are not being proposed.

Regulatory Guide 1.183 Guidance	Degree of Conformance
licensees are free to propose alternatives to these assumptions for consideration by the NRC staff, licensees should avoid use of previously approved staff positions that would adversely affect this consistency. ..."	
5.3 Meteorology Assumptions "Atmospheric dispersion values (X/Q) for the EAB, the LPZ, and the control room that were approved by the staff during initial facility licensing or in subsequent licensing proceedings may be used in performing the radiological analyses identified by this guide. ... All changes in X/Q analysis methodology should be reviewed by the NRC staff."	No changes to Chi/Q atmospheric dispersion values are being proposed. The current USAR Chi/Q values for the Control Room, EAB and LPZ were approved in conjunction with License Amendments 102 and 103, in March 1999. The actual values used are presented in the calculation attached as Enclosure 5.
Section 6. Assumptions for Evaluating the Radiation Doses for Equipment Qualification "The assumptions in Appendix I to this guide are acceptable to the NRC staff for performing radiological assessments associated with equipment qualification. The assumptions in Appendix I will supersede Regulatory Positions 2.c(1) and 2.c(2) and Appendix D of Revision 1 of Regulatory Guide 1.89, "Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants" (Ref. 11), for operating reactors that have amended their licensing basis to use an alternative source term. Except as stated in Appendix I, all other assumptions, methods, and provisions of Revision 1 of Regulatory Guide 1.89 remain effective. The NRC staff is assessing the effect of increased cesium releases on EQ doses to determine whether licensee action is warranted. Until such time as this generic issue is resolved, licensees may use either the AST or the TID14844 assumptions for performing the required EQ analyses. However, no plant modifications are required to address the impact of the difference in source term characteristics (i.e., AST vs TID14844) on EQ doses pending the outcome of the evaluation of the generic issue."	No changes are proposed to equipment qualification requirements at PNPP as a result of the reanalysis of the Fuel Handling Accident. Since most of the particulate radionuclides that escape from the fuel rod gap are assumed to convert to an elemental form prior to release from the water (see the Appendix B discussions below), the source term composition is not significantly different than before, except it has been scrubbed more efficiently by the water in the pool (DF of 200 versus 100). This more efficient scrubbing reduces the overall release above the pools, which is the dose that might be seen by plant equipment. In the Fuel Handling Building, the dose received by equipment from a Fuel Handling Accident would therefore be lower than the dose using the original assumptions. Also, in both the Containment and the Fuel Handling Building, the LOCA is the event that sets the EQ requirements for equipment, rather than the Fuel Handling Accident. Finally, no credit is taken in the revised calculations for the operation of any plant equipment to mitigate the release before it escapes. Therefore it is conservative to retain existing EQ program requirements.
Appendix B ***ASSUMPTIONS FOR EVALUATING THE RADIOLOGICAL CONSEQUENCES OF A FUEL HANDLING ACCIDENT*** ***App. B Section 1. Source Term*** "Acceptable assumptions regarding core inventory and the release of radionuclides from the fuel are provided in Regulatory Position 3 of this guide. The following assumptions also apply. *1.1* The number of fuel rods damaged during the accident should be based on a conservative analysis that considers the most limiting case. This	The number of fuel rods damaged in a Fuel Handling Accident (151) was determined by the fuel vendor, Global Nuclear Fuels (GNF). The vendor used a methodology that has been generically reviewed and approved by the NRC as part of NEDE-24011-P-A (GESTAR II). The analysis considers the weight of a dropped GE 12 or 14 fuel

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analysis should consider parameters such as the weight of the dropped heavy load or the weight of a dropped fuel assembly (plus any attached handling grapples), the height of the drop, and the compression, torsion, and shear stresses on the irradiated fuel rods. Damage to adjacent fuel assemblies, if applicable (e.g., events over the reactor vessel), should be considered. *1.2* The fission product release from the breached fuel is based on Regulatory Position 3.2 of this guide and the estimate of the number of fuel rods breached. All the gap activity in the damaged rods is assumed to be instantaneously released. Radionuclides that should be considered include xenons, kryptons, halogens, cesiums, and rubidiums. *1.3* The chemical form of radioiodine released from the fuel to the spent fuel pool should be assumed to be 95% 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. The NRC staff will consider, on a case-by-case basis, justifiable mechanistic treatment of the iodine release from the pool."	assembly, including the weight of the triangular fuel handling mast. It also considered the height of the drop, and the compression, torsion and shear stresses on the irradiated fuel rods. Damage to adjacent fuel assemblies was also considered. The total core inventory is multiplied by the gap fractions from Position 3.2, a radial peaking factor, and the fraction of fuel rods failed. There are approximately 64,208 fuel rods in the core. The percentage of rods breached is 151/64,208.32, which is 0.235% of the core. This activity is instantaneously released. The radionuclide groups listed in Reg. Guide 1.183 Table 3 were considered. No attempt is made to justify a mechanistic treatment of the halogen release from the pool. The non-organic halogens are assumed to re-evolve in an elemental form.
App. B Section 2. Water Depth "If the depth of water above the damaged fuel is 23 feet or greater, 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. If the depth of water is not 23 feet, the decontamination factor will have to be determined on a case-by-case method (Ref. B-1)."	The only case where the water is not 23 feet or greater is over the reactor vessel flange/refueling shield, as discussed above. The tops of all the irradiated fuel assemblies in storage have greater than 23 feet of coverage. Specifically, the top of the fuel in the reactor vessel is ~ 51 feet below the surface, and the fuel in the Fuel Handling Building is ~ 28 feet below the surface. The fuel in the upper Containment pools is ~ 27 feet below the surface. Therefore, in all the calculations except for the "less than 23-foot" refueling shield calculation discussed above, an overall effective decontamination factor (DF) of 200 is used for the halogens (iodines and bromines). It should be noted that this is a conservatism, since a DF of 500 for the elemental species would actually result in a higher overall effective DF than 200, as discussed in several other plant's submittals on this subject. For the refueling shield calculation, an overall DF was calculated to be 152.4. Despite the reduced DF, this was shown not to be a limiting case,

Regulatory Guide 1.183 Guidance	Degree of Conformance
	primarily due to fewer pins being damaged in this event as compared to the bounding event over the reactor vessel. Details are provided in Appendix A to Enclosure 5.
App. B Section 3. 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)."	100% of the Noble Gases (xenons and kryptons) are assumed to escape the water pool (DF of 1). None of the particulate radionuclides (the alkali metals – cesiums and rubidiums) are assumed to escape the water pool (DF of ∞).
App. B Section 4. Fuel Handling Accidents Within The Fuel Building "For fuel handling accidents postulated to occur within the fuel building, the following assumptions are acceptable to the NRC staff. 4.1 The radioactive material that escapes from the fuel pool to the fuel building is assumed to be released to the environment over a 2-hour time period. 4.2 A reduction in the amount of radioactive material released from the fuel pool by engineered safety feature (ESF) filter systems may be taken into account provided these systems meet the guidance of Regulatory Guide 1.52 and Generic Letter 99-02 (Refs. B-2, B-3). Delays in radiation detection, actuation of the ESF filtration system, or diversion of ventilation flow to the ESF filtration system should be determined and accounted for in the radioactivity release analyses. 4.3 The radioactivity release from the fuel pool should be assumed to be drawn into the ESF filtration system without mixing or dilution in the fuel building. If mixing can be demonstrated, credit for mixing and dilution may be considered on a case-by-case basis. This evaluation should consider the magnitude of the building volume and exhaust rate, the potential for bypass to the environment, the location of exhaust plenums relative to the surface of the pool, recirculation ventilation systems, and internal walls and floors that impede stream flow between the surface of the pool and the exhaust plenums."	The following section (Section 5) addresses "Fuel Handling Accidents Within Containment". At PNPP, a drop within Containment bounds the drop within the Fuel Handling Building. Therefore the next section, which addresses the Containment, will provide more details on the bounding calculation. The Containment drop is bounding because the drop over the reactor vessel would have higher kinetic energy and therefore a greater number of individual fuel rods damaged. The drop distance over the vessel is ~ 30 feet (GE used 34 feet in their calculation), whereas in the Fuel Handling Building, the drop is ~ 7 feet. Since both analyses then assume that the activity which escapes from the pool is treated the same, i.e., it is released immediately and directly to the environment, the FHA inside Containment will be bounding. There also is no practical difference between the two buildings at PNPP during handling of fuel that is not considered to be "recently irradiated". After License Amendment 102, handling of fuel that has been subcritical for more than 7 days has been performed using a two building "envelope" consisting of the Containment and the FHB. The equipment hatch between these two buildings is opened, and the Fuel Handling Building Ventilation System can draw down the two building envelope. This exhaust is then routed through filters and out of the plant vent (note again that the calculations do not credit this filtration or delay time in the release).
App. B Section 5. Fuel Handling Accidents Within Containment "For fuel handling accidents postulated to occur within the containment, the following assumptions are acceptable to the NRC staff. *5.1* If the containment is isolated during fuel handling operations, no radiological consequences need to be analyzed.	No credit is taken for Primary or Secondary Containment isolation during fuel handling, although Shutdown Safety administrative controls will be in place for building closure.

Regulatory Guide 1.183 Guidance	Degree of Conformance
5.2 If the containment is open during fuel handling operations, but designed to automatically isolate in the event of a fuel handling accident, the release duration should be based on ..."	No credit is taken for automatic isolations of the Primary or Secondary Containment.
5.3 If the containment is open during fuel handling operations (e.g., personnel air lock or equipment hatch is open), the radioactive material that escapes from the reactor cavity pool to the containment is released to the environment over a 2-hour time period.	Rather than releasing the activity over a 2-hour time period, the release is conservatively considered to be instantaneous. This ignores the administrative controls that normally keep the two-building envelope (of the Containment and the Fuel Handling Building) closed, and the proceduralized closure plans that are in place to close off pathways out of this two-building envelope if a Fuel Handling Accident would occur. A commitment is made to Revision 3 to NUMARC 93-01, Section 11.3.6.5 to track the continuance of these administrative controls.
5.4 A reduction in the amount of radioactive material released from the containment by ESF filter systems may be taken into account provided that these systems meet the guidance of Regulatory Guide 1.52 and Generic Letter 99-02 (Refs. B-2 and B-3). Delays in radiation detection, actuation of the ESF filtration system, or diversion of ventilation flow to the ESF filtration system should be determined and accounted for in the radioactivity release analyses.	No credit is taken for filter systems, although such systems will continue to be available during fuel handling in accordance with Shutdown Safety administrative controls.
5.5 Credit for dilution or mixing of the activity released from the reactor cavity by natural or forced convection inside the containment may be considered on a case-by-case basis. ..."	No credit is taken for dilution or mixing of the activity inside the Containment.

Regulatory Analysis/Commitments

The NRC's traditional methods (prior to the AST) for calculating the radiological consequences of design basis accidents are described in a series of regulatory guides and Standard Review Plan (SRP) chapters. That guidance was developed to be consistent with the TID-14844 source term and the whole body and thyroid dose guidelines stated in 10 CFR 100.11. Many of those analysis assumptions and methods are inconsistent with the ASTs and with the Total Effective Dose Equivalent (TEDE) criteria provided in 10 CFR 50.67. Regulatory Guide 1.183 provides assumptions and methods that are acceptable to the NRC staff for performing design basis radiological analyses using an AST. This guidance supersedes corresponding radiological analysis assumptions provided in the older regulatory guides and SRP chapters when used in conjunction with an approved AST and the TEDE criteria provided in 10 CFR 50.67. One of the Regulatory Guides that is superceded for PNPP for the Fuel Handling Accident is 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".

Due to the comprehensive nature of Regulatory Guide 1.183, the matrix (Table) given above was incorporated into this submittal to show how each section of the new guidance is being addressed.

Also, the NRC published a new SRP section to address AST. It is Standard Review Plan Section 15.0.1, Rev. 0, entitled "Radiological Consequence Analyses Using Alternative Source Terms". It provides guidance on which NRC branches will review various aspects of an AST license amendment request, but otherwise is consistent with the guidance found in Regulatory Guide 1.183. The plant-specific information provided above to support the license amendment request is believed to adequately address the guidance found in SRP 15.0.1.

Several Regulatory documents other than Regulatory Guide 1.183 are applicable to the proposed change. The following matrix addresses these.

Other Regulatory Documents	**Degree of Conformance**
GDC 61, "Fuel storage and handling and radioactivity control." The fuel storage and handling ...systems ... shall be designed to assure adequate safety under normal and postulated accident conditions. These systems shall be designed (1) with a capability to permit appropriate periodic inspection and testing of components important to safety, (2) with suitable shielding for radiation protection, (3) with appropriate containment, confinement, and filtering systems, ..."	The fuel storage and handling systems, including water coverage over the fuel, are not affected by the proposed changes. These systems can still be periodically inspected and tested. Radiation protection shielding by the buildings is also unaffected. Appropriate containment, confinement, and filtering systems will remain in place under Shutdown Safety administrative controls rather than Technical Specification controls. [Note: the guidance on Fuel Handling Accidents has not required that releases be contained or confined. They are typically assumed to be released through a ventilation system within no longer than a 2-hour period. The ventilation systems that serve the Containment area (Containment and Drywell Purge System, Annulus Exhaust Gas Treatment System, and –with the Containment equipment hatch removed- the exhaust subsystem of the Fuel Handling Building Ventilation System) all contain filtration systems.]
GDC 63, "Monitoring fuel and waste storage." Appropriate systems shall be provided in fuel storage ... systems and associated handling areas (1) to detect ... excessive radiation levels and (2) to initiate appropriate safety actions.	Radiation monitors will remain part of the plant design to detect increases in radiation levels, and along with grab samples, are addressed by the Shutdown Safety administrative controls. Since no credit is taken for filtration in the calculations, no safety actions are required to be initiated, although Shutdown Safety administrative controls will be in place for building closure.
GDC 64, "Monitoring radioactivity releases." Means shall be provided for monitoring the reactor containment atmosphere, ..., effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents.	The Fuel Handling Building Ventilation System is a normally running system, so releases into the combined Containment/Fuel Handling Building envelope will continue to be routed there (or - if they remain running or are started up by the operators - into the Containment and Drywell Purge System or the Annulus Exhaust Gas Treatment System) for monitoring prior to release. The plant vents are monitored for releases. The Shutdown Safety administrative controls include closure plans to block pathways for unmonitored releases from the two-building envelope of the Containment/Fuel Handling Building. [See Commitment 1].
10 CFR 20, 10 CFR 50 Appendix I, Technical Specification 5.5.4 "Radioactive Effluent Controls Program", and Technical Specification 5.6.3 "Radioactive Effluent Release Report", each require monitoring of releases and limitations on their magnitude.	See above discussions. Systems and controls remain in place to meet these requirements.

Other Regulatory Documents	Degree of Conformance
Regulatory Guide 1.13, "Spent fuel storage facility design basis", Revision 1.	PNPP design conforms to this guide with the exception of paragraph C.4. The inventory of radioactive materials available for leakage is based on the assumptions given in Regulatory Guide 1.183.
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", Revision 0.	No longer applicable to PNPP. See Regulatory Guide 1.183 for the fuel handling accident.
Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors", Revision 0.	PNPP conforms to this guide for the fuel handling accident, with minor exceptions to ◆ Appendix B, Item 2 (23-foot coverage over the reactor vessel flange, as addressed above in the discussions for Section 5.1.4 and App. B Item 2), and ◆ Table 6, and Appendix B, Items 4.1 and 5.3 (a puff release rather than a 2-hour release, as discussed above for Sections 4.1.5 and 4.4, and for App. B Items 4.1 and 5.3). The original PNPP licensing basis for a Fuel Handling Accident utilized Regulatory Guide 1.25.
Regulatory Guide 1.140, "Design, testing and maintenance criteria for normal ventilation exhaust system air filtration and adsorption units of light-water-cooled nuclear power plants", Revision 0.	The Fuel Handling Area Ventilation Exhaust Subsystem will now be tested and maintained in accordance with this Regulatory Guide.
Regulatory Guide 1.52, "Design, testing and maintenance criteria for postaccident engineered-safety-feature atmosphere cleanup system air filtration and absorption units of light-water-cooled nuclear power plants", Revision 2.	PNPP design and testing conform to this guide as presented in USAR Tables 6.5-1 and 6.5-3. The Fuel Handling Building filter plenum has been evaluated for compliance to R.G. 1.140.

As the Fuel Handling Accident calculations no longer credit the Containment or Secondary Containment or various ventilation systems, there are no design basis calculations remaining that formally credit these Structures, Systems and Components (SSCs) during plant shutdowns. Therefore, Criterions 1, 2, and 3 of 10 CFR 50.36 (which identify the SSCs which must be retained within the Technical Specifications due to their association with design basis events) no longer apply during shutdown. Although no design basis calculations credit these structures during shutdown, the Technical Specifications for a number of these SSCs still remain applicable during Operations with a Potential for Draining the Reactor Vessel (OPDRVs). Therefore, these SSCs are remaining within the Technical Specifications during OPDRV periods due to Criterion 4 of 10 CFR 50.36, i.e., "A structure, system or component which operating experience or probabilistic risk assessment has shown to be significant to public health and safety."

Additional Licensing/Regulatory information is provided in the USAR markups in Enclosure 7.

The following table identifies the actions that are considered to be regulatory commitments. Any other actions discussed in this document represent intended or planned actions, are described for the NRC's information, and are not regulatory commitments. Please notify the Manager - Regulatory Affairs at the Perry Nuclear Power Plant of any questions regarding this document or any associated regulatory commitments.

Commitments

1. Due to the above requirements, although the Fuel Handling Building Ventilation Exhaust System will no longer be classified as an ESF system, and the Technical Specification controls will be removed, Shutdown Safety administrative controls will still remain in place. As part of the Nuclear Regulatory Commission (NRC) resolution of the proposed Shutdown Rule (1997), the Maintenance Rule, 10 CFR 50.65, was revised to require licensees to assess the impact on shutdown safety before removing equipment from service for maintenance. The industry, through the Nuclear Energy Institute (NEI), developed guidance to implement this new requirement. A recently approved Revision 3 to NUMARC 93-01, Section 11.3.6.5, contains the final approved wording on how the industry is addressing Containment during plant shutdown periods. License Amendment 102 (March 1999), which provided the original approval of handling irradiated fuel under Shutdown Safety controls rather than Technical Specifications at PNPP, contained a commitment to the draft version of this NUMARC (now NEI) document. With this new letter, this commitment is updated to commit to Revision 3 of NUMARC 93-01, Section 11.3.6.5. This ensures that a building closure plan is in effect and ventilation systems remain available to monitor and filter a release from a Fuel Handling Accident.

   Note: The exact wording from NUMARC 93-01, Section 11.3.6.5 is as follows:

   "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 Specification operability amendment is the reduction in doses due to such decay. The goal of maintaining ventilation system and radiation monitor availability is to reduce doses 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."*

2. This maximum core wide radial peaking factor of 2.0 is being added into the list of reload analysis parameters that must be re-verified each cycle.

3. The burnup limit of 62 GWD/MTU on the average exposure of the peak rod, and the LHGR limit of 6.3 kw/ft peak rod average power for the higher burnup fuel (> 54 GWD/MTU), are both being added into the list of reload analysis parameters that must be re-verified each cycle.

4. Procedural guidance for response to a Fuel Handling Accident will be updated to recommend that the operators evaluate what dose minimization method for the Control

Commitments
Room is best suited for the case at hand (filtration or re-initiation of normal intake), then take the appropriate ventilation measures to minimize dose.

Environmental Consideration

A review has determined that 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.

SIGNIFICANT HAZARDS CONSIDERATION

Changes are proposed to the current Perry Nuclear Power Plant (PNPP) Technical Specifications. These changes reflect use of Shutdown Safety administrative controls in place of Technical Specification requirements on OPERABILITY of various buildings and filtration systems, which are no longer credited in the design basis radiological dose calculations for a fuel handling accident. The new Fuel Handling Accident dose calculations were performed using assumptions associated with the Alternative Source Term (AST) outlined in Regulatory Guide 1.183 "Alternative Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors". The revised calculations demonstrate that the regulatory limits for a Fuel Handling Accident can be met without the credit that was previously taken for filtration systems and the Containment/Fuel Handling Buildings . There are no physical changes to the plant associated with the proposed Technical Specification changes. The "modifications" to the plant therefore consist only of the replacement of the Technical Specification controls with Shutdown Safety administrative controls, and the declassification of the Fuel Handling Building Ventilation Exhaust System to a non-Engineered Safety Feature (ESF) system.

The standards used to arrive at a determination that a request for amendment does not involve a significant hazard are included in Commission regulation 10 CFR 50.92, which states that operation of the facility in accordance with the proposed changes would not:

1) involve a significant increase in the probability or consequences of an accident previously evaluated; or
2) create the possibility of a new or different kind of accident from any accident previously evaluated; or
3) involve a significant reduction in a margin of safety.

The proposed amendment has been reviewed with respect to these three factors, and it has been determined that the proposed change does not involve a significant hazard because:

1. **This proposed amendment does not involve a significant increase in the probability or consequences of an accident previously evaluated.**

   The proposed changes involve implementation of the Alternative Source Term for the Fuel Handling Accident at PNPP. There are no physical changes to the plant associated with the proposed Technical Specification changes. The revised calculations and controls over buildings and ventilation systems do not impact the initiators of a Fuel Handling Accident in any way. They also do not impact the initiators for any other design basis events. Therefore, because design basis accident initiators are not being altered by adoption of the Alternative Source Term analyses or by the revised controls, the probability of an accident previously evaluated is not affected.

   With respect to consequences, the only previously evaluated accident that could be affected is the Fuel Handling Accident. The Alternative Source Term is an input to calculations used to evaluate the consequences of an accident, and does not by itself affect the plant response, or the actual pathway of the radiation released from the fuel. It does however, better represent the physical characteristics of the release, so that appropriate mitigation techniques may be applied. For the Fuel Handling Accident, the AST analyses demonstrate acceptable doses, within regulatory limits, without credit for Containment/Fuel Handling building integrity, filtration system operability, or Control Room automatic isolation. Therefore, the consequences of an accident previously evaluated are not significantly increased. Declassification of the Fuel Handling Building Ventilation Exhaust System to a non- ESF system will change the test acceptance criteria used, from Regulatory Guide 1.52 controls to Regulatory Guide 1.140 controls. However, since the results of the design basis calculation for the Fuel Handling

Accident remained within the regulatory acceptance criteria without crediting the Fuel Handling Building filtration components, the consequences of this accident are not considered to be significantly increased by the test acceptance criteria change. In addition, although the Technical Specification controls over filtration systems and the Containment/Fuel Handling Buildings are being removed by the proposed changes, Shutdown Safety administrative controls will remain in place to ensure other requirements are met for filtration and monitoring of releases should a Fuel Handling Accident actually occur. Thus, appropriate mitigating techniques will still exist to minimize consequences of such an event to levels lower than those postulated in the revised calculations.

Based on the above conclusions, this change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. **This proposed amendment does not create the possibility of a new or different kind of accident from any accident previously evaluated.**

   The proposed changes do not involve a physical alteration of the plant (no new or different type of equipment will be installed and there are no physical changes to existing equipment associated with the proposed changes). Also, the changes in methods governing plant/system operation during fuel handling do not create any new initiators or precursors of a new or different kind of accident. New equipment or personnel failure modes that might initiate a new type of accident are not created as a result of the proposed changes.

   Thus, this change does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. **This proposed amendment does not involve a significant reduction in a margin of safety.**

   The proposed changes are associated with the implementation of a new licensing basis for PNPP Fuel Handling Accidents. Approval of the change from the original source term to a new source term taken from Regulatory Guide 1.183 is being requested. The results of the accident analyses, revised in support of the proposed license amendment, are subject to revised acceptance criteria. The analyses have been performed using conservative methodologies, as specified in Regulatory Guide 1.183. Safety margins have been evaluated and analytical conservatism has been utilized to ensure that the analyses adequately bound the postulated limiting event scenario. The dose consequences of the limiting Fuel Handling Accident remains within the acceptance criteria presented in 10 CFR 50.67 "Accident Source Term", and Regulatory Guide 1.183.

   The proposed changes continue to ensure that the doses at the exclusion area and low population zone boundaries, as well as the Control Room, are within corresponding regulatory limits. For the Fuel Handling Accident, Regulatory Guide 1.183 conservatively sets the Exclusion Area Boundary (EAB) and Low Population Zone (LPZ) limits below the 10 CFR 50.67 limit, and sets the Control Room limit consistent with 10 CFR 50.67.

   Since the proposed changes continue to ensure the doses at the EAB, LPZ and Control Room are within corresponding regulatory limits, the proposed license amendments do not involve a significant reduction in a margin of safety.

   Therefore, the change does not involve a significant reduction in a margin of safety.

Based on the above considerations, it is concluded that a significant hazard would not be introduced as a result of this proposed change.

3.3 INSTRUMENTATION

3.3.6.1 Primary Containment and Drywell Isolation Instrumentation

LCO 3.3.6.1 The primary containment and drywell isolation instrumentation for each Function in Table 3.3.6.1-1 shall be OPERABLE.

No changes to this pages included for completeness

APPLICABILITY: According to Table 3.3.6.1-1.

ACTIONS

------------------------------------NOTE------------------------------------
Separate Condition entry is allowed for each channel.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more required channels inoperable.	A.1 Place channel in trip.	12 hours for Functions 2.b, 5.b, and 5.d <u>AND</u> 24 hours for Functions other than Functions 2.b, 5.b, and 5.d
B. One or more automatic Functions with isolation capability not maintained.	B.1 Restore isolation capability.	1 hour

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
K. As required by Required Action C.1 and referenced in Table 3.3.6.1-1.	K.1	Isolate the affected penetration flow path(s).	Immediately
	<u>OR</u>		
	~~K.2.1~~	~~Suspend movement of recently irradiated fuel assemblies in the primary containment.~~	~~Immediately~~
	~~<u>AND</u>~~		
	K.2.2	Initiate action to suspend operations with a potential for draining the reactor vessel.	Immediately
L. As required by Required Action C.1 and referenced in Table 3.3.6.1-1.	L.1	Initiate actions to suspend operations with a potential for draining the reactor vessel.	Immediately

Table 3.3.6.1-1 (page 3 of 6)
Primary Containment and Drywell Isolation Instrumentation

FUNCTION	APPLICABLE MODES OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER TRIP SYSTEM	CONDITIONS REFERENCED FROM REQUIRED ACTION C.1	SURVEILLANCE REQUIREMENTS	ALLOWABLE VALUE
2. Primary Containment and Drywell Isolation					
g. Containment and Drywell Purge Exhaust Plenum Radiation — High (continued)	(d)	2	K	SR 3.3.6.1.1 SR 3.3.6.1.2 SR 3.3.6.1.4 SR 3.3.6.1.5	≤ 4.0 mR/hr above background
h. Manual Initiation	1,2,3	2(b)	G	SR 3.3.6.1.5	NA
	(d)	2	K	SR 3.3.6.1.5	NA
3. Reactor Core Isolation Cooling (RCIC) System Isolation					
a. RCIC Steam Line Flow — High	1,2,3	1	F	SR 3.3.6.1.1 SR 3.3.6.1.2 SR 3.3.6.1.3 SR 3.3.6.1.4 SR 3.3.6.1.5	≤ 298.5 inches water
b. RCIC Steam Line Flow Time Delay	1,2,3	1	F	SR 3.3.6.1.2 SR 3.3.6.1.4 SR 3.3.6.1.5	≥ 3 seconds and ≤ 13 seconds
c. RCIC Steam Supply Line Pressure — Low	1,2,3	1	F	SR 3.3.6.1.1 SR 3.3.6.1.2 SR 3.3.6.1.3 SR 3.3.6.1.4 SR 3.3.6.1.5	≥ 55 psig
d. RCIC Turbine Exhaust Diaphragm Pressure — High	1,2,3	2	F	SR 3.3.6.1.1 SR 3.3.6.1.2 SR 3.3.6.1.3 SR 3.3.6.1.4 SR 3.3.6.1.5	≤ 20 psig
e. RCIC Equipment Area Ambient Temperature — High	1,2,3	1	F	SR 3.3.6.1.1 SR 3.3.6.1.4 SR 3.3.6.1.5 SR 3.3.6.1.7	≤ 145.9°F
f. Main Steam Line Pipe Tunnel Temperature — High	1,2,3	1	F	SR 3.3.6.1.1 SR 3.3.6.1.4 SR 3.3.6.1.5 SR 3.3.6.1.7	≤ 158.9°F

(continued)

(b) Required to initiate the drywell isolation function.

(d) During operations with a potential for draining the reactor vessel. ~~and movement of recently irradiated fuel assemblies in primary containment.~~

3.3 INSTRUMENTATION

3.3.7.1 Control Room Emergency Recirculation (CRER) System Instrumentation

LCO 3.3.7.1 The CRER System instrumentation for each Function in Table 3.3.7.1-1 shall be OPERABLE.

APPLICABILITY: According to Table 3.3.7.1-1.

No changes to this page, included for completeness

ACTIONS

-------------------------------------NOTE-------------------------------------
Separate Condition entry is allowed for each channel.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more channels inoperable.	A.1 Enter the Condition referenced in Table 3.3.7.1-1 for the channel.	Immediately
B. As required by Required Action A.1 and referenced in Table 3.3.7.1-1.	B.1 Declare associated CRER subsystem inoperable. AND B.2 Place channel in trip.	1 hour from discovery of loss of CRER initiation capability in both trip systems 24 hours

(continued)

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Table 3.3.7.1-1 (page 1 of 1)
Control Room Emergency Recirculation System Instrumentation

FUNCTION	APPLICABLE MODES OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER TRIP SYSTEM	CONDITIONS REFERENCED FROM REQUIRED ACTION A.1	SURVEILLANCE REQUIREMENTS	ALLOWABLE VALUE
1. Reactor Vessel Water Level — Low Low Low, Level 1	1,2,3, (a)	2	B	SR 3.3.7.1.1 SR 3.3.7.1.2 SR 3.3.7.1.3 SR 3.3.7.1.4 SR 3.3.7.1.5	≥ 14.3 inches
2. Drywell Pressure — High	1,2,3	2	B	SR 3.3.7.1.1 SR 3.3.7.1.2 SR 3.3.7.1.3 SR 3.3.7.1.4 SR 3.3.7.1.5	≤ 1.88 psig
3. Control Room Ventilation Radiation Monitor	1,2,3, ~~(b)~~ (a)	1	C	SR 3.3.7.1.1 SR 3.3.7.1.2 SR 3.3.7.1.4 SR 3.3.7.1.5	≤ 800 cpm

(a) During operations with a potential for draining the reactor vessel.

~~(b) During operations with a potential for draining the reactor vessel, and movement of recently irradiated fuel assemblies in the primary containment or fuel handling building.~~

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3.6 CONTAINMENT SYSTEMS

3.6.1.2 Primary Containment Air Locks

LCO 3.6.1.2 Two primary containment air locks shall be OPERABLE.

APPLICABILITY: MODES 1, 2, and 3,
~~During movement of recently irradiated fuel assemblies in the primary containment,~~
During operations with a potential for draining the reactor vessel (OPDRVs).

ACTIONS

------------------------------------NOTES------------------------------------

1. Entry and exit is permissible to perform repairs of the affected air lock components.
2. Separate Condition entry is allowed for each air lock.
3. Enter applicable Conditions and Required Actions of LCO 3.6.1.1, "Primary Containment—Operating," when air lock leakage results in exceeding overall containment leakage rate acceptance criteria in MODES 1, 2, and 3.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more primary containment air locks with one primary containment air lock door inoperable.	------------NOTES------------ 1. Required Actions A.1, A.2, and A.3 are not applicable if both doors in the same air lock are inoperable and Condition C is entered. 2. Entry and exit is permissible for 7 days under administrative controls if both air locks are inoperable. -----------------------------	
		(continued)

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
C. (continued)	C.3	Restore air lock to OPERABLE status.	24 hours
D. Required Action and associated Completion Time of Condition A, B, or C not met in MODE 1, 2, or 3.	D.1 AND D.2	Be in MODE 3. Be in MODE 4.	12 hours 36 hours
E. Required Action and associated Completion Time of Condition A, B, or C not met during ~~movement of recently irradiated fuel assemblies in the primary containment, or during~~ OPDRVs.	E.1 AND E.2	~~Suspend movement of recently irradiated fuel assemblies in the primary containment.~~ Initiate action to suspend OPDRVs.	~~Immediately~~ Immediately

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3.6 CONTAINMENT SYSTEMS

3.6.1.3 Primary Containment Isolation Valves (PCIVs)

LCO 3.6.1.3 Each PCIV, except containment vacuum breakers, shall be OPERABLE.

No changes to this page, included for completeness

APPLICABILITY: MODES 1, 2, and 3,
When associated instrumentation is required to be OPERABLE per LCO 3.3.6.1, "Primary Containment and Drywell Isolation Instrumentation."

ACTIONS

-----------------------------------NOTES-----------------------------------

1. Penetration flow paths except for the inboard 42 inch purge valve 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 PCIVs.

4. Enter applicable Conditions and Required Actions of LCO 3.6.1.1, "Primary Containment—Operating," when PCIV leakage results in exceeding overall containment leakage rate acceptance criteria in MODES 1, 2, and 3.

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. One or more penetration flow paths with one PCIV inoperable except due to leakage not within limit.	A.1	Isolate the affected penetration flow path by use of at least one closed and de-activated automatic valve, closed manual valve, blind flange, or check valve with flow through the valve secured.	4 hours except for main steam line AND 8 hours for main steam line
	AND		
			(continued)

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
D. (continued)	D.3	Perform SR 3.6.1.3.6 for the resilient seal purge valves closed to comply with Required Action D.1.	Once per 92 days
E. Required Action and associated Completion Time of Condition A, B, C, or D not met in MODE 1, 2, or 3.	E.1	Be in MODE 3.	12 hours
	AND		
	E.2	Be in MODE 4.	36 hours
~~F. Required Action and associated Completion Time of Condition A, B, C, or D not met for PCIV(s) required to be OPERABLE during movement of recently irradiated fuel assemblies in the primary containment.~~	~~F.1~~	~~Suspend movement of recently irradiated fuel assemblies in primary containment.~~	~~Immediately~~

~~(continued)~~

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
F ~~G~~. Required Action and associated Completion Time of Condition A, B, C, or D not met for PCIV(s) required to be OPERABLE during MODE 4 or 5 or during operations with a potential for draining the reactor vessel (OPDRVs).	F ~~G~~.1 Initiate action to suspend OPDRVs. OR ~~G~~ F.2 Initiate action to restore valve(s) to OPERABLE status.	Immediately Immediately

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3.6 CONTAINMENT SYSTEMS

3.6.1.10 Primary Containment—Shutdown

LCO 3.6.1.10 Primary containment shall be OPERABLE.

APPLICABILITY: ~~During movement of recently irradiated fuel assemblies in the primary containment.~~ ℓ
During operations with a potential for draining the reactor vessel (OPDRVs).

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Primary containment inoperable.	A.1 ~~Suspend movement of recently irradiated fuel assemblies in the primary containment.~~ AND ℓ A.2 Initiate action to suspend OPDRVs.	~~Immediately~~ ℓ Immediately

3.6 CONTAINMENT SYSTEMS

3.6.1.11 Containment Vacuum Breakers

LCO 3.6.1.11 Three containment vacuum breakers shall be OPERABLE and four containment vacuum breakers shall be closed.

APPLICABILITY: MODES 1, 2, and 3,
~~During movement of recently irradiated fuel assemblies in the primary containment,~~
During operations with a potential for draining the reactor vessel (OPDRVs).

ACTIONS

------------------------------NOTE------------------------------
Enter applicable Conditions and Required Actions of LCO 3.6.1.1, "Primary Containment—Operating" when the containment vacuum relief subsystem leakage results in exceeding overall containment leakage acceptance criteria.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. ---------NOTE--------- Separate Condition entry is allowed for each containment vacuum breaker. -------------------- One or two containment vacuum breakers not closed. <u>OR</u> One required containment vacuum breaker inoperable for other reasons.	A.1 Close the associated motor operated isolation valve. <u>AND</u> A.2 Restore required containment vacuum breaker to OPERABLE status.	4 hours 72 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Required Action and associated Completion Time of Condition A not met. OR Three or more containment vacuum breakers not closed. OR Two or more required containment vacuum breakers inoperable for other reasons.	------------NOTE------------ Only applicable in MODE 1, 2 or 3. -----------------------------	
	B.1.1 Be in MODE 3.	12 hours
	AND	
	B.1.2 Be in MODE 4.	36 hours
	AND	
	------------NOTE------------ Only applicable during ~~movement of recently irradiated fuel assemblies in the primary containment, and~~ OPDRVs. -----------------------------	
	B.2.1 ~~Suspend movement of recently irradiated fuel assemblies in the primary containment.~~	~~Immediately~~
	AND	
	B.2.2 Initiate action to suspend OPDRVs.	Immediately

3.6 CONTAINMENT SYSTEMS

3.6.1.12 Containment Humidity Control

LCO 3.6.1.12 Containment average temperature-to-relative humidity shall be maintained within limits.

APPLICABILITY: MODES 1, 2, and 3,
~~During movement of recently irradiated fuel assemblies in the primary containment,~~ e
During operations with a potential for draining the reactor vessel (OPDRVs).

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Requirements of LCO not met.	A.1 Restore containment average temperature-to-relative humidity to within limits.	8 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. Required Action and associated Completion Time of Condition A not met in MODE 1, 2, or 3.	B.1	Be in MODE 3.	12 hours
	AND		
	B.2	Be in MODE 4.	36 hours
C. Required Action and associated Completion Time of Condition A not met during ~~movement of recently irradiated fuel assemblies in the primary containment or during~~ OPDRVs.	C.1	~~Suspend movement of recently irradiated fuel assemblies in the primary containment.~~	~~Immediately~~
	AND		
	C.2	Initiate action to suspend OPDRVs.	Immediately

SURVEILLANCE REQUIREMENT

SURVEILLANCE		FREQUENCY
SR 3.6.1.12.1	Verify containment average temperature-to-relative humidity to be within limits.	24 hours

3.6 CONTAINMENT SYSTEMS

3.6.4.1 Secondary Containment

LCO 3.6.4.1 The secondary containment shall be OPERABLE.

APPLICABILITY: MODES 1, 2, and 3,
~~During movement of recently irradiated fuel assemblies in the primary containment,~~
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

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Secondary containment inoperable during ~~movement of recently irradiated fuel assemblies in the primary containment, or during~~ OPDRVs.	C.1 ~~Suspend movement of recently irradiated fuel assemblies in the primary containment.~~ AND C.2 Initiate action to suspend OPDRVs.	~~Immediately~~ Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.6.4.1.1	Verify secondary containment vacuum is ≥ 0.66 inch of vacuum water gauge.	24 hours
SR 3.6.4.1.2	Verify the primary containment equipment hatch is closed and sealed and the shield blocks are installed adjacent to the shield building.	31 days
SR 3.6.4.1.3	Verify each secondary containment access door is closed, except when the access opening is being used for entry and exit.	31 days

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 primary containment,~~
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 manual valve or blind flange. AND	8 hours
		(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. Required Action and associated Completion Time of Condition A or B not met during ~~movement of recently irradiated fuel assemblies in the primary containment, or during~~ OPDRVs.	D.1 ~~Suspend movement of recently irradiated fuel assemblies in the primary containment.~~ AND D.2 Initiate action to suspend OPDRVs.	~~Immediately~~ Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.6.4.2.1	-------------------NOTES------------------- 1. Valves and blind flanges in high radiation areas may be verified by use of administrative means. 2. Not required to be met for SCIVs that are open under administrative controls. --- Verify each secondary containment isolation manual valve and blind flange that is required to be closed during accident conditions is closed.	31 days

3.6 CONTAINMENT SYSTEMS

3.6.4.3 Annulus Exhaust Gas Treatment (AEGT) System

LCO 3.6.4.3 Two AEGT subsystems shall be OPERABLE.

APPLICABILITY: MODES 1, 2, and 3,
~~During movement of recently irradiated fuel assemblies in the primary containment,~~
During operations with a potential for draining the reactor vessel (OPDRVs).

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One AEGT subsystem inoperable.	A.1 Restore AEGT 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 primary containment, or during~~ OPDRVs.	C.1 Place OPERABLE AEGT subsystem in operation. OR	Immediately (continued)

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
C. (continued)	~~C.2.1~~	~~Suspend movement of recently irradiated fuel assemblies in the primary containment.~~	~~Immediately~~
	~~AND~~		
	C.2.~~2~~	Initiate action to suspend OPDRVs.	Immediately
D. Two AEGT subsystems inoperable in MODE 1, 2, or 3.	D.1	Enter LCO 3.0.3.	Immediately
E. Two AEGT subsystems inoperable during ~~movement of recently irradiated fuel assemblies in the primary containment or during~~ OPDRVs.	E.1	~~Suspend movement of recently irradiated fuel assemblies in the primary containment.~~	~~Immediately~~
	~~AND~~		
	E.2	Initiate action to suspend OPDRVs.	Immediately

3.7 PLANT SYSTEM

3.7.3 Control Room Emergency Recirculation (CRER) System

LCO 3.7.3 Two CRER subsystems shall be OPERABLE.

APPLICABILITY: MODES 1, 2, and 3,
~~During movement of recently irradiated fuel assemblies in the primary containment or fuel handling building,~~
During operations with a potential for draining the reactor vessel (OPDRVs).

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. One CRER subsystem inoperable.	A.1	Restore CRER 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.	12 hours
	AND		
	B.2	Be in MODE 4.	36 hours

(continued)

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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 primary containment or fuel handling building, or during~~ OPDRVs.	~~------------NOTE------------ LCO 3.0.3 is not applicable. ----------------------------~~	
	C.1 Place OPERABLE CRER subsystem in emergency recirculation mode.	Immediately
	<u>OR</u>	
	~~C.2.1 Suspend movement of recently irradiated fuel assemblies in the primary containment and fuel handling building.~~	~~Immediately~~
	~~AND~~	
	C.2.2 Initiate action to suspend OPDRVs.	Immediately
D. Two CRER 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 CRER subsystems inoperable during ~~movement of recently irradiated fuel assemblies in the primary containment or fuel handling building or during~~ OPDRVs.	E.1 ~~Suspend movement of recently irradiated fuel assemblies in the primary containment and fuel handling building.~~	~~Immediately~~
	AND	
	E.2 Initiate action to suspend OPDRVs.	Immediately

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE	FREQUENCY
SR 3.7.3.1	Operate each CRER subsystem for ≥ 10 continuous hours with the heaters operating.	31 days
SR 3.7.3.2	Perform required CRER filter testing in accordance with the Ventilation Filter Testing Program (VFTP).	In accordance with the VFTP
SR 3.7.3.3	Verify each CRER subsystem actuates on an actual or simulated initiation signal.	24 months

(continued)

3.7 PLANT SYSTEMS

3.7.4 Control Room Heating, Ventilating, and Air Conditioning (HVAC) System

LCO 3.7.4 Two control room HVAC subsystems shall be OPERABLE.

APPLICABILITY: MODES 1, 2, and 3,
~~During movement of recently irradiated fuel assemblies in the primary containment or fuel handling building,~~
During operations with a potential for draining the reactor vessel (OPDRVs).

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One control room HVAC subsystem inoperable.	A.1 Restore control room HVAC subsystem to OPERABLE status.	30 days
B. Two control room HVAC subsystems inoperable.	B.1 Verify control room air temperature is ≤ 90°F.	Once per 4 hours
	AND	
	B.2 Restore one control room HVAC subsystem to OPERABLE status.	7 days
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.	12 hours
	AND	
	C.2 Be in MODE 4.	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 primary containment or fuel handling building, or during~~ OPDRVs.	~~------NOTE------ LCO 3.0.3 is not applicable.~~ e	
	D.1 Place OPERABLE control room HVAC subsystem in operation.	Immediately
	OR	
	~~D.2.1 Suspend movement of recently irradiated fuel assemblies in the primary containment and fuel handling building.~~	~~Immediately~~ e
	~~AND~~ e	
	D.2.~~2~~ Initiate action to suspend OPDRVs.	Immediately

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
E. Required Action and associated Completion Time of Condition B not met during ~~movement of recently irradiated fuel assemblies in the primary containment or fuel handling building, or during~~ OPDRVs.	~~-----NOTE----- LCO 3.0.3 is not applicable.~~	
	E.1 ~~Suspend movement of recently irradiated fuel assemblies in the primary containment and fuel handling building.~~	~~Immediately~~
	AND	
	E.2 Initiate action to suspend OPDRVs.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.7.4.1	Verify each control room HVAC subsystem has the capability to remove the assumed heat load.	24 months

No technical changes to this page, only an administrative change.

3.7 PLANT SYSTEMS

3.7.7 Fuel Pool Water Level

LCO 3.7.7 The fuel pool water level shall be ≥ 23 ft over the top of irradiated fuel assemblies seated in the fuel handling building (FHB) and upper containment fuel storage racks.

APPLICABILITY: During movement of irradiated fuel assemblies in the associated fuel storage pools.

Requirements remain unchanged

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Fuel pool water level not within limit.	A.1 --------NOTE--------- LCO 3.0.3 is not applicable. -------------------- Suspend movement of irradiated fuel assemblies in the associated fuel storage pool(s).	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.7.7.1	Verify the fuel pool water level is ≥ 23 ft over the top of irradiated fuel assemblies seated in the storage racks.	7 days

3.7 PLANT SYSTEMS

3.7.8 Fuel Handling Building

LCO 3.7.8 The fuel handling building (FHB) shall be OPERABLE.

APPLICABILITY: During movement of recently irradiated fuel assemblies in the FHB.

ACTIONS

-----NOTE-----
LCO 3.0.3 is not applicable.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. FHB inoperable.	A.1 Suspend movement of recently irradiated fuel assemblies in the FHB.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.7.8.1	Verify all FHB floor hatches and the shield blocks adjacent to the shield building are installed, and the FHB railroad track door is closed.	24 hours
SR 3.7.8.2	Verify each FHB access door is closed, except when the access opening is being used for entry and exit.	24 hours

3.7 PLANT SYSTEMS

3.7.9 Fuel Handling Building Ventilation Exhaust System

LCO 3.7.9 Three fuel handling building (FHB) ventilation exhaust subsystems shall be OPERABLE.

APPLICABILITY: During movement of recently irradiated fuel assemblies in the FHB.

ACTIONS

-----------------------------------NOTE-----------------------------------
LCO 3.0.3 is not applicable.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One required FHB ventilation exhaust subsystem inoperable.	A.1 Restore FHB ventilation exhaust subsystem to OPERABLE status.	7 days
B. Required Action and associated Completion Time of Condition A not met.	B.1 Place two OPERABLE FHB ventilation exhaust subsystems in operation. <u>OR</u> B.2 Suspend movement of recently irradiated fuel assemblies in the FHB.	Immediately Immediately
C. Two or three FHB ventilation exhaust subsystems inoperable.	C.1 Suspend movement of recently irradiated fuel assemblies in the FHB.	Immediately

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
D. FHB ventilation exhaust radiation monitor (noble gas) inoperable.	D.1	Obtain and analyze a grab sample of the FHB ventilation exhaust system effluent.	Every 24 hours
	AND		
	D.2.1	Verify Unit 1 Plant vent noble gas monitor is operable.	Every 24 hours
	OR		
	D.2.2	Place the FHB ventilation exhaust radiation monitor (noble gas) in the tripped condition.	24 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.7.9.1	Operate each FHB ventilation exhaust subsystem for ≥ 10 continuous hours with heaters operating.	31 days
SR 3.7.9.2	Perform FHB ventilation exhaust filter testing in accordance with the Ventilation Filter Testing Program (VFTP).	In accordance with the VFTP
SR 3.7.9.3	Perform a system functional test.	24 months
SR 3.7.9.4	Perform a CHANNEL FUNCTIONAL TEST of the FHB ventilation exhaust radiation monitor (noble gas)	92 days

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 the onsite Class 1E AC electrical power distribution subsystem(s) required by LCO 3.8.8, "Distribution Systems — Shutdown";

b. One diesel generator (DG) capable of supplying one division of the Division 1 or 2 onsite Class 1E AC electrical power distribution subsystem(s) required by LCO 3.8.8; and

c. One qualified circuit, other than the circuit in LCO 3.8.2.a, between the offsite transmission network and the Division 3 onsite Class 1E electrical power distribution subsystem, or the Division 3 DG capable of supplying the Division 3 onsite Class 1E AC electrical power distribution subsystem, when the Division 3 onsite Class 1E electrical power distribution subsystem is required by LCO 3.8.8.

APPLICABILITY: MODES 4 and 5,
~~During movement of recently irradiated fuel assemblies in the primary containment or fuel handling building.~~

ACTIONS

~~-----NOTE-----
LCO 3.0.3 is not applicable.~~

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. LCO Item a not met.	------------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 required feature(s) with no offsite power available from a required circuit inoperable.	Immediately
	OR	
	A.2.1 Suspend CORE ALTERATIONS.	Immediately
	AND	
	~~A.2.2 Suspend movement of recently irradiated fuel assemblies in the primary containment and fuel handling building.~~	~~Immediately~~
	~~AND~~	
	A.2.~~3~~ 2 Initiate action to suspend operations with a potential for draining the reactor vessel (OPDRVs).	Immediately
	AND	
		(continued)

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. (Continued)	A.2.~~4~~ 3	Initiate action to restore required offsite power circuit to OPERABLE status.	Immediately
B. LCO Item b not met.	B.1	Suspend CORE ALTERATIONS.	Immediately
	AND		
	~~B.2~~	~~Suspend movement of recently irradiated fuel assemblies in primary containment and fuel handling building.~~	~~Immediately~~ e
	~~AND~~ e		
	B.~~3~~ 2	Initiate action to suspend OPDRVs.	Immediately
	AND		
	B.~~4~~ 3	Initiate action to restore required DG to OPERABLE status.	Immediately
C. LCO Item c not met.	C.1	Declare High Pressure Core Spray System inoperable.	72 hours

3.8 ELECTRICAL POWER SYSTEMS

3.8.5 DC Sources — Shutdown

LCO 3.8.5 The following DC electrical power subsystems shall be OPERABLE:

a. One Class 1E DC electrical power subsystem capable of supplying one division of the Division 1 or 2 onsite Class 1E electrical power distribution subsystem(s) required by LCO 3.8.8, "Distribution Systems - Shutdown";

b. One Class 1E battery or battery charger, other than the DC electrical power subsystem in LCO 3.8.5.a, capable of supplying the remaining Division 1 or Division 2 onsite Class 1E DC electrical power distribution subsystem when required by LCO 3.8.8; and

c. The Division 3 DC electrical power subsystem capable of supplying the Division 3 onsite Class 1E DC electrical power distribution subsystem, when the Division 3 onsite Class 1E DC electrical power distribution subsystem is required by LCO 3.8.8.

APPLICABILITY: MODES 4 and 5,
~~During movement of recently irradiated fuel assemblies in the primary containment or fuel handling building.~~ e

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ACTIONS

---NOTE---
~~LCO 3.0.3 is not applicable.~~

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more required DC electrical power subsystems inoperable.	A.1 Declare affected required feature(s) inoperable.	Immediately
	OR	
	A.2.1 Suspend CORE ALTERATIONS.	Immediately
	AND	
	~~A.2.2 Suspend movement of recently irradiated fuel assemblies in the primary containment and fuel handling building.~~	~~Immediately~~
	~~AND~~	
	A.2.~~3~~ 2 Initiate action to suspend operations with a potential for draining the reactor vessel.	Immediately
	AND	
	A.2.~~4~~ 3 Initiate action to restore required DC electrical power subsystems to OPERABLE status.	Immediately

3.8 ELECTRICAL POWER SYSTEMS

3.8.8 Distribution Systems — Shutdown

LCO 3.8.8 The necessary portions of the Division 1, Division 2, and Division 3 AC and DC 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 primary containment or fuel handling building.~~ e

ACTIONS

-----NOTE----- e
~~LCO 3.0.3 is not applicable.~~

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more required AC or DC electrical power distribution subsystems inoperable.	A.1 Declare associated supported required feature(s) inoperable.	Immediately
	OR	
	A.2.1 Suspend CORE ALTERATIONS.	Immediately
	AND	
	~~A.2.2 Suspend movement of recently irradiated fuel assemblies in the primary containment and fuel handling building.~~	~~Immediately~~ e
	~~AND~~ e	
		(continued)

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. (continued)	A.2.2 Initiate action to suspend operations with a potential for draining the reactor vessel. AND A.2.3 Initiate actions to restore required AC and DC electrical power distribution subsystems to OPERABLE status. AND A.2.4 Declare associated required shutdown cooling subsystem(s) inoperable and not in operation.	Immediately Immediately Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.8.1	Verify correct breaker alignments and voltage to required AC and DC electrical power distribution subsystems.	7 days

3.9 REFUELING OPERATIONS

3.9.6 Reactor Pressure Vessel (RPV) Water Level—Irradiated Fuel

LCO 3.9.6 RPV water level shall be ≥ 22 ft 9 inches above the top of the RPV flange.

No changes to this page. Included for completeness

APPLICABILITY: During movement of irradiated fuel assemblies within the RPV.

Requirements remain unchanged

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. RPV water level not within limit.	A.1	Suspend movement of irradiated fuel assemblies within the RPV.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.9.6.1	Verify RPV water level is ≥ 22 ft 9 inches above the top of the RPV flange.	24 hours

3.9 REFUELING OPERATIONS

3.9.7 Reactor Pressure Vessel (RPV) Water Level—New Fuel or Control Rods

LCO 3.9.7 RPV water level shall be ≥ 23 ft above the top of irradiated fuel assemblies seated within the RPV.

No changes to this page.
Included for completeness.

APPLICABILITY: During movement of new fuel assemblies or handling of control rods within the RPV when irradiated fuel assemblies are seated within the RPV.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. RPV water level not within limit.	A.1 Suspend movement of new fuel assemblies and handling of control rods within the RPV.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 3.9.7.1 Verify RPV water level is ≥ 23 ft above the top of irradiated fuel assemblies seated within the RPV.	24 hours

No changes to this page.
Included for completeness.

5.5.6 Inservice Testing Program

This program provides controls for inservice testing of ASME Code Class 1, 2, and 3 components. The program shall include the following:

a. Testing frequencies specified in Section XI of the ASME Boiler and Pressure Vessel Code and applicable Addenda as follows:

ASME Boiler and Pressure Vessel Code and applicable Addenda terminology for inservice testing activities	Required frequencies for performing inservice testing activities
Weekly	At least once per 7 days
Monthly	At least once per 31 days
Quarterly or every 3 months	At least once per 92 days
Semiannually or every 6 months	At least once per 184 days
Every 9 months	At least once per 276 days
Yearly or annually	At least once per 366 days
Biennially or every 2 years	At least once per 731 days

b. The provisions of SR 3.0.2 are applicable to the above required frequencies for performing inservice testing activities;

c. The provisions of SR 3.0.3 are applicable to inservice testing activities; and

d. Nothing in the ASME Boiler and Pressure Vessel Code shall be construed to supersede the requirements of any TS.

5.5.7 Ventilation Filter Testing Program (VFTP)

A program shall be established to implement the following required testing of Engineered Safety Feature (ESF) filter ventilation systems at the frequencies specified in Regulatory Guide 1.52, Revision 2.

(continued)

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5.5.7 Ventilation Filter Testing Program (VFTP) (continued)

a. Demonstrate for each of the ESF systems that an inplace test of the high efficiency particulate air (HEPA) filters shows a penetration and system bypass < 0.05% when tested in accordance with Regulatory Guide 1.52, Revision 2 and ANSI N510-1980 at the system flowrate specified below ± 10%:

ESF Ventilation System	Flowrate
a) Control Room Emergency Recirculation	30,000 scfm
b) ~~Fuel Handling Building~~ Deleted	~~15,000 scfm~~
c) Annulus Exhaust Gas Treatment	2,000 scfm

b. Demonstrate for each of the ESF systems that an inplace test of the charcoal adsorber shows a penetration and system bypass < 0.05% when tested in accordance with Regulatory Guide 1.52, Revision 2 and ANSI N510-1980 at the system flowrate specified below ± 10%:

ESF Ventilation System	Flowrate
a) Control Room Emergency Recirculation	30,000 scfm
b) ~~Fuel Handling Building~~ Deleted	~~15,000 scfm~~
c) Annulus Exhaust Gas Treatment	2,000 scfm

c. Demonstrate for each of the ESF systems that a laboratory test of a sample of the charcoal adsorber, when obtained as described in Regulatory Guide 1.52, Revision 2, shows the methyl iodide penetration less than the value specified below when tested in accordance with ASTM D3803-1989 at a temperature of 30 °C and equal to the relative humidity (RH) specified below:

ESF Ventilation System	Penetration	RH
a) Control Room Emergency Recirculation	2.5%	70%
b) ~~Fuel Handling Building~~ Deleted	~~2.5%~~	~~70%~~
c) Annulus Exhaust Gas Treatment	0.5%	70%

(continued)

5.5.7 Ventilation Filter Testing Program (VFTP) (continued)

d. Demonstrate for each of the ESF systems that the pressure drop across the combined HEPA filters and the charcoal adsorbers is less than the value specified below when tested in accordance with Regulatory Guide 1.52, Revision 2, and ANSI N510-1980 at the system flowrate specified below ± 10%:

ESF Ventilation System	Delta P	Flowrate
a) Control Room Emergency Recirculation	4.9" H_2O	30,000 scfm
b) ~~Fuel Handling Building~~ Deleted	~~4.9" H_2O~~	~~15,000 scfm~~
c) Annulus Exhaust Gas Treatment	6.0" H_2O	2,000 scfm

e. Demonstrate that the heaters for each of the ESF systems dissipate the value specified below ± 10% when corrected to nominal input voltage when tested in accordance with ANSI N510-1980:

ESF Ventilation System	Wattage
a) Control Room Emergency Recirculation	100 kW
b) ~~Fuel Handling Building~~ Deleted	~~50 kW~~
c) Annulus Exhaust Gas Treatment	20 kW

The provisions of SR 3.0.2 and SR 3.0.3 are applicable to the VFTP test frequencies.

5.5.8 Explosive Gas and Storage Tank Radioactivity Monitoring Program

This program provides controls for potentially explosive gas mixtures contained in the main condenser offgas treatment system, and the quantity of radioactivity contained in unprotected outdoor liquid storage tanks.

The program shall include:

a. The limits for concentrations of hydrogen in the main condenser offgas treatment system and a surveillance program to ensure the limits are maintained. Such limits shall be appropriate to the system's design criteria (i.e., whether or not the system is designed to withstand a hydrogen explosion); and

(continued)

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INITIATING DOCUMENT Project 99-001-31	CALCULATION TYPE AE Analysis	CALCULATION NO. 3.2.15.14, Rev. 0

TITLE/SUBJECT: Fuel Handling Accident Using Alternative Source Term

CLASSIFICATION	CATEGORY	REFERENCED IN USAR VALIDATION DATABASE?	REFERENCED IN ATLAS?	OPEN ASSUMPTIONS?
☒ SAFETY-RELATED	☒ ACTIVE			
☐ AUGMENTED QUALITY	☐ HISTORICAL	☒ YES	☒ YES	☐ YES
☐ NON SAFETY RELATED	☐ STUDY	☐ NO	☐ NO	☒ NO

COMPUTER PROGRAM(S)

RADTRAD Mod 3.02, Microsoft® Word 2000, Microsoft® Excel 2000

REVISION RECORD

Rev.	Description of Change	Affected Pages	Preparer/Date	☐ Reviewer/Date ☒ Verifier/Date	Lead Engineer/Date
0	Initial Issue	All	Harry A. Wagage 1/3/02	D. L. Stady 1/4/2002	M. Down 1/4/02

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INITIATING DOCUMENT Project 99-001-31	CALCULATION TYPE AE Analysis	CALCULATION NO. 3.2.15.14, Rev. 0

TITLE/SUBJECT: Fuel Handling Accident Using Alternative Source Term

OBJECTIVE OR PURPOSE:

The purpose of this calculation is to determine radiological consequences of a design basis fuel handling accident (FHA) at Perry Nuclear Power Plant (PNPP), which occurs at 24 hours following reactor shutdown. Total effective dose equivalent (TEDE) at the control room, exclusion area boundary (EAB), and outer boundary of the low population zone (LPZ) are to be calculated using a source term derived from NUREG-1465, Reg. Guide 1.183, NEI 99-03, and the following conservative assumptions: [DIN # 1, 2, 3]

- No credit for containment/fuel handling building integrity.
- No credit for Annulus Exhaust Gas Treatment System (AEGTS) or Fuel Handling Area Exhaust Ventilation System (FHAEVS).
- No credit for filtration of Control Room Emergency Recirculation System.
- No credit for the isolation of the control room intake.

This calculation will replace the PNPP FHA dose analyses for the EAB, LPZ, and control room, CEI calculations 3.2.8 and 3.2.8.1, which were performed using Reg. Guide 1.25 and TID-14844 methodologies. [DIN # 4, 5, 6, 7]

SCOPE OF CALCULATION/REVISION

This calculation performs radiological dose analysis at the control room, EAB, and outer boundary of LPZ for a design basis fuel handling accident using an alternative source term. The scope is limited to calculating TEDE for a given number of fuel rods failed.

SUMMARY OF RESULTS/CONCLUSIONS:

Table 7 lists TEDE values calculated for the control room, EAB, and LPZ and compares these with regulatory limits. As shown in Table 7, the RADTRAD calculated TEDE values are well below the regulatory limits. Table 8 shows the TEDE values calculated for control room for the two sensitivity cases assuming the initiation of 1) control room fresh air intake and 2) control room recirculation filtering at two hours after a control room isolation assumed to occur after intake of all the activity. Both cases show TEDE values below the regulatory limit for the control room. Appendix A concluded that the dose consequences for an FHA occurring while transiting fuel over the Refueling Chute is bounded by the dose consequences for the design basis FHA.

IMPACT ON OUTPUT DOCUMENTS:

This calculation will be the basis to revise the USAR and Technical Specifications.

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DOCUMENT INDEX

DIN No.	Document Number/Title	Revision, Edition, Date	Reference	Input	Output
1	NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants"	February 1995	☒	☐	☐
2	Reg. Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors"	July 2000	☐	☒	☐
3	NEI 99-03, "Control Room Habitability Assessment Guidance," Nuclear Energy Institute	June 2001	☐	☒	☐
4	CEI CALC. No. Calculation 3.2.8, "FHA Inside Containment"	Rev. 1	☐	☒	☐
5	CEI CALC. No. 3.2.8.1, "Control Room Habitability Following a Fuel Handling Accident"	Rev. 0, 12/30/1998	☐	☒	☐
6	Reg. Guide 1.25 (Safety Guide 25), "Assumptions Used for Evaluating Radiological Consequences of a Fuel Handling Accident in a Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors"	March 23, 1972	☒	☐	☐
7	TID-14844, "Calculation of Distance Factors for Power and Test Reactor Sites"	1962	☒	☐	☐
8	NUREG/CR-6604, "RADTRAD: A Simplified Model for RADionuclide Transport and Removal And Dose Estimation"	June 1997	☒	☐	☐
9	NUREG/CR-6604, Supplement 1, "RADTRAD: A Simplified Model for RADionuclide Transport and Removal And Dose Estimation"	June 8, 1999	☒	☐	☐
10	Letter from D. R. Rogers to J. B. Balcken, "Fission Product Inventories for Perry High Energy Cycles" (Attachment 2 to DIN # 12)	January 29, 1996; Revised, March 14, 1996	☐	☒	☐

FirstEnergy
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CALCULATION

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DIN No.	Document Number/Title	Revision, Edition, Date	Reference	Input	Output
11	Code of Federal Regulations:				
	10 CFR Part 50.67, "ACCIDENT SOURCE TERM"	01/24/2000	☐	☒	☐
	10 CFR Part 50, Appendix A, "GENERAL DESIGN CRITERIA FOR NUCLEAR POWER PLANTS"	01/24/2000	☒	☐	☐
	10 CFR Part 50, Appendix K	01/24/2000	☐	☒	☐
12	DI-240, "Fuel Handling Accident Input Assumptions: Fuels Input"	Rev. 0, 11-8-01	☐	☒	☐
13	ORNL/TM-7175, "A User's Manual for the ORIGEN 2 Computer Code"	July 1980	☒	☐	☐
14	Federal Guidance Report 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion"	2nd Printing, 1989	☐	☒	☐
15	CCC-652 Oak Ridge National Laboratory RSICC Computer Code Collection MACCS2	V.1.12 Code Package, 1997	☐	☒	☐
16	Federal Guidance Report 12, "External Exposure to Radionuclides in Air, Water, and Soil"	1993	☐	☒	☐
17	PNPP Drawings: 015-026 411-0103 413-0101 413-0102 414-0102 414-0523 4549-18-1 4549-0194-1		☐	☒	☐
18	Calculation PSAT.0840IT.03, "Perry Plant TEDE Calculation"	Rev. 5	☐	☒	☐

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CALCULATION

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19	License Amendment 102	March 1999	☐	☒	☐
20	License Amendment 103	March 1999	☐	☒	☐
21	License Amendment 112	June 2000	☐	☒	☐
22	NEDC-32868P, "GE-14 Compliance with Amendment 22 of NEDC-24011-P-A "GESTAR-II""	Rev. 1, December 11, 2000	☐	☒	☐
23	Perry Technical Specifications 3.9.6		☐	☒	☐
24	Letter from L. R. Conner of Global Nuclear Fuel to P. J. Curran of PNPP, "Fuel Handling Accident – Bounding Fuel Rod Pressure for GE12 and GE14" (Attachment 1 to DIN # 12)	November 5, 2001	☐	☒	☐
25	Calculation CL-M26-01	Rev. 1	☐	☒	☐
26	P&ID 912-610	Rev. CC	☐	☒	☐
27	Periodic Test Instruction PTI-GEN-P0011	Rev.1	☐	☒	☐
28	SCIENTECH Interoffice Memo from H. A. Wagage to T. Bladen, "RADTRAD Code Verification and Validation"	3/14/01	☒	☐	☐
29	Perry letter PY-CEI/NRR-1510L		☒	☐	☐
30	G. Burley, "Evaluation of Fission Product Release and Transport for Fuel Handling Accident," Radiological Safety Branch, Division of Reactor licensing	October 5, 1971	☒	☐	☐

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Appendix A. Fuel Handling Accident while Transiting over the Refueling Shield

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CALCULATION COMPUTATION

1 METHOD OF ANALYSIS

The RADTRAD computer code was used to determine the total effective dose equivalent (TEDE) at the control room, exclusion area boundary (EAB), and outer boundary of the low population zone (LPZ), for the design-basis fuel-handling accident (FHA) inside containment at the Perry Nuclear Power Plant (PNPP) using NUREG-1465 and Reg. Guide 1.183 alternate source terms. [DIN # 8, 9, 1, 2] When comparing an FHA inside containment with an FHA in the Fuel Handling Building, the inside containment event would have higher kinetic energy and greater number of fuel pins damaged. Both analyses make the equivalent assumption that the activity, which escapes from the pool, is released immediately and directly to the environment. Therefore, the present analysis was performed for an FHA inside containment, which will be bounding. Appendix A analyzed and concluded that the dose consequences for an FHA occurring while transiting fuel over the Refueling Shield is bounded by the dose consequences for the design basis FHA.

Although the RADTRAD computer code consists of standardized source term data, the PNPP-specific, GE-calculated core isotope inventory at 24 hours after reactor shutdown was used instead, along with guidance provided in Reg. Guide 1.183. [DIN # 10, 2] All the isotopes of bromine, iodine, krypton, and xenon with core activity greater than 1E-9 Ci/MWt (a total of 20) and their daughters, i.e., an additional three isotopes of cesium and rubidium, were used for the analysis. Thus a total of 23 isotopes were used for TEDE analysis. The source terms of isotopes of cesium and rubidium were ignored as they were assumed to be retained completely by the pool. Sprays and natural deposition that may reduce the quantity of radioactive material were not credited. No filters or deposition of radioactive material in any pathway was modeled. The analysis does not credit the isolation of control room intake following a signal from the Rad. Monitor. The analysis also considers the effects of isolating the CR intake after activity is introduced into the control room (i.e., trapping the activity in the control room). The analysis considers the effects of trapping the activity for two hours followed by the cleanup by either the Control Room Emergency Recirculation System or by reopening the control room intake. Radioactive decay and in-growth of radionuclide daughters were also modeled in this analysis.

The RADTRAD model estimates doses in the control room and at EAB and LPZ. (Figure 1 schematically shows the PNPP FHA Release Model.) The model calculates the changes in radioactivity in the containment as a result of releasing radioactivity from the containment to the environment. Radioactive material is assumed to transport from the release point to the control room air intake, EAB, and LPZ without delay or deposition to the ground. Atmospheric dispersion of radioactivity during transport was accounted by using dispersion factors (χ/Q values). The change in radioactivity in the control room results from radioactivity entering the room with air intake, release of radioactivity with air exhaust, radioactive decay of nuclides in the control room. An additional mechanism of changing activity in the control room is filtering, which was not modeled for the base case calculation but was performed for sensitivity analysis (case 2) (§4.4.2).

Equation 1 shows the modeling of the change in radioactivity in the containment or control room, referred to as a "compartment" in the RADTRAD model. [§2.1.1, DIN # 8]

$$\frac{d}{dt}N_{n,i} = S_{n,i} + \sum_{\substack{j=1 \\ j\neq i}}^{K} F_{i,j}N_{n,j} + \sum_{\substack{j=1 \\ j\neq i}}^{K} \beta_{n,v}\lambda_v N_{v,i} - N_{n,i}\sum_{\substack{j=1 \\ j\neq i}}^{K}\left|F_{i,j}\right| - \lambda_n N_{n,i} - \eta_{n,i}F_{n,rec}N_{n,i} \qquad \text{Equation 1}$$

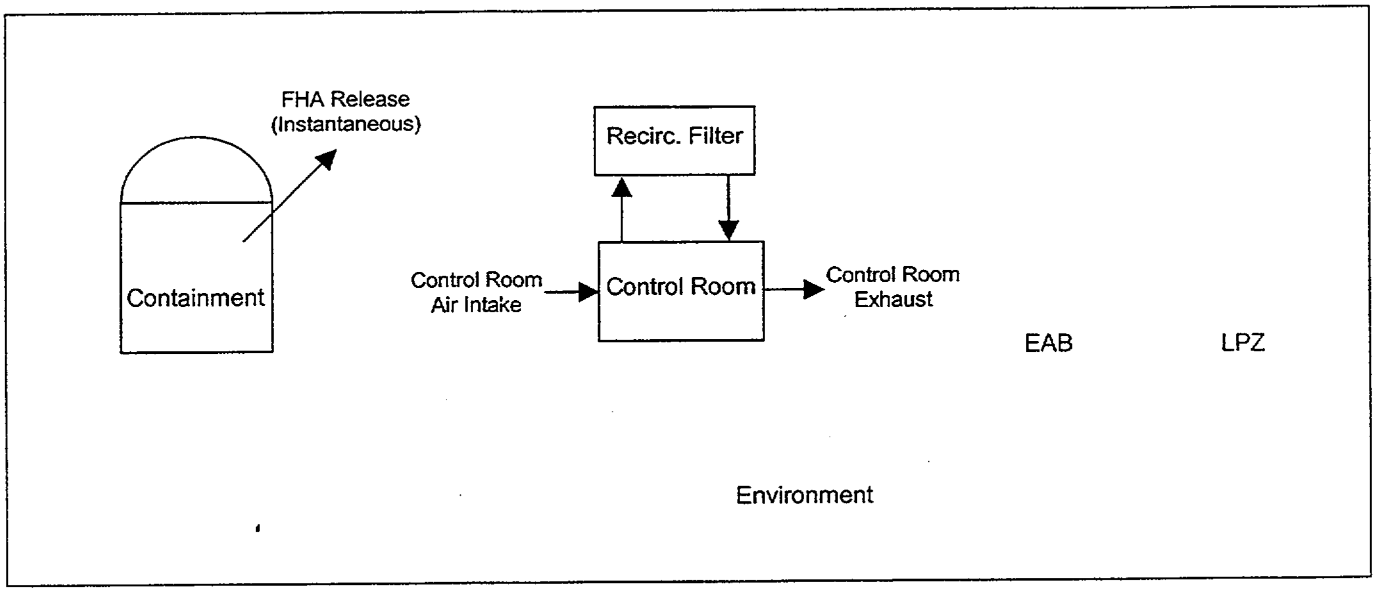

Figure 1. PNPP FHA Release Model[1]

where:

$N_{n,i}$ = number of atoms of nuclide n in compartment i

$S_{n,i}$ = source injection rate of nuclide n into compartment i (atoms/s)

K = Number of compartments defined in the RADTRAD model

$F_{i,j}$ = volume-normalized air flow rate from compartment j to i (s^{-1}) ($F_{i,j} \geq 0$)

$\beta_{n,v}$ = fraction of nuclide v that decays to nuclide n (dimensionless)

λ_n = radioactive decay constant of nuclide n (s^{-1}), which is calculated from radioactive half life, $(t_{1/2})_n$, (s) as shown in Equation 2

$\eta_{n,i}$ = filter efficiency for nuclide n in compartment i (dimensionless)

$F_{n,rec}$ = volume-normalized recirculation air flow rate in compartment i (s^{-1}).

$$\lambda_n = \frac{\ln(2)}{(t_{1/2})_n} \qquad \text{Equation 2}$$

The terms on the right hand side of Equation 1 models the following:

- Injection rate of radioactive source of radionuclide n into compartment i
- Intake rate of radionuclide n from all the other compartments into compartment i
- Generation rate of radionuclide n by decay of radionuclide v in compartment i
- Release rate of radionuclide n as a result of air exhaust from compartment i to all the other compartments. Note that the net airflow rate into a compartment is equal to the net air exhaust rate.

[1] Note that control room recirculation filtering was not modeled for the base case calculation but used only for sensitivity analysis (case 2) (§4.4.2).

- Decay rate of radionuclide *n* in compartment *i*.
- Removal rate of radionuclide *n* from compartment *i* by recirculation filtering.

The TEDE was calculated as the sum of committed effective dose equivalent (CEDE) from inhalation and the effective dose equivalent (EDE), which is assumed to be equivalent to deep dose equivalent (DDE) from external exposure from each nuclide, as shown in Equation 3 (§3.13.4).

$$TEDE^{L} = \sum_{n=1}^{M} \left(EDE_n^L + CEDE_n^L \right) \qquad \text{Equation 3}$$

where *L* represents the location (control room, EAB, or LPZ) and *M* is the total number of radionuclides used in the analysis.

The EDE from each nuclide at environment (env) (EAB or LPZ) is calculated as given in Equation 4. [§2.3.1, DIN # 8]

$$EDE_n^{env} = DCF_{EDE,n} \int_0^T \dot{A}n \left(\chi/Q \right)_{env} dt \qquad \text{Equation 4}$$

where:

EDE_n^{env} = EDE (cloudshine dose) due to nuclide *n* in the environment at given location (rem)

$DCF_{EDE,n}$ = user-provided EDE (cloudshine) dose conversion factor for nuclide *n* $\left(\frac{\text{rem.m}^3}{\text{Ci.s}} \right)$.

T = duration of analysis (s)

$\dot{A}n$ = activity release rate of nuclide *n* (Ci)

$\left(\chi/Q \right)_{env}$ = user-provided atmospheric relative concentration at EAB or LPZ (s/m^3)

t = time (s)

The activity is related to the number of atoms of nuclide n as given in Equation 5.

$$A_n = N_n \lambda_n \qquad \text{Equation 5}$$

The CEDE from each nuclide at environment (env) (EAB or LPZ) is calculated as given in Equation 6. [§2.3.1, DIN # 8]

$$CEDE_n^{env} = DCF_{CEDE,n} \int_0^T \dot{A}n \left(\chi/Q \right)_{env} BR_{env}\, dt \qquad \text{Equation 6}$$

where:

$CEDE_n^{env}$ = CEDE due to nuclide *n* in the environment at given location (rem)

$DCF_{CEDE.n}$ = user-provided CEDE conversion factor for nuclide *n* (rem/Ci).

BR_{env} = user-provided breathing rate for the hypothetical individual at EAB or LPZ (m^3/s).

The EDE from each nuclide in the control room (CR) is calculated as given in Equation 7. [§2.3.2, DIN # 8]

$$EDE_n^{CR} = \frac{DCF_{EDE,n}}{G_F V_{CR}} \int_0^T A_{CR,n}\, OF\, dt \qquad \text{Equation 7}$$

where:

EDE_n^{CR} = EDE (cloudshine dose) due to nuclide n in the control room (rem)
G_F = geometry factor as calculated using Equation 8 (dimensionless)
$A_{CR,n}$ = activity of nuclide n in the control room at time t (Ci)
V_{CR} = Volume of the control room (m^3)
OF = user-provided control room occupancy factor (dimensionless)

$$G_F = \frac{1173}{V_{CR}^{0.338}} \qquad \text{Equation 8}$$

where:

V_{CR} - Volume of the control room (ft^3). *(Note the difference of units of this variable in Equation 7 and Equation 8.)*

The CEDE from each nuclide in the control room is calculated as given in Equation 9. [§2.3.2, DIN # 8]

$$CEDE_n^{CR} = \frac{BR_{CR}\, DCF_{CEDE,n}}{V_{CR}} \int_0^T A_{CR,n}\, OF\, dt \qquad \text{Equation 9}$$

where:

$CEDE_n^{CR}$ = CEDE due to nuclide n in the control room (rem)
BR_{CR} = user-provided breathing rate for the control room operator (m^3/s).

2 ACCEPTANCE CRITERIA

Both EAB and LPZ dose limits for FHA are TEDE of 6.3 rem during the analysis release duration of 2 hours. [Table 6, DIN # 2] The control room dose limit for FHA is TEDE of 5 rem for the duration of the accident (10CFR50.67(b)(2)(iii)). [DIN # 11]

3 ASSUMPTIONS

3.1 The FHA was assumed to occur at 24 hours following reactor shutdown.

3.2 When comparing an FHA inside containment with an FHA in the Fuel Handling Building, the inside containment event would have higher kinetic energy and greater number of fuel pins damaged due to the comparative height of the drop. Both analyses make the equivalent assumption that the activity, which escapes from the pool, is released immediately and directly to the environment. Therefore, the present analysis was performed for an FHA inside containment, which will be bounding.

3.3 No integrity of containment/fuel handling building was assumed.

3.4 No credit was taken for Annulus Exhaust Gas Treatment System (AEGTS) or Fuel Handling Area Exhaust Ventilation System (FHAEVS).
3.5 No credit was taken for filtration of Control Room Emergency Recirculation System during the base case calculation. The effect of control room recirculation filtering following isolation of the control room air intake was studied in sensitivity case 2 (§4.4.2).
3.6 No control room isolation was assumed for the base case calculation. Sensitivity cases were run with RADTRAD to assess the impact of isolating the control room after the activity has entered the control room (§4.4).
3.7 All failed fuel is assumed to be operating at high peaking factors and maximum exposures although the core operating limits on power density would prohibit high-exposure bundles from being at high peaking factors.
3.8 This analysis assumed a radial peaking factor of 2. [DIN # 12]
3.9 Radionuclide release from FHA was assumed to occur instantaneously.
3.10 Radioactive decay and corresponding in-growth of radionuclide daughters were modeled during this analysis.
3.11 Radioactive material is assumed to transport from the release point to the control room air intake, EAB, and LPZ without delay or deposition to the ground.
3.12 Fission Product Inventory (§3.1, Reg. Guide 1.183): [DIN # 2]
Reg. Guide 1.183 states that the inventory of fission products in the reactor core and available for release to the containment should be based on the maximum full power operation of the core with, as a minimum, current licensed rated thermal power times the ECCS evaluation uncertainty.[2] The period of irradiation should be sufficient duration to allow the activity of dose-significant radionuclides to reach equilibrium or to reach maximum values. The core inventory should be determined using an appropriate isotope generation and depletion computer code such as ORIGEN 2. [DIN # 13]
This analysis used the ECCS evaluation uncertainty of 1.02. Fission product inventories were calculated by GE using the ORIGEN 2 computer code assuming 1500 effective full power days (EFPD) of operation. [DIN # 10]
3.13 Offsite Dose Consequences (§4.1, Reg. Guide 1.183): [DIN # 2]
3.13.1 This calculation determines TEDE, which is the sum of CEDE from inhalation and EDE, which is assumed to be equivalent to DDE from external exposure (Equation 3) (§3.13.4). Impact of daughter products was considered by decaying core radionuclides inventory for 24 hours in DIN # 10. Radioactive decay and corresponding in-growth of radionuclide daughters were modeled during this analysis (§3.10).
3.13.2 This calculation applies the CEDE conversion factors from Federal Guidance Report 11, which are readily available in the dose conversion factors file for 825 radionuclides, Dosdat825.inp, which was provided with the MACCS2 computer code package. [DIN # 14, 15] The CEDE conversion factors for the 23 nuclides that were selected for TEDE analysis, as described in §4.1.2.2, are listed in Table 1. Note that for BR 82 and BR 83, this analysis used more conservative CEDE conversion factors, which are for the lung clearance class of W (weeks) as given in DIN # 14 than those used in DIN # 15 for the class D (days).
3.13.3 This calculation applies the recommended breathing rates: 3.5E-4 m^3/s for the first 8 hours, 1.8E-4 m^3/s from 8 to 24 hours, and 2.3E-4 m^3/s thereafter. However, since the release was conservatively modeled as an instantaneous release, the analysis used an effective breathing rate of 3.5E-4 m^3/s.
3.13.4 The DDE should be calculated assuming submergence in semi-infinite cloud assumptions with appropriate credit for attenuation by body tissue. The DDE is nominally equivalent to the effective

[2] The uncertainty factor used in determining the core inventory should be that value provided in Appendix K to 10 CFR Part 50, typically 1.02. [DIN # 11]

dose equivalent (EDE) from external exposure if the whole body is irradiated uniformly. Since this is a reasonable assumption for submergence exposure situations, EDE may be used in lieu of DDE in determining dose to the TEDE.
This calculation applies the EDE conversion factors from Federal Guidance Report 12, which are readily available in the dose conversion factors file for 825 radionuclides, Dosdat825.inp, which was provided with the MACCS2 computer code package. [DIN # 16, 15] The EDE conversion factors for the 23 nuclides that were selected for TEDE analysis, as described in §4.1.2.2, are listed in Table 1.

Table 1. Dose Conversion Factors [DIN # 14, 15, 16]

No.	Isotope	EDE		CEDE	
		(rem-m^3/Ci-s)	(Sv-m^3/Bq-s)	(rem/Ci)	(Sv/Bq)
1	BR 82	4.810E-01	1.300E-13	1.528E+03	4.130E-10
2	BR 83	1.413E-03	3.820E-16	8.917E+01	2.410E-11
3	KR 83M	5.550E-06	1.500E-18	0	0
4	KR 85	4.403E-04	1.190E-16	0	0
5	KR 85M	2.768E-02	7.480E-15	0	0
6	KR 87	1.524E-01	4.120E-14	0	0
7	KR 88	3.774E-01	1.020E-13	0	0
8	RB 87	6.734E-06	1.820E-18	3.234E+03	8.740E-10
9	RB 88	1.243E-01	3.360E-14	8.362E+01	2.260E-11
10	I129	1.406E-03	3.800E-16	1.735E+05	4.690E-08
11	I130	3.848E-01	1.040E-13	2.642E+03	7.140E-10
12	I131	6.734E-02	1.820E-14	3.289E+04	8.890E-09
13	I132	4.144E-01	1.120E-13	3.811E+02	1.030E-10
14	I133	1.088E-01	2.940E-14	5.846E+03	1.580E-09
15	I134	4.810E-01	1.300E-13	1.314E+02	3.550E-11
16	I135	3.069E-01	8.294E-14	1.228E+03	3.320E-10
17	XE129M	3.922E-03	1.060E-15	0	0
18	XE131M	1.439E-03	3.890E-16	0	0
19	XE133	5.772E-03	1.560E-15	0	0
20	XE133M	5.069E-03	1.370E-15	0	0
21	XE135	4.403E-02	1.190E-14	0	0
22	XE135M	7.548E-02	2.040E-14	0	0
23	CS135	2.091E-06	5.650E-19	4.551E+03	1.230E-09

3.13.5 For the EAB, the objective of the TEDE analysis is to consider the dose during the worst two hour period. The maximum allowed duration of release from an FHA is 2 hours. [Table 6, DIN # 2] For this analysis, the release was assumed to transport instantaneously from the release location to the receptor. Because the complete release was assumed to be instantaneous, the initial 2-hour gives the maximum dose. Therefore, TEDE was determined for the first two hours and no sliding window calculations were performed.

3.13.6 The CFR states that the TEDE should be determined for the most limiting receptor at the outer boundary of the LPZ and should be used in determining compliance with the dose criteria in 10 CFR 50.67. [DIN #11]
This calculation determined the TEDE for the first two hours for the most limiting receptor at the outer boundary of LPZ. The radioactivity was available at LPZ during the release, which occurred during the initial 1E-4 hours (0.36 s) because no delay was assumed for the transport of activity. Therefore, no TEDE was received by the receptor at LPZ after 0.36 seconds, as no activity was available.

3.13.7 The dispersion factors used in this calculation do not take credit for ground or any other deposition.

3.14 Control Room Dose Consequences (§4.2, Reg. Guide 1.183): [DIN # 2]

3.14.1 This calculation considers potential radiation sources to the control room operator:

3.14.1.1 Unfiltered intake of the radiation plume into the control room was assumed to occur at 6600 cfm (normal flow rate + 10%) during the release, which occurred during the initial 1E-4 hours (0.36 s). Exhaust flow rate was chosen to be equal to the intake flow rate. After radioactivity was taken into the control room, the exhaust flow rate was conservatively chosen to be at 5400 cfm (normal flow rate – 10%) in order to minimize the purging effect of the ventilation system. During this time, the intake flow rate was chosen to be equal to the exhaust flow rate.

3.14.1.2 Intake or infiltration of airborne radioactive material from areas and structures adjacent to the control room envelope:
Other than the 6600 cfm of unfiltered inleakage being assumed to be introduced directly into the control room from outside, infiltration of airborne radioactive material from adjacent areas and structures was considered to be a negligible dose contributor and was neglected. Normal operation maintains a positive differential pressure between the inside and outside of the control room and thus between adjacent spaces. Control room doors lead to closed chase spaces, closed stairwells, or closed corridor spaces such that neither outside wind conditions nor other ventilation systems can cause infiltration/leakage into the control room.

3.14.1.3 Radiation shine from the external radioactive plume released from the facility:
Radiation shine from the external radioactive plume for the purpose of this calculation was considered to be a negligible dose contributor. The roof of the control complex building consists of a 2'-4.5"-thick concrete slab and the control room ceiling is an 18"-thick concrete slab (PNPP Drawings 015-026 and 414-0523). [DIN # 17] Considering this shielding, the contribution to the control room dose due to the cloud passing by was considered to be negligible and was neglected. This judgment is further supported by the LOCA control room dose calculation, which documents the cloud direct gamma dose for 30 days as being <0.05% of the total control room LOCA dose. [DIN # 18] The percentage should be lower for a fuel handling accident and its resultant brief plume.

3.14.1.4 Radiation shine from radioactive material in the reactor containment:
The direct line from the containment with the least shielding is through the 3'-thick concrete containment shield building, the 2'-thick concrete control building wall and the 1.5'-thick concrete control room ceiling (PNPP Drawings 015-026, 414-0102, 411-0103). [DIN # 17] Other direct lines from the containment to the control room would result in additional concrete shielding. Similarly, the direct line from the fuel handling is through a 3'-thick concrete fuel handling area wall, a 3'-thick concrete Intermediate Building wall and a 2'-thick Control Complex building wall (PNPP Drawings 413-0101, 413-0102, 414-0102). [DIN # 17] Considering this shielding, the contribution to the control room dose due to shine resulting from radioactive material in the containment or fuel-handling building was considered to be negligible and was neglected. This judgment is further supported by the LOCA control room dose calculation which documents the containment direct gamma dose for 30 days as being ~3% of the total control room LOCA dose. [DIN # 18]

3.14.1.5 There are no additional sources of 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. Radioactive material buildup in recirculation filters was not considered as the recirculation filters were not assumed to operate during FHA.
The effect of control room recirculation filtering following isolation of the control room air intake was studied in sensitivity case 2 (§4.4.2). The recirculation filters are located outside the control room envelope. The filter plenum equipment pad as well as the 18"-thick concrete control room ceiling shields the control room envelope. Therefore, radioactivity buildup in control room isolation filters would not affect the results of sensitivity case 2.

3.14.2 The radioactive material releases and radiation levels used in the control room dose analysis were determined using the same source term, transport, and release assumptions used for determining the EAB and LPZ TEDE values.

3.14.3 RADTRAD computer code was used to model transport of radioactive material into and through the control room. This modeling provides suitable conservative estimates of the exposure to control room personnel.

3.14.4 No credit was taken for engineered safety features that mitigate airborne radioactive material within the control room. The effect of trapping the activity in the control room for two hours, followed by cleanup by the emergency filters was studied in sensitivity case 2 (§4.4.2).

3.14.5 No credit was taken for using protective equipment or prophylactic drugs.

3.14.6 The dose receptor for these analyses was the hypothetical maximum exposed individual who is present in the control room for 100% of the time during the first 24 hours after the event, 60% of the time between 1 and 4 days, and 40% of the time from 4 days to 30 days. For the duration of this event, the breathing rate of this individual was assumed to be 3.5E-4 m^3/s.

3.14.7 Control room doses were calculated using the same dose conversion factors as the offsite dose calculation given in Table 1. RADTRAD computer code uses Equation 8 to correct the difference between finite cloud geometry in the control room and the semi-infinite cloud assumption used in calculating the dose conversion factors for the EDE from photons.

3.15 Acceptance Criteria (§4.4, Reg. Guide 1.183): [DIN # 2]
As given in §2, this calculation applies acceptance criteria in Table 6 of Reg. Guide 1.183 and 10CFR50.67 for the offsite and control room doses. [DIN # 2, 11] Instead of the 2-hour release duration that is recommended for FHA in Table 6 of Reg. Guide 1.183, this calculation conservatively used instantaneous release assumption.

3.16 Meteorology Assumptions (§5.3, Reg. Guide 1.183): [DIN # 2]
The analysis uses atmospheric dispersion values (χ/Q) used for the EAB, LPZ, and control room, listed in Table 2, that were previously approved by the NRC. [DIN # 19, 20]

Table 2. Atmospheric dispersion values (χ/Q) used (s/m^3)

Location	χ/Q (s/m^3)	Reference
Control Room	3.5E-4[a]	DIN # 5
EAB	4.3E-4	DIN # 4
LPZ	4.8E-5	DIN # 4

[a] DIN # 5 lists χ/Q values for different time periods up to 30 days. The initial value, which was for 0 to 8 hours, was used in this calculation because FHA release, and thus the activity intake to the control room was assumed to be instantaneous.

3.17 Assumptions for Evaluating the Radiological Consequences of a Fuel Handling Accident (Appendix B, Reg. Guide 1.183): [DIN # 2]

3.17.1 Source Term:

3.17.1.1 The number of fuel rods damaged during an FHA, i.e., 151, was based on the fuel vendor's NRC approved methodology for GE 12 and 14 bundles and triangular fuel handling mast. [DIN # 22]

3.17.1.2 This calculation used the gap fractions in §3.2 of Reg. Guide 1.183, as listed in Table 3, and assumed that the source terms were instantaneously released. Only bromine, iodine, krypton, and xenon radioisotopes were used in the calculation of FHA source term. Cesium and rubidium radioisotopes were assumed to retain completely by the fuel pool water.
Reg. Guide 1.183 noted that these gap fractions were applicable up to a peak rod average exposure of 62 GWD/MTU provided that the maximum linear heat generation rate did not exceed 6.3-kW/ft peak rod average power for burnup exceeding 54 GWD/MTU. As noted in DIN # 12, PNPP fuel designs satisfy this criterion.

Table 3. Gap Fractions for Fuel Handling Accident [Table 3, DIN # 2]

Isotope/Group	Gap Fraction
I-131	8%
Kr-85	10%
Other Noble Gases (Xe, Kr) and Halogens (I, Br)	5%
Alkali Metals[a] (Cs, Rb)	12%

[a] Alkali metals were assumed to be retained completely by the pool (§3.17.1.2, 3.17.3).

3.17.1.3 The chemical form of radioiodine released from the fuel to the spent fuel pool was assumed to be 95% cesium iodide (CsI), 4.85% elemental iodine, and 0.15% organic iodide. The CsI release from the fuel was assumed to completely dissociate in the pool water. Because of the low pH of pool water, the iodine is assumed to re-evolve as elemental iodine. This was assumed to occur instantaneously.
As a halogen, bromine isotopes were modeled identical to iodine in terms of chemical form.

3.17.2 Water Depth:

This calculation used the Reg. Guide 1.183 pool overall DF value of 200 for iodine isotopes. (As a halogen, bromine isotopes were modeled identical to iodine in terms of pool DF.) This assumption requires that PNPP pools maintain at least 23 feet of water coverage above damaged fuel.
The PNPP requires that it maintain at least 23' of water coverage above the fuel in the reactor pressure vessel (RPV) or the spent fuel storage pool. The PNPP has approximately 51.5' of water above the core, 27' above the fuel rack in the upper containment pool, and ~ 28' of coverage over spent fuel in the spent fuel pool (25' above IFTS gate sill). Therefore, if the dropped fuel bundle strikes another irradiated fuel bundle, 23' of water coverage above the damage bundle will be available.
Per Technical Specifications, PNPP requires that only 22'-9" of water coverage above the RPV flange during refueling. If the dropped bundle were to strike the RPV flange versus another bundle, there would be a possibility that only 22'-9" of water coverage is available. [DIN # 23] However, as addressed in the bases for Technical Specifications 3.9.6, such a drop will result in reduced release of fission gasses and it was judged that slight reduction in water level was acceptable. In addition, the drop onto the RPV flange will be on the order of 1.5' to 2', which is significantly less than the drop of 34' that was assumed in the GE analysis, which calculated the number of fuel rods failing during an

FHA. Therefore, the actual number of fuel rods failing in such an event will be significantly less than that assumed for this analysis (i.e., 151 fuel rods) and thus, the slightly reduced water level would be acceptable.

3.17.3 Noble Gases/Particulates:
The retention of noble gases in the water in the fuel pool or reactor cavity was assumed to be negligible (i.e., decontamination factor of 1). Particulate radionuclides (Cs and Rb) were assumed to be retained by the water in the fuel pool or reactor cavity (i.e., decontamination factor of ∞).

3.17.4 Fuel handling Accidents within Containment:

3.17.4.1 It was conservatively assumed that the containment was not isolated during fuel handling operations.

3.17.4.2 It was conservatively assumed that the containment would not isolate in the event of an FHA.

3.17.4.3 For an open containment, Reg. Guide 1.183 recommends assuming that the radioactive material that escapes from the fuel building to be released to the environment over a 2-hour time period. This analysis conservatively assumed that the release took place instantaneously.

3.17.4.4 No credit was assumed for a reduction in the amount of radioactive material released from the containment by engineered safety features filter systems.

3.17.4.5 No credit was assumed for dilution or mixing of the radioactivity released from the reactor cavity by natural or forced convection inside the containment.

3.18 NEI 99-03 Insight on Release Pressure Limit of 1200 psig: [DIN # 3]
For pool overall DF value of 200 for iodine (and bromine) isotopes to be applicable, in addition to a 23' depth in the pool, the release pressure is to be limited to 1200 psig. (See §3.17.2.) In the event of an FHA, the PNPP fuel rod pressure will be below 1200 psig. [DIN # 24]

3.19 General Design Criteria for Nuclear Power Plants (10 CFR 50, Appendix A): [DIN # 11]
General Design Criteria (GDC) 61 and 63 of 10 CFR 50, Appendix A addresses FHA.

3.19.1 GDC 61-Fuel storage and handling and radioactivity control states that the fuel storage and handling, radioactive waste, and other systems which may contain radioactivity shall be designed to assure adequate safety under normal and postulated accident conditions. These systems shall be designed with appropriate containment, confinement, and filtering systems. At PNPP, these systems include the primary and secondary containment, Fuel Handling Building, and AEGTS/FHAEVS. However, this analysis assumes no credit for the presence of these buildings or AEGTS/FHAEVS.

3.19.2 GDC 63-Monitoring fuel and waste storage states that appropriate systems shall be provided in fuel storage and radioactive waste systems and associated handling areas (1) to detect conditions that may result in loss of residual heat removal capability and excessive radiation levels and (2) to initiate appropriate safety actions. This analysis assumes no credit for the initiation of appropriate safety actions.

4 DETAILED CALCULATIONS

Calculations were performed using the RADTRAD computer code, which requires a main input file and three auxiliary input files. The main input file, named as pnpp_fha.psf in this analysis, describes 1) the plant model with compartments and release pathways, 2) the release scenario with source term, release rates, mechanisms of reducing radioactive elements, including overlying pools, suppression pool, sprays, filters, and natural deposition, and 3) the code output. The three auxiliary input files, named as pnpp_fha.rft, pnpp_fha.nif, and pnpp_fha.dcf in this analysis, describe release fraction and timing, radionuclides inventory, and radioactivity to dose conversion factors. Section 4.1 describes the development of input files. Sections 4.2 and 4.3 describe running and results of the RADTRAD code.

4.1 Development of Input Files

4.1.1 Main Input File, pnpp_fha.psf

The input parameters are described in this section in the same order as they appear in the main input file, pnpp_fha.psf, which is given in Attachment 1. The radionuclides inventory file was defined in the main input file as pnpp_fha.nif, which is described in §4.1.2.2. Power level was set to 3833.2 MWt (102% of 3758 MWt). [DIN # 21]

Figure 1 schematically shows the PNPP FHA Release Model, which consists of three compartments, the containment, control room, and environment, and three-release/flow paths, release from the containment to the environment, control room air intake, and control room exhaust.

Table 4 shows the selection of RADTRAD input parameters for the three compartments. Each value of the compartment type is that recommended in the RADTRAD input manual. [DIN # 9] Volume of the containment was arbitrarily selected as 1 ft^3 because the actual value is unimportant for the assumed instantaneous, complete release of the FHA source term. Following example problems given in the RADTRAD input manual, the volume of the environment was chosen as zero. [DIN # 8]

Table 4. Selection of RADTRAD Input Parameters for the Three Compartments

Number	Name	Type [DIN # 9]	Volume (ft^3)
1	Containment	3	1.0 (arbitrary)
2	Environment	2	0
3	Control Room	1	367,070 [DIN # 5, 25]

The three radioactivity release/intake pathways are identified between the compartments as schematically shown in Figure 1. The type of release pathway from the containment to the environment was defined as "air leakage" by choosing number 4 for the release flag. [DIN # 9]

The type of release pathway for 1) air intake from the environment to the control room and 2) air exhaust from the control room to the environment was defined as "filtered pathway" by choosing number 2 for the release flag. [DIN # 9] Note that the filter efficiencies were set to zero for both of these two paths, later in the input file.

The number 1 below the line with "Source Term" identifies that the whole source term was placed in only one compartment. Numbers 1 and 1 in the next line identify that the whole source term was placed in the containment (compartment # 1).

The auxiliary input files giving dose conversion factors, and release fraction and timing are identified as pnpp_fha.dcf and pnpp_fha.rft. These files are described in §4.1.2.3 and 4.1.2.1.

Delay time for the release was chosen as zero in order to model the release as instantaneous. A value of 1 was chosen for the flag to enable the calculation of radioactive daughter products. Next line shows the fractions of aerosol, elemental, and organic halogens and the fraction of halogens that are radioactive as 0, 0.9985, 0.0015, and 1 (§3.17.1.3). (Note that the fraction of halogens that are radioactive is a redundant input required by RADTRAD because specifying the activity of a nuclide implies that it is radioactive.)

No overlying pools were modeled with RADTRAD because decontamination factors were modeled separately in calculating the FHA source term as described in §4.1.2.2.

The number of compartments is given as 3. The first and second numbers under each compartment give flags to indicate whether detail output was to be given and whether radioactive decay is to be calculated. Detailed output was requested only for the control room by choosing a flag value of 1. For all the three compartments, the containment, environment, and control room, radioactive decay was modeled by choosing a flag value of 1.

The dose calculation model was run for 30 days (720 hours). The release rate from the containment was chosen arbitrarily as 1E10 %-volume/day. A high value was chosen to ensure complete, instantaneous release (§3.9).

Both control room intake and exhaust flow rates were set to 6,600 cfm (6000 cfm + 10% is based on the design value as shown on DIN # 26 with an allowable operating tolerance as specified in DIN # 27) during activity intake, which occurred during the initial 1E-4 hours (0.36 s). After the activity was taken into the control room, both intake and exhaust flow rates were set to 5,400 cfm (6000 cfm - 10%). The filter efficiencies for both of intake and exhaust flow paths were set to zero.

TEDE was calculated at three locations, EAB, outer boundary of LPZ, and control room. Atmospheric dispersion values (χ/Q) of 4.3E-4 and 4.8E-5 s/m^3 were used for EAB and the outer boundary of LPZ (Table 2). For both offsite locations the Reg. Guide 1.183 recommended breathing rates were used: 3.5E-4 m^3/s for the first 8 hours, 1.8E-4 m^3/s from 8 to 24 hours, and 2.3E-4 m^3/s thereafter (§3.13.3). However, considering that the release was conservatively modeled as near an instantaneous release, the effective breathing rate used was the highest of the three values recommended, i.e., 3.5E-4 m^3/s.

Atmospheric dispersion value (χ/Q) of 3.5E-4 s/m^3 was used for the control room intake for 30 days (Table 2). The control room occupancy factors used were 100% during the first 24 hours after the event, 60% between 1 and 4 days, and 40% from 4 to 30 days (§3.14.6). A constant breathing rate of 3.5E-4 m^3/s was used for the control room (§3.14.6).

Simulation time steps were selected as follows: 0.025 h from 0 to 8 h, 0.1 h from 8 h to 24 h, and 0.4 h from 24 h to 720 h (30 days).

Flag value of 1 was selected for each to include plant model, scenario description, and results for every simulation in the output.

4.1.2 Auxiliary Input Files

4.1.2.1 Input File on Release Fraction and Timing, pnpp_fha.rft

The auxiliary input file on release fraction and timing, pnpp_fha.rft, given in Attachment 2, shows that 100% of noble gas (Kr and Xe), halogen (Br and I), and alkali metals (Cs and Rb) groups were released to the containment[3] in 1E-4 hours (0.36 s). The source term of Cs and Rb is zero because they were assumed to be retained completely by the pool, thus the timing and fraction of release for alkali metals group is immaterial. (Note that the input file identifies groups, except the noble gases group, by the representative nuclide in each group. Thus, the halogen group is named as iodine group.)

[3] During an FHA, activity in the gap is released into the fuel pool. The radionuclides that are not retained in the pool are immediately released from the top of the pool, in this case to the containment. The FHA source term, as listed in the last column of Table 5, was calculated by accounting for the pool DF. Therefore, the fuel pool was not specifically input to the RADTRAD model, and the complete source term was released to the containment but not to the pool.

4.1.2.2 Input File on Radionuclides Inventory and Decay Data, pnpp_fha.nif

The FHA source term was determined using GE-calculated core inventory for 641 radioisotopes for different decay times for 1500 EFPD of operation. [DIN # 10] These included 17 bromine, 21 iodine, 15 krypton, and 18 xenon isotopes, amounting to a total of 71 isotopes. Note that isotopes of alkali metals (cesium and rubidium) were ignored as they were assumed to be retained completely in the pool. Of 71 isotopes, 48 isotopes with zero activity at 24 hours after reactor shutdown were ignored. In addition three isotopes, BR 84, I128, and XE138, which had activity less than 1E-9 Ci/MWt at 24 hours after reactor shutdown, were also ignored. The remaining 20 isotopes of bromine, iodine, krypton, and xenon were chosen for TEDE analysis. Three additional nuclides, RB 87, RB 88, and CS135, which are daughter products of radioactive decay of KR 87, KR 88, and XE135M that were included in original set of 20 isotopes, were also used for TEDE analysis. Thus a total of 23 radionuclides of bromine, cesium, iodine, krypton, rubidium, and xenon were used for TEDE analysis. Table 5 lists the 23 isotopes used for this analysis and their core inventory at 24 hours after reactor shutdown. [DIN # 10]

Table 5 shows the calculation of FHA source term. The core inventory per unit power was multiplied by the gap fraction, reactor power, the fraction of fuel rods failed, and radial peaking factor and divided by the pool DF. The reactor power, fraction of fuel rods failed, and radial peaking factor were combined to form a single multiplication factor because each parameter was independent of isotopes. This calculation used a reactor power of 3833.2 MWt (102% of 3758 MWt) and a radial peaking factor of 2 (DIN # 21; §3.8). Of effective 64,208.32 rods in the core, this calculation assumed that 151 rods had failed during FHA (DIN # 12; §3.17.1.1). Using these values, the multiplication factor was calculated as 18.029 (= (3833.2 MWt)*((151 rods failed)/(64,208.32 rods in the core))*(2)).

Radionuclides decay data needed for this input file includes, identification of daughter nuclides and fractions and radioactive half-life as listed in Table 6. These data were obtained from the radionuclides data file for 825 radionuclides, Indexr.inp, which was provided with the MACCS2 computer code package. [DIN # 15]

4.1.2.3 Input File on Dose Conversion Factors, pnpp_fha.dcf

The input file on dose conversion factors, pnpp_fha.dcf, which is given in Attachment 4, was developed using the values listed in Table 1. Note that the units of EDE (cloudshine) and CEDE (inhaled chronic) dose conversion factors to be used for this file are in Sv-m^3/Bq-s and Sv/Bq.

4.2 Running RADTRAD Code

The RADTRAD computer code was installed and executed on a Dell Latitude computer running on Windows NT Version 4.0 operating system as currently assigned to Hanry Wagage (owned by Matrix Leasing, no. 210158). Satisfactory operation of the RADTRAD code on this computer has been confirmed by verification. [DIN # 28] The main input file, pnpp_fha.psf and the three auxiliary input files, pnpp_fha.rft, pnpp_fha.nif, and pnpp_fha.dcf were used as input to the code. These files are given in Attachment 1 through Attachment 4. The Output file, pnpp_fha.out, is given in Attachment 5.

4.3 Results of the RADTRAD Run for the Base Case

The detailed results are given in the computer output file, pnpp_fha.out, which is given in Attachment 5. Table 7 lists TEDE values calculated for the control room, EAB, and outer boundary of the LPZ and compare these with regulatory limits. As shown in Table 7, the RADTRAD calculated TEDE values are well below the regulatory limits.

Table 5. Calculation of FHA Source Term

No.	Isotope	Core Activity at 24 hours (Ci/MWt) [DIN # 10]	Gap Fraction [Table 3]	Power* (Fraction of Rods Failed)* (Peaking Factor) (MWt)	Pool DF[a] [§3.17.2, §3.17.3]	FHA Release Activity (Ci)
1	BR 82	1.2390E+02	5%	18.029	200	5.5845E-01
2	BR 83	3.2960E+00	5%	18.029	200	1.4856E-02
3	KR 83M	1.2750E+01	5%	18.029	1	1.1494E+01
4	KR 85	4.1550E+02	10%	18.029	1	7.4911E+02
5	KR 85M	1.6560E+02	5%	18.029	1	1.4928E+02
6	KR 87	2.6830E-02	5%	18.029	1	2.4186E-02
7	KR 88	5.1150E+01	5%	18.029	1	4.6109E+01
8	RB 87	N/A[b]	~~5%~~ 12%	18.029	∞	0
9	RB 88	5.7120E+01[c]	~~5%~~ 12%	18.029	∞	0
10	I129	1.3910E-03	5%	18.029	200	6.2696E-06
11	I130	3.0390E+02	5%	18.029	200	1.3698E+00
12	I131	2.5290E+04	8%	18.029	200	1.8238E+02
13	I132	3.2140E+04	5%	18.029	200	1.4486E+02
14	I133	2.5280E+04	5%	18.029	200	1.1394E+02
15	I134	1.3320E-03	5%	18.029	200	6.0037E-06
16	I135	4.1600E+03	5%	18.029	200	1.8750E+01
17	XE129M	2.3050E-01	5%	18.029	1	2.0778E-01
18	XE131M	3.0440E+02	5%	18.029	1	2.7440E+02
19	XE133	5.1070E+04	5%	18.029	1	4.6037E+04
20	XE133M	1.5560E+03	5%	18.029	1	1.4027E+03
21	XE135	1.4060E+04	5%	18.029	1	1.2674E+04
22	XE135M	6.6640E+02	5%	18.029	1	6.0073E+02
23	CS135	2.7050E-02[c]	~~5%~~ 12%	18.029	∞	0

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Notes:

a. Note that the infinite value for pool DF of RB 87, RB 88, and CS135 indicates that cesium and rubidium were assumed to retain completely in the pool (§3.17.3).

b. DIN # 10 does not list the core inventory for RB 87.

c. The core inventory of RB 88 and CS135 are *not* used for the calculation because of infinite pool DF and are listed only for information. [DIN # 10]

Table 6. Radionuclides Decay Data Used for the Analysis [DIN # 15]

No.	Isotope	Daughter 1		Daughter 2		Radioactive Half-life, $t_{1/2}$	
		Nuclide	Fraction	Nuclide	Fraction	-	(s)
1	BR 82					35.3 h	1.2708000E+05
2	BR 83	KR 83M	1			2.39 h	8.6040000E+03
3	KR 83M					1.83 h	6.5880000E+03
4	KR 85					10.72 y	3.3806592E+08
5	KR 85M	KR 85	0.211			4.48 h	1.6128000E+04
6	KR 87	RB 87	1			76.3 m	4.5780000E+03
7	KR 88	RB 88	1			2.84 h	1.0224000E+04
8	RB 87					4.70E+10 y	1.4821920E+18
9	RB 88					17.8 m	1.0680000E+03
10	I129					1.57E+07 y	4.9511520E+14
11	I130					12.36 h	4.4496000E+04
12	I131	XE131M	0.0111			8.04 d	6.9465600E+05
13	I132					2.3 h	8.2800000E+03
14	I133	XE133M	0.029	XE133	0.971	20.8 h	7.4880000E+04
15	I134					52.6 m	3.1560000E+03
16	I135	XE135M	0.154	XE135	0.846	6.61 h	2.3796000E+04
17	XE129M					8 d	6.9120000E+05
18	XE131M					11.9 d	1.0281600E+06
19	XE133					5.245 d	4.5316800E+05
20	XE133M	XE133	1			2.188 d	1.8904320E+05
21	XE135	Cs-135	1			9.09 h	3.2724000E+04
22	XE135M	XE135	0.9999	CS135	4.50E-05	15.29 m	9.1740000E+02
23	CS135					2.30E+06 y	7.2532800E+13

Table 7. Comparison of TEDE Calculated for Control Room, EAB, and LPZ with Regulatory Limits

Location	Control Room	EAB	LPZ
RADTRAD results (rem) [Attachment 5]	1.03	1.44	0.161
Regulatory limit (rem) [§2]	5	6.3	6.3
$\frac{\text{RADTRAD Value}}{\text{Regulatory Limit}}$	20.5%	22.9%	2.6%

4.4 Sensitivity Analysis

4.4.1 Sensitivity Case 1: Effect of CR Isolation and Fresh Air Intake

Sensitivity Case 1 was run to study the effect of control room isolation and fresh air intake. The Rad Monitor was assumed to isolate the air intake at the worst possible time once the available activity is introduced into the control room. This is considered conservative as it maximizes the ~~does~~ DOSE to the control room operators. No inleakage of air into the control room was assumed. This is conservative, as additional inleakage of fresh air would tend to dilute the radioactivity in the control room. At 2 hours, outside air purge at a rate of 5400cfm (6000cfm -10%) assumed to initiate and continue until the end of dose analysis (30 days). [DIN # 26, 27] The 5400 cfm was considered to be conservative as it kept the activity in the control room longer. AW 1-7-02

The RADTRAD computer code was run with the main input file, which was changed to reflect the above flow rate data, and the same auxiliary input files that were used for the base case. The computer output is listed in Attachment 6. Table 8 compares the control room TEDE for this case with the base case and sensitivity case 2 results. The control room TEDE calculated for starting fresh air intake after 2 hours following control room isolation is 2.81 rem, which is below and 56% of the regulatory limit.

4.4.2 Sensitivity Case 2: Effect of CR Isolation and Recirculation Filtering

Sensitivity Case 2 was run to study the effect of control room isolation and Recirculation Filtering. The Rad Monitor was assumed to isolate the air intake at the worst possible time once the available activity is introduced into the control room. No inleakage of air into the control room was assumed. This is conservative, as additional inleakage of fresh air would tend to dilute the radioactivity in the control room. At 2 hours, the control room emergency recirculation was assumed to initiate. A recirculation flow rate of 27,000 cfm (30,000 -10%) and a charcoal efficiency of 50% were chosen to be consistent with assumptions in the LOCA analysis. [DIN # 18]

The RADTRAD computer code was run with the main input file, which was changed to reflect the above flow rate data, and the same auxiliary input files that were used for the base case. The computer output is listed in Attachment 7. Table 8 compares the control room TEDE for this case with the base case~~s~~ and sensitivity case 1 results. The control room TEDE calculated for starting recirculation filtering after 2 hours following control room isolation is 2.97 rem, which is below and 59% of the regulatory limit. AW 1-7-02

Table 8. Comparison of Sensitivity Analysis Results with the Base Case for TEDE Calculated for Control Room

Case	Control Room TEDE (rem)
Base Case [Table 7]	1.03
Sensitivity Case 1: Effect of CR Isolation and Fresh Air Intake [Attachment 6]	2.81
Sensitivity Case 2: Effect of CR Isolation and Recirculation Filtering [Attachment 7]	2.97

5 COMPUTER INPUT AND OUTPUT

The main input file for the base case, pnpp_fha.psf, and the three auxiliary input files, pnpp_fha.rft, pnpp_fha.nif, and pnpp_fha.dcf were used as input to the code. These files are given in Attachment 1 through Attachment 4. The output file, pnpp_fha.out, is given in Attachment 5. Computer output for sensitivity cases 1 and 2 are given in Attachment 6 and Attachment 7.

Appendix A. Fuel Handling Accident while Transiting over the Refueling Shield

Once a fuel bundle is removed from the core, it is typically taken to either the Inclined Fuel Transfer Tube or the Upper Containment Fuel Pool racks located in an adjacent pool. In order to accomplish this the fuel must be moved from the Reactor Cavity over the Refueling Shield into the adjacent pool. The refueling shield is a device that is put in physically placed during a refueling outage in order to provide radiological shielding to the drywell area below the reactor cavity. The bottom of the refueling shield contains 8"of lead sandwiched between stainless steel plates. The shield is set onto locating pins on the Reactor Cavity/Steam Dryer gate opening and sits on the reactor flange.

In performing reviews of the License Amendment Request for Fuel Handling Accident re-analysis, it was determined that the current Technical Specification Bases for the amount of water above the reactor flange during movement of irradiated fuel within the RPV may not have considered all potential fuel handling accident scenarios.

Currently, Technical Specification 3.9.6 require a minimum water level of 22'-9" above the reactor flange during movement of irradiated fuel within the RPV. [DIN # 23] Regulatory Guidance 1.183 specifies a requirement for 23' providing the basis for the iodine decontamination factor used in the analysis. [DIN # 2] The Tech Spec Bases provides an assessment that while the worst case assumption include the dropping of the irradiated fuel assembly onto the reactor core, the possibility exists of the dropped assembly striking the RPV flange and releasing fission products. The Bases goes on to say that dropping an assembly on the RPV flange will result in reduced releases of fission gases. The Bases conclude that the operation with slightly less than 23' is acceptable in the event of a fuel drop on the reactor flange. The NRC in their response to Perry letter PY-CEI/NRR-1510L had accepted this. [DIN # 29] Perry's letter further noted shielding >23' over the Upper Containment Pool fuel racks and Inclined Fuel Transfer System Upender.

The amount of shielding assumed in the current Technical Specification Section 3.9.6 is 22'-9".
The Refueling Shield bottom height is 9.25" (0.75" thick bottom plate, 8.0" thickness of lead, 0.5" thick upper plate). (Perry Drawing 4549-0194-1) [DIN # 17] Fuel bundle channel square dimension is 5.72" (Perry Drawing 4549-18-1) [DIN # 17]

Therefore, the least amount of shielding for a dropped bundle on the Refueling Shield is ~ 21'6" (21.5') (=22.75' - ((9.25" + 5.72")/12)). This is less than the 22'-9" assumed in the Technical Specifications.

The purpose of this appendix is to examine the effect of this reduced water level on radiological doses at control room, EAB, and LPZ.

Overall decontamination factor for halogen species, DF, can be calculated using individual decontamination factors for inorganic and organic fractions of the species as given in Equation 10.

$$DF = \frac{1}{\frac{f_{inorg}}{DF_{inorg}} + \frac{f_{org}}{DF_{org}}} \qquad \text{Equation 10}$$

Equation 10 can be rewritten to obtain the decontamination factor for inorganic halogen species for known overall and organic decontamination factors as given in Equation 11.

$$DF_{inorg} = \frac{f_{inorg}}{\frac{1}{DF} - \frac{f_{org}}{DF_{org}}} \qquad \text{Equation 11}$$

Burley calculated the decontamination factor for inorganic (elemental) iodine as given by Equation 12. [DIN # 30]

$$DF_{inorg} = \exp\left(\frac{6}{d_b} k_{eff} \frac{H}{v_b}\right) \qquad \text{Equation 12}$$

Where

d_b - Bubble diameter

H - Bubble rise height, i.e., the effective depth of water, defined as the water depth between the top of the damaged fuel rods and the fuel pool surface

k_{eff} - Mass transfer coefficient

v_b - Bubble velocity

Equation 12 can be rewritten as Equation 13 using a constant, C, as defined in Equation 14.

$$DF_{inorg} = \exp(CH) \qquad \text{Equation 13}$$

$$C = \frac{6}{d_b} k_{eff} \frac{1}{v_b} \qquad \text{Equation 14}$$

Using Equation 13, the decontamination factor for inorganic halogen species for a given pool depth can be expressed as given in Equation 15.

$$DF_{inorg,0} = \exp(CH_0) \qquad \text{Equation 15}$$

Equation 16 is obtained by substituting for C from Equation 15 in Equation 13.

$$DF_{inorg} = \left(DF_{inorg,0}\right)^{\frac{H}{H_0}} \qquad \text{Equation 16}$$

Calculations for the design basis FHA, described in the main report, assumed an overall decontamination factor of 200 for a pool depth of 23', and inorganic and organic fractions of halogen species of 99.85% and 0.15% (§3.17.1.3 and 3.17.2). Substituting these values in Equation 11, the corresponding decontamination factor for inorganic halogen species was calculated as 285.3. Using this value for a pool depth of 23', the decontamination factor for inorganic halogen species for a reduced pool depth of 21.5' was calculated as 197.3, using Equation 16. The corresponding value of overall decontamination factor for halogen species was calculated as 152.4, using Equation 10, which is 76.2% of the overall decontamination factor of 200 used in the main report.

Calculations for the design basis FHA, described in the main report, assumed a total number of fuel rods damaged during an FHA as 151 (§3.17.1.1). However, the number of fuel rods damaged in for an FHA occurring while transiting over the Refueling Shield would be limited to 85.84, which is the total number of equivalent full-length fuel rods in a fuel assembly. [DIN # 12] Therefore, the number of fuel rods damaged FHA while transiting over the Refueling Shield is 56.8% (=85.84/151) of that assumed for the design basis FHA.

The doses were calculated to be 74.5% (= (56.8%)/(76.2%)) of those calculated for the design basis FHA. Therefore, the dose consequences for an FHA occurring while transiting over the Refueling Shield will be bounded by the dose consequences for the design basis FHA.

```
Radtrad 3.02 1/5/2000
perry fha
Nuclide Inventory File:
d:\hwagage\computer codes\radtrad\run batch\perry\pnpp_fha.nif
Plant Power Level:
 3.8332E+03
Compartments:
  3
Compartment 1:
Containment
  3
 1.0000E+00
  0
  0
  0
  0
  0
Compartment 2:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Compartment 3:
Control Room
  1
 3.6707E+05
  0
  0
  0
  0
  0
Pathways:
  3
Pathway 1:
Unfiltered Release to Environment
  1
  2
  4
Pathway 2:
Unfiltered Environment to CR
  2
  3
  2
Pathway 3:
Control Room Exhaust
  3
  2
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:
```

```
Source Term:
  1
  1   1.0000E+00
d:\hwagage\computer codes\radtrad\run batch\perry\pnpp_fha.dcf
d:\hwagage\computer codes\radtrad\run batch\perry\pnpp_fha.rft
  0.0000E+00
  1
  0.0000E+00   0.9985E+00   0.0015E+00   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
  0
  0
```

```
  0
  0
  0
  1
  2
  0.0000E+00   1.0000E+10
  7.2000E+02   0.0000E+00
  0
Pathway 2:
  0
  0
  0
  0
  0
  1
  3
  0.0000E+00   6.6000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  0.0001E+00   5.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  7.2000E+02   5.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 3:
  0
  0
  0
  0
  0
  1
  3
  0.0000E+00   6.6000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  0.0001E+00   5.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  7.2000E+02   5.4000E+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
  0.0000E+00   4.3000E-04
  2.0000E+00   0.0000E+00
  1
  3
  0.0000E+00   3.5000E-04
  8.0000E+00   1.8000E-04
  2.4000E+01   2.3000E-04
  0
```

```
Location 2:
Outer Boundary of the LPZ
  2
  1
  2
  0.0000E+00   4.8000E-05
  2.0000E+00   0.0000E+00
  1
  3
  0.0000E+00   3.5000E-04
  8.0000E+00   1.8000E-04
  2.4000E+01   2.3000E-04
  0
Location 3:
Control Room
  3
  0
  1
  2
  0.0000E+00   3.5000E-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
Effective Volume Location:
  1
  2
  0.0000E+00   3.5000E-04
  2.0000E+00   0.0000E+00
Simulation Parameters:
  4
  0.0000E+00   2.5000E-02
  8.0000E+00   1.0000E-01
  2.4000E+01   4.0000E-01
  7.2000E+02   0.0000E+00
Output Filename:

  1
  1
  1
  0
  0
End of Scenario File
```

```
Release Fraction and Timing Name:
Perry FHA
Duration (h):
 0.0001E+00  0.0000E+00  0.0000E+00  0.0000E+00
Noble Gases:
 0.1000E+01  0.0000E+00  0.0000E+00  0.0000E+00
Iodine:
 0.1000E+01  0.0000E+00  0.0000E+00  0.0000E+00
Cesium:
 0.1000E+01  0.0000E+00  0.0000E+00  0.0000E+00
Tellurium:
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
Strontium:
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
Barium:
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
Ruthenium:
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
Cerium:
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
Lanthanum:
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
Non-Radioactive Aerosols (kg):
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
End of Release File
```

```
Nuclide Inventory Name:
 Perry FHA
 Power Level:
  3.8332E+03
 Nuclides:
  23
 Nuclide 001:
 Br-82
   2
  1.2708000000E+05
  0.8200E+02
  5.5845E-01
 none       0.0000E+00
 none       0.0000E+00
 none       0.0000E+00
 Nuclide 002:
 Br-83
   2
  8.6040000000E+03
  0.8300E+02
  1.4856E-02
 Kr-83m     0.1000E+01
 none       0.0000E+00
 none       0.0000E+00
 Nuclide 003:
 Kr-83m
   1
  6.5880000000E+03
  0.8300E+02
  1.1494E+01
 none       0.0000E+00
 none       0.0000E+00
 none       0.0000E+00
 Nuclide 004:
 Kr-85
   1
  3.3806592000E+08
  0.8500E+02
  7.4911E+02
 none       0.0000E+00
 none       0.0000E+00
 none       0.0000E+00
 Nuclide 005:
 Kr-85m
   1
  1.6128000000E+04
  0.8500E+02
  1.4928E+02
 Kr-85      0.2110E+00
 none       0.0000E+00
 none       0.0000E+00
 Nuclide 006:
 Kr-87
   1
  0.4578000000E+04
  0.8700E+02
  2.4186E-02
 Rb-87      0.1000E+01
 none       0.0000E+00
 none       0.0000E+00
 Nuclide 007:
 Kr-88
   1
  1.0224000000E+04
  0.8800E+02
  4.6109E+01
 Rb-88      0.1000E+01
 none       0.0000E+00
 none       0.0000E+00
 Nuclide 008:
 Rb-87
   3
  1.4821920000E+18
  0.8700E+02
  0.0000E+00
 none       0.0000E+00
 none       0.0000E+00
 none       0.0000E+00
 Nuclide 009:
 Rb-88
   3
  1.0680000000E+03
  0.8800E+02
  0.0000E+00
 none       0.0000E+00
 none       0.0000E+00
 none       0.0000E+00
 Nuclide 010:
 I-129
   2
  4.9511520000E+14
  0.1290E+03
  6.2696E-06
 none       0.0000E+00
 none       0.0000E+00
 none       0.0000E+00
 Nuclide 011:
 I-130
   2
  4.4496000000E+04
  0.1300E+03
  1.3698E+00
 none       0.0000E+00
 none       0.0000E+00
 none       0.0000E+00
 Nuclide 012:
 I-131
   2
  6.9465600000E+05
  0.1310E+03
  1.8238E+02
 Xe-131m    0.1110E-01
 none       0.0000E+00
 none       0.0000E+00
```

```
Nuclide 013:
I-132
  2
 8.2800000000E+03
 0.1320E+03
 1.4486E+02
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 014:
I-133
  2
 7.4880000000E+04
 0.1330E+03
 1.1394E+02
Xe-133m   0.2900E-01
Xe-133    0.9710E+00
none      0.0000E+00
Nuclide 015:
I-134
  2
 0.3156000000E+04
 0.1340E+03
 6.0037E-06
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 016:
I-135
  2
 2.3796000000E+04
 0.1350E+03
 1.8750E+01
Xe-135m   0.1540E+00
Xe-135    0.8460E+00
none      0.0000E+00
Nuclide 017:
Xe-129m
  1
 6.9120000000E+05
 0.1290E+03
 2.0778E-01
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 018:
Xe-131m
  1
 1.0281600000E+06
 0.1310E+03
 2.7440E+02
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 019:
Xe-133
  1
 4.5316800000E+05
 0.1330E+03
 4.6037E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 020:
Xe-133m
  1
 1.8904320000E+05
 0.1330E+03
 1.4027E+03
Xe-133    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 021:
Xe-135
  1
 3.2724000000E+04
 0.1350E+03
 1.2674E+04
Cs-135    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 022:
Xe-135m
  1
 9.1740000000E+02
 0.1350E+03
 6.0073E+02
Xe-135    0.9999E+00
Cs-135    4.5000E-05
none      0.0000E+00
Nuclide 023:
Cs-135
  3
 7.2532800000E+13
 0.1350E+03
 0.0000E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
End of Nuclear Inventory File
```

```
fgr 11 and 12 dcfs
        9 ORGANS DEFINED IN THIS FILE:
GONADS
BREAST
LUNGS
RED MARR
BONE SUR
THYROID
REMAINDER
EFFECTIVE
SKIN(FGR)
       23 NUCLIDES DEFINED IN THIS FILE:
Br-82      D
Br-83      H
Kr-83m
Kr-85
Kr-85m
Kr-87
Kr-88
Rb-87      Y
Rb-88
I-129      Y
I-130      H
I-131      D
I-132      D
I-133      D
I-134      M
I-135      D
Xe-129m
Xe-131m
Xe-133
Xe-133m
Xe-135
Xe-135m
Cs-135     Y
```

	CLOUDSHINE	GROUND SHINE 8HR	GROUND SHINE 7DAY	GROUND SHINE RATE	INHALED ACUTE	INHALED CHRONIC	INGESTION
Br-82							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.300E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.130E-10	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Br-83							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	3.820E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.410E-11	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Kr-83m							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.500E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Kr-85							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.190E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Kr-85m							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	7.480E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Kr-87							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	4.120E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Kr-88							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.020E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Rb-87							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.820E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.740E-10	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Rb-88							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

EFFECTIVE	3.360E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.260E-11	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-129							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	3.800E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.690E-08	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-130							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.040E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.140E-10	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-131							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.820E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.890E-09	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-132							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.120E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.030E-10	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-133							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	2.940E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.580E-09	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-134							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.300E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.550E-11	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-135							

GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	8.294E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.320E-10	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Xe-129m							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.060E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Xe-131m							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	3.890E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Xe-133							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.560E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Xe-133m							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.370E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Xe-135							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.190E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Xe-135m							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	2.040E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-135							
GONADS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BREAST	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LUNGS	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RED MARR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BONE SUR	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
REMAINDER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EFFECTIVE	5.650E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.230E-09	0.000E+00
SKIN(FGR)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

```
#########################################################################
          RADTRAD Version 3.02 run on 11/15/2001  at 16:53:48
#########################################################################

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

 Plant file name             = pnpp_fha.psf
 Inventory file name         = d:\hwagage\computer codes\radtrad\run
batch\perry\pnpp_fha.nif
 Scenario file name          = NEW_SDF.SDF
 Release file name           = d:\hwagage\computer codes\radtrad\run
batch\perry\pnpp_fha.rft
 Dose conversion file name = d:\hwagage\computer codes\radtrad\run
batch\perry\pnpp_fha.dcf

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


 Radtrad 3.02 1/5/2000
 perry fha
 Nuclide Inventory File:
 d:\hwagage\computer codes\radtrad\run batch\perry\pnpp_fha.nif
 Plant Power Level:
  3.8332E+03
 Compartments:
   3
 Compartment 1:
 Containment
   3
  1.0000E+00
   0
   0
   0
   0
   0
 Compartment 2:
 Environment
   2
  0.0000E+00
   0
   0
   0
   0
   0
 Compartment 3:
 Control Room
   1
  3.6707E+05
   0
   0
   0
   0
   0
```

```
Pathways:
  3
Pathway 1:
Unfiltered Release to Environment
  1
  2
  4
Pathway 2:
Unfiltered Environment to CR
  2
  3
  2
Pathway 3:
Control Room Exhaust
  3
  2
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
d:\hwagage\computer codes\radtrad\run batch\perry\pnpp_fha.dcf
d:\hwagage\computer codes\radtrad\run batch\perry\pnpp_fha.rft
  0.0000E+00
  1
  0.0000E+00   0.9985E+00   0.0015E+00   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
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   1.0000E+10
  7.2000E+02   0.0000E+00
  0
Pathway 2:
  0
  0
  0
  0
  0
  1
  3
  0.0000E+00   6.6000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  0.0001E+00   5.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  7.2000E+02   5.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 3:
  0
  0
  0
  0
  0
  1
  3
  0.0000E+00   6.6000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  0.0001E+00   5.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  7.2000E+02   5.4000E+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
  0.0000E+00   4.3000E-04
  2.0000E+00   0.0000E+00
  1
  3
  0.0000E+00   3.5000E-04
  8.0000E+00   1.8000E-04
  2.4000E+01   2.3000E-04
  0
Location 2:
Outer Boundary of the LPZ
  2
  1
  2
  0.0000E+00   4.8000E-05
  2.0000E+00   0.0000E+00
  1
  3
  0.0000E+00   3.5000E-04
  8.0000E+00   1.8000E-04
  2.4000E+01   2.3000E-04
  0
Location 3:
Control Room
  3
  0
  1
  2
  0.0000E+00   3.5000E-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
Effective Volume Location:
  1
  2
  0.0000E+00   3.5000E-04
  2.0000E+00   0.0000E+00
Simulation Parameters:
  4
  0.0000E+00   2.5000E-02
  8.0000E+00   1.0000E-01
  2.4000E+01   4.0000E-01
  7.2000E+02   0.0000E+00
Output Filename:

  1
  1
  1
  0
  0
End of Scenario File
```

```
##########################################################################
          RADTRAD Version 3.02 run on 11/15/2001  at 16:53:48
##########################################################################

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

Number of Nuclides =  23

Inventory Power =   3.8332E+03 MWth
Plant Power Level =   3.8332E+03 MWth

Number of compartments    =   3

Compartment information

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

Compartment number  2
Name: Environment
Pathways into and out of compartment  2
    Pathway to compartment number   3: Unfiltered Environment to CR
    Pathway from compartment number 1: Unfiltered Release to Environment
    Pathway from compartment number 3: Control Room Exhaust

Compartment number  3
Name: Control Room
Compartment volume =   3.6707E+05 (Cubic feet)
Pathways into and out of compartment  3
    Pathway to compartment number   2: Control Room Exhaust
    Pathway from compartment number 2: Unfiltered Environment to CR

Total number of pathways =   3
```

```
##########################################################################
        RADTRAD Version 3.02 run on 11/15/2001  at 16:53:48
##########################################################################

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

Radioactive Decay is enabled
Calculation of Daughters is enabled
RELEASE_NAME = Perry FHA
Release Fractions and Timings
                GAP         EARLY IN-VESSEL
             0.0001 hrs       0.0000 hrs
NOBLES       1.0000E+00       0.0000E+00
IODINE       1.0000E+00       0.0000E+00
CESIUM       1.0000E+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     =    0.0000E+00
     Elemental   =    9.9850E-01
     Organic     =    1.5000E-03

COMPARTMENT DATA

Compartment number   1: Containment

Compartment number   2: Environment

Compartment number   3: Control Room

PATHWAY DATA

Pathway number  1: Unfiltered Release to Environment

     Convection Data
      Time (hr)         Flow Rate (% / day)
       0.0000E+00              1.0000E+10
       7.2000E+02              0.0000E+00

Pathway number  2: Unfiltered Environment to CR

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                        (cfm)        Aerosol     Elemental     Organic
       0.0000E+00     6.6000E+03    0.0000E+00   0.0000E+00   0.0000E+00
       1.0000E-04     5.4000E+03    0.0000E+00   0.0000E+00   0.0000E+00
       7.2000E+02     5.4000E+03    0.0000E+00   0.0000E+00   0.0000E+00

Pathway number  3: Control Room Exhaust

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                        (cfm)        Aerosol     Elemental     Organic
```

```
     0.0000E+00    6.6000E+03   0.0000E+00   0.0000E+00   0.0000E+00
     1.0000E-04    5.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
     7.2000E+02    5.4000E+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)
       0.0000E+00           4.3000E-04
       2.0000E+00           0.0000E+00

     Location Breathing Rate Data
      Time (hr)          Breathing Rate (m^3 * sec^-1)
       0.0000E+00                   3.5000E-04
       8.0000E+00                   1.8000E-04
       2.4000E+01                   2.3000E-04
     Location Outer Boundary of the LPZ     is in compartment   2

     Location X/Q Data
      Time (hr)          X/Q (s * m^-3)
       0.0000E+00           4.8000E-05
       2.0000E+00           0.0000E+00

     Location Breathing Rate Data
      Time (hr)          Breathing Rate (m^3 * sec^-1)
       0.0000E+00                   3.5000E-04
       8.0000E+00                   1.8000E-04
       2.4000E+01                   2.3000E-04
     Location Control Room     is in compartment   3

     Location X/Q Data
      Time (hr)          X/Q (s * m^-3)
       0.0000E+00           3.5000E-04
       2.0000E+00           0.0000E+00

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

USER SPECIFIED TIME STEP DATA - SUPPLEMENTAL TIME STEPS
     Time              Time step
      0.0000E+00         2.5000E-02
      8.0000E+00         1.0000E-01
      2.4000E+01         4.0000E-01
      7.2000E+02         0.0000E+00
```

```
########################################################################
          RADTRAD Version 3.02 run on 11/15/2001  at 16:53:48
########################################################################
```

```
 ####   #    #  #####  #####   #    #  #####
#    #  #    #    #    #    #  #    #    #
#    #  #    #    #    #    #  #    #    #
#    #  #    #    #    #####   #    #    #
#    #  #    #    #    #       #    #    #
#    #  #    #    #    #       #    #    #
 ####    ####     #    #        ####     #
```

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

Exclusion Area Boundary Doses:

Time (h) = 0.0001	Whole Body	Thyroid	TEDE
Delta dose (rem)	4.2456E-01	0.0000E+00	1.4377E+00
Accumulated dose (rem)	4.2456E-01	0.0000E+00	1.4377E+00

Outer Boundary of the LPZ Doses:

Time (h) = 0.0001	Whole Body	Thyroid	TEDE
Delta dose (rem)	4.7393E-02	0.0000E+00	1.6048E-01
Accumulated dose (rem)	4.7393E-02	0.0000E+00	1.6048E-01

Control Room Doses:

Time (h) = 0.0001	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.2078E-06	0.0000E+00	4.5686E-05
Accumulated dose (rem)	1.2078E-06	0.0000E+00	4.5686E-05

Control Room Compartment Nuclide Inventory:

Time (h) = 0.0001	Ci	kg	Atoms	Bq
Br-82	6.0733E-04	5.6097E-13	4.1198E+12	2.2471E+07
Br-83	1.6156E-05	1.0227E-15	7.4200E+09	5.9776E+05
Kr-83m	1.2500E-02	6.0583E-13	4.3957E+12	4.6248E+08
Kr-85	8.1467E-01	2.0751E-06	1.4702E+19	3.0143E+10
Kr-85m	1.6234E-01	1.9727E-11	1.3976E+14	6.0067E+09
Kr-87	2.6301E-05	9.2854E-16	6.4273E+09	9.7315E+05
Kr-88	5.0143E-02	3.9989E-12	2.7366E+13	1.8553E+09
Rb-87	4.4281E-24	5.0613E-20	3.5034E+05	1.6384E-13
Rb-88	1.1716E-05	9.7601E-17	6.6792E+08	4.3349E+05
I-129	6.8183E-09	3.8601E-08	1.8020E+17	2.5228E+02
I-130	1.4897E-03	7.6381E-13	3.5383E+12	5.5118E+07
I-131	1.9834E-01	1.5999E-09	7.3546E+15	7.3387E+09
I-132	1.5753E-01	1.5262E-11	6.9627E+13	5.8288E+09
I-133	1.2391E-01	1.0938E-10	4.9529E+14	4.5847E+09
I-134	6.5286E-09	2.4473E-19	1.0999E+06	2.4156E+02
I-135	2.0391E-02	5.8063E-12	2.5901E+13	7.5446E+08
Xe-129m	2.2597E-04	1.7859E-12	8.3372E+12	8.3607E+06
Xe-131m	2.9842E-01	3.5627E-09	1.6378E+16	1.1041E+10
Xe-133	5.0066E+01	2.6747E-07	1.2111E+18	1.8525E+12
Xe-133m	1.5255E+00	3.3997E-09	1.5394E+16	5.6442E+10

Xe-135	1.3783E+01	5.3973E-09	2.4076E+16	5.0998E+11
Xe-135m	6.5313E-01	7.1700E-12	3.1984E+13	2.4166E+10
Cs-135	4.7418E-14	4.1157E-14	1.8359E+11	1.7545E-03

Control Room Transport Group Inventory:

Time (h) = 0.0001	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.5969E+19	0.0000E+00	0.0000E+00
Elemental I (atoms)	1.8787E+17	0.0000E+00	0.0000E+00
Organic I (atoms)	2.8223E+14	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00	0.0000E+00

Time (h) = 0.0001	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

Unfiltered Environment to CR Transport Group Inventory:

Time (h) = 0.0001	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 Exhaust Transport Group Inventory:

Time (h) = 0.0001	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) = 2.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.3779E-03	0.0000E+00	4.7275E-03
Accumulated dose (rem)	4.2594E-01	0.0000E+00	1.4424E+00

Outer Boundary of the LPZ Doses:

Time (h) = 2.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.5382E-04	0.0000E+00	5.2772E-04
Accumulated dose (rem)	4.7547E-02	0.0000E+00	1.6101E-01

Control Room Doses:

Time (h) = 2.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.1084E-02	0.0000E+00	8.5359E-01
Accumulated dose (rem)	2.1086E-02	0.0000E+00	8.5363E-01

Control Room Compartment Nuclide Inventory:

Time (h) = 2.0000	Ci	kg	Atoms	Bq
Br-82	1.0029E-04	9.2638E-14	6.8034E+11	3.7108E+06
Br-83	1.5536E-06	9.8342E-17	7.1353E+08	5.7483E+04
Kr-83m	1.0076E-03	4.8836E-14	3.5434E+11	3.7281E+07
Kr-85	1.3992E-01	3.5639E-07	2.5250E+18	5.1771E+09

Kr-85m	2.0462E-02	2.4865E-12	1.7616E+13	7.5711E+08
Kr-87	1.5187E-06	5.3615E-17	3.7112E+08	5.6191E+04
Kr-88	5.2861E-03	4.2156E-13	2.8849E+12	1.9559E+08
Rb-87	9.2626E-21	1.0587E-16	7.3285E+08	3.4272E-10
Rb-88	5.9844E-03	4.9854E-14	3.4117E+11	2.2142E+08
I-129	1.1711E-09	6.6298E-09	3.0950E+16	4.3329E+01
I-130	2.2871E-04	1.1727E-13	5.4323E+11	8.4623E+06
I-131	3.3822E-02	2.7281E-10	1.2541E+15	1.2514E+09
I-132	1.4809E-02	1.4347E-12	6.5453E+12	5.4793E+08
I-133	1.9910E-02	1.7576E-11	7.9582E+13	7.3667E+08
I-135	2.8396E-03	8.0858E-13	3.6069E+12	1.0507E+08
Xe-129m	3.8531E-05	3.0453E-13	1.4216E+12	1.4256E+06
Xe-131m	5.1007E-02	6.0896E-10	2.7994E+15	1.8873E+09
Xe-133	8.5079E+00	4.5453E-08	2.0581E+17	3.1479E+11
Xe-133m	2.5519E-01	5.6873E-10	2.5752E+15	9.4421E+09
Xe-135	2.0357E+00	7.9713E-10	3.5559E+15	7.5319E+10
Xe-135m	9.5488E-04	1.0483E-14	4.6761E+10	3.5331E+07
Cs-135	1.5125E-10	1.3128E-10	5.8561E+14	5.5963E+00

Control Room Transport Group Inventory:

Time (h) = 2.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	2.7427E+18	0.0000E+00	0.0000E+00
Elemental I (atoms)	3.2268E+16	0.0000E+00	0.0000E+00
Organic I (atoms)	4.8474E+13	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	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

Unfiltered Environment to CR 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 Exhaust 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

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)	4.2594E-01	0.0000E+00	1.4424E+00

Outer Boundary of the LPZ Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00

Accumulated dose (rem)	4.7547E-02	0.0000E+00	1.6101E-01

Control Room Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	3.6824E-03	0.0000E+00	1.7162E-01
Accumulated dose (rem)	2.4768E-02	0.0000E+00	1.0253E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 8.0000	Ci	kg	Atoms	Bq
Br-82	4.4677E-07	4.1267E-16	3.0307E+09	1.6530E+04
Br-83	1.3664E-09	8.6496E-20	6.2758E+05	5.0558E+01
Kr-83m	5.2275E-07	2.5337E-17	1.8383E+08	1.9342E+04
Kr-85	7.0120E-04	1.7860E-09	1.2654E+16	2.5944E+07
Kr-85m	4.0529E-05	4.9249E-15	3.4892E+10	1.4996E+06
Kr-88	6.1254E-06	4.8850E-16	3.3430E+09	2.2664E+05
Rb-87	6.9036E-23	7.8908E-19	5.4620E+06	2.5543E-12
Rb-88	7.0418E-06	5.8663E-17	4.0145E+08	2.6055E+05
I-129	5.8690E-12	3.3226E-11	1.5511E+14	2.1715E-01
I-130	8.1872E-07	4.1978E-16	1.9446E+09	3.0293E+04
I-131	1.6589E-04	1.3381E-12	6.1513E+12	6.1379E+06
I-132	1.2168E-05	1.1788E-15	5.3779E+09	4.5021E+05
I-133	8.1699E-05	7.2121E-14	3.2656E+11	3.0229E+06
I-135	7.5856E-06	2.1600E-15	9.6354E+09	2.8067E+05
Xe-129m	1.8897E-07	1.4935E-15	6.9721E+09	6.9917E+03
Xe-131m	2.5196E-04	3.0081E-12	1.3828E+13	9.3226E+06
Xe-133	4.1296E-02	2.2062E-10	9.9894E+14	1.5279E+09
Xe-133m	1.1817E-03	2.6337E-12	1.1925E+13	4.3725E+07
Xe-135	6.4602E-03	2.5297E-12	1.1285E+13	2.3903E+08
Xe-135m	1.2568E-06	1.3797E-17	6.1547E+07	4.6502E+04
Cs-135	2.4484E-12	2.1251E-12	9.4797E+12	9.0591E-02

Control Room Transport Group Inventory:

Time (h) = 8.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.3745E+16	0.0000E+00	0.0000E+00
Elemental I (atoms)	1.6171E+14	0.0000E+00	0.0000E+00
Organic I (atoms)	2.4294E+11	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	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

Unfiltered Environment to CR 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 Exhaust 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

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)	4.2594E-01	0.0000E+00	1.4424E+00

Outer Boundary of the LPZ Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.7547E-02	0.0000E+00	1.6101E-01

Control Room Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.3641E-05	0.0000E+00	8.2602E-04
Accumulated dose (rem)	2.4782E-02	0.0000E+00	1.0261E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 24.0000	Ci	kg	Atoms	Bq
Kr-85	5.1571E-10	1.3136E-15	9.3064E+09	1.9081E+01
I-129	4.3169E-18	2.4440E-17	1.1409E+08	1.5973E-07
I-131	1.1520E-10	9.2926E-19	4.2718E+06	4.2626E+00
I-133	3.5259E-11	3.1125E-20	1.4093E+05	1.3046E+00
Xe-131m	1.7832E-10	2.1289E-18	9.7868E+06	6.5979E+00
Xe-133	2.7883E-08	1.4896E-16	6.7449E+08	1.0317E+03
Xe-133m	7.0400E-10	1.5690E-18	7.1041E+06	2.6048E+01
Xe-135	1.4044E-09	5.4995E-19	2.4532E+06	5.1963E+01
Cs-135	3.3126E-18	2.8752E-18	1.2826E+07	1.2257E-07

Control Room Transport Group Inventory:

Time (h) = 24.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.0110E+10	0.0000E+00	0.0000E+00
Elemental I (atoms)	1.1895E+08	0.0000E+00	0.0000E+00
Organic I (atoms)	1.7869E+05	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	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

Unfiltered Environment to CR 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 Exhaust 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

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)	4.2594E-01	0.0000E+00	1.4424E+00

Outer Boundary of the LPZ Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.7547E-02	0.0000E+00	1.6101E-01

Control Room Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	3.6064E-12	0.0000E+00	3.3485E-10
Accumulated dose (rem)	2.4782E-02	0.0000E+00	1.0261E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 96.0000	Ci	kg	Atoms	Bq

Control Room Transport Group Inventory:

Time (h) = 96.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	2.5382E-18	0.0000E+00	0.0000E+00
Elemental I (atoms)	2.9862E-20	0.0000E+00	0.0000E+00
Organic I (atoms)	4.4860E-23	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	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

Unfiltered Environment to CR Transport Group Inventory:

Time (h) = 96.0000	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 Exhaust Transport Group Inventory:

Time (h) = 96.0000	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) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.2594E-01	0.0000E+00	1.4424E+00

Outer Boundary of the LPZ Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.7547E-02	0.0000E+00	1.6101E-01

Control Room Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	3.0169E-40	0.0000E+00	4.1186E-38
Accumulated dose (rem)	2.4782E-02	0.0000E+00	1.0261E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 720.0000	Ci	kg	Atoms	Bq

Control Room Transport Group Inventory:

Time (h) = 720.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.5937-257	0.0000E+00	0.0000E+00
Elemental I (atoms)	1.8750-259	0.0000E+00	0.0000E+00
Organic I (atoms)	2.8167-262	0.0000E+00	0.0000E+00
Aerosols (kg),	0.0000E+00	0.0000E+00	0.0000E+00

Time (h) = 720.0000	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

Unfiltered Environment to CR Transport Group Inventory:

Time (h) = 720.0000	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 Exhaust Transport Group Inventory:

Time (h) = 720.0000	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

###
I-131 Summary
###

Time (hr)	Containment I-131 (Curies)	Environment I-131 (Curies)	Control Room I-131 (Curies)
0.000	4.3771E-01	1.8194E+02	1.9834E-01
0.275	0.0000E+00	1.8242E+02	1.5580E-01
0.525	0.0000E+00	1.8245E+02	1.2486E-01
0.775	0.0000E+00	1.8248E+02	1.0006E-01
1.025	0.0000E+00	1.8250E+02	8.0194E-02
1.275	0.0000E+00	1.8251E+02	6.4269E-02
1.525	0.0000E+00	1.8253E+02	5.1507E-02
1.775	0.0000E+00	1.8254E+02	4.1278E-02
2.000	0.0000E+00	1.8254E+02	3.3822E-02
2.250	0.0000E+00	1.8255E+02	2.7100E-02
2.500	0.0000E+00	1.8256E+02	2.1715E-02
2.750	0.0000E+00	1.8256E+02	1.7399E-02
3.000	0.0000E+00	1.8256E+02	1.3941E-02
3.250	0.0000E+00	1.8257E+02	1.1171E-02
3.500	0.0000E+00	1.8257E+02	8.9506E-03
3.750	0.0000E+00	1.8257E+02	7.1718E-03
4.000	0.0000E+00	1.8257E+02	5.7465E-03
4.250	0.0000E+00	1.8257E+02	4.6045E-03
4.500	0.0000E+00	1.8257E+02	3.6894E-03
4.750	0.0000E+00	1.8258E+02	2.9562E-03
5.000	0.0000E+00	1.8258E+02	2.3687E-03
5.250	0.0000E+00	1.8258E+02	1.8979E-03
5.500	0.0000E+00	1.8258E+02	1.5208E-03
5.750	0.0000E+00	1.8258E+02	1.2185E-03
6.000	0.0000E+00	1.8258E+02	9.7636E-04
6.250	0.0000E+00	1.8258E+02	7.8232E-04
6.500	0.0000E+00	1.8258E+02	6.2685E-04
6.750	0.0000E+00	1.8258E+02	5.0227E-04
7.000	0.0000E+00	1.8258E+02	4.0245E-04
7.250	0.0000E+00	1.8258E+02	3.2247E-04
7.500	0.0000E+00	1.8258E+02	2.5838E-04
7.750	0.0000E+00	1.8258E+02	2.0703E-04
8.000	0.0000E+00	1.8258E+02	1.6589E-04
8.400	0.0000E+00	1.8258E+02	1.1637E-04
8.700	0.0000E+00	1.8258E+02	8.9205E-05
9.000	0.0000E+00	1.8258E+02	6.8379E-05
9.300	0.0000E+00	1.8258E+02	5.2415E-05
9.600	0.0000E+00	1.8258E+02	4.0178E-05
9.900	0.0000E+00	1.8258E+02	3.0797E-05
10.200	0.0000E+00	1.8258E+02	2.3607E-05
24.000	0.0000E+00	1.8258E+02	1.1520E-10
96.000	0.0000E+00	1.8258E+02	2.2331E-38
720.000	0.0000E+00	1.8258E+02	1.4904-278

###
Cumulative Dose Summary
###

Time (hr)	Exclusion Area Bounda Thyroid (rem)	TEDE (rem)	Outer Boundary of the Thyroid (rem)	TEDE (rem)	Control Room Thyroid (rem)	TEDE (rem)
0.000	0.0000E+00	1.4377E+00	0.0000E+00	1.6048E-01	0.0000E+00	4.5686E-05
0.275	0.0000E+00	1.4415E+00	0.0000E+00	1.6091E-01	0.0000E+00	2.2323E-01
0.525	0.0000E+00	1.4417E+00	0.0000E+00	1.6094E-01	0.0000E+00	3.8370E-01
0.775	0.0000E+00	1.4419E+00	0.0000E+00	1.6096E-01	0.0000E+00	5.1208E-01
1.025	0.0000E+00	1.4421E+00	0.0000E+00	1.6097E-01	0.0000E+00	6.1479E-01
1.275	0.0000E+00	1.4422E+00	0.0000E+00	1.6099E-01	0.0000E+00	6.9696E-01

1.525	0.0000E+00	1.4423E+00	0.0000E+00	1.6100E-01	0.0000E+00	7.6271E-01
1.775	0.0000E+00	1.4423E+00	0.0000E+00	1.6101E-01	0.0000E+00	8.1533E-01
2.000	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	8.5363E-01
2.250	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	8.8808E-01
2.500	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	9.1564E-01
2.750	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	9.3770E-01
3.000	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	9.5535E-01
3.250	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	9.6947E-01
3.500	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	9.8077E-01
3.750	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	9.8982E-01
4.000	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	9.9706E-01
4.250	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0028E+00
4.500	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0075E+00
4.750	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0112E+00
5.000	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0142E+00
5.250	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0165E+00
5.500	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0184E+00
5.750	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0200E+00
6.000	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0212E+00
6.250	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0222E+00
6.500	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0229E+00
6.750	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0236E+00
7.000	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0241E+00
7.250	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0245E+00
7.500	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0248E+00
7.750	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0250E+00
8.000	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0253E+00
8.400	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0255E+00
8.700	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0256E+00
9.000	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0257E+00
9.300	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0258E+00
9.600	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0259E+00
9.900	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0259E+00
10.200	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0260E+00
24.000	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0261E+00
96.000	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0261E+00
720.000	0.0000E+00	1.4424E+00	0.0000E+00	1.6101E-01	0.0000E+00	1.0261E+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 (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	1.3779E-03	0.0000E+00	4.7275E-03

Outer Boundary of the LPZ

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	1.5382E-04	0.0000E+00	5.2772E-04

Control Room

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	2.1084E-02	0.0000E+00	8.5359E-01

```
##########################################################################
          RADTRAD Version 3.02 run on 11/13/2001   at 13:54:31
##########################################################################

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

 Plant file name           = pnpp_fha.psf
 Inventory file name       = d:\hwagage\computer codes\radtrad\run
batch\perry\pnpp_fha.nif
 Scenario file name        = NEW_SDF.SDF
 Release file name         = d:\hwagage\computer codes\radtrad\run
batch\perry\pnpp_fha.rft
 Dose conversion file name = d:\hwagage\computer codes\radtrad\run
batch\perry\pnpp_fha.dcf



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


 Radtrad 3.02 1/5/2000
 perry fha: sensitivity case 1
 Nuclide Inventory File:
 d:\hwagage\computer codes\radtrad\run batch\perry\pnpp_fha.nif
 Plant Power Level:
  3.8332E+03
 Compartments:
   3
 Compartment 1:
 Containment
   3
  1.0000E+00
   0
   0
   0
   0
   0
 Compartment 2:
 Environment
   2
  0.0000E+00
   0
   0
   0
   0
   0
 Compartment 3:
 Control Room
   1
  3.6707E+05
   0
   0
   0
   0
   0
 Pathways:
   3
 Pathway 1:
 Unfiltered Release to Environment
   1
   2
   4
 Pathway 2:
 Unfiltered Environment to CR
   2
   3
   2
 Pathway 3:
 Control Room Exhaust
   3
   2
   2
 End of Plant Model File
 Scenario Description Name:

 Plant Model Filename:

 Source Term:
   1
   1   1.0000E+00
 d:\hwagage\computer codes\radtrad\run batch\perry\pnpp_fha.dcf
 d:\hwagage\computer codes\radtrad\run batch\perry\pnpp_fha.rft
   0.0000E+00
   1
   0.0000E+00   0.9985E+00   0.0015E+00   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
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   1.0000E+10
 7.2000E+02   0.0000E+00
 0
Pathway 2:
 0
 0
 0
 0
 0
 1
 4
 0.0000E+00   6.6000E+03   0.0000E+00   0.0000E+00   0.0000E+00
 0.0001E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 2.0000E+00   5.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
 7.2000E+02   5.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
 0
 0
 0
 0
 0
 0
Pathway 3:
 0
 0
 0
 0
 0
 1
 4
 0.0000E+00   6.6000E+03   0.0000E+00   0.0000E+00   0.0000E+00
 0.0001E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 2.0000E+00   5.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
 7.2000E+02   5.4000E+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
 0.0000E+00   4.3000E-04
 2.0000E+00   0.0000E+00
 1
 3
 0.0000E+00   3.5000E-04
 8.0000E+00   1.8000E-04
 2.4000E+01   2.3000E-04
 0
Location 2:
Outer Boundary of the LPZ
 2
 1
 2
 0.0000E+00   4.8000E-05
 2.0000E+00   0.0000E+00
 1
 3
 0.0000E+00   3.5000E-04
 8.0000E+00   1.8000E-04
 2.4000E+01   2.3000E-04
 0
Location 3:
Control Room
 3
 0
 1
 2
 0.0000E+00   3.5000E-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
Effective Volume Location:
 1
 2
 0.0000E+00   3.5000E-04
 2.0000E+00   0.0000E+00
Simulation Parameters:
 4
 0.0000E+00   2.5000E-02
 8.0000E+00   1.0000E-01
 2.4000E+01   4.0000E-01
 7.2000E+02   0.0000E+00
Output Filename:

 1
 1
 1
 0
 0
End of Scenario File
```

```
##########################################################################
          RADTRAD Version 3.02 run on 11/13/2001  at 13:54:31
##########################################################################

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

Number of Nuclides =  23

Inventory Power =   3.8332E+03 MWth
Plant Power Level =   3.8332E+03 MWth

Number of compartments    =   3

Compartment information

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

Compartment number  2
Name: Environment
Pathways into and out of compartment  2
    Pathway to compartment number   3: Unfiltered Environment to CR
    Pathway from compartment number 1: Unfiltered Release to Environment
    Pathway from compartment number 3: Control Room Exhaust

Compartment number  3
Name: Control Room
Compartment volume =   3.6707E+05 (Cubic feet)
Pathways into and out of compartment  3
    Pathway to compartment number   2: Control Room Exhaust
    Pathway from compartment number 2: Unfiltered Environment to CR

Total number of pathways =   3
```

```
##########################################################################
        RADTRAD Version 3.02 run on 11/13/2001   at 13:54:31
##########################################################################

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

Radioactive Decay is enabled
Calculation of Daughters is enabled
RELEASE_NAME = Perry FHA
Release Fractions and Timings
             GAP        EARLY IN-VESSEL
             0.0001 hrs    0.0000 hrs
NOBLES       1.0000E+00    0.0000E+00
IODINE       1.0000E+00    0.0000E+00
CESIUM       1.0000E+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    =  0.0000E+00
     Elemental  =  9.9850E-01
     Organic    =  1.5000E-03

COMPARTMENT DATA

Compartment number   1: Containment

Compartment number   2: Environment

Compartment number   3: Control Room

PATHWAY DATA

Pathway number  1: Unfiltered Release to Environment

     Convection Data
      Time (hr)          Flow Rate (% / day)
       0.0000E+00             1.0000E+10
       7.2000E+02             0.0000E+00

Pathway number  2: Unfiltered Environment to CR

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate        Filter Efficiencies (%)
                        (cfm)       Aerosol     Elemental    Organic
       0.0000E+00    6.6000E+03   0.0000E+00   0.0000E+00   0.0000E+00
       1.0000E-04    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
       2.0000E+00    5.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
       7.2000E+02    5.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00

Pathway number  3: Control Room Exhaust

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate        Filter Efficiencies (%)
                        (cfm)       Aerosol     Elemental    Organic
       0.0000E+00    6.6000E+03   0.0000E+00   0.0000E+00   0.0000E+00
       1.0000E-04    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
       2.0000E+00    5.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
       7.2000E+02    5.4000E+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)
       0.0000E+00           4.3000E-04
       2.0000E+00           0.0000E+00

     Location Breathing Rate Data
      Time (hr)          Breathing Rate (m^3 * sec^-1)
       0.0000E+00                3.5000E-04
       8.0000E+00                1.8000E-04
       2.4000E+01                2.3000E-04
     Location Outer Boundary of the LPZ     is in compartment   2

     Location X/Q Data
      Time (hr)          X/Q (s * m^-3)
       0.0000E+00           4.8000E-05
       2.0000E+00           0.0000E+00

     Location Breathing Rate Data
      Time (hr)          Breathing Rate (m^3 * sec^-1)
       0.0000E+00                3.5000E-04
       8.0000E+00                1.8000E-04
       2.4000E+01                2.3000E-04
     Location Control Room     is in compartment   3

     Location X/Q Data
      Time (hr)          X/Q (s * m^-3)
       0.0000E+00           3.5000E-04
       2.0000E+00           0.0000E+00

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

USER SPECIFIED TIME STEP DATA - SUPPLEMENTAL TIME STEPS
     Time           Time step
      0.0000E+00       2.5000E-02
      8.0000E+00       1.0000E-01
      2.4000E+01       4.0000E-01
      7.2000E+02       0.0000E+00
```

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##########################################################################
            RADTRAD Version 3.02 run on 11/13/2001   at 13:54:31
##########################################################################



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


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

Exclusion Area Boundary Doses:

Time (h) =    0.0001    Whole Body  Thyroid      TEDE
Delta dose (rem)         4.2456E-01  0.0000E+00  1.4377E+00
Accumulated dose (rem)   4.2456E-01  0.0000E+00  1.4377E+00

Outer Boundary of the LPZ Doses:

Time (h) =    0.0001    Whole Body  Thyroid      TEDE
Delta dose (rem)         4.7393E-02  0.0000E+00  1.6048E-01
Accumulated dose (rem)   4.7393E-02  0.0000E+00  1.6048E-01

Control Room Doses:

Time (h) =    0.0001    Whole Body  Thyroid      TEDE
Delta dose (rem)         1.2078E-06  0.0000E+00  4.5686E-05
Accumulated dose (rem)   1.2078E-06  0.0000E+00  4.5686E-05

Control Room Compartment Nuclide Inventory:

Time (h) =    0.0001        Ci          kg          Atoms        Bq
Br-82                   6.0733E-04  5.6097E-13  4.1198E+12  2.2471E+07
Br-83                   1.6156E-05  1.0227E-15  7.4200E+09  5.9776E+05
Kr-83m                  1.2500E-02  6.0583E-13  4.3957E+12  4.6248E+08
Kr-85                   8.1467E-01  2.0751E-06  1.4702E+19  3.0143E+10
Kr-85m                  1.6234E-01  1.9727E-11  1.3976E+14  6.0067E+09
Kr-87                   2.6301E-05  9.2854E-16  6.4273E+09  9.7315E+05
Kr-88                   5.0143E-02  3.9989E-12  2.7366E+13  1.8553E+09
Rb-87                   4.4281E-24  5.0613E-20  3.5034E+05  1.6384E-13
Rb-88                   1.1716E-05  9.7601E-17  6.6792E+08  4.3349E+05
I-129                   6.8183E-09  3.8601E-08  1.8020E+17  2.5228E+02
I-130                   1.4897E-03  7.6381E-13  3.5383E+12  5.5118E+07
I-131                   1.9834E-01  1.5999E-09  7.3546E+15  7.3387E+09
I-132                   1.5753E-01  1.5262E-11  6.9627E+13  5.8288E+09
I-133                   1.2391E-01  1.0938E-10  4.9529E+14  4.5847E+09
I-134                   6.5286E-09  2.4473E-19  1.0999E+06  2.4156E+02
I-135                   2.0391E-02  5.8063E-12  2.5901E+13  7.5446E+08
Xe-129m                 2.2597E-04  1.7859E-12  8.3372E+12  8.3607E+06
Xe-131m                 2.9842E-01  3.5627E-09  1.6378E+16  1.1041E+10
Xe-133                  5.0066E+01  2.6747E-07  1.2111E+18  1.8525E+12
Xe-133m                 1.5255E+00  3.3997E-09  1.5394E+16  5.6442E+10
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Xe-135                  1.3783E+01  5.3973E-09  2.4076E+16  5.0998E+11
Xe-135m                 6.5313E-01  7.1700E-12  3.1984E+13  2.4166E+10
Cs-135                  4.7418E-14  4.1157E-14  1.8359E+11  1.7545E-03

Control Room Transport Group Inventory:

                                               Overlying
Time (h) =    0.0001    Atmosphere   Sump        Pool
Noble gases (atoms)     1.5969E+19  0.0000E+00  0.0000E+00
Elemental I (atoms)     1.8787E+17  0.0000E+00  0.0000E+00
Organic I (atoms)       2.8223E+14  0.0000E+00  0.0000E+00
Aerosols (kg)           0.0000E+00  0.0000E+00  0.0000E+00

                        Deposition Recirculating
Time (h) =    0.0001     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

Unfiltered Environment to CR Transport Group Inventory:

                          Pathway
Time (h) =    0.0001       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 Exhaust Transport Group Inventory:

                          Pathway
Time (h) =    0.0001       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) =    2.0000    Whole Body  Thyroid      TEDE
Delta dose (rem)         1.0214E-03  0.0000E+00  3.4587E-03
Accumulated dose (rem)   4.2559E-01  0.0000E+00  1.4411E+00

Outer Boundary of the LPZ Doses:

Time (h) =    2.0000    Whole Body  Thyroid      TEDE
Delta dose (rem)         1.1402E-04  0.0000E+00  3.8609E-04
Accumulated dose (rem)   4.7507E-02  0.0000E+00  1.6087E-01

Control Room Doses:

Time (h) =    2.0000    Whole Body  Thyroid      TEDE
Delta dose (rem)         4.3741E-02  0.0000E+00  1.8080E+00
Accumulated dose (rem)   4.3742E-02  0.0000E+00  1.8080E+00

Control Room Compartment Nuclide Inventory:

Time (h) =    2.0000        Ci          kg          Atoms        Bq
Br-82                   5.8394E-04  5.3937E-13  3.9611E+12  2.1606E+07
Br-83                   9.0455E-06  5.7258E-16  4.1544E+09  3.3468E+05
Kr-83m                  5.8665E-03  2.8434E-13  2.0631E+12  2.1706E+08
Kr-85                   8.1466E-01  2.0750E-06  1.4701E+19  3.0143E+10
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Kr-85m	1.1914E-01	1.4477E-11	1.0257E+14	4.4081E+09
Kr-87	8.8422E-06	3.1216E-16	2.1608E+09	3.2716E+05
Kr-88	3.0777E-02	2.4545E-12	1.6797E+13	1.1388E+09
Rb-87	5.3930E-20	6.1643E-16	4.2669E+09	1.9954E-09
Rb-88	3.4843E-02	2.9027E-13	1.9864E+12	1.2892E+09
I-129	6.8183E-09	3.8601E-08	1.8020E+17	2.5228E+02
I-130	1.3316E-03	6.8277E-13	3.1629E+12	4.9271E+07
I-131	1.9692E-01	1.5884E-09	7.3020E+15	7.2861E+09
I-132	8.6223E-02	8.3532E-12	3.8109E+13	3.1902E+09
I-133	1.1592E-01	1.0233E-10	4.6335E+14	4.2892E+09
I-134	1.3431E-09	5.0346E-20	2.2626E+05	4.9693E+01
I-135	1.6533E-02	4.7078E-12	2.1001E+13	6.1173E+08
Xe-129m	2.2434E-04	1.7731E-12	8.2773E+12	8.3006E+06
Xe-131m	2.9698E-01	3.5456E-09	1.6299E+16	1.0988E+10
Xe-133	4.9536E+01	2.6464E-07	1.1983E+18	1.8328E+12
Xe-133m	1.4858E+00	3.3113E-09	1.4993E+16	5.4975E+10
Xe-135	1.1852E+01	4.6412E-09	2.0704E+16	4.3854E+11
Xe-135m	5.5597E-03	6.1033E-14	2.7226E+11	2.0571E+08
Cs-135	8.8064E-10	7.6435E-10	3.4096E+15	3.2584E+01

Control Room Transport Group Inventory:

Time (h) = 2.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.5969E+19	0.0000E+00	0.0000E+00
Elemental I (atoms)	1.8787E+17	0.0000E+00	0.0000E+00
Organic I (atoms)	2.8223E+14	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	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

Unfiltered Environment to CR 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 Exhaust 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

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)	4.2559E-01	0.0000E+00	1.4411E+00

Outer Boundary of the LPZ Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.7507E-02	0.0000E+00	1.6087E-01

Control Room Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.1440E-02	0.0000E+00	9.9924E-01
Accumulated dose (rem)	6.5182E-02	0.0000E+00	2.8073E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 8.0000	Ci	kg	Atoms	Bq
Br-82	2.6012E-06	2.4027E-15	1.7646E+10	9.6246E+04
Br-83	7.9559E-09	5.0361E-19	3.6540E+06	2.9437E+02
Kr-83m	3.0436E-06	1.4752E-16	1.0703E+09	1.1261E+05
Kr-85	4.0826E-03	1.0399E-08	7.3674E+16	1.5106E+08
Kr-85m	2.3598E-04	2.8674E-14	2.0315E+11	8.7311E+06
Kr-87	1.6835E-09	5.9434E-20	4.1140E+05	6.2290E+01
Kr-88	3.5664E-05	2.8442E-15	1.9464E+10	1.3196E+06
Rb-87	4.0195E-22	4.5943E-18	3.1802E+07	1.4872E-11
Rb-88	4.1000E-05	3.4156E-16	2.3374E+09	1.5170E+06
I-129	3.4171E-11	1.9345E-10	9.0311E+14	1.2643E+00
I-130	4.7669E-06	2.4441E-15	1.1322E+10	1.7637E+05
I-131	9.6586E-04	7.7908E-12	3.5815E+13	3.5737E+07
I-132	7.0844E-05	6.8633E-15	3.1312E+10	2.6212E+06
I-133	4.7568E-04	4.1991E-13	1.9013E+12	1.7600E+07
I-135	4.4166E-05	1.2576E-14	5.6101E+10	1.6341E+06
Xe-129m	1.1002E-06	8.6956E-15	4.0594E+10	4.0708E+04
Xe-131m	1.4670E-03	1.7514E-11	8.0514E+13	5.4279E+07
Xe-133	2.4044E-01	1.2845E-09	5.8162E+15	8.8961E+09
Xe-133m	6.8805E-03	1.5334E-11	6.9432E+13	2.5458E+08
Xe-135	3.7613E-02	1.4729E-11	6.5703E+13	1.3917E+09
Xe-135m	7.3176E-06	8.0332E-17	3.5835E+08	2.7075E+05
Cs-135	1.4255E-11	1.2373E-11	5.5194E+13	5.2745E-01

Control Room Transport Group Inventory:

Time (h) = 8.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	8.0029E+16	0.0000E+00	0.0000E+00
Elemental I (atoms)	9.4155E+14	0.0000E+00	0.0000E+00
Organic I (atoms)	1.4145E+12	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	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

Unfiltered Environment to CR 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 Exhaust Transport Group Inventory:

Pathway

Time (h) = 8.0000	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) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.2559E-01	0.0000E+00	1.4411E+00

Outer Boundary of the LPZ Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.7507E-02	0.0000E+00	1.6087E-01

Control Room Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	7.9420E-05	0.0000E+00	4.8094E-03
Accumulated dose (rem)	6.5262E-02	0.0000E+00	2.8121E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 24.0000	Ci	kg	Atoms	Bq
Kr-85	3.0026E-09	7.6480E-15	5.4185E+10	1.1110E+02
I-129	2.5135E-17	1.4230E-16	6.6428E+08	9.2998E-07
I-131	6.7076E-10	5.4104E-18	2.4872E+07	2.4818E+01
I-133	2.0529E-10	1.8122E-19	8.2055E+05	7.5957E+00
Xe-131m	1.0383E-09	1.2395E-17	5.6982E+07	3.8415E+01
Xe-133	1.6235E-07	8.6731E-16	3.9271E+09	6.0068E+03
Xe-133m	4.0989E-09	9.1350E-18	4.1363E+07	1.5166E+02
Xe-135	8.1770E-09	3.2020E-18	1.4284E+07	3.0255E+02
Cs-135	1.9287E-17	1.6740E-17	7.4676E+07	7.1363E-07

Control Room Transport Group Inventory:

Time (h) = 24.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	5.8866E+10	0.0000E+00	0.0000E+00
Elemental I (atoms)	6.9256E+08	0.0000E+00	0.0000E+00
Organic I (atoms)	1.0404E+06	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	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

Unfiltered Environment to CR 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 Exhaust 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

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)	4.2559E-01	0.0000E+00	1.4411E+00

Outer Boundary of the LPZ Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.7507E-02	0.0000E+00	1.6087E-01

Control Room Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.0998E-11	0.0000E+00	1.9496E-09
Accumulated dose (rem)	6.5262E-02	0.0000E+00	2.8121E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 96.0000	Ci	kg	Atoms	Bq

Control Room Transport Group Inventory:

Time (h) = 96.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.4778E-17	0.0000E+00	0.0000E+00
Elemental I (atoms)	1.7387E-19	0.0000E+00	0.0000E+00
Organic I (atoms)	2.6119E-22	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	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

Unfiltered Environment to CR Transport Group Inventory:

Time (h) = 96.0000	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 Exhaust Transport Group Inventory:

Time (h) = 96.0000	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) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.2559E-01	0.0000E+00	1.4411E+00

Outer Boundary of the LPZ Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.7507E-02	0.0000E+00	1.6087E-01

Control Room Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.7565E-39	0.0000E+00	2.3980E-37
Accumulated dose (rem)	6.5262E-02	0.0000E+00	2.8121E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 720.0000	Ci	kg	Atoms	Bq

Control Room Transport Group Inventory:

Time (h) = 720.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	9.2790-257	0.0000E+00	0.0000E+00
Elemental I (atoms)	1.0917-258	0.0000E+00	0.0000E+00
Organic I (atoms)	1.6400-261	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00	0.0000E+00

Time (h) = 720.0000	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

Unfiltered Environment to CR Transport Group Inventory:

Time (h) = 720.0000	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 Exhaust Transport Group Inventory:

Time (h) = 720.0000	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

2223

##
I-131 Summary
##

Time (hr)	Containment I-131 (Curies)	Environment I-131 (Curies)	Control Room I-131 (Curies)
0.000	4.3771E-01	1.8194E+02	1.9834E-01
0.275	0.0000E+00	1.8238E+02	1.9815E-01
0.525	0.0000E+00	1.8238E+02	1.9797E-01
0.775	0.0000E+00	1.8238E+02	1.9779E-01
1.025	0.0000E+00	1.8238E+02	1.9761E-01
1.275	0.0000E+00	1.8238E+02	1.9744E-01
1.525	0.0000E+00	1.8238E+02	1.9726E-01
1.775	0.0000E+00	1.8238E+02	1.9708E-01
2.000	0.0000E+00	1.8238E+02	1.9692E-01
2.250	0.0000E+00	1.8242E+02	1.5779E-01
2.500	0.0000E+00	1.8245E+02	1.2643E-01
2.750	0.0000E+00	1.8248E+02	1.0130E-01
3.000	0.0000E+00	1.8250E+02	8.1171E-02
3.250	0.0000E+00	1.8251E+02	6.5039E-02
3.500	0.0000E+00	1.8252E+02	5.2114E-02
3.750	0.0000E+00	1.8253E+02	4.1757E-02
4.000	0.0000E+00	1.8254E+02	3.3458E-02
4.250	0.0000E+00	1.8255E+02	2.6809E-02
4.500	0.0000E+00	1.8255E+02	2.1481E-02
4.750	0.0000E+00	1.8256E+02	1.7212E-02
5.000	0.0000E+00	1.8256E+02	1.3791E-02
5.250	0.0000E+00	1.8257E+02	1.1050E-02
5.500	0.0000E+00	1.8257E+02	8.8544E-03
5.750	0.0000E+00	1.8257E+02	7.0947E-03
6.000	0.0000E+00	1.8257E+02	5.6847E-03
6.250	0.0000E+00	1.8257E+02	4.5550E-03
6.500	0.0000E+00	1.8257E+02	3.6497E-03
6.750	0.0000E+00	1.8257E+02	2.9244E-03
7.000	0.0000E+00	1.8257E+02	2.3432E-03
7.250	0.0000E+00	1.8257E+02	1.8775E-03
7.500	0.0000E+00	1.8257E+02	1.5044E-03
7.750	0.0000E+00	1.8257E+02	1.2054E-03
8.000	0.0000E+00	1.8258E+02	9.6586E-04
8.400	0.0000E+00	1.8258E+02	6.7757E-04
8.700	0.0000E+00	1.8258E+02	5.1938E-04
9.000	0.0000E+00	1.8258E+02	3.9812E-04
9.300	0.0000E+00	1.8258E+02	3.0518E-04
9.600	0.0000E+00	1.8258E+02	2.3393E-04
9.900	0.0000E+00	1.8258E+02	1.7931E-04
10.200	0.0000E+00	1.8258E+02	1.3745E-04
24.000	0.0000E+00	1.8258E+02	6.7076E-10
96.000	0.0000E+00	1.8258E+02	1.3002E-37
720.000	0.0000E+00	1.8258E+02	8.6776-278

##
Cumulative Dose Summary
##

	Exclusion Area Bounda		Outer Boundary of the		Control Room	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.000	0.0000E+00	1.4377E+00	0.0000E+00	1.6048E-01	0.0000E+00	4.5686E-05
0.275	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.5085E-01
0.525	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	4.7825E-01
0.775	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	7.0504E-01
1.025	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	9.3124E-01
1.275	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	1.1569E+00
1.525	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	1.3819E+00
1.775	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	1.6064E+00
2.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	1.8080E+00
2.250	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.0086E+00

2.500	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.1691E+00
2.750	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2975E+00
3.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.4003E+00
3.250	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.4825E+00
3.500	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.5483E+00
3.750	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.6010E+00
4.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.6431E+00
4.250	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.6768E+00
4.500	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.7038E+00
4.750	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.7254E+00
5.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.7427E+00
5.250	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.7566E+00
5.500	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.7676E+00
5.750	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.7765E+00
6.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.7836E+00
6.250	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.7893E+00
6.500	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.7938E+00
6.750	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.7975E+00
7.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8004E+00
7.250	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8027E+00
7.500	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8046E+00
7.750	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8061E+00
8.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8073E+00
8.400	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8087E+00
8.700	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8095E+00
9.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8101E+00
9.300	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8106E+00
9.600	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8109E+00
9.900	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8112E+00
10.200	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8114E+00
24.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8121E+00
96.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8121E+00
720.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.8121E+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 (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	1.0214E-03	0.0000E+00	3.4587E-03

Outer Boundary of the LPZ

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	1.1402E-04	0.0000E+00	3.8609E-04

Control Room

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	4.3741E-02	0.0000E+00	1.8080E+00

```
##########################################################################
          RADTRAD Version 3.02 run on 11/13/2001  at 13:56:28
##########################################################################

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

 Plant file name            = pnpp_fha.psf
 Inventory file name        = d:\hwagage\computer codes\radtrad\run
batch\perry\pnpp_fha.nif
 Scenario file name         = NEW_SDF.SDF
 Release file name          = d:\hwagage\computer codes\radtrad\run
batch\perry\pnpp_fha.rft
 Dose conversion file name = d:\hwagage\computer codes\radtrad\run
batch\perry\pnpp_fha.dcf



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


 Radtrad 3.02 1/5/2000
 perry fha: sensitivity case 2
 Nuclide Inventory File:
 d:\hwagage\computer codes\radtrad\run batch\perry\pnpp_fha.nif
 Plant Power Level:
  3.8332E+03
 Compartments:
   3
 Compartment 1:
 Containment
   3
  1.0000E+00
   0
   0
   0
   0
   0
 Compartment 2:
 Environment
   2
  0.0000E+00
   0
   0
   0
   0
   0
 Compartment 3:
 Control Room
   1
  3.6707E+05
   0
   0
   1
   0
   0
 Pathways:
   3
 Pathway 1:
 Unfiltered Release to Environment
   1
   2
   4
 Pathway 2:
 Unfiltered Environment to CR
   2
   3
   2
 Pathway 3:
 Control Room Exhaust
   3
   2
   2
 End of Plant Model File
 Scenario Description Name:

 Plant Model Filename:

 Source Term:
   1
   1   1.0000E+00
 d:\hwagage\computer codes\radtrad\run batch\perry\pnpp_fha.dcf
 d:\hwagage\computer codes\radtrad\run batch\perry\pnpp_fha.rft
   0.0000E+00
   1
   0.0000E+00   0.9985E+00   0.0015E+00   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
```

Enclosure 5
PY-CEI/NRR-2609L

```
 1
 0
 0
 0
 0
 1
 2.7000E+04
 3
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 2.0000E+00   5.0000E+01   5.0000E+01   5.0000E+01
 7.2000E+02   5.0000E+01   5.0000E+01   5.0000E+01
 0
 0
Pathways:
 3
Pathway 1:
 0
 0
 0
 0
 0
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   1.0000E+10
 7.2000E+02   0.0000E+00
 0
Pathway 2:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   6.6000E+03   0.0000E+00   0.0000E+00   0.0000E+00
 0.0001E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 0
 0
 0
 0
 0
 0
Pathway 3:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   6.6000E+03   0.0000E+00   0.0000E+00   0.0000E+00
 0.0001E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 7.2000E+02   0.0000E+00   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
 0.0000E+00   4.3000E-04
 2.0000E+00   0.0000E+00
 1
 3
 0.0000E+00   3.5000E-04
 8.0000E+00   1.8000E-04
 2.4000E+01   2.3000E-04
 0
Location 2:
Outer Boundary of the LPZ
 2
 1
 2
 0.0000E+00   4.8000E-05
 2.0000E+00   0.0000E+00
 1
 3
 0.0000E+00   3.5000E-04
 8.0000E+00   1.8000E-04
 2.4000E+01   2.3000E-04
 0
Location 3:
Control Room
 3
 0
 1
 2
 0.0000E+00   3.5000E-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
Effective Volume Location:
 1
 2
 0.0000E+00   3.5000E-04
 2.0000E+00   0.0000E+00
Simulation Parameters:
 4
 0.0000E+00   2.5000E-02
 8.0000E+00   1.0000E-01
 2.4000E+01   4.0000E-01
 7.2000E+02   0.0000E+00
Output Filename:

 1
 1
 1
 0
 0
End of Scenario File
```

```
#########################################################################
          RADTRAD Version 3.02 run on 11/13/2001   at 13:56:28
#########################################################################

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

Number of Nuclides =  23

Inventory Power =   3.8332E+03 MWth
Plant Power Level =   3.8332E+03 MWth

Number of compartments    =   3

Compartment information

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

Compartment number  2
Name: Environment
Pathways into and out of compartment  2
    Pathway to compartment number   3: Unfiltered Environment to CR
    Pathway from compartment number 1: Unfiltered Release to Environment
    Pathway from compartment number 3: Control Room Exhaust

Compartment number  3
Name: Control Room
Compartment volume =   3.6707E+05 (Cubic feet)
Removal devices within compartment:
     Filter(s)
Pathways into and out of compartment  3
    Pathway to compartment number   2: Control Room Exhaust
    Pathway from compartment number 2: Unfiltered Environment to CR

Total number of pathways =   3
```

```
##########################################################################
         RADTRAD Version 3.02 run on 11/13/2001   at 13:56:28
##########################################################################

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

Radioactive Decay is enabled
Calculation of Daughters is enabled
RELEASE_NAME = Perry FHA
Release Fractions and Timings
                GAP         EARLY IN-VESSEL
             0.0001 hrs      0.0000 hrs
NOBLES       1.0000E+00      0.0000E+00
IODINE       1.0000E+00      0.0000E+00
CESIUM       1.0000E+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    =   0.0000E+00
     Elemental  =   9.9850E-01
     Organic    =   1.5000E-03

COMPARTMENT DATA

Compartment number   1: Containment

Compartment number   2: Environment

Compartment number   3: Control Room

     Compartment Filter Data

      Time (hr)      Flow Rate         Filter Efficiencies (%)
                       (cfm)       Aerosol     Elemental    Organic
       0.0000E+00    2.7000E+04   0.0000E+00  0.0000E+00  0.0000E+00
       2.0000E+00    2.7000E+04   5.0000E+01  5.0000E+01  5.0000E+01
       7.2000E+02    2.7000E+04   5.0000E+01  5.0000E+01  5.0000E+01

PATHWAY DATA

Pathway number   1: Unfiltered Release to Environment

     Convection Data
      Time (hr)          Flow Rate (% / day)
       0.0000E+00             1.0000E+10
       7.2000E+02             0.0000E+00

Pathway number   2: Unfiltered Environment to CR

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate         Filter Efficiencies (%)
                        (cfm)       Aerosol     Elemental    Organic
       0.0000E+00    6.6000E+03   0.0000E+00  0.0000E+00  0.0000E+00
       1.0000E-04    0.0000E+00   0.0000E+00  0.0000E+00  0.0000E+00
       7.2000E+02    0.0000E+00   0.0000E+00  0.0000E+00  0.0000E+00

Pathway number  3: Control Room Exhaust

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate         Filter Efficiencies (%)
                        (cfm)       Aerosol     Elemental    Organic
       0.0000E+00    6.6000E+03   0.0000E+00  0.0000E+00  0.0000E+00
       1.0000E-04    0.0000E+00   0.0000E+00  0.0000E+00  0.0000E+00
       7.2000E+02    0.0000E+00   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)
       0.0000E+00           4.3000E-04
       2.0000E+00           0.0000E+00

     Location Breathing Rate Data
      Time (hr)          Breathing Rate (m^3 * sec^-1)
       0.0000E+00                  3.5000E-04
       8.0000E+00                  1.8000E-04
       2.4000E+01                  2.3000E-04
     Location Outer Boundary of the LPZ     is in compartment   2

     Location X/Q Data
      Time (hr)          X/Q (s * m^-3)
       0.0000E+00           4.8000E-05
       2.0000E+00           0.0000E+00

     Location Breathing Rate Data
      Time (hr)          Breathing Rate (m^3 * sec^-1)
       0.0000E+00                  3.5000E-04
       8.0000E+00                  1.8000E-04
       2.4000E+01                  2.3000E-04
     Location Control Room     is in compartment   3

     Location X/Q Data
      Time (hr)          X/Q (s * m^-3)
       0.0000E+00           3.5000E-04
       2.0000E+00           0.0000E+00

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

USER SPECIFIED TIME STEP DATA - SUPPLEMENTAL TIME STEPS
     Time            Time step
      0.0000E+00      2.5000E-02
      8.0000E+00      1.0000E-01
      2.4000E+01      4.0000E-01
      7.2000E+02      0.0000E+00
```

```
##########################################################################
          RADTRAD Version 3.02 run on 11/13/2001  at 13:56:28
##########################################################################

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

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

Exclusion Area Boundary Doses:

Time (h) = 0.0001	Whole Body	Thyroid	TEDE
Delta dose (rem)	4.2456E-01	0.0000E+00	1.4377E+00
Accumulated dose (rem)	4.2456E-01	0.0000E+00	1.4377E+00

Outer Boundary of the LPZ Doses:

Time (h) = 0.0001	Whole Body	Thyroid	TEDE
Delta dose (rem)	4.7393E-02	0.0000E+00	1.6048E-01
Accumulated dose (rem)	4.7393E-02	0.0000E+00	1.6048E-01

Control Room Doses:

Time (h) = 0.0001	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.2078E-06	0.0000E+00	4.5686E-05
Accumulated dose (rem)	1.2078E-06	0.0000E+00	4.5686E-05

Control Room Compartment Nuclide Inventory:

Time (h) = 0.0001	Ci	kg	Atoms	Bq
Br-82	6.0733E-04	5.6097E-13	4.1198E+12	2.2471E+07
Br-83	1.6156E-05	1.0227E-15	7.4200E+09	5.9776E+05
Kr-83m	1.2500E-02	6.0583E-13	4.3957E+12	4.6248E+08
Kr-85	8.1467E-01	2.0751E-06	1.4702E+19	3.0143E+10
Kr-85m	1.6234E-01	1.9727E-11	1.3976E+14	6.0067E+09
Kr-87	2.6301E-05	9.2854E-16	6.4273E+09	9.7315E+05
Kr-88	5.0143E-02	3.9989E-12	2.7366E+13	1.8553E+09
Rb-87	4.4281E-24	5.0613E-20	3.5034E+05	1.6384E-13
Rb-88	1.1716E-05	9.7601E-17	6.6792E+08	4.3349E+05
I-129	6.8183E-09	3.8601E-08	1.8020E+17	2.5228E+02
I-130	1.4897E-03	7.6381E-13	3.5383E+12	5.5118E+07
I-131	1.9834E-01	1.5999E-09	7.3546E+15	7.3387E+09
I-132	1.5753E-01	1.5262E-11	6.9627E+13	5.8288E+09
I-133	1.2391E-01	1.0938E-10	4.9529E+14	4.5847E+09
I-134	6.5286E-09	2.4473E-19	1.0999E+06	2.4156E+02
I-135	2.0391E-02	5.8063E-12	2.5901E+13	7.5446E+08
Xe-129m	2.2597E-04	1.7859E-12	8.3372E+12	8.3607E+06
Xe-131m	2.9842E-01	3.5627E-09	1.6378E+16	1.1041E+10
Xe-133	5.0066E+01	2.6747E-07	1.2111E+18	1.8525E+12
Xe-133m	1.5255E+00	3.3997E-09	1.5394E+16	5.6442E+10
Xe-135	1.3783E+01	5.3973E-09	2.4076E+16	5.0998E+11
Xe-135m	6.5313E-01	7.1700E-12	3.1984E+13	2.4166E+10
Cs-135	4.7418E-14	4.1157E-14	1.8359E+11	1.7545E-03

Control Room Transport Group Inventory:

Time (h) = 0.0001	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.5969E+19	0.0000E+00	0.0000E+00
Elemental I (atoms)	1.8787E+17	0.0000E+00	0.0000E+00
Organic I (atoms)	2.8223E+14	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	0.0000E+00	0.0000E+00

Time (h) = 0.0001	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

Unfiltered Environment to CR Transport Group Inventory:

Time (h) = 0.0001	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 Exhaust Transport Group Inventory:

Time (h) = 0.0001	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) = 2.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.0214E-03	0.0000E+00	3.4587E-03
Accumulated dose (rem)	4.2559E-01	0.0000E+00	1.4411E+00

Outer Boundary of the LPZ Doses:

Time (h) = 2.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.1402E-04	0.0000E+00	3.8609E-0[illegible]
Accumulated dose (rem)	4.7507E-02	0.0000E+00	1.6087E-01

Control Room Doses:

Time (h) = 2.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	4.3741E-02	0.0000E+00	1.8080E+00
Accumulated dose (rem)	4.3742E-02	0.0000E+00	1.8080E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 2.0000	Ci	kg	Atoms	Bq
Br-82	5.8394E-04	5.3937E-13	3.9611E+12	2.1606E+07
Br-83	9.0455E-06	5.7258E-16	4.1544E+09	3.3468E+05
Kr-83m	5.8665E-03	2.8434E-13	2.0631E+12	2.1706E+08
Kr-85	8.1466E-01	2.0750E-06	1.4701E+19	3.0143E+10

Kr-85m	1.1914E-01	1.4477E-11	1.0257E+14	4.4081E+09
Kr-87	8.8422E-06	3.1216E-16	2.1608E+09	3.2716E+05
Kr-88	3.0777E-02	2.4545E-12	1.6797E+13	1.1388E+09
Rb-87	5.3930E-20	6.1643E-16	4.2669E+09	1.9954E-09
Rb-88	3.4843E-02	2.9027E-13	1.9864E+12	1.2892E+09
I-129	6.8183E-09	3.8601E-08	1.8020E+17	2.5228E+02
I-130	1.3316E-03	6.8277E-13	3.1629E+12	4.9271E+07
I-131	1.9692E-01	1.5884E-09	7.3020E+15	7.2861E+09
I-132	8.6223E-02	8.3532E-12	3.8109E+13	3.1902E+09
I-133	1.1592E-01	1.0233E-10	4.6335E+14	4.2892E+09
I-134	1.3431E-09	5.0346E-20	2.2626E+05	4.9693E+01
I-135	1.6533E-02	4.7078E-12	2.1001E+13	6.1173E+08
Xe-129m	2.2434E-04	1.7731E-12	8.2773E+12	8.3006E+06
Xe-131m	2.9698E-01	3.5456E-09	1.6299E+16	1.0988E+10
Xe-133	4.9536E+01	2.6464E-07	1.1983E+18	1.8328E+12
Xe-133m	1.4858E+00	3.3113E-09	1.4993E+16	5.4975E+10
Xe-135	1.1852E+01	4.6412E-09	2.0704E+16	4.3854E+11
Xe-135m	5.5597E-03	6.1033E-14	2.7226E+11	2.0571E+08
Cs-135	8.8064E-10	7.6435E-10	3.4096E+15	3.2584E+01

Control Room Transport Group Inventory:

Time (h) = 2.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.5969E+19	0.0000E+00	0.0000E+00
Elemental I (atoms)	1.8787E+17	0.0000E+00	0.0000E+00
Organic I (atoms)	2.8223E+14	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	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

Unfiltered Environment to CR 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 Exhaust 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

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)	4.2559E-01	0.0000E+00	1.4411E+00

Outer Boundary of the LPZ Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.7507E-02	0.0000E+00	1.6087E-01

Control Room Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	9.7343E-02	0.0000E+00	4.9289E-01
Accumulated dose (rem)	1.4108E-01	0.0000E+00	2.3009E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 8.0000	Ci	kg	Atoms	Bq
Br-82	9.2289E-10	8.5245E-19	6.2604E+06	3.4147E+01
Kr-83m	6.0467E-04	2.9307E-14	2.1264E+11	2.2373E+07
Kr-85	8.1463E-01	2.0749E-06	1.4701E+19	3.0141E+10
Kr-85m	4.7085E-02	5.7215E-12	4.0536E+13	1.7422E+09
Kr-87	3.3592E-07	1.1859E-17	8.2090E+07	1.2429E+04
Kr-88	7.1163E-03	5.6752E-13	3.8837E+12	2.6330E+08
Rb-87	3.4993E-22	3.9998E-18	2.7686E+07	1.2948E-11
Rb-88	4.0916E-03	3.4086E-14	2.3326E+11	1.5139E+08
I-129	1.2123E-14	6.8636E-14	3.2041E+11	4.4857E-04
I-130	1.6912E-09	8.6715E-19	4.0170E+06	6.2576E+01
I-131	3.4268E-07	2.7641E-15	1.2707E+10	1.2679E+04
I-132	2.5135E-08	2.4350E-18	1.1109E+07	9.2999E+02
I-133	1.6877E-07	1.4898E-16	6.7457E+08	6.2443E+03
I-135	1.5670E-08	4.4619E-18	1.9904E+07	5.7977E+02
Xe-129m	2.1953E-04	1.7351E-12	8.0999E+12	8.1227E+06
Xe-131m	2.9269E-01	3.4944E-09	1.6064E+16	1.0830E+10
Xe-133	4.7973E+01	2.5629E-07	1.1605E+18	1.7750E+12
Xe-133m	1.3727E+00	3.0592E-09	1.3852E+16	5.0790E+10
Xe-135	7.5012E+00	2.9373E-09	1.3103E+16	2.7754E+11
Xe-135m	1.5232E-08	1.6722E-19	7.4592E+05	5.6359E+02
Cs-135	1.2451E-10	1.0807E-10	4.8206E+14	4.6067E+00

Control Room Transport Group Inventory:

Time (h) = 8.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.5969E+19	0.0000E+00	0.0000E+00
Elemental I (atoms)	3.3405E+11	0.0000E+00	0.0000E+00
Organic I (atoms)	5.0183E+08	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	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	1.8787E+17
Organic I (atoms)	0.0000E+00	2.8223E+14
Aerosols (kg)	0.0000E+00	0.0000E+00

Unfiltered Environment to CR 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 Exhaust 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

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)	4.2559E-01	0.0000E+00	1.4411E+00

Outer Boundary of the LPZ Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.7507E-02	0.0000E+00	1.6087E-01

Control Room Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.6709E-01	0.0000E+00	1.6726E-01
Accumulated dose (rem)	3.0817E-01	0.0000E+00	2.4682E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 24.0000	Ci	kg	Atoms	Bq
Kr-83m	1.4111E-06	6.8394E-17	4.9624E+08	5.2211E+04
Kr-85	8.1453E-01	2.0747E-06	1.4699E+19	3.0138E+10
Kr-85m	3.9608E-03	4.8129E-13	3.4099E+12	1.4655E+08
Kr-88	1.4332E-04	1.1430E-14	7.8218E+10	5.3029E+06
Rb-88	9.7010E-05	8.0816E-16	5.5305E+09	3.5894E+06
Xe-129m	2.0721E-04	1.6377E-12	7.6453E+12	7.6668E+06
Xe-131m	2.8154E-01	3.3613E-09	1.5452E+16	1.0417E+10
Xe-133	4.4031E+01	2.3523E-07	1.0651E+18	1.6292E+12
Xe-133m	1.1114E+00	2.4768E-09	1.1215E+16	4.1120E+10
Xe-135	2.2144E+00	8.6714E-10	3.8682E+15	8.1934E+10
Cs-135	3.9856E-11	3.4593E-11	1.5431E+14	1.4747E+00

Control Room Transport Group Inventory:

Time (h) = 24.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.5969E+19	0.0000E+00	0.0000E+00
Elemental I (atoms)	1.5500E-04	0.0000E+00	0.0000E+00
Organic I (atoms)	2.3286E-07	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	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	1.8787E+17
Organic I (atoms)	0.0000E+00	2.8223E+14
Aerosols (kg)	0.0000E+00	0.0000E+00

Unfiltered Environment to CR 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 Exhaust 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

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)	4.2559E-01	0.0000E+00	1.4411E+00

Outer Boundary of the LPZ Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.7507E-02	0.0000E+00	1.6087E-01

Control Room Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.2611E-01	0.0000E+00	2.2611E-01
Accumulated dose (rem)	5.3428E-01	0.0000E+00	2.6943E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 96.0000	Ci	kg	Atoms	Bq
Kr-85	8.1410E-01	2.0736E-06	1.4691E+19	3.0122E+10
Kr-85m	5.7517E-08	6.9891E-18	4.9517E+07	2.1281E+03
Xe-129m	1.5978E-04	1.2628E-12	5.8953E+12	5.9119E+06
Xe-131m	2.3640E-01	2.8224E-09	1.2975E+16	8.7470E+09
Xe-133	2.9847E+01	1.5946E-07	7.2201E+17	1.1044E+12
Xe-133m	4.2964E-01	9.5751E-10	4.3355E+15	1.5897E+10
Xe-135	9.1383E-03	3.5784E-12	1.5963E+13	3.3812E+08
Cs-135	2.2265E-13	1.9325E-13	8.6205E+11	8.2380E-03

Control Room Transport Group Inventory:

Time (h) = 96.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.5969E+19	0.0000E+00	0.0000E+00
Elemental I (atoms)	1.5479E-73	0.0000E+00	0.0000E+00
Organic I (atoms)	2.3253E-76	0.0000E+00	0.0000E+00
Aerosols (kg)	0.0000E+00	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	1.8787E+17
Organic I (atoms)	0.0000E+00	2.8223E+14
Aerosols (kg)	0.0000E+00	0.0000E+00

Unfiltered Environment to CR Transport Group Inventory:

Time (h) = 96.0000	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 Exhaust Transport Group Inventory:

Time (h) = 96.0000	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) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.2559E-01	0.0000E+00	1.4411E+00

Outer Boundary of the LPZ Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	4.7507E-02	0.0000E+00	1.6087E-01

Control Room Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.7824E-01	0.0000E+00	2.7824E-01
Accumulated dose (rem)	8.1252E-01	0.0000E+00	2.9725E+00

Control Room Compartment Nuclide Inventory:

Time (h) = 720.0000	Ci	kg	Atoms	Bq
Kr-85	8.1036E-01	2.0641E-06	1.4624E+19	2.9983E+10
Xe-129m	1.6795E-05	1.3274E-13	6.1967E+11	6.2141E+05
Xe-131m	5.1993E-02	6.2073E-10	2.8535E+15	1.9237E+09
Xe-133	9.7071E-01	5.1859E-09	2.3481E+16	3.5916E+10
Xe-133m	1.1375E-04	2.5352E-13	1.1479E+12	4.2089E+06

Control Room Transport Group Inventory:

Time (h) = 720.0000	Atmosphere	Sump	Overlying Pool
Noble gases (atoms)	1.5969E+19	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

Time (h) = 720.0000	Deposition Surfaces	Recirculating Filter
Noble gases (atoms)	0.0000E+00	0.0000E+00
Elemental I (atoms)	0.0000E+00	1.8787E+17
Organic I (atoms)	0.0000E+00	2.8223E+14
Aerosols (kg)	0.0000E+00	0.0000E+00

Unfiltered Environment to CR Transport Group Inventory:

Time (h) = 720.0000	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 Exhaust Transport Group Inventory:

Time (h) = 720.0000	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

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I-131 Summary

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Time (hr)	Containment I-131 (Curies)	Environment I-131 (Curies)	Control Room I-131 (Curies)
0.000	4.3771E-01	1.8194E+02	1.9834E-01
0.275	0.0000E+00	1.8238E+02	1.9815E-01
0.525	0.0000E+00	1.8238E+02	1.9797E-01
0.775	0.0000E+00	1.8238E+02	1.9779E-01
1.025	0.0000E+00	1.8238E+02	1.9761E-01
1.275	0.0000E+00	1.8238E+02	1.9744E-01
1.525	0.0000E+00	1.8238E+02	1.9726E-01
1.775	0.0000E+00	1.8238E+02	1.9708E-01
2.000	0.0000E+00	1.8238E+02	1.9692E-01
2.250	0.0000E+00	1.8238E+02	1.1332E-01
2.500	0.0000E+00	1.8238E+02	6.5215E-02
2.750	0.0000E+00	1.8238E+02	3.7529E-02
3.000	0.0000E+00	1.8238E+02	2.1597E-02
3.250	0.0000E+00	1.8238E+02	1.2428E-02
3.500	0.0000E+00	1.8238E+02	7.1523E-03
3.750	0.0000E+00	1.8238E+02	4.1159E-03
4.000	0.0000E+00	1.8238E+02	2.3686E-03
4.250	0.0000E+00	1.8238E+02	1.3631E-03
4.500	0.0000E+00	1.8238E+02	7.8441E-04
4.750	0.0000E+00	1.8238E+02	4.5140E-04
5.000	0.0000E+00	1.8238E+02	2.5977E-04
5.250	0.0000E+00	1.8238E+02	1.4949E-04
5.500	0.0000E+00	1.8238E+02	8.6028E-05
5.750	0.0000E+00	1.8238E+02	4.9507E-05
6.000	0.0000E+00	1.8238E+02	2.8490E-05
6.250	0.0000E+00	1.8238E+02	1.6395E-05
6.500	0.0000E+00	1.8238E+02	9.4349E-06
6.750	0.0000E+00	1.8238E+02	5.4295E-06
7.000	0.0000E+00	1.8238E+02	3.1245E-06
7.250	0.0000E+00	1.8238E+02	1.7981E-06
7.500	0.0000E+00	1.8238E+02	1.0348E-06
7.750	0.0000E+00	1.8238E+02	5.9547E-07
8.000	0.0000E+00	1.8238E+02	3.4268E-07
8.400	0.0000E+00	1.8238E+02	1.4155E-07
8.700	0.0000E+00	1.8238E+02	7.2938E-08
9.000	0.0000E+00	1.8238E+02	3.7582E-08
9.300	0.0000E+00	1.8238E+02	1.9365E-08
9.600	0.0000E+00	1.8238E+02	9.9780E-09
9.900	0.0000E+00	1.8238E+02	5.1413E-09
10.200	0.0000E+00	1.8238E+02	2.6491E-09
24.000	0.0000E+00	1.8238E+02	1.5013E-22
96.000	0.0000E+00	1.8238E+02	1.1575E-91
720.000	0.0000E+00	1.8238E+02	0.0000E+00

##

Cumulative Dose Summary

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Time (hr)	Exclusion Area Bounda Thyroid (rem)	Exclusion Area Bounda TEDE (rem)	Outer Boundary of the Thyroid (rem)	Outer Boundary of the TEDE (rem)	Control Room Thyroid (rem)	Control Room TEDE (rem)
0.000	0.0000E+00	1.4377E+00	0.0000E+00	1.6048E-01	0.0000E+00	4.5686E-05
0.275	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.5085E-01
0.525	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	4.7825E-01
0.775	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	7.0504E-01
1.025	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	9.3124E-01
1.275	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	1.1569E+00
1.525	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	1.3819E+00
1.775	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	1.6064E+00
2.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	1.8080E+00
2.250	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	1.9809E+00
2.500	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.0823E+00
2.750	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.1424E+00
3.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.1789E+00
3.250	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2017E+00
3.500	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2166E+00
3.750	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2270E+00
4.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2347E+00
4.250	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2410E+00
4.500	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2463E+00
4.750	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2510E+00
5.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2555E+00
5.250	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2597E+00
5.500	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2638E+00
5.750	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2677E+00
6.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2716E+00
6.250	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2755E+00
6.500	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2792E+00
6.750	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2830E+00
7.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2866E+00
7.250	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2903E+00
7.500	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2939E+00
7.750	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.2974E+00
8.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.3009E+00
8.400	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.3065E+00
8.700	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.3105E+00
9.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.3146E+00
9.300	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.3186E+00
9.600	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.3225E+00
9.900	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.3264E+00
10.200	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.3302E+00
24.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.4682E+00
96.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.6943E+00
720.000	0.0000E+00	1.4411E+00	0.0000E+00	1.6087E-01	0.0000E+00	2.9725E+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 (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	1.0214E-03	0.0000E+00	3.4587E-03

Outer Boundary of the LPZ

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	1.1402E-04	0.0000E+00	3.8609E-04

Control Room

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	4.3741E-02	0.0000E+00	1.8080E+00