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June 30, 2000

Jason H. Schaperow
Mail Stop T10K8
RES/DSARE/SMSAB
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Schaperow,

Enclosed is a copy of the draft letter report for Task 7 (SFP MACCS2 Calculation) of W6352. If you have any questions, please let me know. I will be out of the office the week of July 3, but will be glad to answer any questions you have when I return.

Sincerely,

Donnie

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Risk & Reliability Analysis
Department 6413

Cases 11 and 14

— not Cases 11 and 12

Enclosure

Copy to (w/encl):

MS-0748	R. D. Waters
MS-0748	File Copy
MS-0748	D. W. Whitehead

I-14

- DRAFT -

JCN W6352
Draft Letter Report

Task 7 Letter Report: Investigation of Plume Spreading Uncertainties on the Radiological Consequences Associated with a Spent Fuel Pool Accident

Date: June 2000

Prepared by
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-DRAFT-

Contents

List of Figures

List of Tables

1. Introduction

1.1 Background

The US and the European Communities (EC) have developed probabilistic accident consequence codes--MACCS2 [Chanin, 1998; Jow, 1990] in the US and COSYMA [Kelly, 1991] in the EC--to enable estimates to be made of the risks presented by nuclear installations, based on the postulated frequencies and magnitudes of potential accidents. These risk estimates provide one of a number of inputs in judgments on risk acceptability and areas where further reductions in risk might be achieved at reasonable costs. They also enable comparisons to be made with quantitative safety objectives. Knowledge of the uncertainty associated with these risk estimates has an important role in effective prioritization and allocation of research and development efforts toward reduction of risk and the appropriate use of the results of risk assessments in regulatory activities.

Consequently, in 1992 the US Nuclear Regulatory Commission (NRC) and the Commission of the European Communities (CEC) co-sponsored an uncertainty study of their respective probabilistic consequence codes, MACCS2 and COSYMA. The uncertainty study consists of two major components: (1) identify and quantify the uncertainty in important code inputs and (2) propagate the uncertainty in the inputs, and quantify the uncertainty in the predictions produced by the codes. Although uncertainty analyses have been performed for the predecessors of MACCS2 and COSYMA, the distributions for the input variables were largely developed by the code developers rather than the experts involved in the numerous phenomenological areas of a consequence analysis. To obtain credible and traceable uncertainty distributions for the respective code input variables, a formal expert judgement elicitation process was used. Under previous tasks, panels of experts in the major phenomenological areas that comprise a consequence calculation were assembled. The panels addressed the following subject matter:

- Atmospheric dispersion and deposition [Harper, 1995]
- Behavior of deposited material and its related doses [Goossens, 1997]
- Food chain [Brown, 1997]
- Deterministic/ Early health effects [Haskin, 1997]
- Internal dosimetry [Goossens, 1998]
- Late/ stochastic health effects [Little, 1997].

Expert judgement techniques have been used only for the most important code input parameters–those believed to have the largest contribution to the uncertainty in code predications. Experts

were requested to assess physical quantities that could be hypothetically measured in experiments. However, the required MACCS2 and COSYMA code parameters are not of an observable nature in all cases. When this occurs, post-processing techniques have been applied to the experts' estimates to provide the necessary code parameter distributions from the variables assessed by the experts. Less resource intensive methods were used for the development of uncertainty distributions for the code input parameters that have less contribution to the uncertainty in code predictions.

Since the two organizations will each use a different code and the input parameters are code specific, the post-processing exercise for the MACCS2 parameters has been performed separately from the COSYMA code parameters. Similarly, the propagation of the uncertainties in the input distributions and the quantification of the resulting uncertainty in the code predictions have also been performed separately. This letter report documents the performance of the uncertainty analysis using the MACCS2 code.

1.2 Objectives

The broad objectives of both the CEC and NRC in undertaking the Joint USNRC/CEC Consequence Code Uncertainty Study are: (1) to formulate a generic, state-of-the-art methodology for uncertainty estimation which is capable of finding broad acceptance, (2) to apply the methodology to estimate the uncertainties associated with the prediction of probabilistic accident consequence codes designed for assessing the consequences of commercial nuclear power plant accidents, and (3) to better quantify and obtain more valid estimates of the uncertainties associated with probabilistic accident consequence codes, thus enabling more informed and better judgements to be made in the areas of risk comparison and acceptability and therefore to help set priorities for future research. Within the context of these broad objectives, the specific objectives for Task 7 were:

- Given a specific spent fuel accident (MACCS2 input decks provided by NRC), quantify the uncertainty in the predictions from MACCS2 caused by the uncertainty in plume spreading.
- This is to be accomplished by holding all MACCS2 input variables constant with the exception of the dispersion parameters and the weather variability.
- Implement the distributions for dispersion parameters that were developed in Task 5 of this study.
- Obtain consequence results for early fatalities, latent cancer fatalities and population dose within 100 miles and 500 miles of the site boundary.
- Report the results as distributions of the mean consequences (averaged over the weather

input).

1.3 Scope of Current Work

This report documents Task 7 of this study, which involves applying the MACCS code to evaluate the radiological consequences from accidents involving spent fuel. Specific work performed under this task includes evaluating the effect of additional plume spreading on the radiological consequences of spent fuel pool accidents. The NRC provided the MACCS input files to be used as the starting point for the evaluation. The input files were modified to incorporate the plume spreading results of the expert elicitation which is documented in report NUREG/CR-6244 [Harper, 1995]. The Latin hypercube sampling capabilities developed for Task 5 were used to implement the distributions. The exposure pathways considered for these calculations include external exposure directly from the radioactive plume as it is transported through the atmosphere, external exposure to radioactive material deposited on the ground and internal exposure by inhalation of radioactive particles (inhaled either directly from the plume or from resuspended material), and food and water ingestion. The consequences addressed in this study include early health effects, latent health effects, and dose to the public.

2. Approach

The probabilistic risk assessment (PRA) working group [US NRC, 1994] defines two general types of uncertainty present in reactor accident studies[1]: **stochastic uncertainty** which is due to inherent variability in some quantity and **subjective uncertainty** that results from lack of complete information about systems, phenomena, and processes. Two components of subjective uncertainty that are of relevance for consequence assessments are parameter uncertainty and model/completeness uncertainty. **Parameter uncertainty** results from lack of knowledge about the correct inputs to models being used in the analysis. **Model/completeness uncertainty** occurs because perfect models cannot be constructed that include all significant phenomena and relationships. Model/completeness uncertainty is rarely explicitly and comprehensively addressed in PRAs.

It is often desirable to maintain a distinction between stochastic and subjective uncertainties in the analysis. As discussed by Helton et al. [Helton, 1995a], "stochastic uncertainty is a property of the system under study, and subjective uncertainty is a property of the analysts performing the study." This separation of uncertainties allows one to make a distinction between uncertainties that result from our lack of knowledge (i.e., subjective uncertainty) from those that result from random processes (at least at the level that we are able to model the processes). From the knowledge gained though additional data collection, model improvement, and other research it is possible to reduce the subjective uncertainty. At the level that we model stochastic processes, the uncertainty can be considered a property of the system and cannot be reduced. Hence, by maintaining a distinction, it is possible to identify variables where additional research would reduce the uncertainty in the results.

This uncertainty study was performed using MACCS2, Version 1.12 [Chanin, 1998]. The only stochastic uncertainty considered in the consequence code was the variability in the weather at the time of the accident. The treatment of the weather variability in the MACCS2 code is discussed in Sections 3 and 4.3. The subjective uncertainty considered in this study was that associated with parameter uncertainty. Model uncertainty was included only to the extent that it could be characterized by uncertainty distributions on input parameters (i.e., the distribution for a parameter may reflect results from different underlying models). *In the rest of this report, uncertainty analysis is defined to be the determination of the uncertainty in model predictions that results from the uncertainty in model inputs (i.e., parameter uncertainty).*

[1] Many different terms are used in the literature to characterize the types of uncertainties. The term aleatory refers to the same type of uncertainty as stochastic. Similarly, the terms epistemic and state-of-knowledge refer to the same type of uncertainty as subjective.

2.1 Conceptual Framework

In a previous uncertainty/sensitivity study of the MACCS code [Helton, 1995a; Helton, 1995b; Helton, 1995c], supporting analyses for this study were performed. In that study, a conceptual framework, based on the ordered triple representation for risk, was outlined. This conceptual framework distinguishes between stochastic and subjective uncertainty and can be applied to all portions of the PRA (i.e., Levels 1, 2 and 3). Therefore, the framework is useful for describing how the different uncertainties are represented and displayed and how uncertainties can be consistently treated throughout a Level 3 PRA. Since these concepts are important for the present study, the discussion provided by Helton et al. has been extracted from NUREG/CR-6136 and is summarized below:

The ordered triple representation for risk proposed by Kaplan and Garrick [Kaplan, 1981] provides a useful framework with which to both describe the conceptual structure of a consequence calculation and distinguish between stochastic and subjective uncertainty. In this representation, risk is expressed as a set $\boldsymbol{R}$ of ordered triples of the form

$$R = \{(S_i, pS_i, cS_i),\ i = 1, 2, \ldots, nS\}, \tag{2-1}$$

where $\boldsymbol{S}_i$ is a set of similar occurrences (i.e., a scenario), pS_i is the probability (or frequency, as appropriate) for $\boldsymbol{S}_i$, $\boldsymbol{cS}_i$ is a vector of consequences associated with $\boldsymbol{S}_i$, nS is the number of sets selected for consideration, and the sets $\boldsymbol{S}_i$ have no occurrences in common (i.e., the $\boldsymbol{S}_i$ are disjoint). This representation formally decomposes risk into what can happen (the $\boldsymbol{S}_i$), how likely things are to happen (the pS_i), and the consequences of what can happen (the $\boldsymbol{cS}_i$). In the context of a typical reactor accident consequence model such as MACCS2, the $\boldsymbol{S}_i$ are sets of similar weather conditions, the pS_i are probabilities for these sets of weather conditions, and the $\boldsymbol{cS}_i$ contain consequence values calculated for these sets of weather conditions. (An overview of how $\boldsymbol{cS}_i$ is determined for the MACCS2 model in the present study is provided in Section 3.) To facilitate visual examination, the information in pS_i and $\boldsymbol{cS}_i$ is usually summarized with complementary cumulative distribution functions (CCDFs).

The probabilities pS_i in Eq. (2-1) characterize stochastic uncertainty. Subjective uncertainty enters when the computational reality of evaluating the risk representation in Eq. (2-1) must be addressed. In practice, evaluation of the expression in Eq. (2-1) requires extensive computation and, in turn, this computation requires many inputs. If these inputs are represented by a vector,

$$x = [x_1, x_2, \ldots, x_{nV}], \tag{2-2}$$

where nV is number of such inputs, the representation in Eq. (2-1) becomes

$$R(x) = \{(S_i(x), pS_i(x), cS_i(x)), i = 1, 2, \ldots, nS(x)\}. \tag{2-3}$$

If the vector $\mathbf{x}$ were known with complete certainty, then the expression in Eq. (2-3) could be evaluated and presented as the unambiguous outcome of the analysis. However, $\mathbf{x}$ is not known with certainty in most analyses, with the result that there is not a single CCDF for a particular consequence value that can be identified as the unambiguous outcome of evaluating the expression in Eq. (2-3). In particular, subjective uncertainty in $\mathbf{x}$ leads to a distribution of CCDFs, with the individual CCDFs displaying the effect of stochastic uncertainty conditional on a specific value of $\mathbf{x}$ and the distribution of CCDFs displaying the effect of subjective uncertainty in x.

As previously indicated, the primary focus of this study was on the effect of subjective uncertainty in the MACCS2 model. Thus, the analysis objective was to determine the relationship between the uncertainty in a vector $\mathbf{x}$ of the form defined in Eq. (2-2) and the uncertainty in a risk representative $\boldsymbol{R(x)}$ of the form defined in Eq. (2-3). This relationship was determined by characterizing the uncertainty in $\mathbf{x}$ with a sequence of distributions

$$D_1, D_2, \ldots, D_{nV}, \tag{2-4}$$

where D_j describes a degree of belief as to where the appropriate value to use for x_j is located given that the analysis has been structured so that only a single value of variable x_j is required in the determination of the set $\boldsymbol{R(x)}$. Correlations and other restrictions between the x_j are also possible, which is equivalent to the specification of a joint probability distribution for the variables contained in $\mathbf{x}$. The distributions developed for the x_j are characterizing subjective uncertainty as they indicate the possible locations of fixed, but unknown, quantities.

In practice, Monte Carlo techniques must be used to determine the distribution of CCDFs that results from the subjective uncertainty characterized by the distributions in Eq. (2-4). Specifically, a sample of the form

$$x_k = [x_{1k}, x_{2k}, \ldots, x_{nV,k}], k = 1, 2, \ldots, nLHS, \tag{2-5}$$

is generated by Latin hypercube sampling [Iman, 1984] or some other appropriate sampling procedure according to the distributions characterizing the subjective uncertainty in the individual elements x_j of $\boldsymbol{x}$, where *nLHS* is the sample size. Evaluation of the MACCS2 model for each sample element x_k produces a sequence of results of the form

$$R(x_k) = \{(S_i, pS_i, cS_i(x_k)),\ i = 1, 2, \ldots, nS\} \qquad (2\text{-}6)$$

for $k = 1, 2, \ldots, nLHS$. Although the general representation for $\boldsymbol{R(x)}$ in Eq. (2-3) shows $\boldsymbol{S_i}$, pS_i, $\boldsymbol{cS_i}$ and nS as functions of $\boldsymbol{x}$, only $\boldsymbol{cS_i}$ is a function of $\boldsymbol{x}$ in the present study. As each set $\boldsymbol{R(x_k)}$ yields a CCDF for each consequence result under consideration, distributions of CCDFs are produced that characterize subjective uncertainty. Further, the sets $\boldsymbol{R(x_k)}$ provide a mapping from analysis inputs to analysis results that can be explored with sensitivity analysis techniques based on regression analysis, partial correlation analysis and possibly other procedures [Iman, 1980a; Iman, 1981a; Iman, 1981b; Iman, 1988; Helton, 1991; Helton, 1993].

The information in the CCDF, specifically the probability of the weather sequence, pS_i, and the consequence value that stems from that sequence, $\boldsymbol{cS_i(x)}$, can be combined to yield an expected value, $\overline{cS}$, where the expectation is being taken over stochastic uncertainty. When subjective uncertainty is considered in the calculation of the consequences, the expected value expression becomes:

$$\overline{cS(x)} = \sum_{i=1}^{nS} pS_i\ cS_i(x)\ . \qquad (2\text{-}7)$$

It is this expectation value, $\overline{cS}$, that is used in the calculation of aggregate risk in an integrated Level 3 PRA.

Propagation of Uncertainties Through Consequence Model

The uncertainty distributions over the input parameters were propagated through the MACCS2 code using a stratified form of simple Monte Carlo sampling called Latin Hypercube Sampling (LHS) [Wyss, 1998]. In this approach, a value is selected from each parameter distribution to create one complete set of the inputs to the MACCS2 code. The probability of selecting a specific value for a parameter is proportional to the degree of belief in that value as given in the distribution. This process is then repeated, creating many sets of inputs. Correlations and other

restrictions between distributions can be specified during the sampling process. For example, if it is specified that there is a strong positive correlation between two distributions, then the same regions of the two distributions are sampled simultaneously. The sets of inputs can be visualized as a table where the columns in the table represent the different input parameters and the rows represent the different trials in the Monte Carlo sampling scheme. Hence, each row represents one value for each of the parameters whereas the list of values in one column represents the subjective uncertainty associated with that parameter. Each set of inputs, i.e., row in the table, is called an observation; the entire collection of sets of inputs, i.e., all of the rows, is called the sample. The MACCS2 code is then evaluated once for each set of inputs. The result is a table of outputs that is analogous to the table of inputs where each column in the output table represents a result from the code (e.g., number of early fatalities) and each row represents the output values that result given the set of inputs. Similar to the inputs, a single column in the output table represents the subjective uncertainty in the output result. Once the information in each column has been sorted, summary statistics (e.g., mean, median, 5th, and 95th percentiles) can be calculated and the results can be plotted as a distribution function. A graphical depiction of the propagation of parameter uncertainty through the consequence model is shown in Figure 2-1.

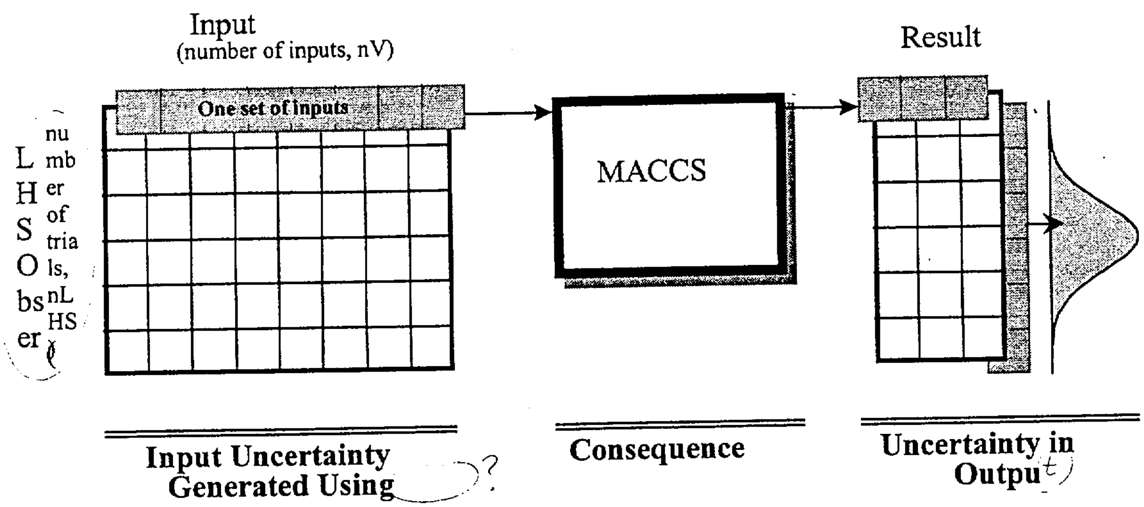


Figure 2-1. Graphical depiction of the propagation of parameter uncertainty through the MACCS2 code using LHS.

The number of observations used in a LHS sample depends on the number of independent distributions that are being sampled. Typically, the "4/3 rule" for sampling (i.e., 4 samples are taken for every 3 variables that have distributions), is employed. However, since the same sample from Task 5 is being applied here with the necessary modifications to reflect the dispersion parameters and the weather variability, the number of sample observations was 300.

3. Overview of the MACCS2 Code

MACCS2 simulates the impact of accidental atmospheric releases of radiological materials on the surrounding environment. The principal phenomena considered in MACCS2 are atmospheric transport, short-term and long-term mitigative actions based on dose projection, dose accumulation by a number of pathways including cloudshine, groundshine, inhalation and food and water ingestion, early and latent health effects, and economic costs. MACCS2 contains simple models with convenient analytical solutions; the phenomenological models are based mostly on empirical data, and the solutions they entail are usually analytical in nature and computationally straightforward.

The models in MACCS2 are implemented in three modules, ATMOS, EARLY and CHRONC. ATMOS treats the atmospheric transport, dispersion, deposition and decay of radiological materials released in the accident. The release of up to four plume segments can be simulated in ATMOS. ATMOS requires the specification of the source term release characteristics for each plume segment, which includes the initial inventory of the radionuclides and fractions released; the sensible heat content; the timing, height, and duration of the release; and the time at which officials are warned to initiate an emergency response. The ATMOS module also requires the specification of meteorological conditions. The fission products released to the atmosphere are modeled as being dispersed while being transported by the prevailing wind, utilizing a Gaussian plume model with Pasquill-Gifford dispersion parameters. Deposition of particulate material on the ground can occur by processes such as gravitational settling, rainout, diffusion, and impaction. Radioactive decay is treated in MACCS2 by consideration of up to six generations of daughter products.

The EARLY module contained in MACCS2 models the consequences of the accident to the surrounding area during a user-defined emergency action period. The emergency phase can last from one to seven days and begins when the first plume of the release arrives at the first downwind distance point. In the EARLY calculation, the user-defined population is exposed to both the radioactive plume and ground-deposited material, resulting in the exposure pathways of cloudshine, groundshine, direct inhalation and resuspension inhalation. Various protective measures can be specified for this phase including evacuation, sheltering and dose-dependent relocation. Both early and latent health effects resulting from early exposure are evaluated in this module.

The CHRONC module considers the long term impact in the period subsequent to the emergency action period. In this portion of the calculation, the exposure of the population results only from

the ground-deposited material (the radioactive cloud is assumed to be gone). Both an intermediate and a long-term phase can be defined in CHRONC. The intermediate phase begins upon the conclusion of the emergency phase, is user-specified (ranging from 0 through 365 days), and includes the exposure pathways of groundshine and resuspension inhalation. The long-term phase begins at the conclusion of the intermediate phase, and the exposure pathways considered include groundshine, resuspension inhalation, and food and water ingestion. Protective measures that can be implemented in the CHRONC module include dose-dependent relocation for both phases and decontamination, temporary interdiction, and condemnation for the long-term phase. Latent health effects resulting from the exposure pathways considered in this portion of the analysis are calculated for the CHRONC module independent of those predicted to occur from early exposure in the EARLY module. The MACCS2 output lists the results from each module separately and provides a combination of the results.

The health effects evaluated in MACCS2 include early mortality and morbidity expected to occur within one year of the accident as well as latent mortality and morbidity expected to occur over the lifetime of the exposed individuals as a result of radiation-induced cancers. The early health effects dose-response model incorporated in the EARLY module implements a sigmoidal dependency of individual risk as a two parameter Weibull hazard function, where a threshold dose to the target organ in an exposed individual must be exceeded in order to implement the risk model. Early mortality is evaluated based on the total cumulative hazard for lethal dose to specified organs (typically red marrow, lungs and GI tract). The MACCS2 model used to evaluate latent mortality and morbidity resulting from radiation-induced cancers utilizes a two-equation piecewise linear zero-threshold dose response function. The function is discontinuous at a dose level dividing high and low exposures. For the low level exposure piece of the function, a dose-dependent reduction factor is applied. The EARLY calculational module implements both of the exposure level pieces, whereas the CHRONC module implements only the low exposure level piece.

A polar-coordinate spatial grid is used in MACCS2 to represent the region in which the accident occurs, centered at the origin of the release. The number of radial divisions in the grid, as well as their endpoint distances, are user-specified. The angular divisions of the grid are fixed and correspond to the sixteen directions of the compass. Population distribution, land usage, economic data, definition of the sheltering/evacuation region, and wind direction are aligned with the spatial grid that is defined for the calculation.

For the consequences calculated for a given accident, MACCS2 can incorporate the stochastic uncertainty that derives from variability in the weather. For the accident site, one year of hourly

meteorological data is specified that defines wind speed and compass direction, stability class, and precipitation amounts. Essentially, each hourly data point is considered to define a weather sequence, starting at that point and continuing for 120 hours (a weather sequence maintains the same wind direction throughout, as there is no calculation of plume meander in MACCS2). Weather sampling can be performed by stratified sampling over all sequences or by stratified weather bin sampling. For the stratified sampling over sequences, each day of the year is divided into a maximum of four equal strata and random sampling performed within each stratum. In the stratified weather bin sampling scheme, bins are characterized by considerations of wind speed, stability class, rain intensity and downwind rain distance at each weather sequence start time, and stratified sampling is performed on a time interval basis for the sequences within each bin (up to ten time interval strata per bin). In addition, rotation of each weather bin sample sequence around the sixteen compass sectors can be performed, where the consequences for each compass sector direction are weighted by the probability of each sequence wind direction within each bin. For the distribution of consequences that is generated due to weather variability, statistical data are available in the MACCS2 output, including selected quantiles, means, peak consequences and complementary cumulative distribution functions (CCDFs).

The code version of MACCS2 that was applied in this study is Version 1.12. The MACCS2 code is the result of the last major code enhancements that were implemented in the MACCS code. The enhancements include an expanded set of radionuclides and associated dose conversion factors, increased flexibility in defining initial plume dimensions and plume dispersion parameters, alternative emergency response modeling, and an alternative food chain model. In addition to the original MACCS evacuation model, where evacuation is limited to outward movement at a constant speed within an angular sector and evacuation delay times are constant, MACCS2 offers an alternative evacuation network model, where the evacuation can occur across angular sector boundaries, evacuation speed can vary with time, and evacuation delay times can vary with radial distance. In addition, up to three population distributions with unique emergency response can be specified. The new alternative foodchain model available to MACCS2 is the COMIDA code, which was developed by Abbott and Rood [Abbott, 1993; Abbott, 1994] of the Idaho National Engineering Laboratory (INEL) specifically for MACCS2. The COMIDA code estimates nuclide concentrations in agricultural food products following an acute fallout event, and is a dynamic foodchain model which models the transfer of radionuclides into the edible portion of plants as a function of plant growth. In addition, COMIDA accounts for linear decay chains up to four nuclides in length, considering ingrowth after deposition.

4. Discussion of MACCS2 Input Variables

The MACCS2 input files for the spent fuel pool calculation were provided by Jason Schaperow of the NRC. The calculation is essentially identical to the MACCS2 Sample Problem A with the following exceptions:

- ***Source Term.*** The source term is a Millstone 1 spent fuel pool inventory scaled for core power to the Susquehanna core by applying a power ratio (3441MWt / 2011MWt). The spent fuel pool contains 11 batches of spent fuel plus the rest of last core inventory. It reflects 1 year of radioactive decay since the last batch was put in the pool. The inventory is based on inventories in NUREG/CR-4982 [Sailor, 1987]. The source term assumptions are listed in Table 4.1.
- ***Population Evacuation Fraction.*** This study applies the actual NUREG-1150 [USNRC, 1990] evacuation fractions, i.e., 99.5% of the population within 10 miles of the plant evacuates and 0.5% does not evacuate continuing normal activities.
- ***Plume Dispersion Parameters.*** The plume dispersion parameters applied in this study are extracted from the dispersion expert panel distributions for Gaussian plume parameters. The parameters are discussed in Section 4.1.

The site for this study is the Surry Power Station, located near Williamsburg, Virginia. The site parameters are consistent with the NUREG-1150 Surry analysis as documented in NUREG/CR-4551 [Breeding, 1990]. The site parameters needed for a MACCS2 calculation include the population distribution, farmland fractions, site exclusion boundary, emergency response zone, core inventory, and meteorological data. The Surry exclusion zone is at 0.32 miles from the reactor site boundary, and the emergency response zone (where evacuation, sheltering and hot-spot relocation intervention occurs) extends to 10 miles from the reactor site boundary. The meteorological data used in the NUREG-1150 Surry plant study was also used in this study; the treatment of weather variability in the MACCS2 code is discussed in Section 4.2.

not a site parameter

The emergency response parameters were based on NUREG-1150 assumptions: evacuation is delayed 2 hours after a general emergency is declared, evacuation occurs radially outward from the site with a speed of 1.8 m/s, and evacuees receive no additional dose once they have traveled 10 miles beyond the emergency response zone. The nonevacuating population is assumed to maintain normal activity.

Table 4-1. Spent Fuel Accident Source Terms

Source Term Release Inventory			
Isotope	**Inventory (Bq)**	**Isotope**	**Inventory (Bq)**
Co-58	1.57E+14	Cs-134	4.79E+17
Co-60	2.29E+16	Cs-136	5.82E+08
Kr-85	1.02E+17	Cs-137	1.43E+18
Rb-86	5.10E+09	Ba-140	1.36E+10
Sr-89	1.98E+16	La-140	1.38E+10
Sr-90	1.02E+18	Ce-141	2.09E+15
Y-90	1.03E+18	Ce-144	1.78E+18
Y-91	5.06E+16	Pr-143	3.78E+10
Zr-95	1.05E+17	Nd-147	2.09E+08
Nb-95	1.36E+17	Np-239	1.83E+14
Ru-103	5.85E+15	Pu-238	3.05E+16
Ru-106	9.87E+17	Pu-239	6.62E+15
Te-127	4.09E+15	Pu-240	9.24E+15
Te-127m	4.16E+15	Pu-241	1.59E+18
Te-129	7.61E+13	Am-241	2.05E+16
Te-129m	7.58E+13	Cm-242	3.03E+16
I-131	3.64E+04	Cm-244	1.44E+16

Source Term	Warn[a] (s)	dEvac[b] (s)	Elev[c] (m)	Energy[d] (W)	Start[e] (s)	Dur[f] (s)
11d/12d	1300	-4800/+10800	0	3.7E+6	3.7E+3	1.8E+3

Source Term	Release Fractions[g]								
	NG[h]	I[i]	Cs[j]	Te[k]	Sr[l]	Ru[m]	La[n]	Ce[o]	Ba[p]
11d/12d	1.0E+0	1.0E+0	1.0E+0	2.0E-2	2.0E-3	1.0E+0	1.0E-6	1.0E-6	2.0E-3

a Time (s) at which warning is given.
b Difference between time evacuation starts and time release starts for an assumed evacuation delay time of 7200 s.
c Elevation (m) of release.
d Energy (W) in release, with one value for each release segment.
e Time (s) at which release starts, with one value for each release segment.
f Duration (s) of release, with one value for each release segment.
g Release fractions (dimensionless) for individual radionuclide release classes, with one value for each release segment.
h Release class includes radioisotopes of Xe, Kr.
I Release class includes radioisotopes of I.
j Release class includes radioisotopes of Rb, Cs.
k Release class includes radioisotopes of Sb, Te.
l Release class includes radioisotopes of Sr.
m Release class includes radioisotopes of Co, Mo, Tc, Ru, Rh.
n Release class includes radioisotopes of Y, Zr, Nb, La, Pr, Nd, Am, Cm.
o Release class includes radioisotopes of Ce, Np, Pu.
p Release class includes radioisotopes of Ba.

7/5/00 at 4:30pm

4.1 Gaussian Plume Parameters

The experts provided probability distributions for measurable physical quantities. The variables that the experts assessed were not always code inputs. In these situations, post-processing techniques were required to obtain distributions over the code parameters from the variables assessed by the experts. The joint NRC/CEC expert panel for Gaussian plume parameter uncertainty [Harper, 1995] provided tables of distributions for the Gaussian plume spreading parameters, σ_y and σ_z for each Pasquill-Gifford stability class. The MACCS2 code however can apply a power law function for σ_y and σ_z, for each stability class, where

$\sigma_y = a_y X^{by}$, and

$\sigma_z = a_z X^{bz}$

Where:

X is the downwind distance,

y is cross wind horizontal plume spreading direction, and

z is the vertical plume spreading direction.

The post-processing of the dispersion parameter distributions was performed at Delft University in the Netherlands [Cook, 1994]. The distributions obtained from the post-processing which were subsequently implemented in MACCS2 for this study are provided in Tables 4.2 through 4.5 for the various stability classes (the experts combined distributions across stability classes A / B and E / F). Tables 4.2 through 4.5 also provide the correlation matrices determined in the post-processing analyses that were implemented in the sample drawn for this study. ?

Table 4-2. Dispersion Parameter Distributions (Stability Classes A/B)

Pasquill-Gifford Stability Classes A/B				
%ile	a_y	b_y	a_z	b_z
0	1.00E-02	5.51E-01	1.00E-02	4.00E-01
5	8.52E-02	7.89E-01	4.14E-02	4.03E-01
15	1.65E-01	8.79E-01	1.72E-01	4.10E-01
25	1.91E-01	9.47E-01	3.52E-01	5.79E-01
50	2.86E-01	9.81E-01	1.54E+00	7.50E-01
75	5.38E-01	1.07E+00	5.54E+00	1.03E+00
85	8.35E-01	1.12E+00	7.79E+00	1.21E+00
95	1.19E+00	1.26E+00	9.99E+00	1.50E+00
100	2.12E+00	2.05E+00	1.00E+01	3.37E+00
	Correlation Matrix			
a_y	1.00E+00	-4.93E-01	-6.56E-02	-5.20E-03
b_y	-4.93E-01	1.00E+00	7.37E-02	-4.32E-01
a_z	-6.56E-02	7.37E-02	1.00E+00	-5.68E-01
b_z	-5.20E-03	-4.32E-01	-5.68E-01	1.00E+00

Table 4-3. Dispersion Parameter Distributions (Stability Class C)

Pasquill-Gifford Stability Class C				
%ile	a_y	b_y	a_z	b_z
0	1.00E-02	4.00E-01	1.00E-02	4.00E-01
5	1.68E-02	4.67E-01	2.04E-02	4.00E-01
15	3.08E-02	5.83E-01	1.07E-01	4.01E-01
25	4.61E-02	6.36E-01	2.05E-01	4.01E-01
50	2.39E-01	9.08E-01	8.47E-01	6.84E-01
75	2.92E+00	1.14E+00	5.22E+00	9.53E-01
85	3.44E+00	1.18E+00	8.15E+00	1.04E+00
95	9.99E+00	1.24E+00	9.99E+00	1.30E+00
100	1.00E+01	2.82E+00	1.00E+01	3.12E+00
	Correlation Matrix			
a_y	1.00E+00	-9.67E-01	-4.05E-01	3.92E-01
b_y	-9.67E-01	1.00E+00	4.20E-01	-4.44E-01
a_z	-4.05E-01	4.20E-01	1.00E+00	-8.99E-01
b_z	3.92E-01	-4.44E-01	-8.99E-01	1.00E+00

Table 4-4. Dispersion Parameter Distributions (Stability Class D)

Pasquill-Gifford Stability Class D				
%ile	a_y	b_y	a_z	b_z
0	1.00E-02	4.00E-01	1.00E-02	4.00E-01
5	1.60E-02	5.52E-01	5.37E-02	4.03E-01
15	2.18E-02	5.86E-01	1.62E-01	4.08E-01
25	3.68E-02	6.41E-01	2.68E-01	4.13E-01
50	1.89E-01	9.32E-01	5.56E-01	6.56E-01
75	2.38E+00	1.16E+00	2.41E+00	8.04E-01
85	3.14E+00	1.20E+00	5.36E+00	8.79E-01
95	7.71E+00	1.28E+00	9.62E+00	1.22E+00
100	1.00E+01	1.77E+00	1.00E+01	3.00E+00
	Correlation Matrix			
a_y	1.00E+00	-9.65E-01	-3.87E-01	3.60E-01
b_y	-9.65E-01	1.00E+00	3.88E-01	-4.02E-01
a_z	-3.87E-01	3.88E-01	1.00E+00	-7.96E-01
b_z	3.60E-01	-4.02E-01	-7.96E-01	1.00E+00

Table 4-5. Dispersion Parameter Distributions (Stability Classes E/F)

Pasquill-Gifford Stability Classes E/F				
%ile	a_y	b_y	a_z	b_z
0	1.00E-02	6.75E-01	1.00E-02	4.00E-01
5	1.88E-02	7.02E-01	6.42E-02	4.05E-01
15	5.75E-02	7.65E-01	2.03E-01	4.15E-01
25	6.97E-02	8.17E-01	3.89E-01	4.25E-01
50	1.24E-01	9.66E-01	1.27E+00	4.49E-01
75	2.81E-01	1.03E+00	5.05E+00	7.06E-01
85	3.20E-01	1.08E+00	5.43E+00	8.69E-01
95	4.13E-01	1.20E+00	8.55E+00	1.28E+00
100	5.00E-01	1.42E+00	1.00E+01	2.62E+00
	Correlation Matrix			
a_y	1.00E+00	-7.16E-01	-4.12E-01	2.68E-01
b_y	-7.16E-01	1.00E+00	4.39E-01	-4.37E-01
a_z	-4.12E-01	4.39E-01	1.00E+00	-8.12E-01
b_z	2.68E-01	-4.37E-01	-8.12E-01	1.00E+00

4.2 Stochastic Weather Variability

Weather variability was incorporated into the analysis, thereby providing a component of stochastic uncertainty. Sampling of the weather was performed by weather bin sampling. The meteorological data were obtained from the site chosen for analysis and consisted of one year of hourly observations of wind speed, atmospheric stability, and precipitation, resulting in the generation of 8760 weather sequences. These weather sequences were sorted into 40 weather bins, which each contained four trial sequences (less, if there are less than four sequences in the bin). The plume shift with rotation option from MACCS2 was exercised, where each plume segment in the release travels in the direction that the wind is blowing at the time that its representative time point leaves the reactor. For this option, each set of modeling results was rotated around the sixteen compass directions to yield sixteen sets of results for each weather trial. Hence, as modeled, the maximum number of weather trials used to capture the stochastic uncertainty in the weather for a given source term was 40 x 4 x 16 = 2560. In practice, some of the weather bins will contain fewer than 4 sequences, in which case the total number of weather trials will be less than 2560. The probability of occurrence for each weather trial was calculated from the weather sequence information. Consequences calculated from these weather trials along with the probabilities of the weather trials were used to construct the CCDF.

5. MACCS2 Consequence Results

5.1 Consequence Code Endpoints

The MACCS2 endpoints selected to investigate the effect of input uncertainty for the current study were limited to an early health effect measure, a latent health effect measure and population dose. The early fatality results are provided for a single distance, i.e., within 100 miles (most early fatalities are actually predicted to occur within 10 miles of the site). The other consequence results are provided for two distances, i.e., within 100 miles and 500 miles from the reactor site. The code endpoints that were selected for this study and their descriptions are provided in Table 5-1. The exposure time regime is for both the early and long-term phases of the accident, and the pathways include cloudshine, groundshine, direct inhalation, resuspension inhalation, and food and water ingestion. The population dose results are whole body effective dose equivalents (as defined by ICRP26), and include the 50-year dose commitment for inhalation exposure.

Table 5-1. Calculational Results

Code Endpoint	Description
Early Fatalities (within 100mi)	The total number of early fatalities occurring within 1 year of the accident due to hematopoietic, pulmonary and gastrointestinal syndromes.
Latent Cancer Fatalities (within 100mi / 500mi)	The total number of latent fatalities by cancer induction from early exposure resulting from leukemia, and cancers of the bone, colon, breast, liver, thyroid, lung, and other sites.
Population Dose (within 100mi / 500mi)	Total population dose (Sv) to individuals within a given distance of the reactor at accident initiation.

5.2 Display of Results

MACCS2 provides results in terms of a Complementary Cumulative Distribution Function (CCDF). The CCDF displays the probability that a consequence of a certain magnitude is exceeded. For a MACCS2 calculation, the range of consequence values arises from the variability in the weather and as such, is a representation of stochastic uncertainty. A CCDF that demonstrates the variability in the prediction of a consequence due to weather variability is shown in Figure 5-1. This is the type of result that is produced for a single execution of MACCS2 when the weather sampling option is exercised.

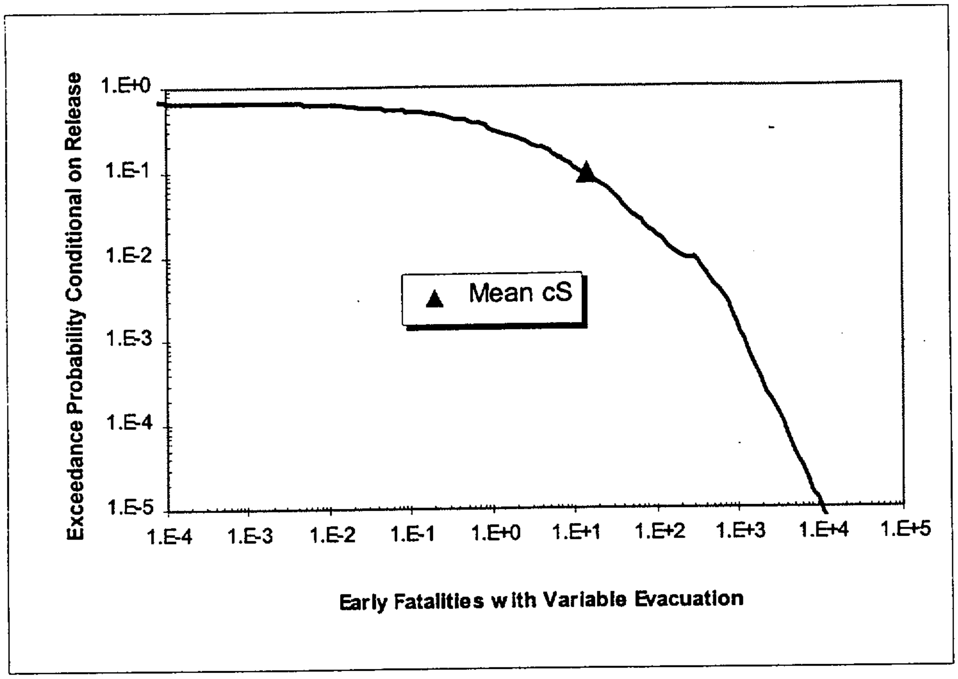


Figure 5-1. Example CCDF for a single calculation of consequence results, cS.

Each sample observation (which includes unique values for each sampled parameter) is realized in a single MACCS2 calculation. Because each MACCS2 calculation provides results that include the weather variability, a CCDF is generated for each observation. The resulting family of CCDFs (300 for this study, since there are 300 observations in the sample) is a representation of uncertainty in model predictions that results from the subjective uncertainty in the model input parameters. Figure 5-2 shows a family of CCDFs that results from multiple MACCS2 calculations that were performed for an uncertainty analysis in which various input parameters were sampled.

Figure 5-2 indicates that, overall, there is significant uncertainty associated with the probability that a certain consequence will be exceeded. The uncertainty originates from the ranges and distributions of the model input variables that are sampled when running the MACCS2 calculations. In order to be able to study the results in a manageable fashion, a method is used in this study whereby the information in each CCDF is collapsed into an expected value--called the mean consequence--where the expectation is taken over the weather variability (as discussed in Section 2.1). This mean value ($\overline{cS}$) is displayed as a triangle in Figure 5-1.

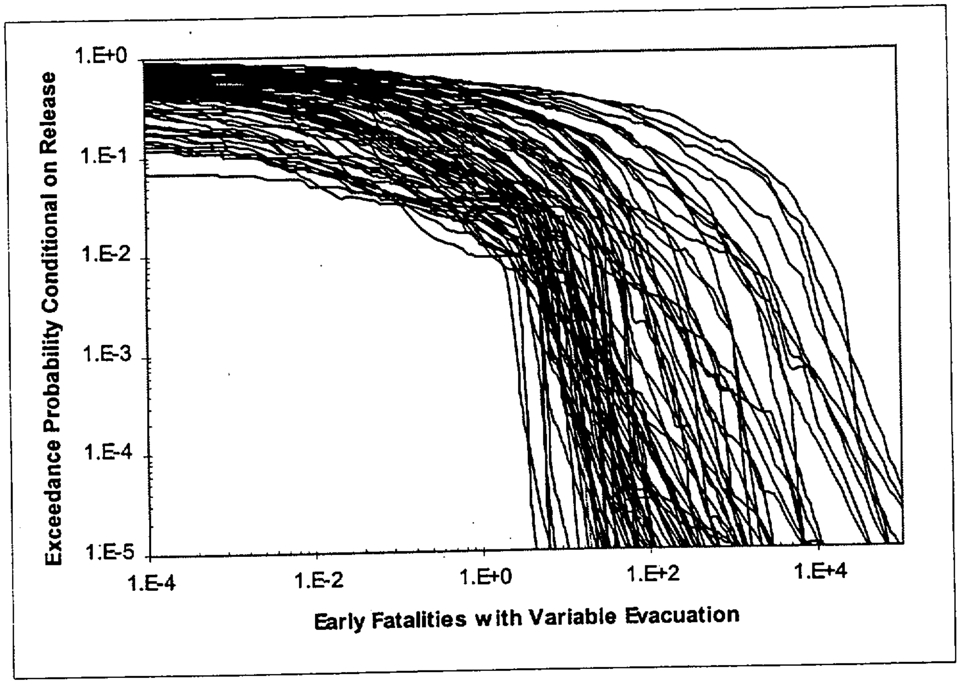


Figure 5-2. Example family of CCDF curves for early fatality consequence results.

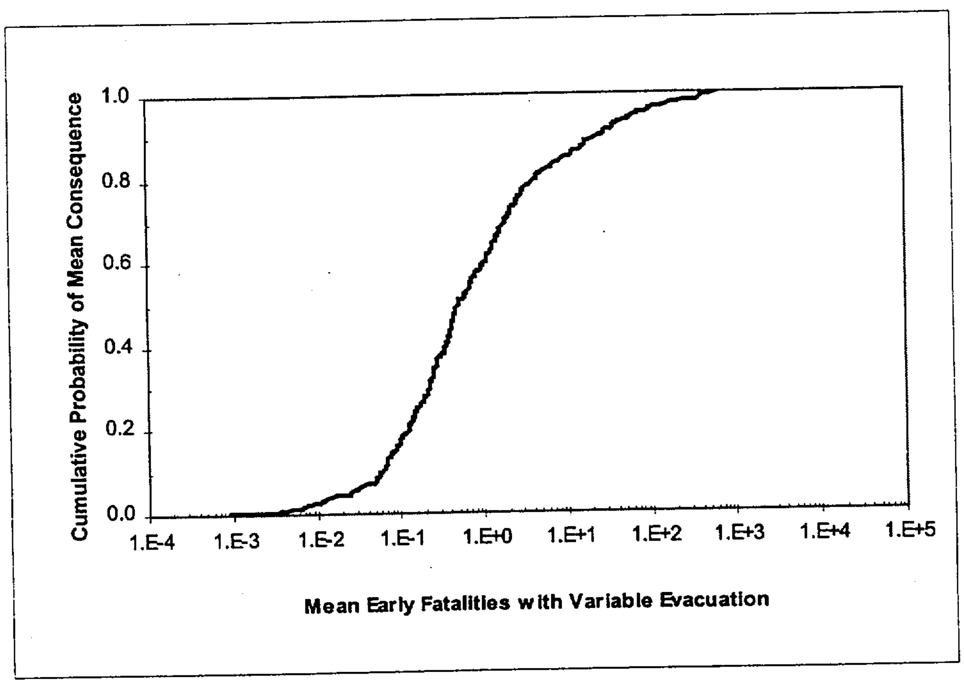
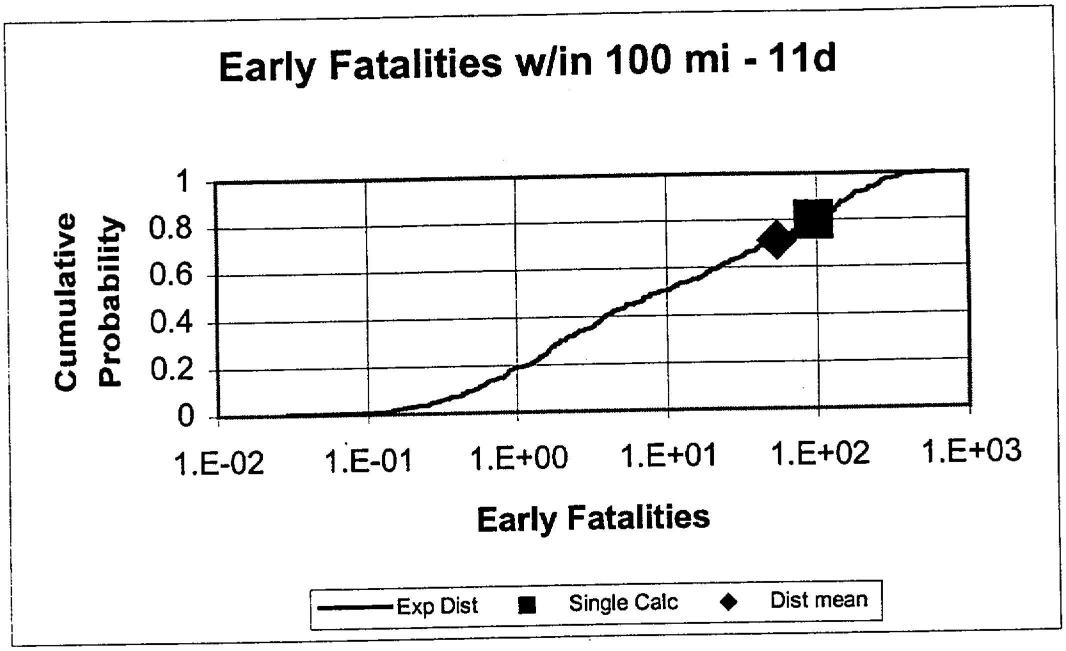


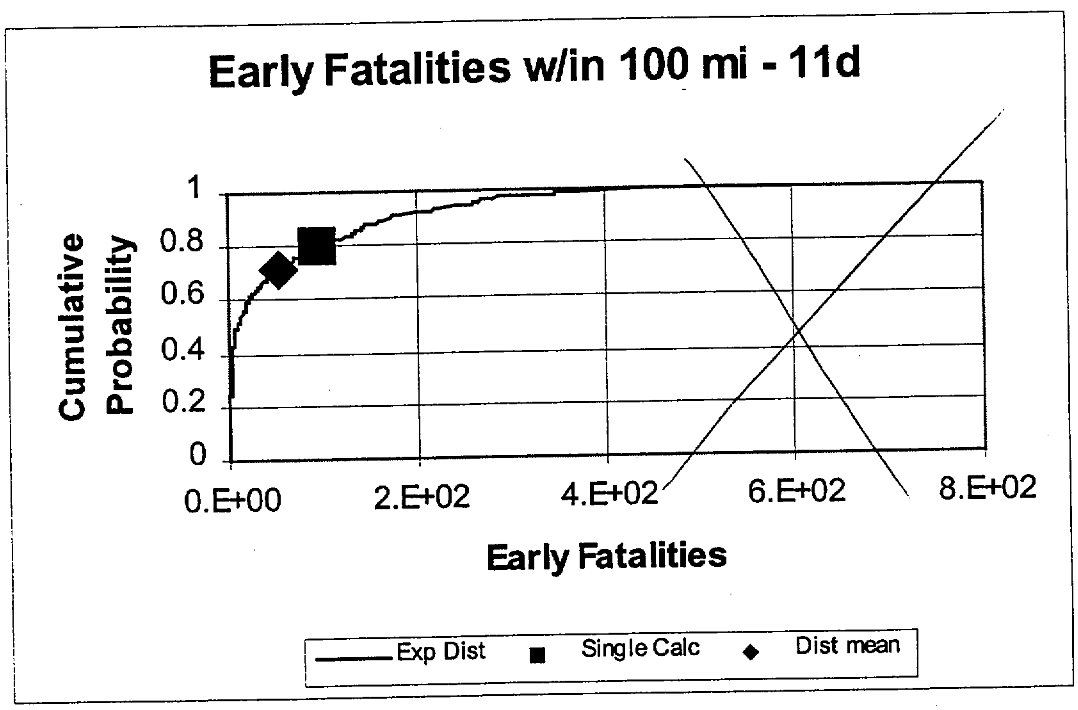
Figure 5-3. Example cumulative distribution function for mean consequences, $\overline{cS}$.

Since in an uncertainty analysis a CCDF is generated for each observation, a mean consequence can also be calculated for each observation resulting in a distribution of mean consequences. This distribution represents the uncertainty in the mean consequences resulting from subjective uncertainty in the input parameters. The distribution of means can then be plotted as a cumulative distribution function (CDF) in Figure 5-3. Figure 5-3 demonstrates the manner in which the results are displayed for this study.

5.3 Results for this Study

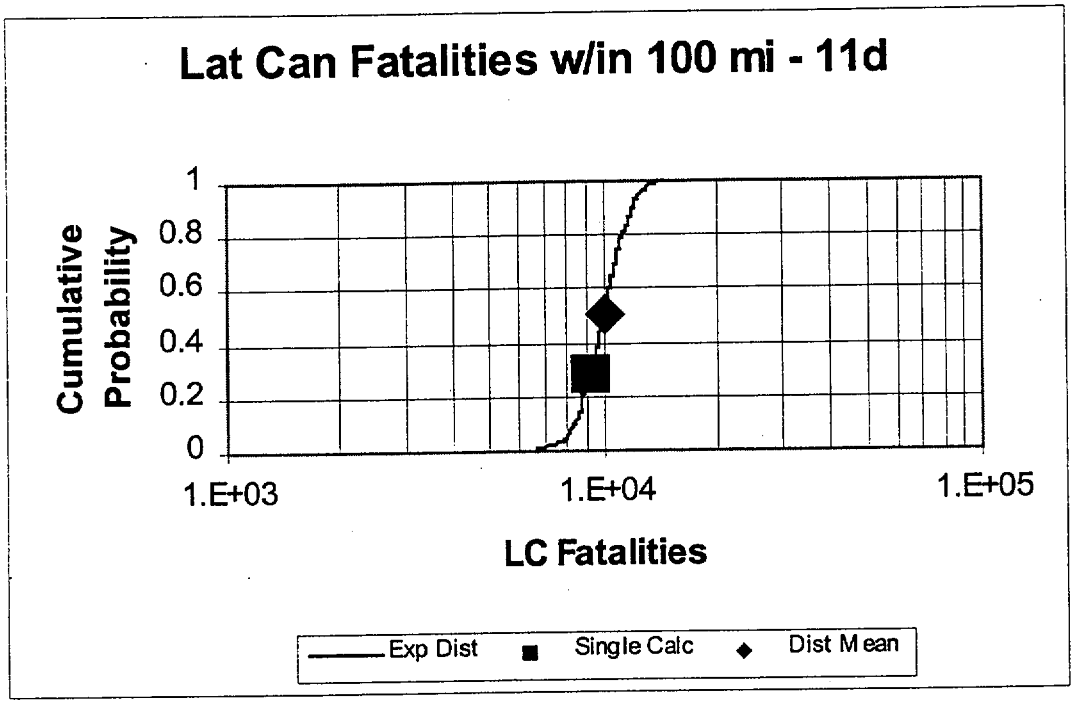
Results from the MACCS2 calculations for Case 11d are presented in Figures 5-4 through 5-8 and results from Case 12d are presented in Figures 5-9 through 5-13. Each figure consists of two graphs displaying the same information, differing only in the scale used for the x-axis (lognormal versus integer/real).





cut off graph at 300

Figure 5-4. Early fatality results within 100 miles for case 11d.



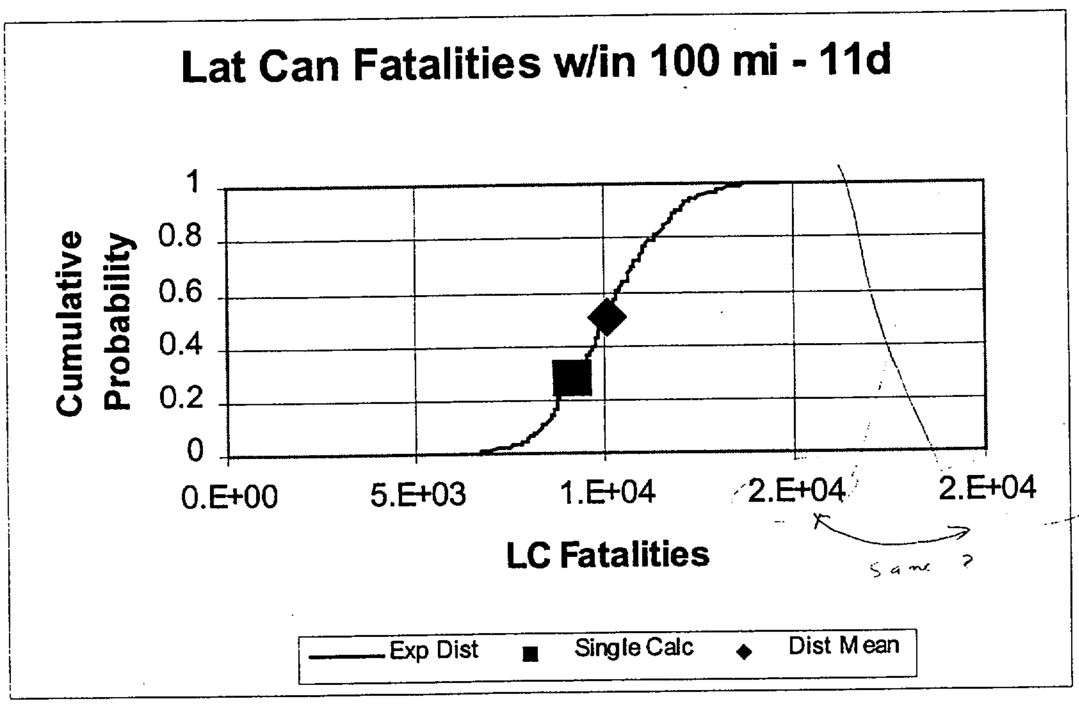
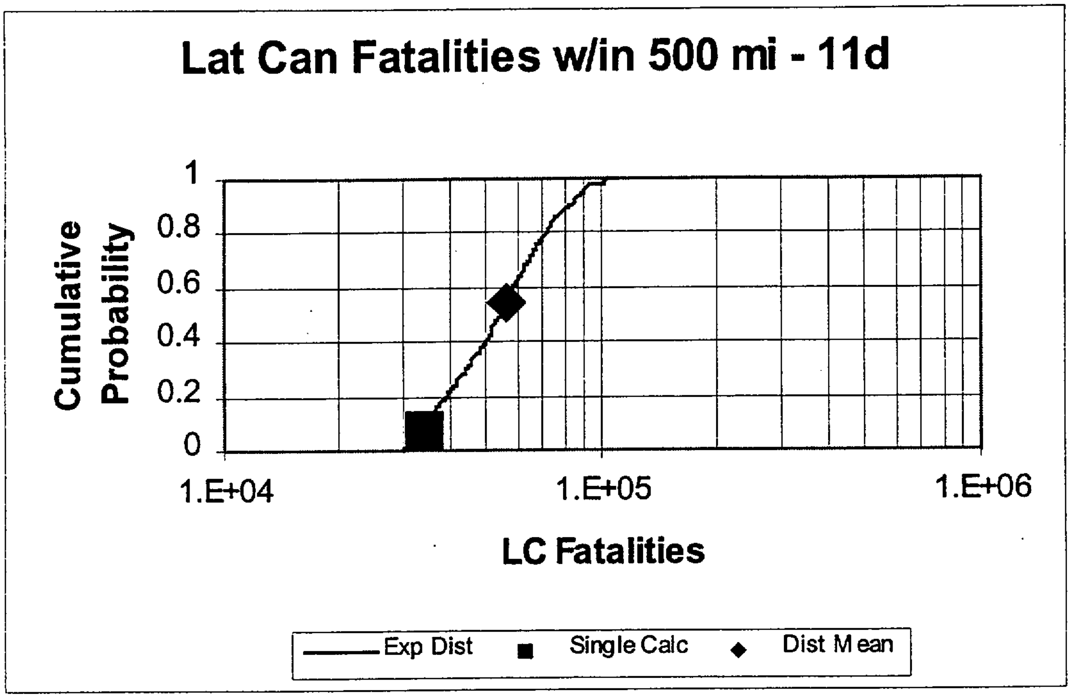


Figure 5-5. Latent cancer fatality results within 100 miles for case 11d.



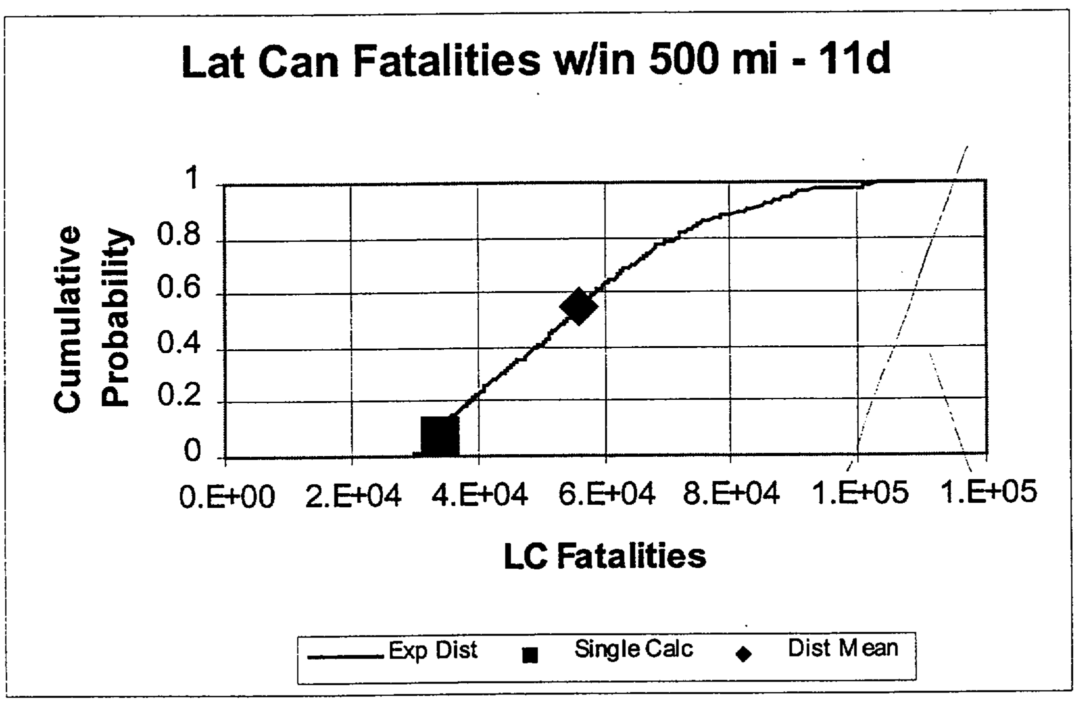
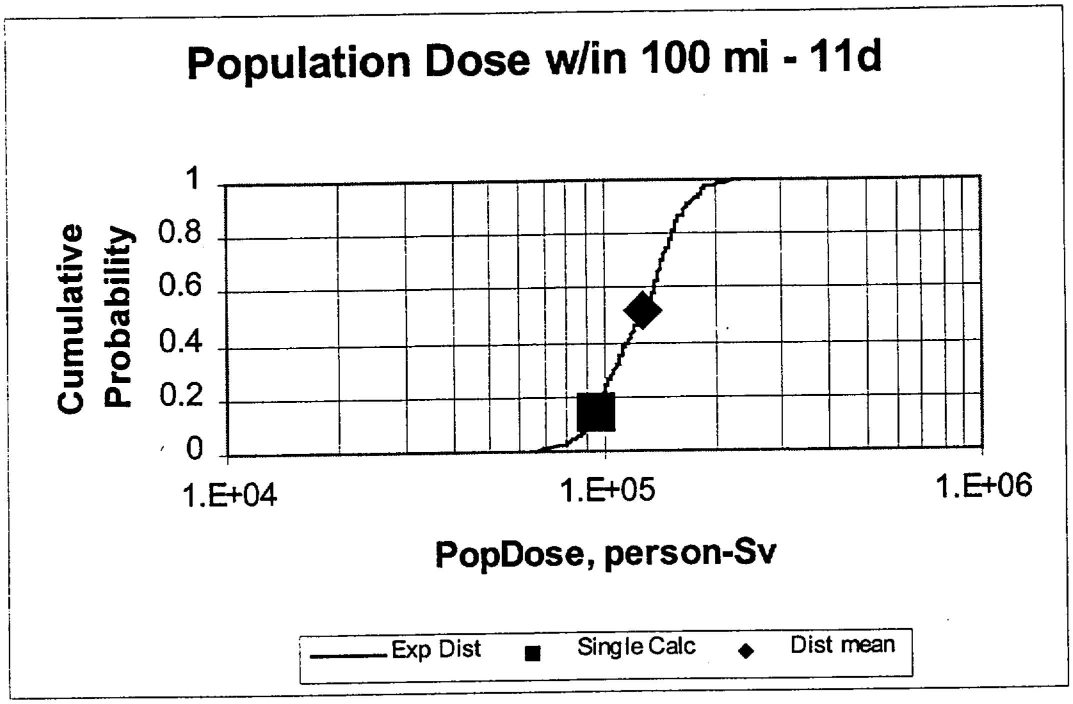


Figure 5-6. Latent cancer fatality results within 500 miles for case 11d.



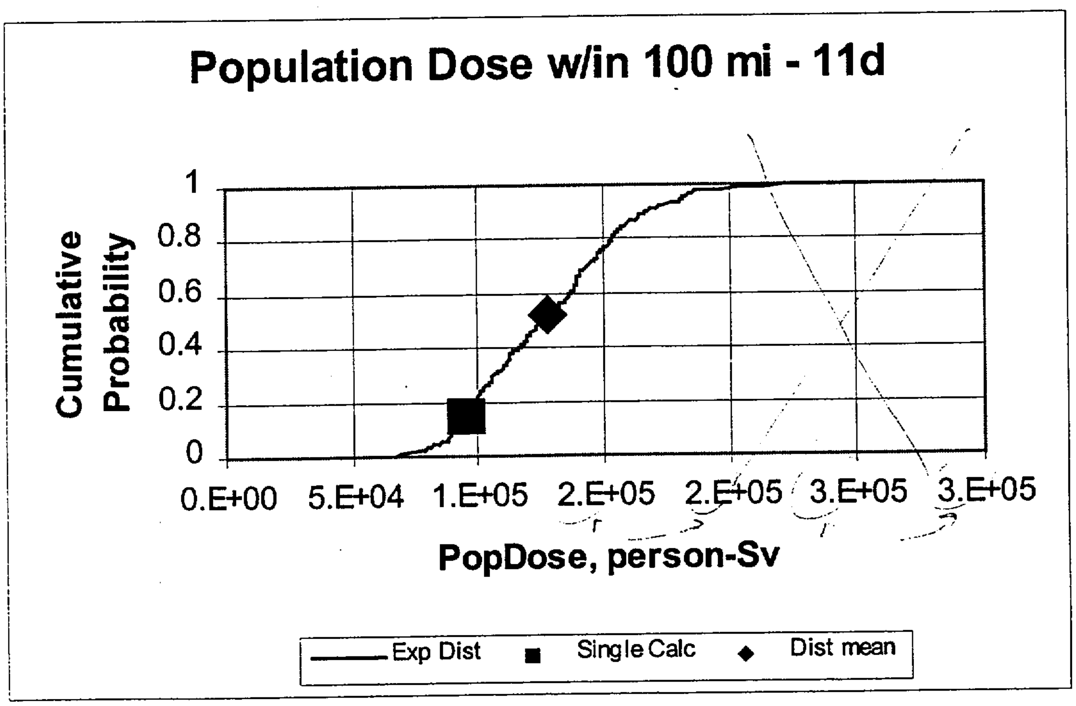
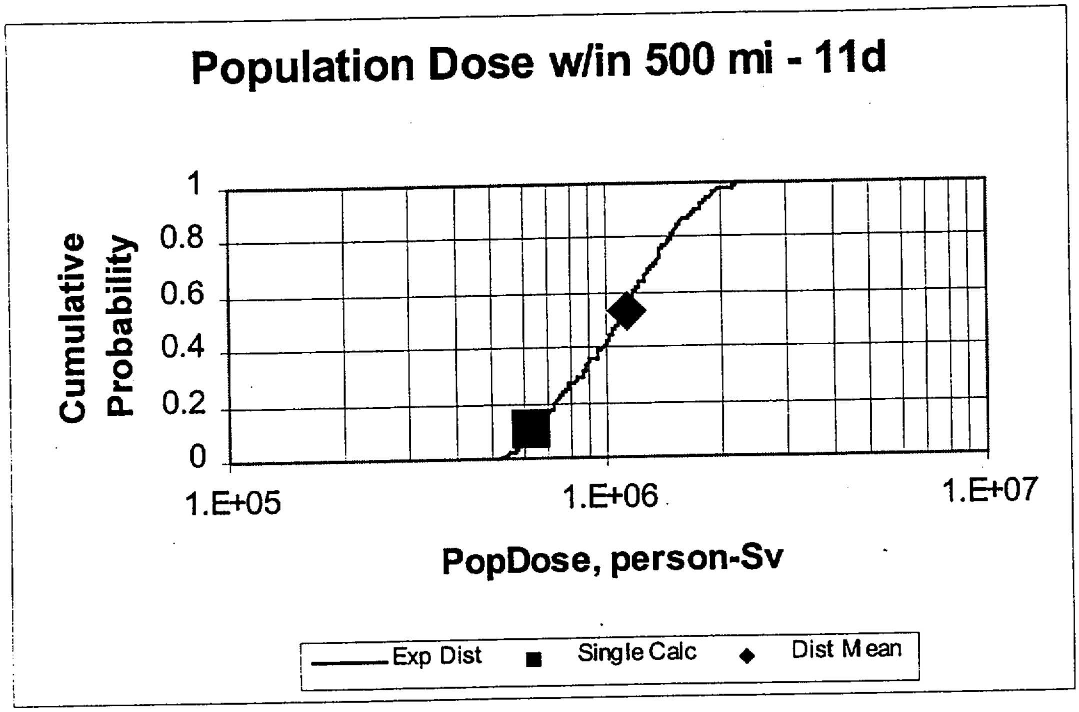


Figure 5-7. Population dose results within 100 miles for case 11d.



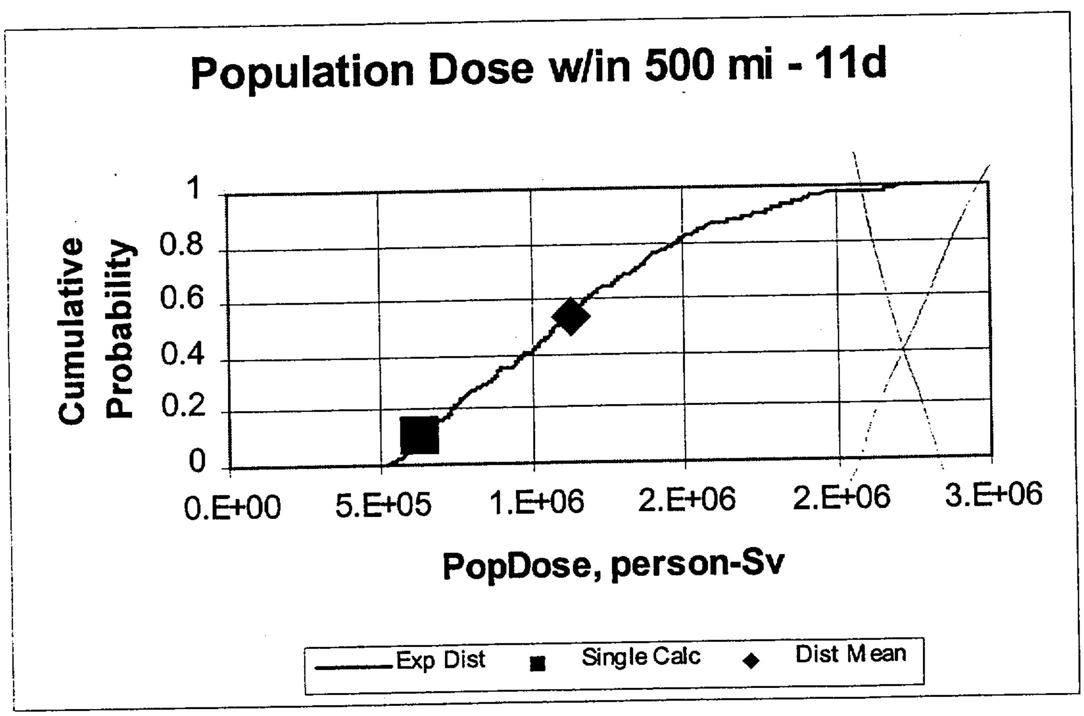
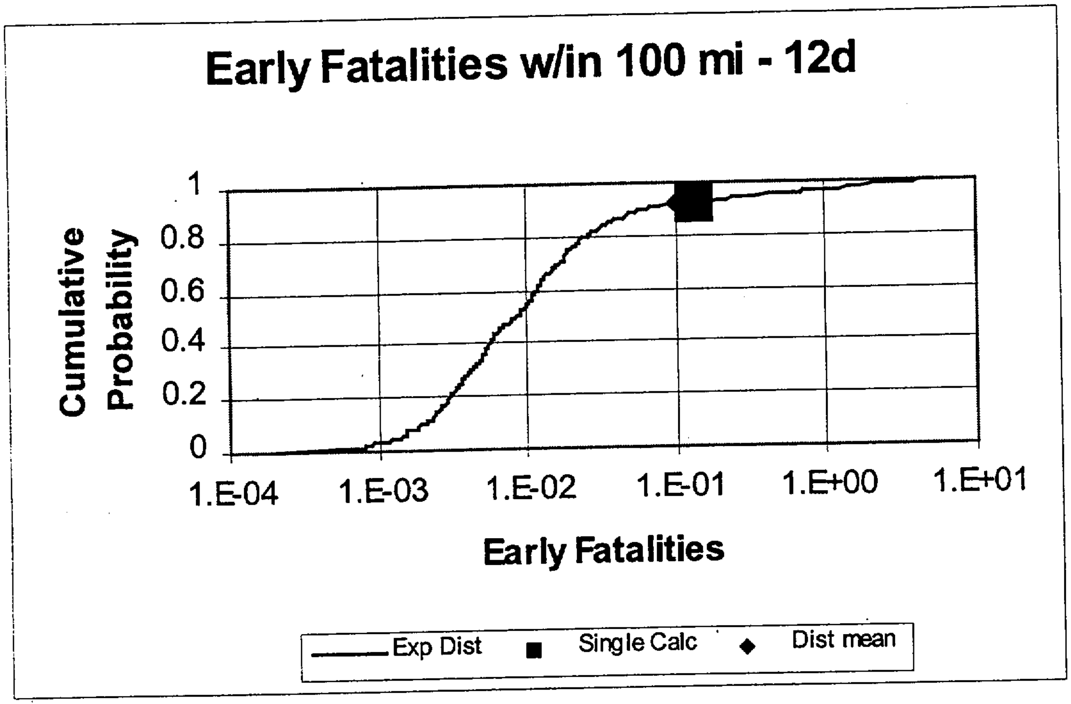


Figure 5-8. Population dose results within 500 miles for case 11d.



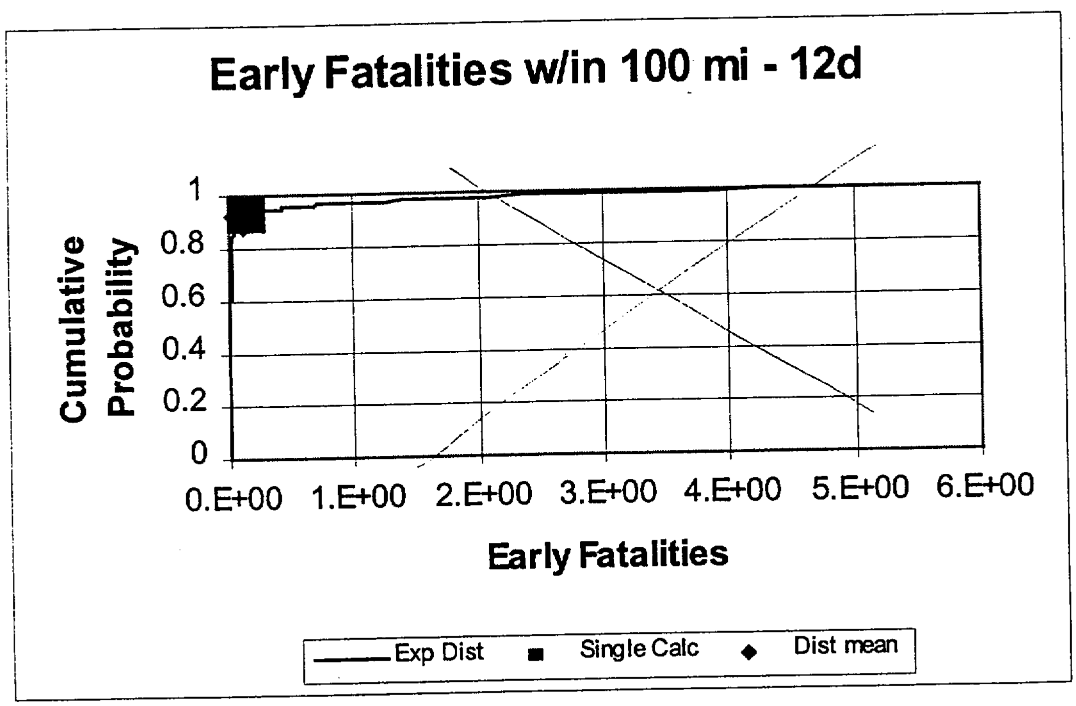
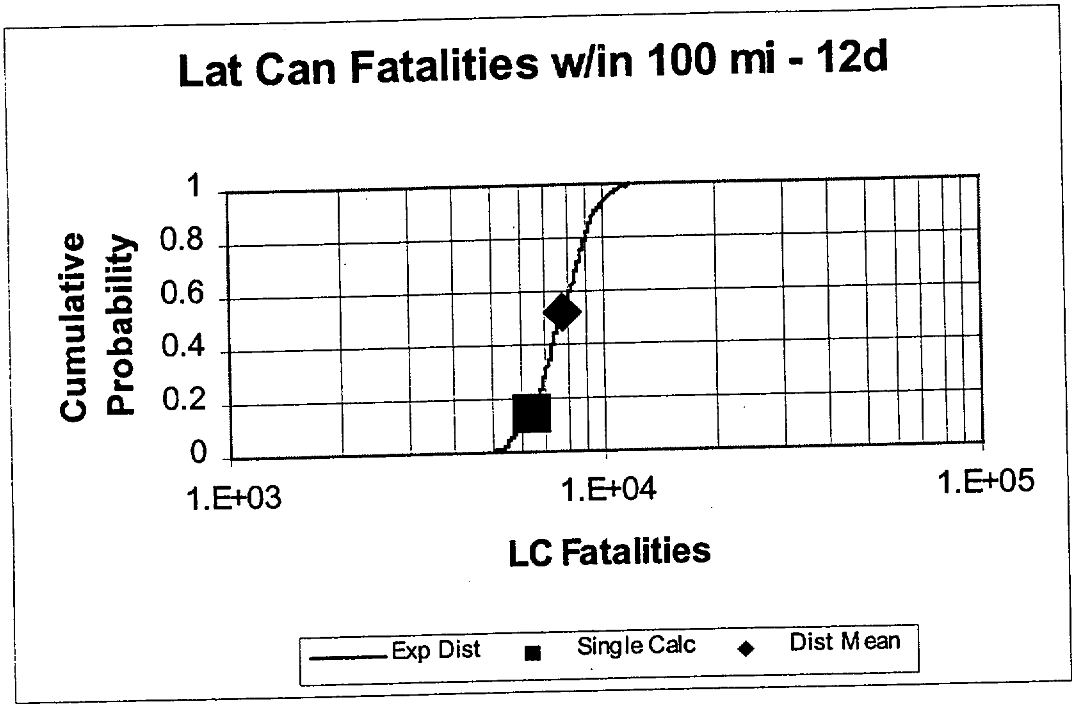


Figure 5-9. Early fatality results within 100 miles for case 12d.



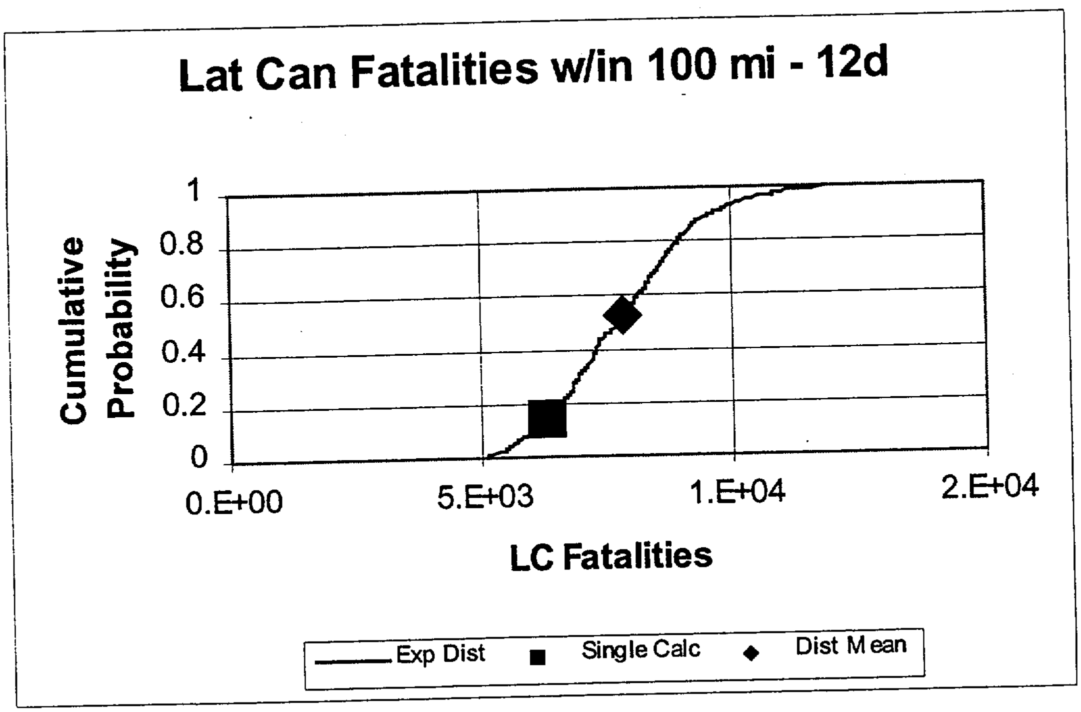
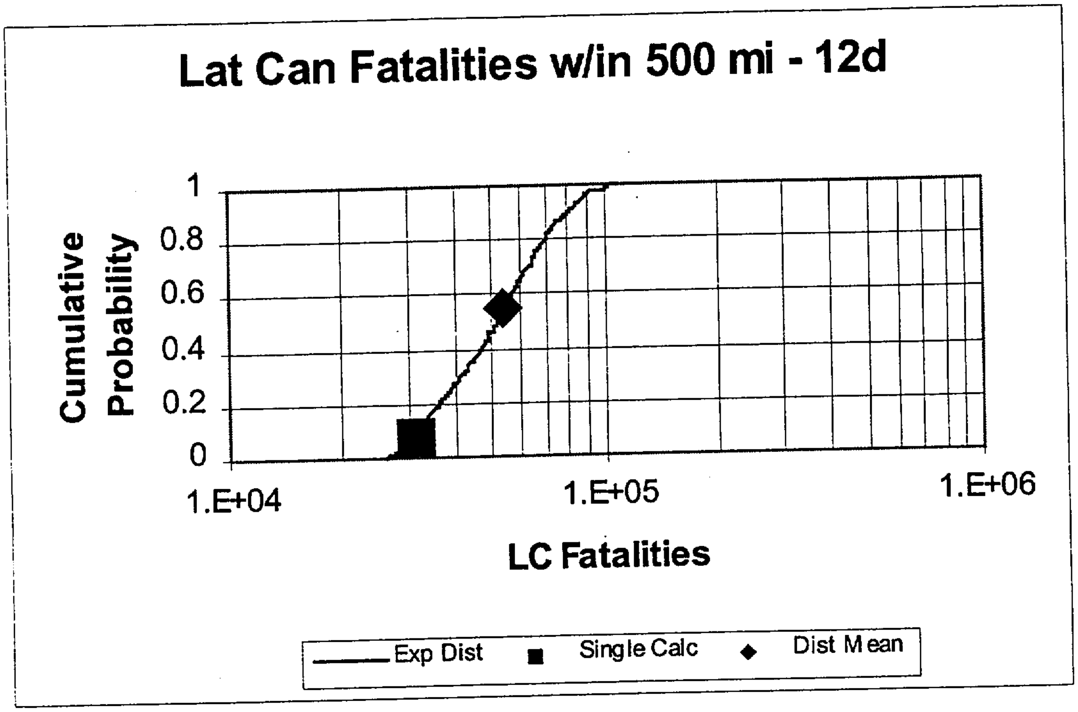


Figure 5-10. Latent Cancer Fatalities within 100 miles for case 12d.



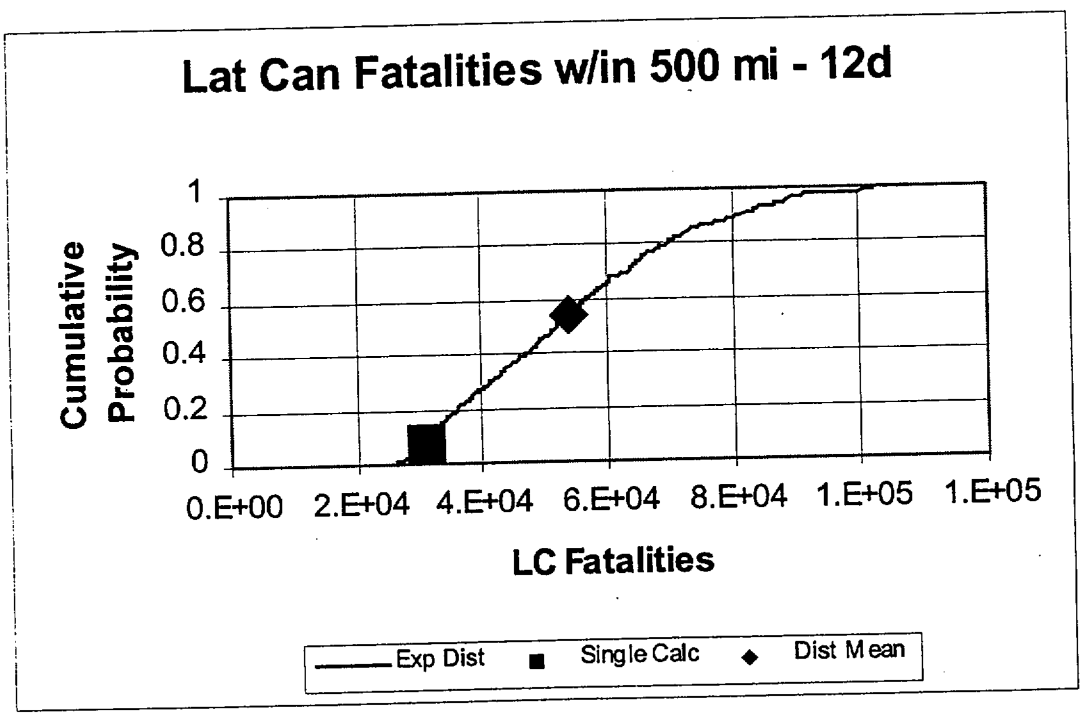
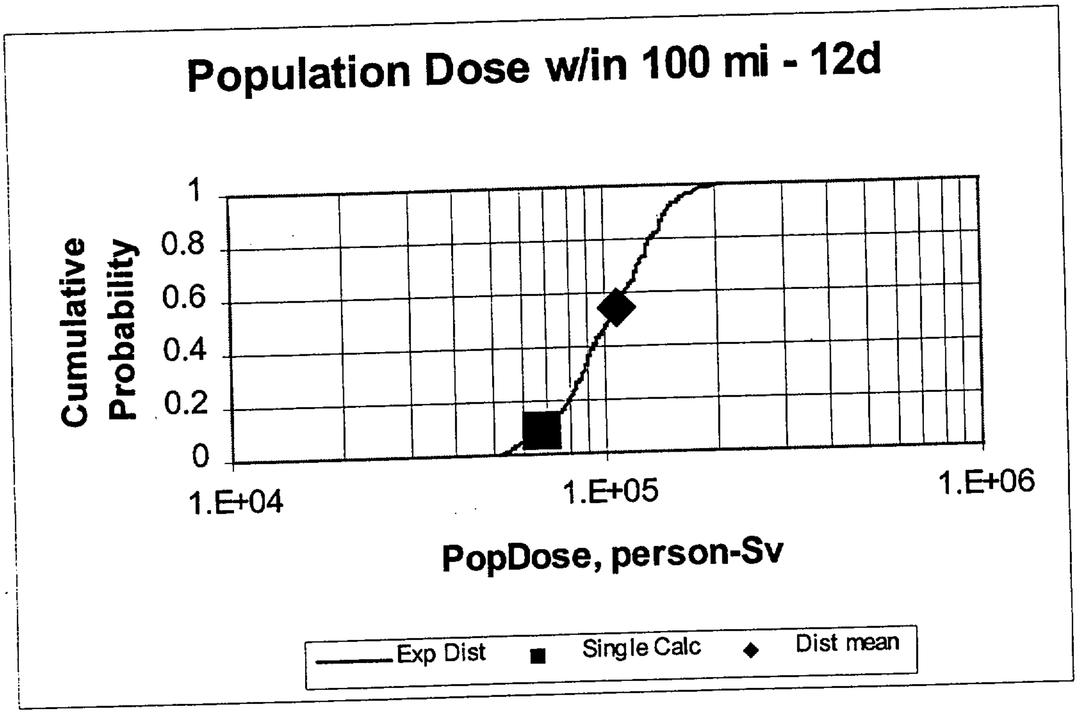


Figure 5-11. Latent cancer fatality results within 500 miles for case 12d.



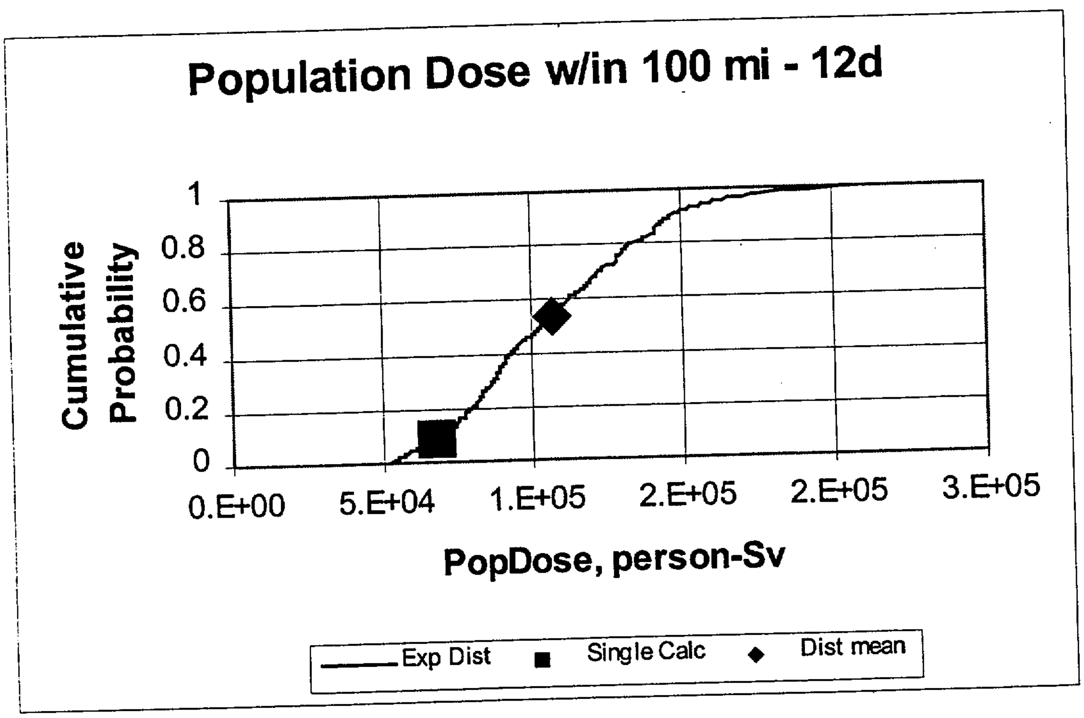
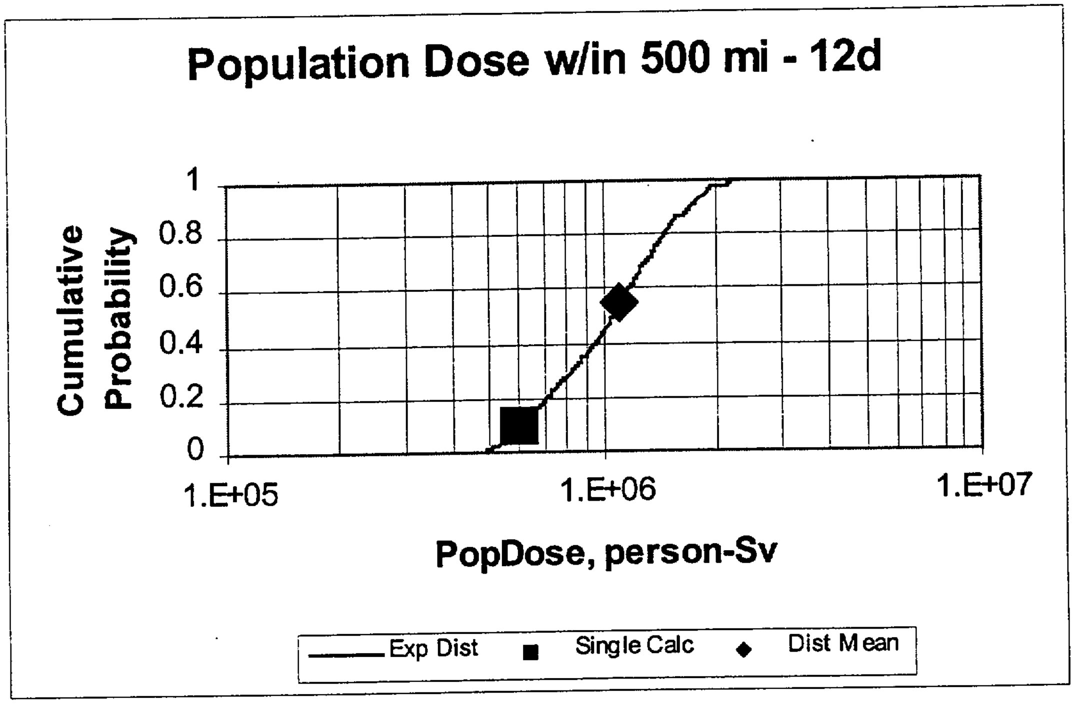


Figure 5-12. Population dose within 100 miles for case 12 d.



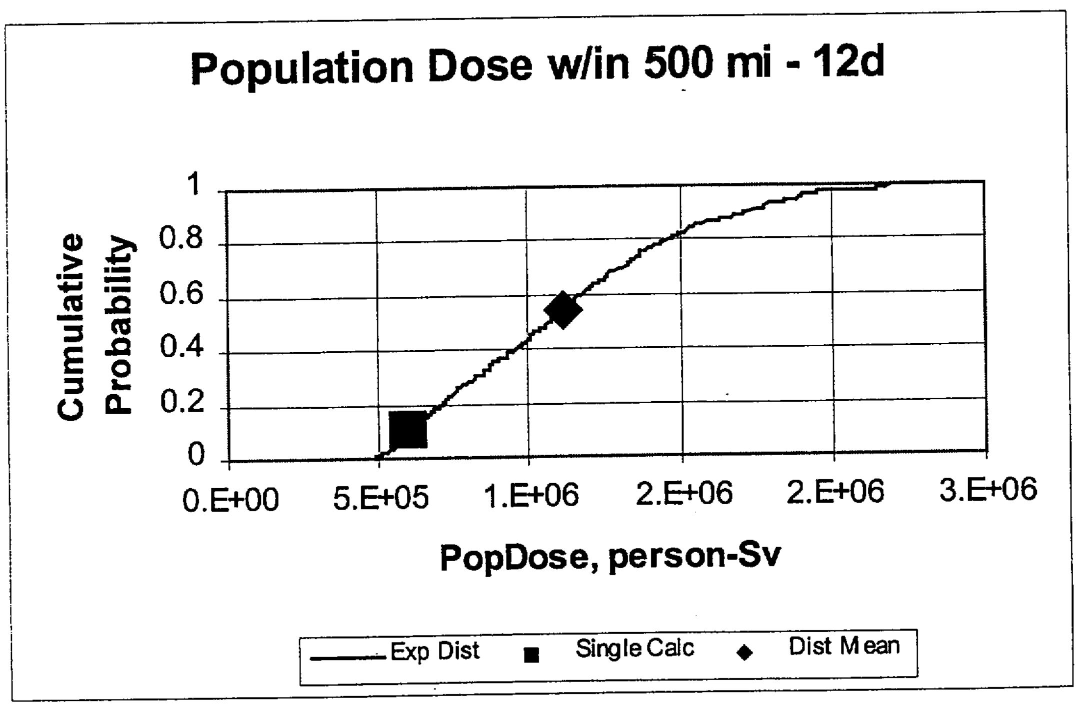


Figure 5-13. Population dose results within 500 miles for case 12d.

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Appendix A MACCS2 Input Files

Table A-1. ATMOS Input File for Case 11d

```
* GENERAL DESCRIPTIVE TITLE DESCRIBING THIS "ATMOS" INPUT
*
RIATNAM1001 'A11D.INP, Sample Problem A--Using Power-Law Sigmas, ATMOS input'
********************************************************************************
* GEOMETRY DATA BLOCK, LOADED BY INPGEO, STORED IN /GEOM/
*
* NUMBER OF RADIAL SPATIAL ELEMENTS
*
GENUMRAD001  26
*
*  SURRY
*
GESPAEND001      .16        .52       1.21       1.61       2.13
GESPAEND002     3.22       4.02       4.83       5.63       8.05
GESPAEND003    11.27      16.09      20.92      25.75      32.19
GESPAEND004    40.23      48.28      64.37      80.47     112.65
GESPAEND005   160.93     241.14     321.87     563.27     804.67
GESPAEND006  1609.34
********************************************************************************
* NUCLIDE DATA BLOCK, LOADED BY INPISO, STORED IN /ISOGRP/, /ISONAM/
*
* Number of pseudo-stable nuclides (used to truncate the decay chains)
*
ISNUMSTB001      27
*
* List of pseudo-stable nuclides
*
ISNAMSTB001     I-129    (daughter of Te-129 and Te-129m)
ISNAMSTB002     Xe-131m  (daughter of I-131)
ISNAMSTB003     Xe-133m  (daughter of I-133)
ISNAMSTB004     Xe-135m  (daughter of I-135)
ISNAMSTB005     Cs-135   (daughter of Xe-135 and Xe-135m)
ISNAMSTB006     Sm-147   (daughter of Pm-147)
ISNAMSTB007     U-234    (daughter of Pu-238)
ISNAMSTB008     U-235    (daughter of Pu-239)
ISNAMSTB009     U-236    (daughter of Pu-240)
ISNAMSTB010     U-237    (daughter of Pu-241)
ISNAMSTB011     Np-237   (daughter of Am-241)
ISNAMSTB012     Rb-87    (daughter of Kr-87)
ISNAMSTB013     Ba-137m  (daughter of Cs-137)
ISNAMSTB014     Rb-88    (daughter of Kr-88)
```

```
ISNAMSTB015     Y-91m    (daughter of Sr-91)
ISNAMSTB016     Zr-93    (daughter of Y-93)
ISNAMSTB017     Nb-93m   (daughter of Zr-93)
ISNAMSTB018     Nb-95m   (daughter of Zr-95)
ISNAMSTB019     Nb-97    (daughter of Zr-97 and Nb-97m)
ISNAMSTB020     Nb-97m   (daughter of Zr-97)
ISNAMSTB021     Tc-99    (daughter of Mo-99)
ISNAMSTB022     Rh-103m  (daughter of Ru-103)
ISNAMSTB023     Rh-106   (daughter of Ru-106)
ISNAMSTB024     Te-131   (daughter of Te-131m)
ISNAMSTB025     Pr-144   (daughter of Ce-144 and Pr-144m)
ISNAMSTB026     Pr-144m  (daughter of Ce-144)
ISNAMSTB027     Pm-147   (daughter of Nd-147)
*
* Number of radioactive nuclides to be considered
*
ISNUMISO001 60
*
* NUMBER OF NUCLIDE GROUPS
*
ISMAXGRP001  9
*
* WET AND DRY DEPOSITION FLAGS FOR EACH NUCLIDE GROUP
*
*               WETDEP     DRYDEP
*
ISDEPFLA001     .FALSE.    .FALSE.
ISDEPFLA002     .TRUE.     .TRUE.
ISDEPFLA003     .TRUE.     .TRUE.
ISDEPFLA004     .TRUE.     .TRUE.
ISDEPFLA005     .TRUE.     .TRUE.
ISDEPFLA006     .TRUE.     .TRUE.
ISDEPFLA007     .TRUE.     .TRUE.
ISDEPFLA008     .TRUE.     .TRUE.
ISDEPFLA009     .TRUE.     .TRUE.
*
* NUCLIDE GROUP DATA FOR 9 NUCLIDE GROUPS
*
*                NUCNAM    IGROUP
*
ISOTPGRP001      Co-58       6
ISOTPGRP002      Co-60       6
ISOTPGRP003      Kr-85       1
ISOTPGRP004      Kr-85m      1
```

ISOTPGRP005	Kr-87	1
ISOTPGRP006	Kr-88	1
ISOTPGRP007	Rb-86	3
ISOTPGRP008	Sr-89	5
ISOTPGRP009	Sr-90	5
ISOTPGRP010	Sr-91	5
ISOTPGRP011	Sr-92	5
ISOTPGRP012	Y-90	7
ISOTPGRP013	Y-91	7
ISOTPGRP014	Y-92	7
ISOTPGRP015	Y-93	7
ISOTPGRP016	Zr-95	7
ISOTPGRP017	Zr-97	7
ISOTPGRP018	Nb-95	7
ISOTPGRP019	Mo-99	6
ISOTPGRP020	Tc-99m	6
ISOTPGRP021	Ru-103	6
ISOTPGRP022	Ru-105	6
ISOTPGRP023	Ru-106	6
ISOTPGRP024	Rh-105	6
ISOTPGRP025	Sb-127	4
ISOTPGRP026	Sb-129	4
ISOTPGRP027	Te-127	4
ISOTPGRP028	Te-127m	4
ISOTPGRP029	Te-129	4
ISOTPGRP030	Te-129m	4
ISOTPGRP031	Te-131m	4
ISOTPGRP032	Te-132	4
ISOTPGRP033	I-131	2
ISOTPGRP034	I-132	2
ISOTPGRP035	I-133	2
ISOTPGRP036	I-134	2
ISOTPGRP037	I-135	2
ISOTPGRP038	Xe-133	1
ISOTPGRP039	Xe-135	1
ISOTPGRP040	Cs-134	3
ISOTPGRP041	Cs-136	3
ISOTPGRP042	Cs-137	3
ISOTPGRP043	Ba-139	9
ISOTPGRP044	Ba-140	9
ISOTPGRP045	La-140	7
ISOTPGRP046	La-141	7
ISOTPGRP047	La-142	7
ISOTPGRP048	Ce-141	8

```
ISOTPGRP049     Ce-143         8
ISOTPGRP050     Ce-144         8
ISOTPGRP051     Pr-143         7
ISOTPGRP052     Nd-147         7
ISOTPGRP053     Np-239         8
ISOTPGRP054     Pu-238         8
ISOTPGRP055     Pu-239         8
ISOTPGRP056     Pu-240         8
ISOTPGRP057     Pu-241         8
ISOTPGRP058     Am-241         7
ISOTPGRP059     Cm-242         7
ISOTPGRP060     Cm-244         7
************************************************************************
* WET DEPOSITION DATA BLOCK, LOADED BY INPWET, STORED IN /WETCON/
*
* WASHOUT COEFFICIENT NUMBER ONE, LINEAR FACTOR
*
WDCWASH1001  9.5E-5   (JON HELTON AFTER JONES, 1986)
*
* WASHOUT COEFFICIENT NUMBER TWO, EXPONENTIAL FACTOR
*
WDCWASH2001  0.8      (JON HELTON AFTER JONES, 1986)
************************************************************************
* DRY DEPOSITION DATA BLOCK, LOADED BY INPDRY, STORED IN /DRYCON/
*
* NUMBER OF PARTICLE SIZE GROUPS
*
DDNPSGRP001   1
*
* DEPOSITION VELOCITY OF EACH PARTICLE SIZE GROUP (M/S)
*
DDVDEPOS001   0.01   (VALUE SELECTED BY S. ACHARYA, NRC)
************************************************************************
* DISPERSION PARAMETER DATA BLOCK, LOADED BY INPDIS, STORED IN /DISPY/, /DISPZ/
*
* # of distances in plume-size tables--which can be used as an alternative to the power-law model:
* (to utilize the power-law model, set NUM_DIST to zero or delete the following data card)
*
NUM_DIST001   0
*
* Tadmor and Gur Parameterization for Distance Range 0.5 to 5.0 km
* as taken from Atmospheric Motion and Air Pollution (Dobbins 1979).
*
* P-G CLASS:        A          B          C          D          E          F
```

```
#DPCYSIGA001    6  'CYSIGA_AB'   'CYSIGA_AB'   'CYSIGA_C'   'CYSIGA_D'   'CYSIGA_EF'   'CYSIGA_EF'
#DPCYSIGB001    6  'CYSIGB_AB'   'CYSIGB_AB'   'CYSIGB_C'   'CYSIGB_D'   'CYSIGB_EF'   'CYSIGB_EF'
#DPCZSIGA001    6  'CZSIGA_AB'   'CZSIGA_AB'   'CZSIGA_C'   'CZSIGA_D'   'CZSIGA_EF'   'CZSIGA_EF'
#DPCZSIGB001    6  'CZSIGB_AB'   'CZSIGB_AB'   'CZSIGB_C'   'CZSIGB_D'   'CZSIGB_EF'   'CZSIGB_EF'
*
*  LINEAR SCALING FACTOR FOR SIGMA-Y FUNCTION, NORMALLY 1
*
DPYSCALE001    1.
*
*  LINEAR SCALING FACTOR FOR SIGMA-Z FUNCTION,
*  NORMALLY USED FOR SURFACE ROUGHNESS LENGTH CORRECTION
*  This was included in expert distributions (for rural/urban surface roughness)
*
DPZSCALE001    1.
************************************************************************** *
* EXPANSION FACTOR DATA BLOCK, LOADED BY INPEXP, STORED IN /EXPAND/
*
* TIME BASE FOR EXPANSION FACTOR (SECONDS)
*
PMTIMBAS001    1800.   (30 min - same as plume duration, therefore no meander)
*
* BREAK POINT FOR FORMULA CHANGE (SECONDS)
*
PMBRKPNT001   3600.   (1 HOUR)
*
* EXPONENTIAL EXPANSION FACTOR NUMBER 1
*
PMXPFAC1001      0.2
*
* EXPONENTIAL EXPANSION FACTOR NUMBER 2
*
PMXPFAC2001      0.25
****************************************************************************
* PLUME RISE DATA BLOCK, LOADED BY INPLRS, STORED IN /PLUMRS/
*
* SCALING FACTOR FOR THE CRITICAL WIND SPEED FOR ENTRAINMENT OF A BOUYANT PLUME
* (USED BY FUNCTION CAUGHT)
*
PRSCLCRW001   1.
*
* SCALING FACTOR FOR THE A-D STABILITY PLUME RISE FORMULA
* (USED BY FUNCTION PLMRIS)
*
PRSCLADP001   1.
```

```
*
* SCALING FACTOR FOR THE E-F STABILITY PLUME RISE FORMULA
* (USED BY FUNCTION PLMRIS)
*
PRSCLEFP001   1.
*************************************************************************************
* RELEASE DATA BLOCK, LOADED BY INPREL, STORED IN /ATNAM2/, /MULREL/
*
RDATNAM2001 'SECOND DRAFT 1150, WORST CASE SOURCE TERM FOR EARLY FATALITIES'
*
* TIME AFTER ACCIDENT INITIATION WHEN THE ACCIDENT REACHES GENERAL EMERGENCY
* CONDITIONS (AS DEFINED IN NUREG-0654), OR WHEN PLANT PERSONNEL CAN RELIABLY
* PREDICT THAT GENERAL EMERGENCY CONDITIONS WILL BE ATTAINED
*
RDOALARM001      1300.
*
* NUMBER OF PLUME SEGMENTS THAT ARE RELEASED
*
RDNUMREL001          1
*
* SELECTION OF RISK DOMINANT PLUME
*
RDMAXRIS001          1
*
* REFERENCE TIME FOR DISPERSION AND RADIOACTIVE DECAY
*
RDREFTIM001       0.00
*
* HEAT CONTENT OF THE RELEASE SEGMENTS (W)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPLHEAT001     3.7E+6
*
* HEIGHT OF THE PLUME SEGMENTS AT RELEASE (M)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPLHITE001         0.
*
* DURATION OF THE PLUME SEGMENTS (S)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPLUDUR001      1800.
*
* TIME OF RELEASE FOR EACH PLUME (S AFTER SCRAM)
```

```
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPDELAY001       3700.
*
* Initial value of sigma-y for each plume--Note: values required for each plume
*
SIGYINIT001  9.302  (initial sigma-y, calculated for 40 meter wide bldg.)
*
* Initial value of sigma-z for each plume--Note: values required for each plume
*
SIGZINIT001  23.26  (initial sigma-z, calculated for 50 meter high bldg.)
*
* Building height (meters)--Note: values required for each plume
*
WEBUILDH001   50.0  (Surry)
*
* PARTICLE SIZE DISTRIBUTION OF EACH NUCLIDE GROUP
* YOU MUST SPECIFY A COLUMN OF DATA FOR EACH OF THE PARTICLE SIZE GROUPS
*
RDPSDIST001      1.
RDPSDIST002      1.
RDPSDIST003      1.
RDPSDIST004      1.
RDPSDIST005      1.
RDPSDIST006      1.
RDPSDIST007      1.
RDPSDIST008      1.
RDPSDIST009      1.
*
* Millstone 1 spent fuel pool inventory
* - spent fuel pool contains 11 batches of spent fuel plus rest of last core
* - inventory reflects 30 days of radioactive decay since last batch
*   was put in pool
* - inventory is based on inventories in NUREG/CR-4982, July 1987
* - Millstone 1 has a power of 2011 MWt
*
*               NUCNAM        CORINV (Bq)
*
RDCORINV001     Co-58         9.170E+13
RDCORINV002     Co-60         1.340E+16
RDCORINV003     Kr-85         5.940E+16
RDCORINV004     Kr-85m        0.000E+00
RDCORINV005     Kr-87         0.000E+00
RDCORINV006     Kr-88         0.000E+00
```

RDCORINV007	Rb-86	2.980E+09
RDCORINV008	Sr-89	1.160E+16
RDCORINV009	Sr-90	5.980E+17
RDCORINV010	Sr-91	0.000E+00
RDCORINV011	Sr-92	0.000E+00
RDCORINV012	Y-90	6.020E+17
RDCORINV013	Y-91	2.960E+16
RDCORINV014	Y-92	0.000E+00
RDCORINV015	Y-93	0.000E+00
RDCORINV016	Zr-95	6.160E+16
RDCORINV017	Zr-97	0.000E+00
RDCORINV018	Nb-95	7.950E+16
RDCORINV019	Mo-99	0.000E+00
RDCORINV020	Tc-99m	0.000E+00
RDCORINV021	Ru-103	3.420E+15
RDCORINV022	Ru-105	0.000E+00
RDCORINV023	Ru-106	5.770E+17
RDCORINV024	Rh-105	0.000E+00
RDCORINV025	Sb-127	0.000E+00
RDCORINV026	Sb-129	0.000E+00
RDCORINV027	Te-127	2.390E+15
RDCORINV028	Te-127m	2.430E+15
RDCORINV029	Te-129	4.450E+13
RDCORINV030	Te-129m	4.430E+13
RDCORINV031	Te-131m	0.000E+00
RDCORINV032	Te-132	0.000E+00
RDCORINV033	I-131	2.130E+04
RDCORINV034	I-132	0.000E+00
RDCORINV035	I-133	0.000E+00
RDCORINV036	I-134	0.000E+00
RDCORINV037	I-135	0.000E+00
RDCORINV038	Xe-133	0.000E+00
RDCORINV039	Xe-135	0.000E+00
RDCORINV040	Cs-134	2.800E+17
RDCORINV041	Cs-136	3.400E+08
RDCORINV042	Cs-137	8.380E+17
RDCORINV043	Ba-139	0.000E+00
RDCORINV044	Ba-140	7.920E+09
RDCORINV045	La-140	8.060E+09
RDCORINV046	La-141	0.000E+00
RDCORINV047	La-142	0.000E+00
RDCORINV048	Ce-141	1.220E+15
RDCORINV049	Ce-143	0.000E+00
RDCORINV050	Ce-144	1.040E+18

```
RDCORINV051     Pr-143          2.210E+10
RDCORINV052     Nd-147          1.220E+08
RDCORINV053     Np-239          1.070E+14
RDCORINV054     Pu-238          1.780E+16
RDCORINV055     Pu-239          3.870E+15
RDCORINV056     Pu-240          5.400E+15
RDCORINV057     Pu-241          9.320E+17
RDCORINV058     Am-241          1.200E+16
RDCORINV059     Cm-242          1.770E+16
RDCORINV060     Cm-244          8.400E+15
*
*  SCALING FACTOR TO ADJUST THE CORE INVENTORY FOR POWER LEVEL
*
RDCORSCA001   1.711  *  convert from Millstone to Susquehanna
*                       by multiplying by ratio of powers
*                       (3441MWt/2011MWt)
*
*
RDAPLFRC001   PARENT      (apply rel fracs the same as prior versions)
*
* RELEASE FRACTIONS FOR ISOTOPE GROUPS IN RELEASE
*
*  ISOTOPE GROUPS:
*
*           XE/KR    I      CS      TE      SR      RU      LA      CE      BA
*
RDRELFRC001 1.0E+0 1.0E+0 1.0E+0 2.0E-2 2.0E-3 1.0E+0 1.0E-6 1.0E-6 2.0E-3
*********************************************************************************
* OUTPUT CONTROL DATA BLOCK, LOADED BY INPOPT, STORED IN /STOPME/, /ATMOPT/
*
* FLAG TO INDICATE THAT THIS IS THE LAST PROGRAM IN THE SERIES TO BE RUN
*
OCENDAT1001  .FALSE. (SET THIS VALUE TO .TRUE. TO SKIP EARLY AND CHRONC)
*
OCIDEBUG001  0
*
* NAME OF THE NUCLIDE TO BE LISTED ON THE DISPERSION LISTINGS
*
OCNUCOUT001  Cs-137
*
*              NUM0
TYPE0NUMBER      2
*
*              INDREL   INDRAD
```

```
TYPE0OUT001      1        9
TYPE0OUT002      1       10          XCCDF
*****************************************************************************
* METEOROLOGICAL SAMPLING DATA BLOCK
*
* METEOROLOGICAL SAMPLING OPTION CODE:
*
* METCOD = 1, USER SPECIFIED DAY AND HOUR IN THE YEAR (FROM MET FILE),
*          2, WEATHER CATEGORY BIN SAMPLING,
*          3, 120 HOURS OF WEATHER SPECIFIED ON THE ATMOS USER INPUT FILE,
*          4, CONSTANT MET (BOUNDARY WEATHER USED FROM THE START),
*          5, STRATIFIED RANDOM SAMPLES FOR EACH DAY OF THE YEAR.
*
M1METCOD001  2
*
* LAST SPATIAL INTERVAL FOR MEASURED WEATHER
*
M2LIMSPA001  25
*
* BOUNDARY WEATHER MIXING LAYER HEIGHT
*
M2BNDMXH001  1000.  (METERS)
*
* BOUNDARY WEATHER STABILITY CLASS INDEX
*
M2IBDSTB001  4      (D-STABILITY)
*
* BOUNDARY WEATHER RAIN RATE
*
M2BNDRAN001  5.     (MM/HR)
*
* BOUNDARY WEATHER WIND SPEED
*
M2BNDWND001  5.     (M/S)
*
* NUMBER OF RAIN DISTANCE INTERVALS FOR BINNING
*
M4NRNINT001  5
*
* ENDPOINTS OF THE RAIN DISTANCE INTERVALS (KILOMETERS)
*
* NOTE: THESE MUST BE CHOSEN TO MATCH THE SPATIAL ENDPOINT DISTANCES
*       SPECIFIED FOR THE ARRAY SPAEND (10 % ERROR IS ALLOWED).
*
```

```
M4RNDSTS001  3.22  5.63  11.27  20.92  32.19
*
* NUMBER OF RAIN INTENSITIY BREAKPOINTS
*
M4NRINTN001   3
*
* RAIN INTENSITY BREAKPOINTS FOR WEATHER BINNING (MILLIMETERS PER HOUR)
*
M4RNRATE001   2.  4.  6.
*
* NUMBER OF SAMPLES PER BIN
*
M4NSMPLS001  4  (THIS NUMBER SHOULD BE SET TO 4 FOR RISK ASSESSMENT)
*
* INITIAL SEED FOR RANDOM NUMBER GENERATOR
*
M4IRSEED001   79
.
*
*
*****************************************************************
* 4/14/99: J. Schaperow commented out source term number 2 of 2.*
*****************************************************************
*
*
********************** RELEASE DATA BLOCK *************
* SOURCE TERM NUMBER 2 OF 2
*
*RDATNAM2001 'RELEASE FRACTIONS OF SOURCE TERM 1 REDUCED BY A FACTOR OF TEN'
*
*             XE/KR    I      CS      TE      SR      RU      LA      CE      BA
*
*RDRELFRC001 1.0E-1 6.8E-2 6.4E-2 1.7E-2 4.2E-4 2.3E-4 1.6E-5 4.0E-5 6.3E-4
*RDRELFRC002 4.3E-4 9.5E-4 2.4E-4 1.4E-2 6.8E-3 4.7E-5 6.8E-4 7.1E-4 5.4E-3
*.
```

Table A-2. EARLY Input File for Case 11d

```
* GENERAL DESCRIPTIVE TITLE DESCRIBING THIS "EARLY" INPUT FILE
*
MIEANAM1001 'IN2A.INP, Sample Problem A of NUREG/CR-4691, Vol. 1, EARLY input'
DCF_FILE001 'DOSDATA.INP'  (DCF file of MACCS 1.5.11.1)
*
*              ORGNAM          ORGFLG
*
MIORGDEF001  'A-SKIN'          .TRUE.
MIORGDEF002  'A-RED MARR'      .TRUE.
MIORGDEF003  'A-LUNGS'         .TRUE.
MIORGDEF004  'A-THYROIDH'      .TRUE.
MIORGDEF005  'A-STOMACH'       .TRUE.
MIORGDEF006  'A-LOWER LI'      .FALSE.  (does not contribute to early fatalities)
MIORGDEF007  'L-EDEWBODY'      .TRUE.
MIORGDEF008  'L-RED MARR'      .TRUE.
MIORGDEF009  'L-BONE SUR'      .TRUE.
MIORGDEF010  'L-BREAST'        .TRUE.
MIORGDEF011  'L-LUNGS'         .TRUE.
MIORGDEF012  'L-THYROID'       .TRUE.
MIORGDEF013  'L-LOWER LI'      .TRUE.
MIORGDEF014  'L-BLAD WAL'      .TRUE.
MIORGDEF015  'L-LIVER'         .FALSE.
MIORGDEF016  'L-THYROIDH'      .TRUE.
*
* FLAG TO INDICATE THAT THIS IS THE LAST PROGRAM IN THE SERIES TO BE RUN
*
MIENDAT2001  .FALSE.    (SET THIS VALUE TO .TRUE. TO SKIP CHRONC)
*
* DISPERSION MODEL OPTION CODE:  1  *  STRAIGHT LINE
*                                2  *  WIND-SHIFT WITH ROTATION
*                                3  *  WIND-SHIFT WITHOUT ROTATION
*
MIIPLUME001  2
*
* NUMBER OF FINE GRID SUBDIVISIONS USED BY THE MODEL
*
MINUMFIN001  7    (3, 5 OR 7 ALLOWED)
*
* LEVEL OF DEBUG OUTPUT REQUIRED, NORMAL RUNS SHOULD SPECIFY ZERO
*
MIIPRINT001  0
```

```
*
* LOGICAL FLAG SIGNIFYING THAT THE BREAKDOWN OF RISK BY WEATHER CATEGORY
* BIN ARE TO BE PRESENTED TO SHOW THEIR RELATIVE CONTRIBUTION TO THE MEAN
*
*             RISBIN
*
MIRISCAT001   .FALSE.
*
* FLAG INDICATING IF WIND-ROSES FROM ATMOS ARE TO BE OVERRIDDEN
*
MIOVRRID001  .FALSE.  (USE THE WIND ROSE CALCULATED FOR EACH WEATHER BIN)
*******************************************************************************
* POPULATION DISTRIBUTION DATA BLOCK, LOADED BY INPOPU, STORED IN /POPDAT/
*
PDPOPFLG001  FILE
*
*PDPOPFLG001  UNIFORM
*PDIBEGIN001  1   (SPATIAL INTERVAL AT WHICH POPULATION BEGINS)
*PDPOPDEN001  50. (POPULATION DENSITY (PEOPLE PER SQUARE KILOMETER))
*******************************************************************************
* SHIELDING AND EXPOSURE FACTORS, LOADED BY INDFAC, STORED IN /EADFAC/
*
* THREE VALUES OF EACH PROTECTION FACTOR ARE SUPPLIED,
* ONE FOR EACH TYPE OF ACTIVTY:
*
* ACTIVITY TYPE:
*     1 - EVACUEES WHILE MOVING
*     2 - NORMAL ACTIVITY IN SHELTERING AND EVACUATION ZONE
*     3 - SHELTERED ACTIVITY
*
* CLOUD SHIELDING FACTOR
*
*    SITE        GG   PB   SEQ  SUR  ZION
*    SHELTERING  0.7  0.5  0.65 0.6  0.5
*
*            EVACUEES  NORMAL  SHELTER
*
SECSFACT001      1.      0.75     0.6    *  SURRY SHELTERING VALUE
*
* PROTECTION FACTOR FOR INHALATION
*
SEPROTIN001      1.      0.41      0.33  * VALUES FOR NORMAL ACTIVITY AND
*                                          SHELTERING SELECTED BY NRC STAFF
*
```

```
* BREATHING RATE (CUBIC METERS PER SECOND)
*
SEBRRATE001  2.66E-4  2.66E-4  2.66E-4
*
* SKIN PROTECTION FACTOR
*
SESKPFAC001  1.0      0.41     0.33    * VALUES FOR NORMAL ACTIVITY AND
*                                        SHELTERING SELECTED BY NRC STAFF
*
* GROUND SHIELDING FACTOR
*
*    SITE         GG   PB   SEQ  SUR  ZION
*    SHELTERING  0.25 0.1  0.2  0.2  0.1
*
SEGSHFAC001      0.5    0.33    0.2    * VALUE FOR NORMAL ACTIVITY SELECTED BY
*                                        NRC STAFF
*
* RESUSPENSION INHALATION MODEL CONCENTRATION COEFFICIENT (/METER)
*
*    RESCON = 1.E-4 IS APPROPRIATE FOR MECHANICAL RESUSPENSION BY VEHICLES.
*    RESHAF = 2.11 DAYS CAUSES 1.E-4 TO DECAY IN ONE WEEK TO 1.E-5, THE VALUE
*    OF RESCON USED IN THE FIRST TERM OF THE LONG-TERM RESUSPENSION EQUATION
*    USED IN CHRONC.
*
SERESCON001   1.E-4     (RESUSPENSION IS TURNED ON)
*
* RESUSPENSION CONCENTRATION COEFFICIENT HALF-LIFE (SEC)
*
SERESHAF001   1.82E5    (2.11 DAYS)
********************************************************************************
* EVACUATION ZONE DATA BLOCK, LOADED BY EVNETW, STORED IN /NETWOR/, /EOPTIO/
*
* SPECIFIC DESCRIPTION OF THE EMERGENCY RESPONSE SCENARIO BEING USED
*
EZEANAM2001  'EVACUATION WITHIN 10 MILES, RELOCATION MODELS APPLY ELSEWHERE'
*
* THE TYPE OF WEIGHTING TO BE APPLIED TO THE EMERGENCY RESPONSE SCENARIOS
* YOU MUST SUPPLY A VALUE OF 'TIME' OR 'PEOPLE'
*
EZWTNAME001  'PEOPLE'
*
* WEIGHTING FRACTION APPLICABLE TO THIS SCENARIO
*
EZWTFRAC001  0.995
```

```
*
* LAST RING IN THE MOVEMENT ZONE
*
EZLASMOV001     15    (EVACUEES DISAPPEAR AFTER TRAVELING TO 20 MILES)
*
*  Flag defining the time at which evacuees "enter" the destination element
*
*TRAVELPOINT   'CENTERPOINT' (new option implemented at MACCS2 v. 1.11f)
TRAVELPOINT   'BOUNDARY'    (functionality derived from MACCS circa 1984)
*
* RADIAL EVACUATION SPEED (M/S)
*
EZESPEED001    1.8   1.8    1.8          (SURRY)
EZEVATYP001     'RADIAL'
EZDURBEG001    86400.0
EZDURMID001    0.0
EZREFPNT001     'ALARM'
EZNUMEVA001      12
EZDLTSHL001   7200.  7200.  7200.  7200.  7200.  7200.
EZDLTSHL002   7200.  7200.  7200.  7200.  7200.  7200.
EZDLTEVA001      0.     0.     0.     0.     0.     0.
EZDLTEVA002      0.     0.     0.     0.     0.     0.
************************************************************************
* SHELTER AND RELOCATION ZONE DATA BLOCK, LOADED BY INPEMR,
*                                         STORED IN /INPSRZ/, /RELOCA/
*
* DURATION OF THE EMERGENCY PHASE (SECONDS FROM PLUME ARRIVAL)
*
SRENDEMP001  604800.   (ONE WEEK)
*
* CRITICAL ORGAN FOR RELOCATION DECISIONS
*
SRCRIORG001 'L-EDEWBODY'
*
* HOT SPOT RELOCATION TIME (SECONDS FROM PLUME ARRIVAL)
*
SRTIMHOT001  43200.    (ONE-HALF DAY)
*
* NORMAL RELOCATION TIME (SECONDS FROM PLUME ARRIVAL)
*
SRTIMNRM001  86400.    (ONE DAY)
*
* HOT SPOT RELOCATION DOSE CRITERION THRESHOLD (SIEVERTS)
*
```

```
SRDOSHOT001  0.5    (50 REM DOSE TO WHOLE BODY IN 1 WEEK TRIGGERS RELOCATION)
*
* NORMAL RELOCATION DOSE CRITERION THRESHOLD (SIEVERTS)
*
SRDOSNRM001  0.25   (25 REM DOSE TO WHOLE BODY IN 1 WEEK TRIGGERS RELOCATION)
*********************************************************************************
* EARLY FATALITY MODEL PARAMETERS, LOADED BY INEFAT, STORED IN /EFATAL/
*
* NUMBER OF EARLY FATALITY EFFECTS
*
EFNUMEFA001   2
*
*            ORGNAM        EFFACA   EFFACB   EFFTHR
*
EFATAGRP001 'A-RED MARR'      3.8      5.0      1.5
EFATAGRP002 'A-LUNGS'        10.0      7.0      5.0
*********************************************************************************
* EARLY INJURY MODEL PARAMETERS, LOADED BY INEINJ, STORED IN /EINJUR/
*
* NUMBER OF EARLY INJURY EFFECTS
*
EINUMEIN001  7
*
*            EINAME            ORGNAM   EISUSC EITHRE EIFACA EIFACB
*
EINJUGRP001 'PRODROMAL VOMIT' 'A-STOMACH' 1.     .5     2.     3.
EINJUGRP002 'DIARRHEA'        'A-STOMACH' 1.     1.     3.     2.5
EINJUGRP003 'PNEUMONITIS'     'A-LUNGS'   1.     5.    10.     7.
EINJUGRP004 'SKIN ERYTHEMA'   'A-SKIN'    1.     3.     6.     5.
EINJUGRP005 'TRANSEPIDERMAL'  'A-SKIN'    1.    10.    20.     5.
EINJUGRP006 'THYROIDITIS'     'A-THYROIDH' 1.   40.   240.     2.
EINJUGRP007 'HYPOTHYROIDISM'  'A-THYROIDH' 1.    2.    60.     1.3
*********************************************************************************
* ACUTE EXPOSURE CANCER PARAMETERS, LOADED BY INACAN STORED IN /ACANCR/.
*
* NUMBER OF ACUTE EXPOSURE CANCER EFFECTS
*
LCNUMACA001   7
*
* THRESHOLD DOSE FOR APPLYING THE DOSE DEPENDENT REDUCTION FACTOR
*
LCDDTHRE001   0.2  (LOWEST DOSE FOR WHICH DDREFA WILL BE APPLIED)
*
* DOSE THRESHOLD FOR LINEAR DOSE RESPONSE (Sv)
```

```
*
LCACTHRE001   0.0  (LINEAR-QUADRATIC MODEL IS NOT BEING USED)
*
*           ACNAME     ORGNAM   ACSUSC DOSEFA DOSEFB CFRISK   CIRISK  DDREFA
*
LCANCERS001 'LEUKEMIA' 'L-RED MARR'  1.0    1.0    0.0    9.70E-3   0.0     2.0
LCANCERS002 'BONE'     'L-BONE SUR'  1.0    1.0    0.0    9.00E-4   0.0     2.0
LCANCERS003 'BREAST'   'L-BREAST'    1.0    1.0    0.0    5.40E-3   1.7E-2  1.0
LCANCERS004 'LUNG'     'L-LUNGS'     1.0    1.0    0.0    1.55E-2   0.0     2.0
LCANCERS005 'THYROID'  'L-THYROIDH'  1.0    1.0    0.0    7.20E-4   7.2E-3  1.0
LCANCERS006 'GI'       'L-LOWER LI'  1.0    1.0    0.0    3.36E-2   0.0     2.0
LCANCERS007 'OTHER'    'L-EDEWBODY'  1.0    1.0    0.0    2.76E-2   0.0     2.0
*****************************************************************************
* RESULT 1 OPTIONS BLOCK, LOADED BY INOUT1, STORED IN /INOUT1/
* TOTAL NUMBER OF A GIVEN EFFECT (LATENT CANCER, EARLY DEATH, EARLY INJURY)
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE1NUMBER    32
*
TYPE1OUT001    'ERL FAT/TOTAL'                1  26   NOCCDF (0 TO 1000 MILES)
TYPE1OUT002    'ERL INJ/PRODROMAL VOMIT'      1  26   NOCCDF
TYPE1OUT003    'ERL INJ/DIARRHEA'             1  26
TYPE1OUT004    'ERL INJ/PNEUMONITIS'          1  26
TYPE1OUT005    'ERL INJ/THYROIDITIS'          1  26
TYPE1OUT006    'ERL INJ/HYPOTHYROIDISM'       1  26
TYPE1OUT007    'ERL INJ/SKIN ERYTHEMA'        1  26
TYPE1OUT008    'ERL INJ/TRANSEPIDERMAL'       1  26
TYPE1OUT009    'CAN FAT/TOTAL'                1  26   NOCCDF
TYPE1OUT010    'CAN FAT/LUNG'                 1  26
TYPE1OUT011    'CAN FAT/THYROID'              1  26
TYPE1OUT012    'CAN FAT/BREAST'               1  26
TYPE1OUT013    'CAN FAT/GI'                   1  26
TYPE1OUT014    'CAN FAT/LEUKEMIA'             1  26
TYPE1OUT015    'CAN FAT/BONE'                 1  26
TYPE1OUT016    'CAN FAT/OTHER'                1  26
TYPE1OUT017    'CAN INJ/THYROID'              1  26
TYPE1OUT018    'CAN INJ/BREAST'               1  26
TYPE1OUT019    'CAN FAT/TOTAL'                1  19  CCDF  (0 TO 50 MILES)
TYPE1OUT020    'ERL FAT/TOTAL'                1  12        (0 TO 10 MILES)
TYPE1OUT021    'ERL INJ/PRODROMAL VOMIT'      1  12
TYPE1OUT022    'ERL INJ/DIARRHEA'             1  12
TYPE1OUT023    'ERL INJ/PNEUMONITIS'          1  12
TYPE1OUT024    'ERL INJ/THYROIDITIS'          1  12
```

```
TYPE1OUT025    'ERL INJ/HYPOTHYROIDISM'       1  12
TYPE1OUT026    'ERL INJ/SKIN ERYTHEMA'        1  12
TYPE1OUT027    'ERL INJ/TRANSEPIDERMAL'       1  12
TYPE1OUT028    'CAN FAT/TOTAL'                1  12
TYPE1OUT029    'ERL FAT/TOTAL'                1  21      (0 TO 100 MILES)
TYPE1OUT030    'ERL FAT/TOTAL'                1  25      (0 TO 500 MILES)
TYPE1OUT031    'CAN FAT/TOTAL'                1  21      (0 TO 100 MILES)
TYPE1OUT032    'CAN FAT/TOTAL'                1  25      (0 TO 500 MILES)
********************************************************************************
* RESULT 2 OPTIONS BLOCK, LOADED BY INOUT2, STORED IN /INOUT2/
* FURTHEST DISTANCE AT WHICH A GIVEN RISK OF EARLY DEATH IS EXCEEDED.
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE2NUMBER  1
*
*            FATALITY RISK THRESHOLD
*
TYPE2OUT001  0.
********************************************************************************
* RESULT 3 OPTIONS BLOCK, LOADED BY INOUT3, STORED IN /INOUT3/
* NUMBER OF PEOPLE WHOSE DOSE TO A GIVEN ORGAN EXCEEDS A GIVEN THRESHOLD.
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE3NUMBER  3
*
*               ORGAN NAME   DOSE THRESHOLD (Sv)
*
TYPE3OUT001    'A-RED MARR'        1.5
TYPE3OUT002    'A-LUNGS'           5.0
TYPE3OUT003    'L-EDEWBODY'        0.05
********************************************************************************
* RESULT 4 OPTIONS BLOCK, LOADED BY INOUT4, STORED IN /INOUT4/
* 360 DEGREE AVERAGE RISK OF A GIVEN EFFECT AT A GIVEN DISTANCE.
*
* POSSIBLE TYPES OF EFFECTS ARE:
*
*   'ERL FAT/TOTAL'
*   'ERL INJ/INJURY NAME'
*   'CAN FAT/CANCER NAME'
*   'CAN FAT/TOTAL'
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
```

```
*
TYPE4NUMBER  5
*
*            RADIAL INDEX   TYPE OF EFFECT
*
TYPE4OUT001       1         'ERL FAT/TOTAL'
TYPE4OUT002       2         'ERL FAT/TOTAL'
TYPE4OUT003       3         'ERL FAT/TOTAL'
TYPE4OUT004       4         'ERL FAT/TOTAL'
TYPE4OUT005       5         'ERL FAT/TOTAL'
********************************************************************************
* RESULT 5 OPTIONS BLOCK, LOADED BY INOUT5, STORED IN /INOUT5/
*
* TOTAL POPULATION DOSE TO A GIVEN ORGAN BETWEEN TWO DISTANCES.
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE5NUMBER     5
*
*             ORGAN        I1DIS5     I2DIS5
*
TYPE5OUT001 'L-EDEWBODY'      1          12          (0-10 MILES)
TYPE5OUT002 'L-EDEWBODY'      1          19    NOCCDF  (0-50 MILES)
TYPE5OUT003 'L-EDEWBODY'      1          26    NOCCDF  (0-1000 MILES)
TYPE5OUT004 'L-EDEWBODY'      1          21          (0-100 MILES)
TYPE5OUT005 'L-EDEWBODY'      1          25          (0-500 MILES)
********************************************************************************
* RESULT 6 OPTIONS BLOCK, LOADED BY INOUT6, STORED IN /INOUT6/
*
* CENTERLINE DOSE TO AN ORGAN VS DIST BY PATHWAY, PATHWAY NAMES ARE AS FOLLOWS:
*
*  PATHWAY NAME:
*    'CLD'     - CLOUDSHINE
*    'GRD'     - GROUNDSHINE
*    'INH ACU' - "ACUTE DOSE EQUIVALENT" FROM DIRECT INHALATION OF THE CLOUD
*    'INH LIF' - "LIFETIME DOSE COMMITMENT" FROM DIRECT INHALATION OF THE CLOUD
*    'RES ACU' - "ACUTE DOSE EQUIVALENT" FROM RESUSPENSION INHALATION
*    'RES LIF' - "LIFETIME DOSE COMMITMENT" FROM RESUSPENSION INHALATION
*    'TOT ACU' - "ACUTE DOSE EQUIVALENT" FROM ALL PATHWAYS
*    'TOT LIF' - "LIFETIME DOSE COMMITMENT" FROM ALL PATHWAYS
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE6NUMBER     0
```

```
*
*              ORGNAM          PATHNM       I1DIS6    I2DIS6
*
*TYPE6OUT001  'A-RED MARR'    'TOT ACU'      1         19      (0-50 MILES)
*TYPE6OUT002  'A-LUNGS'       'TOT ACU'      1         19      (0-50 MILES)
*TYPE6OUT003  'L-EDEWBODY'    'TOT LIF'      1         26      (0-1000 MILES)
*******************************************************************************
* RESULT 7 OPTIONS BLOCK, LOADED BY INOUT7, STORED IN /INOUT7/
*
* CENTERLINE RISK OF A GIVEN EFFECT VS DISTANCE
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE7NUMBER   0
*
*                     NAME            I1DIS7       I2DIS7
*
*TYPE7OUT001     'ERL FAT/TOTAL'        1             19        (0-50 MILES)
*TYPE7OUT002     'CAN FAT/TOTAL'        1             26        (0-1000 MILES)
*******************************************************************************
* RESULT 8 OPTIONS BLOCK, LOADED BY INOUT8, STORED IN /INOUT8/
*
* POPULATION WEIGHTED FATALITY RISK BETWEEN 2 DISTANCES
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE8NUMBER   2
*
*                  NAME       I1DIS8  I2DIS8
*
TYPE8OUT001 'ERL FAT/TOTAL'   1       5      NOCCDF  (0-EXCL ZONE + 1 MI)
TYPE8OUT002 'CAN FAT/TOTAL'   1      12      NOCCDF  (0-10 MILES)
*******************************************************************************
* RESULT A OPTIONS BLOCK, LOADED BY INOUTA, STORED IN /INOUTA/
*
* peak dose to a given organ
*
*             NUMA
TYPEANUMBER   1
*
*               ORGNAM     I1DISA  I2DISA
TYPEAOUT001 'L-EDEWBODY'  1       26
.
*******************************************************************************
```

```
* EMERGENCY RESPONSE SCENARIO NUMBER 2
********************************************************************************
* EVACUATION ZONE DATA BLOCK, LOADED BY EVNETW, STORED IN /NETWOR/, /EOPTIO/
*
* SPECIFIC DESCRIPTION OF THE EMERGENCY RESPONSE SCENARIO BEING USED
*
EZEANAM2001  'NO EVACUATION, RELOCATION MODELS APPLY EVERYWHERE'
*
* WEIGHTING FRACTION APPLICABLE TO THIS SCENARIO
*
EZWTFRAC001  0.005
*
* LAST RING IN THE MOVEMENT ZONE
*
EZLASMOV001     0   (A ZERO TURNS OFF THE EVACUATION MODEL)
```

Table A-3. CHRONC Input File for Case 11d

```
* GENERAL DESCRIPTIVE TITLE DESCRIBING THIS "CHRONC" INPUT FILE
*
CHCHNAME001 'IN3A_N.INP, Sample Problem A, "New" COMIDA2-Based Food Model'
**************************************************************************
* EMERGENCY RESPONSE COST DATA BLOCK
*
* DAILY COST FOR A PERSON WHO IS EVACUATED (DOLLARS/PERSON-DAY)
*
CHEVACST001  27.00   (INCLUDES FOOD AND HOUSING COSTS BUT NOT LOST INCOME)
*
* DAILY COST FOR A PERSON WHO IS RELOCATED (DOLLARS/PERSON-DAY)
*
CHRELCST001  27.00   (INCLUDES FOOD AND HOUSING COSTS BUT NOT LOST INCOME)
**************************************************************************
* LONG TERM PROTECTIVE ACTION DATA BLOCK
*
* Duration of the intermediate phase period--at version 1.11c TMIPND is no
* longer processed.  The new input variable DUR_INTPHAS is the period's
* duration, not the time after plume arrival at which the period ends.
*
DUR_INTPHAS   0.0    (in seconds)   (no intermediate phase)
*
* LONG-TERM PHASE DOSE PROJECTION PERIOD, THE DURATION OF THE EXPOSURE
* PERIOD OVER WHICH THE LONG-TERM DOSE CRITERION IS EVALUATED (SECONDS)
*
CHTMPACT001   1.58E8             (5 YEARS)
*
* DOSE CRITERION FOR INTERMEDIATE PHASE RELOCATION (Sv)
*
CHDSCRTI001   1.0E5              (NO INTERMEDIATE PHASE RELOCATION)
*
* DOSE CRITERION FOR LONG-TERM PHASE RELOCATION (Sv)
*
CHDSCRLT001    0.04
*
* CRITICAL ORGAN NAME FOR LONG-TERM ACTIONS
*
CHCRTOCR001 'L-EDEWBODY'
*
* Long Term Exposure Period    Previously permanently set to:
*    one million years = 3.15 E13 seconds
```

```
*    MACCS2 allowable range is 3.15E7 to 1.E10
*
CHEXPTIM001    1.E10
*********************************************************************************
* DECONTAMINATION PLAN DATA BLOCK
*
* NUMBER OF LEVELS OF DECONTAMINATION
*
CHLVLDEC001  2
*
* DECONTAMINATION TIMES CORRESPONDING TO THE LVLDEC LEVELS OF DECONTAMINATION
*  (SECONDS)
*
CHTIMDEC001   5.184E6  1.0368E7    (60, 120 DAYS)
*
* DOSE REDUCTION FACTORS CORRESPONDING TO THE LVLDEC LEVELS OF DECONTAMINATION
*
CHDSRFCT001   3.      15.
*
* COST OF FARM DECONTAMINATION PER FARMLAND UNIT AREA (DOLLARS/HECTARE)
*  FOR THE VARIOUS LEVELS OF DECONTAMINATION
*
CHCDFRM0001   562.5   1250.
*
* COST OF NONFARM DECONTAMINATION PER RESIDENT PERSON (DOLLARS/PERSON)
*  FOR THE VARIOUS LEVELS OF DECONTAMINATION
*
CHCDNFRM001   3000.   8000.
*
* FRACTION OF FARMLAND DECONTAMINATION COST DUE TO LABOR
*  FOR THE VARIOUS DECONTAMINATION LEVELS
*
CHFRFDL0001  .3      .35
*
* FRACTION OF NON-FARM DECONTAMINATION COST DUE TO LABOR
*  FOR THE VARIOUS DECONTAMINATION LEVELS
*
CHFRNFDL001  .7      .5
*
* FRACTION OF TIME WORKERS IN FARM AREAS SPEND IN CONTAMINATED AREAS
*  FOR THE VARIOUS DECONTAMINATION LEVELS
*
CHTFWKF0001  .10     .33
*
```

```
* FRACTION OF TIME WORKERS IN NON-FARM AREAS SPEND IN CONTAMINATED AREAS
*  FOR THE VARIOUS DECONTAMINATION LEVELS
*
CHTFWKNF001  .33     .33
*
* AVERAGE COST OF DECONTAMINATION LABOR (DOLLARS/MAN-YEAR)
*
CHDLBCST001   35000.
******************************************************************************
* INTERDICTION COST DATA BLOCK
*
* DEPRECIATION (DETERIORATION) RATE DURING INTERDICTION PERIOD (PER YEAR)
*
CHDPRATE001    .20   (VALUE OBTAINED FROM WASH-1400, APPENDIX 6)
*
* INVESTMENT INCOME RETURN (DISCOUNT RATE) DURING INTERDICTION PERIOD (PER YEAR)
* THIS VALUE SHOULD BE DERIVED AS A REAL RETURN RATE ADJUSTED FOR INFLATION
*
CHDSRATE001    .12   (VALUE OBTAINED FROM WASH-1400, APPENDIX 6)
*
* POPULATION RELOCATION COST (DOLLARS/PERSON):
*  ALTERNATIVE HOUSING, MOVING COSTS, AND LOST INCOME FOR PEOPLE IN
*  AREAS WHICH REQUIRE DECONTAMINATION, INTERDICTION, OR CONDEMNATION
*
CHPOPCST001   5000.
******************************************************************************
* GROUNDSHINE WEATHERING DEFINITION DATA BLOCK
*
* NUMBER OF TERMS IN THE GROUNDSHINE WEATHERING RELATIONSHIP (EITHER 1 OR 2)
*
CHNGWTRM001   2
*
* GROUNDSHINE WEATHERING COEFFICIENTS
*
CHGWCOEF001   0.5    0.5            (JON HELTON)
*
* HALF LIVES CORRESPONDING TO THE GROUNDSHINE WEATHERING COEFFICIENTS (S)
*
CHTGWHLF001   1.6E7  2.8E9          (JON HELTON)
******************************************************************************
* RESUSPENSION WEATHERING DEFINITION DATA BLOCK
*
* NUMBER OF TERMS IN THE RESUSPENSION WEATHERING RELATIONSHIP
*
```

```
CHNRWTRM001    3
*
* RESUSPENSION CONCENTRATION COEFFICIENTS   (/ METER)
*  RELATIONSHIP BETWEEN GROUND CONCENTRATION AND INSTANTANEOUS AIR CONC.
*
CHRWCOEF001  1.0E-5   1.0E-7   1.0E-9  (VALUES HERE SELECTED BY JON HELTON)
*
* HALF-LIVES CORRESPONDING TO THE RESUSPENSION CONCENTRATION COEFFICIENTS (S)
*
CHTRWHLF001  1.6E7    1.6E8    1.6E9   (6 MONTHS, 5 YEARS, 50 YEARS)
*******************************************************************************
* SITE REGION DESCRIPTION DATA BLOCK
*
* FRACTION OF AREA THAT IS LAND IN THE REGION
*
CHFRACLD001   0.95   (ROUGH GUESS VALUE, SITE FILE OVERRIDES THIS VALUE)
*
* FRACTION OF LAND DEVOTED TO FARMING IN THE REGION
*
CHFRCFRM001   0.382  (VIRGINIA STATE VALUE, SITE FILE OVERRIDES THIS VALUE)
*
* AVERAGE VALUE OF ANNUAL FARM PRODUCTION IN THE REGION (DOLLARS/HECTARE)
*  (CASH RECEIPTS FROM FARMING PLUS VALUE OF HOME CONSUMPTION)/(LAND IN FARMS)
*
CHFRMPRD001   371.0  (VIRGINIA STATE VALUE, SITE FILE OVERRIDES THIS VALUE)
*
* FRACTION OF FARM PRODUCTION RESULTING FROM DAIRY PRODUCTION IN THE REGION
*  (VALUE OF MILK PRODUCED)/(CASH RECEIPTS FROM FARMING PLUS HOME CONSUMPTION)
*
CHDPFRCT001   0.198  (VIRGINIA STATE VALUE, SITE FILE OVERRIDES THIS VALUE)
*
* VALUE OF FARM WEALTH (DOLLARS/HECTARE)
*  (AVERAGE VALUE PER HECTARE OF FARM LAND AND BUILDINGS TO 100 MILES)
*
CHVALWF0001   2613.  *  SURRY
*
* FRACTION OF FARM WEALTH IN IMPROVEMENTS FOR THE REGION
*
CHFRFIM0001   0.25  *  SURRY
*
* NON-FARM WEALTH, PROPERTY AND IMPROVEMENTS FOR THE REGION (DOLLARS/PERSON)
*  THE VALUE OF ALL RESIDENTIAL, BUSINESS, AND PUBLIC ASSETS WHICH WOULD BE
*  LOST IN THE EVENT OF PERMANENT INTERDICTION (CONDEMNATION) OF THE AREA
*
```

```
CHVALWNF001   84000.  *  SURRY
*
* FRACTION OF NON-FARM WEALTH IN IMPROVEMENTS FOR THE REGION
*
CHFRNFIM001   0.8
***************************************************************************
CHFDPATH001 'NEW'
*
* name of the COMIDA2 binary output file
*
BIN_FILE001 'SAMP_A.BIN'   (revised data file of 8/12/95)
*
* Dose limits triggering first year crop disposal of the separate
* milk and non-milk components of the diet, corresponding in purpose,
* more or less, to the MACCS 1.5 input variables PSCMLK and PSCOTH
*
* For NUREG-1150 calculations, the maximum allowable ground concentrations for
* production of milk and non-milk crops contaminated by an accident occurring
* in the growing season were derived based on an assumed maximum allowable
* dose of 5 rem effective or 15 rem thyroid, per the 1982 FDA guidance that's
* reprinted in the 1992 EPA PAG Manual.  For purposes of comparison against
* the prior results, it is being assumed, for simplicity, that milk and
* non-milk crops contribute equally to the first year dose.  Thus, the 5 rem
* effective dose limit used in NUREG-1150 is equally split between milk and
* non-milk crops, with 2.5 rem allowed for each.  Similarly, the 15 rem
* thyroid limit is split into 7.5 and 7.5 rem for the milk and non-milk
* portions of the diet.
*
*               effective     thyroid  (doses in sieverts)
DOSEMILK001    0.025          0.075
DOSEOTHR001    0.025          0.075
*
* Annual dose limits for the subsequent year's (i.e., after the first year)
* interdiction of BOTH the milk and non-milk (combined) components of the diet
*
* Note: the long-term food critera, GCMAXR, used for NUREG-1150 wre based on
* an ingestion dose integrated from zero to infinity.  It is not possible to
* translate those parameter values into corresponding annual dose limits, as is
* required by the COMIDA2-based food model.  The "total" dose limits used in
* NUREG-1150 for "root uptake", 0.5 rem effective and 1.5 rem thyroid, are used
* here as annual dose limits for interdiction of food production in years the
* years subsequent to the accident.
*
*               effective     thyroid  (doses in sieverts)
```

```
DOSELONG001    0.005          0.015
*
* NUMBER OF NUCLIDES IN THE WATER INGESTION PATHWAY MODEL
*
CHNUMWPI001    4
*
* TABLE OF NUCLIDE DEFINITIONS IN THE WATER INGESTION PATHWAY MODEL
*
* IF A SITE DATA FILE IS DEFINED, THE DATA DEFINING THE WATERSHED INGESTION
*  FACTOR IS SUPERSEDED BY THE CORRESPONDING DATA IN THE SITE DATA FILE
*
*                          INITIAL     ANNUAL    INGESTION FACTOR
*              WATER       WASHOFF     WASHOFF    ((Bq INGESTED)/
*             NUCLIDE      FRACTION     RATE        (Bq IN WATER))
*
*              NAMWPI       WSHFRI      WSHRTA          WINGF
CHWTRISO001   Sr-89          0.01       0.004          5.0E-6
CHWTRISO002   Sr-90          0.01       0.004          5.0E-6
CHWTRISO003   Cs-134         0.005      0.001          5.0E-6
CHWTRISO004   Cs-137         0.005      0.001          5.0E-6
**************************************************************************
* SPECIAL OPTIONS DATA BLOCK
*
* DETAILED PRINT OPTION CONTROL SWITCHES, LOOK AT THE CODE BEFORE TURNING ON!!
*          KSWDSC
*
CHKSWTCH001   0
**************************************************************************
* DEFINE THE TYPE 9 RESULTS
*
* LONG-TERM POPULATION DOSE IN A GIVEN REGION BROKEN DOWN BY THE 12 PATHWAYS
*
* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
* FOR EACH RESULT YOU REQUEST, THE CODE WILL PRODUCE A SET OF 12
*
TYPE9NUMBER   2       (UP TO 10 ALLOWED)
*
*               ORGNAM         INNER      OUTER
*
TYPE9OUT001   'L-EDEWBODY'       1           26    (0-1000 MILES)
TYPE9OUT002   'L-EDEWBODY'       1           19    (0-50 MILES)
**************************************************************************
* ECONOMIC COST RESULTS IN A REGION BROKEN DOWN BY 12 TYPES OF COSTS
*
```

```
* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
* FOR EACH RESULT YOU REQUEST, THE CODE WILL PRODUCE A SET OF 12
*
TYP10NUMBER   2      (UP TO 10 ALLOWED)
*
*               INNER      OUTER
*
TYP10OUT001      1          26    (0-1000 MILES)
TYP10OUT002      1          19    (0-50 MILES)
*******************************************************************************
* DEFINE A FLAG THAT CONTROLS THE PRODUCTION OF THE ACTION DISTANCE RESULTS
*
* SPECIFYING A VALUE OF .TRUE. TURNS ON ALL 8 OF THE ACTION DISTANCE RESULTS,
* A VALUE OF .FALSE. WILL ELIMINATE THE ACTION DISTANCE RESULTS FROM THE OUTPUT.
*
TYP11FLAG11  .TRUE.
*******************************************************************************
* IMPACTED AREA/POPULATION RESULTS IN A REGION BROKEN DOWN BY 6 TYPES OF IMPACTS
*
* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
* FOR EACH RESULT YOU REQUEST, THE CODE WILL PRODUCE A SET OF 8
*
TYP12NUMBER   2      (UP TO 10 ALLOWED)
*
*               INNER      OUTER
*
TYP12OUT001      1          26    (0-1000 MILES)
TYP12OUT002      1          19    (0-50 MILES)
*******************************************************************************
* Maximal annual food ingestion dose to an individual, requested by IXOT13
*
* This result is calculated after accounting for temporary or
* permanent interdiction.  It is only available for the "new" food model.
*
* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
*
TYP13NUMBER   20   (UP TO 10 ALLOWED)
*
* IRAD13 is the radial spatial interval at which results are requested
*
* ORGN13 is the name of the organ for which results are requested
*  (allowable values for ORGN13 are 'EFFECTIVE' or 'THYROID')
*
*          IRAD13   ORGN13
```

```
*
TYP13OUT001   2   EFFECTIVE
TYP13OUT002   4   EFFECTIVE
TYP13OUT003   6   EFFECTIVE
TYP13OUT004   8   EFFECTIVE
TYP13OUT005  10   EFFECTIVE
TYP13OUT006  12   EFFECTIVE
TYP13OUT007  14   EFFECTIVE
TYP13OUT008  16   EFFECTIVE
TYP13OUT009  18   EFFECTIVE
TYP13OUT010  20   EFFECTIVE
TYP13OUT011   2   THYROID
TYP13OUT012   4   THYROID
TYP13OUT013   6   THYROID
TYP13OUT014   8   THYROID
TYP13OUT015  10   THYROID
TYP13OUT016  12   THYROID
TYP13OUT017  14   THYROID
TYP13OUT018  16   THYROID
TYP13OUT019  18   THYROID
TYP13OUT020  20   THYROID
```

Table A-4. ATMOS Input File for Case 12d

```
* GENERAL DESCRIPTIVE TITLE DESCRIBING THIS "ATMOS" INPUT
*
RIATNAM1001 'A12D.INP, Sample Problem A--Using Power-Law Sigmas, ATMOS input'
*************************************************************************
* GEOMETRY DATA BLOCK, LOADED BY INPGEO, STORED IN /GEOM/
*
* NUMBER OF RADIAL SPATIAL ELEMENTS
*
GENUMRAD001  26
*
*  SURRY
*
GESPAEND001      .16       .52      1.21      1.61      2.13
GESPAEND002     3.22      4.02      4.83      5.63      8.05
GESPAEND003    11.27     16.09     20.92     25.75     32.19
GESPAEND004    40.23     48.28     64.37     80.47    112.65
GESPAEND005   160.93    241.14    321.87    563.27    804.67
GESPAEND006  1609.34
*************************************************************************
* NUCLIDE DATA BLOCK, LOADED BY INPISO, STORED IN /ISOGRP/, /ISONAM/
*
* Number of pseudo-stable nuclides (used to truncate the decay chains)
*
ISNUMSTB001      27
*
* List of pseudo-stable nuclides
*
ISNAMSTB001     I-129    (daughter of Te-129 and Te-129m)
ISNAMSTB002     Xe-131m  (daughter of I-131)
ISNAMSTB003     Xe-133m  (daughter of I-133)
ISNAMSTB004     Xe-135m  (daughter of I-135)
ISNAMSTB005     Cs-135   (daughter of Xe-135 and Xe-135m)
ISNAMSTB006     Sm-147   (daughter of Pm-147)
ISNAMSTB007     U-234    (daughter of Pu-238)
ISNAMSTB008     U-235    (daughter of Pu-239)
ISNAMSTB009     U-236    (daughter of Pu-240)
ISNAMSTB010     U-237    (daughter of Pu-241)
ISNAMSTB011     Np-237   (daughter of Am-241)
ISNAMSTB012     Rb-87    (daughter of Kr-87)
ISNAMSTB013     Ba-137m  (daughter of Cs-137)
ISNAMSTB014     Rb-88    (daughter of Kr-88)
```

```
ISNAMSTB015      Y-91m    (daughter of Sr-91)
ISNAMSTB016      Zr-93    (daughter of Y-93)
ISNAMSTB017      Nb-93m   (daughter of Zr-93)
ISNAMSTB018      Nb-95m   (daughter of Zr-95)
ISNAMSTB019      Nb-97    (daughter of Zr-97 and Nb-97m)
ISNAMSTB020      Nb-97m   (daughter of Zr-97)
ISNAMSTB021      Tc-99    (daughter of Mo-99)
ISNAMSTB022      Rh-103m  (daughter of Ru-103)
ISNAMSTB023      Rh-106   (daughter of Ru-106)
ISNAMSTB024     Te-131    (daughter of Te-131m)
ISNAMSTB025      Pr-144   (daughter of Ce-144 and Pr-144m)
ISNAMSTB026      Pr-144m  (daughter of Ce-144)
ISNAMSTB027      Pm-147   (daughter of Nd-147)
*
* Number of radioactive nuclides to be considered
*
ISNUMISO001 60
*
* NUMBER OF NUCLIDE GROUPS
*
ISMAXGRP001  9
*
* WET AND DRY DEPOSITION FLAGS FOR EACH NUCLIDE GROUP
*
*              WETDEP     DRYDEP
*
ISDEPFLA001    .FALSE.   .FALSE.
ISDEPFLA002    .TRUE.    .TRUE.
ISDEPFLA003    .TRUE.    .TRUE.
ISDEPFLA004    .TRUE.    .TRUE.
ISDEPFLA005    .TRUE.    .TRUE.
ISDEPFLA006    .TRUE.    .TRUE.
ISDEPFLA007    .TRUE.    .TRUE.
ISDEPFLA008    .TRUE.    .TRUE.
ISDEPFLA009    .TRUE.    .TRUE.
*
* NUCLIDE GROUP DATA FOR 9 NUCLIDE GROUPS
*
*              NUCNAM    IGROUP
*
ISOTPGRP001    Co-58        6
ISOTPGRP002    Co-60        6
ISOTPGRP003    Kr-85        1
ISOTPGRP004    Kr-85m       1
```

ISOTPGRP005	Kr-87	1
ISOTPGRP006	Kr-88	1
ISOTPGRP007	Rb-86	3
ISOTPGRP008	Sr-89	5
ISOTPGRP009	Sr-90	5
ISOTPGRP010	Sr-91	5
ISOTPGRP011	Sr-92	5
ISOTPGRP012	Y-90	7
ISOTPGRP013	Y-91	7
ISOTPGRP014	Y-92	7
ISOTPGRP015	Y-93	7
ISOTPGRP016	Zr-95	7
ISOTPGRP017	Zr-97	7
ISOTPGRP018	Nb-95	7
ISOTPGRP019	Mo-99	6
ISOTPGRP020	Tc-99m	6
ISOTPGRP021	Ru-103	6
ISOTPGRP022	Ru-105	6
ISOTPGRP023	Ru-106	6
ISOTPGRP024	Rh-105	6
ISOTPGRP025	Sb-127	4
ISOTPGRP026	Sb-129	4
ISOTPGRP027	Te-127	4
ISOTPGRP028	Te-127m	4
ISOTPGRP029	Te-129	4
ISOTPGRP030	Te-129m	4
ISOTPGRP031	Te-131m	4
ISOTPGRP032	Te-132	4
ISOTPGRP033	I-131	2
ISOTPGRP034	I-132	2
ISOTPGRP035	I-133	2
ISOTPGRP036	I-134	2
ISOTPGRP037	I-135	2
ISOTPGRP038	Xe-133	1
ISOTPGRP039	Xe-135	1
ISOTPGRP040	Cs-134	3
ISOTPGRP041	Cs-136	3
ISOTPGRP042	Cs-137	3
ISOTPGRP043	Ba-139	9
ISOTPGRP044	Ba-140	9
ISOTPGRP045	La-140	7
ISOTPGRP046	La-141	7
ISOTPGRP047	La-142	7
ISOTPGRP048	Ce-141	8

```
ISOTPGRP049    Ce-143      8
ISOTPGRP050    Ce-144      8
ISOTPGRP051    Pr-143      7
ISOTPGRP052    Nd-147      7
ISOTPGRP053    Np-239      8
ISOTPGRP054    Pu-238      8
ISOTPGRP055    Pu-239      8
ISOTPGRP056    Pu-240      8
ISOTPGRP057    Pu-241      8
ISOTPGRP058    Am-241      7
ISOTPGRP059    Cm-242      7
ISOTPGRP060    Cm-244      7
*****************************************************************************
* WET DEPOSITION DATA BLOCK, LOADED BY INPWET, STORED IN /WETCON/
*
* WASHOUT COEFFICIENT NUMBER ONE, LINEAR FACTOR
*
WDCWASH1001  9.5E-5   (JON HELTON AFTER JONES, 1986)
*
* WASHOUT COEFFICIENT NUMBER TWO, EXPONENTIAL FACTOR
*
WDCWASH2001  0.8      (JON HELTON AFTER JONES, 1986)
*****************************************************************************
* DRY DEPOSITION DATA BLOCK, LOADED BY INPDRY, STORED IN /DRYCON/
*
* NUMBER OF PARTICLE SIZE GROUPS
*
DDNPSGRP001   1
*
* DEPOSITION VELOCITY OF EACH PARTICLE SIZE GROUP (M/S)
*
DDVDEPOS001   0.01   (VALUE SELECTED BY S. ACHARYA, NRC)
*****************************************************************************
* DISPERSION PARAMETER DATA BLOCK, LOADED BY INPDIS, STORED IN /DISPY/, /DISPZ/
*
* # of distances in plume-size tables--which can be used as an alternative to the power-law model:
* (to utilize the power-law model, set NUM_DIST to zero or delete the following data card)
*
NUM_DIST001   0
*
* Tadmor and Gur Parameterization for Distance Range 0.5 to 5.0 km
* as taken from Atmospheric Motion and Air Pollution (Dobbins 1979).
*
* P-G CLASS:          A          B          C          D          E          F
```

```
#DPCYSIGA001   6  'CYSIGA_AB'  'CYSIGA_AB'  'CYSIGA_C'  'CYSIGA_D'  'CYSIGA_EF'  'CYSIGA_EF'
#DPCYSIGB001   6  'CYSIGB_AB'  'CYSIGB_AB'  'CYSIGB_C'  'CYSIGB_D'  'CYSIGB_EF'  'CYSIGB_EF'
#DPCZSIGA001   6  'CZSIGA_AB'  'CZSIGA_AB'  'CZSIGA_C'  'CZSIGA_D'  'CZSIGA_EF'  'CZSIGA_EF'
#DPCZSIGB001   6  'CZSIGB_AB'  'CZSIGB_AB'  'CZSIGB_C'  'CZSIGB_D'  'CZSIGB_EF'  'CZSIGB_EF'
*
*  LINEAR SCALING FACTOR FOR SIGMA-Y FUNCTION, NORMALLY 1
*
DPYSCALE001    1.
*
*  LINEAR SCALING FACTOR FOR SIGMA-Z FUNCTION,
*  NORMALLY USED FOR SURFACE ROUGHNESS LENGTH CORRECTION
*  This was included in expert distributions (for rural/urban surface roughness)
*
DPZSCALE001    1.
*************************************************************************** *
* EXPANSION FACTOR DATA BLOCK, LOADED BY INPEXP, STORED IN /EXPAND/
*
* TIME BASE FOR EXPANSION FACTOR (SECONDS)
*
PMTIMBAS001    1800.   (30 min - same as plume duration, therefore no meander)
*
* BREAK POINT FOR FORMULA CHANGE (SECONDS)
*
PMBRKPNT001   3600.   (1 HOUR)
*
* EXPONENTIAL EXPANSION FACTOR NUMBER 1
*
PMXPFAC1001      0.2
*
* EXPONENTIAL EXPANSION FACTOR NUMBER 2
*
PMXPFAC2001      0.25
****************************************************************************
* PLUME RISE DATA BLOCK, LOADED BY INPLRS, STORED IN /PLUMRS/
*
* SCALING FACTOR FOR THE CRITICAL WIND SPEED FOR ENTRAINMENT OF A BOUYANT PLUME
* (USED BY FUNCTION CAUGHT)
*
PRSCLCRW001   1.
*
* SCALING FACTOR FOR THE A-D STABILITY PLUME RISE FORMULA
* (USED BY FUNCTION PLMRIS)
*
PRSCLADP001   1.
```

```
*
* SCALING FACTOR FOR THE E-F STABILITY PLUME RISE FORMULA
* (USED BY FUNCTION PLMRIS)
*
PRSCLEFP001   1.
***************************************************************************
* RELEASE DATA BLOCK, LOADED BY INPREL, STORED IN /ATNAM2/, /MULREL/
*
RDATNAM2001 'SECOND DRAFT 1150, WORST CASE SOURCE TERM FOR EARLY FATALITIES'
*
* TIME AFTER ACCIDENT INITIATION WHEN THE ACCIDENT REACHES GENERAL EMERGENCY
* CONDITIONS (AS DEFINED IN NUREG-0654), OR WHEN PLANT PERSONNEL CAN RELIABLY
* PREDICT THAT GENERAL EMERGENCY CONDITIONS WILL BE ATTAINED
*
RDOALARM001      1300.
*
* NUMBER OF PLUME SEGMENTS THAT ARE RELEASED
*
RDNUMREL001          1
*
* SELECTION OF RISK DOMINANT PLUME
*
RDMAXRIS001          1
*
* REFERENCE TIME FOR DISPERSION AND RADIOACTIVE DECAY
*
RDREFTIM001       0.00
*
* HEAT CONTENT OF THE RELEASE SEGMENTS (W)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPLHEAT001     3.7E+6
*
* HEIGHT OF THE PLUME SEGMENTS AT RELEASE (M)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPLHITE001         0.
*
* DURATION OF THE PLUME SEGMENTS (S)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPLUDUR001      1800.
*
* TIME OF RELEASE FOR EACH PLUME (S AFTER SCRAM)
```

```
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPDELAY001     19300.
*
* Initial value of sigma-y for each plume--Note: values required for each plume
*
SIGYINIT001  9.302  (initial sigma-y, calculated for 40 meter wide bldg.)
*
* Initial value of sigma-z for each plume--Note: values required for each plume
*
SIGZINIT001  23.26  (initial sigma-z, calculated for 50 meter high bldg.)
*
* Building height (meters)--Note: values required for each plume
*
WEBUILDH001   50.0  (Surry)
*
* PARTICLE SIZE DISTRIBUTION OF EACH NUCLIDE GROUP
* YOU MUST SPECIFY A COLUMN OF DATA FOR EACH OF THE PARTICLE SIZE GROUPS
*
RDPSDIST001      1.
RDPSDIST002      1.
RDPSDIST003      1.
RDPSDIST004      1.
RDPSDIST005      1.
RDPSDIST006      1.
RDPSDIST007      1.
RDPSDIST008      1.
RDPSDIST009      1.
*
* Millstone 1 spent fuel pool inventory
* - spent fuel pool contains 11 batches of spent fuel plus rest of last core
* - inventory reflects 1 year of radioactive decay since last batch
*   was put in pool
* - inventory is based on inventories in NUREG/CR-4982, July 1987
* - Millstone 1 has a power of 2011 MWt
*
*               NUCNAM        CORINV (Bq)
*
RDCORINV001     Co-58         9.170E+13
RDCORINV002     Co-60         1.340E+16
RDCORINV003     Kr-85         5.940E+16
RDCORINV004     Kr-85m        0.000E+00
RDCORINV005     Kr-87         0.000E+00
RDCORINV006     Kr-88         0.000E+00
```

RDCORINV007	Rb-86	2.980E+09
RDCORINV008	Sr-89	1.160E+16
RDCORINV009	Sr-90	5.980E+17
RDCORINV010	Sr-91	0.000E+00
RDCORINV011	Sr-92	0.000E+00
RDCORINV012	Y-90	6.020E+17
RDCORINV013	Y-91	2.960E+16
RDCORINV014	Y-92	0.000E+00
RDCORINV015	Y-93	0.000E+00
RDCORINV016	Zr-95	6.160E+16
RDCORINV017	Zr-97	0.000E+00
RDCORINV018	Nb-95	7.950E+16
RDCORINV019	Mo-99	0.000E+00
RDCORINV020	Tc-99m	0.000E+00
RDCORINV021	Ru-103	3.420E+15
RDCORINV022	Ru-105	0.000E+00
RDCORINV023	Ru-106	5.770E+17
RDCORINV024	Rh-105	0.000E+00
RDCORINV025	Sb-127	0.000E+00
RDCORINV026	Sb-129	0.000E+00
RDCORINV027	Te-127	2.390E+15
RDCORINV028	Te-127m	2.430E+15
RDCORINV029	Te-129	4.450E+13
RDCORINV030	Te-129m	4.430E+13
RDCORINV031	Te-131m	0.000E+00
RDCORINV032	Te-132	0.000E+00
RDCORINV033	I-131	2.130E+04
RDCORINV034	I-132	0.000E+00
RDCORINV035	I-133	0.000E+00
RDCORINV036	I-134	0.000E+00
RDCORINV037	I-135	0.000E+00
RDCORINV038	Xe-133	0.000E+00
RDCORINV039	Xe-135	0.000E+00
RDCORINV040	Cs-134	2.800E+17
RDCORINV041	Cs-136	3.400E+08
RDCORINV042	Cs-137	8.380E+17
RDCORINV043	Ba-139	0.000E+00
RDCORINV044	Ba-140	7.920E+09
RDCORINV045	La-140	8.060E+09
RDCORINV046	La-141	0.000E+00
RDCORINV047	La-142	0.000E+00
RDCORINV048	Ce-141	1.220E+15
RDCORINV049	Ce-143	0.000E+00
RDCORINV050	Ce-144	1.040E+18

```
RDCORINV051      Pr-143         2.210E+10
RDCORINV052      Nd-147         1.220E+08
RDCORINV053      Np-239         1.070E+14
RDCORINV054      Pu-238         1.780E+16
RDCORINV055      Pu-239         3.870E+15
RDCORINV056      Pu-240         5.400E+15
RDCORINV057      Pu-241         9.320E+17
RDCORINV058      Am-241         1.200E+16
RDCORINV059      Cm-242         1.770E+16
RDCORINV060      Cm-244         8.400E+15
*
*  SCALING FACTOR TO ADJUST THE CORE INVENTORY FOR POWER LEVEL
*
RDCORSCA001   1.711  *  convert from Millstone to Susquehanna
*                       by multiplying by ratio of powers
*                       (3441MWt/2011MWt)
*
*
RDAPLFRC001   PARENT      (apply rel fracs the same as prior versions)
*
* RELEASE FRACTIONS FOR ISOTOPE GROUPS IN RELEASE
*
*  ISOTOPE GROUPS:
*
*            XE/KR    I      CS      TE      SR      RU      LA      CE      BA
*
RDRELFRC001 1.0E+0 1.0E+0 1.0E+0 2.0E-2 2.0E-3 1.0E+0 1.0E-6 1.0E-6 2.0E-3
*****************************************************************************
* OUTPUT CONTROL DATA BLOCK, LOADED BY INPOPT, STORED IN /STOPME/, /ATMOPT/
*
* FLAG TO INDICATE THAT THIS IS THE LAST PROGRAM IN THE SERIES TO BE RUN
*
OCENDAT1001  .FALSE. (SET THIS VALUE TO .TRUE. TO SKIP EARLY AND CHRONC)
*
OCIDEBUG001  0
*
* NAME OF THE NUCLIDE TO BE LISTED ON THE DISPERSION LISTINGS
*
OCNUCOUT001  Cs-137
*
*               NUM0
TYPE0NUMBER       2
*
*               INDREL   INDRAD
```

```
TYPE0OUT001      1       9
TYPE0OUT002      1      10        XCCDF
*******************************************************************************
* METEOROLOGICAL SAMPLING DATA BLOCK
*
* METEOROLOGICAL SAMPLING OPTION CODE:
*
* METCOD = 1, USER SPECIFIED DAY AND HOUR IN THE YEAR (FROM MET FILE),
*          2, WEATHER CATEGORY BIN SAMPLING,
*          3, 120 HOURS OF WEATHER SPECIFIED ON THE ATMOS USER INPUT FILE,
*          4, CONSTANT MET (BOUNDARY WEATHER USED FROM THE START),
*          5, STRATIFIED RANDOM SAMPLES FOR EACH DAY OF THE YEAR.
*
M1METCOD001  2
*
* LAST SPATIAL INTERVAL FOR MEASURED WEATHER
*
M2LIMSPA001  25
*
* BOUNDARY WEATHER MIXING LAYER HEIGHT
*
M2BNDMXH001  1000.  (METERS)
*
* BOUNDARY WEATHER STABILITY CLASS INDEX
*
M2IBDSTB001  4      (D-STABILITY)
*
* BOUNDARY WEATHER RAIN RATE
*
M2BNDRAN001  5.     (MM/HR)
*
* BOUNDARY WEATHER WIND SPEED
*
M2BNDWND001  5.     (M/S)
*
* NUMBER OF RAIN DISTANCE INTERVALS FOR BINNING
*
M4NRNINT001  5
*
* ENDPOINTS OF THE RAIN DISTANCE INTERVALS (KILOMETERS)
*
* NOTE: THESE MUST BE CHOSEN TO MATCH THE SPATIAL ENDPOINT DISTANCES
*       SPECIFIED FOR THE ARRAY SPAEND (10 % ERROR IS ALLOWED).
*
```

```
M4RNDSTS001  3.22  5.63  11.27  20.92  32.19
*
* NUMBER OF RAIN INTENSITIY BREAKPOINTS
*
M4NRINTN001   3
*
* RAIN INTENSITY BREAKPOINTS FOR WEATHER BINNING (MILLIMETERS PER HOUR)
*
M4RNRATE001   2.  4.  6.
*
* NUMBER OF SAMPLES PER BIN
*
M4NSMPLS001  4  (THIS NUMBER SHOULD BE SET TO 4 FOR RISK ASSESSMENT)
*
* INITIAL SEED FOR RANDOM NUMBER GENERATOR
*
M4IRSEED001   79
.
*
*
*****************************************************************
* 4/14/99: J. Schaperow commented out source term number 2 of 2.*
*****************************************************************
*
*
********************** RELEASE DATA BLOCK *************
* SOURCE TERM NUMBER 2 OF 2
*
*RDATNAM2001 'RELEASE FRACTIONS OF SOURCE TERM 1 REDUCED BY A FACTOR OF TEN'
*
*             XE/KR    I      CS      TE      SR      RU      LA      CE      BA
*
*RDRELFRC001 1.0E-1 6.8E-2 6.4E-2 1.7E-2 4.2E-4 2.3E-4 1.6E-5 4.0E-5 6.3E-4
*RDRELFRC002 4.3E-4 9.5E-4 2.4E-4 1.4E-2 6.8E-3 4.7E-5 6.8E-4 7.1E-4 5.4E-3
*.
```

Table A-5. EARLY Input File for Case 12d

```
* GENERAL DESCRIPTIVE TITLE DESCRIBING THIS "EARLY" INPUT FILE
*
MIEANAM1001 'IN2A.INP, Sample Problem A of NUREG/CR-4691, Vol. 1, EARLY input'
DCF_FILE001 'DOSDATA.INP'  (DCF file of MACCS 1.5.11.1)
*
*              ORGNAM          ORGFLG
*
MIORGDEF001  'A-SKIN'          .TRUE.
MIORGDEF002  'A-RED MARR'      .TRUE.
MIORGDEF003  'A-LUNGS'         .TRUE.
MIORGDEF004  'A-THYROIDH'      .TRUE.
MIORGDEF005  'A-STOMACH'       .TRUE.
MIORGDEF006  'A-LOWER LI'      .FALSE.  (does not contribute to early fatalities)
MIORGDEF007  'L-EDEWBODY'      .TRUE.
MIORGDEF008  'L-RED MARR'      .TRUE.
MIORGDEF009  'L-BONE SUR'      .TRUE.
MIORGDEF010  'L-BREAST'        .TRUE.
MIORGDEF011  'L-LUNGS'         .TRUE.
MIORGDEF012  'L-THYROID'       .TRUE.
MIORGDEF013  'L-LOWER LI'      .TRUE.
MIORGDEF014  'L-BLAD WAL'      .TRUE.
MIORGDEF015  'L-LIVER'         .FALSE.
MIORGDEF016  'L-THYROIDH'      .TRUE.
*
* FLAG TO INDICATE THAT THIS IS THE LAST PROGRAM IN THE SERIES TO BE RUN
*
MIENDAT2001  .FALSE.    (SET THIS VALUE TO .TRUE. TO SKIP CHRONC)
*
* DISPERSION MODEL OPTION CODE:  1  *  STRAIGHT LINE
*                                2  *  WIND-SHIFT WITH ROTATION
*                                3  *  WIND-SHIFT WITHOUT ROTATION
*
MIIPLUME001  2
*
* NUMBER OF FINE GRID SUBDIVISIONS USED BY THE MODEL
*
MINUMFIN001  7    (3, 5 OR 7 ALLOWED)
*
* LEVEL OF DEBUG OUTPUT REQUIRED, NORMAL RUNS SHOULD SPECIFY ZERO
*
MIIPRINT001  0
```

```
*
* LOGICAL FLAG SIGNIFYING THAT THE BREAKDOWN OF RISK BY WEATHER CATEGORY
* BIN ARE TO BE PRESENTED TO SHOW THEIR RELATIVE CONTRIBUTION TO THE MEAN
*
*             RISBIN
*
MIRISCAT001   .FALSE.
*
* FLAG INDICATING IF WIND-ROSES FROM ATMOS ARE TO BE OVERRIDDEN
*
MIOVRRID001  .FALSE.  (USE THE WIND ROSE CALCULATED FOR EACH WEATHER BIN)
*******************************************************************************
* POPULATION DISTRIBUTION DATA BLOCK, LOADED BY INPOPU, STORED IN /POPDAT/
*
PDPOPFLG001  FILE
*
*PDPOPFLG001  UNIFORM
*PDIBEGIN001  1    (SPATIAL INTERVAL AT WHICH POPULATION BEGINS)
*PDPOPDEN001  50. (POPULATION DENSITY (PEOPLE PER SQUARE KILOMETER))
*******************************************************************************
* SHIELDING AND EXPOSURE FACTORS, LOADED BY INDFAC, STORED IN /EADFAC/
*
* THREE VALUES OF EACH PROTECTION FACTOR ARE SUPPLIED,
* ONE FOR EACH TYPE OF ACTIVTY:
*
* ACTIVITY TYPE:
*     1 - EVACUEES WHILE MOVING
*     2 - NORMAL ACTIVITY IN SHELTERING AND EVACUATION ZONE
*     3 - SHELTERED ACTIVITY
*
* CLOUD SHIELDING FACTOR
*
*    SITE         GG   PB   SEQ  SUR  ZION
*    SHELTERING   0.7  0.5  0.65 0.6  0.5
*
*             EVACUEES  NORMAL  SHELTER
*
SECSFACT001      1.      0.75     0.6    *  SURRY SHELTERING VALUE
*
* PROTECTION FACTOR FOR INHALATION
*
SEPROTIN001      1.      0.41      0.33  * VALUES FOR NORMAL ACTIVITY AND
*                                          SHELTERING SELECTED BY NRC STAFF
*
```

```
* BREATHING RATE (CUBIC METERS PER SECOND)
*
SEBRRATE001  2.66E-4  2.66E-4  2.66E-4
*
* SKIN PROTECTION FACTOR
*
SESKPFAC001  1.0      0.41     0.33    * VALUES FOR NORMAL ACTIVITY AND
*                                        SHELTERING SELECTED BY NRC STAFF
*
* GROUND SHIELDING FACTOR
*
*    SITE         GG   PB   SEQ  SUR  ZION
*    SHELTERING   0.25 0.1  0.2  0.2  0.1
*
SEGSHFAC001      0.5    0.33    0.2   * VALUE FOR NORMAL ACTIVITY SELECTED BY
*                                       NRC STAFF
*
* RESUSPENSION INHALATION MODEL CONCENTRATION COEFFICIENT (/METER)
*
*   RESCON = 1.E-4 IS APPROPRIATE FOR MECHANICAL RESUSPENSION BY VEHICLES.
*   RESHAF = 2.11 DAYS CAUSES 1.E-4 TO DECAY IN ONE WEEK TO 1.E-5, THE VALUE
*   OF RESCON USED IN THE FIRST TERM OF THE LONG-TERM RESUSPENSION EQUATION
*   USED IN CHRONC.
*
SERESCON001   1.E-4     (RESUSPENSION IS TURNED ON)
*
* RESUSPENSION CONCENTRATION COEFFICIENT HALF-LIFE (SEC)
*
SERESHAF001   1.82E5    (2.11 DAYS)
********************************************************************************
* EVACUATION ZONE DATA BLOCK, LOADED BY EVNETW, STORED IN /NETWOR/, /EOPTIO/
*
* SPECIFIC DESCRIPTION OF THE EMERGENCY RESPONSE SCENARIO BEING USED
*
EZEANAM2001  'EVACUATION WITHIN 10 MILES, RELOCATION MODELS APPLY ELSEWHERE'
*
* THE TYPE OF WEIGHTING TO BE APPLIED TO THE EMERGENCY RESPONSE SCENARIOS
* YOU MUST SUPPLY A VALUE OF 'TIME' OR 'PEOPLE'
*
EZWTNAME001  'PEOPLE'
*
* WEIGHTING FRACTION APPLICABLE TO THIS SCENARIO
*
EZWTFRAC001  0.995
```

```
*
* LAST RING IN THE MOVEMENT ZONE
*
EZLASMOV001     15    (EVACUEES DISAPPEAR AFTER TRAVELING TO 20 MILES)
*
*  Flag defining the time at which evacuees "enter" the destination element
*
*TRAVELPOINT   'CENTERPOINT' (new option implemented at MACCS2 v. 1.11f)
TRAVELPOINT   'BOUNDARY'    (functionality derived from MACCS circa 1984)
*
* RADIAL EVACUATION SPEED (M/S)
*
EZESPEED001    1.8   1.8    1.8          (SURRY)
EZEVATYP001     'RADIAL'
EZDURBEG001    86400.0
EZDURMID001    0.0
EZREFPNT001     'ALARM'
EZNUMEVA001      12
EZDLTSHL001   7200.  7200.  7200.  7200.  7200.  7200.
EZDLTSHL002   7200.  7200.  7200.  7200.  7200.  7200.
EZDLTEVA001      0.     0.     0.     0.     0.     0.
EZDLTEVA002      0.     0.     0.     0.     0.     0.
***********************************************************************
* SHELTER AND RELOCATION ZONE DATA BLOCK, LOADED BY INPEMR,
*                                        STORED IN /INPSRZ/, /RELOCA/
*
* DURATION OF THE EMERGENCY PHASE (SECONDS FROM PLUME ARRIVAL)
*
SRENDEMP001  604800.   (ONE WEEK)
*
* CRITICAL ORGAN FOR RELOCATION DECISIONS
*
SRCRIORG001 'L-EDEWBODY'
*
* HOT SPOT RELOCATION TIME (SECONDS FROM PLUME ARRIVAL)
*
SRTIMHOT001  43200.    (ONE-HALF DAY)
*
* NORMAL RELOCATION TIME (SECONDS FROM PLUME ARRIVAL)
*
SRTIMNRM001  86400.    (ONE DAY)
*
* HOT SPOT RELOCATION DOSE CRITERION THRESHOLD (SIEVERTS)
*
```

```
SRDOSHOT001  0.5    (50 REM DOSE TO WHOLE BODY IN 1 WEEK TRIGGERS RELOCATION)
*
* NORMAL RELOCATION DOSE CRITERION THRESHOLD (SIEVERTS)
*
SRDOSNRM001  0.25   (25 REM DOSE TO WHOLE BODY IN 1 WEEK TRIGGERS RELOCATION)
*******************************************************************************
* EARLY FATALITY MODEL PARAMETERS, LOADED BY INEFAT, STORED IN /EFATAL/
*
* NUMBER OF EARLY FATALITY EFFECTS
*
EFNUMEFA001   2
*
*            ORGNAM       EFFACA   EFFACB   EFFTHR
*
EFATAGRP001 'A-RED MARR'      3.8      5.0     1.5
EFATAGRP002 'A-LUNGS'        10.0      7.0     5.0
*******************************************************************************
* EARLY INJURY MODEL PARAMETERS, LOADED BY INEINJ, STORED IN /EINJUR/
*
* NUMBER OF EARLY INJURY EFFECTS
*
EINUMEIN001  7
*
*            EINAME             ORGNAM   EISUSC EITHRE EIFACA EIFACB
*
EINJUGRP001 'PRODROMAL VOMIT' 'A-STOMACH'  1.     .5     2.     3.
EINJUGRP002 'DIARRHEA'        'A-STOMACH'  1.     1.     3.     2.5
EINJUGRP003 'PNEUMONITIS'     'A-LUNGS'    1.     5.    10.     7.
EINJUGRP004 'SKIN ERYTHEMA'   'A-SKIN'     1.     3.     6.     5.
EINJUGRP005 'TRANSEPIDERMAL'  'A-SKIN'     1.    10.    20.     5.
EINJUGRP006 'THYROIDITIS'     'A-THYROIDH' 1.    40.   240.     2.
EINJUGRP007 'HYPOTHYROIDISM'  'A-THYROIDH' 1.     2.    60.     1.3
*******************************************************************************
* ACUTE EXPOSURE CANCER PARAMETERS, LOADED BY INACAN STORED IN /ACANCR/.
*
* NUMBER OF ACUTE EXPOSURE CANCER EFFECTS
*
LCNUMACA001   7
*
* THRESHOLD DOSE FOR APPLYING THE DOSE DEPENDENT REDUCTION FACTOR
*
LCDDTHRE001   0.2  (LOWEST DOSE FOR WHICH DDREFA WILL BE APPLIED)
*
* DOSE THRESHOLD FOR LINEAR DOSE RESPONSE (Sv)
```

```
*
LCACTHRE001   0.0  (LINEAR-QUADRATIC MODEL IS NOT BEING USED)
*
*           ACNAME      ORGNAM  ACSUSC DOSEFA DOSEFB CFRISK   CIRISK  DDREFA
*
LCANCERS001 'LEUKEMIA' 'L-RED MARR' 1.0   1.0   0.0   9.70E-3  0.0     2.0
LCANCERS002 'BONE'     'L-BONE SUR' 1.0   1.0   0.0   9.00E-4  0.0     2.0
LCANCERS003 'BREAST'   'L-BREAST'   1.0   1.0   0.0   5.40E-3  1.7E-2  1.0
LCANCERS004 'LUNG'     'L-LUNGS'    1.0   1.0   0.0   1.55E-2  0.0     2.0
LCANCERS005 'THYROID'  'L-THYROIDH' 1.0   1.0   0.0   7.20E-4  7.2E-3  1.0
LCANCERS006 'GI'       'L-LOWER LI' 1.0   1.0   0.0   3.36E-2  0.0     2.0
LCANCERS007 'OTHER'    'L-EDEWBODY' 1.0   1.0   0.0   2.76E-2  0.0     2.0
*************************************************************************
* RESULT 1 OPTIONS BLOCK, LOADED BY INOUT1, STORED IN /INOUT1/
* TOTAL NUMBER OF A GIVEN EFFECT (LATENT CANCER, EARLY DEATH, EARLY INJURY)
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE1NUMBER    32
*
TYPE1OUT001    'ERL FAT/TOTAL'                1  26   NOCCDF (0 TO 1000 MILES)
TYPE1OUT002    'ERL INJ/PRODROMAL VOMIT'      1  26   NOCCDF
TYPE1OUT003    'ERL INJ/DIARRHEA'             1  26
TYPE1OUT004    'ERL INJ/PNEUMONITIS'          1  26
TYPE1OUT005    'ERL INJ/THYROIDITIS'          1  26
TYPE1OUT006    'ERL INJ/HYPOTHYROIDISM'       1  26
TYPE1OUT007    'ERL INJ/SKIN ERYTHEMA'        1  26
TYPE1OUT008    'ERL INJ/TRANSEPIDERMAL'       1  26
TYPE1OUT009    'CAN FAT/TOTAL'                1  26   NOCCDF
TYPE1OUT010    'CAN FAT/LUNG'                 1  26
TYPE1OUT011    'CAN FAT/THYROID'              1  26
TYPE1OUT012    'CAN FAT/BREAST'               1  26
TYPE1OUT013    'CAN FAT/GI'                   1  26
TYPE1OUT014    'CAN FAT/LEUKEMIA'             1  26
TYPE1OUT015    'CAN FAT/BONE'                 1  26
TYPE1OUT016    'CAN FAT/OTHER'                1  26
TYPE1OUT017    'CAN INJ/THYROID'              1  26
TYPE1OUT018    'CAN INJ/BREAST'               1  26
TYPE1OUT019    'CAN FAT/TOTAL'                1  19  CCDF  (0 TO 50 MILES)
TYPE1OUT020    'ERL FAT/TOTAL'                1  12        (0 TO 10 MILES)
TYPE1OUT021    'ERL INJ/PRODROMAL VOMIT'      1  12
TYPE1OUT022    'ERL INJ/DIARRHEA'             1  12
TYPE1OUT023    'ERL INJ/PNEUMONITIS'          1  12
TYPE1OUT024    'ERL INJ/THYROIDITIS'          1  12
```

```
TYPE1OUT025    'ERL INJ/HYPOTHYROIDISM'      1  12
TYPE1OUT026    'ERL INJ/SKIN ERYTHEMA'       1  12
TYPE1OUT027    'ERL INJ/TRANSEPIDERMAL'      1  12
TYPE1OUT028    'CAN FAT/TOTAL'               1  12
TYPE1OUT029    'ERL FAT/TOTAL'               1  21       (0 TO 100 MILES)
TYPE1OUT030    'ERL FAT/TOTAL'               1  25       (0 TO 500 MILES)
TYPE1OUT031    'CAN FAT/TOTAL'               1  21       (0 TO 100 MILES)
TYPE1OUT032    'CAN FAT/TOTAL'               1  25       (0 TO 500 MILES)
********************************************************************************
* RESULT 2 OPTIONS BLOCK, LOADED BY INOUT2, STORED IN /INOUT2/
* FURTHEST DISTANCE AT WHICH A GIVEN RISK OF EARLY DEATH IS EXCEEDED.
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE2NUMBER  1
*
*             FATALITY RISK THRESHOLD
*
TYPE2OUT001  0.
********************************************************************************
* RESULT 3 OPTIONS BLOCK, LOADED BY INOUT3, STORED IN /INOUT3/
* NUMBER OF PEOPLE WHOSE DOSE TO A GIVEN ORGAN EXCEEDS A GIVEN THRESHOLD.
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE3NUMBER  3
*
*                ORGAN NAME   DOSE THRESHOLD (Sv)
*
TYPE3OUT001    'A-RED MARR'        1.5
TYPE3OUT002    'A-LUNGS'           5.0
TYPE3OUT003    'L-EDEWBODY'        0.05
********************************************************************************
* RESULT 4 OPTIONS BLOCK, LOADED BY INOUT4, STORED IN /INOUT4/
* 360 DEGREE AVERAGE RISK OF A GIVEN EFFECT AT A GIVEN DISTANCE.
*
* POSSIBLE TYPES OF EFFECTS ARE:
*
*   'ERL FAT/TOTAL'
*   'ERL INJ/INJURY NAME'
*   'CAN FAT/CANCER NAME'
*   'CAN FAT/TOTAL'
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
```

```
*
TYPE4NUMBER  5
*
*            RADIAL INDEX   TYPE OF EFFECT
*
TYPE4OUT001       1          'ERL FAT/TOTAL'
TYPE4OUT002       2          'ERL FAT/TOTAL'
TYPE4OUT003       3          'ERL FAT/TOTAL'
TYPE4OUT004       4          'ERL FAT/TOTAL'
TYPE4OUT005       5          'ERL FAT/TOTAL'
********************************************************************************
* RESULT 5 OPTIONS BLOCK, LOADED BY INOUT5, STORED IN /INOUT5/
*
* TOTAL POPULATION DOSE TO A GIVEN ORGAN BETWEEN TWO DISTANCES.
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE5NUMBER     5
*
*             ORGAN      I1DIS5     I2DIS5
*
TYPE5OUT001 'L-EDEWBODY'      1          12           (0-10 MILES)
TYPE5OUT002 'L-EDEWBODY'      1          19    NOCCDF  (0-50 MILES)
TYPE5OUT003 'L-EDEWBODY'      1          26    NOCCDF  (0-1000 MILES)
TYPE5OUT004 'L-EDEWBODY'      1          21           (0-100 MILES)
TYPE5OUT005 'L-EDEWBODY'      1          25           (0-500 MILES)
********************************************************************************
* RESULT 6 OPTIONS BLOCK, LOADED BY INOUT6, STORED IN /INOUT6/
*
* CENTERLINE DOSE TO AN ORGAN VS DIST BY PATHWAY, PATHWAY NAMES ARE AS FOLLOWS:
*
*  PATHWAY NAME:
*    'CLD'     - CLOUDSHINE
*    'GRD'     - GROUNDSHINE
*    'INH ACU' - "ACUTE DOSE EQUIVALENT" FROM DIRECT INHALATION OF THE CLOUD
*    'INH LIF' - "LIFETIME DOSE COMMITMENT" FROM DIRECT INHALATION OF THE CLOUD
*    'RES ACU' - "ACUTE DOSE EQUIVALENT" FROM RESUSPENSION INHALATION
*    'RES LIF' - "LIFETIME DOSE COMMITMENT" FROM RESUSPENSION INHALATION
*    'TOT ACU' - "ACUTE DOSE EQUIVALENT" FROM ALL PATHWAYS
*    'TOT LIF' - "LIFETIME DOSE COMMITMENT" FROM ALL PATHWAYS
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE6NUMBER     0
```

```
*
*              ORGNAM         PATHNM      I1DIS6    I2DIS6
*
*TYPE6OUT001  'A-RED MARR'     'TOT ACU'      1        19      (0-50 MILES).
*TYPE6OUT002  'A-LUNGS'        'TOT ACU'      1        19      (0-50 MILES)
*TYPE6OUT003  'L-EDEWBODY'     'TOT LIF'      1        26      (0-1000 MILES)
********************************************************************************
* RESULT 7 OPTIONS BLOCK, LOADED BY INOUT7, STORED IN /INOUT7/
*
* CENTERLINE RISK OF A GIVEN EFFECT VS DISTANCE
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE7NUMBER   0
*
*                    NAME            I1DIS7       I2DIS7
*
*TYPE7OUT001     'ERL FAT/TOTAL'        1            19       (0-50 MILES)
*TYPE7OUT002     'CAN FAT/TOTAL'        1            26       (0-1000 MILES)
********************************************************************************
* RESULT 8 OPTIONS BLOCK, LOADED BY INOUT8, STORED IN /INOUT8/
*
* POPULATION WEIGHTED FATALITY RISK BETWEEN 2 DISTANCES
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE8NUMBER   2
*
*                 NAME       I1DIS8  I2DIS8
*
TYPE8OUT001 'ERL FAT/TOTAL'   1       5      NOCCDF  (0-EXCL ZONE + 1 MI)
TYPE8OUT002 'CAN FAT/TOTAL'   1      12      NOCCDF  (0-10 MILES)
********************************************************************************
* RESULT A OPTIONS BLOCK, LOADED BY INOUTA, STORED IN /INOUTA/
*
* peak dose to a given organ
*
*            NUMA
TYPEANUMBER   1
*
*              ORGNAM    I1DISA  I2DISA
TYPEAOUT001 'L-EDEWBODY'  1       26
.
********************************************************************************
```

```
* EMERGENCY RESPONSE SCENARIO NUMBER 2
**************************************************************************
* EVACUATION ZONE DATA BLOCK, LOADED BY EVNETW, STORED IN /NETWOR/, /EOPTIO/
*
* SPECIFIC DESCRIPTION OF THE EMERGENCY RESPONSE SCENARIO BEING USED
*
EZEANAM2001  'NO EVACUATION, RELOCATION MODELS APPLY EVERYWHERE'
*
* WEIGHTING FRACTION APPLICABLE TO THIS SCENARIO
*
EZWTFRAC001  0.005
*
* LAST RING IN THE MOVEMENT ZONE
*
EZLASMOV001     0   (A ZERO TURNS OFF THE EVACUATION MODEL)
*
```

Table A-6. CHRONC Input File for Case 12d

```
* GENERAL DESCRIPTIVE TITLE DESCRIBING THIS "CHRONC" INPUT FILE
*
CHCHNAME001 'IN3A_N.INP, Sample Problem A, "New" COMIDA2-Based Food Model'
********************************************************************************
* EMERGENCY RESPONSE COST DATA BLOCK
*
* DAILY COST FOR A PERSON WHO IS EVACUATED (DOLLARS/PERSON-DAY)
*
CHEVACST001  27.00   (INCLUDES FOOD AND HOUSING COSTS BUT NOT LOST INCOME)
*
* DAILY COST FOR A PERSON WHO IS RELOCATED (DOLLARS/PERSON-DAY)
*
CHRELCST001  27.00   (INCLUDES FOOD AND HOUSING COSTS BUT NOT LOST INCOME)
********************************************************************************
* LONG TERM PROTECTIVE ACTION DATA BLOCK
*
* Duration of the intermediate phase period--at version 1.11c TMIPND is no
* longer processed.  The new input variable DUR_INTPHAS is the period's
* duration, not the time after plume arrival at which the period ends.
*
DUR_INTPHAS   0.0    (in seconds)   (no intermediate phase)
*
* LONG-TERM PHASE DOSE PROJECTION PERIOD, THE DURATION OF THE EXPOSURE
* PERIOD OVER WHICH THE LONG-TERM DOSE CRITERION IS EVALUATED (SECONDS)
*
CHTMPACT001   1.58E8             (5 YEARS)
*
* DOSE CRITERION FOR INTERMEDIATE PHASE RELOCATION (Sv)
*
CHDSCRTI001   1.0E5              (NO INTERMEDIATE PHASE RELOCATION)
*
* DOSE CRITERION FOR LONG-TERM PHASE RELOCATION (Sv)
*
CHDSCRLT001    0.04
*
* CRITICAL ORGAN NAME FOR LONG-TERM ACTIONS
*
CHCRTOCR001 'L-EDEWBODY'
*
* Long Term Exposure Period    Previously permanently set to:
*    one million years = 3.15 E13 seconds
```

```
*    MACCS2 allowable range is 3.15E7 to 1.E10
*
CHEXPTIM001    1.E10
*********************************************************************************
* DECONTAMINATION PLAN DATA BLOCK
*
* NUMBER OF LEVELS OF DECONTAMINATION
*
CHLVLDEC001  2
*
* DECONTAMINATION TIMES CORRESPONDING TO THE LVLDEC LEVELS OF DECONTAMINATION
*  (SECONDS)
*
CHTIMDEC001   5.184E6  1.0368E7    (60, 120 DAYS)
*
* DOSE REDUCTION FACTORS CORRESPONDING TO THE LVLDEC LEVELS OF DECONTAMINATION
*
CHDSRFCT001   3.       15.
*
* COST OF FARM DECONTAMINATION PER FARMLAND UNIT AREA (DOLLARS/HECTARE)
*  FOR THE VARIOUS LEVELS OF DECONTAMINATION
*
CHCDFRM0001   562.5   1250.
*
* COST OF NONFARM DECONTAMINATION PER RESIDENT PERSON (DOLLARS/PERSON)
*  FOR THE VARIOUS LEVELS OF DECONTAMINATION
*
CHCDNFRM001   3000.   8000.
*
* FRACTION OF FARMLAND DECONTAMINATION COST DUE TO LABOR
*  FOR THE VARIOUS DECONTAMINATION LEVELS
*
CHFRFDL0001  .3       .35
*
* FRACTION OF NON-FARM DECONTAMINATION COST DUE TO LABOR
*  FOR THE VARIOUS DECONTAMINATION LEVELS
*
CHFRNFDL001  .7       .5
*
* FRACTION OF TIME WORKERS IN FARM AREAS SPEND IN CONTAMINATED AREAS
*  FOR THE VARIOUS DECONTAMINATION LEVELS
*
CHTFWKF0001  .10      .33
*
```

```
* FRACTION OF TIME WORKERS IN NON-FARM AREAS SPEND IN CONTAMINATED AREAS
*  FOR THE VARIOUS DECONTAMINATION LEVELS
*
CHTFWKNF001  .33     .33
*
* AVERAGE COST OF DECONTAMINATION LABOR (DOLLARS/MAN-YEAR)
*
CHDLBCST001   35000.
******************************************************************************
* INTERDICTION COST DATA BLOCK
*
* DEPRECIATION (DETERIORATION) RATE DURING INTERDICTION PERIOD (PER YEAR)
*
CHDPRATE001    .20   (VALUE OBTAINED FROM WASH-1400, APPENDIX 6)
*
* INVESTMENT INCOME RETURN (DISCOUNT RATE) DURING INTERDICTION PERIOD (PER YEAR)
* THIS VALUE SHOULD BE DERIVED AS A REAL RETURN RATE ADJUSTED FOR INFLATION
*
CHDSRATE001    .12   (VALUE OBTAINED FROM WASH-1400, APPENDIX 6)
*
* POPULATION RELOCATION COST (DOLLARS/PERSON):
*  ALTERNATIVE HOUSING, MOVING COSTS, AND LOST INCOME FOR PEOPLE IN
*  AREAS WHICH REQUIRE DECONTAMINATION, INTERDICTION, OR CONDEMNATION
*
CHPOPCST001   5000.
******************************************************************************
* GROUNDSHINE WEATHERING DEFINITION DATA BLOCK
*
* NUMBER OF TERMS IN THE GROUNDSHINE WEATHERING RELATIONSHIP (EITHER 1 OR 2)
*
CHNGWTRM001   2
*
* GROUNDSHINE WEATHERING COEFFICIENTS
*
CHGWCOEF001   0.5    0.5            (JON HELTON)
*
* HALF LIVES CORRESPONDING TO THE GROUNDSHINE WEATHERING COEFFICIENTS (S)
*
CHTGWHLF001   1.6E7  2.8E9          (JON HELTON)
******************************************************************************
* RESUSPENSION WEATHERING DEFINITION DATA BLOCK
*
* NUMBER OF TERMS IN THE RESUSPENSION WEATHERING RELATIONSHIP
*
```

```
CHNRWTRM001    3
*
* RESUSPENSION CONCENTRATION COEFFICIENTS   (/ METER)
*  RELATIONSHIP BETWEEN GROUND CONCENTRATION AND INSTANTANEOUS AIR CONC.
*
CHRWCOEF001  1.0E-5   1.0E-7   1.0E-9  (VALUES HERE SELECTED BY JON HELTON)
*
* HALF-LIVES CORRESPONDING TO THE RESUSPENSION CONCENTRATION COEFFICIENTS (S)
*
CHTRWHLF001  1.6E7    1.6E8    1.6E9   (6 MONTHS, 5 YEARS, 50 YEARS)
********************************************************************************
* SITE REGION DESCRIPTION DATA BLOCK
*
* FRACTION OF AREA THAT IS LAND IN THE REGION
*
CHFRACLD001   0.95   (ROUGH GUESS VALUE, SITE FILE OVERRIDES THIS VALUE)
*
* FRACTION OF LAND DEVOTED TO FARMING IN THE REGION
*
CHFRCFRM001   0.382  (VIRGINIA STATE VALUE, SITE FILE OVERRIDES THIS VALUE)
*
* AVERAGE VALUE OF ANNUAL FARM PRODUCTION IN THE REGION (DOLLARS/HECTARE)
*  (CASH RECEIPTS FROM FARMING PLUS VALUE OF HOME CONSUMPTION)/(LAND IN FARMS)
*
CHFRMPRD001   371.0  (VIRGINIA STATE VALUE, SITE FILE OVERRIDES THIS VALUE)
*
* FRACTION OF FARM PRODUCTION RESULTING FROM DAIRY PRODUCTION IN THE REGION
*  (VALUE OF MILK PRODUCED)/(CASH RECEIPTS FROM FARMING PLUS HOME CONSUMPTION)
*
CHDPFRCT001   0.198  (VIRGINIA STATE VALUE, SITE FILE OVERRIDES THIS VALUE)
*
* VALUE OF FARM WEALTH (DOLLARS/HECTARE)
*  (AVERAGE VALUE PER HECTARE OF FARM LAND AND BUILDINGS TO 100 MILES)
*
CHVALWF0001   2613.  *  SURRY
*
* FRACTION OF FARM WEALTH IN IMPROVEMENTS FOR THE REGION
*
CHFRFIM0001   0.25  *  SURRY
*
* NON-FARM WEALTH, PROPERTY AND IMPROVEMENTS FOR THE REGION (DOLLARS/PERSON)
*  THE VALUE OF ALL RESIDENTIAL, BUSINESS, AND PUBLIC ASSETS WHICH WOULD BE
*  LOST IN THE EVENT OF PERMANENT INTERDICTION (CONDEMNATION) OF THE AREA
*
```

```
CHVALWNF001   84000.  *  SURRY
*
* FRACTION OF NON-FARM WEALTH IN IMPROVEMENTS FOR THE REGION
*
CHFRNFIM001   0.8
***************************************************************************
CHFDPATH001 'NEW'
*
* name of the COMIDA2 binary output file
*
BIN_FILE001 'SAMP_A.BIN'   (revised data file of 8/12/95)
*
* Dose limits triggering first year crop disposal of the separate
* milk and non-milk components of the diet, corresponding in purpose,
* more or less, to the MACCS 1.5 input variables PSCMLK and PSCOTH
*
* For NUREG-1150 calculations, the maximum allowable ground concentrations for
* production of milk and non-milk crops contaminated by an accident occurring
* in the growing season were derived based on an assumed maximum allowable
* dose of 5 rem effective or 15 rem thyroid, per the 1982 FDA guidance that's
* reprinted in the 1992 EPA PAG Manual.  For purposes of comparison against
* the prior results, it is being assumed, for simplicity, that milk and
* non-milk crops contribute equally to the first year dose.  Thus, the 5 rem
* effective dose limit used in NUREG-1150 is equally split between milk and
* non-milk crops, with 2.5 rem allowed for each.  Similarly, the 15 rem
* thyroid limit is split into 7.5 and 7.5 rem for the milk and non-milk
* portions of the diet.
*
*             effective     thyroid  (doses in sieverts)
DOSEMILK001    0.025          0.075
DOSEOTHR001    0.025          0.075
*
* Annual dose limits for the subsequent year's (i.e., after the first year)
* interdiction of BOTH the milk and non-milk (combined) components of the diet
*
* Note: the long-term food critera, GCMAXR, used for NUREG-1150 wre based on
* an ingestion dose integrated from zero to infinity.  It is not possible to
* translate those parameter values into corresponding annual dose limits, as is
* required by the COMIDA2-based food model.  The "total" dose limits used in
* NUREG-1150 for "root uptake", 0.5 rem effective and 1.5 rem thyroid, are used
* here as annual dose limits for interdiction of food production in years the
* years subsequent to the accident.
*
*             effective     thyroid  (doses in sieverts)
```

```
DOSELONG001    0.005          0.015
*
* NUMBER OF NUCLIDES IN THE WATER INGESTION PATHWAY MODEL
*
CHNUMWPI001    4
*
* TABLE OF NUCLIDE DEFINITIONS IN THE WATER INGESTION PATHWAY MODEL
*
* IF A SITE DATA FILE IS DEFINED, THE DATA DEFINING THE WATERSHED INGESTION
*  FACTOR IS SUPERSEDED BY THE CORRESPONDING DATA IN THE SITE DATA FILE
*
*                        INITIAL     ANNUAL    INGESTION FACTOR
*             WATER      WASHOFF     WASHOFF    ((Bq INGESTED)/
*            NUCLIDE     FRACTION     RATE       (Bq IN WATER))
*
*             NAMWPI      WSHFRI      WSHRTA         WINGF
CHWTRISO001   Sr-89        0.01       0.004          5.0E-6
CHWTRISO002   Sr-90        0.01       0.004          5.0E-6
CHWTRISO003   Cs-134       0.005      0.001          5.0E-6
CHWTRISO004   Cs-137       0.005      0.001          5.0E-6
********************************************************************************
* SPECIAL OPTIONS DATA BLOCK
*
* DETAILED PRINT OPTION CONTROL SWITCHES, LOOK AT THE CODE BEFORE TURNING ON!!
*          KSWDSC
*
CHKSWTCH001   0
********************************************************************************
* DEFINE THE TYPE 9 RESULTS
*
* LONG-TERM POPULATION DOSE IN A GIVEN REGION BROKEN DOWN BY THE 12 PATHWAYS
*
* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
* FOR EACH RESULT YOU REQUEST, THE CODE WILL PRODUCE A SET OF 12
*
TYPE9NUMBER   2      (UP TO 10 ALLOWED)
*
*              ORGNAM         INNER      OUTER
*
TYPE9OUT001   'L-EDEWBODY'       1          26    (0-1000 MILES)
TYPE9OUT002   'L-EDEWBODY'       1          19    (0-50 MILES)
********************************************************************************
* ECONOMIC COST RESULTS IN A REGION BROKEN DOWN BY 12 TYPES OF COSTS
*
```

```
* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
* FOR EACH RESULT YOU REQUEST, THE CODE WILL PRODUCE A SET OF 12
*
TYP10NUMBER   2      (UP TO 10 ALLOWED)
*
*              INNER      OUTER
*
TYP10OUT001      1          26    (0-1000 MILES)
TYP10OUT002      1          19    (0-50 MILES)
****************************************************************************
* DEFINE A FLAG THAT CONTROLS THE PRODUCTION OF THE ACTION DISTANCE RESULTS
*
* SPECIFYING A VALUE OF .TRUE. TURNS ON ALL 8 OF THE ACTION DISTANCE RESULTS,
* A VALUE OF .FALSE. WILL ELIMINATE THE ACTION DISTANCE RESULTS FROM THE OUTPUT.
*
TYP11FLAG11  .TRUE.
****************************************************************************
* IMPACTED AREA/POPULATION RESULTS IN A REGION BROKEN DOWN BY 6 TYPES OF IMPACTS
*
* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
* FOR EACH RESULT YOU REQUEST, THE CODE WILL PRODUCE A SET OF 8
*
TYP12NUMBER   2      (UP TO 10 ALLOWED)
*
*              INNER      OUTER
*
TYP12OUT001      1          26    (0-1000 MILES)
TYP12OUT002      1          19    (0-50 MILES)
****************************************************************************
* Maximal annual food ingestion dose to an individual, requested by IXOT13
*
* This result is calculated after accounting for temporary or
* permanent interdiction.  It is only available for the "new" food model.
*
* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
*
TYP13NUMBER   20   (UP TO 10 ALLOWED)
*
* IRAD13 is the radial spatial interval at which results are requested
*
* ORGN13 is the name of the organ for which results are requested
*  (allowable values for ORGN13 are 'EFFECTIVE' or 'THYROID')
*
*          IRAD13   ORGN13
```

```
*
TYP13OUT001   2    EFFECTIVE
TYP13OUT002   4    EFFECTIVE
TYP13OUT003   6    EFFECTIVE
TYP13OUT004   8    EFFECTIVE
TYP13OUT005  10    EFFECTIVE
TYP13OUT006  12    EFFECTIVE
TYP13OUT007  14    EFFECTIVE
TYP13OUT008  16    EFFECTIVE
TYP13OUT009  18    EFFECTIVE
TYP13OUT010  20    EFFECTIVE
TYP13OUT011   2    THYROID
TYP13OUT012   4    THYROID
TYP13OUT013   6    THYROID
TYP13OUT014   8    THYROID
TYP13OUT015  10    THYROID
TYP13OUT016  12    THYROID
TYP13OUT017  14    THYROID
TYP13OUT018  16    THYROID
TYP13OUT019  18    THYROID
TYP13OUT020  20    THYROID
.
```