# *Analysis of Transportation and Handling Impacts Related to the Proposed Replacement Capability for Disposal of Remote-Handled Low-Level Waste*

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# ACRONYMS

| | |
|---|---|
| ARF | Airborne Release Fraction |
| ATR | Advanced Test Reactor |
| CSDR | Conceptual Safety Design Report |
| DCF | Dose Conversion Factor |
| DOE | U.S. Department of Energy |
| DR | Damage Ratio |
| EA | Environmental Assessment |
| ICRP | International Commission on Radiological Protection |
| ISCORS | Interagency Steering Committee on Radiation Standards |
| LCF | Latent Cancer Fatality |
| LLW | Low-Level Waste |
| LPF | Leak Path Factor |
| MAR | Material at Risk |
| MEI | Maximally Exposed Individual |
| NEPA | National Environmental Policy Act |
| NNSS | Nevada National Security Site |
| NRC | Nuclear Regulatory Commission |
| RF | Respirable Fraction |
| TRU | Transuranic |
| ST | Source Term |

# Analysis of Transportation and Handling Impacts Related to the Proposed Replacement Capability for Disposal of Remote-Handled Low-Level Waste

## 1. INTRODUCTION

The Department of Energy (DOE) is planning for proposed replacement capability for disposal of remote-handled low-level waste (LLW) generated from activities at the DOE's Idaho site. The project disposal activities would be planned to span a 50-year disposal period.

The purpose of this report is to assess the potential impacts to the human environment from transport of remote-handled LLW for disposal. The results of this assessment will be used in the National Environmental Policy Act (NEPA) Environmental Assessment (EA) for the project. The EA includes two action alternatives for achieving the proposed action – onsite disposal at the Idaho site and offsite disposal of all waste at the Nevada National Security Site (NNSS). Because remote-handled ion-exchange resins from the Advanced Test Reactor (ATR) are currently being shipped offsite to NNSS, the no action alternative involves continued shipments of 6 containers of this waste to NNSS per year so long as conditions for disposal at NNSS remain favorable. Therefore, transportation and handling of remote-handled LLW is involved in each alternative.

DOE guidance is used to establish the approach for this transportation and handling impacts analysis (DOE 2002, DOE 2002a, DOE 2004). According to this guidance, both incident-free transportation and transportation accidents should be evaluated for any alternative involving transportation of radioactive and/or hazardous materials. NEPA employs a 'sliding scale' approach that allows the agency to tailor the analysis to the issues involved in the proposed action. Depending on the proposed action and the alternatives being considered, transportation and handling risks may be evaluated for the following persons or groups: a worker (driver), a co-located worker, a maximally exposed individual, and populations along the transport route (off-link and on-link).

This analysis begins with establishing assumptions about the type of wastes to be shipped under the alternatives. For routine or incident free transport, shipments are assumed to be in compliance with allowable limits for exposure from shipping containers of LLW. For the accident scenarios, a representative radionuclide inventory for a shipment of remote-handled LLW was developed for the onsite and offsite shipment alternatives. For the no action alternative accident scenario, the radionuclide inventory from a shipping container of ATR ion-exchange resins is used.

The analysis then reviews the alternatives for impacts under routine or incident free shipping and under accident conditions. For the onsite alternative, it is assumed that the public would not be exposed during incident-free shipments due to use of a recently approved new road within the borders of the Idaho site to which the public will not have access. It is also assumed that impacts to workers onsite from routine handling and transport would be maintained with in DOE occupational safety requirements of 5 rem/year for radiological workers. Impacts to the driver, a collocated worker, and the public are evaluated under an onsite accident scenario.

Under the no action and offsite alternatives, it is assumed that there are potential impacts to the public from incident free shipments due to use of public highways. Impacts from incident-free shipments to the collective population along two potential transportation routes are presented. For the offsite accident scenario, it is assumed the accident could occur in an urban area. Impacts to the surrounding population,

to the driver, to the crew, and to a maximally exposed individual (MEI) close to the accident are presented.

# 2. IDENTIFICATION OF RADIONUCLIDE INVENTORY

Routine or incident-free transport scenarios assume that a container must meet certain contact-dose criteria for shipment; therefore, specific inventory information is not required to analyze incident-free transport. However, a key step in conducting a transportation accident analysis is to identify the radionuclide inventory of the remote-handled LLW planned for transport and that may be released in the event of an accident. The radionuclide inventory used for this NEPA analysis is based upon information provided by the generating facilities (INL 2010, INL 2010a, NRF 2011). This information was used to develop the maximum expected Curies per cubic meter of remote-handled LLW for each radionuclide contributing to the radionuclide dose. For purposes of the analysis, the radionuclides that together contribute 99% of the dose were included in the analysis.

The inventory information is used for determination of the effects of an accident involving release of the contents of a container during transport and/or handling. For the onsite accident scenario, it was assumed that a shipment could carry a container with a 7 $m^3$ capacity, based on current planning for waste shipments from NRF. This is assumed to be the largest container with the greatest inventory for purposes of analyzing the onsite accident. Based on a maximum concentration of NRF waste of 1,000 Curies/$m^3$ of Co-60, an onsite shipment would therefore be estimated at a maximum Co-60 activity of 7,000 Curies per shipment. Shipments from the other INL facilities would not require a container with a 7 $m^3$ capacity, and are assumed contain less Curies than an NRF shipment under the onsite scenario. Maximum Curie concentrations for other nuclides which make up 99% of the dose were included in the container inventory.

Under the alternative of disposing all waste offsite, remote-handled LLW activated metals from ATR present the greatest concentrations of radionuclides that could be released in an accident. For this scenario, a 7 $m^3$ size container could not be approved for shipment using public highways. It is assumed that smaller, 1 $m^3$ shipments would be made offsite for this waste. Therefore, for the offsite accident analysis, the ATR activated metal waste inventory information was used, with the exception that the amount of Co-60 was set at an administrative upper limit of 6,000 Curies per shipment that would be applied through operational controls during packaging at the generating facility. It is assumed that system components would be split into 6,000 Curie packages (1 $m^3$) for shipment, with the other major contributing nuclides included at the maximum Curie inventory.

The no action accident scenario takes into account the current practice of shipping the ATR ion-exchange resins using a NuPac 210-14L Type A shipping cask. It is assumed that this cask could contain up to 6 $m^3$ of remote-handled LLW per shipment. The radionuclide inventory is based upon ATR waste inventory information for the ion-exchange resins.

# 3. TRANSPORTATION AND HANDLING UNDER THE ONSITE ALTERNATIVE

The onsite alternative involves construction of a replacement disposal facility on the Idaho site. The EA will examine two candidate onsite locations, and it is assumed that transportation and handling impacts would be similar for either location. Transport in the 55-ton cask currently used for shipments from the Naval Reactors Facility is assumed as the base case for the onsite alternative.

## 3.1 Onsite Routine Handling and Transport

For routine handling of remote-handled LLW shipments for onsite disposal, exposures to workers would be maintained to assure they are within DOE Occupational Exposure limits of 5 rem/year for radiological workers (DOE 1994a). The public would not have access to the disposal facility. No public roads will be used. Routine waste transport and handling of remote-handled LLW for onsite disposal is not expected to involve impacts to the public.

## 3.2 Onsite Accident Scenario

The analysis of potential accidents involved with onsite transport and handling of the remote-handled LLW has been documented in the Conceptual Safety Design Report (CSDR) for the project (INL 2010b). The CSDR supports the design of a proposed onsite remote-handled LLW disposal facility by providing an initial nuclear facility hazard categorization, identifying potential hazards for processes associated with onsite handling and disposal of remote-handled LLW, evaluating consequences of postulated accidents, and discussing the need for safety features that will become part of the facility design.

The CSDR includes the following range of postulated events that are selected as representative, bounding, or unique:

- Container drop accident (bounds all radioactive material release events)
- Vehicle fuel fire (bounds all fire and explosion events)
- Direct radiation exposure during waste container handling (representative for all direct radiation exposure events)
- Severe seismic event (representative for all natural phenomena hazard events)
- External events (consequences bounded by other events).

For purposes of this onsite transportation and handling accident scenario, it was determined that the CSDR accident of a vehicle fuel fire represented a reasonably foreseeable accident that would not be entirely avoided by facility design. Therefore, this accident was selected as the basis for analysis of the impacts from a severe accident involving a waste transport vehicle crash and fuel fire. The following assumptions and approaches were used for this accident scenario:

1. The lifting and handling of transportation packages and waste containers requires use of trucks, tractor/trailer combinations, and a crane. These vehicles introduce the potential for a vehicle fire that is postulated to occur during transport or during transportation package/waste container unloading activities. Such a fire is postulated to initiate from fuel from the transport vehicle or crane and entirely engulf the transportation package/waste container being transported or unloaded, resulting in volatilization of a fraction of the waste material being handled. This accident analysis considers only material that is affected by the thermal stresses from the fire as container boundaries are breached. Material already in storage is not involved in this accident. The likelihood of this accident is judged as unlikely based on the limited number of miles that transport vehicles would travel on the remote-handled LLW disposal facility site, low speeds, and robust transportation package/waste container design that would prevent a fire from spreading to engulf the entire contents.

2. Dose to the facility worker, collocated worker, and public in this case is assumed to be from intake of radiological material made airborne in the fire. The Material at Risk (MAR) in this scenario is limited to the contents of a single waste container. The unmitigated analysis performed for this event takes no credit for safety features that could mitigate the consequences. This analysis assumes a container failure rate or damage ratio (DR) of 10%, an airborne release fraction (ARF) of 0.05%, and a respirable fraction (RF) of 100%, consistent with the CSDR.

3. The estimate of the radiation dose is then converted to an estimate of health effects. Exposure of populations to low levels of ionizing radiation is associated with an estimated number of resulting latent cancer fatalities (LCFs) in the exposed population. If an accident involved radiation exposures, the potential LCFs would be a consequence. The numbers of radiation-induced LCFs are estimated by multiplying the dose (person-rem) by health risk conversion factors. These factors relate the radiation dose to the potential number of expected LCFs based on comprehensive studies of people historically exposed to large doses of radiation, such as the Japanese atomic bomb survivors. The factors most commonly used in recent assessments are 0.0006 LCF per person-rem of exposure for workers and for members of the public (Interagency Steering Committee on Radiation Standards [ISCORS] 2002).

The RISKIND model was used to estimate the effects from an accident under the onsite alternative. RISKIND estimates risk to populations and to MEIs or receptors at selected locations under hypothetical exposure scenarios that are defined by distance, duration, and frequency of exposure specific to that receptor. The RISKIND model calculates dose as a function of rem per event for moving shipments based on the shipment dimensions.

The RISKIND model and the other transportation models used in this analysis contain data sets of standard values for many parameters that are not route- or package-specific. The analysis uses these data sets to the fullest extent possible. Scenario specific data was also identified from existing sources or based on guidance for developing conservative assumptions (DOE 2002a). The key inputs to RISKIND for the accident analysis are provided in Table 1. A complete list of the action specific input parameters that were applied for the analysis is included in Appendix A.

Table 1. Key accident-specific factors used in RISKIND model for transportation accident analysis.

| **Location of MEI** | **Collision Speed (km/hr)** | **Angle of Impact** | **Duration of Fire** | **Temperature of Fire** | **DR** | **Contaminated Combustible Solids** | | **NRC Risk Response Region (automatically assigned in RISKIND)** |
|---|---|---|---|---|---|---|---|---|
| | | | | | | **ARF** | **RF** | |
| Neutral conditions at 328 ft (160 m) | 65 | 90 | .75 hour | 1350 K | 1.0E-01 | 5.0E-04 | 1.0E+00 | Region VI – probability of 2.33E-07 |

ARF – Airborne Release Fraction
DR – Damage Ratio
RF – Release Fraction

The doses and LCF risk based on the RISKIND evaluation of the onsite accident scenario are shown in Table 2. The facility worker is assumed to be located at the site of the accident. The collocated worker is located 328 ft (100 m) away, and a member of the public is located 2.5 mi (4 km) from the accident (the point of nearest public access to the candidate sites). A report of the RISKIND model input and output is included as Appendix B.

Table 2. Onsite accident scenario.

| Onsite vehicle crash and fuel fire | Facility Worker | | Collocated Worker | | Offsite Public | |
|---|---|---|---|---|---|---|
| | Dose (rem) | LCF Risk | Dose (rem) | LCF Risk | Dose (rem) | LCF Risk |
| | 0.018 | 1E-05 | 0.011 | 7E-06 | 0.000082 | 5E-08 |

DCF – dose conversion factor
LCF – latent cancer fatality

# 4. OFFSITE ALTERNATIVE OF TRANSPORT TO NEVADA NATIONAL SECURITY SITE INCLUDING THE NO ACTION ALTERNATIVE

The offsite alternative involves transport of the remote-handled LLW generated from the Idaho site to the NNSS for disposal. The scenarios include transport of ATR ion-exchange waste only under the no action alternative and transport of all of INL's projected remote-handled LLW under the offsite transportation alternative. Potential impacts to the public and the crew from routine transport and accidents are included in the analysis. These offsite transportation impacts were analyzed in accordance with the 2002 Resource Handbook on DOE Transportation Risk Assessment (DOE 2002).

## 4.1 Computer Models Used in the Analysis

In addition to RISKIND, described in section 3, two computer codes were used to complete the analysis for offsite transportation and handling impacts:

1. TRAGIS – an origin-and-destination pair for a shipment can be entered and the code sets routes for the shipment and designates route segments as urban, suburban or rural so that population densities within 50 mi (80 km) of the route can be estimated. Two potential transport routes have been identified for this alternative, any of which may be taken depending upon the conditions at the time of transport. Route A is the preferred route because it passes through the least populated areas and is shorter than Route B. The two routes are shown on Figure 1. Table 3 summarizes the data generated from TRAGIS for the two routes.

2. RADTRAN – output from TRAGIS is used as input for RADTRAN to set the route segments and associated population densities along each route. RADTRAN calculates collective risks to workers and the public along each route based on representative radiological and physical properties of the material being transported. The dose to crew members along the route, including stops, represents the collective dose to workers. The exposures to members of the pubic within 2,625 ft (800 m) of the transport link (off-link), sharing the transport link (on-link) and at stops are added to yield the collective dose to the public.

Table 3. Route-specific data for the two proposed transportation routes.

| Route Designator | Distance by State (miles) | | | Total Distance | Population Along Route by State | | | Total Population |
|---|---|---|---|---|---|---|---|---|
| | ID | NV | UT | | ID | NV | UT | |
| Route A | 185.9 | 528.2 | 0 | 714.1 | 17,223 | 7,952 | 0 | 25,175 |
| Route B | 140.2 | 441.3 | 210.7 | 792.1 | 17,084 | 7,664 | 86,736 | 111,484 |

## 4.2 Routine or Incident-Free Transportation

Assessment of incident-free transportation impacts involves assessment of collective population dose and of individual doses that may be received along the two potential transport routes from the Idaho site to the NNSS. The transport routes generated using TRAGIS were used as input to RADTRAN (Figure 1).

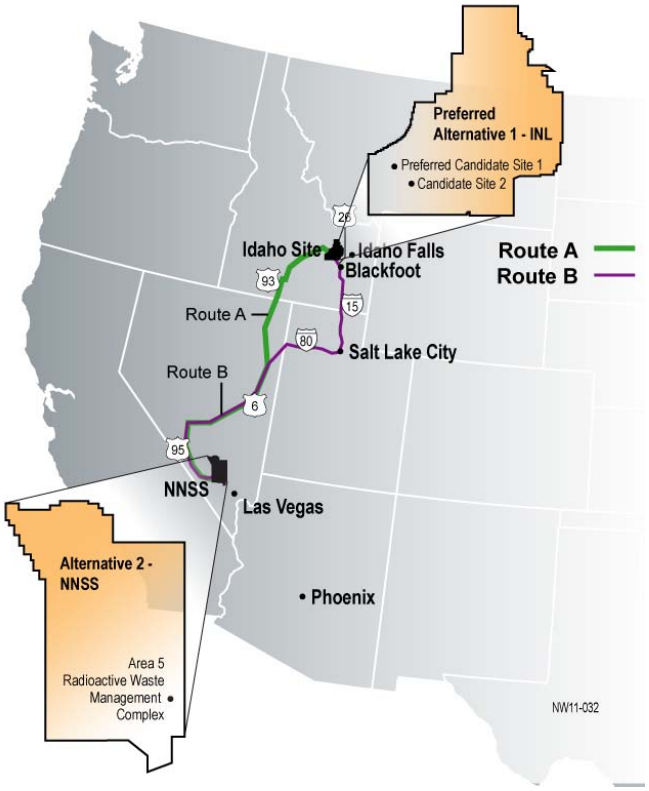


Figure 1. Transportation routes from the Idaho site to the Nevada National Security Site.

Vehicle density and speeds along the segments are based on guidance from the RADTRAN manual. TRAGIS provides information on population distribution along the transport route by state. Table 3 provides the route-specific population data used for the analysis. It is estimated that six shipments will be conducted each year under the no action alternative and that 117 shipments will be conducted each year under the alternative for disposal of all waste offsite.

Nuclear Regulatory Commission (NRC) transportation regulations limit exposures from the contents of the shipping container to10 mrem/hour at 2 meters. However, in accordance with the DOE Handbook for analyzing transportation of remote-handled waste, the exposure limit of 10 mrem/hour at 1 meter was used (DOE 2002a).

It is assumed that the vehicle would stop three times for refueling for each shipment. The vehicle would be a truck-trailer combination carrying a shipping cask authorized by NRC or DOE for transport of Type B quantity radioactive materials.

Off-link doses, on-link doses, doses to crew members, and doses at stops can be included in the calculation of doses using the RADTRAN computer code. Appendix C to this report includes the results of the RADTRAN code run for each of the two shipment routes presented under this alternative.

The estimated collective population dose per shipment can be estimated by adding the off-link, on-link, and stop doses to a dose per shipment. This per shipment dose can be multiplied by the number of shipments per year to estimate the total potential annual dose that could be received by members of the public. Consequences of the dose are expressed in terms of LCF risk using the ISCORS health risk conversion factor of 0.0006 LCF/rem of exposure. Table 4 presents the results of the analysis of impacts to the population along the route for six shipments per year (the no action alternative) and for 117 shipments per year (the offsite transport alternative).

Table 4. Transportation impacts to the surrounding population from routine shipment of remote-handled low-level waste from the Idaho site to the Nevada National Security Site.

| Transport Route | Off-link Dose[1] | On-link Dose | Total Stop Dose[2] | Per Shipment Dose | Dose Per Year (6 Shipments) | LCF Risk[3] | Dose Per Year (117 Shipments) | LCF Risk[3] |
|---|---|---|---|---|---|---|---|---|
| Route A | 0.00014 | 0.0066 | 0.072 | 0.079 | 0.47 | 0.00028 | 9.2 | 0.006 |
| Route B | 0.0002 | 0.0073 | 0.072 | 0.08 | 0.48 | 0.00029 | 9.4 | 0.006 |

1. Dose is presented in person-rem.
2. Total stop dose assumes three ½-hour stops made during the course of each shipment.
3. Conversion factor of 0.0006LCFs per person rem used.

Table 5 presents the results of the RADTRAN analysis for each of the two crew members. It is assumed the crew would be DOE or contractor employees working under DOE requirements that set an administrative control limit of 5 rem/year for radiological workers (LCF risk 3.00E-03).

Table 5. Transportation impacts to the crew from routine shipment of remote-handled low-level waste from the Idaho site to the Nevada National Security Site.

| Transport Route | Crew Member Dose[1] | Total Stop Dose[2] | Per Shipment Dose | Dose Per Year (6 Shipments) | LCF Risk[3] | Dose Per Year (117 Shipments) | LCF Risk[3] |
|---|---|---|---|---|---|---|---|
| Route A | 0.039 | 0.04 | 0.079 | 0.47 | 0.00028 | 9.2 | 0.006 |
| Route B | 0.043 | 0.04 | 0.083 | 0.50 | 0.0003 | 9.7 | 0.006 |

1. Dose is presented in rem.
2. Total stop dose assumes three ½-hour stops made during the course of each shipment.
3. Conversion factor of 0.0006 LCFs per person-rem used.

## 4.3 Accident Scenarios for the No Action and Offsite Disposal Alternatives

The potential impacts of accidents occurring during offsite transportation were based on the radionuclide content of a container of ion-exchange resins from ATR for the no action alternative and on the radionuclide content of a representative drum of remote-handled LLW for the alternative of disposal of all waste offsite at NNSS.

The scenario involves a collision resulting in a fire and release of the contents of the shipping container. This scenario is that same as that used for the onsite accident analysis and assumes that the collision takes place on a public highway. The RISKIND computer code was used to estimate impacts to the population in an urban area, and to the crew, a collocated worker, and a MEI from a reasonably severe accident. The accident specific factors used are included in Table 6. For purposes of the analysis, the driver was located 10 ft (3 m) from the accident. The collocated worker was located 328 ft (100 m) away. Using other DOE NEPA analysis as guidance (DOE 1997), the MEI was located 525 ft (160 m) away from the accident, under neutral weather conditions. The complete results of the RISKIND modeling for offsite accidents are included as Appendix D.

The collective population dose in an urban area from the accidental release of radioactive materials caused by a shipping accident involving a fuel fire and an impact severe enough to damage a shipping container is shown in Table 6. Dose and risk of LCF is presented for the surrounding population, a MEI, the driver and a collocated worker.

Table 6. RISKIND results for offsite transportation accident for no action and offsite disposal alternatives.

| Accident | Collective Population Dose | Collective Population LCF | Dose to MEI | MEI LCF | Dose to Driver | Driver LCF | Dose to Collocated Worker | Collocated Worker LCF |
|---|---|---|---|---|---|---|---|---|
| No Action | .029 person rem | <0.0001 | 0.00013 | <0.0001 | 0.0072 | <0.0001 | 0.00019 | <0.0001 |
| Offsite Disposal | 1.8 person rem | 0.001 | 0.0083 | <0.0001 | 0.077 | <0.0001 | 0.011 | <0.0001 |

# 5. NON-RADIOLOGICAL TRANSPORTATION IMPACTS

Non-radiological impacts related to transportation for the onsite, no action, and offsite alternatives result simply from transporting any material from one location to another independent of the characteristics of the cargo. The presence or absence of cargo is not a factor in the assessment of these risks. Non-radiological risks are directly related to vehicle emissions (greenhouse gases) and the probability of latent health effects from vehicle exhaust or accident related injury/fatality. Table 7 identifies the transportation characteristics for the onsite, no action, and offsite alternatives and applies documented rates of occurrence or risk factors as appropriate.

Table 7. Estimated annual emissions and fatalities resulting from onsite, no action, and offsite shipments.

| Impact Type | Factor | Onsite | No Action | Offsite |
|---|---|---|---|---|
| Miles/Round Trip (mi) | - | 30 mi | 1,584 mi | 1,584 mi |
| Trips/Year (mi) | - | 51 Trips | 6 Trips | 117 Trips |

| Impact Type | Factor | Onsite | No Action | Offsite |
|---|---|---|---|---|
| Distance/Year | - | 1,530 mi<br>2,463 km | 9,504 mi<br>15,295 km | 185,328 mi<br>298,378 km |
| Gallons/Year | 6.6 mi/gallon[1] | 231 gal | 1,440 gal | 28,080 gal |
| Greenhouse Gases | 22.2 lb/gal[2] | 5,128 lb<br>3 tons | 31,968 lb<br>16 tons | 623,376 lb<br>312 tons |
| Exhaust Emission Fatality | 8.36E-10/km[3] | 2.06E-06 | 1.28E-05<br>0.0000128 | 2.5E-04<br>0.00025 |
| Accident Injury | 1.62E-07/km[4] | 4E-04 | 2.48E-03<br>0.00248 | 4.8E-02<br>0.048 |
| Accident Fatality | 2.49E-08/km[5] | 6.1E-05 | 3.8E-04 | 7.4E-03 |

[1] Huai et al., 2006.
[2] EPA 2005.
[3] Unit risk factor of $8.36 \times 10^{-10}$ fatalities/km used for exhaust emissions (Biwer and Butler 1999).
[4] Nevada accident rate of 1.62E-07 per km (heavy truck accidents) used.
[5] Idaho fatality rate of 2.49E-08 fatalities per km (heavy truck accidents) used.

# 6. SUMMARY

For the onsite alternative, no exposure to the general public from incident-free transport is expected. Exposure to workers would be maintained within administrative limits for DOE workers of 5 rem/year (DOE 1994a).

For a severe onsite accident, the estimated LCF risk from a vehicle crash/fuel fire to a member of the public located 2.5 mi (4 km) (the point of nearest public access to the candidate sites), to a facility worker, and to a collocated worker is presented in Table 8.

Table 8. Onsite Accident expected doses and LCF risk to member of public, facility worker, and collocated worker.

| Onsite vehicle crash and fuel fire | Facility Worker | | Collocated Worker | | Offsite Public | |
|---|---|---|---|---|---|---|
| | Dose (rem) | LCF Risk | Dose (rem) | LCF Risk | Dose (rem) | LCF Risk |
| | 0.018 | 1E-05 | 0.011 | 7E-06 | 0.000082 | 5E-08 |

DCF – dose conversion factor
LCF – latent cancer fatality
N/A – Not Applicable

For the no action and offsite alternatives, incident-free radiological exposure per shipment is estimated for general public and the drivers in Table 9. Exposure to drivers would be maintained within administrative limits for DOE workers of 5 rem/year (DOE 1994a).

Table 9. Offsite incident-free transportation – expected dose and LCF risks to the collective population and the crew per shipment.

| Route | Dose to Collective Population | LCF Risk | Dose to Crew | LCF Risk |
|---|---|---|---|---|
| Route A | 0.079 | 4.74E-04 | 0.079 | 4.68E-04 |
| Route B | 0.08 | 4.80E-04 | 0.083 | 4.98E-04 |

For the no action and offsite alternatives, estimated dose and LCF risk from the accidental release of radioactive materials caused by a shipping accident involving a fuel fire and an impact severe enough to damage a shipping container for the collective population, a member of the public, the driver and the collocated worker is presented in Table 10. There is no risk of an acute cancer fatality under any of the accident scenarios.

Table 10. Estimated dose and LCF risk from offsite accident to collective population, maximally exposed individual, driver, and collocated worker under no action and offsite disposal alternatives.

| Accident | Collective Population Dose | Collective Population LCF | Dose to MEI | MEI LCF | Dose to Driver | Driver LCF | Dose to Collocated Worker | Collocated Worker LCF |
|---|---|---|---|---|---|---|---|---|
| No Action | .029 person rem | 0.000017 | 0.00013 | <0.00001 | .0.0072 | <0.00001 | 0.00019 | <0.00001 |
| Offsite Disposal | 1.8 person rem | 0.001 | 0.0083 | <0.00001 | 0.077 | <0.0001 | 0.011 | <0.0001 |

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# Appendix A

## Specific Data for Entry into RADTRAN and RISKIND Models and Assessment

**Specific Data for Entry into RADTRAN and RISKIND Models and Assessment**

| Parameter | RADTRAN (RT), RISKIND (RK) or Both | Number/Value | Source |
|---|---|---|---|
| Number of Shipments | Both | Onsite: 51 annual<br>No Action: 6 annual<br>Offsite: 117 annual | DOE |
| Dose rate of container | Both | 10 mrem/hour at 1 m | DOE Transportation Handbook values for RH waste. |
| Package long dimension | RT | 3.30 m | Dimensions for CNS 10-160B Cask, assumed to be typical |
| Gamma fraction | Both | 1 | Assumed to be all gamma |
| Neutron fraction | RT | 0 | Assumed to be all gamma |
| Crew size | RT | 2 | Waste Management Programmatic EIS (Appendix E Part 1 – Transportation Risk Assessment) |
| Crew distance from source | RT | 3 m | Waste Management Programmatic EIS (Appendix E Part 1 – Transportation Risk Assessment) |
| Crew Shielding | RT | 1 | No shielding assumed |
| Crew view | RT | 3.30 m | Assume upright cask – largest dimension of cargo facing crew is same as the length of the cask |
| Exclusive use | RT | yes | Assume exclusive use |
| Radionuclides | Both | Onsite: 7000 Ci of Co-60 per shipment plus the other radionuclides that together contribute 99% of the dose<br><br>Offsite: 6000 of Co-60 per shipment plus the other radionuclides that together contribute 99% of the dose | Onsite: Based on a maximum activity concentration of 1000 Ci/m$^3$ Co-60 and the worst case concentrations for all other radionuclides (NRF, 2011)<br><br>Offsite: Based on an administrative upper limit of 6000 Ci Co-60 and the worst case inventory for all other radionuclides from ATR, as documented in ECAR-854<br><br>No Action: Based on inventory of ion-exchange resins from ATR as documented in ECAR-851 |
| Transport route | RT | 1204 km | Established through TRAGIS |
| Speed – incident free | RT | 121km/hr – rural<br>88 km/hr – suburban and urban | Assumed 70 mph for transport through rural areas and 55 mph for suburban and urban areas. |
| Population density | RT | Varies | Population density established through TRAGIS |
| Vehicle density | RT | Rural:1155 vehicles/hr<br>Suburban: 2414 vehicles/hr<br>Urban: 5490 vehicles/hr | Sandia National Lab Study, referenced in RADCAT Manual |
| Persons per vehicle sharing route | RT | 2 | RADCAT guidance; WM PEIS value |
| Population density zones | Both | Rural, suburban, and urban | Zones established through TRAGIS based on US Census data. Value of 1303 persons/km$^2$ used for urban area population density in RISKIND (based |

| Parameter | RADTRAN (RT), RISKIND (RK) or Both | Number/Value | Source |
|---|---|---|---|
| | | | on DOE Transportation Handbook guidance). |
| Type of Highway | RT | Primary | Choices are primary or secondary. |
| | RK | Interstate | Choices are interstate, primary or secondary |
| Farm Fraction | RT | Varies | Fraction of farmland for rural areas based on DOE Transportation Handbook values |
| Stops | RT | 3 stops for refueling (1/2 hour each). Each stop involves crew, people at refueling station and residents near stop. No shielding assumed. | RADCAT User Guide – 1 person for crew, 1.3 x $10^4$ people/km for rest stop, suburban population of 2.41 x $10^3$/km for residents near stop |
| Handling | RT | None | Handling at off-site facility not in scope of EA |
| Package diameter | RK | 1.99 m for offsite; 1.07 for onsite; 2.1 m for no action | CNS 10-160B and NuPac 210-14L cask dimensions |
| Location of driver, co-located worker and MEI for accident | RK | Driver – 3 m<br>Co-located worker – 100 m<br>MEI – 160 m for offsite, 4000 m for onsite | Driver – distance from source to crew – WMPEIS<br>Co-located worker - WMPEIS<br>MEI – Default location for MEI in stable atmospheric conditions – WMPEIS for offsite; onsite MEI located at nearest site boundary |
| Exposure duration for accident | RK | Acute | Most conservative scenario selected |
| Weather | RK | Stable | Stability class D selected |
| Cask Impact Velocity | RK | 65 km/hr | RISKIND suggested values |
| Cask Impact Angle | RK | 90° | RISKIND suggested values |
| Cask Orientation Angle | RK | 90° | RISKIND suggested values |
| Impact Object Hardness | RK | Unyielding | RISKIND suggested values |
| Flame Temperature | RK | 1350 (K) | RISKIND suggested values |
| Flame Duration | RK | .75 hr | RISKIND suggested values |
| Fire Location | RK | 0 | RISKIND suggested values |
| Accident Region | RK | 6 | RISKIND suggested value |
| Accident Probability | RK | 2.33E-07 | RISKIND suggested value |
| Fraction Released | RK | 5.0E-4 | CSDR (Airborne Release Fraction) |
| Fraction Dispersed | RK | 1 | CSDR (Respirable Fraction) |
| Fraction of Container Contents Failed | RK | 0.1 | DOE Transportation Handbook (Damage Ratio) |

# Appendix B

# RISKIND Results for Onsite Transportation Accident

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  1
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:42
 Input  File : c:\riskind\input\july272011onsite.inp
 Output File : C:\RISKIND\output\july272011onsite.out
==============================================================================
```

```
==============================================================================
========================== RISKIND Computer Program ==========================
==============================================================================
```

```
Problem Description
___________________________________________

              Individual Receptors

              Accident Calculations
                 User Defined Accident
                 Single Weather Analysis

                 Acute Exposure
                    Plume Inhalation
                    Plume Immersion
                    Early Ground Exposure
                    Exposure to Cask


    Note: * next to input description signifies
          a data dependent default value
```

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  2
 Title       : RHLLW Accident Scenario
 Date/Time   : 07/29/11 08:42
 Input  File : c:\riskind\input\july272011onsite.inp
 Output File : C:\RISKIND\output\july272011onsite.out
============================  Input Parameters  ==============================
```

```
==============================================================================
================== RISKIND Accident Individual Problem Input ==================
==============================================================================
```

Individual Accident Parameters

```
                                   State:  US
                        Population Zone: Urban

     Individual      Average Breathing Rate   Individual Type
                        [BRTIND]   (m3/yr)        [INDTYPE]
    MEI                     8.00E+03             Public
    driver                  8.00E+03             Worker
    co-located work         8.00E+03             Worker
                 Individual type [INDTYPE]:  Worker
            Risk Conversion Factors
                    Non-Fatal Cancers/rem: 8.0E-05
                        Fatal Cancers/rem: 4.0E-04
                      Genetic Effects/rem: 8.0E-05

                 Individual type [INDTYPE]:  Public
            Risk Conversion Factors
                    Non-Fatal Cancers/rem: 1.0E-04
                        Fatal Cancers/rem: 5.0E-04
                      Genetic Effects/rem: 1.3E-04
```

| Individual Name [XNAME] | ======= Location ======= Down Wind [km] | Cross Wind [km] [XRECEP] | Elevation [m] | Acute Exposure Time [hr] [TEXT] | Long Term Exposure [IRTP] | Food Ingestion [IDFOOD] |
|---|---|---|---|---|---|---|
| MEI | 4.00E+00 | 0.00E+00 | 0.00E+00 | 2.00E+00 | | No |
| driver | 3.00E-03 | 0.00E+00 | 0.00E+00 | 2.00E+00 | | No |
| co-located worker | 1.00E-01 | 0.00E+00 | 0.00E+00 | 2.00E+00 | | No |

| Individual Name | Shielding Type Short | Long | Long-Term In | Out | ====== Shielding Factors ==== Acute: Inh | Cld | Ext | Long-Term: Inh | Cld | Ext |
|---|---|---|---|---|---|---|---|---|---|---|
| MEI | None | None | 0.62 | 0.02 | 1.00 | 1.00 | 1.00 | 0.64 | 0.64 | 0.64 |
| driver | None | None | 0.62 | 0.02 | 1.00 | 1.00 | 1.00 | 0.64 | 0.64 | 0.64 |
| co-located worker | None | None | 0.62 | 0.02 | 1.00 | 1.00 | 1.00 | 0.64 | 0.64 | 0.64 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  3
 Title       : RHLLW Accident Scenario
 Date/Time   : 07/29/11 08:42
 Input  File : c:\riskind\input\july272011onsite.inp
 Output File : C:\RISKIND\output\july272011onsite.out
============================  Input Parameters  ==============================

Meteorological Parameters
_____________________________________________

            Dry deposition rates [VDEPNUC]
                        Particulates    : 1.00E-02      m/s
                        Ruthenium       : 1.00E-02      m/s
                        Cesium          : 1.00E-02      m/s
                        Iodine          : 1.00E-02      m/s
                        Gases           : 0.00E+00      m/s
                 Rain fall rate [RAIN]  : 0.00E+00     mm/h
               Anemometer height [ANH]  :    10.00        m
           Ambient Temperature [TABK]   :   283.00        K
                 Mixing height [DMIX]   :  1000.00        m
             Wind at anemometer [WSM]   :     4.00      m/s
        Pasquill stability cat. [ITYPE] :       D


Shipment Parameters
_____________________________________________

           Transportation Mode [IMOD]   :    Truck
                   Dose at 1 m [TIDX]   :    10.00  mrem/hr
           Measurement Offset [TIOFF]   :     0.00        m
             Gamma Fraction [FRAD(1)]   :     1.00
           Neutron Fraction [FRAD(2)]   :     0.00
                  Cask Length [HSIZE]   :     5.23        m
                  Cask Radius [RSIZE]   :     1.07        m
```

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  4
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:42
 Input  File : c:\riskind\input\july272011onsite.inp
 Output File : C:\RISKIND\output\july272011onsite.out
============================  Input Parameters  ============================
```

Nuclide Parameters

Nuclide Inventory and DCFs

| Nuclide Name | Inventory Amount [Ci] | ======= Dose Conversion Factors ====== Inhalation [Sv/Bq] | Ingestion [Sv/Bq] | Cloud [Sv/s] [Bq/m3] | Ground [Sv/s] [Bq/m2] | Nucl. Class | Decay Const. [1/yr] |
|---|---|---|---|---|---|---|---|
| BA137M | 3.39E-01 | 2.49E-09 | 2.49E-09 | 2.88E-14 | 5.86E-16 | Co-60 | 1.40E+05 |
| CO 58 | 5.38E+02 | 2.94E-09 | 9.68E-10 | 4.76E-14 | 9.49E-16 | Co-60 | 3.60E+00 |
| CO 60 | 7.00E+03 | 5.91E-08 | 7.28E-09 | 1.26E-13 | 2.35E-15 | Co-60 | 1.30E-01 |
| EU154 | 1.09E+02 | 7.73E-08 | 2.58E-09 | 6.14E-14 | 1.18E-15 | Co-60 | 7.90E-02 |
| FE 55 | 3.69E+03 | 7.26E-10 | 1.64E-10 | 0.00E+00 | 0.00E+00 | Co-60 | 2.60E-01 |
| MN 54 | 1.09E+02 | 1.81E-09 | 7.48E-10 | 4.09E-14 | 8.12E-16 | Co-60 | 8.10E-01 |
| NB 95 | 1.85E+03 | 1.57E-09 | 6.95E-10 | 3.74E-14 | 7.48E-16 | Co-60 | 7.20E+00 |
| NI 59 | 5.90E+02 | 7.31E-10 | 5.67E-11 | 0.00E+00 | 0.00E+00 | Co-60 | 9.20E-06 |
| NI 63 | 6.94E+04 | 1.70E-09 | 1.56E-10 | 0.00E+00 | 0.00E+00 | Co-60 | 6.90E-03 |
| PU236 | 1.25E-08 | 3.91E-05 | 3.15E-07 | 6.34E-18 | 9.81E-19 | Co-60 | 2.40E-01 |
| PU238 | 1.13E-02 | 1.06E-04 | 8.65E-07 | 4.87E-18 | 8.37E-19 | Co-60 | 7.90E-03 |
| PU239 | 5.38E-03 | 1.16E-04 | 9.56E-07 | 4.24E-18 | 3.67E-19 | Co-60 | 2.90E-05 |
| PU240 | 4.11E-03 | 1.16E-04 | 9.56E-07 | 4.75E-18 | 8.02E-19 | Co-60 | 1.10E-04 |
| PU241 | 5.10E-01 | 2.23E-06 | 1.85E-08 | 2.19E-19 | 5.20E-21 | Co-60 | 4.80E-02 |
| PU244 | 5.84E-11 | 1.09E-04 | 9.00E-07 | 1.62E-14 | 3.31E-16 | Co-60 | 8.40E-09 |
| SB125 | 5.52E+02 | 3.75E-09 | 9.85E-10 | 2.02E-14 | 4.33E-16 | Co-60 | 2.50E-01 |
| SM151 | 5.41E-03 | 8.10E-09 | 1.05E-10 | 3.61E-20 | 5.02E-21 | Co-60 | 7.70E-03 |
| SN119M | 9.31E+02 | 1.69E-09 | 3.76E-10 | 1.01E-16 | 1.04E-17 | Co-60 | 8.60E-01 |
| TA182 | 1.17E+03 | 1.21E-08 | 1.76E-09 | 6.40E-14 | 1.23E-15 | Co-60 | 2.20E+00 |
| TE125M | 1.31E+02 | 1.97E-09 | 9.92E-10 | 4.53E-16 | 3.61E-17 | Co-60 | 4.40E+00 |
| ZR 95 | 8.40E-02 | 6.39E-09 | 1.02E-09 | 3.60E-14 | 7.22E-16 | Co-60 | 4.00E+00 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  5
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:42
 Input  File  : c:\riskind\input\july272011onsite.inp
 Output File  : C:\RISKIND\output\july272011onsite.out
============================  Input Parameters  ============================
```

Nuclide Health Effects Parameters

| Nuclide Name | Solubility Class | Acute Organ Dose Conversion Factors =========Inhalation======== [Sv/Bq] Marrow | Lung | Intestine | ========Ground========== [Sv/s//Bq/m2] Marrow | Lung | Intestine |
|---|---|---|---|---|---|---|---|
| BA137M | D | 2.73E-11 | 2.73E-11 | 0.00E+00 | 5.70E-16 | 5.60E-16 | 5.22E-16 |
| CO 58 | Y | 8.92E-10 | 1.57E-08 | 1.97E-09 | 9.30E-16 | 9.10E-16 | 8.42E-16 |
| CO 60 | Y | 6.22E-09 | 1.24E-07 | 5.95E-09 | 2.34E-15 | 2.27E-15 | 1.94E-15 |
| EU154 | Y | 2.46E-11 | 1.57E-10 | 9.19E-12 | 1.16E-15 | 1.14E-15 | 1.03E-15 |
| FE 55 | W | 1.65E-10 | 1.76E-10 | 1.92E-10 | 0.00E+00 | 0.00E+00 | 1.89E-19 |
| MN 54 | W | 1.08E-09 | 6.49E-09 | 1.32E-09 | 7.96E-16 | 7.77E-16 | 7.18E-16 |
| NB 95 | Y | 4.32E-10 | 8.38E-09 | 1.92E-09 | 7.32E-16 | 7.17E-16 | 6.62E-16 |
| NI 59 | Y | 3.78E-13 | 2.22E-12 | 1.65E-13 | 0.00E+00 | 0.00E+00 | 3.56E-19 |
| NI 63 | Y | 1.05E-12 | 5.95E-12 | 4.59E-13 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| PU236 | Y | 5.35E-05 | 1.84E-05 | 2.97E-09 | 2.37E-19 | 1.09E-19 | 8.50E-19 |
| PU238 | Y | 2.97E-07 | 7.03E-05 | 2.97E-08 | 1.94E-19 | 7.87E-20 | 7.35E-19 |
| PU239 | Y | 2.70E-07 | 6.76E-05 | 2.70E-08 | 1.19E-19 | 7.87E-20 | 3.24E-19 |
| PU240 | Y | 2.70E-07 | 6.76E-05 | 2.70E-08 | 1.88E-19 | 7.81E-20 | 7.02E-19 |
| PU241 | Y | 2.97E-10 | 5.68E-08 | 1.41E-10 | 4.18E-21 | 4.36E-21 | 0.00E+00 |
| PU244 | Y | 2.59E-07 | 6.22E-05 | 4.59E-08 | 3.17E-16 | 3.11E-16 | 4.97E-19 |
| SB125 | W | 2.41E-14 | 7.30E-11 | 3.24E-12 | 4.05E-16 | 4.03E-16 | 3.79E-16 |
| SM151 | Y | 3.78E-12 | 1.19E-11 | 8.65E-13 | 1.39E-21 | 1.01E-21 | 4.45E-21 |
| SN119M | Y | 4.62E-10 | 1.15E-08 | 1.30E-11 | 3.43E-18 | 3.74E-18 | 5.12E-18 |
| TA182 | Y | 1.92E-09 | 8.27E-08 | 4.05E-12 | 1.19E-15 | 1.18E-15 | 1.05E-15 |
| TE125M | W | 5.14E-14 | 1.05E-11 | 2.38E-12 | 1.37E-17 | 1.77E-17 | 1.78E-17 |
| ZR 95 | Y | 1.30E-09 | 4.05E-08 | 3.78E-09 | 7.06E-16 | 6.92E-16 | 6.38E-16 |

Title : RHLLW Accident Scenario
Date/Time : 07/29/11 08:42
Input File : c:\riskind\input\july272011onsite.inp
Output File : C:\RISKIND\output\july272011onsite.out

========== Input Parameters ==========

Nuclide Health Effects Parameters

| Name | Acute Organ Dose Conversion Factors =========Cloudshine======== [Sv/s//Bq/m3] Marrow | Lung | Intestine |
|---|---|---|---|
| BA137M | 2.73E-14 | 2.80E-14 | 2.61E-14 |
| CO 58 | 4.53E-14 | 4.64E-14 | 4.32E-14 |
| CO 60 | 1.23E-13 | 1.24E-13 | 1.11E-13 |
| EU154 | 5.87E-14 | 5.99E-14 | 5.54E-14 |
| FE 55 | 0.00E+00 | 0.00E+00 | 9.85E-19 |
| MN 54 | 3.91E-14 | 3.99E-14 | 3.73E-14 |
| NB 95 | 3.57E-14 | 3.65E-14 | 3.39E-14 |
| NI 59 | 0.00E+00 | 0.00E+00 | 1.65E-18 |
| NI 63 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| PU236 | 2.48E-18 | 1.89E-18 | 5.08E-18 |
| PU238 | 1.68E-18 | 1.06E-18 | 3.77E-18 |
| PU239 | 2.67E-18 | 2.65E-18 | 3.50E-18 |
| PU240 | 1.66E-18 | 1.09E-18 | 3.69E-18 |
| PU241 | 1.75E-19 | 1.99E-19 | 0.00E+00 |
| PU244 | 1.53E-14 | 1.58E-14 | 2.30E-18 |
| SB125 | 1.88E-14 | 1.95E-14 | 1.82E-14 |
| SM151 | 1.13E-20 | 7.13E-21 | 3.91E-20 |
| SN119M | 3.65E-17 | 3.60E-17 | 9.34E-17 |
| TA182 | 6.10E-14 | 6.24E-14 | 5.70E-14 |
| TE125M | 1.86E-16 | 2.23E-16 | 4.10E-16 |
| ZR 95 | 3.43E-14 | 3.51E-14 | 3.26E-14 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  7
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:42
 Input  File : c:\riskind\input\july272011onsite.inp
 Output File : C:\RISKIND\output\july272011onsite.out
==============  Input Parameters  - Accident Response Region:  6===============

Accident Parameters
___________________________________________

              Physical Release Height [HS]:     1.00        m
  Dispersion Model Coefficients [IDISPMOD]: Based on Eff. Rel. Height
                   Accident Analysis Type: Consequence


Accident Response Region Determined By
___________________________________________
            Accident Cask Velocity [VCASK]:    65.00     km/h
                 Cask Impact Angle [ALPHA]:    90.00  Degrees
             Cask Orientation Angle [BETA]:    90.00  Degrees
            Impact Object Hardness [IHARD]:  1
                Flame Temperature [TFLAME]: 1.35E+03       K
                     Fire Duration [DFIRE]:     0.75      hr
                     Fire Location [FLOCA]:     0.00       m


Accident Response Region Parameters
___________________________________________
                  Response Region [IYOURS]:        6
     Region Conditional Probability [FSEV]: 2.33E-07
                         Heat Flux [HEATF]: 2.00E+06   cal/s
      Loss of Cask Shielding Factor [SEXT]
                                    Gamma:     1.00
                                  Neutron:     1.00
                     Failure Rate [FAILS]: 1.00E-01
               Crud Spallation Rate [FSPAL]: 0.00E+00
                 Crud Release Rate [FRCRUD]: 1.00E+00
```

| Nuclide Class [NUTYPE] | Conditional Release Fraction [FRELS] | Dispersion Fraction [FDISP] | Released and Dispersed Fraction (FRELS*FAILS*FDISP) |
|---|---|---|---|
| Co-60 | 5.00E-04 | 1.00E+00 | 5.00E-05 |
| Pu-239 | 5.00E-04 | 1.00E+00 | 5.00E-05 |
| | 2.00E-04 | 0.00E+00 | 0.00E+00 |
| | 4.30E-03 | 0.00E+00 | 0.00E+00 |
| | 6.30E-01 | 0.00E+00 | 0.00E+00 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  8
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:42
 Input  File : c:\riskind\input\july272011onsite.inp
 Output File : C:\RISKIND\output\july272011onsite.out
============== Intermediate Calcs - Accident Response Region:  6===============
```

==========
========== Nuclide Release ==========
==========

| Nuclide Name | Release Amount [Ci] | Hazard Index Inhalation | Hazard Index Ingestion | Hazard Index Ground |
|---|---|---|---|---|
| CO 60 | 3.50E-01 | 7.27E-01 | 3.08E-01 | 9.71E-01 |
| EU154 | 5.45E-03 | 1.47E-02 | 5.84E-04 | 1.17E-02 |
| NI 63 | 3.47E+00 | 2.06E-01 | 6.65E-01 | 0.00E+00 |
| TA182 | 5.85E-02 | 2.52E-02 | 1.35E-02 | 5.53E-03 |
| Total | 3.88E+00 | 9.73E-01 | 9.87E-01 | 9.88E-01 |

Hazard Limit [HZLM] = 0.0100

==========
========== Puff Calculations ==========
==========

| Individual Name | Plume Parameters: Effective Release Height [m] | Dispersion Sigma (Horizontal) [m] | Dispersion Sigma (Vertical) [m] |
|---|---|---|---|
| MEI | 8.79E+00 | 2.66E+02 | 7.82E+01 |
| driver | 4.49E+00 | 1.49E+00 | 1.52E+00 |
| co-located worker | 8.79E+00 | 1.03E+01 | 5.79E+00 |

| Individual Name | Chi/Q: Air [s/m3] | Chi/Q: Ground [1/m2] | Depletion Fraction | Wet/Dry Ratio |
|---|---|---|---|---|
| MEI | | | | |
| Particulates | 3.11E-06 | 3.11E-08 | 1.82E-01 | 0.00E+00 |
| Ruthenium | 3.11E-06 | 3.11E-08 | 1.82E-01 | 0.00E+00 |
| Cesium | 3.11E-06 | 3.11E-08 | 1.82E-01 | 0.00E+00 |
| Iodine | 3.11E-06 | 3.11E-08 | 1.82E-01 | 0.00E+00 |
| Gases | 3.80E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| driver | | | | |
| Particulates | 4.38E-04 | 4.38E-06 | 3.69E-05 | 0.00E+00 |
| Ruthenium | 4.38E-04 | 4.38E-06 | 3.69E-05 | 0.00E+00 |
| Cesium | 4.38E-04 | 4.38E-06 | 3.69E-05 | 0.00E+00 |
| Iodine | 4.38E-04 | 4.38E-06 | 3.69E-05 | 0.00E+00 |
| Gases | 4.38E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| co-located worker | | | | |
| Particulates | 4.20E-04 | 4.20E-06 | 4.60E-03 | 0.00E+00 |
| Ruthenium | 4.20E-04 | 4.20E-06 | 4.60E-03 | 0.00E+00 |
| Cesium | 4.20E-04 | 4.20E-06 | 4.60E-03 | 0.00E+00 |
| Iodine | 4.20E-04 | 4.20E-06 | 4.60E-03 | 0.00E+00 |
| Gases | 4.22E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  9
 Title       : RHLLW Accident Scenario
 Date/Time   : 07/29/11 08:42
 Input  File : c:\riskind\input\july272011onsite.inp
 Output File : C:\RISKIND\output\july272011onsite.out
==============      Results       - Accident Response Region:  6===============

==============================================================================
==============          Accident Dose to : MEI                ===============
==============================================================================
```

| Individual Summary Results Per Accident | | |
|---|---|---|
| Committed Effective Dose Equivalent | 8.22E-05 | rem |
| Expected Genetic Effects | 1.07E-08 | |
| Expected Non-fatal Cancers | 8.22E-09 | |
| Expected Cancer Fatalities | 4.11E-08 | |
| Acute Risk (Expected fatalities) | 0.00E+00 | |

| Pathway | Doses (rem) | | | |
|---|---|---|---|---|
| Acute | 8.22E-05 | | | |
| Cask | | 3.21E-11 | | |
| Ground Shine | | 7.47E-07 | | |
| Inhalation | | 8.09E-05 | | |
| Cloud Shine | | 5.55E-07 | | |
| Long-Term | 0.00E+00 | | | |
| Ground Shine | | 0.00E+00 | | |
| Inhalation | | 0.00E+00 | | |
| Cloud Shine | | 0.00E+00 | | |
| Ingestion | | 0.00E+00 | | |
| Initial Year | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Long-Term | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Water | | | | 0.00E+00 |

| Exposure Parameter | Organ Exposure Marrow | Lung | Intestine | Gonads |
|---|---|---|---|---|
| Long-Term Dose [rem] | 3.81E-05 | 3.87E-04 | 9.12E-06 | 1.44E-05 |
| Brief Dose [Gy] | 1.37E-08 | 2.18E-08 | 6.91E-08 | |
| Brief Exposure Time [d] | 1.00E+00 | 1.00E+00 | 1.00E+00 | |
| Brief Dose Rate [Gy/hr] | 6.45E-09 | 6.71E-09 | 7.96E-09 | |
| Prolonged Dose [Gy] | 1.40E-08 | 1.41E-06 | 6.09E-08 | |
| Prolong Exposure Time [d] | 3.00E+01 | 3.65E+02 | 7.00E+00 | |
| Prolong Dose Rate [Gy/hr] | 1.94E-11 | 1.80E-10 | 2.34E-09 | |
| Hazard | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Acute Risk [Expected fatalities] | 0.00E+00 | 0.00E+00 | 0.00E+00 | |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 10
 Title       : RHLLW Accident Scenario
 Date/Time   : 07/29/11 08:42
 Input  File : c:\riskind\input\july272011onsite.inp
 Output File : C:\RISKIND\output\july272011onsite.out
==============      Results       - Accident Response Region:  6===============

==============================================================================
==============          Accident Dose to : driver                ===============
==============================================================================
```

| Individual Summary Results Per Accident | | |
|---|---|---|
| Committed Effective Dose Equivalent | 1.77E-02 | rem |
| Expected Genetic Effects | 1.42E-06 | |
| Expected Non-fatal Cancers | 1.42E-06 | |
| Expected Cancer Fatalities | 7.09E-06 | |
| Acute Risk (Expected fatalities) | 0.00E+00 | |

| Pathway | Doses (rem) | | | |
|---|---|---|---|---|
| Acute | 1.77E-02 | | | |
| Cask | | 6.17E-03 | | |
| Ground Shine | | 1.05E-04 | | |
| Inhalation | | 1.14E-02 | | |
| Cloud Shine | | 7.80E-05 | | |
| Long-Term | 0.00E+00 | | | |
| Ground Shine | | 0.00E+00 | | |
| Inhalation | | 0.00E+00 | | |
| Cloud Shine | | 0.00E+00 | | |
| Ingestion | | 0.00E+00 | | |
| Initial Year | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Long-Term | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Water | | | | 0.00E+00 |

| | Organ Exposure | | | |
|---|---|---|---|---|
| Exposure Parameter | Marrow | Lung | Intestine | Gonads |
| Long-Term Dose [rem] | 1.15E-02 | 6.05E-02 | 7.45E-03 | 8.20E-03 |
| Brief Dose [Gy] | 6.36E-05 | 6.48E-05 | 7.14E-05 | |
| Brief Exposure Time [d] | 1.00E+00 | 1.00E+00 | 1.00E+00 | |
| Brief Dose Rate [Gy/hr] | 3.18E-05 | 3.18E-05 | 3.20E-05 | |
| Prolonged Dose [Gy] | 6.37E-05 | 2.60E-04 | 7.03E-05 | |
| Prolong Exposure Time [d] | 3.00E+01 | 3.65E+02 | 7.00E+00 | |
| Prolong Dose Rate [Gy/hr] | 9.77E-09 | 3.24E-08 | 3.36E-07 | |
| Hazard | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Acute Risk [Expected fatalities] | 0.00E+00 | 0.00E+00 | 0.00E+00 | |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 11
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:42
 Input  File  : c:\riskind\input\july272011onsite.inp
 Output File  : C:\RISKIND\output\july272011onsite.out
==============       Results       - Accident Response Region:  6===============

==============================================================================
==============          Accident Dose to : co-located worker    ===============
==============================================================================
```

Individual Summary Results Per Accident

| | | |
|---|---|---|
| Committed Effective Dose Equivalent | 1.11E-02 | rem |
| Expected Genetic Effects | 8.89E-07 | |
| Expected Non-fatal Cancers | 8.89E-07 | |
| Expected Cancer Fatalities | 4.44E-06 | |
| Acute Risk (Expected fatalities) | 0.00E+00 | |

| Pathway | Doses (rem) | | | |
|---|---|---|---|---|
| Acute | 1.11E-02 | | | |
| Cask | | 7.34E-06 | | |
| Ground Shine | | 1.01E-04 | | |
| Inhalation | | 1.09E-02 | | |
| Cloud Shine | | 7.49E-05 | | |
| Long-Term | 0.00E+00 | | | |
| Ground Shine | | 0.00E+00 | | |
| Inhalation | | 0.00E+00 | | |
| Cloud Shine | | 0.00E+00 | | |
| Ingestion | | 0.00E+00 | | |
| Initial Year | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Long-Term | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Water | | | | 0.00E+00 |

| | Organ Exposure | | | |
|---|---|---|---|---|
| Exposure Parameter | Marrow | Lung | Intestine | Gonads |
| Long-Term Dose [rem] | 5.15E-03 | 5.22E-02 | 1.24E-03 | 1.95E-03 |
| Brief Dose [Gy] | 1.92E-06 | 3.01E-06 | 9.41E-06 | |
| Brief Exposure Time [d] | 1.00E+00 | 1.00E+00 | 1.00E+00 | |
| Brief Dose Rate [Gy/hr] | 9.07E-07 | 9.43E-07 | 1.11E-06 | |
| Prolonged Dose [Gy] | 1.96E-06 | 1.90E-04 | 8.29E-06 | |
| Prolong Exposure Time [d] | 3.00E+01 | 3.65E+02 | 7.00E+00 | |
| Prolong Dose Rate [Gy/hr] | 2.63E-09 | 2.43E-08 | 3.16E-07 | |
| Hazard | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Acute Risk [Expected fatalities] | 0.00E+00 | 0.00E+00 | 0.00E+00 | |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 12
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:42
 Input  File  : c:\riskind\input\july272011onsite.inp
 Output File  : C:\RISKIND\output\july272011onsite.out
============================       Results       ==============================

==============================================================================
======================== Accident Risk to Individuals ========================
==============================================================================
```

Individual Accident Dose Summary Results
Consequences

| | Acute | | Total | | | |
|---|---|---|---|---|---|---|
| | Dose [rem] | Risk [Fatality] | Dose [rem] | Expected Non-Fatal Cancer Incidence | Expected Cancer Fatalities | Expected Genetic Effects |
| MEI | 8.22E-05 | 0.0E+00 | 8.22E-05 | 8.2E-09 | 4.1E-08 | 1.1E-08 |
| driver | 1.77E-02 | 0.0E+00 | 1.77E-02 | 1.4E-06 | 7.1E-06 | 1.4E-06 |
| co-located work | 1.11E-02 | 0.0E+00 | 1.11E-02 | 8.9E-07 | 4.4E-06 | 8.9E-07 |

# Appendix C

## RADTRAN Results for Offsite Incident-Free Transportation for Routes A and B

**Route A: Page C-2 through C-10**

**Route B: Page C-11 through C-19**

```
                    RUN DATE: [ 04-11-2011   AT 12:56 ]            PAGE    1

 RRRR    AAA   DDDD   TTTTT  RRRR    AAA   N   N      6          000    000
 R   R  A   A  D   D    T    R   R  A   A  NN  N      6         0   0  0   0
 R   R  A   A  D   D    T    R   R  A   A  N N N      6         0   0  0   0
 RRRR   A   A  D   D    T    RRRR   A   A  N  NN      6666      0   0  0   0
 R R    AAAAA  D   D    T    R R    AAAAA  N   N      6   6     0   0  0   0
 R  R   A   A  D   D    T    R  R   A   A  N   N      6   6     0   0  0   0
 R   R  A   A  DDDD     T    R   R  A   A  N   N       666   *   000    000

                         RADTRAN 6.00    September 28, 2007

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                                 INPUT ECHO
                                 ----------


RADTRAN 6      July 2008
 TITLE ROUTE_A
 INPUT STANDARD
       STD: 0 18                                  && DIMEN=NSEV NAREAS
       STD: 3 3 0                                 && PARM=IANA ISEN IPSQSB
       STD: .TRUE. .FALSE. .FALSE.                && FORM = UNIT, SI-OUTPUT,  S
       STD: 2.3E12                                && NEVAL FOR CF252
       STD: 9.25E5 5.77E6 1.27E6                  && RPCTHY FOR I125, I129, I13
       STD: 0.0 0.0 0.0 0.0 0.0                   && TRANSFER GAMMA [COEF(1,0-4
       STD: 7.42E-3 2.02E-2 6.17E-5 3.17E-8 0.0   && TRANSFER NEUTRON [COEF(2,0
       STD: 30  24                                && MITDDIST  MITDVEL
       STD: 1  2   .0018                          && ITRAIN FMINCL DDRWEF
       STD:    33    68    105   244   369                 &&
       STD:   561  1018   1628  2308  4269                 && CENTER LINE DIST
       STD:  5468 11136  13097 21334 40502                 && FOR AVERAGE US C
       STD: 69986 89860 120878 0 0 0 0 0 0 0 0 0 0 0 0     &&
       STD: 4.59E+02 1.53E+03 3.94E+03 1.25E+04 3.04E+04 6.85E+04 1.76E+05 4.4
       STD: 8.59E+05 2.55E+06 4.45E+06 1.03E+07 2.16E+07 5.52E+07 1.77E+08 4.8
       STD: 8.12E+08 1.35E+09 0 0 0 0 0 0 0 0 0 0 0 0      && AREADA
       STD: 3.42E-03 1.72E-03 8.58E-04 3.42E-04 1.72E-04 8.58E-05 3.42E-05 1.7
       STD:  8.58E-06 3.42E-06 1.72E-06 8.58E-07 3.42E-07 1.72E-07 8.58E-08 5.
       STD:  4.30E-08 3.42E-08 0 0 0 0 0 0 0 0 0 0 0 0     && DFLEV
       STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
       STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
       STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0         && RADIST
       STD: 0.5                          && SMLPKG
       STD: 1.0  0.87  0.018             && SHIELDING FACTORS RR  RS  RU
       STD:  30  30  800                 && OFFLIM {FREEWAY}
       STD:  27  30  800                 && OFFLIM {NON-FREEWAY}
       STD:   5   8  800                 && OFFLIM {CITY STREETS}
       STD:  30  30  800                 && OFFLIM {RAILWAY}
       STD: 200 200 1000                 && OFFLIM {WATERWAY}
       STD: 15  3  3  3  4               && ONLINK {FWAY NONFWY STREET RAIL ADJ}
       STD: 6.0  4  40.0                 && RPD FNOATT INTERDICT (ci/micro-Ci)
       STD: 0.05   0.2   3.3E-4          && BDF CULVL BRATE
       STD: 0.9   0.1                    && UBF USWF
       STD: 1.0  10.0 1.0                && EVACUATION SURVEY CAMPAIGN
 □
                    RUN DATE: [ 04-11-2011   AT 12:56 ]            PAGE    2

                                 ROUTE_A
```

```
      STD: 0.0 0.0 0.0 0.0 0.0 0.0   && PSPROB
      STD: 0.67  0.67  0.42          && TIMENDE NON-DISPERSAL EVAC TIME (LCF&
      STD: 2 2 0                     && FLAGS=IUOPT IACC REGCHECK (OFF)
      STD: 5E-4, 4E-4, 1.0E-4        && LCFCON(1), LCFCON(2), GECON
      STD: RT6_Ingestion.BIN         && INGESTION FILE
OUTPUT CI_REM
FORM UNIT
DIMEN 0 0 18
PARM 0 1 3 0
SEVERITY
   NPOP=1
      NMODE=1

   NPOP=2
      NMODE=1

   NPOP=3
      NMODE=1

RELEASE
   GROUP=RHLLW
      RFRAC

      AERSOL

      RESP

      DEPVEL 0.0
PACKAGE RHLLW 10.0 1.0 0.0 3.3
   CO60 2000.0 RHLLW
   PU239 0.34 RHLLW
END
VEHICLE -1 INLNNSS 1.000000E01 1.0 0.0 3.3 1.0 2.0 3.0 1.0 3.0
      RHLLW 1.0
FLAGS
   IACC 2
   IUOPT 2
   REGCHECK 1
MODSTD
   DISTOFF FREEWAY 3.000000E01 3.000000E01 8.000000E02
   DISTOFF SECONDARY 2.700000E01 3.000000E01 8.000000E02
□
                    RUN DATE: [ 04-11-2011   AT 12:56 ]            PAGE    3

                                   ROUTE_A

   DISTOFF STREET 5.000000E00 8.000000E00 8.000000E02
   DISTON
FREEWAY 1.500000E01
SECONDARY 3.000000E00
STREET 3.000000E00
ADJACENT 4.000000E00
   BDF 5.000000E-02
   BRATE 3.300000E-04
   CULVL 2.000000E-01
   EVACUATION 1.000000E00
   GECON 1.000000E-04
   INTERDICT 4.000000E01
   LCFCON 5.000000E-04 4.000000E-04
   SURVEY 1.000000E01
   UBF 5.200000E-01
   USWF 4.800000E-01
   CAMPAIGN 8.330000E-02
```

```
   MITDDIST 3.000000E01
   MITDVEL 2.400000E01
   RPD 6.000000E00
   RR 1.000000E00
   RU 1.800000E-02
   RS 8.700000E-01
   SMALLPKG 5.000000E-01
   RPCTHYROID
I1311.270000E06
EOF
LINK RURAL_ID INLNNSS 285.3 121.0 2.0 4.9 1160.0 3.94E-7 2.49E-8 R 1 0.254
LINK SUBURBN_ID INLNNSS 8.8 88.0 2.0 326.7 2410.0 3.94E-7 2.49E-8 S 1 0.0
LINK URBAN_ID INLNNSS 5.0 88.0 2.0 2110.4 5490.0 3.94E-7 2.49E-8 U 1 0.0
LINK RURAL_NV INLNNSS 838.1 121.0 2.0 1.9 1160.0 1.62E-7 8.9E-9 R 1 0.183
LINK SUBURBN_NV INLNNSS 11.2 88.0 2.0 369.7 2410.0 1.62E-7 8.9E-9 S 1 0.0
LINK URBAN_NV INLNNSS 0.7 88.0 2.0 1764.7 5490.0 1.62E-7 8.9E-9 U 1 0.0

STOP STOP_1 INLNNSS 1.0 1.0 1.0 1.0 1.5
STOP STOP_2 INLNNSS 13000.0 1.0 15.8 1.0 1.5
STOP STOP_3 INLNNSS 22410.0 30.0 800.0 1.0 1.5


EOF
□
                    RUN DATE: [ 04-11-2011   AT 12:56 ]            PAGE    4

                                  ROUTE_A

                        CONTROL INPUT DATA (DIMEN & PARM)
                        *********************************


    NUMBER OF ACCIDENT SEVERITY CATEGORIES     =     0
    NUMBER OF LOSS OF SHIELDING PROBABILITIES  =     0
    NUMBER OF DEPOSITION AREAS (ISOPLETHS)     =    18
    INCIDENT FREE ANALYSIS INVOKED
    DETAILED INPUT, FULL OUTPUT, SENSITIVITY ANALYIS EDIT & POPULATION RISK E
                    & FULL ECONOMIC OUTPUT
    USER SUPPLIED OR NATIONAL AVERAGE WEATHER DILUTION INPUT
    HISTORICAL UNITS ON INPUT
    HISTORICAL UNITS ON OUTPUT
    DOSE UNITS ON OUTPUT

    INGESTION FILE = RT6_Ingestion.BIN


                     PACKAGE AND MATERIAL CHARACTERISTICS INPUT DATA
                     ***********************************************

                  DIMENSION  EFFECTIVE     K(0)     FRACTION   FRACTION  DOSE
        MATERIAL   (METERS)  DIMENSION  METERS SQ.    GAMMA     NEUTRON  (mre
           RHLLW  3.300E+00  3.300E+00  7.023E+00  1.000E+00  0.000E+00  1.00

    K(0) IS DOSE RATE CONVERSION FACTOR
□
                    RUN DATE: [ 04-11-2011   AT 12:56 ]            PAGE    5

                                  ROUTE_A


                       VEHICLE CHARACTERISTICS INPUT DATA
                       **********************************
```

```
VEHICLE NAME                    INLNNSS
MODE TYPE                        HIGHWAY
EXCLUSIVE USE                      YES
DOSE RATE (mrem/hr)             1.00E+01
FRACTION OF GAMMA FOR VEH       1.00E+00
FRACTION OF NEUTRON FOR V       0.00E+00
K(0) (SQ. METERS)               7.02E+00
VEHICLE SIZE (M)                3.30E+00
EFFECTIVE SIZE (M)              3.30E+00
NUMBER OF SHIPMENTS             1.00E+00
NUMBER OF CREW                  2.00E+00
CREW DISTANCE (M)               3.00E+00
CREW DOSE ADJUSTMENT FACT       1.00E+00
CREW EXPOSER WIDTH (M)          3.00E+00
EFFECTIVE EXPOSER WIDTH         3.00E+00
K(0) (SQ M) CREW EXPOSURE       6.25E+00


  VEHICLE     MATERIAL   NO.PACKAGES
INLNNSS
                 RHLLW    1.00E+00


TRANSFER
COEFFICIENTS:     MU       A(1)      A(2)      A(3)      A(4)
      GAMMA   0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
    NEUTRON   7.420E-03 2.020E-02 6.170E-05 3.170E-08 0.000E+00


DISTANCES (METERS)   FREEWAY SECONDARY   STREET     RAIL     WATER    AD
OFFLINK:
MINIMUM DISTANCE    3.00E+01  2.70E+01  5.00E+00  3.00E+01  2.00E+02
SIDEWALK + MINIMUM  3.00E+01  3.00E+01  8.00E+00  3.00E+01  2.00E+02
MAXIMUM DISTANCE    8.00E+02  8.00E+02  8.00E+02  8.00E+02  1.00E+03
ONLINK:
OPPOSITE DIRECTION  1.50E+01  3.00E+00  3.00E+00  3.00E+00
ADJACENT VEHICLE                                                     4.
```

```
              RUN DATE: [ 04-11-2011   AT 12:56 ]            PAGE    6

                              ROUTE_A


                      STOP RELATED INPUT DATA
                      ***********************
STOP                   STOP_1      STOP_2      STOP_3
VEHICLE                 INLNNSS     INLNNSS     INLNNSS
PERSONS                1.00E+00    1.30E+04    2.24E+04
MINIMUM DISTANCE(M)    1.00E+00    1.00E+00    3.00E+01
MAXIMUM DISTANCE(M)    1.00E+00    1.58E+01    8.00E+02
SHIELDING FACTOR       1.00E+00    1.00E+00    1.00E+00
TIME (HR)              1.50E+00    1.50E+00    1.50E+00


                      LINK RELATED INPUT DATA
                      ***********************
 LINK                          RURAL_ID  SUBURBN_ID    URBAN_ID    RURA
 VEHICLE                        INLNNSS     INLNNSS     INLNNSS     INL
```

```
DISTANCE (KM)                    2.85E+02    8.80E+00    5.00E+00    8.38
PERSONS PER VEHICLE              2.00E+00    2.00E+00    2.00E+00    2.00
SPEED (KM/HR)                    1.21E+02    8.80E+01    8.80E+01    1.21
POPULATION DENSITY (#/KM^2)      4.90E+00    3.27E+02    2.11E+03    1.90
VEHICLE DENSITY (#/HR)           1.16E+03    2.41E+03    5.49E+03    1.16
ACCIDENT RATE/KM                 3.94E-07    3.94E-07    3.94E-07    1.62
FATALITIES/ACCIDENT              2.49E-08    2.49E-08    2.49E-08    8.90
ZONE                             RURAL       SUBURBAN    URBAN       RURA
ROAD TYPE                           FREEWAY     FREEWAY     FREEWAY      F
FARMING FRACTION                 2.54E-01    0.00E+00    0.00E+00    1.83
LINK                             URBAN_NV
VEHICLE                           INLNNSS
DISTANCE (KM)                    7.00E-01
PERSONS PER VEHICLE              2.00E+00
SPEED (KM/HR)                    8.80E+01
POPULATION DENSITY (#/KM^2)      1.76E+03
VEHICLE DENSITY (#/HR)           5.49E+03
ACCIDENT RATE/KM                 1.62E-07
FATALITIES/ACCIDENT              8.90E-09
ZONE                             URBAN
ROAD TYPE                           FREEWAY
FARMING FRACTION                 0.00E+00

                        END OF INPUT EDIT
                        *****************
```

□

```
                RUN DATE: [ 04-11-2011   AT 12:56 ]            PAGE    7

                              ROUTE_A

RRRR    AAA   DDDD   TTTTT  RRRR    AAA   N   N      6          000    000
R   R  A   A  D   D    T    R   R  A   A  NN  N      6         0   0  0   0
R   R  A   A  D   D    T    R   R  A   A  N N N      6         0   0  0   0
RRRR   A   A  D   D    T    RRRR   A   A  N  NN      6666      0   0  0   0
R R    AAAAA  D   D    T    R R    AAAAA  N   N      6   6     0   0  0   0
R  R   A   A  D   D    T    R  R   A   A  N   N      6   6     0   0  0   0
R   R  A   A  DDDD     T    R   R  A   A  N   N       666   *   000    000

                     RADTRAN 6.00    September 28, 2007

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 OOO   U   U  TTTTT  PPPP   U   U  TTTTT
O   O  U   U    T    P   P  U   U    T
O   O  U   U    T    P   P  U   U    T
O   O  U   U    T    PPPP   U   U    T
O   O  U   U    T    P      U   U    T
O   O  U   U    T    P      U   U    T
 OOO   UUUUU    T    P      UUUUU    T

                     RADTRAN 6.00    September 28, 2007

                     Copyright 2007 Sandia Corporation
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                RUN DATE: [ 04-11-2011   AT 12:56 ]            PAGE    8

                              ROUTE_A
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NON-RADIOLOGICAL DATA (ACCIDENTS and FATALITIES)
**********

HIGHWAY
INLNNSS

| LINK | ACCIDENT RATE | ACCIDENTS | FATALITIES |
|---|---|---|---|
| RURAL_ID | 3.94E-07 | 1.12E-04 | 2.80E-12 |
| SUBURBN_ID | 3.94E-07 | 3.47E-06 | 8.63E-14 |
| URBAN_ID | 3.94E-07 | 1.97E-06 | 4.91E-14 |
| RURAL_NV | 1.62E-07 | 1.36E-04 | 1.21E-12 |
| SUBURBN_NV | 1.62E-07 | 1.81E-06 | 1.61E-14 |
| URBAN_NV | 1.62E-07 | 1.13E-07 | 1.01E-15 |
| TOTALS: | | 2.56E-04 | 4.16E-12 |



ROUTE_A

REGULATORY CHECKS

THE SHIPMENT BY INLNNSS IS DESIGNATED AS EXCLUSIVE USE
BUT IS NOT REQUIRED TO BE SO DESIGNATED BY REGULATIONS

FOR THE SHIPMENT BY INLNNSS
THE DOSE RATE IN THE CREW COMPARTMENT COULD EXCEED 2 mrem/hr
THE DOSE RATE HAS BEEN RESET FROM 6.94 TO 2 FOR CREW CALCULATIONS



ROUTE_A

INCIDENT-FREE SUMMARY
******** **** *******

IN-TRANSIT POPULATION EXPOSURE IN PERSON-REM
*INPUT DATA WERE ALTERED WITH REGULATORY CHECKS

| | CREW | OFF LINK | ON LINK |
|---|---|---|---|
| RURAL_ID | 9.51E-03 | 1.69E-05 | 1.50E-03 |
| SUBURBN_ID | 4.03E-04 | 4.15E-05 | 1.84E-04 |
| URBAN_ID | 2.29E-04 | 3.15E-06 | 2.38E-04 |
| RURAL_NV | 2.79E-02 | 1.92E-05 | 4.41E-03 |
| SUBURBN_NV | 5.13E-04 | 5.98E-05 | 2.34E-04 |
| URBAN_NV | 3.21E-05 | 3.69E-07 | 3.34E-05 |
| ZONE | | | |
| RURAL | 3.74E-02 | 3.61E-05 | 5.92E-03 |
| SUBURB | 9.16E-04 | 1.01E-04 | 4.19E-04 |
| URBAN | 2.61E-04 | 3.52E-06 | 2.72E-04 |
| TOTALS: | 3.86E-02 | 1.41E-04 | 6.61E-03 |

MAXIMUM INDIVIDUAL IN-TRANSIT DOSE

INLNNSS 2.68E-07 REM

STOP EXPOSURE IN PERSON-REM

| | | |
|---|---|---|
| LINE-SOURCE | STOP_1 | 3.98E-02 |
| ANNULAR AREA | STOP_2 | 2.37E-02 |
| ANNULAR AREA | STOP_3 | 4.87E-02 |
| | TOTAL: | 1.12E-01 |

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ROUTE_A

INCIDENT-FREE IMPORTANCE ANALYSIS SUMMARY
ESTIMATES THE PERSON-REM INFLUENCE OF A ONE PERCENT INCREASE IN THE PARAMETER

| LINK | PARAMETER | IMPORTANCE | CHANGE |
|---|---|---|---|
| RURAL_ID | | | |
| | VELOCITY | -1.253E-04 | -1.1363 % |
| | DISTANCE TRAVELED | 1.103E-04 | 1.0000 % |
| | NUMBER OF SHIPMENTS | 1.103E-04 | 1.0000 % |
| | DOSE RATE FOR VEHICLE (TI) | 1.103E-04 | 1.0000 % |
| | CREW DOSE ADJUSTMENT FACTOR | 9.507E-05 | 0.8622 % |
| | NUMBER OF CREW MEMBERS | 9.507E-05 | 0.8622 % |
| | DISTANCE FROM PACKAGE TO CREW | -2.113E-05 | -0.1916 % |
| | TRAFFIC COUNT | 1.503E-05 | 0.1363 % |
| | NUMBER OF PEOPLE PER VEHICLE | 1.503E-05 | 0.1363 % |
| | SHIELDING FACTOR (RR,RS,RU) | 1.687E-07 | 0.0015 % |
| | POPULATION DENSITY | 1.687E-07 | 0.0015 % |
| SUBURBN_ID | | | |
| | VELOCITY | -8.131E-06 | -1.2929 % |
| | DISTANCE TRAVELED | 6.289E-06 | 1.0000 % |
| | NUMBER OF SHIPMENTS | 6.289E-06 | 1.0000 % |
| | DOSE RATE FOR VEHICLE (TI) | 6.289E-06 | 1.0000 % |
| | CREW DOSE ADJUSTMENT FACTOR | 4.032E-06 | 0.6411 % |
| | NUMBER OF CREW MEMBERS | 4.032E-06 | 0.6411 % |
| | NUMBER OF PEOPLE PER VEHICLE | 1.842E-06 | 0.2929 % |
| | TRAFFIC COUNT | 1.842E-06 | 0.2929 % |
| | DISTANCE FROM PACKAGE TO CREW | -8.960E-07 | -0.1425 % |
| | POPULATION DENSITY | 4.151E-07 | 0.0660 % |
| | SHIELDING FACTOR (RR,RS,RU) | 4.151E-07 | 0.0660 % |
| URBAN_ID | | | |
| | VELOCITY | -7.091E-06 | -1.5066 % |
| | NUMBER OF SHIPMENTS | 4.707E-06 | 1.0000 % |
| | DOSE RATE FOR VEHICLE (TI) | 4.707E-06 | 1.0000 % |
| | DISTANCE TRAVELED | 4.707E-06 | 1.0000 % |
| | NUMBER OF PEOPLE PER VEHICLE | 2.384E-06 | 0.5066 % |
| | TRAFFIC COUNT | 2.384E-06 | 0.5066 % |
| | NUMBER OF CREW MEMBERS | 2.291E-06 | 0.4867 % |
| | CREW DOSE ADJUSTMENT FACTOR | 2.291E-06 | 0.4867 % |
| | DISTANCE FROM PACKAGE TO CREW | -5.091E-07 | -0.1082 % |
| | SHIELDING FACTOR (RR,RS,RU) | 3.152E-08 | 0.0067 % |
| | POPULATION DENSITY | 3.152E-08 | 0.0067 % |

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ROUTE_A

INCIDENT-FREE IMPORTANCE ANALYSIS SUMMARY
ESTIMATES THE PERSON-REM INFLUENCE OF A ONE PERCENT INCREASE IN THE PARAMETER

| LINK | PARAMETER | IMPORTANCE | CHANGE |
|---|---|---|---|
| RURAL_NV | VELOCITY | -3.678E-04 | -1.1364 % |
| | DISTANCE TRAVELED | 3.236E-04 | 1.0000 % |
| | NUMBER OF SHIPMENTS | 3.236E-04 | 1.0000 % |
| | DOSE RATE FOR VEHICLE (TI) | 3.236E-04 | 1.0000 % |
| | NUMBER OF CREW MEMBERS | 2.793E-04 | 0.8630 % |
| | CREW DOSE ADJUSTMENT FACTOR | 2.793E-04 | 0.8630 % |
| | DISTANCE FROM PACKAGE TO CREW | -6.206E-05 | -0.1918 % |
| | NUMBER OF PEOPLE PER VEHICLE | 4.414E-05 | 0.1364 % |
| | TRAFFIC COUNT | 4.414E-05 | 0.1364 % |
| | SHIELDING FACTOR (RR,RS,RU) | 1.922E-07 | 0.0006 % |
| | POPULATION DENSITY | 1.922E-07 | 0.0006 % |
| SUBURBN_NV | VELOCITY | -1.042E-05 | -1.2904 % |
| | DOSE RATE FOR VEHICLE (TI) | 8.074E-06 | 1.0000 % |
| | NUMBER OF SHIPMENTS | 8.074E-06 | 1.0000 % |
| | DISTANCE TRAVELED | 8.074E-06 | 1.0000 % |
| | CREW DOSE ADJUSTMENT FACTOR | 5.132E-06 | 0.6356 % |
| | NUMBER OF CREW MEMBERS | 5.132E-06 | 0.6356 % |
| | NUMBER OF PEOPLE PER VEHICLE | 2.344E-06 | 0.2904 % |
| | TRAFFIC COUNT | 2.344E-06 | 0.2904 % |
| | DISTANCE FROM PACKAGE TO CREW | -1.140E-06 | -0.1412 % |
| | POPULATION DENSITY | 5.978E-07 | 0.0740 % |
| | SHIELDING FACTOR (RR,RS,RU) | 5.978E-07 | 0.0740 % |
| URBAN_NV | VELOCITY | -9.920E-07 | -1.5071 % |
| | NUMBER OF SHIPMENTS | 6.582E-07 | 1.0000 % |
| | DOSE RATE FOR VEHICLE (TI) | 6.582E-07 | 1.0000 % |
| | DISTANCE TRAVELED | 6.582E-07 | 1.0000 % |
| | NUMBER OF PEOPLE PER VEHICLE | 3.338E-07 | 0.5071 % |
| | TRAFFIC COUNT | 3.338E-07 | 0.5071 % |
| | NUMBER OF CREW MEMBERS | 3.207E-07 | 0.4873 % |
| | CREW DOSE ADJUSTMENT FACTOR | 3.207E-07 | 0.4873 % |
| | DISTANCE FROM PACKAGE TO CREW | -7.127E-08 | -0.1083 % |
| | SHIELDING FACTOR (RR,RS,RU) | 3.690E-09 | 0.0056 % |
| | POPULATION DENSITY | 3.690E-09 | 0.0056 % |

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ROUTE_A

INCIDENT-FREE IMPORTANCE ANALYSIS SUMMARY
ESTIMATES THE PERSON-REM INFLUENCE OF A ONE PERCENT INCREASE IN THE PARAMETER

| STOP | PARAMETER | IMPORTANCE | CHANGE |
|---|---|---|---|
| STOP_1 | NUMBER OF SHIPMENTS | 3.975E-04 | 1.0000 % |
| | POPULATION/POPULATION DENSITY | 3.975E-04 | 1.0000 % |
| | MINIMUM DISTANCE AT STOP | -3.975E-04 | -1.0000 % |
| | DOSE RATE FOR VEHICLE | 3.975E-04 | 1.0000 % |
| | STOP TIME | 3.975E-04 | 1.0000 % |
| STOP_2 | | | |

```
                MAXIMUM DISTANCE AT STOP          -4.769E-04    -2.0080 %
                STOP TIME                          2.375E-04     1.0000 %
                POPULATION/POPULATION DENSITY      2.375E-04     1.0000 %
                NUMBER OF SHIPMENTS                2.375E-04     1.0000 %
                DOSE RATE FOR VEHICLE              2.375E-04     1.0000 %
                MINIMUM DISTANCE AT STOP           1.910E-06     0.0080 %

      STOP_3 ---------------------------------------------------------------
                MAXIMUM DISTANCE AT STOP          -9.754E-04    -2.0028 %
                STOP TIME                          4.870E-04     1.0000 %
                POPULATION/POPULATION DENSITY      4.870E-04     1.0000 %
                NUMBER OF SHIPMENTS                4.870E-04     1.0000 %
                DOSE RATE FOR VEHICLE              4.870E-04     1.0000 %
                MINIMUM DISTANCE AT STOP           1.372E-06     0.0028 %
EOI
END OF RUN
SUCCESSFUL COMPLETION
```

```
                    RUN DATE: [ 04-11-2011   AT 13:02 ]            PAGE    1

 RRRR    AAA   DDDD   TTTTT  RRRR    AAA   N   N      6          000    000
 R   R  A   A  D   D    T    R   R  A   A  NN  N      6         0   0  0   0
 R   R  A   A  D   D    T    R   R  A   A  N N N      6         0   0  0   0
 RRRR   A   A  D   D    T    RRRR   A   A  N  NN      6666      0   0  0   0
 R R    AAAAA  D   D    T    R R    AAAAA  N   N      6   6     0   0  0   0
 R  R   A   A  D   D    T    R  R   A   A  N   N      6   6     0   0  0   0
 R   R  A   A  DDDD     T    R   R  A   A  N   N       666   *   000    000

                         RADTRAN 6.00    September 28, 2007

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                                 INPUT ECHO
                                 ----------


RADTRAN 6      July 2008
 TITLE ROUTE_B
 INPUT STANDARD
       STD: 0 18                                  && DIMEN=NSEV NAREAS
       STD: 3 3 0                                 && PARM=IANA ISEN IPSQSB
       STD: .TRUE. .FALSE. .FALSE.                && FORM = UNIT, SI-OUTPUT,  S
       STD: 2.3E12                                && NEVAL FOR CF252
       STD: 9.25E5 5.77E6 1.27E6                  && RPCTHY FOR I125, I129, I13
       STD: 0.0 0.0 0.0 0.0 0.0                   && TRANSFER GAMMA [COEF(1,0-4
       STD: 7.42E-3 2.02E-2 6.17E-5 3.17E-8 0.0   && TRANSFER NEUTRON [COEF(2,0
       STD: 30  24                                && MITDDIST  MITDVEL
       STD: 1  2   .0018                          && ITRAIN FMINCL DDRWEF
       STD:    33    68    105   244   369                 &&
       STD:   561  1018   1628  2308  4269                 && CENTER LINE DIST
       STD:  5468 11136  13097 21334 40502                 && FOR AVERAGE US C
       STD: 69986 89860 120878 0 0 0 0 0 0 0 0 0 0 0 0     &&
       STD: 4.59E+02 1.53E+03 3.94E+03 1.25E+04 3.04E+04 6.85E+04 1.76E+05 4.4
       STD: 8.59E+05 2.55E+06 4.45E+06 1.03E+07 2.16E+07 5.52E+07 1.77E+08 4.8
       STD: 8.12E+08 1.35E+09 0 0 0 0 0 0 0 0 0 0 0 0      && AREADA
       STD: 3.42E-03 1.72E-03 8.58E-04 3.42E-04 1.72E-04 8.58E-05 3.42E-05 1.7
       STD:  8.58E-06 3.42E-06 1.72E-06 8.58E-07 3.42E-07 1.72E-07 8.58E-08 5.
       STD:  4.30E-08 3.42E-08 0 0 0 0 0 0 0 0 0 0 0 0     && DFLEV
       STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
       STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
       STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0         && RADIST
       STD: 0.5                          && SMLPKG
       STD: 1.0  0.87  0.018             && SHIELDING FACTORS RR  RS  RU
       STD:  30  30  800                 && OFFLIM {FREEWAY}
       STD:  27  30  800                 && OFFLIM {NON-FREEWAY}
       STD:   5   8  800                 && OFFLIM {CITY STREETS}
       STD:  30  30  800                 && OFFLIM {RAILWAY}
       STD: 200 200 1000                 && OFFLIM {WATERWAY}
       STD: 15  3  3  3  4               && ONLINK {FWAY NONFWY STREET RAIL ADJ}
       STD: 6.0  4  40.0                 && RPD FNOATT INTERDICT (ci/micro-Ci)
       STD: 0.05   0.2   3.3E-4          && BDF CULVL BRATE
       STD: 0.9   0.1                    && UBF USWF
       STD: 1.0  10.0 1.0                && EVACUATION SURVEY CAMPAIGN
 □
                    RUN DATE: [ 04-11-2011   AT 13:02 ]            PAGE    2

                                 ROUTE_B
```

```
      STD: 0.0 0.0 0.0 0.0 0.0 0.0   && PSPROB
      STD: 0.67  0.67  0.42          && TIMENDE NON-DISPERSAL EVAC TIME (LCF&
      STD: 2 2 0                     && FLAGS=IUOPT IACC REGCHECK (OFF)
      STD: 5E-4, 4E-4, 1.0E-4        && LCFCON(1), LCFCON(2), GECON
      STD: RT6_Ingestion.BIN         && INGESTION FILE
OUTPUT CI_REM
FORM UNIT
DIMEN 0 0 18
PARM 0 1 3 0
SEVERITY
   NPOP=1
      NMODE=1

   NPOP=2
      NMODE=1

   NPOP=3
      NMODE=1

RELEASE
   GROUP=RHLLW
      RFRAC

      AERSOL

      RESP

      DEPVEL 0.0
PACKAGE RHLLW 10.0 1.0 0.0 3.3
   CO60 2000.0 RHLLW
   PU239 0.34 RHLLW
END
VEHICLE -1 INLNNSS 1.000000E01 1.0 0.0 3.3 1.0 2.0 3.0 1.0 3.0
      RHLLW 1.0
FLAGS
   IACC 2
   IUOPT 2
   REGCHECK 1
MODSTD
   DISTOFF FREEWAY 3.000000E01 3.000000E01 8.000000E02
   DISTOFF SECONDARY 2.700000E01 3.000000E01 8.000000E02
□
                    RUN DATE: [ 04-11-2011   AT 13:02 ]            PAGE    3

                                   ROUTE_B

   DISTOFF STREET 5.000000E00 8.000000E00 8.000000E02
   DISTON
FREEWAY 1.500000E01
SECONDARY 3.000000E00
STREET 3.000000E00
ADJACENT 4.000000E00
   BDF 5.000000E-02
   BRATE 3.300000E-04
   CULVL 2.000000E-01
   EVACUATION 1.000000E00
   GECON 1.000000E-04
   INTERDICT 4.000000E01
   LCFCON 5.000000E-04 4.000000E-04
   SURVEY 1.000000E01
   UBF 5.200000E-01
   USWF 4.800000E-01
   CAMPAIGN 8.330000E-02
```

```
   MITDDIST 3.000000E01
   MITDVEL 2.400000E01
   RPD 6.000000E00
   RR 1.000000E00
   RU 1.800000E-02
   RS 8.700000E-01
   SMALLPKG 5.000000E-01
   RPCTHYROID
I1311.270000E06
EOF
LINK RURAL_ID INLNNSS 273.3 121.0 2.0 6.3 1160.0 3.94E-7 2.49E-8 R 1 0.254
LINK SUBURBN_ID INLNNSS 21.9 88.0 2.0 315.2 2410.0 3.94E-7 2.49E-8 S 1 0.0
LINK URBAN_ID INLNNSS 1.3 88.0 2.0 2041.8 5490.0 3.94E-7 2.49E-8 U 1 0.0
LINK RURAL_NV INLNNSS 815.5 121.0 2.0 2.2 1160.0 1.62E-7 8.9E-9 R 1 0.183
LINK SUBURBN_NV INLNNSS 11.6 88.0 2.0 337.2 2410.0 1.62E-7 8.9E-9 S 1 0.0
LINK URBAN_NV INLNNSS 0.7 88.0 2.0 1764.7 5490.0 1.62E-7 8.9E-9 U 1 0.0
LINK RURAL_UT INLNNSS 152.0 121.0 2.0 1.0 1160.0 2.84E-7 1.39E-8 R 1 0.132
LINK SUBURBN_UT INLNNSS 0.0 88.0 2.0 0.0 2410.0 2.84E-7 1.39E-8 S 1 0.0
LINK URBAN_UT INLNNSS 0.0 88.0 2.0 0.0 5490.0 2.84E-7 1.39E-8 U 1 0.0

STOP STOP_1 INLNNSS 1.0 1.0 1.0 1.0 1.5
STOP STOP_2 INLNNSS 13000.0 1.0 15.8 1.0 1.5
STOP STOP_3 INLNNSS 22410.0 30.0 800.0 1.0 1.5


EOF
□
                    RUN DATE: [ 04-11-2011   AT 13:02 ]            PAGE    4

                                  ROUTE_B

                         CONTROL INPUT DATA (DIMEN & PARM)
                         *********************************


    NUMBER OF ACCIDENT SEVERITY CATEGORIES     =     0
    NUMBER OF LOSS OF SHIELDING PROBABILITIES  =     0
    NUMBER OF DEPOSITION AREAS (ISOPLETHS)     =    18
    INCIDENT FREE ANALYSIS INVOKED
    DETAILED INPUT, FULL OUTPUT, SENSITIVITY ANALYIS EDIT & POPULATION RISK B
                    & FULL ECONOMIC OUTPUT
    USER SUPPLIED OR NATIONAL AVERAGE WEATHER DILUTION INPUT
    HISTORICAL UNITS ON INPUT
    HISTORICAL UNITS ON OUTPUT
    DOSE UNITS ON OUTPUT

    INGESTION FILE = RT6_Ingestion.BIN


                     PACKAGE AND MATERIAL CHARACTERISTICS INPUT DATA
                     ***********************************************

                  DIMENSION  EFFECTIVE     K(0)      FRACTION   FRACTION  DOSE
      MATERIAL     (METERS)  DIMENSION  METERS SQ.    GAMMA     NEUTRON  (mre
         RHLLW   3.300E+00  3.300E+00  7.023E+00  1.000E+00  0.000E+00  1.00

    K(0) IS DOSE RATE CONVERSION FACTOR
□
                    RUN DATE: [ 04-11-2011   AT 13:02 ]            PAGE    5

                                  ROUTE_B
```

```
                    VEHICLE CHARACTERISTICS INPUT DATA
                    **********************************


VEHICLE NAME                  INLNNSS
MODE TYPE                      HIGHWAY
EXCLUSIVE USE                    YES
DOSE RATE (mrem/hr)           1.00E+01
FRACTION OF GAMMA FOR VEH     1.00E+00
FRACTION OF NEUTRON FOR V     0.00E+00
K(0) (SQ. METERS)             7.02E+00
VEHICLE SIZE (M)              3.30E+00
EFFECTIVE SIZE (M)            3.30E+00
NUMBER OF SHIPMENTS           1.00E+00
NUMBER OF CREW                2.00E+00
CREW DISTANCE (M)             3.00E+00
CREW DOSE ADJUSTMENT FACT     1.00E+00
CREW EXPOSER WIDTH (M)        3.00E+00
EFFECTIVE EXPOSER WIDTH       3.00E+00
K(0) (SQ M) CREW EXPOSURE     6.25E+00


  VEHICLE     MATERIAL   NO.PACKAGES
INLNNSS
                 RHLLW    1.00E+00


TRANSFER
COEFFICIENTS:     MU       A(1)      A(2)      A(3)      A(4)
      GAMMA   0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
    NEUTRON   7.420E-03 2.020E-02 6.170E-05 3.170E-08 0.000E+00


DISTANCES (METERS)   FREEWAY SECONDARY   STREET     RAIL     WATER    AD
OFFLINK:
MINIMUM DISTANCE    3.00E+01  2.70E+01  5.00E+00  3.00E+01  2.00E+02
SIDEWALK + MINIMUM  3.00E+01  3.00E+01  8.00E+00  3.00E+01  2.00E+02
MAXIMUM DISTANCE    8.00E+02  8.00E+02  8.00E+02  8.00E+02  1.00E+03
ONLINK:
OPPOSITE DIRECTION  1.50E+01  3.00E+00  3.00E+00  3.00E+00
ADJACENT VEHICLE                                                     4.
```

```
                RUN DATE: [ 04-11-2011   AT 13:02 ]            PAGE    6

                              ROUTE_B


                       STOP RELATED INPUT DATA
                       ***********************
STOP                    STOP_1      STOP_2      STOP_3
VEHICLE                  INLNNSS     INLNNSS     INLNNSS
PERSONS                 1.00E+00    1.30E+04    2.24E+04
MINIMUM DISTANCE(M)     1.00E+00    1.00E+00    3.00E+01
MAXIMUM DISTANCE(M)     1.00E+00    1.58E+01    8.00E+02
SHIELDING FACTOR        1.00E+00    1.00E+00    1.00E+00
TIME (HR)               1.50E+00    1.50E+00    1.50E+00


                       LINK RELATED INPUT DATA
```

```
                        **********************
LINK                          RURAL_ID  SUBURBN_ID    URBAN_ID    RURA
VEHICLE                        INLNÑSS    INLNÑSS      INLNÑSS     INL
DISTANCE (KM)                 2.73E+02   2.19E+01    1.30E+00    8.16
PERSONS PER VEHICLE           2.00E+00   2.00E+00    2.00E+00    2.00
SPEED (KM/HR)                 1.21E+02   8.80E+01    8.80E+01    1.21
POPULATION DENSITY (#/KM^2)   6.30E+00   3.15E+02    2.04E+03    2.20
VEHICLE DENSITY (#/HR)        1.16E+03   2.41E+03    5.49E+03    1.16
ACCIDENT RATE/KM              3.94E-07   3.94E-07    3.94E-07    1.62
FATALITIES/ACCIDENT           2.49E-08   2.49E-08    2.49E-08    8.90
ZONE                          RURAL      SUBURBAN    URBAN       RURA
ROAD TYPE                        FREEWAY    FREEWAY     FREEWAY      F
FARMING FRACTION              2.54E-01   0.00E+00    0.00E+00    1.83
LINK                          URBAN_NV   RURAL_UT  SUBURBN_UT    URBA
VEHICLE                        INLNÑSS    INLNÑSS      INLNÑSS     INL
DISTANCE (KM)                 7.00E-01   1.52E+02    0.00E+00    0.00
PERSONS PER VEHICLE           2.00E+00   2.00E+00    2.00E+00    2.00
SPEED (KM/HR)                 8.80E+01   1.21E+02    8.80E+01    8.80
POPULATION DENSITY (#/KM^2)   1.76E+03   1.00E+00    0.00E+00    0.00
VEHICLE DENSITY (#/HR)        5.49E+03   1.16E+03    2.41E+03    5.49
ACCIDENT RATE/KM              1.62E-07   2.84E-07    2.84E-07    2.84
FATALITIES/ACCIDENT           8.90E-09   1.39E-08    1.39E-08    1.39
ZONE                          URBAN      RURAL       SUBURBAN    URBA
ROAD TYPE                        FREEWAY    FREEWAY     FREEWAY      F
FARMING FRACTION              0.00E+00   1.32E-01    0.00E+00    0.00

                        END OF INPUT EDIT
                        *****************
```

```
                 RUN DATE: [ 04-11-2011   AT 13:02 ]            PAGE    7

                              ROUTE_B

RRRR    AAA   DDDD   TTTTT  RRRR    AAA   N   N      6          000    000
R   R  A   A  D   D    T    R   R  A   A  NN  N      6         0   0  0   0
R   R  A   A  D   D    T    R   R  A   A  N N N      6         0   0  0   0
RRRR   A   A  D   D    T    RRRR   A   A  N  NN      6666      0   0  0   0
R R    AAAAA  D   D    T    R R    AAAAA  N   N      6   6     0   0  0   0
R  R   A   A  D   D    T    R  R   A   A  N   N      6   6     0   0  0   0
R   R  A   A  DDDD     T    R   R  A   A  N   N       666   *   000    000

                       RADTRAN 6.00    September 28, 2007

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                 OOO   U   U  TTTTT  PPPP   U   U  TTTTT
                O   O  U   U    T    P   P  U   U    T
                O   O  U   U    T    P   P  U   U    T
                O   O  U   U    T    PPPP   U   U    T
                O   O  U   U    T    P      U   U    T
                O   O  U   U    T    P      U   U    T
                 OOO   UUUUU    T    P      UUUUU    T

                       RADTRAN 6.00    September 28, 2007

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                 RUN DATE: [ 04-11-2011   AT 13:02 ]            PAGE    8

                              ROUTE_B
```

NON-RADIOLOGICAL DATA (ACCIDENTS and FATALITIES)
**********

HIGHWAY
INLNNSS

| LINK | ACCIDENT RATE | ACCIDENTS | FATALITIES |
|---|---|---|---|
| RURAL_ID | 3.94E-07 | 1.08E-04 | 2.68E-12 |
| SUBURBN_ID | 3.94E-07 | 8.63E-06 | 2.15E-13 |
| URBAN_ID | 3.94E-07 | 5.12E-07 | 1.28E-14 |
| RURAL_NV | 1.62E-07 | 1.32E-04 | 1.18E-12 |
| SUBURBN_NV | 1.62E-07 | 1.88E-06 | 1.67E-14 |
| URBAN_NV | 1.62E-07 | 1.13E-07 | 1.01E-15 |
| RURAL_UT | 2.84E-07 | 4.32E-05 | 6.00E-13 |
| SUBURBN_UT | 2.84E-07 | 0.00E+00 | 0.00E+00 |
| URBAN_UT | 2.84E-07 | 0.00E+00 | 0.00E+00 |
| TOTALS: | | 2.94E-04 | 4.70E-12 |



ROUTE_B

REGULATORY CHECKS

THE SHIPMENT BY INLNNSS IS DESIGNATED AS EXCLUSIVE USE
BUT IS NOT REQUIRED TO BE SO DESIGNATED BY REGULATIONS

FOR THE SHIPMENT BY INLNNSS
THE DOSE RATE IN THE CREW COMPARTMENT COULD EXCEED 2 mrem/hr
THE DOSE RATE HAS BEEN RESET FROM 6.94 TO 2 FOR CREW CALCULATIONS



ROUTE_B

INCIDENT-FREE SUMMARY
******** **** *******

IN-TRANSIT POPULATION EXPOSURE IN PERSON-REM
*INPUT DATA WERE ALTERED WITH REGULATORY CHECKS

| | CREW | OFF LINK | ON LINK |
|---|---|---|---|
| RURAL_ID | 9.11E-03 | 2.08E-05 | 1.44E-03 |
| SUBURBN_ID | 1.00E-03 | 9.97E-05 | 4.58E-04 |
| URBAN_ID | 5.96E-05 | 7.93E-07 | 6.20E-05 |
| RURAL_NV | 2.72E-02 | 2.17E-05 | 4.30E-03 |
| SUBURBN_NV | 5.31E-04 | 5.65E-05 | 2.43E-04 |
| URBAN_NV | 3.21E-05 | 3.69E-07 | 3.34E-05 |
| RURAL_UT | 5.06E-03 | 1.83E-06 | 8.01E-04 |
| SUBURBN_UT | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| URBAN_UT | 0.00E+00 | 0.00E+00 | 0.00E+00 |

```
ZONE
  RURAL   4.13E-02  4.43E-05  6.54E-03
  SUBURB  1.53E-03  1.56E-04  7.01E-04
  URBAN   9.16E-05  1.16E-06  9.54E-05


 TOTALS:  4.30E-02  2.02E-04  7.33E-03



              MAXIMUM INDIVIDUAL IN-TRANSIT DOSE


                   INLNNSS     2.68E-07 REM

              STOP EXPOSURE IN PERSON-REM

        LINE-SOURCE         STOP_1   3.98E-02
        ANNULAR AREA        STOP_2   2.37E-02
        ANNULAR AREA        STOP_3   4.87E-02

                            TOTAL:   1.12E-01
□
        RUN DATE: [ 04-11-2011   AT 13:02 ]            PAGE   11

                         ROUTE_B

       INCIDENT-FREE IMPORTANCE ANALYSIS SUMMARY
ESTIMATES THE PERSON-REM INFLUENCE OF A ONE PERCENT INCREASE IN THE PARAMETER

     LINK        PARAMETER                          IMPORTANCE       CHANGE
   RURAL_ID ------------------------------------------------------------------
               VELOCITY                            -1.201E-04    -1.1362 %
               DISTANCE TRAVELED                    1.057E-04     1.0000 %
               NUMBER OF SHIPMENTS                  1.057E-04     1.0000 %
               DOSE RATE FOR VEHICLE (TI)           1.057E-04     1.0000 %
               NUMBER OF CREW MEMBERS               9.107E-05     0.8618 %
               CREW DOSE ADJUSTMENT FACTOR          9.107E-05     0.8618 %
               DISTANCE FROM PACKAGE TO CREW       -2.024E-05    -0.1915 %
               NUMBER OF PEOPLE PER VEHICLE         1.440E-05     0.1362 %
               TRAFFIC COUNT                        1.440E-05     0.1362 %
               SHIELDING FACTOR (RR,RS,RU)          2.078E-07     0.0020 %
               POPULATION DENSITY                   2.078E-07     0.0020 %

  SUBURBN_ID ----------------------------------------------------------------
               VELOCITY                            -2.020E-05    -1.2936 %
               DISTANCE TRAVELED                    1.561E-05     1.0000 %
               NUMBER OF SHIPMENTS                  1.561E-05     1.0000 %
               DOSE RATE FOR VEHICLE (TI)           1.561E-05     1.0000 %
               CREW DOSE ADJUSTMENT FACTOR          1.003E-05     0.6426 %
               NUMBER OF CREW MEMBERS               1.003E-05     0.6426 %
               NUMBER OF PEOPLE PER VEHICLE         4.584E-06     0.2936 %
               TRAFFIC COUNT                        4.584E-06     0.2936 %
               DISTANCE FROM PACKAGE TO CREW       -2.230E-06    -0.1428 %
               POPULATION DENSITY                   9.966E-07     0.0638 %
               SHIELDING FACTOR (RR,RS,RU)          9.966E-07     0.0638 %

    URBAN_ID ------------------------------------------------------------------
               VELOCITY                            -1.843E-06    -1.5067 %
               NUMBER OF SHIPMENTS                  1.223E-06     1.0000 %
               DOSE RATE FOR VEHICLE (TI)           1.223E-06     1.0000 %
```

```
                DISTANCE TRAVELED                  1.223E-06     1.0000 %
                NUMBER OF PEOPLE PER VEHICLE       6.199E-07     0.5067 %
                TRAFFIC COUNT                      6.199E-07     0.5067 %
                NUMBER OF CREW MEMBERS             5.956E-07     0.4868 %
                CREW DOSE ADJUSTMENT FACTOR        5.956E-07     0.4868 %
                DISTANCE FROM PACKAGE TO CREW     -1.324E-07    -0.1082 %
                SHIELDING FACTOR (RR,RS,RU)        7.929E-09     0.0065 %
                POPULATION DENSITY                 7.929E-09     0.0065 %
□
                  RUN DATE: [ 04-11-2011   AT 13:02 ]            PAGE   12

                                ROUTE_B

                INCIDENT-FREE IMPORTANCE ANALYSIS SUMMARY
ESTIMATES THE PERSON-REM INFLUENCE OF A ONE PERCENT INCREASE IN THE PARAMETER

     LINK        PARAMETER                         IMPORTANCE       CHANGE
    RURAL_NV ----------------------------------------------------------------
                VELOCITY                          -3.579E-04    -1.1364 %
                DISTANCE TRAVELED                  3.149E-04     1.0000 %
                NUMBER OF SHIPMENTS                3.149E-04     1.0000 %
                DOSE RATE FOR VEHICLE (TI)         3.149E-04     1.0000 %
                NUMBER OF CREW MEMBERS             2.717E-04     0.8629 %
                CREW DOSE ADJUSTMENT FACTOR        2.717E-04     0.8629 %
                DISTANCE FROM PACKAGE TO CREW     -6.039E-05    -0.1918 %
                NUMBER OF PEOPLE PER VEHICLE       4.295E-05     0.1364 %
                TRAFFIC COUNT                      4.295E-05     0.1364 %
                SHIELDING FACTOR (RR,RS,RU)        2.165E-07     0.0007 %
                POPULATION DENSITY                 2.165E-07     0.0007 %

  SUBURBN_NV ----------------------------------------------------------------
                VELOCITY                          -1.074E-05    -1.2923 %
                DOSE RATE FOR VEHICLE (TI)         8.308E-06     1.0000 %
                NUMBER OF SHIPMENTS                8.308E-06     1.0000 %
                DISTANCE TRAVELED                  8.308E-06     1.0000 %
                CREW DOSE ADJUSTMENT FACTOR        5.315E-06     0.6398 %
                NUMBER OF CREW MEMBERS             5.315E-06     0.6398 %
                NUMBER OF PEOPLE PER VEHICLE       2.428E-06     0.2923 %
                TRAFFIC COUNT                      2.428E-06     0.2923 %
                DISTANCE FROM PACKAGE TO CREW     -1.181E-06    -0.1422 %
                POPULATION DENSITY                 5.647E-07     0.0680 %
                SHIELDING FACTOR (RR,RS,RU)        5.647E-07     0.0680 %

    URBAN_NV ----------------------------------------------------------------
                VELOCITY                          -9.920E-07    -1.5071 %
                NUMBER OF SHIPMENTS                6.582E-07     1.0000 %
                DOSE RATE FOR VEHICLE (TI)         6.582E-07     1.0000 %
                DISTANCE TRAVELED                  6.582E-07     1.0000 %
                NUMBER OF PEOPLE PER VEHICLE       3.338E-07     0.5071 %
                TRAFFIC COUNT                      3.338E-07     0.5071 %
                NUMBER OF CREW MEMBERS             3.207E-07     0.4873 %
                CREW DOSE ADJUSTMENT FACTOR        3.207E-07     0.4873 %
                DISTANCE FROM PACKAGE TO CREW     -7.127E-08    -0.1083 %
                SHIELDING FACTOR (RR,RS,RU)        3.690E-09     0.0056 %
                POPULATION DENSITY                 3.690E-09     0.0056 %
□
                  RUN DATE: [ 04-11-2011   AT 13:02 ]            PAGE   13

                                ROUTE_B

                INCIDENT-FREE IMPORTANCE ANALYSIS SUMMARY
ESTIMATES THE PERSON-REM INFLUENCE OF A ONE PERCENT INCREASE IN THE PARAMETER
```

```
     LINK        PARAMETER                          IMPORTANCE       CHANGE
    RURAL_UT ----------------------------------------------------------------
                 VELOCITY                          -6.668E-05    -1.1364 %
                 DISTANCE TRAVELED                  5.867E-05     1.0000 %
                 NUMBER OF SHIPMENTS                5.867E-05     1.0000 %
                 DOSE RATE FOR VEHICLE (TI)         5.867E-05     1.0000 %
                 NUMBER OF CREW MEMBERS             5.065E-05     0.8632 %
                 CREW DOSE ADJUSTMENT FACTOR        5.065E-05     0.8632 %
                 DISTANCE FROM PACKAGE TO CREW     -1.126E-05    -0.1918 %
                 NUMBER OF PEOPLE PER VEHICLE       8.006E-06     0.1364 %
                 TRAFFIC COUNT                      8.006E-06     0.1364 %
                 SHIELDING FACTOR (RR,RS,RU)        1.834E-08     0.0003 %
                 POPULATION DENSITY                 1.834E-08     0.0003 %

  SUBURBN_UT ----------------------------------------------------------------
                 SHIELDING FACTOR (RR,RS,RU)        1.834E-08    Infinit %

    URBAN_UT ----------------------------------------------------------------
                 SHIELDING FACTOR (RR,RS,RU)        1.834E-08    Infinit %
□
                   RUN DATE: [ 04-11-2011   AT 13:02 ]            PAGE   14

                                  ROUTE_B

                 INCIDENT-FREE IMPORTANCE ANALYSIS SUMMARY
ESTIMATES THE PERSON-REM INFLUENCE OF A ONE PERCENT INCREASE IN THE PARAMETER

     STOP        PARAMETER                          IMPORTANCE       CHANGE
      STOP_1 ----------------------------------------------------------------
                 NUMBER OF SHIPMENTS                3.975E-04     1.0000 %
                 POPULATION/POPULATION DENSITY      3.975E-04     1.0000 %
                 MINIMUM DISTANCE AT STOP          -3.975E-04    -1.0000 %
                 DOSE RATE FOR VEHICLE              3.975E-04     1.0000 %
                 STOP TIME                          3.975E-04     1.0000 %

      STOP_2 ----------------------------------------------------------------
                 MAXIMUM DISTANCE AT STOP          -4.769E-04    -2.0080 %
                 STOP TIME                          2.375E-04     1.0000 %
                 POPULATION/POPULATION DENSITY      2.375E-04     1.0000 %
                 NUMBER OF SHIPMENTS                2.375E-04     1.0000 %
                 DOSE RATE FOR VEHICLE              2.375E-04     1.0000 %
                 MINIMUM DISTANCE AT STOP           1.910E-06     0.0080 %

      STOP_3 ----------------------------------------------------------------
                 MAXIMUM DISTANCE AT STOP          -9.754E-04    -2.0028 %
                 STOP TIME                          4.870E-04     1.0000 %
                 POPULATION/POPULATION DENSITY      4.870E-04     1.0000 %
                 NUMBER OF SHIPMENTS                4.870E-04     1.0000 %
                 DOSE RATE FOR VEHICLE              4.870E-04     1.0000 %
                 MINIMUM DISTANCE AT STOP           1.372E-06     0.0028 %
EOI
END OF RUN
SUCCESSFUL COMPLETION
```

# Appendix D

## RISKIND Results for Alternatives Involving Offsite Transportation Accidents

**Collective Population Results under No Action (Transport of Ion-Exchange Waste Only): Page D-2 through 17**

**Individual Results under No Action (Transport of Ion-Exchange Waste Only): Page D-18 through 32**

**Collective Population Results for Offsite Transport of All Waste: Page D-33 through D-45**

**Individual Results for Offsite Transport of All Waste: Page D-46 through D-57**

```
====================== RISKIND Program Output, Version 2.0 =========== Page:  1
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 18:13
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
==============================================================================


==============================================================================
========================== RISKIND Computer Program ==========================
==============================================================================


Problem Description
___________________________________________

              Population Dose

              Accident Calculations
                 User Defined Accident
                 Single Weather Analysis

                 Acute Exposure
                    Plume Inhalation
                    Plume Immersion
                    Early Ground Exposure
                    Exposure to Cask


   Note: * next to input description signifies
         a data dependent default value
```

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  2
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 18:13
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
============================  Input Parameters  ==============================


==============================================================================
===================== RISKIND Accident Population Input ======================
==============================================================================

Population Accident Parameters
_____________________________________________

                 Minimum Distance [XPZ(1)]:    0.05          km
                 Maximum Distance [XPZ(2)]:   80.00          km
                 Population Density [POPD]: 1303.00 person/km2
            Average Breathing Rate [BRTPOP]: 8000.00       m3/yr
        Accident Exposure Duration [HTEXP]:    2.00          hr
            Accident Indoor Fraction [RFIE]:    0.00
                 Population type [POPTYPE]:  Public
              Risk Conversion Factors
               Non-Fatal Cancers/person-rem: 1.0E-04
                   Fatal Cancers/person-rem: 5.0E-04
                 Genetic Effects/person-rem: 1.3E-04
        Fraction of Indoor Shelter [WSHLT]
                                Frame House:    0.36
                                Brick House:    0.38
                                Office Bldg:    0.21
                                Automobile :    0.05
                                Other      :    0.00

Derived Shielding Factors
_________________________________________

                            Acute Inhalation:    1.00
                           Acute Cloud Shine:    1.00
                              Acute External:    1.00
```

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  3
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 18:13
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
============================  Input Parameters  ==============================

Meteorological Parameters
_____________________________________________

                Dry deposition rate [VDEP]: 1.00E-02      m/s
                     Rain fall rate [RAIN]: 0.00E+00     mm/h
                   Anemometer height [ANH]:    10.00        m
                Ambient Temperature [TABK]:   283.00        K
                      Mixing height [DMIX]:  1000.00        m
                  Wind at anemometer [WSM]:     4.00      m/s
           Pasquill stability cat. [ITYPE]:       D



Shipment Parameters
_____________________________________________

                Transportation Mode [IMOD]:    Truck
                         Dose at 1 m [TIDX]:    10.00  mrem/hr
                Measurement Offset [TIOFF]:     0.00        m
                  Gamma Fraction [FRAD(1)]:     1.00
                Neutron Fraction [FRAD(2)]:     0.00
                       Cask Length [HSIZE]:     2.10        m
                       Cask Radius [RSIZE]:     2.20        m
```

Title : RHLLW Accident Scenario
Date/Time : 12/13/11 18:13
Input File : c:\riskind\input\atrresinoffsite12132011.inp
Output File : C:\RISKIND\output\atrresinoffsite12132011.out

========== Input Parameters ==========

Nuclide Parameters

Nuclide Inventory and DCFs

| Nuclide Name | Inventory Amount [Ci] | ======= Dose Conversion Factors ====== Inhalation [Sv/Bq] | Ingestion [Sv/Bq] | Cloud [Sv/s] [Bq/m3] | Ground [Sv/s] [Bq/m2] | Nucl. Class | Decay Const. [1/yr] |
|---|---|---|---|---|---|---|---|
| AG110M | 3.06E-02 | 2.17E-08 | 2.92E-09 | 1.35E-13 | 2.65E-15 | Co-60 | 1.00E+00 |
| AM241 | 3.40E-03 | 1.20E-04 | 9.84E-07 | 8.18E-16 | 2.74E-17 | Co-60 | 1.60E-03 |
| BA137M | 6.12E-01 | 2.49E-09 | 2.49E-09 | 2.88E-14 | 5.86E-16 | Co-60 | 1.40E+05 |
| BA140 | 2.03E-02 | 1.01E-09 | 2.56E-09 | 8.58E-15 | 1.81E-16 | Co-60 | 2.00E+01 |
| C 14 | 3.64E-02 | 5.64E-10 | 5.64E-10 | 2.25E-19 | 1.61E-20 | Co-60 | 1.20E-04 |
| CA 45 | 4.62E-04 | 1.79E-09 | 8.55E-10 | 8.62E-19 | 4.61E-20 | Co-60 | 1.60E+00 |
| CD109 | 6.42E-03 | 3.09E-08 | 3.55E-09 | 2.94E-16 | 2.25E-17 | Co-60 | 5.50E-01 |
| CE141 | 6.66E-02 | 2.42E-09 | 7.83E-10 | 3.43E-15 | 7.37E-17 | Co-60 | 7.80E+00 |
| CE144 | 5.98E+00 | 1.01E-07 | 5.71E-09 | 2.80E-15 | 5.83E-17 | Co-60 | 8.90E-01 |
| CM242 | 1.14E-04 | 4.67E-06 | 3.10E-08 | 5.68E-18 | 9.55E-19 | Co-60 | 1.60E+00 |
| CM244 | 8.34E-04 | 6.70E-05 | 5.45E-07 | 4.91E-18 | 8.78E-19 | Co-60 | 3.80E-02 |
| CO 57 | 1.57E-04 | 2.45E-09 | 3.20E-10 | 5.61E-15 | 1.15E-16 | Co-60 | 9.30E-01 |
| CO 58 | 2.00E+01 | 2.94E-09 | 9.68E-10 | 4.76E-14 | 9.49E-16 | Co-60 | 3.60E+00 |
| CO 60 | 4.99E+01 | 5.91E-08 | 7.28E-09 | 1.26E-13 | 2.35E-15 | Co-60 | 1.30E-01 |
| CR 51 | 1.16E+02 | 9.03E-11 | 3.98E-11 | 1.50E-15 | 3.08E-17 | Co-60 | 9.10E+00 |
| CS134 | 1.48E-01 | 1.25E-08 | 1.98E-08 | 7.56E-14 | 1.52E-15 | Co-60 | 3.40E-01 |
| CS137 | 1.26E+00 | 1.10E-08 | 1.59E-08 | 2.73E-14 | 5.54E-16 | Co-60 | 2.30E-02 |
| EU152 | 2.11E-01 | 5.97E-08 | 1.75E-09 | 5.65E-14 | 1.10E-15 | Co-60 | 5.10E-02 |
| EU154 | 2.70E-01 | 7.73E-08 | 2.58E-09 | 6.14E-14 | 1.18E-15 | Co-60 | 7.90E-02 |
| EU155 | 9.00E-02 | 1.12E-08 | 4.13E-10 | 2.49E-15 | 5.90E-17 | Co-60 | 1.40E-01 |
| FE 55 | 1.54E+02 | 7.26E-10 | 1.64E-10 | 0.00E+00 | 0.00E+00 | Co-60 | 2.60E-01 |
| FE 59 | 9.12E+00 | 4.00E-09 | 1.81E-09 | 5.96E-14 | 1.12E-15 | Co-60 | 5.70E+00 |
| H 3 | 1.49E-02 | 1.73E-11 | 1.73E-11 | 0.00E+00 | 0.00E+00 | Co-60 | 5.60E-02 |
| HF175 | 2.22E-02 | 1.51E-09 | 4.92E-10 | 1.69E-14 | 3.62E-16 | Co-60 | 3.60E+00 |
| HF181 | 6.84E-02 | 4.17E-09 | 1.27E-09 | 2.63E-14 | 5.46E-16 | Co-60 | 6.00E+00 |
| I129 | 1.99E-02 | 4.69E-08 | 7.46E-08 | 3.80E-16 | 2.58E-17 | Co-60 | 4.40E-08 |
| I131 | 6.06E-03 | 8.89E-09 | 1.44E-08 | 1.82E-14 | 3.75E-16 | Co-60 | 3.10E+01 |
| I132 | 1.09E-03 | 1.03E-10 | 1.82E-10 | 1.12E-13 | 2.21E-15 | Co-60 | 2.60E+03 |
| I133 | 4.33E-03 | 1.58E-09 | 2.80E-09 | 2.94E-14 | 5.96E-16 | Co-60 | 2.90E+02 |
| IN113M | 1.53E-02 | 1.11E-11 | 2.83E-11 | 1.20E-14 | 2.54E-16 | Co-60 | 3.70E+03 |
| IN114 | 1.53E-05 | 1.20E-11 | 1.20E-11 | 1.39E-16 | 2.70E-18 | Co-60 | 3.00E+05 |
| IN114M | 1.53E-05 | 2.40E-08 | 4.61E-09 | 4.18E-15 | 9.15E-17 | Co-60 | 5.10E+00 |
| LA140 | 3.47E-02 | 1.31E-09 | 2.28E-09 | 1.17E-13 | 2.15E-15 | Co-60 | 1.50E+02 |
| MN 54 | 8.04E+00 | 1.81E-09 | 7.48E-10 | 4.09E-14 | 8.12E-16 | Co-60 | 8.10E-01 |
| MO 99 | 2.21E-06 | 1.07E-09 | 1.36E-09 | 7.27E-15 | 1.47E-16 | Co-60 | 9.20E+01 |
| NA 24 | 1.84E-06 | 3.27E-10 | 3.84E-10 | 2.18E-13 | 3.61E-15 | Co-60 | 4.00E+02 |
| NB 93M | 3.91E-09 | 7.90E-09 | 1.41E-10 | 4.43E-18 | 9.39E-19 | Co-60 | 4.70E-02 |
| NB 94 | 3.80E-01 | 1.12E-07 | 1.93E-09 | 7.70E-14 | 1.53E-15 | Co-60 | 3.40E-05 |
| NB 95 | 8.94E-01 | 1.57E-09 | 6.95E-10 | 3.74E-14 | 7.48E-16 | Co-60 | 7.20E+00 |
| NB 95M | 5.68E-05 | 6.59E-10 | 6.22E-10 | 2.93E-15 | 6.26E-17 | Co-60 | 7.00E+01 |
| NI 59 | 1.52E-01 | 7.31E-10 | 5.67E-11 | 0.00E+00 | 0.00E+00 | Co-60 | 9.20E-06 |
| NI 63 | 1.44E+01 | 1.70E-09 | 1.56E-10 | 0.00E+00 | 0.00E+00 | Co-60 | 6.90E-03 |
| NP237 | 4.58E-05 | 1.46E-04 | 1.20E-06 | 1.04E-14 | 2.24E-16 | Co-60 | 3.20E-07 |
| PR144 | 7.14E+00 | 1.17E-11 | 3.15E-11 | 1.94E-15 | 3.79E-17 | Co-60 | 2.10E+04 |
| PU238 | 3.40E-03 | 1.06E-04 | 8.65E-07 | 4.87E-18 | 8.37E-19 | Pu-239 | 7.90E-03 |
| PU239 | 1.22E-02 | 1.16E-04 | 9.56E-07 | 4.24E-18 | 3.67E-19 | Pu-239 | 2.90E-05 |
| PU240 | 3.07E-04 | 1.16E-04 | 9.56E-07 | 4.75E-18 | 8.02E-19 | Pu-239 | 1.10E-04 |
| PU241 | 4.57E-04 | 2.23E-06 | 1.85E-08 | 2.19E-19 | 5.20E-21 | Pu-239 | 4.80E-02 |
| RE188 | 1.22E-01 | 5.44E-10 | 8.31E-10 | 2.87E-15 | 5.90E-17 | Co-60 | 3.60E+02 |
| RH103M | 4.88E-03 | 1.38E-12 | 3.14E-12 | 8.80E-18 | 1.25E-18 | Co-60 | 6.50E+03 |
| RH106 | 2.42E-02 | 8.95E-10 | 8.95E-10 | 1.04E-14 | 2.12E-16 | Co-60 | 7.30E+05 |
| RU106 | 2.42E-02 | 1.30E-07 | 8.30E-09 | 1.04E-14 | 2.12E-16 | Co-60 | 6.90E-01 |
| SB125 | 4.62E-02 | 3.75E-09 | 9.85E-10 | 2.02E-14 | 4.33E-16 | Co-60 | 2.50E-01 |
| SC 46 | 3.83E-02 | 8.01E-09 | 1.73E-09 | 9.98E-14 | 1.92E-15 | Co-60 | 3.00E+00 |
| SN113 | 1.53E-02 | 2.88E-09 | 8.33E-10 | 3.82E-16 | 2.13E-17 | Co-60 | 2.20E+00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SN119M | 1.67E-01 | 1.69E-09 | 3.76E-10 | 1.01E-16 | 1.04E-17 | Co-60 | 8.60E-01 |
| SN123 | 6.36E-03 | 8.79E-09 | 2.27E-09 | 4.03E-16 | 8.36E-18 | Co-60 | 2.00E+00 |
| SR 89 | 4.62E-06 | 1.12E-08 | 2.50E-09 | 7.73E-17 | 2.27E-18 | Co-60 | 5.00E+00 |
| SR 90 | 4.87E+00 | 3.53E-07 | 4.14E-08 | 1.97E-16 | 5.61E-18 | Co-60 | 2.40E-02 |
| TA182 | 2.45E-03 | 1.21E-08 | 1.76E-09 | 6.40E-14 | 1.23E-15 | Co-60 | 2.20E+00 |
| TC 99 | 8.76E-01 | 2.25E-09 | 3.95E-10 | 1.62E-18 | 7.79E-20 | Pu-239 | 3.30E-06 |
| TE123M | 6.18E-07 | 2.86E-09 | 1.53E-09 | 6.51E-15 | 1.42E-16 | Co-60 | 2.10E+00 |
| TE125M | 1.06E-02 | 1.97E-09 | 9.92E-10 | 4.53E-16 | 3.61E-17 | Co-60 | 4.40E+00 |
| TE127 | 2.92E-09 | 8.60E-11 | 1.87E-10 | 2.42E-16 | 5.17E-18 | Co-60 | 6.50E+02 |
| TE132 | 3.97E-08 | 2.55E-09 | 2.54E-09 | 1.03E-14 | 2.28E-16 | Co-60 | 7.80E+01 |
| TH228 | 5.28E-07 | 9.32E-05 | 2.24E-07 | 8.03E-14 | 1.41E-15 | Co-60 | 3.60E-01 |
| U234 | 4.58E-05 | 3.58E-05 | 7.66E-08 | 7.63E-18 | 7.48E-19 | Co-60 | 2.80E-06 |
| U235 | 2.26E-06 | 3.32E-05 | 7.23E-08 | 7.72E-15 | 1.67E-16 | Co-60 | 9.80E-10 |
| W187 | 1.79E-01 | 1.67E-10 | 7.46E-10 | 2.28E-14 | 4.69E-16 | Co-60 | 2.50E+02 |
| Y 90 | 4.90E+00 | 2.28E-09 | 2.91E-09 | 1.90E-16 | 5.33E-18 | Co-60 | 9.50E+01 |
| Y 91 | 1.77E-05 | 1.32E-08 | 2.57E-09 | 2.60E-16 | 5.73E-18 | Co-60 | 4.30E+00 |
| ZN 65 | 9.72E+00 | 5.51E-09 | 3.90E-09 | 2.91E-14 | 5.53E-16 | Co-60 | 1.00E+00 |
| ZR 93 | 9.12E-03 | 8.67E-08 | 4.48E-10 | 0.00E+00 | 0.00E+00 | Co-60 | 4.50E-07 |

Title : RHLLW Accident Scenario
Date/Time : 12/13/11 18:13
Input File : c:\riskind\input\atrresinoffsite12132011.inp
Output File : C:\RISKIND\output\atrresinoffsite12132011.out

========== Input Parameters ==========

Nuclide Health Effects Parameters

Acute Organ Dose Conversion Factors

| Nuclide Name | Solubility Class | Inhalation [Sv/Bq] Marrow | Inhalation [Sv/Bq] Lung | Inhalation [Sv/Bq] Intestine | Ground [Sv/s//Bq/m2] Marrow | Ground [Sv/s//Bq/m2] Lung | Ground [Sv/s//Bq/m2] Intestine |
|---|---|---|---|---|---|---|---|
| AG110M | Y | 3.24E-13 | 1.57E-10 | 1.00E-11 | 2.61E-15 | 2.55E-15 | 2.29E-15 |
| AM241 | W | 4.32E-06 | 1.81E-05 | 2.97E-08 | 1.68E-17 | 2.00E-17 | 2.52E-17 |
| BA137M | D | 2.73E-11 | 2.73E-11 | 0.00E+00 | 5.70E-16 | 5.60E-16 | 5.22E-16 |
| BA140 | D | 1.24E-09 | 1.68E-09 | 4.32E-09 | 1.71E-16 | 1.70E-16 | 1.70E-16 |
| C 14 | D | 5.68E-10 | 5.68E-10 | 5.68E-10 | 7.25E-21 | 8.65E-21 | 0.00E+00 |
| CA 45 | W | 2.92E-09 | 9.68E-09 | 7.57E-14 | 2.48E-20 | 2.95E-20 | 1.83E-25 |
| CD109 | Y | 3.46E-09 | 3.35E-09 | 7.30E-12 | 8.30E-18 | 7.72E-18 | 8.10E-18 |
| CE141 | Y | 8.92E-11 | 1.68E-08 | 4.05E-09 | 6.48E-17 | 6.80E-17 | 7.47E-17 |
| CE144 | Y | 1.08E-09 | 5.68E-07 | 3.24E-08 | 5.31E-17 | 5.43E-17 | 1.83E-17 |
| CM242 | W | 2.35E-06 | 1.54E-05 | 3.24E-08 | 2.28E-19 | 1.05E-19 | 8.00E-19 |
| CM244 | W | 4.59E-06 | 1.92E-05 | 3.24E-08 | 2.04E-19 | 9.00E-20 | 7.10E-19 |
| CO 57 | Y | 4.32E-10 | 1.22E-08 | 6.49E-10 | 1.04E-16 | 1.08E-16 | 1.22E-16 |
| CO 58 | Y | 8.92E-10 | 1.57E-08 | 1.97E-09 | 9.30E-16 | 9.10E-16 | 8.42E-16 |
| CO 60 | Y | 6.22E-09 | 1.24E-07 | 5.95E-09 | 2.34E-15 | 2.27E-15 | 1.94E-15 |
| CR 51 | W | 0.00E+00 | 4.86E-13 | 1.14E-13 | 2.95E-17 | 2.94E-17 | 2.91E-17 |
| CS134 | D | 1.08E-08 | 1.08E-08 | 1.27E-08 | 1.48E-15 | 1.46E-15 | 1.34E-15 |
| CS137 | D | 7.57E-09 | 8.11E-09 | 8.11E-09 | 5.39E-16 | 5.30E-16 | 4.93E-16 |
| EU152 | Y | 1.46E-11 | 9.19E-11 | 4.05E-12 | 1.07E-15 | 1.05E-15 | 9.51E-16 |
| EU154 | Y | 2.46E-11 | 1.57E-10 | 9.19E-12 | 1.16E-15 | 1.14E-15 | 1.03E-15 |
| EU155 | Y | 3.78E-12 | 2.54E-11 | 1.59E-12 | 4.71E-17 | 5.34E-17 | 6.05E-17 |
| FE 55 | W | 1.65E-10 | 1.76E-10 | 1.92E-10 | 0.00E+00 | 0.00E+00 | 1.89E-19 |
| FE 59 | W | 3.24E-09 | 3.51E-09 | 4.86E-09 | 1.11E-15 | 1.08E-15 | 9.34E-16 |
| H 3 | D | 1.62E-11 | 1.62E-11 | 1.62E-11 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| HF175 | Y | 4.41E-09 | 7.24E-10 | 4.05E-12 | 3.35E-16 | 3.43E-16 | 5.29E-18 |
| HF181 | Y | 8.22E-09 | 1.26E-09 | 4.05E-12 | 5.19E-16 | 5.21E-16 | 4.93E-16 |
| I129 | D | 1.22E-10 | 2.97E-10 | 7.57E-11 | 1.07E-17 | 1.48E-17 | 1.86E-17 |
| I131 | D | 6.22E-11 | 6.49E-10 | 2.59E-11 | 3.60E-16 | 3.58E-16 | 3.45E-16 |
| I132 | D | 1.41E-11 | 2.70E-10 | 1.14E-11 | 2.16E-15 | 2.12E-15 | 1.95E-15 |
| I133 | D | 2.70E-11 | 8.11E-10 | 2.05E-11 | 5.80E-16 | 5.72E-16 | 5.27E-16 |
| IN113M | Y | 3.62E-12 | 4.97E-11 | 1.30E-11 | 2.41E-16 | 2.40E-16 | 2.33E-16 |
| IN114 | Y | 1.11E-11 | 1.11E-11 | 1.30E-11 | 2.59E-18 | 2.54E-18 | 2.77E-17 |
| IN114M | Y | 8.32E-08 | 5.57E-09 | 1.30E-11 | 8.28E-17 | 8.22E-17 | 8.37E-17 |
| LA140 | W | 2.14E-10 | 4.32E-09 | 5.41E-09 | 2.13E-15 | 2.08E-15 | 1.82E-15 |
| MN 54 | W | 1.08E-09 | 6.49E-09 | 1.32E-09 | 7.96E-16 | 7.77E-16 | 7.18E-16 |
| MO 99 | Y | 5.14E-11 | 4.32E-09 | 5.41E-09 | 1.42E-16 | 1.40E-16 | 1.36E-16 |
| NA 24 | D | 4.59E-13 | 4.59E-13 | 4.59E-13 | 3.60E-15 | 3.50E-15 | 3.03E-15 |
| NB 93M | Y | 2.70E-12 | 8.38E-12 | 6.22E-13 | 2.01E-19 | 4.94E-20 | 8.82E-19 |
| NB 94 | Y | 2.26E-08 | 7.49E-07 | 6.22E-13 | 1.50E-15 | 1.47E-15 | 1.35E-15 |
| NB 95 | Y | 4.32E-10 | 8.38E-09 | 1.92E-09 | 7.32E-16 | 7.17E-16 | 6.62E-16 |
| NB 95M | Y | 5.86E-11 | 3.08E-09 | 1.92E-09 | 5.67E-17 | 5.60E-17 | 5.90E-17 |
| NI 59 | Y | 3.78E-13 | 2.22E-12 | 1.65E-13 | 0.00E+00 | 0.00E+00 | 3.56E-19 |
| NI 63 | Y | 1.05E-12 | 5.95E-12 | 4.59E-13 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| NP237 | W | 4.05E-06 | 1.59E-05 | 2.97E-08 | 2.02E-16 | 2.05E-16 | 2.75E-17 |
| PR144 | Y | 1.92E-14 | 9.46E-11 | 2.16E-14 | 3.66E-17 | 3.61E-17 | 2.54E-17 |
| PU238 | Y | 2.97E-07 | 7.03E-05 | 2.97E-08 | 1.94E-19 | 7.87E-20 | 7.35E-19 |
| PU239 | Y | 2.70E-07 | 6.76E-05 | 2.70E-08 | 1.19E-19 | 7.87E-20 | 3.24E-19 |
| PU240 | Y | 2.70E-07 | 6.76E-05 | 2.70E-08 | 1.88E-19 | 7.81E-20 | 7.02E-19 |
| PU241 | Y | 2.97E-10 | 5.68E-08 | 1.41E-10 | 4.18E-21 | 4.36E-21 | 0.00E+00 |
| RE188 | Y | 2.70E-11 | 2.52E-09 | 5.14E-12 | 5.55E-17 | 5.59E-17 | 5.29E-17 |
| RH103M | Y | 8.84E-14 | 7.76E-12 | 3.78E-08 | 3.38E-19 | 2.32E-19 | 9.85E-19 |
| RH106 | Y | 2.58E-10 | 2.58E-10 | 1.14E-09 | 2.06E-16 | 2.03E-16 | 1.80E-16 |
| RU106 | Y | 1.05E-09 | 6.76E-07 | 3.51E-08 | 2.06E-16 | 2.03E-16 | 1.80E-16 |
| SB125 | W | 2.41E-14 | 7.30E-11 | 3.24E-12 | 4.05E-16 | 4.03E-16 | 3.79E-16 |
| SC 46 | W | 2.97E-11 | 0.00E+00 | 8.65E-12 | 1.90E-15 | 1.85E-15 | 1.65E-15 |
| SN113 | Y | 7.70E-10 | 1.84E-08 | 1.30E-11 | 9.76E-18 | 1.00E-17 | 1.30E-17 |
| SN119M | Y | 4.62E-10 | 1.15E-08 | 1.30E-11 | 3.43E-18 | 3.74E-18 | 5.12E-18 |
| SN123 | Y | 1.78E-13 | 7.57E-11 | 1.05E-11 | 7.94E-18 | 7.86E-18 | 5.58E-18 |
| SR 89 | Y | 1.05E-10 | 8.38E-08 | 1.38E-08 | 1.86E-18 | 1.98E-18 | 1.16E-19 |
| SR 90 | Y | 1.08E-09 | 7.03E-07 | 1.70E-08 | 4.77E-18 | 4.98E-18 | 0.00E+00 |
| TA182 | Y | 1.92E-09 | 8.27E-08 | 4.05E-12 | 1.19E-15 | 1.18E-15 | 1.05E-15 |
| TC 99 | W | 4.05E-11 | 1.65E-08 | 5.68E-10 | 4.48E-20 | 5.29E-20 | 5.30E-22 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TE123M | W | 5.78E-09 | 6.05E-10 | 7.30E-09 | 1.24E-16 | 1.29E-16 | 1.39E-16 |
| TE125M | W | 5.14E-14 | 1.05E-11 | 2.38E-12 | 1.37E-17 | 1.77E-17 | 1.78E-17 |
| TE127 | W | 4.05E-12 | 4.32E-10 | 2.27E-10 | 4.86E-18 | 4.87E-18 | 4.38E-18 |
| TE132 | W | 3.24E-10 | 1.65E-09 | 1.57E-09 | 2.01E-16 | 2.06E-16 | 2.11E-16 |
| TH228 | Y | 2.14E-06 | 3.51E-04 | 1.30E-07 | 1.38E-15 | 1.35E-15 | 2.36E-18 |
| U234 | Y | 1.46E-09 | 6.22E-05 | 2.57E-08 | 2.21E-19 | 1.40E-19 | 6.91E-19 |
| U235 | Y | 2.14E-09 | 5.68E-05 | 2.70E-08 | 1.46E-16 | 1.49E-16 | 1.46E-16 |
| W187 | Y | 2.38E-16 | 9.73E-13 | 5.14E-12 | 4.50E-16 | 4.48E-16 | 4.22E-16 |
| Y 90 | Y | 1.51E-11 | 9.19E-09 | 1.27E-08 | 4.57E-18 | 4.76E-18 | 0.00E+00 |
| Y 91 | Y | 2.97E-10 | 9.73E-08 | 1.46E-08 | 5.29E-18 | 5.31E-18 | 2.83E-18 |
| ZN 65 | Y | 2.70E-09 | 1.59E-08 | 2.22E-09 | 5.46E-16 | 5.31E-16 | 4.67E-16 |
| ZR 93 | Y | 7.84E-13 | 5.68E-12 | 4.05E-13 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

Title : RHLLW Accident Scenario
Date/Time : 12/13/11 18:13
Input File : c:\riskind\input\atrresinoffsite12132011.inp
Output File : C:\RISKIND\output\atrresinoffsite12132011.out

========== Input Parameters ==========

Nuclide Health Effects Parameters

| Name | Acute Organ Dose Conversion Factors =========Cloudshine========= [Sv/s//Bq/m3] Marrow | Lung | Intestine |
|---|---|---|---|
| AG110M | 1.30E-13 | 1.33E-13 | 1.22E-13 |
| AM241 | 5.21E-16 | 6.74E-16 | 8.00E-16 |
| BA137M | 2.73E-14 | 2.80E-14 | 2.61E-14 |
| BA140 | 7.93E-15 | 8.28E-15 | 8.04E-15 |
| C 14 | 1.22E-19 | 1.53E-19 | 0.00E+00 |
| CA 45 | 5.34E-19 | 6.65E-19 | 7.00E-25 |
| CD109 | 1.56E-16 | 1.66E-16 | 9.42E-17 |
| CE141 | 2.82E-15 | 3.17E-15 | 3.28E-15 |
| CE144 | 2.55E-15 | 2.68E-15 | 7.73E-16 |
| CM242 | 1.89E-18 | 1.13E-18 | 4.20E-18 |
| CM244 | 1.46E-18 | 7.07E-19 | 3.57E-18 |
| CO 57 | 4.58E-15 | 5.21E-15 | 5.41E-15 |
| CO 58 | 4.53E-14 | 4.64E-14 | 4.32E-14 |
| CO 60 | 1.23E-13 | 1.24E-13 | 1.11E-13 |
| CR 51 | 1.37E-15 | 1.45E-15 | 1.35E-15 |
| CS134 | 7.19E-14 | 7.37E-14 | 6.84E-14 |
| CS137 | 2.59E-14 | 2.65E-14 | 2.48E-14 |
| EU152 | 5.37E-14 | 5.50E-14 | 5.03E-14 |
| EU154 | 5.87E-14 | 5.99E-14 | 5.54E-14 |
| EU155 | 1.85E-15 | 2.22E-15 | 2.42E-15 |
| FE 55 | 0.00E+00 | 0.00E+00 | 9.85E-19 |
| FE 59 | 5.79E-14 | 5.86E-14 | 5.26E-14 |
| H 3 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| HF175 | 1.49E-14 | 1.60E-14 | 1.97E-16 |
| HF181 | 2.38E-14 | 2.52E-14 | 2.32E-14 |
| I129 | 1.64E-16 | 2.14E-16 | 3.52E-16 |
| I131 | 1.68E-14 | 1.76E-14 | 1.64E-14 |
| I132 | 1.07E-13 | 1.09E-13 | 1.01E-13 |
| I133 | 2.77E-14 | 2.86E-14 | 2.62E-14 |
| IN113M | 1.11E-14 | 1.16E-14 | 1.09E-14 |
| IN114 | 1.34E-16 | 1.35E-16 | 1.38E-15 |
| IN114M | 3.81E-15 | 3.98E-15 | 3.92E-15 |
| LA140 | 1.14E-13 | 1.15E-13 | 1.05E-13 |
| MN 54 | 3.91E-14 | 3.99E-14 | 3.73E-14 |
| MO 99 | 6.83E-15 | 7.06E-15 | 6.83E-15 |
| NA 24 | 2.16E-13 | 2.15E-13 | 2.04E-13 |
| NB 93M | 1.18E-18 | 2.51E-19 | 5.79E-18 |
| NB 94 | 7.35E-14 | 7.51E-14 | 6.99E-14 |
| NB 95 | 3.57E-14 | 3.65E-14 | 3.39E-14 |
| NB 95M | 2.59E-15 | 2.77E-15 | 2.59E-15 |
| NI 59 | 0.00E+00 | 0.00E+00 | 1.65E-18 |
| NI 63 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| NP237 | 9.05E-15 | 9.78E-15 | 9.77E-16 |
| PR144 | 1.88E-15 | 1.91E-15 | 1.52E-15 |
| PU238 | 1.68E-18 | 1.06E-18 | 3.77E-18 |
| PU239 | 2.67E-18 | 2.65E-18 | 3.50E-18 |
| PU240 | 1.66E-18 | 1.09E-18 | 3.69E-18 |
| PU241 | 1.75E-19 | 1.99E-19 | 0.00E+00 |
| RE188 | 2.58E-15 | 2.74E-15 | 2.54E-15 |
| RH103M | 2.82E-18 | 1.88E-18 | 8.56E-18 |
| RH106 | 9.76E-15 | 1.01E-14 | 8.99E-15 |
| RU106 | 9.76E-15 | 1.01E-14 | 8.99E-15 |
| SB125 | 1.88E-14 | 1.95E-14 | 1.82E-14 |
| SC 46 | 9.62E-14 | 9.77E-14 | 8.99E-14 |
| SN113 | 2.58E-16 | 2.69E-16 | 3.58E-16 |
| SN119M | 3.65E-17 | 3.60E-17 | 9.34E-17 |
| SN123 | 3.81E-16 | 3.91E-16 | 3.08E-16 |
| SR 89 | 6.39E-17 | 7.09E-17 | 6.12E-18 |
| SR 90 | 1.68E-16 | 1.84E-16 | 0.00E+00 |
| TA182 | 6.10E-14 | 6.24E-14 | 5.70E-14 |
| TC 99 | 1.05E-18 | 1.29E-18 | 2.24E-20 |

| | | | |
|---|---|---|---|
| TE123M | 5.45E-15 | 6.02E-15 | 6.12E-15 |
| TE125M | 1.86E-16 | 2.23E-16 | 4.10E-16 |
| TE127 | 2.21E-16 | 2.33E-16 | 2.07E-16 |
| TE132 | 8.95E-15 | 9.66E-15 | 9.34E-15 |
| TH228 | 7.81E-14 | 7.88E-14 | 8.40E-17 |
| U234 | 4.20E-18 | 4.39E-18 | 6.50E-18 |
| U235 | 6.53E-15 | 7.18E-15 | 6.55E-15 |
| W187 | 2.12E-14 | 2.21E-14 | 2.06E-14 |
| Y 90 | 1.62E-16 | 1.77E-16 | 0.00E+00 |
| Y 91 | 2.41E-16 | 2.50E-16 | 1.59E-16 |
| ZN 65 | 2.80E-14 | 2.85E-14 | 2.58E-14 |
| ZR 93 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  7
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 18:13
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
==============  Input Parameters  - Accident Response Region:  6===============

Accident Parameters
_____________________________________________

              Physical Release Height [HS] :     1.00        m
  Dispersion Model Coefficients [IDISPMOD] : Based on Eff. Rel. Height
                    Accident Analysis Type: Consequence


Accident Response Region Determined By
_____________________________________________
            Accident Cask Velocity [VCASK] :    65.00     km/h
                 Cask Impact Angle [ALPHA] :    90.00  Degrees
             Cask Orientation Angle [BETA] :    90.00  Degrees
            Impact Object Hardness [IHARD] :  1
                Flame Temperature [TFLAME] : 1.35E+03       K
                     Fire Duration [DFIRE] :     0.75      hr
                     Fire Location [FLOCA] :     0.00       m


Accident Response Region Parameters
_____________________________________________
                  Response Region [IYOURS] :        6
     Region Conditional Probability [FSEV] : 2.33E-07
                         Heat Flux [HEATF] : 2.00E+06   cal/s
      Loss of Cask Shielding Factor [SEXT]
                                    Gamma :     1.00
                                  Neutron :     1.00
                     Failure Rate [FAILS] : 1.00E-01
               Crud Spallation Rate [FSPAL] : 0.00E+00
                 Crud Release Rate [FRCRUD] : 1.00E+00
```

| Nuclide Class [NUTYPE] | Conditional Release Fraction [FRELS] | Dispersion Fraction [FDISP] | Released and Dispersed Fraction (FRELS*FAILS*FDISP) |
|---|---|---|---|
| Co-60 | 5.00E-04 | 1.00E+00 | 5.00E-05 |
| Pu-239 | 5.00E-04 | 1.00E+00 | 5.00E-05 |
| | 2.00E-04 | 0.00E+00 | 0.00E+00 |
| | 4.30E-03 | 0.00E+00 | 0.00E+00 |
| | 6.30E-01 | 0.00E+00 | 0.00E+00 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  8
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 18:13
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
============== Intermediate Calcs - Accident Response Region:  6===============

==============================================================================
============================== Nuclide Release ===============================
==============================================================================
```

| Nuclide Name | Release Amount [Ci] | Hazard Index Inhalation | Hazard Index Ingestion | Hazard Index Ground |
|---|---|---|---|---|
| AM241 | 1.70E-07 | 5.09E-02 | 1.33E-04 | 3.68E-06 |
| C 14 | 1.82E-06 | 2.56E-06 | 4.10E-02 | 2.39E-08 |
| CE144 | 2.99E-04 | 7.53E-02 | 4.53E-04 | 4.38E-04 |
| CO 60 | 2.50E-03 | 3.71E-01 | 1.40E-01 | 9.25E-01 |
| CS137 | 6.30E-05 | 1.75E-03 | 3.57E-02 | 1.81E-02 |
| FE 55 | 7.70E-03 | 1.39E-02 | 5.02E-04 | 0.00E+00 |
| NB 94 | 1.90E-05 | 5.32E-03 | 7.22E-03 | 2.38E-02 |
| PU238 | 1.70E-07 | 4.49E-02 | 1.02E-04 | 9.84E-08 |
| PU239 | 6.10E-07 | 1.76E-01 | 4.78E-04 | 1.83E-07 |
| SR 90 | 2.44E-04 | 2.14E-01 | 3.69E-01 | 6.96E-04 |
| TC 99 | 4.38E-05 | 2.46E-04 | 1.40E-01 | 2.79E-06 |
| ZN 65 | 4.86E-04 | 6.82E-03 | 2.47E-01 | 6.02E-03 |
| Total | 1.14E-02 | 9.61E-01 | 9.81E-01 | 9.74E-01 |

Hazard Limit [HZLM] = 0.0100

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  9
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 18:13
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
============== Intermediate Calcs - Accident Response Region:  6===============

==============================================================================
======================== Population Intermediate Calcs =======================
==============================================================================

                 Integral of X/Q (air)    : 5.93E+01      s/m
                 Integral of X/Q (ground): 5.93E-01 unitless
                 Effective Release Height: 8.79E+00        m
```

Population Air Isopleth Areas and X/Qa Values

| Area # | Distance Near [km] | Distance Far [km] | Contaminated Area [km2] | X/Q Range [s/m3] |
|---|---|---|---|---|
| 1 | 5.00E-02 | 3.15E-01 | 8.26E-03 | 5.20E-04 - 1.64E-04 |
| 2 | 5.00E-02 | 6.84E-01 | 3.43E-02 | 1.64E-04 - 5.19E-05 |
| 3 | 5.00E-02 | 1.40E+00 | 1.31E-01 | 5.20E-05 - 1.64E-05 |
| 4 | 5.00E-02 | 2.89E+00 | 5.16E-01 | 1.64E-05 - 5.19E-06 |
| 5 | 5.00E-02 | 5.97E+00 | 2.04E+00 | 5.20E-06 - 1.64E-06 |
| 6 | 5.00E-02 | 1.22E+01 | 8.00E+00 | 1.64E-06 - 5.19E-07 |
| 7 | 5.00E-02 | 2.47E+01 | 3.07E+01 | 5.20E-07 - 1.64E-07 |
| 8 | 5.00E-02 | 4.92E+01 | 1.13E+02 | 1.64E-07 - 5.19E-08 |
| 9 | 5.00E-02 | 8.00E+01 | 3.35E+02 | 5.20E-08 - 1.64E-08 |
| 10 | 5.00E-02 | 8.00E+01 | 2.24E+02 | 1.64E-08 - 5.19E-09 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 10
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 18:13
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
============== Intermediate Calcs - Accident Response Region:  6===============
```

Population Ground Isopleth Areas and X/Qg Values

| Area # | Distance Near [km] | Distance Far [km] | Contaminated Area [km2] | X/Qg Range [1/m2] |
|---|---|---|---|---|
| 1 | 5.00E-02 | 3.15E-01 | 8.26E-03 | 5.20E-06 - 1.64E-06 |
| 2 | 5.00E-02 | 6.84E-01 | 3.43E-02 | 1.64E-06 - 5.19E-07 |
| 3 | 5.00E-02 | 1.40E+00 | 1.31E-01 | 5.20E-07 - 1.64E-07 |
| 4 | 5.00E-02 | 2.89E+00 | 5.16E-01 | 1.64E-07 - 5.19E-08 |
| 5 | 5.00E-02 | 5.97E+00 | 2.04E+00 | 5.20E-08 - 1.64E-08 |
| 6 | 5.00E-02 | 1.22E+01 | 8.00E+00 | 1.64E-08 - 5.19E-09 |
| 7 | 5.00E-02 | 2.47E+01 | 3.07E+01 | 5.20E-09 - 1.64E-09 |
| 8 | 5.00E-02 | 4.92E+01 | 1.13E+02 | 1.64E-09 - 5.19E-10 |
| 9 | 5.00E-02 | 8.00E+01 | 3.35E+02 | 5.20E-10 - 1.64E-10 |
| 10 | 5.00E-02 | 8.00E+01 | 2.24E+02 | 1.64E-10 - 5.19E-11 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 11
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 18:13
 Input  File  : c:\riskind\input\atrresinoffsite12132011.inp
 Output File  : C:\RISKIND\output\atrresinoffsite12132011.out
============== Intermediate Calcs - Accident Response Region:  6===============

==============================================================================
========================= Population Intermediate Calcs ======================
==============================================================================
```

(Does NOT INCLUDE ingestion dose which is considered as a societal dose)

| Area # | People Affected [people] | Area Dose [person-rem] | =====Individual Dose===== Short-Term [rem] | Long-Term [rem] | Clean-up Factor |
|---|---|---|---|---|---|
| 1 | 1.08E+01 | 1.19E-03 | 1.10E-04 | 0.00E+00 | 1.00E+00 |
| 2 | 4.47E+01 | 1.56E-03 | 3.49E-05 | 0.00E+00 | 1.00E+00 |
| 3 | 1.71E+02 | 1.89E-03 | 1.10E-05 | 0.00E+00 | 1.00E+00 |
| 4 | 6.73E+02 | 2.35E-03 | 3.49E-06 | 0.00E+00 | 1.00E+00 |
| 5 | 2.66E+03 | 2.94E-03 | 1.10E-06 | 0.00E+00 | 1.00E+00 |
| 6 | 1.04E+04 | 3.64E-03 | 3.49E-07 | 0.00E+00 | 1.00E+00 |
| 7 | 3.99E+04 | 4.41E-03 | 1.10E-07 | 0.00E+00 | 1.00E+00 |
| 8 | 1.48E+05 | 5.16E-03 | 3.49E-08 | 0.00E+00 | 1.00E+00 |
| 9 | 4.36E+05 | 4.82E-03 | 1.10E-08 | 0.00E+00 | 1.00E+00 |
| 10 | 2.92E+05 | 1.02E-03 | 3.49E-09 | 0.00E+00 | 1.00E+00 |
| Totals | 9.30E+05 | 2.90E-02 | | | |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 12
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 18:13
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
==============       Results        - Accident Response Region:  6===============

==============================================================================
========================== Accident Dose to Population ========================
==============================================================================
```

| Population Summary Results Per Accident | |
|---|---|
| Committed Effective Dose Equivalent | 2.92E-02 person-rem |
| Expected Genetic Effects | 3.79E-06 |
| Expected Non-fatal Cancers | 2.92E-06 |
| Expected Cancer Fatalities | 1.46E-05 |
| Acute Risk (Expected Fatalities) | 0.00E+00 |

| Pathway | Dose per Accident (person-rem) | | | |
|---|---|---|---|---|
| Acute | 2.92E-02 | | | |
| Cask | | 1.25E-03 | | |
| Ground Shine | | 3.55E-08 | | |
| Inhalation | | 2.78E-02 | | |
| Cloud Shine | | 9.51E-05 | | |
| Long-Term | 0.00E+00 | | | |
| Ground Shine | | 0.00E+00 | | |
| Inhalation | | 0.00E+00 | | |
| Cloud Shine | | 0.00E+00 | | |
| Ingestion | | 0.00E+00 | | |
| Initial Year | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Long-Term | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Water | | | | 0.00E+00 |

| Exposure Parameter | Organ Exposure Marrow | Lung | Intestine | Gonad |
|---|---|---|---|---|
| Population Exposure: | | | | |
| Long-Term Dose [person-rem] | 1.71E-02 | 1.35E-01 | 4.54E-03 | 6.57E-03 |
| Maximum Individual: | | | | |
| Brief Dose [Gy] | 2.75E-08 | 3.93E-08 | 1.09E-07 | |
| Brief Exposure Time [d] | 1.00E+00 | 1.00E+00 | 1.00E+00 | |
| Brief Dose Rate [Gy/hr] | 1.35E-08 | 1.39E-08 | 1.63E-08 | |
| Prolonged Dose [Gy] | 2.88E-08 | 1.88E-06 | 1.06E-07 | |
| Brief Exposure Time [d] | 3.00E+01 | 3.65E+02 | 7.00E+00 | |
| Prolong Dose Rate [Gy/hr] | 1.64E-11 | 2.98E-10 | 3.36E-09 | |
| Hazard | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Risk [Expected Fatalities] | 0.00E+00 | 0.00E+00 | 0.00E+00 | |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 13
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 18:13
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
============================       Results       ==============================

==============================================================================
========================== Accident Risk to Population ========================
==============================================================================
```

| Population Accident Dose Summary Results | | | |
|---|---|---|---|
| ====== Acute ======= | | ===== Total ======= | |
| Dose [person-rem] | Risk [Fatality] | Dose [person-rem] | Risk [Fatality] |
| 2.92E-02 | 0.00E+00 | 2.92E-02 | 1.46E-05 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  1
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 17:58
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
==============================================================================
```

```
==============================================================================
========================== RISKIND Computer Program ==========================
==============================================================================
```

Problem Description

```
              Individual Receptors

              Accident Calculations
                 User Defined Accident
                 Single Weather Analysis

                 Acute Exposure
                    Plume Inhalation
                    Plume Immersion
                    Early Ground Exposure
                    Exposure to Cask


   Note: * next to input description signifies
         a data dependent default value
```

```
====================== RISKIND Program Output, Version 2.0 =========== Page:  2
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 17:58
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
============================  Input Parameters  ============================


==========================================================================
================== RISKIND Accident Individual Problem Input ==================
==========================================================================
```

Individual Accident Parameters

```
                                   State:  US
                        Population Zone: Urban

     Individual      Average Breathing Rate   Individual Type
                        [BRTIND]  (m3/yr)        [INDTYPE]
    MEI                     8.00E+03             Public
    driver                  8.00E+03             Worker
    colocated worke         8.00E+03             Worker
                 Individual type [INDTYPE]:  Worker
            Risk Conversion Factors
                    Non-Fatal Cancers/rem: 8.0E-05
                        Fatal Cancers/rem: 4.0E-04
                      Genetic Effects/rem: 8.0E-05

                 Individual type [INDTYPE]:  Public
            Risk Conversion Factors
                    Non-Fatal Cancers/rem: 1.0E-04
                        Fatal Cancers/rem: 5.0E-04
                      Genetic Effects/rem: 1.3E-04
```

| Individual Name [XNAME] | ======= Location ======= Down Wind [km] | Cross Wind [km] [XRECEP] | Elevation [m] | Acute Exposure Time [hr] [TEXT] | Long Term Exposure [IRTP] | Food Ingestion [IDFOOD] |
|---|---|---|---|---|---|---|
| MEI | 1.60E-01 | 0.00E+00 | 0.00E+00 | 2.00E+00 | | No |
| driver | 3.00E-03 | 0.00E+00 | 0.00E+00 | 2.00E+00 | | No |
| colocated worker | 1.00E-01 | 0.00E+00 | 0.00E+00 | 2.00E+00 | | No |

| Individual Name | Shielding Type Short | Long | Long-Term In | Out | ====== Shielding Factors ==== Acute: Inh | Cld | Ext | Long-Term: Inh | Cld | Ext |
|---|---|---|---|---|---|---|---|---|---|---|
| MEI | None | None | 0.62 | 0.02 | 1.00 | 1.00 | 1.00 | 0.64 | 0.64 | 0.64 |
| driver | None | None | 0.62 | 0.02 | 1.00 | 1.00 | 1.00 | 0.64 | 0.64 | 0.64 |
| colocated worker | None | None | 0.62 | 0.02 | 1.00 | 1.00 | 1.00 | 0.64 | 0.64 | 0.64 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  3
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 17:58
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
============================  Input Parameters  ==============================

Meteorological Parameters
_____________________________________________

            Dry deposition rates [VDEPNUC]
                          Particulates    : 1.00E-02      m/s
                          Ruthenium       : 1.00E-02      m/s
                          Cesium          : 1.00E-02      m/s
                          Iodine          : 1.00E-02      m/s
                          Gases           : 0.00E+00      m/s
                   Rain fall rate [RAIN] : 0.00E+00     mm/h
                 Anemometer height [ANH] :    10.00        m
             Ambient Temperature [TABK] :   283.00        K
                   Mixing height [DMIX] :  1000.00        m
               Wind at anemometer [WSM] :     4.00      m/s
          Pasquill stability cat. [ITYPE] :       D


Shipment Parameters
_____________________________________________

             Transportation Mode [IMOD] :    Truck
                     Dose at 1 m [TIDX] :    10.00  mrem/hr
             Measurement Offset [TIOFF] :     0.00        m
               Gamma Fraction [FRAD(1)] :     1.00
             Neutron Fraction [FRAD(2)] :     0.00
                    Cask Length [HSIZE] :     2.10        m
                    Cask Radius [RSIZE] :     2.20        m
```

```
====================== RISKIND Program Output, Version 2.0 =========== Page:  4
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 17:58
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
============================  Input Parameters  ==============================
```

Nuclide Parameters

Nuclide Inventory and DCFs

| Nuclide Name | Inventory Amount [Ci] | ======= Dose Conversion Factors ====== Inhalation [Sv/Bq] | Ingestion [Sv/Bq] | Cloud [Sv/s] [Bq/m3] | Ground [Sv/s] [Bq/m2] | Nucl. Class | Decay Const. [1/yr] |
|---|---|---|---|---|---|---|---|
| AG110M | 3.06E-02 | 2.17E-08 | 2.92E-09 | 1.35E-13 | 2.65E-15 | Co-60 | 1.00E+00 |
| AM241 | 3.40E-03 | 1.20E-04 | 9.84E-07 | 8.18E-16 | 2.74E-17 | Co-60 | 1.60E-03 |
| BA137M | 6.12E-01 | 2.49E-09 | 2.49E-09 | 2.88E-14 | 5.86E-16 | Co-60 | 1.40E+05 |
| BA140 | 2.03E-02 | 1.01E-09 | 2.56E-09 | 8.58E-15 | 1.81E-16 | Co-60 | 2.00E+01 |
| C 14 | 3.64E-02 | 5.64E-10 | 5.64E-10 | 2.25E-19 | 1.61E-20 | Co-60 | 1.20E-04 |
| CA 45 | 4.62E-04 | 1.79E-09 | 8.55E-10 | 8.62E-19 | 4.61E-20 | Co-60 | 1.60E+00 |
| CD109 | 6.42E-03 | 3.09E-08 | 3.55E-09 | 2.94E-16 | 2.25E-17 | Co-60 | 5.50E-01 |
| CE141 | 6.66E-02 | 2.42E-09 | 7.83E-10 | 3.43E-15 | 7.37E-17 | Co-60 | 7.80E+00 |
| CE144 | 5.98E+00 | 1.01E-07 | 5.71E-09 | 2.80E-15 | 5.83E-17 | Co-60 | 8.90E-01 |
| CM242 | 1.14E-04 | 4.67E-06 | 3.10E-08 | 5.68E-18 | 9.55E-19 | Co-60 | 1.60E+00 |
| CM244 | 8.34E-04 | 6.70E-05 | 5.45E-07 | 4.91E-18 | 8.78E-19 | Co-60 | 3.80E-02 |
| CO 57 | 1.57E-04 | 2.45E-09 | 3.20E-10 | 5.61E-15 | 1.15E-16 | Co-60 | 9.30E-01 |
| CO 58 | 2.00E+01 | 2.94E-09 | 9.68E-10 | 4.76E-14 | 9.49E-16 | Co-60 | 3.60E+00 |
| CO 60 | 4.99E+01 | 5.91E-08 | 7.28E-09 | 1.26E-13 | 2.35E-15 | Co-60 | 1.30E-01 |
| CR 51 | 1.16E+02 | 9.03E-11 | 3.98E-11 | 1.50E-15 | 3.08E-17 | Co-60 | 9.10E+00 |
| CS134 | 1.48E-01 | 1.25E-08 | 1.98E-08 | 7.56E-14 | 1.52E-15 | Co-60 | 3.40E-01 |
| CS137 | 1.26E+00 | 1.10E-08 | 1.59E-08 | 2.73E-14 | 5.54E-16 | Co-60 | 2.30E-02 |
| EU152 | 2.11E-01 | 5.97E-08 | 1.75E-09 | 5.65E-14 | 1.10E-15 | Co-60 | 5.10E-02 |
| EU154 | 2.70E-01 | 7.73E-08 | 2.58E-09 | 6.14E-14 | 1.18E-15 | Co-60 | 7.90E-02 |
| EU155 | 9.00E-02 | 1.12E-08 | 4.13E-10 | 2.49E-15 | 5.90E-17 | Co-60 | 1.40E-01 |
| FE 55 | 1.54E+02 | 7.26E-10 | 1.64E-10 | 0.00E+00 | 0.00E+00 | Co-60 | 2.60E-01 |
| FE 59 | 9.12E+00 | 4.00E-09 | 1.81E-09 | 5.96E-14 | 1.12E-15 | Co-60 | 5.70E+00 |
| H 3 | 1.49E-02 | 1.73E-11 | 1.73E-11 | 0.00E+00 | 0.00E+00 | Co-60 | 5.60E-02 |
| HF175 | 2.22E-02 | 1.51E-09 | 4.92E-10 | 1.69E-14 | 3.62E-16 | Co-60 | 3.60E+00 |
| HF181 | 6.84E-02 | 4.17E-09 | 1.27E-09 | 2.63E-14 | 5.46E-16 | Co-60 | 6.00E+00 |
| I129 | 1.99E-02 | 4.69E-08 | 7.46E-08 | 3.80E-16 | 2.58E-17 | Co-60 | 4.40E-08 |
| I131 | 6.06E-03 | 8.89E-09 | 1.44E-08 | 1.82E-14 | 3.75E-16 | Co-60 | 3.10E+01 |
| I132 | 1.09E-03 | 1.03E-10 | 1.82E-10 | 1.12E-13 | 2.21E-15 | Co-60 | 2.60E+03 |
| I133 | 4.33E-03 | 1.58E-09 | 2.80E-09 | 2.94E-14 | 5.96E-16 | Co-60 | 2.90E+02 |
| IN113M | 1.53E-02 | 1.11E-11 | 2.83E-11 | 1.20E-14 | 2.54E-16 | Co-60 | 3.70E+03 |
| IN114 | 1.53E-05 | 1.20E-11 | 1.20E-11 | 1.39E-16 | 2.70E-18 | Co-60 | 3.00E+05 |
| IN114M | 1.53E-05 | 2.40E-08 | 4.61E-09 | 4.18E-15 | 9.15E-17 | Co-60 | 5.10E+00 |
| LA140 | 3.47E-02 | 1.31E-09 | 2.28E-09 | 1.17E-13 | 2.15E-15 | Co-60 | 1.50E+02 |
| MN 54 | 8.04E+00 | 1.81E-09 | 7.48E-10 | 4.09E-14 | 8.12E-16 | Co-60 | 8.10E-01 |
| MO 99 | 2.21E-06 | 1.07E-09 | 1.36E-09 | 7.27E-15 | 1.47E-16 | Co-60 | 9.20E+01 |
| NA 24 | 1.84E-06 | 3.27E-10 | 3.84E-10 | 2.18E-13 | 3.61E-15 | Co-60 | 4.00E+02 |
| NB 93M | 3.91E-09 | 7.90E-09 | 1.41E-10 | 4.43E-18 | 9.39E-19 | Co-60 | 4.70E-02 |
| NB 94 | 3.80E-01 | 1.12E-07 | 1.93E-09 | 7.70E-14 | 1.53E-15 | Co-60 | 3.40E-05 |
| NB 95 | 8.94E-01 | 1.57E-09 | 6.95E-10 | 3.74E-14 | 7.48E-16 | Co-60 | 7.20E+00 |
| NB 95M | 5.68E-05 | 6.59E-10 | 6.22E-10 | 2.93E-15 | 6.26E-17 | Co-60 | 7.00E+01 |
| NI 59 | 1.52E-01 | 7.31E-10 | 5.67E-11 | 0.00E+00 | 0.00E+00 | Co-60 | 9.20E-06 |
| NI 63 | 1.44E+01 | 1.70E-09 | 1.56E-10 | 0.00E+00 | 0.00E+00 | Co-60 | 6.90E-03 |
| NP237 | 4.58E-05 | 1.46E-04 | 1.20E-06 | 1.04E-14 | 2.24E-16 | Co-60 | 3.20E-07 |
| PR144 | 7.14E+00 | 1.17E-11 | 3.15E-11 | 1.94E-15 | 3.79E-17 | Co-60 | 2.10E+04 |
| PU238 | 3.40E-03 | 1.06E-04 | 8.65E-07 | 4.87E-18 | 8.37E-19 | Pu-239 | 7.90E-03 |
| PU239 | 1.22E-02 | 1.16E-04 | 9.56E-07 | 4.24E-18 | 3.67E-19 | Pu-239 | 2.90E-05 |
| PU240 | 3.07E-04 | 1.16E-04 | 9.56E-07 | 4.75E-18 | 8.02E-19 | Pu-239 | 1.10E-04 |
| PU241 | 4.57E-04 | 2.23E-06 | 1.85E-08 | 2.19E-19 | 5.20E-21 | Pu-239 | 4.80E-02 |
| RE188 | 1.22E-01 | 5.44E-10 | 8.31E-10 | 2.87E-15 | 5.90E-17 | Co-60 | 3.60E+02 |
| RH103M | 4.88E-03 | 1.38E-12 | 3.14E-12 | 8.80E-18 | 1.25E-18 | Co-60 | 6.50E+03 |
| RH106 | 2.42E-02 | 8.95E-10 | 8.95E-10 | 1.04E-14 | 2.12E-16 | Co-60 | 7.30E+05 |
| RU106 | 2.42E-02 | 1.30E-07 | 8.30E-09 | 1.04E-14 | 2.12E-16 | Co-60 | 6.90E-01 |
| SB125 | 4.62E-02 | 3.75E-09 | 9.85E-10 | 2.02E-14 | 4.33E-16 | Co-60 | 2.50E-01 |
| SC 46 | 3.83E-02 | 8.01E-09 | 1.73E-09 | 9.98E-14 | 1.92E-15 | Co-60 | 3.00E+00 |
| SN113 | 1.53E-02 | 2.88E-09 | 8.33E-10 | 3.82E-16 | 2.13E-17 | Co-60 | 2.20E+00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SN119M | 1.67E-01 | 1.69E-09 | 3.76E-10 | 1.01E-16 | 1.04E-17 | Co-60 | 8.60E-01 |
| SN123 | 6.36E-03 | 8.79E-09 | 2.27E-09 | 4.03E-16 | 8.36E-18 | Co-60 | 2.00E+00 |
| SR 89 | 4.62E-06 | 1.12E-08 | 2.50E-09 | 7.73E-17 | 2.27E-18 | Co-60 | 5.00E+00 |
| SR 90 | 4.87E+00 | 3.53E-07 | 4.14E-08 | 1.97E-16 | 5.61E-18 | Co-60 | 2.40E-02 |
| TA182 | 2.45E-03 | 1.21E-08 | 1.76E-09 | 6.40E-14 | 1.23E-15 | Co-60 | 2.20E+00 |
| TC 99 | 8.76E-01 | 2.25E-09 | 3.95E-10 | 1.62E-18 | 7.79E-20 | Pu-239 | 3.30E-06 |
| TE123M | 6.18E-07 | 2.86E-09 | 1.53E-09 | 6.51E-15 | 1.42E-16 | Co-60 | 2.10E+00 |
| TE125M | 1.06E-02 | 1.97E-09 | 9.92E-10 | 4.53E-16 | 3.61E-17 | Co-60 | 4.40E+00 |
| TE127 | 2.92E-09 | 8.60E-11 | 1.87E-10 | 2.42E-16 | 5.17E-18 | Co-60 | 6.50E+02 |
| TE132 | 3.97E-08 | 2.55E-09 | 2.54E-09 | 1.03E-14 | 2.28E-16 | Co-60 | 7.80E+01 |
| TH228 | 5.28E-07 | 9.32E-05 | 2.24E-07 | 8.03E-14 | 1.41E-15 | Co-60 | 3.60E-01 |
| U234 | 4.58E-05 | 3.58E-05 | 7.66E-08 | 7.63E-18 | 7.48E-19 | Co-60 | 2.80E-06 |
| U235 | 2.26E-06 | 3.32E-05 | 7.23E-08 | 7.72E-15 | 1.67E-16 | Co-60 | 9.80E-10 |
| W187 | 1.79E-01 | 1.67E-10 | 7.46E-10 | 2.28E-14 | 4.69E-16 | Co-60 | 2.50E+02 |
| Y 90 | 4.90E+00 | 2.28E-09 | 2.91E-09 | 1.90E-16 | 5.33E-18 | Co-60 | 9.50E+01 |
| Y 91 | 1.77E-05 | 1.32E-08 | 2.57E-09 | 2.60E-16 | 5.73E-18 | Co-60 | 4.30E+00 |
| ZN 65 | 9.72E+00 | 5.51E-09 | 3.90E-09 | 2.91E-14 | 5.53E-16 | Co-60 | 1.00E+00 |
| ZR 93 | 9.12E-03 | 8.67E-08 | 4.48E-10 | 0.00E+00 | 0.00E+00 | Co-60 | 4.50E-07 |

Title : RHLLW Accident Scenario
Date/Time : 12/13/11 17:58
Input File : c:\riskind\input\atrresinoffsite12132011.inp
Output File : C:\RISKIND\output\atrresinoffsite12132011.out

========== Input Parameters ==========

Nuclide Health Effects Parameters

Acute Organ Dose Conversion Factors

| Nuclide Name | Solubility Class | Inhalation [Sv/Bq] Marrow | Inhalation [Sv/Bq] Lung | Inhalation [Sv/Bq] Intestine | Ground [Sv/s//Bq/m2] Marrow | Ground [Sv/s//Bq/m2] Lung | Ground [Sv/s//Bq/m2] Intestine |
|---|---|---|---|---|---|---|---|
| AG110M | Y | 3.24E-13 | 1.57E-10 | 1.00E-11 | 2.61E-15 | 2.55E-15 | 2.29E-15 |
| AM241 | W | 4.32E-06 | 1.81E-05 | 2.97E-08 | 1.68E-17 | 2.00E-17 | 2.52E-17 |
| BA137M | D | 2.73E-11 | 2.73E-11 | 0.00E+00 | 5.70E-16 | 5.60E-16 | 5.22E-16 |
| BA140 | D | 1.24E-09 | 1.68E-09 | 4.32E-09 | 1.71E-16 | 1.70E-16 | 1.70E-16 |
| C 14 | D | 5.68E-10 | 5.68E-10 | 5.68E-10 | 7.25E-21 | 8.65E-21 | 0.00E+00 |
| CA 45 | W | 2.92E-09 | 9.68E-09 | 7.57E-14 | 2.48E-20 | 2.95E-20 | 1.83E-25 |
| CD109 | Y | 3.46E-09 | 3.35E-09 | 7.30E-12 | 8.30E-18 | 7.72E-18 | 8.10E-18 |
| CE141 | Y | 8.92E-11 | 1.68E-08 | 4.05E-09 | 6.48E-17 | 6.80E-17 | 7.47E-17 |
| CE144 | Y | 1.08E-09 | 5.68E-07 | 3.24E-08 | 5.31E-17 | 5.43E-17 | 1.83E-17 |
| CM242 | W | 2.35E-06 | 1.54E-05 | 3.24E-08 | 2.28E-19 | 1.05E-19 | 8.00E-19 |
| CM244 | W | 4.59E-06 | 1.92E-05 | 3.24E-08 | 2.04E-19 | 9.00E-20 | 7.10E-19 |
| CO 57 | Y | 4.32E-10 | 1.22E-08 | 6.49E-10 | 1.04E-16 | 1.08E-16 | 1.22E-16 |
| CO 58 | Y | 8.92E-10 | 1.57E-08 | 1.97E-09 | 9.30E-16 | 9.10E-16 | 8.42E-16 |
| CO 60 | Y | 6.22E-09 | 1.24E-07 | 5.95E-09 | 2.34E-15 | 2.27E-15 | 1.94E-15 |
| CR 51 | W | 0.00E+00 | 4.86E-13 | 1.14E-13 | 2.95E-17 | 2.94E-17 | 2.91E-17 |
| CS134 | D | 1.08E-08 | 1.08E-08 | 1.27E-08 | 1.48E-15 | 1.46E-15 | 1.34E-15 |
| CS137 | D | 7.57E-09 | 8.11E-09 | 8.11E-09 | 5.39E-16 | 5.30E-16 | 4.93E-16 |
| EU152 | Y | 1.46E-11 | 9.19E-11 | 4.05E-12 | 1.07E-15 | 1.05E-15 | 9.51E-16 |
| EU154 | Y | 2.46E-11 | 1.57E-10 | 9.19E-12 | 1.16E-15 | 1.14E-15 | 1.03E-15 |
| EU155 | Y | 3.78E-12 | 2.54E-11 | 1.59E-12 | 4.71E-17 | 5.34E-17 | 6.05E-17 |
| FE 55 | W | 1.65E-10 | 1.76E-10 | 1.92E-10 | 0.00E+00 | 0.00E+00 | 1.89E-19 |
| FE 59 | W | 3.24E-09 | 3.51E-09 | 4.86E-09 | 1.11E-15 | 1.08E-15 | 9.34E-16 |
| H 3 | D | 1.62E-11 | 1.62E-11 | 1.62E-11 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| HF175 | Y | 4.41E-09 | 7.24E-10 | 4.05E-12 | 3.35E-16 | 3.43E-16 | 5.29E-18 |
| HF181 | Y | 8.22E-09 | 1.26E-09 | 4.05E-12 | 5.19E-16 | 5.21E-16 | 4.93E-16 |
| I129 | D | 1.22E-10 | 2.97E-10 | 7.57E-11 | 1.07E-17 | 1.48E-17 | 1.86E-17 |
| I131 | D | 6.22E-11 | 6.49E-10 | 2.59E-11 | 3.60E-16 | 3.58E-16 | 3.45E-16 |
| I132 | D | 1.41E-11 | 2.70E-10 | 1.14E-11 | 2.16E-15 | 2.12E-15 | 1.95E-15 |
| I133 | D | 2.70E-11 | 8.11E-10 | 2.05E-11 | 5.80E-16 | 5.72E-16 | 5.27E-16 |
| IN113M | Y | 3.62E-12 | 4.97E-11 | 1.30E-11 | 2.41E-16 | 2.40E-16 | 2.33E-16 |
| IN114 | Y | 1.11E-11 | 1.11E-11 | 1.30E-11 | 2.59E-18 | 2.54E-18 | 2.77E-17 |
| IN114M | Y | 8.32E-08 | 5.57E-09 | 1.30E-11 | 8.28E-17 | 8.22E-17 | 8.37E-17 |
| LA140 | W | 2.14E-10 | 4.32E-09 | 5.41E-09 | 2.13E-15 | 2.08E-15 | 1.82E-15 |
| MN 54 | W | 1.08E-09 | 6.49E-09 | 1.32E-09 | 7.96E-16 | 7.77E-16 | 7.18E-16 |
| MO 99 | Y | 5.14E-11 | 4.32E-09 | 5.41E-09 | 1.42E-16 | 1.40E-16 | 1.36E-16 |
| NA 24 | D | 4.59E-13 | 4.59E-13 | 4.59E-13 | 3.60E-15 | 3.50E-15 | 3.03E-15 |
| NB 93M | Y | 2.70E-12 | 8.38E-12 | 6.22E-13 | 2.01E-19 | 4.94E-20 | 8.82E-19 |
| NB 94 | Y | 2.26E-08 | 7.49E-07 | 6.22E-13 | 1.50E-15 | 1.47E-15 | 1.35E-15 |
| NB 95 | Y | 4.32E-10 | 8.38E-09 | 1.92E-09 | 7.32E-16 | 7.17E-16 | 6.62E-16 |
| NB 95M | Y | 5.86E-11 | 3.08E-09 | 1.92E-09 | 5.67E-17 | 5.60E-17 | 5.90E-17 |
| NI 59 | Y | 3.78E-13 | 2.22E-12 | 1.65E-13 | 0.00E+00 | 0.00E+00 | 3.56E-19 |
| NI 63 | Y | 1.05E-12 | 5.95E-12 | 4.59E-13 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| NP237 | W | 4.05E-06 | 1.59E-05 | 2.97E-08 | 2.02E-16 | 2.05E-16 | 2.75E-17 |
| PR144 | Y | 1.92E-14 | 9.46E-11 | 2.16E-14 | 3.66E-17 | 3.61E-17 | 2.54E-17 |
| PU238 | Y | 2.97E-07 | 7.03E-05 | 2.97E-08 | 1.94E-19 | 7.87E-20 | 7.35E-19 |
| PU239 | Y | 2.70E-07 | 6.76E-05 | 2.70E-08 | 1.19E-19 | 7.87E-20 | 3.24E-19 |
| PU240 | Y | 2.70E-07 | 6.76E-05 | 2.70E-08 | 1.88E-19 | 7.81E-20 | 7.02E-19 |
| PU241 | Y | 2.97E-10 | 5.68E-08 | 1.41E-10 | 4.18E-21 | 4.36E-21 | 0.00E+00 |
| RE188 | Y | 2.70E-11 | 2.52E-09 | 5.14E-12 | 5.55E-17 | 5.59E-17 | 5.29E-17 |
| RH103M | Y | 8.84E-14 | 7.76E-12 | 3.78E-08 | 3.38E-19 | 2.32E-19 | 9.85E-19 |
| RH106 | Y | 2.58E-10 | 2.58E-10 | 1.14E-09 | 2.06E-16 | 2.03E-16 | 1.80E-16 |
| RU106 | Y | 1.05E-09 | 6.76E-07 | 3.51E-08 | 2.06E-16 | 2.03E-16 | 1.80E-16 |
| SB125 | W | 2.41E-14 | 7.30E-11 | 3.24E-12 | 4.05E-16 | 4.03E-16 | 3.79E-16 |
| SC 46 | W | 2.97E-11 | 0.00E+00 | 8.65E-12 | 1.90E-15 | 1.85E-15 | 1.65E-15 |
| SN113 | Y | 7.70E-10 | 1.84E-08 | 1.30E-11 | 9.76E-18 | 1.00E-17 | 1.30E-17 |
| SN119M | Y | 4.62E-10 | 1.15E-08 | 1.30E-11 | 3.43E-18 | 3.74E-18 | 5.12E-18 |
| SN123 | Y | 1.78E-13 | 7.57E-11 | 1.05E-11 | 7.94E-18 | 7.86E-18 | 5.58E-18 |
| SR 89 | Y | 1.05E-10 | 8.38E-08 | 1.38E-08 | 1.86E-18 | 1.98E-18 | 1.16E-19 |
| SR 90 | Y | 1.08E-09 | 7.03E-07 | 1.70E-08 | 4.77E-18 | 4.98E-18 | 0.00E+00 |
| TA182 | Y | 1.92E-09 | 8.27E-08 | 4.05E-12 | 1.19E-15 | 1.18E-15 | 1.05E-15 |
| TC 99 | W | 4.05E-11 | 1.65E-08 | 5.68E-10 | 4.48E-20 | 5.29E-20 | 5.30E-22 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TE123M | W | 5.78E-09 | 6.05E-10 | 7.30E-09 | 1.24E-16 | 1.29E-16 | 1.39E-16 |
| TE125M | W | 5.14E-14 | 1.05E-11 | 2.38E-12 | 1.37E-17 | 1.77E-17 | 1.78E-17 |
| TE127 | W | 4.05E-12 | 4.32E-10 | 2.27E-10 | 4.86E-18 | 4.87E-18 | 4.38E-18 |
| TE132 | W | 3.24E-10 | 1.65E-09 | 1.57E-09 | 2.01E-16 | 2.06E-16 | 2.11E-16 |
| TH228 | Y | 2.14E-06 | 3.51E-04 | 1.30E-07 | 1.38E-15 | 1.35E-15 | 2.36E-18 |
| U234 | Y | 1.46E-09 | 6.22E-05 | 2.57E-08 | 2.21E-19 | 1.40E-19 | 6.91E-19 |
| U235 | Y | 2.14E-09 | 5.68E-05 | 2.70E-08 | 1.46E-16 | 1.49E-16 | 1.46E-16 |
| W187 | Y | 2.38E-16 | 9.73E-13 | 5.14E-12 | 4.50E-16 | 4.48E-16 | 4.22E-16 |
| Y 90 | Y | 1.51E-11 | 9.19E-09 | 1.27E-08 | 4.57E-18 | 4.76E-18 | 0.00E+00 |
| Y 91 | Y | 2.97E-10 | 9.73E-08 | 1.46E-08 | 5.29E-18 | 5.31E-18 | 2.83E-18 |
| ZN 65 | Y | 2.70E-09 | 1.59E-08 | 2.22E-09 | 5.46E-16 | 5.31E-16 | 4.67E-16 |
| ZR 93 | Y | 7.84E-13 | 5.68E-12 | 4.05E-13 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

Title : RHLLW Accident Scenario
Date/Time : 12/13/11 17:58
Input File : c:\riskind\input\atrresinoffsite12132011.inp
Output File : C:\RISKIND\output\atrresinoffsite12132011.out

========== Input Parameters ==========

Nuclide Health Effects Parameters

| Name | Acute Organ Dose Conversion Factors =========Cloudshine========= [Sv/s//Bq/m3] Marrow | Lung | Intestine |
|---|---|---|---|
| AG110M | 1.30E-13 | 1.33E-13 | 1.22E-13 |
| AM241 | 5.21E-16 | 6.74E-16 | 8.00E-16 |
| BA137M | 2.73E-14 | 2.80E-14 | 2.61E-14 |
| BA140 | 7.93E-15 | 8.28E-15 | 8.04E-15 |
| C 14 | 1.22E-19 | 1.53E-19 | 0.00E+00 |
| CA 45 | 5.34E-19 | 6.65E-19 | 7.00E-25 |
| CD109 | 1.56E-16 | 1.66E-16 | 9.42E-17 |
| CE141 | 2.82E-15 | 3.17E-15 | 3.28E-15 |
| CE144 | 2.55E-15 | 2.68E-15 | 7.73E-16 |
| CM242 | 1.89E-18 | 1.13E-18 | 4.20E-18 |
| CM244 | 1.46E-18 | 7.07E-19 | 3.57E-18 |
| CO 57 | 4.58E-15 | 5.21E-15 | 5.41E-15 |
| CO 58 | 4.53E-14 | 4.64E-14 | 4.32E-14 |
| CO 60 | 1.23E-13 | 1.24E-13 | 1.11E-13 |
| CR 51 | 1.37E-15 | 1.45E-15 | 1.35E-15 |
| CS134 | 7.19E-14 | 7.37E-14 | 6.84E-14 |
| CS137 | 2.59E-14 | 2.65E-14 | 2.48E-14 |
| EU152 | 5.37E-14 | 5.50E-14 | 5.03E-14 |
| EU154 | 5.87E-14 | 5.99E-14 | 5.54E-14 |
| EU155 | 1.85E-15 | 2.22E-15 | 2.42E-15 |
| FE 55 | 0.00E+00 | 0.00E+00 | 9.85E-19 |
| FE 59 | 5.79E-14 | 5.86E-14 | 5.26E-14 |
| H 3 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| HF175 | 1.49E-14 | 1.60E-14 | 1.97E-16 |
| HF181 | 2.38E-14 | 2.52E-14 | 2.32E-14 |
| I129 | 1.64E-16 | 2.14E-16 | 3.52E-16 |
| I131 | 1.68E-14 | 1.76E-14 | 1.64E-14 |
| I132 | 1.07E-13 | 1.09E-13 | 1.01E-13 |
| I133 | 2.77E-14 | 2.86E-14 | 2.62E-14 |
| IN113M | 1.11E-14 | 1.16E-14 | 1.09E-14 |
| IN114 | 1.34E-16 | 1.35E-16 | 1.38E-15 |
| IN114M | 3.81E-15 | 3.98E-15 | 3.92E-15 |
| LA140 | 1.14E-13 | 1.15E-13 | 1.05E-13 |
| MN 54 | 3.91E-14 | 3.99E-14 | 3.73E-14 |
| MO 99 | 6.83E-15 | 7.06E-15 | 6.83E-15 |
| NA 24 | 2.16E-13 | 2.15E-13 | 2.04E-13 |
| NB 93M | 1.18E-18 | 2.51E-19 | 5.79E-18 |
| NB 94 | 7.35E-14 | 7.51E-14 | 6.99E-14 |
| NB 95 | 3.57E-14 | 3.65E-14 | 3.39E-14 |
| NB 95M | 2.59E-15 | 2.77E-15 | 2.59E-15 |
| NI 59 | 0.00E+00 | 0.00E+00 | 1.65E-18 |
| NI 63 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| NP237 | 9.05E-15 | 9.78E-15 | 9.77E-16 |
| PR144 | 1.88E-15 | 1.91E-15 | 1.52E-15 |
| PU238 | 1.68E-18 | 1.06E-18 | 3.77E-18 |
| PU239 | 2.67E-18 | 2.65E-18 | 3.50E-18 |
| PU240 | 1.66E-18 | 1.09E-18 | 3.69E-18 |
| PU241 | 1.75E-19 | 1.99E-19 | 0.00E+00 |
| RE188 | 2.58E-15 | 2.74E-15 | 2.54E-15 |
| RH103M | 2.82E-18 | 1.88E-18 | 8.56E-18 |
| RH106 | 9.76E-15 | 1.01E-14 | 8.99E-15 |
| RU106 | 9.76E-15 | 1.01E-14 | 8.99E-15 |
| SB125 | 1.88E-14 | 1.95E-14 | 1.82E-14 |
| SC 46 | 9.62E-14 | 9.77E-14 | 8.99E-14 |
| SN113 | 2.58E-16 | 2.69E-16 | 3.58E-16 |
| SN119M | 3.65E-17 | 3.60E-17 | 9.34E-17 |
| SN123 | 3.81E-16 | 3.91E-16 | 3.08E-16 |
| SR 89 | 6.39E-17 | 7.09E-17 | 6.12E-18 |
| SR 90 | 1.68E-16 | 1.84E-16 | 0.00E+00 |
| TA182 | 6.10E-14 | 6.24E-14 | 5.70E-14 |
| TC 99 | 1.05E-18 | 1.29E-18 | 2.24E-20 |

| | | | |
|---|---|---|---|
| TE123M | 5.45E-15 | 6.02E-15 | 6.12E-15 |
| TE125M | 1.86E-16 | 2.23E-16 | 4.10E-16 |
| TE127 | 2.21E-16 | 2.33E-16 | 2.07E-16 |
| TE132 | 8.95E-15 | 9.66E-15 | 9.34E-15 |
| TH228 | 7.81E-14 | 7.88E-14 | 8.40E-17 |
| U234 | 4.20E-18 | 4.39E-18 | 6.50E-18 |
| U235 | 6.53E-15 | 7.18E-15 | 6.55E-15 |
| W187 | 2.12E-14 | 2.21E-14 | 2.06E-14 |
| Y 90 | 1.62E-16 | 1.77E-16 | 0.00E+00 |
| Y 91 | 2.41E-16 | 2.50E-16 | 1.59E-16 |
| ZN 65 | 2.80E-14 | 2.85E-14 | 2.58E-14 |
| ZR 93 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  7
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 17:58
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
==============  Input Parameters  - Accident Response Region:  6===============

Accident Parameters
_____________________________________________

              Physical Release Height [HS]:     1.00        m
  Dispersion Model Coefficients [IDISPMOD]: Based on Eff. Rel. Height
                    Accident Analysis Type: Consequence


Accident Response Region Determined By
_____________________________________________

            Accident Cask Velocity [VCASK]:    65.00     km/h
                 Cask Impact Angle [ALPHA]:    90.00  Degrees
             Cask Orientation Angle [BETA]:    90.00  Degrees
            Impact Object Hardness [IHARD]:  1
                Flame Temperature [TFLAME]: 1.35E+03       K
                     Fire Duration [DFIRE]:     0.75      hr
                     Fire Location [FLOCA]:     0.00       m


Accident Response Region Parameters
_____________________________________________

                  Response Region [IYOURS]:        6
     Region Conditional Probability [FSEV]: 2.33E-07
                         Heat Flux [HEATF]: 2.00E+06   cal/s
      Loss of Cask Shielding Factor [SEXT]
                                    Gamma:     1.00
                                  Neutron:     1.00
                     Failure Rate [FAILS]: 1.00E-01
               Crud Spallation Rate [FSPAL]: 0.00E+00
                 Crud Release Rate [FRCRUD]: 1.00E+00
```

| Nuclide Class [NUTYPE] | Conditional Release Fraction [FRELS] | Dispersion Fraction [FDISP] | Released and Dispersed Fraction (FRELS*FAILS*FDISP) |
|---|---|---|---|
| Co-60 | 5.00E-04 | 1.00E+00 | 5.00E-05 |
| Pu-239 | 5.00E-04 | 1.00E+00 | 5.00E-05 |
| | 2.00E-04 | 0.00E+00 | 0.00E+00 |
| | 4.30E-03 | 0.00E+00 | 0.00E+00 |
| | 6.30E-01 | 0.00E+00 | 0.00E+00 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  8
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 17:58
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
============== Intermediate Calcs - Accident Response Region:  6===============
```

==========
========== Nuclide Release ==========
==========

| Nuclide Name | Release Amount [Ci] | Hazard Index Inhalation | Hazard Index Ingestion | Hazard Index Ground |
|---|---|---|---|---|
| AM241 | 1.70E-07 | 5.09E-02 | 1.33E-04 | 3.68E-06 |
| C 14 | 1.82E-06 | 2.56E-06 | 4.10E-02 | 2.39E-08 |
| CE144 | 2.99E-04 | 7.53E-02 | 4.53E-04 | 4.38E-04 |
| CO 60 | 2.50E-03 | 3.71E-01 | 1.40E-01 | 9.25E-01 |
| CS137 | 6.30E-05 | 1.75E-03 | 3.57E-02 | 1.81E-02 |
| FE 55 | 7.70E-03 | 1.39E-02 | 5.02E-04 | 0.00E+00 |
| NB 94 | 1.90E-05 | 5.32E-03 | 7.22E-03 | 2.38E-02 |
| PU238 | 1.70E-07 | 4.49E-02 | 1.02E-04 | 9.84E-08 |
| PU239 | 6.10E-07 | 1.76E-01 | 4.78E-04 | 1.83E-07 |
| SR 90 | 2.44E-04 | 2.14E-01 | 3.69E-01 | 6.96E-04 |
| TC 99 | 4.38E-05 | 2.46E-04 | 1.40E-01 | 2.79E-06 |
| ZN 65 | 4.86E-04 | 6.82E-03 | 2.47E-01 | 6.02E-03 |
| Total | 1.14E-02 | 9.61E-01 | 9.81E-01 | 9.74E-01 |

Hazard Limit [HZLM] = 0.0100

==========
========== Puff Calculations ==========
==========

| Individual Name | Plume Parameters: Effective Release Height [m] | Dispersion Sigma (Horizontal) [m] | Dispersion Sigma (Vertical) [m] |
|---|---|---|---|
| MEI | 8.79E+00 | 1.51E+01 | 8.93E+00 |
| driver | 4.49E+00 | 1.44E+00 | 2.40E+00 |
| colocated worker | 8.79E+00 | 1.02E+01 | 6.68E+00 |

| Individual Name | Chi/Q Air [s/m3] | Chi/Q Ground [1/m2] | Depletion Fraction | Wet/Dry Ratio |
|---|---|---|---|---|
| MEI | | | | |
| Particulates | 3.57E-04 | 3.57E-06 | 1.51E-02 | 0.00E+00 |
| Ruthenium | 3.57E-04 | 3.57E-06 | 1.51E-02 | 0.00E+00 |
| Cesium | 3.57E-04 | 3.57E-06 | 1.51E-02 | 0.00E+00 |
| Iodine | 3.57E-04 | 3.57E-06 | 1.51E-02 | 0.00E+00 |
| Gases | 3.63E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| driver | | | | |
| Particulates | 3.98E-03 | 3.98E-05 | 4.03E-04 | 0.00E+00 |
| Ruthenium | 3.98E-03 | 3.98E-05 | 4.03E-04 | 0.00E+00 |
| Cesium | 3.98E-03 | 3.98E-05 | 4.03E-04 | 0.00E+00 |
| Iodine | 3.98E-03 | 3.98E-05 | 4.03E-04 | 0.00E+00 |
| Gases | 3.98E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| colocated worker | | | | |
| Particulates | 4.87E-04 | 4.87E-06 | 7.14E-03 | 0.00E+00 |
| Ruthenium | 4.87E-04 | 4.87E-06 | 7.14E-03 | 0.00E+00 |
| Cesium | 4.87E-04 | 4.87E-06 | 7.14E-03 | 0.00E+00 |
| Iodine | 4.87E-04 | 4.87E-06 | 7.14E-03 | 0.00E+00 |
| Gases | 4.90E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

```
====================== RISKIND Program Output, Version 2.0 =========== Page:  9
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 17:58
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
==============       Results       - Accident Response Region:  6===============

==============================================================================
==============          Accident Dose to : MEI                  ===============
==============================================================================
```

| Individual Summary Results Per Accident | | |
|---|---|---|
| Committed Effective Dose Equivalent | 1.32E-04 | rem |
| Expected Genetic Effects | 1.72E-08 | |
| Expected Non-fatal Cancers | 1.32E-08 | |
| Expected Cancer Fatalities | 6.61E-08 | |
| Acute Risk (Expected fatalities) | 0.00E+00 | |

| Pathway | Doses(rem) | | | |
|---|---|---|---|---|
| Acute | 1.32E-04 | | | |
| Cask | | 2.54E-06 | | |
| Ground Shine | | 5.91E-07 | | |
| Inhalation | | 1.29E-04 | | |
| Cloud Shine | | 4.40E-07 | | |
| Long-Term | 0.00E+00 | | | |
| Ground Shine | | 0.00E+00 | | |
| Inhalation | | 0.00E+00 | | |
| Cloud Shine | | 0.00E+00 | | |
| Ingestion | | 0.00E+00 | | |
| Initial Year | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Long-Term | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Water | | | | 0.00E+00 |

| Exposure Parameter | Organ Exposure Marrow | Lung | Intestine | Gonads |
|---|---|---|---|---|
| Long-Term Dose [rem] | 7.63E-05 | 6.21E-04 | 1.83E-05 | 2.73E-05 |
| Brief Dose [Gy] | 3.63E-08 | 5.08E-08 | 1.36E-07 | |
| Brief Exposure Time [d] | 1.00E+00 | 1.00E+00 | 1.00E+00 | |
| Brief Dose Rate [Gy/hr] | 1.78E-08 | 1.84E-08 | 2.13E-08 | |
| Prolonged Dose [Gy] | 3.79E-08 | 2.30E-06 | 1.32E-07 | |
| Prolong Exposure Time [d] | 3.00E+01 | 3.65E+02 | 7.00E+00 | |
| Prolong Dose Rate [Gy/hr] | 2.04E-11 | 3.64E-10 | 4.10E-09 | |
| Hazard | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Acute Risk [Expected fatalities] | 0.00E+00 | 0.00E+00 | 0.00E+00 | |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 10
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 17:58
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
==============       Results        - Accident Response Region:  6===============

==============================================================================
==============          Accident Dose to : driver                ===============
==============================================================================
```

| Individual Summary Results Per Accident | | |
|---|---|---|
| Committed Effective Dose Equivalent | 7.19E-03 | rem |
| Expected Genetic Effects | 5.75E-07 | |
| Expected Non-fatal Cancers | 5.75E-07 | |
| Expected Cancer Fatalities | 2.87E-06 | |
| Acute Risk (Expected fatalities) | 0.00E+00 | |

| Pathway | Doses (rem) | | | |
|---|---|---|---|---|
| Acute | 7.19E-03 | | | |
| Cask | | 5.74E-03 | | |
| Ground Shine | | 6.59E-06 | | |
| Inhalation | | 1.43E-03 | | |
| Cloud Shine | | 4.90E-06 | | |
| Long-Term | 0.00E+00 | | | |
| Ground Shine | | 0.00E+00 | | |
| Inhalation | | 0.00E+00 | | |
| Cloud Shine | | 0.00E+00 | | |
| Ingestion | | 0.00E+00 | | |
| Initial Year | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Long-Term | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Water | | | | 0.00E+00 |

| | Organ Exposure | | | |
|---|---|---|---|---|
| Exposure Parameter | Marrow | Lung | Intestine | Gonads |
| Long-Term Dose [rem] | 6.56E-03 | 1.26E-02 | 5.92E-03 | 6.02E-03 |
| Brief Dose [Gy] | 5.75E-05 | 5.77E-05 | 5.87E-05 | |
| Brief Exposure Time [d] | 1.00E+00 | 1.00E+00 | 1.00E+00 | |
| Brief Dose Rate [Gy/hr] | 2.88E-05 | 2.88E-05 | 2.88E-05 | |
| Prolonged Dose [Gy] | 5.76E-05 | 8.27E-05 | 5.86E-05 | |
| Prolong Exposure Time [d] | 3.00E+01 | 3.65E+02 | 7.00E+00 | |
| Prolong Dose Rate [Gy/hr] | 6.75E-09 | 1.06E-08 | 5.22E-08 | |
| Hazard | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Acute Risk [Expected fatalities] | 0.00E+00 | 0.00E+00 | 0.00E+00 | |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 11
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 17:58
 Input  File : c:\riskind\input\atrresinoffsite12132011.inp
 Output File : C:\RISKIND\output\atrresinoffsite12132011.out
==============       Results       - Accident Response Region:  6===============

==============================================================================
==============          Accident Dose to : colocated worker     ===============
==============================================================================
```

| Individual Summary Results Per Accident | | |
|---|---|---|
| Committed Effective Dose Equivalent | 1.85E-04 | rem |
| Expected Genetic Effects | 1.48E-08 | |
| Expected Non-fatal Cancers | 1.48E-08 | |
| Expected Cancer Fatalities | 7.41E-08 | |
| Acute Risk (Expected fatalities) | 0.00E+00 | |

| Pathway | Doses (rem) | | | |
|---|---|---|---|---|
| Acute | 1.85E-04 | | | |
| Cask | | 8.57E-06 | | |
| Ground Shine | | 8.06E-07 | | |
| Inhalation | | 1.75E-04 | | |
| Cloud Shine | | 5.99E-07 | | |
| Long-Term | 0.00E+00 | | | |
| Ground Shine | | 0.00E+00 | | |
| Inhalation | | 0.00E+00 | | |
| Cloud Shine | | 0.00E+00 | | |
| Ingestion | | 0.00E+00 | | |
| Initial Year | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Long-Term | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Water | | | | 0.00E+00 |

| | Organ Exposure | | | |
|---|---|---|---|---|
| Exposure Parameter | Marrow | Lung | Intestine | Gonads |
| Long-Term Dose [rem] | 1.09E-04 | 8.51E-04 | 3.00E-05 | 4.23E-05 |
| Brief Dose [Gy] | 1.01E-07 | 1.20E-07 | 2.36E-07 | |
| Brief Exposure Time [d] | 1.00E+00 | 1.00E+00 | 1.00E+00 | |
| Brief Dose Rate [Gy/hr] | 4.98E-08 | 5.06E-08 | 5.46E-08 | |
| Prolonged Dose [Gy] | 1.03E-07 | 3.18E-06 | 2.31E-07 | |
| Prolong Exposure Time [d] | 3.00E+01 | 3.65E+02 | 7.00E+00 | |
| Prolong Dose Rate [Gy/hr] | 3.36E-11 | 5.02E-10 | 5.59E-09 | |
| Hazard | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Acute Risk [Expected fatalities] | 0.00E+00 | 0.00E+00 | 0.00E+00 | |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 12
 Title        : RHLLW Accident Scenario
 Date/Time    : 12/13/11 17:58
 Input  File  : c:\riskind\input\atrresinoffsite12132011.inp
 Output File  : C:\RISKIND\output\atrresinoffsite12132011.out
============================       Results       ============================

==============================================================================
======================== Accident Risk to Individuals ========================
==============================================================================
```

Individual Accident Dose Summary Results
Consequences

| | Acute | | Total | | | |
|---|---|---|---|---|---|---|
| | Dose [rem] | Risk [Fatality] | Dose [rem] | Expected Non-Fatal Cancer Incidence | Expected Cancer Fatalities | Expected Genetic Effects |
| MEI | 1.32E-04 | 0.0E+00 | 1.32E-04 | 1.3E-08 | 6.6E-08 | 1.7E-08 |
| driver | 7.19E-03 | 0.0E+00 | 7.19E-03 | 5.7E-07 | 2.9E-06 | 5.7E-07 |
| colocated worke | 1.85E-04 | 0.0E+00 | 1.85E-04 | 1.5E-08 | 7.4E-08 | 1.5E-08 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  1
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:58
 Input  File : c:\riskind\input\july2920116000cioffsite.inp
 Output File : C:\RISKIND\output\july2920116000cioffsite.out
==============================================================================
```

```
==============================================================================
========================== RISKIND Computer Program ==========================
==============================================================================
```

Problem Description

---

Population Dose

Accident Calculations
- User Defined Accident
- Single Weather Analysis

  - Acute Exposure
    - Plume Inhalation
    - Plume Immersion
    - Early Ground Exposure
    - Exposure to Cask

Note: * next to input description signifies
a data dependent default value

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  2
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:58
 Input  File : c:\riskind\input\july2920116000cioffsite.inp
 Output File : C:\RISKIND\output\july2920116000cioffsite.out
============================  Input Parameters  ==============================


==============================================================================
===================== RISKIND Accident Population Input ======================
==============================================================================

Population Accident Parameters
_____________________________________________

                 Minimum Distance [XPZ(1)]:    0.05          km
                 Maximum Distance [XPZ(2)]:   80.00          km
                 Population Density [POPD]: 1303.00 person/km2
            Average Breathing Rate [BRTPOP]: 8000.00      m3/yr
        Accident Exposure Duration [HTEXP]:    2.00          hr
            Accident Indoor Fraction [RFIE]:    0.00
                 Population type [POPTYPE]:  Public
              Risk Conversion Factors
               Non-Fatal Cancers/person-rem: 1.0E-04
                   Fatal Cancers/person-rem: 5.0E-04
                 Genetic Effects/person-rem: 1.3E-04
        Fraction of Indoor Shelter [WSHLT]
                              Frame House:    0.36
                              Brick House:    0.38
                              Office Bldg:    0.21
                              Automobile :    0.05
                              Other      :    0.00

Derived Shielding Factors
_____________________________________________
                           Acute Inhalation:    1.00
                         Acute Cloud Shine:    1.00
                            Acute External:    1.00
```

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  3
 Title       : RHLLW Accident Scenario
 Date/Time   : 07/29/11 08:58
 Input  File : c:\riskind\input\july2920116000cioffsite.inp
 Output File : C:\RISKIND\output\july2920116000cioffsite.out
============================  Input Parameters  ============================

Meteorological Parameters
-----------------------------------------------

                Dry deposition rate [VDEP] : 1.00E-02      m/s
                     Rain fall rate [RAIN] : 0.00E+00     mm/h
                   Anemometer height [ANH] :    10.00        m
                Ambient Temperature [TABK] :   283.00        K
                      Mixing height [DMIX] :  1000.00        m
                  Wind at anemometer [WSM] :     4.00      m/s
            Pasquill stability cat. [ITYPE] :       D


Shipment Parameters
-----------------------------------------------

                Transportation Mode [IMOD] :    Truck
                        Dose at 1 m [TIDX] :    10.00  mrem/hr
                Measurement Offset [TIOFF] :     0.00        m
                  Gamma Fraction [FRAD(1)] :     1.00
                Neutron Fraction [FRAD(2)] :     0.00
                       Cask Length [HSIZE] :     3.30        m
                       Cask Radius [RSIZE] :     1.99        m
```

Title : RHLLW Accident Scenario
Date/Time : 07/29/11 08:58
Input File : c:\riskind\input\july2920116000cioffsite.inp
Output File : C:\RISKIND\output\july2920116000cioffsite.out

========== Input Parameters ==========

Nuclide Parameters

Nuclide Inventory and DCFs

| Nuclide Name | Inventory Amount [Ci] | ======= Dose Conversion Factors ====== Inhalation [Sv/Bq] | Ingestion [Sv/Bq] | Cloud [Sv/s] [Bq/m3] | Ground [Sv/s] [Bq/m2] | Nucl. Class | Decay Const. [1/yr] |
|---|---|---|---|---|---|---|---|
| BA137M | 2.17E-25 | 2.49E-09 | 2.49E-09 | 2.88E-14 | 5.86E-16 | Co-60 | 1.40E+05 |
| CO 58 | 2.63E-11 | 2.94E-09 | 9.68E-10 | 4.76E-14 | 9.49E-16 | Co-60 | 3.60E+00 |
| CO 60 | 6.00E+03 | 5.91E-08 | 7.28E-09 | 1.26E-13 | 2.35E-15 | Co-60 | 1.30E-01 |
| FE 55 | 7.42E+04 | 7.26E-10 | 1.64E-10 | 0.00E+00 | 0.00E+00 | Co-60 | 2.60E-01 |
| MN 54 | 3.32E+01 | 1.81E-09 | 7.48E-10 | 4.09E-14 | 8.12E-16 | Co-60 | 8.10E-01 |
| NB 95 | 2.65E-18 | 1.57E-09 | 6.95E-10 | 3.74E-14 | 7.48E-16 | Co-60 | 7.20E+00 |
| NI 59 | 3.80E+02 | 7.31E-10 | 5.67E-11 | 0.00E+00 | 0.00E+00 | Co-60 | 9.20E-06 |
| NI 63 | 4.82E+04 | 1.70E-09 | 1.56E-10 | 0.00E+00 | 0.00E+00 | Co-60 | 6.90E-03 |
| PU239 | 5.38E-03 | 1.16E-04 | 9.56E-07 | 4.24E-18 | 3.67E-19 | Co-60 | 2.90E-05 |
| SB125 | 7.29E-04 | 3.75E-09 | 9.85E-10 | 2.02E-14 | 4.33E-16 | Co-60 | 2.50E-01 |
| SN119M | 7.29E-04 | 1.69E-09 | 3.76E-10 | 1.01E-16 | 1.04E-17 | Co-60 | 8.60E-01 |
| TA182 | 2.08E-04 | 1.21E-08 | 1.76E-09 | 6.40E-14 | 1.23E-15 | Co-60 | 2.20E+00 |
| TE125M | 1.69E-01 | 1.97E-09 | 9.92E-10 | 4.53E-16 | 3.61E-17 | Co-60 | 4.40E+00 |
| ZR 95 | 5.26E-17 | 6.39E-09 | 1.02E-09 | 3.60E-14 | 7.22E-16 | Co-60 | 4.00E+00 |

Title : RHLLW Accident Scenario
Date/Time : 07/29/11 08:58
Input File : c:\riskind\input\july2920116000cioffsite.inp
Output File : C:\RISKIND\output\july2920116000cioffsite.out

========== Input Parameters ==========

Nuclide Health Effects Parameters

| Nuclide Name | Solubility Class | Acute Organ Dose Conversion Factors: Inhalation [Sv/Bq] Marrow | Lung | Intestine | Ground [Sv/s//Bq/m2] Marrow | Lung | Intestine |
|---|---|---|---|---|---|---|---|
| BA137M | D | 2.73E-11 | 2.73E-11 | 0.00E+00 | 5.70E-16 | 5.60E-16 | 5.22E-16 |
| CO 58 | Y | 8.92E-10 | 1.57E-08 | 1.97E-09 | 9.30E-16 | 9.10E-16 | 8.42E-16 |
| CO 60 | Y | 6.22E-09 | 1.24E-07 | 5.95E-09 | 2.34E-15 | 2.27E-15 | 1.94E-15 |
| FE 55 | W | 1.65E-10 | 1.76E-10 | 1.92E-10 | 0.00E+00 | 0.00E+00 | 1.89E-19 |
| MN 54 | W | 1.08E-09 | 6.49E-09 | 1.32E-09 | 7.96E-16 | 7.77E-16 | 7.18E-16 |
| NB 95 | Y | 4.32E-10 | 8.38E-09 | 1.92E-09 | 7.32E-16 | 7.17E-16 | 6.62E-16 |
| NI 59 | Y | 3.78E-13 | 2.22E-12 | 1.65E-13 | 0.00E+00 | 0.00E+00 | 3.56E-19 |
| NI 63 | Y | 1.05E-12 | 5.95E-12 | 4.59E-13 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| PU239 | Y | 2.70E-07 | 6.76E-05 | 2.70E-08 | 1.19E-19 | 7.87E-20 | 3.24E-19 |
| SB125 | W | 2.41E-14 | 7.30E-11 | 3.24E-12 | 4.05E-16 | 4.03E-16 | 3.79E-16 |
| SN119M | Y | 4.62E-10 | 1.15E-08 | 1.30E-11 | 3.43E-18 | 3.74E-18 | 5.12E-18 |
| TA182 | Y | 1.92E-09 | 8.27E-08 | 4.05E-12 | 1.19E-15 | 1.18E-15 | 1.05E-15 |
| TE125M | W | 5.14E-14 | 1.05E-11 | 2.38E-12 | 1.37E-17 | 1.77E-17 | 1.78E-17 |
| ZR 95 | Y | 1.30E-09 | 4.05E-08 | 3.78E-09 | 7.06E-16 | 6.92E-16 | 6.38E-16 |

Title : RHLLW Accident Scenario
Date/Time : 07/29/11 08:58
Input File : c:\riskind\input\july2920116000cioffsite.inp
Output File : C:\RISKIND\output\july2920116000cioffsite.out

========== Input Parameters ==========

Nuclide Health Effects Parameters

| Name | Acute Organ Dose Conversion Factors =========Cloudshine======== [Sv/s//Bq/m3] Marrow | Lung | Intestine |
|---|---|---|---|
| BA137M | 2.73E-14 | 2.80E-14 | 2.61E-14 |
| CO 58 | 4.53E-14 | 4.64E-14 | 4.32E-14 |
| CO 60 | 1.23E-13 | 1.24E-13 | 1.11E-13 |
| FE 55 | 0.00E+00 | 0.00E+00 | 9.85E-19 |
| MN 54 | 3.91E-14 | 3.99E-14 | 3.73E-14 |
| NB 95 | 3.57E-14 | 3.65E-14 | 3.39E-14 |
| NI 59 | 0.00E+00 | 0.00E+00 | 1.65E-18 |
| NI 63 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| PU239 | 2.67E-18 | 2.65E-18 | 3.50E-18 |
| SB125 | 1.88E-14 | 1.95E-14 | 1.82E-14 |
| SN119M | 3.65E-17 | 3.60E-17 | 9.34E-17 |
| TA182 | 6.10E-14 | 6.24E-14 | 5.70E-14 |
| TE125M | 1.86E-16 | 2.23E-16 | 4.10E-16 |
| ZR 95 | 3.43E-14 | 3.51E-14 | 3.26E-14 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  7
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:58
 Input  File  : c:\riskind\input\july2920116000cioffsite.inp
 Output File  : C:\RISKIND\output\july2920116000cioffsite.out
==============  Input Parameters  - Accident Response Region:  6===============

Accident Parameters
_____________________________________________

              Physical Release Height [HS]:     1.00        m
  Dispersion Model Coefficients [IDISPMOD]: Based on Eff. Rel. Height
                   Accident Analysis Type: Consequence


Accident Response Region Determined By
_____________________________________________
            Accident Cask Velocity [VCASK]:    65.00     km/h
                 Cask Impact Angle [ALPHA]:    90.00  Degrees
             Cask Orientation Angle [BETA]:    90.00  Degrees
            Impact Object Hardness [IHARD]:  1
                Flame Temperature [TFLAME]: 1.35E+03       K
                     Fire Duration [DFIRE]:     0.75      hr
                     Fire Location [FLOCA]:     0.00       m


Accident Response Region Parameters
_____________________________________________
                  Response Region [IYOURS]:        6
     Region Conditional Probability [FSEV]: 2.33E-07
                         Heat Flux [HEATF]: 2.00E+06   cal/s
      Loss of Cask Shielding Factor [SEXT]
                                    Gamma:     1.00
                                  Neutron:     1.00
                       Failure Rate [FAILS]: 1.00E-01
                 Crud Spallation Rate [FSPAL]: 0.00E+00
                   Crud Release Rate [FRCRUD]: 1.00E+00
```

| Nuclide Class [NUTYPE] | Conditional Release Fraction [FRELS] | Dispersion Fraction [FDISP] | Released and Dispersed Fraction (FRELS*FAILS*FDISP) |
|---|---|---|---|
| Co-60 | 5.00E-04 | 1.00E+00 | 5.00E-05 |
| Pu-239 | 5.00E-04 | 1.00E+00 | 5.00E-05 |
| | 2.00E-04 | 0.00E+00 | 0.00E+00 |
| | 4.30E-03 | 0.00E+00 | 0.00E+00 |
| | 6.30E-01 | 0.00E+00 | 0.00E+00 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  8
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:58
 Input  File  : c:\riskind\input\july2920116000cioffsite.inp
 Output File  : C:\RISKIND\output\july2920116000cioffsite.out
============== Intermediate Calcs - Accident Response Region:  6===============

==============================================================================
=============================== Nuclide Release ==============================
==============================================================================
```

| Nuclide Name | Release Amount [Ci] | ==========Hazard Index========== Inhalation | Ingestion | Ground |
|---|---|---|---|---|
| CO 60 | 3.00E-01 | 7.23E-01 | 3.61E-01 | 1.00E+00 |
| FE 55 | 3.71E+00 | 1.09E-01 | 5.19E-03 | 0.00E+00 |
| NI 63 | 2.41E+00 | 1.66E-01 | 6.31E-01 | 0.00E+00 |
| Total | 6.42E+00 | 9.98E-01 | 9.98E-01 | 1.00E+00 |

Hazard Limit [HZLM] = 0.0100

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  9
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:58
 Input  File : c:\riskind\input\july2920116000cioffsite.inp
 Output File : C:\RISKIND\output\july2920116000cioffsite.out
============== Intermediate Calcs - Accident Response Region:  6===============

==============================================================================
======================== Population Intermediate Calcs =======================
==============================================================================

                Integral of X/Q (air)    : 5.93E+01      s/m
                Integral of X/Q (ground): 5.93E-01 unitless
                Effective Release Height: 8.79E+00        m
```

Population Air Isopleth Areas and X/Qa Values

| Area # | Distance Near [km] | Distance Far [km] | Contaminated Area [km2] | X/Q Range [s/m3] |
|---|---|---|---|---|
| 1 | 5.00E-02 | 3.29E-01 | 9.11E-03 | 4.91E-04 - 1.55E-04 |
| 2 | 5.00E-02 | 7.10E-01 | 3.70E-02 | 1.55E-04 - 4.91E-05 |
| 3 | 5.00E-02 | 1.46E+00 | 1.41E-01 | 4.91E-05 - 1.55E-05 |
| 4 | 5.00E-02 | 3.00E+00 | 5.53E-01 | 1.55E-05 - 4.91E-06 |
| 5 | 5.00E-02 | 6.19E+00 | 2.19E+00 | 4.91E-06 - 1.55E-06 |
| 6 | 5.00E-02 | 1.26E+01 | 8.55E+00 | 1.55E-06 - 4.91E-07 |
| 7 | 5.00E-02 | 2.56E+01 | 3.27E+01 | 4.91E-07 - 1.55E-07 |
| 8 | 5.00E-02 | 5.08E+01 | 1.21E+02 | 1.55E-07 - 4.91E-08 |
| 9 | 5.00E-02 | 8.00E+01 | 3.39E+02 | 4.91E-08 - 1.55E-08 |
| 10 | 5.00E-02 | 8.00E+01 | 2.19E+02 | 1.55E-08 - 4.91E-09 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 10
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:58
 Input  File  : c:\riskind\input\july2920116000cioffsite.inp
 Output File  : C:\RISKIND\output\july2920116000cioffsite.out
============== Intermediate Calcs - Accident Response Region:  6===============
```

Population Ground Isopleth Areas and X/Qg Values

| Area # | Distance Near [km] | Distance Far [km] | Contaminated Area [km2] | X/Qg Range [1/m2] |
|---|---|---|---|---|
| 1 | 5.00E-02 | 3.29E-01 | 9.11E-03 | 4.91E-06 - 1.55E-06 |
| 2 | 5.00E-02 | 7.10E-01 | 3.70E-02 | 1.55E-06 - 4.91E-07 |
| 3 | 5.00E-02 | 1.46E+00 | 1.41E-01 | 4.91E-07 - 1.55E-07 |
| 4 | 5.00E-02 | 3.00E+00 | 5.53E-01 | 1.55E-07 - 4.91E-08 |
| 5 | 5.00E-02 | 6.19E+00 | 2.19E+00 | 4.91E-08 - 1.55E-08 |
| 6 | 5.00E-02 | 1.26E+01 | 8.55E+00 | 1.55E-08 - 4.91E-09 |
| 7 | 5.00E-02 | 2.56E+01 | 3.27E+01 | 4.91E-09 - 1.55E-09 |
| 8 | 5.00E-02 | 5.08E+01 | 1.21E+02 | 1.55E-09 - 4.91E-10 |
| 9 | 5.00E-02 | 8.00E+01 | 3.39E+02 | 4.91E-10 - 1.55E-10 |
| 10 | 5.00E-02 | 8.00E+01 | 2.19E+02 | 1.55E-10 - 4.91E-11 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 11
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:58
 Input  File  : c:\riskind\input\july2920116000cioffsite.inp
 Output File  : C:\RISKIND\output\july2920116000cioffsite.out
============== Intermediate Calcs - Accident Response Region:  6===============

==============================================================================
======================== Population Intermediate Calcs =======================
==============================================================================
```

(Does NOT INCLUDE ingestion dose which is considered as a societal dose)

| Area # | People Affected [people] | Area Dose [person-rem] | =====Individual Dose===== Short-Term [rem] | Long-Term [rem] | Clean-up Factor |
|---|---|---|---|---|---|
| 1 | 1.19E+01 | 7.59E-02 | 6.40E-03 | 0.00E+00 | 1.00E+00 |
| 2 | 4.82E+01 | 9.74E-02 | 2.02E-03 | 0.00E+00 | 1.00E+00 |
| 3 | 1.84E+02 | 1.17E-01 | 6.40E-04 | 0.00E+00 | 1.00E+00 |
| 4 | 7.21E+02 | 1.46E-01 | 2.02E-04 | 0.00E+00 | 1.00E+00 |
| 5 | 2.85E+03 | 1.82E-01 | 6.40E-05 | 0.00E+00 | 1.00E+00 |
| 6 | 1.11E+04 | 2.25E-01 | 2.02E-05 | 0.00E+00 | 1.00E+00 |
| 7 | 4.26E+04 | 2.73E-01 | 6.40E-06 | 0.00E+00 | 1.00E+00 |
| 8 | 1.58E+05 | 3.19E-01 | 2.02E-06 | 0.00E+00 | 1.00E+00 |
| 9 | 4.42E+05 | 2.82E-01 | 6.40E-07 | 0.00E+00 | 1.00E+00 |
| 10 | 2.86E+05 | 5.78E-02 | 2.02E-07 | 0.00E+00 | 1.00E+00 |
| Totals | 9.42E+05 | 1.78E+00 | | | |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 12
 Title       : RHLLW Accident Scenario
 Date/Time   : 07/29/11 08:58
 Input  File : c:\riskind\input\july2920116000cioffsite.inp
 Output File : C:\RISKIND\output\july2920116000cioffsite.out
=============      Results       - Accident Response Region:  6===============

==============================================================================
========================= Accident Dose to Population =========================
==============================================================================
```

| Population Summary Results Per Accident | |
|---|---|
| Committed Effective Dose Equivalent | 1.79E+00 person-rem |
| Expected Genetic Effects | 2.32E-04 |
| Expected Non-fatal Cancers | 1.79E-04 |
| Expected Cancer Fatalities | 8.94E-04 |
| Acute Risk (Expected Fatalities) | 0.00E+00 |

| Pathway | Dose per Accident (person-rem) | | | |
|---|---|---|---|---|
| Acute | 1.79E+00 | | | |
| Cask | | 1.29E-03 | | |
| Ground Shine | | 4.03E-06 | | |
| Inhalation | | 1.78E+00 | | |
| Cloud Shine | | 1.08E-02 | | |
| Long-Term | 0.00E+00 | | | |
| Ground Shine | | 0.00E+00 | | |
| Inhalation | | 0.00E+00 | | |
| Cloud Shine | | 0.00E+00 | | |
| Ingestion | | 0.00E+00 | | |
| Initial Year | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Long-Term | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Water | | | | 0.00E+00 |

| Exposure Parameter | Organ Exposure Marrow | Lung | Intestine | Gonad |
|---|---|---|---|---|
| Population Exposure: | | | | |
| Long-Term Dose [person-rem] | 8.21E-01 | 7.95E+00 | 3.27E-01 | 3.85E-01 |
| Maximum Individual: | | | | |
| Brief Dose [Gy] | 9.73E-07 | 1.48E-06 | 6.96E-06 | |
| Brief Exposure Time [d] | 1.00E+00 | 1.00E+00 | 1.00E+00 | |
| Brief Dose Rate [Gy/hr] | 4.58E-07 | 4.73E-07 | 6.50E-07 | |
| Prolonged Dose [Gy] | 1.13E-06 | 9.81E-05 | 6.49E-06 | |
| Brief Exposure Time [d] | 3.00E+01 | 3.65E+02 | 7.00E+00 | |
| Prolong Dose Rate [Gy/hr] | 1.55E-09 | 1.20E-08 | 2.49E-07 | |
| Hazard | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Risk [Expected Fatalities] | 0.00E+00 | 0.00E+00 | 0.00E+00 | |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 13
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:58
 Input  File  : c:\riskind\input\july2920116000cioffsite.inp
 Output File  : C:\RISKIND\output\july2920116000cioffsite.out
============================       Results       ==============================

==============================================================================
========================= Accident Risk to Population ========================
==============================================================================
```

Population Accident Dose Summary Results

| ====== Acute ======= | | ===== Total ======= | |
|---|---|---|---|
| Dose [person-rem ] | Risk [Fatality] | Dose [person-rem] | Risk [Fatality] |
| 1.79E+00 | 0.00E+00 | 1.79E+00 | 8.94E-04 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  1
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:56
 Input  File : c:\riskind\input\july2920116000cioffsite.inp
 Output File : C:\RISKIND\output\july2920116000cioffsite.out
==============================================================================
```

```
==============================================================================
========================== RISKIND Computer Program ==========================
==============================================================================
```

Problem Description

---

Individual Receptors

Accident Calculations
- User Defined Accident
- Single Weather Analysis

- Acute Exposure
  - Plume Inhalation
  - Plume Immersion
  - Early Ground Exposure
  - Exposure to Cask

Note: * next to input description signifies
a data dependent default value

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  2
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:56
 Input  File : c:\riskind\input\july2920116000cioffsite.inp
 Output File : C:\RISKIND\output\july2920116000cioffsite.out
============================  Input Parameters  ============================


==============================================================================
================= RISKIND Accident Individual Problem Input ==================
==============================================================================


Individual Accident Parameters
```

State: US
Population Zone: Urban

| Individual | Average Breathing Rate [BRTIND] (m3/yr) | Individual Type [INDTYPE] |
|---|---|---|
| MEI | 8.00E+03 | Public |
| driver | 8.00E+03 | Worker |
| colocated worke | 8.00E+03 | Worker |

Individual type [INDTYPE]: Worker
Risk Conversion Factors
Non-Fatal Cancers/rem: 8.0E-05
Fatal Cancers/rem: 4.0E-04
Genetic Effects/rem: 8.0E-05

Individual type [INDTYPE]: Public
Risk Conversion Factors
Non-Fatal Cancers/rem: 1.0E-04
Fatal Cancers/rem: 5.0E-04
Genetic Effects/rem: 1.3E-04

| Individual Name [XNAME] | ======= Location ======= Down Wind [km] | Cross Wind [km] [XRECEP] | Elevation [m] | Acute Exposure Time [hr] [TEXT] | Long Term Exposure [IRTP] | Food Ingestion [IDFOOD] |
|---|---|---|---|---|---|---|
| MEI | 1.60E-01 | 0.00E+00 | 0.00E+00 | 2.00E+00 | | No |
| driver | 3.00E-03 | 0.00E+00 | 0.00E+00 | 2.00E+00 | | No |
| colocated worker | 1.00E-01 | 0.00E+00 | 0.00E+00 | 2.00E+00 | | No |

| Individual Name | Shielding Type Short | Long | Long-Term In | Out | ====== Shielding Factors ==== Acute: Inh | Cld | Ext | Long-Term: Inh | Cld | Ext |
|---|---|---|---|---|---|---|---|---|---|---|
| MEI | None | None | 0.62 | 0.02 | 1.00 | 1.00 | 1.00 | 0.64 | 0.64 | 0.64 |
| driver | None | None | 0.62 | 0.02 | 1.00 | 1.00 | 1.00 | 0.64 | 0.64 | 0.64 |
| colocated worker | None | None | 0.62 | 0.02 | 1.00 | 1.00 | 1.00 | 0.64 | 0.64 | 0.64 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  3
 Title       : RHLLW Accident Scenario
 Date/Time   : 07/29/11 08:56
 Input  File : c:\riskind\input\july2920116000cioffsite.inp
 Output File : C:\RISKIND\output\july2920116000cioffsite.out
============================  Input Parameters  ============================

Meteorological Parameters
_____________________________________________

            Dry deposition rates [VDEPNUC]
                        Particulates    : 1.00E-02      m/s
                        Ruthenium       : 1.00E-02      m/s
                        Cesium          : 1.00E-02      m/s
                        Iodine          : 1.00E-02      m/s
                        Gases           : 0.00E+00      m/s
                  Rain fall rate [RAIN] : 0.00E+00     mm/h
               Anemometer height [ANH]  :    10.00        m
           Ambient Temperature [TABK]   :   283.00        K
                 Mixing height [DMIX]   :  1000.00        m
             Wind at anemometer [WSM]   :     4.00      m/s
          Pasquill stability cat. [ITYPE]:       D


Shipment Parameters
_____________________________________________

           Transportation Mode [IMOD]   :    Truck
                   Dose at 1 m [TIDX]   :    10.00  mrem/hr
           Measurement Offset [TIOFF]   :     0.00        m
             Gamma Fraction [FRAD(1)]   :     1.00
           Neutron Fraction [FRAD(2)]   :     0.00
                  Cask Length [HSIZE]   :     3.30        m
                  Cask Radius [RSIZE]   :     1.99        m
```

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  4
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:56
 Input  File : c:\riskind\input\july2920116000cioffsite.inp
 Output File : C:\RISKIND\output\july2920116000cioffsite.out
============================  Input Parameters  ==============================
```

Nuclide Parameters

Nuclide Inventory and DCFs

| Nuclide Name | Inventory Amount [Ci] | ======= Dose Conversion Factors ====== Inhalation [Sv/Bq] | Ingestion [Sv/Bq] | Cloud [Sv/s] [Bq/m3] | Ground [Sv/s] [Bq/m2] | Nucl. Class | Decay Const. [1/yr] |
|---|---|---|---|---|---|---|---|
| BA137M | 2.17E-25 | 2.49E-09 | 2.49E-09 | 2.88E-14 | 5.86E-16 | Co-60 | 1.40E+05 |
| CO 58 | 2.63E-11 | 2.94E-09 | 9.68E-10 | 4.76E-14 | 9.49E-16 | Co-60 | 3.60E+00 |
| CO 60 | 6.00E+03 | 5.91E-08 | 7.28E-09 | 1.26E-13 | 2.35E-15 | Co-60 | 1.30E-01 |
| FE 55 | 7.42E+04 | 7.26E-10 | 1.64E-10 | 0.00E+00 | 0.00E+00 | Co-60 | 2.60E-01 |
| MN 54 | 3.32E+01 | 1.81E-09 | 7.48E-10 | 4.09E-14 | 8.12E-16 | Co-60 | 8.10E-01 |
| NB 95 | 2.65E-18 | 1.57E-09 | 6.95E-10 | 3.74E-14 | 7.48E-16 | Co-60 | 7.20E+00 |
| NI 59 | 3.80E+02 | 7.31E-10 | 5.67E-11 | 0.00E+00 | 0.00E+00 | Co-60 | 9.20E-06 |
| NI 63 | 4.82E+04 | 1.70E-09 | 1.56E-10 | 0.00E+00 | 0.00E+00 | Co-60 | 6.90E-03 |
| PU239 | 5.38E-03 | 1.16E-04 | 9.56E-07 | 4.24E-18 | 3.67E-19 | Co-60 | 2.90E-05 |
| SB125 | 7.29E-04 | 3.75E-09 | 9.85E-10 | 2.02E-14 | 4.33E-16 | Co-60 | 2.50E-01 |
| SN119M | 7.29E-04 | 1.69E-09 | 3.76E-10 | 1.01E-16 | 1.04E-17 | Co-60 | 8.60E-01 |
| TA182 | 2.08E-04 | 1.21E-08 | 1.76E-09 | 6.40E-14 | 1.23E-15 | Co-60 | 2.20E+00 |
| TE125M | 1.69E-01 | 1.97E-09 | 9.92E-10 | 4.53E-16 | 3.61E-17 | Co-60 | 4.40E+00 |
| ZR 95 | 5.26E-17 | 6.39E-09 | 1.02E-09 | 3.60E-14 | 7.22E-16 | Co-60 | 4.00E+00 |

Title : RHLLW Accident Scenario
Date/Time : 07/29/11 08:56
Input File : c:\riskind\input\july2920116000cioffsite.inp
Output File : C:\RISKIND\output\july2920116000cioffsite.out

========== Input Parameters ==========

Nuclide Health Effects Parameters

| Nuclide Name | Solubility Class | Acute Organ Dose Conversion Factors: Inhalation [Sv/Bq] Marrow | Lung | Intestine | Ground [Sv/s//Bq/m2] Marrow | Lung | Intestine |
|---|---|---|---|---|---|---|---|
| BA137M | D | 2.73E-11 | 2.73E-11 | 0.00E+00 | 5.70E-16 | 5.60E-16 | 5.22E-16 |
| CO 58 | Y | 8.92E-10 | 1.57E-08 | 1.97E-09 | 9.30E-16 | 9.10E-16 | 8.42E-16 |
| CO 60 | Y | 6.22E-09 | 1.24E-07 | 5.95E-09 | 2.34E-15 | 2.27E-15 | 1.94E-15 |
| FE 55 | W | 1.65E-10 | 1.76E-10 | 1.92E-10 | 0.00E+00 | 0.00E+00 | 1.89E-19 |
| MN 54 | W | 1.08E-09 | 6.49E-09 | 1.32E-09 | 7.96E-16 | 7.77E-16 | 7.18E-16 |
| NB 95 | Y | 4.32E-10 | 8.38E-09 | 1.92E-09 | 7.32E-16 | 7.17E-16 | 6.62E-16 |
| NI 59 | Y | 3.78E-13 | 2.22E-12 | 1.65E-13 | 0.00E+00 | 0.00E+00 | 3.56E-19 |
| NI 63 | Y | 1.05E-12 | 5.95E-12 | 4.59E-13 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| PU239 | Y | 2.70E-07 | 6.76E-05 | 2.70E-08 | 1.19E-19 | 7.87E-20 | 3.24E-19 |
| SB125 | W | 2.41E-14 | 7.30E-11 | 3.24E-12 | 4.05E-16 | 4.03E-16 | 3.79E-16 |
| SN119M | Y | 4.62E-10 | 1.15E-08 | 1.30E-11 | 3.43E-18 | 3.74E-18 | 5.12E-18 |
| TA182 | Y | 1.92E-09 | 8.27E-08 | 4.05E-12 | 1.19E-15 | 1.18E-15 | 1.05E-15 |
| TE125M | W | 5.14E-14 | 1.05E-11 | 2.38E-12 | 1.37E-17 | 1.77E-17 | 1.78E-17 |
| ZR 95 | Y | 1.30E-09 | 4.05E-08 | 3.78E-09 | 7.06E-16 | 6.92E-16 | 6.38E-16 |

```
Title       : RHLLW Accident Scenario
Date/Time   : 07/29/11 08:56
Input  File : c:\riskind\input\july2920116000cioffsite.inp
Output File : C:\RISKIND\output\july2920116000cioffsite.out
============================  Input Parameters  ==============================
```

Nuclide Health Effects Parameters

| Name | Acute Organ Dose Conversion Factors =========Cloudshine======== [Sv/s//Bq/m3] Marrow | Lung | Intestine |
|---|---|---|---|
| BA137M | 2.73E-14 | 2.80E-14 | 2.61E-14 |
| CO 58 | 4.53E-14 | 4.64E-14 | 4.32E-14 |
| CO 60 | 1.23E-13 | 1.24E-13 | 1.11E-13 |
| FE 55 | 0.00E+00 | 0.00E+00 | 9.85E-19 |
| MN 54 | 3.91E-14 | 3.99E-14 | 3.73E-14 |
| NB 95 | 3.57E-14 | 3.65E-14 | 3.39E-14 |
| NI 59 | 0.00E+00 | 0.00E+00 | 1.65E-18 |
| NI 63 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| PU239 | 2.67E-18 | 2.65E-18 | 3.50E-18 |
| SB125 | 1.88E-14 | 1.95E-14 | 1.82E-14 |
| SN119M | 3.65E-17 | 3.60E-17 | 9.34E-17 |
| TA182 | 6.10E-14 | 6.24E-14 | 5.70E-14 |
| TE125M | 1.86E-16 | 2.23E-16 | 4.10E-16 |
| ZR 95 | 3.43E-14 | 3.51E-14 | 3.26E-14 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  7
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:56
 Input  File  : c:\riskind\input\july2920116000cioffsite.inp
 Output File  : C:\RISKIND\output\july2920116000cioffsite.out
==============  Input Parameters  - Accident Response Region:  6===============

Accident Parameters
_____________________________________________

              Physical Release Height [HS] :     1.00        m
  Dispersion Model Coefficients [IDISPMOD] : Based on Eff. Rel. Height
                   Accident Analysis Type: Consequence


Accident Response Region Determined By
_____________________________________________
            Accident Cask Velocity [VCASK] :    65.00     km/h
                 Cask Impact Angle [ALPHA] :    90.00  Degrees
             Cask Orientation Angle [BETA] :    90.00  Degrees
            Impact Object Hardness [IHARD] :  1
                Flame Temperature [TFLAME] : 1.35E+03       K
                     Fire Duration [DFIRE] :     0.75      hr
                     Fire Location [FLOCA] :     0.00       m


Accident Response Region Parameters
_____________________________________________
                  Response Region [IYOURS] :        6
     Region Conditional Probability [FSEV] : 2.33E-07
                         Heat Flux [HEATF] : 2.00E+06   cal/s
      Loss of Cask Shielding Factor [SEXT]
                                    Gamma:     1.00
                                  Neutron:     1.00
                       Failure Rate [FAILS] : 1.00E-01
               Crud Spallation Rate [FSPAL] : 0.00E+00
                 Crud Release Rate [FRCRUD] : 1.00E+00
```

| Nuclide Class [NUTYPE] | Conditional Release Fraction [FRELS] | Dispersion Fraction [FDISP] | Released and Dispersed Fraction (FRELS*FAILS*FDISP) |
|---|---|---|---|
| Co-60 | 5.00E-04 | 1.00E+00 | 5.00E-05 |
| Pu-239 | 5.00E-04 | 1.00E+00 | 5.00E-05 |
| | 2.00E-04 | 0.00E+00 | 0.00E+00 |
| | 4.30E-03 | 0.00E+00 | 0.00E+00 |
| | 6.30E-01 | 0.00E+00 | 0.00E+00 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  8
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:56
 Input  File : c:\riskind\input\july2920116000cioffsite.inp
 Output File : C:\RISKIND\output\july2920116000cioffsite.out
============== Intermediate Calcs - Accident Response Region:  6===============

==============================================================================
============================== Nuclide Release ===============================
==============================================================================
```

| Nuclide Name | Release Amount [Ci] | Hazard Index Inhalation | Hazard Index Ingestion | Hazard Index Ground |
|---|---|---|---|---|
| CO 60 | 3.00E-01 | 7.23E-01 | 3.61E-01 | 1.00E+00 |
| FE 55 | 3.71E+00 | 1.09E-01 | 5.19E-03 | 0.00E+00 |
| NI 63 | 2.41E+00 | 1.66E-01 | 6.31E-01 | 0.00E+00 |
| Total | 6.42E+00 | 9.98E-01 | 9.98E-01 | 1.00E+00 |

Hazard Limit [HZLM] = 0.0100

```
==============================================================================
============================== Puff Calculations =============================
==============================================================================
```

| Individual Name | Effective Release Height [m] | Dispersion Sigma (Horizontal) [m] | Dispersion Sigma (Vertical) [m] |
|---|---|---|---|
| MEI | 8.79E+00 | 1.52E+01 | 8.77E+00 |
| driver | 4.49E+00 | 1.54E+00 | 2.22E+00 |
| colocated worker | 8.79E+00 | 1.03E+01 | 6.51E+00 |

| Individual Name | Chi/Q Air [s/m3] | Chi/Q Ground [1/m2] | Depletion Fraction | Wet/Dry Ratio |
|---|---|---|---|---|
| MEI | | | | |
| Particulates | 3.55E-04 | 3.55E-06 | 1.46E-02 | 0.00E+00 |
| Ruthenium | 3.55E-04 | 3.55E-06 | 1.46E-02 | 0.00E+00 |
| Cesium | 3.55E-04 | 3.55E-06 | 1.46E-02 | 0.00E+00 |
| Iodine | 3.55E-04 | 3.55E-06 | 1.46E-02 | 0.00E+00 |
| Gases | 3.60E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| driver | | | | |
| Particulates | 3.02E-03 | 3.02E-05 | 3.20E-04 | 0.00E+00 |
| Ruthenium | 3.02E-03 | 3.02E-05 | 3.20E-04 | 0.00E+00 |
| Cesium | 3.02E-03 | 3.02E-05 | 3.20E-04 | 0.00E+00 |
| Iodine | 3.02E-03 | 3.02E-05 | 3.20E-04 | 0.00E+00 |
| Gases | 3.02E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| colocated worker | | | | |
| Particulates | 4.73E-04 | 4.73E-06 | 6.64E-03 | 0.00E+00 |
| Ruthenium | 4.73E-04 | 4.73E-06 | 6.64E-03 | 0.00E+00 |
| Cesium | 4.73E-04 | 4.73E-06 | 6.64E-03 | 0.00E+00 |
| Iodine | 4.73E-04 | 4.73E-06 | 6.64E-03 | 0.00E+00 |
| Gases | 4.76E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

```
===================== RISKIND Program Output, Version 2.0 =========== Page:  9
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:56
 Input  File : c:\riskind\input\july2920116000cioffsite.inp
 Output File : C:\RISKIND\output\july2920116000cioffsite.out
==============       Results       - Accident Response Region:  6===============

==============================================================================
==============          Accident Dose to : MEI                  ===============
==============================================================================
```

| Individual Summary Results Per Accident | | |
|---|---|---|
| Committed Effective Dose Equivalent | 8.29E-03 | rem |
| Expected Genetic Effects | 1.08E-06 | |
| Expected Non-fatal Cancers | 8.29E-07 | |
| Expected Cancer Fatalities | 4.14E-06 | |
| Acute Risk (Expected fatalities) | 0.00E+00 | |

| Pathway | Doses(rem) | | | |
|---|---|---|---|---|
| Acute | 8.29E-03 | | | |
| Cask | | 2.67E-06 | | |
| Ground Shine | | 6.67E-05 | | |
| Inhalation | | 8.17E-03 | | |
| Cloud Shine | | 4.97E-05 | | |
| Long-Term | 0.00E+00 | | | |
| Ground Shine | | 0.00E+00 | | |
| Inhalation | | 0.00E+00 | | |
| Cloud Shine | | 0.00E+00 | | |
| Ingestion | | 0.00E+00 | | |
| Initial Year | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Long-Term | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Water | | | | 0.00E+00 |

| | Organ Exposure | | | |
|---|---|---|---|---|
| Exposure Parameter | Marrow | Lung | Intestine | Gonads |
| Long-Term Dose [rem] | 3.84E-03 | 3.66E-02 | 1.55E-03 | 1.78E-03 |
| Brief Dose [Gy] | 1.26E-06 | 1.91E-06 | 8.96E-06 | |
| Brief Exposure Time [d] | 1.00E+00 | 1.00E+00 | 1.00E+00 | |
| Brief Dose Rate [Gy/hr] | 5.91E-07 | 6.11E-07 | 8.39E-07 | |
| Prolonged Dose [Gy] | 1.46E-06 | 1.26E-04 | 8.35E-06 | |
| Prolong Exposure Time [d] | 3.00E+01 | 3.65E+02 | 7.00E+00 | |
| Prolong Dose Rate [Gy/hr] | 1.99E-09 | 1.54E-08 | 3.21E-07 | |
| Hazard | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Acute Risk [Expected fatalities] | 0.00E+00 | 0.00E+00 | 0.00E+00 | |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 10
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:56
 Input  File  : c:\riskind\input\july2920116000cioffsite.inp
 Output File  : C:\RISKIND\output\july2920116000cioffsite.out
==============       Results        - Accident Response Region:  6===============

==============================================================================
==============          Accident Dose to : driver                ===============
==============================================================================
```

| Individual Summary Results Per Accident | | |
|---|---|---|
| Committed Effective Dose Equivalent | 7.66E-02 | rem |
| Expected Genetic Effects | 6.13E-06 | |
| Expected Non-fatal Cancers | 6.13E-06 | |
| Expected Cancer Fatalities | 3.07E-05 | |
| Acute Risk (Expected fatalities) | 0.00E+00 | |

| Pathway | | Doses(rem) | | |
|---|---|---|---|---|
| Acute | 7.66E-02 | | | |
| Cask | | 6.20E-03 | | |
| Ground Shine | | 5.67E-04 | | |
| Inhalation | | 6.95E-02 | | |
| Cloud Shine | | 4.22E-04 | | |
| Long-Term | 0.00E+00 | | | |
| Ground Shine | | 0.00E+00 | | |
| Inhalation | | 0.00E+00 | | |
| Cloud Shine | | 0.00E+00 | | |
| Ingestion | | 0.00E+00 | | |
| Initial Year | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Long-Term | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Water | | | | 0.00E+00 |

| | Organ Exposure | | | |
|---|---|---|---|---|
| Exposure Parameter | Marrow | Lung | Intestine | Gonads |
| Long-Term Dose [rem] | 3.88E-02 | 3.18E-01 | 1.94E-02 | 2.13E-02 |
| Brief Dose [Gy] | 7.24E-05 | 7.80E-05 | 1.38E-04 | |
| Brief Exposure Time [d] | 1.00E+00 | 1.00E+00 | 1.00E+00 | |
| Brief Dose Rate [Gy/hr] | 3.59E-05 | 3.61E-05 | 3.80E-05 | |
| Prolonged Dose [Gy] | 7.41E-05 | 1.13E-03 | 1.33E-04 | |
| Prolong Exposure Time [d] | 3.00E+01 | 3.65E+02 | 7.00E+00 | |
| Prolong Dose Rate [Gy/hr] | 2.40E-08 | 1.38E-07 | 2.73E-06 | |
| Hazard | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Acute Risk [Expected fatalities] | 0.00E+00 | 0.00E+00 | 0.00E+00 | |

```
====================== RISKIND Program Output, Version 2.0 =========== Page: 11
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:56
 Input  File  : c:\riskind\input\july2920116000cioffsite.inp
 Output File  : C:\RISKIND\output\july2920116000cioffsite.out
==============       Results       - Accident Response Region:  6===============

==============================================================================
==============          Accident Dose to : colocated worker     ===============
==============================================================================
```

| Individual Summary Results Per Accident | | |
|---|---|---|
| Committed Effective Dose Equivalent | 1.10E-02 | rem |
| Expected Genetic Effects | 8.83E-07 | |
| Expected Non-fatal Cancers | 8.83E-07 | |
| Expected Cancer Fatalities | 4.41E-06 | |
| Acute Risk (Expected fatalities) | 0.00E+00 | |

| Pathway | Doses (rem) | | | |
|---|---|---|---|---|
| Acute | 1.10E-02 | | | |
| Cask | | 9.04E-06 | | |
| Ground Shine | | 8.87E-05 | | |
| Inhalation | | 1.09E-02 | | |
| Cloud Shine | | 6.61E-05 | | |
| Long-Term | 0.00E+00 | | | |
| Ground Shine | | 0.00E+00 | | |
| Inhalation | | 0.00E+00 | | |
| Cloud Shine | | 0.00E+00 | | |
| Ingestion | | 0.00E+00 | | |
| Initial Year | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Long-Term | | | 0.00E+00 | |
| Vegetable | | | | 0.00E+00 |
| Meat | | | | 0.00E+00 |
| Milk | | | | 0.00E+00 |
| Water | | | | 0.00E+00 |

| Exposure Parameter | Organ Exposure Marrow | Lung | Intestine | Gonads |
|---|---|---|---|---|
| Long-Term Dose [rem] | 5.11E-03 | 4.87E-02 | 2.07E-03 | 2.37E-03 |
| Brief Dose [Gy] | 1.73E-06 | 2.59E-06 | 1.20E-05 | |
| Brief Exposure Time [d] | 1.00E+00 | 1.00E+00 | 1.00E+00 | |
| Brief Dose Rate [Gy/hr] | 8.14E-07 | 8.40E-07 | 1.14E-06 | |
| Prolonged Dose [Gy] | 1.99E-06 | 1.68E-04 | 1.12E-05 | |
| Prolong Exposure Time [d] | 3.00E+01 | 3.65E+02 | 7.00E+00 | |
| Prolong Dose Rate [Gy/hr] | 2.65E-09 | 2.05E-08 | 4.26E-07 | |
| Hazard | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Acute Risk [Expected fatalities] | 0.00E+00 | 0.00E+00 | 0.00E+00 | |

```
===================== RISKIND Program Output, Version 2.0 =========== Page: 12
 Title        : RHLLW Accident Scenario
 Date/Time    : 07/29/11 08:56
 Input  File  : c:\riskind\input\july2920116000cioffsite.inp
 Output File  : C:\RISKIND\output\july2920116000cioffsite.out
============================       Results       ============================

==============================================================================
======================== Accident Risk to Individuals ========================
==============================================================================
```

Individual Accident Dose Summary Results
Consequences

| | Acute | | Total | | | |
|---|---|---|---|---|---|---|
| | Dose [rem] | Risk [Fatality] | Dose [rem] | Expected Non-Fatal Cancer Incidence | Expected Cancer Fatalities | Expected Genetic Effects |
| MEI | 8.29E-03 | 0.0E+00 | 8.29E-03 | 8.3E-07 | 4.1E-06 | 1.1E-06 |
| driver | 7.66E-02 | 0.0E+00 | 7.66E-02 | 6.1E-06 | 3.1E-05 | 6.1E-06 |
| colocated worke | 1.10E-02 | 0.0E+00 | 1.10E-02 | 8.8E-07 | 4.4E-06 | 8.8E-07 |