ATTACHMENT 2

Calculation DRE02-0037, "Re-analysis of Control Rod Drop Accident (CRDA) Using Alternative Source Terms," Revision 1

ATTACHMENT 1
Design Analysis Cover Sheet

Design Analysis (Major Revision)		**Last Page No.**[6] 18 / Att. F-2	
Analysis No.:[1]	DRE02-0037	**Revision:**[2]	1
Title:[3]	Re-analysis of Control Rod Drop Accident (CRDA) Using Alternative Source Terms		
EC/ECR No.:[4]	356383	**Revision:**[5]	0

Station(s):[7]	Dresden	**Component(s):**[14]	
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CONTROLLED DOCUMENT REFERENCES[15]

Document No.:	From/To	Document No.:	From/To
DRE04-0030, R1	From	DR-357-M-004, R0	From
DRE01-0028, R1	From	GE-NE-A22-00103-64-01, R0	From
DRE01-0071, R0	From		
DRE01-0040, R0	From		

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] DRE02-0037, Rev. 0 in its entirety.

Description of Revision (list affected pages for partials):[19]

This revision incorporates responses to pertinent NRC Request for Additional Information (RAIs) with respect to all Exelon Nuclear Station Alternative Source Term License Amendment Applications. The revisions are to remove any consideration of Mechanical Vacuum Pumps operation following a CRDA, based on their tripping closed at the initiation of a CRDA from a high radiation signal from the Main Steam Line Radiation Monitors, and to remove deposition credit for releases from the gland seal condenser. Revised X/Q values from a new calculation are also utilized. Finally, additional assumptions from Regulatory Guide 1.183 are included to directly indicate conformance with this Regulatory Guide.

	Print Name	Sign Name	Date
Preparer:[20]	Harold Rothstein	Harold Rothstein	8/12/05

Method of Review:[21] Detailed Review ☒ Alternate Calculations (attached) ☐ Testing ☐

	Print Name	Sign Name	Date
Reviewer:[22]	Paul Reichert	Paul Reichert	8/12/05

Review Notes:[23] Additional Independent review ☒ Peer review ☐
HUAAIRR Third Party reviews by: J. Johnson (S&L), W. McCurdy (MPR), A. Zarechnak (MPR)

(For External Analyses Only)

	Print Name	Sign Name	Date
External Approver:[24]	Harold Rothstein	Harold Rothstein	8/12/05
Exelon Reviewer:[25]	T. J. Mscisz	Tmscisz	8/13/05

Is a Supplemental Review Required?[26] Yes ☐ No ☒ If yes, complete Attachment 3
based on Third Party Review

	Print Name	Sign Name	Date
Exelon Approver:[27]	E. Flick	Elliott Flick	8/13/05

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1. PURPOSE/OBJECTIVE

The objective of this calculation is to re-analyze the radiological consequences of a Control Rod Drop Accident (CRDA) as described in UFSAR Section 15.4.10. The re-analysis is based on the use of Alternative Source Terms (AST) as defined in Regulatory Guide (RG) 1.183 (Ref. 2) Appendix C and with scenario guidance from NEDO-31400A (Ref. 19).

The design basis CRDA results in the release of radioactivity to the condenser. For the case where the condenser is isolated from the reactor after release of activity to the condenser (Scenario 1 of Ref. 19), the isolated condenser is assumed to exhaust at a rate of 1% per day, per Ref. 2, Appendix C.

However, per Ref. 2, Appendix C, footnote 2, forced flow pathways from the condenser must also be considered, such as un-isolated mechanical vacuum pumps or unprocessed air ejectors. These are evaluated as follows:

> For Case 1 as per UFSAR Section 15.4.10.5, the main condenser mechanical vacuum pump is isolated following initiation of CRDA on Main Steam Line Radiation Monitors (MSLRM) high radiation signals. Therefore this path is not considered further. This is in accordance with the traditional CRDA scenarios and bounding accident considerations as defined in NEDO-31400A (Ref. 19).
>
> For Case 2, where the condenser is not isolated from the reactor and the steam flow is sufficient for Steam Jet Air Ejector (SJAE) operation, the SJAE exhaust is processed by the charcoal delay beds in the Augmented Off-Gas System. While Ref. 2 does not require further analysis of this scenario, it is evaluated in this calculation as defined in Ref. 19, Scenario 2. The augmented off-gas system provides SJAE flow processing through charcoal delay beds which would eliminate iodine releases and greatly delay noble gas releases allowing for decay even with normal off-gas flow rates.

Finally, releases via steam flow to the turbine gland sealing system are considered, as has been done historically for this event, with all iodine and noble gases entering the gland seal condenser from the turbine seals released to the environment effectively immediately (well within $^1/_2$ hour), without credit for any fission product deposition in the gland seal condenser.

2. METHODOLOGY AND ACCEPTANCE CRITERIA

2.1. General Description

In 1996 the Dresden Nuclear Station demonstrated that removal of the automatic MSIV isolation action following an MSLRM detection of high radiation was within regulatory practices. Exelon letter RS-01-183 (Ref. 13) indicated the acceptability of this for Extended Power Uprate (EPU) conditions. Now a CRDA, an event that would cause such radiation levels, will not lead to MSIV closure, and therefore cannot be credited in this analysis. However, as per the Dresden UFSAR Section 15.4.10.5 on Radiological Consequences of a CRDA, the main condenser's mechanical vacuum pump is isolated following the initiation of the CRDA, as the vacuum pump trips on MSLRM high radiation signals were not removed.

Following a CRDA, radioisotopes postulated to be released will be transported through the Main Steam Lines (MSLs) directly to the main steam condenser. With tripping of the MVPs by the MSLRMs, the release will be from condenser leakage (assumed at 1% per day) and Gland Sealing

Steam system leakage. The Gland Sealing Steam leakage is assumed, as historically done (per the analysis in References 11 and 12) and documented in the UFSAR, with the fraction of activity released from reactor coolant and transferred to the gland seal condenser as 0.0015. The activity is postulated to leak from the Turbine Building to the environment as an unfiltered ground release, corresponding to the MSIV leakage path used in the current AST LOCA calculations, with worst case X/Qs derived in Reference 8. The doses from either accident scenario should not exceed the acceptance criteria of the applicable regulatory guidance (Ref. 2).

A third scenario is for a CRDA assumed to occur during SJAE operation. In this Scenario, activity is released to a system of Charcoal Delay Beds, where Iodines and particulate are effectively removed and only delayed release of noble gas nuclides occurs. Although this release pathway (like the gland seal release) would be through the Station Chimney, for conservatism as was done for UFSAR Section 15.4.10.5, the release pathway is treated as a ground level release with higher X/Qs.

2.2. Core Source Term

For conservatism, the CRDA core source terms are those associated with 102% power, and for a reactor trip followed by an immediate restart. These source terms are per Reference 15.

2.3. Fuel Damage Assessment

The current design basis for fuel damage from a CRDA is not impacted by application of AST and is, therefore, unchanged. The fuel damage (number of rods with failed cladding and fuel melting) assumptions correspond to those of the Dresden UFSAR and the Extended Power Uprate described in the calculation of Reference 12.

2.4. Radioactivity Transport

Release fractions and transport fractions are per RG 1.183, Appendix C and Table 3, as shown in the spreadsheet in Attachment A to this calculation for both the main condenser and the gland seal condenser (where credit for fission product deposition is not taken).

2.5. Release Pathways

2.5.1. Turbine /Condenser 1% / day Leakage

Releases from the Turbine/Condenser are assumed to be at ground level without credit for dilution or holdup in the Turbine Building.

2.5.2. Steam Jet Air Ejector Discharge

When in operation the Steam Jet Air Ejectors discharge to the augmented off-gas system. This pathway is assessed in Attachment E, through the use of a spreadsheet crediting elimination of Iodine releases and a delay of noble gas releases by the augmented off-gas system charcoal delay beds, per UFSAR Section 11.3.2.1.2.10. Although the releases would be through the Station Chimney, for conservatism they are assumed to be at ground level.

2.5.3. Gland Seal Condenser Release

For the Turbine Gland Seal Condenser release path, as per the analysis in References 11 and 12, the fraction of activity released from reactor coolant that is transferred to the gland seal condenser is 0.0015. Although the releases would be through the Station Chimney, for conservatism they are assumed to be at ground level through the MSIV leakage path used in the current AST LOCA calculations.

2.6. Dose Conversion Factors

The revised Dose Conversion Factors (DCFs) from the U.S. Federal Guidance Report 11&12 (Ref. 17,18) are used for this analysis. The RADTRAD code inputs these values directly from its internal database, and when used in spreadsheet analyses they are input directly.

2.7. Control Room Dose Model

For the analysis performed by the RADTRAD code, the Dresden Unit 2&3 Control Room is modeled as a closed volume of 64,000 ft^3. Although normal maximum flow into the CR is 2000 cfm + 10%, a Control Room changeover rate of 1 CR Volume per minute is used for conservatism and to allow for any unfiltered inleakage Flow into the CR is therefore assumed to be 64,000 CFM, and to balance the system for analytical purposes, an equal flow of clean air is considered to leave the CR. No credit is taking for any filtration of flows into the CR.

The CR $^{\chi}/_{Q}$'s have been determined in Reference 8. Worst-case ground level releases through the MSIV leakage path used in the current AST LOCA calculations are assumed. Having determined these dispersion factors, the total dose is modeled in RADTRAD 3.03 to determine the CR total dose throughout the duration of the accident. The methodologies significant to this analysis are the dose consequence analysis in NUREG/CR 6604 Section 2.3 (Ref. 5) and the Radioactive Decay Calculations, Section 2.4.3 (Ref. 5).

2.8. EAB and LPZ Dose Model

The EAB and LPZ $^{\chi}/_{Q}$'s have been determined in Reference 8. Worst-case ground level releases through the MSIV leakage path used in the current AST LOCA calculations are assumed. The EAB and LPZ are located 800m and 8000m from the postulated release points. Because of the distance of these locations from the plant, the release is simplified to be all from one point for the duration of the accident. Having determined these dispersion factors, the total dose is modeled in RADTRAD 3.03 using the same RADTRAD analysis as used in determining the CR total dose.

2.9. Acceptance Criteria

Radiological doses resulting from a design basis CRDA for the control room operator and a person located at EAB or LPZ are to be less than the regulatory dose limits as given in Table 2.1.

Table 2.1. Regulatory Dose Limits

Dose Type	Control Room (rem)	EAB and LPZ (rem)
TEDE Dose	5[a]	6.25[b]

Notes:
[a] 10 CFR 50.67 (Ref. 10)
[b] SRP 15.0.1 (Ref. 4), Reg. Guide 1.183 (Ref. 2)

Direct conformance with the relevant sections of the body of Regulatory Guide 1.183 (such as the Acceptance Criteria provided above) and all of the Assumptions in its Appendix C "Assumptions for Evaluating the Radiological Consequences of a BWR Rod Drop Accident" is provided by this analysis, as shown in the Conformance Matrix Table 2.2.

Table 2.2: Conformance with RG 1.183 Appendix C (Control Rod Drop Accident)			
RG Section	**RG Position**	**Dresden/Quad Cities Analysis**	**Comments**
1	Assumptions acceptable to the NRC staff regarding core inventory are provided in Regulatory Position 3 of this guide. For the rod drop accident, the release from the breached fuel is based on the estimate of the number of fuel rods breached and the assumption that 10% of the core inventory of the noble gases and iodines is in the fuel gap. The release attributed to fuel melting is based on the fraction of the fuel that reaches or exceeds the initiation temperature for fuel melting and on the assumption that 100% of the noble gases and 50% of the iodines contained in that fraction are released to the reactor coolant.	Conforms	100% of the noble gases and 50% of the iodines released from melted fuel. Other releases also based on Regulatory Position 3.
2	If no or minimal fuel damage is postulated for the limiting event, the released activity should be the maximum coolant activity (typically 4 μCi/gm DE I-131) allowed by the technical specifications.	Conforms	Fuel damage is postulated. Therefore, coolant activity is neglected.
3.1	The activity released from the fuel from either the gap or from fuel pellets is assumed to be instantaneously mixed in the reactor coolant within the pressure vessel.	Conforms	
3.2	Credit should not be assumed for partitioning in the pressure vessel or for removal by the steam separators.	Conforms	
3.3	Of the activity released from the reactor coolant within the pressure vessel, 100% of the noble gases, 10% of the iodine, and 1% of the remaining radionuclides are assumed to reach the turbine and condensers.	Conforms	
3.4	Of the activity that reaches the turbine and condenser, 100% of the noble gases, 10% of the iodine, and 1% of the particulate radionuclides are available for release to the environment. The turbine and condensers leak to the atmosphere as a ground- level release at a rate of 1% per day for a period of 24 hours, at which time the leakage is assumed to terminate. No credit should be assumed for dilution or holdup within the turbine building. Radioactive decay during holdup in the turbine and condenser may be assumed.	Conforms	Release rate of 1% per day for 24 hours. Decay is assumed in the condenser.
3.5	In lieu of the transport assumptions provided in paragraphs 3.2 through	Conforms	Paragraphs 3.2 through 3.4

Table 2.2: Conformance with RG 1.183 Appendix C (Control Rod Drop Accident)			
RG Section	**RG Position**	**Dresden/Quad Cities Analysis**	**Comments**
	3.4 above, a more mechanistic analysis may be used on a case-by-case basis. Such analyses account for the quantity of contaminated steam carried from the pressure vessel to the turbine and condensers based on a review of the minimum transport time from the pressure vessel to the first main steam isolation (MSIV) and considers MSIV closure time.		above are utilized
3.6	The iodine species released from the reactor coolant within the pressure vessel should be assumed to be 95% CsI as an aerosol, 4.85% elemental, and 0.15% organic. The release from the turbine and condenser should be assumed to be 97% elemental and 3% organic.	Conforms	
Foot-note 1	The activity assumed in the analysis should be based on the activity associated with the projected fuel damage or the maximum technical specification values, whichever maximizes the radiological consequences. In determining the dose equivalent I-131 (DE I-131), only the radioiodine associated with normal operations or iodine spikes should be included. Activity from projected fuel damage should not be included.	Conforms	Projected fuel damage is the limiting case.
Foot-note 2	If there are forced flow paths from the turbine or condenser, such as unisolated motor vacuum pumps or unprocessed air ejectors, the leakage rate should be assumed to be the flow rate associated with the most limiting of these paths. Credit for collection and processing of releases, such as by off gas or standby gas treatment, will be considered on a case-by-case basis.	Conforms	Forced flow paths are considered and the most limiting path is determined.

3. ASSUMPTIONS

1. Core inventory was based on a power level of 102% to account for uncertainty in the core power level.
2. An average power peaking factor of 1.7 per pin was assumed, as per Reference 14 (more conservative than UFSAR value of 1.5). 10% of the core inventory of noble gases and iodines are released from the fuel gap (Appendix C of Ref. 2). Release fractions of other nuclide groups contained in the fuel gap are detailed in Table 3 of Reg. Guide 1.183 (Ref. 2).
3. 0.77% of the fuel will melt during the CRDA (Ref. 19 and UFSAR Section 15.4.10.5). 100% of noble gases and 50% of the iodines contained in the melted fuel fraction are assumed to be released to the reactor coolant (Appendix C of Ref. 2). Fractions of other nuclides released from the melted fuel are used from Table 1 of Reg. Guide 1.183 (Ref. 2). Though these are described as LOCA values for fuel melt release, they are used to conservatively supplement for missing guidance in regards to the other nuclide groups.
4. The activity released from the fuel from either the gap or from fuel pellets is assumed to be instantaneously mixed with the reactor coolant within the pressure vessel (Ref. 2, 4).
5. 100% of all noble gases, 10% of the iodines, and 1% of remaining nuclides are transported to the turbine/condenser (Ref. 2, 4).
6. Of the activity that reaches the turbine and condenser, 100% of the noble gases, 10% of the iodine, and 1% of the particulate nuclides are available for release to the environment. (Appendix C of Ref. 2). However, for the gland seal condenser, it is assumed due to the forced flow pathway for releases that 100% of all of the activity that reaches this condenser are available for release to the environment.
7. All leakage from the main steam turbine condenser leaks to the atmosphere as a ground level release at a rate of 1% per day through the worst case LOCA MSIV release points, for a period of 24 hours (Ref. 2, 4).
8. The control room occupancy factor was assumed to be 1 because the duration of this analysis of the CRDA is 24 hours. Therefore the occupancy factor is essentially ignored.

4. DESIGN INPUT

4.1. $\chi/_Q$ Calculations (Meteorology)

The CR $\chi/_Q$ values input to RADTRAD were taken from ARCON96 results of Exelon (ComEd) Design Calculation DRE04-0030, Rev. 1. The $\chi/_Q$ calculated by ARCON96 for the worst-case MSIV release point to the Control Room fresh air intake is used for the 1% per day condenser leakage.

The CR atmospheric relative concentrations used are as follows (Ref. 8):

$\chi/_Q$ =1.30E-03 sec/m^3 (0-2 hours)
$\chi/_Q$ =1.06E-03 sec/m^3 (2-8 hours)
$\chi/_Q$ =4.49E-04 sec/m^3 (8-24 hours)

The EAB and LPZ $\chi/_Q$ values input to RADTRAD were taken from PAVAN results of Exelon (ComEd) Design Calculation DRE04-0030, Rev. 1. They reflect the worst-case $\chi/_Q$ which are the MSIV release pathway values at ground-level. The EAB/LPZ atmospheric relative concentrations used are as follows (Ref. 8):

EAB	$\chi/_Q$ =2.51E-04 sec/m^3 (0-2 hours)
LPZ	$\chi/_Q$ =2.63E-05 sec/m^3 (0-2 hours)
	$\chi/_Q$ =1.09E-05 sec/m^3 (2-8 hours)
	$\chi/_Q$ =7.02E-06 sec/m^3 (8-24 hours)

4.2. Plant Data

- Power Level, (102% of 2957 to account for uncertainty) (Ref. 12) — 3016 MWt
- Radial Peaking Factor (Ref. 14) — 1.7
- Number of Failed Fuel Rods, bounding case (Ref. 7 and UFSAR Section 15.4.10.5, for bounding 7 x 7 fuel array) — 850
- Isotopic Release Fractions, as per Reg. Guide 1.183 (Ref. 2) — See Attachment A
- Volume of primary system (MSL and dome) (Conservatively reduced from 8,431 ft^3) (Ref. 11) — 5,000 ft^3
- Vapor space volume of the condenser (UFSAR 15.4.10.5) (Ref. 3) — 55,000 ft^3
- Gland Seal Condenser Release Fraction (Ref. 11) — .0015

4.3. *Control Room Data*

- Volume of Control Room Emergency Zone, ft^3 (Ref. 3, 7) 81,000
- Volume of Control Room Proper, ft^3 (Ref. 3, 7) 64,000
- Control Room Normal Intake Flow, scfm 64,000

(Smaller Control Room volume is used, as the flow rate maximizes inhalation doses, and for interior cloud doses, the appropriate volume is the control room proper).

4.4. *Source Terms*

The AST values used in this analysis were derived using guidance outlined in Reg. Guide 1.183. A list of 60 core isotopic nuclides and their curie per megawatt activities were extracted from Appendix D of the GE task report No. GE-NE-A22-00103-64-01 (Ref. 15) for input into the RADTRAD "NIF" (see Attachment C). The release fractions associated with all of these nuclide groups, as detailed in Reg. Guide 1.183, were applied to their given groups in Attachment A, and subsequently input into the appropriate RADTRAD "RTF", as seen in Attachment D. RADTRAD uses these files combined with the power of 3016 MWt (102% power, to account for uncertainty) to develop the source terms for this CRDA.

5. REFERENCES

1. NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants", February 1995
2. USNRC Regulatory Guide 1.183, "Alternative Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors", July 2000
3. Dresden Unit 2 & 3 UFSAR, Rev. 4.
4. USNRC SRP 15.0.1; Rev. 0, Radiological Consequences Using Alternate Source Terms.
5. NUREG/CR-6604, "RADTRAD: A Simplified Model for RADionuclide Transport and Removal And Dose Estimation", April1998, and Supplement 1, June 1999.
6. TID 14844 , "Calculation of Distance Factors for Power and Test Reactor Sites", March, 1962.
7. Exelon (ComEd) Design Analysis DRE00-0028, Analytic Limit for MSLRM Reading Following a CRDA, Rev. 1.
8. Exelon (ComEd) Design Analysis DRE04-0030, Atmospheric Dispersion Factors (X/Qs) for Accident Release, Rev. 1.
9. Deleted
10. 10 CFR 50.67
11. Bechtel Power Corporation Design Calculation DR-357-M-004, "Control Rod Drop Accident/ MSLRM Removal", Rev. 0.
12. Exelon (ComEd) Design Analysis DRE00-0071, "Impact of Extended Power Uprate on Site Boundary and Control Room Doses for LOCA and Non-LOCA Events", Rev. 0.
13. Exelon Letter RS-01-183 to the USNRC, "Additional Radiation Dose Information Supporting the License Amendment Request to Permit Uprated Power Operation", Aug. 31, 2001.
14. NEDC-32868P, GE14 GESTAR Compliance Document
15. GE Task Report No. GE-NE-A22-00103-64-01, Rev. 0, Project Task Report: "Dresden and Quad Cities Asset Enhancement Program - Task T0802: Radiation Sources and Fission Products", August 2000.
16. Deleted
17. U.S. Federal Guidance Report No.11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion", 1988.
18. U.S. Federal Guidance Report No.12, "External Exposure to Radionuclides in Air, Water, and Soil", 1993.
19. NEDO-31400A Class I, "Safety Evaluation for Eliminating the BWR MSIV Closure Function and Scram Function of the MSLRM", October 1992

6. CALCULATIONS

6.1. Source Term Calculation

The source terms are calculated by RADTRAD, using input values of core activity (as a function of power), nuclide release fractions, and core power. For this analysis, a list of 60 core isotopic nuclides and their curie per megawatt activities were extracted from Appendix D of the GE task report No. GE-NE-A22-00103-64-01 (Ref. 15) for input into the RADTRAD "NIF" (see Attachment C). The AST release fractions associated with all of these nuclide groups are derived using guidance outlined in Reg. Guide 1.183, as applied in Attachment A. The final gap release and fuel melt release fraction calculated in that attachment, for each nuclide group, is then input into the appropriate RADTRAD "RTF", as seen in Attachment D. RADTRAD applies the input core power of 3016 MWt (102% power, to account for uncertainty) (Ref. 12) to these two input files to develop the core source term activities for this CRDA. Radioactive decay and daughter products are considered in RADTRAD, with this RADTRAD option turned "on".

6.2. Dose Calculations

The RADTRAD v. 3.03 computer code is used to determine Dresden 2&3 CRDA doses at the three dose points cited in Reg. Guide 1.183 (Ref. 2); the Exclusion Area Boundary (EAB), Low Population Zone (LPZ), and Control Room. 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.

RADTRAD estimates the releases using the Reference 2 Alternate Source Term source terms and assumptions. The RADTRAD code uses a combination of tables and/or numerical models of source term reduction phenomena to determine the time-dependent dose at user-specified locations for a given accident scenario. The code system also provides the inventory, decay chain, and dose conversion factor tables needed for the dose calculation. The technical basis for the RADTRAD code is documented in Section 2 of NUREG/CR-6604 (Ref. 5).

Separate RADTRAD runs are made for the main condenser and the gland seal condenser leakages. This output is provided in Attachment B. The following is a parameter and descriptions listing of input into the RADTRAD models:

A. Compartments

1. Reactor Coolant – This compartment represents the cooling water within the primary containment vessel.
   a. Compartment type – Other – since it is not the environment or control room.
   b. Volume – 1 ft^3 – This nominal value, used to simplify input, is based on there being a fractional leak rate associated with this compartment.
   c. Source term fraction – 1.0 – All of the source term is generated in the reactor coolant.
   d. Compartment features – none selected.

2. Condenser – This compartment is the internal volume of the steam condenser.
   a. Compartment type – Other – since it is not the environment or control room.
   b. Volume – 55,000 ft^3 – actual free volume.
   c. Source term fraction – 0.0
   d. Compartment features – none selected.

3. Environment
   a. Compartment type – Environment

4. Control Room
   a. Compartment type – Control Room
   b. Volume – 64,000 ft^3 – Proper volume.
   c. Source term fraction – 0.0
   d. Compartment features – none selected.

B. Transfer Pathways – Main Condenser

1. Filtered Flow, Reactor Coolant to Condenser
   a. From Compartment 1 – Reactor Coolant
   b. To Compartment 2 – Condenser
   c. Transfer mechanism – "Filter" selected
   d. Filter Efficiency Panel – Flow rate – 275 cfm – With the Reactor Coolant volume set to the nominal value of 1 ft^3, this flow rate transfers 99% of the intended activity to the Condenser within 1 second.
   e. Filter Efficiency Panel – Filter efficiency is 0.0%, as no filtration is considered for this accident analysis.
   f. Active Pathway – Yes

2. Filtered Flow, Condenser to Environment
   a. From Compartment 2 – Condenser
   b. To Compartment 3 – Environment
   c. Transfer mechanism – "Filter" selected –
   d. Filter Efficiency Panel – Flow rate – 0.3819 cfm for 0.0-24 hrs – This indicates the activity leaks from the Main Condenser at a rate of 1% per day for the duration of the accident.
   e. Filter Efficiency Panel – Filter efficiency is 0.0%, as no filtration is considered for this accident analysis.
   f. Active Pathway – Yes

3. Filtered Flow, Environment to Control Room
   a. From Compartment 3 – Environment
   b. To Compartment 4 – Control Room
   c. Transfer mechanism – "Filter" selected –
   d. Filter Efficiency Panel – Flow rate – 64,000 cfm – Artificially high CR intake flowrate of one air change per minute, to conservatively allow for any unfiltered inleakage, for the duration of the accident.
   e. Filter Efficiency Panel – Filter efficiency is 0.0%, as no filtration is considered for this accident analysis.
   f. Active Pathway – Yes

4. Filtered Flow, Control Room to Environment
   a. From Compartment 4 – Control Room
   b. To Compartment 3 – Environment
   c. Transfer mechanism – "Filter" selected –
   d. Filter Efficiency Panel – Flow rate – 64,000 cfm – for the duration of the accident.

e. Filter Efficiency Panel – Filter efficiency is entered as 100.0% iodine chemical for all time periods. This is the exit from the control room to the environment; the filtration prevents a double counting of the iodine release.
f. Active Pathway – Yes

C. Transfer Pathways – Gland Seal Condenser

5. Filtered Flow, Reactor Coolant to Condenser
   a From Compartment 1 – Reactor Coolant
   b To Compartment 2 – Condenser
   c Transfer mechanism – "Filter" selected
   d Filter Efficiency Panel – Flow rate – 275 cfm – With the Reactor Coolant volume set to the nominal value of 1 ft^3, this flow rate transfers 99% of the intended activity to the Condenser within 1 second.
   e Filter Efficiency Panel – Filter efficiency is 0.0%, as no filtration is considered for this accident analysis.
   f Active Pathway – Yes

6. Filtered Flow, Environment to Control Room
   a From Compartment 3 – Environment
   b To Compartment 4 – Control Room
   c Transfer mechanism – "Filter" selected –
   d Filter Efficiency Panel – Flow rate – 64,000 cfm – Artificially high CR intake flowrate of one air change per minute, to conservatively allow for any unfiltered inleakage, for the duration of the accident.
   e Filter Efficiency Panel – Filter efficiency is 0.0%, as no filtration is considered for this accident analysis.
   f Active Pathway – Yes

7. Filtered Flow, Control Room to Environment
   a From Compartment 4 – Control Room
   b To Compartment 3 – Environment
   c Transfer mechanism – "Filter" selected –
   d Filter Efficiency Panel – Flow rate – 64,000 cfm – for the duration of the accident.
   e Filter Efficiency Panel – Filter efficiency is entered as 100.0% iodine chemical for all time periods. This is the exit from the control room to the environment; the filtration prevents a double counting of the iodine release.
   f Active Pathway – Yes

8. Filtered Flow, Reactor Coolant to Environment
   a. From Compartment 1 – Reactor Coolant
   b. To Compartment 3 – Environment – Through Gland Seal system
   c. Transfer Mechanism – "Filter" selected
   d. Filter Efficiency Panel – Flow Rate 0.4125 cfm – 0.15% of the 275 cfm nominal value is chosen as the rate to evacuate activity from the coolant to the gland seal steam condenser, as described on sheet 13 of Reference 11.
   e. Filter Efficiency Panel – Filter efficiency is 0.0%, as no filtration is considered for this release path.
   f. Active Pathway – Yes

D. Dose Locations

1. Exclusion Area Boundary
   a. In Compartment 3 – Environment
   b. Breathing Rate Default – not checked
   c. $\chi/_Q$ –2.51E-04 sec/m^3 for 0-2 hrs – This represents the conservatively chosen MSIV LOCA release points.
   d. Breathing Rate – 3.47E-04 m^3/sec – this is the Reg. Guide 1.183 specified breathing rate, with the traditional three digit accuracy (RADTRAD default). This value is entered from time 0 to the end of the accident.

2. Low Population Zone
   a. In Compartment 2 – Environment
   b. Breathing Rate Default – not checked
   c. $\chi/_Q$ –2.63E-05 sec/m^3 for 0-2 hrs; 1.09E-05 sec/m^3 for 2-8 hrs; 7.02E-06 sec/m^3 for 8-24 hrs; – These represent the conservatively chosen MSIV LOCA release points.
   d. Breathing Rate – 3.47E-04 m^3/sec for 0-8 hrs; 1.75E-04 m^3/sec for 8-24 hrs – this is the Reg. Guide 1.183 specified breathing rate, with the traditional three digit accuracy (RADTRAD default), assuming a time dependant reduction.

3. Control Room
   a. In Compartment 3 – Control Room
   b. Breathing Rate Default – not checked
   c. $\chi/_Q$ – 1.30E-03 sec/m^3 for 0-2 hrs; 1.06E-03 sec/m^3 for 2-8 hrs; and 4.49E-04 sec/m^3 for 8-24 hrs – These represent the conservatively chosen MSIV LOCA release points.
   d. Breathing Rate – 3.47E-04 m^3/sec for 0-24 hrs – this is the Reg. Guide 1.183 specified breathing rate, with the traditional three digit accuracy (RADTRAD default).
   e. Occupancy Factor – 1 – For the duration of the accident.

E. Source Term
   a. The "*Dres QDC Source Terms.nif*" file [Attachment C] reflects the Dresden core activities, and is modified to reflect the "Alternate Source Term" activities provided by Reference 15.
   b. The power level of 3016.00 MWt, as per Section 4.2 above, reflects a core at 102% power, accounting for uncertainty.
   c. There is no credited delay in the release of activity.
   d. The RADTRAD radioactive decay and daughter products option is turned "on".
   e. The dre-qdc-crda.rft files [Attachment D] is designed to reflect gap activity fractions per RG 1.183, Appendix C, with one for the main condenser and one (without condenser fission product deposition credit) for the gland seal condenser.

The source terms, which are calculated in Section 6.1 above, are input as a separate RADTRAD "NIF" file. This file is included in Attachment C.

Washington Group International has pre-qualified RADTRAD for application to perform such calculations, as documented in the Computer Disclosure Sheet of Attachment F. The new design basis RADTRAD simulations utilized the design input parameters as provided in Section 4.

6.3. SJAE Release Pathway

The calculation of the dose consequence from the SJAE release pathway was performed using the spreadsheet in Attachment E. The SJAE Release Pathway dose is dependent only upon the noble gas alternate source term, because all iodine and particulate nuclides are eliminated by the charcoal delay beds. The initial core activity for each noble gas, calculated at 3016 MWt (Ref. 12), is then multiplied by the total noble gas release fraction calculated in Attachment A. This activity is then decayed for the period of time that it is delayed in the charcoal beds:

$$\alpha = \alpha_o e^{-\lambda t}$$

where:

α= nuclide activity after decay period (Ci)
α_o= initial nuclide activity (Ci)
e= exponential constant
λ= decay constant (hours^{-1})
t= time of delay (hours)

It is important to note that the two noble gases in the source term of this plant, Krypton and Xenon, are characterized by different delay periods.

When the decayed activities are found, the dose conversion factors (DCF), dispersion factor (χ/Q), and (for the control room dose location) geometry factors are applied. The resulting dose is what is seen via the SJAE release pathway at each respective dose location following a CRDA. See Attachment E. This does not include the release associated with steam flow to the turbine gland sealing system, which is calculated separately as described in Section 6.2.

7. SUMMARY AND CONCLUSIONS

Table 3 provides the Scenario 2 results from the RADTRAD code, as well as the prescribed dose acceptance criteria.

Table 7.1. RADTRAD Analysis Results and Comparisons to the Acceptance Criteria

	EAB	LPZ	CR
Prescribed Dose Limits (TEDE)/ Basis Document	**6.25 rem/ RG 1.183**	**6.25 rem/ RG 1.183**	**5 rem/ 10CFR50.67**
RADTRAD Analysis Results in Attachment B (main condenser leakage)	0.132 rem	0.0385 rem	3.00 rem
RADTRAD Analysis Results in Attachment B (gland seal condenser leakage)	0.263 rem	0.0276 rem	1.01 rem
SJAE Release from Attachment E	0.292 rem	0.0306 rem	0.0544 rem
Total Main and Gland Seal Condenser Leakage	0.395 rem	0.0661 rem	4.01 rem
Total Gland Seal Condenser Leakage and SJAE Release	0.555 rem	0.0582 rem	1.06 rem

All doses are acceptable.

8. OWNER'S ACCEPTANCE REVIEW CHECKLIST FOR EXTERNAL DESIGN ANALYSIS

DESIGN ANALYSIS NO. DRE02-0037 REV: 1

		Yes	No	N/A
1.	Do assumptions have sufficient rationale?	☑	☐	☐
2.	Are assumptions compatible with the way the plant is operated and with the licensing basis?	☑	☐	☐
3.	Do the design inputs have sufficient rationale?	☑	☐	☐
4.	Are design inputs correct and reasonable?	☑	☐	☐
5.	Are design inputs compatible with the way the plant is operated and with the licensing basis?	☑	☐	☐
6.	Are Engineering Judgments clearly documented and justified?	☑	☐	☐
7.	Are Engineering Judgments compatible with the way the plant is operated and with the licensing basis?	☑	☐	☐
8.	Do the results and conclusions satisfy the purpose and objective of the Design Analysis?	☑	☐	☐
9.	Are the results and conclusions compatible with the way the plant is operated and with the licensing basis?	☑	☐	☐
10.	Does the Design Analysis include the applicable design basis documentation?	☑	☐	☐
11.	Have any limitations on the use of the results been identified and transmitted to the appropriate organizations?	☑	☐	☐
12.	Are there any unverified assumptions?	☐	☑	☐
13.	Do all unverified assumptions have a tracking and closure mechanism in place?	☐	☐	☑
14.	Have all affected design analyses been documented on the Affected Documents List (ADL) for the associated Configuration Change?	☑	☐	☐
15.	Do the sources of inputs **and** analysis methodology used meet current technical requirements and regulatory commitments? (If the input sources **or** analysis methodology are based on an out-of-date methodology or code, additional reconciliation may be required if the site has since committed to a more recent code)	☑	☐	☐
16.	Have vendor supporting technical documents and references (including GE DRFs) been reviewed when necessary?	☑	☐	☐

EXELON REVIEWER: T.J. Mscisz / [signature]
Print / Sign

DATE: 8/13/05

CRDA AST RADTRAD INPUTS DERIVATION - RELEASE FRACTION THAT LEAVES THE CONDENSER USING RG 1.183 APP. C

Constants:

Value	Description	Basis
850	Failed fuel rods - bounding case	DRE00-0071/QDC-0000-N-1020
45612	Fuel rods in full core	DRE00-0071/QDC-0000-N-1020
0.018635	Fraction of rods in core with gap activity release	850/45612
1.7	Peaking factor	NEDC-32868P
0.03168	Gap activity release potential with peaking	1.7 x .018635
0.0077	Fraction of fuel in failed rods assumed to melt	DRE00-0071/QDC-0000-N-1020
0.000244	Melted fuel activity release potential with peakin	.03168 x .0077

Activity Fraction Released from Gap[1]	Fraction Released from Vessel[2]	Fraction Available for Release from Condenser	Duration (h): 1.0000E-03	Activity Fraction Released from Melted Fuel	Duration (h): 1.0000E-03
			Noble Gases:		Noble Gases:
0.1	1	1	3.1680E-03	0.9	2.1954E-04
			Iodine:		Iodine:
0.1	0.1	0.1	3.1680E-05	0.45	1.0977E-06
			Cesium:		Cesium:
0.12	0.01	0.01	3.8016E-07	0.2	4.8788E-09
			Tellurium:		Tellurium:
0	0.01	0.01	0.0000E+00	0.05	1.2197E-09
			Strontium:		Strontium:
0	0.01	0.01	0.0000E+00	0.02	4.8788E-10
			Barium:		Barium:
0	0.01	0.01	0.0000E+00	0.02	4.8788E-10
			Ruthenium:		Ruthenium:
0	0.01	0.01	0.0000E+00	0.0025	6.0984E-11
			Cerium:		Cerium:
0	0.01	0.01	0.0000E+00	0.0005	1.2197E-11
			Lanthanum:		Lanthanum:
0	0.01	0.01	0.0000E+00	0.0002	4.8788E-12

[1] From Appendix C, paragraph 1. (for Noble gases and Iodine) and Table 3 (for Cesium, an Alkali Metal) of Regulatory Guide 1.183

[2] From Appendix C, paragraph 3.3 of Regulatory Guide 1.183

[3] From Appendix C, paragraph 3.4 of Regulatory Guide 1.183

[4] From Reg. Guide 1.183, Table 1, Early In-vessel Release Column, with 50% total Iodine release per Appendix C, paragraph 1 to account for the 50% Iodines release from fuel melting per Appendix C paragraph 1.

CRDA AST RADTRAD INPUTS DERIVATION - RELEASE FRACTION THAT LEAVES THE CONDENSER USING RG 1.183 APP. C

Constants:

Value	Description	Basis
850	Failed fuel rods - bounding case	DRE00-0071/QDC-0000-N-1020
45612	Fuel rods in full core	DRE00-0071/QDC-0000-N-1020
0.018635	Fraction of rods in core with gap activity release potential	850/45612
1.7	Peaking factor	NEDC-32868P
0.03168	Gap activity release potential with peaking	1.7 x .018635
0.0077	Fraction of fuel in failed rods assumed to melt	DRE00-0071/QDC-0000-N-1020
0.000244	Melted fuel activity release potential with peaking	.03168 x .0077

Activity Fraction Released from Gap[1]	Fraction Released from Vessel[2]	Fraction Available for Release from Condenser[3]	Duration (h): 1.0000E-03	Activity Fraction Released from Melted Fuel[4]	Duration (h): 1.0000E-03
			Noble Gases:		Noble Gases:
0.1	1	1	3.1680E-03	0.9	2.1954E-04
			Iodine:		Iodine:
0.1	0.1	1	3.1680E-04	0.45	1.0977E-05
			Cesium:		Cesium:
0.12	0.01	1	3.8016E-05	0.2	4.8788E-07
			Tellurium:		Tellurium:
0	0.01	1	0.0000E+00	0.05	1.2197E-07
			Strontium:		Strontium:
0	0.01	1	0.0000E+00	0.02	4.8788E-08
			Barium:		Barium:
0	0.01	1	0.0000E+00	0.02	4.8788E-08
			Ruthenium:		Ruthenium:
0	0.01	1	0.0000E+00	0.0025	6.0984E-09
			Cerium:		Cerium:
0	0.01	1	0.0000E+00	0.0005	1.2197E-09
			Lanthanum:		Lanthanum:
0	0.01	1	0.0000E+00	0.0002	4.8788E-10

[1] From Appendix C, paragraph 1. (for Noble gases and Iodine) and Table 3 (for Cesium, an Alkali Metal) of Regulatory Guide 1.183

[2] From Appendix C, paragraph 3.3 of Regulatory Guide 1.183

[3] Without Regulatory Guide 1.183 Paragraph 3.4 credit for no deposition in the Gland Seal Condenser for forced releases

[4] From Reg. Guide 1.183, Table 1, Early In-vessel Release Column, with 50% total iodine release per Appendix C, paragraph 1
to account for the 50% iodines release from fuel melting per Appendix C paragraph 1.

CRDA AST RADTRA[								
Constants:								
Value			**Description**				**Basis**	
850			Failed fuel rods - bounding case				DRE00-0071/QDC-0000-N	
45612			Fuel rods in full core				DRE00-0071/QDC-0000-N	
=A5/A6			Fraction of rods in core with gap activi				850/45612	
1.7			Peaking factor				NEDC-32868P	
=A7*A8			Gap activity release potential with pea				1.7 x .018635	
0.0077			Fraction of fuel in failed rods assumed				DRE00-0071/QDC-0000-N	
=A9*A10			Melted fuel activity release potential w				.03168 x .0077	
							F	
		Fraction					Activity	
Activity	Fraction	Available for					Fraction	
Fraction	Released	Release	Duration (h):				Released	Duration (h):
Released	from	from	0.001				from	0.001
from Gap[1]	Vessel[2]	Condenser[3]	Noble Gases:				Melted Fuel[4]	Noble Gases:
0.1	1	1	=A$9*A20*B20*C20				=(1-A20)	=A$11*H20*B20*C20
			Iodine:					Iodine:
0.1	0.1	1	=A$9*A22*B22*C22				0.45	=A$11*H22*B22*C22
			Cesium:					Cesium:
0.12	0.01	1	=A$9*A24*B24*C24				0.2	=A$11*H24*B24*C24
			Tellurium:					Tellurium:
0	0.01	1	=A$9*A26*B26*C26				0.05	=A$11*H26*B26*C26
			Strontium:					Strontium:
0	0.01	1	=A$9*A28*B28*C28				0.02	=A$11*H28*B28*C28
			Barium:					Barium:
0	0.01	1	=A$9*A30*B30*C30				0.02	=A$11*H30*B30*C30
			Ruthenium:					Ruthenium:
0	0.01	1	=A$9*A32*B32*C32				0.0025	=A$11*H32*B32*C32
			Cerium:					Cerium:
0	0.01	1	=A$9*A34*B34*C34				0.0005	=A$11*H34*B34*C34
			Lanthanum:					Lanthanum:
0	0.01	1	=A$9*A36*B36*C36				0.0002	=A$11*H36*B36*C36
[1] From Appendix C, pa								
[2] From Appendix C, pa								
[3] Without Regulatory G								
[4] From Reg. Guide 1.1								
to account for the 50%								

```
#####################################################################
   RADTRAD Version 3.03 (Spring 2001) run on  8/12/2005  at 20:55:26
#####################################################################

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

 Plant file          = P:\Users\Nuc\Exelon EOC\Discipline Files\Process\AST\Dresden &
Quad Cities AST\DRE CRDA\DRE-CRDA (Gland Seal only)(1CR airchange per min.psf
 Inventory file      = p:\users\nuc\exelon eoc\discipline files\process\ast\dresden &
quad cities ast\dre crda\dres qdc source terms.nif
 Release file        = p:\users\nuc\exelon eoc\discipline files\process\ast\dresden &
quad cities ast\dre crda\dre-qdc-crda-gland_seal_condenser.rft
 Dose Conversion file = c:\program files\radtrad3-03\defaults\fgr11&12.inp


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

 Radtrad 3.03 4/15/2001
 Dresden Units 2&3 CRDA with Gland Sealing Steam System Operation only (1CR airchange per
min)
 Nuclide Inventory File:
 p:\users\nuc\exelon eoc\discipline files\process\ast\dresden & quad cities ast\dre
crda\dres qdc source terms.nif
 Plant Power Level:
  3.0160E+03
 Compartments:
   4
 Compartment 1:
 Reactor Coolant
   3
  1.0000E+00
   0
   0
   0
   0
   0
 Compartment 2:
 Condenser
   3
  5.5000E+04
   0
   0
   0
   0
```

```
  0
Compartment 3:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Compartment 4:
Control Room
  1
 6.4000E+04
  0
  0
  0
  0
  0
Pathways:
  5
Pathway 1:
Reactor Coolant to condenser
  1
  2
  2
Pathway 2:
Condenser to environment
  2
  3
  2
Pathway 3:
Environment to Control Room
  3
  4
  2
Pathway 4:
Control Room to  Environment
  4
  3
  2
Pathway 5:
Reactor Coolant to  Environment
  1
  3
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\program files\radtrad3-03\defaults\fgr11&12.inp
p:\users\nuc\exelon eoc\discipline files\process\ast\dresden & quad cities ast\dre
crda\dre-qdc-crda-gland_seal_condenser.rft
```

```
  0.0000E+00
  0
  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
  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
  0
  0
  0
Pathways:
  5
Pathway 1:
  0
  0
```

```
  0
  0
  0
  1
  3
  0.0000E+00   2.7500E+02   0.0000E+00   0.0000E+00   0.0000E+00
  1.6670E-01   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  2.4000E+01   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 2:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  2.4000E+01   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
  2
  0.0000E+00   6.4000E+04   0.0000E+00   0.0000E+00   0.0000E+00
  2.4000E+01   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
  2
  0.0000E+00   6.4000E+04   1.0000E+02   1.0000E+02   1.0000E+02
  2.4000E+01   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   4.1250E-01   0.0000E+00   0.0000E+00   0.0000E+00
  2.4000E+01   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Dose Locations:
  3
Location 1:
EAB
  3
  1
  2
  0.0000E+00   2.5100E-04
  2.0000E+00   0.0000E+00
  1
  2
  0.0000E+00   3.4700E-04
  2.0000E+00   0.0000E+00
  0
Location 2:
LPZ
  3
  1
  4
  0.0000E+00   2.6300E-05
  2.0000E+00   1.0900E-05
  8.0000E+00   7.0200E-06
  2.4000E+01   0.0000E+00
  1
  3
  0.0000E+00   3.4700E-04
  8.0000E+00   1.7500E-04
  2.4000E+01   0.0000E+00
  0
Location 3:
Control Room
  4
  0
  1
  2
  0.0000E+00   3.4700E-04
```

```
  2.4000E+01   0.0000E+00
  1
  2
  0.0000E+00   1.0000E+00
  2.4000E+01   0.0000E+00
Effective Volume Location:
  1
  4
  0.0000E+00   1.3000E-03
  2.0000E+00   1.0600E-03
  8.0000E+00   4.4900E-04
  2.4000E+01   0.0000E+00
Simulation Parameters:
  5
  0.0000E+00   1.0000E-04
  1.0000E-02   1.0000E-03
  1.0000E-01   1.0000E-02
  1.0000E+00   1.0000E+00
  2.4000E+01   0.0000E+00
Output Filename:
P:\Users\Nuc\Exelon EOC\Discipline Files\Process\AST\Dresden & Quad Cities AST\DRE
CRDA\DRE-CRDA (Gland Seal only)(1CR airchange per min.o0
  1
  2
  1
  0
  1
End of Scenario File
```

```
##########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on  8/12/2005  at 20:55:26
##########################################################################

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

Number of Nuclides =  60

Inventory Power =   1.0000E+00 MWth
Plant Power Level =   3.0160E+03 MWth

Number of compartments    =   4

Compartment information

Compartment number  1  (Source term fraction =   1.0000E+00
)
Name: Reactor Coolant
Compartment volume =   1.0000E+00 (Cubic feet)
Compartment type is Normal
Pathways into and out of compartment  1
   Exit Pathway Number    1: Reactor Coolant to condenser
   Exit Pathway Number    5: Reactor Coolant to  Environment

Compartment number  2
Name: Condenser
Compartment volume =   5.5000E+04 (Cubic feet)
Compartment type is Normal
Pathways into and out of compartment  2
   Inlet Pathway Number   1: Reactor Coolant to condenser
   Exit Pathway Number    2: Condenser to environment

Compartment number  3
Name: Environment
Compartment type is Environment
Pathways into and out of compartment  3
   Inlet Pathway Number   2: Condenser to environment
   Inlet Pathway Number   4: Control Room to  Environment
   Inlet Pathway Number   5: Reactor Coolant to  Environment
   Exit Pathway Number    3: Environment to Control Room

Compartment number  4
Name: Control Room
Compartment volume =   6.4000E+04 (Cubic feet)
Compartment type is Control Room
Pathways into and out of compartment  4
   Inlet Pathway Number   3: Environment to Control Room
   Exit Pathway Number    4: Control Room to  Environment

Total number of pathways =   5
```

```
##########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on  8/12/2005  at 20:55:26
##########################################################################



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


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

Detailed model information at time (H) =     0.0010

EAB Doses:

Time (h) =    0.0010    Whole Body   Thyroid       TEDE
Delta dose (rem)         5.7988E-02  4.8202E+00  2.1780E-01
Accumulated dose (rem)   5.7988E-02  4.8202E+00  2.1780E-01

LPZ Doses:

Time (h) =    0.0010    Whole Body   Thyroid       TEDE
Delta dose (rem)         6.0760E-03  5.0507E-01  2.2821E-02
Accumulated dose (rem)   6.0760E-03  5.0507E-01  2.2821E-02

Control Room Doses:

Time (h) =    0.0010    Whole Body   Thyroid       TEDE
Delta dose (rem)         3.0001E-04  6.9456E-01  2.3328E-02
Accumulated dose (rem)   3.0001E-04  6.9456E-01  2.3328E-02

Detailed model information at time (H) =     0.0020

EAB Doses:

Time (h) =    0.0020    Whole Body   Thyroid       TEDE
Delta dose (rem)         1.2770E-02  9.7304E-01  4.5063E-02
Accumulated dose (rem)   7.0758E-02  5.7933E+00  2.6286E-01

LPZ Doses:

Time (h) =    0.0020    Whole Body   Thyroid       TEDE
Delta dose (rem)         1.3380E-03  1.0196E-01  4.7217E-03
Accumulated dose (rem)   7.4141E-03  6.0702E-01  2.7543E-02

Control Room Doses:
```

```
Time (h) =    0.0020    Whole Body   Thyroid       TEDE
Delta dose (rem)         7.2078E-04  1.6577E+00  5.5685E-02
Accumulated dose (rem)   1.0208E-03  2.3523E+00  7.9013E-02

Detailed model information at time (H) =     0.1667

EAB Doses:

Time (h) =    0.1667    Whole Body   Thyroid       TEDE
Delta dose (rem)         2.0644E-04  1.0776E-02  5.6606E-04
Accumulated dose (rem)   7.0964E-02  5.8040E+00  2.6343E-01

LPZ Doses:

Time (h) =    0.1667    Whole Body   Thyroid       TEDE
Delta dose (rem)         2.1631E-05  1.1291E-03  5.9313E-05
Accumulated dose (rem)   7.4357E-03  6.0815E-01  2.7602E-02

Control Room Doses:

Time (h) =    0.1667    Whole Body   Thyroid       TEDE
Delta dose (rem)         1.2106E-02  2.7706E+01  9.3077E-01
Accumulated dose (rem)   1.3127E-02  3.0058E+01  1.0098E+00

Detailed model information at time (H) =     2.0000

EAB Doses:

Time (h) =    2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)         0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)   7.0964E-02  5.8040E+00  2.6343E-01

LPZ Doses:

Time (h) =    2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)         0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)   7.4357E-03  6.0815E-01  2.7602E-02

Control Room Doses:

Time (h) =    2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)         6.0085E-07  1.4464E-03  4.8523E-05
Accumulated dose (rem)   1.3128E-02  3.0059E+01  1.0098E+00

Detailed model information at time (H) =     8.0000

EAB Doses:

Time (h) =    8.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)         0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)   7.0964E-02  5.8040E+00  2.6343E-01

LPZ Doses:

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

```
Accumulated dose (rem)  7.4357E-03  6.0815E-01  2.7602E-02

Control Room Doses:

Time (h) =   8.0000    Whole Body   Thyroid      TEDE
Delta dose (rem)        1.7868E-54  6.9882E-51  2.3204E-52
Accumulated dose (rem)  1.3128E-02  3.0059E+01  1.0098E+00

Detailed model information at time (H) =   24.0000

EAB Doses:

Time (h) =  24.0000    Whole Body   Thyroid      TEDE
Delta dose (rem)        0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)  7.0964E-02  5.8040E+00  2.6343E-01

LPZ Doses:

Time (h) =  24.0000    Whole Body   Thyroid      TEDE
Delta dose (rem)        0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)  7.4357E-03  6.0815E-01  2.7602E-02

Control Room Doses:

Time (h) =  24.0000    Whole Body   Thyroid      TEDE
Delta dose (rem)        2.7947-211  2.9035-207  9.5487-209
Accumulated dose (rem)  1.3128E-02  3.0059E+01  1.0098E+00

    411

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

Time (hr)	Reactor Coolant I-131 (Curies)	Condenser I-131 (Curies)	Environment I-131 (Curies)
0.000	1.2669E+03	1.3208E+03	1.9812E+00
0.001	1.5672E+03	2.4293E+04	3.6440E+01
0.002	5.4302E+01	2.9196E+04	4.3794E+01
0.167	0.0000E+00	2.9233E+04	4.3876E+01
0.420	0.0000E+00	2.9206E+04	4.3876E+01
0.670	0.0000E+00	2.9180E+04	4.3876E+01
0.920	0.0000E+00	2.9154E+04	4.3876E+01
1.300	0.0000E+00	2.9114E+04	4.3876E+01
1.600	0.0000E+00	2.9083E+04	4.3876E+01
1.900	0.0000E+00	2.9051E+04	4.3876E+01
2.000	0.0000E+00	2.9041E+04	4.3876E+01
2.300	0.0000E+00	2.9010E+04	4.3876E+01
2.600	0.0000E+00	2.8979E+04	4.3876E+01
2.900	0.0000E+00	2.8947E+04	4.3876E+01
3.200	0.0000E+00	2.8916E+04	4.3876E+01
3.500	0.0000E+00	2.8885E+04	4.3876E+01
3.800	0.0000E+00	2.8854E+04	4.3876E+01
4.100	0.0000E+00	2.8823E+04	4.3876E+01
4.400	0.0000E+00	2.8792E+04	4.3876E+01
4.700	0.0000E+00	2.8761E+04	4.3876E+01
5.000	0.0000E+00	2.8730E+04	4.3876E+01

5.300	0.0000E+00	2.8699E+04	4.3876E+01
5.600	0.0000E+00	2.8668E+04	4.3876E+01
5.900	0.0000E+00	2.8637E+04	4.3876E+01
6.200	0.0000E+00	2.8606E+04	4.3876E+01
6.500	0.0000E+00	2.8575E+04	4.3876E+01
6.800	0.0000E+00	2.8545E+04	4.3876E+01
7.100	0.0000E+00	2.8514E+04	4.3876E+01
7.400	0.0000E+00	2.8483E+04	4.3876E+01
7.700	0.0000E+00	2.8452E+04	4.3876E+01
8.000	0.0000E+00	2.8422E+04	4.3876E+01
8.300	0.0000E+00	2.8391E+04	4.3876E+01
8.600	0.0000E+00	2.8361E+04	4.3876E+01
8.900	0.0000E+00	2.8330E+04	4.3876E+01
9.200	0.0000E+00	2.8300E+04	4.3876E+01
9.500	0.0000E+00	2.8269E+04	4.3876E+01
9.800	0.0000E+00	2.8239E+04	4.3876E+01
10.100	0.0000E+00	2.8208E+04	4.3876E+01
10.400	0.0000E+00	2.8178E+04	4.3876E+01
24.000	0.0000E+00	2.6834E+04	4.3876E+01

Time (hr)	Control Room I-131 (Curies)
0.000	7.7619E-02
0.001	1.3911E+00
0.002	1.5848E+00
0.167	8.1077E-05
0.420	2.0328E-11
0.670	6.2128E-18
0.920	1.8988E-24
1.300	2.3764E-34
1.600	3.6150E-42
1.900	5.4990E-50
2.000	1.3625E-52
2.300	2.0726E-60
2.600	3.1529E-68
2.900	4.7961E-76
3.200	7.2957E-84
3.500	1.1098E-91
3.800	1.6882E-99
4.100	2.5681-107
4.400	3.9065-115
4.700	5.9425-123
5.000	9.0396-131
5.300	1.3751-138
5.600	2.0918-146
5.900	3.1820-154
6.200	4.8403-162
6.500	7.3630-170
6.800	1.1200-177
7.100	1.7038-185
7.400	2.5918-193
7.700	3.9426-201
8.000	5.9973-209
8.300	9.1230-217
8.600	1.3878-224
8.900	2.1111-232
9.200	3.2113-240

9.500	4.8850-248
9.800	7.4309-256
10.100	1.1304-263
10.400	1.7195-271
24.000	0.0000E+00

##
Cumulative Dose Summary
##

	EAB		LPZ		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
0.001	4.8202E+00	2.1780E-01	5.0507E-01	2.2821E-02	6.9456E-01	2.3328E-02
0.002	5.7933E+00	2.6286E-01	6.0702E-01	2.7543E-02	2.3523E+00	7.9013E-02
0.167	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0058E+01	1.0098E+00
0.420	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
0.670	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
0.920	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
1.300	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
1.600	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
1.900	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
2.000	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
2.300	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
2.600	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
2.900	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
3.200	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
3.500	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
3.800	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
4.100	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
4.400	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
4.700	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
5.000	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
5.300	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
5.600	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
5.900	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
6.200	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
6.500	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
6.800	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
7.100	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
7.400	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
7.700	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
8.000	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
8.300	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
8.600	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
8.900	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
9.200	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
9.500	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
9.800	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
10.100	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
10.400	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00
24.000	5.8040E+00	2.6343E-01	6.0815E-01	2.7602E-02	3.0059E+01	1.0098E+00

##
Worst Two-Hour Doses
##

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	7.0964E-02	5.8040E+00	2.6343E-01

```
##########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on  8/12/2005  at 20:51:24
##########################################################################

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

 Plant file          = P:\Users\Nuc\Exelon EOC\Discipline Files\Process\AST\Dresden &
Quad Cities AST\DRE CRDA\DRE-CRDA_condenser_path (1CR airchange per min).psf
 Inventory file      = p:\users\nuc\exelon eoc\discipline files\process\ast\dresden &
quad cities ast\dre crda\dres qdc source terms.nif
 Release file        = p:\users\nuc\exelon eoc\discipline files\process\ast\dresden &
quad cities ast\dre crda\dre-qdc-crda-main_condenser.rft
 Dose Conversion file = c:\program files\radtrad3-03\defaults\fgr11&12.inp


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

 Radtrad 3.03 4/15/2001
 Dresden Units 2&3 CRDA with 1 percent per day condenser volume release rate (1CR
airchange per min)
 Nuclide Inventory File:
 p:\users\nuc\exelon eoc\discipline files\process\ast\dresden & quad cities ast\dre
crda\dres qdc source terms.nif
 Plant Power Level:
  3.0160E+03
 Compartments:
   4
 Compartment 1:
 Reactor Coolant
   3
  1.0000E+00
   0
   0
   0
   0
   0
 Compartment 2:
 Condenser
   3
  5.5000E+04
   0
   0
   0
   0
```

```
  0
Compartment 3:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Compartment 4:
Control Room
  1
 6.4000E+04
  0
  0
  0
  0
  0
Pathways:
  5
Pathway 1:
Reactor Coolant to condenser
  1
  2
  2
Pathway 2:
Condenser to environment
  2
  3
  2
Pathway 3:
Environment to Control Room
  3
  4
  2
Pathway 4:
Control Room to  Environment
  4
  3
  2
Pathway 5:
Reactor Coolant to  Environment
  1
  3
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\program files\radtrad3-03\defaults\fgr11&12.inp
p:\users\nuc\exelon eoc\discipline files\process\ast\dresden & quad cities ast\dre
crda\dre-qdc-crda-main_condenser.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
  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
  0
  0
  0
Pathways:
  5
Pathway 1:
  0
  0
```

```
  0
  0
  0
  1
  3
  0.0000E+00   2.7500E+02   0.0000E+00   0.0000E+00   0.0000E+00
  1.6670E-01   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  2.4000E+01   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   3.8190E-01   0.0000E+00   0.0000E+00   0.0000E+00
  2.4000E+01   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  4.8000E+01   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
  2
  0.0000E+00   6.4000E+04   0.0000E+00   0.0000E+00   0.0000E+00
  4.8000E+01   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
  2
  0.0000E+00   6.4000E+04   1.0000E+02   1.0000E+02   1.0000E+02
  4.8000E+01   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   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 2.4000E+01   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 0
 0
 0
 0
 0
 0
Dose Locations:
 3
Location 1:
EAB
 3
 1
 2
 0.0000E+00   2.5100E-04
 2.0000E+00   0.0000E+00
 1
 3
 0.0000E+00   3.4700E-04
 8.0000E+00   1.7500E-04
 2.4000E+01   0.0000E+00
 0
Location 2:
LPZ
 3
 1
 8
 0.0000E+00   2.6300E-05
 2.0000E+00   1.0900E-05
 8.0000E+00   7.0200E-06
 2.4000E+01   1.0000E-12
 2.8000E+01   1.0000E-12
 3.2000E+01   1.0000E-12
 4.0000E+01   1.0000E-12
 4.8000E+01   0.0000E+00
 1
 4
 0.0000E+00   3.4700E-04
 8.0000E+00   1.7500E-04
 2.4000E+01   0.0000E+00
 4.8000E+01   0.0000E+00
 0
```

```
Location 3:
Control Room
  4
  0
  1
  3
  0.0000E+00   3.4700E-04
  2.4000E+01   3.4700E-04
  4.8000E+01   0.0000E+00
  1
  3
  0.0000E+00   1.0000E+00
  2.4000E+01   6.0000E-01
  4.8000E+01   0.0000E+00
Effective Volume Location:
  1
  5
  0.0000E+00   1.3000E-03
  1.6670E-01   1.3000E-03
  2.0000E+00   1.0600E-03
  8.0000E+00   4.4900E-04
  2.4000E+01   0.0000E+00
Simulation Parameters:
  6
  0.0000E+00   1.0000E-04
  1.0000E-02   1.0000E-03
  1.0000E-01   1.0000E-02
  1.0000E+00   1.0000E+00
  2.4000E+01   2.0000E+00
  4.8000E+01   0.0000E+00
Output Filename:
P:\Users\Nuc\Exelon EOC\Discipline Files\Process\AST\Dresden & Quad Cities AST\DRE
CRDA\DRE-CRDA_condenser_path (1CR airchange per min).o0
  1
  2
  1
  0
  1
End of Scenario File
```

```
########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on  8/12/2005  at 20:51:24
########################################################################

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

Number of Nuclides =  60

Inventory Power =   1.0000E+00 MWth
Plant Power Level =   3.0160E+03 MWth

Number of compartments    =   4

Compartment information

Compartment number  1  (Source term fraction =   1.0000E+00
)
Name: Reactor Coolant
Compartment volume =   1.0000E+00 (Cubic feet)
Compartment type is Normal
Pathways into and out of compartment  1
   Exit Pathway Number    1: Reactor Coolant to condenser
   Exit Pathway Number    5: Reactor Coolant to  Environment

Compartment number  2
Name: Condenser
Compartment volume =   5.5000E+04 (Cubic feet)
Compartment type is Normal
Pathways into and out of compartment  2
   Inlet Pathway Number   1: Reactor Coolant to condenser
   Exit'Pathway Number    2: Condenser to environment

Compartment number  3
Name: Environment
Compartment type is Environment
Pathways into and out of compartment  3
   Inlet Pathway Number   2: Condenser to environment
   Inlet Pathway Number   4: Control Room to  Environment
   Inlet Pathway Number   5: Reactor Coolant to  Environment
   Exit Pathway Number    3: Environment to Control Room

Compartment number  4
Name: Control Room
Compartment volume =   6.4000E+04 (Cubic feet)
Compartment type is Control Room
Pathways into and out of compartment  4
   Inlet Pathway Number   3: Environment to Control Room
   Exit Pathway Number    4: Control Room to  Environment

Total number of pathways =   5
```

```
#########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on  8/12/2005  at 20:51:24
#########################################################################


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


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

Detailed model information at time (H) =     0.0010

EAB Doses:

Time (h) =     0.0010     Whole Body   Thyroid       TEDE
Delta dose (rem)           7.6067E-06  6.3233E-04  2.8571E-05
Accumulated dose (rem)     7.6067E-06  6.3233E-04  2.8571E-05

LPZ Doses:

Time (h) =     0.0010     Whole Body   Thyroid       TEDE
Delta dose (rem)           7.9704E-07  6.6256E-05  2.9937E-06
Accumulated dose (rem)     7.9704E-07  6.6256E-05  2.9937E-06

Control Room Doses:

Time (h) =     0.0010     Whole Body   Thyroid       TEDE
Delta dose (rem)           2.6552E-08  6.1473E-05  2.0647E-06
Accumulated dose (rem)     2.6552E-08  6.1473E-05  2.0647E-06

Detailed model information at time (H) =     0.0020

EAB Doses:

Time (h) =     0.0020     Whole Body   Thyroid       TEDE
Delta dose (rem)           1.8887E-05  1.5506E-03  7.0293E-05
Accumulated dose (rem)     2.6494E-05  2.1829E-03  9.8865E-05

LPZ Doses:

Time (h) =     0.0020     Whole Body   Thyroid       TEDE
Delta dose (rem)           1.9790E-06  1.6247E-04  7.3654E-06
Accumulated dose (rem)     2.7760E-06  2.2873E-04  1.0359E-05

Control Room Doses:
```

Time (h) = 0.0020	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.8236E-07	4.2056E-04	1.4126E-05
Accumulated dose (rem)	2.0891E-07	4.8204E-04	1.6190E-05

Detailed model information at time (H) = 0.1667

EAB Doses:

Time (h) = 0.1667	Whole Body	Thyroid	TEDE
Delta dose (rem)	3.1333E-03	2.5891E-01	1.1713E-02
Accumulated dose (rem)	3.1598E-03	2.6109E-01	1.1812E-02

LPZ Doses:

Time (h) = 0.1667	Whole Body	Thyroid	TEDE
Delta dose (rem)	3.2831E-04	2.7129E-02	1.2273E-03
Accumulated dose (rem)	3.3109E-04	2.7358E-02	1.2376E-03

Control Room Doses:

Time (h) = 0.1667	Whole Body	Thyroid	TEDE
Delta dose (rem)	5.2716E-04	1.2159E+00	4.0818E-02
Accumulated dose (rem)	5.2737E-04	1.2164E+00	4.0834E-02

Detailed model information at time (H) = 2.0000

EAB Doses:

Time (h) = 2.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.6341E-02	2.8346E+00	1.1994E-01
Accumulated dose (rem)	2.9501E-02	3.0957E+00	1.3175E-01

LPZ Doses:

Time (h) = 2.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	2.7600E-03	2.9702E-01	1.2567E-02
Accumulated dose (rem)	3.0911E-03	3.2437E-01	1.3805E-02

Control Room Doses:

Time (h) = 2.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	4.8987E-03	1.4681E+01	4.8968E-01
Accumulated dose (rem)	5.4260E-03	1.5898E+01	5.3051E-01

Detailed model information at time (H) = 8.0000

EAB Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	2.9501E-02	3.0957E+00	1.3175E-01

LPZ Doses:

Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.7031E-03	3.8060E-01	1.4201E-02

```
Accumulated dose (rem)  4.7942E-03  7.0497E-01  2.8006E-02

Control Room Doses:

Time (h) =   8.0000    Whole Body  Thyroid     TEDE
Delta dose (rem)        5.9660E-03  3.7086E+01  1.2238E+00
Accumulated dose (rem)  1.1392E-02  5.2984E+01  1.7543E+00

Detailed model information at time (H) =   24.0000

EAB Doses:

Time (h) =  24.0000    Whole Body  Thyroid     TEDE
Delta dose (rem)        0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)  2.9501E-02  3.0957E+00  1.3175E-01

LPZ Doses:

Time (h) =  24.0000    Whole Body  Thyroid     TEDE
Delta dose (rem)        9.3815E-04  2.9186E-01  1.0501E-02
Accumulated dose (rem)  5.7324E-03  9.9683E-01  3.8507E-02

Control Room Doses:

Time (h) =  24.0000    Whole Body  Thyroid     TEDE
Delta dose (rem)        2.1716E-03  3.7187E+01  1.2205E+00
Accumulated dose (rem)  1.3564E-02  9.0171E+01  2.9749E+00

Detailed model information at time (H) =   28.0000

EAB Doses:

Time (h) =  28.0000    Whole Body  Thyroid     TEDE
Delta dose (rem)        0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)  2.9501E-02  3.0957E+00  1.3175E-01

LPZ Doses:

Time (h) =  28.0000    Whole Body  Thyroid     TEDE
Delta dose (rem)        0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)  5.7324E-03  9.9683E-01  3.8507E-02

Control Room Doses:

Time (h) =  28.0000    Whole Body  Thyroid     TEDE
Delta dose (rem)        2.3543E-05  6.4007E-01  2.1009E-02
Accumulated dose (rem)  1.3587E-02  9.0811E+01  2.9959E+00

Detailed model information at time (H) =   32.0000

EAB Doses:

Time (h) =  32.0000    Whole Body  Thyroid     TEDE
Delta dose (rem)        0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)  2.9501E-02  3.0957E+00  1.3175E-01

LPZ Doses:
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```
Time (h) =  32.0000     Whole Body   Thyroid        TEDE
Delta dose (rem)         0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)   5.7324E-03  9.9683E-01  3.8507E-02

Control Room Doses:

Time (h) =  32.0000     Whole Body   Thyroid        TEDE
Delta dose (rem)         1.1869-109  3.6140-105  1.1869-106
Accumulated dose (rem)   1.3587E-02  9.0811E+01  2.9959E+00

Detailed model information at time (H) =    40.0000

EAB Doses:

Time (h) =  40.0000     Whole Body   Thyroid        TEDE
Delta dose (rem)         0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)   2.9501E-02  3.0957E+00  1.3175E-01

LPZ Doses:

Time (h) =  40.0000     Whole Body   Thyroid        TEDE
Delta dose (rem)         0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)   5.7324E-03  9.9683E-01  3.8507E-02

Control Room Doses:

Time (h) =  40.0000     Whole Body   Thyroid        TEDE
Delta dose (rem)         6.1296-214  2.0446-209  6.7202-211
Accumulated dose (rem)   1.3587E-02  9.0811E+01  2.9959E+00

Detailed model information at time (H) =    48.0000

EAB Doses:

Time (h) =  48.0000     Whole Body   Thyroid        TEDE
Delta dose (rem)         0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)   2.9501E-02  3.0957E+00  1.3175E-01

LPZ Doses:

Time (h) =  48.0000     Whole Body   Thyroid        TEDE
Delta dose (rem)         0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)   5.7324E-03  9.9683E-01  3.8507E-02

Control Room Doses:

Time (h) =  48.0000     Whole Body   Thyroid        TEDE
Delta dose (rem)         0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)   1.3587E-02  9.0811E+01  2.9959E+00

    435

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

DRE – Gland Seal

Time (hr)	Reactor Coolant I-131 (Curies)	Condenser I-131 (Curies)	Environment I-131 (Curies)
0.000	1.2681E+03	1.3216E+03	2.0576E-05
0.001	1.5695E+03	2.4327E+04	4.7803E-03
0.002	5.4388E+00	2.8562E+04	1.6503E-02
0.167	0.0000E+00	2.8548E+04	1.9760E+00
0.420	0.0000E+00	2.8519E+04	4.9872E+00
0.670	0.0000E+00	2.8491E+04	7.9560E+00
0.920	0.0000E+00	2.8462E+04	1.0922E+01
1.300	0.0000E+00	2.8419E+04	1.5424E+01
1.600	0.0000E+00	2.8385E+04	1.8973E+01
1.900	0.0000E+00	2.8351E+04	2.2518E+01
2.000	0.0000E+00	2.8339E+04	2.3699E+01
2.300	0.0000E+00	2.8305E+04	2.7238E+01
2.600	0.0000E+00	2.8271E+04	3.0773E+01
2.900	0.0000E+00	2.8237E+04	3.4304E+01
3.200	0.0000E+00	2.8203E+04	3.7830E+01
3.500	0.0000E+00	2.8169E+04	4.1352E+01
3.800	0.0000E+00	2.8136E+04	4.4870E+01
4.100	0.0000E+00	2.8102E+04	4.8384E+01
4.400	0.0000E+00	2.8068E+04	5.1894E+01
4.700	0.0000E+00	2.8034E+04	5.5399E+01
5.000	0.0000E+00	2.8001E+04	5.8900E+01
5.300	0.0000E+00	2.7967E+04	6.2397E+01
5.600	0.0000E+00	2.7933E+04	6.5890E+01
5.900	0.0000E+00	2.7900E+04	6.9379E+01
6.200	0.0000E+00	2.7866E+04	7.2863E+01
6.500	0.0000E+00	2.7833E+04	7.6343E+01
6.800	0.0000E+00	2.7799E+04	7.9819E+01
7.100	0.0000E+00	2.7766E+04	8.3291E+01
7.400	0.0000E+00	2.7732E+04	8.6758E+01
7.700	0.0000E+00	2.7699E+04	9.0222E+01
8.000	0.0000E+00	2.7666E+04	9.3681E+01
8.300	0.0000E+00	2.7633E+04	9.7136E+01
8.600	0.0000E+00	2.7599E+04	1.0059E+02
8.900	0.0000E+00	2.7566E+04	1.0403E+02
9.200	0.0000E+00	2.7533E+04	1.0748E+02
9.500	0.0000E+00	2.7500E+04	1.1092E+02
9.800	0.0000E+00	2.7467E+04	1.1435E+02
10.100	0.0000E+00	2.7434E+04	1.1778E+02
10.400	0.0000E+00	2.7401E+04	1.2121E+02
24.000	0.0000E+00	2.5947E+04	2.7208E+02
28.000	0.0000E+00	2.5577E+04	2.7208E+02
32.000	0.0000E+00	2.5212E+04	2.7208E+02
40.000	0.0000E+00	2.4498E+04	2.7208E+02
48.000	0.0000E+00	2.3804E+04	2.7208E+02

Time (hr)	Control Room I-131 (Curies)
0.000	8.0663E-07
0.001	1.8420E-04
0.002	6.2038E-04
0.167	7.7834E-03
0.420	7.7759E-03
0.670	7.7681E-03
0.920	7.7603E-03
1.300	7.7485E-03

1.600	7.7392E-03
1.900	7.7299E-03
2.000	7.7268E-03
2.300	6.2927E-03
2.600	6.2851E-03
2.900	6.2776E-03
3.200	6.2700E-03
3.500	6.2625E-03
3.800	6.2550E-03
4.100	6.2475E-03
4.400	6.2400E-03
4.700	6.2325E-03
5.000	6.2250E-03
5.300	6.2175E-03
5.600	6.2100E-03
5.900	6.2025E-03
6.200	6.1951E-03
6.500	6.1876E-03
6.800	6.1802E-03
7.100	6.1728E-03
7.400	6.1654E-03
7.700	6.1579E-03
8.000	6.1505E-03
8.300	2.6021E-03
8.600	2.5990E-03
8.900	2.5959E-03
9.200	2.5928E-03
9.500	2.5897E-03
9.800	2.5865E-03
10.100	2.5834E-03
10.400	2.5803E-03
24.000	2.4434E-03
28.000	1.4037-107
32.000	8.0642-212
40.000	0.0000E+00
48.000	0.0000E+00

##
Cumulative Dose Summary
##

	EAB		LPZ		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
0.001	6.3233E-04	2.8571E-05	6.6256E-05	2.9937E-06	6.1473E-05	2.0647E-06
0.002	2.1829E-03	9.8865E-05	2.2873E-04	1.0359E-05	4.8204E-04	1.6190E-05
0.167	2.6109E-01	1.1812E-02	2.7358E-02	1.2376E-03	1.2164E+00	4.0834E-02
0.420	6.5782E-01	2.9453E-02	6.8927E-02	3.0861E-03	3.2712E+00	1.0970E-01
0.670	1.0477E+00	4.6456E-02	1.0978E-01	4.8677E-03	5.2903E+00	1.7724E-01
0.920	1.4359E+00	6.3096E-02	1.5045E-01	6.6112E-03	7.3008E+00	2.4437E-01
1.300	2.0231E+00	8.7834E-02	2.1199E-01	9.2033E-03	1.0343E+01	3.4578E-01
1.600	2.4843E+00	1.0690E-01	2.6031E-01	1.1201E-02	1.2731E+01	4.2528E-01
1.900	2.9432E+00	1.2560E-01	3.0839E-01	1.3160E-02	1.5108E+01	5.0428E-01
2.000	3.0957E+00	1.3175E-01	3.2437E-01	1.3805E-02	1.5898E+01	5.3051E-01
2.300	3.0957E+00	1.3175E-01	3.4418E-01	1.4598E-02	1.7897E+01	5.9686E-01
2.600	3.0957E+00	1.3175E-01	3.6390E-01	1.5378E-02	1.9814E+01	6.6043E-01

2.900	3.0957E+00	1.3175E-01	3.8352E-01	1.6146E-02	2.1723E+01	7.2365E-01
3.200	3.0957E+00	1.3175E-01	4.0306E-01	1.6903E-02	2.3623E+01	7.8654E-01
3.500	3.0957E+00	1.3175E-01	4.2252E-01	1.7650E-02	2.5515E+01	8.4911E-01
3.800	3.0957E+00	1.3175E-01	4.4189E-01	1.8388E-02	2.7399E+01	9.1137E-01
4.100	3.0957E+00	1.3175E-01	4.6117E-01	1.9117E-02	2.9275E+01	9.7333E-01
4.400	3.0957E+00	1.3175E-01	4.8038E-01	1.9838E-02	3.1142E+01	1.0350E+00
4.700	3.0957E+00	1.3175E-01	4.9951E-01	2.0552E-02	3.3002E+01	1.0964E+00
5.000	3.0957E+00	1.3175E-01	5.1855E-01	2.1259E-02	3.4855E+01	1.1575E+00
5.300	3.0957E+00	1.3175E-01	5.3753E-01	2.1959E-02	3.6700E+01	1.2183E+00
5.600	3.0957E+00	1.3175E-01	5.5642E-01	2.2652E-02	3.8537E+01	1.2789E+00
5.900	3.0957E+00	1.3175E-01	5.7524E-01	2.3340E-02	4.0368E+01	1.3391E+00
6.200	3.0957E+00	1.3175E-01	5.9399E-01	2.4022E-02	4.2191E+01	1.3992E+00
6.500	3.0957E+00	1.3175E-01	6.1266E-01	2.4698E-02	4.4007E+01	1.4590E+00
6.800	3.0957E+00	1.3175E-01	6.3126E-01	2.5369E-02	4.5816E+01	1.5185E+00
7.100	3.0957E+00	1.3175E-01	6.4979E-01	2.6035E-02	4.7618E+01	1.5778E+00
7.400	3.0957E+00	1.3175E-01	6.6826E-01	2.6697E-02	4.9413E+01	1.6369E+00
7.700	3.0957E+00	1.3175E-01	6.8665E-01	2.7354E-02	5.1202E+01	1.6957E+00
8.000	3.0957E+00	1.3175E-01	7.0497E-01	2.8006E-02	5.2984E+01	1.7543E+00
8.300	3.0957E+00	1.3175E-01	7.1090E-01	2.8233E-02	5.3907E+01	1.7847E+00
8.600	3.0957E+00	1.3175E-01	7.1681E-01	2.8457E-02	5.4657E+01	1.8093E+00
8.900	3.0957E+00	1.3175E-01	7.2270E-01	2.8680E-02	5.5403E+01	1.8338E+00
9.200	3.0957E+00	1.3175E-01	7.2856E-01	2.8901E-02	5.6147E+01	1.8583E+00
9.500	3.0957E+00	1.3175E-01	7.3441E-01	2.9120E-02	5.6889E+01	1.8826E+00
9.800	3.0957E+00	1.3175E-01	7.4023E-01	2.9338E-02	5.7627E+01	1.9069E+00
10.100	3.0957E+00	1.3175E-01	7.4604E-01	2.9554E-02	5.8363E+01	1.9311E+00
10.400	3.0957E+00	1.3175E-01	7.5182E-01	2.9769E-02	5.9097E+01	1.9552E+00
24.000	3.0957E+00	1.3175E-01	9.9683E-01	3.8507E-02	9.0171E+01	2.9749E+00
28.000	3.0957E+00	1.3175E-01	9.9683E-01	3.8507E-02	9.0811E+01	2.9959E+00
32.000	3.0957E+00	1.3175E-01	9.9683E-01	3.8507E-02	9.0811E+01	2.9959E+00
40.000	3.0957E+00	1.3175E-01	9.9683E-01	3.8507E-02	9.0811E+01	2.9959E+00
48.000	3.0957E+00	1.3175E-01	9.9683E-01	3.8507E-02	9.0811E+01	2.9959E+00

##
Worst Two-Hour Doses
##

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	2.9501E-02	3.0957E+00	1.3175E-01

```
Nuclide Inventory Name:
 Source Document Calc. #GE-NE-A22-00103-64-01 Appendix D for Dresden and Quad
Cities
 Power Level:
  0.1000E+01
 Nuclides:
  60
 Nuclide 001:
 Co-58
   7
  0.6117120000E+07
  0.5800E+02
  0.1529E+03
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 002:
 Co-60
   7
  0.1663401096E+09
  0.6000E+02
  0.1830E+03
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 003:
 Kr-85
   1
  0.3382974720E+09
  0.8500E+02
  4.3644E+02
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 004:
 Kr-85m
   1
  0.1612800000E+05
  0.8500E+02
  6.7720E+03
 Kr-85     0.2100E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 005:
 Kr-87
   1
  0.4578000000E+04
  0.8700E+02
  1.2910E+04
 Rb-87     0.1000E+01
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 006:
 Kr-88
   1
  0.1022400000E+05
  0.8800E+02
  1.8150E+04
 Rb-88     0.1000E+01
```

```
none      0.0000E+00
none      0.0000E+00
Nuclide 007:
Rb-86
  3
 0.1612224000E+07
 0.8600E+02
 7.096E+01
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 008:
Sr-89
  5
 0.4363200000E+07
 0.8900E+02
 2.4284E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 009:
Sr-90
  5
 0.9189573120E+09
 0.9000E+02
 3.5283E+03
Y-90      0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 010:
Sr-91
  5
 0.3420000000E+05
 0.9100E+02
 3.0810E+04
Y-91m     0.5800E+00
Y-91      0.4200E+00
none      0.0000E+00
Nuclide 011:
Sr-92
  5
 0.9756000000E+04
 0.9200E+02
 3.3620E+04
Y-92      0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 012:
Y-90
  9
 0.2304000000E+06
 0.9000E+02
 3.6249E+03
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 013:
Y-91
  9
```

```
 0.5055264000E+07
 0.9100E+02
 3.1549E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 014:
Y-92
  9
 0.1274400000E+05
 0.9200E+02
 3.3767E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 015:
Y-93
  9
 0.3636000000E+05
 0.9300E+02
 3.9417E+04
Zr-93    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 016:
Zr-95
  9
 0.5527872000E+07
 0.9500E+02
 4.4427E+04
Nb-95m   0.7000E-02
Nb-95    0.9900E+00
none     0.0000E+00
Nuclide 017:
Zr-97
  9
 0.6084000000E+05
 0.9700E+02
 4.4971E+04
Nb-97m   0.9500E+00
Nb-97    0.5300E-01
none     0.0000E+00
Nuclide 018:
Nb-95
  9
 0.3036960000E+07
 0.9500E+02
 4.4637E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 019:
Mo-99
  7
 0.2376000000E+06
 0.9900E+02
 5.1210E+04
Tc-99m   0.8800E+00
Tc-99    0.1200E+00
```

```
none      0.0000E+00
Nuclide 020:
Tc-99m
  7
 0.2167200000E+05
 0.9900E+02
 4.4837E+04
Tc-99     0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 021:
Ru-103
  7
 0.3393792000E+07
 0.1030E+03
 4.3107E+04
Rh-103m   0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 022:
Ru-105
  7
 0.1598400000E+05
 0.1050E+03
 3.0337E+04
Rh-105    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 023:
Ru-106
  7
 0.3181248000E+08
 0.1060E+03
 1.8366E+04
Rh-106    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 024:
Rh-105
  7
 0.1272960000E+06
 0.1050E+03
 2.8824E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 025:
Sb-127
  4
 0.3326400000E+06
 0.1270E+03
 2.9994E+03
Te-127m   0.1800E+00
Te-127    0.8200E+00
none      0.0000E+00
Nuclide 026:
Sb-129
  4
 0.1555200000E+05
```

```
 0.1290E+03
 8.8770E+03
Te-129m  0.2200E+00
Te-129   0.7700E+00
none     0.0000E+00
Nuclide 027:
Te-127
  4
 0.3366000000E+05
 0.1270E+03
 2.9857E+03
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 028:
Te-127m
  4
 0.9417600000E+07
 0.1270E+03
 4.0597E+02
Te-127   0.9800E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 029:
Te-129
  4
 0.4176000000E+04
 0.1290E+03
 8.7350E+03
I-129    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 030:
Te-129m
  4
 0.2903040000E+07
 0.1290E+03
 1.3004E+03
Te-129   0.6500E+00
I-129    0.3500E+00
none     0.0000E+00
Nuclide 031:
Te-131m
  4
 0.1080000000E+06
 0.1310E+03
 3.9549E+03
Te-131   0.2200E+00
I-131    0.7800E+00
none     0.0000E+00
Nuclide 032:
Te-132
  4
 0.2815200000E+06
 0.1320E+03
 3.8497E+04
I-132    0.1000E+01
none     0.0000E+00
none     0.0000E+00
```

```
Nuclide 033:
I-131
  2
 0.6946560000E+06
 0.1310E+03
 2.7104E+04
Xe-131m  0.1100E-01
none     0.0000E+00
none     0.0000E+00
Nuclide 034:
I-132
  2
 0.8280000000E+04
 0.1320E+03
 3.9136E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 035:
I-133
  2
 0.7488000000E+05
 0.1330E+03
 5.5010E+04
Xe-133m  0.2900E-01
Xe-133   0.9700E+00
none     0.0000E+00
Nuclide 036:
I-134
  2
 0.3156000000E+04
 0.1340E+03
 6.0353E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 037:
I-135
  2
 0.2379600000E+05
 0.1350E+03
 5.1570E+04
Xe-135m  0.1500E+00
Xe-135   0.8500E+00
none     0.0000E+00
Nuclide 038:
Xe-133
  1
 0.4531680000E+06
 0.1330E+03
 5.2821E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 039:
Xe-135
  1
 0.3272400000E+05
 0.1350E+03
```

```
 2.1437E+04
Cs-135   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 040:
Cs-134
  3
 0.6507177120E+08
 0.1340E+03
 8.0091E+03
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 041:
Cs-136
  3
 0.1131840000E+07
 0.1360E+03
 2.3791E+03
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 042:
Cs-137
  3
 0.9467280000E+09
 0.1370E+03
 4.9283E+03
Ba-137m  0.9500E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 043:
Ba-139
  6
 0.4962000000E+04
 0.1390E+03
 4.8879E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 044:
Ba-140
  6
 0.1100736000E+07
 0.1400E+03
 4.7141E+04
La-140   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 045:
La-140
  9
 0.1449792000E+06
 0.1400E+03
 5.0553E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 046:
```

```
La-141
  9
 0.1414800000E+05
 0.1410E+03
 4.4469E+04
Ce-141   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 047:
La-142
  9
 0.5550000000E+04
 0.1420E+03
 4.2864E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 048:
Ce-141
  8
 0.2808086400E+07
 0.1410E+03
 4.4650E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 049:
Ce-143
  8
 0.1188000000E+06
 0.1430E+03
 4.1011E+04
Pr-143   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 050:
Ce-144
  8
 0.2456352000E+08
 0.1440E+03
 3.6823E+04
Pr-144m  0.1800E-01
Pr-144   0.9800E+00
none     0.0000E+00
Nuclide 051:
Pr-143
  9
 0.1171584000E+07
 0.1430E+03
 3.9634E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 052:
Nd-147
  9
 0.9486720000E+06
 0.1470E+03
 1.7999E+04
```

```
Pm-147   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 053:
Np-239
  8
 0.2034720000E+06
 0.2390E+03
 5.5866E+05
Pu-239   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 054:
Pu-238
  8
 0.2768863824E+10
 0.2380E+03
 1.7677E+02
U-234    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 055:
Pu-239
  8
 0.7594336440E+12
 0.2390E+03
 1.4743E+01
U-235    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 056:
Pu-240
  8
 0.2062920312E+12
 0.2400E+03
 2.0014E+01
U-236    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 057:
Pu-241
  8
 0.4544294400E+09
 0.2410E+03
 6.6999E+03
U-237    0.2400E-04
Am-241   0.1000E+01
none     0.0000E+00
Nuclide 058:
Am-241
  9
 0.1363919472E+11
 0.2410E+03
 9.8566E+00
Np-237   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 059:
Cm-242
```

```
  9
 0.1406592000E+08
 0.2420E+03
 2.2847E+03
Pu-238   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 060:
Cm-244
  9
 0.5715081360E+09
 0.2440E+03
 1.6212E+02
Pu-240   0.1000E+01
none     0.0000E+00
none     0.0000E+00
End of Nuclear Inventory File
```

```
Release Fraction and Timing Name:
 Dresden and Quad Cities -Gland Seal Condenser
 Duration (h):    Control Rod Drop Accident
  0.0010D+00  0.0010D+00  0.0000D+00  0.0000D+00
 Noble Gases:
  3.1680E-03  2.1954E-04  0.0000D+00  0.0000D+00
 Iodine:
  3.1680E-04  1.0977E-05  0.0000E+00  0.0000E+00
 Cesium:
  3.8016E-05  4.8788E-07  0.0000E+00  0.0000E+00
 Tellurium:
  0.0000E+00  1.2197E-07  0.0000E+00  0.0000E+00
 Strontium:
  0.0000E+00  4.8788E-08  0.0000E+00  0.0000E+00
 Barium:
  0.0000E+00  4.8788E-08  0.0000E+00  0.0000E+00
 Ruthenium:
  0.0000E+00  6.0984E-09  0.0000E+00  0.0000E+00
 Cerium:
  0.0000E+00  1.2197E-09  0.0000E+00  0.0000E+00
 Lanthanum:
  0.0000E+00  4.8788E-10  0.0000E+00  0.0000E+00
 Non-Radioactive Aerosols (kg):
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 End of Release File
```

```
Release Fraction and Timing Name:
 Dresden and Quad Cities -Main Condenser
 Duration (h):   Control Rod Drop Accident
  0.0010D+00  0.0010D+00  0.0000D+00  0.0000D+00
 Noble Gases:
  3.1680E-03  2.1954E-04  0.0000D+00  0.0000D+00
 Iodine:
  3.1680E-04  1.0977E-06  0.0000E+00  0.0000E+00
 Cesium:
  3.8016E-05  4.8788E-09  0.0000E+00  0.0000E+00
 Tellurium:
  0.0000E+00  1.2197E-09  0.0000E+00  0.0000E+00
 Strontium:
  0.0000E+00  4.8788E-10  0.0000E+00  0.0000E+00
 Barium:
  0.0000E+00  4.8788E-10  0.0000E+00  0.0000E+00
 Ruthenium:
  0.0000E+00  6.0984E-11  0.0000E+00  0.0000E+00
 Cerium:
  0.0000E+00  1.2197E-11  0.0000E+00  0.0000E+00
 Lanthanum:
  0.0000E+00  4.8788E-12  0.0000E+00  0.0000E+00
 Non-Radioactive Aerosols (kg):
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 End of Release File
```

	A	B	C	D	E	F	G	H	I	J	K	L
1						Core	Release	Initial Core		Decay	Release to	Release to
2				Half-Live	Nominal	Source	Fractions	Activity	Half-Live	Constant	Delay Bed	Environment
3	Nuclide	Isotope	Class	(seconds)	At. Wt.	Ci/MW	0-0.5hr	(Ci)	(hours)	(hours)$^{-1}$	(Ci)	(Ci)
4	003:	Kr-85	1	3.38E+08	85	4.3644E+02	0.05	1.32E+06	9.40E+04	7.38E-06	4.46E+03	4.46E+03
5	004:	Kr-85m	1	1.61E+04	85	6.7720E+03	0.05	2.04E+07	4.48E+00	1.55E-01	6.92E+04	3.44E+03
6	005:	Kr-87	1	4.58E+03	87	1.2910E+04	0.05	3.89E+07	1.27E+00	5.45E-01	1.32E+05	3.37E+00
7	006:	Kr-88	1	1.02E+04	88	1.8150E+04	0.05	5.47E+07	2.84E+00	2.44E-01	1.85E+05	1.63E+03
8	038:	Xe-133	1	4.53E+05	133	5.2821E+04	0.05	1.59E+08	1.26E+02	5.51E-03	5.40E+05	7.84E+04
9	039:	Xe-135	1	3.27E+04	135	2.1437E+04	0.05	6.47E+07	9.09E+00	7.63E-02	2.19E+05	5.45E-07
10												
11												
12	0.003388	=CRDA Noble Gas Release Fraction[3]										
13	19.4	=Krypton Holdup in Delay Bed (hrs)[4]										
14	350.4	=Xenon Holdup in Delay Bed (hrs)[4]										
15	2.51E-04	=Worst Case EAB X/Q (sec/m3)5										
16	2.63E-05	=Worst Case LPZ X/Q (sec/m3)5										
17	1.30E-03	=Worst Case CR X/Q (sec/m3)6										
18	3.59E-02	=Control Room Geometry Factor (Murphy-Campe Based)[2]										
19												
20												
21		Release to										
22		Environment	DCF[1]	EAB Dose	LPZ Dose	CR Dose						
23	Isotope	(Ci)		(rem TEDE)	(rem TEDE)	(rem TEDE)						
24	Kr-85	4.46E+03	4.403E-04	4.93E-04	5.16E-05	9.16E-05						
25	Kr-85m	3.44E+03	2.768E-02	2.39E-02	2.50E-03	4.44E-03						
26	Kr-87	3.37E+00	1.524E-01	1.29E-04	1.35E-05	2.40E-05						
27	Kr-88	1.63E+03	3.774E-01	1.54E-01	1.62E-02	2.87E-02						
28	Xe-133	7.84E+04	5.770E-03	1.14E-01	1.19E-02	2.11E-02						
29	Xe-135	5.45E-07	4.400E-02	6.02E-12	6.31E-13	1.12E-12						
30												
31		Total Dose (rem TEDE):		2.92E-01	3.06E-02	5.44E-02						
32												
33												
34												
35	[1]	Dose Conversion Factor (rem-m^3/Curie-second) from FGR 12 per Reg. Guide 1.183										
36	[2]	K.G. Murphy and K.W. Campe, 13th AEC Air Cleaning Conference, "Nuclear Power Plant Control Room										
37		Ventilation System Design for Meeting General Criterion 19", August 1974										
38	[3]	Summation from Attachment A										
39	[4]	Section 11.3 of Dresden UFSAR										
40	[5]	Reference 8										
41	[6]	Reference 8										

	A	B	C	D	E	F	G	H	I	J	K	L
1						Core	Release	Initial Core		Decay	Release to	Release to
2				Half-Live	Nominal	Source	Fractions	Activity	Half-Live	Constant	Delay Bed	Environment
3	Nuclide	Isotope	Class	(seconds)	At. Wt.	Ci/MW	0-0.5hr	(Ci)	(hours)	(hours)$^{-1}$	(Ci)	(Ci)
4	003:	Kr-85	1	338297472	85	436.442857142857	0.05	=F4*3016	=D4/3600	=LN(2)/I4	=H4*A12	=K4*EXP(-J4*A13)
5	004:	Kr-85m	1	16128	85	6772	0.05	=F5*3016	=D5/3600	=LN(2)/I5	=H5*A12	=K5*EXP(-J5*A13)
6	005:	Kr-87	1	4578	87	12910	0.05	=F6*3016	=D6/3600	=LN(2)/I6	=H6*A12	=K6*EXP(-J6*A13)
7	006:	Kr-88	1	10224	88	18150	0.05	=F7*3016	=D7/3600	=LN(2)/I7	=H7*A12	=K7*EXP(-J7*A13)
8	038:	Xe-133	1	453168	133	52821.4285714286	0.05	=F8*3016	=D8/3600	=LN(2)/I8	=H8*A12	=K8*EXP(-J8*A14)
9	039:	Xe-135	1	32724	135	21437.1428571429	0.05	=F9*3016	=D9/3600	=LN(2)/I9	=H9*A12	=K9*EXP(-J9*A14)
10												
11												
12	0.0033875701569762	=CRDA Noble Gas Release Fr										
13	19.4	=Krypton Holdup in Delay Bed										
14	=14.6*24	=Xenon Holdup in Delay Bed (I										
15	0.000251	=Worst Case EAB X/Q (sec/m3										
16	0.0000263	=Worst Case LPZ X/Q (sec/m3										
17	0.0013	=Worst Case CR X/Q (sec/m3)										
18	=(64000^0.338)/1173	=Control Room Geometry Fact										
19												
20												
21		Release to										
22		Environment	DCF[1]	EAB Dose	LPZ Dose	CR Dose						
23	Isotope	(Ci)		(rem TEDE)	(rem TEDE)	(rem TEDE)						
24	Kr-85	=L4	0.0004403	=$B24*$A$15*$C24	=$B24*$A$16*$C24	=$B24*$A$17*$C24*A18						
25	Kr-85m	=L5	0.027676	=$B25*$A$15*$C25	=$B25*$A$16*$C25	=$B25*$A$17*$C25*A18						
26	Kr-87	=L6	0.15244	=$B26*$A$15*$C26	=$B26*$A$16*$C26	=$B26*$A$17*$C26*A18						
27	Kr-88	=L7	0.3774	=$B27*$A$15*$C27	=$B27*$A$16*$C27	=$B27*$A$17*$C27*A18						
28	Xe-133	=L8	0.00577	=$B28*$A$15*$C28	=$B28*$A$16*$C28	=$B28*$A$17*$C28*A18						
29	Xe-135	=L9	0.044	=$B29*$A$15*$C29	=$B29*$A$16*$C29	=$B29*$A$17*$C29*A18						
30												
31			Total Dose (rem TEDE):	=SUM(D24:D29)	=SUM(E24:E29)	=SUM(F24:F29)						
32												
33												
34												
35		[1]Dose Conversion Factor (rem-m^3/C										
36		[2]K.G. Murphy and K.W. Campe, 13th AEC Air Cleaning Conference, "Nuclear Power Plant Control Room Ventilation System Design for Meeting General Criterion 19",										
37		August 1974										
38		[3]Summation from Attachment A										
39		[4]Section 11.3 of Dresden UFSA										
40		[5]Reference 8										
41		[6]Reference 8										

Computer Disclosure Sheet

Discipline Nuclear

Client: Exelon Corporation
Project: Dresden Units 2&3 CRDA AST

Date: August, 2005
Job No.

Program(s) used	Rev No.	Rev Date
Attachment A spreadsheet	N/A	N/A
Attachment E spreadsheet	N/A	N/A

Calculation Set No.: DRE02-0037, Rev. 1

Status [ ] Prelim.
[X] Final
[ ] Void

WGI Prequalification [ ] Yes
[X] No

Run No. Description:

Analysis Description: Spreadsheet used to perform dose assessments for CRDA, as described in calculation.

The attached computer output has been reviewed, the input data checked,
And the results approved for release. Input criteria for this analysis were established.

By: On: August 2005

Run by: H. Rothstein Harold Rothstein

Checked by: P. Reichert P. Reichert

Approved by: H. Rothstein Harold Rothstein

Remarks:
This spreadsheet is applied in a straight-forward manner and was hand checked. The Attachments include the spreadsheets in both normal and formula display mode and therefore is completely documented.

Computer Disclosure Sheet

Discipline Nuclear

Client: Exelon Corporation
Project: Dresden Units 2&3 CRDA AST

Date: August 2005
Job No.

Program(s) used:	Rev No.	Rev Date	Calculation Set No.: DRE02-0037, Rev. 0
RADTRAD 3.03 Runs in Att. B	0	January 2003 (Prequalification Date)	
RADTRAD 3.03 NIF File in Att. C	0	January 2003	Status [ ] Prelim.
RADTRAD 3.03 RFT File in Att. D	0	January 2003	[X] Final

WGI Prequalification [X] Yes
[ ] No

Run No. Description:

Analysis Description: RADTRAD output files, where applied to calculations of CRDA dose assessments, as described in calculation.

The attached computer output has been reviewed, the input data checked,
And the results approved for release. Input criteria for this analysis were established.

By: On: August 2005

Run by: H. Rothstein Harold Rothstein

Checked by: P. Reichert P. Reichert

Approved by: H. Rothstein Harold Rothstein

Remarks:
The RADTRAD computer code is applied in a manner fitting its intended purpose, and well within its operating parameters. All outputs were hand checked. Attachments C & D include the Nuclide Information File and Release Fraction and Timing File used by the RADTRAD code and generated specifically for the Dresden Nuclear Power Station. Both were also hand checked for accuracy.