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MACCS Best Practices as Applied in the State-of-the-Art Reactor Consequence Analyses (SOARCA) Project

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ABSTRACT

The evaluation of accident phenomena and the offsite consequences of severe reactor accidents has been the subject of considerable research by the U.S. Nuclear Regulatory Commission (NRC) over the last several decades. By applying modern analysis tools and techniques, a body of knowledge regarding the realistic outcomes of severe reactor accidents has been developed. The integrated modeling of accident progression and offsite consequences in the State-of-the-Art Reactor Consequence Analyses (SOARCA) project has created best modeling practices drawn from the collective wisdom of the severe accident analysis community. The objective of this document is to describe the consequence model improvements, modeling approach, parameter selection, and consequence analyses that support the SOARCA project and also explain the significance of the modeling improvements and approaches. This document presents a compilation of experience from using the MELCOR Accident Consequence Code System (MACCS) to model the offsite consequences, in terms of health effect risk, for NUREG-1935, “State-of-the-Art Reactor Consequence Analyses (SOARCA) Report.” This provides a description of how MACCS modeling capabilities were used to represent important aspects of radionuclide atmospheric transport, emergency response, and dose response to radiation exposure. Additionally, a description of choices among certain alternative modeling options and input parameters is provided.

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EXECUTIVE SUMMARY

The purpose of this report is to describe best practices for the MELCOR Accident Consequence Code System (MACCS), as implemented in the State-of-the-Art Reactor Consequence Analyses (SOARCA) project for the Peach Bottom Atomic Power Station and the Surry Power Station. By applying modern analysis tools and techniques in the SOARCA project, a body of knowledge regarding the realistic outcomes of severe reactor accidents has been developed through the integrated modeling of accident progression and offsite consequences. The SOARCA project provides analyses that use state-of-the-art source term and consequence modeling together with consideration of current operational practices and procedures. Collectively, this information represents the "best practice" modeling approach for using MACCS in performing consequence analyses of severe reactor accidents in the SOARCA project. This best practices document provides a compilation of the parameters and inputs used in the SOARCA documents. It also includes additional detail on the approach to developing some of the input values and methodologies applied in the SOARCA studies.

The objective of this document is to describe the consequence model improvements, modeling approach, parameter selection, and consequence analyses that support the SOARCA project analyses in NUREG-1935 [1], NUREG/CR-7110 Volume 1 [2], and NUREG/CR-7110 Volume 2 [3]. This document also includes observations concerning the significance of key modeling improvements and approaches used in SOARCA and their relevance to other analyses. This NUREG/CR is intended to provide guidance and insights for developers and users of MACCS.

The MACCS best practice approach applied in SOARCA included:

- Update of parameters to reflect current state of knowledge, such as the cancer risk factors which were updated based on Biological Effects of Ionizing Radiation (BEIR) V,

- MACCS code enhancements that were implemented to provide more realism in the analysis, such as increasing the number of plume segments, increasing angular resolution, increasing the maximum number of cohorts allowed, and improving the network evacuation model, and

- User specified choices, such as the use of site-specific emergency plan data in the development of emergency response related parameters.

Important parameter updates that were integrated into the MACCS models for SOARCA included the cancer fatality risk factors and dose response factors. In 2009, the National Research Council released the BEIR VII report, which is the most up-to-date study of cancer induction from exposure to ionizing radiation. However, because the dose coefficients used in the SOARCA study are from Federal Guidance Report 13 (FGR-13) and this report was developed using risk factors from BEIR V, the SOARCA staff made the decision to await Environmental Protection Agency's (EPA's) review of BEIR VII and subsequent update of FGR-13 and used BEIR V risk coefficients in SOARCA.

Many of the MACCS code enhancements were recommended by the Expert Review Panel conducted in August 2006, prior to the commencement of the SOARCA analyses. Some of the panel's recommendations on MACCS enhancements that were implemented for SOARCA include:

- atmospheric transport and dispersion modeling improvements,
- increasing angular resolution to 64 compass directions up from 16,
- increasing the limit to 200 plume segments instead of the previous limit of 4,
- increasing the limit to 20 emergency phase cohorts instead of the original limit of 3,
- enhancing the treatment of evacuation speed and direction to better reflect the spatial and temporal response of individual cohorts,
- incorporating of a potassium iodide (KI) ingestion model to account for dose reduction to the thyroid from inhalation of radioiodine, and
- adding several new options for latent cancer fatality (LCF) dose response.

Lastly, user specified choices are available throughout MACCS. A team of knowledgeable analysts developed best practice choices for each specific site. For example, the choices of times associated with normal and hotspot relocation depended on the specific accident scenario because they are based on plume arrival and on the expected resources available in the area. The corresponding normal and hotspot relocation doses may be established by the Environmental Protection Agency (EPA) or by the State where the reactor is located. The choices for emergency response parameters related to sheltering and evacuation require information from the site emergency procedures, offsite response organization emergency plans, and the evacuation time estimate (ETE). The choices used in SOARCA and the bases for selecting these values are described in this best practices document.

Conducting a project such as SOARCA provided an opportunity to investigate consequence analyses at a much greater level of detail than was done for analyses performed in the past. Throughout the process, advanced knowledge and insights were gained that benefit the probabilistic risk assessment (PRA) and emergency response communities. The following insights related to offsite consequence analyses were developed from the SOARCA project.

1. Through investigation of the importance of each chemical class, the SOARCA analyses confirmed that the cesium group followed by the tellurium and barium/strontium groups is generally the most important contributor to long-term and overall latent cancer fatality (LCF) risk when using the linear no-threshold (LNT) dose-response model. However, SOARCA found that the cerium group, followed by the barium/strontium group, dominates over the cesium group in the Peach Bottom unmitigated short term station blackout (STSBO) scenario without reactor core isolation cooling (RCIC) system blackstart[1]. This scenario involves significant core-concrete interactions with insertions of unoxidized zirconium. Even though the cerium release is small in terms of percentage, it is significant in terms of activity because of its large initial inventory. This results in the cerium group, followed by the barium/strontium group, being the largest contributor to LCF risk for this scenario. This trend was not observed for any of the other Peach Bottom or Surry scenarios and is more likely to occur in a BWR because of the significantly larger quantity of zirconium in the reactor vessel of a BWR.

[1] Blackstart of the RCIC system refers to starting RCIC without any ac or dc control power. NUREG/CR-7110 Volume 1 contains an expanded description of this scenario [2].

2. Sensitivity analyses on the effect of the surface roughness parameter show that a surface roughness increase from 10 cm to 60 cm results in a risk reduction of about 20% for the intermediate distances (10 to 50 miles) and a risk increase of about 10% within 10 miles for the calculated LCF risks using the LNT dose-response model. The reduction in risk for the two truncation dose-response models reported in SOARCA is generally greater than 20%.

3. The development of emergency response parameters based on site-specific data obtained from the emergency plan and offsite response organizations enables realistic modeling of the response of the public. The results of the analyses show that for the selected SOARCA scenarios, the emergency response is very effective within the evacuation zone during the emergency phase. The risks are very small and entirely represent the non-evacuating population, with the exception of the Surry STSBO with a thermally induced steam generator tube rupture (TISGTR) accident scenario in which the release starts much earlier than in the others.

4. Using the LNT dose-response model, the largest contributor to LCF risk for most scenarios is the long-term risk incurred after the emergency phase, and this risk is controlled by the habitability criterion.

5. Increasing the number of aerosol bins and accounting for deposition velocity as a function of particle size has a significant effect on the results. The effect is comparable to specifying a single deposition velocity of 0.3 cm/s; which reduces ground concentrations by about a factor of 3 at the distances reported in SOARCA compared with the NUREG-1150 methodology of using a single value of 1 cm/s.

6. Increasing the number of compass sectors from 16 to 64 does not significantly affect LCF risk calculated using the LNT dose-response model. There would likely be a greater effect on LCF risk using the truncation dose-response models; however these calculations were not performed.

7. Increasing the number of plume segments has a small effect on calculated LCF risk using the LNT dose-response model. There would likely be a greater effect on LCF risk using the truncation dose-response models; however these calculations were not performed.

8. Insight from the evaluation of seismic activity on emergency response (ER) shows the effect to be site-specific. For Peach Bottom, the seismic event's impact on ER has an insignificant effect on health consequences primarily because the damage to infrastructure in this EPZ is projected to be limited to a few roadway sections. For Surry, the overall impact on the ER from the seismic activity is significant with regard to the damage to infrastructure; however, because this damage occurs in the developed areas which are beyond 5 miles from the plant, there is no appreciable effect on health consequences. Although the ER is impacted considerably by the postulated seismic event, the effect on overall risk is not significant, and the prompt fatality risk remains zero.

9. Sensitivity analyses on the size of the evacuation area were performed for two scenarios: the Peach Bottom unmitigated STSBO and the Surry unmitigated ISLOCA. These sensitivities show that the effect of expanding the size of the evacuation area is

site-specific and scenario-specific. For the Peach Bottom unmitigated STSBO, expanding the size of the evacuation area decreases individual LCF risk beyond the 10-mile radius but increases individual LCF risk within 10 miles. The increase in risk to the population residing within 10 miles occurs because of the increased traffic congestion which is caused by the larger evacuation. For areas with a radius greater than 20 miles, the risk reduction associated with increasing the size of the evacuation area is slight. For the Surry unmitigated ISLOCA, the results show very little benefit from evacuation of areas beyond 10 miles.

ACKNOWLEDGMENTS

Contributions to this best practices document were received from NRC and Sandia National Laboratories (SNL) project managers and technical experts dedicated to the production of a valuable resource for the user community. Information received from the 2006 Expert Review Panel influenced the MACCS best practices. The Peer Review Committee for the SOARCA project provided insights and information that also influenced the best practices. The NRC Project Manager, Jonathan Barr, provided the leadership to ensure this project met the objectives of the program. Numerous NRC staff provided technical insights supporting key elements of the document. SNL technical staff worked with these experts to develop the criteria and document the approach that was used in SOARCA and described in this report.

ABBREVIATIONS AND ACRONYMS

BEF	Biological Effectiveness Factors
BEIR	Biological Effects of Ionizing Radiations
BWR	Boiling Water Reactor
CDF	Core Damage Frequency
CPI	Consumer Price Index
CSARP	Cooperative Severe Accident Research Program
DOE	U.S. Department of Energy
DRF	Dose Reduction Factor
EAL	Emergency Action Level
EAS	Emergency Alert System
EOP	Emergency Operating Procedure
EP	Emergency Preparedness
EPA	U.S. Environmental Protection Agency
EPZ	Emergency Planning Zone
ER	Emergency Response
ESPMUL	Evacuation Speed Multiplier
ETE	Evacuation Time Estimate
FGR	Federal Guidance Report
GE	General Emergency
GUI	Graphical User Interface
HPS	Health Physics Society
ICRP	International Commission on Radiation Protection
ISLOCA	Interfacing Systems Loss of Coolant Accident
LCF	Latent Cancer Fatality
LET	Linear Energy Transfer
LHS	Latin Hypercube Sampling
LNT	Linear No Threshold
LOCA	Loss of Coolant Accident
LTSBO	Long Term Station Blackout
MACCS	MELCOR Accident Consequence Code System
ORNL	Oak Ridge National Laboratory
ORO	Offsite Response Organization
PAG	Protective Action Guide
PAR	Protective Action Recommendation
PRA	Probabilistic Risk Assessment
PRC	Peer Review Committee
RCIC	Reactor Core Isolation Cooling system
ROP	Reactor Oversight Program
SAE	Site Area Emergency
SAMA	Severe Accident Mitigation Alternatives
SAMG	Severe Accident Management Guidelines
SECPOP	SECtor POPulation and Economic Estimator
SNL	Sandia National Laboratories
SOARCA	State-of-the-Art Reactor Consequence Analyses project
STSBO	Short Term Station Blackout
TISGTR	Thermally Induced Steam Generator Tube Rupture
TSC	Technical Support Center
USBGR	U.S. Background

1.0 INTRODUCTION

The NRC initiated the State-of-the-Art Reactor Consequence Analyses (SOARCA) project to develop best estimates of the offsite radiological health consequences for potential severe reactor accidents for two pilot plants: the Peach Bottom Atomic Power Station and the Surry Power Station. The SOARCA project provides analyses that use state-of-the-art source term and consequence modeling together with consideration of current operational practices and procedures. Specifically, SOARCA assessed the benefits of 10 CFR 50.54(hh) equipment and procedures that have become institutionalized in the last decade. By applying modern analysis tools and techniques and updated parameters in the SOARCA project, a body of knowledge regarding the realistic outcomes of severe reactor accidents has been developed. As a result, the application of the MELCOR Accident Consequence Code System (MACCS) in the SOARCA project represents the “best practice” modeling approach for using MACCS in performing consequence analyses. It should be noted that some of the model and parameter choices used in SOARCA may not be optimal for other consequence analyses, depending on their objectives and the types of results to be reported. Discussion is provided to help the MACCS user determine which of the SOARCA model and parameter choices might be useful for other applications.

SOARCA presents the NRC’s most detailed and realistic severe accident analysis to date. This document describes MACCS best practices used in SOARCA [1] for the Peach Bottom Atomic Power Station [2] and the Surry Power Station [3]. The term ‘best practice’ as used in this document describes the modeling approaches and parameter choices.

A compilation of experience from using MACCS to model offsite consequences, in terms of health effect risks for SOARCA, is presented herein. The document describes the use of updated parameters, MACCS code enhancements, and specific parameter selection in establishing best practices. The MACCS modeling capabilities are described with regard to important aspects of radionuclide atmospheric transport, emergency response, and dose response to radiation exposure. A description of choices among alternative modeling options and input parameters is provided. Insights are drawn from the application of these MACCS approaches, enhancements, and parameters in the SOARCA project.

As a follow-on to the SOARCA study, NRC conducted an uncertainty analysis of the unmitigated long term station blackout (LTSBO) for the Peach Bottom site. Many of the uncertain parameters implemented in the Peach Bottom uncertainty analysis were selected based on the insights identified in this best practices document. The Peach Bottom uncertainty analysis evaluated the robustness of the SOARCA deterministic results and conclusions, and developed insights into the overall sensitivity of the SOARCA results to uncertainty in key modeling inputs. Insights gained from this uncertainty analysis are documented in NUREG/CR-7155 [4].

1.1 Background

MACCS was developed at Sandia National Laboratories (SNL) for the NRC. Its primary use is in performing PRAs for commercial nuclear reactors to evaluate the impact of accidental atmospheric releases of radiological materials on humans and on the surrounding environment. MACCS has been widely distributed and used by the NRC and its subcontractors, private industry, and throughout the U.S. Department of Energy (DOE) complex. It has also been distributed to members of the Cooperative Severe Accident Research Program (CSARP) and other international organizations.

In 2001, the NRC initiated an effort to create a Windows-based interface and framework for performing consequence analyses using the MACCS model. This effort was intended to address the following needs:

- To simplify the effort required to create or modify input files;
- To improve quality assurance by reducing the likelihood of user errors in performing consequence analyses;
- To enable the user to conveniently account for uncertainties in input data with the goal of making uncertainty assessments routine; and
- To replace the original batch framework with a Windows-based framework.

The result of this development effort is WinMACCS, which now provides a user friendly interface to the MACCS code. WinMACCS is currently integrated with MACCS, COMIDA2, and LHS (Latin Hypercube Sampling) to perform the required functionality. The original MACCS framework was preserved, and MACCS can still be run in a stand-alone fashion as a batch process if desired.

1.2 Objective

The objective of this document is to describe the consequence model improvements, modeling approach, parameter selection, and consequence analyses that support the SOARCA project analyses in NUREG-1935 [1], NUREG/CR-7110 Volume 1 [2] and NUREG/CR-7110 Volume 2 [3]. This document also explains the significance of key modeling improvements and approaches used in SOARCA.

1.3 Important Differences in Approach from Prior Work

The SOARCA project staff made enhancements to MACCS to address recommendations from NRC staff and the SOARCA Expert Panel review [6]. The code enhancements for SOARCA were primarily to improve model fidelity, code performance, and functionality. These enhancements had a significant effect on the fidelity of the analyses performed in the SOARCA project, facilitating for instance, the modeling of an increased number of plume segments, 64 sectors for wind direction and atmospheric transport, and emergency response in much greater detail than in previous analyses. Selected improvements to the MACCS code are described below:

- atmospheric transport and dispersion modeling improvements (e.g., morning and afternoon mixing heights, alternative Briggs plume rise model, alternative plume meander model based on NRC Regulatory Guide 1.145 [34], an alternative way to specify plume buoyancy parameters, and an alternative long-range plume spreading model),
- capability to treat wind directions in up to 64 compass directions (i.e., instead of 16),
- higher limits on several input parameters (e.g., a limit of 200 plume segments instead of the previous limit of 4),
- more emergency phase cohorts, up to 20 instead of the original limit of 3, to allow variations in emergency response for different segments of the population,

- enhancements in the treatment of evacuation speed and direction to better reflect the spatial and temporal response of individual cohorts,

- incorporation of a potassium iodide (KI) ingestion model to account for dose reduction to the thyroid from inhalation of radioiodine,

- capability to run on a cluster of computers instead of an individual processor, and

- the addition of several new options for latent cancer fatality (LCF) dose response (i.e., user-input annual truncation values, user-input annual truncation values with a lifetime restriction, and a very flexible piecewise-linear model).

Specific aspects of the consequence modeling in SOARCA that depart from NUREG-1150 [7] and MACCS Sample Problem A are described in Section 3.0 and Section 4.0. NUREG-1150 values are taken from NUREG/CR-4551 Volume 2, Rev. 1, Part 7 [8] and contain values for one of the Peach Bottom accident scenarios. Sample Problem A is taken from the MACCS users' manual (NUREG/CR-6613) and contains parameters from NUREG-1150 for one of the Surry accident scenarios. However, it is important to note that Sample Problem A departs from NUREG-1150 choices to demonstrate two new features in MACCS that were not available in the original MACCS code. These new features were a lookup table for dispersion parameters and the use of the COMIDA2 food ingestion model. In addition, Sample Problem A mistakenly designated a 5% fraction of the population to be in the non-evacuating cohort; whereas, NUREG-1150 used 0.5% for this fraction. Many of the tabulated values below show differences between Peach Bottom (from NUREG/CR-4551) and Surry (from NUREG/CR-6613). Some of these differences are related to differences in the two plants and the surrounding sites, (e.g., shielding and protection factors); other differences are due to demonstration of new models in MACCS (e.g., using the dispersion lookup-table feature introduced in MACCS instead of the original power-law formulation). Appendix C provides a list of all MACCS input parameters for the Surry and Peach Bottom SOARCA unmitigated LTSBO calculations and associated MACCS Sample Problem A (Surry) and NUREG-1150 (Peach Bottom) values.

1.4 Independent Peer Review

Two independent review groups were established for the SOARCA project. The first group was an expert panel convened in a public meeting forum on August 21-24, 2006. The purpose of the meeting was to determine whether the MELCOR and MACCS modeling approach was consistent with the project objectives to use state-of-the art modeling with emphasis on realism in phenomenological and system treatments. The review was conducted by two panels drawn from the nuclear industry and the DOE national laboratory complex with recognized expertise in the MELCOR and MACCS numerical simulation tools. Observations and recommendations specific to each model were provided. The experts found the MELCOR code and the proposed approach for application of the codes (i.e., best practices) to be generally appropriate for performing realistic predictions of accident progression and source term for the SOARCA project. The experts found the MACCS code and the proposed approach to applying it to be generally appropriate for performing realistic predictions of offsite consequences for the SOARCA project [6].

The second review was conducted by a formal Peer Review Committee (PRC) of internationally renowned experts established in 2009 to evaluate and suggest improvements to the SOARCA project. The PRC evaluated the project approach, assumptions, results, and conclusions. To support the peer review, a series of PRC meetings were held where NRC and SNL staff presented technical details regarding the MELCOR accident progression modeling, emergency preparedness (EP), and MACCS consequence modeling. The PRC was provided draft documents for review prior to the meetings. Technical discussions were conducted on all major topics such as the accident sequence selection and screening process, seismic analysis, emergency response, angular resolution, and code validation.

The PRC reviewed the modeling approach, parameter development, parameter selection, and consequence results. The PRC provided insights and identified gaps and issues for consideration throughout the project. The final letter of each PRC member is provided in Appendix B to NUREG-1935 [1]. A detailed summary of the peer review, including staff resolutions to individual PRC comments may be found in "Summary Report: Peer Review of the State-of-the Art Reactor Consequence Analyses (SOARCA) Project Results" [5]. Some of the PRC items regarding the consequence analyses are discussed within this document. This MACCS best practices document was not included in the PRC review because it was completed after the publication of the SOARCA project primary documentation: NUREG-1935 and NUREG/CR-7110 Volumes 1 and 2 [1][2][3].

2.0 TECHNICAL APPROACH

MACCS [12] is a consequence analysis code for evaluating the impacts of atmospheric releases of radioactive aerosols and vapors on human health and the environment. The code includes all of the relevant dose pathways: cloudshine, inhalation, skin contamination, resuspension, groundshine, and ingestion. Figure 2-1 provides a graphic showing the atmospheric transport processes and dose pathways modeled by MACCS. Because MACCS is primarily a PRA tool, it accounts for the uncertainty in weather that is inherent with a hypothetical accident that could occur at some unknown point in the future. WinMACCS is a user-friendly front end to MACCS that facilitates the selection of input parameters, sampling of uncertain inputs, and performs post-processing of results. The SOARCA calculations used WinMACCS Version 3.6 and MACCS Version 2.5 for offsite consequence calculations.

The best practice approach applied in SOARCA is discussed in subsequent sections of this document. Best practices were applied in three different ways:

1. Update of parameters to reflect current state of knowledge such as the cancer risk factors based on Biological Effects of Ionizing Radiation (BEIR) V

2. Code enhancements that were implemented to provide more realism in the analysis, such as the increased angular resolution to 64 sectors from the original 16 sectors

3. User specified practices such as the use of site-specific emergency plan data in the development of emergency response related parameters

To demonstrate the application of the best practices, the parameters are described with regard to the LTSBO scenario for each site. It should be understood that parameters are scenario-specific, and the LTSBO presents only one set of parameters. NUREG/CR-7110 Volumes 1 and 2 include the parameters for all of the scenarios [2] [3].

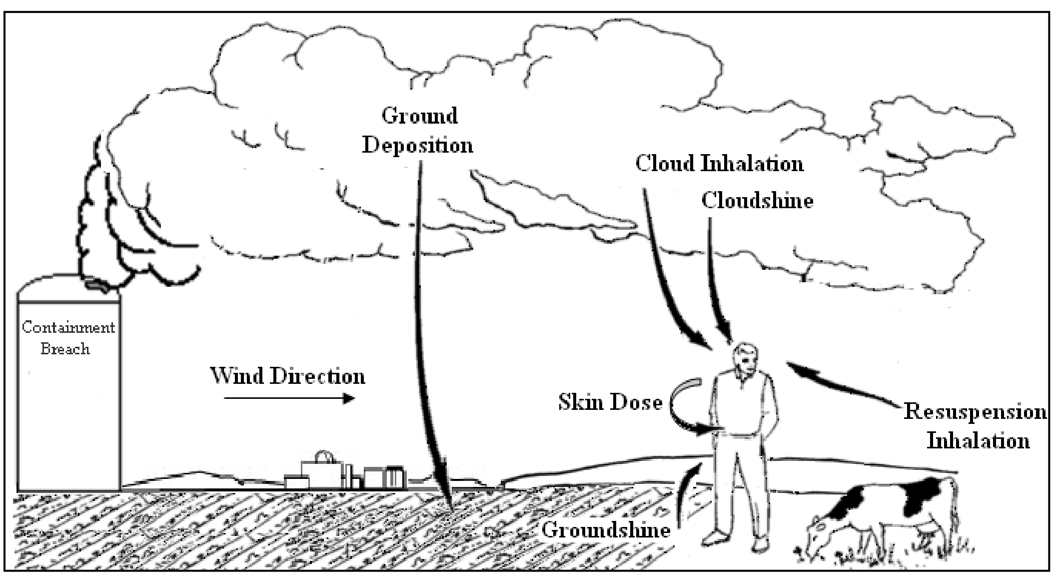

Figure 2-1 Relevant MACCS exposure pathways used in SOARCA

The basic consequence analysis approach used in SOARCA included the following activities:

- The NRC obtained raw weather data for two years from each of the two SOARCA sites. NRC determined, based largely on data recovery, which of the two years was more suitable for use in SOARCA. An NRC meteorologist filled in the missing hours of data using standard guidelines from NRC regulatory guides and processed the data for 16, 32, 48, and 64 compass directions. SNL performed consistency checks on the weather data and created the final files that were used as MACCS input, choosing 64 compass sectors for all of the SOARCA calculations.

- SNL generated the site files using SECPOP2000 [28]. Site files were initially created for 16 compass sectors, which was the only angular resolution supported by the code at the time. WinMACCS was then used to interpolate the site data onto the 64 compass sector grid that was used for the SOARCA consequence analyses.

- The NRC, SNL, and Brookhaven National Laboratory reviewed the MACCS parameters to determine the values to be used for the SOARCA project for the two plant sites. A table of parameters was created of the NUREG-1150 values, Sample Problem A values, and the value used in the SOARCA calculations. Appendix C provides a list of all MACCS SOARCA LTSBO input parameters and their associated Sample Problem A or NUREG-1150 values.

- Source terms were generated with the MELCOR code and interpreted with MELMACCS which is a program used to create a MACCS radionuclide input file from the MELCOR output file. MELMACCS extracts information from the MELCOR plot file and converts it into MACCS input values. The MELMACCS user affects the interpretation of the MELCOR results in several ways, including associating MELCOR mass values with an ORIGEN output that allows masses of chemical classes to be converted to activities of individual radionuclides, the chemical classes that are to be included in the analysis, estimation of aerosol deposition velocities, and the timeframes to be used for each plume segment. A standard process was developed to digest each of the MELCOR source terms in a consistent fashion.

- A detailed emergency response model was developed. NRC staff met with the sites to discuss the emergency action levels for each of the accident sequences to support development of the emergency response timelines, which in turn were converted into WinMACCS parameters. Emergency response timelines were established for each accident sequence. Emergency phase cohorts were established to represent unique segments of the population who respond in a similar manner. Six emergency phase cohorts were defined in SOARCA whereas previous studies defined only two or three cohorts (e.g., an evacuating and a non-evacuating cohort). Use of additional cohorts in SOARCA allowed greater fidelity in modeling the emergency response of the public.

- The network evacuation model was used to represent the site-specific evacuation routes. This implemented the WinMACCS capability to overlay the MACCS grid onto roadway maps. Expected evacuation travel directions were defined within each grid cell for the site emergency planning zones (EPZs). The network evacuation model also allowed the use of speed multipliers to adjust the flow of traffic to better represent urban and rural traffic flow.

- The consequence analyses were conducted using WinMACCS. The results were interpreted with respect to individual prompt fatality risk and individual latent cancer fatality risk in order to quantify the risk. Some comparisons were made with the results presented in the 1982 Siting Study [14].

2.1 WinMACCS

WinMACCS is the user interface to MACCS allowing greater user friendliness in the development of the analysis model. Some of the activities applied through WinMACCS for SOARCA are described below:

- Analysts modified input parameters and model settings. Both settings and parameters can be saved in the project database.

- Analysts imported source term data and other inputs into the database. This option was used in conjunction with MELMACCS to create consequence models for each of the accident scenarios.

- Analysts executed multiple MACCS simulations. WinMACCS builds the MACCS input files using the values saved in the project database. The cyclical file capability in WinMACCS was used to execute multiple simulations.

- Analysts ran groups of simulations on a Windows cluster. This option was used to run several calculations simultaneously and to minimize the time needed for computing the consequence analyses. This option was used most often to run a group of dose response models and accident scenarios simultaneously.

WinMACCS is linked with the following executable files:

- Latin Hypercube Sampling (LHS) generates values for uncertain input variables. This capability was not used in the SOARCA baseline study, but is being used in the SOARCA uncertainty analysis of the unmitigated Peach Bottom LTSBO scenario.

- COMIDA2 is a semi-dynamic food chain model that estimates annual concentrations (essentially food-pathway dose coefficients) given a set of radionuclides and transfer coefficients for each crop type considered. COMIDA2 can be run in deterministic or uncertain modes. Sampling in the uncertain mode is performed in conjunction with LHS. This capability was not used in the SOARCA study because the food pathway was not treated. The rationale for excluding the ingestion pathway is that food is plentiful in the U.S. and alternative food production can easily compensate for the lack of production in a contaminated area. Furthermore, the U.S. population is generally averse to consuming food containing even small amounts of contamination. Most, if not all, consumers would go out of their way to find uncontaminated food and such food would be in adequate supply.

- PopMod reads an ASCII site file (e.g., a file created by SECPOP2000). PopMod creates a new population file containing more compass sectors. The work of PopMod is primarily interpolation and reformatting. No new information is added to the site data file that is created. PopMod was written to allow WinMACCS to support more compass directions by reformatting a site data file created by SECPOP2000. At the time of the SOARCA study, SECPOP2000 only supported 16 compass sectors; a new version now supports up to 64 compass sectors. PopMod was used in the SOARCA study to convert 16-sector site files to ones with 64 compass sectors.

- Dose coefficient utility is used to create dose coefficients to calculate doses for a set of organs from radionuclide exposures corresponding to a set of exposure pathways. This utility can modify data from a standard dose coefficient file, including sampling from distributions to account for uncertainty in dose coefficients. This utility works in conjunction with LHS when sampling is to be performed. It was not used in the SOARCA study, but is being used in the SOARCA uncertainty analysis of the unmitigated Peach Bottom LTSBO scenario.

MACCS is the modeling engine and can be initiated by WinMACCS or from a command prompt window.

WinMACCS is linked with the following data files:

- Project Files are data files managed by WinMACCS and include a set of auxiliary files, such as the site file, the meteorological data file, the COMIDA2 binary file(s), and the dose coefficient file(s). The project files also consist of input files created by WinMACCS and output files primarily created by MACCS.

- Project Database is an Access 2000 database file that is modified by WinMACCS. This file contains all the project settings and parameter values that define the project.

- The meteorological data file contains one year of meteorological data that includes hourly, half-hourly, or quarter-hourly wind direction and speed, stability class, and precipitation rate data and seasonal morning and afternoon mixing height data.

- Dose coefficient files contain the dose coefficients needed to convert concentrations or activities into organ or effective doses. One dose coefficient file is needed for the linear no threshold (LNT) dose-response model; a set of 51 files are needed for truncation dose-response models.

- The site file contains population, land use, and economic data for a specific site.

- The Comida2 binary file is used to define food-chain dose coefficients. Food-chain modeling was not performed in the SOARCA study.

Figure 2-2 provides a graphical representation of how WinMACCS interacts with MACCS, COMIDA2, LHS, PopMod, the project files, and the project database.

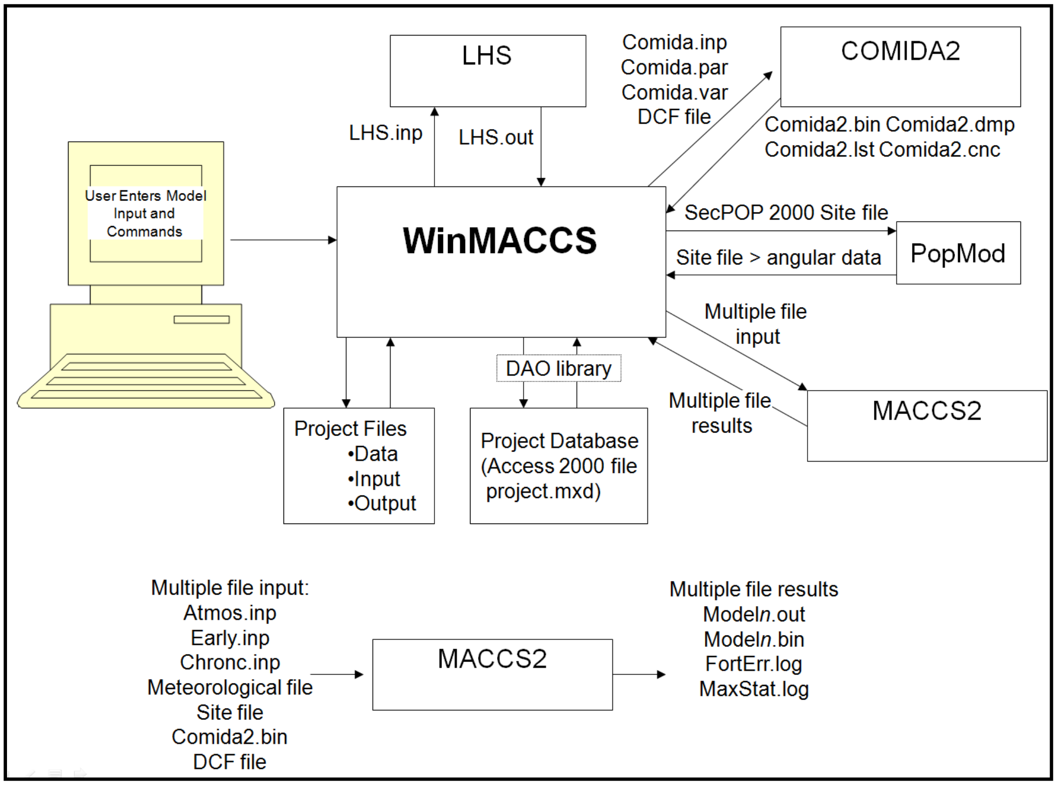

Figure 2-2 WinMACCS computational flow path

3.0 CODE ENHANCEMENTS

Multiple MACCS code enhancements were implemented as part of the SOARCA project. The subsequent sections describe the parameters that were adjusted or updated to support the analyses. Important code enhancements included:

- increased angular resolution to 64 sectors from the original 16 sectors,
- updated dose coefficients and cancer risk factors,
- atmospheric transport and dispersion modeling improvements,
- increased the plume segment limit to 200 instead of the previous limit of 4,
- increased number of emergency phase cohorts to 20 instead of the previous limit of 3,
- enhanced treatment of evacuation speed and direction to better reflect the spatial and temporal response of individual cohorts,
- added potassium iodide (KI) ingestion model to account for dose reduction to the thyroid from inhalation of radioiodine, and
- added new options for LCF dose response.

3.1 Increased Angular Resolution

MACCS was originally structured with an angular grid divided into 16 compass directions. The expert panel review discussed in Section 1.4 recommended an increase in the number of compass directions to enhance model fidelity. This recommendation was addressed by enabling MACCS to treat 32, 48, or 64 compass sectors in addition to the original 16. SOARCA used the highest resolution option of 64 compass sectors. Moreover, to be consistent with the higher spatial resolution, wind directions were tabulated with the 64 compass sector resolution using hourly time averaging periods for the weather data. MACCS currently allows 15, 30, and 60 minute time averaging periods for the weather data, but the data that were available for the two sites were only for hourly time periods.

The expectation was that peak doses during an accident should be reduced when angular resolution is increased, especially when maximum advantage is taken of potential hourly wind shifts in the meteorological data. This is because MACCS allows each plume segment to travel only in the direction of the wind at the beginning of its release. Finer angular resolution means that the wind is more likely to shift from one sector to another during successive hours.

Increased angular resolution was expected to have a significant effect on prompt fatality risk and to have some effect on LCF risk. Prompt fatality risk is based on a highly nonlinear dose-response curve, so a reduction in the estimated peak dose can significantly reduce the estimated risk. LCF risk using the LNT dose-response assumption can be insensitive to peak doses as long as total population doses are relatively unaffected. In other words, better accounting for variations in wind direction can lead to smaller individual doses, but those doses are spread over a larger segment of the population, which may result in approximately the same LCF risk. LCF risk based on a threshold type dose-response relationship, like prompt fatality risk, is expected to be much more sensitive to angular resolution.

For SOARCA, 64 compass directions were used together with hourly plume segments to take advantage of potential wind shifts in the meteorological data. A sensitivity study based on the Peach Bottom site indicated less than a 10% reduction in LCF risk when switching from 16 to 64 compass sectors. Prompt fatality risk was essentially zero for all of the SOARCA accident scenarios due to the relatively small releases calculated by MELCOR for the scenarios studied in SOARCA.

The one accident scenario that produced nonzero values for prompt fatality risk is the Surry interfacing systems loss of coolant accident (ISLOCA), and the risks for that scenario were trivial (i.e., ~10^{-6} per event). The extent to which the added realism of capturing wind shifts affected the low prompt-fatality risks reported for this sequence is not known. However, it is certain that capturing wind shifts reduced the estimated prompt fatality risks compared with methodologies used in previous studies, such as NUREG-1150. For accident sequences producing somewhat larger source terms than the ones considered in SOARCA, the effect of 64 compass sectors combined with hourly or more frequent plume segments could easily have a significant effect on predicted prompt fatality risk. Similarly, higher spatial resolution is expected to have a significant effect on threshold-type dose-response models because these models estimate higher risks when peak doses are large for a smaller population than when smaller doses are spread over a larger population.

3.2 Dose Coefficient Update

MACCS analyses for NRC applications prior to SOARCA used dose coefficients based on the International Commission on Radiological Protection (ICRP) publications ICRP 26 [36] and ICRP 30 [37]. The SOARCA project used the dose coefficients provided in FGR-13 [39], which are based on ICRP-72 published in 1996 [38]. Thus the dose coefficients used in SOARCA were updated from previous studies.

Several adjustments were made to the dose coefficients based on recommendations from Dr. Keith Eckerman in the 2012 Oak Ridge National Laboratory (ORNL) memo [24]. They include the following: (1) a relative biological effectiveness factor (RBE) of 10 was used for high linear energy transfer (LET) radiation (alpha particles) in the breast instead of the standard radiation weighting factor of 20, and (2) an RBE of 1 for high-LET radiation was used for the bone marrow instead of the standard value of 20. These adjustments were made to account for specific cancer types (i.e., breast cancer and leukemia, respectively) associated with these two organs and were implemented in a special version of the FGR-13 dose coefficient file. In addition, the dose coefficients for the pancreas were copied into the dose coefficients for the bladder wall as a workaround. Dr. Eckerman recommended that the pancreas be used as the surrogate organ to associate with residual cancers. MACCS reads a hardwired set of organs, and the set includes bladder wall but not pancreas. Rather than modifying the MACCS code, the dose coefficients for pancreas were copied into the organ labeled bladder wall and bladder wall was associated with residual cancers.

3.3 Atmospheric Transport and Dispersion

The atmospheric transport and dispersion modeling improvements were structured to allow morning and afternoon mixing heights, an alternative Briggs plume rise model, an alternative plume meander model based on NRC Regulatory Guide 1.145 [34], an alternative way to specify plume buoyancy parameters, and an alternative long-range plume spreading model.

3.4 Increased Plume Segments

The number of allowable plume segments in MACCS was increased from 4 to 200. This enhancement allowed significant releases to be broken up into 1-hour plume segments. MACCS allows each plume segment to travel in only one compass direction based on the weather data at the time that plume segment is released. More plume segments can better represent plume transport and dispersion due to possible changes in the weather (such as the wind direction) during the release. Longer plume segments were sometimes used for trivial releases, such as those where the segment content is a very small fraction of the total release. Finer resolution of these releases was not necessary to maintain the fidelity of the calculation. The MELCOR analyses provided the amount of each chemical element group in each aerosol bin for each plume segment.

3.5 Increased Emergency Phase Cohorts

The number of emergency phase cohorts was increased from 3 to 20. For each site, six cohorts were established, each of which represents a discrete segment of the population that has similar response characteristics. The use of six cohorts provided greater fidelity in the treatment of emergency response than was possible with the original version of MACCS.

3.6 Enhanced Treatment of Evacuation Speed and Direction

Enhancements in the treatment of evacuation speed and direction were implemented to better reflect the spatial and temporal response of individual cohorts. While the network evacuation model in MACCS has been available for some time, it has been made considerably easier to use by the development of WinMACCS, which provides a graphic interface for the user to input speed and direction variations for each evacuating cohort. The original version of MACCS allowed the input of direction at the grid element level; however, this required the analyst to input the data in a table that represented the grid. As discussed later in Section 4.1.1, the network evacuation model now allows this information to be input directly onto the grid using a layer that shows the roadway network underlying the analysis area.

3.7 Potassium Iodide Model

A potassium iodide (KI) model was added to MACCS to account specifically for the implementation of a KI program. The purpose of the KI is to saturate the thyroid gland with stable iodine so that further uptake of radioiodine by the thyroid is diminished. If taken at the right time, the KI can nearly eliminate doses to the thyroid gland from inhaled radioiodine. Assumptions regarding the fraction of residents expected to ingest KI and the efficacy of the KI are input into the model.

3.8 Addition of Options for LCF Dose Response

Additional options for user-input of LCF dose response included a yearly truncation value, user-input yearly truncation value with a lifetime limit, and a piece-wise linear model.

4.0 USER-SPECIFIED INPUT CHOICES AND PARAMETERS

In addition to the code enhancements, many of the input variables and parameter updates used for consequence analysis in SOARCA were evaluated and revised for the specific application. The SOARCA team reviewed all of the MACCS parameters to determine which parameters should be adjusted for the SOARCA project and which values did not require adjustment (e.g., breathing rate). The team compiled tables of parameters which included NUREG-1150 values, MACCS Sample Problem A values, and the SOARCA user selected value to support the review. These tables are provided in Appendix C. The best practices discussed in this section are not values to be used in MACCS in all cases. Many of the values discussed are site-specific to Peach Bottom and Surry. Other choices made in SOARCA may not have significant benefit in some other analyses. Some guidance is provided on the effect of model and parameter choices made in SOARCA.

4.1 Calculational Area

MACCS calculates results based on a polar-coordinate spatial grid. The region potentially affected by a release is represented with an (r, θ) grid system centered on the location of the release. The radius, r, represents downwind distance. The angle, θ, is the angular offset from north in the clockwise direction.

The number of radial intervals as well as the radial boundary distances, input with the variable SPAEND, in SOARCA are the same as the values used in NUREG-1150, except for three of the first five radial rings. NUREG-1150 used different radial distances for each plant; whereas, SOARCA used Surry values taken from NUREG-1150 for both plants. Table 4-1 shows the first six radial distances used in SOARCA and used in NUREG-1150 for Peach Bottom. The complete list of boundary distances is provided in Appendix C.

Table 4-1 Radial distance parameter variations between SOARCA and NUREG-1150 for the Peach Bottom site

Variable	Description	SOARCA	NUREG-1150 Peach Bottom
SPAEND	Radial distances for grid boundaries (km (mi))		
	Ring 1	0.16 km (0.1 mi)	0.40 km (0.25 mi)
	Ring 2	0.52 (0.33)	0.82 (0.5)
	Ring 3	1.21 (0.75)	1.21 (0.75)
	Ring 4	1.61 (1.0)	1.61 (1.0)
	Ring 5	2.13 (1.33)	2.43 (1.5)
	Ring 6	3.22 (2.0)	3.22 (2.0)

4.1.1 Network Evacuation Model

The network evacuation model in MACCS is now implemented via WinMACCS, which provides a graphic interface for the user to input speed and direction variations for each evacuating cohort. To develop the input used in SOARCA, the evacuation routes were reviewed to determine the expected direction evacuees would travel. The evacuation area was mapped onto a grid with 64 compass sectors and 15 radii. The direction for each grid element was selected based on the expected roadways that would be used in the evacuation. Speed adjustment factors were applied to speed up or slow down evacuees depending on whether congestion was expected (in urban areas) or whether free flow was expected (in rural areas).

An example of the Network Evacuation Model directional arrows and speed adjustment factors for the Peach Bottom site is shown in Figure 4-1. One evacuation network at each site was developed and used for all accident sequences except the seismic sensitivity analyses. A separate evacuation network was implemented for the seismic sensitivity analyses to represent the loss of parts of the roadway network and loss of traffic signals. The response timing and evacuation speed parameters were developed specifically for each accident sequence.

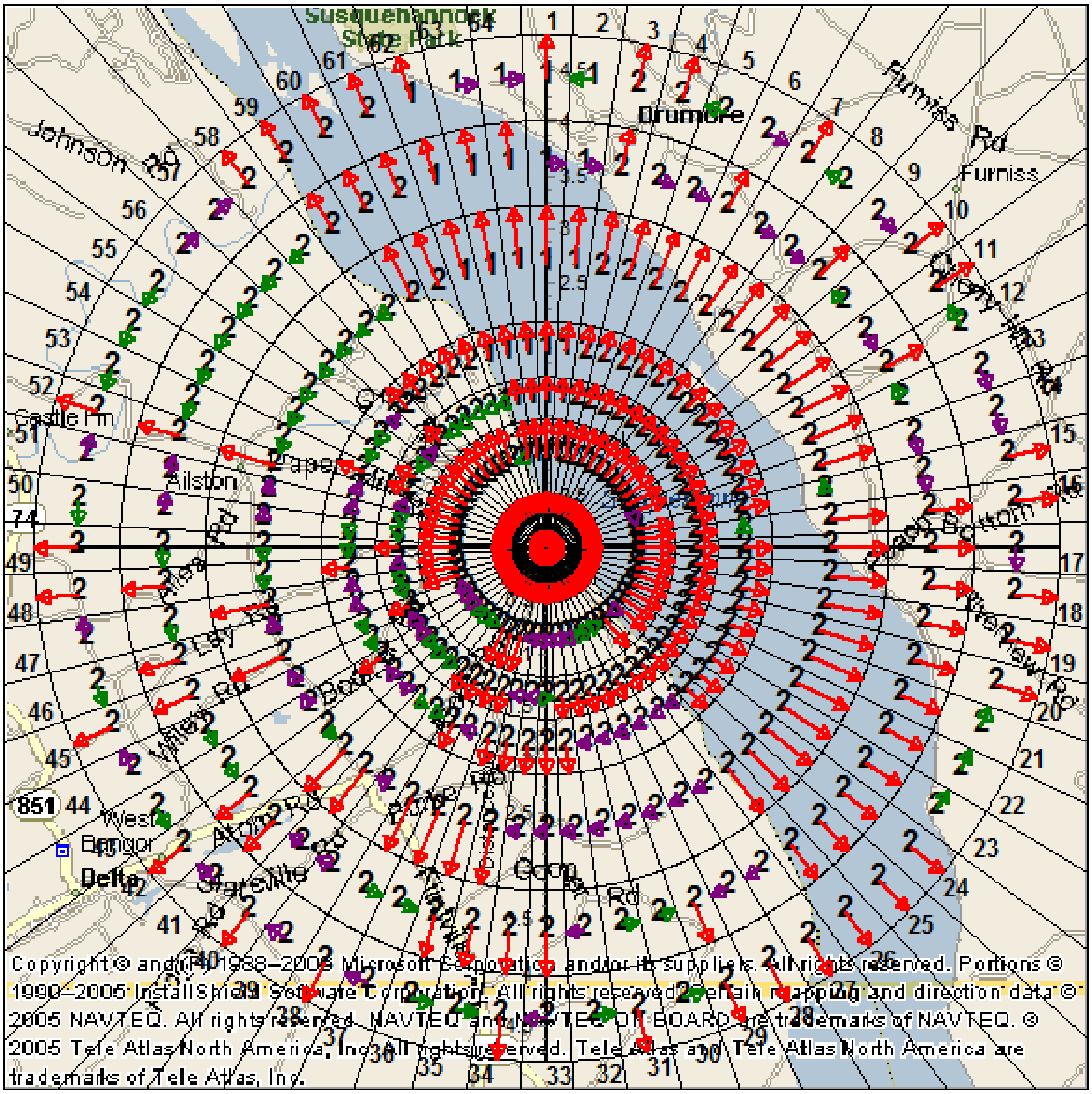

Figure 4-1 Example of WinMACCS grid showing traffic direction arrows and speed multipliers around Peach Bottom

Table 4-2 shows the evacuation parameters used in SOARCA, Sample Problem A and NUREG-1150. As identified in the table, the evacuation type (EVATYP) for SOARCA was the NETWORK evacuation model. Previous analyses implemented the RADIAL evacuation model where the evacuees are represented as traveling along the centerline (centerpoint) of each sector until they are out of the evacuation area, in part because the original NETWORK evacuation model was cumbersome to implement. In SOARCA, the CENTERPOINT option was selected for evacuee movement because it is the only option allowed when evacuation speeds are specified to vary by phase.

Table 4-2 Evacuation parameter variations between SOARCA, Sample Problem A, and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
EVATYP	Evacuation Type	NETWORK	NETWORK	RADIAL	RADIAL
TRAVELPOINT	Evacuee Movement Option	CENTERPOINT	CENTERPOINT	BOUNDARY	Not used in MACCS model

4.1.2 SECPOP

In the SOARCA analyses, site files were initially created using SECPOP2000 to estimate the population within 50 miles of each plant for 16 compass sectors, which is the only angular resolution supported by that code. The population for each site was projected from 2000 to 2005, the SOARCA project target year, using a national population growth multiplier of 1.0533 obtained from the U.S. Census Bureau. SECPOP2000 interpolates U.S. Census data at the block level[2] onto a MACCS grid. The economic values are from the Bureau of Economic Analysis (BEA) for the year 2002 and are tabulated at the county level. These values were scaled to 2005 dollars by applying a multiplier of 1.0900, which is the ratio of the consumer price index (CPI) for 2005 to the value for 2002. WinMACCS was then used to interpolate the site files onto a 64-compass-sector grid that was used for the SOARCA consequence analyses. Population values for transients, schools, and special facilities were obtained from the evacuation time estimate (ETE).

4.2 Source Term

The specification of the release characteristics is designated as a "source term," and can consist of multiple Gaussian plumes. The radioactive materials released are modeled as being dispersed in the atmosphere while being transported by the prevailing wind. During transport, whether or not there is precipitation, aerosols can be modeled as being deposited on the ground. If contamination levels exceed user-specified criteria, mitigative actions can be triggered to limit radiation exposures.

4.2.1 Fission Product Inventory

Fuel burnup at the time of the 1982 Siting Study was much lower than current practice. The inventory used for the SOARCA evaluation at Peach Bottom was based on current fuel cycle practices. SOARCA assumes that each accident scenario occurs mid-cycle. For Peach Bottom, SOARCA used an ORIGEN calculation based on medium burnup: 49 MW-days/kg peak fuel rod at mid-cycle for Peach Bottom Unit 2 [42]. For Surry, a mid-cycle calculation of the fission product inventory considering current fuel cycle practices was not available. Instead, the core decay heat and fission product inventories were calculated using results from a SCALE/ORIGEN calculation based on end-of-cycle [40]. A burnup of 65 MW-days/kg for the peak fuel rod was assumed. The high burnup fission product inventory was slightly conservative relative to best estimate values and significantly larger for some isotopes than the low burnup values used in earlier studies [41]. The decay heats, masses, and activities as a

[2] Census blocks are the smallest geographic area for which the Census Bureau collects and tabulates decennial census data and are formed by streets, roads, railroads, streams and other bodies of water, other visible physical and cultural features, and the legal boundaries shown on Census Bureau maps.

function of time were processed and consistently used as inputs to MELCOR to define decay heat and as inputs to MELMACCS to define the radionuclide inventory.

4.2.2 Particle Size Distribution

Consequence analyses of commercial nuclear reactor units prior to SOARCA used a single deposition velocity to represent all particle sizes and all radionuclide groups. In other words, all aerosols were assumed to deposit at the same velocity. The SOARCA project implemented advancements in the MELCOR to MACCS interface using MELMACCS to provide binned particle size information for each of the radionuclide groups. Particle size distribution data are provided for Surry in Appendix A, Table A-3 and for Peach Bottom in Appendix B, Table B-3.

4.2.3 MELMACCS

MELMACCS is a Windows based program developed by SNL in 2002 that is used to create a MACCS source term input file from the MELCOR plot file. MELMACCS version 1.7.0 was used in the SOARCA project. MELCOR plot files contain large amounts of data, only a small fraction of which is needed for MACCS calculations. The MELMACCS software was created to provide an interface utility between MELCOR and MACCS to extract and evaluate the required source term data for a consequence analysis.

MELMACCS obtains two classes of data from the MELCOR plot files. The first is time-independent data, which are data that remain constant throughout the MELCOR calculation. Examples are initial masses of each chemical group and flow paths to the environment. The second class is time-dependent data, which is written to the MELCOR plot file for each plot file time step. The plot file time step is defined by the MELCOR user. Examples of these data are fluid temperatures and flow rates for a flow path to the environment and the released mass of each chemical group for a flow path into the environment.

MELMACCS uses a graphical user interface (GUI) to allow the user to convert one MELCOR plot file into a source term input file (.INP) for MACCS. The inputs contained in this file are used in the ATMOS portion of MACCS.

Prior to MELMACCS converting the MELCOR plot file, the user must first specify inputs that are needed to create the MACCS file, but are not provided by MELCOR. These inputs are:

- the radionuclide classes to include,
- high, medium, or low burnup fuel and the type of reactor (PWR or BWR),
- time of accident initiation in the MELCOR time frame,
- grade (ground height) relative to the MELCOR coordinate system,
- building height and initial plume width and height for building wake calculations,
- parameters and choices used to estimate deposition velocities,
- mass-fraction thresholds for paths and plume segments to be considered, and
- time intervals for plume segments.

The MELMACCS inputs used for SOARCA are illustrated for the Peach Bottom LTSBO in Figure 4-2 through Figure 4-9. Figure 4-2 shows that all nine of the standard chemical groups were selected and a medium burnup calculated specifically for Peach Bottom was chosen. This same inventory was used to define the decay heat levels in the MELCOR calculation.

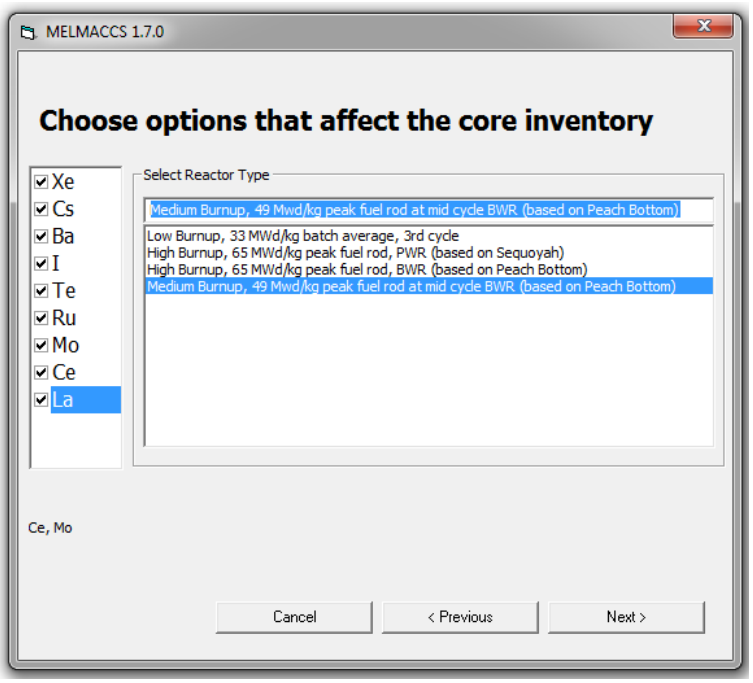

Figure 4-2 Choices of chemical groups and burnup used for Peach Bottom

Figure 4-3 shows that the accident starts at time = 0.0 seconds in the MELCOR time frame and that ground level (grade) is at -4.04 meters in the MELCOR reference frame. The Peach Bottom reactor building is 50 meters high, and the initial plume dispersion parameters are chosen to be 11.6 meters and 23.3 meters in the crosswind and vertical dimensions, respectively.

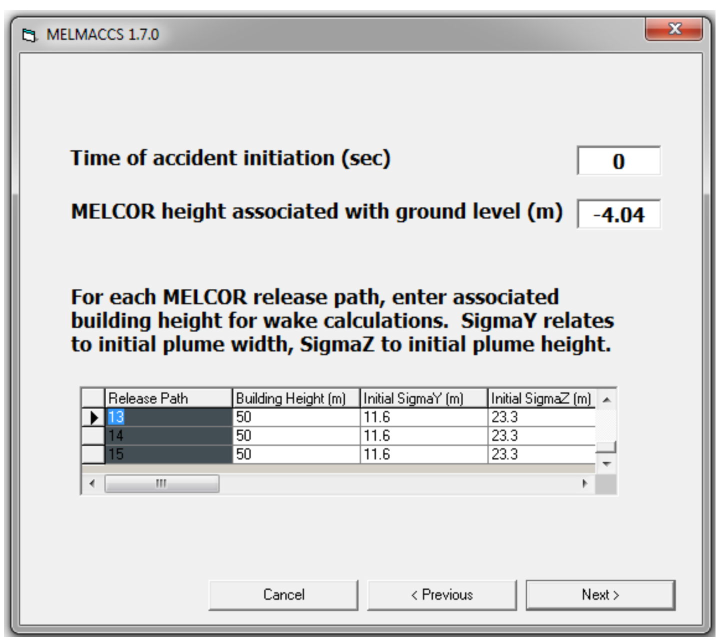

Figure 4-3 MELCOR release paths into the environment, MELCOR time of accident initiation, height of ground level in MELCOR reference frame, and initial plume dispersion parameters

Figure 4-4 shows the choices used to calculate deposition velocity. Two optional models for deposition velocity are available. The one used in SOARCA is considered to be the better option for smaller size aerosols: *Calculate deposition velocities based on expert elicitation data* [18]. With this option, the user must specify three additional parameters. The first is surface roughness. This was chosen to be 0.1 meters (10 cm) in all SOARCA cases except the sensitivity analysis in which it was set to be 60 cm. Wind speed was chosen to be 2.2 m/s, which is very close to the average wind speed at both the Peach Bottom and Surry sites. Finally, the quantile was chosen to be 0.5, which represents a median or best-estimate value from the expert elicitation. The option to *Disable deposition velocity results in MACCS file* was not selected. This choice causes MELMACCS to write deposition velocity information onto the output file.

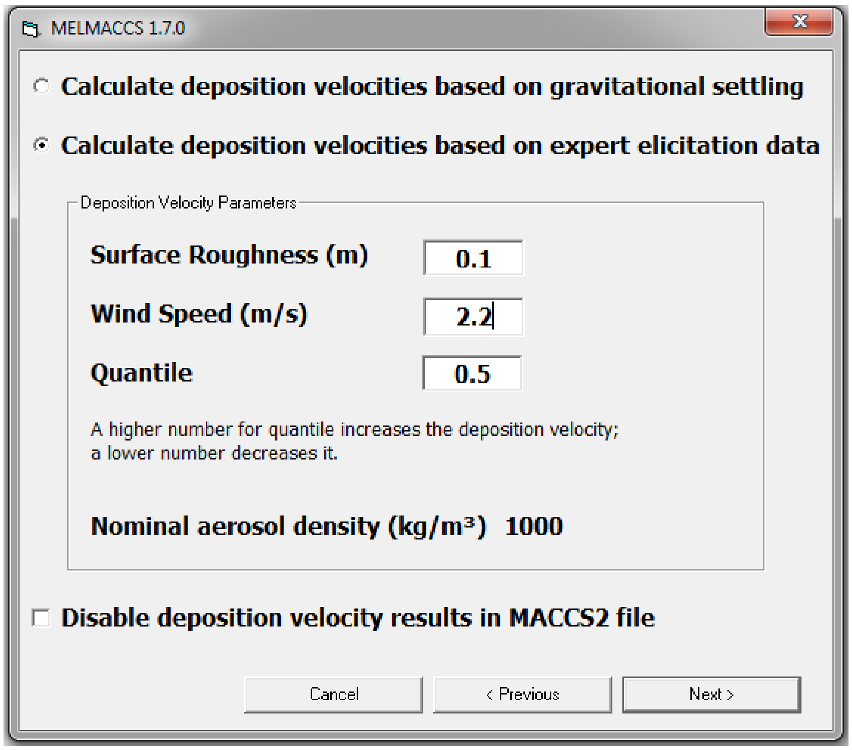

Figure 4-4 MELMACCS parameters for calculating deposition velocity

Figure 4-5 shows two parameters that control which of the MELCOR paths are displayed and which plume segments are considered. The first of these causes flow paths to be evaluated only when more than 0.001 (0.1%) of the total release of any chemical group occurs through a flow path. Of the 15 flow paths in the MELCOR analysis of the SOARCA Peach Bottom unmitigated LTSBO, only two of them (i.e., flow path 4 – refueling bay blowout panels to the environment and flow path 11 – reactor building equipment lock door at 135-feet to the environment) have a significant release according to this threshold criterion. The second parameter causes a plume segment to be evaluated if any of the chemical groups in that segment contribute 0.001 (0.1%) to the total release of that chemical group.

Figure 4-6 shows the timing of release for each of the chemical groups on a log scale, as calculated by MELCOR for release path 4; the dominant release path. The release begins at about 72,000 seconds (20 hours) and ends at 172,800 seconds (48 hours), when the MELCOR calculation is terminated. The *Auto Insert* function is used to automatically split the release into 3600 second (1 hour) plume segments, which is shown as a set of vertical black lines dividing the time period into segments. The values selected on this screen are saved by clicking the *Apply* button. This creates 28 plume segments for release path 4.

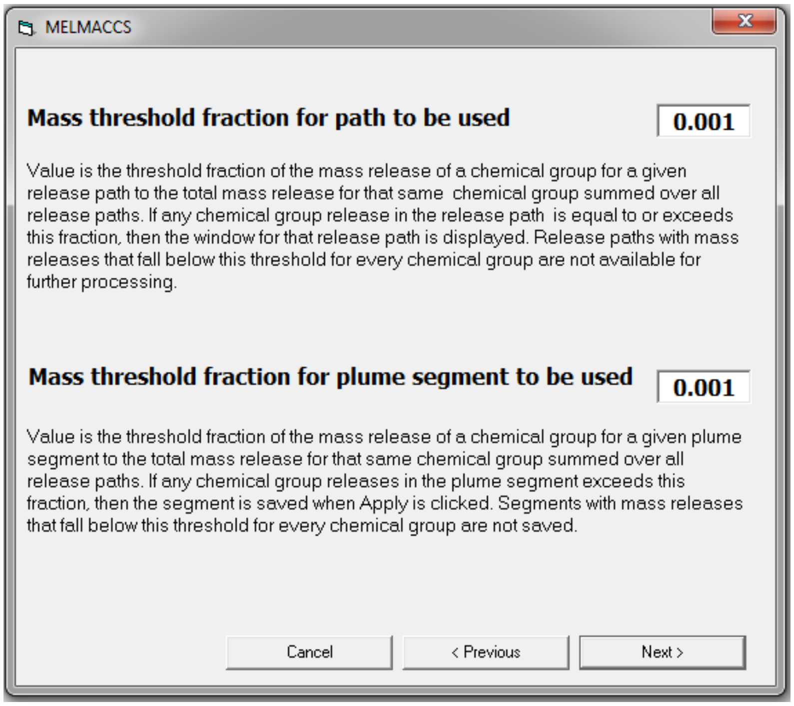

Figure 4-5 MELMACCS threshold parameters for paths and plume segments

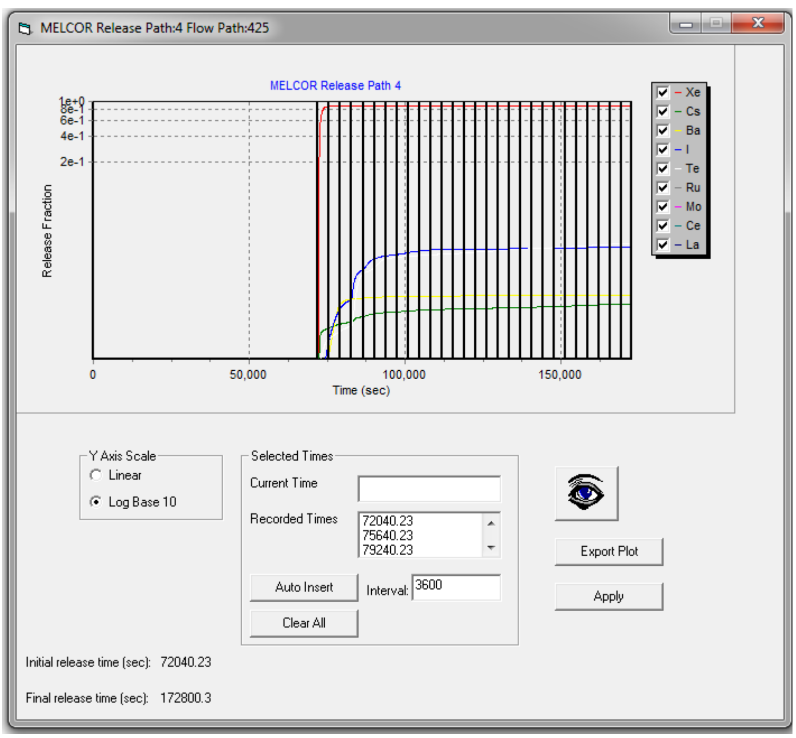

Figure 4-6 Dividing the overall release into plume segments for release path 4

A similar process is applied for release path 11, as shown in Figure 4-7. However, only the first plume segment from release path 11 meets the threshold criterion specified in Figure 4-5, so only one additional plume segment is created. This is the first plume segment shown in Figure 4-7; no significant release occurs through this flow path after the initial release. Furthermore, only noble gas releases are significant through this release path.

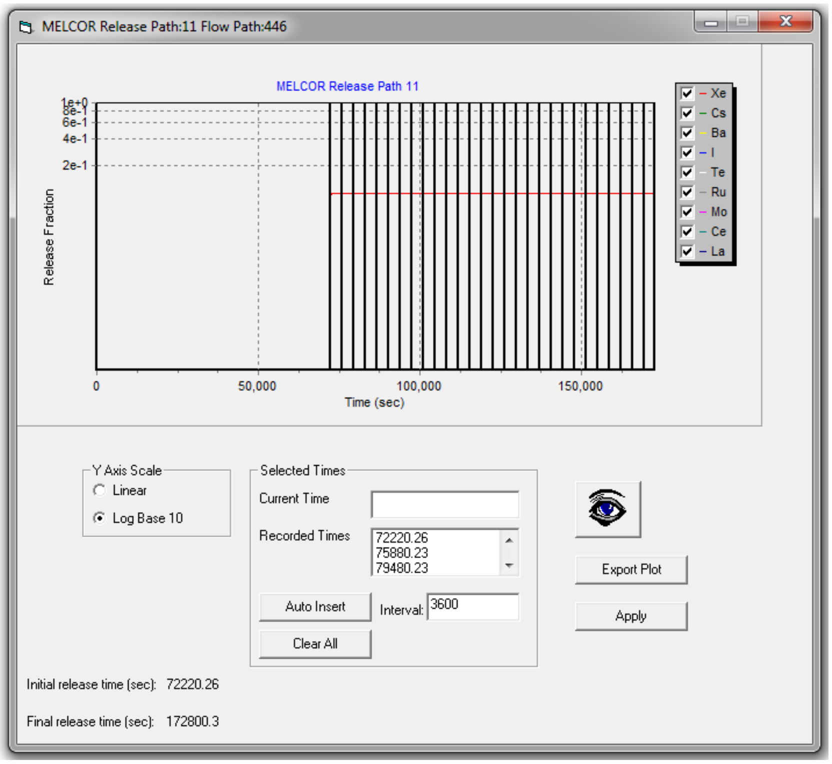

Figure 4-7 Dividing the overall release into plume segments for release path 11

The description of the plume segments, as defined by the user, is shown in Figure 4-8 and Figure 4-9. The first column in Figure 4-8 shows which MELCOR release path corresponds to the specified MACCS plume segment. The second and third columns define the timing of the release. The fourth column contains the initial release height measured above grade. Columns five (Figure 4-8) through seven (see Figure 4-9 for columns six and seven) provide values used to determine plume buoyancy. The final nine columns provide release fractions of each chemical group. Three of these last nine columns are shown in Figure 4-9. All of the information contained in Figure 4-8 and Figure 4-9 plus additional data defining the deposition velocity for each aerosol bin, default values for deposition flags, initial plume dimensions for each plume segment, a particle size distribution for each chemical group, a default value of REFTIM for each plume segment, and fission product inventory data are contained in the MELMACCS output file.

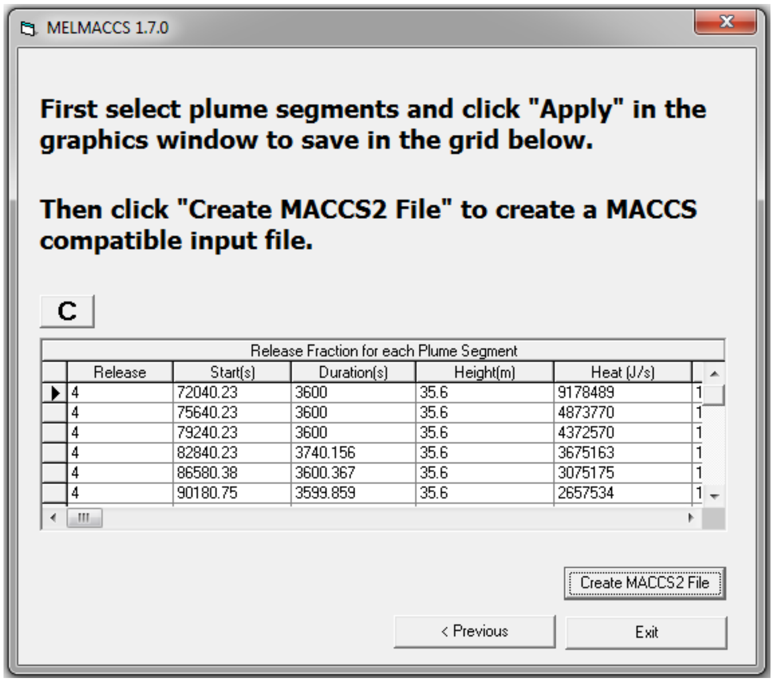

Figure 4-8 Definition of plume segments (release path through heat)

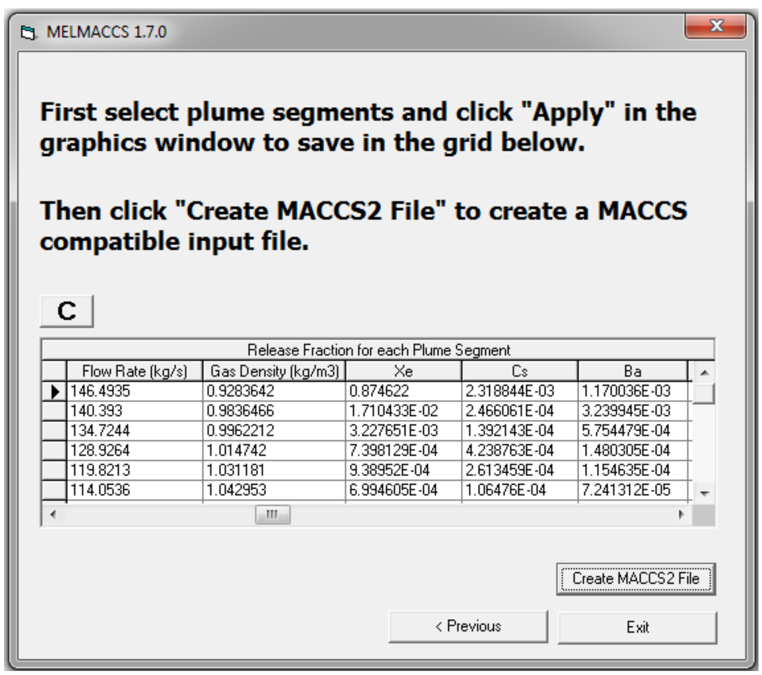

Figure 4-9 Definition of plume segments (flow rate through barium release fraction)

Cesium iodide (CsI) and cesium molybdate (Cs_2MoO_4) are included in the release calculation performed by MELMACCS. The activities contained in CsI are split into Class 2, cesium (Cs), and Class 4, halogens (I), and the activities in Cs_2MoO_4 are split into Class 2 and Class 7, molybdenum (Mo). These results are then used to calculate the total fractional releases of the core inventory for cesium, iodine, and molybdenum.

For the SOARCA scenarios, each of the radionuclide classes listed in Table 4-3 were considered for environmental impacts. Class 10, uranium (U), Class 11, more volatile main group (Cd), and Class 12, less volatile main group (Sn), were not considered in the environmental impacts because these classes do not contain any isotopes that are considered to be important in a consequence analysis. MACCS analyses for commercial nuclear reactors usually use the 60 radionuclides that were evaluated to be important for health effects in the NUREG-1150 study; however, the NUREG-1150 study implicitly included a set of nine daughters that are now treated explicitly. Thus, 69 radionuclides are included in MACCS analyses of commercial nuclear reactors.

For additional information regarding these radionuclide classes and the isotopes used in the consequence analyses for Peach Bottom and Surry, see Table A-1 in NUREG/CR-7110 Volume 1 [2], and Table B-1 in NUREG/CR-7110 Volume 2 [3], respectively.

Table 4-3 Radionuclide classes used in SOARCA

Class	Name	Representative	Member Elements
1	Noble Gas	Xe	He, Ne, Ar, Kr, Xe, Rn, H, N
2	Alkali Metals	Cs	Li, Na, K, Rb, Cs, Fr, Cu
3	Alkali Earths	Ba	Be, Mg, Ca, Sr, Ba, Ra, Es, Fm
4	Halogens	I	F, Cl, Br, I, At
5	Chalcogens	Te	O, S, Se, Te, Po
6	Platinoids	Ru	Ru, Rh, Pd, Re, Os, Ir, Pt, Au, Ni
7	Early Transition Elements	Mo	V, Cr, Fe, Co, Mn, Nb, Mo, Tc, Ta, W
8	Tetravalent	Ce	Ti, Zr, Hf, Ce, Th, Pa, Np, Pu, C
9	Trivalents	La	Al, Sc, Y, La, Ac, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Am, Cm, Bk, Cf

4.3 Atmospheric Transport

Plume dispersion during downwind transport in MACCS is modeled using a segmented Gaussian plume model. This model uses a normal (i.e., Gaussian) distribution for air concentration in the crosswind and vertical dimensions. The Gaussian plume equations depend on the wind speed, atmospheric stability class, the effect of surface roughness, release height, and the height of the mixing layer.

The Gaussian plume model uses two spatially dependent dispersion parameters, sigma-y and sigma-z, to estimate the atmospheric dispersion. These parameters can be specified in two ways in MACCS: as power-law functions or with lookup tables. The dispersion parameters are specified for each stability class. The SOARCA project used the power-law functions, as specified with the DISPMD variable. The long-range distance-based model was chosen, which means that the same power-law functions were used at all downwind distances. This choice was made largely to facilitate uncertainty analyses to be performed in a follow-on study.

Table 4-4 shows the Gaussian plume model input variations between SOARCA, Sample Problem A, and NUREG-1150 for Peach Bottom. Sample Problem A used the weather lookup tables while NUREG-1150 used power-law function values from Dobbins [13]. SOARCA used power-law function values from a more recent evaluation of expert elicitation data [18]. A comparison of all the values for the power-law function can be found in Appendix C.

The SOARCA project used the MACCS diurnal mixing height model. This model allows for two values of mixing height for each of the four seasons of the year. The first of these two values corresponds to the morning (minimum) mixing height and the second to the afternoon (maximum) mixing height. The start day of each weather sequence determines the season in which that sequence lies.

Table 4-4 Plume model input variation between SOARCA, Sample Problem A, and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
BNDWND	Boundary Wind Speed (m/sec)	2.2	2.2	5	0.5
CYSIGA	Linear Coefficient for sigma-y				
	Stability Class A	0.7507	0.7507	Weather lookup table	0.3658
	Stability Class B	0.7507	0.7507		0.2751
	Stability Class C	0.4063	0.4063		0.2089
	Stability Class D	0.2779	0.2779		0.1474
	Stability Class E	0.2158	0.2158		0.1046
	Stability Class F	0.2158	0.2158		0.0722
CYSIGB	Exponential Term for sigma-y				
	Stability Class A	0.866	0.866	Weather lookup table	0.9301
	Stability Class B	0.866	0.866		0.9301
	Stability Class C	0.865	0.865		0.9301
	Stability Class D	0.881	0.881		0.9301
	Stability Class E	0.866	0.866		0.9301
	Stability Class F	0.866	0.866		0.9301
CZSIGA	Linear Coefficient for sigma-z				
	Stability Class A	0.0361	0.0361	Weather lookup table	0.00025
	Stability Class B	0.0361	0.0361		0.0019
	Stability Class C	0.2036	0.2036		0.2
	Stability Class D	0.2636	0.2636		0.3
	Stability Class E	0.2463	0.2463		0.4
	Stability Class F	0.2463	0.2463		0.2
CZSIGB	Exponential Term for sigma-z				
	Stability Class A	1.277	1.277	Weather lookup table	2.125
	Stability Class B	1.277	1.277		1.6021
	Stability Class C	0.859	0.859		0.8543
	Stability Class D	0.751	0.751		0.6532
	Stability Class E	0.619	0.619		0.6021
	Stability Class F	0.619	0.619		0.602
DISPMD	Dispersion Model Flag	LRDIST	LRDIST	Not available in the MACCS 1.12 model	Not available in the MACCS model

4.3.1 MACCS Plume Model

In NUREG-1150, the option was used to include wind shift and wind rotation (IPLUME=2). In SOARCA, the option to include wind rotation was not available because the network evacuation model was employed, and these two options are incompatible. Instead wind shift without rotation was chosen (IPLUME=3).

The wind shift option allows each plume segment to travel in the direction that the wind is blowing at the time point represented by the plume segment. This option was used in both NUREG-1150 and in SOARCA. Furthermore, in SOARCA, maximum advantage was taken of the effects of wind shifts by splitting the release into hourly plume segments. By matching the duration of each plume segment with the averaging period for wind data, the realistic treatment of the effect of fluctuations in wind directions on local exposures is exploited.

Wind rotation serves the purpose of maximizing information while minimizing computational work. For each weather trial, wind rotation considers the possibility that, for otherwise similar conditions, the wind could have blown in any of the compass directions. Thus, MACCS evaluates the consequences that would have resulted for each wind direction, but accounts for the relative frequency that the wind blows in each compass direction based on the wind rose. A separate wind rose is computed for each weather bin, so only similar conditions are considered in applying wind rotation.

There are two reasons why wind rotation was not used in SOARCA. First, wind rotation is incompatible with network evacuation. The wind rotation model assumes that, other than population density, the problem is axisymmetric. This is not true when using the network evacuation model. MACCS prevents the user from pairing these two modeling options. The second reason is that the wind rotation model assumes that similar wind shifts would occur regardless of the initial wind direction. In other words, when wind rotation is employed, wind shifts for each subsequent plume segment following the initial plume segment are the same relative to the initial direction. This assumption becomes more dubious as more plume segments are employed. This is a key difference between NUREG-1150 and SOARCA. NUREG-1150 used two plume segments for all but one of the five plants and used three plume segments for Zion; SOARCA used between about 30 and 200 plume segments for each scenario. The assumption that the pattern of directions is independent of the initial wind direction is better justified when using two plume segments than when using more than a few plume segments.

4.3.2 Plume Rise Model

Two models for plume rise currently exist in MACCS and both are based on the work of Briggs [50], [51]. The more recently implemented model has been demonstrated to better approximate the actual rise of a plume. This more recent model was used in SOARCA but was not available at the time of NUREG-1150.

The current version of MACCS also allows two ways of inputting the parameters that are used for estimating plume buoyancy. The original method, which was used in NUREG-1150, estimates buoyancy based on the rate of latent heat release in the plume. The rate of latent heat release is proportional to the difference between the temperatures of the plume and of the surrounding air. The second method, which is used in SOARCA, estimates buoyancy based on the mass rate of release and the density of the plume being released. The second method is considered superior when releases contain significant quantities of hydrogen, as they sometimes do during a severe accident because it accounts for density differences induced by both temperature and molecular weight.

To escape the building wake, a plume must overcome the turbulent wake effects of the reactor building. This is modeled in MACCS with an equation that depends on the building height and on the amount of buoyancy in the plume. The equation compares the actual wind speed with a critical wind speed that is just large enough to trap the plume. Based on this comparison, the plume either rises due to its buoyancy or is released at its initial elevation.

Two additional dispersion parameters, an initial sigma-y and sigma-z, are used to define the initial size of the plume as it is released. These initial values are calculated based on the height and width of the reactor or other building from which the release occurs. Table 4-5 provides the initial dispersion parameters used in SOARCA and for Sample Problem A. As seen in Table 4-5, it appears the only difference in the Surry values between SOARCA and Sample Problem A is the number of significant figures used. Both the Surry and the Peach Bottom values are consistent with those used in NUREG-1150 for those reactors.

Table 4-5 Plume raise inputs for SOARCA and Sample Problem A

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)
SIGYINIT	Initial Sigma-y for All Plume Segments (m)	9.3	11.6	9.302
SIGZINIT	Initial Sigma-z for All Plume Segments (m)	23.3	23.3	23.26

4.3.3 Plume Meander Model

Plume meander was not treated in SOARCA. The NRC Regulatory Guide 1.145 plume meander model [34] was considered, but it would have had a minimal impact on the predicted doses for even the closest residents to the sites because this model only affects the plume dimensions at relatively short distances. Table 4-6 shows the variations of the plume meander inputs between SOARCA, Sample Problem A, and NUREG-1150. The changes reflect the decision to not account for plume meander in SOARCA.

Table 4-6 Plume meander model variation between SOARCA and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
TIMBAS	Time Base for Plume Expansion Factor (sec)	Not Used	Not Used	600	600
XPFAC1	Base Time for Meander Expansion Factor	Not Used	Not Used	0.2	0.2
XPFAC2	Breakpoint for Expansion Factor Model	Not Used	Not Used	0.25	0.25

4.3.4 Weather Sampling

Weather binning is an approach used in MACCS to categorize similar sets of weather data based on wind speed[3], stability class, and the occurrence of precipitation. The weather sampling strategy adopted for SOARCA uses the nonuniform weather-binning approach in MACCS. This approach, which allows the user to specify a different number of random samples

[3] With regard to wind direction, the assumption is that sampling within each weather bin is sufficient to adequately represent the wind rose for that bin. Accounting for the fact that each plume segment travels in its own direction, this assumption should be satisfied.

for each bin, has been available since MACCS was first released [12] but was not used in previous studies.

In the SOARCA project, the same weather binning structure was defined as in NUREG-1150 and Sample Problem A, which consisted of 16 predefined bins for combinations of stability class and wind speed and 20 user-defined bins for rain occurring before the plume travels 32 km (20 miles). The rain bins differentiate rain intensity and the distance the plume travels before rain begins. The parameters used to define the rain bins are the same as those used in NUREG-1150 and documented in the MACCS User's Manual [12]. An approach called uniform weather bin sampling was used in NUREG-1150 and in Sample Problem A. Four weather sequences were sampled per bin, resulting in a nominal 144 weather trials. In some cases, a bin contained fewer than 4 weather sequences, resulting in a total number of weather trials less than 144 (e.g., 135 for Surry). In conjunction with this sampling method, an additional strategy called wind rotation was used. Wind rotation expands the set of weather trials by a factor of 16 (i.e., the number of compass sectors used in the analysis) by reevaluating the results for each weather trial assuming that the wind had blown in each of the other compass directions. The consequences for each wind direction are assigned a probability that accounts for the wind rose probability. In effect, this strategy results in 16 x 144 = 2304 nominal weather trials (e.g., 2160 for Surry).

For the nonuniform weather sampling strategy approach adopted in SOARCA, the number of trials selected from each bin is the maximum of 12 trials and 10 percent of the number of trials in the bin. Some bins contain fewer than 12 trials. In those cases, all of the trials within the bin are used for sampling. This strategy results in roughly 1,000 weather trials for both Peach Bottom and Surry. Table 4-7 shows the variations of the weather sampling inputs between SOARCA Surry and Peach Bottom. MACCS does not allow wind rotation in conjunction with one of the other models used in SOARCA, network evacuation. Thus, expanding the number of weather trials by the number of compass sectors was not used in SOARCA, which is one of the main reasons that the number of weather trials was significantly increased.

Table 4-7 Weather sampling input variation between SOARCA, Sample Problem A, and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
INWGHT	Number of Samples for Each Bin Used for Nonuniform Weather Bin Sampling			4[4]	4[4]
	Bin 1	12	71		
	Bin 2	14	42		
	Bin 3	12	12		
	Bin 4	39	52		
	Bin 5	85	57		
	Bin 6	94	74		
	Bin 7	16	21		
	Bin 8	12	12		
	Bin 9	27	49		
	Bin 10	134	103		
	Bin 11	119	77		
	Bin 12	74	35		
	Bin 13	92	51		
	Bin 14	43	75		
	Bin 15	12	14		
	Bin 16	12	4		
	Bin 17	37	44		
	Bin 18	12	12		
	Bin 19	13	17		
	Bin 20	17	24		
	Bin 21	14	24		
	Bin 22	12	12		
	Bin 23	6	4		
	Bin 24	6	8		
	Bin 25	12	12		
	Bin 26	12	12		
	Bin 27	12	12		
	Bin 28	1	1		
	Bin 29	5	3		
	Bin 30	6	5		
	Bin 31	5	4		
	Bin 32	12	12		
	Bin 33	5	1		
	Bin 34	12	7		
	Bin 35	12	9		
	Bin 36	12	12		
NSBINS	Number of Weather Bins to Sample	36	36	36	36

[4] The value 4 is actually assigned to the variable NSMPLS, which is used to uniformly select 4 weather trials from each bin. This would be expected to result in 4 x 36 = 144 weather trials; however, some bins do not contain 4 hours of weather data and the net result is that fewer than 144 weather trials are actually performed. For example, 135 weather trials were performed in Sample Problem A.

4.3.5 Weather Data

Meteorological data used in the SOARCA project consisted of one year of hourly meteorological data for each site (i.e., 8,760 hourly data points per site for each meteorological parameter). This was primarily accomplished via a cooperative effort between the licensee, the NRC, and SNL. Each licensee provided two years of data from onsite meteorological tower observations. Stability class data were derived from temperature measurements at two elevations on the site meteorological towers. The specific year of data chosen for each reactor was based on data recovery (e.g., greater than 90 percent being desirable) and proximity to the target year for SOARCA, which was 2005. Different trends (e.g., wind-rose pattern and hours of precipitation) between the years were evaluated and estimated to have a relatively minor (i.e., less than ±10 percent) effect on the final results.

Well over 90 percent of the weather data used in SOARCA was actual site weather data. The missing data were bridged by following the "Procedures for Substituting Values for Missing National Weather Service Meteorological Data for Use in Regulatory Air Quality Models" [29]. The meteorological data parameters were formatted for the MACCS computer code.

The NRC staff ensured a joint data recovery rate above 90 percent (i.e., all parameters were measured for a given hour for at least 90 percent of the hours of the year), which is in accordance with the NRC Regulatory Guide 1.23, Revision 1 [31], for the wind speed, wind direction, and atmospheric stability parameters. The staff performed quality assurance evaluations of all meteorological data using the methodology described in NUREG-0917 [30]. In addition, atmospheric stability was evaluated to determine if the time of occurrence and duration of reported stability conditions were generally consistent with expected meteorological conditions (e.g., neutral and slightly stable conditions predominated during the year with stable and neutral conditions occurring at night and unstable and neutral conditions occurring during the day). The mixing height data were retrieved from the U.S. Environmental Protection Agency's (EPA's) SCRAM database using data from the years 1984 through 1992. Data needed for MACCS includes 10-meter wind speed, 10-meter wind direction (in 64 compass directions for the SOARCA analyses), stability class (i.e., Pasquill-Gifford stability class using representative values of 1 through 6 for stability classes A through F/G), hourly precipitation, and diurnal (morning and afternoon) seasonal mixing heights.

Boundary weather was implemented for all of the SOARCA consequence analyses, but it was imposed beyond the outer boundary (i.e., 50 miles) for which results are reported. Thus, the choice of boundary weather had no influence on the consequence results that are reported in SOARCA. The Peach Bottom [2] and Surry [3] reports provide the specific parameters chosen to describe the boundary weather. They are also included in Appendix C.

Table 4-8 presents a summary of the meteorological statistical data and shows that the annual average 10-m wind speeds were generally low, ranging from 2.02 to 2.27 meters per second (m/s) at Surry and 2.12 to 2.17 m/s at Peach Bottom. The atmospheric stability frequencies were found to be consistent with expected meteorological conditions. The neutral and slightly stable conditions predominated during the year, with stable and neutral conditions occurring at night and unstable and neutral conditions occurring during the day.

Figure 4-10 and Figure 4-11 show the wind direction (i.e., wind rose) that the wind blows towards and atmospheric stability (i.e., unstable,[5] neutral,[6] and stable[7]) conditions for the years that were used in the SOARCA consequence analyses (i.e., 2006 for Peach Bottom and 2004 for Surry). Figure 4-10 and Figure 4-11 show the Pasquill-Gifford stability categories in terms of unstable conditions (categories A through C), neutral stability (category D), and stable conditions (categories E and F) for the two weather years used in SOARCA on an hourly basis. The trends shown in the figures are expected, which is that unstable conditions occur during daylight hours, peaking around mid-day, and stable conditions primarily occur during nighttime hours. Neutral conditions are more frequent at the Surry site than at the Peach Bottom site, primarily because cloud cover is more frequent at Surry.

Table 4-8 Statistical summary of raw meteorological data for SOARCA sites

Parameter		Peach Bottom		Surry	
		Year 2005	Year 2006	Year 2001	Year 2004†
Average Wind Speed (m/s)		2.17	2.12	2.02	2.27
Yearly Precipitation (hr) (% of Annual Weather)		588 (6.7%)	593 (6.8%)	388 (4.4%)	521 (5.9%)
Atmospheric Stability (%)	Unstable	21.43	17.75*	7.09	3.94
	Neutral	63.97	24.57*	69.67	77.59
	Stable	14.60	57.68*	23.24	18.47
Joint Data Recovery (%)		97.53	99.25	99.58	99.24

† Year 2004, as used in the Surry meteorological analysis, is a leap year (8,784 total hourly data points versus 8,760 hourly data points for a regular annual period).

* Subsequent analysis of Peach Bottom 2006 meteorological data revealed that atmospheric stability distribution data in this table was incorrectly reported in NUREG-1935 Table 2, however the correct data was used in the analyses. The corrected data is presented here.

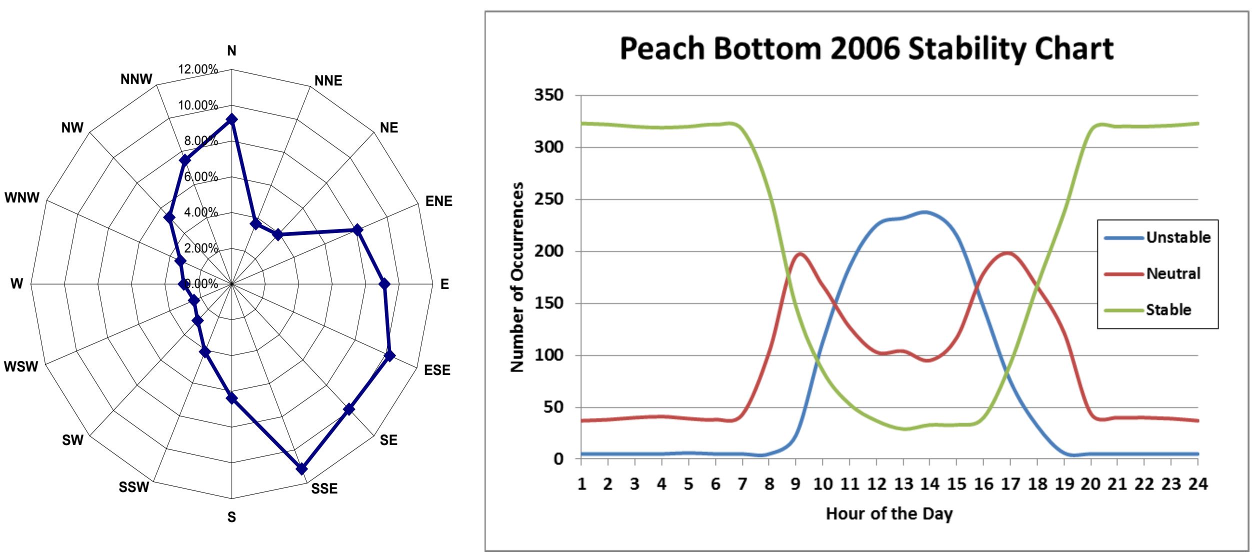

Figure 4-10 Peach Bottom wind rose and atmospheric stability chart, year 2006

5 This corresponds to Pasquill-Gifford stability classes A, B, and C.
6 This corresponds to Pasquill-Gifford stability class D.
7 This corresponds to Pasquill-Gifford stability classes E, F, and G.

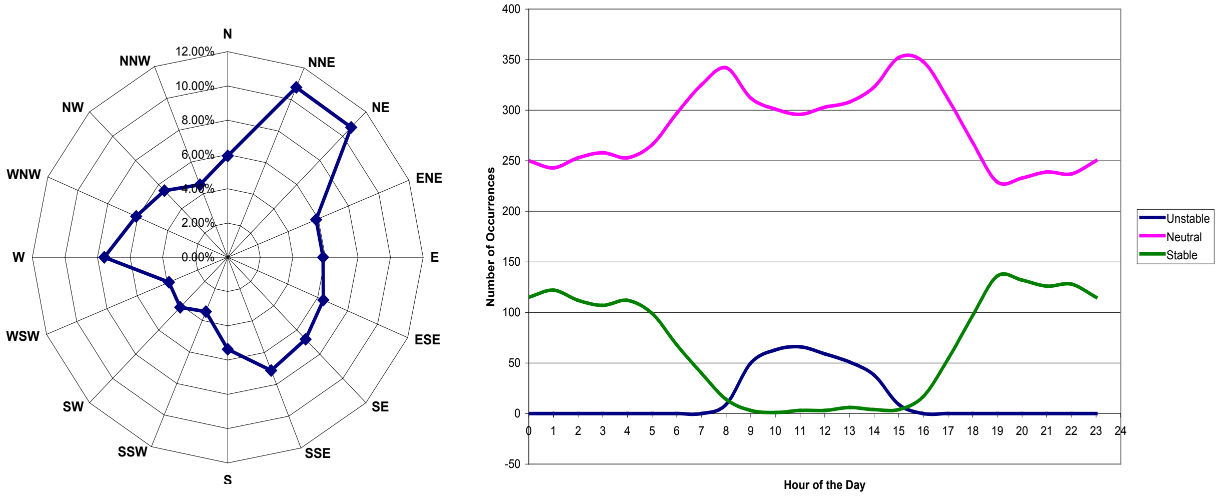

Figure 4-11 Surry wind rose and atmospheric stability chart, year 2004

Table 4-9 shows the variations of the precipitation inputs between SOARCA, Sample Problem A, and NUREG-1150 for Peach Bottom. The values used in SOARCA are identical to those in Sample Problem A because there was no good reason to change them. In particular, boundary weather was implemented at the outer edge of the grid, well beyond the distances where results were presented, so the presence of boundary rain did not affect any of the reported results. The choice of rain distances and intensities did affect the weather sampling used in the SOARCA study, but these choices were considered to be reasonable. Since essentially no early fatalities were calculated in SOARCA, the definitions of the rain bins should have had a negligible effect on the reported results. The value for the boundary rain rate, 5 mm/hr, was used in Sample Problem A to ensure that nearly all of the radionuclides would deposit before leaving the computational domain. This choice clearly introduces a conservative bias and is not always appropriate, especially when the computational grid has a radius significantly less than the 1000-mi radius used in Sample Problem A.

Table 4-9 Precipitation input variation between SOARCA and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
BNDRAN	Boundary Weather Rain Rate (mm/hr)	5	5	5	0
RNDSTS	Endpoints of Rain Distance Intervals (km)				
	Interval 1	3.22	3.22	3.22	3.22
	Interval 2	5.63	5.63	5.63	5.63
	Interval 3	11.27	11.27	11.27	11.27
	Interval 4	20.92	20.92	20.92	20.92
	Interval 5	32.19	32.19	32.19	40.23
	Interval 6	N/A	N/A	N/A	80.47
RNRATE	Rain Intensity Breakpoints for Weather Binning (mm/hr)				
	Intensity 1	2	2	2	1
	Intensity 2	4	4	4	2
	Intensity 3	6	6	6	3

4.3.6 Adverse Weather

Adverse weather is typically defined as rain, ice, or snow that affects the response of the public during an emergency. A normal weather winter day was selected for the analysis. However, because real weather data was used in the calculation, the travel speed of each cohort is reduced when adverse weather occurs. The evacuation speed multiplier (ESPMUL) parameter in WinMACCS is used to reduce travel speed when precipitation is occurring, as indicated from the meteorological weather file. The ESPMUL factor was set at 0.7, which effectively slows down the evacuating public to 70 percent of the established travel speed during the time precipitation occurs. The SOARCA team estimated this value through review of existing ETE guidance [20].

Impacts of adverse weather can vary based on the region and familiarity of the drivers with the weather condition; therefore, the factors provided in NUREG/CR-7002, "Criteria for Development of Evacuation Time Estimate Studies," [20] to adjust roadway speed and capacity depend on the weather conditions that may be experienced. The weather capacity factors in NUREG/CR-7002 apply to roadway capacity and speed, which when considered together, show that the 0.7 value for ESPMUL is reasonable.

4.3.7 Dry Deposition Modeling

Table 4-10 shows the particle size distribution and dry deposition velocity input variation used in SOARCA, Sample Problem A, and NUREG-1150. As indicated in the table, particle size distribution data are provided in Tables A-3 and B-3 in the appendices.

As shown in Table 4-11, the SOARCA project used the 10 aerosol bins defined in MELCOR to represent the dependence of deposition velocity on aerosol size. In connection with aerosol size distribution data for each chemical group, the modeling allows the deposition velocity behavior to be different for each chemical group.

Table 4-10 Particle size distribution and dry deposition velocity input variation between SOARCA and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
NPSGRP	Number of Particle Size Groups	10	10	1	1
PSDIST	Particle Size Distribution by Group	MELMACCS data Appendix A Table A-3	MELMACCS data Appendix B Table B-3	1. for all groups	1. for all groups
VDEPOS	Dry Deposition Velocities (m/sec)				
	Aerosol Bin 1	5.35E-04	5.35E-04	0.01	0.01
	Aerosol Bin 2	4.91E-04	4.91E-04		
	Aerosol Bin 3	6.43E-04	6.43E-04		
	Aerosol Bin 4	1.08E-03	1.08E-03		
	Aerosol Bin 5	2.12E-03	2.12E-03		
	Aerosol Bin 6	4.34E-03	4.34E-03		
	Aerosol Bin 7	8.37E-03	8.37E-03		
	Aerosol Bin 8	1.37E-02	1.37E-02		
	Aerosol Bin 9	1.70E-02	1.70E-02		
	Aerosol Bin 10	1.70E-02	1.70E-02		

Table 4-11 Dry deposition velocities used for the SOARCA studies for each of the ten aerosol bins in MELCOR

Mass Median Aerosol Diameter (mm)	Deposition Velocity (cm/s)
0.15	0.053
0.29	0.049
0.53	0.064
0.99	0.11
1.8	0.21
3.4	0.43
6.4	0.84
11.9	1.4
22.1	1.7
41.2	1.7

4.3.8 Wet Deposition Modeling

Wet deposition is an important phenomenon that strongly affects atmospheric transport. Under heavy rains, wet deposition rapidly depletes the plume. Even under light rains, the plume is depleted much faster than by dry deposition alone. The wet deposition process can produce concentrated deposits on the ground and create what is often referred to as a hotspot (i.e., an area of higher radioactivity than the surrounding areas). While rain occurs less than 10% of the time for most of the U.S., it can significantly affect consequence calculations when it does occur.

For SOARCA, parameters used in the wet deposition model were reevaluated from those used in NUREG-1150. Both the linear and exponential coefficients for washout (CWASH1 and CWASH2, respectively) were modified based on expert elicitation data [18]. Table 4-12 shows the CWASH1 and CWASH2 variables used in SOARCA and NUREG-1150. The values in Sample Problem A are identical to those in NUREG-1150.

Table 4-12 Wet deposition model variation between SOARCA and NUREG-1150

Variable	Description	SOARCA	NUREG-1150
CWASH1	Linear Coefficient for Washout	1.89×10^{-5}	9.50×10^{-5}
CWASH2	Exponential Term for Washout	0.664	0.80

4.3.9 Surface Roughness

Surface roughness affects both vertical dispersion and dry deposition velocities. All of the SOARCA base case analyses, for both sites, used a surface roughness length of 10 cm. The value of 10 cm for surface roughness is the same as the value used in NUREG-1150 [7] and in Sample Problem A. The area surrounding Surry may be characterized by a mosaic of surface water, forests, farmland, suburban areas, and urban areas. The James River covers a significant fraction of the EPZ. The value of 10 cm used in the base case was representative of the farmland and river. Woodland forests and urban areas also make up a significant fraction of the area and have a mean surface roughness of about 20 to 100 cm. An intermediate choice representing the average between cornfields and woodland forest, about 50 to 60 cm, might also have been a reasonable choice for this area. Because the river dominates the landscape and the urban areas are across the river, which is 2 to 3 miles wide in some areas, the lower value of 10 cm was chosen for this site.

Peach Bottom is located directly adjacent to the Susquehanna River near the southern border of Pennsylvania. As seen in Table 4-13, the area surrounding Peach Bottom is characterized by a mosaic of forests, farmland mostly used to grow corn, suburban areas, and several stone quarries. Farmland and forests are the major land-use categories. Each of these land-use types correspond to a typical surface roughness or a range of surface roughness as shown in [19].

Table 4-13 Surface roughness for various land-use categories for the area surrounding the Peach Bottom site

Land-Use Category	Surface Roughness (cm)
Farmland recently plowed	1
Farmland with mature corn	10
Suburban housing	5 to 20
Suburban institutional buildings	70
Woodland forests	20 to 100
Stone quarries	50 to 200

For Peach Bottom, the value of 10 cm used in the base case is representative of the corn fields that make up a significant fraction of the countryside surrounding the Peach Bottom site. Woodland forests also make up a significant fraction of the area and have a mean surface roughness of about 20 to 100 cm. An intermediate choice representing the average between cornfields and woodland forest, about 30 to 60 cm, is also a reasonable choice for this area. For Peach Bottom, a sensitivity analysis was performed as part of the SOARCA study using a 60-cm surface roughness.

The surface roughness sensitivity analysis showed that an increase from 10 cm to 60 cm results in a risk reduction of about 20% for the intermediate distances (10 to 50 miles) and a risk increase of about 10% within 10 miles for the predicted LCF risks using LNT dose-response [2]. Generally the risk is lower when a higher value of surface roughness is assumed. Because the overall effect of surface roughness was determined to be relatively small, a similar study was not performed for Surry.

The effect of surface roughness on vertical dispersion has traditionally been modeled by means of a multiplicative factor. The empirical expression for this factor is the ratio of surface roughness at the site in question to a standard value of surface roughness to the $1/5^{th}$ power. Most of the data upon which empirical dispersion models have been based were taken at a site characterized by prairie grass [17], which was estimated to have a surface roughness of 3 cm. Thus, the empirical equation used to scale vertical dispersion uses the actual surface roughness divided by 3 cm to the $1/5^{th}$ power. The standard multiplicative factor corresponding to a 10 cm surface roughness is $(10 / 3)^{0.2} = 1.27$, which is the value used in all of the base-case analyses presented in SOARCA. A surface roughness length of 60 cm corresponds to a multiplicative factor of 1.82, which was used in the surface roughness sensitivity analysis presented in NUREG/CR-7110 Volume 1, Section 7.3.7.

The effect of surface roughness on deposition velocity has been characterized by Bixler et al. [18] based on expert elicitation data [15]. Bixler et al. provides a set of correlations for estimating deposition velocity as a function of aerosol diameter, wind speed, surface roughness, and percentile representing degree of belief by the experts. Based on these results, the best estimate for the 50th percentile correlation is as follows:

$$\ln(v_d) = -3.112 + 0.992 \cdot ln(d_p) + 0.190 \cdot [ln(d_p)]^2 - 0.072 \cdot [ln(d_p)]^3 + 5.922 \cdot z_0 - 6.314 \cdot {z_0}^2 + 0.169 \cdot v$$

where:

v_d = deposition velocity (cm/s)
d_p = aerosol diameter (μm)
z_0 = surface roughness (m)
v = mean wind speed (m/s)

This correlation is valid for aerosol diameters up to about 20 μm and surface roughness up to about 60 cm.

For elevated releases, enhanced vertical dispersion increases the ground level concentrations close to the point of release because the plume spreads down to the ground more quickly. The MACCS results show that ground level concentrations and resulting doses are greater for the sensitivity case within about 4 miles of the plant; at greater distances the ground level doses are smaller for the sensitivity case. At intermediate distances, enhanced vertical dispersion reduces ground level concentrations because the plume spreads more rapidly in the vertical dimension and, as a result, becomes more dilute at ground level. At long distances, the ground level concentrations are about the same because the plume becomes well mixed within the mixing layer where the plume is confined.

Compounding the effect of increased surface roughness on vertical dispersion is the fact that the deposition velocity is also increased. This leads to more deposition at shorter distances and faster depletion of the plume. As a result, ground concentrations at short distances are increased and those at longer distances are diminished. The breakpoint between short and long distances depends on the application, but it is generally at a distance greater than 80 km (50 miles). Thus, for the distances reported in SOARCA, higher deposition velocities (larger surface roughness) result in larger long-term doses because they are proportional to deposition.

From this discussion, the overall trend corresponding to a larger surface roughness is not clear. Increased dispersion tends to diminish doses, while increased deposition velocity tends to increase them. The general trend observed in the SOARCA study is that increased surface roughness decreases average individual LCF risk within a 50-mile region. The effect is about 10% for LNT and greater than 20% for the two truncation dose-response models.

4.4 Exposure Pathways

For SOARCA, the exposure pathways considered during the emergency phase period are cloudshine, groundshine, and direct and resuspension inhalation. Mitigative actions can be specified for the emergency phase such as evacuation, sheltering, and relocation based on dose projections.

The exposure pathways for the long-term phase are groundshine, resuspension inhalation, and food and water ingestion. Only the groundshine and resuspension inhalation exposure pathways were considered in SOARCA because adequate supplies of uncontaminated food and water are available in the U.S.; contaminated food and water would not need to be consumed.

4.4.1 Shielding and Protection Factors

In MACCS, shielding and protection factors are specified for each dose pathway and directly affect the doses received by individuals at each location. The shielding factors are used as multipliers on the dose that a person would receive if there were no shielding or protection. Thus, a shielding factor of one represents the limiting case of a person receiving the full dose (i.e., standing outdoors and completely unprotected from the exposure); a shielding factor of zero represents the limiting case of complete shielding from the exposure. The shielding factors used in the MACCS calculation are clearly important because the doses received are directly proportional to these factors.

Three types of activity: normal, sheltering, and evacuation, are evaluated for each dose pathway. In this context, normal activity refers to a combination of activities that are averaged over a week and over the population, including being indoors at home, commuting, being indoors at work, and being outdoors. Table 4-14 shows the cloudshine shielding factor, groundshine shielding factor, inhalation protection factor, and skin protection factor variables used in SOARCA, Sample Problem A, and NUREG-1150. Appendix C provides a full comparison of the differences between NUREG-1150 and SOARCA.

Shielding factors applied to evacuation, normal activity, and sheltering for each relevant dose pathway (i.e., inhalation, deposition onto skin, cloudshine, and groundshine) were evaluated for each site based on values used in NUREG-1150 [7] and NUREG/CR-6953, Volume 1 [11]. The normal activity values assume that the average person spends 19 percent of the day outdoors and 81 percent of the day indoors [45].

Each parameter (CSFACT, GSHFAC, PROTIN, and SKPFAC) can be specified for each cohort in WinMACCS. In the SOARCA study, shielding values for Cohorts 1, 2, 3, 5, and 6 are identical. Cohort 4 which corresponds to populations in special facilities, has different shielding values because of the larger, more robust buildings that are used for these facilities.

Table 4-14 Cloudshine factor, groundshine factor, inhalation protection factor, and skin protection factor variations between SOARCA, Sample Problem A, and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
CSFACT	Cloudshine Shielding Factors				
	Evacuation Shielding Factor for All but Cohort 4	1	1	1	1
	Normal Activity Shielding Factor for All but Cohort 4	0.68	0.6	0.75	0.75
	Sheltering Shielding Factor for All but Cohort 4	0.6	0.5	0.6	0.5
	Evacuation Shielding Factor for Cohort 4	1	1	This cohort was not used	This cohort was not used
	Normal Activity Shielding Factor for Cohort 4	0.31	0.31	This cohort was not used	This cohort was not used
	Sheltering Shielding Factor for Cohort 4	0.31	0.31	This cohort was not used	This cohort was not used
GSHFAC	Groundshine Shielding Factors				
	Evacuation Shielding Factor for All but Cohort 4	0.5	0.5	0.5	0.5
	Normal Activity Shielding Factor for All but Cohort 4	0.26	0.18	0.33	0.33
	Sheltering Shielding Factor for All but Cohort 4	0.2	0.1	0.2	0.1
	Evacuation Shielding Factor for Cohort 4	0.5	0.5	This cohort was not used	This cohort was not used
	Normal Activity Shielding Factor for Cohort 4	0.05	0.05	This cohort was not used	This cohort was not used
	Sheltering Shielding Factor for Cohort 4	0.05	0.05	This cohort was not used	This cohort was not used
PROTIN [E]	Inhalation Protection Factor – evacuation for all but Cohort 4	0.98	0.98	1	1
PROTIN [N]	Inhalation Protection Factor - normal activity for all but Cohort 4	0.46	0.46	0.41	0.41
PROTIN [S]	Inhalation Protection Factor – sheltering for all but Cohort 4	0.33	0.33	0.33	0.33
PROTIN [E]	Inhalation Protection Factor – evacuation for Cohort 4	0.98	0.98	This cohort was not used	This cohort was not used
PROTIN [N]	Inhalation Protection Factor - normal activity for Cohort 4	0.33	0.33	This cohort was not used	This cohort was not used
PROTIN [S]	Inhalation Protection Factor – sheltering for Cohort 4	0.33	0.33	This cohort was not used	This cohort was not used
SKPFAC [E]	Skin Protection Factors – evacuation for all but Cohort 4	0.98	0.98	1	1
SKPFAC [N]	Skin Protection Factors - normal activity for all but Cohort 4	0.46	0.46	0.41	0.41
SKPFAC [S]	Skin Protection Factors – sheltering for all cohorts	0.33	0.33	0.33	0.33
SKPFAC [E]	Skin Protection Factors – evacuation for Cohort 4	0.98	0.98	This cohort was not used	This cohort was not used
SKPFAC [N]	Skin Protection Factors - normal activity Cohort 4	0.33	0.33	This cohort was not used	This cohort was not used

Table 4-15 shows the long-term groundshine protection factor and inhalation protection factor variables used in SOARCA, Sample Problem A, and NUREG-1150. The values used in SOARCA are identical to the normal activity values used for the emergency phase shown in Table 4-14. Likewise the values used in NUREG-1150 are identical to the normal activity values used in the emergency phase.

Table 4-15 Long-term groundshine factor and inhalation protection factor variations between SOARCA, Sample Problem A, and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
LGSHFAC	Long-Term Groundshine Protection Factor	0.26	0.18	0.33	0.33
LPROTIN	Long-Term Inhalation Protection Factor	0.46	0.46	0.41	0.41

4.4.2 Food Ingestion Model

The ingestion pathway was not treated in SOARCA. An underlying assumption in SOARCA was that uncontaminated food and water supplies are abundant within the United States, and it is unlikely that the public would eat radioactively contaminated food. Thus, the MACCS 'No Food Model' option was used for all consequence analyses. Including the COMIDA2 food ingestion model would not have affected the results presented in the SOARCA study because the reported risks do not include societal doses from ingestion or to decontamination workers.

4.5 Dose Models

The SOARCA results of the consequence analyses are presented in terms of probabilities and risks to members of the public for each of the accident scenarios identified [2], [3]. Both conditional probabilities and scenario-specific risks (the product of accident frequency and conditional probability) of health effects for individuals were tabulated. The conditional probabilities assume that the accident occurs and show the probabilities of health effects occurring to individuals as a result of the accident. The scenario-specific risks are the product of the accident frequency and the conditional probabilities. The scenario-specific risks are the likelihood of receiving a fatal cancer or early fatality for an average individual living within a specified radius of the plant per year of plant operation.

The metrics in SOARCA were LCF risk and early fatality risk to residents in circular regions surrounding the plant. The risks were averaged over the entire residential population within the circular region. The risk values represent the predicted number of fatalities for the three choices of dose truncation level divided by the population. These risk metrics account for the distribution of the population within the circular region and for the interplay between the population distribution and the wind rose probabilities.

4.5.1 Dose-Response Models

Risk results in SOARCA are presented for three dose-response assumptions including:

1. LNT hypothesis;

2. Linear dose response but with a dose truncation level of 620 mrem/yr, i.e., the U.S. average natural background dose combined with average annual medical dose [44] (USBGR); and

3. Linear dose response but with a dose truncation level based on the Health Physics Society's (HPS) position paper that there is a dose below which, due to uncertainties, a quantified risk should not be assigned, which is 5 rem/yr with a lifetime limit of 10 rem [35].

A 10 mrem/yr dose truncation level was also investigated, but it produced results that were only slightly lower than with the LNT assumption, and thus were not included in the final version of the SOARCA documents.

4.5.2 Exposure and Commitment Periods

The exposure period for internal pathways, inhalation and ingestion, is the period of time when the inhalation or ingestion occurs; however, doses can continue over a person's entire lifetime following the exposure. The period of time over which doses are received from an internal pathway is accounted for in the construction of dose coefficients by integrating the doses over a finite period, representing a person's lifetime, called a dose commitment period, which is usually taken to be 50 years when calculating internal pathway dose coefficients for adults. The implicit assumption is that the average adult lives for an additional 50 years following the exposure.

Because ingestion (i.e., food and water uptake) doses were not included, inhalation is the only internal pathway that is treated in SOARCA. A significant portion of the exposures during the emergency phase are from inhalation. As explained above, these exposures are assumed to lead to doses over the commitment period, which is the next 50 years following the exposure. However, depending on the radionuclide inhaled, the doses received may diminish rapidly and become negligible for most of the dose commitment period.

Most of the exposures during the long-term phase are from groundshine; a small fraction is from inhalation of resuspended aerosols. Since groundshine is an external pathway, doses received are concurrent with the exposure, whereas, exposures from inhalation during each year of the long-term phase contribute to doses received over the subsequent 50-year commitment period.

Doses received in the first year thus correspond to:

- all of the dose from external exposure during the emergency phase,
- most of the dose from internal exposure during the emergency phase,
- all of the dose from external exposure during the first year of the long-term phase, and
- most of the dose from internal exposure during the first year of the long-term phase.

Doses received in the second and subsequent years correspond to:

- a fraction of the dose from internal exposure during all previous years plus most of the dose from internal exposure during that year, and
- all of the dose from external exposure during that year.

Table 4-16 shows the parameter updates between SOARCA, Sample Problem A, and NUREG-1150 for the exposure period. NUREG-1150 and Sample Problem A used the maximum value of exposure period allowed by MACCS, 10^{10} seconds, which is approximately 317 years. More recent analyses have used exposure periods chosen to be the same as the commitment period. In SOARCA, 1.58×10^9 seconds (50 years) was chosen.

Table 4-16 SOARCA, Sample Problem A, and NUREG-1150 exposure period and action period input parameters

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
EXPTIM	Maximum Exposure Time (sec)	1.58×10^{9}	1.58×10^{9}	10^{10}	10^{10}

4.5.3 Risk Factors for Cancer

Cancer risk factors used in the 1982 Siting Study [14] are presumed to have come from the National Research Council's Committee on the BEIR III report, which was published in 1980 and would have been the latest available at the time. Cancer risk factors in the SOARCA study are based on BEIR V [27], which was published in 1990. These risk factors include seven organ specific cancers plus residual cancers that are not accounted for directly. Based on Table 4-4 in BEIR V, the BEIR V risk factors are about a factor of 3-5 higher, on average, than those from BEIR III, and are dependent upon the exposure duration and cancer type.

In 2009, the National Research Council released the BEIR VII report, which is the most up-to-date study of cancer induction from exposure to ionizing radiation. However, because the dose coefficients used in the SOARCA study are from Federal Guidance Report 13 (FGR-13) and this report was developed using risk factors from BEIR V, it was decided to use risk factors from BEIR V rather than BEIR VII. The SOARCA staff made the decision to await EPA's review of BEIR VII and subsequent update of FGR-13 before implementing BEIR VII risk coefficients.

The dose coefficients used in the SOARCA analyses are based on FGR-13 [25]. This guidance report also recommended changes to the biological effectiveness factors (BEFs) for alpha radiation for two of the organs used to estimate latent cancer health effects to be consistent with the way the risk factors for cancers associated with those organs were evaluated. The two organs are bone marrow and breast. For these organs, the RBE factors for alpha radiation were changed from the standard value of 20 to 1 and 10, respectively. Doses to these organs are used to evaluate occurrences of leukemia and breast cancer, respectively. The choice of BEFs for these organs follows EPA Guidance (EPA 402-R-93-076 [26]).

The dose to the pancreas was used as a surrogate for dose to soft tissue to estimate residual cancers following the recommendations of Dr. Keith Eckerman in the 2012 Oak Ridge National Laboratory (ORNL) memo [24]. Because MACCS does not currently read the data for the pancreas from the dose coefficient file, a workaround was created. Values of the dose coefficients for the pancreas were copied into the organ called bladder wall. Thus, residual cancers are associated with the organ called bladder wall, which actually contains dose coefficients for the pancreas.

The ORNL memo [24] also recommended risk factors for latent health effects that come from BEIR V [27], and are consistent with the modified dose coefficient file described in the preceding paragraph. These risk factors include seven organ specific cancers plus residual cancers that are not accounted for directly.

A dose and dose rate effectiveness factor was applied to all doses in the late phase of the offsite consequence calculation and to those doses in the early phase that were less than 20 rem (0.2 Sv) to the whole body. This factor, which appears in the denominator, accounts for the fact that protracted low doses are believed to be less effective in causing cancers than acute doses. The dose and dose rate effectiveness factor for all cancers except for the breast was 2.0, and for the breast, it was 1.0, as recommended in the BEIR V report.

SOARCA added an additional cancer, liver cancer, and changed the name for cancer of the gastrointestinal tract, 'GI' in NUREG-1150, to colon cancer in SOARCA. Table 4-17 shows the updates between SOARCA unmitigated long-term station blackout (LTSBO) scenarios and NUREG-1150 for cancer risk factors. Also, the naming convention used for residual cancers (i.e., all other cancers not listed in ACNAME for SOARCA in Table 4-17) in SOARCA is different than what was used for NUREG-1150. A complete comparison of cancer risk factors is provided in Appendix C.

The cancer fatality risk factors for SOARCA listed in Table 4-17 (CFRISK) were updated from those in NUREG-1150 and Sample Problem A. The risk factors used in NUREG-1150 are attributed to BEIR III; the ones used in SOARCA are from BEIR V. Sample Problem A updated the risk factors to values from BEIR V, but those values are not fully traceable. The ORNL memo, "Risk Coefficients for SOARCA Project" [24] provides a basis for the risk factors used in SOARCA, which are taken from FGR-13 and have their origin in the BEIR V report. Notice that the Sample Problem A risk factors are similar but somewhat different than those used in SOARCA. The cancer injury risk factors used in SOARCA are listed in Table 4-17 (CIRISK) and have the same heritage as the cancer fatality risk factors. However, cancer injuries are not reported in SOARCA and so these values have no influence on the published results.

The critical organ for the EARLY phase (CRIORG) is the same as the critical organ for the CHRONC phase (CRTOCR). The critical organ used in SOARCA is listed in Table 4-17 (CRIORG) and is similar to the critical organ in NUREG-1150 and Sample Problem A (i.e., both represent effective doses). The change in nomenclature corresponds to the fact that different tissue weighting factors were used to determine the effective doses for NUREG-1150 and Sample Problem A. The tissue weighting factors used in NUREG-1150 are based on ICRP-30; for SOARCA, they are based on the more current ICRP-60 and are consistent with FGR-13.

The cancer dose-response linear and quadratic factors for SOARCA, listed in Table 4-17 (DOSEFA and DOSEFB, respectively) are consistent with those used in Sample Problem A and are taken from BEIR V, which recommends a linear dose-response model for all cancer types. These factors are updated from the values used in NUREG-1150, which are taken from BEIR III, which recommends a linear-quadratic dose response model for all cancer types except thyroid and breast. BEIR III recommends a linear dose-response for thyroid and breast cancers.

Table 4-17 SOARCA, Sample Problem A, and NUREG-1150 cancer input parameters

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
ACNAME	Latent Cancer Effect				
	Cancer Type 1	LEUKEMIA	LEUKEMIA	LEUKEMIA	LEUKEMIA
	Cancer Type 2	BONE	BONE	BONE	BONE
	Cancer Type 3	BREAST	BREAST	BREAST	BREAST
	Cancer Type 4	LUNG	LUNG	LUNG	LUNG
	Cancer Type 5	THYROID	THYROID	THYROID	THYROID
	Cancer Type 6	LIVER	LIVER	GI	GI
	Cancer Type 7	COLON	COLON	OTHER	OTHER
	Cancer Type 8	RESIDUAL	RESIDUAL	N/A	N/A
CFRISK	Lifetime Cancer Fatality Risk Factors				
	Cancer Type 1	0.0111	0.0111	0.0097	0.0037
	Cancer Type 2	0.00019	0.00019	0.0009	0.00015
	Cancer Type 3	0.00506	0.00506	0.0054	0.006
	Cancer Type 4	0.0198	0.0198	0.0155	0.0051
	Cancer Type 5	0.000648	0.000648	0.00072	0.00072
	Cancer Type 6	0.003	0.003	0.0336	0.015
	Cancer Type 7	0.0208	0.0208	0.0276	0.0075
	Cancer Type 8	0.0493	0.0493	N/A	N/A
CIRISK	Lifetime Cancer Injury Risk Factors				
	Cancer Type 1	0.0113	0.0113	0	0.0037
	Cancer Type 2	0.000271	0.000271	0	0.00015
	Cancer Type 3	0.0101	0.0101	0.017	0.017
	Cancer Type 4	0.0208	0.0208	0	0.0057
	Cancer Type 5	0.00648	0.00648	0.0072	0.0072
	Cancer Type 6	0.00316	0.00316	0	0.025
	Cancer Type 7	0.0378	0.0378	0	0.013
	Cancer Type 8	0.169	0.169	N/A	N/A
CRIORG	Critical Organ for EARLY Phase	L-ICRP60ED	L-ICRP60ED	L-EDEWBODY	L-EDEWBODY
CRTOCR	Critical Organ for CHRONC Phase	L-ICRP60ED	L-ICRP60ED	L-EDEWBODY	L-EDEWBODY
DOSEFA	Cancer Dose-Response Linear Factors	1 for all organs	1 for all organs	1 for all organs	1 for THYROID and BREAST 0.39 for all other organs
DOSEFB	Cancer Dose-Response Quadratic Factors	0 for all organs	0 for all organs	0 for all organs	0 for THYROID and BREAST 0.61 for all other organs
ORGFLG	Doses to be Calculated for Specified Organ	All TRUE for FGR-13 All TRUE for DOSFAC2 except for A-Lower LI and L-Liver, which are FALSE	All TRUE for FGR-13 All TRUE for DOSFAC2 except for A-Lower LI and L-Liver, which are FALSE	All TRUE except for A-Lower LI and L-Liver, which are FALSE	Not available in the MACCS model

4.5.4 Acute Health Effects

Parameters representing four types of acute health effects are derived from expert elicitation data [47]. Three of these are potentially fatal, including the hematopoietic, gastrointestinal, and pulmonary syndromes. Pneumonitis represents an injury. Table 4-18 shows the parameter updates between SOARCA, Sample Problem A, and NUREG-1150 for these four acute health effects. Six other acute injuries were not considered in the expert elicitation, so the parameters used in NUREG-1150 were maintained in SOARCA since newer information was not available.

Table 4-18 SOARCA, Sample Problem A, and NUREG-1150 prompt health effects input parameters

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
EFFACA	LD50 for Early Fatality Types				
	A-RED MARR	5.6	5.6	3.8	4
	A-LUNGS	23.5	23.5	10	10
	A-STOMACH	12.1	12.1	Not used	N/A
	LOWER-LI	N/A	N/A	15	15
EFFACB	Shape Factor for Early Fatality Types				
	A-RED MARR	6.1	6.1	5	6
	A-LUNGS	9.6	9.6	7	7
	A-STOMACH	9.3	9.3	Not used	N/A
	LOWER-LI	N/A	N/A	10	10
EFFTHR	Threshold Dose to Target Organ				
	A-RED MARR	2.32	2.32	1.5	1.5
	A-LUNGS	13.6	13.6	5	5
	A-STOMACH	6.5	6.5	Not used	N/A
	LOWER-LI	N/A	N/A	8	7.5
EIFACA	LD50 For Early Injuries				
	PNEUMONITIS	16.6	16.6	10	10
EIFACB	Shape Factor for Early Injuries				
	PNEUMONITIS	7.3	7.3	7	7
EITHRE	Early Injury Dose Threshold				
	PNEUMONITIS	9.2	9.2	5	5
RISTHR	Risk Threshold for Fatality Radius Output	0	0	0	Not available in the MACCS model

4.6 Protective Actions

The development of WinMACCS allowed the SOARCA project to model protective actions in a more detailed and more realistic manner using site-specific information (e.g., using the network evacuation model for the SOARCA Surry and Peach Bottom LTSBO scenarios). The analysis included modeling of the timing of onsite and offsite decisions and implementation of protective actions applied to multiple population segments called cohorts.

4.6.1 Emergency Planning

WinMACCS facilitates implementation of multiple cohorts and using the network evacuation model to obtain a more realistic treatment of emergency response. This added functionality required data that had not previously been developed for consequence analyses.

Emergency response programs for nuclear power plants are designed to protect public health and safety in the unlikely event of a radiological accident. These emergency response programs are developed, tested, and evaluated and are in place as an element of defense in depth. These programs include detailed emergency response planning in place within the 10-mile EPZ with consideration that such planning provides a substantial base for expansion of response efforts in the event that this proves necessary [9]. Site-specific information, such as emergency action level timing from the sites and planned siren activation, was obtained from the plant and from offsite response organizations (OROs). This information was used to support development of timelines by which protective actions would likely be implemented, including early actions such as evacuation of schools following declaration of a site area emergency.

Historically, the evacuation area has been chosen to represent the EPZ and did not consider shadow evacuation (i.e., evacuation of people not residing within the officially declared evacuation area). The SOARCA analyses consider a shadow evacuation beyond the EPZ out to a distance of 20 miles from the plant and evacuating to a 30-mile radius. This results in the outermost evacuees traveling 10 miles beyond their initial location. For dose calculation purposes, evacuees are treated in the model as traveling to a point 30 miles from the site, at which point they are assumed not to receive any further dose. This treatment was implemented to be consistent with previous calculations (e.g., NUREG-1150) in which evacuees moved 10 miles beyond the evacuation zone. The LASMOV variable defines the outermost ring in which evacuees will receive exposures during evacuation. LASMOV was set at ring 17 as shown in Table 4-19 which corresponded to 30 miles. The NUMEVA variable defines the number of concentric rings in which evacuation and/or sheltering can occur for the resident population. NUMEVA was set at ring 15 as shown in Table 4-19 to allow protective actions to be modeled to a distance of 20 miles.

Table 4-19 Evacuation parameter variations between SOARCA and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
LASMOV	Last Ring in Movement Zone	17	17	15	15
NUMEVA	Outer Boundary of Evacuation/Shelter Region	Cohort 1 – 15 Cohorts 2 to 5 - 12	Cohort 1 – 15 Cohorts 2 to 5 - 12	12	12

For each site, six cohorts were established. Use of a larger number of cohorts allows the analyst to more realistically represent the response of the public than when MACCS was limited to three cohorts. In SOARCA, the accident was assumed to occur when school is in session, thus one cohort was established for schoolchildren within the EPZ. Other cohorts from within the EPZ included the general public, special facilities, the evacuation tail, and a non-evacuating cohort. An additional cohort was established for shadow evacuees from areas beyond the EPZ. These cohorts are discussed further in Section 4.6.3.

The non-evacuating cohort represents a small fraction (0.5 percent in this case) of the population who may choose not to evacuate when directed to do so. Research has shown that a fraction of the population refuse to evacuate when under evacuation orders [10]. However, there is little quantifiable data available regarding these non-evacuees. In the draft documents for NUREG-1150, a 5 percent value for non-evacuees was initially used; however, this value was changed to 0.5 percent for the final NUREG-1150 document [7]. In Sample Problem A, a 5 percent value is identified [12] and this likely came from the draft NUREG-1150 document.

SOARCA was the first application to use more than three cohorts in MACCS. During early planning meetings with the model experts, it was suggested that a maximum of six cohorts should be used in the analysis to ensure that model run times would be manageable. In more recent, non-SOARCA applications, as many as 12 cohorts have been modeled. Computer run times increase roughly in proportion to the number of cohorts. Therefore, although six cohorts were used in SOARCA, a more general best practice is to define as many cohorts as needed to represent the response characteristics of the population within the EPZ. When modeling an EPZ, the general public might be divided into multiple cohorts with unique response characteristics to represent the evacuation distribution. Additionally, an amusement park, summer beach population, or other large transient population can be modeled as a separate cohort when present within an EPZ. However, the user should understand that MACCS treats all cohorts as residents, assigning dose and decontamination cost values as if they live within the area.

4.6.2 Evacuation Time Estimates

WinMACCS input parameters related to response characteristics of the public were developed primarily from documentation of the site-specific ETE, which is required to be developed and updated by the licensee under 10 CFR 50.47 (b)(10), "Emergency Plans." ETEs provide the time required to evacuate various sectors and distances within the EPZ for transient and permanent residents and provide information to develop speeds and response timing for evacuating cohorts. The ETEs provided the mobilization times and travel times of different segments of the population as well as evacuation routing information.

The guidance in NUREG/CR-7002 [20] describes the detail included in an ETE study. Important information in an ETE study includes demographic and response data for the following four population segments and may be readily converted into cohorts, if appropriate:

1. Permanent Residents and Transient Population – permanent residents include all people having a residence in the area. The transient population includes tourists, shoppers, employees, etc., who visit but do not reside in the area.

2. Transit Dependent Permanent Residents – permanent residents who do not have access to a vehicle or are dependent upon help from outside the home to evacuate. This group depends upon public transportation to evacuate, which can take additional time to implement.

3. Special Facility Residents – residents of nursing homes, assisted living centers, and those confined to hospitals, jails, prisons, etc. These facilities require specialized vehicles to support the evacuation, the availability of which is facility-specific. Some facilities have onsite vehicles while most have contracts in place for offsite resources to support an evacuation if needed. The time to mobilize and evacuate this population group should be considered separately from the general public.

4. Schools – all private and public educational facilities within the EPZ. Colleges and universities should be assessed on a case by case basis, recognizing that college students typically have access to a vehicle. If there are not enough buses to evacuate schools in a single trip, return trips should be considered, and this affects the response characteristics for the cohort.

The ETE typically includes about 10 scenarios which vary by season, day of the week, time of day, weather conditions, special events, roadway impact, or other EPZ-specific situations. The scenario-specific data are used in the MACCS analyses. For example, when a summer or weekend scenario is analyzed, there may be no need to develop a school related cohort. In SOARCA, a winter weekday scenario was modeled and included residents at work and children at school at the time of declaration of the emergency. The selection of the scenario should be site-specific and be consistent with the objectives of the analysis undertaken.

Although consequence modeling has evolved to allow the use of multiple cohorts and can address many individual aspects of each cohort, the approach to modeling evacuations using the ETE is not direct. Evacuations include mobilizing and evacuating the public over a period of time, which is best modeled as a distribution of data. MACCS requires this distribution of data be converted into discrete events. In SOARCA for example, upon the sounding of the sirens and issuance of the emergency alert system (EAS) messaging, all members of the public are modeled as sheltering and 1 hour later they enter the roadway network together at the same time and begin to evacuate. Research on existing evacuations for technological hazards has shown that the evacuating public actually enters the roadway network over a period of time [10]. To better approximate the time dependence of evacuees entering the roadway, analysts can divide the general public into multiple smaller groups with incremental response characteristics to better represent the evacuating public as a distribution.

4.6.3 Cohort Modeling

As described earlier, the advancements in MACCS allow for discrete analysis of individual segments of the population by establishing many cohorts. The number of cohorts is limited but to a relatively large number (20), but there is diminishing value in establishing a large number of cohorts because the response characteristics begin to overlap within the evacuation period and the effects on different cohorts become indistinguishable. SOARCA was the first application to use more than three cohorts. The cohorts used in SOARCA are shown in Table 4-20.

Table 4-20 SOARCA evacuation cohorts

	Peach Bottom	Surry
Cohort 1	0 to 10 Public	0 to 10 Public
Cohort 2	10 to 20 Shadow	10 to 20 Shadow
Cohort 3	0 to 10 Schools and 0 to 10 Shadow*	0 to 10 Schools
Cohort 4	0 to 10 Special Facilities	0 to 10 Special Facilities
Cohort 5	0 to 10 Tail	0 to 10 Tail
Cohort 6	Non-Evacuating Public	Non-Evacuating Public

* At Peach Bottom, sirens are sounded at the Site Area Emergency (SAE). This action provides broad notification to the general public and would be expected to cause a shadow evacuation from within the EPZ. Surry sirens are not sounded at SAE.

Cohorts were established to represent members of the public who may evacuate early, evacuate late, those who refuse to evacuate, and those who evacuate from areas not under an evacuation order (e.g., the shadow evacuation). Cohort descriptions are provided below:

<u>Cohort 1: 0 to 10 Public.</u> This cohort included the general public residing within the EPZ. The entire general public was modeled as a single cohort.

<u>Cohort 2: 10 to 20 Shadow.</u> This cohort included a shadow evacuation from the 10 to 20 mile area, just beyond the EPZ. A shadow evacuation occurs when members of the public evacuate from areas that are not under official evacuation orders and typically begin when a large scale evacuation is ordered [10]. It was assumed that 20 percent of the residents in the area beyond

the EPZ would evacuate without being ordered to do so. This value was obtained from results of a telephone survey of residents of EPZs conducted by the NRC in 2008 [16]. For the SOARCA sites, which are largely rural, the 20 percent shadow evacuation from the area beyond the EPZ had no measurable effect on the evacuation of the EPZ residents.

Cohort 3: 0 to 10 Schools and 0 to 10 Shadow. This cohort included elementary, middle, and high school student populations within the EPZ. Schools receive early and direct warning from OROs and have response plans in place to support busing of students out of the EPZ. The ETE provides considerable detail regarding schools including the number of schools, student and staff population, number of buses required to evacuate the students, and the ETE which considers whether return trips are required.

A 0 to 10 mile shadow evacuation was included for the Peach Bottom site because sirens are sounded at the SAE. This is a local decision implemented by the OROs. The shadow evacuation would begin early, about the same time as the evacuation of the schools. Because the 0 to 10 shadow would evacuate at about the same time as the schools, only one cohort was used to represent the two population groups for the Peach Bottom analysis.

Cohort 4: 0 to 10 Special Facilities. The special facilities population includes residents of hospitals, nursing homes, prisons, etc. In an emergency, special facilities would be evacuated individually over a period of time based upon available transportation and the number of return trips needed to evacuate a facility. Special facilities were modeled as a single cohort. It was determined that an appropriate representation of this cohort in the modeling would be to start the evacuation later in the event and apply shielding factors consistent with the types of structures within which these residents reside. The percent of population of this cohort is often relatively small, therefore it may not be beneficial to separate the special facilities into multiple cohorts.

Cohort 5: 0 to 10 Tail. The 0 to 10 tail is defined as the last 10 percent of the public to evacuate [22] from the 10 mile EPZ. The evacuation tail takes longer to evacuate for valid reasons, such as shutting down farming or manufacturing operations, performing other time consuming actions prior to evacuating, or they may have missed the initial notification.

Cohort 6: Non-Evacuating Public. This cohort represents a portion of the public from 0 to 10 miles who may refuse to evacuate. It is assumed to be 0.5 percent of the population who are modeled as though they are performing normal activities. This percentage of the population that does not evacuate is consistent with research on large scale evacuations that has shown a small percentage of the public refuses to evacuate [10].

Table 4-21 shows the cohort weighting parameters used in SOARCA, Sample Problem A, and NUREG-1150. As indicated in the table, only two cohorts were used in Sample Problem A with percentages of 95 percent for the general public and 5 percent for the non-evacuating public. The percentages were adjusted to 99.5% and 0.5%, respectively, in the final NUREG-1150 report. In SOARCA the population fractions were developed based on the actual site population data. The 0 to 10 public was expected to be the cohort of greatest interest; therefore, Cohort 1 was defined as the 0 to 10 public and has the same response characteristics as Cohort 2 shadow evacuation, which is the cohort that extends the greatest distance and defines the limits of the array. Thus, within the WinMACCS input file, Cohorts 1 and 2 were defined to meet the requirement that maximum distance be established with the first cohort. The WinMACCS model input parameters for Cohort 1 were extended from the plant out to 20 miles, and Cohort 2 extends from the plant out to 10 miles. In the WinMACCS input file, Cohort 1 is input as 20 percent of the population from 0 to 20 miles. This captures the 20 percent of the population between 10 and 20 miles involved in the shadow evacuation beyond the EPZ. The combination of Cohorts 1 and 2 from 0 to 10 miles in the WinMACCS model represent all of the 0 to 10 public cohort defined above. For the remaining cohorts, application of parameters in the WinMACCS model is direct, and the population fractions directly correspond to the cohort descriptions.

To calculate the population fractions, shadow populations were assessed first as 20 percent of the population. After subtracting the shadow, non-evacuee, special needs, and schools, 10 percent of the remaining population in each region was assumed as the evacuation tail, and the remainder was used as the total for the general public.

Table 4-21 Cohort weighting fraction parameter variations between SOARCA, Sample Problem A, and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
WTFRAC	Weighting Fraction Applicable to this Scenario				
	Cohort 1	0.2	0.2	0.95	0.995
	Cohort 2	0.535	0.355	0.05	0.005
	Cohort 3	0.193	0.372	These cohorts were not used	These cohorts were not used
	Cohort 4	0.007	0.006		
	Cohort 5	0.06	0.062		
	Cohort 6	0.005	0.005		

When MACCS implements the cohort function, the population fractions are distributed uniformly. For example, a school population cohort of 10 percent would be treated in MACCS as though the school population was a uniformly distributed fraction of the EPZ population. In reality, the schools are clustered with local populations of a few hundred students each. It is not expected that the uniform distribution of population fractions would have a noticeable effect on the risk results for the SOARCA analyses. An improvement added to MACCS after the SOARCA project is the SUMPOP feature which allows cohorts such as schools, special facilities, or other populations, to be modeled precisely within the grid element wherein the facility is located.

4.6.4 Cohort Response Times

As required by 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” OROs develop emergency response plans for implementation in the event of a nuclear power plant accident. These plans are regularly drilled and inspected biennially (every two years) through a demonstration exercise performed with the licensee. In biennial exercises, ORO personnel demonstrate timely decision making and the ability to implement public protective actions. Emergency plans escalate response activities in accordance with a classification scheme based on EALs. Preplanned actions are implemented at each classification level, including Unusual Event, Alert, Site Area Emergency (SAE), and General Emergency (GE). Public protective actions are required at the GE level, but offsite emergency plans commonly include precautionary protective actions at the SAE level and sometimes at the Alert level, and these actions should be considered in the modeling. For example, at Peach Bottom the ORO emergency plans include sounding sirens at the SAE to inform the public that an incident has occurred and they should monitor EAS stations for updated information. For Surry, the ORO emergency plan includes notifying schools at the SAE, but sirens are only sounded for a GE.

The time to receive notification was based on the assumption that sirens will sound when needed. The NRC Reactor Oversight Program (ROP) data for siren performance for Peach Bottom shows an average siren performance indicator of 99.8 percent and 99.9 percent for Surry, indicating that sirens will perform when needed. The ROP information is available for all EPZs.

Loss of power accidents result in the loss of power to some offsite areas of the EPZ and may affect siren performance when backup batteries are not available. However, it may be reasonable to expect that the power will be available in parts of the 10 mile EPZ. For those areas where the power outage affects sirens, route alerting would be conducted by OROs to alert residents. The analyst should determine whether any delay should be included to represent additional time for implementation of backup notification methods.

Adjustments may be made to the evacuation speeds based on review of population densities and capacity limits in the roadway network. The baseline speed is typically assigned to the general public cohort and then adjusted using speed adjustment factors. In SOARCA these adjustments ranged from 75 percent to 150 percent of the average speed, as appropriate for the rural and urban areas. The ETE often identifies specific routes where congestion will occur, and this information is useful in estimating the speed adjustment factors.

Using the information and approach described above, the evacuation timing and speeds for each cohort were developed. Selected input parameters for WinMACCS are described below:

- Delay to shelter (DLTSHL) represents a delay from the time of the start of the accident until cohorts enter a shelter.

- Delay to evacuation (DLTEVA) represents the length of the sheltering period from the time a cohort enters a shelter until the point at which it begins to evacuate.

- The speed (ESPEED) is assigned for each of the three phases (Early, Middle, and Late) used in WinMACCS.

- Duration of beginning phase (DURBEG) is the duration assigned to the beginning phase of the evacuation and may be assigned uniquely for each cohort. This period begins when the sheltering period ends.

- Duration of middle phase (DURMID) is the duration assigned to the middle phase of the evacuation and may be assigned uniquely for each cohort. This period begins when the beginning phase (DURBEG) ends.

The initial response parameter in MACCS is OALARM, which defines the time at which notification is given to off-site emergency response officials to initiate protective measures for the surrounding population. This time is a function of the accident sequence and is traditionally implemented as the time sirens sound notifying the public. However, because early protective actions are implemented at Peach Bottom with the notification of the schools at SAE, OALARM was not implemented in the traditional manner for SOARCA because MACCS does not allow the movement of cohorts before OALARM. Therefore, for SOARCA, OALARM was measured from accident initiation and was set at 0.0. Table 4-22 shows the time selected for OALARM in SOARCA, Sample Problem A, and NUREG-1150, as documented in NUREG/CR-4551 [8] for one of the Peach Bottom source terms. OALARM can be a useful parameter if multiple analyses are being performed and the response timeline is being adjusted. However, users should review the values for OALARM carefully when implementing this parameter because it can be misunderstood.

Table 4-22 Time to GE condition variations between SOARCA and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
OALARM	Elapsed Time from Accident Initiation to Notify the Public (sec)	0.0	0.0	1,300	14,000

4.6.5 Delay to Shelter

The delay to shelter (DLTSHL) defines the duration it takes for the residents within the EPZ to receive the alert and notification and enter a shelter [12]. The shelter is typically assumed to be their residence or workplace, not a separate facility. Table 4-23 shows the delay to shelter parameters used in SOARCA, Sample Problem A, and NUREG-1150. As indicated, Cohort 3 (Schools), is notified directly by the ORO in about 15 minutes. The OROs sound the sirens and issue EAS messages which provide the notification to the remaining cohorts. The baseline DLTSHL value for Peach Bottom is 1.5 hours, and 2.75 hours for Surry. The time for these actions is represented in the table below.

Table 4-23 Delay to shelter parameter variations between SOARCA, Sample Problem A, and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
DLTSHL	Delay from Alarm Time to Shelter (sec)				
	Cohort 1	9,900	5,400	7,200	0
	Cohort 2	9,900	5,400	N/A	N/A
	Cohort 3	900	900	These cohorts were not used	These cohorts were not used
	Cohort 4	9,900	5,400		
	Cohort 5	9,900	5,400		
	Cohort 6	N/A	N/A		

4.6.6 Evacuation Delay

Delay to evacuation (DLTEVA) defines the duration of the sheltering period that occurs before evacuation of residents begins [12]. Delay to evacuation might be affected by a delay in response to the evacuation order, a need to wait for the return of commuters, a need to wait for public transportation, a need to shut down operations prior to leaving work, etc. Research shows that delay is not uniform with most of the evacuees experiencing a small delay (e.g., 90 percent of the public evacuates in about 60 percent of the response time) [11], [22]. As described earlier, there is high confidence in the alert and notification system to warn the public; however, response of the public is a function of the time to receive the notification and the time to prepare to evacuate [49]. Table 4-24 shows the evacuation delay parameters used in SOARCA, Sample Problem A, and NUREG-1150.

Table 4-24 Evacuation delay parameter variations between SOARCA, Sample Problem A, and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
DLTEVA	Delay from Beginning of Shelter to Evacuation (sec)				
	Cohort 1	3,600	3,600	0	0
	Cohort 2	3,600	3,600	N/A	N/A
	Cohort 3	3,600	2,700	These cohorts were not used	These cohorts were not used
	Cohort 4	39,600	15,300		
	Cohort 5	39,600	15,300		
	Cohort 6	N/A	N/A		

Cohorts 1 and 2 together represent the 0-10 public and 10-20 shadow, and the baseline DLTEVA value is one hour. This value is supported by the ORNL-6615 study, which provided empirical data showing that most of the public is mobilized in about an hour [49]. The shadow evacuation, Cohort 2, is aligned with the general public evacuation of Cohort 1.

Cohort 3 represents the schools and the 0-10 shadow evacuation for Peach Bottom and represents only the schools for Surry. The 0-10 shadow has the same response characteristics because this cohort has been defined in SOARCA as evacuating when the schools evacuate. The 0-10 shadow at Peach Bottom evacuates spontaneously (i.e., prior to receiving an evacuation order) when the emergency is communicated to the residents of the EPZ via the sirens and emergency evacuation system messaging for the SAE. Shadow evacuation of the public has been demonstrated to begin quickly for industrial accidents [10]. For Peach Bottom, a baseline value of 45 minutes was used because schools are notified early and are prepared to evacuate when the official order is issued. The Pennsylvania emergency management plan explains that evacuation can be implemented for an SAE or a GE. The early warning for schools provides time for buses to mobilize and be ready if an evacuation were to be ordered. Evacuation drills at schools demonstrate the ability to prepare and move students quickly. For Surry, upon receipt of the declaration of SAE by the site, the Virginia Department of Emergency Management would notify the schools in accordance with the offsite emergency response plan. It is assumed schools are notified at SAE and begin sheltering in about 15 minutes. Buses would be mobilized, and it is assumed schools begin evacuating 1 hour after the shelter period.

Cohort 4 represents special facilities that can take longer as a whole than the general public. It was determined that the best representation of this cohort in the modeling is to evacuate with the tail and apply shielding factors consistent with the types of structures within which these residents reside.

Cohort 5 is the evacuation tail, which by definition begins evacuating at the end of the general public evacuation. For Peach Bottom, the baseline value of 4.25 hours was based on the site-specific evacuation time estimate (ETE) study which showed that 90% of the population had completed the evacuation in 4.25 hours. Using the evacuation data provided in the Surry ETE study, 90 percent of the evacuation of the EPZ is complete at approximately 11 hours into the evacuation, and this corresponds to the departure time for the 0 to 10 Tail.

4.6.7 Evacuation Phase Duration and Speed

Departure speeds and durations of the beginning and middle periods for MACCS were also developed from the Surry and Peach Bottom ETE studies. Table 4-25 shows the evacuation phase duration and speed parameters used in SOARCA and NUREG-1150. As shown in the table, the DURBEG and DURMID values were established for each cohort, whereas in NUREG-1150 and Sample Problem A, fewer cohorts were used and generic values were applied. The values in SOARCA were based on the response characteristics developed for the cohorts. ESPEEDs specific to each cohort were used in the analyses. For the late phase, an ESPEED of 20 mph was applied to all cohorts because at this point in the evacuation, they are well beyond the EPZ where traffic is less congested. In NUREG-1150 and Sample Problem A, generic speed values were used.

The duration and speed values were based on evacuation of a full 10 mile EPZ beginning with the initial alert and notification. This implementation was necessary because the protective action modeling could not be synchronized with the MACCS weather trials which totaled about 1,000 for each site. This modeling approach represents the current expected Peach Bottom protective action to evacuate the full EPZ, but most sites, including Surry, would typically implement a keyhole evacuation of a smaller area and expand to a full EPZ only if necessary based on the source term release data. A keyhole evacuation model was added to MACCS after the SOARCA project was completed and will be released in a future version of MACCS. This model allows the user to define the evacuation region with the radius of the inner, circular area, the number of sectors to evacuate beyond the circular area, and the outer radius of the evacuation area. The keyhole is centered on the initial wind direction but then expands as the wind changes direction in subsequent hours.

Table 4-25 Evacuation phase duration and speed parameter variations between SOARCA, Sample Problem A, and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
DURBEG	Duration of Beginning of Evacuation Phase (sec)				
	Cohort 1	900	900	86,400	N/A
	Cohort 2	900	900	N/A	N/A
	Cohort 3	900	3,600	These cohorts were not used	These cohorts were not used
	Cohort 4	3,600	1,800		
	Cohort 5	3,600	1,800		
	Cohort 6	N/A	N/A		
DURMID	Duration of Middle of Evacuation Phase (sec)				
	Cohort 1	35,100	10,800	0	N/A
	Cohort 2	35,100	10,800	N/A	N/A
	Cohort 3	1,800	1,800	These cohorts were not used	These cohorts were not used
	Cohort 4	3,600	1,800		
	Cohort 5	3,600	1,800		
	Cohort 6	N/A	N/A		
ESPEED	Evaluation Speed (m/s)				
	Initial Evacuation Phase Cohort 1	2.235	2.235	1.8	4.8
	Middle Evacuation Phase Cohort 1	0.447	1.341	1.8	4.8
	Late Evacuation Phase Cohort 1	8.941	8.941	1.8	4.8
	Initial Evacuation Phase Cohort 2	2.235	2.235	1.8	N/A
	Middle Evacuation Phase Cohort 2	0.447	1.341	1.8	N/A
	Late Evacuation Phase Cohort 2	8.941	8.941	1.8	N/A
	Initial Evacuation Phase Cohort 3	4.47	8.941	These cohorts were not used	These cohorts were not used
	Middle Evacuation Phase Cohort 3	4.47	8.941		
	Late Evacuation Phase Cohort 3	8.941	8.941		
	Initial Evacuation Phase Cohort 4	0.447	1.341		
	Middle Evacuation Phase Cohort 4	4.47	8.941		
	Late Evacuation Phase Cohort 4	8.941	8.941		
	Initial Evacuation Phase Cohort 5	0.447	1.341		
	Middle Evacuation Phase Cohort 5	4.47	8.941		
	Late Evacuation Phase Cohort 5	8.941	8.941		
	Cohort 6	N/A	N/A		

4.6.8 Potassium Iodide

The purpose of using potassium iodide (KI) as a protective measure is to saturate the thyroid gland with stable iodine so that further uptake of radioiodine by the thyroid is diminished. If taken at the right time, the KI can nearly eliminate doses to the thyroid gland from inhaled radioiodine. Ingestion of KI should be modeled for residents near plants where KI has been distributed by the State or local government. The States distribute KI within the EPZ at the Peach Bottom and Surry sites and KI ingestion was therefore considered in SOARCA. It was assumed that half of the residents within the EPZ take KI and some of these residents do not take KI at the optimal time (i.e., shortly before to immediately after plume arrival), so the efficacy was selected as 70 percent (i.e., the thyroid dose from inhaled radioiodine is reduced by 70 percent).

The KI model was not available for the consequence analyses in NUREG-1150 and thus a comparison of the MACCS inputs for the population taking KI and efficacy of KI cannot be made.

4.6.9 Hotspot and Normal Relocation

Hotspot and normal relocation are additional protective actions implemented by OROs. In addition to evacuation, residents would be relocated from areas during the accident where the dose exceeds the emergency phase protective action criteria based on EPA Protective Action Guides (PAGs) [23]. OROs would determine the affected areas based on dose projections using State, utility, and Federal agency computer models and field measurements. Hotspot and normal relocation models are included in the MACCS code to reflect this activity. These models include dose from cloudshine, groundshine, direct inhalation, and resuspension inhalation. When these models are applied within the MACCS calculation, individuals who would be relocated because their projected total dose from these pathways exceeds the protective action criteria, are prevented from receiving any additional dose during the emergency phase. Table 4-26 shows the hotspot and normal relocation parameters used in SOARCA, Sample Problem A, and NUREG-1150.

Table 4-26 Hotspot and normal relocation parameter variations between SOARCA, Sample Problem A, and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
DOSHOT	Hot-Spot Relocation Dose Threshold (Sv)	0.05	0.05	0.5	0.5
DOSNRM	Normal Relocation Dose Threshold (Sv)	0.01	0.005	0.25	0.25
TIMHOT	Hotspot Relocation Time (sec)	86,400	43,200	43,200	43,200
TIMNRM	Normal Relocation Time (sec)	129,600	86,400	86,400	86,400

In MACCS, hotspot relocation is performed first and normal relocation second. The choices of times associated with normal and hotspot relocation depended on the specific accident scenario because they are based on plume arrival. The scenario-specific time for completion of the relocation includes the time for response personnel to identify the involved area, for them to notify the residents within that area that relocation is necessary, and for the residents to remove themselves from the area. Because the timing of relocation is keyed to plume arrival, there is always a period of exposure prior to initiation of relocation. The relocation times used in SOARCA were 12 hours for hotspot and 24 hours for normal relocation for Peach Bottom and 24 hours for hotspot and 36 hours for normal relocation for Surry. The values for Surry are longer than Peach Bottom because the population density is greater and the area north and east of the plant is heavily urban. This would require additional resources to notify residents and support relocating them out of the affected area. Notifying and relocating the larger population would be expected to take a longer time.

In SOARCA, this application affects the non-evacuating cohort and the public beyond the EPZ who have not already evacuated. These population groups were relocated from areas where the projected dose during the emergency phase exceeded a set of two upper bounds. These bounds were based on a range of protective action guide dose levels published by EPA, which is 1 to 5 rem [23]. In SOARCA, the upper limit of this range (5 rem) was used to trigger hot-spot relocation for both Surry and Peach Bottom, and the lower limit of this range (1 rem) was used to trigger normal relocation for Surry, while 0.5 rem was used for Peach Bottom to be consistent with the Pennsylvania habitability criterion.

4.6.10 Habitability

Habitability is the consequence model parameter that is used to establish the dose level at which residents are allowed to return to their homes during the long-term phase. In the MACCS code, habitability applies to everyone, not just evacuees. The MACCS CHRONC model implements user-defined habitability criterion. Habitability decision making with MACCS can result in three possible outcomes:

1. land is immediately habitable,
2. land will be habitable after decontamination,
3. land will be habitable after a combination of decontamination and interdiction, and
4. land cannot be made habitable, or it is not cost effective to do so, so the land is condemned.

States may establish a specific criterion for long-term habitability, although most states adhere to the EPA guidelines, which specify a maximum allowable dose of 2 rem in the first year and 0.5 rem per year thereafter. A draft EPA recommendation [32] used in NUREG-1150 has traditionally been implemented in MACCS as a cumulative 4 rem over the first 5 years (2 rem in the first year + 4 years x 0.5 rem/year) of exposure. Some States expect to implement a more strict habitability criterion. For instance, Pennsylvania establishes a 0.5 rem per year limit beginning in the first year, and this value was used in the Peach Bottom analysis. The long term habitability criteria used in NUREG-1150 of 0.04 Sv (4 rem) over a 5 year period [7] was used for the Surry MACCS analyses [3]. Table 4-27 shows the long-term phase dose criterion variables used in SOARCA, Sample Problem A, and NUREG-1150.

Table 4-27 Long-term phase dose criterion variations between SOARCA, Sample Problem A, and NUREG-1150

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
DSCRLT	Long-Term Phase Dose Criterion (Sv)	0.04	0.005	0.04	0.04

If the property cannot be made habitable within 30 years or if the cost of reclaiming habitability of the property exceeds the cost of condemning it, the property will be condemned and permanently withdrawn from use.

Table 4-28 shows the parameters chosen for SOARCA, Sample Problem A, and NUREG-1150 for the exposure period. As explained above, the habitability criterion used for Peach Bottom is a 0.005 Sv (500 mrem) in each year. Thus, the exposure period is one year (3.16×10^7 seconds). For Surry, the EPA recommendation is implemented as 0.04 Sv (4 rem) in 5 years

($1.58x10^8$ sec). This latter criterion was used for both Surry and Peach Bottom in NUREG-1150 and Sample Problem A.

Table 4-28 SOARCA and NUREG-1150 action period input parameter

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
TMPACT	Time Action Period Ends (sec)	$1.58x10^8$	$3.16x10^7$	$1.58x10^8$	$1.58x10^8$

4.7 Decontamination and Cost Parameters

Decontamination parameters were based on values from NUREG-1150 [7] and were not reviewed for SOARCA because SOARCA did not calculate economic consequences; thus cost decisions were only used to support the habitability decisions in the model. The cost parameters associated with decontamination were escalated to account for inflation using the CPI. These parameters affect decisions on whether contaminated areas can be restored to habitability and therefore affect predicted doses and health effect risks. Two levels of decontamination represented by dose reduction factors (DRF) of 3 and 15 were considered in SOARCA and were the same as in NUREG-1150.

The user should understand that use of two DRFs provides a level of conservatism because for any area where a DRF of 3 is insufficient, the model applies the much higher DRF of 15, which costs more to implement than a DRF of 3. For example, if the model calculates the need for a DRF of greater than 3 but less than 15, such as a DRF of 4, the full cost for a DRF of 15 is applied. As a best practice it may be appropriate to include an intermediate DRF. Analysts should review the basis and applicability of the decontamination and cost parameters for site-specific analyses.

5.0 INSIGHTS

Conducting a project such as SOARCA provided an opportunity to investigate consequence analyses at a much greater level of detail than was done for analyses performed in the past. Throughout the process, advanced knowledge and insights were gained that benefit the PRA and emergency response communities. The following insights related to offsite consequence analyses were developed from the SOARCA project.

1. Through investigation of the importance of each chemical class, the SOARCA analyses confirmed that the cesium group followed by the tellurium and barium/strontium groups, is generally the most important contributor to long-term and overall LCF risk when using the LNT dose-response model. However, SOARCA found that the cerium group, followed by the barium/strontium group, dominates over the cesium group in the Peach Bottom unmitigated STSBO scenario without RCIC blackstart. This scenario involves significant core-concrete interactions with insertions of unoxidized zirconium. Even though the cerium release is small in terms of percentage, it is significant in terms of activity because of its large initial inventory. This results in the cerium group, followed by the barium/strontium group, being the largest contributor to LCF risk for this scenario. This trend was not observed for any of the other Peach Bottom or Surry scenarios and is more likely to occur in a BWR scenario because of the significantly larger quantity of zirconium in the reactor vessel of a BWR. As shown below, and discussed in detail in NUREG/CR-7110, for the Peach Bottom STSBO without RCIC blackstart, cesium is the third most important chemical group whereas it is first in all other scenarios. Chemical groups not listed contribute less than a few percent to the overall LCF risk for the specified scenarios.

    a. For the Peach Bottom unmitigated LTSBO, the order of importance beyond the EPZ is cesium, tellurium, barium/strontium, cerium, and iodine.

    b. For the Peach Bottom unmitigated STSBO with RCIC blackstart, the order of importance beyond the EPZ is cesium, tellurium, barium/strontium, and cerium.

    c. For the Peach Bottom unmitigated STSBO without RCIC blackstart, the order of importance beyond the EPZ is cerium, barium/strontium, cesium, and tellurium.

    d. For the Surry unmitigated ISLOCA, the order of importance beyond the EPZ is cesium, tellurium, and iodine.

2. Sensitivity analyses on the effect of the surface roughness parameter show that a surface roughness increase from 10 cm to 60 cm results in a risk reduction of about 20% for the intermediate distances (10 to 50 miles) and a risk increase of about 10% within 10 miles for the calculated LCF risks using the LNT dose-response model. The reduction in risk for the two truncation dose-response models reported in SOARCA is generally greater than 20%.

3. The development of emergency response parameters based on site-specific data obtained from the emergency plan and offsite response organizations enables realistic modeling of the response of the public. The results of the analyses show that for the selected SOARCA scenarios, the emergency response is very effective within the evacuation zone during the emergency phase. The risks are very small and entirely

represent the non-evacuating population, with the exception of the Surry STSBO with a TISGTR accident scenario in which the release starts much earlier than in the others.

4. Using the LNT dose-response model, the largest contributor to LCF risk for most scenarios is the long-term risk incurred after the emergency phase, and this risk is controlled by the habitability criterion.

5. Increasing the number of aerosol bins and accounting for the deposition velocity as a function of particle size has a significant effect on the results. The effect is comparable to specifying a single deposition velocity of 0.3 cm/s; which reduces ground concentrations by about a factor of 3 at the distances reported in SOARCA compared with the NUREG-1150 methodology of using a single value of 1 cm/s.

6. Increasing the number of compass sectors from 16 to 64 does not significantly affect LCF risk calculated using the LNT dose-response model. There would likely be a greater effect on LCF risk using the truncation dose-response models; however these calculations were not performed.

7. Increasing the number of plume segments has a small effect on calculated LCF risk using the LNT dose-response model. There would likely be a greater effect on LCF risk using the truncation dose-response models; however these calculations were not performed.

8. Insight from the evaluation of seismic activity on emergency response (ER) shows the effect to be site-specific. For Peach Bottom, the seismic event's impact on ER has an insignificant effect on health consequences primarily because the damage to infrastructure in this EPZ is projected to be limited to a few roadway sections. For Surry, the overall impact on the ER from the seismic activity is significant with regard to the damage to infrastructure; however, because this damage occurs in the developed areas which are beyond 5 miles from the plant, there is no appreciable effect on health consequences. Although the ER is impacted considerably by the postulated seismic event, the effect on overall risk is not significant, and the prompt fatality risk remains zero.

9. Sensitivity analyses on the size of the evacuation area were performed for two scenarios: the Peach Bottom unmitigated STSBO and the Surry unmitigated ISLOCA. These sensitivities show that the effect of expanding the size of the evacuation area is site-specific and scenario-specific. For the Peach Bottom unmitigated STSBO, expanding the size of the evacuation area decreases individual LCF risk beyond the 10-mile radius but increases individual LCF risk within 10 miles. The increase in risk to the population residing within 10 miles occurs because of the increased traffic congestion which is caused by the larger evacuation. For areas with a radius greater than 20 miles, the risk reduction associated with increasing the size of the evacuation area is slight. For the Surry unmitigated ISLOCA, the results show very little benefit from evacuation of areas beyond 10 miles.

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APPENDIX A: MACCS SURRY POWER STATION SOARCA MODELING PARAMETERS

SURRY INPUT PARAMETERS FOR SOARCA

The input parameters used for the SOARCA LTSBO, STSBO, ISLOCA, TISGTR mitigated and unmitigated scenarios are shown in this appendix in tabular form. Table A-1 contains the more general ATMOS input parameters used for these three scenarios. Table A-2 through Table A-4 contain specific inputs related to the source terms that were extracted from MELCOR results via the MELMACCS code. Table A-5 contains general EARLY input parameters. Table A-6 and Table A-7 contain parameters associated with the network evacuation model that was used to treat emergency response. Table A-8 contains the evacuation direction parameters. Table A-9 contains the CHRONC input parameters.

Table A-1 ATMOS input parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
APLFRC	Method of Applying Release Fraction	PARENT	PARENT	PARENT	PARENT	PARENT
ATNAM1	Title Describing the ATMOS Assumptions	SOARCA Surry Unmitigated LTSBO	SOARCA Surry Unmitigated STSBO	SOARCA Surry Unmitigated STSBO	SOARCA Surry Mitigated TISGTR	SOARCA Surry Unmitigated TISGTR
ATNAM2	Title Describing the Source Term	Surry source term for unmitigated long-term station blackout.	Surry source term for unmitigated short-term station blackout.	Surry source term for unmitigated short-term station blackout.	Surry source term for mitigated, thermally-induced, steam-generator-tube rupture	Surry source term for unmitigated short-term station blackout.
BNDMXH	Boundary Weather Mixing Layer Height	1000	1000	1000	1000	1000
BNDRAN	Boundary Weather Rain Rate	5	5	5	5	5
BNDWND	Boundary Wind Speed	2.2	2.2	2.2	2.2	2.2
BRKPNT	Breakpoint Time for Plume Meander	3600	3600	3600	3600	3600
BUILDH	Building Height for all Plume Segments	50	50	50	50	50
CORINV	Isotopic Inventory at Time of Reactor Shutdown	from MELMACCS	from MELMACCS	from MELMACCS	from MELMACCS	from MELMACCS
CORSCA	Linear Scaling Factor on Core Inventory	1	1	1	1	1
CWASH1	Linear Coefficient for Washout	1.89E-05	1.89E-05	1.89E-05	1.89E-05	1.89E-05
CWASH2	Exponential Term for Washout	0.664	0.664	0.664	0.664	0.664
CYSIGA	Linear Coefficient for sigma-y					
	Stability Class A	0.7507	0.7507	0.7507	0.7507	0.7507
	Stability Class B	0.7507	0.7507	0.7507	0.7507	0.7507

Table A-1 ATMOS input parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
CYSIGA	Stability Class C	0.4063	0.4063	0.4063	0.4063	0.4063
	Stability Class D	0.2779	0.2779	0.2779	0.2779	0.2779
	Stability Class E	0.2158	0.2158	0.2158	0.2158	0.2158
	Stability Class F	0.2158	0.2158	0.2158	0.2158	0.2158
CYSIGB	Exponential Term for sigma-y					
	Stability Class A	0.866	0.866	0.866	0.866	0.866
	Stability Class B	0.866	0.866	0.866	0.866	0.866
	Stability Class C	0.865	0.865	0.865	0.865	0.865
	Stability Class D	0.881	0.881	0.881	0.881	0.881
	Stability Class E	0.866	0.866	0.866	0.866	0.866
	Stability Class F	0.866	0.866	0.866	0.866	0.866
CZSIGA	Linear Coefficient for sigma-z					
	Stability Class A	0.0361	0.0361	0.0361	0.0361	0.0361
	Stability Class B	0.0361	0.0361	0.0361	0.0361	0.0361
	Stability Class C	0.2036	0.2036	0.2036	0.2036	0.2036
	Stability Class D	0.2636	0.2636	0.2636	0.2636	0.2636
	Stability Class E	0.2463	0.2463	0.2463	0.2463	0.2463
	Stability Class F	0.2463	0.2463	0.2463	0.2463	0.2463
CZSIGB	Exponential Term for sigma-z					
	Stability Class A	1.277	1.277	1.277	1.277	1.277
	Stability Class B	1.277	1.277	1.277	1.277	1.277
	Stability Class C	0.859	0.859	0.859	0.859	0.859
	Stability Class D	0.751	0.751	0.751	0.751	0.751
	Stability Class E	0.619	0.619	0.619	0.619	0.619
	Stability Class F	0.619	0.619	0.619	0.619	0.619
DISPMD	Dispersion Model Flag	LRDIST	LRDIST	LRDIST	LRDIST	LRDIST
DRYDEP	Dry Deposition Flag	Xe = .FALSE. Other Groups = .TRUE.	Xe = .FALSE. Other Groups = .TRUE.	Xe = .FALSE. Other Groups = .TRUE.	Xe = .FALSE. Other Groups = .TRUE.	Xe = .FALSE. Other Groups = .TRUE.
ENDAT1	Control flag indicating only ATMOS is to be run	.FALSE.	.FALSE.	.FALSE.	.FALSE.	.FALSE.

Table A-1 ATMOS input parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
GRPNAM	Names of the Chemical Classes (Used by WinMACCS)					
	Chemical Class 1	Xe	Xe	Xe	Xe	Xe
	Chemical Class 2	Cs	Cs	Cs	Cs	Cs
	Chemical Class 3	Ba	Ba	Ba	Ba	Ba
	Chemical Class 4	I	I	I	I	I
	Chemical Class 5	Te	Te	Te	Te	Te
	Chemical Class 6	Ru	Ru	Ru	Ru	Ru
	Chemical Class 7	Mo	Mo	Mo	Mo	Mo
	Chemical Class 8	Ce	Ce	Ce	Ce	Ce
	Chemical Class 9	La	La	La	La	La
IBDSTB	Boundary Weather Stability Class Index	4	4	4	4	4
IDEBUG	Debug Switch for Extra Debugging Print	0	0	0	0	0
IGROUP	Definition of Radionuclide Group Numbers	1 = Xe	1 = Xe	1 = Xe	1 = Xe	1 = Xe
		2 = Cs	2 = Cs	2 = Cs	2 = Cs	2 = Cs
		3 = Ba	3 = Ba	3 = Ba	3 = Ba	3 = Ba
		4 = I	4 = I	4 = I	4 = I	4 = I
		5 = Te	5 = Te	5 = Te	5 = Te	5 = Te
		6 = Ru	6 = Ru	6 = Ru	6 = Ru	6 = Ru
		7 = Mo	7 = Mo	7 = Mo	7 = Mo	7 = Mo
		8 = Ce	8 = Ce	8 = Ce	8 = Ce	8 = Ce
		9 = La	9 = La	9 = La	9 = La	9 = La
INWGHT	Number of Samples for Each Bin Used for Nonuniform Weather Bin Sampling					
	Bin 1	12	12	12	12	12
	Bin 2	14	14	14	14	14
	Bin 3	12	12	12	12	12
	Bin 4	39	39	39	39	39
	Bin 5	85	85	85	85	85
	Bin 6	94	94	94	94	94
	Bin 7	16	16	16	16	16
	Bin 8	12	12	12	12	12
	Bin 9	27	27	27	27	27
	Bin 10	134	134	134	134	134
	Bin 11	119	119	119	119	119

Table A-1 ATMOS input parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
INWGHT	Bin 12	74	74	74	74	74
	Bin 13	92	92	92	92	92
	Bin 14	43	43	43	43	43
	Bin 15	12	12	12	12	12
	Bin 16	12	12	12	12	12
	Bin 17	37	37	37	37	37
	Bin 18	12	12	12	12	12
	Bin 19	13	13	13	13	13
	Bin 20	17	17	17	17	17
	Bin 21	14	14	14	14	14
	Bin 22	12	12	12	12	12
	Bin 23	6	6	6	6	6
	Bin 24	6	6	6	6	6
	Bin 25	12	12	12	12	12
	Bin 26	12	12	12	12	12
	Bin 27	12	12	12	12	12
	Bin 28	1	1	1	1	1
	Bin 29	5	5	5	5	5
	Bin 30	6	6	6	6	6
	Bin 31	5	5	5	5	5
	Bin 32	12	12	12	12	12
	Bin 33	5	5	5	5	5
	Bin 34	12	12	12	12	12
	Bin 35	12	12	12	12	12
	Bin 36	12	12	12	12	12
IRSEED	Seed for Random Number Generator	79	79	79	79	79
LATITU	Latitude of Power Plant	37˚ 9' 56"	37˚ 9' 56"	37˚ 9' 56"	37˚ 9' 56"	37˚ 9' 56"
LIMSPA	Last Interval for Measured Weather	25	25	25	25	25
LONGIT	Longitude of Power Plant	76˚ 41' 54"	76˚ 41' 54"	76˚ 41' 54"	76˚ 41' 54"	76˚ 41' 54"
MAXGRP	Number of Radionuclide Groups	9	9	9	9	9
MAXHGT	Flag for Mixing Height	DAY_AND_NIGHT	DAY_AND_NIGHT	DAY_AND_NIGHT	DAY_AND_NIGHT	DAY_AND_NIGHT
MAXRIS	Selection of Risk Dominant Plume	3	3	1	1	1
METCOD	Meteorological Sampling Option Code	2	2	2	2	2
MNDMOD	Plume Meander Model Flag	OFF	OFF	OFF	OFF	OFF
NAMSTB	List of Pseudo stable Nuclides					
	Isotope 1	I-129	I-129	I-129	I-129	I-129
	Isotope 2	Xe-131m	Xe-131m	Xe-131m	Xe-131m	Xe-131m
	Isotope 3	Xe-133m	Xe-133m	Xe-133m	Xe-133m	Xe-133m
	Isotope 4	Cs-135	Cs-135	Cs-135	Cs-135	Cs-135

Table A-1 ATMOS input parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
NAMSTB	Isotope 5	Sm-147	Sm-147	Sm-147	Sm-147	Sm-147
	Isotope 6	U-234	U-234	U-234	U-234	U-234
	Isotope 7	U-235	U-235	U-235	U-235	U-235
	Isotope 8	U-236	U-236	U-236	U-236	U-236
	Isotope 9	U-237	U-237	U-237	U-237	U-237
	Isotope 10	Np-237	Np-237	Np-237	Np-237	Np-237
	Isotope 11	Rb-87	Rb-87	Rb-87	Rb-87	Rb-87
	Isotope 12	Zr-93	Zr-93	Zr-93	Zr-93	Zr-93
	Isotope 13	Nb-93m	Nb-93m	Nb-93m	Nb-93m	Nb-93m
	Isotope 14	Nb-95m	Nb-95m	Nb-95m	Nb-95m	Nb-95m
	Isotope 15	Tc-99	Tc-99	Tc-99	Tc-99	Tc-99
	Isotope 16	Pm-147	Pm-147	Pm-147	Pm-147	Pm-147
NPSGRP	Number of Particle Size Groups	10	10	10	10	10
NRINTN	Number of Rain Intensity Breakpoints	3	3	3	3	3
NRNINT	Number of Rain Distance Intervals	5	5	5	5	5
NSBINS	Number of Weather Bins to Sample	36	36	36	36	36
NUCNAM	Radionuclide Names	See Table 4-3	See Table 4-3	See Table 4-3	See Table 4-3	See Table 4-3
NUCOUT	Radionuclide Used in Dispersion Print	Cs-137	Cs-137	Cs-137	Cs-137	Cs-137
NUMCOR	Number of Compass Sectors in the Grid	64	64	64	64	64
NUMISO	Number of Radionuclides	69	69	69	69	69
NUMRAD	Number of Radial Spatial Intervals	26	26	26	26	26
NUMREL	Number of Released Plume Segments	28	24	24	49	24
NUMSTB	Number of Defined Pseudo stable Radionuclides	16	16	16	16	16
OALARM	Time to Reach General Emergency Conditions	0	0	0	0	0
PDELAY	Plume Release Times	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)
PLHEAT	Plume Heat Contents	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)
PLHITE	Plume Release Heights	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)
PLMDEN	Plume Mass Density	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)
PLMFLA	Plume Mass Flow Rate	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)

Table A-1 ATMOS input parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
PLMMOD	Flag for Plume Rise Input Option	DENSITY	DENSITY	DENSITY	DENSITY	DENSITY
PLUDUR	Plume Segment Durations	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table A-2)
PSDIST	Particle Size Distribution by Group	MELMACCS Data (See Table A-3)	MELMACCS Data (See Table A-3)	MELMACCS Data (See Table A-3)	MELMACCS Data (See Table A-3)	MELMACCS Data (See Table A-3)
REFTIM	Plume Reference Time Point	0. for first 0.5 for subsequent	0. for first 0.5 for subsequent	0. for first 0.5 for subsequent	0. for first 0.5 for subsequent	0. for first 0.5 for subsequent
RELFRC	Release Fractions of the Source Term	MELMACCS Data (See Table A-4)	MELMACCS Data (See Table A-4)	MELMACCS Data (See Table A-4)	MELMACCS Data (See Table A-4)	MELMACCS Data (See Table A-4)
RNDSTS	Endpoints of Rain Distance Intervals					
	Interval 1	3.22	3.22	3.22	3.22	3.22
	Interval 2	5.63	5.63	5.63	5.63	5.63
	Interval 3	11.27	11.27	11.27	11.27	11.27
	Interval 4	20.92	20.92	20.92	20.92	20.92
	Interval 5	32.19	32.19	32.19	32.19	32.19
RNRATE	Rain Intensity Breakpoints for Weather Binning					
	Intensity 1	2	2	2	2	2
	Intensity 2	4	4	4	4	4
	Intensity 3	6	6	6	6	6
SCLADP	Scaling Factor for A-D Plume Rise	1.0	1.0	1.0	1.0	1.0
SCLCRW	Scaling Factor for Critical Wind Speed	1.0	1.0	1.0	1.0	1.0
SCLEFP	Scaling Factor for E-F Plume Rise	1.0	1.0	1.0	1.0	1.0
SIGYINIT	Initial Sigma-y for All Plume Segments	9.3	9.3	9.3	9.3	9.3
SIGZINIT	Initial Sigma-z for All Plume Segments	23.3	23.3	23.3	23.3	23.3
SPAEND	Radial distances for grid boundaries					
	Ring 1	0.16	0.16	0.16	0.16	0.16
	Ring 2	0.52	0.52	0.52	0.52	0.52
	Ring 3	1.21	1.21	1.21	1.21	1.21
	Ring 4	1.61	1.61	1.61	1.61	1.61
	Ring 5	2.13	2.13	2.13	2.13	2.13
	Ring 6	3.22	3.22	3.22	3.22	3.22
	Ring 7	4.02	4.02	4.02	4.02	4.02
	Ring 8	4.83	4.83	4.83	4.83	4.83
	Ring 9	5.63	5.63	5.63	5.63	5.63
	Ring 10	8.05	8.05	8.05	8.05	8.05
	Ring 11	11.27	11.27	11.27	11.27	11.27
	Ring 12	16.09	16.09	16.09	16.09	16.09

Table A-1 ATMOS input parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
SPAEND	Ring 13	20.92	20.92	20.92	20.92	20.92
	Ring 14	25.75	25.75	25.75	25.75	25.75
	Ring 15	32.19	32.19	32.19	32.19	32.19
	Ring 16	40.23	40.23	40.23	40.23	40.23
	Ring 17	48.28	48.28	48.28	48.28	48.28
	Ring 18	64.37	64.37	64.37	64.37	64.37
	Ring 19	80.47	80.47	80.47	80.47	80.47
	Ring 20	112.65	112.65	112.65	112.65	112.65
	Ring 21	160.93	160.93	160.93	160.93	160.93
	Ring 22	241.14	241.14	241.14	241.14	241.14
	Ring 23	321.87	321.87	321.87	321.87	321.87
	Ring 24	563.27	563.27	563.27	563.27	563.27
	Ring 25	804.67	804.67	804.67	804.67	804.67
	Ring 26	1609.34	1609.34	1609.34	1609.34	1609.34
TIMBAS	Time Base for Plume Expansion Factor	600	600	600	600	600
VDEPOS	Dry Deposition Velocities					
	Aerosol Bin 1	5.35E-04	5.35E-04	5.35E-04	5.35E-04	5.35E-04
	Aerosol Bin 2	4.91E-04	4.91E-04	4.91E-04	4.91E-04	4.91E-04
	Aerosol Bin 3	6.43E-04	6.43E-04	6.43E-04	6.43E-04	6.43E-04
	Aerosol Bin 4	1.08E-03	1.08E-03	1.08E-03	1.08E-03	1.08E-03
	Aerosol Bin 5	2.12E-03	2.12E-03	2.12E-03	2.12E-03	2.12E-03
	Aerosol Bin 6	4.34E-03	4.34E-03	4.34E-03	4.34E-03	4.34E-03
	Aerosol Bin 7	8.37E-03	8.37E-03	8.37E-03	8.37E-03	8.37E-03
	Aerosol Bin 8	1.37E-02	1.37E-02	1.37E-02	1.37E-02	1.37E-02
	Aerosol Bin 9	1.70E-02	1.70E-02	1.70E-02	1.70E-02	1.70E-02
	Aerosol Bin 10	1.70E-02	1.70E-02	1.70E-02	1.70E-02	1.70E-02
WETDEP	Wet Deposition Flag	Xe = .FALSE. Other groups = .TRUE.	Xe = .FALSE. Other groups = .TRUE.	Xe = .FALSE. Other groups = .TRUE.	Xe = .FALSE. Other groups = .TRUE.	Xe = .FALSE. Other groups = .TRUE.
XPFAC1	Base Time for Meander Expansion Factor	0.2	0.2	0.2	0.2	0.2
XPFAC2	Breakpoint for Expansion Factor Model	0.25	0.25	0.25	0.25	0.25
YSCALE	Scale Factor for Horizontal Dispersion	1	1	1	1	1
ZSCALE	Scale Factor for Vertical Dispersion	1.27	1.27	1.27	1.27	1.27

Table A-2 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios

Surry LTSBO						
Plume Segment	PDELAY	PLHEAT	PLHITE	PLMDEN	PLMFLA	PLUDUR
1	1.63E+05	5.11E+04	8.40E+00	1.77E-01	4.85E-01	3.60E+03
2	1.67E+05	1.14E+05	8.40E+00	3.89E-01	4.83E-01	3.60E+03
3	1.70E+05	2.07E+05	8.40E+00	7.01E-01	4.81E-01	3.60E+03
4	1.74E+05	3.05E+05	8.40E+00	1.02E+00	4.79E-01	3.60E+03
5	1.77E+05	3.81E+05	8.40E+00	1.27E+00	4.76E-01	3.72E+03
6	1.81E+05	4.44E+05	8.40E+00	1.46E+00	4.74E-01	3.48E+03
7	1.85E+05	4.82E+05	8.40E+00	1.57E+00	4.72E-01	3.60E+03
8	1.88E+05	5.07E+05	8.40E+00	1.63E+00	4.70E-01	3.60E+03
9	1.92E+05	5.25E+05	8.40E+00	1.67E+00	4.69E-01	3.60E+03
10	1.95E+05	5.38E+05	8.40E+00	1.70E+00	4.67E-01	3.60E+03
11	1.99E+05	5.48E+05	8.40E+00	1.72E+00	4.65E-01	3.60E+03
12	2.03E+05	5.59E+05	8.40E+00	1.73E+00	4.63E-01	3.60E+03
13	2.06E+05	5.71E+05	8.40E+00	1.76E+00	4.62E-01	3.60E+03
14	2.10E+05	5.75E+05	8.40E+00	1.75E+00	4.60E-01	3.60E+03
15	2.13E+05	5.79E+05	8.40E+00	1.75E+00	4.58E-01	3.60E+03
16	2.17E+05	5.85E+05	8.40E+00	1.75E+00	4.57E-01	3.60E+03
17	2.21E+05	5.94E+05	8.40E+00	1.77E+00	4.55E-01	3.60E+03
18	2.24E+05	6.02E+05	8.40E+00	1.78E+00	4.54E-01	3.60E+03
19	2.28E+05	6.11E+05	8.40E+00	1.79E+00	4.52E-01	3.60E+03
20	2.31E+05	6.17E+05	8.40E+00	1.80E+00	4.51E-01	3.60E+03
21	2.35E+05	6.22E+05	8.40E+00	1.80E+00	4.50E-01	3.60E+03
22	2.39E+05	6.33E+05	8.40E+00	1.81E+00	4.48E-01	3.60E+03
23	2.42E+05	6.56E+05	8.40E+00	1.81E+00	4.42E-01	3.60E+03
24	2.46E+05	6.52E+05	8.40E+00	1.76E+00	4.39E-01	3.60E+03
25	2.49E+05	6.46E+05	8.40E+00	1.71E+00	4.36E-01	3.60E+03
26	2.53E+05	6.37E+05	8.40E+00	1.66E+00	4.34E-01	3.72E+03
27	2.57E+05	6.30E+05	8.40E+00	1.62E+00	4.32E-01	2.40E+03
28	2.59E+05	6.27E+05	8.40E+00	1.60E+00	4.31E-01	1.20E+02

Table A-2 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry STSBO						
Plume Segment	PDELAY	PLHEAT	PLHITE	PLMDEN	PLMFLA	PLUDUR
1	9.19E+04	5.78E+04	8.40E+00	4.84E-01	1.97E-01	3.72E+03
2	9.56E+04	1.49E+05	8.40E+00	4.81E-01	5.03E-01	3.48E+03
3	9.91E+04	2.84E+05	8.40E+00	4.78E-01	9.44E-01	3.72E+03
4	1.03E+05	4.10E+05	8.40E+00	4.76E-01	1.35E+00	3.48E+03
5	1.06E+05	5.07E+05	8.40E+00	4.73E-01	1.64E+00	3.60E+03
6	1.10E+05	5.66E+05	8.40E+00	4.71E-01	1.81E+00	3.60E+03
7	1.14E+05	6.01E+05	8.40E+00	4.68E-01	1.90E+00	3.72E+03
8	1.17E+05	6.23E+05	8.40E+00	4.66E-01	1.95E+00	3.60E+03
9	1.21E+05	6.39E+05	8.40E+00	4.64E-01	1.97E+00	3.60E+03
10	1.24E+05	6.53E+05	8.40E+00	4.62E-01	2.00E+00	3.60E+03
11	1.28E+05	6.63E+05	8.40E+00	4.60E-01	2.01E+00	3.48E+03
12	1.32E+05	6.71E+05	8.40E+00	4.58E-01	2.01E+00	3.60E+03
13	1.35E+05	6.78E+05	8.40E+00	4.56E-01	2.01E+00	3.72E+03
14	1.39E+05	6.84E+05	8.40E+00	4.54E-01	2.01E+00	3.48E+03
15	1.42E+05	6.90E+05	8.40E+00	4.53E-01	2.01E+00	3.60E+03
16	1.46E+05	6.96E+05	8.40E+00	4.51E-01	2.01E+00	3.72E+03
17	1.50E+05	7.04E+05	8.40E+00	4.49E-01	2.02E+00	3.60E+03
18	1.53E+05	7.09E+05	8.40E+00	4.48E-01	2.02E+00	3.48E+03
19	1.57E+05	7.26E+05	8.40E+00	4.44E-01	2.01E+00	3.60E+03
20	1.60E+05	7.34E+05	8.40E+00	4.38E-01	1.96E+00	3.60E+03
21	1.64E+05	7.26E+05	8.40E+00	4.35E-01	1.90E+00	3.72E+03
22	1.68E+05	7.16E+05	8.40E+00	4.32E-01	1.84E+00	3.48E+03
23	1.71E+05	7.08E+05	8.40E+00	4.30E-01	1.80E+00	1.68E+03
24	1.73E+05	7.05E+05	8.40E+00	4.30E-01	1.78E+00	1.20E+02

Table A-2 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry ISLOCA						
Plume Segment	PDELAY	PLHEAT	PLHITE	PLMDEN	PLMFLA	PLUDUR
1	4.59E+04	3.65E+05	2.17E+01	1.07E+00	1.83E+01	4.20E+03
2	4.59E+04	3.65E+05	2.17E+01	1.07E+00	1.83E+01	4.20E+03
3	4.83E+04	7.72E+04	7.90E+00	8.94E-01	1.05E+00	4.20E+03
4	4.83E+04	2.66E+05	5.64E+00	5.77E-01	6.65E-01	4.20E+03
5	4.86E+04	5.34E+03	6.39E-01	4.54E-01	1.13E-02	3.90E+03
6	4.86E+04	7.64E+05	4.91E+00	5.51E-01	1.75E+00	3.90E+03
7	5.01E+04	5.28E+05	4.91E+00	5.10E-01	1.66E+00	3.00E+02
8	5.01E+04	6.68E+05	2.17E+01	1.00E+00	1.68E+01	3.30E+03
9	5.01E+04	6.68E+05	2.17E+01	1.00E+00	1.68E+01	3.30E+03
10	5.04E+04	4.32E+05	4.91E+00	5.09E-01	1.14E+00	3.00E+03
11	5.25E+04	4.90E+05	4.91E+00	6.22E-01	2.13E+00	3.60E+03
12	5.25E+04	6.64E+04	7.90E+00	9.09E-01	1.23E+00	3.60E+03
13	5.25E+04	1.92E+05	5.64E+00	5.99E-01	8.21E-01	3.60E+03
14	5.34E+04	4.39E+05	4.91E+00	3.72E-01	1.11E+00	3.60E+03
15	5.34E+04	4.47E+05	2.17E+01	1.04E+00	1.76E+01	3.90E+03
16	5.34E+04	4.47E+05	2.17E+01	1.04E+00	1.76E+01	3.90E+03
17	5.61E+04	4.13E+05	4.91E+00	6.57E-01	2.03E+00	3.60E+03
18	5.61E+04	6.61E+04	7.90E+00	9.11E-01	1.21E+00	3.60E+03
19	5.61E+04	1.56E+05	5.64E+00	6.86E-01	8.55E-01	3.60E+03
20	5.70E+04	5.58E+04	4.91E+00	4.25E-01	1.47E-01	3.60E+03
21	5.73E+04	2.91E+05	2.17E+01	1.08E+00	1.75E+01	3.30E+03
22	5.73E+04	2.91E+05	2.17E+01	1.08E+00	1.75E+01	3.30E+03
23	5.97E+04	1.67E+04	4.91E+00	1.07E+00	8.97E-01	3.60E+03
24	5.97E+04	2.33E+04	7.90E+00	1.03E+00	8.08E-01	3.60E+03
25	5.97E+04	1.34E+04	5.64E+00	1.06E+00	6.77E-01	3.60E+03
26	6.06E+04	1.58E+04	2.17E+01	1.15E+00	1.83E+01	3.90E+03
27	6.06E+04	1.58E+04	2.17E+01	1.15E+00	1.83E+01	3.90E+03
28	6.45E+04	-2.35E+04	2.17E+01	1.16E+00	1.82E+01	3.30E+03
29	6.45E+04	-2.35E+04	2.17E+01	1.16E+00	1.82E+01	3.30E+03
30	7.02E+04	3.67E+02	4.91E+00	1.14E+00	5.20E-02	3.60E+03
31	7.02E+04	4.58E+03	7.90E+00	1.12E+00	3.38E-01	3.60E+03
32	7.02E+04	4.68E+02	5.64E+00	1.16E+00	2.11E-01	3.60E+03
33	7.17E+04	8.31E+00	1.20E+00	8.27E-01	5.62E-05	3.60E+03
34	7.17E+04	6.12E+04	3.38E+00	1.12E+00	7.11E+00	3.30E+03
35	7.50E+04	5.92E+04	3.38E+00	1.12E+00	7.12E+00	3.90E+03
36	7.53E+04	1.03E+01	1.20E+00	8.56E-01	1.19E-04	3.60E+03
37	7.89E+04	1.30E+01	1.20E+00	8.51E-01	1.39E-04	3.60E+03
38	7.89E+04	5.68E+04	3.38E+00	1.12E+00	7.13E+00	3.60E+03
39	8.10E+04	1.35E+03	4.91E+00	1.12E+00	1.80E-01	3.60E+03
40	8.10E+04	5.49E+02	5.64E+00	1.14E+00	1.38E-01	3.60E+03
41	8.22E+04	4.76E+02	4.91E+00	9.18E-01	1.47E-01	3.60E+03
42	8.25E+04	1.63E+01	1.20E+00	8.39E-01	1.50E-04	3.60E+03
43	8.25E+04	5.54E+04	3.38E+00	1.12E+00	7.14E+00	3.30E+03
44	8.46E+04	1.51E+03	4.91E+00	1.12E+00	1.60E-01	3.60E+03
45	8.46E+04	5.91E+02	5.64E+00	1.15E+00	1.52E-01	3.60E+03
46	8.58E+04	5.41E+04	3.38E+00	1.12E+00	7.65E+00	4.20E+03

Table A-2 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry ISLOCA						
Plume Segment	PDELAY	PLHEAT	PLHITE	PLMDEN	PLMFLA	PLUDUR
47	9.00E+04	5.16E+04	3.38E+00	1.12E+00	7.15E+00	3.60E+03
48	9.18E+04	3.12E+03	4.91E+00	1.14E+00	2.60E-01	4.35E+03
49	9.36E+04	2.07E+03	4.91E+00	1.04E+00	6.92E-02	3.60E+03
50	9.36E+04	5.03E+04	3.38E+00	1.12E+00	7.16E+00	3.60E+03
51	9.62E+04	3.43E+03	4.91E+00	1.12E+00	4.74E-01	3.75E+03
52	9.62E+04	1.16E+03	5.64E+00	1.13E+00	1.93E-01	3.75E+03
53	9.72E+04	4.88E+04	3.38E+00	1.12E+00	7.17E+00	3.60E+03
54	1.01E+05	4.70E+04	3.38E+00	1.13E+00	7.17E+00	3.60E+03
55	1.03E+05	3.37E+03	4.91E+00	1.12E+00	3.66E-01	4.50E+03
56	1.04E+05	4.53E+04	3.38E+00	1.13E+00	7.18E+00	3.60E+03
57	1.07E+05	5.20E+03	4.91E+00	1.10E+00	5.49E-01	2.70E+03
58	1.08E+05	4.48E+04	3.38E+00	1.13E+00	7.18E+00	3.60E+03
59	1.10E+05	6.56E+03	4.91E+00	1.11E+00	6.23E-01	4.50E+03
60	1.12E+05	4.27E+04	3.38E+00	1.13E+00	7.19E+00	3.60E+03
61	1.14E+05	8.29E+03	4.91E+00	1.13E+00	6.96E-01	3.60E+03
62	1.15E+05	4.04E+04	3.38E+00	1.13E+00	7.20E+00	3.60E+03
63	1.18E+05	1.41E+04	4.91E+00	1.12E+00	7.79E-01	3.60E+03
64	1.18E+05	4.19E+03	5.64E+00	1.12E+00	2.50E-01	3.60E+03
65	1.19E+05	3.78E+04	3.38E+00	1.13E+00	7.21E+00	3.60E+03
66	1.22E+05	2.59E+04	4.91E+00	1.07E+00	9.14E-01	3.60E+03
67	1.22E+05	7.68E+03	5.64E+00	1.07E+00	3.05E-01	3.60E+03
68	1.22E+05	6.05E+03	4.91E+00	9.36E-01	2.44E-01	3.60E+03
69	1.25E+05	2.95E+04	4.91E+00	1.04E+00	9.47E-01	2.70E+03
70	1.25E+05	8.85E+03	5.64E+00	1.02E+00	3.20E-01	2.70E+03
71	1.26E+05	9.16E+03	4.91E+00	8.37E-01	2.63E-01	3.60E+03
72	1.28E+05	3.05E+04	4.91E+00	1.08E+00	9.52E-01	4.50E+03
73	1.28E+05	5.90E+03	7.90E+00	1.10E+00	3.51E-01	4.50E+03
74	1.28E+05	9.19E+03	5.64E+00	1.06E+00	3.22E-01	4.50E+03
75	1.30E+05	1.78E+04	4.91E+00	8.29E-01	3.61E-01	3.60E+03
76	1.30E+05	3.40E+04	3.38E+00	1.14E+00	7.23E+00	3.60E+03
77	1.32E+05	4.56E+04	4.91E+00	1.02E+00	1.06E+00	2.70E+03
78	1.32E+05	8.92E+03	7.90E+00	1.09E+00	4.36E-01	2.70E+03
79	1.33E+05	3.27E+04	4.91E+00	8.54E-01	6.85E-01	3.60E+03
80	1.35E+05	4.78E+04	4.91E+00	1.06E+00	1.10E+00	3.60E+03
81	1.35E+05	1.02E+04	7.90E+00	1.08E+00	4.68E-01	3.60E+03
82	1.35E+05	1.51E+04	5.64E+00	1.01E+00	3.96E-01	3.60E+03
83	1.37E+05	3.49E+04	4.91E+00	8.44E-01	7.07E-01	3.60E+03
84	1.39E+05	4.88E+04	4.91E+00	1.09E+00	1.11E+00	3.60E+03
85	1.39E+05	1.56E+04	5.64E+00	1.07E+00	4.05E-01	3.60E+03
86	1.40E+05	3.80E+04	4.91E+00	8.90E-01	7.59E-01	3.60E+03
87	1.42E+05	5.31E+04	4.91E+00	1.05E+00	1.16E+00	4.50E+03
88	1.42E+05	1.72E+04	5.64E+00	1.02E+00	4.22E-01	4.50E+03
89	1.44E+05	4.67E+04	4.91E+00	8.54E-01	9.27E-01	3.60E+03
90	1.47E+05	5.61E+04	4.91E+00	1.01E+00	1.19E+00	2.70E+03
91	1.48E+05	5.53E+04	4.91E+00	8.60E-01	1.09E+00	3.60E+03
92	1.49E+05	5.79E+04	4.91E+00	1.06E+00	1.22E+00	3.60E+03

Table A-2 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry ISLOCA						
Plume Segment	PDELAY	PLHEAT	PLHITE	PLMDEN	PLMFLA	PLUDUR
93	1.51E+05	5.47E+04	4.91E+00	8.62E-01	1.08E+00	3.60E+03
94	1.53E+05	5.64E+04	4.91E+00	1.08E+00	1.21E+00	3.60E+03
95	1.55E+05	5.22E+04	4.91E+00	8.62E-01	1.04E+00	3.60E+03
96	1.57E+05	5.42E+04	4.91E+00	1.10E+00	1.19E+00	3.60E+03
97	1.58E+05	5.03E+04	4.91E+00	8.64E-01	1.02E+00	3.60E+03
98	1.60E+05	4.98E+04	4.91E+00	1.05E+00	1.14E+00	4.50E+03
99	1.60E+05	1.27E+04	7.90E+00	1.08E+00	5.15E-01	4.50E+03
100	1.60E+05	1.65E+04	5.64E+00	1.03E+00	4.25E-01	4.50E+03
101	1.62E+05	3.94E+04	4.91E+00	8.64E-01	8.23E-01	3.60E+03
102	1.62E+05	2.78E+04	3.38E+00	1.14E+00	7.27E+00	3.60E+03
103	1.65E+05	3.89E+04	4.91E+00	1.08E+00	9.95E-01	2.70E+03
104	1.65E+05	1.06E+04	7.90E+00	1.08E+00	4.70E-01	2.70E+03
105	1.66E+05	2.81E+04	4.91E+00	8.65E-01	6.22E-01	3.60E+03
106	1.67E+05	3.70E+04	4.91E+00	1.11E+00	9.62E-01	3.60E+03
107	1.69E+05	2.69E+04	4.91E+00	8.69E-01	6.18E-01	3.60E+03

Table A-2 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry Mitigated TISGTR						
Plume Segment	PDELAY	PLHEAT	PLHITE	PLMDEN	PLMFLA	PLUDUR
1	10600	4.32E+01	8.4	0.73919	4.11E-04	3619.6
2	12800	8.88E+05	24.643	0.29498	1.0716	3639.9
3	14220	8.97E+01	8.4	0.6666	7.40E-04	3600.4
4	16440	6.76E+04	24.643	0.3208	0.091864	3600.1
5	17820	1.12E+02	8.4	0.64171	8.13E-04	3599.9
6	20040	6.10E+04	24.643	0.2937	0.08302	3599.9
7	21420	1.28E+02	8.4	0.62148	8.23E-04	3600
8	23640	5.47E+04	24.643	0.28461	0.074318	3600
9	25020	1.48E+02	8.4	0.60385	8.97E-04	3599.9
10	27240	5.95E+04	24.643	0.33478	0.088723	3600.1
11	28620	1.21E+02	8.4	0.6199	8.26E-04	3660.1
12	30840	4.60E+04	24.643	0.33994	0.069402	3600.1
13	34440	2.31E+04	24.643	0.3649	0.039585	3599.9
14	38040	7.49E+03	24.643	0.40498	0.01627	3600
15	41640	3.83E+02	24.643	0.71955	0.002878	3600
16	52440	1.49E+03	24.643	0.71162	0.007903	3600
17	56040	1.24E+04	24.643	0.50849	0.036427	3599.9
18	59640	2.03E+04	24.643	0.42415	0.045113	3600.2
19	63240	2.50E+04	24.643	0.41032	0.05232	3599.9
20	66840	2.88E+04	24.643	0.40342	0.058182	3600
21	70440	3.23E+04	24.643	0.39798	0.063655	3600.1
22	74040	3.58E+04	24.643	0.39336	0.069014	3599.8
23	77640	3.92E+04	24.643	0.38949	0.074187	3600
24	81240	4.26E+04	24.643	0.38619	0.079248	3600.2
25	84840	4.41E+04	24.643	0.38476	0.081656	3599.9
26	88440	4.63E+04	24.643	0.3831	0.085028	3600
27	92040	4.86E+04	24.643	0.38153	0.088779	3599.9
28	95640	5.10E+04	24.643	0.38011	0.09261	3600
29	99240	5.34E+04	24.643	0.37894	0.096455	3600.1
30	1.03E+05	5.58E+04	24.643	0.37793	0.10035	3600.1
31	1.06E+05	5.83E+04	24.643	0.37704	0.10438	3600
32	1.10E+05	6.08E+04	24.643	0.3762	0.10847	3599.9
33	1.14E+05	6.33E+04	24.643	0.37533	0.11268	3600.1
34	1.17E+05	6.58E+04	24.643	0.37489	0.11697	3600.1
35	1.21E+05	6.83E+04	24.643	0.37457	0.12131	3599.8
36	1.24E+05	7.09E+04	24.643	0.37437	0.12571	3600
37	1.28E+05	7.34E+04	24.643	0.37426	0.13016	3600.1
38	1.32E+05	7.59E+04	24.643	0.37422	0.13468	3600
39	1.35E+05	7.84E+04	24.643	0.37428	0.13924	3600
40	1.39E+05	8.09E+04	24.643	0.37442	0.14384	3599.9
41	1.42E+05	8.33E+04	24.643	0.37464	0.14848	3600.2
42	1.46E+05	8.58E+04	24.643	0.37494	0.15318	3599.9
43	1.50E+05	8.82E+04	24.643	0.3753	0.15791	3600.1
44	1.53E+05	9.06E+04	24.643	0.37573	0.16268	3599.9
45	1.57E+05	9.30E+04	24.643	0.37623	0.1675	3599.8
46	1.60E+05	9.53E+04	24.643	0.37687	0.17236	3600.3
47	1.64E+05	9.76E+04	24.643	0.37757	0.17724	3599.7

Table A-2 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry Mitigated TISGTR						
Plume Segment	PDELAY	PLHEAT	PLHITE	PLMDEN	PLMFLA	PLUDUR
48	1.68E+05	9.98E+04	24.643	0.37832	0.18216	3600.1
49	1.71E+05	1.01E+05	24.643	0.37889	0.1857	1560.1

Table A-2 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry Unmitigated TISGTR						
Plume Segment	PDELAY	PLHEAT	PLHITE	PLMDEN	PLMFLA	PLUDUR
1	10600	4.32E+01	8.4	7.39E-01	4.11E-04	3619.6
2	12800	8.88E+05	24.643	2.95E-01	1.07E+00	3639.9
3	14220	8.97E+01	8.4	6.67E-01	7.40E-04	3600.4
4	16440	6.76E+04	24.643	3.21E-01	9.19E-02	3600.1
5	17820	1.12E+02	8.4	6.42E-01	8.13E-04	3599.9
6	20040	6.10E+04	24.643	2.94E-01	8.30E-02	3599.9
7	21420	1.28E+02	8.4	6.21E-01	8.23E-04	3600
8	23640	5.47E+04	24.643	2.85E-01	7.43E-02	3600
9	25020	1.48E+02	8.4	6.04E-01	8.97E-04	3599.9
10	27240	6.21E+04	24.643	3.45E-01	9.66E-02	3600
11	28620	2.00E+02	8.4	5.80E-01	1.08E-03	3660
12	30840	6.41E+04	24.643	3.64E-01	1.06E-01	3600
13	32280	2.26E+02	8.4	5.66E-01	1.12E-03	3600.2
14	34440	6.88E+04	24.643	3.62E-01	1.12E-01	3600.1
15	35880	2.45E+02	8.4	5.60E-01	1.18E-03	3600
16	38040	7.38E+04	24.643	3.58E-01	1.18E-01	3600.1
17	39480	2.63E+02	8.4	5.55E-01	1.24E-03	3600
18	41640	7.87E+04	24.643	3.55E-01	1.24E-01	3599.9
19	43080	2.85E+02	8.4	5.49E-01	1.31E-03	3600
20	45240	8.38E+04	24.643	3.53E-01	1.29E-01	3600.1
21	46680	3.07E+02	8.4	5.43E-01	1.37E-03	3600.1
22	48840	8.93E+04	24.643	3.55E-01	1.36E-01	3600.1
23	50280	3.30E+02	8.4	5.39E-01	1.43E-03	3600
24	52440	9.51E+04	24.643	3.52E-01	1.42E-01	3599.8
25	53880	3.54E+02	8.4	5.35E-01	1.51E-03	3600
26	56040	1.01E+05	24.643	3.48E-01	1.49E-01	3600
27	57480	3.80E+02	8.4	5.31E-01	1.60E-03	3599.9
28	59640	1.08E+05	24.643	3.45E-01	1.55E-01	3600
29	61080	4.06E+02	8.4	5.28E-01	1.66E-03	3600
30	63240	1.15E+05	24.643	3.42E-01	1.63E-01	3600.1
31	64680	4.33E+02	8.4	5.24E-01	1.74E-03	3599.8
32	66840	1.22E+05	24.643	3.39E-01	1.70E-01	3600
33	68280	4.62E+02	8.4	5.21E-01	1.83E-03	3600.3
34	70440	1.29E+05	24.643	3.36E-01	1.78E-01	3599.9
35	71880	4.91E+02	8.4	5.18E-01	1.92E-03	3599.9
36	74040	1.37E+05	24.643	3.33E-01	1.86E-01	3600.1
37	75480	5.21E+02	8.4	5.14E-01	2.01E-03	3600
38	77640	1.45E+05	24.643	3.31E-01	1.95E-01	3600
39	79080	5.53E+02	8.4	5.11E-01	2.10E-03	3600
40	81240	1.53E+05	24.643	3.29E-01	2.03E-01	3600.1
41	82680	5.84E+02	8.4	5.08E-01	2.18E-03	3599.8
42	84840	1.61E+05	24.643	3.27E-01	2.12E-01	3599.8
43	86280	6.16E+02	8.4	5.05E-01	2.27E-03	3600.3
44	88440	1.68E+05	24.643	3.26E-01	2.20E-01	3600.2
45	89880	6.49E+02	8.4	5.02E-01	2.36E-03	3600
46	92040	1.76E+05	24.643	3.24E-01	2.29E-01	3599.9

Table A-2 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry Unmitigated TISGTR						
Plume Segment	PDELAY	PLHEAT	PLHITE	PLMDEN	PLMFLA	PLUDUR
47	93480	6.82E+02	8.4	4.99E-01	2.45E-03	3599.8
48	95640	1.85E+05	24.643	3.23E-01	2.38E-01	3599.8
49	97080	7.16E+02	8.4	4.97E-01	2.55E-03	3600
50	99240	1.93E+05	24.643	3.22E-01	2.47E-01	3600.3
51	1.00E+05	4.91E+04	8.4	4.94E-01	1.72E-01	3720
52	1.01E+05	7.49E+02	8.4	4.94E-01	2.63E-03	3600
53	1.03E+05	2.00E+05	24.643	3.21E-01	2.55E-01	3600
54	1.04E+05	1.57E+05	8.4	4.91E-01	5.45E-01	3480.1
55	1.04E+05	7.79E+02	8.4	4.91E-01	2.71E-03	3600.1
56	1.06E+05	2.06E+05	24.643	3.20E-01	2.62E-01	3600
57	1.08E+05	2.85E+05	8.4	4.89E-01	9.81E-01	3720
58	1.08E+05	8.02E+02	8.4	4.89E-01	2.76E-03	3600.1
59	1.10E+05	2.11E+05	24.643	3.20E-01	2.67E-01	3600
60	1.11E+05	4.00E+05	8.4	4.87E-01	1.36E+00	3599.9
61	1.11E+05	8.20E+02	8.4	4.87E-01	2.79E-03	3600
62	1.14E+05	2.13E+05	24.643	3.19E-01	2.70E-01	3600
63	1.15E+05	4.77E+05	8.4	4.85E-01	1.61E+00	3480.3
64	1.15E+05	8.33E+02	8.4	4.85E-01	2.79E-03	3561.3
65	1.17E+05	2.15E+05	24.643	3.18E-01	2.71E-01	3600
66	1.18E+05	5.32E+05	8.4	4.83E-01	1.77E+00	3719.9
67	1.19E+05	8.45E+02	8.4	4.83E-01	2.86E-03	3638.5
68	1.21E+05	2.17E+05	24.643	3.18E-01	2.72E-01	3599.8
69	1.22E+05	5.65E+05	8.4	4.81E-01	1.86E+00	3599.8
70	1.22E+05	8.53E+02	8.4	4.81E-01	2.82E-03	3600.1
71	1.24E+05	2.18E+05	24.643	3.17E-01	2.73E-01	3600.2
72	1.26E+05	5.85E+05	8.4	4.79E-01	1.91E+00	3600.2
73	1.26E+05	8.61E+02	8.4	4.79E-01	2.81E-03	3600.1
74	1.28E+05	2.19E+05	24.643	3.17E-01	2.73E-01	3599.9
75	1.29E+05	5.98E+05	8.4	4.77E-01	1.94E+00	3480
76	1.29E+05	8.68E+02	8.4	4.77E-01	2.81E-03	3600
77	1.32E+05	2.19E+05	24.643	3.16E-01	2.74E-01	3600
78	1.33E+05	6.08E+05	8.4	4.75E-01	1.95E+00	3600.1
79	1.33E+05	8.74E+02	8.4	4.75E-01	2.81E-03	3599.7
80	1.35E+05	2.20E+05	24.643	3.16E-01	2.74E-01	3600.1
81	1.36E+05	6.17E+05	8.4	4.73E-01	1.97E+00	3599.9
82	1.37E+05	8.80E+02	8.4	4.73E-01	2.80E-03	3600.1
83	1.39E+05	2.20E+05	24.643	3.16E-01	2.74E-01	3600
84	1.40E+05	6.26E+05	8.4	4.72E-01	1.98E+00	3720.1
85	1.40E+05	8.87E+02	8.4	4.72E-01	2.80E-03	3600
86	1.42E+05	2.21E+05	24.643	3.15E-01	2.74E-01	3599.9
87	1.44E+05	6.60E+05	8.4	4.67E-01	2.03E+00	3479.8
88	1.44E+05	9.08E+02	8.4	4.67E-01	2.78E-03	3600.1
89	1.46E+05	2.19E+05	24.643	3.15E-01	2.71E-01	3599.8
90	1.47E+05	6.75E+05	8.4	4.62E-01	2.01E+00	3720.1
91	1.47E+05	9.18E+02	8.4	4.62E-01	2.73E-03	3600
92	1.50E+05	2.15E+05	24.643	3.15E-01	2.67E-01	3600.3

Table A-2 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry Unmitigated TISGTR						
Plume Segment	**PDELAY**	**PLHEAT**	**PLHITE**	**PLMDEN**	**PLMFLA**	**PLUDUR**
93	1.51E+05	6.74E+05	8.4	4.60E-01	1.97E+00	3479.9
94	1.51E+05	9.15E+02	8.4	4.60E-01	2.67E-03	3600
95	1.53E+05	2.12E+05	24.643	3.14E-01	2.62E-01	3599.7
96	1.54E+05	6.72E+05	8.4	4.57E-01	1.94E+00	3600
97	1.55E+05	9.11E+02	8.4	4.57E-01	2.62E-03	3600
98	1.57E+05	2.08E+05	24.643	3.14E-01	2.57E-01	3600.4
99	1.58E+05	6.69E+05	8.4	4.55E-01	1.90E+00	3600.2
100	1.58E+05	9.05E+02	8.4	4.55E-01	2.57E-03	3600.1
101	1.60E+05	2.05E+05	24.643	3.14E-01	2.52E-01	3599.6
102	1.62E+05	6.65E+05	8.4	4.53E-01	1.86E+00	3719.9
103	1.62E+05	8.98E+02	8.4	4.53E-01	2.51E-03	3599.8
104	1.64E+05	2.01E+05	24.643	3.14E-01	2.48E-01	3600
105	1.65E+05	6.60E+05	8.4	4.51E-01	1.83E+00	3480
106	1.65E+05	8.90E+02	8.4	4.51E-01	2.46E-03	3600.3
107	1.68E+05	1.98E+05	24.643	3.13E-01	2.43E-01	3600.3
108	1.69E+05	6.55E+05	8.4	4.49E-01	1.79E+00	3600
109	1.69E+05	8.82E+02	8.4	4.49E-01	2.41E-03	3599.8
110	1.71E+05	1.95E+05	24.643	3.13E-01	2.40E-01	1559.9
111	1.72E+05	6.52E+05	8.4	4.49E-01	1.77E+00	359.91
112	1.73E+05	8.77E+02	8.4	4.48E-01	2.38E-03	120
113	1.73E+05	6.52E+05	8.4	4.48E-01	1.77E+00	119.89
114	1.73E+05	8.78E+02	8.4	4.48E-01	2.38E-03	119.89
115	1.73E+05	1.95E+05	24.643	3.13E-01	2.38E-01	119.89

Table A-3 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios

Surry LTSBO										
Class	**Bin 1**	**Bin 2**	**Bin 3**	**Bin 4**	**Bin 5**	**Bin 6**	**Bin 7**	**Bin 8**	**Bin 9**	**Bin 10**
Xe	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01
Cs	1.73E-03	1.26E-02	6.19E-02	2.00E-01	3.36E-01	2.52E-01	1.09E-01	2.37E-02	2.32E-03	1.05E-03
Ba	6.94E-03	3.56E-02	1.35E-01	3.69E-01	3.45E-01	8.98E-02	1.49E-02	2.50E-03	2.54E-04	3.58E-04
I	6.47E-03	3.22E-02	1.21E-01	3.28E-01	3.57E-01	1.32E-01	1.85E-02	1.95E-03	3.19E-04	1.44E-03
Te	7.53E-03	3.45E-02	1.31E-01	3.49E-01	3.40E-01	1.14E-01	1.86E-02	2.44E-03	2.44E-04	1.34E-03
Ru	8.80E-03	3.73E-02	1.35E-01	3.24E-01	3.13E-01	1.27E-01	2.71E-02	1.02E-02	3.38E-03	1.40E-02
Mo	2.39E-04	3.89E-03	2.78E-02	1.01E-01	2.67E-01	3.30E-01	1.98E-01	6.34E-02	8.46E-03	3.76E-04
Ce	7.52E-03	3.22E-02	1.15E-01	2.85E-01	3.34E-01	1.73E-01	3.59E-02	7.97E-03	1.65E-03	8.02E-03
La	4.89E-03	2.37E-02	9.23E-02	2.54E-01	3.44E-01	2.04E-01	6.15E-02	1.20E-02	1.34E-03	2.86E-03

Table A-3 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry STSBO										
Class	**Bin 1**	**Bin 2**	**Bin 3**	**Bin 4**	**Bin 5**	**Bin 6**	**Bin 7**	**Bin 8**	**Bin 9**	**Bin 10**
Xe	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01
Cs	1.22E-03	1.01E-02	5.26E-02	1.73E-01	3.33E-01	2.86E-01	1.21E-01	2.05E-02	1.15E-03	1.19E-03
Ba	7.02E-03	3.61E-02	1.42E-01	3.43E-01	3.18E-01	1.19E-01	2.65E-02	3.58E-03	2.58E-04	4.40E-03
I	6.19E-03	2.94E-02	1.06E-01	2.66E-01	3.44E-01	2.03E-01	3.96E-02	2.54E-03	1.97E-04	2.36E-03
Te	4.03E-03	2.31E-02	9.45E-02	2.70E-01	3.62E-01	1.94E-01	4.57E-02	4.65E-03	2.33E-04	1.50E-03
Ru	5.15E-03	2.69E-02	1.07E-01	2.75E-01	3.43E-01	1.80E-01	4.05E-02	6.86E-03	1.67E-03	1.36E-02
Mo	2.51E-04	4.22E-03	3.10E-02	1.14E-01	2.91E-01	3.42E-01	1.78E-01	3.66E-02	2.37E-03	9.36E-05
Ce	5.06E-03	2.57E-02	9.95E-02	2.57E-01	3.41E-01	2.04E-01	4.92E-02	6.85E-03	1.30E-03	9.52E-03
La	3.14E-03	1.80E-02	7.61E-02	2.18E-01	3.44E-01	2.45E-01	8.08E-02	1.18E-02	7.95E-04	2.68E-03

Table A-3 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry ISLOCA										
Class	Bin 1	Bin 2	Bin 3	Bin 4	Bin 5	Bin 6	Bin 7	Bin 8	Bin 9	Bin 10
Xe	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01
Cs	9.37E-03	2.56E-02	6.96E-02	2.73E-01	4.01E-01	1.78E-01	4.04E-02	2.62E-03	4.33E-05	5.48E-04
Ba	2.23E-02	4.72E-02	1.38E-01	2.92E-01	3.24E-01	1.41E-01	3.05E-02	2.46E-03	7.74E-05	2.58E-03
I	9.15E-03	2.41E-02	7.56E-02	2.81E-01	3.96E-01	1.72E-01	3.85E-02	2.53E-03	4.28E-05	6.21E-04
Te	1.28E-02	3.01E-02	8.65E-02	2.83E-01	3.82E-01	1.65E-01	3.72E-02	2.50E-03	4.58E-05	5.42E-04
Ru	1.13E-02	3.05E-02	9.69E-02	2.91E-01	3.75E-01	1.59E-01	3.34E-02	2.13E-03	3.54E-05	4.80E-04
Mo	1.02E-02	2.46E-02	6.13E-02	2.34E-01	3.80E-01	2.16E-01	6.41E-02	8.89E-03	7.41E-04	3.93E-04
Ce	7.90E-03	3.31E-02	2.20E-01	4.00E-01	1.92E-01	8.59E-02	4.09E-02	1.27E-02	1.26E-03	6.03E-03
La	2.07E-02	4.49E-02	2.46E-01	3.92E-01	1.74E-01	7.55E-02	3.43E-02	9.34E-03	8.08E-04	2.15E-03

Table A-3 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry Mitigated TISGTR										
Class	Bin 1	Bin 2	Bin 3	Bin 4	Bin 5	Bin 6	Bin 7	Bin 8	Bin 9	Bin 10
Xe	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01
Cs	2.39E-02	3.93E-02	6.33E-02	2.06E-01	3.47E-01	2.16E-01	7.68E-02	2.30E-02	4.35E-03	6.63E-04
Ba	1.29E-02	1.87E-02	5.47E-02	2.44E-01	4.15E-01	1.96E-01	4.50E-02	1.17E-02	2.38E-03	3.65E-04
I	3.45E-02	4.99E-02	6.35E-02	2.09E-01	3.47E-01	2.03E-01	6.82E-02	2.00E-02	3.72E-03	5.92E-04
Te	1.50E-02	2.65E-02	5.69E-02	2.17E-01	3.69E-01	2.16E-01	7.29E-02	2.20E-02	4.16E-03	6.11E-04
Ru	1.60E-03	5.33E-03	3.94E-02	2.20E-01	4.24E-01	2.24E-01	6.31E-02	1.87E-02	3.45E-03	4.43E-04
Mo	1.61E-02	5.22E-02	6.90E-02	2.98E-01	4.12E-01	1.16E-01	2.79E-02	6.85E-03	1.28E-03	1.92E-04
Ce	1.27E-03	8.45E-03	7.31E-02	2.80E-01	4.20E-01	1.79E-01	2.96E-02	7.03E-03	2.00E-03	2.70E-04
La	8.71E-03	2.82E-02	8.14E-02	2.99E-01	4.07E-01	1.45E-01	2.36E-02	5.32E-03	1.43E-03	1.89E-04

Table A-3 Plume parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry Unmitigated TISGTR										
Class	**Bin 1**	**Bin 2**	**Bin 3**	**Bin 4**	**Bin 5**	**Bin 6**	**Bin 7**	**Bin 8**	**Bin 9**	**Bin 10**
Xe	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01
Cs	4.84E-03	1.55E-02	5.85E-02	1.91E-01	4.04E-01	2.69E-01	5.05E-02	5.54E-03	7.83E-04	1.17E-04
Ba	6.37E-03	2.58E-02	8.09E-02	2.35E-01	3.81E-01	2.25E-01	4.35E-02	2.94E-03	2.34E-04	4.00E-05
I	1.14E-02	2.75E-02	6.76E-02	2.02E-01	3.54E-01	2.49E-01	7.56E-02	1.12E-02	1.36E-03	2.20E-04
Te	8.56E-03	2.61E-02	7.12E-02	2.00E-01	3.56E-01	2.59E-01	7.19E-02	7.63E-03	6.94E-04	1.06E-04
Ru	1.80E-03	6.34E-03	4.20E-02	2.21E-01	4.19E-01	2.23E-01	6.39E-02	1.89E-02	3.48E-03	4.41E-04
Mo	3.95E-03	1.86E-02	6.60E-02	1.76E-01	3.29E-01	2.92E-01	1.04E-01	1.05E-02	3.31E-04	8.27E-05
Ce	4.18E-03	2.17E-02	9.15E-02	2.48E-01	3.59E-01	2.03E-01	5.65E-02	1.35E-02	2.38E-03	2.42E-04
La	2.27E-03	1.47E-02	6.50E-02	2.00E-01	3.99E-01	2.64E-01	5.12E-02	3.73E-03	2.51E-04	2.79E-05

Table A-4 Release fraction parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios

Surry LTSBO									
Plume Segment	Xe	Cs	Ba	I	Te	Ru	Mo	Ce	La
1	3.36E-03	3.50E-06	5.31E-07	3.62E-05	5.09E-05	7.77E-08	2.69E-07	1.93E-07	1.21E-08
2	7.20E-03	7.08E-06	1.03E-06	7.43E-05	1.04E-04	1.52E-07	5.22E-07	3.77E-07	2.42E-08
3	1.27E-02	1.17E-05	1.64E-06	1.24E-04	1.75E-04	2.44E-07	8.35E-07	6.06E-07	3.96E-08
4	1.80E-02	1.55E-05	2.17E-06	1.66E-04	2.36E-04	3.18E-07	1.09E-06	7.92E-07	5.28E-08
5	2.24E-02	1.79E-05	2.51E-06	1.94E-04	2.79E-04	3.63E-07	1.23E-06	9.05E-07	6.15E-08
6	2.35E-02	1.76E-05	2.47E-06	1.91E-04	2.78E-04	3.50E-07	1.19E-06	8.74E-07	6.07E-08
7	2.55E-02	1.79E-05	2.52E-06	1.96E-04	2.87E-04	3.50E-07	1.18E-06	8.75E-07	6.20E-08
8	2.59E-02	1.71E-05	2.41E-06	1.88E-04	2.79E-04	3.27E-07	1.10E-06	8.20E-07	5.94E-08
9	2.58E-02	1.60E-05	2.27E-06	1.78E-04	2.66E-04	3.02E-07	1.01E-06	7.57E-07	5.62E-08
10	2.54E-02	1.49E-05	2.12E-06	1.67E-04	2.54E-04	2.76E-07	9.16E-07	6.93E-07	5.27E-08
11	2.50E-02	1.39E-05	1.98E-06	1.57E-04	2.42E-04	2.51E-07	8.29E-07	6.33E-07	4.94E-08
12	2.45E-02	1.29E-05	1.86E-06	1.48E-04	2.32E-04	2.29E-07	7.50E-07	5.79E-07	4.64E-08
13	2.42E-02	1.21E-05	1.75E-06	1.40E-04	2.25E-04	2.10E-07	6.81E-07	5.32E-07	4.38E-08
14	2.34E-02	1.12E-05	1.62E-06	1.30E-04	2.16E-04	1.90E-07	6.09E-07	4.82E-07	4.08E-08
15	2.27E-02	1.04E-05	1.52E-06	1.22E-04	2.09E-04	1.72E-07	5.45E-07	4.37E-07	3.81E-08
16	2.21E-02	9.69E-06	1.42E-06	1.15E-04	2.03E-04	1.56E-07	4.88E-07	3.98E-07	3.59E-08
17	2.16E-02	9.11E-06	1.35E-06	1.09E-04	2.00E-04	1.43E-07	4.40E-07	3.66E-07	3.40E-08
18	2.11E-02	8.57E-06	1.27E-06	1.04E-04	1.98E-04	1.31E-07	3.96E-07	3.36E-07	3.22E-08
19	2.06E-02	8.08E-06	1.21E-06	9.86E-05	1.98E-04	1.20E-07	3.55E-07	3.09E-07	3.07E-08
20	2.00E-02	7.60E-06	1.15E-06	9.37E-05	1.97E-04	1.09E-07	3.17E-07	2.83E-07	2.91E-08
21	1.94E-02	7.17E-06	1.09E-06	8.93E-05	1.97E-04	1.00E-07	2.83E-07	2.60E-07	2.76E-08
22	1.90E-02	6.81E-06	1.04E-06	8.56E-05	1.99E-04	9.19E-08	2.54E-07	2.40E-07	2.64E-08
23	1.87E-02	6.57E-06	9.94E-07	8.34E-05	2.04E-04	8.55E-08	2.31E-07	2.24E-07	2.56E-08
24	1.81E-02	6.23E-06	9.12E-07	7.96E-05	2.08E-04	7.79E-08	2.06E-07	2.05E-07	2.44E-08
25	1.75E-02	5.91E-06	8.37E-07	7.63E-05	2.17E-04	7.08E-08	1.83E-07	1.88E-07	2.32E-08
26	1.75E-02	5.82E-06	7.95E-07	7.57E-05	2.40E-04	6.64E-08	1.68E-07	1.77E-07	2.28E-08
27	1.10E-02	3.62E-06	4.78E-07	4.73E-05	1.67E-04	3.94E-08	9.86E-08	1.06E-07	1.41E-08
28	5.41E-04	1.78E-07	2.32E-08	2.33E-06	8.68E-06	1.90E-09	4.73E-09	5.10E-09	6.93E-10

Table A-4 Release fraction parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry Unmitigated STSBO									
Plume Segment	Xe	Cs	Ba	I	Te	Ru	Mo	Ce	La
1	3.86E-03	6.41E-06	1.13E-06	5.54E-05	8.81E-05	1.60E-07	6.91E-07	2.84E-07	1.18E-08
2	8.94E-03	1.38E-05	2.41E-06	1.24E-04	1.85E-04	3.30E-07	1.41E-06	5.85E-07	2.51E-08
3	1.74E-02	2.53E-05	4.36E-06	2.35E-04	3.28E-04	5.74E-07	2.42E-06	1.02E-06	4.52E-08
4	2.26E-02	3.11E-05	5.28E-06	3.00E-04	3.88E-04	6.68E-07	2.79E-06	1.19E-06	5.43E-08
5	2.77E-02	3.66E-05	6.12E-06	3.64E-04	4.39E-04	7.39E-07	3.05E-06	1.32E-06	6.21E-08
6	2.96E-02	3.78E-05	6.20E-06	3.89E-04	4.33E-04	7.14E-07	2.91E-06	1.28E-06	6.21E-08
7	3.10E-02	3.83E-05	6.20E-06	4.05E-04	4.21E-04	6.79E-07	2.73E-06	1.21E-06	6.13E-08
8	2.98E-02	3.50E-05	5.70E-06	3.78E-04	3.77E-04	5.92E-07	2.35E-06	1.06E-06	5.56E-08
9	2.93E-02	3.30E-05	5.41E-06	3.64E-04	3.47E-04	5.31E-07	2.08E-06	9.54E-07	5.19E-08
10	2.86E-02	3.12E-05	5.14E-06	3.51E-04	3.20E-04	4.76E-07	1.83E-06	8.58E-07	4.85E-08
11	2.69E-02	2.85E-05	4.72E-06	3.27E-04	2.84E-04	4.12E-07	1.55E-06	7.44E-07	4.38E-08
12	2.70E-02	2.79E-05	4.64E-06	3.27E-04	2.71E-04	3.81E-07	1.40E-06	6.90E-07	4.23E-08
13	2.70E-02	2.74E-05	4.52E-06	3.27E-04	2.58E-04	3.52E-07	1.27E-06	6.38E-07	4.09E-08
14	2.44E-02	2.45E-05	4.01E-06	2.97E-04	2.23E-04	2.95E-07	1.04E-06	5.36E-07	3.59E-08
15	2.44E-02	2.43E-05	3.95E-06	2.99E-04	2.14E-04	2.74E-07	9.45E-07	5.00E-07	3.50E-08
16	2.44E-02	2.42E-05	3.90E-06	3.02E-04	2.06E-04	2.54E-07	8.57E-07	4.65E-07	3.41E-08
17	2.28E-02	2.26E-05	3.62E-06	2.86E-04	1.86E-04	2.21E-07	7.32E-07	4.07E-07	3.13E-08
18	2.13E-02	2.07E-05	3.29E-06	2.64E-04	1.69E-04	1.93E-07	6.25E-07	3.56E-07	2.87E-08
19	2.14E-02	1.99E-05	3.12E-06	2.55E-04	1.65E-04	1.82E-07	5.78E-07	3.37E-07	2.84E-08
20	2.08E-02	1.84E-05	2.81E-06	2.37E-04	1.56E-04	1.65E-07	5.15E-07	3.07E-07	2.72E-08
21	2.07E-02	1.74E-05	2.60E-06	2.25E-04	1.52E-04	1.53E-07	4.70E-07	2.87E-07	2.67E-08
22	1.87E-02	1.50E-05	2.24E-06	1.95E-04	1.33E-04	1.29E-07	3.90E-07	2.43E-07	2.38E-08
23	8.79E-03	6.81E-06	1.06E-06	8.87E-05	6.16E-05	5.77E-08	1.73E-07	1.09E-07	1.11E-08
24	6.22E-04	4.76E-07	7.62E-08	6.21E-06	4.33E-06	4.01E-09	1.20E-08	7.59E-09	7.84E-10

Table A-4 Release fraction parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry ISLOCA									
Plume Segment	Xe	Cs	Ba	I	Te	Ru	Mo	Ce	La
1	1.69E-01	4.06E-05	3.31E-07	2.78E-04	2.62E-04	2.94E-07	5.76E-06	3.45E-11	3.18E-11
2	1.69E-01	4.06E-05	3.31E-07	2.78E-04	2.62E-04	2.94E-07	5.76E-06	3.45E-11	3.18E-11
3	3.74E-02	1.90E-03	7.82E-06	1.38E-02	1.17E-02	1.88E-05	2.58E-04	2.12E-09	1.97E-09
4	6.30E-02	3.39E-03	1.38E-05	2.50E-02	2.12E-02	3.49E-05	4.59E-04	3.94E-09	3.67E-09
5	1.84E-03	9.89E-05	3.27E-07	6.88E-04	5.85E-04	7.40E-07	1.42E-05	8.74E-11	8.20E-11
6	1.67E-01	9.01E-03	3.57E-05	6.62E-02	5.65E-02	9.23E-05	1.22E-03	1.04E-08	9.74E-09
7	1.47E-02	8.96E-04	2.50E-06	6.76E-03	5.66E-03	1.07E-05	1.19E-04	1.15E-09	1.06E-09
8	9.90E-02	2.71E-05	1.22E-07	2.20E-04	2.02E-04	4.19E-07	3.30E-06	4.77E-11	4.49E-11
9	9.90E-02	2.71E-05	1.22E-07	2.20E-04	2.02E-04	4.19E-07	3.30E-06	4.77E-11	4.49E-11
10	3.66E-02	1.88E-03	9.81E-06	1.55E-02	1.40E-02	2.90E-05	2.23E-04	3.34E-09	3.23E-09
11	2.36E-02	8.73E-04	6.97E-06	8.57E-03	5.73E-03	2.66E-05	7.64E-05	4.00E-09	3.78E-09
12	6.07E-03	2.36E-04	1.58E-06	2.13E-03	1.59E-03	5.53E-06	2.43E-05	7.65E-10	7.22E-10
13	8.81E-03	3.27E-04	2.62E-06	3.21E-03	2.14E-03	1.01E-05	2.86E-05	1.51E-09	1.42E-09
14	1.27E-02	3.65E-04	3.51E-06	3.78E-03	2.43E-03	1.45E-05	2.81E-05	2.15E-09	2.03E-09
15	2.21E-02	3.33E-06	3.81E-08	3.55E-05	2.30E-05	1.35E-07	2.38E-07	2.11E-11	1.99E-11
16	2.21E-02	3.33E-06	3.81E-08	3.55E-05	2.30E-05	1.35E-07	2.38E-07	2.11E-11	1.99E-11
17	3.61E-03	1.05E-04	2.45E-06	1.19E-03	6.08E-04	1.11E-06	5.30E-06	3.37E-10	3.19E-10
18	1.09E-03	3.24E-05	5.70E-07	3.58E-04	2.14E-04	7.16E-07	1.91E-06	1.57E-10	1.51E-10
19	1.59E-03	4.62E-05	1.01E-06	5.22E-04	2.64E-04	4.84E-07	2.31E-06	1.47E-10	1.39E-10
20	8.99E-04	2.72E-05	1.12E-06	2.49E-04	1.63E-04	2.26E-07	2.06E-06	3.31E-11	3.18E-11
21	4.73E-03	4.89E-07	1.06E-08	5.62E-06	2.16E-06	2.40E-09	2.06E-08	4.53E-13	4.29E-13
22	4.73E-03	4.89E-07	1.06E-08	5.62E-06	2.16E-06	2.40E-09	2.06E-08	4.53E-13	4.29E-13
23	4.37E-04	3.08E-05	6.50E-07	3.07E-04	1.69E-04	2.27E-07	2.26E-06	8.01E-11	7.47E-11
24	2.90E-04	1.65E-05	3.66E-07	1.67E-04	8.59E-05	1.20E-07	1.16E-06	3.72E-11	3.47E-11
25	2.85E-04	2.04E-05	4.43E-07	2.02E-04	1.12E-04	1.54E-07	1.52E-06	5.24E-11	4.88E-11
26	3.46E-03	1.77E-06	3.53E-08	1.71E-05	1.09E-05	2.35E-08	1.44E-07	8.27E-12	7.63E-12
27	3.46E-03	1.77E-06	3.53E-08	1.71E-05	1.09E-05	2.35E-08	1.44E-07	8.27E-12	7.63E-12
28	2.90E-03	5.23E-07	1.14E-08	5.29E-06	4.57E-06	2.77E-08	4.48E-08	6.73E-12	6.33E-12
29	2.90E-03	5.23E-07	1.14E-08	5.29E-06	4.57E-06	2.77E-08	4.48E-08	6.73E-12	6.33E-12
30	8.94E-07	7.45E-08	9.77E-09	8.72E-07	7.60E-07	7.71E-10	2.91E-09	3.71E-08	1.60E-09
31	2.09E-06	7.89E-08	4.17E-09	8.23E-07	7.30E-07	3.00E-09	5.91E-09	1.06E-08	4.58E-10
32	4.25E-07	3.00E-08	3.70E-09	3.56E-07	3.13E-07	3.82E-10	1.34E-09	1.38E-08	5.95E-10
33	3.73E-08	1.25E-08	2.61E-08	3.42E-08	3.02E-08	2.92E-10	1.20E-09	1.49E-08	6.30E-10
34	8.35E-06	3.37E-07	2.33E-08	4.01E-06	4.02E-06	4.75E-09	1.44E-08	6.59E-08	2.92E-09
35	5.24E-06	9.34E-07	4.54E-08	1.26E-05	1.02E-05	2.62E-09	1.10E-08	1.21E-07	7.04E-09
36	7.76E-08	2.01E-08	4.12E-08	5.86E-08	5.57E-08	4.56E-10	1.92E-09	2.31E-08	1.02E-09
37	8.87E-08	1.69E-08	3.45E-08	5.16E-08	5.16E-08	3.75E-10	1.59E-09	1.90E-08	8.71E-10
38	3.99E-06	1.23E-06	4.35E-08	1.70E-05	1.02E-05	5.72E-10	4.81E-09	1.22E-07	7.92E-09
39	9.39E-07	5.34E-07	9.40E-09	7.47E-06	2.62E-06	8.00E-11	1.16E-09	2.53E-08	1.84E-09
40	3.58E-07	2.00E-07	3.63E-09	2.80E-06	9.87E-07	4.37E-11	3.49E-10	9.88E-09	7.14E-10
41	3.80E-07	2.20E-07	3.55E-09	3.10E-06	8.90E-07	4.37E-11	3.49E-10	1.04E-08	7.33E-10
42	9.27E-08	1.24E-08	2.47E-08	4.36E-08	4.04E-08	2.64E-10	1.13E-09	1.35E-08	6.41E-10
43	2.47E-06	1.26E-06	2.33E-08	1.76E-05	5.90E-06	2.28E-10	2.41E-09	6.36E-08	4.57E-09
44	1.39E-06	8.23E-07	1.15E-08	1.16E-05	2.19E-06	1.31E-10	9.31E-10	3.72E-08	2.54E-09
45	4.47E-07	2.60E-07	3.59E-09	3.65E-06	6.80E-07	4.00E-11	3.49E-10	1.15E-08	7.93E-10
46	3.47E-06	4.51E-06	2.63E-08	6.35E-05	6.90E-06	1.99E-10	3.79E-09	5.78E-08	5.02E-09
47	1.86E-06	7.33E-06	1.40E-08	1.03E-04	4.64E-06	7.55E-11	2.40E-09	2.60E-08	2.93E-09
48	1.46E-06	1.06E-05	8.87E-09	1.49E-04	4.47E-06	6.55E-11	1.51E-09	1.70E-08	2.13E-09

Table A-4 Release fraction parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry ISLOCA									
Plume Segment	Xe	Cs	Ba	I	Te	Ru	Mo	Ce	La
49	8.05E-07	5.46E-06	5.14E-09	7.72E-05	2.39E-06	2.18E-11	8.73E-10	9.83E-09	1.22E-09
50	1.58E-06	9.65E-06	9.89E-09	1.36E-04	4.27E-06	5.26E-11	1.68E-09	1.81E-08	2.18E-09
51	4.49E-06	1.58E-05	3.21E-08	2.23E-04	7.14E-06	1.38E-10	2.68E-09	4.08E-08	3.39E-09
52	1.42E-06	5.42E-06	9.50E-09	7.66E-05	2.40E-06	4.73E-11	8.15E-10	1.25E-08	1.07E-09
53	3.41E-06	2.10E-05	1.54E-08	2.97E-04	8.60E-06	8.75E-11	2.32E-09	2.37E-08	2.73E-09
54	1.62E-06	2.08E-05	7.31E-09	2.94E-04	1.02E-05	2.64E-11	1.48E-09	9.50E-09	1.65E-09
55	1.74E-06	1.73E-05	9.86E-09	2.44E-04	2.12E-05	2.91E-11	1.51E-09	8.71E-09	1.76E-09
56	1.48E-06	1.69E-05	7.56E-09	2.38E-04	1.55E-05	1.84E-11	1.28E-09	7.19E-09	1.43E-09
57	1.91E-06	1.46E-05	1.53E-08	2.06E-04	3.25E-05	2.18E-11	1.86E-09	8.41E-09	1.82E-09
58	2.08E-06	1.43E-05	1.61E-08	2.03E-04	3.50E-05	2.17E-11	1.83E-09	8.76E-09	1.90E-09
59	3.90E-06	1.14E-05	4.19E-08	1.62E-04	1.05E-04	3.64E-11	3.96E-09	1.48E-08	3.48E-09
60	2.34E-06	6.81E-06	2.39E-08	9.61E-05	5.96E-05	2.07E-11	2.26E-09	8.55E-09	2.01E-09
61	3.84E-06	2.35E-06	6.81E-08	3.29E-05	1.65E-04	2.18E-11	4.89E-09	1.24E-08	3.20E-09
62	2.23E-06	1.70E-06	3.51E-08	2.38E-05	8.65E-05	1.64E-11	2.60E-09	7.05E-09	1.79E-09
63	5.29E-06	7.39E-07	1.45E-07	9.87E-06	3.54E-04	5.09E-11	8.85E-09	1.48E-08	4.12E-09
64	1.60E-06	2.27E-07	4.38E-08	3.02E-06	1.07E-04	1.09E-11	2.79E-09	4.46E-09	1.25E-09
65	1.73E-06	3.55E-07	4.23E-08	4.84E-06	1.02E-04	1.08E-11	2.64E-09	4.78E-09	1.31E-09
66	7.61E-06	8.07E-07	1.97E-07	1.01E-05	7.22E-04	3.64E-11	1.86E-08	1.84E-08	5.55E-09
67	2.27E-06	2.41E-07	5.90E-08	3.02E-06	2.15E-04	7.28E-12	5.47E-09	5.49E-09	1.66E-09
68	2.29E-06	2.46E-07	7.59E-08	3.04E-06	2.40E-04	1.46E-11	6.26E-09	5.34E-09	1.65E-09
69	6.29E-06	6.79E-07	2.28E-06	7.93E-06	7.39E-04	2.18E-11	2.33E-08	1.31E-08	4.25E-09
70	1.91E-06	2.07E-07	6.78E-07	2.41E-06	2.25E-04	1.09E-11	7.16E-09	3.99E-09	1.30E-09
71	3.40E-06	3.77E-07	2.55E-06	4.26E-06	2.86E-04	1.09E-11	1.48E-08	6.70E-09	2.24E-09
72	1.06E-05	1.09E-06	8.55E-06	1.24E-05	4.93E-04	3.64E-11	4.28E-08	1.86E-08	6.51E-09
73	2.33E-06	2.44E-07	1.90E-06	2.73E-06	1.41E-04	9.09E-12	9.78E-09	4.22E-09	1.45E-09
74	3.29E-06	3.39E-07	2.66E-06	3.83E-06	1.54E-04	1.46E-11	1.32E-08	5.77E-09	2.02E-09
75	5.54E-06	4.65E-07	2.61E-06	5.58E-06	1.88E-04	1.82E-11	1.42E-08	8.30E-09	2.98E-09
76	5.90E-07	5.81E-08	4.53E-07	6.57E-07	2.80E-05	1.99E-12	2.28E-09	9.98E-10	3.48E-10
77	8.43E-06	5.09E-07	6.02E-07	6.76E-06	1.37E-04	1.46E-11	7.33E-09	1.00E-08	3.68E-09
78	2.00E-06	1.33E-07	3.32E-07	1.71E-06	4.54E-05	3.64E-12	2.71E-09	2.55E-09	9.28E-10
79	9.52E-06	6.24E-07	6.17E-07	8.24E-06	1.26E-04	1.82E-11	9.72E-09	1.08E-08	4.09E-09
80	1.12E-05	8.62E-07	6.30E-07	1.13E-05	1.43E-04	2.18E-11	1.41E-08	1.19E-08	4.68E-09
81	2.97E-06	2.06E-07	1.84E-07	2.72E-06	3.90E-05	9.09E-12	3.32E-09	3.18E-09	1.23E-09
82	3.60E-06	2.74E-07	2.02E-07	3.62E-06	4.59E-05	3.64E-12	4.42E-09	3.81E-09	1.50E-09
83	9.49E-06	1.10E-06	5.06E-07	1.47E-05	1.19E-04	1.82E-11	1.48E-08	9.45E-09	3.88E-09
84	1.08E-05	2.89E-06	6.09E-07	3.97E-05	1.39E-04	1.46E-11	2.06E-08	1.00E-08	4.28E-09
85	3.49E-06	9.30E-07	1.97E-07	1.28E-05	4.50E-05	0.00E+00	6.64E-09	3.24E-09	1.39E-09
86	9.67E-06	6.08E-06	5.08E-07	8.46E-05	1.38E-04	1.09E-11	2.20E-08	7.74E-09	3.43E-09
87	1.38E-05	1.78E-05	5.18E-07	2.49E-04	1.97E-04	7.28E-12	3.85E-08	9.01E-09	4.16E-09
88	4.51E-06	5.79E-06	1.69E-07	8.11E-05	6.44E-05	1.09E-11	1.26E-08	2.95E-09	1.36E-09
89	1.12E-05	1.43E-05	3.66E-07	2.00E-04	1.69E-04	7.28E-12	3.56E-08	6.76E-09	3.20E-09
90	8.43E-06	1.74E-06	2.92E-07	2.29E-05	1.43E-04	1.46E-11	2.86E-08	4.49E-09	2.22E-09
91	1.27E-05	2.41E-06	4.58E-07	3.15E-05	2.09E-04	1.09E-11	4.58E-08	6.39E-09	3.23E-09
92	1.14E-05	2.90E-06	3.97E-07	3.83E-05	1.90E-04	0.00E+00	4.71E-08	5.45E-09	2.84E-09
93	1.23E-05	4.49E-06	4.21E-07	6.02E-05	2.17E-04	7.28E-12	6.01E-08	5.66E-09	3.05E-09
94	1.09E-05	5.55E-06	4.05E-07	7.52E-05	1.76E-04	1.46E-11	6.30E-08	4.81E-09	2.68E-09
95	1.16E-05	7.72E-06	4.75E-07	1.05E-04	1.43E-04	3.64E-12	8.27E-08	4.96E-09	2.85E-09

Table A-4 Release fraction parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry ISLOCA									
Plume Segment	Xe	Cs	Ba	I	Te	Ru	Mo	Ce	La
96	1.04E-05	7.01E-06	4.54E-07	9.55E-05	6.92E-05	7.28E-12	9.58E-08	4.26E-09	2.52E-09
97	1.12E-05	5.40E-06	5.25E-07	7.21E-05	2.49E-05	0.00E+00	1.45E-07	4.48E-09	2.72E-09
98	1.21E-05	4.81E-06	5.16E-07	6.34E-05	1.31E-05	3.64E-11	9.60E-05	4.34E-09	2.74E-09
99	3.57E-06	1.41E-06	1.57E-07	1.87E-05	4.95E-06	7.28E-12	1.72E-05	1.30E-09	8.06E-10
100	4.02E-06	1.59E-06	1.72E-07	2.10E-05	4.36E-06	3.64E-12	3.17E-05	1.44E-09	9.10E-10
101	9.43E-06	4.23E-06	3.34E-07	5.63E-05	1.08E-05	4.37E-11	1.02E-04	3.11E-09	2.03E-09
102	1.29E-06	4.87E-07	5.19E-08	6.43E-06	1.39E-06	2.10E-12	7.90E-06	4.29E-10	2.70E-10
103	6.71E-06	3.05E-06	1.26E-07	4.09E-05	8.04E-06	5.09E-11	7.34E-06	1.95E-09	1.37E-09
104	1.90E-06	8.34E-07	3.97E-08	1.12E-05	2.07E-06	7.28E-12	9.25E-06	5.33E-10	3.65E-10
105	7.76E-06	2.48E-06	1.35E-07	3.25E-05	9.91E-06	7.28E-11	6.71E-06	2.16E-09	1.55E-09
106	8.48E-06	1.70E-06	1.43E-07	2.11E-05	1.16E-05	5.82E-11	5.76E-06	2.26E-09	1.67E-09
107	7.34E-06	1.64E-06	1.28E-07	2.05E-05	1.09E-05	5.82E-11	4.12E-06	1.95E-09	1.47E-09

Table A-4 Release fraction parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry Mitigated TISGTR									
Plume Segment	Xe	Cs	Ba	I	Te	Ru	Mo	Ce	La
1	2.59E-06	1.08E-06	9.51E-09	9.49E-07	9.10E-07	4.72E-09	2.76E-07	9.80E-14	9.80E-14
2	0.055065	0.00187	1.69E-05	0.00218	0.00138	7.61E-06	4.68E-04	1.91E-10	1.90E-10
3	1.89E-05	4.81E-06	2.49E-08	4.65E-06	4.80E-06	1.09E-07	1.28E-06	1.85E-12	1.85E-12
4	0.002275	2.77E-04	2.55E-06	2.81E-04	2.88E-04	9.07E-06	7.27E-05	2.37E-10	2.37E-10
5	2.62E-05	7.31E-06	5.41E-08	7.33E-06	7.52E-06	1.97E-07	1.93E-06	4.79E-12	4.79E-12
6	0.013924	7.47E-04	2.18E-05	0.00103	0.00105	6.80E-05	1.96E-04	1.81E-09	1.81E-09
7	3.05E-05	6.87E-06	8.66E-08	7.48E-06	7.63E-06	2.82E-07	1.81E-06	7.39E-12	7.44E-12
8	0.011313	8.78E-04	4.59E-05	0.00132	0.00149	1.29E-04	2.25E-04	6.95E-08	4.28E-09
9	3.40E-05	5.25E-06	8.35E-07	6.06E-06	6.27E-06	3.27E-07	1.38E-06	1.53E-07	2.77E-09
10	0.001501	1.26E-04	5.64E-05	8.95E-05	9.78E-05	1.47E-05	3.38E-05	9.75E-06	2.06E-07
11	3.17E-05	8.52E-07	4.11E-07	9.50E-07	9.84E-07	5.43E-08	2.24E-07	8.03E-08	1.64E-09
12	4.35E-04	5.64E-06	5.95E-07	5.57E-05	2.36E-06	3.33E-08	4.74E-07	6.44E-08	4.02E-09
13	2.18E-04	3.60E-06	3.96E-08	4.98E-05	8.47E-07	1.02E-09	1.96E-08	2.16E-09	7.28E-10
14	1.29E-04	1.75E-06	6.61E-09	2.47E-05	3.21E-07	1.31E-10	2.21E-09	3.47E-10	1.66E-10
15	1.83E-06	1.58E-08	4.37E-11	2.23E-07	2.79E-09	0	0	3.64E-12	1.39E-12
16	1.85E-06	1.30E-08	1.75E-10	1.81E-07	7.45E-09	0	9.71E-08	4.55E-12	4.41E-12
17	6.48E-06	1.12E-07	6.32E-09	1.58E-06	2.22E-07	0	4.21E-06	1.47E-10	1.46E-10
18	8.20E-07	1.03E-07	1.36E-08	1.46E-06	2.74E-07	0	8.92E-06	2.76E-10	2.81E-10
19	5.22E-08	1.03E-07	1.59E-08	1.46E-06	1.98E-07	0	1.01E-05	3.06E-10	3.09E-10
20	7.45E-09	9.31E-08	1.59E-08	1.32E-06	1.29E-07	0	9.80E-06	2.97E-10	3.00E-10
21	0	8.66E-08	1.58E-08	1.23E-06	8.66E-08	0	9.43E-06	2.88E-10	2.92E-10
22	0	7.92E-08	1.55E-08	1.12E-06	6.01E-08	0	9.02E-06	2.79E-10	2.83E-10
23	0	7.08E-08	1.53E-08	1.00E-06	4.05E-08	0	8.70E-06	2.73E-10	2.76E-10
24	0	6.29E-08	1.49E-08	8.83E-07	2.93E-08	0	8.27E-06	2.62E-10	2.66E-10
25	0	5.40E-08	1.43E-08	7.66E-07	2.10E-08	0	7.75E-06	2.48E-10	2.51E-10
26	0	4.80E-08	1.37E-08	6.77E-07	1.54E-08	0	7.30E-06	2.35E-10	2.38E-10
27	0	4.38E-08	1.32E-08	6.17E-07	1.21E-08	0	6.94E-06	2.22E-10	2.25E-10
28	0	3.91E-08	1.31E-08	5.54E-07	8.85E-09	0	6.78E-06	2.16E-10	2.19E-10
29	0	3.73E-08	1.28E-08	5.23E-07	8.38E-09	0	6.56E-06	2.08E-10	2.10E-10
30	0	3.40E-08	1.26E-08	4.84E-07	7.45E-09	0	6.38E-06	1.98E-10	2.02E-10
31	0	3.03E-08	1.25E-08	4.27E-07	6.52E-09	0	6.25E-06	1.95E-10	1.96E-10
32	0	2.56E-08	1.19E-08	3.66E-07	4.66E-09	0	5.92E-06	1.81E-10	1.84E-10
33	0	2.33E-08	1.13E-08	3.24E-07	3.26E-09	0	5.54E-06	1.67E-10	1.69E-10
34	7.45E-09	2.00E-08	1.13E-08	2.83E-07	3.26E-09	0	5.52E-06	1.63E-10	1.66E-10
35	3.73E-08	1.72E-08	1.13E-08	2.46E-07	1.86E-09	0	5.48E-06	1.60E-10	1.62E-10
36	1.42E-07	1.49E-08	1.13E-08	2.14E-07	1.40E-09	0	5.41E-06	1.56E-10	1.58E-10
37	1.71E-07	1.35E-08	1.13E-08	1.88E-07	1.86E-09	0	5.35E-06	1.52E-10	1.54E-10
38	8.20E-08	1.16E-08	1.12E-08	1.64E-07	9.31E-10	0	5.25E-06	1.47E-10	1.50E-10
39	3.73E-08	1.02E-08	1.14E-08	1.44E-07	9.31E-10	0	5.28E-06	1.47E-10	1.49E-10
40	7.45E-09	8.85E-09	1.05E-08	1.24E-07	9.31E-10	0	4.82E-06	1.33E-10	1.34E-10
41	7.45E-09	7.45E-09	1.07E-08	1.09E-07	9.31E-10	0	4.89E-06	1.32E-10	1.34E-10
42	0	6.98E-09	1.17E-08	9.59E-08	4.66E-10	0	5.26E-06	1.41E-10	1.43E-10
43	0	6.05E-09	1.19E-08	8.52E-08	9.31E-10	0	5.31E-06	1.42E-10	1.43E-10
44	0	5.12E-09	1.20E-08	7.45E-08	0	0	5.30E-06	1.38E-10	1.41E-10
45	0	4.66E-09	1.17E-08	6.47E-08	9.31E-10	0	5.13E-06	1.33E-10	1.35E-10
46	0	4.19E-09	1.11E-08	5.68E-08	4.66E-10	0	4.84E-06	1.25E-10	1.26E-10
47	0	3.26E-09	1.10E-08	4.94E-08	0	0	4.74E-06	1.21E-10	1.22E-10

Table A-4 Release fraction parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry Mitigated TISGTR									
Plume Segment	Xe	Cs	Ba	I	Te	Ru	Mo	Ce	La
48	0	2.79E-09	1.04E-08	4.28E-08	0	0	4.43E-06	1.11E-10	1.13E-10
49	0	1.40E-09	4.38E-09	1.68E-08	0	0	1.85E-06	4.64E-11	4.69E-11

Table A-4 Release fraction parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry Unmitigated TISGTR									
Plume Segment	Xe	Cs	Ba	I	Te	Ru	Mo	Ce	La
1	2.59E-06	1.08E-06	9.51E-09	9.49E-07	9.10E-07	4.72E-09	2.76E-07	9.80E-14	9.80E-14
2	0.055065	0.00187	1.69E-05	0.002182	0.001379	7.61E-06	4.68E-04	1.91E-10	1.90E-10
3	1.89E-05	4.81E-06	2.49E-08	4.65E-06	4.80E-06	1.09E-07	1.28E-06	1.85E-12	1.85E-12
4	0.0022745	2.77E-04	2.55E-06	2.81E-04	2.88E-04	9.07E-06	7.27E-05	2.37E-10	2.37E-10
5	2.62E-05	7.31E-06	5.41E-08	7.33E-06	7.52E-06	1.97E-07	1.93E-06	4.79E-12	4.79E-12
6	0.013924	7.47E-04	2.18E-05	0.001034	0.001054	6.80E-05	1.96E-04	1.81E-09	1.81E-09
7	3.05E-05	6.87E-06	8.66E-08	7.48E-06	7.63E-06	2.82E-07	1.81E-06	7.39E-12	7.44E-12
8	0.011313	8.78E-04	4.59E-05	0.001322	0.001489	1.29E-04	2.25E-04	6.95E-08	4.28E-09
9	3.40E-05	5.25E-06	8.35E-07	6.06E-06	6.27E-06	3.27E-07	1.38E-06	1.53E-07	2.77E-09
10	0.0024109	1.36E-04	6.16E-05	1.07E-04	1.10E-04	1.53E-05	3.62E-05	1.07E-05	2.30E-07
11	3.79E-05	3.39E-06	1.63E-06	3.74E-06	3.87E-06	2.17E-07	8.92E-07	3.21E-07	6.45E-09
12	0.0032437	2.29E-05	1.02E-05	5.99E-05	3.03E-05	1.24E-06	5.31E-06	1.93E-06	5.04E-08
13	3.79E-05	1.72E-06	8.32E-07	2.00E-06	2.00E-06	1.10E-07	4.51E-07	1.63E-07	3.38E-09
14	0.0034168	1.21E-05	4.71E-06	4.71E-05	2.04E-05	6.96E-07	2.52E-06	1.04E-06	2.50E-08
15	3.83E-05	8.91E-07	4.25E-07	1.18E-06	1.08E-06	5.69E-08	2.30E-07	8.46E-08	1.78E-09
16	0.0035156	9.70E-06	2.59E-06	6.63E-05	1.50E-05	4.16E-07	1.44E-06	6.22E-07	1.56E-08
17	3.87E-05	5.65E-07	2.56E-07	1.13E-06	7.06E-07	3.48E-08	1.39E-07	5.17E-08	1.11E-09
18	0.0035655	1.17E-05	1.73E-06	1.18E-04	1.35E-05	2.82E-07	9.46E-07	4.21E-07	1.11E-08
19	3.91E-05	4.54E-07	1.74E-07	1.76E-06	5.49E-07	2.41E-08	9.42E-08	3.58E-08	7.89E-10
20	0.0036008	1.74E-05	1.40E-06	2.12E-04	1.55E-05	2.06E-07	8.74E-05	3.08E-07	8.68E-09
21	3.94E-05	4.56E-07	1.30E-07	3.02E-06	5.05E-07	1.80E-08	1.33E-06	2.68E-08	6.09E-10
22	0.0036017	6.49E-06	1.52E-06	6.58E-05	1.81E-05	1.63E-07	0	2.46E-07	7.91E-09
23	3.97E-05	3.95E-07	1.06E-07	2.90E-06	5.28E-07	1.44E-08	0	2.15E-08	5.11E-10
24	0.003629	5.13E-06	1.29E-06	5.19E-05	1.97E-05	1.32E-07	0	1.98E-07	6.77E-09
25	3.99E-05	3.18E-07	8.60E-08	2.42E-06	5.49E-07	1.13E-08	0	1.69E-08	4.22E-10
26	0.0036535	4.56E-06	1.05E-06	4.91E-05	2.30E-05	9.99E-08	0	1.51E-07	5.56E-09
27	4.02E-05	2.38E-07	6.51E-08	1.89E-06	5.63E-07	8.25E-09	0	1.23E-08	3.25E-10
28	0.0036759	3.98E-06	8.17E-07	4.55E-05	2.68E-05	7.08E-08	0	1.08E-07	4.40E-09
29	4.04E-05	1.72E-07	4.75E-08	1.42E-06	5.90E-07	5.75E-09	0	8.62E-09	2.42E-10
30	0.0036984	3.46E-06	6.34E-07	4.15E-05	2.88E-05	5.00E-08	0	7.63E-08	3.54E-09
31	4.06E-05	1.27E-07	3.54E-08	1.10E-06	6.34E-07	4.06E-09	0	6.09E-09	1.84E-10
32	0.0037173	2.96E-06	5.20E-07	3.66E-05	2.78E-05	3.61E-08	0	5.56E-08	2.94E-09
33	4.08E-05	9.77E-08	2.77E-08	8.82E-07	6.72E-07	2.96E-09	0	4.45E-09	1.47E-10
34	0.0037368	2.10E-06	4.41E-07	2.59E-05	2.41E-05	2.71E-08	0	4.20E-08	2.52E-09
35	4.09E-05	7.75E-08	2.26E-08	7.27E-07	6.80E-07	2.23E-09	0	3.36E-09	1.22E-10
36	0.0037562	1.30E-06	4.02E-07	1.55E-05	2.15E-05	2.09E-08	0	3.27E-08	2.22E-09
37	4.10E-05	6.28E-08	1.93E-08	6.11E-07	6.74E-07	1.72E-09	0	2.61E-09	1.05E-10
38	0.0037724	9.50E-07	3.74E-07	1.13E-05	1.90E-05	1.64E-08	0	2.59E-08	1.97E-09
39	4.11E-05	5.15E-08	1.70E-08	5.16E-07	6.56E-07	1.35E-09	0	2.06E-09	9.24E-11
40	0.003791	7.33E-07	3.50E-07	8.66E-06	1.66E-05	1.32E-08	0	2.09E-08	1.78E-09
41	4.12E-05	4.26E-08	1.54E-08	4.37E-07	6.29E-07	1.08E-09	0	1.65E-09	8.26E-11
42	0.0038074	7.72E-07	3.26E-07	9.60E-06	1.44E-05	1.06E-08	0	1.71E-08	1.63E-09
43	4.13E-05	3.62E-08	1.42E-08	3.82E-07	5.92E-07	8.73E-10	0	1.35E-09	7.50E-11
44	0.0038235	8.27E-07	3.04E-07	1.07E-05	1.27E-05	8.67E-09	0	1.41E-08	1.50E-09
45	4.14E-05	3.19E-08	1.32E-08	3.48E-07	5.51E-07	7.13E-10	0	1.11E-09	6.89E-11
46	0.0038394	8.64E-07	2.85E-07	1.14E-05	1.13E-05	7.17E-09	0	1.18E-08	1.38E-09
47	4.14E-05	2.89E-08	1.24E-08	3.26E-07	5.09E-07	5.88E-10	0	9.20E-10	6.38E-11
48	0.0038542	9.01E-07	2.60E-07	1.21E-05	9.93E-06	5.97E-09	0	9.97E-09	1.29E-09

Table A-4 Release fraction parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry Unmitigated TISGTR									
Plume Segment	Xe	Cs	Ba	I	Te	Ru	Mo	Ce	La
49	4.14E-05	2.68E-08	1.17E-08	3.13E-07	4.67E-07	4.90E-10	0	7.72E-10	5.97E-11
50	0.0038672	9.73E-07	2.41E-07	1.32E-05	8.72E-06	5.04E-09	0	8.50E-09	1.21E-09
51	0.0027853	1.70E-06	7.38E-07	2.05E-05	2.83E-05	2.71E-08	0	4.32E-08	3.75E-09
52	4.14E-05	2.54E-08	1.10E-08	3.05E-07	4.25E-07	4.10E-10	0	6.53E-10	5.61E-11
53	0.0038613	1.06E-06	2.32E-07	1.45E-05	7.72E-06	4.21E-09	0	7.25E-09	1.13E-09
54	0.0079969	4.70E-06	2.04E-06	5.80E-05	7.49E-05	6.69E-08	0	1.08E-07	1.03E-08
55	4.11E-05	2.42E-08	1.05E-08	2.98E-07	3.85E-07	3.44E-10	0	5.54E-10	5.27E-11
56	0.0038298	1.21E-06	2.37E-07	1.68E-05	6.85E-06	3.54E-09	0	6.20E-09	1.06E-09
57	0.014864	8.52E-06	3.71E-06	1.07E-04	1.27E-04	1.06E-07	0	1.73E-07	1.82E-08
58	4.04E-05	2.32E-08	1.01E-08	2.92E-07	3.46E-07	2.89E-10	0	4.70E-10	4.95E-11
59	0.0037684	1.42E-06	2.26E-07	1.98E-05	6.07E-06	2.97E-09	0	5.29E-09	1.00E-09
60	0.019254	1.09E-05	4.74E-06	1.40E-04	1.51E-04	1.18E-07	0	1.95E-07	2.27E-08
61	3.95E-05	2.23E-08	9.71E-09	2.86E-07	3.09E-07	2.42E-10	0	3.99E-10	4.66E-11
62	0.0036753	1.40E-06	2.17E-07	1.95E-05	5.40E-06	2.47E-09	0	4.56E-09	9.52E-10
63	0.021255	1.19E-05	5.18E-06	1.56E-04	1.53E-04	1.13E-07	0	1.89E-07	2.44E-08
64	3.80E-05	2.13E-08	9.25E-09	2.78E-07	2.73E-07	2.01E-10	0	3.36E-10	4.34E-11
65	0.0035692	1.41E-06	2.08E-07	1.97E-05	4.86E-06	2.10E-09	0	3.94E-09	9.06E-10
66	0.024223	1.35E-05	5.88E-06	1.79E-04	1.61E-04	1.12E-07	0	1.90E-07	2.71E-08
67	3.75E-05	2.09E-08	9.11E-09	2.77E-07	2.49E-07	1.73E-10	0	2.93E-10	4.20E-11
68	0.0034562	1.38E-06	1.99E-07	1.94E-05	4.46E-06	1.76E-09	0	3.43E-09	8.66E-10
69	0.023745	1.32E-05	5.76E-06	1.77E-04	1.48E-04	9.61E-08	0	1.66E-07	2.62E-08
70	3.58E-05	2.00E-08	8.69E-09	2.68E-07	2.22E-07	1.45E-10	0	2.49E-10	3.96E-11
71	0.0033394	1.34E-06	1.92E-07	1.88E-05	4.10E-06	1.54E-09	0	3.02E-09	8.35E-10
72	0.023485	1.32E-05	5.72E-06	1.78E-04	1.38E-04	8.37E-08	0	1.47E-07	2.58E-08
73	3.45E-05	1.94E-08	8.41E-09	2.62E-07	2.02E-07	1.23E-10	0	2.16E-10	3.79E-11
74	0.0032239	1.32E-06	1.86E-07	1.86E-05	3.80E-06	1.27E-09	0	2.67E-09	8.07E-10
75	0.0222	1.26E-05	5.45E-06	1.71E-04	1.24E-04	7.02E-08	0	1.26E-07	2.43E-08
76	3.33E-05	1.88E-08	8.16E-09	2.57E-07	1.85E-07	1.04E-10	0	1.88E-10	3.64E-11
77	0.0031118	1.25E-06	1.80E-07	1.76E-05	3.54E-06	1.09E-09	0	2.37E-09	7.81E-10
78	0.022319	1.26E-05	5.53E-06	1.73E-04	1.19E-04	6.29E-08	0	1.16E-07	2.46E-08
79	3.20E-05	1.80E-08	7.94E-09	2.48E-07	1.70E-07	8.97E-11	0	1.65E-10	3.52E-11
80	0.0030011	1.16E-06	1.74E-07	1.63E-05	3.33E-06	9.60E-10	0	2.12E-09	7.58E-10
81	0.021661	1.19E-05	5.44E-06	1.64E-04	1.12E-04	5.46E-08	0	1.03E-07	2.41E-08
82	3.08E-05	1.68E-08	7.75E-09	2.33E-07	1.58E-07	7.70E-11	0	1.46E-10	3.42E-11
83	0.0028905	1.11E-06	1.68E-07	1.57E-05	3.18E-06	8.44E-10	0	1.91E-09	7.35E-10
84	0.021648	1.16E-05	5.52E-06	1.61E-04	1.09E-04	4.88E-08	0	9.50E-08	2.43E-08
85	2.96E-05	1.59E-08	7.56E-09	2.20E-07	1.49E-07	6.65E-11	0	1.30E-10	3.33E-11
86	0.0027884	1.05E-06	1.64E-07	1.49E-05	3.06E-06	6.69E-10	0	1.74E-09	7.19E-10
87	0.020122	1.07E-05	5.24E-06	1.49E-04	1.00E-04	4.10E-08	0	8.24E-08	2.31E-08
88	2.86E-05	1.52E-08	7.44E-09	2.12E-07	1.42E-07	5.80E-11	0	1.17E-10	3.28E-11
89	0.0026983	8.68E-07	1.62E-07	1.23E-05	3.03E-06	6.26E-10	0	1.62E-09	7.16E-10
90	0.020926	1.13E-05	5.58E-06	1.59E-04	1.05E-04	3.89E-08	0	8.09E-08	2.46E-08
91	2.75E-05	1.49E-08	7.34E-09	2.09E-07	1.38E-07	5.09E-11	0	1.06E-10	3.24E-11
92	0.0025999	8.47E-07	1.58E-07	1.20E-05	3.11E-06	5.82E-10	0	1.51E-09	7.08E-10
93	0.018819	1.05E-05	5.14E-06	1.48E-04	9.61E-05	3.20E-08	0	6.88E-08	2.27E-08
94	2.64E-05	1.48E-08	7.21E-09	2.08E-07	1.35E-07	4.46E-11	0	9.64E-11	3.19E-11
95	0.002504	8.43E-07	1.54E-07	1.20E-05	3.28E-06	4.80E-10	0	1.40E-09	6.99E-10

Table A-4 Release fraction parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Surry Unmitigated TISGTR									
Plume Segment	Xe	Cs	Ba	I	Te	Ru	Mo	Ce	La
96	0.018722	1.09E-05	5.22E-06	1.53E-04	9.93E-05	2.91E-08	0	6.51E-08	2.32E-08
97	2.53E-05	1.47E-08	7.07E-09	2.08E-07	1.35E-07	3.90E-11	0	8.77E-11	3.14E-11
98	0.0024121	7.11E-07	1.49E-07	1.01E-05	3.52E-06	4.51E-10	0	1.31E-09	6.95E-10
99	0.017989	1.10E-05	5.10E-06	1.55E-04	1.01E-04	2.55E-08	0	5.97E-08	2.29E-08
100	2.43E-05	1.48E-08	6.88E-09	2.10E-07	1.37E-07	3.42E-11	0	8.03E-11	3.10E-11
101	0.0023166	6.38E-07	1.17E-07	9.05E-06	3.94E-06	3.64E-10	0	1.23E-09	6.87E-10
102	0.017843	1.15E-05	4.96E-06	1.63E-04	1.09E-04	2.31E-08	0	5.66E-08	2.34E-08
103	2.33E-05	1.50E-08	6.47E-09	2.13E-07	1.43E-07	3.00E-11	0	7.37E-11	3.06E-11
104	0.0022242	6.10E-07	1.11E-07	8.66E-06	4.47E-06	3.35E-10	0	1.15E-09	6.80E-10
105	0.016027	1.09E-05	4.35E-06	1.55E-04	1.10E-04	1.90E-08	0	4.89E-08	2.16E-08
106	2.23E-05	1.53E-08	6.05E-09	2.17E-07	1.53E-07	2.63E-11	0	6.80E-11	3.02E-11
107	0.0021344	6.16E-07	1.05E-07	8.75E-06	5.07E-06	2.91E-10	0	1.09E-09	6.72E-10
108	0.015927	1.15E-05	4.24E-06	1.63E-04	1.24E-04	1.73E-08	0	4.70E-08	2.22E-08
109	2.14E-05	1.55E-08	5.69E-09	2.20E-07	1.67E-07	2.32E-11	0	6.29E-11	2.98E-11
110	8.98E-04	2.63E-07	4.40E-08	3.73E-06	2.41E-06	1.31E-10	0	4.51E-10	2.89E-10
111	0.0015566	1.16E-06	4.11E-07	1.65E-05	1.30E-05	1.61E-09	0	4.51E-09	2.20E-09
112	6.97E-07	5.20E-10	1.84E-10	7.39E-09	5.86E-09	6.82E-13	0	1.88E-12	9.88E-13
113	5.17E-04	3.86E-07	1.36E-07	5.49E-06	4.38E-06	5.33E-10	0	1.50E-09	7.34E-10
114	6.96E-07	5.20E-10	1.83E-10	7.39E-09	5.89E-09	6.82E-13	0	1.99E-12	9.88E-13
115	6.84E-05	2.00E-08	3.33E-09	2.86E-07	1.91E-07	0	0	3.27E-11	2.23E-11

Table A-5 EARLY parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR Scenarios

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
ACNAME	Latent Cancer Effect					
	Cancer Type 1	LEUKEMIA	LEUKEMIA	LEUKEMIA	LEUKEMIA	LEUKEMIA
	Cancer Type 2	BONE	BONE	BONE	BONE	BONE
	Cancer Type 3	BREAST	BREAST	BREAST	BREAST	BREAST
	Cancer Type 4	LUNG	LUNG	LUNG	LUNG	LUNG
	Cancer Type 5	THYROID	THYROID	THYROID	THYROID	THYROID
	Cancer Type 6	LIVER	LIVER	LIVER	LIVER	LIVER
	Cancer Type 7	COLON	COLON	COLON	COLON	COLON
	Cancer Type 8	RESIDUAL	RESIDUAL	RESIDUAL	RESIDUAL	RESIDUAL
ACSUSC	Population Susceptible to Cancer	1.0 for all cancers	1.0 for all cancers	1.0 for all cancers	1.0 for all cancers	1.0 for all cancers
ACTHRE	Linear Dose-Response Threshold	0	0	0	0	0
BRRATE	Breathing Rate (for all activity types)	0.000266	0.000266	0.000266	0.000266	0.000266
CFRISK	Lifetime Cancer Fatality Risk Factors					
	Cancer Type 1	0.0111	0.0111	0.0111	0.0111	0.0111
	Cancer Type 2	0.00019	0.00019	0.00019	0.00019	0.00019
	Cancer Type 3	0.00506	0.00506	0.00506	0.00506	0.00506
	Cancer Type 4	0.0198	0.0198	0.0198	0.0198	0.0198
	Cancer Type 5	0.000648	0.000648	0.000648	0.000648	0.000648
	Cancer Type 6	0.003	0.003	0.003	0.003	0.003
	Cancer Type 7	0.0208	0.0208	0.0208	0.0208	0.0208
	Cancer Type 8	0.0493	0.0493	0.0493	0.0493	0.0493

Table A-5 EARLY parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR Scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
CIRISK	Lifetime Cancer Injury Risk Factors					
	Cancer Type 1	0.0113	0.0113	0.0113	0.0113	0.0113
	Cancer Type 2	0.000271	2.71E-04	2.71E-04	2.71E-04	2.71E-04
	Cancer Type 3	0.0101	0.0101	0.0101	0.0101	0.0101
	Cancer Type 4	0.0208	0.0208	0.0208	0.0208	0.0208
	Cancer Type 5	0.00648	0.00648	0.00648	0.00648	0.00648
	Cancer Type 6	0.00316	0.00316	0.00316	0.00316	0.00316
	Cancer Type 7	0.0378	0.0378	0.0378	0.0378	0.0378
	Cancer Type 8	0.169	0.169	0.169	0.169	0.169
CRIORG	Critical Organ for EARLY Phase	L-ICRP60ED	L-ICRP60ED	L-ICRP60ED	L-ICRP60ED	L-ICRP60ED
CSFACT	Cloudshine Shielding Factors					
	Evacuation Shielding Factor for All but Cohort 4	1	1	1	1	1
	Normal Activity Shielding Factor for All but Cohort 4	0.68	0.68	0.68	0.68	0.68
	Sheltering Shielding Factor for All but Cohort 4	0.6	0.6	0.6	0.6	0.6
	Evacuation Shielding Factor for Cohort 4	1	1	1	1	1
	Normal Activity Shielding Factor for Cohort 4	0.31	0.31	0.31	0.31	0.31
	Sheltering Shielding Factor for Cohort 4	0.31	0.31	0.31	0.31	0.31
DCF_FILE	Name of Dose Coefficient File	FGR13GyEquiv DCF.INP	FGR13GyEquiv DCF.INP	FGR13GyEquiv DCF.INP	FGR13GyEquiv DCF.INP	FGR13GyEquiv DCF.INP
DDREFA	Dose-Dependent Reduction Factor					
	Cancer Type 1	2	2	2	2	2
	Cancer Type 2	2	2	2	2	2
	Cancer Type 3	1	1	1	1	1
	Cancer Type 4	2	2	2	2	2

Table A-5 EARLY parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR Scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
DDREFA	Cancer Type 5	2	2	2	2	2
	Cancer Type 6	2	2	2	2	2
	Cancer Type 7	2	2	2	2	2
	Cancer Type 8	2	2	2	2	2
DDTHRE	Threshold for Applying Dose-Dependent Reduction Factor	0.2	0.2	0.2	0.2	0.2
DLTSHL	Delay from Alarm Time to Shelter					
	Cohort 1	9900	9900	9900	9900	9900
	Cohort 2	9900	9900	9900	9900	9900
	Cohort 3	900	900	900	900	900
	Cohort 4	9900	9900	9900	9900	9900
	Cohort 5	9900	9900	9900	9900	9900
	Cohort 6	N/A	N/A	N/A	N/A	N/A
DLTEVA	Delay from Beginning of Shelter to Evacuation					
	Cohort 1	3600	3600	3600	3600	3600
	Cohort 2	3600	3600	3600	3600	3600
	Cohort 3	3600	3600	6300	3600	3600
	Cohort 4	39600	39600	39600	39600	39600
	Cohort 5	39600	39600	39600	39600	39600
	Cohort 6	N/A	N/A	N/A	N/A	N/A
DOSEFA	Cancer Dose-Response Linear Factors	1 for all organs	1 for all organs	1 for all organs	1 for all organs	1 for all organs
DOSEFB	Cancer Dose-Response Quadratic Factors	0 for all organs	0 for all organs	0 for all organs	0 for all organs	0 for all organs
DOSHOT	Hot-Spot Relocation Dose Threshold	0.05	0.05	0.05	0.05	0.05
DOSMOD	Dose-Response Model Flag	AT	AT	AT	AT	AT
DOSNRM	Normal Relocation Dose Threshold	0.01	0.01	0.01	0.01	0.01
DURBEG	Duration of Beginning of Evacuation Phase					
	Cohort 1	900	900	900	900	900
	Cohort 2	900	900	900	900	900
	Cohort 3	900	900	900	900	900
	Cohort 4	3600	3600	3600	3600	3600
	Cohort 5	3600	3600	3600	3600	3600
	Cohort 6	N/A	N/A	N/A	N/A	N/A

Table A-5 EARLY parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR Scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
DURMID	Duration of Middle of Evacuation Phase					
	Cohort 1	35100	35100	35100	35100	35100
	Cohort 2	35100	35100	35100	35100	35100
	Cohort 3	1800	1800	1800	1800	1800
	Cohort 4	3600	3600	3600	3600	3600
	Cohort 5	3600	3600	3600	3600	3600
	Cohort 6	N/A	N/A	N/A	N/A	N/A
EANAM1	Text Describing the EARLY Assumptions	SOARCA Surry LTSBO Calculation	SOARCA Surry STSBO Calculation	SOARCA Surry STSBO ISLOCA Calculation	SOARCA Surry STSBO with TI-SGTR Calculation	SOARCA Surry STSBO with TI-SGTR Calculation
EANAM2	Text Describing the Emergency Response					
	Cohort 1	Group 1	Group 1	Group 1	Group 1	Group 1
	Cohort 2	Group 2	Group 2	Group 2	Group 2	Group 2
	Cohort 3	Group 3	Group 3	Group 3	Group 3	Group 3
	Cohort 4	Group 4	Group 4	Group 4	Group 4	Group 4
	Cohort 5	Group 5	Group 5	Group 5	Group 5	Group 5
	Cohort 6	Group 6	Group 6	Group 6	Group 6	Group 6
EFFACA	LD50 for Early Fatality Types					
	A-RED MARR	5.6	5.6	5.6	5.6	5.6
	A-LUNGS	23.5	23.5	23.5	23.5	23.5
	A-STOMACH	12.1	12.1	12.1	12.1	12.1
EFFACB	Shape Factor for Early Fatality Types					
	A-RED MARR	6.1	6.1	6.1	6.1	6.1
	A-LUNGS	9.6	9.6	9.6	9.6	9.6
	A-STOMACH	9.3	9.3	9.3	9.3	9.3
EFFACY	Efficacy of the KI Ingestion	0.7	0.7	0.7	0.7	0.7
EFFTHR	Threshold Dose to Target Organ					
	A-RED MARR	2.32	2.32	2.32	2.32	2.32
	A-LUNGS	13.6	13.6	13.6	13.6	13.6
	A-STOMACH	6.5	6.5	6.5	6.5	6.5
EIFACA	LD50 For Early Injuries					
	PRODROMAL VOMIT	2	2	2	2	2
	DIARRHEA	3	3	3	3	3
	PNEUMONITIS	16.6	16.6	16.6	16.6	16.6
	SKIN ERYTHRMA	6	6	6	6	6
	TRANSEPIDERMAL	20	20	20	20	20
	THYROIDITIS	240	240	240	240	240
	HYPOTHYROIDISM	60	60	60	60	60

Table A-5 EARLY parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR Scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
EIFACB	Shape Factor for Early Injuries					
	PRODROMAL VOMIT	3	3	3	3	3
	DIARRHEA	2.5	2.5	2.5	2.5	2.5
	PNEUMONITIS	7.3	7.3	7.3	7.3	7.3
	SKIN ERYTHRMA	5	5	5	5	5
	TRANSEPIDERMAL	5	5	5	5	5
	THYROIDITIS	2	2	2	2	2
	HYPOTHYROIDISM	1.3	1.3	1.3	1.3	1.3
EINAME	Early Injury Effect Names and Corresponding Organ					
	PRODROMAL VOMIT	A-STOMACH	A-STOMACH	A-STOMACH	A-STOMACH	A-STOMACH
	DIARRHEA	A-STOMACH	A-STOMACH	A-STOMACH	A-STOMACH	A-STOMACH
	PNEUMONITIS	A-LUNGS	A-LUNGS	A-LUNGS	A-LUNGS	A-LUNGS
	SKIN ERYTHRMA	A-SKIN	A-SKIN	A-SKIN	A-SKIN	A-SKIN
	TRANSEPIDERMAL	A-SKIN	A-SKIN	A-SKIN	A-SKIN	A-SKIN
	THYROIDITIS	A-THYROID	A-THYROID	A-THYROID	A-THYROID	A-THYROID
	HYPOTHYROIDISM	A-THYROID	A-THYROID	A-THYROID	A-THYROID	A-THYROID
EISUSC	Susceptible Population Fraction	1. for all health effects	1. for all health effects	1. for all health effects	1. for all health effects	1. for all health effects
EITHRE	Early Injury Dose Threshold					
	PRODROMAL VOMIT	0.5	0.5	0.5	0.5	0.5
	DIARRHEA	1	1	1	1	1
	PNEUMONITIS	9.2	9.2	9.2	9.2	9.2
	SKIN ERYTHRMA	3	3	3	3	3
	TRANSEPIDERMAL	10	10	10	10	10
	THYROIDITIS	40	40	40	40	40
	HYPOTHYROIDISM	2	2	2	2	2
ENDAT2	Control flag indicating only ATMOS and EARLY are to be run	.FALSE.	.FALSE.	.FALSE.	.FALSE.	.FALSE.
ENDEMP	Time Duration for the Emergency Phase	604800	604800	604800	604800	604800
ESPEED	Evaluation Speed					
	Initial Evacuation Phase, Cohort 1	2.235	2.235	2.235	2.235	2.235

Table A-5 EARLY parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR Scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
ESPEED	Middle Evacuation Phase, Cohort 1	0.447	0.447	0.447	0.447	0.447
	Late Evacuation Phase, Cohort 1	8.941	8.941	8.941	8.941	8.941
	Initial Evacuation Phase, Cohort 2	2.235	2.235	2.235	2.235	2.235
	Middle Evacuation Phase, Cohort 2	0.447	0.447	0.447	0.447	0.447
	Late Evacuation Phase, Cohort 2	8.941	8.941	8.941	8.941	8.941
	Initial Evacuation Phase, Cohort 3	4.47	4.47	4.47	4.47	4.47
	Middle Evacuation Phase, Cohort 3	4.47	4.47	4.47	4.47	4.47
	Late Evacuation Phase, Cohort 3	8.941	8.941	8.941	8.941	8.941
	Initial Evacuation Phase, Cohort 4	0.447	0.447	0.447	0.447	0.447
	Middle Evacuation Phase, Cohort 4	4.47	4.47	4.47	4.47	4.47
	Late Evacuation Phase, Cohort 4	8.941	8.941	8.941	8.941	8.941
	Initial Evacuation Phase, Cohort 5	0.447	0.447	0.447	0.447	0.447
	Middle Evacuation Phase, Cohort 5	4.47	4.47	4.47	4.47	4.47

Table A-5 EARLY parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR Scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
ESPEED	Late Evacuation Phase, Cohort 5	8.941	8.941	8.941	8.941	8.941
	Cohort 6	N/A	N/A	N/A	N/A	N/A
ESPGRD	Speed Multiplier to Account for Grid-Level Variations in Road Network	Table A-6 Table A-7	Table A-6 Table A-7	Table A-6 Table A-7	Table A-6 Table A-7	Table A-6 Table A-7
ESPMUL	Speed Multiplier Employed During Precipitation	0.7	0.7	0.7	0.7	0.7
EVATYP	Evacuation Type	NETWORK	NETWORK	NETWORK	NETWORK	NETWORK
GSHFAC	Groundshine Shielding Factors					
	Evacuation Shielding Factor for All but Cohort 4	0.5	0.5	0.5	0.5	0.5
	Normal Activity Shielding Factor for All but Cohort 4	0.26	0.26	0.26	0.26	0.26
	Sheltering Shielding Factor for All but Cohort 4	0.2	0.2	0.2	0.2	0.2
	Evacuation Shielding Factor for Cohort 4	0.5	0.5	0.5	0.5	0.5
	Normal Activity Shielding Factor for Cohort 4	0.05	0.05	0.05	0.05	0.05
	Sheltering Shielding Factor for Cohort 4	0.05	0.05	0.05	0.05	0.05
IDIREC	Direction in Network Evacuation Model	Table A-8	Table A-8	Table A-8	Table A-8	Table A-8
IPLUME	Plume Model Dispersion Code	3	3	3	3	3
KIMODL	Model Flag for KI Ingestion	KI	KI	KI	KI	KI

Table A-5 EARLY parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR Scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
LASMOV	Last Ring in Movement Zone	17	17	17	17	17
NUMACA	Number of Latent Cancer Health Effects	8	8	8	8	8
NUMEFA	Number of Early Fatality Effects	3	3	3	3	3
NUMEIN	Number of Early Injury Effects	7	7	7	7	7
NUMEVA	Outer Boundary of Evacuation/Shelter Region	Cohort 1 - 15 Cohorts 2 to 5 - 12	Cohort 1 - 15 Cohorts 2 to 5 - 12	Cohort 1 - 15 Cohorts 2 to 5 - 12	Cohort 1 - 15 Cohorts 2 to 5 - 12	Cohort 1 - 15 Cohorts 2 to 5 - 12
NUMFIN	Number of Fine Grid Subdivisions	7	7	7	7	7
ORGFLG	Doses to be Calculated for Specified Organ	All TRUE for FGR-13 All TRUE for DOSFAC2 except for A-Lower LI and L-Liver, which are FALSE	All TRUE for FGR-13 All TRUE for DOSFAC2 except for A-Lower LI and L-Liver, which are FALSE	All TRUE for FGR-13 All TRUE for DOSFAC2 except for A-Lower LI and L-Liver, which are FALSE	All TRUE for FGR-13 All TRUE for DOSFAC2 except for A-Lower LI and L-Liver, which are FALSE	All TRUE for FGR-13 All TRUE for DOSFAC2 except for A-Lower LI and L-Liver, which are FALSE
OVRRID	Wind Rose Probability Override	.FALSE.	.FALSE.	.FALSE.	.FALSE.	.FALSE.
POPFLG	Population Distribution Flag	FILE	FILE	FILE	FILE	FILE
POPFRAC	Population Fraction Ingesting KI	Cohort 2 - 1.0 Cohort 1, 3-6 - 0.0	Cohort 2 - 1.0 Cohort 1, 3-6 - 0.0	Cohort 2 - 1.0 Cohort 1, 3-6 - 0.0	Cohort 2 - 1.0 Cohort 1, 3-6 - 0.0	Cohort 2 - 1.0 Cohort 1, 3-6 - 0.0
PROTIN [E]	Inhalation Protection Factor – evacuation for all but Cohort 4	0.98	0.98	0.98	0.98	0.98
PROTIN [N]	Inhalation Protection Factor - normal activity for all but Cohort 4	0.46	0.46	0.46	0.46	0.46
PROTIN [S]	Inhalation Protection Factor – sheltering for all but Cohort 4	0.33	0.33	0.33	0.33	0.33
PROTIN [E]	Inhalation Protection Factor – evacuation for Cohort 4	0.98	0.98	0.98	0.98	0.98
PROTIN [N]	Inhalation Protection Factor - normal activity for Cohort 4	0.33	0.33	0.33	0.33	0.33
PROTIN [S]	Inhalation Protection Factor – sheltering for Cohort 4	0.33	0.33	0.33	0.33	0.33
REFPNT	Reference Time Point (ARRIVAL or SCRAM)	ALARM	ALARM	ALARM	ALARM	ALARM

Table A-5 EARLY parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR Scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
RESCON	Emergency phase resuspension coefficient	0.0001	0.0001	0.0001	0.0001	0.0001
RESHAF	Resuspension Concentration Half-Life	182000	182000	182000	182000	182000
RISCAT	Risk by Weather-Category Flag	.FALSE.	.FALSE.	.FALSE.	.FALSE.	.FALSE.
RISTHR	Risk Threshold for Fatality Radius	0	0	0	0	0
SKPFAC [E]	Skin Protection Factors – evacuation for all cohorts	0.98	0.98	0.98	0.98	0.98
SKPFAC [N]	Skin Protection Factors - normal activity for all but Cohort 4	0.46	0.46	0.46	0.46	0.46
SKPFAC [S]	Skin Protection Factors – sheltering for all cohorts	0.33	0.33	0.33	0.33	0.33
SKPFAC [N]	Skin Protection Factors - normal activity Cohort 4	0.33	0.33	0.33	0.33	0.33
TIMHOT	Hotspot Relocation Time	86400	86400	86400	86400	86400
TIMNRM	Normal Relocation Time	129600	129600	129600	129600	129600
TRAVEL POINT	Evacuee Movement Option	CENTER POINT	CENTER POINT	CENTER POINT	CENTER POINT	CENTER POINT
WTFRAC	Weighting Fraction Applicable to this Scenario					
	Cohort 1	0.2	0.2	0.2	0.2	0.2
	Cohort 2	0.535	0.535	0.535	0.535	0.535
	Cohort 3	0.193	0.193	0.193	0.193	0.193
	Cohort 4	0.007	0.007	0.007	0.007	0.007
	Cohort 5	0.060	0.060	0.060	0.060	0.060
	Cohort 6	0.005	0.005	0.005	0.005	0.005
WTNAME	Type of Weighting for Cohorts	PEOPLE	PEOPLE	PEOPLE	PEOPLE	PEOPLE

Table A-6 Grid-level evacuation speed multipliers used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios for cohorts 1-2

	Compass Sector															
Radial Ring	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
7	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
9	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
10	1	1	1	1	1	1	3	3	3	3	3	3	3	3	3	3
11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table A-6 Grid-level evacuation speed multipliers used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios for cohorts 1-2 (continued)

	Compass Sector															
Radial Ring	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
7	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
9	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
11	1	1	1	1	1	1	3	3	3	3	3	3	3	3	3	3
12	1	1	1	1	1	1	1	3	3	3	3	3	3	3	3	3
13	1	1	1	1	1	1	1	3	3	3	3	3	3	3	3	3
14	1	1	1	1	1	1	1	3	3	3	3	3	3	3	3	3
15	1	1	1	1	1	1	1	1	3	3	3	3	3	3	3	3
16	1	1	1	1	1	1	1	1	1	3	3	3	3	3	3	3
17	1	1	1	1	1	1	3	3	3	3	3	3	3	3	3	3

Table A-6 Grid-level evacuation speed multipliers used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios for cohorts 1-2 (continued)

	Compass Sector															
Radial Ring	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
7	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
9	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
11	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
13	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
15	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
16	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
17	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Table A-6 Grid-level evacuation speed multipliers used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios for cohorts 1-2 (continued)

	Compass Sector															
Radial Ring	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**
1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
7	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
9	3	3	3	3	3	3	3	1	1	1	1	3	3	3	3	3
10	3	3	3	3	3	3	3	1	1	1	1	1	1	1	1	1
11	3	3	3	3	3	3	3	1	1	1	1	1	1	1	1	1
12	3	3	3	3	3	3	3	1	1	1	1	1	1	1	1	1
13	3	3	3	3	3	1	1	1	1	1	1	1	1	1	1	1
14	3	3	3	3	3	1	1	1	1	1	1	1	1	1	1	1
15	3	3	3	3	3	1	1	1	1	1	1	1	1	1	1	1
16	3	3	3	3	1	1	1	1	1	1	1	1	1	1	1	1
17	3	3	3	3	1	1	1	1	1	1	1	1	1	1	1	1

Table A-7 Grid-level evacuation speed multipliers used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios for cohorts 3-5

	Compass Sector															
Radial Ring	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
7	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
8	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
9	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2
11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table A-7 Grid-level evacuation speed multipliers used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios for cohorts 3-5 (continued)

	Compass Sector															
Radial Ring	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
7	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
8	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
9	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2
12	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
13	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
14	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
15	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
16	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
17	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2

Table A-7 Grid-level evacuation speed multipliers used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios for cohorts 3-5 (continued)

	Compass Sector															
Radial Ring	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
7	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
8	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
9	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
12	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
13	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
14	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
15	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
16	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
17	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Table A-7 Grid-level evacuation speed multipliers used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios for cohorts 3-5 (continued)

	Compass Sector															
Radial Ring	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**
1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
7	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
8	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
9	2	2	2	2	2	2	2	1	1	1	1	2	2	2	2	2
10	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1
11	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1
12	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1
13	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
14	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
15	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
16	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
17	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1

Table A-8 Evacuation direction parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios

	Compass Sector															
Radial Ring	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2
5	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2
6	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2
7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	4
12	1	1	1	1	4	4	4	4	2	2	2	2	2	1	1	1
13	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	4	4	2	2	2	2	2	1	4	4	4	4	1	2	2	2
15	1	2	2	2	1	1	4	4	4	4	4	4	4	1	1	1
16	2	2	1	4	4	4	4	1	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table A-8 Evacuation direction parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

	Compass Sector															
Radial Ring	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	4	4	4	4	2	2	2	1	1	1	1
4	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
6	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	2	2	2	1	1	2	2	2
9	1	1	1	1	1	1	1	1	1	1	2	2	2	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	1
11	4	4	4	4	4	4	1	1	1	1	1	1	1	2	2	2
12	1	1	1	1	4	4	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	4	1	1	1	1	2	2	1	1	1	1
14	2	2	2	2	1	4	4	1	1	2	2	2	1	1	1	1
15	1	2	2	2	2	1	1	4	1	2	2	2	1	4	4	4
16	1	1	2	2	1	1	4	2	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table A-8 Evacuation direction parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

	Compass Sector															
Radial Ring	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	4	4	4	4	4	4	4	4	4	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	4	4	4	4	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	2	2	2	1	1	1	4	4	4	4	4	4	4
11	2	2	2	2	2	1	1	4	4	2	2	1	1	1	1	1
12	1	1	1	1	1	1	1	4	4	2	2	1	1	1	1	4
13	1	1	1	1	1	1	2	2	1	2	1	4	4	2	2	1
14	1	4	4	4	4	2	2	2	1	2	1	2	2	2	2	2
15	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	4
16	1	1	1	2	2	2	2	2	2	2	2	2	1	1	1	1
17	4	4	4	4	4	4	2	2	2	1	1	1	2	2	2	1

Table A-8 Evacuation direction parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

	Compass Sector															
Radial Ring	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	1	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1
12	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1	1
13	4	4	4	1	1	2	1	1	2	2	1	1	1	1	1	1
14	1	1	4	4	2	2	2	2	2	2	2	2	2	1	1	4
15	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	2	2	2	2	2	1	4	4	4	2
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table A-9 CHRONC input parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
CHNAME	CHRONC Problem Identification	Surry with no Food-Chain Modeling	Surry with no Food-Chain Modeling	Surry with no Food-Chain Modeling	Surry with no Food-Chain Modeling	Surry with no Food-Chain Modeling
CDFRM	Farmland Decontamination Cost					
	Level 1	1330	1330	1330	1330	1330
	Level 2	2960	2960	2960	2960	2960
CDNFRM	Nonfarmland Decontamination Cost					
	Level 1	7110	7110	7110	7110	7110
	Level 2	19000	19000	19000	19000	19000
CRTOCR	Critical Organ for CHRONC Phase	L-ICRP60ED	L-ICRP60ED	L-ICRP60ED	L-ICRP60ED	L-ICRP60ED
DPRATE	Property Depreciation Rate	0.2	0.2	0.2	0.2	0.2
DLBCST	Hourly Labor Cost for Decontamination Worker	84000	84000	84000	84000	84000
DPFRCT	Farm Production Dairy Fraction	Surry site file	Surry site file	Surry site file	Surry site file	Surry site file
DSCRLT	Long-Term Phase Dose Criterion	0.04	0.04	0.04	0.04	0.04
DSCRTI	Intermediate-Phase Dose Criterion	100000	100000	100000	100000	100000
DSRATE	Societal Discount Rate for Property	0.12	0.12	0.12	0.12	0.12
DSRFCT	Decontamination Factors					
	Level 1	3	3	3	3	3
	Level 2	15	15	15	15	15
DUR_INTPHAS	Duration of the Intermediate Phase	0	0	0	0	0
EVACST	Emergency Phase Cost of Evacuation/Relocation	172	172	172	172	172
EXPTIM	Maximum Exposure Time	1580000000	1580000000	1580000000	1580000000	1580000000
FDPATH	COMIDA2 vs. MACCS Food Model Switch	OFF	OFF	OFF	OFF	OFF
FRACLD	Fraction of Area that is Land	Surry site file	Surry site file	Surry site file	Surry site file	Surry site file
FRCFRM	Fraction of Area Used for Farming	Surry site file	Surry site file	Surry site file	Surry site file	Surry site file
FRFDL	Fraction of Decontamination Cost for Labor					
	Level 1	0.3	0.3	0.3	0.3	0.3
	Level 2	0.35	0.35	0.35	0.35	0.35
FRFIM	Farm Wealth Improvements Fraction	0.25	0.25	0.25	0.25	0.25
FRMPRD	Average Annual Farm Production	Surry site file	Surry site file	Surry site file	Surry site file	Surry site file
FRNFIM	Nonfarm Wealth Improvements Fraction	0.8	0.8	0.8	0.8	0.8
FRNFDL	Nonfarm Labor Cost Fraction					
	Level 1	0.7	0.7	0.7	0.7	0.7
	Level 2	0.5	0.5	0.5	0.5	0.5

Table A-9 CHRONC input parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
GWCOEF	Long-Term Groundshine Coefficients					
	Term 1	0.5	0.5	0.5	0.5	0.5
	Term 2	0.5	0.5	0.5	0.5	0.5
KSWTCH	Diagnostic Output Option Switch	0	0	0	0	0
LBRRATE	Long-Term Breathing Rate	0.000266	0.000266	0.000266	0.000266	0.000266
LGSHFAC	Long-Term Groundshine Protection Factor	0.26	0.26	0.26	0.26	0.26
LPROTIN	Long-Term Inhalation Protection Factor	0.46	0.46	0.46	0.46	0.46
LVLDEC	Number of Decontamination Levels	2	2	2	2	2
NGWTRM	Number of Terms in Groundshine Weathering Equation	2	2	2	2	2
NRWTRM	Number of Terms in Resuspension Weathering Equation	3	3	3	3	3
POPCST	Per Capita Cost of Long-Term Relocation	12000	12000	12000	12000	12000
RELCST	Relocation Cost per Person-Day	172	172	172	172	172
RWCOEF	Long-Term Resuspension Factor Coefficients					
	Term 1	0.00001	0.00001	0.00001	0.00001	0.00001
	Term 2	0.0000001	0.0000001	0.0000001	0.0000001	0.0000001
	Term 3	0.000000001	0.000000001	0.000000001	0.000000001	0.000000001
TFWKF	Fraction Farmland Worker Time in Contaminated Zone					
	Level 1	0.1	0.1	0.1	0.1	0.1
	Level 2	0.33	0.33	0.33	0.33	0.33
TFWKNF	Fraction Nonfarmland Worker Time in Contaminated Zone					
	Level 1	0.33	0.33	0.33	0.33	0.33
	Level 2	0.33	0.33	0.33	0.33	0.33
TGWHLF	Groundshine Weathering Half-Lives					
	Term 1	16000000	16000000	16000000	16000000	16000000
	Term 2	2800000000	2800000000	2800000000	2800000000	2800000000
TIMDEC	Decontamination Times					
	Level 1	5184000	5184000	5184000	5184000	5184000
	Level 2	10368000	10368000	10368000	10368000	10368000
TMPACT	Time Action Period Ends	158000000	158000000	158000000	158000000	158000000
TRWHLF	Resuspension Weathering Half-Lives					
	Term 1	16000000	16000000	16000000	16000000	16000000
	Term 2	160000000	160000000	160000000	160000000	160000000
	Term 3	1600000000	1600000000	1600000000	1600000000	1600000000

Table A-9 CHRONC input parameters used in the Surry LTSBO, STSBO, ISLOCA, and mitigated and unmitigated TISGTR scenarios (continued)

Variable	Description	LTSBO	STSBO	ISLOCA	TISGTR Mitigated	TISGTR Unmitigated
VALWF	Value of Farm Wealth	6900	6900	6900	6900	6900
VALWNF	Value of Nonfarm Wealth	220000	220000	220000	220000	220000

APPENDIX B: MACCS PEACH BOTTOM ATOMIC POWER STATION SOARCA MODELING PARAMETERS

PEACH BOTTOM INPUT PARAMETERS FOR SOARCA

The input parameters used for the SOARCA Peach Bottom unmitigated LTSBO scenario and the STSBO with and without RCIC blackstart are shown in this appendix in tabular form. Table B-1 contains the more general ATMOS input parameters used for these three scenarios. Table B-2 through Table B-4 contain specific inputs related to the source terms that were extracted from MELCOR results via the MELMACCS code. Table B-5 contains general EARLY input parameters. Table B-6 and Table B-7 contain parameters associated with the network evacuation model that was used to treat emergency response. Table B-8 contains the CHRONC input parameters.

Table B-1 ATMOS input parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios

Variable	Description	LTSBO	STSBO with RCIC Blackstart	STSBO without RCIC Blackstart
APLFRC	Method of Applying Release Fraction	PARENT	PARENT	PARENT
ATNAM1	Title Describing the ATMOS Assumptions	SOARCA PB Source Term Long-Term SBO	SOARCA PB Source Term Short-Term SBO	SOARCA PB Source Term Short-Term SBO
ATNAM2	Title Describing the Source Term	Peach Bottom source term for long term station blackout.	Peach Bottom source term for short term station blackout.	Peach Bottom source term for short term station blackout.
BNDMXH	Boundary Weather Mixing Layer Height	1000	1000	1000
BNDRAN	Boundary Weather Rain Rate	5	5	5
BNDWND	Boundary Wind Speed	2.2	2.2	2.2
BRKPNT	Breakpoint Time for Plume Meander	3600	3600	3600
BUILDH	Building Height for all Plume Segments	50	50	50
CORINV	Isotopic Inventory at Time of Reactor Shutdown	from MELMACCS	from MELMACCS	from MELMACCS
CORSCA	Linear Scaling Factor on Core Inventory	1	1	1
CWASH1	Linear Coefficient for Washout	1.89E-05	1.89E-05	1.89E-05
CWASH2	Exponential Term for Washout	0.664	0.664	0.664
CYSIGA	Linear Coefficient for sigma-y			
	Stability Class A	0.7507	0.7507	0.7507
	Stability Class B	0.7507	0.7507	0.7507
	Stability Class C	0.4063	0.4063	0.4063
	Stability Class D	0.2779	0.2779	0.2779
	Stability Class E	0.2158	0.2158	0.2158
	Stability Class F	0.2158	0.2158	0.2158

Table B-1 ATMOS input parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Variable	Description	LTSBO	STSBO with RCIC Blackstart	STSBO without RCIC Blackstart
CYSIGB	Exponential Term for sigma-y			
	Stability Class A	0.866	0.866	0.866
	Stability Class B	0.866	0.866	0.866
	Stability Class C	0.865	0.865	0.865
	Stability Class D	0.881	0.881	0.881
	Stability Class E	0.866	0.866	0.866
	Stability Class F	0.866	0.866	0.866
CZSIGA	Linear Coefficient for sigma-z			
	Stability Class A	0.0361	0.0361	0.0361
	Stability Class B	0.0361	0.0361	0.0361
	Stability Class C	0.2036	0.2036	0.2036
	Stability Class D	0.2636	0.2636	0.2636
	Stability Class E	0.2463	0.2463	0.2463
	Stability Class F	0.2463	0.2463	0.2463
CZSIGB	Exponential Term for sigma-z			
	Stability Class A	1.277	1.277	1.277
	Stability Class B	1.277	1.277	1.277
	Stability Class C	0.859	0.859	0.859
	Stability Class D	0.751	0.751	0.751
	Stability Class E	0.619	0.619	0.619
	Stability Class F	0.619	0.619	0.619
DISPMD	Dispersion Model Flag	LRDIST	LRDIST	LRDIST
DRYDEP	Dry Deposition Flag	Xe = .FALSE. Other Groups = .TRUE.	Xe = .FALSE. Other Groups = .TRUE.	Xe = .FALSE. Other Groups = .TRUE.
ENDAT1	Control flag indicating only ATMOS is to be run	.FALSE.	.FALSE.	.FALSE.
GRPNAM	Names of the Chemical Classes (Used by WinMACCS)			
	Chemical Class 1	Xe	Xe	Xe
	Chemical Class 2	Cs	Cs	Cs
	Chemical Class 3	Ba	Ba	Ba
	Chemical Class 4	I	I	I
	Chemical Class 5	Te	Te	Te
	Chemical Class 6	Ru	Ru	Ru
	Chemical Class 7	Mo	Mo	Mo
	Chemical Class 8	Ce	Ce	Ce
	Chemical Class 9	La	La	La
IBDSTB	Boundary Weather Stability Class Index	4	4	4
IDEBUG	Debug Switch for Extra Debugging Print	0	0	0

Table B-1 ATMOS input parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Variable	Description	LTSBO	STSBO with RCIC Blackstart	STSBO without RCIC Blackstart
IGROUP	Definition of Radionuclide Group Numbers	1 = Xe	1 = Xe	1 = Xe
		2 = Cs	2 = Cs	2 = Cs
		3 = Ba	3 = Ba	3 = Ba
		4 = I	4 = I	4 = I
		5 = Te	5 = Te	5 = Te
		6 = Ru	6 = Ru	6 = Ru
		7 = Mo	7 = Mo	7 = Mo
		8 = Ce	8 = Ce	8 = Ce
		9 = La	9 = La	9 = La
INWGHT	Number of Samples for Each Bin Used for Nonuniform Weather Bin Sampling			
	Bin 1	71	71	71
	Bin 2	42	42	42
	Bin 3	12	12	12
	Bin 4	52	52	52
	Bin 5	57	57	57
	Bin 6	74	74	74
	Bin 7	21	21	21
	Bin 8	12	12	12
	Bin 9	49	49	49
	Bin 10	103	103	103
	Bin 11	77	77	77
	Bin 12	35	35	35
	Bin 13	51	51	51
	Bin 14	75	75	75
	Bin 15	14	14	14
	Bin 16	4	4	4
	Bin 17	44	44	44
	Bin 18	12	12	12
	Bin 19	17	17	17
	Bin 20	24	24	24
	Bin 21	24	24	24
	Bin 22	12	12	12
	Bin 23	4	4	4
	Bin 24	8	8	8
	Bin 25	12	12	12
	Bin 26	12	12	12
	Bin 27	12	12	12
	Bin 28	1	1	1
	Bin 29	3	3	3
	Bin 30	5	5	5
	Bin 31	4	4	4
	Bin 32	12	12	12
	Bin 33	1	1	1
	Bin 34	7	7	7
	Bin 35	9	9	9

Table B-1 ATMOS input parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

	Bin 36	12	12	12
Variable	**Description**	**LTSBO**	**STSBO with RCIC Blackstart**	**STSBO without RCIC Blackstart**
IRSEED	Seed for Random Number Generator	79	79	79
LATITU	Latitude of Power Plant	39˚ 45' 32"	39˚ 45' 32"	39˚ 45' 32"
LIMSPA	Last Interval for Measured Weather	25	25	25
LONGIT	Longitude of Power Plant	76˚ 16' 09"	76˚ 16' 09"	76˚ 16' 09"
MAXGRP	Number of Radionuclide Groups	9	9	9
MAXHGT	Flag for Mixing Height	DAY_AND_NIGHT	DAY_AND_NIGHT	DAY_AND_NIGHT
MAXRIS	Selection of Risk Dominant Plume	2	1	9
METCOD	Meteorological Sampling Option Code	2	2	2
MNDMOD	Plume Meander Model Flag	OFF	OFF	OFF
NAMSTB	List of Pseudostable Nuclides			
	Isotope 1	I-129	I-129	I-129
	Isotope 2	Xe-131m	Xe-131m	Xe-131m
	Isotope 3	Xe-133m	Xe-133m	Xe-133m
	Isotope 4	Cs-135	Cs-135	Cs-135
	Isotope 5	Sm-147	Sm-147	Sm-147
	Isotope 6	U-234	U-234	U-234
	Isotope 7	U-235	U-235	U-235
	Isotope 8	U-236	U-236	U-236
	Isotope 9	U-237	U-237	U-237
	Isotope 10	Np-237	Np-237	Np-237
	Isotope 11	Rb-87	Rb-87	Rb-87
	Isotope 12	Zr-93	Zr-93	Zr-93
	Isotope 13	Nb-93m	Nb-93m	Nb-93m
	Isotope 14	Nb-95m	Nb-95m	Nb-95m
	Isotope 15	Tc-99	Tc-99	Tc-99
	Isotope 16	Pm-147	Pm-147	Pm-147
NPSGRP	Number of Particle Size Groups	10	10	10
NRINTN	Number of Rain Intensity Breakpoints	3	3	3
NRNINT	Number of Rain Distance Intervals	5	5	5
NSBINS	Number of Weather Bins to Sample	36	36	36
NUCNAM	Radionuclide Names	See Table 4-3	See Table 4-3	See Table 4-3
NUCOUT	Radionuclide Used in Dispersion Print	Cs-137	Cs-137	Cs-137
NUMCOR	Number of Compass Sectors in the Grid	64	64	64
NUMISO	Number of Radionuclides	69	69	69
NUMRAD	Number of Radial Spatial Intervals	26	26	26
NUMREL	# Released Plume sgmnts	29	33	86

Table B-1 ATMOS input parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Variable	Description	LTSBO	STSBO with RCIC Blackstart	STSBO without RCIC Blackstart
NUMSTB	Number of Defined Pseudostable Radionuclides	16	16	16
OALARM	Time to Reach General Emergency Conditions	0	0	0
PDELAY	Plume Release Times	MELMACCS Data (See Table B-2)	MELMACCS Data (See Table B-2)	MELMACCS Data (See Table B-2)
PLHEAT	Plume Heat Contents	MELMACCS Data (See Table B-2)	MELMACCS Data (See Table B-2)	MELMACCS Data (See Table B-2)
PLHITE	Plume Release Heights	MELMACCS Data (See Table B-2)	MELMACCS Data (See Table B-2)	MELMACCS Data (See Table B-2)
PLMDEN	Plume Mass Density	MELMACCS Data (See Table B-2)	MELMACCS Data (See Table B-2)	MELMACCS Data (See Table B-2)
PLMFLA	Plume Mass Flow Rate	MELMACCS Data (See Table B-2)	MELMACCS Data (See Table B-2)	MELMACCS Data (See Table B-2)
PLMMOD	Flag for Plume Rise Input Option	DENSITY	DENSITY	DENSITY
PLUDUR	Plume Segment Durations	MELMACCS Data (See Table B-2)	MELMACCS Data (See Table B-2)	MELMACCS Data (See Table B-2)
PSDIST	Particle Size Distribution by Group	MELMACCS Data (See Table B-3)	MELMACCS Data (See Table B-3)	MELMACCS Data (See Table B-3)
REFTIM	Plume Reference Time Point	0. for first 0.5 for subsequent	0. for first 0.5 for subsequent	0. for first 0.5 for subsequent
RELFRC	Release Fractions of the Source Term	MELMACCS Data (See Table B-4)	MELMACCS Data (See Table B-4)	MELMACCS Data (See Table B-4)
RNDSTS	Endpoints of Rain Distance Intervals			
	Interval 1	3.22	3.22	3.22
	Interval 2	5.63	5.63	5.63
	Interval 3	11.27	11.27	11.27
	Interval 4	20.92	20.92	20.92
	Interval 5	32.19	32.19	32.19
RNRATE	Rain Intensity Breakpoints for Weather Binning			
	Intensity 1	2	2	2
	Intensity 2	4	4	4
	Intensity 3	6	6	6
SCLADP	Scaling Factor for A-D Plume Rise	1.0	1.0	1.0
SCLCRW	Scaling Factor for Critical Wind Speed	1.0	1.0	1.0
SCLEFP	Scaling Factor for E-F Plume Rise	1.0	1.0	1.0
SIGYINIT	Initial Sigma-y for All Plume Segments	11.6	11.6	11.6
SIGYINIT	Initial Sigma-z for All Plume Segments	23.3	23.3	23.3
SPAEND	Radial distances for grid boundaries			
	Ring 1	0.16	0.16	0.16
	Ring 2	0.52	0.52	0.52

Table B-1 ATMOS input parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Variable	Description	LTSBO	STSBO with RCIC Blackstart	STSBO without RCIC Blackstart
SPAEND	Ring 3	1.21	1.21	1.21
	Ring 4	1.61	1.61	1.61
	Ring 5	2.13	2.13	2.13
	Ring 6	3.22	3.22	3.22
	Ring 7	4.02	4.02	4.02
	Ring 8	4.83	4.83	4.83
	Ring 9	5.63	5.63	5.63
	Ring 10	8.05	8.05	8.05
	Ring 11	11.27	11.27	11.27
	Ring 12	16.09	16.09	16.09
	Ring 13	20.92	20.92	20.92
	Ring 14	25.75	25.75	25.75
	Ring 15	32.19	32.19	32.19
	Ring 16	40.23	40.23	40.23
	Ring 17	48.28	48.28	48.28
	Ring 18	64.37	64.37	64.37
	Ring 19	80.47	80.47	80.47
	Ring 20	112.65	112.65	112.65
	Ring 21	160.93	160.93	160.93
	Ring 22	241.14	241.14	241.14
	Ring 23	321.87	321.87	321.87
	Ring 24	563.27	563.27	563.27
	Ring 25	804.67	804.67	804.67
	Ring 26	1609.34	1609.34	1609.34
TIMBAS	Time Base for Plume Expansion Factor	36000	36000	36000
VDEPOS	Dry Deposition Velocities			
	Aerosol Bin 1	5.35E-04	5.35E-04	5.35E-04
	Aerosol Bin 2	4.91E-04	4.91E-04	4.91E-04
	Aerosol Bin 3	6.43E-04	6.43E-04	6.43E-04
	Aerosol Bin 4	1.08E-03	1.08E-03	1.08E-03
	Aerosol Bin 5	2.12E-03	2.12E-03	2.12E-03
	Aerosol Bin 6	4.34E-03	4.34E-03	4.34E-03
	Aerosol Bin 7	8.37E-03	8.37E-03	8.37E-03
	Aerosol Bin 8	1.37E-02	1.37E-02	1.37E-02
	Aerosol Bin 9	1.70E-02	1.70E-02	1.70E-02
	Aerosol Bin 10	1.70E-02	1.70E-02	1.70E-02
WETDEP	Wet Deposition Flag	Xe = .FALSE. Other groups = .TRUE.	Xe = .FALSE. Other groups = .TRUE.	Xe = .FALSE. Other groups = .TRUE.
XPFAC1	Base Time for Meander Expansion Factor	0.01	0.01	0.01
XPFAC2	Breakpoint for Expansion Factor Model	0.01	0.01	0.01
YSCALE	Scale Factor for Horizontal Dispersion	1	1	1
ZSCALE	Scale Factor for Vertical Dispersion	1.27	1.27	1.27

Table B-2 Plume parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios

Peach Bottom LTSBO						
Plume Segment	PDELAY	PLHEAT	PLHITE	PLMDEN	PLMFLA	PLUDUR
1	7.20E+04	9.18E+06	3.96E+01	9.28E-01	1.46E+02	3.60E+03
2	7.22E+04	6.96E+05	4.00E+00	5.44E-01	6.87E+00	3.66E+03
3	7.56E+04	4.87E+06	3.96E+01	9.84E-01	1.40E+02	3.60E+03
4	7.92E+04	4.37E+06	3.96E+01	9.96E-01	1.35E+02	3.60E+03
5	8.28E+04	3.68E+06	3.96E+01	1.01E+00	1.29E+02	3.74E+03
6	8.66E+04	3.08E+06	3.96E+01	1.03E+00	1.20E+02	3.60E+03
7	9.02E+04	2.66E+06	3.96E+01	1.04E+00	1.14E+02	3.60E+03
8	9.38E+04	2.21E+06	3.96E+01	1.06E+00	1.08E+02	3.60E+03
9	9.74E+04	1.94E+06	3.96E+01	1.06E+00	1.03E+02	3.60E+03
10	1.01E+05	1.75E+06	3.96E+01	1.07E+00	9.96E+01	3.60E+03
11	1.05E+05	1.58E+06	3.96E+01	1.08E+00	9.63E+01	3.60E+03
12	1.08E+05	1.48E+06	3.96E+01	1.08E+00	9.42E+01	3.60E+03
13	1.12E+05	1.45E+06	3.96E+01	1.08E+00	9.32E+01	3.60E+03
14	1.15E+05	1.40E+06	3.96E+01	1.08E+00	9.20E+01	3.60E+03
15	1.19E+05	1.36E+06	3.96E+01	1.09E+00	9.10E+01	3.60E+03
16	1.23E+05	1.33E+06	3.96E+01	1.09E+00	9.01E+01	3.60E+03
17	1.26E+05	1.30E+06	3.96E+01	1.09E+00	8.95E+01	3.60E+03
18	1.30E+05	1.28E+06	3.96E+01	1.09E+00	8.90E+01	3.60E+03
19	1.33E+05	1.27E+06	3.96E+01	1.09E+00	8.86E+01	3.60E+03
20	1.37E+05	1.26E+06	3.96E+01	1.09E+00	8.83E+01	3.60E+03
21	1.41E+05	1.25E+06	3.96E+01	1.09E+00	8.81E+01	3.60E+03
22	1.44E+05	1.25E+06	3.96E+01	1.09E+00	8.79E+01	3.60E+03
23	1.48E+05	1.25E+06	3.96E+01	1.09E+00	8.79E+01	3.60E+03
24	1.51E+05	1.24E+06	3.96E+01	1.09E+00	8.78E+01	3.60E+03
25	1.55E+05	1.24E+06	3.96E+01	1.09E+00	8.77E+01	3.60E+03
26	1.59E+05	1.24E+06	3.96E+01	1.09E+00	8.76E+01	3.60E+03
27	1.62E+05	1.24E+06	3.96E+01	1.09E+00	8.75E+01	3.60E+03
28	1.66E+05	1.24E+06	3.96E+01	1.09E+00	8.74E+01	3.60E+03
29	1.69E+05	1.24E+06	3.96E+01	1.09E+00	8.73E+01	3.42E+03

Table B-2 Plume parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Peach Bottom STSBO with RCIC Blackstart						
Plume Segment	**PDELAY**	**PLHEAT**	**PLHITE**	**PLMDEN**	**PLMFLA**	**PLUDUR**
1	6.09E+04	8.80E+06	3.96E+01	9.42E-01	1.40E+02	3.60E+03
2	6.09E+04	9.39E+05	4.00E+00	6.17E-01	6.61E+00	3.60E+03
3	6.45E+04	3.69E+06	3.96E+01	1.01E+00	1.29E+02	3.60E+03
4	6.81E+04	3.63E+06	3.96E+01	1.02E+00	1.27E+02	3.60E+03
5	7.17E+04	3.18E+06	3.96E+01	1.03E+00	1.22E+02	3.63E+03
6	7.54E+04	2.84E+06	3.96E+01	1.04E+00	1.17E+02	3.60E+03
7	7.90E+04	2.45E+06	3.96E+01	1.05E+00	1.11E+02	3.60E+03
8	8.26E+04	2.11E+06	3.96E+01	1.06E+00	1.06E+02	3.60E+03
9	8.62E+04	1.91E+06	3.96E+01	1.07E+00	1.03E+02	3.60E+03
10	8.98E+04	1.73E+06	3.96E+01	1.07E+00	9.92E+01	3.60E+03
11	9.34E+04	1.58E+06	3.96E+01	1.08E+00	9.64E+01	3.60E+03
12	9.70E+04	1.48E+06	3.96E+01	1.08E+00	9.43E+01	3.60E+03
13	1.01E+05	1.41E+06	3.96E+01	1.08E+00	9.29E+01	3.60E+03
14	1.04E+05	1.36E+06	3.96E+01	1.08E+00	9.18E+01	3.60E+03
15	1.08E+05	1.33E+06	3.96E+01	1.09E+00	9.09E+01	3.60E+03
16	1.11E+05	1.30E+06	3.96E+01	1.09E+00	9.02E+01	3.60E+03
17	1.15E+05	1.34E+06	3.96E+01	1.09E+00	9.09E+01	3.60E+03
18	1.19E+05	1.28E+06	3.96E+01	1.09E+00	9.11E+01	3.60E+03
19	1.22E+05	1.27E+06	3.96E+01	1.09E+00	8.92E+01	3.60E+03
20	1.26E+05	1.27E+06	3.96E+01	1.09E+00	8.90E+01	3.60E+03
21	1.29E+05	1.26E+06	3.96E+01	1.09E+00	8.87E+01	3.60E+03
22	1.33E+05	1.26E+06	3.96E+01	1.09E+00	8.85E+01	3.60E+03
23	1.37E+05	1.26E+06	3.96E+01	1.09E+00	8.84E+01	3.60E+03
24	1.40E+05	1.25E+06	3.96E+01	1.09E+00	8.83E+01	3.60E+03
25	1.44E+05	1.25E+06	3.96E+01	1.09E+00	8.82E+01	3.60E+03
26	1.47E+05	1.25E+06	3.96E+01	1.09E+00	8.81E+01	3.60E+03
27	1.51E+05	1.25E+06	3.96E+01	1.09E+00	8.80E+01	3.60E+03
28	1.55E+05	1.25E+06	3.96E+01	1.09E+00	8.80E+01	3.60E+03
29	1.58E+05	1.25E+06	3.96E+01	1.09E+00	8.78E+01	3.60E+03
30	1.62E+05	1.24E+06	3.96E+01	1.09E+00	8.78E+01	3.60E+03
31	1.65E+05	1.24E+06	3.96E+01	1.09E+00	8.77E+01	3.60E+03
32	1.69E+05	1.24E+06	3.96E+01	1.09E+00	8.76E+01	3.60E+03
33	1.73E+05	1.24E+06	3.96E+01	1.09E+00	6.56E+01	2.40E+02

Table B-2 Plume parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Peach Bottom STSBO without RCIC Blackstart						
Plume Segment	PDELAY	PLHEAT	PLHITE	PLMDEN	PLMFLA	PLUDUR
1	2.93E+04	1.94E+00	1.75E+01	1.11E+00	1.94E+00	3.60E+03
2	3.05E+04	4.02E+01	3.96E+01	6.64E-01	4.02E+01	3.60E+03
3	3.05E+04	2.17E+01	4.00E+00	6.43E-01	2.17E+01	3.60E+03
4	3.12E+04	1.44E+02	3.96E+01	9.81E-01	1.44E+02	3.66E+03
5	3.41E+04	8.34E+00	4.00E+00	5.24E-01	8.34E+00	3.62E+03
6	3.48E+04	1.18E+02	3.96E+01	1.05E+00	1.18E+02	3.56E+03
7	3.77E+04	3.85E+00	4.00E+00	5.49E-01	3.85E+00	3.60E+03
8	3.84E+04	1.04E+02	3.96E+01	1.07E+00	1.04E+02	3.60E+03
9	4.01E+04	1.75E+00	1.75E+01	1.11E+00	1.75E+00	3.60E+03
10	4.13E+04	2.65E+00	4.00E+00	4.72E-01	2.65E+00	3.60E+03
11	4.20E+04	9.13E+01	3.96E+01	1.09E+00	9.13E+01	3.60E+03
12	4.37E+04	3.34E+00	1.75E+01	1.11E+00	3.34E+00	3.60E+03
13	4.56E+04	8.39E+01	3.96E+01	1.11E+00	8.39E+01	3.60E+03
14	4.73E+04	3.59E+00	1.75E+01	1.11E+00	3.59E+00	3.60E+03
15	4.92E+04	8.17E+01	3.96E+01	1.11E+00	8.17E+01	3.60E+03
16	5.09E+04	3.58E+00	1.75E+01	1.11E+00	3.58E+00	3.60E+03
17	5.28E+04	8.04E+01	3.96E+01	1.11E+00	8.04E+01	3.60E+03
18	5.45E+04	3.51E+00	1.75E+01	1.11E+00	3.51E+00	3.60E+03
19	5.64E+04	7.92E+01	3.96E+01	1.12E+00	7.92E+01	3.60E+03
20	5.81E+04	3.41E+00	1.75E+01	1.11E+00	3.41E+00	3.60E+03
21	6.00E+04	7.82E+01	3.96E+01	1.12E+00	7.82E+01	3.60E+03
22	6.17E+04	3.31E+00	1.75E+01	1.12E+00	3.31E+00	3.60E+03
23	6.36E+04	7.75E+01	3.96E+01	1.12E+00	7.75E+01	3.60E+03
24	6.53E+04	3.21E+00	1.75E+01	1.12E+00	3.21E+00	3.60E+03
25	6.72E+04	7.73E+01	3.96E+01	1.12E+00	7.73E+01	3.60E+03
26	6.89E+04	3.14E+00	1.75E+01	1.12E+00	3.14E+00	3.63E+03
27	7.08E+04	7.77E+01	3.96E+01	1.12E+00	7.77E+01	3.60E+03
28	7.25E+04	3.16E+00	1.75E+01	1.12E+00	3.16E+00	3.60E+03
29	7.44E+04	7.77E+01	3.96E+01	1.12E+00	7.77E+01	3.60E+03
30	7.61E+04	3.22E+00	1.75E+01	1.12E+00	3.22E+00	3.60E+03
31	7.80E+04	7.90E+01	3.96E+01	1.12E+00	7.90E+01	3.60E+03
32	7.97E+04	3.35E+00	1.75E+01	1.11E+00	3.35E+00	3.60E+03
33	8.16E+04	8.60E+01	3.96E+01	1.11E+00	8.60E+01	3.60E+03
34	8.33E+04	3.81E+00	1.75E+01	1.11E+00	3.81E+00	3.60E+03
35	8.52E+04	8.83E+01	3.96E+01	1.11E+00	8.83E+01	3.72E+03
36	8.69E+04	4.19E+00	1.75E+01	1.10E+00	4.19E+00	3.60E+03
37	8.82E+04	5.96E-01	3.96E+01	1.11E+00	5.96E-01	3.60E+03
38	8.89E+04	8.60E+01	3.96E+01	1.11E+00	8.60E+01	3.60E+03
39	9.05E+04	4.47E+00	1.75E+01	1.09E+00	4.47E+00	3.60E+03
40	9.18E+04	5.99E-01	3.96E+01	1.11E+00	5.99E-01	3.60E+03
41	9.25E+04	8.72E+01	3.96E+01	1.11E+00	8.72E+01	3.60E+03
42	9.41E+04	4.68E+00	1.75E+01	1.09E+00	4.68E+00	3.60E+03
43	9.54E+04	6.12E-01	3.96E+01	1.11E+00	6.12E-01	3.60E+03
44	9.61E+04	8.79E+01	3.96E+01	1.11E+00	8.79E+01	3.60E+03

Table B-2 Plume parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

45	9.77E+04	4.89E+00	1.75E+01	1.08E+00	4.89E+00	3.60E+03
46	9.97E+04	8.85E+01	3.96E+01	1.11E+00	8.85E+01	3.60E+03
Plume Segment	**PDELAY**	**PLHEAT**	**PLHITE**	**PLMDEN**	**PLMFLA**	**PLUDUR**
47	1.01E+05	5.05E+00	1.75E+01	1.08E+00	5.05E+00	3.60E+03
48	1.03E+05	8.89E+01	3.96E+01	1.10E+00	8.89E+01	3.60E+03
49	1.05E+05	5.18E+00	1.75E+01	1.08E+00	5.18E+00	3.60E+03
50	1.07E+05	8.93E+01	3.96E+01	1.10E+00	8.93E+01	3.60E+03
51	1.09E+05	5.28E+00	1.75E+01	1.07E+00	5.28E+00	3.60E+03
52	1.11E+05	8.95E+01	3.96E+01	1.10E+00	8.95E+01	3.60E+03
53	1.12E+05	5.34E+00	1.75E+01	1.07E+00	5.34E+00	3.60E+03
54	1.14E+05	8.97E+01	3.96E+01	1.10E+00	8.97E+01	3.60E+03
55	1.16E+05	5.39E+00	1.75E+01	1.07E+00	5.39E+00	3.60E+03
56	1.18E+05	8.99E+01	3.96E+01	1.10E+00	8.99E+01	3.60E+03
57	1.19E+05	5.44E+00	1.75E+01	1.07E+00	5.44E+00	3.60E+03
58	1.21E+05	9.00E+01	3.96E+01	1.10E+00	9.00E+01	3.60E+03
59	1.23E+05	5.47E+00	1.75E+01	1.07E+00	5.47E+00	3.60E+03
60	1.25E+05	9.01E+01	3.96E+01	1.10E+00	9.01E+01	3.60E+03
61	1.27E+05	5.50E+00	1.75E+01	1.07E+00	5.50E+00	3.60E+03
62	1.29E+05	9.02E+01	3.96E+01	1.10E+00	9.02E+01	3.60E+03
63	1.30E+05	5.53E+00	1.75E+01	1.07E+00	5.53E+00	3.60E+03
64	1.32E+05	9.01E+01	3.96E+01	1.10E+00	9.01E+01	3.60E+03
65	1.34E+05	5.56E+00	1.75E+01	1.06E+00	5.56E+00	3.60E+03
66	1.36E+05	9.02E+01	3.96E+01	1.10E+00	9.02E+01	3.60E+03
67	1.37E+05	5.57E+00	1.75E+01	1.06E+00	5.57E+00	3.60E+03
68	1.39E+05	9.03E+01	3.96E+01	1.10E+00	9.03E+01	3.60E+03
69	1.41E+05	5.59E+00	1.75E+01	1.06E+00	5.59E+00	3.60E+03
70	1.43E+05	9.03E+01	3.96E+01	1.10E+00	9.03E+01	3.60E+03
71	1.45E+05	5.60E+00	1.75E+01	1.06E+00	5.60E+00	3.60E+03
72	1.47E+05	9.03E+01	3.96E+01	1.10E+00	9.03E+01	3.60E+03
73	1.48E+05	5.62E+00	1.75E+01	1.06E+00	5.62E+00	3.60E+03
74	1.50E+05	9.03E+01	3.96E+01	1.10E+00	9.03E+01	3.60E+03
75	1.52E+05	5.63E+00	1.75E+01	1.06E+00	5.63E+00	3.60E+03
76	1.54E+05	9.03E+01	3.96E+01	1.10E+00	9.03E+01	3.60E+03
77	1.55E+05	5.64E+00	1.75E+01	1.06E+00	5.64E+00	3.60E+03
78	1.57E+05	9.02E+01	3.96E+01	1.10E+00	9.02E+01	3.60E+03
79	1.59E+05	5.65E+00	1.75E+01	1.06E+00	5.65E+00	3.60E+03
80	1.61E+05	9.02E+01	3.96E+01	1.10E+00	9.02E+01	3.60E+03
81	1.63E+05	5.66E+00	1.75E+01	1.06E+00	5.66E+00	3.60E+03
82	1.65E+05	9.01E+01	3.96E+01	1.10E+00	9.01E+01	3.60E+03
83	1.66E+05	5.68E+00	1.75E+01	1.06E+00	5.68E+00	3.60E+03
84	1.68E+05	9.00E+01	3.96E+01	1.10E+00	9.00E+01	3.60E+03
85	1.70E+05	5.68E+00	1.75E+01	1.06E+00	5.68E+00	3.06E+03
86	1.72E+05	8.98E+01	3.96E+01	1.10E+00	8.98E+01	1.08E+03

Table B-3 Plume parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios

Peach Bottom LTSBO										
Class	**Bin 1**	**Bin 2**	**Bin 3**	**Bin 4**	**Bin 5**	**Bin 6**	**Bin 7**	**Bin 8**	**Bin 9**	**Bin 10**
Xe	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
Cs	0.1171	0.1602	0.3303	0.3061	0.0575	0.0180	0.0071	0.0025	0.0009	0.0004
Ba	0.0412	0.2230	0.4450	0.2275	0.0486	0.0111	0.0030	0.0005	0.0001	0.0001
I	0.0231	0.1503	0.5219	0.2579	0.0333	0.0102	0.0027	0.0005	0.0001	0.0000
Te	0.0286	0.1370	0.4603	0.2779	0.0643	0.0249	0.0059	0.0009	0.0002	0.0001
Ru	0.0393	0.1512	0.3597	0.2682	0.1214	0.0484	0.0104	0.0011	0.0002	0.0001
Mo	0.1553	0.1638	0.2563	0.3259	0.0649	0.0202	0.0087	0.0033	0.0012	0.0005
Ce	0.0306	0.1930	0.4357	0.2427	0.0708	0.0218	0.0047	0.0005	0.0001	0.0001
La	0.0235	0.1473	0.3990	0.2664	0.1109	0.0433	0.0089	0.0007	0.0000	0.0000

Table B-3 Plume parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Peach Bottom STSBO with RCIC Blackstart										
Class	**Bin 1**	**Bin 2**	**Bin 3**	**Bin 4**	**Bin 5**	**Bin 6**	**Bin 7**	**Bin 8**	**Bin 9**	**Bin 10**
Xe	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
Cs	0.1704	0.1914	0.2388	0.2874	0.0796	0.0169	0.0094	0.0039	0.0017	0.0005
Ba	0.0303	0.1751	0.4211	0.3035	0.0581	0.0084	0.0023	0.0008	0.0003	0.0001
I	0.0322	0.1958	0.4343	0.2527	0.0634	0.0164	0.0040	0.0008	0.0003	0.0001
Te	0.0499	0.1770	0.3605	0.2675	0.0987	0.0353	0.0088	0.0016	0.0005	0.0001
Ru	0.0501	0.1443	0.2997	0.3035	0.1406	0.0480	0.0114	0.0017	0.0005	0.0001
Mo	0.2081	0.1901	0.1871	0.2966	0.0834	0.0167	0.0108	0.0047	0.0021	0.0006
Ce	0.0188	0.1393	0.4164	0.3264	0.0786	0.0164	0.0034	0.0005	0.0001	0.0001
La	0.0218	0.1333	0.3404	0.3148	0.1352	0.0442	0.0093	0.0008	0.0001	0.0000

Table B-3 Plume parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Peach Bottom STSBO without RCIC Blackstart										
Class	**Bin 1**	**Bin 2**	**Bin 3**	**Bin 4**	**Bin 5**	**Bin 6**	**Bin 7**	**Bin 8**	**Bin 9**	**Bin 10**
Xe	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
Cs	0.0288	0.2922	0.2076	0.2174	0.1847	0.0587	0.0089	0.0012	0.0002	0.0003
Ba	0.0178	0.0546	0.1120	0.3364	0.3641	0.0994	0.0135	0.0018	0.0002	0.0001
I	0.0282	0.5160	0.2181	0.1261	0.0864	0.0217	0.0023	0.0003	0.0003	0.0006
Te	0.0393	0.3360	0.2596	0.2010	0.1225	0.0376	0.0034	0.0004	0.0001	0.0001
Ru	0.0323	0.0946	0.1503	0.2915	0.2935	0.1127	0.0209	0.0036	0.0005	0.0003
Mo	0.0300	0.1217	0.1995	0.2859	0.2584	0.0880	0.0141	0.0020	0.0002	0.0002
Ce	0.0219	0.0558	0.1024	0.3281	0.3666	0.1076	0.0151	0.0021	0.0002	0.0002
La	0.0203	0.0724	0.1218	0.3231	0.3501	0.0976	0.0127	0.0016	0.0002	0.0002

Table B-4 Release fraction parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios

Peach Bottom LTSBO									
Plume Segment	Xe	Cs	Ba	I	Te	Ru	Mo	Ce	La
1	8.75E-01	2.32E-03	1.17E-03	1.65E-03	1.73E-03	1.31E-06	6.39E-04	1.32E-05	1.91E-06
2	7.93E-02	3.29E-04	2.01E-05	4.99E-05	1.27E-04	9.46E-08	9.48E-05	1.85E-07	2.79E-08
3	1.71E-02	2.47E-04	3.24E-03	2.27E-03	4.00E-04	7.92E-07	2.52E-05	4.90E-05	3.49E-06
4	3.23E-03	1.39E-04	5.75E-04	1.10E-03	3.01E-04	7.10E-07	1.65E-05	1.01E-05	2.83E-06
5	7.40E-04	4.24E-04	1.48E-04	6.08E-03	7.48E-03	4.11E-07	7.67E-06	3.23E-06	2.40E-06
6	9.39E-04	2.61E-04	1.15E-04	3.64E-03	1.76E-03	4.13E-07	6.80E-06	2.46E-06	2.05E-06
7	6.99E-04	1.06E-04	7.24E-05	1.22E-03	2.99E-03	4.31E-07	6.98E-06	2.13E-06	1.95E-06
8	2.97E-04	6.06E-05	6.33E-05	5.46E-04	7.42E-04	4.12E-07	6.36E-06	1.74E-06	1.64E-06
9	1.39E-04	8.02E-05	2.80E-05	8.82E-04	3.63E-04	4.13E-07	5.89E-06	1.23E-06	1.18E-06
10	8.46E-05	7.28E-05	2.15E-05	8.05E-04	4.03E-04	4.21E-07	5.29E-06	1.71E-06	1.69E-06
11	5.97E-05	5.33E-05	1.02E-05	5.08E-04	2.82E-04	4.19E-07	5.07E-06	1.65E-06	1.63E-06
12	4.96E-05	3.33E-05	4.59E-06	1.56E-04	2.06E-04	4.11E-07	5.63E-06	1.57E-06	1.55E-06
13	4.42E-05	3.02E-05	5.34E-06	9.41E-05	2.47E-04	4.01E-07	6.04E-06	1.45E-06	1.44E-06
14	3.96E-05	2.74E-05	1.36E-05	7.53E-05	3.13E-04	3.94E-07	5.77E-06	1.35E-06	1.34E-06
15	3.59E-05	2.63E-05	2.23E-05	6.53E-05	4.07E-04	3.84E-07	5.62E-06	1.26E-06	1.25E-06
16	3.34E-05	2.66E-05	5.12E-06	6.08E-05	3.28E-04	3.78E-07	5.74E-06	1.19E-06	1.18E-06
17	3.06E-05	2.76E-05	4.04E-06	6.02E-05	3.34E-04	3.70E-07	5.98E-06	1.12E-06	1.11E-06
18	2.93E-05	2.85E-05	4.33E-06	5.94E-05	3.93E-04	3.62E-07	6.36E-06	1.05E-06	1.04E-06
19	2.71E-05	3.00E-05	4.34E-06	6.02E-05	3.89E-04	3.53E-07	6.84E-06	9.87E-07	9.83E-07
20	2.55E-05	3.23E-05	8.15E-06	6.31E-05	2.78E-04	3.44E-07	7.41E-06	9.35E-07	9.31E-07
21	2.27E-05	3.47E-05	1.38E-05	6.71E-05	2.68E-04	3.35E-07	8.10E-06	8.90E-07	8.86E-07
22	2.11E-05	3.65E-05	5.32E-06	7.33E-05	2.96E-04	3.07E-07	8.54E-06	8.51E-07	8.47E-07
23	2.05E-05	4.15E-05	5.60E-06	8.51E-05	3.42E-04	3.09E-07	9.73E-06	8.15E-07	8.12E-07
24	1.95E-05	4.67E-05	5.86E-06	1.02E-04	3.42E-04	3.06E-07	1.09E-05	7.82E-07	7.78E-07
25	1.86E-05	5.16E-05	6.03E-06	1.27E-04	3.43E-04	2.99E-07	1.18E-05	7.53E-07	7.50E-07
26	1.82E-05	5.72E-05	6.11E-06	1.61E-04	3.53E-04	2.92E-07	1.28E-05	7.26E-07	7.23E-07
27	1.74E-05	6.10E-05	6.32E-06	2.05E-04	3.79E-04	2.86E-07	1.31E-05	6.99E-07	6.96E-07
28	1.67E-05	3.25E-05	6.38E-06	1.11E-04	3.51E-04	2.79E-07	6.72E-06	6.75E-07	6.72E-07
29	1.54E-05	2.55E-05	6.04E-06	7.60E-05	1.98E-04	2.59E-07	5.37E-06	6.19E-07	6.16E-07

Table B-4 Release fraction parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Peach Bottom STSBO with RCIC Blackstart									
Plume Segment	Xe	Cs	Ba	I	Te	Ru	Mo	Ce	La
1	8.60E-01	2.42E-03	1.66E-03	1.90E-03	2.29E-03	1.20E-06	6.56E-04	1.68E-05	2.13E-06
2	8.85E-02	4.22E-04	3.99E-05	7.02E-05	2.09E-04	1.32E-07	1.20E-04	2.40E-07	3.26E-08
3	2.02E-02	2.15E-04	4.28E-03	2.29E-03	8.33E-04	4.01E-07	1.76E-05	7.56E-05	3.61E-06
4	5.32E-03	1.02E-04	5.37E-04	1.07E-03	3.48E-04	3.81E-07	7.97E-06	1.00E-05	2.41E-06
5	1.51E-03	6.39E-05	8.13E-05	6.60E-04	2.14E-04	3.61E-07	5.06E-06	3.33E-06	2.45E-06
6	8.70E-04	1.26E-04	4.44E-05	1.75E-03	1.75E-03	2.84E-07	3.25E-06	2.42E-06	2.15E-06
7	8.32E-04	7.58E-05	5.18E-05	1.05E-03	7.84E-04	2.15E-07	2.03E-06	2.14E-06	1.90E-06
8	4.41E-04	1.04E-04	4.80E-05	1.50E-03	6.51E-04	2.40E-07	1.70E-06	1.28E-06	1.16E-06
9	2.13E-04	4.35E-05	5.05E-05	5.72E-04	1.71E-03	2.57E-07	1.61E-06	1.80E-06	1.75E-06
10	1.20E-04	2.69E-05	5.92E-05	3.06E-04	7.49E-04	2.65E-07	1.71E-06	1.71E-06	1.68E-06
11	7.74E-05	1.51E-05	2.86E-05	9.63E-05	2.02E-04	2.67E-07	2.06E-06	1.61E-06	1.60E-06
12	4.05E-05	1.61E-05	3.02E-05	7.74E-05	1.96E-04	2.66E-07	2.56E-06	1.51E-06	1.50E-06
13	4.17E-05	1.40E-05	2.40E-05	6.22E-05	2.37E-04	2.62E-07	2.53E-06	1.40E-06	1.39E-06
14	5.76E-05	1.33E-05	3.86E-05	5.33E-05	3.01E-04	2.59E-07	2.49E-06	1.31E-06	1.30E-06
15	5.39E-05	1.29E-05	5.58E-05	4.97E-05	3.54E-04	2.56E-07	2.42E-06	1.23E-06	1.22E-06
16	4.91E-05	1.31E-05	1.47E-05	4.81E-05	2.81E-04	2.49E-07	2.49E-06	1.16E-06	1.15E-06
17	4.75E-05	4.58E-05	5.74E-05	3.28E-04	9.72E-04	3.29E-07	6.42E-06	1.09E-06	1.08E-06
18	4.05E-05	2.05E-05	1.58E-05	1.52E-04	5.36E-04	2.12E-07	2.83E-06	1.02E-06	1.01E-06
19	3.79E-05	1.84E-05	6.90E-06	1.27E-04	2.59E-04	2.10E-07	2.71E-06	9.75E-07	9.68E-07
20	3.53E-05	1.56E-05	7.82E-06	6.08E-05	2.72E-04	2.05E-07	3.13E-06	9.28E-07	9.22E-07
21	3.25E-05	1.68E-05	8.97E-06	5.73E-05	1.65E-04	1.88E-07	3.55E-06	8.86E-07	8.80E-07
22	2.99E-05	1.87E-05	7.47E-06	6.39E-05	1.64E-04	1.71E-07	3.99E-06	8.47E-07	8.41E-07
23	2.83E-05	2.15E-05	4.55E-06	7.57E-05	1.81E-04	1.69E-07	4.60E-06	8.11E-07	8.06E-07
24	2.66E-05	2.48E-05	4.35E-06	9.32E-05	2.02E-04	1.65E-07	5.26E-06	7.80E-07	7.75E-07
25	2.49E-05	2.88E-05	4.28E-06	1.17E-04	2.28E-04	1.61E-07	5.96E-06	7.50E-07	7.46E-07
26	2.35E-05	3.33E-05	4.23E-06	1.50E-04	2.59E-04	1.57E-07	6.64E-06	7.22E-07	7.18E-07
27	2.22E-05	3.17E-05	4.17E-06	8.83E-05	2.95E-04	1.54E-07	7.34E-06	6.96E-07	6.92E-07
28	2.09E-05	3.06E-05	4.11E-06	6.29E-05	1.87E-04	1.50E-07	7.47E-06	6.70E-07	6.66E-07
29	1.96E-05	2.42E-05	4.06E-06	7.08E-05	1.19E-04	1.45E-07	5.43E-06	6.45E-07	6.42E-07
30	1.85E-05	2.15E-05	4.01E-06	8.06E-05	1.19E-04	1.42E-07	4.46E-06	6.24E-07	6.21E-07
31	1.76E-05	1.40E-05	3.96E-06	9.33E-05	1.21E-04	1.39E-07	2.02E-06	6.03E-07	6.00E-07
32	1.66E-05	1.50E-05	3.92E-06	1.09E-04	1.22E-04	1.36E-07	2.04E-06	5.83E-07	5.80E-07
33	1.01E-06	1.06E-06	2.59E-07	7.85E-06	8.25E-06	9.00E-09	1.39E-07	3.82E-08	3.80E-08

Table B-4 Release fraction parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Peach Bottom STSBO without RCIC Blackstart									
Plume Segment	Xe	Cs	Ba	I	Te	Ru	Mo	Ce	La
1	1.13E-03	5.67E-06	9.10E-05	1.11E-05	9.18E-06	4.79E-09	1.41E-06	8.74E-06	1.16E-07
2	5.21E-01	2.40E-03	2.98E-02	3.75E-03	3.58E-03	2.58E-06	6.15E-04	2.95E-03	3.72E-05
3	7.48E-02	3.61E-04	1.09E-02	1.29E-03	9.89E-04	2.26E-07	7.37E-05	8.41E-04	1.41E-05
4	1.98E-01	8.81E-04	3.80E-02	4.19E-03	3.15E-03	3.02E-07	1.49E-04	2.66E-03	4.90E-05
5	3.70E-03	8.13E-05	1.69E-04	2.12E-04	2.11E-04	8.78E-09	1.58E-05	7.26E-06	4.70E-07
6	2.01E-02	3.61E-04	1.18E-03	8.66E-04	8.98E-04	5.36E-08	7.27E-05	6.02E-05	2.34E-06
7	1.16E-03	5.96E-05	5.39E-04	1.03E-04	7.69E-05	3.28E-09	1.33E-05	2.25E-06	1.84E-07
8	1.08E-02	4.65E-04	3.59E-03	6.22E-04	3.91E-04	3.09E-08	1.09E-04	3.11E-05	1.48E-06
9	1.12E-03	7.34E-06	1.01E-04	1.63E-05	1.36E-05	3.48E-09	1.66E-06	7.42E-06	1.20E-07
10	5.67E-04	3.23E-05	6.83E-05	1.24E-05	3.72E-05	1.82E-09	8.03E-06	1.37E-06	1.05E-07
11	6.67E-03	2.46E-04	5.78E-04	1.27E-04	4.14E-04	1.88E-08	5.93E-05	1.84E-05	9.53E-07
12	1.95E-03	1.55E-05	1.70E-04	2.80E-05	2.78E-05	5.78E-09	3.57E-06	1.20E-05	2.05E-07
13	5.32E-03	2.57E-04	8.56E-04	2.24E-04	1.99E-04	1.34E-08	5.84E-05	1.05E-05	8.08E-07
14	1.95E-03	1.91E-05	1.71E-04	3.02E-05	2.88E-05	5.45E-09	4.37E-06	1.10E-05	2.00E-07
15	5.01E-03	2.81E-04	1.58E-03	4.31E-04	1.25E-04	1.07E-08	6.18E-05	8.28E-06	8.70E-07
16	1.81E-03	2.17E-05	1.76E-04	3.38E-05	2.65E-05	4.75E-09	4.92E-06	9.33E-06	1.85E-07
17	4.78E-03	2.98E-04	1.18E-03	4.10E-04	1.11E-04	9.07E-09	6.94E-05	7.01E-06	1.12E-06
18	1.66E-03	2.39E-05	1.65E-04	3.66E-05	2.39E-05	4.07E-09	5.45E-06	7.79E-06	1.75E-07
19	4.60E-03	3.20E-04	4.99E-04	5.76E-04	1.05E-04	7.47E-09	7.33E-05	5.77E-06	1.05E-06
20	1.51E-03	2.55E-05	1.45E-04	4.10E-05	2.16E-05	3.46E-09	5.82E-06	6.46E-06	1.63E-07
21	4.40E-03	2.53E-04	7.84E-04	5.51E-04	1.00E-04	6.58E-09	5.32E-05	4.84E-06	9.73E-07
22	1.38E-03	2.56E-05	1.34E-04	4.37E-05	1.95E-05	2.95E-09	5.76E-06	5.36E-06	1.51E-07
23	4.23E-03	2.36E-04	1.13E-03	3.10E-04	9.64E-05	5.95E-09	5.24E-05	4.13E-06	9.16E-07
24	1.26E-03	2.51E-05	1.30E-04	4.04E-05	1.77E-05	2.51E-09	5.66E-06	4.45E-06	1.40E-07
25	4.11E-03	2.21E-04	6.95E-04	4.65E-05	1.03E-04	5.46E-09	5.58E-05	3.58E-06	8.67E-07
26	1.17E-03	2.47E-05	1.17E-04	3.42E-05	1.64E-05	2.17E-09	5.66E-06	3.74E-06	1.31E-07
27	3.96E-03	2.34E-04	8.36E-05	4.40E-05	1.19E-04	5.02E-09	5.98E-05	3.10E-06	8.24E-07
28	1.11E-03	2.13E-05	8.54E-05	2.53E-05	1.37E-05	1.63E-09	4.98E-06	2.73E-06	1.06E-07
29	3.89E-03	2.44E-04	5.21E-05	5.61E-05	1.44E-04	4.51E-09	6.33E-05	2.47E-06	7.83E-07
30	1.07E-03	1.91E-05	6.14E-05	1.89E-05	1.21E-05	1.23E-09	4.56E-06	1.97E-06	8.78E-08
31	4.12E-03	2.36E-04	3.97E-05	8.28E-05	1.83E-04	4.41E-09	6.07E-05	2.03E-06	7.60E-07
32	1.07E-03	1.91E-05	4.95E-05	1.80E-05	1.30E-05	1.05E-09	4.62E-06	1.60E-06	8.31E-08
33	9.23E-03	1.43E-04	3.99E-05	5.78E-04	2.49E-04	3.51E-09	2.73E-05	2.15E-06	8.15E-07
34	1.24E-03	2.04E-05	4.70E-05	2.90E-05	1.71E-05	1.04E-09	4.77E-06	1.54E-06	9.33E-08
35	7.72E-03	3.45E-04	7.37E-05	4.52E-03	4.74E-04	3.31E-09	1.42E-05	3.19E-06	7.50E-07
36	1.38E-03	3.17E-05	4.54E-05	2.02E-04	3.07E-05	1.03E-09	4.80E-06	1.48E-06	1.04E-07
37	3.22E-05	9.69E-06	6.78E-07	1.42E-04	9.97E-06	2.30E-11	1.35E-07	2.05E-08	4.80E-09
38	4.20E-03	1.54E-03	8.71E-05	2.28E-02	1.69E-03	3.07E-09	1.89E-05	2.77E-06	6.85E-07
39	1.38E-03	6.87E-05	4.21E-05	7.82E-04	7.56E-05	9.79E-10	4.74E-06	1.36E-06	1.10E-07
40	2.06E-05	1.04E-05	3.48E-07	1.56E-04	1.99E-05	1.55E-11	1.08E-07	1.30E-08	4.52E-09
41	2.80E-03	1.48E-03	4.78E-05	2.21E-02	3.45E-03	2.18E-09	1.55E-05	1.70E-06	6.50E-07
42	1.32E-03	1.02E-04	3.79E-05	1.31E-03	1.79E-04	9.09E-10	4.56E-06	1.22E-06	1.14E-07
43	1.50E-05	8.34E-06	3.61E-07	1.24E-04	4.99E-05	1.48E-11	1.14E-07	9.31E-09	4.34E-09
44	2.02E-03	1.09E-03	5.50E-05	1.61E-02	8.02E-03	2.14E-09	1.68E-05	1.30E-06	6.17E-07
45	1.24E-03	1.20E-04	3.44E-05	1.60E-03	4.07E-04	8.48E-10	4.46E-06	1.09E-06	1.18E-07
46	1.47E-03	6.02E-04	8.16E-05	8.38E-03	9.10E-03	2.10E-09	1.91E-05	1.15E-06	5.85E-07

Table B-4 Release fraction parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

47	1.14E-03	1.21E-04	3.21E-05	1.63E-03	6.55E-04	7.90E-10	4.44E-06	9.64E-07	1.19E-07
Peach Bottom STSBO without RCIC Blackstart									
Plume Segment	**Xe**	**Cs**	**Ba**	**I**	**Te**	**Ru**	**Mo**	**Ce**	**La**
48	1.09E-03	3.24E-04	1.06E-04	4.00E-03	1.11E-02	1.94E-09	1.95E-05	1.03E-06	5.55E-07
49	1.02E-03	1.13E-04	3.06E-05	1.51E-03	9.56E-04	7.32E-10	4.43E-06	8.44E-07	1.20E-07
50	8.15E-04	1.99E-04	9.58E-05	1.94E-03	1.45E-02	1.92E-09	2.07E-05	9.29E-07	5.30E-07
51	9.09E-04	1.01E-04	2.89E-05	1.32E-03	1.29E-03	6.76E-10	4.43E-06	7.34E-07	1.19E-07
52	6.24E-04	1.37E-04	9.13E-05	1.02E-03	7.55E-03	1.77E-09	1.95E-05	8.48E-07	5.07E-07
53	7.96E-04	8.88E-05	2.73E-05	1.13E-03	1.33E-03	6.23E-10	4.39E-06	6.34E-07	1.17E-07
54	4.85E-04	1.21E-04	1.08E-04	7.21E-04	3.31E-03	1.77E-09	2.02E-05	7.73E-07	4.86E-07
55	6.92E-04	7.77E-05	2.66E-05	9.60E-04	1.22E-03	5.78E-10	4.37E-06	5.48E-07	1.14E-07
56	3.85E-04	1.17E-04	1.29E-04	6.32E-04	1.97E-03	1.74E-09	2.06E-05	7.12E-07	4.67E-07
57	6.00E-04	6.84E-05	2.66E-05	8.14E-04	1.08E-03	5.39E-10	4.37E-06	4.74E-07	1.12E-07
58	3.12E-04	1.16E-04	9.57E-05	6.42E-04	1.57E-03	1.66E-09	1.99E-05	6.61E-07	4.50E-07
59	5.16E-04	6.05E-05	2.53E-05	6.92E-04	9.41E-04	5.04E-10	4.35E-06	4.11E-07	1.09E-07
60	2.58E-04	1.20E-04	4.82E-05	6.56E-04	1.55E-03	1.64E-09	2.08E-05	5.93E-07	4.34E-07
61	4.43E-04	5.39E-05	2.24E-05	5.88E-04	8.29E-04	4.73E-10	4.36E-06	3.56E-07	1.06E-07
62	2.17E-04	8.83E-05	2.79E-05	2.00E-04	1.60E-03	1.59E-09	2.01E-05	5.49E-07	4.19E-07
63	3.80E-04	4.74E-05	1.93E-05	4.89E-04	7.40E-04	4.47E-10	4.34E-06	3.09E-07	1.03E-07
64	1.86E-04	8.44E-05	2.10E-05	1.31E-04	1.72E-03	1.58E-09	2.01E-05	5.17E-07	4.04E-07
65	3.25E-04	4.20E-05	1.65E-05	4.04E-04	6.72E-04	4.25E-10	4.34E-06	2.70E-07	9.95E-08
66	1.62E-04	8.79E-05	1.92E-05	1.06E-04	1.92E-03	1.60E-09	2.15E-05	4.88E-07	3.91E-07
67	2.77E-04	3.76E-05	1.42E-05	3.33E-04	6.24E-04	4.08E-10	4.38E-06	2.37E-07	9.64E-08
68	1.41E-04	8.52E-05	1.77E-05	8.70E-05	1.86E-03	1.51E-09	2.10E-05	4.63E-07	3.79E-07
69	2.36E-04	3.41E-05	1.22E-05	2.74E-04	5.78E-04	3.92E-10	4.42E-06	2.09E-07	9.35E-08
70	1.24E-04	8.90E-05	1.77E-05	7.19E-05	1.22E-03	1.54E-09	2.23E-05	4.38E-07	3.66E-07
71	2.01E-04	3.12E-05	1.06E-05	2.25E-04	5.18E-04	3.79E-10	4.48E-06	1.86E-07	9.06E-08
72	1.11E-04	9.11E-05	1.76E-05	5.95E-05	1.07E-03	1.53E-09	2.30E-05	4.18E-07	3.55E-07
73	1.71E-04	2.90E-05	9.30E-06	1.85E-04	4.61E-04	3.68E-10	4.56E-06	1.66E-07	8.78E-08
74	9.89E-05	9.35E-05	1.73E-05	4.94E-05	6.69E-04	1.55E-09	2.38E-05	4.00E-07	3.46E-07
75	1.46E-04	2.73E-05	8.22E-06	1.52E-04	4.02E-04	3.61E-10	4.67E-06	1.50E-07	8.52E-08
76	8.89E-05	9.70E-05	1.59E-05	4.12E-05	6.33E-04	1.56E-09	2.49E-05	3.85E-07	3.38E-07
77	1.24E-04	2.61E-05	7.29E-06	1.25E-04	3.52E-04	3.55E-10	4.80E-06	1.36E-07	8.28E-08
78	7.95E-05	9.99E-05	1.46E-05	3.43E-05	6.44E-04	1.57E-09	2.58E-05	3.71E-07	3.30E-07
79	1.05E-04	2.52E-05	6.49E-06	1.03E-04	3.12E-04	3.51E-10	4.94E-06	1.24E-07	8.06E-08
80	7.25E-05	9.60E-05	1.36E-05	2.87E-05	6.22E-04	1.50E-09	2.49E-05	3.61E-07	3.26E-07
81	8.96E-05	2.44E-05	5.81E-06	8.46E-05	2.78E-04	3.47E-10	5.04E-06	1.15E-07	7.87E-08
82	6.69E-05	9.50E-05	1.31E-05	2.42E-05	6.00E-04	1.56E-09	2.49E-05	3.55E-07	3.23E-07
83	7.62E-05	2.37E-05	5.24E-06	6.95E-05	2.50E-04	3.45E-10	5.12E-06	1.06E-07	7.71E-08
84	6.12E-05	9.83E-05	1.35E-05	2.04E-05	6.25E-04	1.62E-09	2.67E-05	3.49E-07	3.22E-07
85	5.57E-05	1.98E-05	4.09E-06	4.92E-05	1.96E-04	2.94E-10	4.46E-06	8.52E-08	6.45E-08
86	1.73E-05	3.07E-05	4.19E-06	5.48E-06	1.96E-04	5.06E-10	8.72E-06	1.03E-07	9.65E-08

Table B-5 EARLY parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios

Variable	Description	LTSBO	STSBO with RCIC Blackstart	STSBO without RCIC Blackstart
ACNAME	Latent Cancer Effect			
	Cancer Type 1	LEUKEMIA	LEUKEMIA	LEUKEMIA
	Cancer Type 2	BONE	BONE	BONE
	Cancer Type 3	BREAST	BREAST	BREAST
	Cancer Type 4	LUNG	LUNG	LUNG
	Cancer Type 5	THYROID	THYROID	THYROID
	Cancer Type 6	LIVER	LIVER	LIVER
	Cancer Type 7	COLON	COLON	COLON
	Cancer Type 8	RESIDUAL	RESIDUAL	RESIDUAL
ACSUSC	Population Susceptible to Cancer	1.0 for all cancers	1.0 for all cancers	1.0 for all cancers
ACTHRE	Linear Dose-Response Threshold	0	0	0
BRRATE	Breathing Rate (for all activity types)	0.000266	0.000266	0.000266
CFRISK	Lifetime Cancer Fatality Risk Factors			
	Cancer Type 1	0.0111	0.0111	0.0111
	Cancer Type 2	0.00019	0.00019	0.00019
	Cancer Type 3	0.00506	0.00506	0.00506
	Cancer Type 4	0.0198	0.0198	0.0198
	Cancer Type 5	0.000648	0.000648	0.000648
	Cancer Type 6	0.003	0.003	0.003
	Cancer Type 7	0.0208	0.0208	0.0208
	Cancer Type 8	0.0493	0.0493	0.0493
CIRISK	Lifetime Cancer Injury Risk Factors			
	Cancer Type 1	0.0113	0.0113	0.0113
	Cancer Type 2	0.000271	0.000271	0.000271
	Cancer Type 3	0.0101	0.0101	0.0101
	Cancer Type 4	0.0208	0.0208	0.0208
	Cancer Type 5	0.00648	0.00648	0.00648
	Cancer Type 6	0.00316	0.00316	0.00316
	Cancer Type 7	0.0378	0.0378	0.0378
	Cancer Type 8	0.169	0.169	0.169
CRIORG	Critical Organ for EARLY Phase	L-ICRP60ED	L-ICRP60ED	L-ICRP60ED
CSFACT	Cloudshine Shielding Factors			
	Evacuation Shielding Factor for All but Cohort 4	1	1	1
	Normal Activity Shielding Factor for All but Cohort 4	0.6	0.6	0.6
	Sheltering Shielding Factor for All but Cohort 4	0.5	0.5	0.5

Table B-5 EARLY parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Variable	Description	LTSBO	STSBO with RCIC Blackstart	STSBO without RCIC Blackstart
CSFACT	Evacuation Shielding Factor for Cohort 4	1	1	1
	Normal Activity Shielding Factor for Cohort 4	0.31	0.31	0.31
	Sheltering Shielding Factor for Cohort 4	0.31	0.31	0.31
DCF_FILE	Name of Dose Coefficient File	FGR13GyEquivDCF .INP	FGR13GyEquivDCF .INP	FGR13GyEquivDCF .INP
DDREFA	Dose-Dependent Reduction Factor			
	Cancer Type 1	2	2	2
	Cancer Type 2	2	2	2
	Cancer Type 3	1	1	1
	Cancer Type 4	2	2	2
	Cancer Type 5	2	2	2
	Cancer Type 6	2	2	2
	Cancer Type 7	2	2	2
	Cancer Type 8	2	2	2
DDTHRE	Threshold for Applying Dose-Dependent Reduction Factor	0.2	0.2	0.2
DLTSHL	Delay from Alarm Time to Shelter			
	Cohort 1	5400	3600	3600
	Cohort 2	5400	3600	3600
	Cohort 3	900	900	900
	Cohort 4	5400	3600	3600
	Cohort 5	5400	3600	3600
	Cohort 6	N/A	N/A	N/A
DLTEVA	Delay from Beginning of Shelter to Evacuation			
	Cohort 1	3600	3600	3600
	Cohort 2	3600	3600	3600
	Cohort 3	2700	2700	2700
	Cohort 4	15300	15300	15300
	Cohort 5	15300	15300	15300
	Cohort 6	N/A	N/A	N/A
DOSEFA	Cancer Dose-Response Linear Factors	1 for all organs	1 for all organs	1 for all organs
DOSEFB	Cancer Dose-Response Quadratic Factors	0 for all organs	0 for all organs	0 for all organs
DOSHOT	Hot-Spot Relocation Dose Threshold	0.05	0.05	0.05
DOSMOD	Dose-Response Model Flag	LNT, AT	LNT, AT	LNT, AT
DOSNRM	Normal Relocation Dose Threshold	0.005	0.005	0.005
DURBEG	Duration of Beginning of Evacuation Phase			
	Cohort 1	900	900	900

Table B-5 EARLY parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Variable	Description	LTSBO	STSBO with RCIC Blackstart	STSBO without RCIC Blackstart
DURBEG	Cohort 2	900	900	900
	Cohort 3	3600	3600	3600
	Cohort 4	1800	1800	1800
	Cohort 5	1800	1800	1800
	Cohort 6	N/A	N/A	N/A
DURMID	Duration of Middle of Evacuation Phase			10800
	Cohort 1	10800	10800	10800
	Cohort 2	10800	10800	10800
	Cohort 3	1800	1800	1800
	Cohort 4	1800	1800	1800
	Cohort 5	1800	1800	1800
	Cohort 6	N/A	N/A	N/A
EANAM1	Text Describing the EARLY Assumptions	SOARCA calculation for Peach Bottom LTSBO, EARLY input	SOARCA calculation for Peach Bottom STSBO, EARLY input	SOARCA calculation for Peach Bottom STSBO, EARLY input
EANAM2	Text Describing the Emergency Response			
	Cohort 1	Group 1	Group 1	Group 1
	Cohort 2	Group 2	Group 2	Group 2
	Cohort 3	Group 3	Group 3	Group 3
	Cohort 4	Group 4	Group 4	Group 4
	Cohort 5	Group 5	Group 5	Group 5
	Cohort 6	Group 6	Group 6	Group 6
EFFACA	LD50 for Early Fatality Types			
	A-RED MARR	5.6	5.6	5.6
	A-LUNGS	23.5	23.5	23.5
	A-STOMACH	12.1	12.1	12.1
EFFACB	Shape Factor for Early Fatality Types			
	A-RED MARR	6.1	6.1	6.1
	A-LUNGS	9.6	9.6	9.6
	A-STOMACH	9.3	9.3	9.3
EFFACY	Efficacy of the KI Ingestion	0.7	0.7	0.7
EFFTHR	Threshold Dose to Target Organ			
	A-RED MARR	2.32	2.32	2.32
	A-LUNGS	13.6	13.6	13.6
	A-STOMACH	6.5	6.5	6.5
EIFACA	LD50 For Early Injuries			
	PRODROMAL VOMIT	2	2	2
	DIARRHEA	3	3	3
	PNEUMONITIS	16.6	16.6	16.6
	SKIN ERYTHRMA	6	6	6
	TRANSEPIDERMAL	20	20	20
	THYROIDITIS	240	240	240

Table B-5 EARLY parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Variable	Description	LTSBO	STSBO with RCIC Blackstart	STSBO without RCIC Blackstart
EIFACA	HYPOTHYROIDISM	60	60	60
EIFACB	Shape Factor for Early Injuries			
	PRODROMAL VOMIT	3	3	3
	DIARRHEA	2.5	2.5	2.5
	PNEUMONITIS	7.3	7.3	7.3
	SKIN ERYTHRMA	5	5	5
	TRANSEPIDERMAL	5	5	5
	THYROIDITIS	2	2	2
	HYPOTHYROIDISM	1.3	1.3	1.3
EINAME	Early Injury Effect Names and Corresponding Organ			
	PRODROMAL VOMIT	A-STOMACH	A-STOMACH	A-STOMACH
	DIARRHEA	A-STOMACH	A-STOMACH	A-STOMACH
	PNEUMONITIS	A-LUNGS	A-LUNGS	A-LUNGS
	SKIN ERYTHRMA	A-SKIN	A-SKIN	A-SKIN
	TRANSEPIDERMAL	A-SKIN	A-SKIN	A-SKIN
	THYROIDITIS	A-THYROID	A-THYROID	A-THYROID
	HYPOTHYROIDISM	A-THYROID	A-THYROID	A-THYROID
EISUSC	Susceptible Population Fraction	1. for all health effects	1. for all health effects	1. for all health effects
EITHRE	Early Injury Dose Threshold			
	PRODROMAL VOMIT	0.5	0.5	0.5
	DIARRHEA	1	1	1
	PNEUMONITIS	9.2	9.2	9.2
	SKIN ERYTHRMA	3	3	3
	TRANSEPIDERMAL	10	10	10
	THYROIDITIS	40	40	40
	HYPOTHYROIDISM	2	2	2
ENDAT2	Control flag indicating only ATMOS and EARLY are to be run	.FALSE.	.FALSE.	.FALSE.
ENDEMP	Time Duration for the Emergency Phase	604800	604800	604800
ESPEED	Evaluation Speed			
	Initial Evacuation Phase, Cohort 1	2.235	2.235	2.235
	Middle Evacuation Phase, Cohort 1	1.341	1.341	1.341
	Late Evacuation Phase, Cohort 1	8.941	8.941	8.941
	Initial Evacuation Phase, Cohort 2	2.235	2.235	2.235
	Middle Evacuation Phase, Cohort 2	1.341	1.341	1.341
	Late Evacuation Phase, Cohort 2	8.941	8.941	8.941
	Initial Evacuation Phase, Cohort 3	8.941	8.941	8.941
	Middle Evacuation Phase, Cohort 3	8.941	8.941	8.941

Table B-5 EARLY parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Variable	Description	LTSBO	STSBO with RCIC Blackstart	STSBO without RCIC Blackstart
ESPEED	Late Evacuation Phase, Cohort 3	8.941	8.941	8.941
	Initial Evacuation Phase, Cohort 4	1.341	1.341	1.341
	Middle Evacuation Phase, Cohort 4	8.941	8.941	8.941
	Late Evacuation Phase, Cohort 4	8.941	8.941	8.941
	Initial Evacuation Phase, Cohort 5	1.341	1.341	1.341
	Middle Evacuation Phase, Cohort 5	8.941	8.941	8.941
	Late Evacuation Phase, Cohort 5	8.941	8.941	8.941
	Cohort 6	N/A	N/A	N/A
ESPGRD	Speed Multiplier to Account for Grid-Level Variations in Road Network	Table B-6	Table B-6	Table B-6
ESPMUL	Speed Multiplier Employed During Precipitation	0.7	0.7	0.7
EVATYP	Evacuation Type	NETWORK	NETWORK	NETWORK
GSHFAC	Groundshine Shielding Factors			
	Evacuation Shielding Factor for All but Cohort 4	0.5	0.5	0.5
	Normal Activity Shielding Factor for All but Cohort 4	0.18	0.18	0.18
	Sheltering Shielding Factor for All but Cohort 4	0.1	0.1	0.1
	Evacuation Shielding Factor for Cohort 4	0.5	0.5	0.5
	Normal Activity Shielding Factor for Cohort 4	0.05	0.05	0.05
	Sheltering Shielding Factor for Cohort 4	0.05	0.05	0.05
IDIREC	Direction in Network Evacuation Model	Table B-7	Table B-7	Table B-7
IPLUME	Plume Model Dispersion Code	3	3	3
KIMODL	Model Flag for KI Ingestion	KI	KI	KI
LASMOV	Last Ring in Movement Zone	17	17	17
NUMACA	Number of Latent Cancer Health Effects	8	8	8
NUMEFA	Number of Early Fatality Effects	3	3	3
NUMEIN	Number of Early Injury Effects	7	7	7
NUMEVA	Outer Boundary of Evacuation/Shelter Region	Cohort 1 - 15 Cohorts 2 to 5 - 12	Cohort 1 - 15 Cohorts 2 to 5 - 12	Cohort 1 - 15 Cohorts 2 to 5 - 12

Table B-5 EARLY parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Variable	Description	LTSBO	STSBO with RCIC Blackstart	STSBO without RCIC Blackstart
NUMFIN	Number of Fine Grid Subdivisions	7	7	7
ORGFLG	Doses to be Calculated for Specified Organ	All TRUE for FGR-13 All TRUE for DOSFAC2 except for A-Lower LI and L-Liver, which are FALSE	All TRUE for FGR-13 All TRUE for DOSFAC2 except for A-Lower LI and L-Liver, which are FALSE	All TRUE for FGR-13 All TRUE for DOSFAC2 except for A-Lower LI and L-Liver, which are FALSE
OVRRID	Wind Rose Probability Override	.FALSE.	.FALSE.	.FALSE.
POPFLG	Population Distribution Flag	FILE	FILE	FILE
POPFRAC	Population Fraction Ingesting KI	Cohort 1 and 2 - 1.0 Cohort 3 to 6 - 0.0	Cohort 1 and 2 - 1.0 Cohort 3 to 6 - 0.1	Cohort 1 and 2 - 1.0 Cohort 3 to 6 - 0.1
PROTIN [E]	Inhalation Protection Factor – evacuation for all cohorts but cohort 4	0.98	0.98	0.98
PROTIN [N]	Inhalation Protection Factor - normal activity for all cohorts except Cohort 4	0.46	0.46	0.46
PROTIN [N]	Inhalation Protection Factor - normal activity for Cohort 4	0.33	0.33	0.33
PROTIN [S]	Inhalation Protection Factor - sheltering for all cohorts	0.33	0.33	0.33
REFPNT	Reference Time Point (ARRIVAL or SCRAM)	ALARM	ALARM	ALARM
RESCON	Emergency phase resuspension coefficient	0.0001	0.0001	0.0001
RESHAF	Resuspension Concentration Half-Life	182000	182000	182000
RISCAT	Risk by Weather-Category Flag	.FALSE.	.FALSE.	.FALSE.
RISTHR	Risk Threshold for Fatality Radius	0	0	0
SKPFAC [E]	Skin Protection Factors – evacuation for all cohorts	0.98	0.98	0.98
SKPFAC [N]	Skin Protection Factors - normal activity for all cohorts but cohort 4	0.46	0.46	0.46
SKPFAC [N]	Skin Protection Factors - normal activity for cohort 4	0.33	0.33	0.33
SKPFAC [S]	Skin Protection Factors – sheltering for all cohorts	0.33	0.33	0.33
TIMHOT	Hotspot Relocation Time	43200	43200	43200
TIMNRM	Normal Relocation Time	86400	86400	86400
TRAVEL POINT	Evacuee Movement Option	CENTERPOINT	CENTERPOINT	CENTERPOINT
WTFRAC	WTFRAC for Scenario Cohort 1 Cohort 2 Cohort 3	 0.2 0.355 0.372	 0.2 0.355 0.372	 0.2 0.355 0.372

Table B-5 EARLY parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Variable	Description	LTSBO	STSBO with RCIC Blackstart	STSBO without RCIC Blackstart
WTFRAC	Cohort 4	0.006	0.006	0.006
	Cohort 5	0.062	0.062	0.062
	Cohort 6	0.005	0.005	0.005
WTNAME	Type of Weighting for Cohorts	PEOPLE	PEOPLE	PEOPLE

Table B-6 Grid-level evacuation speed multipliers used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios

	Compass Sector															
Radial Ring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
16	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
17	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table B-6 Grid-level evacuation speed multipliers used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

	Compass Sector															
Radial Ring	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50	1.00	1.00
15	1.00	1.00	1.00	1.00	1.00	1.50	1.50	1.50	1.00	1.00	1.00	1.00	1.00	1.50	1.50	1.50
16	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
17	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table B-6 Grid-level evacuation speed multipliers used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

	Compass Sector															
Radial Ring	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15	1.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
16	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
17	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table B-6 Grid-level evacuation speed multipliers used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

	Compass Sector															
Radial Ring	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
1	100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
13	1.00	1.00	1.00	1.00	1.00	1.00	0.75	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
14	1.00	1.00	1.00	1.00	1.00	1.00	0.75	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
15	1.00	1.00	1.00	1.00	1.00	1.00	0.75	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
16	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75
17	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.75

Table B-7 Evacuation direction parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios

Radial Ring	Compass Sector															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1
7	2	2	1	2	2	1	2	2	1	4	2	1	4	2	2	1
8	1	4	1	1	4	2	1	4	2	1	1	4	2	2	1	1
9	1	1	4	2	1	1	2	1	1	4	1	4	1	4	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	1	1	4	2	1	4	2	1	4	4	2	1	4	2	1	4
12	2	1	1	4	1	1	4	1	4	4	2	1	4	2	1	1
13	1	1	4	1	4	2	1	1	2	1	4	4	2	2	1	1
14	1	1	4	1	1	1	2	1	2	1	2	1	1	2	1	1
15	1	1	4	2	2	2	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table B-7 Evacuation direction parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Radial Ring	Compass Sector															
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	2	1	4	4	4	4	2	2
4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1
6	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2
7	1	1	1	1	1	1	1	1	1	1	2	2	1	4	4	2
8	2	1	1	1	4	4	4	1	1	1	1	1	1	4	1	4
9	1	2	1	1	1	4	4	4	1	1	4	1	2	2	2	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	4	4	4
11	4	2	2	2	2	2	2	1	4	4	1	1	4	2	2	1
12	4	4	2	2	2	1	4	1	2	1	2	2	1	4	4	2
13	1	1	1	1	1	2	1	2	2	1	1	2	1	4	2	2
14	1	1	1	1	1	4	1	1	1	1	2	1	4	1	1	1
15	1	1	1	1	1	1	1	4	4	4	2	2	2	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table B-7 Evacuation direction parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

	Compass Sector															
Radial Ring	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	2	2	2	1	1	1	4	4	4	4	2	2	2	1	1	1
4	4	2	2	1	1	1	1	4	4	4	2	2	1	4	4	2
5	1	1	1	1	2	1	4	4	2	2	1	4	4	2	2	1
6	2	2	1	1	1	1	2	1	1	4	2	2	1	2	1	4
7	1	1	1	1	4	4	2	2	1	1	4	4	1	1	4	1
8	2	1	4	4	2	1	2	1	2	1	4	2	1	4	2	1
9	1	2	1	4	2	1	2	1	2	1	1	4	1	4	1	4
10	2	2	2	2	1	2	1	4	2	1	1	1	4	2	1	4
11	1	1	4	2	1	4	1	4	2	1	4	1	1	2	1	1
12	2	1	1	4	4	2	1	1	1	1	4	1	1	1	1	4
13	1	4	2	1	4	4	1	1	4	2	1	1	2	1	2	1
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
15	1	1	1	1	1	1	1	1	1	1	1	4	1	2	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table B-7 Evacuation direction parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

	Compass Sector															
Radial Ring	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1
4	1	4	4	2	1	1	4	2	1	4	4	4	4	4	1	1
5	4	4	2	2	1	4	4	2	1	1	1	1	1	1	1	1
6	4	2	2	1	4	4	4	4	4	4	4	1	1	1	1	1
7	4	2	2	1	4	4	4	4	4	4	1	1	1	1	1	1
8	1	4	2	1	4	4	4	2	2	1	1	1	1	1	2	2
9	4	2	2	1	4	2	1	4	1	4	1	1	1	2	2	2
10	4	2	2	1	1	1	1	1	4	4	1	1	1	1	1	1
11	4	4	4	2	2	2	1	4	4	4	2	2	1	4	2	2
12	4	4	2	2	2	2	1	4	2	1	1	2	2	1	4	2
13	4	4	2	2	2	1	1	4	2	1	4	2	1	4	1	1
14	1	4	4	2	2	1	1	4	1	4	1	1	1	1	1	1
15	1	4	2	1	2	1	1	2	1	1	2	2	2	1	2	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table B-8 CHRONC input parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios

Variable	Description	LTSBO	STSBO with RCIC Blackstart	STSBO without RCIC Blackstart
CHNAME	CHRONC Problem Identification	Peach Bottom with no Food-Chain Modeling	Peach Bottom with no Food-Chain Modeling	Peach Bottom with no Food-Chain Modeling
CDFRM	Farmland Decontamination Cost			
	Level 1	1330	1330	1330
	Level 2	2960	2960	2960
CDNFRM	Nonfarmland Decontamination Cost			
	Level 1	7110	7110	7110
	Level 2	19000	19000	19000
CRTOCR	Critical Organ for CHRONC Phase	L-ICRP60ED	L-ICRP60ED	L-ICRP60ED
DPRATE	Property Depreciation Rate	0.2	0.2	0.2
DLBCST	Hourly Labor Cost for Decontamination Worker	84000	84000	84000
DPFRCT	Farm Production Dairy Fraction	Peach Bottom Site File	Peach Bottom Site File	Peach Bottom Site File
DSCRLT	Long-Term Phase Dose Criterion	0.005	0.005	0.005
DSCRTI	Intermediate-Phase Dose Criterion	100000	100000	100000
DSRATE	Societal Discount Rate for Property	0.12	0.12	0.12
DSRFCT	Decontamination Factors			
	Level 1	3	3	3
	Level 2	15	15	15
DUR_INTPHAS	Duration of the Intermediate Phase	0	0	0
EVACST	Emergency Phase Cost of Evac./Reloc.	172	172	172
EXPTIM	Maximum Exposure Time	1580000000	1580000000	1580000000
FDPATH	COMIDA2 vs. MACCS Food Model Switch	OFF	OFF	OFF
FRACLD	Fraction of Area that is Land	Peach Bottom Site File	Peach Bottom Site File	Peach Bottom Site File
FRCFRM	Fraction of Area Used for Farming	Peach Bottom Site File	Peach Bottom Site File	Peach Bottom Site File
FRFDL	Fraction of Decontamination Cost for Labor			
	Level 1	0.3	0.3	0.3
	Level 2	0.35	0.35	0.35
FRFIM	Farm Wealth Improvements Fraction	0.25	0.25	0.25
FRMPRD	Average Annual Farm Production	Peach Bottom Site File	Peach Bottom Site File	Peach Bottom Site File
FRNFIM	Nonfarm Wealth Improvements Fraction	0.8	0.8	0.8
FRNFDL	Nonfarm Labor Cost Fraction			
	Level 1	0.7	0.7	0.7
	Level 2	0.5	0.5	0.5
GWCOEF	Long-Term Groundshine Coefficients			
	Term 1	0.5	0.5	0.5
	Term 2	0.5	0.5	0.5
KSWTCH	Diagnostic Output Option Switch	0	0	0
LBRRATE	Long-Term Breathing Rate	0.000266	0.000266	0.000266

Table B-8 CHRONC input parameters used in the Peach Bottom unmitigated LTSBO and STSBO with and without RCIC blackstart scenarios (continued)

Variable	Description	LTSBO	STSBO with RCIC Blackstart	STSBO without RCIC Blackstart
LGSHFAC	Long-Term Groundshine Protection Factor	0.18	0.18	0.18
LPROTIN	Long-Term Inhalation Protection Factor	0.46	0.46	0.46
LVLDEC	Number of Decontamination Levels	2	2	2
NGWTRM	Number of Terms in Groundshine Weathering Equation	2	2	2
NRWTRM	Number of Terms in Resuspension Weathering Equation	3	3	3
POPCST	Per Capita Cost of Long-Term Relocation	12000	12000	12000
RELCST	Relocation Cost per Person-Day	172	172	172
RWCOEF	Long-Term Resuspension Factor Coefficients			
	Term 1	0.00001	0.00001	0.00001
	Term 2	0.0000001	0.0000001	0.0000001
	Term 3	0.00000001	0.00000001	0.00000001
TFWKF	Fraction Farmland Worker Time in Contaminated Zone			
	Level 1	0.1	0.1	0.1
	Level 2	0.33	0.33	0.33
TFWKNF	Fraction Nonfarmland Worker Time in Contaminated Zone			
	Level 1	0.33	0.33	0.33
	Level 2	0.33	0.33	0.33
TGWHLF	Groundshine Weathering Half-Lives			
	Term 1	16000000	16000000	16000000
	Term 2	2800000000	2800000000	2800000000
TIMDEC	Decontamination Times			
	Level 1	5184000	5184000	5184000
	Level 2	10368000	10368000	10368000
TMPACT	Time Action Period Ends	31600000	31600000	31600000
TRWHLF	Resuspension Weathering Half-Lives			
	Term 1	16000000	16000000	16000000
	Term 2	160000000	160000000	160000000
	Term 3	1600000000	1600000000	1600000000
VALWF	Value of Farm Wealth	9040	9040	9040
VALWNF	Value of Nonfarm Wealth	210000	210000	210000

APPENDIX C: MACCS SOARCA MODELING PARAMETERS COMPARED TO SAMPLE PROBLEM A INPUTS

SOARCA INPUT PARAMETERS FOR CONSEQUENCE ANALYSIS

The input parameters used for the SOARCA Surry and Peach Bottom accident scenarios are compared with the MACCS Sample Problem A input parameters where applicable for the ATMOS, EARLY, and CHRONC modules. Non-site-specific input parameters in Sample Problem A which differ from the SOARCA input parameters are discussed within the main document. Table C-1 is a comparison of the ATMOS input parameters. Table C-2 is a comparison of the EARLY input parameters. Table C-3 is a comparison of the CHRONC input parameters. Table C-4 provides the list of radionuclides used in Sample Problem A. Table C-5 and Table C-6 provide the release fraction data for the Surry Sample Problem A and NUREG-1150, Peach Bottom inputs, respectively.

The MACCS Sample Problem A – Surry input parameters are based on a NUREG-1150 Surry MACCS deck and are documented in NUREG/CR-6613, “Code Manual for MACCS: Volume 1, User’s Guide.” This MACCS input deck is provided in the MACCS Version 1.13.1 download. The NUREG-1150 Peach Bottom input parameters are taken from a Peach Bottom MACCS deck documented in NUREG/CR-4551 Volume 2, Revision 1, Part 7, “Evaluation of Severe Accident Risks: Quantification of Major Input Parameters, MACCS Input.”

Table C-1 ATMOS input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
APLFRC	Method of Applying Release Fraction	PARENT	PARENT	PARENT	PARENT
ATNAM1	Title Describing the ATMOS Assumptions	SOARCA Surry Unmitigated LTSBO	SOARCA Peach Bottom Source Term LTSBO	Surry	ATMOS Input for Final NUREG-1150 Calculation
ATNAM2	Title Describing the Source Term	Surry source term for the unmitigated long-term station blackout.	Peach Bottom source term for the unmitigated long-term station blackout.	Second Draft NUREG-1150, worst case source term for early fatalities	NUREG-1150 Peach Bottom source term PB-15-1
BNDMXH	Boundary Weather Mixing Layer Height (m)	1000	1000	1000	1000
BNDRAN	Boundary Weather Rain Rate (mm/hr)	5	5	5	0
BNDWND	Boundary Wind Speed (m/sec)	2.2	2.2	5	0.5
BRKPNT	Breakpoint Time for Plume Meander (sec)	3600	3600	3600	3600
BUILDH	Building Height for all Plume Segments (m)	50	50	50	50
CORINV	Isotopic Inventory at Time of Reactor Shutdown (Bq)	from MELMACCS	from MELMACCS	NUREG-1150 Surry source term	NUREG-1150 Peach Bottom source term PB-15-1
CORSCA	Linear Scaling Factor on Core Inventory	1	1	0.715	0.92
CWASH1	Linear Coefficient for Washout	1.89E-05	1.89E-05	9.50E-05	9.50E-05
CWASH2	Exponential Term for Washout	0.664	0.664	0.8	0.8
CYSIGA	Linear Coefficient for sigma-y				
	Stability Class A	0.7507	0.7507	Note 1	0.3658
	Stability Class B	0.7507	0.7507		0.2751
	Stability Class C	0.4063	0.4063		0.2089
	Stability Class D	0.2779	0.2779		0.1474
	Stability Class E	0.2158	0.2158		0.1046
	Stability Class F	0.2158	0.2158		0.0722
CYSIGB	Exponential Term for sigma-y				
	Stability Class A	0.866	0.866	Note 1	0.9301
	Stability Class B	0.866	0.866		0.9301
	Stability Class C	0.865	0.865		0.9301
	Stability Class D	0.881	0.881		0.9301
	Stability Class E	0.866	0.866		0.9301
	Stability Class F	0.866	0.866		0.9301

Table C-1 ATMOS input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs (continued)

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
CZSIGA	Linear Coefficient for sigma-z				
	Stability Class A	0.0361	0.0361	Note 1	0.00025
	Stability Class B	0.0361	0.0361		0.0019
	Stability Class C	0.2036	0.2036		0.2
	Stability Class D	0.2636	0.2636		0.3
	Stability Class E	0.2463	0.2463		0.4
	Stability Class F	0.2463	0.2463		0.2
CZSIGB	Exponential Term for sigma-z				
	Stability Class A	1.277	1.277	Note 1	2.125
	Stability Class B	1.277	1.277		1.6021
	Stability Class C	0.859	0.859		0.8543
	Stability Class D	0.751	0.751		0.6532
	Stability Class E	0.619	0.619		0.6021
	Stability Class F	0.619	0.619		0.602
DISPMD	Dispersion Model Flag	LRDIST	LRDIST	Note 2	Note 2
DRYDEP	Dry Deposition Flag	Xe = .FALSE. Other Groups = .TRUE.	Xe = .FALSE. Other Groups = .TRUE.	Xe = .FALSE. Other Groups = .TRUE.	Xe = .FALSE. Other Groups = .TRUE.
ENDAT1	Control flag indicating only ATMOS is to be run	.FALSE.	.FALSE.	.FALSE.	.FALSE.
GRPNAM	Names of the Chemical Classes (Used by WinMACCS)				
	Chemical Class 1	Xe	Xe	Note 2	Note 2
	Chemical Class 2	Cs	Cs		
	Chemical Class 3	Ba	Ba		
	Chemical Class 4	I	I		
	Chemical Class 5	Te	Te		
	Chemical Class 6	Ru	Ru		
	Chemical Class 7	Mo	Mo		
	Chemical Class 8	Ce	Ce		
	Chemical Class 9	La	La		
IBDSTB	Boundary Weather Stability Class Index	4	4	4	1
IDEBUG	Debug Switch for Extra Debugging Print	0	0	0	0
IGROUP	Definition of Radionuclide Group Numbers	1 = Xe	1 = Xe	1 = Xe	1 = Xe
		2 = Cs	2 = Cs	2 = I	2 = I
		3 = Ba	3 = Ba	3 = Cs	3 = Cs
		4 = I	4 = I	4 = Te	4 = Te
		5 = Te	5 = Te	5 = Sr	5 = Sr
		6 = Ru	6 = Ru	6 = Mo	6 = Mo
		7 = Mo	7 = Mo	7 = La	7 = La
		8 = Ce	8 = Ce	8 = Ce	8 = Ce
		9 = La	9 = La	9 = Ba	9 = Ba

Table C-1 ATMOS input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs (continued)

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
INWGHT	Number of Samples for Each Bin Used for Nonuniform Weather Bin Sampling			Note 1	Note 3
	Bin 1	12	71		
	Bin 2	14	42		
	Bin 3	12	12		
	Bin 4	39	52		
	Bin 5	85	57		
	Bin 6	94	74		
	Bin 7	16	21		
	Bin 8	12	12		
	Bin 9	27	49		
	Bin 10	134	103		
	Bin 11	119	77		
	Bin 12	74	35		
	Bin 13	92	51		
	Bin 14	43	75		
	Bin 15	12	14		
	Bin 16	12	4		
	Bin 17	37	44		
	Bin 18	12	12		
	Bin 19	13	17		
	Bin 20	17	24		
	Bin 21	14	24		
	Bin 22	12	12		
	Bin 23	6	4		
	Bin 24	6	8		
	Bin 25	12	12		
	Bin 26	12	12		
	Bin 27	12	12		
	Bin 28	1	1		
	Bin 29	5	3		
	Bin 30	6	5		
	Bin 31	5	4		
	Bin 32	12	12		
	Bin 33	5	1		
	Bin 34	12	7		
	Bin 35	12	9		
	Bin 36	12	12		
IRSEED	Seed for Random Number Generator	79	79	79	1
LATITU	Latitude of Power Plant	37˚ 9' 56"	39˚ 45' 32"	Note 2	Note 2
LIMSPA	Last Interval for Measured Weather	25	25	25	25
LONGIT	Longitude of Power Plant	76˚ 41' 54"	76˚ 16' 09"	Note 2	Note 2
MAXGRP	Number of Radionuclide Groups	9	9	9	9

Table C-1 ATMOS input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs (continued)

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
MAXHGT	Flag for Mixing Height	DAY_AND_NIGHT	DAY_AND_NIGHT	Note 2	Note 2
MAXRIS	Selection of Risk Dominant Plume	3	2	1	1
METCOD	Meteorological Sampling Option Code	2	2	2	2
MNDMOD	Plume Meander Model Flag	OFF	OFF	Note 2	Note 2
NAMSTB	List of Pseudo stable Nuclides				Note 3
	Isotope 1	I-129	I-129	I-129	
	Isotope 2	Xe-131m	Xe-131m	Xe-131m	
	Isotope 3	Xe-133m	Xe-133m	Xe-133m	
	Isotope 4	Cs-135	Cs-135	Xe-135m	
	Isotope 5	Sm-147	Sm-147	Cs-135	
	Isotope 6	U-234	U-234	Sm-147	
	Isotope 7	U-235	U-235	U-234	
	Isotope 8	U-236	U-236	U-235	
	Isotope 9	U-237	U-237	U-236	
	Isotope 10	Np-237	Np-237	U-237	
	Isotope 11	Rb-87	Rb-87	Np-237	
	Isotope 12	Zr-93	Zr-93	Rb-87	
	Isotope 13	Nb-93m	Nb-93m	Ba-137m	
	Isotope 14	Nb-95m	Nb-95m	Rb-88	
	Isotope 15	Tc-99	Tc-99	Y-91m	
	Isotope 16	Pm-147	Pm-147	Zr-93	
	Isotope 17	N/A	N/A	Nb-93m	
	Isotope 18	N/A	N/A	Nb-95m	
	Isotope 19	N/A	N/A	Nb-97	
	Isotope 20	N/A	N/A	Nb-97m	
	Isotope 21	N/A	N/A	Tc-99	
	Isotope 22	N/A	N/A	Rh-103	
	Isotope 23	N/A	N/A	Rh-106	
	Isotope 24	N/A	N/A	Te-131	
	Isotope 25	N/A	N/A	Pr-144	
	Isotope 26	N/A	N/A	Pr-144m	
	Isotope 27	N/A	N/A	Pm-147	
NPSGRP	Number of Particle Size Groups	10	10	1	1
NRINTN	Number of Rain Intensity Breakpoints	3	3	3	3
NRNINT	Number of Rain Distance Intervals	5	5	5	6
NSBINS	Number of Weather Bins to Sample	36	36	Note 1	6
NUCNAM	Radionuclide Names	See Table 4-2	See Table 4-2	See Table C.4	See Table C.4
NUCOUT	Radionuclide Used in Dispersion Print	Cs-137	Cs-137	Cs-137	Cs-137
NUMCOR	Number of Compass Sectors in the Grid	64	64	Note 2	Note 2
NUMISO	Number of Radionuclides	69	69	60	60

Table C-1 ATMOS input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs (continued)

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
NUMRAD	Number of Radial Spatial Intervals	26	26	26	26
NUMREL	Number of Released Plume Segments	28	29	2	2
NUMSTB	Number of Defined Pseudo stable Radionuclides	16	16	27	0
OALARM	Time to Reach General Emergency Conditions (sec)	0	0	1300	14000
PDELAY	Plume Release Times (sec)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table B-2)	3700.0, 10000.0	25100.0, 25800.0
PLHEAT	Plume Heat Contents (W)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table B-2)	3.7E+06, 1.7E+05	1.4E+07, 1.49E+06
PLHITE	Plume Release Heights (m)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table B-2)	0.0, 0.0	30.0, 30.0
PLMDEN	Plume Mass Density (kg/m^3)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table B-2)	Note 2	Note 2
PLMFLA	Plume Mass Flow Rate (kg/s)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table B-2)	Note 2	Note 2
PLMMOD	Flag for Plume Rise Input Option	DENSITY	DENSITY	Note 2	Note 2
PLUDUR	Plume Segment Durations (sec)	MELMACCS Data (See Table A-2)	MELMACCS Data (See Table B-2)	1800.0, 22000.0	240.0, 14000.0
PSDIST	Particle Size Distribution by Group	MELMACCS Data (See Table A-3)	MELMACCS Data (See Table B-3)	1. for all groups	1. for all groups
REFTIM	Plume Reference Time Point	0. for first 0.5 for subsequent	0. for first 0.5 for subsequent	0. for first 0.5 for subsequent	0. for first 0.5 for subsequent
RELFRC	Release Fractions of the Source Term	MELMACCS Data (See Table A-4)	MELMACCS Data (See Table B-4)	See Table C.5	See Table C.6
RNDSTS	Endpoints of Rain Distance Intervals (km)				
	Interval 1	3.22	3.22	3.22	3.22
	Interval 2	5.63	5.63	5.63	5.63
	Interval 3	11.27	11.27	11.27	11.27
	Interval 4	20.92	20.92	20.92	20.92
	Interval 5	32.19	32.19	32.19	40.23
	Interval 6	N/A	N/A	N/A	80.47
RNRATE	Rain Intensity Breakpoints for Weather Binning (mm/hr)				
	Intensity 1	2	2	2	1
	Intensity 2	4	4	4	2
	Intensity 3	6	6	6	3
SCLADP	Scaling Factor for A-D Plume Rise	1	1	1	1
SCLCRW	Scaling Factor for Critical Wind Speed	1	1	1	1
SCLEFP	Scaling Factor for E-F Plume Rise	1	1	1	1
SIGYINIT	Initial Sigma-y for All Plume Segments (m)	9.3	11.6	9.302	Note 3

Table C-1 ATMOS input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs (continued)

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
SIGZINIT	Initial Sigma-z for All Plume Segments (m)	23.3	23.3	23.26	Note 3
SPAEND	Radial distances for grid boundaries (km)				
	Ring 1	0.16	0.16	0.16	0.40
	Ring 2	0.52	0.52	0.52	0.82
	Ring 3	1.21	1.21	1.21	1.21
	Ring 4	1.61	1.61	1.61	1.61
	Ring 5	2.13	2.13	2.13	2.43
	Ring 6	3.22	3.22	3.22	3.22
	Ring 7	4.02	4.02	4.02	4.02
	Ring 8	4.83	4.83	4.83	4.83
	Ring 9	5.63	5.63	5.63	5.63
	Ring 10	8.05	8.05	8.05	8.05
	Ring 11	11.27	11.27	11.27	11.27
	Ring 12	16.09	16.09	16.09	16.09
	Ring 13	20.92	20.92	20.92	20.92
	Ring 14	25.75	25.75	25.75	25.75
	Ring 15	32.19	32.19	32.19	32.19
	Ring 16	40.23	40.23	40.23	40.23
	Ring 17	48.28	48.28	48.28	48.28
	Ring 18	64.37	64.37	64.37	64.37
	Ring 19	80.47	80.47	80.47	80.47
	Ring 20	112.65	112.65	112.65	112.65
	Ring 21	160.93	160.93	160.93	160.93
	Ring 22	241.14	241.14	241.14	241.14
	Ring 23	321.87	321.87	321.87	321.87
	Ring 24	563.27	563.27	563.27	563.27
	Ring 25	804.67	804.67	804.67	804.67
	Ring 26	1609.34	1609.34	1609.34	1609.34
TIMBAS	Time Base for Plume Expansion Factor (sec)	600	36000	600	600
VDEPOS	Dry Deposition Velocities (m/sec)				
	Aerosol Bin 1	5.35E-04	5.35E-04	0.01	0.01
	Aerosol Bin 2	4.91E-04	4.91E-04		
	Aerosol Bin 3	6.43E-04	6.43E-04		
	Aerosol Bin 4	1.08E-03	1.08E-03		
	Aerosol Bin 5	2.12E-03	2.12E-03		
	Aerosol Bin 6	4.34E-03	4.34E-03		
	Aerosol Bin 7	8.37E-03	8.37E-03		
	Aerosol Bin 8	1.37E-02	1.37E-02		
	Aerosol Bin 9	1.70E-02	1.70E-02		
	Aerosol Bin 10	1.70E-02	1.70E-02		
WETDEP	Wet Deposition Flag	Xe = .FALSE. Other groups = .TRUE.	Xe = .FALSE. Other groups = .TRUE.	Xe = .FALSE. Other groups = .TRUE.	Xe = .FALSE. Other groups = .TRUE.

Table C-1 ATMOS input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs (continued)

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
XPFAC1	Base Time for Meander Expansion Factor	0.2	0.01	0.2	0.2
XPFAC2	Breakpoint for Expansion Factor Model	0.25	0.01	0.25	0.25
YSCALE	Scale Factor for Horizontal Dispersion	1	1	1	1
ZSCALE	Scale Factor for Vertical Dispersion	1.27	1.27	1.27	1.27

Note 1: A weather lookup table was used for Sample Problem A – Surry
Note 2: This variable was not available for this MACCS model
Note 3: This variable was not provide for Sample Problem A – Peach Bottom

Table C-2 EARLY input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
ACNAME	Latent Cancer Effect				
	Cancer Type 1	LEUKEMIA	LEUKEMIA	LEUKEMIA	LEUKEMIA
	Cancer Type 2	BONE	BONE	BONE	BONE
	Cancer Type 3	BREAST	BREAST	BREAST	BREAST
	Cancer Type 4	LUNG	LUNG	LUNG	LUNG
	Cancer Type 5	THYROID	THYROID	THYROID	THYROID
	Cancer Type 6	LIVER	LIVER	GI	GI
	Cancer Type 7	COLON	COLON	OTHER	OTHER
	Cancer Type 8	RESIDUAL	RESIDUAL	N/A	N/A
ACSUSC	Population Susceptible to Cancer	1.0 for all cancers	1.0 for all cancers	1.0 for all cancers	1.0 for all cancers
ACTHRE	Linear Dose-Response Threshold	0	0	0	1.5
BRRATE	Breathing Rate (for all activity types) (m^3/sec)	0.000266	0.000266	0.000266	0.000266
CFRISK	Lifetime Cancer Fatality Risk Factors				
	Cancer Type 1	0.0111	0.0111	0.0097	0.0037
	Cancer Type 2	0.00019	0.00019	0.0009	0.00015
	Cancer Type 3	0.00506	0.00506	0.0054	0.006
	Cancer Type 4	0.0198	0.0198	0.0155	0.0051
	Cancer Type 5	0.000648	0.000648	0.00072	0.00072
	Cancer Type 6	0.003	0.003	0.0336	0.015
	Cancer Type 7	0.0208	0.0208	0.0276	0.0075
	Cancer Type 8	0.0493	0.0493	N/A	N/A
CIRISK	Lifetime Cancer Injury Risk Factors				
	Cancer Type 1	0.0113	0.0113	0	0.0037
	Cancer Type 2	0.000271	0.000271	0	0.00015
	Cancer Type 3	0.0101	0.0101	0.017	0.017
	Cancer Type 4	0.0208	0.0208	0	0.0057
	Cancer Type 5	0.00648	0.00648	0.0072	0.0072
	Cancer Type 6	0.00316	0.00316	0	0.025
	Cancer Type 7	0.0378	0.0378	0	0.013
	Cancer Type 8	0.169	0.169	N/A	N/A
CRIORG	Critical Organ for EARLY Phase	L-ICRP60ED	L-ICRP60ED	L-EDEWBODY	L-EDEWBODY
CSFACT	Cloudshine Shielding Factors				
	Evacuation Shielding Factor for All but Cohort 4	1	1	1	1
	Normal Activity Shielding Factor for All but Cohort 4	0.68	0.6	0.75	0.75
	Sheltering Shielding Factor for All but Cohort 4	0.6	0.5	0.6	0.5

Table C-2 EARLY input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs (continued)

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
CSFACT	Evacuation Shielding Factor for Cohort 4	1	1	Note 4	Note 4
	Normal Activity Shielding Factor for Cohort 4	0.31	0.31	Note 4	Note 4
	Sheltering Shielding Factor for Cohort 4	0.31	0.31	Note 4	Note 4
DCF_FILE	Name of Dose Coefficient File	FGR13GyEquivDCF.INP	FGR13GyEquivDCF.INP	dosdata.inp	dosdata.inp
DDREFA	Dose-Dependent Reduction Factor				
	Cancer Type 1	2	2	2	Note 2
	Cancer Type 2	2	2	2	Note 2
	Cancer Type 3	1	1	1	Note 2
	Cancer Type 4	2	2	2	Note 2
	Cancer Type 5	2	2	1	Note 2
	Cancer Type 6	2	2	2	Note 2
	Cancer Type 7	2	2	2	Note 2
	Cancer Type 8	2	2	N/A	N/A
DDTHRE	Threshold for Applying Dose-Dependent Reduction Factor	0.2	0.2	0.2	Note 2
DLTSHL	Delay from Alarm Time to Shelter				
	Cohort 1	9900	5400	7200	0
	Cohort 2	9900	5400	7200	Note 4
	Cohort 3	900	900	Note 4	Note 4
	Cohort 4	9900	5400	Note 4	Note 4
	Cohort 5	9900	5400	Note 4	Note 4
	Cohort 6	N/A	N/A	Note 4	Note 4
DLTEVA	Delay from Beginning of Shelter to Evacuation (sec)				
	Cohort 1	3600	3600	0	0
	Cohort 2	3600	3600	0	Note 4
	Cohort 3	3600	2700	Note 4	Note 4
	Cohort 4	39600	15300	Note 4	Note 4
	Cohort 5	39600	15300	Note 4	Note 4
	Cohort 6	N/A	N/A	Note 4	Note4
DOSEFA	Cancer Dose-Response Linear Factors	1 for all organs	1 for all organs	1 for all organs	1 for THYROID and BREAST 0.39 for all other organs
DOSEFB	Cancer Dose-Response Quadratic Factors	0 for all organs	0 for all organs	0 for all organs	0 for THYROID and BREAST 0.61 for all other organs
DOSHOT	Hot-Spot Relocation Dose Threshold (Sv)	0.05	0.05	0.5	0.5
DOSMOD	Dose-Response Model Flag	LNT, AT	LNT, AT	LNT	LNT

Table C-2 EARLY input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs (continued)

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
DOSNRM	Normal Relocation Dose Threshold (Sv)	0.01	0.005	0.25	0.25
DURBEG	Duration of Beginning of Evacuation Phase (sec)				
	Cohort 1	900	900	86400	5400
	Cohort 2	900	900	86400	Note 4
	Cohort 3	900	3600	Note 4	Note 4
	Cohort 4	3600	1800	Note 4	Note 4
	Cohort 5	3600	1800	Note 4	Note 4
	Cohort 6	N/A	N/A	Note 4	Note 4
DURMID	Duration of Middle of Evacuation Phase (sec)				
	Cohort 1	35100	10800	0	0
	Cohort 2	35100	10800	0	Note 4
	Cohort 3	1800	1800	Note 4	Note 4
	Cohort 4	3600	1800	Note 4	Note 4
	Cohort 5	3600	1800	Note 4	Note 4
	Cohort 6	N/A	N/A	Note 4	Note 4
EANAM1	Text Describing the EARLY Assumptions	SOARCA Surry LTSBO EARLY input	SOARCA Peach Bottom LTSBO EARLY input	IN2A.INP, Sample Problem A of NUREG/CR-4691, Vol.1, EARLY input	EARLY input for final NUREG-1150 calculations
EANAM2	Text Describing the Emergency Response				
	Cohort 1	Group 1	Group 1	Evacuation within 10 miles, relocation models apply elsewhere	Evacuation within 10 miles with hotspot and normal relocation
	Cohort 2	Group 2	Group 2	No evacuation, relocation models apply everywhere	Note 4
	Cohort 3	Group 3	Group 3	Note 4	Note 4
	Cohort 4	Group 4	Group 4	Note 4	Note 4
	Cohort 5	Group 5	Group 5	Note 4	Note 4
	Cohort 6	Group 6	Group 6	Note 4	Note 4
EFFACA	LD50 for Early Fatality Types				
	A-RED MARR	5.6	5.6	3.8	4
	A-LUNGS	23.5	23.5	10	10

Table C-2 EARLY input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs (continued)

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
EFFACA	A-STOMACH	12.1	12.1	Note 5	N/A
	LOWER-LI	N/A	N/A	Note 5	15
EFFACB	Shape Factor for Early Fatality Types				
	A-RED MARR	6.1	6.1	5	6
	A-LUNGS	9.6	9.6	7	7
	A-STOMACH	9.3	9.3	Note 5	N/A
	LOWER-LI	N/A	N/A	Note 5	10
EFFACY	Efficacy of the KI Ingestion	0.7	0.7	Note 2	Note 2
EFFTHR	Threshold Dose to Target Organ				
	A-RED MARR	2.32	2.32	1.5	1.5
	A-LUNGS	13.6	13.6	5	5
	A-STOMACH	6.5	6.5	Note 5	N/A
	LOWER-LI	N/A	N/A	Note 5	7.5
EIFACA	LD50 For Early Injuries				
	PRODROMAL VOMIT	2	2	2	2
	DIARRHEA	3	3	3	3
	PNEUMONITIS	16.6	16.6	10	10
	SKIN ERYTHRMA	6	6	6	6
	TRANSEPIDERMAL	20	20	20	20
	THYROIDITIS	240	240	240	240
	HYPOTHYROIDISM	60	60	60	60
EIFACB	Shape Factor for Early Injuries				
	PRODROMAL VOMIT	3	3	3	3
	DIARRHEA	2.5	2.5	2.5	2.5
	PNEUMONITIS	7.3	7.3	7	7
	SKIN ERYTHRMA	5	5	5	5
	TRANSEPIDERMAL	5	5	5	5
	THYROIDITIS	2	2	2	2
	HYPOTHYROIDISM	1.3	1.3	1.3	1.3
EINAME	Early Injury Effect Names and Corresponding Organ				
	PRODROMAL VOMIT	A-STOMACH	A-STOMACH	A-STOMACH	STOMACH
	DIARRHEA	A-STOMACH	A-STOMACH	A-STOMACH	STOMACH
	PNEUMONITIS	A-LUNGS	A-LUNGS	A-LUNGS	LUNGS
	SKIN ERYTHRMA	A-SKIN	A-SKIN	A-SKIN	SKIN
	TRANSEPIDERMAL	A-SKIN	A-SKIN	A-SKIN	SKIN
	THYROIDITIS	A-THYROID	A-THYROID	A-THYROID	THYROID
	HYPOTHYROIDISM	A-THYROID	A-THYROID	A-THYROID	THYROID
EISUSC	Susceptible Population Fraction	1. for all health effects	1. for all health effects	1. for all health effects	1. for all health effects

Table C-2 EARLY input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs (continued)

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
EITHRE	Early Injury Dose Threshold				
	PRODROMAL VOMIT	0.5	0.5	0.5	0.5
	DIARRHEA	1	1	1	1
	PNEUMONITIS	9.2	9.2	5	5
	SKIN ERYTHRMA	3	3	3	3
	TRANSEPIDERMAL	10	10	10	10
	THYROIDITIS	40	40	40	40
	HYPOTHYROIDISM	2	2	2	2
ENDAT2	Control flag indicating only ATMOS and EARLY are to be run	.FALSE.	.FALSE.	.FALSE.	.FALSE.
ENDEMP	Time Duration for the Emergency Phase (sec)	604800	604800	604800	604800
ESPEED	Evaluation Speed (m/s)				
	Initial Evacuation Phase, Cohort 1	2.235	2.235	1.8	4.8
	Middle Evacuation Phase, Cohort 1	0.447	1.341	1.8	4.8
	Late Evacuation Phase, Cohort 1	8.941	8.941	1.8	4.8
	Initial Evacuation Phase, Cohort 2	2.235	2.235	1.8	Note 4
	Middle Evacuation Phase, Cohort 2	0.447	1.341	1.8	Note 4
	Late Evacuation Phase, Cohort 2	8.941	8.941	1.8	Note 4
	Initial Evacuation Phase, Cohort 3	4.47	8.941	Note 4	Note 4
	Middle Evacuation Phase, Cohort 3	4.47	8.941	Note 4	Note 4
	Late Evacuation Phase, Cohort 3	8.941	8.941	Note 4	Note 4
	Initial Evacuation Phase, Cohort 4	0.447	1.341	Note 4	Note 4
	Middle Evacuation Phase, Cohort 4	4.47	8.941	Note 4	Note 4
	Late Evacuation Phase, Cohort 4	8.941	8.941	Note 4	Note 4
	Initial Evacuation Phase, Cohort 5	0.447	1.341	Note 4	Note 4
	Middle Evacuation Phase, Cohort 5	4.47	8.941	Note 4	Note 4
	Late Evacuation Phase, Cohort 5	8.941	8.941	Note 4	Note 4
	Cohort 6	N/A	N/A	Note 4	Note 4
ESPGRD	Speed Multiplier to Account for Grid-Level Variations in Road Network	Table A-6 Table A-7	Table B-6	Note 2	Note 2
ESPMUL	Speed Multiplier Employed During Precipitation	0.7	0.7	Note 2	Note 2
EVATYP	Evacuation Type	NETWORK	NETWORK	RADIAL	RADIAL

Table C-2 EARLY input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs (continued)

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
GSHFAC	Groundshine Shielding Factors				
	Evacuation Shielding Factor for All but Cohort 4	0.5	0.5	0.5	0.5
	Normal Activity Shielding Factor for All but Cohort 4	0.26	0.18	0.33	0.33
	Sheltering Shielding Factor for All but Cohort 4	0.2	0.1	0.2	0.1
	Evacuation Shielding Factor for Cohort 4	0.5	0.5	Note 4	Note 4
	Normal Activity Shielding Factor for Cohort 4	0.05	0.05	Note 4	Note 4
	Sheltering Shielding Factor for Cohort 4	0.05	0.05	Note 4	Note 4
IDIREC	Direction in Network Evacuation Model	Table A-8	Table B-7	Note 2	Note 2
IPLUME	Plume Model Dispersion Code	3	3	2	2
KIMODL	Model Flag for KI Ingestion	KI	KI	Note 2	Note 2
LASMOV	Last Ring in Movement Zone	17	17	15 for cohort 1 0 for cohort 2	15
NUMACA	Number of Latent Cancer Health Effects	8	8	7	7
NUMEFA	Number of Early Fatality Effects	3	3	2	3
NUMEIN	Number of Early Injury Effects	7	7	7	7
NUMEVA	Outer Boundary of Evacuation/Shelter Region	Cohort 1 - 15 Cohorts 2 to 5 - 12	Cohort 1 - 15 Cohorts 2 to 6 - 12	12	12
NUMFIN	Number of Fine Grid Subdivisions	7	7	7	7
ORGFLG	Doses to be Calculated for Specified Organ	All TRUE for FGR-13 All TRUE for DOSFAC2 except for A-Lower LI and L-Liver, which are FALSE	All TRUE for FGR-13 All TRUE for DOSFAC2 except for A-Lower LI and L-Liver, which are FALSE	All TRUE except for A-Lower LI and L-Liver, which are FALSE	Note 2
OVRRID	Wind Rose Probability Override	.FALSE.	.FALSE.	.FALSE.	.FALSE.
POPFLG	Population Distribution Flag	FILE	FILE	FILE	FILE
POPFRAC	Population Fraction Ingesting KI	Cohort 2 - 1.0 Cohort 1, 3-6 - 0.0	Cohort 1 and 2 - 1.0 Cohort 3 to 6 - 0.0	Note 2	Note 2
PROTIN [E]	Inhalation Protection Factor – evacuation for all but Cohort 4	0.98	0.98	1	1
PROTIN [N]	Inhalation Protection Factor - normal activity for all but Cohort 4	0.46	0.46	0.41	0.41
PROTIN [S]	Inhalation Protection Factor – sheltering for all but Cohort 4	0.33	0.33	0.33	0.33

Table C-2 EARLY input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs (continued)

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
PROTIN [E]	Inhalation Protection Factor – evacuation for Cohort 4	0.98	0.98	Note 4	Note 4
PROTIN [N]	Inhalation Protection Factor - normal activity for Cohort 4	0.33	0.33	Note 4	Note 4
PROTIN [S]	Inhalation Protection Factor – sheltering for Cohort 4	0.33	0.33	Note 4	Note 4
REFPNT	Reference Time Point (ARRIVAL or SCRAM)	ALARM	ALARM	ALARM	Note 2
RESCON	Emergency phase resuspension coefficient	0.0001	0.0001	0.0001	0.0001
RESHAF	Resuspension Concentration Half-Life (sec)	182000	182000	182000	182000
RISCAT	Risk by Weather-Category Flag	.FALSE.	.FALSE.	.FALSE.	.FALSE.
RISTHR	Risk Threshold for Fatality Radius	0	0	Note 2	Note 2
SKPFAC [E]	Skin Protection Factors – evacuation for all but Cohort 4	0.98	0.98	1	1
SKPFAC [N]	Skin Protection Factors - normal activity for all but Cohort 4	0.46	0.46	0.41	0.41
SKPFAC [S]	Skin Protection Factors – sheltering for all cohorts	0.33	0.33	0.33	0.33
SKPFAC [E]	Skin Protection Factors – evacuation for Cohort 4	0.98	0.98	Note 4	Note 4
SKPFAC [N]	Skin Protection Factors - normal activity Cohort 4	0.33	0.33	Note 4	Note 4
TIMHOT	Hotspot Relocation Time (sec)	86400	43200	43200	43200
TIMNRM	Normal Relocation Time (sec)	129600	86400	86400	86400
TRAVELPOINT	Evacuee Movement Option	CENTERPOINT	CENTERPOINT	BOUNDARY	Note 2
WTFRAC	Weighting Fraction Applicable to this Scenario				
	Cohort 1	0.2	0.2	0.95	0.995
	Cohort 2	0.535	0.355	0.05	0.005
	Cohort 3	0.193	0.372	Note 4	Note 4
	Cohort 4	0.007	0.006	Note 4	Note 4
	Cohort 5	0.06	0.062	Note 4	Note 4
	Cohort 6	0.005	0.005	Note 4	Note 4
WTNAME	Type of Weighting for Cohorts	PEOPLE	PEOPLE	PEOPLE	PEOPLE

Note 4: This cohort was not used for this MACCS model
Note 5: This variable was not used in Sample Problem A – Surry

Table C-3 CHRONC input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
CHNAME	CHRONC Problem Identification	Surry with no Food-Chain Modeling	Peach Bottom with no Food-Chain Modeling	IN3A_N.INP, Sample Problem A, "New" COMIDA2-based food model	CHRONC input for final NUREG-1150 calculations
CDFRM	Farmland Decontamination Cost ($/hectare)				
	Level 1	1330	1330	562.5	562.5
	Level 2	2960	2960	1250	1250
CDNFRM	Nonfarmland Decontamination Cost ($/person)				
	Level 1	7110	7110	3000	3000
	Level 2	19000	19000	8000	8000
CRTOCR	Critical Organ for CHRONC Phase	L-ICRP60ED	L-ICRP60ED	L-EDEWBODY	L-EDEWBODY
DPRATE	Property Depreciation Rate	0.2	0.2	0.2	0.2
DLBCST	Hourly Labor Cost for Decontamination Worker ($/man-year)	84000	84000	35000	35000
DPFRCT	Farm Production Dairy Fraction	Note 6	Note 6	Note 6	Note 6
DSCRLT	Long-Term Phase Dose Criterion (Sv)	0.04	0.005	0.04	0.04
DSCRTI	Intermediate-Phase Dose Criterion (Sv)	100000	100000	100000	100000
DSRATE	Societal Discount Rate for Property	0.12	0.12	0.12	0.12
DSRFCT	Decontamination Factors				
	Level 1	3	3	3	3
	Level 2	15	15	15	15
DUR_INTPHAS	Duration of the Intermediate Phase	0	0	0	0
EVACST	Emergency Phase Cost of Evacuation/Relocation ($/person-day)	172	172	27	27
EXPTIM	Maximum Exposure Time (sec)	1580000000	1580000000	10000000000	10000000000
FDPATH	COMIDA2 vs. MACCS Food Model Switch	OFF	OFF	NEW	Note 7
FRACLD	Fraction of Area that is Land	Note 6	Note 6	Note 6	Note 6
FRCFRM	Fraction of Area Used for Farming	Note 6	Note 6	Note 6	Note 6
FRFDL	Fraction of Decontamination Cost for Labor				
	Level 1	0.3	0.3	0.3	0.3
	Level 2	0.35	0.35	0.35	0.35
FRFIM	Farm Wealth Improvements Fraction	0.25	0.25	0.25	0.25

Table C-3 CHRONC input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs (continued)

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
FRMPRD	Average Annual Farm Production	Note 6	Note 6	Note 6	Note 6
FRNFIM	Nonfarm Wealth Improvements Fraction	0.8	0.8	0.8	0.8
FRNFDL	Nonfarm Labor Cost Fraction				
	Level 1	0.7	0.7	0.7	0.7
	Level 2	0.5	0.5	0.5	0.5
GWCOEF	Long-Term Groundshine Coefficients				
	Term 1	0.5	0.5	0.5	0.5
	Term 2	0.5	0.5	0.5	0.5
KSWTCH	Diagnostic Output Option Switch	0	0	0	0
LBRRATE	Long-Term Breathing Rate (m^3/sec)	0.000266	0.000266	0.000266	0.000266
LGSHFAC	Long-Term Groundshine Protection Factor	0.26	0.18	0.33	0.33
LPROTIN	Long-Term Inhalation Protection Factor	0.46	0.46	0.41	0.41
LVLDEC	Number of Decontamination Levels	2	2	2	2
NGWTRM	Number of Terms in Groundshine Weathering Equation	2	2	2	2
NRWTRM	Number of Terms in Resuspension Weathering Equation	3	3	3	3
POPCST	Per Capita Cost of Long-Term Relocation ($/person)	12000	12000	5000	5000
RELCST	Relocation Cost per Person-Day ($/person-day)	172	172	27	27
RWCOEF	Long-Term Resuspension Factor Coefficients				
	Term 1	0.00001	0.00001	0.00001	0.00001
	Term 2	0.0000001	0.0000001	0.0000001	0.0000001
	Term 3	0.000000001	0.00000001	0.000000001	0.000000001
TFWKF	Fraction Farmland Worker Time in Contaminated Zone				
	Level 1	0.1	0.1	0.1	0.1
	Level 2	0.33	0.33	0.33	0.33
TFWKNF	Fraction Nonfarmland Worker Time in Contaminated Zone				
	Level 1	0.33	0.33	0.33	0.33
	Level 2	0.33	0.33	0.33	0.33
TGWHLF	Groundshine Weathering Half-Lives (sec)				
	Term 1	16000000	16000000	16000000	16000000
	Term 2	2800000000	2800000000	2800000000	2800000000

Table C-3 CHRONC input parameters used in the SOARCA accident scenarios compared with the MACCS Sample Problem A inputs (continued)

Variable	Description	SOARCA Surry LTSBO	SOARCA Peach Bottom LTSBO	Sample Problem A (Surry)	NUREG-1150 Peach Bottom
TIMDEC	Decontamination Times (sec)				
	Level 1	5184000	5184000	5184000	5184000
	Level 2	10368000	10368000	10368000	10368000
TMPACT	Time Action Period Ends (sec)	158000000	31600000	158000000	158000000
TRWHLF	Resuspension Weathering Half-Lives (sec)				
	Term 1	16000000	16000000	16000000	16000000
	Term 2	160000000	160000000	160000000	160000000
	Term 3	1600000000	1600000000	1600000000	1600000000
VALWF	Value of Farm Wealth ($/hectare)	6900	9040	2613	3421
VALWNF	Value of Nonfarm Wealth ($/person)	220000	210000	84000	78000

Note 6: Value is site-specific and provided in the respective site file

Note 7: COMIDA2 was not available for NUREG-1150. Instead a MACCS food model was used.

Table C-4 Sample Problem A radionuclide names

Co-58	Te-131m	Zr-95	La-141
Co-60	Te-132	Zr-97	La-142
Kr-85	I-131	Nb-95	Ce-141
Kr-85m	I-132	Mo-99	Ce-143
Kr-87	I-133	Tc-99m	Ce-144
Kr-88	I-134	Ru-103	Pr-143
Rb-86	I-135	Ru-105	Nd-147
Sr-89	Xe-133	Ru-106	Np-239
Sr-90	Xe-135	Rh-105	Pu-238
Sr-91	Cs-134	Sb-127	Pu-239
Sr-92	Cs-136	Sb-129	Pu-240
Y-90	Cs-137	Te-127	Pu-241
Y-91	Ba-139	Te-127m	Am-241
Y-92	Ba-140	Te-129	Cm-242
Y-93	La-140	Te-129m	Cm-244

Table C-5 Sample Problem A – Surry environmental source term release fractions

	Xe	I	Cs	Te	Sr	Ru	La	Ce	Ba
Plume segment 1	1.0E+00	6.8E-01	6.4E-01	1.7E-01	4.2E-03	2.3E-03	1.6E-04	4.0E-04	6.3E-03
Plume segment 2	4.3E-03	9.5E-03	2.4E-03	1.4E-01	6.8E-02	4.7E-04	6.8E-03	7.1E-03	5.4E-02

Table C-6 Sample Problem A – Peach Bottom environmental source term release fractions

	Xe	I	Cs	Te	Sr	Ru	La	Ce	Ba
Plume segment 1	6.6E-01	8.5E-03	9.4E-03	1.9E-02	2.6E-02	3.5E-03	2.8E-03	5.4E-03	2.6E-02
Plume segment 2	3.4E-01	4.9E-01	5.4E-01	6.1E-01	7.2E-01	9.3E-03	6.2E-02	1.2E-01	6.20E-01

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10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

The modeling approach used in the State-of-the-Art Reactor Consequence Analyses (SOARCA) project to characterize the offsite consequences of releases of radionuclides to the environment accompanying a postulated severe (core damage) accident is based on plant-specific applications of the MELCOR Accident Consequence Code System (MACCS). The objective of this document is to describe the consequence model improvements, modeling approach, parameter selection, and consequence analyses that support the SOARCA project and also explain the significance of the modeling improvements and approaches. This document presents a compilation of experience from using MACCS to model the offsite consequences, in terms of health effect risk, for NUREG-1935, "State-of-the-Art Reactor Consequence Analyses (SOARCA) Report." This provides a description of how MACCS modeling capabilities were used to represent important aspects of radionuclide atmospheric transport, emergency response, and dose response to radiation exposure. Additionally, a description of choices among certain alternative modeling options and input parameters is provided.

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