Exelon Generation®

4300 Winfield Road
Warrenville, IL 60555
630 657 2000 Office

RS-16-225 10 CFR 50.90

November 8, 2016

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

LaSalle County Station, Units 1 and 2
Renewed Facility Operating License Nos. NPF-11 and NPF-18
NRC Docket Nos. 50-373 and 50-374

Subject: Revised Request for License Amendment Regarding High Burnup Atrium-10 Partial Length Fuel Rods and Request for Exigent Review

References:
1. Letter from D. M. Gullott (Exelon Generation Company, LLC) to U.S. NRC, "Request for License Amendment Regarding High Burnup Atrium-10 Partial Length Fuel Rods," dated September 30, 2016
2. Letter from B. K. Vaidya (U.S. NRC) to B. C. Hanson (Exelon Generation Company, LLC), "LaSalle County Station, Units 1 and 2, – Supplemental Information Needed for Acceptance of Requested Licensing Action Regarding High Burnup Atrium-10 Partial Length Fuel Rods (CAC Nos. MF8442 and MF8443)," dated October 31, 2016

In Reference 1, Exelon Generation Company, LLC (EGC) requested an amendment to Facility Operating License Nos. NPF-11 and NPF-18 for LaSalle County Station (LSCS), Units 1 and 2, respectively. The proposed change would revise the LSCS licensing basis to address Atrium-10 fuel bundles containing part length rods that exceed the burnup limit of 62,000 MWD/MTU, which is specified in NRC Regulatory Guide (RG) 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors."

In Reference 2, the NRC requested additional information that is needed to support the acceptance review of the license amendment request. In response to this request, EGC is providing the attached information.

As discussed with the NRC during a conference call on October 27, 2016, EGC's interpretation of the RG 1.183 release fractions and associated footnotes was that release fractions for the loss-of-coolant accident (LOCA), listed in Table 1 of RG 1.183, could be used if individual fuel rods exceed a peak burnup of 62,000 MWD/MTU. This interpretation was based, in part, on the fact that EGC's LOCA dose consequence analysis applies release fractions uniformly to the

entire core and the core average exposure is not projected to exceed the 62,000 MWD/MTU burnup limit. However, in Reference 2, the NRC clarified that this limit is established in RG 1.183 as an upper boundary to the applicability of the release fractions provided in Tables 1 and 3. Specifically, Reference 2 states that the footnote to Table 1 of RG 1.183 indicates that the limit is for peak burnups rather than average burnups.

As a result, EGC is revising the Evaluation of Proposed Change that was submitted to the NRC as Attachment 1 of Reference 1 to also request NRC approval to exceed the burnup limit specified in Footnote 10 of RG 1.183. The attached information completely supersedes the information previously provided to the NRC in Reference 1.

Current projections show that at the end of the current operating cycle for LSCS Unit 2, 12 Atrium-10 part length rods will have exceeded the 62,000 MWD/MTU burnup limit. To date, none of the part length rods have exceeded the burnup limit. However, projections show that the limit will be exceeded on November 22, 2016.

As a result, EGC requests that further NRC review of the proposed change proceed on an exigent basis in accordance with 10 CFR 50.91, "Notice for public comment; State consultation," paragraph (a)(6) because time does not permit the NRC to publish a Federal Register notice allowing 30 days for prior public comment. The basis for exigency is provided in Attachment 1.

This request is subdivided as follows.

- Attachment 1 provides a description and evaluation of the proposed change.
- Attachment 2 provides Design Analysis L-003067, "Re-Analysis of Fuel Handling Accident (FHA) Using Alternative Source Terms," Revision 2D.
- Attachment 3 provides Technical Evaluation EC407055, "Evaluation of LaSalle Alternative Source Term Loss of Coolant Accident Dose for L2C16 and Impact of Part Length Rods with Burnup > 62 GWd/MTUs," Revision 0.

The proposed change has been reviewed by the LSCS Plant Operations Review Committee in accordance with the requirements of the EGC Quality Assurance Program.

EGC requests approval of the proposed change by November 21, 2016, to support continued plant operation following the date that the burnup limit will be exceeded. Once approved, the amendment will be implemented immediately.

In accordance with 10 CFR 50.91, "Notice for public comment; State consultation," paragraph (b), EGC is notifying the State of Illinois of this application for license amendment by transmitting a copy of this letter and its attachments to the designated State Official.

There are no regulatory commitments contained in this letter. Should you have any questions concerning this letter, please contact Mr. Kenneth M. Nicely at (630) 657-2803.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 8th day of November 2016.

Respectfully,

Patrick R. Simpson
Manager – Licensing

Attachments:

1. Evaluation of Proposed Change
2. Design Analysis L-003067, "Re-Analysis of Fuel Handling Accident (FHA) Using Alternative Source Terms," Revision 2D
3. Technical Evaluation EC407055, "Evaluation of LaSalle Alternative Source Term Loss of Coolant Accident Dose for L2C16 and Impact of Part Length Rods with Burnup > 62 GWd/MTUs," Revision 0

cc: NRC Regional Administrator, Region III
NRC Senior Resident Inspector – LaSalle County Station
Illinois Emergency Management Agency – Division of Nuclear Safety

ATTACHMENT 1
Evaluation of Proposed Change

1.0 SUMMARY DESCRIPTION

In accordance with 10 CFR 50.90, "Application for amendment of license, construction permit, or early site permit," Exelon Generation Company, LLC (EGC) requests an amendment to Renewed Facility Operating License Nos. NPF-11 and NPF-18 for LaSalle County Station (LSCS), Units 1 and 2, respectively. The proposed change revises the LSCS licensing basis to allow movement of irradiated Atrium-10 fuel bundles containing part length rods that have been in operation above 62,000 MWD/MTU, which is the current rod average burnup limit specified in Footnote 11 of NRC Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors" (i.e., Reference 1, to which LSCS is committed). In addition, the proposed change allows use of the release fractions listed in Table 1 of RG 1.183 for these Atrium-10 part length rods that are currently in the Unit 2 Cycle 16 reactor core for the remainder of the current operating cycle.

EGC requests NRC approval of the proposed change on an exigent basis in accordance with 10 CFR 50.91, "Notice for public comment; State consultation," paragraph (a)(6) because time does not permit the NRC to publish a Federal Register notice allowing 30 days for prior public comment, as discussed below.

As discussed with the NRC during a conference call on October 27, 2016, EGC's interpretation of the Reference 1 release fractions and associated footnotes was that release fractions for the loss-of-coolant accident (LOCA), listed in Table 1 of Reference 1, could be used if individual fuel rods exceed a peak burnup of 62,000 MWD/MTU. This interpretation was based, in part, on the fact that EGC's LOCA dose consequence analysis applies release fractions uniformly to the entire core and the core average exposure is not projected to exceed the 62,000 MWD/MTU burnup limit. However, during the conference call, the NRC clarified that this limit is established in Reference 1 as an upper boundary to the applicability of the release fractions provided in Tables 1 and 3, and the limit applied to peak rod exposures regardless of the core average exposure. As a result, EGC determined that the Unit 2 Cycle 16 core design was based on a misinterpretation of Footnote 10, and the core design was nonconforming with the LSCS licensing basis. This nonconforming condition was entered into EGC's Corrective Action Program. EGC evaluated the nonconforming condition and its impact on continued plant operation in accordance with EGC procedures that implement guidance contained in NRC Inspection Manual Chapter 0326, "Operability Determinations & Functionality Assessments for Conditions Adverse to Quality or Safety," and determined operability was supported. However, based on additional discussions with the NRC on November 8, 2016, the NRC expressed that evaluation of the nonconforming condition under EGC's operability determination process could not be used for this situation and that NRC approval of the proposed change described herein was needed prior to exceeding the burnup limit of 62,000 MWD/MTU.

Current projections show that at the end of the current operating cycle for LSCS Unit 2, 12 Atrium-10 part length rods will exceed the 62,000 MWD/MTU burnup limit. To date, none of the part length rods have exceeded the burnup limit. However, projections show that the limit will be exceeded on November 22, 2016. Therefore, EGC is requesting NRC approval of the proposed change by November 21, 2016, to support continued plant operation for LSCS Unit 2.

2.0 DETAILED DESCRIPTION

In Reference 2, the NRC issued amendments 197 and 184 to the facility operating licenses for LSCS, Units 1 and 2, respectively. The amendments support the application of alternative source term (AST) methodology with respect to the loss-of-coolant accident (LOCA) and the fuel handling accident (FHA). EGC's AST analyses for LSCS were performed following the guidance in NRC Regulatory Guide 1.183; Standard Review Plan 15.0.1, "Radiological Consequence Analyses Using Alternative Source Terms" (i.e., Reference 3); and 10 CFR 50.67, "Accident source term."

Section 3 of Reference 1 provides an AST that is acceptable to the NRC, and states that once approved, the AST assumptions or parameters specified in these positions become part of the facility's design basis. After the NRC has approved an implementation of an AST, subsequent changes to the AST require NRC review under 10 CFR 50.67.

LSCS's AST analyses used the core inventory release fractions for the gap release and early in-vessel damage phases for the design basis accident (DBA) LOCA that are listed in Table 1 of Reference 1. For the FHA event, LSCS's analyses used the fractions of the core inventory assumed to be in the gap for the various radionuclides in Table 3 of Reference 1. These release fractions were used in conjunction with the fission product inventory calculated with the maximum core radial peaking factor.

The discussion of release fractions in Reference 1 is annotated with the following footnote:

> [10]The release fractions listed here have been determined to be acceptable for use with currently approved LWR fuel with a peak burnup of 62,000 MWD/MTU. The data in this section may not be applicable to cores containing mixed oxide (MOX) fuel.

Table 3 is annotated with the following footnote:

> [11]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. For the BWR rod drop accident and the PWR rod ejection accident, the gap fractions are assumed to be 10% for iodines and noble gases.

On April 14, 2014, Issue Report 1647125 was initiated under EGC's Corrective Action Program to document a concern that 19 fuel bundles in the Unit 1 Cycle 16 reactor core contain at least one part length rod that exceeds the 62,000 MWD/MTU burnup limit specified in Table 3 of Reference 1. At that time, it was projected that the burnup limit would be reached in September 2015. The fuel bundles containing part length rods were removed from the reactor core during the refueling outage in the first quarter of 2016.

Subsequent reviews identified that some part length rods in the Unit 2 Cycle 16 reactor core were also expected to exceed the 62,000 MWD/MTU burnup limit. The impact of this issue on Unit 2 was documented in Issue Report 2537519. The affected fuel bundles in the Unit 2 Cycle 16 reactor core are currently expected to reach the burnup limit on November 22, 2016.

The NRC's review of these Issue Reports is discussed in Reference 4. In summary, the NRC's review identified a Green finding and a Severity Level IV non-cited violation of 10 CFR 50.59. The NRC concluded that a change to the plant as described in the UFSAR was made, pursuant to 10 CFR 50.59(c), and EGC did not perform an accurate written evaluation which provided the bases for determining that these changes did not require a license amendment. Specifically, EGC did not provide an accurate written evaluation supporting the determination that exceeding the peak burnup limit of 62,000 MWD/MTU for fuel, provided that the maximum linear heat generation rate did not exceed 6.3 kw/ft peak rod average power for burnups exceeding 54,000 MWD/MTU, did not require a license amendment.

The proposed change resolves the Green finding and Severity Level IV non-cited violation by requesting NRC approval to revise the LSCS licensing basis to allow movement of irradiated Atrium-10 fuel bundles containing part length rods that have been in operation above 62,000 MWD/MTU. In addition, the proposed change allows use of the release fractions listed in Table 1 of RG 1.183 for these Atrium-10 part length rods that are currently in the Unit 2 Cycle 16 reactor core for the remainder of the current operating cycle.

For Unit 1, the fuel bundles containing part length rods were removed from the reactor core and placed in the spent fuel storage pool in the first quarter of 2016. However, approval of the proposed change would support future movement of those fuel bundles in the spent fuel storage pool since a fuel handling accident involving fuel bundles containing high burnup part length rods could occur. Administrative controls have been put in place to prevent movement of the affected Unit 1 fuel bundles, and these controls will remain in place until NRC approval of the proposed change is received.

For Unit 2, the affected fuel bundles are currently expected to exceed the burnup limit on November 22, 2016. The proposed change would allow continued plant operation past this date, for the remainder of the current operating cycle. In addition, approval of the proposed change would support movement of the affected Unit 2 fuel bundles.

3.0 TECHNICAL EVALUATION

The fuel bundles containing part length rods that have exceeded, or are projected to exceed, the 62,000 MWD/MTU burnup limit are Atrium-10 fuel bundles. There are 12 part length rods that are projected to exceed this limit by the end the current operating cycle for LSCS Unit 2 (i.e., Cycle 16) by a maximum of 849 MWD/MTU. In addition, another eight part length rods are projected to come within 110 MWD/MTU of exceeding the limit.

The Atrium-10 part length rod is a fuel rod that is shorter than a full length rod, and is located in the bottom portion of the reactor core. It has less uranium content and, as a result of the axial power distribution due to voiding in the top of the core, it experiences higher rod-average exposure. However, it is very similar to the corresponding segment of the full length rod. Essentially the segment is the same as a full length rod, except it has the top portion of uranium

removed. Using this equivalence aspect and the gap fraction calculation procedure, a comparative analysis was performed to determine the impact on the FHA analysis and to demonstrate that a part length rod is bounded by a full length rod.

The associated design analysis is provided in Attachment 2. The scope of the design analysis is limited to the Atrium-10 fuel design at LSCS. The methodology associated with this design analysis is the AST as defined in Reference 1. Reference 1 provides gap release fractions for non-LOCA events in Table 3. These gap release fractions were developed prior to July 2000 and do not explicitly address part length rods. For LSCS, the fuel handling accident is the only non-LOCA event that uses AST methodology in the radiological consequence analyses.

A calculation procedure available to assess the gap inventory is specified in ANSI/ANS-5.4-2011, "Method for Calculating the Fractional Release of Volatile Fission Products from Oxide Fuel," (i.e., Reference 5) to assess the gap inventory. In that calculation procedure, the fractional release of fission gases is computed in a radial and axial (nodal) domain that represents the uranium oxide fuel pellet stack. The effective release fraction is then computed by a volume and power weighted average of the spatial dependent release fractions. The design analysis used this approach to demonstrate that the gap release fraction of the part length rod is bounded by the full length rod, given operational characteristics inherent to the part length rods.

The design analysis demonstrates that the power and burnup for an Atrium-10 part length rod is bounded by the power and burnup in the same axial portion of several neighboring full length rods. Therefore, since the full length rod operating characteristics bound the part length rod, and since the power and burnup of the full length rods comply with the limits specified in Footnote 11 of Reference 1, the Atrium-10 part length rods may operate beyond the 62,000 MWD/MTU burnup limit and meet the intent of Reference 1 (i.e., there is no increase in the non-LOCA gap release fraction required), with an adjustment to the Atrium-10 core damage fraction.

The core damage fraction was adjusted to provide conservatism and to make the Atrium-10 portion of the current analysis of record consistent with this approach. The Atrium-10 fuel assembly at LSCS has eight part length rods that have 90-inch active fuel length and 83 full length rods that have 149-inch active fuel length. Therefore, a part length rod is equivalent to 60.4 percent of the fueled mass of a full length rod. Using this basis, the total equivalent full length rods in the bundle is 87.83 and the revised core damage fraction is 0.002325 versus the current analysis value of 0.002244. This increase of 3.6 percent effectively assumes that the part length rods contain the same source term inventory as the full length rods. However, the limiting GE14 core damage fraction of 0.002578 remains bounding over Atrium-10. Therefore, there is no change in the dose consequences of the analysis of record. With a radial peaking factor of 1.7, the release fraction becomes 0.00395. The margin between the Atrium-10 and limiting dose consequences is therefore approximately 10 percent.

EGC has also performed an evaluation to assess the impact of considering the Unit 2 Cycle 16 specific core design on the AST LOCA dose analysis, and to further show that the consequences of a small number of part length rods in the Atrium-10 batch exceeding the 62,000 MWD/MTU peak rod average limit in Footnote 10 of Reference 1 will not cause LOCA doses to exceed the current analysis of record results. This evaluation, which was prepared to

address the supplemental information requested by the NRC in Reference 6, is provided in Attachment 3. The impact of part length rods exceeding 62,000 MWD/MTU was determined using the same method of substituting full length rod activity for part length rod activity developed in Attachment 2. That analysis demonstrated that every full length rod in Atrium-10 fuel that meets the 62,000 MWD/MTU limit has an axial section equivalent to the part length rod that exceeds the limit by more than the part length rods. Since the full length rod power and burnup is more limiting, it can be used to satisfy the Reference 1 Footnote 10 burnup restrictions, and the LOCA release fractions can be applied unchanged provided full length rods are analytically substituted for part length rods which exceed 62,000 MWD/MTU. The results of this evaluation conclude that the small number of Unit 2 Cycle 16 Atrium-10 part length rods that will exceed or come close to exceeding the 62,000 MWD/MTU limit by the end of the current operating cycle would not result in doses from a LOCA exceeding the current licensing basis results.

4.0 REGULATORY EVALUATION

4.1 Applicable Regulatory Requirements/Criteria

In accordance with 10 CFR 50.67, a licensee may revise its current accident source term by re-evaluating the consequences of DBAs with the AST. In Reference 2, the NRC approved the allocation of AST methodology at LSCS with respect to the LOCA and FHA. The guidance associated with the implementation of an AST is provided in NRC Regulatory Guide 1.183 (i.e., Reference 1), which states that subsequent changes to the AST require NRC review under 10 CFR 50.67.

Fundamental to the definition of an AST according to Reference 1 are the release fractions. Table 1 of Reference 1 provides core inventory release fractions, by radionuclide groups, for the gap release and early in-vessel damage phases for DBA LOCAs. These fractions are applied to the equilibrium core inventory developed for LSCS. Footnote 10 limits the peak burnup to 62,000 MWD/MTU. Table 3 of Reference 1 provides gap release fractions for various volatile fission product isotopes and isotope groups, to be applied to non-LOCA accidents. Footnote 11 of Table 3 limits the peak burnup 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 54,000 MWD/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. For the BWR rod drop accident and the PWR rod ejection accident, the gap fractions are assumed to be 10% for iodines and noble gases.

EGC's analyses demonstrate that the radiological consequences of a FHA and LOCA are not affected by the proposed change.

4.2 No Significant Hazards Consideration

In accordance with 10 CFR 50.90, "Application for amendment of license, construction permit, or early site permit," Exelon Generation Company, LLC (EGC) requests an amendment to Renewed Facility Operating License Nos. NPF-11 and NPF-18 for LaSalle County Station (LSCS), Units 1 and 2, respectively. The proposed change revises the LSCS licensing basis to allow movement of irradiated Atrium-10 fuel bundles containing part length rods that have been in operation above 62,000 MWD/MTU, which is the current rod average burnup limit specified in Footnote 11 of NRC Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors." In addition, the proposed change allows use of the release fractions listed in Table 1 of NRC Regulatory Guide 1.183 for these Atrium-10 part length rods that are currently in the Unit 2 Cycle 16 reactor core for the remainder of the current operating cycle.

According to 10 CFR 50.92, "Issuance of amendment," paragraph (c), a proposed amendment to an operating license involves no significant hazards consideration if operation of the facility in accordance with the proposed amendment would not:

(1) Involve a significant increase in the probability or consequences of any 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.

EGC has evaluated the proposed change, using the criteria in 10 CFR 50.92, and has determined that the proposed change does not involve a significant hazards consideration. The following information is provided to support a finding of no significant hazards consideration.

1. Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

   Response: No

   The proposed change revises the LSCS licensing basis to allow movement of irradiated Atrium-10 fuel bundles containing part length rods that have been in operation above 62,000 MWD/MTU. In addition, the proposed change allows use of the release fractions listed in Table 1 of NRC Regulatory Guide 1.183 for these Atrium-10 part length rods that are currently in the Unit 2 Cycle 16 reactor core for the remainder of the current operating cycle. The proposed change does not involve any physical changes to the plant design and is not an initiator of an accident. The proposed change does not adversely affect accident initiators or precursors, and does not alter the design assumptions, conditions, or configuration of the plant or the manner in which the plant is operated or maintained. Therefore, the proposed change does not affect the probability of a

loss-of-coolant accident. In addition, the proposed change does not affect the probability of a fuel handling accident because the method and frequency of fuel movement activities are not changing.

Analyses have been performed that demonstrate that the power and burnup for an Atrium-10 part length rod is bounded by the power and burnup in the same axial portion of neighboring full length rods. Therefore, since the full length rod operating characteristics bound the part length rod, and since the power and burnup of the full length rods comply with the limits specified in Footnotes 10 and 11 of NRC Regulatory Guide 1.183, the Atrium-10 part length rods may operate beyond the 62,000 MWD/MTU burnup limit and meet the intent of NRC Regulatory Guide 1.183. There are no changes in the dose consequences of the analyses of record for the fuel handling accident and loss-of-coolant accident.

Therefore, the proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

   Response: No

   The proposed change revises the LSCS licensing basis to allow movement of irradiated Atrium-10 fuel bundles containing part length rods that have been in operation above 62,000 MWD/MTU. In addition, the proposed change allows use of the release fractions listed in Table 1 of NRC Regulatory Guide 1.183 for these Atrium-10 part length rods that are currently in the Unit 2 Cycle 16 reactor core for the remainder of the current operating cycle. The proposed change does not introduce any changes or mechanisms that create the possibility of a new or different kind of accident. The proposed change does not install any new or different type of equipment, and installed equipment is not being operated in a new or different manner. No new effects on existing equipment are created nor are any new malfunctions introduced.

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

3. Does the proposed change involve a significant reduction in a margin of safety?

   Response: No

   The proposed change revises the LSCS licensing basis to allow movement of irradiated Atrium-10 fuel bundles containing part length rods that have been in operation above 62,000 MWD/MTU. In addition, the proposed change allows use of the release fractions listed in Table 1 of NRC Regulatory Guide 1.183 for these Atrium-10 part length rods that are currently in the Unit 2 Cycle 16 reactor core for the remainder of the current operating cycle. Analyses have been performed that demonstrate that the power and burnup for an Atrium-10 part

length rod is bounded by the power and burnup in the same axial portion of neighboring full length rods. There is no change in the dose consequences of the fuel handling accident or loss-of-coolant accident analyses of record. The margin of safety, as defined by 10 CFR 50.67 and NRC Regulatory Guide 1.183, has been maintained.

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

Based on the above evaluation, EGC concludes that the proposed amendment presents no significant hazards consideration under the standards set forth in 10 CFR 50.92, paragraph (c), and accordingly, a finding of no significant hazards consideration is justified.

4.3 Conclusions

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

5.0 ENVIRONMENTAL CONSIDERATION

EGC has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, "Standards for Protection Against Radiation." However, the proposed amendment does not involve: (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluent that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22, "Criterion for categorical exclusion; identification of licensing and regulatory actions eligible for categorical exclusion or otherwise not requiring environmental review," paragraph (c)(9). Therefore, pursuant to 10 CFR 51.22, paragraph (b), no environmental impact statement or environmental assessment needs to be prepared in connection with the proposed amendment.

6.0 REFERENCES

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

2. Letter from C. Gratton (U.S. NRC) to M. J. Pacilio (Exelon Nuclear), "LaSalle County Station, Units 1 and 2 – Issuance of Amendments Re: Application of Alternative Source Term (TAC Nos. ME0068 and ME0069)," dated September 6, 2010

3. NRC Standard Review Plan 15.0.1, "Radiological Consequence Analyses Using Alternative Source Terms," Revision 0, dated July 2000

4. Letter from B. Dickson (U.S. NRC) to B. C. Hanson (Exelon Generation Company, LLC), "LaSalle County Station, Units 1 and 2 – NRC Integrated Inspection Report 05000373/2016002; 05000374/2016002," dated August 4, 2016

5. ANSI/ANS-5.4-2011, "Method for Calculating the Fractional Release of Volatile Fission Products from Oxide Fuel"

6. Letter from B. K. Vaidya (U.S. NRC) to B. C. Hanson (Exelon Generation Company, LLC), "LaSalle County Station, Units 1 and 2, – Supplemental Information Needed for Acceptance of Requested Licensing Action Regarding High Burnup Atrium-10 Partial Length Fuel Rods (CAC Nos. MF8442 and MF8443)," dated October 31, 2016

ATTACHMENT 2

Design Analysis L-003067, "Re-Analysis of Fuel Handling Accident (FHA) Using Alternative Source Terms," Revision 2D

ATTACHMENT 1
Design Analysis Cover Sheet
Page 1 of 5

Design Analysis		**Last Page No.** [6] H-14	
Analysis No.: [1]	L-003067	**Revision:** [2] 2D Major ☐	Minor ☒
Title: [3]	Re-Analysis of Fuel Handling Accident (FHA) Using Alternative Source Terms		
EC/ECR No.: [4]	406676	**Revision:** [5]	001

		Component(s): [14]	
Station(s): [7]	LAS		
Unit No.: [8]	1 & 2	NA	
Discipline: [9]	MEDC, NUDC		
Descrip. Code/Keyword: [10]	R01 & R02/ FHA, AST, DBA, Dose		
Safety/QA Class: [11]	SR		
System Code: [12]	VC, VG, VS, ZZ		
Structure: [13]	NA		

CONTROLLED DOCUMENT REFERENCES [15]

Document No.:	From/To	Document No.:	From/To
NF-AB-110-2210	From		
Drawing 5054774	From		
UFSAR CH 15 Table 15.7-21	To		

Is this Design Analysis Safeguards Information? [16] **Yes** ☐ **No** ☒ If yes, see SY-AA-101-106

Does this Design Analysis contain Unverified Assumptions? [17] **Yes** ☐ **No** ☒ If yes, ATI/AR#:

This Design Analysis SUPERCEDES: [18] **L-003067 Rev. 2C** **in its entirety.**

Description of Revision (list changed pages when all pages of original analysis were not changed): [19]
Revision addresses Atrium-10 part-length rods exposure impacts on the FHA dose consequences and addresses IR 2691476 related to a violation of 10 CFR 50.59. Affected pages are 5, 6, and addition of a new Attachment H.

Preparer: [20]	Shane Gardner	Shane R. Gardner	2016-09-27 14:51-04:00
	Print Name	Sign Name	Date
Method of Review: [21]	**Detailed Review** ☒	**Alternate Calculations (attached)** ☐	**Testing** ☐
Reviewer: [22]	Greg Heasley		9/27/16
	Print Name	Sign Name	Date

Review Notes: [23]
Independent review ☒ Peer review ☐
An independent review of the evaluation was performed in accordance with CC-AA-309 Revision 11 and T&RM CC-AA-309-1001 Revision 8. All review comments were resolved satisfactorily. Based on the review, the numeric analysis and results support the conclusion.

(For External Analyses Only)

External Approver: [24]	NA		
	Print Name	Sign Name	Date
Exelon Reviewer: [25]	NA		
	Print Name	Sign Name	Date

Independent 3rd Party Review Reqd? [26] **Yes** ☐ **No** ☒

Exelon Approver: [27]	John Massari		9/27/2016
	Print Name	Sign Name	Date

values utilized, and an evaluation of the acceptability of consideration of an additional Secondary Containment penetration being left open (consideration of any such penetrations is removed in this Revision 2).

Revision 2 of this calculation:

- removed the definition of recently irradiated fuel,
- added the requirement for Secondary Containment Integrity and Standby Gas Treatment System operability, with filtration availability following an assumed Secondary Containment drawdown period,
- removed point and diffuse area pathways associated with not having Secondary Containment Integrity
- applied revised χ/Q values,
- added CRAF operability with intake filter credit after 20 minutes and recirculation filter credit after 4 hours (in the same manner as is used for the AST Loss of Cooling Accident), and
- added several minor clarifications.

2. METHOD OF ANALYSIS AND ACCEPTANCE CRITERIA

Analyses of radiological consequences resulting from a design basis FHA are performed using the guidance for application of AST to this event in RG 1.183, and the approved AST Values for FHA provided in the Ref. 13 "Transmittal of Design Information".

Analyses of radiation transport and dose assessment are performed using RADTRAD v. 3.03. RADTRAD is a simplified model of RADionuclide Transport and Removal And Dose Estimation developed for the NRC and endorsed by the NRC as an acceptable methodology for reanalysis of the radiological consequences of design basis accidents. The technical basis for the RADTRAD code is documented in NUREG/CR-6604 (Ref. 3). The methodologies significant to this analysis are the dose consequence analysis (NUREG Section 2.3) and the Radioactive Decay Calculations (NUREG Section 2.4). This version of RADTRAD has been pre-qualified for safety related design analysis by URS per its 10CFR50 Appendix B Quality Assurance program.

2.1. Fuel Source Term Model

As per Ref. 13, the fuel source term is based on the reactor core source terms described in Attachment A. These source terms are bounding for LSCS fuel cycle designs as documented in Attachment A, which repeats the relevant source term information from Ref. 20 for convenience.

The fraction of the core fuel (in the 764 fuel bundle core) damaged is per the Ref. 9, Ref. 10, and Ref. 11 GESTAR II limiting case of damaging 172 fuel pins (based on a "Heavy Mast" design; i.e., the "NF500 mast" in Ref. 10) from GE12 or GE14 10x10 fuel bundle arrays with the equivalent of 87.33 pins per bundle, and with all of the damaged fuel assumed to have a limiting Radial Peaking Factor (PF) of 1.7 (per Ref. 13). This analysis is for an assembly and mast drop from a 34 feet maximum height from the refueling platform over the reactor well onto the reactor core, bounding in terms of fuel damage potential. Based on fuel damage assessments in references 11, 14, ~~and~~ 15 as shown in Table 1 below, this bounds all currently used and historical fuel types (including any 7x7 array fuel that may have been used early in the reactor life, now sufficiently decayed that any releases will be bounded by the other fuel types considered below).

and Attachment H

Table 1: Bounding Fuel Bundle Type Evaluation

Bundle Type	Fuel Array	Assumed Pins in Bundle	Failed Pins	Damaged Core Fraction	Radial Peaking Factor (PF)	Damaged Core Fraction with PF
GE-Various	8x8	62	124	0.002618	1.5	0.003927
FANP Atrium-9B	9x9	72	131	0.002381	1.5	0.003572
Atrium-10	10x10	87.83	156	0.002325	1.7	0.003952
GE11&GE13	9x9	74	140	0.002476	1.5	0.003714
GE12&GE14*	10x10	87.33	172	0.002578	1.7	0.004382

*Bounding Assembly type, with Radial Peaking Factor commensurate with full core application.

With a 1.7 radial peaking factor, the associated power of the damaged fuel = 3559 MWth * 0.002578 * 1.7 = 15.597 MWth.

This accident analysis evaluates the movement of fuel that has decayed a minimum of 24 hours since it occupied part of a critical reactor core.

2.2. *Gap Activity*

This calculation is applicable to fuel whose burnup and power limits are bounded by those specified in RG 1.183, footnote 11. This allows application of the gap activity fractions for Non-Loss of Coolant Accident (LOCA) events per Table 3 of RG 1.183, which are as follows:

5% of the noble gases (excluding Kr-85)
10% of the Kr-85
5% of the Iodine inventory (excluding I-131)
8% of the I-131
12% of the Alkali metal inventory

(Atrium-10 part-length rods are evaluated in Attachment H)

The noble gas and iodine inventories are provided for RADTRAD use in the Release Fraction and Timing ("rft") file "lasalle ast fha.rft" file included as Attachment D. Because RADTRAD does not allow for application of isotope specific release fractions, the Nuclide Information File ("nif") file "lscs ast source terms for fha.nif", included as Attachment C, is modified to accommodate the differential gap activities among the halogen (I-131) and noble gas (Kr-85) gap fractions dictated by RG 1.183 (Ref. 2) shown above. Therefore, the initial activity of isotope I-131 and Kr-85 are multiplied by 1.6 and 2.0, respectively, in this "nif" file in order to accommodate the respective 10% and 8% release fractions directed by regulatory guidance (Ref. 2).

2.3. *Pool Decontamination Factor (DF)*

Attachment E provides assessments of worst-case water coverage and fuel damage for FHAs over the reactor well and the spent fuel pool, and demonstrates that the drop over the reactor well is more limiting and therefore the bounding case. This is due to the greater number of fuel rods damaged for the reactor well drop (117 for the spent fuel pool drop vs. 172 for the reactor well drop for the bounding 10x10 fuel array, or a ratio of 68.0%), and the fact that the lower than

PURPOSE/OVERVIEW

IR 1647125 identified a concern with excessive exposure in part-length rods for LaSalle 1 Cycle 16. Subsequently IR 2537519 was written to document the condition as it relates to Alternative Source Terms (AST) Regulatory Guide (RG) 1.183 footnote limitation of 62 GWD/MTU for non-LOCA gap release fractions specified in Table 3 of the RG. The other RG 1.183 footnote limitation of 6.3 kW/ft for rod average burnup exceeding 54 GWD/MTU is not a concern for part-length rods as documented in Reference 1. Therefore, a minor revision is necessary to resolve the impact of a few part-length rods that exceed 62 GWD/MTU rod average burnup. This minor revision can be incorporated into future major revision of the design analysis by inserting this attachment in its entirety as a new attachment.

SCOPE

The scope of this design analysis is limited to LaSalle station. The results and limitations of this design analysis revision are not applicable to other stations. The data evaluated supports LaSalle 1 Cycle 16, but this analysis can be utilized for other operating cycles, including at LaSalle 2, provided the fuel rod characteristics used to support the conclusions herein remain bounding.

CONCLUSIONS

The impact on the AST FHA analysis of record due to operation of Atrium-10 part-length rods in excess of 62 GWD/MTU has been evaluated. A comparative analysis was performed to understand how the part-length rod compares to the full-length rod, which are co-located in the fuel bundle and experience similar nuclear operating characteristics. It was concluded that power and burnup for an Atrium-10 part-length rod is bounded by the power and burnup in the same axial portion of several neighboring full-length rods. Therefore, since the full-length rod operating characteristics bound the part-length rod, and since the power and burnup of the full-length rods comply with the RG 1.183 footnote 11 limits, it can be concluded that Atrium-10 part-length rods may operate beyond 62 GWD/MTU burnup and meet the intent of RG 1.183 (i.e. there is no increase in the non-LOCA gap release fraction required). This conclusion required an adjustment to the Atrium-10 core damage fraction. The discussion in the original analysis of record and the UFSAR (Table 15.7-21) should be updated to reflect that Atrium-10 part-length rods are treated separately with respect to the RG 1.183 footnote 11 limits.

METHODOLOGY

The methodology associated with this design analysis is the Alternative Source Term (AST) as defined in RG 1.183. A part of this methodology is the gap release fractions for non-LOCA events like FHA as specified in Table 3 of RG 1.183. These fractions were developed prior to July 2000 and do not explicitly address part-length rods.

A calculation procedure available to assess the gap inventory is specified in ANSI/ANS-5.4-2011, “Method for Calculating the Fractional Release of Volatile Fission Products from Oxide Fuel.” In that calculation procedure the fractional release of fission gases is computed in a radial and axial (nodal) domain that represents the uranium oxide fuel pellet stack. The effective release fraction is then computed by a volume and power weighted average of the spatial dependent release fractions. This design analysis revision will rely on this approach to

demonstrate that the gap release fraction of the part-length rod is bounded by the full-length rod, given operational characteristics inherent to the part-length rods.

The Atrium-10 part-length rod is a fuel rod that is shorter than a full-length rod and is located in the bottom portion of the core. It has less uranium content and, as a result of the axial power distribution due to voiding in the top of the core, it experiences higher rod-average exposure. However, it is very similar to the corresponding segment of the full-length rod. Essentially the segment is the same as a full-length rod, except it has the top portion of uranium removed. Using this equivalence aspect and the gap fraction calculation procedure a comparative analysis is performed to demonstrate that a part-length rod is bounded by a full-length rod.

Consider the following depiction of a full and part-length rod in Figure H-1.

Figure H-1 – Diagram of Full and Part-Length Fuel Rod

(Not to scale; Example burnup profile from LaSalle data)

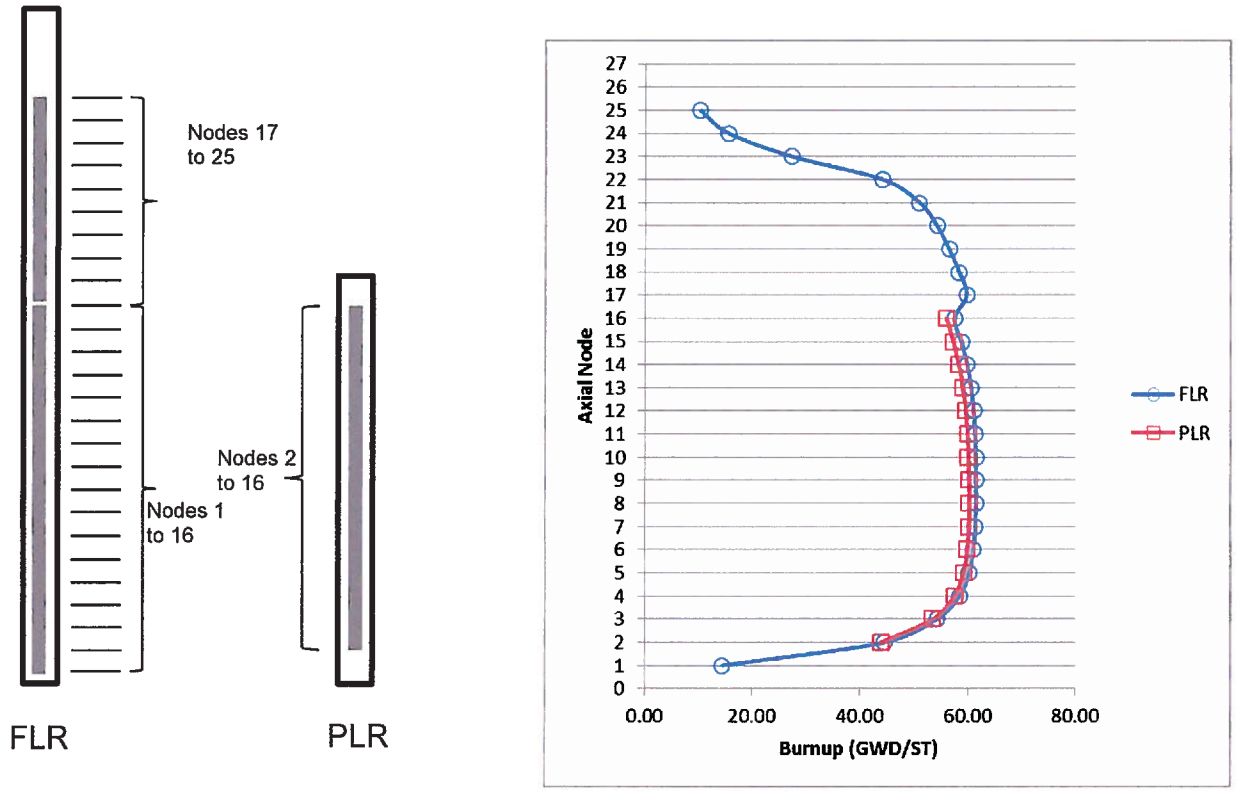


Figure H-1 shows a depiction of the Atrium-10 full and part-length rods in use at LaSalle. The burnup profile shows a typical comparison of the two rods. The part-length rod has a slightly lower burnup than the corresponding portion of the full-length rod. This behavior is partly due to the decrease in neutron multiplication in the upper portion of the part-length rod as a result of the missing fueled region above node 16. This behavior forms the basis for this evaluation.

Actual plant fuel rod power and exposure data will be evaluated to confirm this behavior exists. Once it is concluded that the part-length rod is bounded by the corresponding section of the

full-length rod then it can be concluded that the corresponding full-length rod gap fission product release fraction also bounds the part-length rod. Again, as stated above, this approach can be taken because the overall fission gas release fraction is a power and spatial average over the entire rod. In other words, based on the physical process of fission gas release, if the power and burnup of the portion of fuel in the full length rod is higher than the part-length rod it is reasonable to expect that the fission gas release from that portion of fuel is larger than part-length rod.

Should the evaluation of the fuel rod data indicate that part-length rods are not bounded by the full-length rods, then the dose consequence analysis would require modification accordingly. Since the current analysis considers an Atrium-10 core damage fraction of 0.002244 based on 156 failed rods and 91 rods per bundle an adjustment will be made to be more consistent with this full-length rod equivalency methodology used in this minor revision. The damage of 156 rods is not affected by this revision.

INPUTS

Inputs to this analysis are taken from References 1, 2, and 3 and generally correspond to Atrium-10 fuel design and operating data. The inputs are referenced throughout this minor revision.

ASSUMPTIONS

1. It is assumed that the data provided Reference 1 is a bounding representation of all part-length rods in LaSalle Cycles 14 through 16. This assumption is justified by Reference 1, which states the data was extracted from the bundle (34C217) projected to host the part-length rod with the highest average exposure at end of cycle 16.

NUMERIC ANALYSIS AND RESULTS

LaSalle fuel rod data was provided in Reference 1. This data corresponds to the rod histories for the LaSalle 1 Cycle 16 fuel bundle with the highest part-length rod exposure at end of cycle. This bundle was chosen to be representative of and bounding over all Atrium-10 part-length rods through LaSalle 1 Cycle 16. This bundle can also apply to other cycles and LaSalle 2, provided the fuel rod characteristics remain bounding.

The data provided in Reference 1 was reformatted and plotted to allow for comparisons of part-length rods to full-length rods, which is shown in the Appendix to this minor revision. Fuel rod design layout and axial distributions are taken from Reference 2. A review of the data shows that each part-length rod is bounded by several full-length rods for the average of nodes 2 through 16. It was determined that for all cycle depletion steps each part-length rod has at least one neighbor that is more limiting in exposure, while in most situations a part-length rod will be bounded by several neighboring rods. With respect to power, part-length rods (9,2) and (2,2) have a few instances where the part-length rod has a slightly higher power. However, the difference is between approximately 0.2 and 0.3 kW/ft, which is small and not expected to have an adverse effect on the fission gas release fraction. Note, the observation that the part-length rods are bounded by some neighboring full-length rods applies to both burnup and power. The data shows that the part-length rod is not the leading rod in terms of power and burnup in the assembly.

Based on the analysis of the fuel rod data the following conclusions are made:

1. Full-length rod power and burnup in the axial region corresponding to the part-length rod (i.e. nodes 2 through 16) is typically higher than part-length rods.
2. Since the full-length rod power and burnup is more limiting, it can be used to satisfy the Regulatory Guide 1.183 footnote 11 rod power and burnup restrictions.
3. Since the fuel rod power and burnup restrictions in Regulatory Guide 1.183 footnote 11 are controlled by core design (Reference 3) and since full-length rods have been shown to bound the part-length rods, it can be concluded that this FHA analysis meets the intent of Regulatory Guide 1.183. No increase in the Regulatory Guide 1.183 Table 3 non-LOCA gap release fractions is required for part-length rods provided they are bounded by a full length rod as described above.

To provide conservatism and make the Atrium-10 portion of the current analysis of record consistent with this approach, the core damage fraction will be modified. The Atrium-10 fuel assembly at LaSalle has 8 part-length rods that have 90 inch active fuel length and 83 full-length rods that have 149 inch active fuel length (Reference 2). Therefore, a part-length rod is equivalent to 60.4% of the fueled mass of a full-length rod. Using this basis, the total equivalent full length rods in the bundle is 87.83 (8*0.604+83) and the revised core damage fraction is 0.002325 (156/87.83/764) vs. the current analysis value of 0.002244. This increase of 3.6% effectively assumes that the PLRs contain the same source term inventory as the FLRs. However, the limiting GE14 core damage fraction of 0.002578 remains bounding over Atrium-10. Therefore, there is no change in the final dose consequences of the analysis of record. With the radial peaking factor of 1.7, the release fraction becomes 0.00395. The margin between the Atrium-10 and limiting dose consequences is therefore now about 10% (0.004382/0.003952-1).

IDENTIFICATION OF COMPUTER PROGRAMS

There are no computer programs utilized in this design analysis. Only Personal Productivity Software (PPS) Excel was used for data manipulation, reformatting and display.

REFERENCES

1. NF TODI NF151446, Rev. 0, “LaSalle Unit 1 Cycle 16 Limiting Bundle Edits Supporting AST Evaluation.”
2. LaSalle UFSAR
    a. Section 4.2.2.3, Rev. 21, “Fuel Bundle.”
    b. Table 4.2-4(d), Rev. 17, “Data for the AREVA Atrium-10 Fuel Design.”
    c. Figure 4.2-3d, Rev. 15, “Fuel Bundle FANP Atrium-10 Type.”.
3. NF-AB-110-2210, Rev 16, “Core Loading Pattern Development.”

APPENDIX – FUEL ROD DATA

The following figures show data corresponding to the LaSalle 1 Cycle 16 bundle with the limiting part-length rods. This bundle is evaluated as being representative and bounding with respect to all the LaSalle 1 Cycle 16 part-length rods that are projected to exceed a rod-average burnup of 62 GWD/MTU. This data was provided in Reference 1. A pin map is provided in Figure H-10 and a description of the burnup steps is provided in Figure H-11.

Note that all burnup information is presented in the figures below in GWD/ST. A burnup of 62 GWD/MTU is equal to 56.245 GWD/ST.

In the pin exposure/power plots, the part-length rods are indicated by thick solid outline. The pin exposure/power plots are showing the behavior of the rods at approximately the beginning, middle and end of the cycle. Pin powers are expressed in kW/ft.

Figure H-2 – LaSalle 1 Cycle 14 Pin Exposure Plots

Step 4 = ~BOC, Step 8 = ~MOC, Step 16 = ~EOC

STEP: 4 NODE: 2-16 AVE

	1	2	3	4	5	6	7	8	9	10
1	8.6	8.9	8.9	8.8	8.7	8.4	8.6	9.0	8.9	8.6
2	8.9	8.7	7.0	3.4	6.6	6.6	3.4	7.1	8.8	8.9
3	8.9	7.0	3.2	5.7	6.3	6.3	5.6	4.0	7.1	9.0
4	8.8	3.4	5.7	6.3	7.3	7.4	3.4	5.5	3.4	8.6
5	8.7	6.6	6.3	7.3				3.6	6.6	8.6
6	8.4	6.6	6.3	7.4				7.3	7.0	8.7
7	8.6	3.4	5.6	3.4				6.9	3.7	8.4
8	9.0	7.1	4.0	5.5	3.6	7.3	6.9	3.5	7.4	9.2
9	8.9	8.8	7.1	3.4	6.6	7.0	3.7	7.4	8.7	9.1
10	8.6	8.9	9.0	8.6	8.6	8.7	8.4	9.2	9.1	8.7

STEP: 8 NODE: 2-16 AVE

	1	2	3	4	5	6	7	8	9	10
1	16.1	16.7	17.0	16.9	16.7	16.2	16.5	17.1	16.8	16.1
2	16.7	16.5	13.8	8.2	12.9	13.0	8.3	14.0	16.7	16.8
3	17.0	13.8	7.5	11.5	12.4	12.4	11.5	9.0	14.1	17.1
4	16.9	8.2	11.5	12.5	14.2	14.5	8.6	11.5	8.4	16.6
5	16.7	12.9	12.4	14.2				9.0	13.3	16.5
6	16.2	13.0	12.4	14.5				14.7	14.1	16.8
7	16.5	8.3	11.5	8.6				14.1	9.3	16.3
8	17.1	14.0	9.0	11.5	9.0	14.7	14.1	8.9	14.8	17.6
9	16.8	16.7	14.1	8.4	13.3	14.1	9.3	14.8	16.6	17.1
10	16.1	16.8	17.1	16.6	16.5	16.8	16.3	17.6	17.1	16.4

STEP: 16 NODE: 2-16 AVE

	1	2	3	4	5	6	7	8	9	10
1	23.2	24.4	25.2	25.7	25.5	24.9	25.6	26.5	26.4	25.6
2	24.4	25.1	22.1	16.3	21.3	21.5	17.0	23.5	27.3	27.1
3	25.2	22.1	15.2	19.8	21.0	21.4	20.8	18.3	24.4	28.4
4	25.7	16.3	19.8	21.4	24.4	25.3	19.1	21.8	18.7	28.3
5	25.5	21.3	21.0	24.4				20.3	24.2	28.3
6	24.9	21.5	21.4	25.3				26.2	25.2	28.7
7	25.6	17.0	20.8	19.1				25.6	20.6	28.1
8	26.5	23.5	18.3	21.8	20.3	26.2	25.6	20.1	26.4	29.7
9	26.4	27.3	24.4	18.7	24.2	25.2	20.6	26.4	28.5	28.5
10	25.6	27.1	28.4	28.3	28.3	28.7	28.1	29.7	28.5	27.1

FLR-to-PLR Neighbor Ratios

	1	2	3	4	5	6	7	8	9	10
1	0.99	1.02	1.03	1.35	1.33	1.29		1.02	1.02	0.98
2	1.02	1.00	0.81	0.52	1.00	1.00		0.81	1.00	1.02
3	1.03	0.81	0.37	0.87	0.96	0.96		0.46	0.81	1.03
4	1.35	0.52	0.87							
5	1.33	1.00	0.96					0.51	0.94	1.22
6	1.29	1.00	0.96					1.04	1.00	1.24
7								0.99	0.52	1.20
8	1.02	0.81	0.46		0.51	1.04	0.99	0.41	0.86	1.06
9	1.02	1.00	0.81		0.94	1.00	0.52	0.86	1.00	1.05
10	0.98	1.02	1.03		1.22	1.24	1.20	1.06	1.05	1.01

	1	2	3	4	5	6	7	8	9	10
1	0.97	1.01	1.02	1.31	1.29	1.25		1.02	1.01	0.97
2	1.01	1.00	0.83	0.64	1.00	1.00		0.84	1.00	1.01
3	1.02	0.83	0.46	0.89	0.96	0.96		0.54	0.84	1.03
4	1.31	0.64	0.89							
5	1.29	1.00	0.96					0.64	0.95	1.18
6	1.25	1.00	0.96					1.04	1.00	1.19
7								1.00	0.66	1.16
8	1.02	0.84	0.54		0.64	1.04	1.00	0.54	0.89	1.06
9	1.01	1.00	0.84		0.95	1.00	0.66	0.89	1.00	1.03
10	0.97	1.01	1.03		1.18	1.19	1.16	1.06	1.03	0.98

	1	2	3	4	5	6	7	8	9	10
1	0.93	0.97	1.01	1.21	1.20	1.17		0.97	0.97	0.94
2	0.97	1.00	0.88	0.76	1.00	1.01		0.86	1.00	1.00
3	1.01	0.88	0.61	0.93	0.99	1.01		0.67	0.90	1.04
4	1.21	0.76	0.93							
5	1.20	1.00	0.99					0.81	0.96	1.12
6	1.17	1.01	1.01					1.04	1.00	1.14
7								1.02	0.82	1.12
8	0.97	0.86	0.67		0.81	1.04	1.02	0.71	0.93	1.04
9	0.97	1.00	0.90		0.96	1.00	0.82	0.93	1.00	1.00
10	0.94	1.00	1.04		1.12	1.14	1.12	1.04	1.00	0.95

Figure H-3 – LaSalle 1 Cycle 15 Pin Exposure Plots

Step 17 = ~BOC, Step 24 = ~MOC, Step 33 = ~EOC

STEP: 17 NODE: 2-16 AVE

	1	2	3	4	5	6	7	8	9	10
1	23.3	24.5	25.3	25.8	25.6	25.0	25.6	26.6	26.5	25.7
2	24.5	25.1	22.2	16.3	21.3	21.6	17.0	23.6	27.4	27.2
3	25.3	22.2	15.3	19.9	21.1	21.5	20.9	18.4	24.5	28.5
4	25.8	16.3	19.9	21.5	24.4	25.4	19.2	21.9	18.7	28.4
5	25.6	21.3	21.1	24.4				20.4	24.3	28.3
6	25.0	21.6	21.5	25.4				26.3	25.3	28.8
7	25.6	17.0	20.9	19.2				25.7	20.7	28.2
8	26.6	23.6	18.4	21.9	20.4	26.3	25.7	20.2	26.5	29.8
9	26.5	27.4	24.5	18.7	24.3	25.3	20.7	26.5	28.6	28.6
10	25.7	27.2	28.5	28.4	28.3	28.8	28.2	29.8	28.6	27.2

STEP: 24 NODE: 2-16 AVE

	1	2	3	4	5	6	7	8	9	10
1	33.3	34.9	36.5	37.4	37.2	36.4	37.3	38.3	37.7	36.5
2	34.9	36.3	33.1	27.2	32.0	32.4	28.4	35.2	39.4	38.5
3	36.5	33.1	25.9	30.3	31.6	32.3	32.1	30.0	36.4	40.6
4	37.4	27.2	30.3	32.2	36.0	37.5	31.7	33.8	31.0	40.9
5	37.2	32.0	31.6	36.0				33.3	36.4	40.8
6	36.4	32.4	32.3	37.5				38.9	37.5	41.3
7	37.3	28.4	32.1	31.7				38.2	33.3	40.5
8	38.3	35.2	30.0	33.8	33.3	38.9	38.2	32.9	38.9	42.1
9	37.7	39.4	36.4	31.0	36.4	37.5	33.3	38.9	40.8	40.2
10	36.5	38.5	40.6	40.9	40.8	41.3	40.5	42.1	40.2	38.3

STEP: 33 NODE: 2-16 AVE

	1	2	3	4	5	6	7	8	9	10
1	40.0	41.7	43.7	45.0	44.8	43.9	45.0	46.0	45.1	43.8
2	41.7	43.6	40.5	34.7	39.4	39.9	36.2	43.0	47.4	46.0
3	43.7	40.5	33.4	37.7	39.1	40.0	40.0	38.1	44.5	48.7
4	45.0	34.7	37.7	39.8	44.1	45.8	40.3	42.2	39.4	49.3
5	44.8	39.4	39.1	44.1				42.1	44.7	49.3
6	43.9	39.9	40.0	45.8				47.4	45.9	49.8
7	45.0	36.2	40.0	40.3				46.8	41.9	48.8
8	46.0	43.0	38.1	42.2	42.1	47.4	46.8	41.7	47.4	50.4
9	45.1	47.4	44.5	39.4	44.7	45.9	41.9	47.4	49.0	48.0
10	43.8	46.0	48.7	49.3	49.3	49.8	48.8	50.4	48.0	46.0

FLR-to-PLR Neighbor Ratios

	1	2	3	4	5	6	7	8	9	10
1	0.93	0.97	1.01	1.21	1.20	1.17		0.97	0.97	0.94
2	0.97	1.00	0.88	0.77	1.00	1.01		0.86	1.00	0.99
3	1.01	0.88	0.61	0.93	0.99	1.01		0.67	0.90	1.04
4	1.21	0.77	0.93							
5	1.20	1.00	0.99					0.81	0.96	1.12
6	1.17	1.01	1.01					1.04	1.00	1.14
7								1.02	0.82	1.12
8	0.97	0.86	0.67		0.81	1.04	1.02	0.71	0.93	1.04
9	0.97	1.00	0.90		0.96	1.00	0.82	0.93	1.00	1.00
10	0.94	0.99	1.04		1.12	1.14	1.12	1.04	1.00	0.95

	1	2	3	4	5	6	7	8	9	10
1	0.92	0.96	1.00	1.17	1.16	1.14		0.97	0.96	0.93
2	0.96	1.00	0.91	0.85	1.00	1.01		0.89	1.00	0.98
3	1.00	0.91	0.71	0.95	0.99	1.01		0.76	0.92	1.03
4	1.17	0.85	0.95							
5	1.16	1.00	0.99					0.89	0.97	1.09
6	1.14	1.01	1.01					1.04	1.00	1.10
7								1.02	0.89	1.08
8	0.97	0.89	0.76		0.89	1.04	1.02	0.81	0.95	1.03
9	0.96	1.00	0.92		0.97	1.00	0.89	0.95	1.00	0.98
10	0.93	0.98	1.03		1.09	1.10	1.08	1.03	0.98	0.94

	1	2	3	4	5	6	7	8	9	10
1	0.92	0.96	1.00	1.14	1.14	1.12		0.97	0.95	0.92
2	0.96	1.00	0.93	0.88	1.00	1.01		0.91	1.00	0.97
3	1.00	0.93	0.77	0.96	0.99	1.02		0.80	0.94	1.03
4	1.14	0.88	0.96							
5	1.14	1.00	0.99					0.92	0.98	1.07
6	1.12	1.01	1.02					1.03	1.00	1.09
7								1.02	0.91	1.06
8	0.97	0.91	0.80		0.92	1.03	1.02	0.85	0.97	1.03
9	0.95	1.00	0.94		0.98	1.00	0.91	0.97	1.00	0.98
10	0.92	0.97	1.03		1.07	1.09	1.06	1.03	0.98	0.94

Figure H-4 – LaSalle 1 Cycle 16 Pin Exposure Plots

Step 34 = ~BOC, Step 41 = ~MOC, Step 50 = ~EOC

	STEP: 34				NODE: 2-16 AVE					
	1	2	3	4	5	6	7	8	9	10
1	39.9	41.6	43.6	44.9	44.7	43.8	45.0	45.9	45.1	43.8
2	41.6	43.5	40.4	34.6	39.3	39.9	36.2	43.0	47.4	46.0
3	43.6	40.4	33.3	37.7	39.1	40.0	40.0	38.1	44.5	48.7
4	44.9	34.6	37.7	39.8	44.1	45.8	40.3	42.2	39.4	49.3
5	44.7	39.3	39.1	44.1				42.1	44.8	49.3
6	43.8	39.9	40.0	45.8				47.4	45.9	49.8
7	45.0	36.2	40.0	40.3				46.8	42.0	48.9
8	45.9	43.0	38.1	42.2	42.1	47.4	46.8	41.7	47.4	50.4
9	45.1	47.4	44.5	39.4	44.8	45.9	42.0	47.4	49.0	48.0
10	43.8	46.0	48.7	49.3	49.3	49.8	48.9	50.4	48.0	46.0

	STEP: 41				NODE: 2-16 AVE					
	1	2	3	4	5	6	7	8	9	10
1	45.3	47.1	49.4	51.0	50.7	49.7	50.8	51.5	50.3	48.8
2	47.1	49.3	46.1	40.4	45.0	45.5	41.9	48.6	52.8	51.0
3	49.4	46.1	39.0	43.2	44.6	45.5	45.5	43.7	50.0	53.9
4	51.0	40.4	43.2	45.3	49.6	51.4	46.0	47.8	45.0	54.6
5	50.7	45.0	44.6	49.6				47.8	50.2	54.6
6	49.7	45.5	45.5	51.4				52.9	51.3	55.1
7	50.8	41.9	45.5	46.0				52.2	47.5	54.1
8	51.5	48.6	43.7	47.8	47.8	52.9	52.2	47.3	52.7	55.6
9	50.3	52.8	50.0	45.0	50.2	51.3	47.5	52.7	54.1	52.9
10	48.8	51.0	53.9	54.6	54.6	55.1	54.1	55.6	52.9	50.9

	STEP: 50				NODE: 2-16 AVE					
	1	2	3	4	5	6	7	8	9	10
1	49.5	51.3	53.7	55.5	55.2	54.1	55.2	55.7	54.2	52.7
2	51.3	53.6	50.5	44.8	49.2	49.8	46.3	52.8	56.9	54.8
3	53.7	50.5	43.4	47.5	48.8	49.7	49.8	48.0	54.1	57.9
4	55.5	44.8	47.5	49.4	53.8	55.6	50.3	52.1	49.2	58.7
5	55.2	49.2	48.8	53.8				52.1	54.3	58.7
6	54.1	49.8	49.7	55.6				57.0	55.4	59.1
7	55.2	46.3	49.8	50.3				56.3	51.6	58.0
8	55.7	52.8	48.0	52.1	52.1	57.0	56.3	51.4	56.7	59.4
9	54.2	56.9	54.1	49.2	54.3	55.4	51.6	56.7	57.9	56.6
10	52.7	54.8	57.9	58.7	58.7	59.1	58.0	59.4	56.6	54.6

FLR-to-PLR Neighbor Ratios

	1	2	3	4	5	6	7	8	9	10
1	0.92	0.96	1.00	1.14	1.14	1.11		0.97	0.95	0.92
2	0.96	1.00	0.93	0.88	1.00	1.01		0.91	1.00	0.97
3	1.00	0.93	0.77	0.96	0.99	1.02		0.80	0.94	1.03
4	1.14	0.88	0.96							
5	1.14	1.00	0.99					0.92	0.98	1.07
6	1.11	1.01	1.02					1.03	1.00	1.09
7								1.02	0.91	1.06
8	0.97	0.91	0.80		0.92	1.03	1.02	0.85	0.97	1.03
9	0.95	1.00	0.94		0.98	1.00	0.91	0.97	1.00	0.98
10	0.92	0.97	1.03		1.07	1.09	1.06	1.03	0.98	0.94

	1	2	3	4	5	6	7	8	9	10
1	0.92	0.96	1.00	1.13	1.13	1.11		0.98	0.95	0.92
2	0.96	1.00	0.94	0.90	1.00	1.01		0.92	1.00	0.97
3	1.00	0.94	0.79	0.96	0.99	1.01		0.83	0.95	1.02
4	1.13	0.90	0.96							
5	1.13	1.00	0.99					0.93	0.98	1.07
6	1.11	1.01	1.01					1.03	1.00	1.07
7								1.02	0.93	1.05
8	0.98	0.92	0.83		0.93	1.03	1.02	0.87	0.97	1.03
9	0.95	1.00	0.95		0.98	1.00	0.93	0.97	1.00	0.98
10	0.92	0.97	1.02		1.07	1.07	1.05	1.03	0.98	0.94

	1	2	3	4	5	6	7	8	9	10
1	0.92	0.96	1.00	1.13	1.12	1.10		0.98	0.95	0.93
2	0.96	1.00	0.94	0.91	1.00	1.01		0.93	1.00	0.96
3	1.00	0.94	0.81	0.96	0.99	1.01		0.84	0.95	1.02
4	1.13	0.91	0.96							
5	1.12	1.00	0.99					0.94	0.98	1.06
6	1.10	1.01	1.01					1.03	1.00	1.07
7								1.02	0.93	1.05
8	0.98	0.93	0.84		0.94	1.03	1.02	0.89	0.98	1.03
9	0.95	1.00	0.95		0.98	1.00	0.93	0.98	1.00	0.98
10	0.93	0.96	1.02		1.06	1.07	1.05	1.03	0.98	0.94

Figure H-5 – LaSalle 1 Cycle 14 Pin Power Plots

Step 4 = ~BOC, Step 8 = ~MOC, Step 16 = ~EOC

STEP: 4 NODE: 2-16 AVE

	1	2	3	4	5	6	7	8	9	10
1	7.4	7.5	7.6	7.6	7.5	7.3	7.4	7.7	7.7	7.5
2	7.5	7.3	6.2	3.7	5.8	5.8	3.7	6.3	7.5	7.7
3	7.5	6.2	3.4	5.2	5.5	5.6	5.2	4.1	6.3	7.8
4	7.5	3.7	5.1	5.5	6.3	6.4	3.8	5.2	3.8	7.5
5	7.4	5.7	5.5	6.3				4.0	6.0	7.5
6	7.2	5.8	5.5	6.4				6.5	6.3	7.6
7	7.3	3.7	5.1	3.7				6.3	4.1	7.4
8	7.6	6.2	4.0	5.2	3.9	6.5	6.3	3.9	6.6	7.9
9	7.5	7.3	6.2	3.7	5.9	6.2	4.1	6.6	7.4	7.8
10	7.3	7.5	7.6	7.4	7.4	7.5	7.3	7.8	7.7	7.5

STEP: 8 NODE: 2-16 AVE

	1	2	3	4	5	6	7	8	9	10
1	7.1	7.3	7.6	7.7	7.6	7.4	7.5	7.6	7.4	7.0
2	7.3	7.4	6.6	5.2	6.2	6.3	5.3	6.7	7.5	7.3
3	7.6	6.6	4.7	5.8	5.9	6.0	6.0	5.3	6.8	7.6
4	7.7	5.2	5.8	6.0	6.6	6.9	5.6	6.3	5.4	7.6
5	7.6	6.2	5.9	6.6				5.9	6.7	7.6
6	7.4	6.3	6.0	6.9				7.1	6.9	7.6
7	7.6	5.3	6.0	5.6				7.0	6.0	7.5
8	7.6	6.7	5.3	6.3	5.9	7.2	7.0	5.8	7.2	7.8
9	7.4	7.5	6.8	5.4	6.7	6.9	6.0	7.2	7.5	7.4
10	7.0	7.3	7.6	7.6	7.6	7.6	7.5	7.8	7.4	7.1

STEP: 16 NODE: 2-16 AVE

	1	2	3	4	5	6	7	8	9	10
1	5.8	5.7	5.9	6.0	6.0	5.8	6.0	5.9	5.6	5.3
2	5.7	5.6	5.2	4.5	4.9	5.0	4.7	5.3	5.6	5.4
3	5.8	5.2	4.2	4.6	4.7	4.8	5.0	4.8	5.3	5.6
4	6.0	4.4	4.6	4.7	5.1	5.4	5.0	5.2	4.8	5.7
5	5.9	4.9	4.7	5.1				5.1	5.3	5.7
6	5.8	5.0	4.8	5.4				5.5	5.3	5.7
7	5.9	4.6	4.9	4.9				5.5	4.9	5.6
8	5.8	5.2	4.7	5.1	5.1	5.5	5.4	4.9	5.4	5.6
9	5.5	5.5	5.2	4.7	5.2	5.3	4.9	5.4	5.4	5.3
10	5.1	5.2	5.5	5.6	5.6	5.6	5.5	5.5	5.2	5.0

FLR-to-PLR Neighbor Ratios

	1	2	3	4	5	6	7	8	9	10
1	1.01	1.03	1.04	1.31	1.30	1.26		1.03	1.03	1.00
2	1.02	1.00	0.84	0.64	1.00	1.00		0.84	1.00	1.03
3	1.03	0.84	0.47	0.89	0.95	0.96		0.55	0.85	1.04
4	1.31	0.64	0.90							
5	1.29	1.00	0.95					0.63	0.95	1.19
6	1.25	1.00	0.96					1.03	1.00	1.20
7								1.00	0.65	1.18
8	1.03	0.85	0.55		0.63	1.04	1.00	0.53	0.89	1.07
9	1.02	1.00	0.85		0.95	1.00	0.66	0.89	1.00	1.05
10	1.00	1.02	1.04		1.18	1.20	1.17	1.06	1.04	1.02

	1	2	3	4	5	6	7	8	9	10
1	0.96	0.99	1.02	1.24	1.22	1.19		1.02	0.99	0.94
2	0.99	1.00	0.90	0.83	1.00	1.01		0.90	1.00	0.98
3	1.02	0.90	0.64	0.92	0.95	0.97		0.71	0.91	1.02
4	1.24	0.83	0.92							
5	1.22	1.00	0.95					0.86	0.97	1.10
6	1.19	1.01	0.97					1.04	1.00	1.11
7								1.02	0.87	1.09
8	1.02	0.90	0.71		0.86	1.04	1.02	0.77	0.96	1.04
9	0.99	1.00	0.91		0.97	1.00	0.87	0.96	1.00	0.99
10	0.94	0.98	1.02		1.10	1.11	1.09	1.04	0.99	0.95

	1	2	3	4	5	6	7	8	9	10
1	1.03	1.02	1.05	1.22	1.20	1.18		1.05	1.00	0.94
2	1.02	1.00	0.93	0.90	1.00	1.01		0.95	1.00	0.96
3	1.04	0.92	0.76	0.94	0.95	0.98		0.85	0.95	1.00
4	1.22	0.90	0.94							
5	1.20	1.00	0.95					0.96	0.99	1.06
6	1.17	1.01	0.98					1.04	1.00	1.06
7								1.02	0.92	1.04
8	1.05	0.95	0.86		0.96	1.04	1.03	0.91	1.00	1.04
9	0.99	1.00	0.95		0.99	1.00	0.93	1.00	1.00	0.97
10	0.93	0.95	1.00		1.05	1.06	1.04	1.02	0.97	0.93

Figure H-6 – LaSalle 1 Cycle 15 Pin Power Plots

Step 17 = ~BOC, Step 24 = ~MOC, Step 33 = ~EOC

STEP: 17 NODE: 2-16 AVE

	1	2	3	4	5	6	7	8	9	10
1	5.4	5.5	5.7	5.9	5.8	5.8	5.9	5.9	5.7	5.4
2	5.5	5.6	5.3	4.6	5.2	5.3	4.9	5.6	5.9	5.6
3	5.6	5.3	4.5	5.0	5.1	5.3	5.5	5.3	5.8	6.0
4	5.8	4.6	5.0	5.2	5.8	6.1	5.6	5.8	5.4	6.2
5	5.8	5.1	5.1	5.7				5.8	5.9	6.2
6	5.7	5.2	5.3	6.1				6.3	6.0	6.2
7	5.8	4.9	5.5	5.6				6.2	5.6	6.1
8	5.9	5.6	5.3	5.9	5.8	6.3	6.3	5.7	6.2	6.2
9	5.7	6.0	5.9	5.5	6.1	6.1	5.7	6.2	6.2	5.9
10	5.5	5.8	6.2	6.4	6.4	6.4	6.3	6.4	5.9	5.6

STEP: 24 NODE: 2-16 AVE

	1	2	3	4	5	6	7	8	9	10
1	5.5	5.5	5.7	5.9	5.8	5.7	5.8	5.7	5.3	5.0
2	5.5	5.5	5.3	4.7	5.1	5.1	4.8	5.3	5.4	5.0
3	5.7	5.3	4.6	4.9	4.9	5.0	5.1	4.9	5.2	5.2
4	5.9	4.7	4.9	5.0	5.2	5.4	5.0	5.3	4.8	5.3
5	5.8	5.1	4.9	5.2				5.0	5.2	5.3
6	5.7	5.1	5.0	5.4				5.4	5.2	5.3
7	5.8	4.8	5.1	5.0				5.4	4.8	5.2
8	5.6	5.3	4.9	5.3	5.0	5.4	5.4	4.9	5.3	5.2
9	5.3	5.4	5.3	4.8	5.3	5.3	4.9	5.3	5.1	4.9
10	5.0	5.0	5.3	5.4	5.4	5.3	5.2	5.2	4.9	4.8

STEP: 33 NODE: 2-16 AVE

	1	2	3	4	5	6	7	8	9	10
1	4.6	4.5	4.6	4.7	4.7	4.6	4.7	4.6	4.3	4.1
2	4.5	4.4	4.3	3.9	4.2	4.2	3.9	4.3	4.2	4.0
3	4.6	4.3	3.8	4.1	4.0	4.1	4.2	4.0	4.2	4.2
4	4.8	3.9	4.1	4.1	4.2	4.3	4.0	4.3	3.9	4.2
5	4.7	4.2	4.1	4.2				4.0	4.2	4.2
6	4.7	4.2	4.1	4.3				4.3	4.2	4.2
7	4.7	3.9	4.2	4.0				4.3	3.8	4.1
8	4.6	4.3	4.0	4.3	4.0	4.3	4.3	3.9	4.1	4.1
9	4.3	4.2	4.2	3.8	4.2	4.1	3.8	4.1	4.0	3.9
10	4.1	4.1	4.2	4.2	4.2	4.2	4.1	4.1	3.9	4.0

FLR-to-PLR Neighbor Ratios

	1	2	3	4	5	6	7	8	9	10
1	0.97	0.98	1.02	1.13	1.13	1.11		0.99	0.95	0.90
2	0.98	1.00	0.95	0.90	1.00	1.02		0.95	1.00	0.95
3	1.02	0.95	0.81	0.97	0.99	1.02		0.88	0.98	1.01
4	1.13	0.90	0.98							
5	1.12	1.00	1.00					0.96	0.99	1.03
6	1.11	1.02	1.03					1.04	1.00	1.03
7								1.04	0.93	1.02
8	0.98	0.94	0.88		0.95	1.04	1.03	0.92	1.00	1.01
9	0.95	1.00	0.98		0.99	1.00	0.93	1.01	1.00	0.95
10	0.91	0.96	1.03		1.04	1.05	1.03	1.03	0.96	0.91

	1	2	3	4	5	6	7	8	9	10
1	1.01	1.01	1.04	1.15	1.14	1.12		1.06	0.98	0.93
2	1.00	1.00	0.96	0.93	1.00	1.01		0.99	1.00	0.93
3	1.03	0.96	0.84	0.97	0.96	0.98		0.92	0.98	0.97
4	1.14	0.93	0.97							
5	1.13	1.00	0.97					0.96	1.00	1.01
6	1.11	1.01	0.98					1.03	1.00	1.01
7								1.03	0.92	0.99
8	1.05	0.99	0.91		0.96	1.03	1.02	0.96	1.03	1.01
9	0.98	1.00	0.98		1.00	1.00	0.93	1.03	1.00	0.95
10	0.93	0.94	0.98		1.02	1.02	1.00	1.02	0.96	0.94

	1	2	3	4	5	6	7	8	9	10
1	1.04	1.03	1.05	1.14	1.13	1.11		1.08	1.01	0.98
2	1.03	1.00	0.97	0.93	1.00	1.00		1.01	1.00	0.95
3	1.05	0.97	0.86	0.98	0.97	0.98		0.94	0.99	0.98
4	1.14	0.93	0.97							
5	1.13	1.00	0.97					0.96	1.00	1.01
6	1.11	1.00	0.98					1.03	1.00	1.01
7								1.02	0.92	0.99
8	1.08	1.01	0.94		0.96	1.03	1.03	0.97	1.03	1.02
9	1.01	1.00	0.99		1.00	1.00	0.92	1.03	1.00	0.98
10	0.98	0.96	0.99		1.01	1.01	1.00	1.02	0.98	0.99

Figure H-7 – LaSalle 1 Cycle 16 Pin Power Plots

Step 34 = ~BOC, Step 41 = ~MOC, Step 50 = ~EOC

STEP: 34	NODE: 2-16 AVE									
	1	2	3	4	5	6	7	8	9	10
1	2.8	2.9	3.1	3.2	3.3	3.3	3.4	3.4	3.2	3.2
2	2.6	2.7	2.7	2.5	2.8	2.9	2.7	3.0	3.1	3.0
3	2.6	2.5	2.3	2.6	2.6	2.7	2.8	2.8	3.0	3.1
4	2.6	2.2	2.4	2.5	2.7	2.8	2.7	2.9	2.7	3.1
5	2.5	2.3	2.4	2.6				2.7	2.9	3.0
6	2.4	2.3	2.3	2.6				2.8	2.8	3.0
7	2.3	2.1	2.3	2.3				2.7	2.5	2.8
8	2.2	2.2	2.2	2.4	2.3	2.5	2.6	2.4	2.7	2.8
9	2.0	2.1	2.2	2.1	2.3	2.4	2.2	2.5	2.5	2.6
10	1.9	1.9	2.1	2.2	2.2	2.3	2.3	2.3	2.3	2.5

STEP: 41	NODE: 2-16 AVE									
	1	2	3	4	5	6	7	8	9	10
1	2.4	2.6	2.8	2.9	3.0	3.0	3.1	3.1	3.0	3.1
2	2.3	2.4	2.5	2.4	2.6	2.7	2.6	2.9	2.9	2.9
3	2.2	2.3	2.2	2.4	2.5	2.6	2.7	2.6	2.8	2.9
4	2.2	2.0	2.3	2.3	2.5	2.6	2.5	2.7	2.6	2.9
5	2.1	2.1	2.2	2.3				2.5	2.7	2.9
6	2.1	2.1	2.1	2.3				2.6	2.6	2.8
7	2.0	1.9	2.1	2.1				2.5	2.4	2.7
8	1.9	2.0	1.9	2.2	2.1	2.3	2.4	2.3	2.5	2.6
9	1.7	1.8	1.9	1.9	2.1	2.1	2.0	2.3	2.3	2.4
10	1.6	1.7	1.8	1.9	2.0	2.0	2.1	2.1	2.2	2.4

STEP: 50	NODE: 2-16 AVE									
	1	2	3	4	5	6	7	8	9	10
1	1.7	1.8	1.9	2.1	2.1	2.1	2.2	2.2	2.2	2.3
2	1.6	1.6	1.7	1.6	1.8	1.9	1.8	2.0	2.0	2.1
3	1.5	1.6	1.5	1.7	1.7	1.8	1.9	1.8	2.0	2.1
4	1.5	1.4	1.6	1.6	1.7	1.8	1.7	1.9	1.8	2.1
5	1.4	1.4	1.5	1.6				1.7	1.9	2.0
6	1.4	1.4	1.5	1.6				1.8	1.8	2.0
7	1.3	1.3	1.4	1.4				1.7	1.6	1.9
8	1.3	1.3	1.3	1.5	1.4	1.6	1.6	1.5	1.7	1.8
9	1.2	1.2	1.3	1.3	1.4	1.4	1.4	1.6	1.6	1.7
10	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.7

FLR-to-PLR Neighbor Ratios

	1	2	3	4	5	6	7	8	9	10
1	1.03	1.07	1.15	1.16	1.17	1.18		1.09	1.04	1.03
2	0.96	1.00	1.02	0.91	1.00	1.03		0.99	1.00	0.98
3	0.96	0.94	0.87	0.92	0.94	0.98		0.90	0.97	1.00
4	1.09	0.95	1.04							
5	1.06	1.00	1.02					0.96	1.02	1.07
6	1.02	0.98	1.00					1.00	1.00	1.05
7								0.97	0.90	1.01
8	1.05	1.05	1.02		0.98	1.07	1.10	0.98	1.07	1.11
9	0.95	1.00	1.03		0.98	1.00	0.95	1.00	1.00	1.03
10	0.88	0.91	0.97		0.93	0.95	0.96	0.94	0.93	0.99

	1	2	3	4	5	6	7	8	9	10
1	1.01	1.07	1.15	1.12	1.15	1.16		1.08	1.05	1.07
2	0.95	1.00	1.04	0.90	1.00	1.03		0.99	1.00	1.01
3	0.93	0.95	0.90	0.92	0.95	0.98		0.91	0.98	1.01
4	1.05	0.96	1.07							
5	1.01	1.00	1.03					0.95	1.03	1.08
6	0.97	0.98	1.01					0.99	1.00	1.06
7								0.96	0.90	1.02
8	1.03	1.06	1.05		0.97	1.08	1.11	0.97	1.07	1.13
9	0.94	1.00	1.05		0.97	1.00	0.96	0.99	1.00	1.06
10	0.89	0.92	0.98		0.92	0.95	0.97	0.93	0.94	1.03

	1	2	3	4	5	6	7	8	9	10
1	1.04	1.10	1.18	1.13	1.15	1.17		1.09	1.08	1.13
2	0.96	1.00	1.05	0.90	1.00	1.03		0.99	1.00	1.04
3	0.93	0.95	0.91	0.92	0.94	0.98		0.91	0.97	1.03
4	1.04	0.96	1.08							
5	1.00	1.00	1.04					0.95	1.03	1.11
6	0.96	0.97	1.02					0.99	1.00	1.08
7								0.96	0.90	1.04
8	1.03	1.06	1.08		0.98	1.09	1.12	0.97	1.07	1.16
9	0.96	1.00	1.06		0.97	1.00	0.96	0.98	1.00	1.09
10	0.92	0.94	1.00		0.92	0.95	0.98	0.93	0.96	1.07

Figure H-8 – LaSalle 1 Cycles 14 thru 16 Representative Exposure Histories

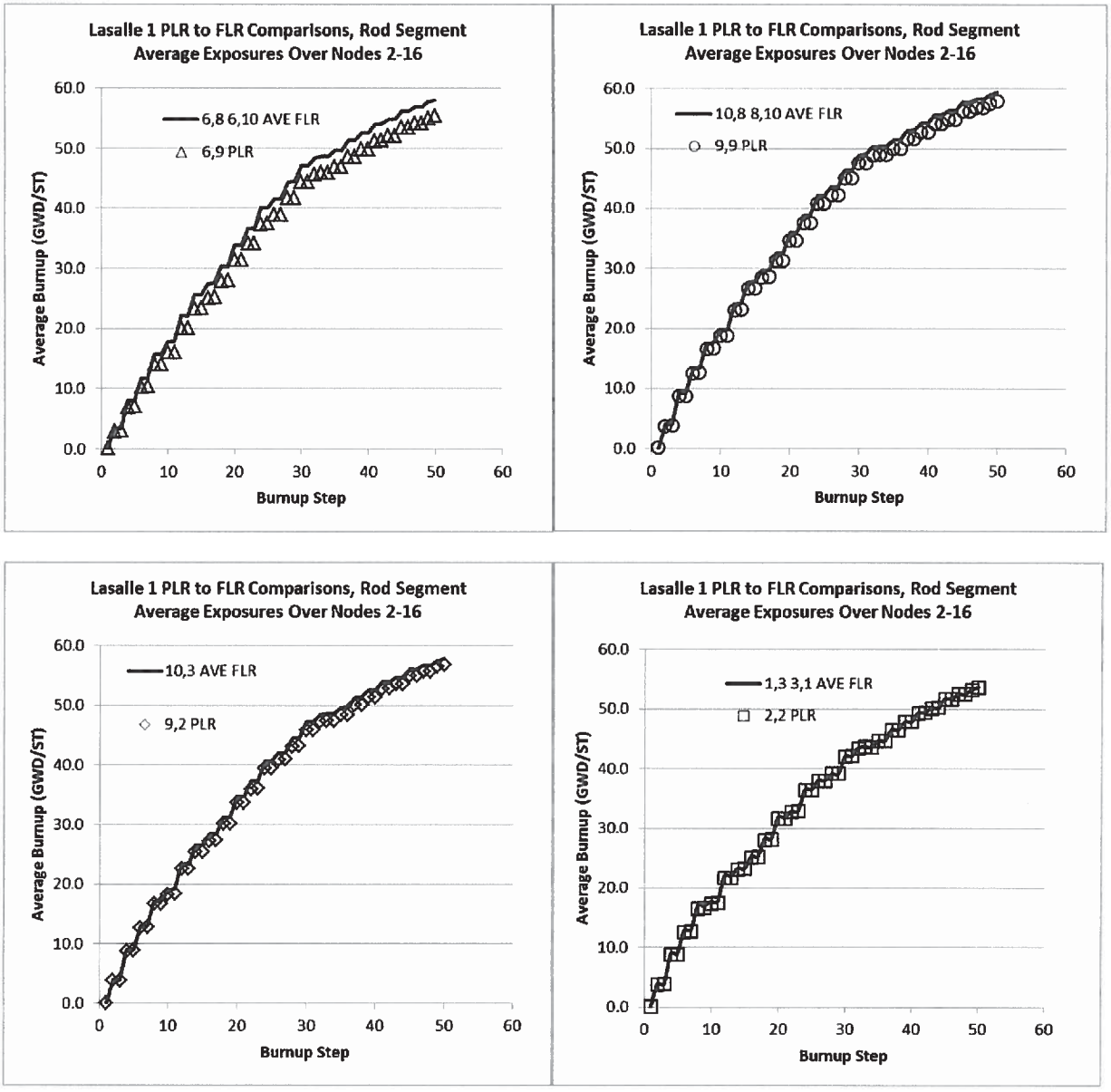
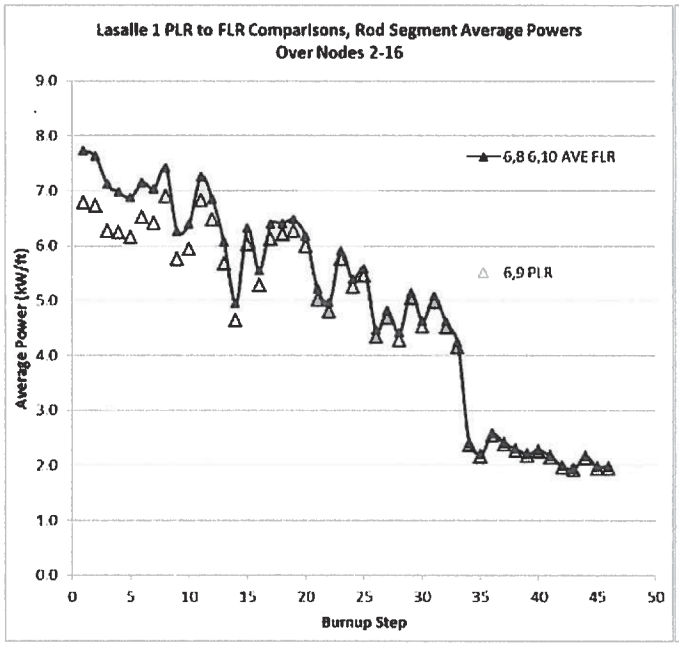
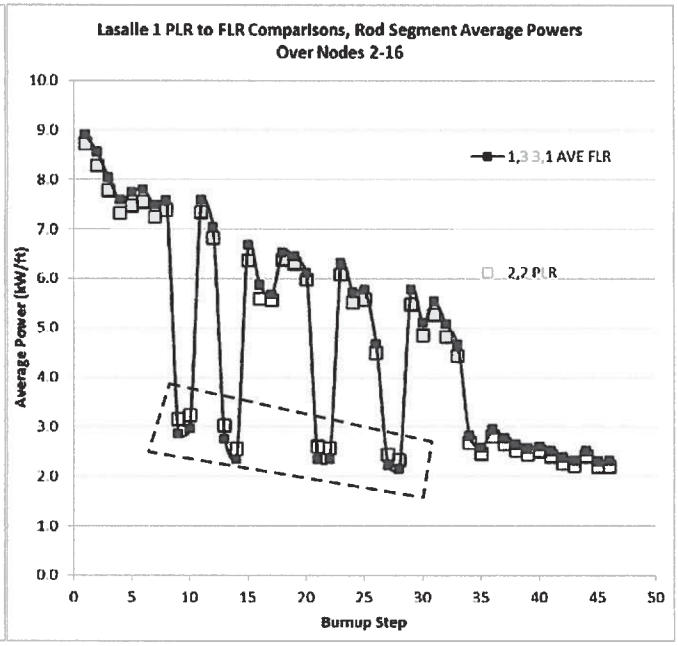
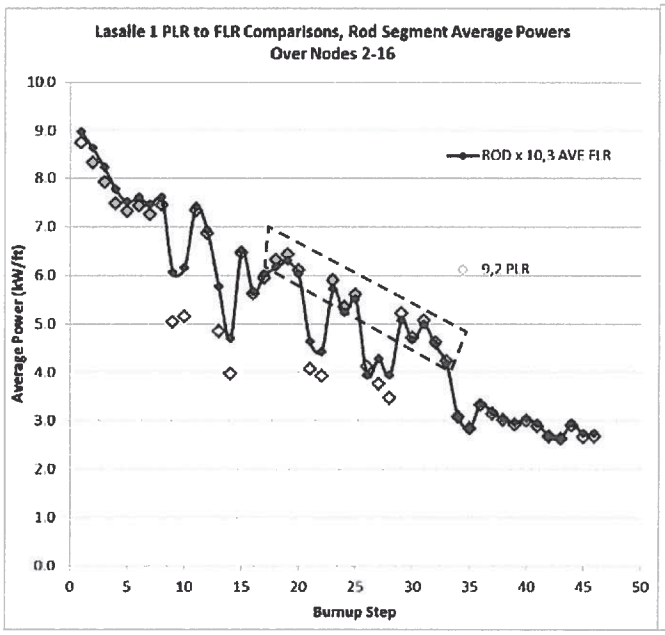


Figure H-9 – LaSalle 1 Cycles 14 thru 16 Representative Power Histories







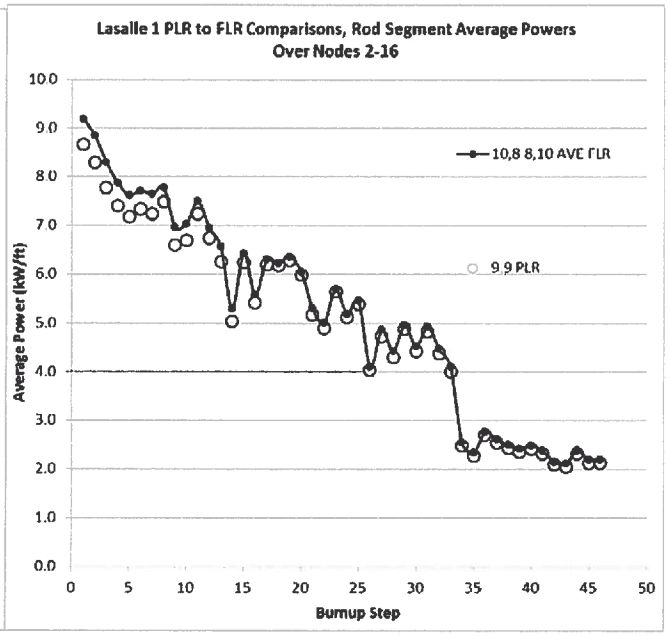


Figure H-10 – LaSalle Atrium-10 Pin Layout

This geometry in this figure is derived from Reference 2.c

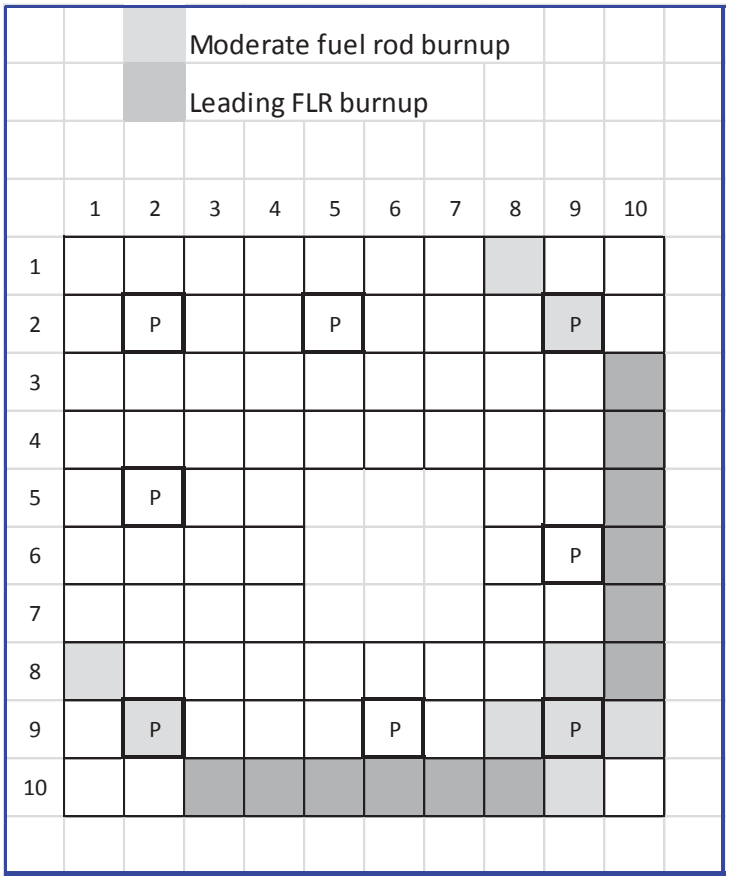


Figure H-11 Burnup Step Map to Cycle Exposure

BURNUP STEP	CYCLE	CYCLE EXPOSURE (GWD/ST)
1	14	0.06
2	14	1.78
3	14	1.801
4	14	4.381
5	14	4.402
6	14	6.504
7	14	6.549
8	14	8.77
9	14	8.792
10	14	10.07
11	14	10.115
12	14	12.552
13	14	12.597
14	14	15.057
15	14	15.078
16	14	16.393

BURNUP STEP	CYCLE	CYCLE EXPOSURE (GWD/ST)
17	15	0.057
18	15	1.826
19	15	1.846
20	15	4.129
21	15	4.149
22	15	6.388
23	15	6.432
24	15	8.831
25	15	8.874
26	15	9.971
27	15	9.99
28	15	12.436
29	15	12.478
30	15	14.714
31	15	14.779
32	15	15.866
33	15	16.012

BURNUP STEP	CYCLE	CYCLE EXPOSURE (GWD/ST)
34	16	0.036
35	16	1.732
36	16	1.775
37	16	4.299
38	16	4.342
39	16	6.33
40	16	6.373
41	16	8.735
42	16	8.778
43	16	10.178
44	16	10.221
45	16	12.7
46	16	12.701
47	16	14.05
48	16	14.051
49	16	15.53
50	16	16.369

ATTACHMENT 3

Technical Evaluation EC407055, "Evaluation of LaSalle Alternative Source Term Loss of Coolant Accident Dose for L2C16 and Impact of Part Length Rods with Burnup > 62 GWd/MTUs," Revision 0

Document No.: EC407055 Revision: 0

Revision Summary: Initial Issue – All pages Rev. 0.

Title: Evaluation of LaSalle Alternative Source Term Loss of Coolant Accident Dose for L2C16 and Impact of Part Length Rods with Burnup > 62 GWd/MTU s

Name

Preparer: John Massari / Emily Yokopenic

Reviewer: Shane Gardner

Approver: Carlos Delahoz

Review Documentation: See section 7

Table of Contents

1. Reason for Evaluation/Scope

The purpose and limited scope of this evaluation is to perform an assessment of the impact of considering the LaSalle 2 Cycle 16 specific core design on Alternative Source Term (AST) Loss of Coolant Accident (LOCA) dose analysis, and to further show that the consequences of a small number of Part Length Rods (PLRs) in the Atrium-10 batch exceeding the 62,000 MWd/MTU peak rod average limit in RG 1.183 Footnote 10 will not cause LOCA doses to exceed the current Analysis of Record (AOR) results. As detailed in Table 1, there are 12 PLRs that will exceed this limit by End of Cycle (EOC) by a maximum of 849 MWd/MTU, and another 8 PLRs will come within 110 MWd/MTU of exceeding the limit (Reference 13). This assessment is prepared to respond to an NRC acceptance review question that is documented in an NRC letter dated October 31, 2016, "LaSalle County Station, Units 1 and 2, - Supplemental Information Needed for Acceptance of Requested Licensing Action Regarding High Burnup Atrium-10 Partial Length Fuel Rods (CAC Nos. MF8442 and MF8443)."

Table 1 – List of Part Length Rods > 62 GWd/MTU in L2C16
(all fuel is Atrium-10)

#	PL Rod Exposure (GWD/MTU)	Comment
1	62.84863	
2	62.82176	
3	62.28073	
4	62.21566	
5	62.18846	
6	62.18846	
7	62.15251	
8	62.15251	
9	62.06749	
10	62.06749	
11	62.05986	
12	62.03599	
13	61.97504	> 110 MWD/MT setback
14	61.97504	> 110 MWD/MT setback
15	61.95112	> 110 MWD/MT setback
16	61.95112	> 110 MWD/MT setback
17	61.93125	> 110 MWD/MT setback
18	61.93125	> 110 MWD/MT setback
19	61.89082	> 110 MWD/MT setback
20	61.89082	> 110 MWD/MT setback

2. Technical Task Risk/Rigor Assessment

This Technical Evaluation is performed in accordance with CC-AA-309-101, Rev. 15. Since this evaluation is not updating design basis results use of the CC-AA-309-101 process is appropriate. A Technical Task Risk/Rigor Assessment was performed for this evaluation in accordance with HU-AA-1212, Rev 7 on 11/3/2016. This task was identified as a Risk rank of 1, based on a Medium Consequence Risk Factor and a Low Probability of Error.

3. Detailed Evaluation

3.1 Design Inputs

3.1.1 ORIGEN2 Inputs

The ORIGEN2 models in L-003128 (Reference 9), which were used to generate the AST LOCA source term listed in UFSAR Table 15.6-28 using AREVA Atrium-10 equilibrium core parameters, are used in this evaluation. The model is adjusted by changing the gram mass of the uranium isotopes and batch power, as summarized in Reference 2. Two core designs were examined for this effort: the GNF2 new fuel introduction (NFI) equilibrium core design and the LaSalle Unit 2 Cycle 16 (L2C16) specific core design. The former was done primarily to benchmark this work to the current L-003068 LOCA AST dose analysis of Reference 12 to demonstrate that the same dose results are achieved utilizing the same fuel parameters detailed in Reference 2. For the L2C16 assessment, the Reference 9 model is adjusted to reflect fuel parameters for the mixed GNF2/Atrium-10 core used for L2C16, as shown in Table 3 (Reference 1, Table 5-1). The L2C16 parameters for input to ORIGEN2 are summarized below in Table 2. The actual L2C16 design of 702.4 effective full power days (EFPD) is also used in place of the 711 EFPD used in Reference 2 and 9 (the latter is retained as an assumption for prior cycles). The 702.44 EFPD is determined by dividing the cycle design energy of 2490841 MWd by the core rated thermal power of 3546 MWt. Note the actual L2C16 cycle may differ from the Reference 1 design in areas such as EOC core average exposure, which is projected to be over 500 MWd/MTU lower based on cycle performance, and slightly lower total core mass.

Table 2 – LaSalle 2 Cycle 16 ORIGEN2 summary input parameters

L2C16	1/4 core basis							power MW	power MW	power MW
batch	g u235	g u238	g totU	g Oxygen	U235 enr Table 3, Col K	batch MTU Table 3, Col R/4	# FA Table 3, Col J/4	cycle 1 Table 3, Col Q/4	cycle 2 Table 3, Col Q/4	cycle3
1	342921	8143304	8486225	1140962	4.041%	8.4862	48	230.1	230.1	98.6
2	568371	13479067	14047438	1888660	4.046%	14.0474	76		409.6	394.9
3	499378	11939397	12438775	1672378	4.015%	12.4388	67			393.0

g u235	=	batch MTU * U235enr * 1e6 g/MTU
g u238	=	batch MTU * (1-U235enr) * 1e6 g/MTU
g tot U	=	g u235 + gu238
g Oxygen	=	g tot U * 2 * 15.994 / 238

Table 3 – Detailed LaSalle 2 Cycle 16 Core Design (Reference 1, Table 5-1)

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
												batch	batch		702.4	prior	
					Burnup	Burnup	Burnup	Burnup				Burnup	Burnup		cycle	711 efpd	
					BOC	EOC	BOC	EOC	batch	batch	batch	BOC	EOC	Delta	batch	cyc batch	batch
batch	type	enr	#	kgU	gwd/st	gwd/st	gwd/mt	gwd/mt	size	avg enr	avg kgU	gwd/mt	gwd/mt	gwd/mt	MW	MW	MTU
3	GNF2	3.91	8	185.552	0.000	19.741	0.000	21.761	268	4.015	185.6534	0.000	22.192	22.192	1571.9	n/a	49.7551
3	GNF2	4.1	24	185.793	0.000	19.811	0.000	21.838									
3	GNF2	3.94	40	185.516	0.000	20.791	0.000	22.918									
3	GNF2	3.94	20	185.531	0.000	19.948	0.000	21.989									
3	GNF2	3.91	8	185.552	0.000	21.003	0.000	23.152									
3	GNF2	4.1	104	185.793	0.000	19.338	0.000	21.316									
3	GNF2	3.94	32	185.516	0.000	21.296	0.000	23.475									
3	GNF2	3.94	32	185.531	0.000	20.966	0.000	23.111									
1	ATRM10XM	3.85	2	181.256	27.328	39.173	30.124	43.181	192	4.041	176.7964	38.559	46.719	8.161	394.3567	920.44058	33.9449
1	ATRM10	4.06	80	177.049	35.137	42.670	38.732	47.036									
1	ATRM10	3.97	36	176.473	36.001	42.403	39.684	46.741									
1	ATRM10	4.06	74	176.56	34.525	42.151	38.057	46.464									
2	GNF2	4.03	8	184.79	19.127	39.170	21.084	43.178	304	4.046	184.8347	20.729	40.479	19.749	1579.795	1638.2343	56.18975
2	GNF2	4.02	88	184.682	19.394	37.153	21.378	40.954									
2	GNF2	4.08	40	185.225	17.952	35.532	19.789	39.167									
2	GNF2	4.1	40	184.982	17.776	35.310	19.595	38.923									
2	GNF2	4.08	32	184.967	19.670	38.623	21.682	42.575									
2	GNF2	4.03	32	184.887	19.200	37.638	21.164	41.489									
2	GNF2	4.02	64	184.622	18.505	36.041	20.398	39.728									
CORE AVERAGES		4.034		183.1018	16.042	32.195	17.683	35.4889									

H	=	Column G / 0.907185
I	=	Column F / 0.907186
J	=	Sum of Column D for Batch
K	=	Batch Avg of Column C weighted by Columns D & E
L	=	Batch Avg of Column E weight by Column D
M	=	Batch Avg of Column H weighted by Columns D & E
N	=	Batch Avg of Column I weighted by Columns D & E
O	=	N - M for Batch
P	=	(O * 1000) / (J * L * 1000 * 702.44)
Q	=	(M * 1000) / (J * L * 1000 * 711 * # prior cycles)
R	=	J * L * 1000

3.1.2 RADTRAD LOCA Dose Models

The LaSalle AST LOCA RADTRAD models were obtained from Reference 12. No changes to any plant parameters are made for this evaluation. The core power of 3559 MWt (i.e., 102% of 3489 MWt) from Reference 12 is maintained. The AST LOCA analysis has several post-LOCA release pathway cases. Table 4 summarizes the base doses from Reference 12 for each of these pathways. The Current Licensing Basis (CLB) represents the dose obtained using the Reference 9 core inventory, and is the source of the doses listed in UFSAR Table 15.6-29 (note that UFSAR results are achieved from rounding each pathway to 2 decimal places prior to summing the individual pathways). The GNF2 results were generated using the core inventory from Reference 2.

Table 4 – Summary of Current LaSalle AST LOCA Dose Results (Reference 12, Table 3)

Post-LOCA Release Paths	Percentage Makeup Flow	Dose (rem (TEDE))			RADTRAD Run Number
		Control Room	EAB	LPZ	
PC Leakage	25% CLB	1.7549	2.4285	0.2186	P25CLB00.o0
	25% GNF2	1.7500	2.4278	0.2192	P25GNF00.o0
MSIV Line A	25% CLB	1.0700	0.0220	0.0182	MA25CLB00.o0
	25% GNF2	1.0685	0.0220	0.0182	MA25GNF00.o0
MSIV Line B	25% CLB	1.2995	0.0313	0.0208	MB25CLB00.o0
	25% GNF2	1.2976	0.0313	0.0208	MB25GNF00.o0
Total MSIV	25% CLB	2.3695	0.0533	0.0390	
	25% GNF2	2.3661	0.0534	0.0390	
ECCS Leakage	25% CLB	0.1000	0.1135	0.0103	E25CLB00.o0
	25% GNF2	0.0999	0.1134	0.0103	E25GNF00.o0
CR Shine Dose		0.0400	0.0000	0.0000	Reference 2, page 75
Post-LOCA Total Dose	25% CLB	4.2644	2.5953	0.2679	
	25% GNF2	4.2560	2.5945	0.2685	

3.2 Assumptions

1. The Fuel Management Summary Report core design for L2C16 (Reference 1) is assumed to provide a conservative representation of L2C16 given that the cycle is still in progress. This is based on the actual core mass being slightly lower (139.71 mtu versus 139.89 mtu in Reference 1), and the projected actual EOC burnup being lower.
2. For reinsert fuel (batches 1 and 2 in Table 2), the burnup achieved prior to L2C16 is assumed to occur in 711 EFPD cycles, with all prior cycles for a given batch having the same batch power. The purpose of these cycles is to achieve the correct L2C16 BOC burnup for the batch to ensure long-lived actinides and fission products are at the correct concentration. Short lived fission product activities will be driven by the L2C16 specific batch power and will reach equilibrium before 100 EFPD.
3. Consistent with References 2 and 9, the inventory of each isotope is determined by taking the maximum of the 100 EFPD and End of Cycle (EOC) activities. This is conservative since it will result in a dose which bounds anytime in the L2C16 core life even though the cycle is more than half over.

4. For the purposes of ratioing up the batch 1 dose to account for substitution of FLRs for PLRs, the entire batch is assumed to be composed of Atrium-10 bundles, even though 2 bundles in the batch are Atrium-10XM. The Atrium-10XM bundles have a slightly lower number of effective FLRs because there are more PLRs that are slightly shorter than those in the Atrium-10 bundles. This assumption is considered appropriate since core design has indicated that none of the PLRs in Atrium-10XM bundles are projected to exceed 62 GWd/MTU rod average burnup by end of cycle. Also, given the small number of Atrium-10XM bundles, a weight average would not result in a significantly different FLR-to-PLR factor.
5. The control room gamma shine dose from Table 4 is applied without change to the L2C16 cycle specific results. This is conservative since all other pathway doses are reduced with application of the L2C16 specific core inventory inventory.
6. It is assumed that applying the FLR substitution methodology of Reference 8 to ratio up doses for bundles that have PLRs exceeding 62 GWd/MTU is a conservative means of accounting for the higher rod average burnup associated with the shorter active length of the PLR. This results in an ~3% increase in dose from bundles with such PLRs. NUREG/CR-6703 (Reference 14, p. 29) concluded that "The consequences of a postulated LOCA increase by about ten percent as peak-rod burnup increases from 60 GWd/MTU to 75 GWd/MTU." In making this determination, it was noted that the NUREG did not modify the RG 1.183 Table 1 or 2 release fractions, only the core inventory. Thus, the increase in dose from the FLR substitution method appears conservative given that peak PLR rod average burnup is less than 63 GWd/MTU.

3.3 Methodology and Use of Computer Codes

The ORIGEN2 computer code (References 3 and 4) is used to perform the fuel depletions in the same manner as the LaSalle analysis of record (Reference 9). ORIGEN2 is listed on the Exelon Digital Technology Software Quality Assurance (DTSQA) database under tracking number EX0004724, and has been installed, verified and executed on Virtual Machine NFW-KSQ-01, and validated in Reference 10.

The dose calculations are performed using the RADTRAD computer code version 3.03 (References 5, 6 and 7) in the same manner as the LaSalle analysis of record (Reference 12). RADTRAD is listed on the Exelon Digital Technology Software Quality Assurance (DTSQA) database under tracking number EX0009077, and has been installed, verified and executed on Virtual Machine NFW-KSQ-01, and validated in Reference 11.

All computer files associated with this evaluation have been attached at the end of this technical evaluation.

3.4 Impacts on Core/Fuel Radionuclide Inventory

ORIGEN2 cases were run for the GNF2 NFI and L2C16 core designs. In addition, a third case was run to quantify the radionuclide inventory of just the Atrium-10 batch 1 by commenting out the ADD cards that save the batch 2 and 3 irradiation results to vectors -9 and -10. To convert the ORIGEN2 radionuclide output to a full core Ci/MWt basis, the results are scaled by the factor of 0.001128 (equal to 4/3546 MWt) since the batch-average inputs were determined using ¼ core exposure information. This approach was utilized in Reference 2. The results of all three cases are summarized in Table 5 and are transferred to the NIF files used in the subsequent RADTRAD runs. The Co-58 and Co-60 activities are maintained at UFSAR Ci/MWt values for all cases, since they have been previously used for both Atrium-10 and GNF2 fuel at LaSalle, and come from NUREG/CR-6604 Table 1.4.3.2-3.

Table 5 – GNF2 NFI, L2C16 and L2C16 Atrium-10 batch activities

Isotope	GNF2 Ci/MWt	L2C16 Ci/MWt	L2C16 Atrium Batch Ci/MWt
KR-85	3.993E+02	3.816E+02	1.076E+02
KR-85M	8.390E+03	8.439E+03	7.104E+02
KR-87	1.649E+04	1.659E+04	1.346E+03
KR-88	2.327E+04	2.342E+04	1.888E+03
RB-86	6.338E+01	6.081E+01	9.845E+00
SR-89	2.840E+04	2.845E+04	3.408E+03
SR-90	3.214E+03	3.066E+03	9.005E+02
SR-91	3.835E+04	3.858E+04	3.231E+03
SR-92	4.050E+04	4.069E+04	3.560E+03
Y-90	3.306E+03	3.155E+03	9.149E+02
Y-91	3.501E+04	3.495E+04	4.716E+03
Y-92	4.062E+04	4.082E+04	3.577E+03
Y-93	4.557E+04	4.575E+04	4.221E+03
ZR-95	4.500E+04	4.510E+04	7.029E+03
ZR-97	4.668E+04	4.671E+04	4.946E+03
NB-95	4.525E+04	4.534E+04	8.644E+03
MO-99	5.075E+04	5.071E+04	5.727E+03
TC-99M	4.443E+04	4.440E+04	5.014E+03
RU-103	4.194E+04	4.175E+04	6.067E+03
RU-105	2.898E+04	2.874E+04	3.850E+03
RU-106	1.727E+04	1.666E+04	4.545E+03
RH-105	2.739E+04	2.716E+04	3.748E+03
SB-127	2.897E+03	2.886E+03	3.525E+02
SB-129	8.641E+03	8.623E+03	1.018E+03
TE-127	2.872E+03	2.861E+03	3.720E+02
TE-127M	3.848E+02	3.825E+02	7.873E+01
TE-129	8.502E+03	8.483E+03	1.003E+03
TE-129M	1.267E+03	1.263E+03	1.716E+02
TE-131M	3.871E+03	3.868E+03	4.456E+02
TE-132	3.824E+04	3.825E+04	4.311E+03
I-131	2.688E+04	2.686E+04	3.052E+03
I-132	3.884E+04	3.885E+04	4.387E+03
I-133	5.561E+04	5.559E+04	6.107E+03
I-134	6.170E+04	6.168E+04	6.702E+03

Table 5 – GNF2 NFI, L2C16 and L2C16 Atrium-10 batch activities

Isotope	GNF2 Ci/MWt	L2C16 Ci/MWt	L2C16 Atrium Batch Ci/MWt
I-135	5.196E+04	5.191E+04	5.742E+03
XE-133	5.495E+04	5.504E+04	6.121E+03
XE-135	2.223E+04	2.213E+04	3.527E+03
CS-134	7.193E+03	6.578E+03	1.995E+03
CS-136	1.955E+03	1.903E+03	3.325E+02
CS-137	4.585E+03	4.323E+03	1.345E+03
BA-139	5.093E+04	5.095E+04	5.400E+03
BA-140	4.909E+04	4.910E+04	5.228E+03
LA-140	5.025E+04	5.022E+04	5.463E+03
LA-141	4.652E+04	4.657E+04	4.893E+03
LA-142	4.546E+04	4.550E+04	4.707E+03
CE-141	4.519E+04	4.503E+04	5.697E+03
CE-143	4.442E+04	4.450E+04	4.482E+03
CE-144	3.621E+04	3.597E+04	8.316E+03
PR-143	4.310E+04	4.316E+04	4.395E+03
ND-147	1.840E+04	1.839E+04	2.001E+03
NP-239	5.378E+05	5.355E+05	6.418E+04
PU-238	1.780E+02	1.525E+02	6.671E+01
PU-239	1.230E+01	1.214E+01	3.023E+00
PU-240	1.320E+01	1.298E+01	3.365E+00
PU-241	6.373E+03	6.179E+03	2.050E+03
AM-241	1.043E+01	9.817E+00	5.014E+00
CM-242	2.239E+03	2.089E+03	7.677E+02
CM-244	2.467E+02	1.834E+02	9.464E+01

3.5 Impacts on Off-Site and Control Room Dose

Control room and off-site LOCA doses were calculated for each source term in Table 5. These calculations were performed by adjusting the nuclide inventories in the Reference 12 base case NIF file. The external shine results from Reference 12 were retained since their contribution was small and the slight core design changes would be unlikely to significantly impact shine results. The GNF2 results evaluated to benchmark the model demonstrated results consistent with those in Table 4 and are therefore not repeated.

The impact of PLRs exceeding 62,000 MWd/MTU was determined using the same method of substituting Full Length Rod (FLR) activity for PLR activity developed in Reference 8. That analysis demonstrated that every FLR in Atrium-10 fuel that meets the 62,000 MWd/MTU limit has an axial section equivalent to the PLR that exceeds the limit by more than the PLRs. Since the FLR power and burnup is more limiting, it can be used to satisfy the RG 1.183 footnote 10 burnup restrictions, and the LOCA release fractions can be applied unchanged provided FLRs are analytically substituted for PLRs which exceed 62,000 MWd/MTU. The Atrium-10 fuel assembly at LaSalle has 8 PLRs that have 90 inch active fuel length and 83 FLRs that have 149 inch active fuel length (Reference 8, p. H-4). Therefore, a PLR is equivalent to 60.4% of the fueled mass of an FLR. Using this basis, the total equivalent full length rods in the bundle is 87.83 (8*0.604+83). For this technical evaluation, the dose contribution to all pathways for the non-Atrium-10 ("other") batches in L2C16 is determined by subtracting the Atrium-10 batch contribution to dose from the total L2C16 core inventory dose. The portion of the Atrium-10 batch dose subject to FLR/PLR substitution is then increased by the ratio of 91/87.83, and then added to portion of dose from the unaffected portion of the Atrium-10 batch and the "other" batch, to determine the total LOCA dose. The results are provided in Table 6 for 30d control room, worst 0-2h site exclusion area boundary (EAB), and 30d low population zone (LPZ). The results indicate that all of the 1,536 PLRs in the Atrium-10 batch could have FLRs substituted without exceeding the AST LOCA current licensing basis results.

4. Design Impact and Configuration Control Change Screening:

No design change or configuration change is associated with the limited scope of this technical evaluation. Therefore a Design Impact and Configuration Control Change Impact screening is not required for this technical evaluation.

5. Conclusions/Findings

Based on this assessment, it is concluded that the small number of L2C16 PLRs that will exceed or come close to exceeding the 62,000 MWd/MTU limit by EOC, as identified in Table 1, could not result in LOCA doses exceeding the current licensing basis results.

Table 6 – Summary of LOCA AST Doses

Pathway	Core Design	TEDE (Rem)			Reference
		CR	EAB	LPZ	
PC Leakage	L2C16	1.7121	2.3904	0.2175	l2c16_PC25.out
	L2C16 - Atrium batch only	0.2788	0.3492	0.0278	l2c16_atrium_batch_only_PC25.out
MSIV A	L2C16	1.0537	0.0220	0.0182	l2c16_MSIVA.out
	L2C16 - Atrium batch only	0.1583	0.0027	0.0021	l2c16_atrium_batch_only_MSIVA.out
MSIV B	L2C16	1.2818	0.0313	0.0208	l2c16_MSIVB.out
	L2C16 - Atrium batch only	0.1852	0.0039	0.0024	l2c16_atrium_batch_only_MSIVB.out
ECCS Leakage	L2C16	0.0998	0.1133	0.0103	l2c16_ESF.o0
	L2C16 - Atrium batch only	0.0112	0.0127	0.0012	l2c16_Atrium_ESF.o0
Pathway Total	L2C16	4.1474	2.5570	0.2667	n/a
	L2C16 - Atrium batch only	0.6335	0.3684	0.0335	
	L2C16 - Other batches	3.5139	2.1886	0.2333	L2C16 – L2C16 Atrium batch only
CR Shine	Common	0.0400	0.0000	0.0000	Reference 12
TOTAL DOSE	**GNF2**	**4.2560**	**2.5945**	**0.2685**	Table 4
	Current Licensing Basis	**4.2644**	**2.5953**	**0.2679**	Table 4
	Regulatory Limits	**5**	**25**	**25**	RG 1.183
	L2C16	**4.1874**	**2.5570**	**0.2667**	L2C16 Pathway Total + CR Shine
	L2C16 FLR Substituted for 100% of PLR in Atrium Batch	**4.2103**	**2.5703**	**0.2679**	L2C16 Pathway Total Other + L2C16 Pathway Total Atrium * 91/87.83 + CR Shine

6. References

1. GNF-000N9237 Revision 1, “Fuel Management Summary Report LaSalle 2 Cycle 16,” June 2014

2. L-003696 Rev. 1, “NEDC-33647P, GNF2 Fuel Design Cycle-Independent Analyses for Exelon LaSalle County Station Units 1 and 2,” February 15, 2012.

3. RSIC CODE PACKAGE CCC-371, “ORIGEN2.1 Isotope Generation and Depletion Code Matrix Exponential Method,” May 1999.

4. ORNL/TM-11018, “Standard- and Extended- Burnup PWR and BWR Reactor Models for the ORIGEN2 Computer Code,” S. Ludwig, J. Renier, December 1989.

5. "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation", NUREG/CR-6604, SAND98-0272.

6. "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation", NUREG/CR-6604, SAND98-0272/1, Supplement 1.

7. "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation", NUREG/CR-6604, Supplement 2

8. Calculation L-003067 Rev. 2D, “Re-Analysis of Fuel Handling Accident (FHA) Using Alternative Source Terms,” September 27, 2016.

9. Calculation L-003128 Rev. 1A, “LaSalle Source Terms for Use in Alternative Source Terms,” February 18, 2011.

10. EX0004724, Rev. 0, “ORIGEN 2.1, EX0004724 TEST SUMMARY REPORT,” October 2014.

11. EX0009077, Rev. 0, “RADTRAD Version 3.03, EX0009077 TEST SUMMARY REPORT,” June 2014.

12. Calculation L-003068 Rev. 2B, “Reanalysis of Loss of Coolant Accident (LOCA) Using Alternative Source Terms,” March 1, 2012.

13. TODI NF162526, “L2C16 EOC Part Length Rod Exposure Data,” November 3, 2016.

14. NUREG/CR-6703, “Environmental Effects of Extending Fuel Burnup Above 60 GWd/MTU,” January 2001.

7. Review Notes

The Technical Evaluation was independently reviewed. The evaluation provides results that directly address the purpose and scope as stated. All input data and development was independently verified to be correct against references and assumptions. Translation of the core inputs into ORIGEN2 input files was verified. RADTRAD was reviewed to ensure that the core inventory inputs were correctly input to the code. Note, the remainder of the RADTRAD inputs related to the plant parameters, release and dose conversion factors were not verified against the reference analysis of record, but rather the benchmarking of the GNF2 results against the reference were reviewed and considered to be confirmation that the RADTRAD runs were accurate to the analysis of record. RADTRAD output extraction and post-processing hand calculations were also independently verified. Alternative calculations were performed to independently verify the dose increases due to the substitution of the partial length rods with the activity of full length rods. A fairly accurate hand calculation can be performed using the Atrium-10 batch relative power (i.e. relative to average bundle power of 3546 MWt/764 or 4.64 MWt/bundle) and the relative increase due to increasing the uranium mass, both being a direct multiple on the PLR inventory (and hence dose). The relative increase due to the uranium mass increase is (139.89 MTU + (91/87.83-1)*39.9449 MTU)/139.89 MTU or 1%. The average power of the Atrium-10 bundles in L2C16 is 394.6 MWt/batch / 192 bundles/batch or 2.06 MWt/bundle leading to a relative bundle power of 0.44. Assuming that there are minor burnup and enrichment effects that increase the Atrium-10 batch dose results by 10% relative to the core average would lead to a net increase factor of 0.48% (1%*0.44*1.1) or about 0.5%. Inspection of the results corresponding to the 100% substitution of the PLRs the relative dose increase is between 0.45% and 0.55%. Thus, this independent calculation confirms the dose sensitivity results are valid. Based on the considerations provided above, the Technical Evaluation is accurate and the results are reasonable given the inputs, assumptions and methodology utilized.

8. Attachments

LaSalle 2 Cycle 16 Quarter Core ORIGEN2 input

```
-1
-1
-1
BAS     Grams of Heavy Metal per Fuel Batch
RDA     PLACE FUEL into vectors -1, -2 and -3
LIP     0  0  0
LIB     0  1  2  3   657   658   659  9  3  0  1 42
PHO     0 0 0 10
RDA     READ FUEL COMPOSITION FOR BATCH 3
INP     -1  1  -1 -1  1  1
RDA     READ FUEL COMPOSITION FOR BATCH 2
INP     -2  1  -1 -1  1  1
RDA     READ FUEL COMPOSITION FOR BATCH 1
INP     -3  1  -1 -1  1  1
RDA TIT     IRRADIATION OF LaSalle Quarter CORE L2C16
MOV     -3  1  0  1.0       BATCH 1 FRESH
HED     1    CHARGE
RDA     BATCH 1 BURNUP IN CYCLE 1
BUP
IRP     50.0   230.1    1   9   4 2
IRP    100.0   230.1    9   2   4 0
IRP    150.0   230.1    2   9   4 0
IRP    200.0   230.1    9   3   4 0
IRP    250.0   230.1    3   9   4 0
IRP    300.0   230.1    9   4   4 0
IRP    350.0   230.1    4   9   4 0
IRP    400.0   230.1    9   5   4 0
IRP    450.0   230.1    5   9   4 0
IRP    500.0   230.1    9   6   4 0
IRP    550.0   230.1    6   9   4 0
IRP    600.0   230.1    9   7   4 0
IRP    650.0   230.1    7   9   4 0
IRP    711.0   230.1    9   8   4 0
BUP
OPTL    4*8 8 8 8 8 8 15*8
OPTA    4*8 8 8 5 8 8 15*8
OPTF    4*8 8 8 5 8 8 15*8
RDA OUT     -8  1  -1  0
MOV      8  1  0  1.0       BATCH 1 ONCE BURNED
HED     1    CHARGE
RDA     BATCH 1 BURNUP IN CYCLE 2
BUP
IRP    761.0   230.1     1   9   4 3
IRP    811.0   230.1     9   2   4 0
IRP    861.0   230.1     2   9   4 0
IRP    911.0   230.1     9   3   4 0
IRP    961.0   230.1     3   9   4 0
IRP   1011.0   230.1     9   4   4 0
IRP   1061.0   230.1     4   9   4 0
IRP   1111.0   230.1     9   5   4 0
IRP   1161.0   230.1     5   9   4 0
IRP   1211.0   230.1     9   6   4 0
IRP   1261.0   230.1     6   9   4 0
IRP   1311.0   230.1     9   7   4 0
IRP   1361.0   230.1     7   9   4 0
IRP   1422.0   230.1     9   8   4 0
BUP
RDA OUT     -8  1  -1  0
MOV      8  1  0  1.0       BATCH 1 TWICE BURNED
HED     1    CHARGE
RDA     BATCH 1 BURNUP IN CYCLE 3
BUP
```

```
IRP   1472.0    98.6    1   9   4 3
IRP   1522.0    98.6    9   2   4 0
IRP   1572.0    98.6    2   9   4 0
IRP   1622.0    98.6    9   3   4 0
IRP   1672.0    98.6    3   9   4 0
IRP   1722.0    98.6    9   4   4 0
IRP   1772.0    98.6    4   9   4 0
IRP   1822.0    98.6    9   5   4 0
IRP   1872.0    98.6    5   9   4 0
IRP   1922.0    98.6    9   6   4 0
IRP   1972.0    98.6    6   9   4 0
IRP   2022.0    98.6    9   7   4 0
IRP   2072.0    98.6    7   9   4 0
IRP   2124.4    98.6    9   8   4 0
BUP
RDA OUT     -8  1  -1  0
MOV      2 -9   0  1.0       BATCH 1 100 EFPD PLACED IN TEMP VECTOR -9
MOV      8 -10  0  1.0       BATCH 1 EOC3 PLACED IN TEMP VECTOR -10
RDA     BATCH 2 BURNUP IN CYCLE 2
MOV     -2  1  0  1.0       BATCH 2 FRESH
HED     1    CHARGE
RDA     BATCH 2 BURNUP IN CYCLE 2
BUP
IRP     50.0   409.6    1   9   4 2
IRP    100.0   409.6    9   2   4 0
IRP    150.0   409.6    2   9   4 0
IRP    200.0   409.6    9   3   4 0
IRP    250.0   409.6    3   9   4 0
IRP    300.0   409.6    9   4   4 0
IRP    350.0   409.6    4   9   4 0
IRP    400.0   409.6    9   5   4 0
IRP    450.0   409.6    5   9   4 0
IRP    500.0   409.6    9   6   4 0
IRP    550.0   409.6    6   9   4 0
IRP    600.0   409.6    9   7   4 0
IRP    650.0   409.6    7   9   4 0
IRP    711.0   409.6    9   8   4 0
BUP
RDA OUT     -8  1  -1  0
MOV      8  1  0  1.0       BATCH 2 ONCE BURNED
HED     1    CHARGE
RDA     BATCH 2  BURNUP IN CYCLE 3
BUP
IRP    761.0   394.9    1   9   4 3
IRP    811.0   394.9    9   2   4 0
IRP    861.0   394.9    2   9   4 0
IRP    911.0   394.9    9   3   4 0
IRP    961.0   394.9    3   9   4 0
IRP   1011.0   394.9    9   4   4 0
IRP   1061.0   394.9    4   9   4 0
IRP   1111.0   394.9    9   5   4 0
IRP   1161.0   394.9    5   9   4 0
IRP   1211.0   394.9    9   6   4 0
IRP   1261.0   394.9    6   9   4 0
IRP   1311.0   394.9    9   7   4 0
IRP   1361.0   394.9    7   9   4 0
IRP   1413.4   394.9    9   8   4 0
BUP
RDA OUT     -8  1  -1  0
ADD     2 -9   0  1.0       BATCH 2 100 EFPD ADDED TO TEMP VECTOR -9
ADD     8 -10  0  1.0       BATCH 2 EOC3 ADDED TO TEMP VECTOR -10
MOV     -1  1  0  1.0       BATCH 3 FRESH
HED     1    CHARGE
RDA     BATCH 3  BURNUP IN CYCLE 3
BUP
IRP     50.0   393.0    1   9   4 2
IRP    100.0   393.0    9   2   4 0
IRP    150.0   393.0    2   9   4 0
IRP    200.0   393.0    9   3   4 0
IRP    250.0   393.0    3   9   4 0
IRP    300.0   393.0    9   4   4 0
IRP    350.0   393.0    4   9   4 0
```

```
IRP    400.0   393.0    9   5   4 0
IRP    450.0   393.0    5   9   4 0
IRP    500.0   393.0    9   6   4 0
IRP    550.0   393.0    6   9   4 0
IRP    600.0   393.0    9   7   4 0
IRP    650.0   393.0    7   9   4 0
IRP    702.4   393.0    9   8   4 0
BUP
RDA OUT     -8  1  -1  0
ADD      2 -9   0  1.0
ADD      8 -10  0  1.0
MOV     -9  1  0  1.0       CYCLE 3 @ 100 EFPD
MOV    -10  2  0  1.0       CYCLE 3 @ EOC
HED      1     100 EFPD
HED      2     EOC3
OUT     -2  1  -1  0
END
2   922340  0.0  922350  499378.0  922360  0.0  922380  11939397.0  0  0.0
4   080000  1672378.0  0  0.0
0
2   922340  0.0  922350  568371.0  922360  0.0  922380  13479067.0  0  0.0
4   080000  1888660.0  0  0.0
0
2   922340  0.0  922350  342921.0  922360  0.0  922380  8143304.0  0  0.0
4   080000  1140962.0  0  0.0
0
END
```

LaSalle 2 Cycle 16 MSIV A Pathway RADTRAD Output File

```
 ###########################################################################
    RADTRAD Version 3.03 (Spring 2001) run on 10/31/2016  at 23:29:22
 ###########################################################################

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

 Plant file           = C:\Users\E42031\AppData\Local\Temp\14\\temp.psf
 Inventory file       = H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 MSIVA\l2c16
MSIVA.nif
 Release file         = H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 MSIVA\l2c16
MSIVA.rft
 Dose Conversion file = H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 MSIVA\l2c16
MSIVA.inp




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


 Radtrad 3.03 4/15/2001
 LSCS LOCA MSIV A with 25% Makeup
 Nuclide Inventory File:
 H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 MSIVA\l2c16 MSIVA.nif
 Plant Power Level:
  3.5590E+03
 Compartments:
   6
 Compartment 1:
 Containment
   3
  3.9430E+05
   1
   0
   0
   1
   0
 Compartment 2:
 (Node 1) Inboard MSL A Volume
   3
  3.81E+02
   0
   0
   0
   0
   0
 Compartment 3:
 (Nodes 2& 3) Outboard MSL A Volume
   3
  9.89E+02
   0
   0
   0
   0
   0
 Compartment 4:
```

```
 Condenser
   3
  2.4635E+05
   0
   0
   0
   0
   0
 Compartment 5:
 Environment
   2
  0.0000E+00
   0
   0
   0
   0
   0
 Compartment 6:
 Control Room
   1
  1.1740E+05
   0
   0
   1
   0
   0
Pathways:
   9
Pathway 1:
Containment to (Node 1) Inboard MSL A Volume
   1
   2
   2
Pathway 2:
(Node 1) Inboard MSL A Volume to (Nodes 2& 3) Outboard MSL A Volume
   2
   3
   2
Pathway 3:
(Nodes 2& 3) Outboard MSL A Volume to Condenser
   3
   4
   2
Pathway 4:
Condenser to Environment
   4
   5
   2
Pathway 5:
Environment to Control Room
   5
   6
   2
Pathway 6:
Environment to Control Room
   5
   6
   2
Pathway 7:
Environment to Control Room
   5
   6
   2
Pathway 8:
Control Room to Environment
   6
   5
   2
Pathway 9:
(Nodes 2& 3) Outboard MSL A Volume to Environment
   3
```

```
   5
   2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
   1
   1   1.0000E+00
 H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 MSIVA\l2c16 MSIVA.inp
 H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 MSIVA\l2c16 MSIVA.rft
   0.0000E+00
   1
   9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
 Overlying Pool:
   0
   0.0000E+00
   0
   0
   0
   0
 Compartments:
   6
 Compartment 1:
   0
   1
   1
   0.0000E+00
   0
   1
   0.0000E+00
   3
   0.0000E+00   3.8600E+00
   2.0000E+00   1.8600E+00
   3.8500E+00   0.0000E+00
   1
   0.0000E+00
   0
   0
   0
   3
   3
   1.0000E+01
   1
   1
   0.0000E+00   0.0000E+00
 Compartment 2:
   0
   1
   0
   0
   0
   0
   0
   0
   0
 Compartment 3:
   0
   1
   0
   0
   0
   0
   0
   0
   0
Compartment 4:
   0
   1
   0
```

```
   0
   0
   0
   0
   0
   0
Compartment 5:
   0
   1
   0
   0
   0
   0
   0
   0
   0
Compartment 6:
   0
   1
   0
   0
   0
   0
   1
   1.4650E+04
   4
   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
   3.3300E-01   0.0000E+00   0.0000E+00   0.0000E+00
   4.0000E+00   0.0000E+00   6.6500E+01   6.6500E+01
   7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00
   0
   0
Pathways:
   9
 Pathway 1:
   0
   0
   0
   0
   0
   1
   3
   0.0000E+00   2.9960E+00   0.0000E+00   0.0000E+00   0.0000E+00
   2.0000E+00   1.7440E+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 2:
   0
   0
   0
   0
   0
   1
   6
   0.0000E+00   2.9960E+00   9.8530E+01   3.1570E+01   0.0000E+00
   3.3330E-01   2.9960E+00   9.9950E+01   3.1570E+01   0.0000E+00
   2.0000E+00   1.7440E+00   9.9950E+01   3.1570E+01   0.0000E+00
   2.4000E+01   1.7440E+00   0.0000E+00   5.0820E+01   0.0000E+00
   9.6000E+01   1.7440E+00   0.0000E+00   8.6800E+01   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
  5
  0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  3.3300E-01   6.3760E+00   0.0000E+00   2.4680E+01   0.0000E+00
  2.4000E+01   5.4920E+00   0.0000E+00   4.5990E+01   0.0000E+00
  9.6000E+01   4.1670E+00   0.0000E+00   8.7720E+01   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 4:
  0
  0
  0
  0
  0
  1
  4
  0.0000E+00   7.3230E+00   0.0000E+00   9.9370E+01   0.0000E+00
  2.4000E+01   7.3230E+00   0.0000E+00   9.9370E+01   0.0000E+00
  9.6000E+01   7.3230E+00   0.0000E+00   9.9370E+01   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 5:
  0
  0
  0
  0
  0
  1
  4
  0.0000E+00   1.1000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  3.3330E-01   9.0000E+02   9.9000E+01   8.8440E+01   8.8440E+01
  4.0000E+00   9.0000E+02   9.9000E+01   9.6130E+01   9.6130E+01
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 6:
  0
  0
  0
  0
  0
  1
  4
  0.0000E+00   2.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  3.3330E-01   2.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  4.0000E+00   2.4000E+03   0.0000E+00   6.6500E+01   6.6500E+01
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
```

```
   0
   0
Pathway 7:
   0
   0
   0
   0
   0
   1
   4
   0.0000E+00   5.0000E+01   0.0000E+00   0.0000E+00   0.0000E+00
   3.3330E-01   5.0000E+01   0.0000E+00   0.0000E+00   0.0000E+00
   4.0000E+00   5.0000E+01   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 8:
   0
   0
   0
   0
   0
   1
   4
   0.0000E+00   3.5500E+03   1.0000E+02   1.0000E+02   1.0000E+02
   3.3330E-01   3.3500E+03   1.0000E+02   1.0000E+02   1.0000E+02
   4.0000E+00   3.3500E+03   1.0000E+02   1.0000E+02   1.0000E+02
   7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
   0
   0
   0
   0
   0
   0
Pathway 9:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   6.3760E+00   0.0000E+00   2.4680E+01   0.0000E+00
   3.3330E-01   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
   5
   1
   3
   0.0000E+00   6.6300E-04
   2.4000E+01   0.0000E+00
   7.2000E+02   0.0000E+00
   1
   3
   0.0000E+00   3.5000E-04
   2.4000E+01   0.0000E+00
   7.2000E+02   0.0000E+00
   0
 Location 2:
```

```
Low Population Zone
  5
  1
  8
  0.0000E+00   2.6500E-05
  2.5000E-01   2.6500E-05
  1.5000E+00   2.6500E-05
  2.0000E+00   1.0800E-05
  8.0000E+00   6.8700E-06
  2.4000E+01   2.6300E-06
  9.6000E+01   6.7400E-07
  7.2000E+02   0.0000E+00
  1
  4
  0.0000E+00   3.5000E-04
  8.0000E+00   1.8000E-04
  2.4000E+01   2.3000E-04
  7.2000E+02   0.0000E+00
  0
Location 3:
Control Room
  6
  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
  8
  0.0000E+00   8.1300E-03
  2.5000E-01   8.1300E-03
  1.5000E+00   8.1300E-03
  2.0000E+00   6.0900E-03
  8.0000E+00   2.4200E-03
  2.4000E+01   1.7600E-03
  9.6000E+01   1.4600E-03
  7.2000E+02   0.0000E+00
Simulation Parameters:
  3
  0.0000E+00   2.5000E-01
  2.4000E+01   2.4000E+01
  7.2000E+02   0.0000E+00
Output Filename:
H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 MSIVA\l2c16 MSIVA.out
  1
  1
  1
  0
  0
End of Scenario File
```

```
##############################################################################
   RADTRAD Version 3.03 (Spring 2001) run on 10/31/2016  at 23:29:22
##############################################################################

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

Number of Nuclides =  60

Inventory Power =   1.0000E+00 MWth
Plant Power Level =   3.5590E+03 MWth

Number of compartments    =   6

Compartment information

Compartment number  1  (Source term fraction =   1.0000E+00
)
Name: Containment
Compartment volume =   3.9430E+05 (Cubic feet)
Compartment type is Normal
Removal devices within compartment:
     Spray(s)
     Deposition
Pathways into and out of compartment  1
   Exit Pathway Number    1: ontainment to (Node 1) Inboard MSL A Volume

Compartment number  2
Name: (Node 1) Inboard MSL A Volume
Compartment volume =   3.8100E+02 (Cubic feet)
Compartment type is Normal
Pathways into and out of compartment  2
   Inlet Pathway Number   1: ontainment to (Node 1) Inboard MSL A Volume
   Exit Pathway Number    2: Node 1) Inboard MSL A Volume to (Nodes 2& 3) Outbo

Compartment number  3
Name: (Nodes 2& 3) Outboard MSL A Volume
Compartment volume =   9.8900E+02 (Cubic feet)
Compartment type is Normal
Pathways into and out of compartment  3
   Inlet Pathway Number   2: Node 1) Inboard MSL A Volume to (Nodes 2& 3) Outbo
   Exit Pathway Number    3: Nodes 2& 3) Outboard MSL A Volume to Condenser
   Exit Pathway Number    9: Nodes 2& 3) Outboard MSL A Volume to Environment

Compartment number  4
Name: Condenser
Compartment volume =   2.4635E+05 (Cubic feet)
Compartment type is Normal
Pathways into and out of compartment  4
   Inlet Pathway Number   3: Nodes 2& 3) Outboard MSL A Volume to Condenser
   Exit Pathway Number    4: ondenser to Environment

Compartment number  5
Name: Environment
Compartment type is Environment
Pathways into and out of compartment  5
   Inlet Pathway Number   4: ondenser to Environment
   Inlet Pathway Number   8: ontrol Room to Environment
   Inlet Pathway Number   9: Nodes 2& 3) Outboard MSL A Volume to Environment
   Exit Pathway Number    5: nvironment to Control Room
   Exit Pathway Number    6: nvironment to Control Room
   Exit Pathway Number    7: nvironment to Control Room

Compartment number  6
Name: Control Room
Compartment volume =   1.1740E+05 (Cubic feet)
Compartment type is Control Room
Removal devices within compartment:
     Filter(s)
```

```
Pathways into and out of compartment  6
   Inlet Pathway Number   5: nvironment to Control Room
   Inlet Pathway Number   6: nvironment to Control Room
   Inlet Pathway Number   7: nvironment to Control Room
   Exit Pathway Number    8: ontrol Room to Environment

Total number of pathways =   9
```

```
##########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on 10/31/2016  at 23:29:22
##########################################################################

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

Radioactive Decay is enabled
Calculation of Daughters is enabled

Release Fractions and Timings
               GAP       EARLY IN-VESSEL  LATE RELEASE    RELEASE MASS
          0.500000 hr     1.5000 hrs      0.0000 hrs          (gm)
NOBLES       5.0000E-02     9.5000E-01      0.0000E+00        4.551E+03
IODINE       5.0000E-02     2.5000E-01      0.0000E+00        3.060E+02
CESIUM       5.0000E-02     2.0000E-01      0.0000E+00        4.876E+04
TELLURIUM    0.0000E+00     5.0000E-02      0.0000E+00        4.042E+01
STRONTIUM    0.0000E+00     2.0000E-02      0.0000E+00        1.671E+03
BARIUM       0.0000E+00     2.0000E-02      0.0000E+00        4.796E+01
RUTHENIUM    0.0000E+00     2.5000E-03      0.0000E+00        5.864E+01
CERIUM       0.0000E+00     5.0000E-04      0.0000E+00        5.986E+02
LANTHANUM    0.0000E+00     2.0000E-04      0.0000E+00        8.157E+00

Inventory Power =      3559. MWt

Nuclide  Group  Specific     half     Whole Body   Inhaled     Inhaled
 Name          Inventory     life        DCF       Thyroid    Effective
               (Ci/MWt)      (s)     (Sv-m3/Bq-s)  (Sv/Bq)     (Sv/Bq)
 Co-58     7   1.529E+02  6.117E+06   4.760E-14   8.720E-10   2.940E-09
 Co-60     7   1.830E+02  1.663E+08   1.260E-13   1.620E-08   5.910E-08
 Kr-85     1   3.816E+02  3.383E+08   1.190E-16   0.000E+00   0.000E+00
 Kr-85m    1   8.439E+03  1.613E+04   7.480E-15   0.000E+00   0.000E+00
 Kr-87     1   1.659E+04  4.578E+03   4.120E-14   0.000E+00   0.000E+00
 Kr-88     1   2.342E+04  1.022E+04   1.020E-13   0.000E+00   0.000E+00
 Rb-86     3   6.081E+01  1.612E+06   4.810E-15   1.330E-09   1.790E-09
 Sr-89     5   2.845E+04  4.363E+06   7.730E-17   7.960E-12   1.120E-08
 Sr-90     5   3.066E+03  9.190E+08   7.530E-18   2.690E-10   3.510E-07
 Sr-91     5   3.858E+04  3.420E+04   4.924E-14   9.930E-12   4.547E-10
 Sr-92     5   4.069E+04  9.756E+03   6.790E-14   3.920E-12   2.180E-10
 Y-90      9   3.155E+03  2.304E+05   1.900E-16   5.170E-13   2.280E-09
 Y-91      9   3.495E+04  5.055E+06   2.600E-16   8.500E-12   1.320E-08
 Y-92      9   4.082E+04  1.274E+04   1.300E-14   1.050E-12   2.110E-10
 Y-93      9   4.575E+04  3.636E+04   4.800E-15   9.260E-13   5.820E-10
 Zr-95     9   4.510E+04  5.528E+06   3.600E-14   1.440E-09   6.390E-09
 Zr-97     9   4.671E+04  6.084E+04   4.432E-14   2.315E-11   1.171E-09
 Nb-95     9   4.534E+04  3.037E+06   3.740E-14   3.580E-10   1.570E-09
 Mo-99     7   5.070E+04  2.376E+05   7.280E-15   1.520E-11   1.070E-09
 Tc-99m    7   4.440E+04  2.167E+04   5.890E-15   5.010E-11   8.800E-12
 Ru-103    7   4.175E+04  3.394E+06   2.251E-14   2.570E-10   2.421E-09
 Ru-105    7   2.874E+04  1.598E+04   3.810E-14   4.150E-12   1.230E-10
 Ru-106    7   1.666E+04  3.181E+07   1.040E-14   1.720E-09   1.290E-07
 Rh-105    7   2.716E+04  1.273E+05   3.720E-15   2.880E-12   2.580E-10
 Sb-127    4   2.886E+03  3.326E+05   3.330E-14   6.150E-11   1.630E-09
 Sb-129    4   8.623E+03  1.555E+04   7.140E-14   9.720E-12   1.740E-10
 Te-127    4   2.861E+03  3.366E+04   2.420E-16   1.840E-12   8.600E-11
 Te-127m   4   3.825E+02  9.418E+06   1.470E-16   9.660E-11   5.810E-09
 Te-129    4   8.483E+03  4.176E+03   2.750E-15   5.090E-13   2.090E-11
 Te-129m   4   1.263E+03  2.903E+06   3.337E-15   1.563E-10   6.484E-09
 Te-131m   4   3.868E+03  1.080E+05   7.463E-14   3.669E-08   1.758E-09
 Te-132    4   3.825E+04  2.815E+05   1.030E-14   6.280E-08   2.550E-09
 I-131     2   2.686E+04  6.947E+05   1.820E-14   2.920E-07   8.890E-09
 I-132     2   3.885E+04  8.280E+03   1.120E-13   1.740E-09   1.030E-10
 I-133     2   5.559E+04  7.488E+04   2.940E-14   4.860E-08   1.580E-09
 I-134     2   6.168E+04  3.156E+03   1.300E-13   2.880E-10   3.550E-11
 I-135     2   5.191E+04  2.380E+04   8.294E-14   8.460E-09   3.320E-10
 Xe-133    1   5.504E+04  4.532E+05   1.560E-15   0.000E+00   0.000E+00
 Xe-135    1   2.213E+04  3.272E+04   1.190E-14   0.000E+00   0.000E+00
 Cs-134    3   6.578E+03  6.507E+07   7.570E-14   1.110E-08   1.250E-08
 Cs-136    3   1.903E+03  1.132E+06   1.060E-13   1.730E-09   1.980E-09
```

Cs-137	3	4.323E+03	9.467E+08	2.725E-14	7.930E-09	8.630E-09
Ba-139	6	5.095E+04	4.962E+03	2.170E-15	2.400E-12	4.640E-11
Ba-140	6	4.910E+04	1.101E+06	8.580E-15	2.560E-10	1.010E-09
La-140	9	5.022E+04	1.450E+05	1.170E-13	6.870E-11	1.310E-09
La-141	9	4.656E+04	1.415E+04	2.390E-15	9.400E-12	1.570E-10
La-142	9	4.550E+04	5.550E+03	1.440E-13	8.740E-12	6.840E-11
Ce-141	8	4.503E+04	2.808E+06	3.430E-15	2.550E-11	2.420E-09
Ce-143	8	4.450E+04	1.188E+05	1.290E-14	6.230E-12	9.160E-10
Ce-144	8	3.597E+04	2.456E+07	2.773E-15	2.920E-10	1.010E-07
Pr-143	9	4.316E+04	1.172E+06	2.100E-17	1.680E-18	2.190E-09
Nd-147	9	1.839E+04	9.487E+05	6.190E-15	1.820E-11	1.850E-09
Np-239	8	5.355E+05	2.035E+05	7.690E-15	7.620E-12	6.780E-10
Pu-238	8	1.525E+02	2.769E+09	4.880E-18	3.860E-10	7.790E-05
Pu-239	8	1.214E+01	7.594E+11	4.240E-18	3.750E-10	8.330E-05
Pu-240	8	1.298E+01	2.063E+11	4.750E-18	3.760E-10	8.330E-05
Pu-241	8	6.179E+03	4.544E+08	7.250E-20	9.150E-12	1.340E-06
Am-241	9	9.817E+00	1.364E+10	8.180E-16	1.600E-09	1.200E-04
Cm-242	9	2.089E+03	1.407E+07	5.690E-18	9.410E-10	4.670E-06
Cm-244	9	1.834E+02	5.715E+08	4.910E-18	1.010E-09	6.700E-05

Nuclide	Daughter	Fraction	Daughter	Fraction	Daughter	Fraction
Kr-85m	Kr-85	0.21	none	0.00	none	0.00
Kr-87	Rb-87	1.00	none	0.00	none	0.00
Kr-88	Rb-88	1.00	none	0.00	none	0.00
Sr-90	Y-90	1.00	none	0.00	none	0.00
Sr-91	Y-91m	0.58	Y-91	0.42	none	0.00
Sr-92	Y-92	1.00	none	0.00	none	0.00
Y-93	Zr-93	1.00	none	0.00	none	0.00
Zr-95	Nb-95m	0.01	Nb-95	0.99	none	0.00
Zr-97	Nb-97m	0.95	Nb-97	0.05	none	0.00
Mo-99	Tc-99m	0.88	Tc-99	0.12	none	0.00
Tc-99m	Tc-99	1.00	none	0.00	none	0.00
Ru-103	Rh-103m	1.00	none	0.00	none	0.00
Ru-105	Rh-105	1.00	none	0.00	none	0.00
Ru-106	Rh-106	1.00	none	0.00	none	0.00
Sb-127	Te-127m	0.18	Te-127	0.82	none	0.00
Sb-129	Te-129m	0.22	Te-129	0.77	none	0.00
Te-127m	Te-127	0.98	none	0.00	none	0.00
Te-129	I-129	1.00	none	0.00	none	0.00
Te-129m	Te-129	0.65	I-129	0.35	none	0.00
Te-131m	Te-131	0.22	I-131	0.78	none	0.00
Te-132	I-132	1.00	none	0.00	none	0.00
I-131	Xe-131m	0.01	none	0.00	none	0.00
I-133	Xe-133m	0.03	Xe-133	0.97	none	0.00
I-135	Xe-135m	0.15	Xe-135	0.85	none	0.00
Xe-135	Cs-135	1.00	none	0.00	none	0.00
Cs-137	Ba-137m	0.95	none	0.00	none	0.00
Ba-140	La-140	1.00	none	0.00	none	0.00
La-141	Ce-141	1.00	none	0.00	none	0.00
Ce-143	Pr-143	1.00	none	0.00	none	0.00
Ce-144	Pr-144m	0.02	Pr-144	0.98	none	0.00
Nd-147	Pm-147	1.00	none	0.00	none	0.00
Np-239	Pu-239	1.00	none	0.00	none	0.00
Pu-238	U-234	1.00	none	0.00	none	0.00
Pu-239	U-235	1.00	none	0.00	none	0.00
Pu-240	U-236	1.00	none	0.00	none	0.00
Pu-241	U-237	0.00	Am-241	1.00	none	0.00
Am-241	Np-237	1.00	none	0.00	none	0.00
Cm-242	Pu-238	1.00	none	0.00	none	0.00
Cm-244	Pu-240	1.00	none	0.00	none	0.00

Iodine fractions

Aerosol	=	9.5000E-01
Elemental	=	4.8500E-02
Organic	=	1.5000E-03

COMPARTMENT DATA

Compartment number 1: Containment

Sprays: Elemental Removal Data

Time (hr)	Removal Coef. (hr^-1)
0.0000E+00	3.8600E+00
2.0000E+00	1.8600E+00
3.8500E+00	0.0000E+00

Natural Deposition (Powers' model): Aerosol data
Reactor type: 3
Percentile = 10 (%)

Natural Deposition: Elemental Removal Data

Time (hr)	Removal Coef. (hr^-1)
0.0000E+00	0.0000E+00

Compartment number 2: (Node 1) Inboard MSL A Volume

Compartment number 3: (Nodes 2& 3) Outboard MSL A Volume

Compartment number 4: Condenser

Compartment number 5: Environment

Compartment number 6: Control Room

Compartment Filter Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	1.4650E+04	0.0000E+00	0.0000E+00	0.0000E+00
3.3300E-01	1.4650E+04	0.0000E+00	0.0000E+00	0.0000E+00
4.0000E+00	1.4650E+04	0.0000E+00	6.6500E+01	6.6500E+01
7.2000E+02	1.4650E+04	0.0000E+00	0.0000E+00	0.0000E+00

PATHWAY DATA

Pathway number 1: ontainment to (Node 1) Inboard MSL A Volume

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	2.9960E+00	0.0000E+00	0.0000E+00	0.0000E+00
2.0000E+00	1.7440E+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 2: Node 1) Inboard MSL A Volume to (Nodes 2& 3) Outbo

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	2.9960E+00	9.8530E+01	3.1570E+01	0.0000E+00
3.3330E-01	2.9960E+00	9.9950E+01	3.1570E+01	0.0000E+00
2.0000E+00	1.7440E+00	9.9950E+01	3.1570E+01	0.0000E+00
2.4000E+01	1.7440E+00	0.0000E+00	5.0820E+01	0.0000E+00
9.6000E+01	1.7440E+00	0.0000E+00	8.6800E+01	0.0000E+00
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 3: Nodes 2& 3) Outboard MSL A Volume to Condenser

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
3.3300E-01	6.3760E+00	0.0000E+00	2.4680E+01	0.0000E+00
2.4000E+01	5.4920E+00	0.0000E+00	4.5990E+01	0.0000E+00
9.6000E+01	4.1670E+00	0.0000E+00	8.7720E+01	0.0000E+00
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 4: ondenser to Environment

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	7.3230E+00	0.0000E+00	9.9370E+01	0.0000E+00
2.4000E+01	7.3230E+00	0.0000E+00	9.9370E+01	0.0000E+00
9.6000E+01	7.3230E+00	0.0000E+00	9.9370E+01	0.0000E+00
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 5: nvironment to Control Room

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	1.1000E+03	0.0000E+00	0.0000E+00	0.0000E+00
3.3330E-01	9.0000E+02	9.9000E+01	8.8440E+01	8.8440E+01
4.0000E+00	9.0000E+02	9.9000E+01	9.6130E+01	9.6130E+01
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 6: nvironment to Control Room

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	2.4000E+03	0.0000E+00	0.0000E+00	0.0000E+00
3.3330E-01	2.4000E+03	0.0000E+00	0.0000E+00	0.0000E+00
4.0000E+00	2.4000E+03	0.0000E+00	6.6500E+01	6.6500E+01
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 7: nvironment to Control Room

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	5.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00
3.3330E-01	5.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00
4.0000E+00	5.0000E+01	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 8: ontrol Room to Environment

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	3.5500E+03	1.0000E+02	1.0000E+02	1.0000E+02
3.3330E-01	3.3500E+03	1.0000E+02	1.0000E+02	1.0000E+02
4.0000E+00	3.3500E+03	1.0000E+02	1.0000E+02	1.0000E+02
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 9: Nodes 2& 3) Outboard MSL A Volume to Environment

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	6.3760E+00	0.0000E+00	2.4680E+01	0.0000E+00
3.3330E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

LOCATION DATA

Location Exclusion Area Boundary is in compartment 5

Location X/Q Data

Time (hr)	X/Q (s * m^-3)
0.0000E+00	6.6300E-04
2.4000E+01	0.0000E+00
7.2000E+02	0.0000E+00

Location Breathing Rate Data

```
       Time (hr)         Breathing Rate (m^3 * sec^-1)
        0.0000E+00                3.5000E-04
        2.4000E+01                0.0000E+00
        7.2000E+02                0.0000E+00
      Location Low Population Zone     is in compartment   5

      Location X/Q Data
       Time (hr)         X/Q (s * m^-3)
        0.0000E+00           2.6500E-05
        2.5000E-01           2.6500E-05
        1.5000E+00           2.6500E-05
        2.0000E+00           1.0800E-05
        8.0000E+00           6.8700E-06
        2.4000E+01           2.6300E-06
        9.6000E+01           6.7400E-07
        7.2000E+02           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
        7.2000E+02                0.0000E+00
      Location Control Room     is in compartment   6

      Location X/Q Data
       Time (hr)         X/Q (s * m^-3)
        0.0000E+00           8.1300E-03
        2.5000E-01           8.1300E-03
        1.5000E+00           8.1300E-03
        2.0000E+00           6.0900E-03
        8.0000E+00           2.4200E-03
        2.4000E+01           1.7600E-03
        9.6000E+01           1.4600E-03
        7.2000E+02           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-01
       2.4000E+01       2.4000E+01
       7.2000E+02       0.0000E+00
```

```
########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on 10/31/2016  at 23:29:22
########################################################################




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


########################################################################
                                Dose Output
########################################################################

Exclusion Area Boundary Doses:

Time (h) =   0.2500    Whole Body   Thyroid       TEDE
Delta dose (rem)        4.5110E-05  1.5735E-03  1.0157E-04
Accumulated dose (rem)  4.5110E-05  1.5735E-03  1.0157E-04

Low Population Zone Doses:

Time (h) =   0.2500    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.8031E-06  6.2892E-05  4.0597E-06
Accumulated dose (rem)  1.8031E-06  6.2892E-05  4.0597E-06

Control Room Doses:

Time (h) =   0.2500    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.4051E-06  1.9275E-03  7.1484E-05
Accumulated dose (rem)  2.4051E-06  1.9275E-03  7.1484E-05

Exclusion Area Boundary Doses:

Time (h) =   0.3330    Whole Body   Thyroid       TEDE
Delta dose (rem)        9.1574E-05  3.1291E-03  2.0433E-04
Accumulated dose (rem)  1.3668E-04  4.7026E-03  3.0590E-04

Low Population Zone Doses:

Time (h) =   0.3330    Whole Body   Thyroid       TEDE
Delta dose (rem)        3.6602E-06  1.2507E-04  8.1672E-06
Accumulated dose (rem)  5.4633E-06  1.8796E-04  1.2227E-05

Control Room Doses:

Time (h) =   0.3330    Whole Body   Thyroid       TEDE
Delta dose (rem)        6.5327E-06  5.1732E-03  1.9256E-04
Accumulated dose (rem)  8.9378E-06  7.1007E-03  2.6405E-04

Exclusion Area Boundary Doses:

Time (h) =   0.3333    Whole Body   Thyroid       TEDE
Delta dose (rem)        4.6778E-07  1.6085E-05  1.0482E-06
Accumulated dose (rem)  1.3715E-04  4.7187E-03  3.0695E-04

Low Population Zone Doses:

Time (h) =   0.3333    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.8697E-08  6.4290E-07  4.1897E-08
Accumulated dose (rem)  5.4820E-06  1.8861E-04  1.2269E-05

Control Room Doses:
```

```
Time (h) =   0.3333    Whole Body   Thyroid       TEDE
Delta dose (rem)        3.4624E-08  2.7824E-05  1.0358E-06
Accumulated dose (rem)  8.9724E-06  7.1285E-03  2.6508E-04

Exclusion Area Boundary Doses:

Time (h) =   0.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        5.5029E-08  6.3515E-07  8.1107E-08
Accumulated dose (rem)  1.3721E-04  4.7193E-03  3.0703E-04

Low Population Zone Doses:

Time (h) =   0.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.1995E-09  2.5387E-08  3.2418E-09
Accumulated dose (rem)  5.4842E-06  1.8863E-04  1.2272E-05

Control Room Doses:

Time (h) =   0.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.6623E-05  1.3491E-02  5.0200E-04
Accumulated dose (rem)  2.5596E-05  2.0619E-02  7.6708E-04

Exclusion Area Boundary Doses:

Time (h) =   1.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.9375E-05  7.5418E-05  3.2169E-05
Accumulated dose (rem)  1.6658E-04  4.7948E-03  3.3920E-04

Low Population Zone Doses:

Time (h) =   1.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.1741E-06  3.0145E-06  1.2858E-06
Accumulated dose (rem)  6.6583E-06  1.9165E-04  1.3558E-05

Control Room Doses:

Time (h) =   1.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        4.0868E-05  3.3468E-02  1.2443E-03
Accumulated dose (rem)  6.6463E-05  5.4088E-02  2.0113E-03

Exclusion Area Boundary Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.1123E-04  1.9312E-04  1.1823E-04
Accumulated dose (rem)  2.7781E-04  4.9879E-03  4.5743E-04

Low Population Zone Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        4.4459E-06  7.7189E-06  4.7256E-06
Accumulated dose (rem)  1.1104E-05  1.9936E-04  1.8283E-05

Control Room Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.5486E-05  4.9140E-03  2.0224E-04
Accumulated dose (rem)  9.1949E-05  5.9002E-02  2.2136E-03

Exclusion Area Boundary Doses:

Time (h) =   3.8500    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.2695E-03  3.8111E-03  2.4076E-03
Accumulated dose (rem)  2.5474E-03  8.7990E-03  2.8651E-03

Low Population Zone Doses:

Time (h) =   3.8500    Whole Body   Thyroid       TEDE
Delta dose (rem)        3.6970E-05  6.2081E-05  3.9219E-05
Accumulated dose (rem)  4.8074E-05  2.6145E-04  5.7503E-05
```

Control Room Doses:

Time (h) = 3.8500	Whole Body	Thyroid	TEDE
Delta dose (rem)	5.4774E-04	1.9613E-02	1.2553E-03
Accumulated dose (rem)	6.3969E-04	7.8615E-02	3.4689E-03

Exclusion Area Boundary Doses:

Time (h) = 4.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	3.4413E-04	6.2306E-04	3.6664E-04
Accumulated dose (rem)	2.8915E-03	9.4220E-03	3.2317E-03

Low Population Zone Doses:

Time (h) = 4.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	5.6057E-06	1.0149E-05	5.9724E-06
Accumulated dose (rem)	5.3680E-05	2.7160E-04	6.3475E-05

Control Room Doses:

Time (h) = 4.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	9.3338E-05	3.0437E-03	2.0306E-04
Accumulated dose (rem)	7.3303E-04	8.1658E-02	3.6719E-03

Exclusion Area Boundary Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.8235E-02	4.5075E-02	1.9823E-02
Accumulated dose (rem)	2.1127E-02	5.4497E-02	2.3054E-02

Low Population Zone Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.9704E-04	7.3425E-04	3.2290E-04
Accumulated dose (rem)	3.5072E-04	1.0058E-03	3.8638E-04

Control Room Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	5.8284E-03	6.5720E-02	8.9286E-03
Accumulated dose (rem)	6.5615E-03	1.4738E-01	1.2600E-02

Exclusion Area Boundary Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.3825E-01	9.4689E-01	1.6915E-01
Accumulated dose (rem)	1.5937E-01	1.0014E+00	1.9221E-01

Low Population Zone Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.4325E-03	5.0460E-03	1.5972E-03
Accumulated dose (rem)	1.7832E-03	6.0518E-03	1.9836E-03

Control Room Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.1390E-02	3.7161E-01	3.7418E-02
Accumulated dose (rem)	2.7952E-02	5.1899E-01	5.0019E-02

Exclusion Area Boundary Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	1.5937E-01	1.0014E+00	1.9221E-01

Low Population Zone Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	3.8859E-03	4.2607E-02	5.3059E-03
Accumulated dose (rem)	5.6692E-03	4.8659E-02	7.2895E-03

Control Room Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	6.7847E-02	2.9150E+00	2.0942E-01
Accumulated dose (rem)	9.5798E-02	3.4340E+00	2.5944E-01

Exclusion Area Boundary Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	1.5937E-01	1.0014E+00	1.9221E-01

Low Population Zone Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	6.9440E-03	1.2443E-01	1.0888E-02
Accumulated dose (rem)	1.2613E-02	1.7309E-01	1.8177E-02

Control Room Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.6357E-01	1.2494E+01	7.9423E-01
Accumulated dose (rem)	3.5936E-01	1.5928E+01	1.0537E+00

897

##
I-131 Summary
##

Time (hr)	Containment I-131 (Curies)	(Node 1) Inboard MSL I-131 (Curies)	(Nodes 2& 3) Outboard I-131 (Curies)
0.000	5.3091E+03	6.7233E-04	2.8573E-09
0.250	2.1565E+06	1.2212E+02	2.0949E-01
0.333	2.7820E+06	2.0921E+02	4.6310E-01
0.333	2.7841E+06	2.0957E+02	4.6419E-01
0.500	3.9260E+06	4.4017E+02	1.0463E+00
0.750	7.1398E+06	9.9147E+02	2.6818E+00
1.000	1.0124E+07	1.8132E+03	5.4981E+00
1.250	1.2909E+07	2.8524E+03	9.5260E+00
1.500	1.5516E+07	4.0645E+03	1.4651E+01
1.750	1.7955E+07	5.4117E+03	2.0723E+01
2.000	2.0239E+07	6.8614E+03	2.7589E+01
2.250	1.5666E+07	7.5430E+03	3.0693E+01
2.500	1.2133E+07	7.9209E+03	3.3700E+01
2.750	9.4015E+06	8.0741E+03	3.6466E+01
3.000	7.2888E+06	8.0629E+03	3.8918E+01
3.250	5.6541E+06	7.9331E+03	4.1033E+01
3.500	4.3888E+06	7.7198E+03	4.2812E+01
3.750	3.4092E+06	7.4494E+03	4.4272E+01
3.850	3.0823E+06	7.3299E+03	4.4772E+01
4.000	2.6522E+06	7.1418E+03	4.5438E+01
4.250	2.0664E+06	6.8123E+03	4.6342E+01
4.500	1.6125E+06	6.4717E+03	4.7018E+01
4.750	1.2606E+06	6.1284E+03	4.7494E+01
5.000	9.8790E+05	5.7883E+03	4.7798E+01
5.250	8.5176E+05	5.4582E+03	4.7954E+01
5.500	7.3533E+05	5.1422E+03	4.7983E+01
5.750	6.3577E+05	4.8406E+03	4.7903E+01
6.000	5.5062E+05	4.5533E+03	4.7733E+01
6.250	4.7781E+05	4.2803E+03	4.7486E+01
6.500	4.1553E+05	4.0213E+03	4.7175E+01
6.750	3.6227E+05	3.7760E+03	4.6812E+01
7.000	3.1672E+05	3.5440E+03	4.6407E+01
7.250	2.7777E+05	3.3249E+03	4.5969E+01
7.500	2.4445E+05	3.1182E+03	4.5505E+01
7.750	2.1595E+05	2.9235E+03	4.5021E+01
8.000	1.9157E+05	2.7401E+03	4.4524E+01
8.250	1.7072E+05	2.5676E+03	4.4019E+01
8.500	1.5509E+05	2.4055E+03	4.3509E+01

8.750	1.4144E+05	2.2534E+03	4.2999E+01
9.000	1.2952E+05	2.1107E+03	4.2491E+01
9.250	1.1910E+05	1.9768E+03	4.1988E+01
9.500	1.1000E+05	1.8514E+03	4.1492E+01
9.750	1.0205E+05	1.7338E+03	4.1005E+01
10.000	9.5099E+04	1.6236E+03	4.0528E+01
10.250	8.9026E+04	1.5204E+03	4.0063E+01
24.000	4.5134E+04	7.6739E+01	2.9995E+01
96.000	3.4159E+04	3.3038E+01	2.5457E+01
720.000	3.0768E+03	2.9759E+00	2.8717E+00

Time (hr)	Condenser I-131 (Curies)	Environment I-131 (Curies)	Control Room I-131 (Curies)
0.000	0.0000E+00	1.2768E-13	1.7388E-15
0.250	0.0000E+00	4.4378E-03	5.5219E-05
0.333	0.0000E+00	1.3273E-02	1.6030E-04
0.333	4.5476E-05	1.3318E-02	1.6083E-04
0.500	3.8335E-02	1.3320E-02	1.2084E-04
0.750	1.7418E-01	1.3331E-02	7.8784E-05
1.000	4.7645E-01	1.3360E-02	5.1532E-05
1.250	1.0381E+00	1.3419E-02	3.4039E-05
1.500	1.9490E+00	1.3535E-02	2.3097E-05
1.750	3.2898E+00	1.3742E-02	1.6706E-05
2.000	5.1302E+00	1.4089E-02	1.3663E-05
2.250	7.3616E+00	1.4630E-02	1.2144E-05
2.500	9.8325E+00	1.5405E-02	1.2543E-05
2.750	1.2531E+01	1.6448E-02	1.4402E-05
3.000	1.5437E+01	1.7796E-02	1.7432E-05
3.250	1.8526E+01	1.9488E-02	2.1450E-05
3.500	2.1775E+01	2.1562E-02	2.6339E-05
3.750	2.5157E+01	2.4056E-02	3.2021E-05
3.850	2.6543E+01	2.5180E-02	3.4503E-05
4.000	2.8652E+01	2.7007E-02	3.8441E-05
4.250	3.2237E+01	3.0453E-02	1.8185E-05
4.500	3.5894E+01	3.4427E-02	1.5968E-05
4.750	3.9608E+01	3.8966E-02	1.7214E-05
5.000	4.3363E+01	4.4102E-02	1.9178E-05
5.250	4.7148E+01	4.9868E-02	2.1335E-05
5.500	5.0951E+01	5.6294E-02	2.3575E-05
5.750	5.4764E+01	6.3409E-02	2.5870E-05
6.000	5.8578E+01	7.1241E-02	2.8206E-05
6.250	6.2387E+01	7.9817E-02	3.0575E-05
6.500	6.6184E+01	8.9162E-02	3.2968E-05
6.750	6.9966E+01	9.9300E-02	3.5378E-05
7.000	7.3727E+01	1.1025E-01	3.7800E-05
7.250	7.7465E+01	1.2204E-01	4.0227E-05
7.500	8.1176E+01	1.3469E-01	4.2655E-05
7.750	8.4858E+01	1.4822E-01	4.5081E-05
8.000	8.8511E+01	1.6263E-01	4.7499E-05
8.250	9.2132E+01	1.7796E-01	3.3147E-05
8.500	9.5720E+01	1.9422E-01	2.8457E-05
8.750	9.9275E+01	2.1141E-01	2.6540E-05
9.000	1.0280E+02	2.2957E-01	2.5768E-05
9.250	1.0628E+02	2.4869E-01	2.5614E-05
9.500	1.0974E+02	2.6879E-01	2.5837E-05
9.750	1.1316E+02	2.8988E-01	2.6298E-05
10.000	1.1654E+02	3.1197E-01	2.6910E-05
10.250	1.1990E+02	3.3507E-01	2.7617E-05
24.000	2.7292E+02	3.2600E+00	6.7110E-05
96.000	7.6566E+02	6.4413E+01	1.8713E-04
720.000	3.1428E+02	8.0330E+02	5.2252E-05

##
Cumulative Dose Summary
##

Time (hr)	Exclusion Area Bounda Thyroid (rem)	TEDE (rem)	Low Population Zone Thyroid (rem)	TEDE (rem)	Control Room Thyroid (rem)	TEDE (rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.250	1.5735E-03	1.0157E-04	6.2892E-05	4.0597E-06	1.9275E-03	7.1484E-05

```
   0.333 4.7026E-03 3.0590E-04 1.8796E-04 1.2227E-05 7.1007E-03 2.6405E-04
   0.333 4.7187E-03 3.0695E-04 1.8861E-04 1.2269E-05 7.1285E-03 2.6508E-04
   0.500 4.7193E-03 3.0703E-04 1.8863E-04 1.2272E-05 2.0619E-02 7.6708E-04
   0.750 4.7233E-03 3.0776E-04 1.8879E-04 1.2301E-05 3.4802E-02 1.2937E-03
   1.000 4.7333E-03 3.1055E-04 1.8919E-04 1.2413E-05 4.4030E-02 1.6358E-03
   1.250 4.7543E-03 3.1888E-04 1.9003E-04 1.2746E-05 5.0069E-02 1.8601E-03
   1.500 4.7948E-03 3.3920E-04 1.9165E-04 1.3558E-05 5.4088E-02 2.0113E-03
   1.750 4.8671E-03 3.8114E-04 1.9454E-04 1.5234E-05 5.6878E-02 2.1211E-03
   2.000 4.9879E-03 4.5743E-04 1.9936E-04 1.8283E-05 5.9002E-02 2.2136E-03
   2.250 5.1759E-03 5.8152E-04 2.0243E-04 2.0305E-05 6.0805E-02 2.3031E-03
   2.500 5.4442E-03 7.6033E-04 2.0680E-04 2.3218E-05 6.2531E-02 2.4002E-03
   2.750 5.8046E-03 9.9889E-04 2.1267E-04 2.7104E-05 6.4416E-02 2.5170E-03
   3.000 6.2695E-03 1.3019E-03 2.2024E-04 3.2039E-05 6.6643E-02 2.6628E-03
   3.250 6.8513E-03 1.6734E-03 2.2972E-04 3.8092E-05 6.9361E-02 2.8451E-03
   3.500 7.5625E-03 2.1171E-03 2.4130E-04 4.5319E-05 7.2696E-02 3.0705E-03
   3.750 8.4154E-03 2.6358E-03 2.5520E-04 5.3768E-05 7.6761E-02 3.3445E-03
   3.850 8.7990E-03 2.8651E-03 2.6145E-04 5.7503E-05 7.8615E-02 3.4689E-03
   4.000 9.4220E-03 3.2317E-03 2.7160E-04 6.3475E-05 8.1658E-02 3.6719E-03
   4.250 1.0594E-02 3.9063E-03 2.9069E-04 7.4464E-05 8.5262E-02 3.9876E-03
   4.500 1.1943E-02 4.6604E-03 3.1266E-04 8.6749E-05 8.7597E-02 4.2934E-03
   4.750 1.3479E-02 5.4945E-03 3.3768E-04 1.0034E-04 8.9920E-02 4.6295E-03
   5.000 1.5213E-02 6.4084E-03 3.6592E-04 1.1522E-04 9.2476E-02 5.0039E-03
   5.250 1.7154E-02 7.4012E-03 3.9754E-04 1.3139E-04 9.5318E-02 5.4187E-03
   5.500 1.9312E-02 8.4721E-03 4.3270E-04 1.4884E-04 9.8461E-02 5.8744E-03
   5.750 2.1695E-02 9.6195E-03 4.7152E-04 1.6753E-04 1.0191E-01 6.3710E-03
   6.000 2.4312E-02 1.0842E-02 5.1415E-04 1.8744E-04 1.0568E-01 6.9083E-03
   6.250 2.7171E-02 1.2137E-02 5.6072E-04 2.0854E-04 1.0977E-01 7.4861E-03
   6.500 3.0279E-02 1.3503E-02 6.1134E-04 2.3079E-04 1.1418E-01 8.1037E-03
   6.750 3.3642E-02 1.4938E-02 6.6612E-04 2.5416E-04 1.1891E-01 8.7604E-03
   7.000 3.7266E-02 1.6438E-02 7.2517E-04 2.7861E-04 1.2396E-01 9.4555E-03
   7.250 4.1159E-02 1.8003E-02 7.8858E-04 3.0409E-04 1.2933E-01 1.0188E-02
   7.500 4.5325E-02 1.9629E-02 8.5644E-04 3.3058E-04 1.3503E-01 1.0957E-02
   7.750 4.9769E-02 2.1314E-02 9.2884E-04 3.5802E-04 1.4105E-01 1.1762E-02
   8.000 5.4497E-02 2.3054E-02 1.0058E-03 3.8638E-04 1.4738E-01 1.2600E-02
   8.250 5.9511E-02 2.4849E-02 1.0326E-03 4.0410E-04 1.5273E-01 1.3347E-02
   8.500 6.4817E-02 2.6696E-02 1.0608E-03 4.2231E-04 1.5690E-01 1.3949E-02
   8.750 7.0418E-02 2.8591E-02 1.0907E-03 4.4098E-04 1.6064E-01 1.4473E-02
   9.000 7.6317E-02 3.0533E-02 1.1221E-03 4.6009E-04 1.6418E-01 1.4952E-02
   9.250 8.2518E-02 3.2520E-02 1.1552E-03 4.7961E-04 1.6766E-01 1.5408E-02
   9.500 8.9022E-02 3.4550E-02 1.1898E-03 4.9952E-04 1.7113E-01 1.5853E-02
   9.750 9.5833E-02 3.6620E-02 1.2261E-03 5.1980E-04 1.7465E-01 1.6294E-02
  10.000 1.0295E-01 3.8728E-02 1.2641E-03 5.4043E-04 1.7822E-01 1.6736E-02
  10.250 1.1038E-01 4.0874E-02 1.3037E-03 5.6139E-04 1.8188E-01 1.7182E-02
  24.000 1.0014E+00 1.9221E-01 6.0518E-03 1.9836E-03 5.1899E-01 5.0019E-02
  96.000 1.0014E+00 1.9221E-01 4.8659E-02 7.2895E-03 3.4340E+00 2.5944E-01
 720.000 1.0014E+00 1.9221E-01 1.7309E-01 1.8177E-02 1.5928E+01 1.0537E+00

########################################################################
                        Worst Two-Hour Doses
########################################################################

Exclusion Area Boundary
   Time    Whole Body    Thyroid        TEDE
   (hr)      (rem)         (rem)         (rem)
   10.3   1.7795E-02   1.2960E-01   2.2012E-02
```

LaSalle 2 Cycle 16 MSIV B Pathway RADTRAD Output File

```
 ##########################################################################
    RADTRAD Version 3.03 (Spring 2001) run on 10/31/2016  at 23:29:25
 ##########################################################################

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

 Plant file           = C:\Users\E42031\AppData\Local\Temp\14\\temp.psf
 Inventory file       = H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 MSIVB\l2c16
MSIVB.nif
 Release file         = H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 MSIVB\l2c16
MSIVB.rft
 Dose Conversion file = H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 MSIVB\l2c16
MSIVB.inp




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


 Radtrad 3.03 4/15/2001
 LSCS LOCA MSIV B with 25% Makeup
 Nuclide Inventory File:
 H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 MSIVB\l2c16 MSIVB.nif
 Plant Power Level:
  3.5590E+03
 Compartments:
   6
 Compartment 1:
 Containment
   3
  3.9430E+05
   1
   0
   0
   1
   0
 Compartment 2:
 (Node 1) Inboard MSL B Volume
   3
  1.00E-04
   0
   0
   0
   0
   0
 Compartment 3:
 (Nodes 2& 3) Outboard MSL B Volume
   3
  9.64E+02
   0
   0
   0
   0
   0
 Compartment 4:
 Condenser
```

```
   3
  2.4635E+05
   0
   0
   0
   0
   0
 Compartment 5:
 Environment
   2
  0.0000E+00
   0
   0
   0
   0
   0
 Compartment 6:
 Control Room
   1
  1.1740E+05
   0
   0
   1
   0
   0
Pathways:
   9
Pathway 1:
Containment to (Node 1) Inboard MSL B Volume
   1
   2
   2
Pathway 2:
(Node 1) Inboard MSL B Volume to (Nodes 2& 3) Outboard MSL B Volume
   2
   3
   2
Pathway 3:
(Nodes 2& 3) Outboard MSL B Volume to Condenser
   3
   4
   2
Pathway 4:
Condenser to Environment
   4
   5
   2
Pathway 5:
Environment to Control Room
   5
   6
   2
Pathway 6:
Environment to Control Room
   5
   6
   2
Pathway 7:
Environment to Control Room
   5
   6
   2
Pathway 8:
Control Room to Environment
   6
   5
   2
Pathway 9:
(Nodes 2& 3) Outboard MSL B Volume to Environment
   3
   5
```

```
   2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
   1
   1   1.0000E+00
 H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 MSIVB\l2c16 MSIVB.inp
 H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 MSIVB\l2c16 MSIVB.rft
   0.0000E+00
   1
   9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
 Overlying Pool:
   0
   0.0000E+00
   0
   0
   0
   0
 Compartments:
   6
 Compartment 1:
   0
   1
   1
   0.0000E+00
   0
   1
   0.0000E+00
   3
   0.0000E+00   3.8600E+00
   2.0000E+00   1.8600E+00
   3.8500E+00   0.0000E+00
   1
   0.0000E+00
   0
   0
   0
   3
   3
   1.0000E+01
   1
   1
   0.0000E+00   0.0000E+00
 Compartment 2:
   0
   1
   0
   0
   0
   0
   0
   0
   0
 Compartment 3:
   0
   1
   0
   0
   0
   0
   0
   0
   0
Compartment 4:
   0
   1
   0
   0
```

```
   0
   0
   0
   0
   0
Compartment 5:
   0
   1
   0
   0
   0
   0
   0
   0
   0
Compartment 6:
   0
   1
   0
   0
   0
   0
   1
   1.4650E+04
   4
   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
   3.3300E-01   0.0000E+00   0.0000E+00   0.0000E+00
   4.0000E+00   0.0000E+00   6.6500E+01   6.6500E+01
   7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00
   0
   0
Pathways:
   9
 Pathway 1:
   0
   0
   0
   0
   0
   1
   5
   0.0000E+00   2.9960E+00   0.0000E+00   0.0000E+00   0.0000E+00
   2.0000E+00   1.7440E+00   0.0000E+00   0.0000E+00   0.0000E+00
   2.4000E+01   1.7440E+00   0.0000E+00   0.0000E+00   0.0000E+00
   9.6000E+01   1.7440E+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 2:
   0
   0
   0
   0
   0
   1
   5
   0.0000E+00   2.9960E+00   0.0000E+00   0.0000E+00   0.0000E+00
   2.0000E+00   1.7440E+00   0.0000E+00   0.0000E+00   0.0000E+00
   2.4000E+01   1.7440E+00   0.0000E+00   0.0000E+00   0.0000E+00
   9.6000E+01   1.7440E+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
  5
  0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  3.3300E-01   6.3760E+00   9.9800E+01   2.4210E+01   0.0000E+00
  2.4000E+01   5.4920E+00   0.0000E+00   4.5370E+01   0.0000E+00
  9.6000E+01   4.1670E+00   0.0000E+00   8.7450E+01   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 4:
  0
  0
  0
  0
  0
  1
  4
  0.0000E+00   7.3230E+00   0.0000E+00   9.9370E+01   0.0000E+00
  2.4000E+01   7.3230E+00   0.0000E+00   9.9370E+01   0.0000E+00
  9.6000E+01   7.3230E+00   0.0000E+00   9.9370E+01   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 5:
  0
  0
  0
  0
  0
  1
  4
  0.0000E+00   1.1000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  3.3330E-01   9.0000E+02   9.9000E+01   8.8440E+01   8.8440E+01
  4.0000E+00   9.0000E+02   9.9000E+01   9.6130E+01   9.6130E+01
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 6:
  0
  0
  0
  0
  0
  1
  4
  0.0000E+00   2.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  3.3330E-01   2.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  4.0000E+00   2.4000E+03   0.0000E+00   6.4430E+01   6.4430E+01
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
```

```
   0
   0
Pathway 7:
   0
   0
   0
   0
   0
   1
   4
   0.0000E+00   5.0000E+01   0.0000E+00   0.0000E+00   0.0000E+00
   3.3330E-01   5.0000E+01   0.0000E+00   0.0000E+00   0.0000E+00
   4.0000E+00   5.0000E+01   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 8:
   0
   0
   0
   0
   0
   1
   4
   0.0000E+00   3.5500E+03   1.0000E+02   1.0000E+02   1.0000E+02
   3.3330E-01   3.3500E+03   1.0000E+02   1.0000E+02   1.0000E+02
   4.0000E+00   3.3500E+03   1.0000E+02   1.0000E+02   1.0000E+02
   7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
   0
   0
   0
   0
   0
   0
Pathway 9:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   6.3760E+00   9.1960E+01   2.4210E+01   0.0000E+00
   3.3330E-01   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
   5
   1
   4
   0.0000E+00   6.6300E-04
   2.4000E+01   0.0000E+00
   9.6000E+01   0.0000E+00
   7.2000E+02   0.0000E+00
   1
   3
   0.0000E+00   3.5000E-04
   2.4000E+01   0.0000E+00
   7.2000E+02   0.0000E+00
   0
```

```
Location 2:
Low Population Zone
  5
  1
  8
  0.0000E+00   2.6500E-05
  2.5000E-01   2.6500E-05
  1.5000E+00   2.6500E-05
  2.0000E+00   1.0800E-05
  8.0000E+00   6.8700E-06
  2.4000E+01   2.6300E-06
  9.6000E+01   6.7400E-07
  7.2000E+02   0.0000E+00
  1
  4
  0.0000E+00   3.5000E-04
  8.0000E+00   1.8000E-04
  2.4000E+01   2.3000E-04
  7.2000E+02   0.0000E+00
  0
Location 3:
Control Room
  6
  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
  8
  0.0000E+00   8.1300E-03
  2.5000E-01   8.1300E-03
  1.5000E+00   8.1300E-03
  2.0000E+00   6.0900E-03
  8.0000E+00   2.4200E-03
  2.4000E+01   1.7600E-03
  9.6000E+01   1.4600E-03
  7.2000E+02   0.0000E+00
Simulation Parameters:
  3
  0.0000E+00   2.5000E-01
  2.4000E+01   2.4000E+01
  7.2000E+02   0.0000E+00
Output Filename:
H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 MSIVB\l2c16 MSIVB.out
  1
  1
  1
  0
  0
End of Scenario File
```

```
########################################################################
    RADTRAD Version 3.03 (Spring 2001) run on 10/31/2016  at 23:29:25
 ########################################################################

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

 Number of Nuclides =  60

 Inventory Power =   1.0000E+00 MWth
 Plant Power Level =   3.5590E+03 MWth

 Number of compartments    =   6

 Compartment information

 Compartment number  1  (Source term fraction =   1.0000E+00
 )
 Name: Containment
 Compartment volume =   3.9430E+05 (Cubic feet)
 Compartment type is Normal
 Removal devices within compartment:
      Spray(s)
      Deposition
 Pathways into and out of compartment  1
    Exit Pathway Number    1: ontainment to (Node 1) Inboard MSL B Volume

 Compartment number  2
 Name: (Node 1) Inboard MSL B Volume
 Compartment volume =   1.0000E-04 (Cubic feet)
 Compartment type is Normal
 Pathways into and out of compartment  2
    Inlet Pathway Number   1: ontainment to (Node 1) Inboard MSL B Volume
    Exit Pathway Number    2: Node 1) Inboard MSL B Volume to (Nodes 2& 3) Outbo

 Compartment number  3
 Name: (Nodes 2& 3) Outboard MSL B Volume
 Compartment volume =   9.6400E+02 (Cubic feet)
 Compartment type is Normal
 Pathways into and out of compartment  3
    Inlet Pathway Number   2: Node 1) Inboard MSL B Volume to (Nodes 2& 3) Outbo
    Exit Pathway Number    3: Nodes 2& 3) Outboard MSL B Volume to Condenser
    Exit Pathway Number    9: Nodes 2& 3) Outboard MSL B Volume to Environment

 Compartment number  4
 Name: Condenser
 Compartment volume =   2.4635E+05 (Cubic feet)
 Compartment type is Normal
 Pathways into and out of compartment  4
    Inlet Pathway Number   3: Nodes 2& 3) Outboard MSL B Volume to Condenser
    Exit Pathway Number    4: ondenser to Environment

 Compartment number  5
 Name: Environment
 Compartment type is Environment
 Pathways into and out of compartment  5
    Inlet Pathway Number   4: ondenser to Environment
    Inlet Pathway Number   8: ontrol Room to Environment
    Inlet Pathway Number   9: Nodes 2& 3) Outboard MSL B Volume to Environment
    Exit Pathway Number    5: nvironment to Control Room
    Exit Pathway Number    6: nvironment to Control Room
    Exit Pathway Number    7: nvironment to Control Room

 Compartment number  6
 Name: Control Room
 Compartment volume =   1.1740E+05 (Cubic feet)
 Compartment type is Control Room
 Removal devices within compartment:
      Filter(s)
```

```
Pathways into and out of compartment  6
   Inlet Pathway Number   5: nvironment to Control Room
   Inlet Pathway Number   6: nvironment to Control Room
   Inlet Pathway Number   7: nvironment to Control Room
   Exit Pathway Number    8: ontrol Room to Environment

Total number of pathways =   9
```

```
##############################################################################
   RADTRAD Version 3.03 (Spring 2001) run on 10/31/2016  at 23:29:25
##############################################################################

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

Radioactive Decay is enabled
Calculation of Daughters is enabled

Release Fractions and Timings
               GAP       EARLY IN-VESSEL  LATE RELEASE    RELEASE MASS
            0.500000 hr    1.5000 hrs      0.0000 hrs          (gm)
NOBLES       5.0000E-02     9.5000E-01      0.0000E+00        4.551E+03
IODINE       5.0000E-02     2.5000E-01      0.0000E+00        3.060E+02
CESIUM       5.0000E-02     2.0000E-01      0.0000E+00        4.876E+04
TELLURIUM    0.0000E+00     5.0000E-02      0.0000E+00        4.042E+01
STRONTIUM    0.0000E+00     2.0000E-02      0.0000E+00        1.671E+03
BARIUM       0.0000E+00     2.0000E-02      0.0000E+00        4.796E+01
RUTHENIUM    0.0000E+00     2.5000E-03      0.0000E+00        5.864E+01
CERIUM       0.0000E+00     5.0000E-04      0.0000E+00        5.986E+02
LANTHANUM    0.0000E+00     2.0000E-04      0.0000E+00        8.157E+00

Inventory Power =      3559. MWt

Nuclide  Group  Specific     half     Whole Body   Inhaled     Inhaled
 Name          Inventory     life        DCF       Thyroid    Effective
               (Ci/MWt)      (s)     (Sv-m3/Bq-s)  (Sv/Bq)     (Sv/Bq)
 Co-58     7   1.529E+02  6.117E+06   4.760E-14   8.720E-10   2.940E-09
 Co-60     7   1.830E+02  1.663E+08   1.260E-13   1.620E-08   5.910E-08
 Kr-85     1   3.816E+02  3.383E+08   1.190E-16   0.000E+00   0.000E+00
 Kr-85m    1   8.439E+03  1.613E+04   7.480E-15   0.000E+00   0.000E+00
 Kr-87     1   1.659E+04  4.578E+03   4.120E-14   0.000E+00   0.000E+00
 Kr-88     1   2.342E+04  1.022E+04   1.020E-13   0.000E+00   0.000E+00
 Rb-86     3   6.081E+01  1.612E+06   4.810E-15   1.330E-09   1.790E-09
 Sr-89     5   2.845E+04  4.363E+06   7.730E-17   7.960E-12   1.120E-08
 Sr-90     5   3.066E+03  9.190E+08   7.530E-18   2.690E-10   3.510E-07
 Sr-91     5   3.858E+04  3.420E+04   4.924E-14   9.930E-12   4.547E-10
 Sr-92     5   4.069E+04  9.756E+03   6.790E-14   3.920E-12   2.180E-10
 Y-90      9   3.155E+03  2.304E+05   1.900E-16   5.170E-13   2.280E-09
 Y-91      9   3.495E+04  5.055E+06   2.600E-16   8.500E-12   1.320E-08
 Y-92      9   4.082E+04  1.274E+04   1.300E-14   1.050E-12   2.110E-10
 Y-93      9   4.575E+04  3.636E+04   4.800E-15   9.260E-13   5.820E-10
 Zr-95     9   4.510E+04  5.528E+06   3.600E-14   1.440E-09   6.390E-09
 Zr-97     9   4.671E+04  6.084E+04   4.432E-14   2.315E-11   1.171E-09
 Nb-95     9   4.534E+04  3.037E+06   3.740E-14   3.580E-10   1.570E-09
 Mo-99     7   5.070E+04  2.376E+05   7.280E-15   1.520E-11   1.070E-09
 Tc-99m    7   4.440E+04  2.167E+04   5.890E-15   5.010E-11   8.800E-12
 Ru-103    7   4.175E+04  3.394E+06   2.251E-14   2.570E-10   2.421E-09
 Ru-105    7   2.874E+04  1.598E+04   3.810E-14   4.150E-12   1.230E-10
 Ru-106    7   1.666E+04  3.181E+07   1.040E-14   1.720E-09   1.290E-07
 Rh-105    7   2.716E+04  1.273E+05   3.720E-15   2.880E-12   2.580E-10
 Sb-127    4   2.886E+03  3.326E+05   3.330E-14   6.150E-11   1.630E-09
 Sb-129    4   8.623E+03  1.555E+04   7.140E-14   9.720E-12   1.740E-10
 Te-127    4   2.861E+03  3.366E+04   2.420E-16   1.840E-12   8.600E-11
 Te-127m   4   3.825E+02  9.418E+06   1.470E-16   9.660E-11   5.810E-09
 Te-129    4   8.483E+03  4.176E+03   2.750E-15   5.090E-13   2.090E-11
 Te-129m   4   1.263E+03  2.903E+06   3.337E-15   1.563E-10   6.484E-09
 Te-131m   4   3.868E+03  1.080E+05   7.463E-14   3.669E-08   1.758E-09
 Te-132    4   3.825E+04  2.815E+05   1.030E-14   6.280E-08   2.550E-09
 I-131     2   2.686E+04  6.947E+05   1.820E-14   2.920E-07   8.890E-09
 I-132     2   3.885E+04  8.280E+03   1.120E-13   1.740E-09   1.030E-10
 I-133     2   5.559E+04  7.488E+04   2.940E-14   4.860E-08   1.580E-09
 I-134     2   6.168E+04  3.156E+03   1.300E-13   2.880E-10   3.550E-11
 I-135     2   5.191E+04  2.380E+04   8.294E-14   8.460E-09   3.320E-10
 Xe-133    1   5.504E+04  4.532E+05   1.560E-15   0.000E+00   0.000E+00
 Xe-135    1   2.213E+04  3.272E+04   1.190E-14   0.000E+00   0.000E+00
 Cs-134    3   6.578E+03  6.507E+07   7.570E-14   1.110E-08   1.250E-08
 Cs-136    3   1.903E+03  1.132E+06   1.060E-13   1.730E-09   1.980E-09
```

```
 Cs-137    3   4.323E+03  9.467E+08   2.725E-14   7.930E-09   8.630E-09
 Ba-139    6   5.095E+04  4.962E+03   2.170E-15   2.400E-12   4.640E-11
 Ba-140    6   4.910E+04  1.101E+06   8.580E-15   2.560E-10   1.010E-09
 La-140    9   5.022E+04  1.450E+05   1.170E-13   6.870E-11   1.310E-09
 La-141    9   4.656E+04  1.415E+04   2.390E-15   9.400E-12   1.570E-10
 La-142    9   4.550E+04  5.550E+03   1.440E-13   8.740E-12   6.840E-11
 Ce-141    8   4.503E+04  2.808E+06   3.430E-15   2.550E-11   2.420E-09
 Ce-143    8   4.450E+04  1.188E+05   1.290E-14   6.230E-12   9.160E-10
 Ce-144    8   3.597E+04  2.456E+07   2.773E-15   2.920E-10   1.010E-07
 Pr-143    9   4.316E+04  1.172E+06   2.100E-17   1.680E-18   2.190E-09
 Nd-147    9   1.839E+04  9.487E+05   6.190E-15   1.820E-11   1.850E-09
 Np-239    8   5.355E+05  2.035E+05   7.690E-15   7.620E-12   6.780E-10
 Pu-238    8   1.525E+02  2.769E+09   4.880E-18   3.860E-10   7.790E-05
 Pu-239    8   1.214E+01  7.594E+11   4.240E-18   3.750E-10   8.330E-05
 Pu-240    8   1.298E+01  2.063E+11   4.750E-18   3.760E-10   8.330E-05
 Pu-241    8   6.179E+03  4.544E+08   7.250E-20   9.150E-12   1.340E-06
 Am-241    9   9.817E+00  1.364E+10   8.180E-16   1.600E-09   1.200E-04
 Cm-242    9   2.089E+03  1.407E+07   5.690E-18   9.410E-10   4.670E-06
 Cm-244    9   1.834E+02  5.715E+08   4.910E-18   1.010E-09   6.700E-05

Nuclide    Daughter  Fraction   Daughter  Fraction   Daughter  Fraction
 Kr-85m    Kr-85      0.21       none       0.00       none       0.00
 Kr-87     Rb-87      1.00       none       0.00       none       0.00
 Kr-88     Rb-88      1.00       none       0.00       none       0.00
 Sr-90     Y-90       1.00       none       0.00       none       0.00
 Sr-91     Y-91m      0.58       Y-91       0.42       none       0.00
 Sr-92     Y-92       1.00       none       0.00       none       0.00
 Y-93      Zr-93      1.00       none       0.00       none       0.00
 Zr-95     Nb-95m     0.01       Nb-95      0.99       none       0.00
 Zr-97     Nb-97m     0.95       Nb-97      0.05       none       0.00
 Mo-99     Tc-99m     0.88       Tc-99      0.12       none       0.00
 Tc-99m    Tc-99      1.00       none       0.00       none       0.00
 Ru-103    Rh-103m    1.00       none       0.00       none       0.00
 Ru-105    Rh-105     1.00       none       0.00       none       0.00
 Ru-106    Rh-106     1.00       none       0.00       none       0.00
 Sb-127    Te-127m    0.18       Te-127     0.82       none       0.00
 Sb-129    Te-129m    0.22       Te-129     0.77       none       0.00
 Te-127m   Te-127     0.98       none       0.00       none       0.00
 Te-129    I-129      1.00       none       0.00       none       0.00
 Te-129m   Te-129     0.65       I-129      0.35       none       0.00
 Te-131m   Te-131     0.22       I-131      0.78       none       0.00
 Te-132    I-132      1.00       none       0.00       none       0.00
 I-131     Xe-131m    0.01       none       0.00       none       0.00
 I-133     Xe-133m    0.03       Xe-133     0.97       none       0.00
 I-135     Xe-135m    0.15       Xe-135     0.85       none       0.00
 Xe-135    Cs-135     1.00       none       0.00       none       0.00
 Cs-137    Ba-137m    0.95       none       0.00       none       0.00
 Ba-140    La-140     1.00       none       0.00       none       0.00
 La-141    Ce-141     1.00       none       0.00       none       0.00
 Ce-143    Pr-143     1.00       none       0.00       none       0.00
 Ce-144    Pr-144m    0.02       Pr-144     0.98       none       0.00
 Nd-147    Pm-147     1.00       none       0.00       none       0.00
 Np-239    Pu-239     1.00       none       0.00       none       0.00
 Pu-238    U-234      1.00       none       0.00       none       0.00
 Pu-239    U-235      1.00       none       0.00       none       0.00
 Pu-240    U-236      1.00       none       0.00       none       0.00
 Pu-241    U-237      0.00       Am-241     1.00       none       0.00
 Am-241    Np-237     1.00       none       0.00       none       0.00
 Cm-242    Pu-238     1.00       none       0.00       none       0.00
 Cm-244    Pu-240     1.00       none       0.00       none       0.00

Iodine fractions
     Aerosol     =   9.5000E-01
     Elemental   =   4.8500E-02
     Organic     =   1.5000E-03

COMPARTMENT DATA

Compartment number   1: Containment

     Sprays:  Elemental Removal Data
```

```
      Time (hr)          Removal Coef. (hr^-1)
       0.0000E+00          3.8600E+00
       2.0000E+00          1.8600E+00
       3.8500E+00          0.0000E+00
Natural Deposition (Powers' model):  Aerosol data
      Reactor type:   3
      Percentile =  10 (%)

     Natural Deposition:  Elemental Removal Data
      Time (hr)          Removal Coef. (hr^-1)
       0.0000E+00          0.0000E+00

Compartment number   2: (Node 1) Inboard MSL B Volume

Compartment number   3: (Nodes 2& 3) Outboard MSL B Volume

Compartment number   4: Condenser

Compartment number   5: Environment

Compartment number   6: Control Room

     Compartment Filter Data

      Time (hr)      Flow Rate          Filter Efficiencies (%)
                       (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    1.4650E+04   0.0000E+00   0.0000E+00   0.0000E+00
       3.3300E-01    1.4650E+04   0.0000E+00   0.0000E+00   0.0000E+00
       4.0000E+00    1.4650E+04   0.0000E+00   6.6500E+01   6.6500E+01
       7.2000E+02    1.4650E+04   0.0000E+00   0.0000E+00   0.0000E+00

PATHWAY DATA

Pathway number  1: ontainment to (Node 1) Inboard MSL B Volume

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                       (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    2.9960E+00   0.0000E+00   0.0000E+00   0.0000E+00
       2.0000E+00    1.7440E+00   0.0000E+00   0.0000E+00   0.0000E+00
       2.4000E+01    1.7440E+00   0.0000E+00   0.0000E+00   0.0000E+00
       9.6000E+01    1.7440E+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  2: Node 1) Inboard MSL B Volume to (Nodes 2& 3) Outbo

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                       (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    2.9960E+00   0.0000E+00   0.0000E+00   0.0000E+00
       2.0000E+00    1.7440E+00   0.0000E+00   0.0000E+00   0.0000E+00
       2.4000E+01    1.7440E+00   0.0000E+00   0.0000E+00   0.0000E+00
       9.6000E+01    1.7440E+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: Nodes 2& 3) Outboard MSL B Volume to Condenser

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                       (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
       3.3300E-01    6.3760E+00   9.9800E+01   2.4210E+01   0.0000E+00
       2.4000E+01    5.4920E+00   0.0000E+00   4.5370E+01   0.0000E+00
       9.6000E+01    4.1670E+00   0.0000E+00   8.7450E+01   0.0000E+00
       7.2000E+02    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00

Pathway number  4: ondenser to Environment
```

```
     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                        (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    7.3230E+00   0.0000E+00   9.9370E+01   0.0000E+00
       2.4000E+01    7.3230E+00   0.0000E+00   9.9370E+01   0.0000E+00
       9.6000E+01    7.3230E+00   0.0000E+00   9.9370E+01   0.0000E+00
       7.2000E+02    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00

Pathway number  5: nvironment to Control Room

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                        (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    1.1000E+03   0.0000E+00   0.0000E+00   0.0000E+00
       3.3330E-01    9.0000E+02   9.9000E+01   8.8440E+01   8.8440E+01
       4.0000E+00    9.0000E+02   9.9000E+01   9.6130E+01   9.6130E+01
       7.2000E+02    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00

Pathway number  6: nvironment to Control Room

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                        (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    2.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
       3.3330E-01    2.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
       4.0000E+00    2.4000E+03   0.0000E+00   6.4430E+01   6.4430E+01
       7.2000E+02    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00

Pathway number  7: nvironment to Control Room

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                        (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    5.0000E+01   0.0000E+00   0.0000E+00   0.0000E+00
       3.3330E-01    5.0000E+01   0.0000E+00   0.0000E+00   0.0000E+00
       4.0000E+00    5.0000E+01   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  8: ontrol Room to Environment

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                        (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    3.5500E+03   1.0000E+02   1.0000E+02   1.0000E+02
       3.3330E-01    3.3500E+03   1.0000E+02   1.0000E+02   1.0000E+02
       4.0000E+00    3.3500E+03   1.0000E+02   1.0000E+02   1.0000E+02
       7.2000E+02    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00

Pathway number  9: Nodes 2& 3) Outboard MSL B Volume to Environment

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                        (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    6.3760E+00   9.1960E+01   2.4210E+01   0.0000E+00
       3.3330E-01    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00

LOCATION DATA
     Location Exclusion Area Boundary     is in compartment   5

     Location X/Q Data
      Time (hr)         X/Q (s * m^-3)
       0.0000E+00          6.6300E-04
       2.4000E+01          0.0000E+00
       9.6000E+01          0.0000E+00
       7.2000E+02          0.0000E+00
```

```
     Location Breathing Rate Data
      Time (hr)         Breathing Rate (m^3 * sec^-1)
       0.0000E+00                3.5000E-04
       2.4000E+01                0.0000E+00
       7.2000E+02                0.0000E+00
     Location Low Population Zone     is in compartment   5

     Location X/Q Data
      Time (hr)         X/Q (s * m^-3)
       0.0000E+00          2.6500E-05
       2.5000E-01          2.6500E-05
       1.5000E+00          2.6500E-05
       2.0000E+00          1.0800E-05
       8.0000E+00          6.8700E-06
       2.4000E+01          2.6300E-06
       9.6000E+01          6.7400E-07
       7.2000E+02          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
       7.2000E+02                0.0000E+00
     Location Control Room     is in compartment   6

     Location X/Q Data
      Time (hr)         X/Q (s * m^-3)
       0.0000E+00          8.1300E-03
       2.5000E-01          8.1300E-03
       1.5000E+00          8.1300E-03
       2.0000E+00          6.0900E-03
       8.0000E+00          2.4200E-03
       2.4000E+01          1.7600E-03
       9.6000E+01          1.4600E-03
       7.2000E+02          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-01
      2.4000E+01       2.4000E+01
      7.2000E+02       0.0000E+00
```

```
########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on 10/31/2016  at 23:29:25
########################################################################




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


########################################################################
                                Dose Output
########################################################################

Exclusion Area Boundary Doses:

Time (h) =   0.2500    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.1113E-03  1.6238E-01  8.5379E-03
Accumulated dose (rem)  2.1113E-03  1.6238E-01  8.5379E-03

Low Population Zone Doses:

Time (h) =   0.2500    Whole Body   Thyroid       TEDE
Delta dose (rem)        8.4388E-05  6.4903E-03  3.4126E-04
Accumulated dose (rem)  8.4388E-05  6.4903E-03  3.4126E-04

Control Room Doses:

Time (h) =   0.2500    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.3269E-04  2.3423E-01  9.3886E-03
Accumulated dose (rem)  1.3269E-04  2.3423E-01  9.3886E-03

Exclusion Area Boundary Doses:

Time (h) =   0.3330    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.6955E-03  2.0698E-01  1.0930E-02
Accumulated dose (rem)  4.8068E-03  3.6936E-01  1.9468E-02

Low Population Zone Doses:

Time (h) =   0.3330    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.0774E-04  8.2728E-03  4.3687E-04
Accumulated dose (rem)  1.9213E-04  1.4763E-02  7.7812E-04

Control Room Doses:

Time (h) =   0.3330    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.4065E-04  4.2736E-01  1.7193E-02
Accumulated dose (rem)  3.7334E-04  6.6159E-01  2.6581E-02

Exclusion Area Boundary Doses:

Time (h) =   0.3333    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.2194E-05  9.4821E-04  4.9979E-05
Accumulated dose (rem)  4.8190E-03  3.7030E-01  1.9518E-02

Low Population Zone Doses:

Time (h) =   0.3333    Whole Body   Thyroid       TEDE
Delta dose (rem)        4.8739E-07  3.7900E-05  1.9977E-06
Accumulated dose (rem)  1.9262E-04  1.4801E-02  7.8012E-04

Control Room Doses:
```

```
Time (h) =   0.3333    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.1733E-06  2.1220E-03  8.5425E-05
Accumulated dose (rem)  3.7451E-04  6.6371E-01  2.6667E-02

Exclusion Area Boundary Doses:

Time (h) =   0.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        9.0626E-07  3.7196E-06  1.0454E-06
Accumulated dose (rem)  4.8199E-03  3.7031E-01  1.9519E-02

Low Population Zone Doses:

Time (h) =   0.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        3.6223E-08  1.4867E-07  4.1785E-08
Accumulated dose (rem)  1.9265E-04  1.4801E-02  7.8016E-04

Control Room Doses:

Time (h) =   0.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        5.6262E-04  1.0284E+00  4.1393E-02
Accumulated dose (rem)  9.3713E-04  1.6921E+00  6.8060E-02

Exclusion Area Boundary Doses:

Time (h) =   1.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.7795E-04  7.1644E-04  3.0693E-04
Accumulated dose (rem)  5.0979E-03  3.7102E-01  1.9826E-02

Low Population Zone Doses:

Time (h) =   1.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.1110E-05  2.8636E-05  1.2268E-05
Accumulated dose (rem)  2.0376E-04  1.4830E-02  7.9243E-04

Control Room Doses:

Time (h) =   1.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.2711E-03  2.5352E+00  1.0191E-01
Accumulated dose (rem)  2.2082E-03  4.2274E+00  1.6997E-01

Exclusion Area Boundary Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        7.4277E-04  1.6361E-03  8.1213E-04
Accumulated dose (rem)  5.8407E-03  3.7266E-01  2.0638E-02

Low Population Zone Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.9689E-05  6.5396E-05  3.2461E-05
Accumulated dose (rem)  2.3345E-04  1.4895E-02  8.2489E-04

Control Room Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.8714E-04  3.2332E-01  1.3138E-02
Accumulated dose (rem)  2.4953E-03  4.5507E+00  1.8311E-01

Exclusion Area Boundary Doses:

Time (h) =   3.8500    Whole Body   Thyroid       TEDE
Delta dose (rem)        9.6256E-03  2.2299E-02  1.0592E-02
Accumulated dose (rem)  1.5466E-02  3.9496E-01  3.1230E-02

Low Population Zone Doses:

Time (h) =   3.8500    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.5680E-04  3.6324E-04  1.7255E-04
Accumulated dose (rem)  3.9025E-04  1.5258E-02  9.9744E-04
```

Control Room Doses:

Time (h) = 3.8500	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.5902E-03	3.2660E-01	1.5918E-02
Accumulated dose (rem)	5.0855E-03	4.8773E+00	1.9903E-01

Exclusion Area Boundary Doses:

Time (h) = 4.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.2128E-03	3.0205E-03	1.3429E-03
Accumulated dose (rem)	1.6679E-02	3.9798E-01	3.2573E-02

Low Population Zone Doses:

Time (h) = 4.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.9756E-05	4.9202E-05	2.1875E-05
Accumulated dose (rem)	4.1000E-04	1.5308E-02	1.0193E-03

Control Room Doses:

Time (h) = 4.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	3.5864E-04	1.8096E-02	1.1308E-03
Accumulated dose (rem)	5.4441E-03	4.8954E+00	2.0016E-01

Exclusion Area Boundary Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	4.5315E-02	1.4118E-01	5.1118E-02
Accumulated dose (rem)	6.1995E-02	5.3916E-01	8.3691E-02

Low Population Zone Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	7.3817E-04	2.2997E-03	8.3269E-04
Accumulated dose (rem)	1.1482E-03	1.7607E-02	1.8520E-03

Control Room Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.5322E-02	3.9146E-01	3.6220E-02
Accumulated dose (rem)	2.0766E-02	5.2868E+00	2.3638E-01

Exclusion Area Boundary Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.9729E-01	1.4528E+00	2.4946E-01
Accumulated dose (rem)	2.5928E-01	1.9920E+00	3.3315E-01

Low Population Zone Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.0443E-03	7.7421E-03	2.3223E-03
Accumulated dose (rem)	3.1925E-03	2.5349E-02	4.1743E-03

Control Room Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	3.1444E-02	9.9587E-01	8.2665E-02
Accumulated dose (rem)	5.2210E-02	6.2827E+00	3.1904E-01

Exclusion Area Boundary Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	2.5928E-01	1.9920E+00	3.3315E-01

Low Population Zone Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	4.1771E-03	4.4818E-02	5.6364E-03
Accumulated dose (rem)	7.3696E-03	7.0167E-02	9.8107E-03

Control Room Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	7.3029E-02	2.8691E+00	2.0098E-01
Accumulated dose (rem)	1.2524E-01	9.1518E+00	5.2002E-01

Exclusion Area Boundary Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	2.5928E-01	1.9920E+00	3.3315E-01

Low Population Zone Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	7.0301E-03	1.2529E-01	1.0953E-02
Accumulated dose (rem)	1.4400E-02	1.9545E-01	2.0764E-02

Control Room Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.6687E-01	1.2800E+01	7.6176E-01
Accumulated dose (rem)	3.9210E-01	2.1952E+01	1.2818E+00

897

##
I-131 Summary
##

Time (hr)	Containment I-131 (Curies)	(Node 1) Inboard MSL I-131 (Curies)	(Nodes 2& 3) Outboard I-131 (Curies)
0.000	5.3091E+03	1.3451E-06	6.7100E-04
0.250	2.1565E+06	5.4691E-04	1.2289E+02
0.333	2.7820E+06	7.0554E-04	2.1096E+02
0.333	2.7841E+06	7.0610E-04	2.1129E+02
0.500	3.9260E+06	9.9570E-04	4.4565E+02
0.750	7.1398E+06	1.8108E-03	1.0088E+03
1.000	1.0124E+07	2.5675E-03	1.8537E+03
1.250	1.2909E+07	3.2740E-03	2.9305E+03
1.500	1.5516E+07	3.9350E-03	4.1968E+03
1.750	1.7955E+07	4.5537E-03	5.6159E+03
2.000	2.0239E+07	5.1329E-03	7.1556E+03
2.250	1.5666E+07	3.9732E-03	7.5989E+03
2.500	1.2133E+07	3.0771E-03	7.7460E+03
2.750	9.4015E+06	2.3844E-03	7.6828E+03
3.000	7.2888E+06	1.8486E-03	7.4740E+03
3.250	5.6541E+06	1.4340E-03	7.1676E+03
3.500	4.3888E+06	1.1131E-03	6.7996E+03
3.750	3.4092E+06	8.6462E-04	6.3962E+03
3.850	3.0823E+06	7.8173E-04	6.2295E+03
4.000	2.6522E+06	6.7263E-04	5.9769E+03
4.250	2.0664E+06	5.2408E-04	5.5555E+03
4.500	1.6125E+06	4.0895E-04	5.1416E+03
4.750	1.2606E+06	3.1971E-04	4.7419E+03
5.000	9.8790E+05	2.5054E-04	4.3607E+03
5.250	8.5176E+05	2.1602E-04	4.0033E+03
5.500	7.3533E+05	1.8649E-04	3.6719E+03
5.750	6.3577E+05	1.6124E-04	3.3653E+03
6.000	5.5062E+05	1.3965E-04	3.0821E+03
6.250	4.7781E+05	1.2118E-04	2.8209E+03
6.500	4.1553E+05	1.0539E-04	2.5804E+03
6.750	3.6227E+05	9.1878E-05	2.3591E+03
7.000	3.1672E+05	8.0326E-05	2.1557E+03
7.250	2.7777E+05	7.0446E-05	1.9691E+03
7.500	2.4445E+05	6.1995E-05	1.7980E+03
7.750	2.1595E+05	5.4767E-05	1.6412E+03
8.000	1.9157E+05	4.8585E-05	1.4977E+03
8.250	1.7072E+05	4.3297E-05	1.3665E+03
8.500	1.5509E+05	3.9333E-05	1.2466E+03

8.750	1.4144E+05	3.5872E-05	1.1372E+03
9.000	1.2952E+05	3.2848E-05	1.0374E+03
9.250	1.1910E+05	3.0206E-05	9.4645E+02
9.500	1.1000E+05	2.7898E-05	8.6352E+02
9.750	1.0205E+05	2.5881E-05	7.8796E+02
10.000	9.5099E+04	2.4118E-05	7.1912E+02
10.250	8.9026E+04	2.2578E-05	6.5643E+02
24.000	4.5134E+04	1.1447E-05	3.3022E+01
96.000	3.4159E+04	8.6631E-06	2.6540E+01
720.000	3.0768E+03	7.8032E-07	3.1515E+00

Time (hr)	Condenser I-131 (Curies)	Environment I-131 (Curies)	Control Room I-131 (Curies)
0.000	0.0000E+00	5.6470E-09	7.6899E-11
0.250	0.0000E+00	4.5630E-01	5.5547E-03
0.333	0.0000E+00	1.0386E+00	1.2188E-02
0.333	7.7497E-04	1.0413E+00	1.2218E-02
0.500	6.1942E-01	1.0413E+00	9.1790E-03
0.750	2.4154E+00	1.0414E+00	5.9782E-03
1.000	5.6332E+00	1.0417E+00	3.8952E-03
1.250	1.0462E+01	1.0422E+00	2.5413E-03
1.500	1.6944E+01	1.0433E+00	1.6636E-03
1.750	2.5067E+01	1.0452E+00	1.0979E-03
2.000	3.4798E+01	1.0480E+00	7.3728E-04
2.250	4.5465E+01	1.0520E+00	5.0414E-04
2.500	5.6159E+01	1.0574E+00	3.6030E-04
2.750	6.6609E+01	1.0643E+00	2.7501E-04
3.000	7.6662E+01	1.0726E+00	2.2808E-04
3.250	8.6240E+01	1.0824E+00	2.0626E-04
3.500	9.5313E+01	1.0937E+00	2.0087E-04
3.750	1.0388E+02	1.1065E+00	2.0619E-04
3.850	1.0716E+02	1.1120E+00	2.1042E-04
4.000	1.1195E+02	1.1207E+00	2.1844E-04
4.250	1.1955E+02	1.1365E+00	1.4077E-04
4.500	1.2673E+02	1.1537E+00	1.3186E-04
4.750	1.3351E+02	1.1724E+00	1.3636E-04
5.000	1.3993E+02	1.1925E+00	1.4354E-04
5.250	1.4602E+02	1.2141E+00	1.5120E-04
5.500	1.5181E+02	1.2370E+00	1.5877E-04
5.750	1.5732E+02	1.2614E+00	1.6610E-04
6.000	1.6258E+02	1.2871E+00	1.7310E-04
6.250	1.6761E+02	1.3141E+00	1.7975E-04
6.500	1.7244E+02	1.3425E+00	1.8604E-04
6.750	1.7707E+02	1.3722E+00	1.9198E-04
7.000	1.8153E+02	1.4033E+00	1.9757E-04
7.250	1.8583E+02	1.4356E+00	2.0285E-04
7.500	1.8999E+02	1.4693E+00	2.0782E-04
7.750	1.9401E+02	1.5042E+00	2.1251E-04
8.000	1.9792E+02	1.5404E+00	2.1693E-04
8.250	2.0172E+02	1.5778E+00	1.6170E-04
8.500	2.0541E+02	1.6165E+00	1.3540E-04
8.750	2.0902E+02	1.6565E+00	1.2047E-04
9.000	2.1254E+02	1.6977E+00	1.1150E-04
9.250	2.1598E+02	1.7401E+00	1.0615E-04
9.500	2.1936E+02	1.7837E+00	1.0309E-04
9.750	2.2267E+02	1.8285E+00	1.0148E-04
10.000	2.2592E+02	1.8746E+00	1.0081E-04
10.250	2.2912E+02	1.9218E+00	1.0073E-04
24.000	3.7460E+02	6.2496E+00	1.3633E-04
96.000	8.3560E+02	7.0554E+01	1.8295E-04
720.000	3.2111E+02	8.1465E+02	5.4705E-05

##
Cumulative Dose Summary
##

Time (hr)	Exclusion Area Bounda Thyroid (rem)	TEDE (rem)	Low Population Zone Thyroid (rem)	TEDE (rem)	Control Room Thyroid (rem)	TEDE (rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.250	1.6238E-01	8.5379E-03	6.4903E-03	3.4126E-04	2.3423E-01	9.3886E-03

```
   0.333 3.6936E-01 1.9468E-02 1.4763E-02 7.7812E-04 6.6159E-01 2.6581E-02
   0.333 3.7030E-01 1.9518E-02 1.4801E-02 7.8012E-04 6.6371E-01 2.6667E-02
   0.500 3.7031E-01 1.9519E-02 1.4801E-02 7.8016E-04 1.6921E+00 6.8060E-02
   0.750 3.7034E-01 1.9528E-02 1.4802E-02 7.8052E-04 2.7728E+00 1.1152E-01
   1.000 3.7043E-01 1.9561E-02 1.4806E-02 7.8184E-04 3.4745E+00 1.3971E-01
   1.250 3.7064E-01 1.9647E-02 1.4814E-02 7.8530E-04 3.9304E+00 1.5803E-01
   1.500 3.7102E-01 1.9826E-02 1.4830E-02 7.9243E-04 4.2274E+00 1.6997E-01
   1.750 3.7167E-01 2.0140E-02 1.4856E-02 8.0501E-04 4.4218E+00 1.7783E-01
   2.000 3.7266E-01 2.0638E-02 1.4895E-02 8.2489E-04 4.5507E+00 1.8311E-01
   2.250 3.7408E-01 2.1358E-02 1.4918E-02 8.3663E-04 4.6377E+00 1.8676E-01
   2.500 3.7598E-01 2.2311E-02 1.4949E-02 8.5214E-04 4.6981E+00 1.8940E-01
   2.750 3.7838E-01 2.3493E-02 1.4988E-02 8.7140E-04 4.7426E+00 1.9147E-01
   3.000 3.8128E-01 2.4899E-02 1.5036E-02 8.9430E-04 4.7778E+00 1.9324E-01
   3.250 3.8469E-01 2.6520E-02 1.5091E-02 9.2071E-04 4.8083E+00 1.9490E-01
   3.500 3.8861E-01 2.8347E-02 1.5155E-02 9.5048E-04 4.8369E+00 1.9656E-01
   3.750 3.9304E-01 3.0369E-02 1.5227E-02 9.8341E-04 4.8655E+00 1.9830E-01
   3.850 3.9496E-01 3.1230E-02 1.5258E-02 9.9744E-04 4.8773E+00 1.9903E-01
   4.000 3.9798E-01 3.2573E-02 1.5308E-02 1.0193E-03 4.8954E+00 2.0016E-01
   4.250 4.0341E-01 3.4948E-02 1.5396E-02 1.0580E-03 4.9194E+00 2.0192E-01
   4.500 4.0933E-01 3.7481E-02 1.5492E-02 1.0993E-03 4.9386E+00 2.0362E-01
   4.750 4.1573E-01 4.0160E-02 1.5597E-02 1.1429E-03 4.9576E+00 2.0539E-01
   5.000 4.2260E-01 4.2974E-02 1.5709E-02 1.1887E-03 4.9775E+00 2.0727E-01
   5.250 4.2994E-01 4.5911E-02 1.5828E-02 1.2366E-03 4.9984E+00 2.0925E-01
   5.500 4.3773E-01 4.8961E-02 1.5955E-02 1.2863E-03 5.0204E+00 2.1134E-01
   5.750 4.4597E-01 5.2113E-02 1.6089E-02 1.3376E-03 5.0434E+00 2.1352E-01
   6.000 4.5465E-01 5.5357E-02 1.6231E-02 1.3905E-03 5.0673E+00 2.1579E-01
   6.250 4.6377E-01 5.8686E-02 1.6379E-02 1.4447E-03 5.0921E+00 2.1814E-01
   6.500 4.7331E-01 6.2089E-02 1.6535E-02 1.5001E-03 5.1178E+00 2.2056E-01
   6.750 4.8327E-01 6.5560E-02 1.6697E-02 1.5567E-03 5.1443E+00 2.2306E-01
   7.000 4.9364E-01 6.9091E-02 1.6866E-02 1.6142E-03 5.1715E+00 2.2562E-01
   7.250 5.0442E-01 7.2676E-02 1.7041E-02 1.6726E-03 5.1994E+00 2.2823E-01
   7.500 5.1560E-01 7.6308E-02 1.7224E-02 1.7317E-03 5.2279E+00 2.3090E-01
   7.750 5.2718E-01 7.9981E-02 1.7412E-02 1.7916E-03 5.2571E+00 2.3362E-01
   8.000 5.3916E-01 8.3691E-02 1.7607E-02 1.8520E-03 5.2868E+00 2.3638E-01
   8.250 5.5152E-01 8.7433E-02 1.7673E-02 1.8883E-03 5.3125E+00 2.3881E-01
   8.500 5.6426E-01 9.1202E-02 1.7741E-02 1.9248E-03 5.3329E+00 2.4076E-01
   8.750 5.7738E-01 9.4995E-02 1.7811E-02 1.9616E-03 5.3505E+00 2.4243E-01
   9.000 5.9087E-01 9.8808E-02 1.7883E-02 1.9984E-03 5.3664E+00 2.4391E-01
   9.250 6.0474E-01 1.0264E-01 1.7957E-02 2.0354E-03 5.3813E+00 2.4528E-01
   9.500 6.1897E-01 1.0648E-01 1.8033E-02 2.0724E-03 5.3956E+00 2.4659E-01
   9.750 6.3356E-01 1.1034E-01 1.8110E-02 2.1096E-03 5.4095E+00 2.4786E-01
  10.000 6.4851E-01 1.1420E-01 1.8190E-02 2.1467E-03 5.4232E+00 2.4910E-01
  10.250 6.6382E-01 1.1808E-01 1.8272E-02 2.1839E-03 5.4369E+00 2.5033E-01
  24.000 1.9920E+00 3.3315E-01 2.5349E-02 4.1743E-03 6.2827E+00 3.1904E-01
  96.000 1.9920E+00 3.3315E-01 7.0167E-02 9.8107E-03 9.1518E+00 5.2002E-01
 720.000 1.9920E+00 3.3315E-01 1.9545E-01 2.0764E-02 2.1952E+01 1.2818E+00

########################################################################
                        Worst Two-Hour Doses
########################################################################

Exclusion Area Boundary
   Time    Whole Body    Thyroid        TEDE
   (hr)      (rem)         (rem)         (rem)
   10.3   2.4400E-02   1.9319E-01   3.1284E-02
```

LaSalle 2 Cycle 16 Containment Leakage Pathway RADTRAD Output File

```
 ##########################################################################
    RADTRAD Version 3.03 (Spring 2001) run on 10/31/2016  at 23:29:27
 ##########################################################################

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

 Plant file           = C:\Users\E42031\AppData\Local\Temp\14\\temp.psf
 Inventory file       = H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 PC25\l2c16
PC25.nif
 Release file         = H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 PC25\l2c16
PC25.rft
 Dose Conversion file = H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 PC25\l2c16
PC25.inp




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


 Radtrad 3.03 4/15/2001
 LSCS LOCA PC Leak with 25% Makeup
 Nuclide Inventory File:
 H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 PC25\l2c16 PC25.nif
 Plant Power Level:
  3.5590E+03
 Compartments:
   4
 Compartment 1:
 Containment
   3
  3.9430E+05
   1
   0
   0
   1
   0
 Compartment 2:
 Reactor Building
   3
  1.00E+00
   0
   0
   0
   0
   0
 Compartment 3:
 Environment
   2
  0.0000E+00
   0
   0
   0
   0
   0
 Compartment 4:
```

```
 Control Room
   1
  1.1740E+05
   0
   0
   1
   0
   0
Pathways:
   6
Pathway 1:
Containment to Reactor Building
   1
   2
   4
Pathway 2:
Reactor Building to Environment
   2
   3
   2
 Pathway 3:
 Environment to Control Room Filtered Outside Air Intake
   3
   4
   2
 Pathway 4:
 Environment to Control Room Filtered by Recirc Filter Only
   3
   4
   2
 Pathway 5:
 Environment to Control Room Outside air Unfiltered Before Supply Fan
   3
   4
   2
 Pathway 6:
 Control Room to Environment
   4
   3
   2
 End of Plant Model File
 Scenario Description Name:

 Plant Model Filename:

 Source Term:
   1
   1   1.0000E+00
 H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 PC25\l2c16 PC25.inp
 H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 PC25\l2c16 PC25.rft
   0.0000E+00
   1
   9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
 Overlying Pool:
   0
   0.0000E+00
   0
   0
   0
   0
 Compartments:
   4
 Compartment 1:
   0
   1
   1
   0.0000E+00
   0
   1
   0.0000E+00
   3
```

```
   0.0000E+00   3.8600E+00
   2.0000E+00   1.8600E+00
   3.8500E+00   0.0000E+00
   1
   0.0000E+00
   0
   0
   0
   3
   3
   1.0000E+01
   1
   1
   0.0000E+00   0.0000E+00
 Compartment 2:
   0
   1
   0
   0
   0
   0
   0
   0
   0
 Compartment 3:
   0
   1
   0
   0
   0
   0
   0
   0
   0
 Compartment 4:
   0
   1
   0
   0
   0
   0
   1
   1.4650E+04
   4
   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
   3.3300E-01   0.0000E+00   0.0000E+00   0.0000E+00
   4.0000E+00   0.0000E+00   6.6500E+01   6.6500E+01
   7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00
   0
   0
Pathways:
   6
 Pathway 1:
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   1.0000E+00
   7.2000E+02   0.0000E+00
   0
 Pathway 2:
   0
   0
```

```
  0
  0
  0
  1
  3
  0.0000E+00   1.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  2.5000E-01   1.0000E+00   9.8500E+01   9.8500E+01   9.8500E+01
  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
  4
  0.0000E+00   1.1000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  3.3300E-01   9.0000E+02   9.9000E+01   8.8440E+01   8.8440E+01
  4.0000E+00   9.0000E+02   9.9000E+01   9.6130E+01   9.6130E+01
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 4:
  0
  0
  0
  0
  0
  1
  4
  0.0000E+00   2.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  3.3300E-01   2.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  4.0000E+00   2.4000E+03   0.0000E+00   6.6500E+01   6.6500E+01
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 5:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   5.0000E+01   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 6:
  0
  0
  0
  0
```

```
   0
   1
   3
   0.0000E+00   3.5500E+03   1.0000E+02   1.0000E+02   1.0000E+02
   3.3300E-01   3.3500E+03   1.0000E+02   1.0000E+02   1.0000E+02
   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
   3
   1
   8
   0.0000E+00   6.6300E-04
   2.5000E-01   2.7400E-06
   1.5000E+00   8.8000E-05
   2.0000E+00   1.2900E-06
   8.0000E+00   8.8300E-07
   2.4000E+01   3.8900E-07
   9.6000E+01   1.2000E-07
   7.2000E+02   0.0000E+00
   1
   4
   0.0000E+00   3.5000E-04
   8.0000E+00   1.8000E-04
   2.4000E+01   2.3000E-04
   7.2000E+02   0.0000E+00
   0
 Location 2:
 Low Population Zone
   3
   1
   8
   0.0000E+00   2.6500E-05
   2.5000E-01   1.7700E-06
   1.5000E+00   1.0500E-05
   2.0000E+00   8.3400E-07
   8.0000E+00   5.7200E-07
   2.4000E+01   2.5300E-07
   9.6000E+01   7.8100E-08
   7.2000E+02   0.0000E+00
   1
   4
   0.0000E+00   3.5000E-04
   8.0000E+00   1.8000E-04
   2.4000E+01   2.3000E-04
   7.2000E+02   0.0000E+00
   0
 Location 3:
 Control Room
   4
   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
   8
```

```
   0.0000E+00   6.8300E-04
   2.5000E-01   1.1700E-05
   1.5000E+00   1.1700E-05
   2.0000E+00   1.0000E-36
   8.0000E+00   1.0000E-36
   2.4000E+01   7.1700E-08
   9.6000E+01   2.2500E-08
   7.2000E+02   0.0000E+00
 Simulation Parameters:
   1
   0.0000E+00   0.0000E+00
Output Filename:
 H:\LaSalle\Off-Site and Control Room Dose\PLR LOCA\l2c16 PC25\l2c16 PC25.out
   1
   1
   1
   0
   0
 End of Scenario File
```

```
########################################################################
    RADTRAD Version 3.03 (Spring 2001) run on 10/31/2016  at 23:29:27
 ########################################################################

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

 Number of Nuclides =  60

 Inventory Power =   1.0000E+00 MWth
 Plant Power Level =   3.5590E+03 MWth

 Number of compartments    =   4

 Compartment information

 Compartment number  1  (Source term fraction =   1.0000E+00
 )
 Name: Containment
 Compartment volume =   3.9430E+05 (Cubic feet)
 Compartment type is Normal
 Removal devices within compartment:
      Spray(s)
      Deposition
 Pathways into and out of compartment  1
    Exit Pathway Number    1: ontainment to Reactor Building

 Compartment number  2
 Name: Reactor Building
 Compartment volume =   1.0000E+00 (Cubic feet)
 Compartment type is Normal
 Pathways into and out of compartment  2
    Inlet Pathway Number   1: ontainment to Reactor Building
    Exit Pathway Number    2: eactor Building to Environment

 Compartment number  3
 Name: Environment
 Compartment type is Environment
 Pathways into and out of compartment  3
    Inlet Pathway Number   2: eactor Building to Environment
    Inlet Pathway Number   6: Control Room to Environment
    Exit Pathway Number    3: Environment to Control Room Filtered Outside Air I
    Exit Pathway Number    4: Environment to Control Room Filtered by Recirc Fil
    Exit Pathway Number    5: Environment to Control Room Outside air Unfiltered

 Compartment number  4
 Name: Control Room
 Compartment volume =   1.1740E+05 (Cubic feet)
 Compartment type is Control Room
 Removal devices within compartment:
      Filter(s)
 Pathways into and out of compartment  4
    Inlet Pathway Number   3: Environment to Control Room Filtered Outside Air I
    Inlet Pathway Number   4: Environment to Control Room Filtered by Recirc Fil
    Inlet Pathway Number   5: Environment to Control Room Outside air Unfiltered
    Exit Pathway Number    6: Control Room to Environment

 Total number of pathways =   6
```

```
##############################################################################
   RADTRAD Version 3.03 (Spring 2001) run on 10/31/2016  at 23:29:27
##############################################################################

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

Radioactive Decay is enabled
Calculation of Daughters is enabled

Release Fractions and Timings
               GAP       EARLY IN-VESSEL  LATE RELEASE    RELEASE MASS
           0.500000 hr     1.5000 hrs      0.0000 hrs          (gm)
NOBLES       5.0000E-02     9.5000E-01      0.0000E+00        4.551E+03
IODINE       5.0000E-02     2.5000E-01      0.0000E+00        3.060E+02
CESIUM       5.0000E-02     2.0000E-01      0.0000E+00        4.876E+04
TELLURIUM    0.0000E+00     5.0000E-02      0.0000E+00        4.042E+01
STRONTIUM    0.0000E+00     2.0000E-02      0.0000E+00        1.671E+03
BARIUM       0.0000E+00     2.0000E-02      0.0000E+00        4.796E+01
RUTHENIUM    0.0000E+00     2.5000E-03      0.0000E+00        5.864E+01
CERIUM       0.0000E+00     5.0000E-04      0.0000E+00        5.986E+02
LANTHANUM    0.0000E+00     2.0000E-04      0.0000E+00        8.157E+00

Inventory Power =      3559. MWt

Nuclide  Group  Specific     half     Whole Body   Inhaled     Inhaled
 Name          Inventory     life        DCF       Thyroid    Effective
               (Ci/MWt)      (s)     (Sv-m3/Bq-s)  (Sv/Bq)     (Sv/Bq)
 Co-58     7   1.529E+02  6.117E+06   4.760E-14   8.720E-10   2.940E-09
 Co-60     7   1.830E+02  1.663E+08   1.260E-13   1.620E-08   5.910E-08
 Kr-85     1   3.816E+02  3.383E+08   1.190E-16   0.000E+00   0.000E+00
 Kr-85m    1   8.439E+03  1.613E+04   7.480E-15   0.000E+00   0.000E+00
 Kr-87     1   1.659E+04  4.578E+03   4.120E-14   0.000E+00   0.000E+00
 Kr-88     1   2.342E+04  1.022E+04   1.020E-13   0.000E+00   0.000E+00
 Rb-86     3   6.081E+01  1.612E+06   4.810E-15   1.330E-09   1.790E-09
 Sr-89     5   2.845E+04  4.363E+06   7.730E-17   7.960E-12   1.120E-08
 Sr-90     5   3.066E+03  9.190E+08   7.530E-18   2.690E-10   3.510E-07
 Sr-91     5   3.858E+04  3.420E+04   4.924E-14   9.930E-12   4.547E-10
 Sr-92     5   4.069E+04  9.756E+03   6.790E-14   3.920E-12   2.180E-10
 Y-90      9   3.155E+03  2.304E+05   1.900E-16   5.170E-13   2.280E-09
 Y-91      9   3.495E+04  5.055E+06   2.600E-16   8.500E-12   1.320E-08
 Y-92      9   4.082E+04  1.274E+04   1.300E-14   1.050E-12   2.110E-10
 Y-93      9   4.575E+04  3.636E+04   4.800E-15   9.260E-13   5.820E-10
 Zr-95     9   4.510E+04  5.528E+06   3.600E-14   1.440E-09   6.390E-09
 Zr-97     9   4.671E+04  6.084E+04   4.432E-14   2.315E-11   1.171E-09
 Nb-95     9   4.534E+04  3.037E+06   3.740E-14   3.580E-10   1.570E-09
 Mo-99     7   5.070E+04  2.376E+05   7.280E-15   1.520E-11   1.070E-09
 Tc-99m    7   4.440E+04  2.167E+04   5.890E-15   5.010E-11   8.800E-12
 Ru-103    7   4.175E+04  3.394E+06   2.251E-14   2.570E-10   2.421E-09
 Ru-105    7   2.874E+04  1.598E+04   3.810E-14   4.150E-12   1.230E-10
 Ru-106    7   1.666E+04  3.181E+07   1.040E-14   1.720E-09   1.290E-07
 Rh-105    7   2.716E+04  1.273E+05   3.720E-15   2.880E-12   2.580E-10
 Sb-127    4   2.886E+03  3.326E+05   3.330E-14   6.150E-11   1.630E-09
 Sb-129    4   8.623E+03  1.555E+04   7.140E-14   9.720E-12   1.740E-10
 Te-127    4   2.861E+03  3.366E+04   2.420E-16   1.840E-12   8.600E-11
 Te-127m   4   3.825E+02  9.418E+06   1.470E-16   9.660E-11   5.810E-09
 Te-129    4   8.483E+03  4.176E+03   2.750E-15   5.090E-13   2.090E-11
 Te-129m   4   1.263E+03  2.903E+06   3.337E-15   1.563E-10   6.484E-09
 Te-131m   4   3.868E+03  1.080E+05   7.463E-14   3.669E-08   1.758E-09
 Te-132    4   3.825E+04  2.815E+05   1.030E-14   6.280E-08   2.550E-09
 I-131     2   2.686E+04  6.947E+05   1.820E-14   2.920E-07   8.890E-09
 I-132     2   3.885E+04  8.280E+03   1.120E-13   1.740E-09   1.030E-10
 I-133     2   5.559E+04  7.488E+04   2.940E-14   4.860E-08   1.580E-09
 I-134     2   6.168E+04  3.156E+03   1.300E-13   2.880E-10   3.550E-11
 I-135     2   5.191E+04  2.380E+04   8.294E-14   8.460E-09   3.320E-10
 Xe-133    1   5.504E+04  4.532E+05   1.560E-15   0.000E+00   0.000E+00
 Xe-135    1   2.213E+04  3.272E+04   1.190E-14   0.000E+00   0.000E+00
 Cs-134    3   6.578E+03  6.507E+07   7.570E-14   1.110E-08   1.250E-08
 Cs-136    3   1.903E+03  1.132E+06   1.060E-13   1.730E-09   1.980E-09
```

Cs-137	3	4.323E+03	9.467E+08	2.725E-14	7.930E-09	8.630E-09
Ba-139	6	5.095E+04	4.962E+03	2.170E-15	2.400E-12	4.640E-11
Ba-140	6	4.910E+04	1.101E+06	8.580E-15	2.560E-10	1.010E-09
La-140	9	5.022E+04	1.450E+05	1.170E-13	6.870E-11	1.310E-09
La-141	9	4.656E+04	1.415E+04	2.390E-15	9.400E-12	1.570E-10
La-142	9	4.550E+04	5.550E+03	1.440E-13	8.740E-12	6.840E-11
Ce-141	8	4.503E+04	2.808E+06	3.430E-15	2.550E-11	2.420E-09
Ce-143	8	4.450E+04	1.188E+05	1.290E-14	6.230E-12	9.160E-10
Ce-144	8	3.597E+04	2.456E+07	2.773E-15	2.920E-10	1.010E-07
Pr-143	9	4.316E+04	1.172E+06	2.100E-17	1.680E-18	2.190E-09
Nd-147	9	1.839E+04	9.487E+05	6.190E-15	1.820E-11	1.850E-09
Np-239	8	5.355E+05	2.035E+05	7.690E-15	7.620E-12	6.780E-10
Pu-238	8	1.525E+02	2.769E+09	4.880E-18	3.860E-10	7.790E-05
Pu-239	8	1.214E+01	7.594E+11	4.240E-18	3.750E-10	8.330E-05
Pu-240	8	1.298E+01	2.063E+11	4.750E-18	3.760E-10	8.330E-05
Pu-241	8	6.179E+03	4.544E+08	7.250E-20	9.150E-12	1.340E-06
Am-241	9	9.817E+00	1.364E+10	8.180E-16	1.600E-09	1.200E-04
Cm-242	9	2.089E+03	1.407E+07	5.690E-18	9.410E-10	4.670E-06
Cm-244	9	1.834E+02	5.715E+08	4.910E-18	1.010E-09	6.700E-05

Nuclide	Daughter	Fraction	Daughter	Fraction	Daughter	Fraction
Kr-85m	Kr-85	0.21	none	0.00	none	0.00
Kr-87	Rb-87	1.00	none	0.00	none	0.00
Kr-88	Rb-88	1.00	none	0.00	none	0.00
Sr-90	Y-90	1.00	none	0.00	none	0.00
Sr-91	Y-91m	0.58	Y-91	0.42	none	0.00
Sr-92	Y-92	1.00	none	0.00	none	0.00
Y-93	Zr-93	1.00	none	0.00	none	0.00
Zr-95	Nb-95m	0.01	Nb-95	0.99	none	0.00
Zr-97	Nb-97m	0.95	Nb-97	0.05	none	0.00
Mo-99	Tc-99m	0.88	Tc-99	0.12	none	0.00
Tc-99m	Tc-99	1.00	none	0.00	none	0.00
Ru-103	Rh-103m	1.00	none	0.00	none	0.00
Ru-105	Rh-105	1.00	none	0.00	none	0.00
Ru-106	Rh-106	1.00	none	0.00	none	0.00
Sb-127	Te-127m	0.18	Te-127	0.82	none	0.00
Sb-129	Te-129m	0.22	Te-129	0.77	none	0.00
Te-127m	Te-127	0.98	none	0.00	none	0.00
Te-129	I-129	1.00	none	0.00	none	0.00
Te-129m	Te-129	0.65	I-129	0.35	none	0.00
Te-131m	Te-131	0.22	I-131	0.78	none	0.00
Te-132	I-132	1.00	none	0.00	none	0.00
I-131	Xe-131m	0.01	none	0.00	none	0.00
I-133	Xe-133m	0.03	Xe-133	0.97	none	0.00
I-135	Xe-135m	0.15	Xe-135	0.85	none	0.00
Xe-135	Cs-135	1.00	none	0.00	none	0.00
Cs-137	Ba-137m	0.95	none	0.00	none	0.00
Ba-140	La-140	1.00	none	0.00	none	0.00
La-141	Ce-141	1.00	none	0.00	none	0.00
Ce-143	Pr-143	1.00	none	0.00	none	0.00
Ce-144	Pr-144m	0.02	Pr-144	0.98	none	0.00
Nd-147	Pm-147	1.00	none	0.00	none	0.00
Np-239	Pu-239	1.00	none	0.00	none	0.00
Pu-238	U-234	1.00	none	0.00	none	0.00
Pu-239	U-235	1.00	none	0.00	none	0.00
Pu-240	U-236	1.00	none	0.00	none	0.00
Pu-241	U-237	0.00	Am-241	1.00	none	0.00
Am-241	Np-237	1.00	none	0.00	none	0.00
Cm-242	Pu-238	1.00	none	0.00	none	0.00
Cm-244	Pu-240	1.00	none	0.00	none	0.00

Iodine fractions

Aerosol	=	9.5000E-01
Elemental	=	4.8500E-02
Organic	=	1.5000E-03

COMPARTMENT DATA

Compartment number 1: Containment

Sprays: Elemental Removal Data

Time (hr)	Removal Coef. (hr^-1)
0.0000E+00	3.8600E+00
2.0000E+00	1.8600E+00
3.8500E+00	0.0000E+00

Natural Deposition (Powers' model): Aerosol data
Reactor type: 3
Percentile = 10 (%)

Natural Deposition: Elemental Removal Data

Time (hr)	Removal Coef. (hr^-1)
0.0000E+00	0.0000E+00

Compartment number 2: Reactor Building

Compartment number 3: Environment

Compartment number 4: Control Room

Compartment Filter Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	1.4650E+04	0.0000E+00	0.0000E+00	0.0000E+00
3.3300E-01	1.4650E+04	0.0000E+00	0.0000E+00	0.0000E+00
4.0000E+00	1.4650E+04	0.0000E+00	6.6500E+01	6.6500E+01
7.2000E+02	1.4650E+04	0.0000E+00	0.0000E+00	0.0000E+00

PATHWAY DATA

Pathway number 1: ontainment to Reactor Building

Convection Data

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

Pathway number 2: eactor Building to Environment

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
2.5000E-01	1.0000E+00	9.8500E+01	9.8500E+01	9.8500E+01
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 3: Environment to Control Room Filtered Outside Air I

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	1.1000E+03	0.0000E+00	0.0000E+00	0.0000E+00
3.3300E-01	9.0000E+02	9.9000E+01	8.8440E+01	8.8440E+01
4.0000E+00	9.0000E+02	9.9000E+01	9.6130E+01	9.6130E+01
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 4: Environment to Control Room Filtered by Recirc Fil

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	2.4000E+03	0.0000E+00	0.0000E+00	0.0000E+00
3.3300E-01	2.4000E+03	0.0000E+00	0.0000E+00	0.0000E+00
4.0000E+00	2.4000E+03	0.0000E+00	6.6500E+01	6.6500E+01
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 5: Environment to Control Room Outside air Unfiltered

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	5.0000E+01	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 6: Control Room to Environment

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	3.5500E+03	1.0000E+02	1.0000E+02	1.0000E+02
3.3300E-01	3.3500E+03	1.0000E+02	1.0000E+02	1.0000E+02
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

LOCATION DATA

Location Exclusion Area Boundary is in compartment 3

Location X/Q Data

Time (hr)	X/Q (s * m^-3)
0.0000E+00	6.6300E-04
2.5000E-01	2.7400E-06
1.5000E+00	8.8000E-05
2.0000E+00	1.2900E-06
8.0000E+00	8.8300E-07
2.4000E+01	3.8900E-07
9.6000E+01	1.2000E-07
7.2000E+02	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
7.2000E+02	0.0000E+00

Location Low Population Zone is in compartment 3

Location X/Q Data

Time (hr)	X/Q (s * m^-3)
0.0000E+00	2.6500E-05
2.5000E-01	1.7700E-06
1.5000E+00	1.0500E-05
2.0000E+00	8.3400E-07
8.0000E+00	5.7200E-07
2.4000E+01	2.5300E-07
9.6000E+01	7.8100E-08
7.2000E+02	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
7.2000E+02	0.0000E+00

Location Control Room is in compartment 4

Location X/Q Data

Time (hr)	X/Q (s * m^-3)
0.0000E+00	6.8300E-04
2.5000E-01	1.1700E-05
1.5000E+00	1.1700E-05
2.0000E+00	1.0000E-36
8.0000E+00	1.0000E-36
2.4000E+01	7.1700E-08
9.6000E+01	2.2500E-08
7.2000E+02	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       0.0000E+00
```

```
########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on 10/31/2016  at 23:29:27
########################################################################




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


########################################################################
                                Dose Output
########################################################################

Exclusion Area Boundary Doses:

Time (h) =   0.2500    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.0815E-01  3.6434E+01  1.7549E+00
Accumulated dose (rem)  2.0815E-01  3.6434E+01  1.7549E+00

Low Population Zone Doses:

Time (h) =   0.2500    Whole Body   Thyroid       TEDE
Delta dose (rem)        8.3197E-03  1.4562E+00  7.0142E-02
Accumulated dose (rem)  8.3197E-03  1.4562E+00  7.0142E-02

Control Room Doses:

Time (h) =   0.2500    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.3075E-03  5.2339E+00  2.2341E-01
Accumulated dose (rem)  1.3075E-03  5.2339E+00  2.2341E-01

Exclusion Area Boundary Doses:

Time (h) =   0.3330    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.1995E-04  1.7914E-03  1.9611E-04
Accumulated dose (rem)  2.0827E-01  3.6435E+01  1.7551E+00

Low Population Zone Doses:

Time (h) =   0.3330    Whole Body   Thyroid       TEDE
Delta dose (rem)        7.7484E-05  1.1572E-03  1.2669E-04
Accumulated dose (rem)  8.3972E-03  1.4574E+00  7.0268E-02

Control Room Doses:

Time (h) =   0.3330    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.0996E-03  4.5624E+00  1.9481E-01
Accumulated dose (rem)  2.4071E-03  9.7964E+00  4.1821E-01

Exclusion Area Boundary Doses:

Time (h) =   0.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        3.3812E-04  4.9875E-03  5.5045E-04
Accumulated dose (rem)  2.0861E-01  3.6440E+01  1.7556E+00

Low Population Zone Doses:

Time (h) =   0.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.1842E-04  3.2219E-03  3.5558E-04
Accumulated dose (rem)  8.6156E-03  1.4606E+00  7.0624E-02

Control Room Doses:
```

```
Time (h) =   0.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.7182E-03  7.3862E+00  3.1533E-01
Accumulated dose (rem)  4.1253E-03  1.7183E+01  7.3354E-01

Exclusion Area Boundary Doses:

Time (h) =   1.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.4384E-02  9.2096E-02  1.9403E-02
Accumulated dose (rem)  2.2299E-01  3.6532E+01  1.7750E+00

Low Population Zone Doses:

Time (h) =   1.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        9.2921E-03  5.9493E-02  1.2534E-02
Accumulated dose (rem)  1.7908E-02  1.5201E+00  8.3158E-02

Control Room Doses:

Time (h) =   1.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        4.7817E-03  1.8296E+01  7.8326E-01
Accumulated dose (rem)  8.9070E-03  3.5479E+01  1.5168E+00

Exclusion Area Boundary Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        4.5967E-01  2.6849E+00  6.1542E-01
Accumulated dose (rem)  6.8267E-01  3.9217E+01  2.3904E+00

Low Population Zone Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        5.4848E-02  3.2036E-01  7.3431E-02
Accumulated dose (rem)  7.2755E-02  1.8405E+00  1.5659E-01

Control Room Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.9782E-03  2.4445E+00  1.0840E-01
Accumulated dose (rem)  1.0885E-02  3.7923E+01  1.6252E+00

Exclusion Area Boundary Doses:

Time (h) =   3.8500    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.2797E-02  7.5115E-02  2.7213E-02
Accumulated dose (rem)  7.0546E-01  3.9292E+01  2.4177E+00

Low Population Zone Doses:

Time (h) =   3.8500    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.4738E-02  4.8563E-02  1.7593E-02
Accumulated dose (rem)  8.7494E-02  1.8890E+00  1.7418E-01

Control Room Doses:

Time (h) =   3.8500    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.1778E-03  1.8222E+00  8.3312E-02
Accumulated dose (rem)  1.3063E-02  3.9745E+01  1.7085E+00

Exclusion Area Boundary Doses:

Time (h) =   4.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.4553E-03  1.8903E-03  1.5669E-03
Accumulated dose (rem)  7.0692E-01  3.9294E+01  2.4192E+00

Low Population Zone Doses:

Time (h) =   4.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        9.4089E-04  1.2221E-03  1.0130E-03
Accumulated dose (rem)  8.8435E-02  1.8903E+00  1.7520E-01
```

Control Room Doses:

Time (h) = 4.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.5719E-05	1.7770E-02	8.1004E-04
Accumulated dose (rem)	1.3079E-02	3.9763E+01	1.7093E+00

Exclusion Area Boundary Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.6310E-02	1.3396E-02	2.7089E-02
Accumulated dose (rem)	7.3323E-01	3.9308E+01	2.4463E+00

Low Population Zone Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.7010E-02	8.6608E-03	1.7514E-02
Accumulated dose (rem)	1.0544E-01	1.8989E+00	1.9271E-01

Control Room Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	4.7246E-05	5.8518E-02	2.6899E-03
Accumulated dose (rem)	1.3126E-02	3.9822E+01	1.7120E+00

Exclusion Area Boundary Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.1660E-02	1.3643E-03	2.1714E-02
Accumulated dose (rem)	7.5489E-01	3.9309E+01	2.4680E+00

Low Population Zone Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.4031E-02	8.8380E-04	1.4066E-02
Accumulated dose (rem)	1.1948E-01	1.8998E+00	2.0678E-01

Control Room Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.5044E-08	5.8560E-05	2.7108E-06
Accumulated dose (rem)	1.3126E-02	3.9822E+01	1.7120E+00

Exclusion Area Boundary Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.1011E-02	1.8287E-03	1.1067E-02
Accumulated dose (rem)	7.6590E-01	3.9311E+01	2.4791E+00

Low Population Zone Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	7.1614E-03	1.1894E-03	7.1978E-03
Accumulated dose (rem)	1.2664E-01	1.9010E+00	2.1397E-01

Control Room Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	5.2682E-05	2.0742E-05	5.3318E-05
Accumulated dose (rem)	1.3179E-02	3.9822E+01	1.7121E+00

Exclusion Area Boundary Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	5.3500E-03	1.4437E-03	5.3940E-03
Accumulated dose (rem)	7.7125E-01	3.9312E+01	2.4845E+00

Low Population Zone Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	3.4820E-03	9.3958E-04	3.5106E-03
Accumulated dose (rem)	1.3012E-01	1.9019E+00	2.1748E-01

Control Room Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.7859E-05	1.1241E-05	1.8201E-05
Accumulated dose (rem)	1.3197E-02	3.9822E+01	1.7121E+00

839

##
I-131 Summary
##

Time (hr)	Containment I-131 (Curies)	Reactor Building I-131 (Curies)	Environment I-131 (Curies)
0.000	5.3091E+03	6.0776E-04	6.7719E-06
0.250	2.1565E+06	1.4062E+01	1.0208E+02
0.333	2.7820E+06	1.8463E+01	1.0329E+02
0.500	3.9261E+06	2.6509E+01	1.0669E+02
0.800	7.7569E+06	5.2453E+01	1.1731E+02
1.100	1.1265E+07	7.6927E+01	1.3482E+02
1.400	1.4499E+07	9.9484E+01	1.5867E+02
1.500	1.5522E+07	1.0661E+02	1.6794E+02
1.800	1.8431E+07	1.2690E+02	1.9950E+02
2.000	2.0245E+07	1.3956E+02	2.2349E+02
2.300	1.4889E+07	1.0518E+02	2.5667E+02
2.600	1.0958E+07	7.7410E+01	2.8113E+02
2.900	8.0710E+06	5.7013E+01	2.9913E+02
3.200	5.9493E+06	4.2023E+01	3.1239E+02
3.500	4.3892E+06	3.1002E+01	3.2217E+02
3.800	3.2418E+06	2.2896E+01	3.2939E+02
3.850	3.0825E+06	2.1770E+01	3.3040E+02
4.000	2.6522E+06	1.8730E+01	3.3313E+02
4.300	1.9661E+06	1.3883E+01	3.3750E+02
4.600	1.4608E+06	1.0313E+01	3.4074E+02
4.900	1.0886E+06	7.6841E+00	3.4315E+02
5.200	8.7716E+05	6.1517E+00	3.4498E+02
5.500	7.3517E+05	5.1554E+00	3.4650E+02
5.800	6.1749E+05	4.3296E+00	3.4778E+02
6.100	5.1996E+05	3.6452E+00	3.4886E+02
6.400	4.3912E+05	3.0779E+00	3.4976E+02
6.700	3.7211E+05	2.6077E+00	3.5053E+02
7.000	3.1657E+05	2.2180E+00	3.5118E+02
7.300	2.7054E+05	1.8949E+00	3.5173E+02
7.600	2.3238E+05	1.6272E+00	3.5220E+02
7.900	2.0074E+05	1.4052E+00	3.5261E+02
8.000	1.9145E+05	1.3399E+00	3.5274E+02
8.300	1.6681E+05	1.1670E+00	3.5307E+02
8.600	1.4887E+05	1.0402E+00	3.5337E+02
8.900	1.3363E+05	9.3337E-01	3.5364E+02
9.200	1.2066E+05	8.4253E-01	3.5388E+02
9.500	1.0964E+05	7.6528E-01	3.5409E+02
9.800	1.0026E+05	6.9959E-01	3.5429E+02
10.100	9.2287E+04	6.4371E-01	3.5447E+02
10.400	8.5502E+04	5.9616E-01	3.5464E+02
24.000	4.4985E+04	3.1240E-01	3.5901E+02
96.000	3.3677E+04	2.3387E-01	3.7655E+02
720.000	2.7602E+03	1.9168E-02	4.2467E+02

Time (hr)	Control Room I-131 (Curies)
0.000	7.7472E-09
0.250	1.0157E-01
0.333	8.7369E-02
0.500	6.5644E-02
0.800	3.9350E-02
1.100	2.3707E-02
1.400	1.4426E-02
1.500	1.2267E-02
1.800	7.6694E-03
2.000	5.7184E-03

2.300	3.4178E-03
2.600	2.0427E-03
2.900	1.2209E-03
3.200	7.2970E-04
3.500	4.3612E-04
3.800	2.6066E-04
3.850	2.3923E-04
4.000	1.8495E-04
4.300	1.0735E-04
4.600	6.3734E-05
4.900	3.8035E-05
5.200	2.2725E-05
5.500	1.3581E-05
5.800	8.1170E-06
6.100	4.8513E-06
6.400	2.8995E-06
6.700	1.7330E-06
7.000	1.0358E-06
7.300	6.1905E-07
7.600	3.6999E-07
7.900	2.2114E-07
8.000	1.8627E-07
8.300	1.1133E-07
8.600	6.6540E-08
8.900	3.9769E-08
9.200	2.3769E-08
9.500	1.4206E-08
9.800	8.4908E-09
10.100	5.0748E-09
10.400	3.0331E-09
24.000	2.2304E-19
96.000	9.4620E-10
720.000	2.4336E-11

##
Cumulative Dose Summary
##

	Exclusion Area Bounda		Low Population Zone		Control Room	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.250	3.6434E+01	1.7549E+00	1.4562E+00	7.0142E-02	5.2339E+00	2.2341E-01
0.333	3.6435E+01	1.7551E+00	1.4574E+00	7.0268E-02	9.7964E+00	4.1821E-01
0.500	3.6440E+01	1.7556E+00	1.4606E+00	7.0624E-02	1.7183E+01	7.3354E-01
0.800	3.6456E+01	1.7582E+00	1.4708E+00	7.2324E-02	2.6130E+01	1.1156E+00
1.100	3.6483E+01	1.7638E+00	1.4879E+00	7.5900E-02	3.1485E+01	1.3446E+00
1.400	3.6519E+01	1.7718E+00	1.5111E+00	8.1101E-02	3.4713E+01	1.4835E+00
1.500	3.6532E+01	1.7750E+00	1.5201E+00	8.3158E-02	3.5479E+01	1.5168E+00
1.800	3.8059E+01	2.1247E+00	1.7022E+00	1.2489E-01	3.7162E+01	1.5908E+00
2.000	3.9217E+01	2.3904E+00	1.8405E+00	1.5659E-01	3.7923E+01	1.6252E+00
2.300	3.9241E+01	2.3962E+00	1.8556E+00	1.6034E-01	3.8691E+01	1.6604E+00
2.600	3.9258E+01	2.4013E+00	1.8668E+00	1.6364E-01	3.9149E+01	1.6813E+00
2.900	3.9271E+01	2.4059E+00	1.8749E+00	1.6659E-01	3.9422E+01	1.6937E+00
3.200	3.9280E+01	2.4100E+00	1.8809E+00	1.6924E-01	3.9584E+01	1.7011E+00
3.500	3.9287E+01	2.4137E+00	1.8853E+00	1.7164E-01	3.9681E+01	1.7056E+00
3.800	3.9292E+01	2.4171E+00	1.8886E+00	1.7384E-01	3.9738E+01	1.7082E+00
3.850	3.9292E+01	2.4177E+00	1.8890E+00	1.7418E-01	3.9745E+01	1.7085E+00
4.000	3.9294E+01	2.4192E+00	1.8903E+00	1.7520E-01	3.9763E+01	1.7093E+00
4.300	3.9297E+01	2.4222E+00	1.8922E+00	1.7711E-01	3.9787E+01	1.7104E+00
4.600	3.9300E+01	2.4249E+00	1.8937E+00	1.7888E-01	3.9801E+01	1.7111E+00
4.900	3.9301E+01	2.4275E+00	1.8947E+00	1.8052E-01	3.9809E+01	1.7114E+00
5.200	3.9303E+01	2.4298E+00	1.8955E+00	1.8206E-01	3.9814E+01	1.7117E+00
5.500	3.9304E+01	2.4321E+00	1.8962E+00	1.8350E-01	3.9817E+01	1.7118E+00
5.800	3.9304E+01	2.4342E+00	1.8968E+00	1.8485E-01	3.9819E+01	1.7119E+00
6.100	3.9305E+01	2.4361E+00	1.8972E+00	1.8613E-01	3.9820E+01	1.7119E+00
6.400	3.9306E+01	2.4380E+00	1.8976E+00	1.8733E-01	3.9821E+01	1.7120E+00
6.700	3.9306E+01	2.4397E+00	1.8980E+00	1.8846E-01	3.9821E+01	1.7120E+00
7.000	3.9307E+01	2.4414E+00	1.8982E+00	1.8953E-01	3.9821E+01	1.7120E+00
7.300	3.9307E+01	2.4430E+00	1.8985E+00	1.9055E-01	3.9821E+01	1.7120E+00
7.600	3.9307E+01	2.4444E+00	1.8987E+00	1.9151E-01	3.9822E+01	1.7120E+00

```
   7.900 3.9308E+01 2.4459E+00 1.8989E+00 1.9242E-01 3.9822E+01 1.7120E+00
   8.000 3.9308E+01 2.4463E+00 1.8989E+00 1.9271E-01 3.9822E+01 1.7120E+00
   8.300 3.9308E+01 2.4472E+00 1.8990E+00 1.9329E-01 3.9822E+01 1.7120E+00
   8.600 3.9308E+01 2.4481E+00 1.8990E+00 1.9384E-01 3.9822E+01 1.7120E+00
   8.900 3.9308E+01 2.4489E+00 1.8991E+00 1.9437E-01 3.9822E+01 1.7120E+00
   9.200 3.9308E+01 2.4496E+00 1.8991E+00 1.9487E-01 3.9822E+01 1.7120E+00
   9.500 3.9308E+01 2.4504E+00 1.8991E+00 1.9535E-01 3.9822E+01 1.7120E+00
   9.800 3.9308E+01 2.4511E+00 1.8991E+00 1.9581E-01 3.9822E+01 1.7120E+00
  10.100 3.9308E+01 2.4518E+00 1.8992E+00 1.9624E-01 3.9822E+01 1.7120E+00
  10.400 3.9308E+01 2.4524E+00 1.8992E+00 1.9666E-01 3.9822E+01 1.7120E+00
  24.000 3.9309E+01 2.4680E+00 1.8998E+00 2.0678E-01 3.9822E+01 1.7120E+00
  96.000 3.9311E+01 2.4791E+00 1.9010E+00 2.1397E-01 3.9822E+01 1.7121E+00
 720.000 3.9312E+01 2.4845E+00 1.9019E+00 2.1748E-01 3.9822E+01 1.7121E+00

########################################################################
                        Worst Two-Hour Doses
########################################################################

Exclusion Area Boundary
   Time    Whole Body    Thyroid        TEDE
   (hr)      (rem)        (rem)         (rem)
    0.0   6.8267E-01   3.9217E+01   2.3904E+00
```

LaSalle 2 Cycle 16 ECCS Leakage Pathway RADTRAD Output File

```
##########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on 11/01/2016  at 11:38:04
##########################################################################

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

Plant file           = H:\Dose Analysis\LaSalle\l2c16_ESF.psf
Inventory file       = H:\Dose Analysis\LaSalle\l2c16_esf.nif
Release file         = H:\Dose Analysis\bwr_dba.rft
Dose Conversion file = C:\Program Files (x86)\radtrad3.03\Defaults\Fgr11&12.inp



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


Radtrad 3.03 4/15/2001
LSCS LOCA ECCS Leak with 25% Makeup
Nuclide Inventory File:
H:\Dose Analysis\LaSalle\l2c16_esf.nif
Plant Power Level:
 3.5590E+03
Compartments:
  4
Compartment 1:
Suppression Pool
  3
 1.2880E+05
  0
  0
  0
  0
  0
Compartment 2:
Reactor Building
  3
 1.0000E+00
  0
  0
  0
  0
  0
Compartment 3:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Compartment 4:
Control Room
  1
 1.1740E+05
```

```
  0
  0
  1
  0
  0
Pathways:
  6
Pathway 1:
Suppression Pool to Reactor Building
  1
  2
  2
Pathway 2:
Reactor Building to Environment
  2
  3
  2
Pathway 3:
Environment to Control Room Filtered Outside Air Intake
  3
  4
  2
Pathway 4:
Environment to Control Room Filtered by Recirc Filter Only
  3
  4
  2
Pathway 5:
Environment to Control Room Outside air Unfiltered Before Supply Fan
  3
  4
  2
Pathway 6:
Control Room to Environment
  4
  3
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
C:\Program Files (x86)\radtrad3.03\Defaults\Fgr11&12.inp
H:\Dose Analysis\bwr_dba.rft
  0.0000E+00
  1
  0.0000E+00   9.7000E-01   3.0000E-02   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  4
Compartment 1:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 2:
  0
```

```
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 3:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 4:
  0
  1
  0
  0
  0
  0
  1
  1.4650E+04
  4
  0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  3.3300E-01   0.0000E+00   0.0000E+00   0.0000E+00
  4.0000E+00   0.0000E+00   6.6500E+01   6.6500E+01
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
Pathways:
  6
Pathway 1:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   6.6840E-01   0.0000E+00   9.0000E+01   9.0000E+01
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 2:
  0
  0
  0
  0
  0
  1
  3
  0.0000E+00   1.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  2.5000E-01   1.0000E+00   9.8500E+01   9.8500E+01   9.8500E+01
  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
  4
  0.0000E+00   1.1000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  3.3300E-01   9.0000E+02   9.9000E+01   8.8440E+01   8.8440E+01
  4.0000E+00   9.0000E+02   9.9000E+01   9.6130E+01   9.6130E+01
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 4:
  0
  0
  0
  0
  0
  1
  4
  0.0000E+00   2.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  3.3300E-01   2.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
  4.0000E+00   2.4000E+03   0.0000E+00   6.6500E+01   6.6500E+01
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 5:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   5.0000E+01   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 6:
  0
  0
  0
  0
  0
  1
  3
  0.0000E+00   3.5500E+03   1.0000E+02   1.0000E+02   1.0000E+02
  3.3300E-01   3.3500E+03   1.0000E+02   1.0000E+02   1.0000E+02
  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
```

```
  3
  1
  8
  0.0000E+00   6.6300E-04
  2.5000E-01   2.7400E-06
  1.5000E+00   8.8000E-05
  2.0000E+00   1.2900E-06
  8.0000E+00   8.8300E-07
  2.4000E+01   3.8900E-07
  9.6000E+01   1.2000E-07
  7.2000E+02   0.0000E+00
  1
  4
  0.0000E+00   3.5000E-04
  8.0000E+00   1.8000E-04
  2.4000E+01   2.3000E-04
  7.2000E+02   0.0000E+00
  0
Location 2:
Low Population Zone
  3
  1
  8
  0.0000E+00   2.6500E-05
  2.5000E-01   1.7700E-06
  1.5000E+00   1.0500E-05
  2.0000E+00   8.3400E-07
  8.0000E+00   5.7200E-07
  2.4000E+01   2.5300E-07
  9.6000E+01   7.8100E-08
  7.2000E+02   0.0000E+00
  1
  4
  0.0000E+00   3.5000E-04
  8.0000E+00   1.8000E-04
  2.4000E+01   2.3000E-04
  7.2000E+02   0.0000E+00
  0
Location 3:
Control Room
  4
  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
  8
  0.0000E+00   6.8300E-04
  2.5000E-01   1.1700E-05
  1.5000E+00   1.1700E-05
  2.0000E+00   1.0000E-36
  8.0000E+00   1.0000E-36
  2.4000E+01   7.1700E-08
  9.6000E+01   2.2500E-08
  7.2000E+02   0.0000E+00
Simulation Parameters:
  1
  0.0000E+00   0.0000E+00
Output Filename:
H:\Dose Analysis\LaSalle\l2c16_ESF.o0
  1
  1
  1
```

```
  0
  0
End of Scenario File

################################################################################
   RADTRAD Version 3.03 (Spring 2001) run on 11/01/2016  at 11:38:04
################################################################################

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

Number of Nuclides =  60

Inventory Power =   1.0000E+00 MWth
Plant Power Level =   3.5590E+03 MWth

Number of compartments    =   4

Compartment information

Compartment number  1  (Source term fraction =   1.0000E+00
)
Name: Suppression Pool
Compartment volume =   1.2880E+05 (Cubic feet)
Compartment type is Normal
Pathways into and out of compartment  1
   Exit Pathway Number    1: Suppression Pool to Reactor Building

Compartment number  2
Name: Reactor Building
Compartment volume =   1.0000E+00 (Cubic feet)
Compartment type is Normal
Pathways into and out of compartment  2
   Inlet Pathway Number   1: Suppression Pool to Reactor Building
   Exit Pathway Number    2: Reactor Building to Environment

Compartment number  3
Name: Environment
Compartment type is Environment
Pathways into and out of compartment  3
   Inlet Pathway Number   2: Reactor Building to Environment
   Inlet Pathway Number   6: Control Room to Environment
   Exit Pathway Number    3: Environment to Control Room Filtered Outside Air I
   Exit Pathway Number    4: Environment to Control Room Filtered by Recirc Fil
   Exit Pathway Number    5: Environment to Control Room Outside air Unfiltered

Compartment number  4
Name: Control Room
Compartment volume =   1.1740E+05 (Cubic feet)
Compartment type is Control Room
Removal devices within compartment:
     Filter(s)
Pathways into and out of compartment  4
   Inlet Pathway Number   3: Environment to Control Room Filtered Outside Air I
   Inlet Pathway Number   4: Environment to Control Room Filtered by Recirc Fil
   Inlet Pathway Number   5: Environment to Control Room Outside air Unfiltered
   Exit Pathway Number    6: Control Room to Environment

Total number of pathways =   6
```

```
##########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on 11/01/2016  at 11:38:04
##########################################################################

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

Radioactive Decay is enabled
Calculation of Daughters is enabled

Release Fractions and Timings
               GAP       EARLY IN-VESSEL  LATE RELEASE    RELEASE MASS
            0.500000 hr    1.5000 hrs      0.0000 hrs          (gm)
NOBLES       5.0000E-02     9.5000E-01      0.0000E+00        0.000E+00
IODINE       5.0000E-02     2.5000E-01      0.0000E+00        3.060E+02
CESIUM       5.0000E-02     2.0000E-01      0.0000E+00        0.000E+00
TELLURIUM    0.0000E+00     5.0000E-02      0.0000E+00        0.000E+00
STRONTIUM    0.0000E+00     2.0000E-02      0.0000E+00        0.000E+00
BARIUM       0.0000E+00     2.0000E-02      0.0000E+00        0.000E+00
RUTHENIUM    0.0000E+00     2.5000E-03      0.0000E+00        0.000E+00
CERIUM       0.0000E+00     5.0000E-04      0.0000E+00        0.000E+00
LANTHANUM    0.0000E+00     2.0000E-04      0.0000E+00        0.000E+00

Inventory Power =      3559. MWt

Nuclide  Group  Specific     half     Whole Body   Inhaled     Inhaled
 Name          Inventory     life        DCF       Thyroid    Effective
                (Ci/MWt)     (s)     (Sv-m3/Bq-s)  (Sv/Bq)     (Sv/Bq)
 I-131     2   2.686E+04  6.947E+05   1.820E-14   2.920E-07   8.890E-09
 I-132     2   3.885E+04  8.280E+03   1.120E-13   1.740E-09   1.030E-10
 I-133     2   5.559E+04  7.488E+04   2.940E-14   4.860E-08   1.580E-09
 I-134     2   6.168E+04  3.156E+03   1.300E-13   2.880E-10   3.550E-11
 I-135     2   5.191E+04  2.380E+04   8.294E-14   8.460E-09   3.320E-10

Nuclide    Daughter  Fraction   Daughter  Fraction   Daughter  Fraction
 I-131     Xe-131m    0.01       none       0.00       none       0.00

Iodine fractions
     Aerosol     =   0.0000E+00
     Elemental   =   9.7000E-01
     Organic     =   3.0000E-02

COMPARTMENT DATA

Compartment number   1: Suppression Pool

Compartment number   2: Reactor Building

Compartment number   3: Environment

Compartment number   4: Control Room

     Compartment Filter Data

      Time (hr)      Flow Rate          Filter Efficiencies (%)
                       (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    1.4650E+04   0.0000E+00   0.0000E+00   0.0000E+00
       3.3300E-01    1.4650E+04   0.0000E+00   0.0000E+00   0.0000E+00
       4.0000E+00    1.4650E+04   0.0000E+00   6.6500E+01   6.6500E+01
       7.2000E+02    1.4650E+04   0.0000E+00   0.0000E+00   0.0000E+00

PATHWAY DATA

Pathway number  1: Suppression Pool to Reactor Building

     Pathway Filter: Removal Data

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

```
       0.0000E+00    6.6840E-01   0.0000E+00   9.0000E+01   9.0000E+01
       7.2000E+02    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00

Pathway number  2: Reactor Building to Environment

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                        (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    1.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
       2.5000E-01    1.0000E+00   9.8500E+01   9.8500E+01   9.8500E+01
       7.2000E+02    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00

Pathway number  3: Environment to Control Room Filtered Outside Air I

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                        (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    1.1000E+03   0.0000E+00   0.0000E+00   0.0000E+00
       3.3300E-01    9.0000E+02   9.9000E+01   8.8440E+01   8.8440E+01
       4.0000E+00    9.0000E+02   9.9000E+01   9.6130E+01   9.6130E+01
       7.2000E+02    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00

Pathway number  4: Environment to Control Room Filtered by Recirc Fil

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                        (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    2.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
       3.3300E-01    2.4000E+03   0.0000E+00   0.0000E+00   0.0000E+00
       4.0000E+00    2.4000E+03   0.0000E+00   6.6500E+01   6.6500E+01
       7.2000E+02    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00

Pathway number  5: Environment to Control Room Outside air Unfiltered

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                        (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    5.0000E+01   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  6: Control Room to Environment

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                        (cfm)        Aerosol     Elemental    Organic
       0.0000E+00    3.5500E+03   1.0000E+02   1.0000E+02   1.0000E+02
       3.3300E-01    3.3500E+03   1.0000E+02   1.0000E+02   1.0000E+02
       7.2000E+02    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00

LOCATION DATA
     Location Exclusion Area Boundary     is in compartment   3

     Location X/Q Data
      Time (hr)         X/Q (s * m^-3)
       0.0000E+00          6.6300E-04
       2.5000E-01          2.7400E-06
       1.5000E+00          8.8000E-05
       2.0000E+00          1.2900E-06
       8.0000E+00          8.8300E-07
       2.4000E+01          3.8900E-07
       9.6000E+01          1.2000E-07
       7.2000E+02          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
        7.2000E+02                0.0000E+00
      Location Low Population Zone     is in compartment   3

      Location X/Q Data
       Time (hr)         X/Q (s * m^-3)
        0.0000E+00          2.6500E-05
        2.5000E-01          1.7700E-06
        1.5000E+00          1.0500E-05
        2.0000E+00          8.3400E-07
        8.0000E+00          5.7200E-07
        2.4000E+01          2.5300E-07
        9.6000E+01          7.8100E-08
        7.2000E+02          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
        7.2000E+02                0.0000E+00
      Location Control Room     is in compartment   4

      Location X/Q Data
       Time (hr)         X/Q (s * m^-3)
        0.0000E+00          6.8300E-04
        2.5000E-01          1.1700E-05
        1.5000E+00          1.1700E-05
        2.0000E+00          1.0000E-36
        8.0000E+00          1.0000E-36
        2.4000E+01          7.1700E-08
        9.6000E+01          2.2500E-08
        7.2000E+02          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       0.0000E+00
```

```
##########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on 11/01/2016  at 11:38:04
##########################################################################




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


##########################################################################
                                Dose Output
##########################################################################

Exclusion Area Boundary Doses:

Time (h) =   0.2500    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.3263E-02  2.8750E+00  1.0411E-01
Accumulated dose (rem)  1.3263E-02  2.8750E+00  1.0411E-01

Low Population Zone Doses:

Time (h) =   0.2500    Whole Body   Thyroid       TEDE
Delta dose (rem)        5.3011E-04  1.1491E-01  4.1612E-03
Accumulated dose (rem)  5.3011E-04  1.1491E-01  4.1612E-03

Control Room Doses:

Time (h) =   0.2500    Whole Body   Thyroid       TEDE
Delta dose (rem)        8.2485E-05  4.0795E-01  1.2972E-02
Accumulated dose (rem)  8.2485E-05  4.0795E-01  1.2972E-02

Exclusion Area Boundary Doses:

Time (h) =   0.3330    Whole Body   Thyroid       TEDE
Delta dose (rem)        6.5035E-07  1.4826E-04  5.3316E-06
Accumulated dose (rem)  1.3263E-02  2.8751E+00  1.0411E-01

Low Population Zone Doses:

Time (h) =   0.3330    Whole Body   Thyroid       TEDE
Delta dose (rem)        4.2012E-07  9.5771E-05  3.4441E-06
Accumulated dose (rem)  5.3053E-04  1.1501E-01  4.1646E-03

Control Room Doses:

Time (h) =   0.3330    Whole Body   Thyroid       TEDE
Delta dose (rem)        6.9766E-05  3.6081E-01  1.1462E-02
Accumulated dose (rem)  1.5225E-04  7.6876E-01  2.4434E-02

Exclusion Area Boundary Doses:

Time (h) =   0.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.8086E-06  4.3300E-04  1.5471E-05
Accumulated dose (rem)  1.3265E-02  2.8756E+00  1.0413E-01

Low Population Zone Doses:

Time (h) =   0.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.1683E-06  2.7971E-04  9.9940E-06
Accumulated dose (rem)  5.3170E-04  1.1529E-01  4.1746E-03

Control Room Doses:
```

```
Time (h) =   0.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.0789E-04  5.8413E-01  1.8540E-02
Accumulated dose (rem)  2.6014E-04  1.3529E+00  4.2974E-02

Exclusion Area Boundary Doses:

Time (h) =   1.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.7851E-05  8.3715E-03  2.9119E-04
Accumulated dose (rem)  1.3293E-02  2.8840E+00  1.0442E-01

Low Population Zone Doses:

Time (h) =   1.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.7992E-05  5.4079E-03  1.8811E-04
Accumulated dose (rem)  5.4969E-04  1.2070E-01  4.3627E-03

Control Room Doses:

Time (h) =   1.5000    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.2959E-04  1.4487E+00  4.5848E-02
Accumulated dose (rem)  4.8973E-04  2.8016E+00  8.8822E-02

Exclusion Area Boundary Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        7.1274E-04  2.6033E-01  8.8827E-03
Accumulated dose (rem)  1.4006E-02  3.1443E+00  1.1330E-01

Low Population Zone Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        8.5043E-05  3.1063E-02  1.0599E-03
Accumulated dose (rem)  6.3473E-04  1.5176E-01  5.4226E-03

Control Room Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.3976E-05  1.9649E-01  6.1911E-03
Accumulated dose (rem)  5.1371E-04  2.9981E+00  9.5013E-02

Exclusion Area Boundary Doses:

Time (h) =   4.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        3.7145E-05  1.7586E-02  5.8734E-04
Accumulated dose (rem)  1.4043E-02  3.1619E+00  1.1389E-01

Low Population Zone Doses:

Time (h) =   4.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.4015E-05  1.1369E-02  3.7972E-04
Accumulated dose (rem)  6.5875E-04  1.6313E-01  5.8023E-03

Control Room Doses:

Time (h) =   4.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.5317E-05  1.5030E-01  4.7227E-03
Accumulated dose (rem)  5.2902E-04  3.1484E+00  9.9736E-02

Exclusion Area Boundary Doses:

Time (h) =   8.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        4.7718E-05  3.3748E-02  1.0986E-03
Accumulated dose (rem)  1.4091E-02  3.1956E+00  1.1499E-01

Low Population Zone Doses:

Time (h) =   8.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        3.0850E-05  2.1819E-02  7.1025E-04
Accumulated dose (rem)  6.8960E-04  1.8495E-01  6.5126E-03
```

```
Control Room Doses:

Time (h) =   8.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        9.9696E-08  1.3086E-03  4.0950E-05
Accumulated dose (rem)  5.2912E-04  3.1497E+00  9.9777E-02

Exclusion Area Boundary Doses:

Time (h) =  24.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        6.3786E-05  4.2658E-02  1.3822E-03
Accumulated dose (rem)  1.4154E-02  3.2383E+00  1.1637E-01

Low Population Zone Doses:

Time (h) =  24.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        4.1320E-05  2.7634E-02  8.9541E-04
Accumulated dose (rem)  7.3092E-04  2.1258E-01  7.4080E-03

Control Room Doses:

Time (h) =  24.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.4923E-19  2.9583E-15  9.2037E-17
Accumulated dose (rem)  5.2912E-04  3.1497E+00  9.9777E-02

Exclusion Area Boundary Doses:

Time (h) =  96.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        3.7001E-05  7.9692E-02  2.4751E-03
Accumulated dose (rem)  1.4191E-02  3.3180E+00  1.1885E-01

Low Population Zone Doses:

Time (h) =  96.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.4065E-05  5.1830E-02  1.6097E-03
Accumulated dose (rem)  7.5498E-04  2.6441E-01  9.0177E-03

Control Room Doses:

Time (h) =  96.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.2064E-08  9.0261E-04  2.7625E-05
Accumulated dose (rem)  5.2914E-04  3.1506E+00  9.9804E-02

Exclusion Area Boundary Doses:

Time (h) = 720.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.7863E-05  6.4481E-02  1.9813E-03
Accumulated dose (rem)  1.4209E-02  3.3825E+00  1.2083E-01

Low Population Zone Doses:

Time (h) = 720.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.1626E-05  4.1966E-02  1.2895E-03
Accumulated dose (rem)  7.6661E-04  3.0638E-01  1.0307E-02

Control Room Doses:

Time (h) = 720.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        4.0312E-09  5.0202E-04  1.5291E-05
Accumulated dose (rem)  5.2914E-04  3.1511E+00  9.9820E-02

    838

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

             Suppression Pool      Reactor Building         Environment
Time (hr)    I-131 (Curies)         I-131 (Curies)       I-131 (Curies)
   0.000       5.3104E+03             4.5424E-05           5.0611E-07
   0.250       2.3875E+06             1.1564E+00           8.1372E+00
   0.333       3.1791E+06             1.5672E+00           8.2389E+00
```

0.500	4.7704E+06	2.3931E+00	8.5365E+00
0.800	9.5303E+06	4.8083E+00	9.5021E+00
1.100	1.4279E+07	7.2730E+00	1.1133E+01
1.400	1.9018E+07	9.7322E+00	1.3428E+01
1.500	2.0595E+07	1.0551E+01	1.4341E+01
1.800	2.5319E+07	1.3002E+01	1.7520E+01
2.000	2.8463E+07	1.4634E+01	2.0007E+01
2.300	2.8430E+07	1.4753E+01	2.3990E+01
2.600	2.8396E+07	1.4736E+01	2.7970E+01
2.900	2.8363E+07	1.4719E+01	3.1946E+01
3.200	2.8330E+07	1.4702E+01	3.5917E+01
3.500	2.8297E+07	1.4684E+01	3.9884E+01
3.800	2.8264E+07	1.4667E+01	4.3845E+01
4.000	2.8242E+07	1.4656E+01	4.6484E+01
4.300	2.8208E+07	1.4639E+01	5.0438E+01
4.600	2.8175E+07	1.4622E+01	5.4387E+01
4.900	2.8142E+07	1.4604E+01	5.8332E+01
5.200	2.8110E+07	1.4587E+01	6.2272E+01
5.500	2.8077E+07	1.4570E+01	6.6208E+01
5.800	2.8044E+07	1.4553E+01	7.0139E+01
6.100	2.8011E+07	1.4536E+01	7.4065E+01
6.400	2.7978E+07	1.4519E+01	7.7987E+01
6.700	2.7945E+07	1.4502E+01	8.1904E+01
7.000	2.7913E+07	1.4485E+01	8.5817E+01
7.300	2.7880E+07	1.4468E+01	8.9725E+01
7.600	2.7847E+07	1.4451E+01	9.3628E+01
7.900	2.7815E+07	1.4434E+01	9.7527E+01
8.000	2.7804E+07	1.4429E+01	9.8826E+01
8.300	2.7771E+07	1.4412E+01	1.0272E+02
8.600	2.7739E+07	1.4395E+01	1.0661E+02
8.900	2.7706E+07	1.4378E+01	1.1049E+02
9.200	2.7674E+07	1.4361E+01	1.1437E+02
9.500	2.7642E+07	1.4345E+01	1.1824E+02
9.800	2.7609E+07	1.4328E+01	1.2211E+02
10.100	2.7577E+07	1.4311E+01	1.2598E+02
10.400	2.7545E+07	1.4294E+01	1.2984E+02
24.000	2.6121E+07	1.3555E+01	2.9998E+02
96.000	1.9721E+07	1.0234E+01	1.0643E+03
720.000	1.7261E+06	8.9574E-01	3.2135E+03

Time (hr)	Control Room I-131 (Curies)
0.000	5.7900E-10
0.250	8.1146E-03
0.333	6.9800E-03
0.500	5.2448E-03
0.800	3.1456E-03
1.100	1.8984E-03
1.400	1.1602E-03
1.500	9.8915E-04
1.800	6.2656E-04
2.000	4.7436E-04
2.300	2.8351E-04
2.600	1.6945E-04
2.900	1.0128E-04
3.200	6.0530E-05
3.500	3.6177E-05
3.800	2.1622E-05
4.000	1.5342E-05
4.300	2.0589E-06
4.600	2.7631E-07
4.900	3.7082E-08
5.200	4.9765E-09
5.500	6.6785E-10
5.800	8.9627E-11
6.100	1.2028E-11
6.400	1.6142E-12
6.700	2.1663E-13
7.000	2.9072E-14
7.300	3.9016E-15
7.600	5.2360E-16

7.900	7.0268E-17
8.000	3.5976E-17
8.300	4.8280E-18
8.600	6.4793E-19
8.900	8.6954E-20
9.200	1.1669E-20
9.500	1.5661E-21
9.800	2.1017E-22
10.100	2.8205E-23
10.400	3.7852E-24
24.000	7.6486E-37
96.000	4.1404E-08
720.000	1.1372E-09

##
Cumulative Dose Summary
##

	Exclusion Area Bounda		Low Population Zone		Control Room	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.250	2.8750E+00	1.0411E-01	1.1491E-01	4.1612E-03	4.0795E-01	1.2972E-02
0.333	2.8751E+00	1.0411E-01	1.1501E-01	4.1646E-03	7.6876E-01	2.4434E-02
0.500	2.8756E+00	1.0413E-01	1.1529E-01	4.1746E-03	1.3529E+00	4.2974E-02
0.800	2.8770E+00	1.0418E-01	1.1619E-01	4.2066E-03	2.0607E+00	6.5404E-02
1.100	2.8793E+00	1.0426E-01	1.1772E-01	4.2598E-03	2.4845E+00	7.8811E-02
1.400	2.8826E+00	1.0438E-01	1.1985E-01	4.3336E-03	2.7407E+00	8.6898E-02
1.500	2.8840E+00	1.0442E-01	1.2070E-01	4.3627E-03	2.8016E+00	8.8822E-02
1.800	3.0302E+00	1.0942E-01	1.3815E-01	4.9597E-03	2.9364E+00	9.3069E-02
2.000	3.1443E+00	1.1330E-01	1.5176E-01	5.4226E-03	2.9981E+00	9.5013E-02
2.300	3.1470E+00	1.1339E-01	1.5349E-01	5.4810E-03	3.0609E+00	9.6987E-02
2.600	3.1496E+00	1.1348E-01	1.5520E-01	5.5389E-03	3.0983E+00	9.8162E-02
2.900	3.1523E+00	1.1357E-01	1.5692E-01	5.5962E-03	3.1205E+00	9.8861E-02
3.200	3.1549E+00	1.1366E-01	1.5862E-01	5.6530E-03	3.1338E+00	9.9277E-02
3.500	3.1575E+00	1.1375E-01	1.6032E-01	5.7094E-03	3.1417E+00	9.9525E-02
3.800	3.1601E+00	1.1383E-01	1.6201E-01	5.7653E-03	3.1464E+00	9.9672E-02
4.000	3.1619E+00	1.1389E-01	1.6313E-01	5.8023E-03	3.1484E+00	9.9736E-02
4.300	3.1645E+00	1.1398E-01	1.6481E-01	5.8576E-03	3.1496E+00	9.9771E-02
4.600	3.1670E+00	1.1406E-01	1.6648E-01	5.9125E-03	3.1497E+00	9.9776E-02
4.900	3.1696E+00	1.1415E-01	1.6814E-01	5.9670E-03	3.1497E+00	9.9777E-02
5.200	3.1722E+00	1.1423E-01	1.6980E-01	6.0212E-03	3.1497E+00	9.9777E-02
5.500	3.1747E+00	1.1431E-01	1.7145E-01	6.0751E-03	3.1497E+00	9.9777E-02
5.800	3.1773E+00	1.1440E-01	1.7309E-01	6.1286E-03	3.1497E+00	9.9777E-02
6.100	3.1798E+00	1.1448E-01	1.7473E-01	6.1819E-03	3.1497E+00	9.9777E-02
6.400	3.1823E+00	1.1456E-01	1.7636E-01	6.2348E-03	3.1497E+00	9.9777E-02
6.700	3.1848E+00	1.1464E-01	1.7798E-01	6.2875E-03	3.1497E+00	9.9777E-02
7.000	3.1873E+00	1.1472E-01	1.7960E-01	6.3399E-03	3.1497E+00	9.9777E-02
7.300	3.1898E+00	1.1480E-01	1.8121E-01	6.3920E-03	3.1497E+00	9.9777E-02
7.600	3.1923E+00	1.1488E-01	1.8282E-01	6.4438E-03	3.1497E+00	9.9777E-02
7.900	3.1948E+00	1.1496E-01	1.8442E-01	6.4954E-03	3.1497E+00	9.9777E-02
8.000	3.1956E+00	1.1499E-01	1.8495E-01	6.5126E-03	3.1497E+00	9.9777E-02
8.300	3.1965E+00	1.1502E-01	1.8551E-01	6.5313E-03	3.1497E+00	9.9777E-02
8.600	3.1974E+00	1.1505E-01	1.8607E-01	6.5499E-03	3.1497E+00	9.9777E-02
8.900	3.1982E+00	1.1508E-01	1.8663E-01	6.5684E-03	3.1497E+00	9.9777E-02
9.200	3.1991E+00	1.1510E-01	1.8718E-01	6.5868E-03	3.1497E+00	9.9777E-02
9.500	3.1999E+00	1.1513E-01	1.8773E-01	6.6051E-03	3.1497E+00	9.9777E-02
9.800	3.2008E+00	1.1516E-01	1.8829E-01	6.6233E-03	3.1497E+00	9.9777E-02
10.100	3.2016E+00	1.1519E-01	1.8884E-01	6.6414E-03	3.1497E+00	9.9777E-02
10.400	3.2025E+00	1.1522E-01	1.8938E-01	6.6594E-03	3.1497E+00	9.9777E-02
24.000	3.2383E+00	1.1637E-01	2.1258E-01	7.4080E-03	3.1497E+00	9.9777E-02
96.000	3.3180E+00	1.1885E-01	2.6441E-01	9.0177E-03	3.1506E+00	9.9804E-02
720.000	3.3825E+00	1.2083E-01	3.0638E-01	1.0307E-02	3.1511E+00	9.9820E-02

##
Worst Two-Hour Doses
##

Exclusion Area Boundary

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)

```
0.0   1.4006E-02   3.1443E+00   1.1330E-01
```