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Probabilistic Accident Consequence Uncertainty Assessment Using COSYMA

Uncertainty from the Early and Late Health Effects Module

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FOREWORD

This is one of a series of reports describing an uncertainty analysis on the predictions of the accident consequence assessment code COSYMA. A complete list of the reports produced in this project is given in Appendix A, where the reports are divided into those describing the expert judgement study on the distributions of the input parameter values and those describing the results of the analysis. This report describes the results of the analysis of the uncertainty in the predicted consequences of accidental releases reflecting the uncertainty in the values of the input parameters for calculating the risk of early and late health effects given the dose in time periods.

All of the reports describing the results of the analysis have common material in their introductory sections, so that any single report can be read without having to refer to background material in other reports of the series. This is one of four reports which describe the different module analyses. Section 1 (Background to the study) is identical in each of these reports. Sections 2.1and 2.4 are very similar in each of the module analysis reports. Those parts of section 2 describing the general approach, the methods for combining distributions and sampling from them are identical in these reports apart from a few sentences referring to particular features of the module in question. The opening part of section 3 is also the same in these reports.

Sections 1.1 and 1.2 of this report are almost identical to the first chapter of the "Methodology Report", with differences for references to material that is explained in more detail in that report. Section 1.2 of the Methodology Report includes a final paragraph that is not in the other reports.

Sections 1.1, 1.2 and 1.4 and the opening part of section 3 are very similar to the equivalent sections of the overall analysis report.

Appendices A (list of reports from the project) and B (description of the models in COSYMA) are included in each of the reports on the uncertainty analysis.

ABSTRACT

A study to perform an uncertainty analysis of the European accident consequence assessment system, COSYMA, has been carried out under contract to the European Commission. The study involved a series of analyses of the uncertainty in different sections of the system, followed by a final analysis of the uncertainty in the whole system.

The overall aims of the study can be summarised as:

1 to formulate a state-of-the-art expert judgement methodology which is capable of finding broad acceptance,
2 to apply the methodology to estimate uncertainties associated with the predictions of the probabilistic accident consequence assessment system COSYMA,
3 to provide an input to identifying future R&D priorities.

This report describes the analysis of the uncertainty in the health module of COSYMA. Specifically it describes the analysis of the uncertainty in the model predictions resulting from uncertainty in the values to be assigned to the input parameters describing the risk of health effects from known doses of radiation. The main aim of this part of the study was to identify the input parameters whose uncertainties make large contributions to the overall uncertainty; the parameters identified would then be included in the final analysis of the uncertainty in the whole system.

Uncertainty analysis involves specifying probability distributions for the values of each of the parameters involved, sampling sets of values from those distributions and propagating them through the model to derive information on the uncertainty in the model prediction. Those parameters whose uncertainties make major contributions to the overall uncertainty can then be identified using correlation coefficients between the input values and the model outputs. An earlier expert judgement study has provided distributions on the values of the parameters describing the risk of exposure to particular doses.

The study evaluated the uncertainty on the individual and collective risks of early and late health effects in the population. The calculations were undertaken for a number of situations with and without allowing for the effects of countermeasures. Some licensing procedures require estimates of he potential individual doses and risks at points near the reactor site. Potential doses and risks are calculated assuming people are outdoors for the whole of the period of interest, and so make no allowance for countermeasures or shielding by normal occupation of buildings. The study evaluated such risks of health effects associated with such potential doses. Consequences assuming normal living (ie allowing for shielding by buildings but no countermeasures) are considered in the licensing procedures of several countries. Hence calculations were undertaken for individual and collective risks for normal living.

The source terms chosen encompass a wide range of characteristics (eg magnitude and composition) of source terms that have been postulated for LWRs. They are taken from analyses of the pressurised water reactor proposed for Hinkley Point in the UK. UK1 is a very large release; it is the

risk-dominant source term for early health effects and a major contributor to the overall risk of late health effects from the reactor. CB2 is a smaller, but less unlikely, sequence that also makes a major contribution to the overall risk of late health effects from the reactor. DBA is a design basis accident.

The study showed that the uncertainty (expressed as the ratio of the 95th to the 5th percentile of the probability distribution on the expectation value of the consequence) is between about a factor of 3 and a factor of 14 for most early health effects. The uncertainty on the expectation value of the numbers of fatal cancers is a factor of about 30 to 40 for the different conditions considered.

The uncertainty on the numbers of early mortalities reflect mainly the uncertainties on the parameters in the dose response relationships for death from the haematopoietic syndrome and from skin burns. The uncertainties on the risk coefficients for cancers in different organs make similar contributions to the overall uncertainty on the numbers of fatal cancers.

In many situations, very few input parameters contribute to the endpoints considered, and so the uncertainty on each of the input parameters can make a significant contribution to the overall uncertainty on the predicted consequences. Therefore, all the input parameters for this part of the system were included in the final analysis.

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1 BACKGROUND TO THE STUDY

1.1 Introduction

Despite the elaborate precautions taken in the design, construction and operation of nuclear facilities, there will always remain the possibility, however small, of accidental releases of radioactivity into the environment. There is a need to evaluate the risks arising from potential accidents, on a probabilistic basis, taking into account the spectrum of possible consequences of accidents and their associated probability of occurrence. Probabilistic risk assessment (PRA) or accident consequence assessment (ACA) is the process whereby the consequences of potential accidental releases are assessed, taking into account the range of conditions which may prevail at the time of the accident, and the associated probability of these conditions. Such assessments have applications in the design, siting, licensing and operating phases of a nuclear installation. They can be used to evaluate the risks posed by a specific or representative nuclear site, for example for comparison with safety criteria. They can be used for evaluating the effects of design changes or of plant modifications. They also have an input into emergency planning and to some aspects of siting studies.

A number of computer systems have been developed for use in such assessments. Such systems include models for describing the pathways by which people are irradiated following discharges of material, and for calculating the doses and the associated health risks. The models require values to be specified for a large number of input parameters. The predictions of such models are uncertain for two main reasons, which can be summarised as:

(a) *modelling uncertainties,* arising from a lack of knowledge about the most appropriate mathematical formulation to represent environmental processes,
(b) *parameter value uncertainties,* arising from inadequate knowledge about the most appropriate values to be assigned to the many parameters in the model.

The models adopted are not perfect as they contain idealisations and simplifying assumptions. They may not describe all features concerned; features which have been omitted because they make only a small contribution to the "best estimate" model prediction may make larger contributions to the uncertainty. The most appropriate values to be assigned to the many parameters involved in the model may not be known with certainty, leading to uncertainty in the final predictions of the model.

Two computer systems for use in probabilistic accident consequence assessments (COSYMA[1] in the European Union and MACCS[2] in the US) were developed around 1990, and made generally available. There has been an interest in quantifying the uncertainty in the predictions of such systems, and extensive analyses of the uncertainty on predecessors of both programs have been carried out [3,4,5]. An important feature of an uncertainty analysis is the derivation of a joint distribution* on the values of the many parameters involved. In the earlier

* The joint distribution assigns a probability to each feasible set of values of the input parameters.

studies, the joint distribution was largely specified by the system developers, rather than experts in the many different fields involved in accident consequence modelling.

In 1991, both the European Commission (EC) and the United States Nuclear Regulatory Commission (USNRC) were considering initiating studies to better quantify the uncertainty in the input parameter values and in the predictions of the systems. An essential aspect of these studies was to obtain distributions and information on the dependencies between parameter values using formal expert judgement elicitation techniques. The studies were combined into a single EC/USNRC project intended to develop credible and traceable uncertainty distributions for the respective system input parameters. A further intention was for these distributions to be propagated through the two systems, and so quantify the uncertainty in the predictions.

The broad objectives of both the EC and USNRC for this study can be summarised as:

1 to formulate a state-of-the-art expert judgement methodology which is capable of finding broad acceptance;

2 to apply the methodology to estimate uncertainties associated with the predictions of the probabilistic accident consequence systems COSYMA and MACCS;

3 to provide an input to identifying future R&D priorities.

Within these broad objectives, small differences in emphasis exist between the EC and USNRC. This report concentrates on the analysis using COSYMA, and the EC aims and objectives.

The first objective was met in two ways. First, the collaboration between research teams from the US and Europe led to the development of agreed methods for the study, and in particular for the formal elicitation of expert judgement. Second, a protocol document describing the methods to be used for the final uncertainty analyses on COSYMA was distributed to a number of researchers in the field for comment. The views expressed on that document have been incorporated into the methods used for the analysis.

The second objective was met by using the joint distribution on the uncertain parameter values derived from the expert elicitation in an analysis of the uncertainty in the predictions of the consequences of accidental releases using COSYMA. Undertaking rigorous uncertainty analyses involves considerable computational costs and substantial effort. It is not possible to carry out such analyses on every occasion when accident consequence assessments are undertaken. It was intended that the levels of uncertainty obtained in this study would indicate the likely levels of uncertainty in other, similar, situations. Therefore, this analysis has been undertaken for several combinations of source term and types of population behaviour with the intention of deriving indicative levels of uncertainty should COSYMA be applied in other situations. For example, if the study shows that the uncertainty in a particular endpoint for a particular countermeasures strategy is a factor of 10, then it can be assumed that in similar situations the uncertainty is also a factor of 10, not 100.

There are several aspects to the third objective above. The uncertainty was better quantified because the distributions on the parameter values were determined from formal techniques of expert judgement. In addition to calculating the uncertainty on the model predictions, the study also identified the input parameters whose uncertainties make major contributions to the overall uncertainty. This can form an input into identifying research priorities.

Uncertainty analyses can be considered to consist of three broad stages, each of which could be further divided into smaller steps. The first step is to determine what types of uncertainty are present in the model being analysed, which types will be considered in the analysis and which of the model's input parameters will be considered to be uncertain. This step also includes identifying those model endpoints for which the uncertainty will be analysed. The second broad step is to determine the joint distribution on the values of the model input parameters that are being considered. This joint distribution includes not only the ranges of each of the parameter values, but also the probability distribution of the input parameter taking different values within that range and any dependencies between the values of the different parameters within their ranges. In this study, the joint distribution over the model input parameters has been obtained using formal techniques for eliciting expert judgement. These parts of the study have been described in a series of reports, as listed in Appendix A. The final broad step is to sample sets of input parameter values from the joint distribution, to propagate those values through the model, to determine the uncertainty on the model endpoints and identify those parameters whose uncertainties make large contributions to the overall uncertainty.

The models included in COSYMA are described in Appendix B. There are many hundreds of parameters involved in describing the transfer of radioactive material from its release through the environment to man and calculating the subsequent doses and risks. It would not be possible to consider all these parameters in a single analysis, because of the complexity of the analyses and amount of computation that would be required. Therefore, a series of analyses of parts of the complete COSYMA system have been carried out. These are described as “module analyses”, although the parts of the code considered in these analyses do not necessarily correspond exactly to the defined modules of COSYMA[1]. Throughout this report, the term “module” is used to refer to the part of the system under analysis, unless indicated otherwise. Each module includes a number of different models. Those parameters whose uncertainties make major contributions to the overall uncertainty for each module were identified and included in a final overall analysis. The following module analyses were carried out before the final analysis:

1) Dispersion and deposition
2) Foodchain transfer
3) Dosimetry - external, inhalation and ingestion doses
4) Early and late health effects.

The main aim of the module analyses was to identify the parameters which should be included in the final overall analysis, and the list of parameters constitutes the main conclusions of this report. A further part of the overall analysis is to explain the relative uncertainties on the

different quantities considered. This report gives explanations for the relative uncertainties within this module, and so contributes to the process of understanding the results of the final analysis. These explanations are also one of the conclusions of this section of the study. These explanations are included in section 3 of this report, where the endpoints are discussed in turn. This means that the main conclusions of this report are presented in section 3, rather than being drawn together in a separate "conclusions" section.

The module analysis reports do not include any discussions of the extent to which the results of the analysis might be applicable in other situations (e.g. other sites or source terms). The report on the overall analysis[6] does include a discussion on the extent to which the results of this study can be applied in other situations.

The analyses reported here calculated the uncertainty on the overall endpoints of COSYMA coming from the uncertainty in the input parameters for the particular module, rather than simply considering the uncertainty on the endpoints of that particular module. In this way, the importance of the parameter uncertainties can be judged in terms of their contribution to the overall uncertainty and not simply in terms of their contribution to some intermediate quantity in the calculation. Default values were allocated to the parameters of the other modules for which the uncertainty was not considered in the particular analysis. Thus the analysis of the uncertainty on the dispersion and deposition module assumed default values for the parameters describing food chain transfer, dose models and health effects models. This division into modules is such that no single parameter is input to more than one module, and there are no large correlations between the values of the input parameters for the different modules.

Since the study was intended to derive indicative levels for the uncertainty to be expected under normal applications of COSYMA, it was necessary to make as few changes as possible to COSYMA for this analysis. For this reason, the models used in COSYMA were not modified to give a better fit to the distributions provided by the experts. In some cases, the models included in COSYMA are complex and an uncertainty analysis of the full version of the system would have required excessive amounts of computer resources. In these cases, the models were simplified so that the uncertainty analysis could be carried out more easily. Simplifications were introduced in the calculation of the risk of late health effects, the models for transfer of some radionuclides to animal products, and the model for human metabolism of actinides. These simplifications will not have significantly altered the extent of the uncertainty on the predictions of COSYMA, though they may have altered slightly the central values about which the uncertainty is expressed. They have not affected the aims of the study, as the objective was to evaluate the extent of the uncertainty in the predictions for typical COSYMA calculations, rather than the absolute value of the consequences of particular accidental releases.

This is one of a series of reports describing the overall analysis of the uncertainty in the predictions of COSYMA. The starting point for this series of reports is taken as the end of the expert elicitation process. Appendix A gives a complete list of the reports relating to the project. The remainder of this chapter gives information relating to the study that is common to all the analyses, namely the source terms, endpoints, uncertainties and selection of atmospheric conditions adopted in the study. Further information on the methods adopted, and on the way in which the

results are presented, is given in one of the companion reports[7].

1.2 Situations considered

Three source terms, encompassing a wide range of characteristics of source terms that have been postulated for LWRs (e.g. magnitude and composition), have been considered in this study. They were taken from analyses of the pressurised water reactor proposed for the Hinkley Point site in the UK. UK1 is a very large release; it was identified as the risk-dominant source term for early health effects and a major contributor to the overall risk of late health effects from the reactor[8]. CB2 is a smaller, but less unlikely, sequence that also makes a major contribution to the overall risk of late health effects from the reactor[9]. DBA is a design basis accident[10]. This is a fault which the plant is designed to take or can be shown to withstand without unacceptable consequences, by virtue of the plant's inherent characteristics or safety systems. The amounts of material released for the UK1 and CB2 source terms were calculated from the reactor inventory and the release fractions which apply to groups of elements; the amount of each isotope released for the DBA source term was specified directly. The source terms are summarised in Table 1.1 to Table 1.3. Table 1.1 shows the assumed inventory of the reactor; Table 1.2 gives the release fractions used for the UK1 and CB2 source terms, and Table 1.3 gives the amount of each nuclide released in the DBA source term. Table 1.2 also gives approximate release fractions for the DBA source term, to enable easy comparisons of the magnitude of this and the other source terms.

The calculations were undertaken for a range of patterns of population behaviour. Some licensing procedures require estimates of the potential individual doses and risks at points near the reactor site. Potential doses are calculated assuming people are outdoors for the whole of the period of interest, and so make no allowance for countermeasures or shielding by normal occupation of buildings. The study evaluated such potential doses, and the associated risks of health effects. Consequences assuming normal living (i.e. allowing for shielding by buildings but no countermeasures) are considered in the licensing procedures of several countries. Hence calculations were also undertaken for individual and collective doses and risks for normal living.

There is also an interest in calculating the uncertainty on the predictions of COSYMA if allowance is made for the countermeasures that might be imposed following a reactor accident. International organisations have suggested ranges of criteria for implementing countermeasures, recognising that intervention levels might depend on the situation and scale of accident that occurs. A countermeasures strategy based on the IAEA[11] intervention levels for sheltering, evacuation, iodine tablets and relocation together with the EU levels for banning food[12,13,14] was used. The intervention levels and implementation times used for this study are given in Table 1.4 Doses and risks are calculated assuming normal living for those not subject to countermeasures, or not subject to countermeasures in a given time period.

COSYMA gives information on a wide variety of consequences of an accident. It was not possible to generate information on all of these endpoints in this study. Therefore, the study evaluated the uncertainty on a selection of endpoints; information on the uncertainty in other endpoints can be deduced from these results. A complete list of endpoints is given in Table 1.5;

they can be summarised as follows:

- air concentration and deposition of ^{131}I and ^{137}Cs at selected distances.
- individual dose to 7 days in bone marrow, thyroid and skin at selected distances.
- individual and collective risks of early health effects (total risks of mortality, and of the haematopoietic syndrome, the total risks of morbidities and of lung morbidity and hypothyroidism).
- the areas with emergency actions for sheltering, evacuation and distribution of stable iodine tablets.
- individual and collective committed effective dose and doses in bone marrow and thyroid.
- individual and collective risks of the numbers of fatal cancers (total and from thyroid) and leukaemia.
- the areas and their time integrals affected by relocation and by food restrictions, for meat, milk, green vegetables and grain.

Different sub-sets of the complete list of endpoints are considered in the different module analyses, as some of the input parameter values for some of the modules do not influence all the endpoints. The endpoints considered in this module are identified in Section 3.

The collective health effects were evaluated for a hypothetical site in central Europe, as defined in a recent international intercomparison of reactor accident programs[15].

As stated earlier, the aim of the exercise was to derive indicative levels of uncertainty that should be appropriate for other, similar analyses using COSYMA. The size of uncertainty associated with the predictions may change for different magnitudes of the source term, and for calculations with and without countermeasures. The following set of situations was chosen for analysis, where NE and NL refer to the separate sub-systems of COSYMA relating to the calculation of early effects (NE sub-system) and late effects (NL sub-system):-

UK1 potential outdoor doses and risks, for those NE endpoints relating to individual doses and risks.
UK1 normal living with no countermeasures, for those NE endpoints relating to individual doses and risks, and to numbers of health effects.
UK1 with countermeasures, for those NE endpoints relating to individual doses and risks, and to numbers of health effects.
CB2 normal living with no countermeasures, for those NL endpoints relating to individual doses and risks, collective doses and numbers of late health effects.
CB2 with countermeasures, for all NE and NL endpoints.
DBA potential outdoor doses and risks, for those NL endpoints relating to individual doses and risks.
DBA with countermeasures, for all NL endpoints.

The following terminology is used when the results are presented in Section 3 for the three situations considered. “Potential doses” is used to refer to the calculation of doses outdoors and with no

countermeasures; this is adopted as the calculations give the highest doses that could potentially be received after the accident. “Normal living” is used to refer to the situation with no countermeasures; these calculations include the effects of buildings in reducing exposure, allowing for average behaviour of the population and occupancy of buildings. “With countermeasures” is used for the final situation; these calculations assume that all members of the population follow the adopted countermeasures strategy, but use the normal living assumptions for other aspects of the calculations.

The uncertainty on individual doses and risks for early effects (the NE endpoints) were evaluated at 0.875, 5 and 20 km, while the uncertainties on individual doses and risks for late effects (the NL endpoints) were evaluated at 5, 20 and 100 km. COSYMA calculates doses at discrete points on a spatial grid, and assumes that the dose at the centre of each grid area applies throughout that area. Thus the dose at 0.875 km is calculated as representing the doses over the distance band between 0.75 and 1 km.

This combination of conditions means that information on the uncertainty of the numbers of early health effects in the population was obtained mainly from the analyses for the UK1 source term. Little information on the uncertainty on these endpoints could be obtained from the analyses with the CB2 source term as doses from this source term were generally below the thresholds for producing early health effects. Information on the uncertainties in doses over short time periods and risks of early health effects for people who are outdoors at the time of the accident, for people who are living normally with no countermeasures taken, and if countermeasures are taken on the basis of doses in the exposed population were obtained from the analyses for the UK1 source term. The predicted risks of early health effects, and the associated uncertainties in the predictions, will not depend on the criteria used to invoke countermeasures unless they are such that some people who receive doses above the threshold for deterministic effects are not sheltered and evacuated. Although the analysis for the CB2 source term could not give much information on risks of early health effects, it did give results for the doses in short time periods, both for normal living and if countermeasures were taken.

Information on the uncertainty in the predicted extent of early countermeasures (sheltering, evacuation and distribution of stable iodine tablets) was obtained from the analyses for the CB2 source term. Information on the uncertainty on the late countermeasures (relocation and food restrictions) was obtained from the analyses for the CB2 and DBA source terms. Two source terms were selected for this part of the analysis as they have different relative contributions from the iodine and caesium isotopes.

Information on the predicted risks of late health effects was also obtained from the CB2 and DBA source terms, for both individual and collective risks. Again, the two source terms were used because of the different relative contributions of the iodine and caesium isotopes.

The extent of the uncertainty on the predicted air concentration and deposition does not depend on the size of the release. The endpoints relating to concentration and deposition were only considered in the analysis for the CB2 source term, as this is the only source term for which all four distances (from NE and NL) were considered.

The results from a single run of COSYMA are presented using the complementary cumulative frequency distribution function (ccdf), which gives the probability that the consequence is greater than a particular value. The distribution can be summarised using various characteristic quantities such as the expectation value (the mean or average of the distribution) and various percentiles. The *nth* percentile is the level of consequence that is exceeded with a probability of (100-n) percent. This study concentrates on the uncertainty on the mean value, the 95th and 99th percentiles.

The uncertainty analysis involved running COSYMA many times, so that many different values for the various endpoints were obtained. A probability distribution can be derived from these results, for each endpoint, and the uncertainty on the predicted consequence is then described by percentiles of that probability distribution. The general discussion of the extent of the uncertainty is presented using the ratio of the 95th to the 5th percentiles of the uncertainty distribution; the term "uncertainty factor" is used in this report to represent this factor. The same quantity is used in the reports describing the results of the expert elicitation, where it is termed "range factor". More detailed information is presented in Appendix C, where the 5th, 10th, 25th, 50th, 75th, 90th and 95th percentiles of the uncertainty distributions on the different parts of the ccdf considered are given. These descriptions of the uncertainty are evaluated for the mean value and the 95th and 99th percentiles of the ccdf. Some results are also presented in terms of the "mean curve", which is the average of the ccdfs from each of the COSYMA runs. The process is described in more detail in the "methodology report".[7] There is also an interest in the extent to which predictions obtained using the default value for each input parameter could underestimate the results. Therefore the ratio of the 95th percentile of the uncertainty distribution to the value obtained with the default values for the input parameters was also determined. This quantity is termed the "reference uncertainty coefficient".

One of the aims of the module analysis reports is to explain the relative magnitude of the uncertainty on different quantities, and to identify those parameters whose uncertainties make large contributions to the overall uncertainty. The explanations concentrate on the results for the mean value and the 99th percentile of the distribution, rather than on the 95th percentile. To some extent this reflects the difficulties in trying to explain the findings for the 95th percentile. The results for the 99th percentile reflect those for essentially the worst conditions that can arise. If individual doses or risks are being considered, this is on the plume centre line in adverse weather conditions. It is less clear, however, what conditions correspond to the 95th percentile. In general, this could occur in a variety of situations depending on values allocated to the many parameters involved in the analyses. In extreme cases of broad plumes, it could represent doses off the centre line. The mean value, representing the average across all conditions, is also easier to relate to the values of the parameters involved.

1.3 Items considered uncertain in the module analyses

The analyses look at the uncertainty on the COSYMA endpoints resulting from the uncertainty on the parameters for the particular module considered in the analysis, using default

values for the parameters of the other modules. The doses calculated in each of the module analyses are those summed over all routes of exposure considered in COSYMA, even though the particular uncertainties considered may not affect the doses from some of the routes. Equally, the runs with countermeasures consider all the countermeasures considered in this analysis, even though the imposition of some of them may not be affected by the uncertainty on the parameters for the module being analysed.

1.4 Choice of sequences of atmospheric conditions for the analysis

Runs of COSYMA, when not considering uncertainty, assume that there is a single value for all parameters except the atmospheric conditions during the period of the release and the time taken for material to travel over the region of interest. Therefore, COSYMA predicts the probability distribution of consequences should an accident occur in any of the wide range of atmospheric conditions (including the changes of conditions during the travel of the plume) which might occur at the site of interest during the period in which the site operates. The sequences of conditions are obtained by using a data file giving atmospheric conditions every hour over a period of a few years, and assuming that the conditions during the future operation of the site will be similar to those observed in the past. It is not possible to undertake the calculations for every sequence of conditions over the operating period of the site, and even considering every sequence recorded over a one-year period would require excessive computer resources in an uncertainty analysis. Therefore a representative sample of starting times must be used. The predictions of COSYMA depend on the way in which these sequences are chosen. This source of uncertainty is not considered in the module analyses or in the overall analysis incorporating the parameters identified from the module analyses of this study. A separate study of the uncertainty from meteorological sampling was undertaken alongside the overall analysis and is described in reference 6.

The atmospheric conditions at the time of the release can affect the predictions of all the modules of COSYMA, not simply the dispersion and deposition module. Some radionuclides deposit at different rates relative to each other in wet and dry conditions. This can affect the relative mix of radionuclides contributing to doses from all pathways of exposure. The travel time of the plume to different distances can affect the extent to which countermeasures can reduce the doses received by the population, since countermeasures are modelled to require time for organisation and implementation before they are effective. Therefore the uncertainty analysis of all the modules must consider the possible range of atmospheric conditions that can occur.

Each of the module analyses was undertaken using runs of COSYMA considering 144 sequences of conditions selected using cyclic sampling. The reasons for this choice of sampling scheme are described in the “methodology report”[7] on this study.

1.5 Method of identifying important parameter uncertainties

The method of identifying the important uncertain parameters is described in the

"methodology report"[7], which also describes the reasons for the choice of the particular method. It is summarised here to provide the background for the discussions in Section 3 of this report. Two indicators of importance were used in this project.

The first indicator is the partial rank correlation coefficients (PRCC) between the input parameter values and the COSYMA predictions. These measure the strength of monotonic relationships between values of an input parameter and a model prediction, when account has been taken of the simultaneous effects of monotonic relationships with all other parameters.

The second indicator is the contribution of each parameter to the overall uncertainty. The coefficient of determination (R^2) measures the fraction of the variation of the model output that can be explained by linear relationships between the model prediction and all of the input parameter values. The ratio of R^2 values from an analysis with only one parameter considered to be uncertain to that from an analysis with all parameters considered to be uncertain represents the fraction of the overall uncertainty caused by the particular parameter.

The important uncertain parameters were identified for the mean value, 95th and 99th percentiles of the ccdf, for each of the endpoints and source terms considered. Parameters were included in the overall analysis if they were placed in the first or second rank according to their PRCC or if they were identified as contributing more than 15% of the overall uncertainty according to their contribution to the value of R^2. The justification for these criteria are given in the "methodology report"[7].

1.6 References

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Table 1.1 Reactor inventory considered

Radionuclide	Inventory (Bq)	Half-life	Radionuclide	Inventory (Bq)	Half-life
^{58}Co	$3.08\ 10^{16}$	70.8 d	^{131m}Te	$3.47\ 10^{17}$	30.0 h
^{60}Co	$1.14\ 10^{16}$	5.27 y	^{132}Te	$4.85\ 10^{18}$	78.2 h
^{85}Kr	$2.17\ 10^{16}$	10.7 y	^{131}I	$3.39\ 10^{18}$	8.04 d
^{85m}Kr	$9.25\ 10^{17}$	4.48 h	^{132}I	$4.96\ 10^{8}$	2.30 h
^{87}Kr	$1.70\ 10^{18}$	76.3 min	^{133}I	$6.81\ 10^{18}$	20.8 h
^{88}Kr	$2.34\ 10^{18}$	2.84 h	^{134}I	$7.84\ 10^{18}$	52.6 min
^{86}Rb	$7.96\ 10^{15}$	18.6 d	^{135}I	$6.40\ 10^{18}$	6.61 h
^{89}Sr	$3.37\ 10^{18}$	50.5 d	^{133}Xe	$6.85\ 10^{18}$	5.25 d
^{90}Sr	$1.75\ 10^{17}$	29.1 y	^{135}Xe	$1.67\ 10^{18}$	9.09 h
^{91}Sr	$4.37\ 10^{18}$	8.48 h	^{134}Cs	$3.85\ 10^{17}$	2.06 y
^{90}Y	$1.82\ 10^{17}$	2.67 d	^{136}Cs	$1.33\ 10^{17}$	13.2 d
^{91}Y	$4.51\ 10^{18}$	58.6 d	^{137}Cs	$2.29\ 10^{17}$	30.0 y
^{95}Zr	$5.88\ 10^{18}$	65.5 d	^{140}Ba	$6.14\ 10^{18}$	12.7 d
^{95}Nb	$5.81\ 10^{18}$	35.1 d	^{140}La	$6.32\ 10^{18}$	40.3 h
^{97}Zr	$5.88\ 10^{18}$	16.9 h	^{141}Ce	$5.92\ 10^{18}$	32.5 d
^{99}Mo	$6.44\ 10^{18}$	66.02 h	^{143}Ce	$5.44\ 10^{18}$	33.0 h
^{99m}Tc	$5.55\ 10^{18}$	6.02 h	^{144}Ce	$3.59\ 10^{18}$	285 d
^{103}Ru	$5.25\ 10^{18}$	39.4 d	^{143}Pr	$5.40\ 10^{18}$	13.6 d
^{105}Ru	$3.51\ 10^{18}$	4.44 h	^{147}Nd	$2.36\ 10^{18}$	11.0 d
^{106}Rh	$3.18\ 10^{18}$	1.47 d	^{239}Np	$7.32\ 10^{19}$	2.36 d
^{106}Ru	$1.30\ 10^{18}$	368 d	^{238}Pu	$3.17\ 10^{15}$	87.7 y
^{127}Sb	$2.93\ 10^{17}$	3.89 d	^{239}Pu	$1.11\ 10^{15}$	$2.41\ 10^{4}$ y
^{129}Sb	$9.95\ 10^{17}$	4.31 h	^{240}Pu	$1.06\ 10^{15}$	6550 y
^{127}Te	$2.85\ 10^{17}$	9.35 h	^{241}Pu	$3.12\ 10^{17}$	14.4 y
^{127m}Te	$4.37\ 10^{16}$	109 d	^{241}Am	$2.06\ 10^{14}$	432 y
^{129}Te	$9.40\ 10^{17}$	69.6 min	^{242}Cm	$6.62\ 10^{16}$	163 d
^{129m}Te	$1.67\ 10^{17}$	33.6 d	^{244}Cm	$2.75\ 10^{15}$	18.1 y

Table 1.2 Source terms considered for the assessment

Source term	Fraction of core inventory released to the environment								
	Xe-Kr	Organic iodine	Inorganic iodine	Cs-Rb	Te-Sb	Ba-Sr	Ru[(a)]	La[(b)]	Pu[(c)]
UK1	$9\ 10^{-1}$	$7\ 10^{-3}$	$7\ 10^{-1}$	$5\ 10^{-1}$	$3\ 10^{-1}$	$6\ 10^{-2}$	$2\ 10^{-2}$	$4\ 10^{-3}$	$4\ 10^{-3}$
CB2	$1\ 10^{-2}$	$5\ 10^{-6}$	$2\ 10^{-3}$	$8\ 10^{-3}$	$8\ 10^{-6}$	$8\ 10^{-7}$	$8\ 10^{-7}$	$8\ 10^{-7}$	$3\ 10^{-7}$
DBA[(d)]	$1\ 10^{-7}$	-	$1\ 10^{-6}$	$1\ 10^{-6}$	$1\ 10^{-8}$	$1\ 10^{-8}$	$1\ 10^{-8}$	$1\ 10^{-8}$	$1\ 10^{-10}$

Notes

a Includes Ru, Rh, Co, Mo, Tc.
b Includes Y, La, Zr, Nb, Ce, Pr, Nd.
c Includes Np, Pu, Am, Cm.
d This source term is defined in terms of the amount of each radionuclide released. The information has been converted into the form presented here for comparison with the other source terms. The release fractions for different isotopes of the same element and for different elements differ from the values given here by up to a factor of 3.

Table 1.3 Activity released in the DBA source term

Radionuclide	Release (Bq)	Radionuclide	Release (Bq)	Radionuclide	Release (Bq)
^{24}Na	$7.0\ 10^{10}$	^{51}Cr	$1.4\ 10^{11}$	^{54}Mn	$1.4\ 10^{11}$
^{55}Fe	$5.2\ 10^{9}$	^{59}Fe	$5.2\ 10^{9}$	^{58}Co	$3.4\ 10^{11}$
^{60}Co	$3.2\ 10^{10}$	^{63}Ni	$5.6\ 10^{9}$	^{65}Zn	$1.4\ 10^{11}$
^{83}Br	$9.3\ 10^{10}$	^{84}Br	$2.6\ 10^{12}$	$^{85}Br^{(a)}$	$4.8\ 10^{9}$
^{83m}Kr	$5.2\ 10^{9}$	^{85m}Kr	$1.1\ 10^{11}$	^{85}Kr	$2.3\ 10^{9}$
^{87}Kr	$9.3\ 10^{10}$	^{88}Kr	$1.1\ 10^{11}$	^{89}Kr	$8.1\ 10^{10}$
^{86}Rb	$4.4\ 10^{9}$	^{88}Rb	$3.5\ 10^{13}$	^{89}Rb	$8.1\ 10^{12}$
^{89}Sr	$4.4\ 10^{10}$	^{90}Sr	$3.7\ 10^{8}$	^{91}Sr	$2.3\ 10^{11}$
^{90}Y	$4.4\ 10^{8}$	^{91m}Y	$6.3\ 10^{10}$	^{91}Y	$4.8\ 10^{8}$
^{93}Y	$3.7\ 10^{11}$	^{95}Zr	$4.1\ 10^{10}$	^{95}Nb	$4.4\ 10^{10}$
^{99}Mo	$1.6\ 10^{11}$	^{99m}Tc	$3.7\ 10^{10}$	^{103}Ru	$2.7\ 10^{10}$
^{106}Ru	$1.6\ 10^{10}$	^{103m}Rh	$6.3\ 10^{10}$	^{106}Rh	$3.5\ 10^{10}$
^{110m}Ag	$5.6\ 10^{10}$	^{122}Sb	$1.0\ 10^{11}$	^{124}Sb	$2.5\ 10^{10}$
^{125m}Te	1.7 10	^{127m}Te	$1.8\ 10^{9}$	^{127}Te	$8.5\ 10^{9}$
^{129m}Te	$3.3\ 10^{10}$	^{129}Te	$8.9\ 10^{12}$	^{131m}Te	$1.2\ 10^{11}$
^{131}Te	$2.3\ 10^{12}$	^{132}Te	$1.8\ 10^{10}$	^{130}I	$1.9\ 10^{10}$
^{131}I	$1.9\ 10^{12}$	^{132}I	$5.2\ 10^{12}$	^{133}I	$8.1\ 10^{12}$
^{134}I	$6.3\ 10^{12}$	^{135}I	$3.6\ 10^{12}$	^{131m}Xe	$2.3\ 10^{10}$
^{133m}Xe	$2.8\ 10^{10}$	^{133}Xe	$1.5\ 10^{12}$	^{135m}Xe	$9.3\ 10^{10}$
^{135}Xe	$3.4\ 10^{11}$	^{137}Xe	$8.1\ 10^{11}$	^{138}Xe	$4.1\ 10^{11}$
^{134}Cs	$2.1\ 10^{11}$	^{136}Cs	$2.5\ 10^{10}$	^{137}Cs	$2.7\ 10^{11}$
^{138}Cs	$5.9\ 10^{12}$	^{139}Cs	$2.0\ 10^{13}$	^{137m}Ba	$8.9\ 10^{11}$
^{139}Ba	$4.4\ 10^{12}$	^{140}Ba	$6.7\ 10^{10}$	^{140}La	$3.5\ 10^{10}$
^{141}Ce	$1.0\ 10^{10}$	^{143}Ce	$3.7\ 10^{10}$	^{144}Ce	$3.7\ 10^{10}$
^{143}Pr	$3.6\ 10^{8}$	^{144}Pr	$3.7\ 10^{10}$	^{187}W	$2.2\ 10^{11}$
^{237}U	$2.5\ 10^{8}$	^{239}U	$1.0\ 10^{10}$	^{239}Np	$4.1\ 10^{9}$
^{236}Pu	$1.7\ 10^{5}$	^{238}Pu	$3.7\ 10^{5}$	^{239}Pu	$1.5\ 10^{5}$
^{240}Pu	$1.4\ 10^{5}$	^{241}Pu	$4.1\ 10^{7}$	^{242}Pu	$4.4\ 10^{2}$
^{243}Pu	$8.5\ 10^{7}$	^{241}Am	$7.0\ 10^{4}$	^{242m}Am	$2.4\ 10^{3}$
^{242}Am	$4.8\ 10^{7}$	^{243}Am	$8.1\ 10^{3}$	^{244}Am	$2.7\ 10^{6}$
^{242}Cm	$1.6\ 10^{6}$	^{243}Cm	$6.3\ 10^{2}$	^{244}Cm	$9.6\ 10^{4}$

Table 1.4 Countermeasures criteria and timings adopted in the study

Action	Criteria		
Sheltering	10 mSv effective dose, total of committed inhalation dose and external dose to 7 days to a person outdoors		
Evacuation	50 mSv effective dose, total of committed inhalation dose and external dose to 7 days to a person outdoors		
Iodine tablets	100 mSv committed inhalation dose to thyroid to a person outdoors		
Relocation	30 mSv external dose in 30 days to a person in normal living		
Return from relocation	10 mSv external dose in 30 days to a person in normal living		
Food restrictions	Activity concentration levels in food		
	Radionuclide	Milk (Bq l^{-1})	Other foods (Bq kg^{-1})
	Strontium	125	750
	Iodine	500	2000
	Caesium and other long-lived radionuclides	1000	1250
	α - emitters	20	80

Action	Time when action initiated	Time when action withdrawn
Sheltering	2 hours	8 hours
Evacuation	6 hours	2 days
Iodine tablets	4 hours	-[a]
Relocation	Depends on relocation area[b]	When dose rate drops below criterion
Food restrictions	Start of first time period in which concentrations are above the criterion	End of last time period in which concentrations are above the criterion

Notes:

a COSYMA assumes that iodine tablets are taken on a single occasion only.
b COSYMA calculates an average relocation time, assuming that the area affected can be relocated at a rate of 100 km^2 per day, and assumes that everyone is relocated at that time

Table 1.5 List of endpoints considered in the analysis

For COSYMA NE[a] runs

Activity concentrations, at 0.875, 5 and 20 km.
in air and on the ground, for Cs-137 and I-131.

Individual doses, at 0.875, 5 and 20 km
integrated to 7 days for both inhalation and external dose
for bone marrow, thyroid and skin.

Individual risks of deterministic health effects, at 0.875, 5 and 20 km.
for mortality, the sum and the risk of the haematopoietic syndrome,
for morbidity, the sum and the risk of lung morbidity, hypothyroidism and skin burns.

Areas with emergency actions,
for sheltering only, evacuation and distribution of stable iodine tablets.

Number of deterministic health effects
for mortality, the sum and haematopoietic syndrome.
for morbidity, the sum and numbers of cases of lung morbidity, hypothyroidism and of skin burns.

For COSYMA NL[b] runs

Activity concentrations, at 5, 20 and 100 km
in air and on the ground, for Cs-137 and I-131.

Individual doses, at 5, 20 and 100 km
integrated to 50 years for both inhalation and external dose
effective dose and for bone marrow and thyroid.

Individual risk of fatal stochastic health effects, at 5, 20 and 100 km
for total, and the risks of death from leukaemia and thyroid cancer.

Areas with countermeasures
for relocation, the initial area and its time integral
for restrictions of milk, grain, leafy vegetables and beef, the initial area and its time integral.

Collective doses
effective dose and for bone marrow and thyroid.

Numbers of fatal stochastic health effects
the sum, and numbers of deaths from leukaemia and thyroid cancer.

Notes:

a NE refers to the sub-system of COSYMA calculating short term doses, early health effects and the appropriate countermeasures.

b NL refers to the sub-system of COSYMA calculating long term doses, late health effects and the appropriate countermeasures.

2 DISTRIBUTIONS ON THE INPUT PARAMETER VALUES

2.5 Introduction

The main stages of an uncertainty analysis were summarised in Section 1 of this report. The first stage is to take information from expert panels, supplemented from other sources where necessary, and to generate marginal distributions* for those module input parameters considered to be uncertain, together with a correlation matrix describing the relationships between the marginal distributions for the different parameters. Sets of input parameter values are then sampled from these correlated marginal distributions for use in the uncertainty analysis. Section 2 describes this process for the health effects module.

Code input parameters for which marginal distributions and a correlation matrix have to be specified (ie the uncertain input parameters) are named target variables. Variables for which the experts have to give assessments are called elicitation variables. A fundamental aspect of the methodology of formal expert judgement elicitation is that experts should only be asked to provide assessments on elicitation variables that are physically observable, potentially measurable and with which the expert is familiar. Different experts may prefer different models for certain phenomena. An expert may be unwilling to give assessments on model dependent target variables. He may not relate to these target variables, if he does not agree with the model which is described by these target variables. Therefore it is better to have elicitation variables which are not related to a certain model, and so to have elicitation variables which can be considered as model independent. Some of the parameters in accident consequence models represent quantities that can, in principle, be measured and for which distributions can be obtained directly from expert judgement. Others cannot and so must be derived from distributions on the values of other measurable quantities.

This process yields distributions on the parameters for the different models (or for different parts of the overall model) considered within the module analysis. These distributions must then be combined into a single joint distribution** on all of the parameters considered in the module analysis. The program used for the sampling could only handle joint distributions when they are expressed as marginal distributions for each of the parameters and the correlations between them. Therefore the distribution has to be expressed in this form. The steps required to obtain samples of target variable values are summarised below, and described in more detail in the later parts of section 2.

1. Identify the models comprising the module and the uncertain target variables in those models.
2. Identify suitable elicitation variables from which the distributions on the target variables can obtained. Construct joint distributions, expressed in terms of marginal distributions and correlations, on the elicitation variables for the different models. These distributions come directly from information provided by the experts, supplemented, in some cases, by further information provided by project staff.

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* The marginal distribution assigns a probability to each feasible value of a single parameter.

** The joint distribution assigns a probability to each feasible set of values of the input parameters.

3. Obtain the joint distribution on the target variables for each model from the joint distribution on the elicitation variables obtained from step 2; this procedure is known as "probabilistic inversion". Express the joint distribution on the target variables in terms of marginal distributions for each of the target variables involved, together with a correlation matrix between those distributions, for each model, as required by the program used for the sampling.
4. Combine the distributions on the target variables for each of the models into a distribution over the whole set of target variables involved in this module analysis, allowing for correlations between the different sub-sets of parameters. The distribution is expressed in terms of marginal distributions on each of the variables and correlations between them, so that it can be input to the program used for the final sampling.
5. Finally, sample the input values for the COSYMA module analysis from the distribution resulting from step 4.

As a check on the inversion process, a sub-step 3a was added. In this the COSYMA health effects models and the joint distribution on the target variables are used to replicate the marginal distributions on the elicitation variables. The resulting distributions can then be compared with those obtained from the experts, as a check on the adequacy of the inversion process.

The summary above identified a number of steps which must be carried out for the parameters in each of the models considered in the module analysis. The structure of the remainder of Section 2 is as follows:

- Section 2.6 describes step 1 above, namely the models used in COSYMA, and the parameters that were considered to be uncertain.
- Section 2.7 describes step 2 above, namely the identification of the elicitation variables and the derivation of distributions on them from information provided by the expert panel, supplemented where necessary by information from the project staff.
- Section 2.8 outlines the methods used for probabilistic inversion, which is step 3 above.
- Sections 2.9 and 2.10 (for early and late health effects respectively) describe details of step 3 and 3a relating to this module analysis. These sections describe the derivation of distributions on the target variables and give the distributions used in this study, together with the comparison of the distributions on the elicitation variables as reconstructed from the target variables and as specified by the experts.
- Section 2.11 describes step 4 above, namely the construction of the overall distribution on the whole set of target variables, in a form which is suitable for input to the sampling program used.
- Section 2.12 describes step 5 above, namely the sampling from the overall distribution.

2.6 Models for risks of health effects in COSYMA and uncertain target variables

This section describes the way in which risk calculations are undertaken in COSYMA, and the parameters that were considered to be uncertain. Identifying the parameters that are regarded as uncertain is step 1 from Section 2.5.

2.6.1 Early health effects

COSYMA calculates the risk of early health effects, given the dose and dose rate in the period immediately after the accident, using the so-called "hazard function" in which the probability of an individual being affected, r, is given by

$$r = 1 - e^{-H}$$

where

$$H = \ln 2 \left(\frac{D}{D_{50}}\right)^{V}$$

in which

D is the dose received in the appropriate period,

D_{50} is the dose which causes the effect in 50% of the exposed population,

and V is the shape parameter, which characterises the slope of the dose-risk relationship.

Doses which are accumulated at a low dose rate are much less effective in causing early health effects than doses delivered at high dose rates. This is included in COSYMA by summing the doses delivered in a number of time periods with appropriate values for D_{50}. The risk is given by the formula above, but with the ratio (D/D_{50}) replaced by

$$\frac{D}{D_{50}} = \sum \frac{D^i}{D^i_{50}}$$

in which

D^i is the dose received in the appropriate time period

and D^i_{50} is the dose which causes the effect in 50% of the exposed population, in the time period considered.

The variation of D_{50} with dose rate is given by

$$D^{i}_{50} = D_{\infty} + \frac{D_0}{DR^{i}}$$

where

D_∞	is the value of D_{50} at high dose rate,
DR^i	is the dose rate averaged over the period considered
D_0	is a parameter.

Here the first term describes the value of D_{50} at high dose rate, while the second term describes the variation of D_{50} with dose rate .

The model described above is applied for the risk of death from the haematopoietic syndrome, the pulmonary syndrome and the gastrointestinal syndrome, and the risk of lung function impairment. It is also applied for the risk of skin morbidities, combining different effects into a single dose response relationship for "skin burns". Death from skin burns is then calculated on the assumption that a fraction of the population will die as a result of skin burns over the exposed part of the body. The target variables are those identified in the above equations as D_0, D_∞ and V, for the risk of death from the haematopoietic syndrome, the pulmonary syndrome and the gastrointestinal syndrome, for lung function impairment and for skin burns, together with the fraction of the population dying from partial body skin burns. They are listed in the first column of Table 2.1.

2.6.2 Late health effects

The method normally used in COSYMA for calculating the risk of late health effects is very complex, as it allows for the variation of risk of death from radiation induced cancers with age at exposure, the risk of dying from other causes before the cancer can appear and the time period over which the dose is delivered. For this study, the simpler model included in PC COSYMA was adopted. The risk of late health effects was taken to be the product of the committed dose in an organ and the risk coefficient for that organ. The risk is evaluated for each organ separately, and the total cancer risk then obtained by summing over the risks in the different organs. The target variables are the risk coefficients for fatal cancer for the different organs. The risk coefficients represent the risk in the exposed population, and so include the uncertainty on the variation of risk with age at exposure and the age distribution of the population. They are summarised in the first column of Table 2.2.

2.7 Distributions for the elicitation variables

Identifying suitable elicitation variables and determining distributions on them is step 2 from Section 2.5. The distributions on the elicitation variables for this module analysis were expressed as marginal distributions for each parameter together with correlations between them. They were derived from information provided by two expert panels, supplemented by information from project staff. The expert judgement aspects of the study were undertaken jointly by the USNRC and EC. The method for undertaking expert judgement elicitations was based on methods

used in earlier American[1] and European[2] studies. The method used in this project, together with some comments and suggestions for further improvements, is described in reference 3. The information used in this module analysis comes from two different panels of experts, one addressing the uncertainty on modelling risks of early health effects[4] and one addressing the uncertainty on modelling risks of late health effects[5]. The expert judgement elicitation process is described in detail in the reports on the panels, which also present the distributions on the elicitation variables.

The target variables for early health effects were identified in Section 2.6 as the parameters D_0, D_∞ and V, for the various effects, together with the fraction of the population dying from partial body skin burns. The parameters D_0, D_∞ and V are not directly observable, and so cannot be used as elicitation variables. However, values for these target variables could be determined from values for the risk of observing the effect in people exposed to specified doses and dose rates, using the relationships given in Section 2.6.1. The panel organisers considered that values for the LD_{10}, LD_{50}, and LD_{90} at different dose rates could in principle be measured, and so be used as elicitation variables, for each of the effects other than the haematopoietic syndrome. The panel organisers considered that these quantities could not be measured for the haematopoietic syndrome, as it is not possible to irradiate the whole of the bone marrow without also irradiating other organs. The panel organisers considered that the risk of the haematopoietic syndrome could be derived from information on the LD_{10}, LD_{50}, and LD_{90} for whole body exposure if allowance is made for the risks of the pulmonary and gastrointestinal syndromes, and so these quantities were used as elicitation variables. The risk of death from partial body skin burns could be measured, and so is suitable for use as an elicitation variable. The elicitation variables considered are listed in Table 2.3; the last column of Table 2.1 indicates which elicitation variables were used to derive distributions on each of the target variables. One of the aims of the expert judgement study was to derive a library of uncertainty distributions that could be used in other studies. Therefore, distributions were obtained on some quantities that were not used in the COSYMA uncertainty analysis.

Note that the expert panel did not provide uncertainty distributions on the risk factors for hypothyroidism; the project staff felt unable to quantify the uncertainty on this risk, and it is not included in the module analysis.

The target variables for late health effects are the risk coefficients at low dose and low dose rate for life-time risk of the different cancers considered in COSYMA. These variables could have been used as elicitation variables. However, the elicitation variables adopted were the risk coefficients at low and high dose rates for cancers appearing in various time periods after irradiation, but not including the life-time risk for exposure at low dose rates. The elicitation variables are summarised in Table 2.4; the last column of Table 2.2 indicates which elicitation variables were used to derive distributions on each of the target variables.

2.7.1 Conditions included in the uncertainty distributions

The experts were asked to provide uncertainty distributions as if the elicitation variables had been measured in defined conditions. However, the conditions were defined in a way that did not specify values for every quantity that each expert might feel could influence the value of the variable. The experts were asked to include any variation in the elicitation variables, reflecting the range of possible conditions, within the distributions they provided.

The distributions for the risks of early health effects included the uncertainty caused by uncertainties in dose reconstruction (e.g. for A-bomb survivors), the efficacy of medical treatment and synergistic effects. The distributions are for an average population including members with different states of health and in different age groups.

The distributions for the risks of late health effects included the uncertainty caused by different models for cancer risk (relative compared to absolute), relative biological effectiveness, transport of data between populations and synergistic effects. The distributions are for an average population including members with different age groups and states of health, with mortality and cancer incidence rates typical of those in the US and western Europe,

2.8 Probabilistic inversion

Step 3 from Section 2.5 is to generate joint distributions on the target variables (ie the model input parameters) and express them as marginal distributions and correlations. This section outlines the methods used for this part of the analysis. The details of the process are given in Sections 2.9 and 2.10, for the models for early and late health effects respectively.

Most of the target variables for the models for the risk of early health effects are quantities that cannot be measured and so could not be used as elicitation variables. In this situation, it is the task of the uncertainty analyst to design the elicitation in such a way that, based on the information available on elicitation variables, a joint distribution on the target variables can be determined. This process is called probabilistic inversion. The problems which arise are similar to other inversion problems, yet different enough to require different methods to be used. Techniques for performing probabilistic inversion in the context of expert judgement have been under development for some years, and are still being refined. The methods adopted for this process in this study are summarised in the "Methodology Report"[6], and described in more detail in references 7 and 8. The computer programs used to implement these methods are described in reference 9. The following paragraph summarises the process.

For a given model, a set of observable quantities can be predicted by the model when suitable values are assigned to various model parameters. Starting with values for the observables, and inverting the model, gives model parameter values which, when used with the model, ideally yield the observed values. Such an inversion is not always possible; for example the model may not adequately represent the processes occurring in the environment. Furthermore, in probabilistic inversion, the starting point is a (joint) distribution (in this study, obtained from expert judgement) over possible values of the observables, rather than single values. A (joint) distribution over model parameters is sought which, when used with the model, returns the original distribution on the

observables. Here again, it may not possible to find a joint distribution that accurately reproduces the original joint distribution for the values of the observed quantities. In such cases a distribution over model parameters is sought which reproduces 'as well as possible' the distributions over the input values.

The target variables for the model to calculate the risks of late health effects could have served as elicitation variables, but the organisers of the expert panel did not ask for the exact quantities required for this analysis. The uncertainty distributions on the target variables were generated using simple manipulations of the uncertainty distributions on the elicitation variables considered. The procedure adopted, which is described in Section 2.10, does not include "probabilistic inversion" as defined here.

2.9 Uncertainty distributions on parameters for early health effects

The target variables for each of the health effects considered are given in Table 2.1, which also indicates the elicitation variables from which the distributions on the target variables were obtained.

The distributions on the parameters for the gastrointestinal syndrome were obtained from the expert responses for that syndrome, as the experts gave information on the values of LD_{10}, LD_{50} and LD_{90} for that syndrome at four dose rates. The distributions on the parameters for the pulmonary syndrome were extracted from the expert responses for that syndrome for β radiation, since α exposure only makes a small contribution to the total lung dose for the source terms considered in this analysis.

The organisers of the expert panel considered that the number of deaths from the haematopoietic syndrome cannot be observed directly, as it is not possible to irradiate only the bone marrow, without irradiating other organs. Therefore the elicitation variables are the LD_{10}, LD_{50} and LD_{90} for uniform irradiation of the whole body. This was taken to represent the total risk of death from the GI, pulmonary and haematopoietic syndromes, for which the risk is given by

$$r = 1 - e^{-(H_{GI} + H_P + H_{BM})}$$

where H_{GI}, H_P and H_{BM} are the hazard functions for the GI, pulmonary and haematopoietic syndromes, respectively. The joint distribution on the parameter values for the haematopoietic syndrome were obtained by fitting this expression to the information given by the experts, using the joint distributions which had already been obtained for the parameters in the hazard functions for the GI and pulmonary syndromes.

The experts gave information on the ED_{10}, ED_{50} and ED_{90} at four dose rates for lung morbidities, for β irradiation. The joint distribution on the COSYMA parameters for this endpoint were obtained from these quantities.

The expert elicitation provided information on the dose response relationships for three different types of effects on skin. Distributions for the values of D_0, D_∞ and V for each of these effects were obtained, and then combined into a single dose response relationship for "skin burns".

The distributions obtained for the COSYMA input parameters are summarised in the early effects parts of Table 2.5, which shows the marginal distributions of the parameter values. The procedures adopted automatically give information on the dependencies between the parameter values for each of the early health effects separately, and between those for the gastro-intestinal, pulmonary and haematopoietic syndrome. Table 2.6 gives those pairs of parameters with large correlations between their values. There are strong correlations between the values of the parameters V, D_0 and D_∞ for each of the early effects considered. In many cases these correlations are sufficiently strong that all three pairs of parameters are included in Table 2.6; in some cases the correlation between one of the pairs of parameters is below the cut-off value used for that table. There are also strong correlations between the values for some of the parameters of the pulmonary and gastrointestinal syndromes, and between the values of some of the parameters of the haematopoietic and gastrointestinal syndromes. Note that these distributions were derived for application in the models adopted in COSYMA. They should only be used in other models if the parameters have the same meanings as in the models adopted here

The distributions for early health effects show that there is considered to be rather more uncertainty on the parameters for lung effects than for the other effects. The ratio of the 95th to 5th percentiles of the distributions of D_∞ for lung function impairment and the pulmonary syndrome are about 20, while those for the other effects considered are between about 3 and 6. The uncertainties on the shape parameters for each of the effects are similar, with the ratio of the 95th to 5th percentiles of the distributions being about 2 or 3. In general the default values of the parameters for early health effects are near the centres of the distributions obtained from the experts, except for the parameters for the haematopoietic and gastrointestinal syndromes. For the haematopoietic syndrome the default value for the shape parameter is greater than the maximum value of the range obtained, while the default values for the parameters D_0 and D_∞ are below the 5th and above the 95th percentiles of the distribution respectively. For the gastrointestinal syndrome, the default value for the shape parameter is greater than the maximum value of the experts' range, while the default value for the parameter D_0 is below the minimum value of the experts' range. The importance of these features is discussed in Section 3, when the results of the study are presented.

Step 3a is to use the distributions on the target variables with the COSYMA risk models to reconstruct the marginal distributions on the elicitation variables, and compare them with the distributions provided by the experts. The results of the comparisons are given in Tables 2.7 to 2.10 for the gastrointestinal syndrome, pulmonary syndrome, risk of whole body exposure and lung morbidities, respectively. For the gastrointestinal syndrome, a good fit is obtained for some of the percentiles and quantities but in other cases the predicted value is lower than that given by the experts by about a factor of 2. General experience shows that COSYMA only predicts deaths from the gastrointestinal syndrome if the risks of the pulmonary and haemotopoietic syndromes are large. Therefore the discrepancies between the experts' ranges and those obtained with the fitted parameters for the gastrointestinal syndrome are unlikely to have a large impact on the results of the analysis. In general, the fitted distributions for the pulmonary syndrome are reasonably close to those specified by the experts. However, the fitted distributions give values of the LD_{10}, LD_{50} and LD_{90} at a dose rate of 1 G_y/hr which are consistently lower than those specified by the experts for

all percentiles of the distribution. The 95th percentiles of the expert distributions at the highest two dose rates considered are also underestimated. It is difficult to determine the impact of these discrepancies on the results of the analysis. The comparison for uniform irradiation of the whole body shows that, in general, the distributions obtained provide a good fit for the expert distributions at the lowest dose rate considered. The fit gets worse at higher dose rates, where the fitted distributions yield values which are lower than those provided by the experts by factors of 1.5 to 2. The discrepancies at the higher dose rates are unlikely to have any effect on the results of the study. At a dose rate of 100 Gy/hr the LD_{90} values are reached within a few minutes of exposure. The dose rate is unlikely to change over this time so that the total dose received will be so far above the LD_{90} that the risk is essentially 1.0 and not sensitive to the actual values of the parameters in the model relating doses to risks. For lung morbidities the fitted distributions provide a reasonable fit to the expert values other than for the 95th percentile of the various quantities at the higher dose rates.

2.10 Uncertainty distributions on parameters for late health effects

Probabilistic inversion, as considered in the earlier parts of Section 2, was not required for the target variables associated with the model for late health effects, and so step 3 of Section 2.5 was not required for this part of the model. However, the target variables did not coincide with the elicitation variables, and some processing was required, as described in this section.

The expert panel gave information on the risk coefficients for fatal cancer following exposures of 1 Gy in 1 minute, and of 1 Gy in 1 year, for death occurring within various periods of exposure. The panel gave information on the life-time risk of cancer only for the higher exposure rate (1 Gy in 1 minute) considered. The project staff considered that most of the dose received by the exposed population following an accident would be delivered at much lower rates than this, and that the risk from a dose rate of 1 Gy in 1 year would better represent the risks of late health effects following reactor accidents. Therefore the project staff decided to extract information on the risk of cancer over a life-time from low dose rate exposure from several pieces of information provided by the experts.

The experts provided distributions on the risk coefficients at the two dose rates for effects occurring within 40 years of exposure. These distributions were used to give the reduction in risk for exposure at low dose rate compared to that at high dose rate, for each organ considered. These reduction factors were then used with the risk coefficients for cancer deaths in a life-time following exposure at 1 Gy in a minute to give risk coefficients for exposure at low dose rate.

The marginal distributions obtained for the COSYMA input parameters are summarised in the late effects part of Table 2.5, which also shows the default values of the parameters. Note that these distributions were derived for application in the models adopted in COSYMA. They should only be used in other models if the parameters have the same meanings as in the models adopted here

The distributions for the risk coefficients for late health effects show large uncertainties, with a long tail towards the low end of the distribution reflecting the opinion of one expert that there is a small probability that low doses of radiation may not cause cancer[5]. There is typically more than 3 orders of magnitude between the 5th and 20th percentiles of the distributions. The distribution for the risk of lung, stomach and colon cancer and for cancer in "other organs" are particularly wide, with a factor of about10^6 or greater between the 95th and 5th percentiles. The narrowest distributions are those for skin cancer and leukaemia, where the factors between the 95^{th} and 5^{th} percentiles are about 6 10^4 and 8 10^4 respectively; the distribution for thyroid cancer risk is also relatively narrow, with the ratio between the 95^{th} and 5^{th} percentiles being just greater than 10^5. The default values of the risk coefficients generally lie in the central parts of the overall distributions. The importance of these features is discussed in Section 3, when the results of the study are presented.

2.11 Construction of the joint distribution on input parameter values used in the study

The preceding sections have described the methods used to derive joint distributions for the target variables for the early and late health effects models, expressed as marginal distributions for each of the target variables with correlations between them. Step 4 of Section 2.5 is to combine the distributions on each of the (groups of) target variables into a single joint distribution, also expressed in terms of marginal distributions and correlations, over all of the target variables considered.

27 input parameters for the health effects module were considered to be uncertain. The joint distribution was constructed using the simulation program UNICORN[10]. The joint distributions on the input parameters for each of the early health effects were combined retaining the dependencies generated from the information given by the experts. The experts considered that there are no strong correlations between the distributions for the risk coefficients for the different late effects considered. The project staff considered that there are no dependencies between the risks of early and late health effects. The construction of the joint distribution was done in such a way that the corresponding rank correlation matrix is assured to be positive definite (see the Methodology report[6] for further information on this requirement). Marginal distributions for the values of each parameter, and the correlations between them, were then extracted from the joint distribution. This process does not alter the marginal distributions but may introduce correlations between groups of parameters for the different models.

The complete distribution is summarised in Table 2.5, which shows the marginal distribution for each parameter, and Table 2.6 which shows the pairs of parameters with large correlations. Note that these distributions were derived for application in the models adopted in COSYMA. They should only be used in other models if the parameters have the same meanings as in the models adopted here.

The distribution as calculated using UNICORN includes the values for each percentile (from 0 to 100) of the marginal distributions, which are thus described by 101 values. The

sampling program used (the Sandia LHS program[11]) cannot use such a large number of points, and so the distributions were simplified slightly by describing them in terms of the values at the smaller number of percentiles given in Table 2.5.

2.12 Sampling from the distributions

The final step from Section 2.5 is to sample sets of input parameter values from the complete distribution. This was undertaken using the Sandia LHS code[11]; the input to this code is the joint distribution on the input parameters expressed as marginal distributions on the values for each of the parameters together with a correlation matrix between those values. This program ensures that the correlations specified between the input parameter values are reflected in the sets of input parameter values obtained.

2.13 References

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Table 2.1 Uncertain input parameters and the elicitation variables from which they were derived for early health effects

COSYMA parameter	Distribution obtained from[a]
Parameters V, D_0 and D_∞ in the formula[b] for risk of death from the haematopoietic syndrome	1a, 2, 3a
Parameters V, D_0 and D_∞ in the formula[b] for risk of death from the pulmonary syndrome	3a
Parameters V, D_0 and D_∞ in the formula[b] for risk of death from the gastrointestinal syndrome	2
Parameters V, D_0 and D_∞ in the formula[b] for risk of lung function impairment	3b
Parameters V, D_0 and D_∞ in the formula[b] for risk of skin morbidities	4
Probability of death for partial body skin burns	4

Notes:
a The numbers refer to the identifiers given in column 1 of Table 2.3
b The formula adopted in COSYMA for risk of early health effects is given in equations 1 to 4.

Table 2.2 Uncertain input parameters and the elicitation variables from which they were derived for late health effects

Uncertain input parameter	Distribution obtained from[a]
Risk of death from radiation induced leukaemia and cancer in bone, breast, lung, stomach, colon, liver, pancreas, thyroid, skin and all other organs[b] in a lifetime following exposure to low LET radiation at low dose rate	1, 5

Note:
a The numbers refer to the identifiers given in column 1 of Table 2.4.
b The risk in all other organs is expressed using a single risk coefficient.

Table 2.3 Summary of elicitation variables for which distributions were obtained from expert judgement for early health effects

Identifier	Quantities for which distributions were obtained
1a	Values of the threshold and the LD_{10}, LD_{50} and LD_{90} for an average population, for whole body exposure at dose rates of 0.2, 1, 10 and 100 Gy/hour, for minimal and supportive treatment
1b	Dose rate at which the value of LD_{50} is double its value at 100 Gy/hour
2	Values of the threshold and the LD_{10}, LD_{50} and LD_{90} for deaths from the GI syndrome, for an average population, for whole body exposure at dose rates of 0.2, 1, 10 and 100 Gy/hour
3a	Values of the threshold and the LD_{10}, LD_{50} and LD_{90} for deaths from the pulmonary syndrome, for people below or above age 40, for β exposure of the lung at dose rates of 0.2, 1, 10 and 100 Gy/hour
3b	Values of the threshold and the LD_{10}, LD_{50} and LD_{90} for cases of lung morbidity, for people below or above age 40, for β exposure of the lung at dose rates of 0.2, 1, 10 and 100 Gy/hour
3c	Values of the threshold and the LD_{10}, LD_{50} and LD_{90} for deaths from the pulmonary syndrome, for people below or above age 40, for α exposure of the lung for a period of 3 years
4a	Values of the threshold and the LD_{10}, LD_{50} and LD_{90} for acute ulceration, for an average population, if the dose is delivered in 1 day. Values were obtained assuming that 24, 40 and 60% of the skin was exposed and to give the effect in 50 and 90% of the exposed skin.
	Fraction of the exposed population dying assuming that 24, 40 and 60% of the skin was exposed and the effect was observed in 50 and 90% of the exposed skin.
4b	Values of the threshold and the LD_{10}, LD_{50} and LD_{90} for acute epidermal necrosis, for an average population, if the dose is delivered in 1 day. Values were obtained assuming that 24, 40 and 60% of the skin was exposed and to give the effect in 50 and 90% of the exposed skin.
	Fraction of the exposed population dying assuming that 24, 40 and 60% of the skin was exposed and the effect was observed in 50 and 90% of the exposed skin.
4c	Values of the threshold and the LD_{10}, LD_{50} and LD_{90} for moist desquamation and secondary ulceration, for an average population, if the dose is delivered in 1 day. Values were obtained assuming that 24, 40 and 60% of the skin was exposed and to give the effect in 50 and 90% of the exposed skin.
	Fraction of the exposed population dying assuming that 24, 40 and 60% of the skin was exposed and the effect was observed in 50 and 90% of the exposed skin.
5	Values of the threshold and the LD_{10}, LD_{50} and LD_{90} for an average population, for deaths from hole body exposure at two specified sets of dose rates over a period of 1 day, for minimal and supportive treatment
6	Values of the threshold and the LD_{10}, LD_{50} and LD_{90} for deaths from the pulmonary syndrome, for people below or above age 40, for exposure of the lung for a specified changing dose pattern over a period of 7 days
7	Values of the threshold and the LD_{10}, LD_{50} and LD_{90} for deaths from all causes, for an average population, for specified exposure patterns in the bone marrow, lungs, small and large intestine and skin over a period of 7 days, for minimal and supportive treatment

Table 2.4 Summary of elicitation variables for which distributions were obtained from expert judgement for late health effects

Identifier	Quantities for which distributions were obtained
1	Risk of death from radiation induced cancer for an average population in 10 organs, all other organs and the total, for a dose of 1 Gy low LET radiation delivered over 1 minute. Risks were elicited within 20 and 40 years of exposure and over a lifetime.
2	Risk of death from radiation induced cancer for children in 3 organs and the total, for a dose of 1 Gy low LET radiation delivered over 1 minute. Risks were elicited within 40 years of exposure and over a lifetime.
3	Risk of death from radiation induced leukaemia and all other cancers for those who survive exposure in utero, for a dose of 1 Gy low LET radiation uniformly over the pregnancy. Risks were elicited within 20 years of exposure and over a lifetime.
4	Risk of incidence of radiation induced cancer for an average population in 10 organs, all other organs and the total, for a dose of 1 Gy low LET radiation delivered over 1 minute. Risks were elicited within 40 years of exposure.
5	Risk of death from radiation induced cancer for an average population in 10 organs, all other organs and the total, for a dose of 1 Gy low LET radiation delivered over 1 year. Risks were elicited within 40 years of exposure.
6	Risk of incidence of skin cancer from a dose of 1 mGy of high LET exposure over 1 year. Risks were elicited within 40 years of exposure.
7	Risk of death from radiation induced cancer in an average population following inhalation of 10^4 Bq of ^{90}Sr or ^{239}Pu.Risks were elicited within 40 years of exposure.
8	Numbers of years of life lost for each radiation induced cancer.
9	The threshold dose below which the risk of radiation induced cancer is zero.

Table 2.5 Distributions on the COSYMA input parameters[(a)]

Uncertain parameter	Unit	Default value	Percentiles of the distribution on the input parameter								
			Minimum	5%	20%	35%	50%	65%	80%	95%	Maximum
Parameters for early effects											
Lung function impairment: shape parameter V		7.0	1.73	3.04	4.42	5.22	6.4	7.58	8.53	9.57	$2.23\ 10^{1}$
Lung function impairment: model parameter D_0	$Gy^2\ h^{-1}$	$1.5\ 10^{1}$	$6.25\ 10^{-2}$	$5.51\ 10^{-1}$	2.21	5.19	7	$1.08\ 10^{1}$	$1.47\ 10^{1}$	$2.7\ 10^{1}$	$1.37\ 10^{3}$
Lung function impairment: model parameter D_∞	Gy	5.0	$1.05\ 10^{-1}$	2.96	4.58	5.34	6.4	$1.92\ 10^{1}$	$3.01\ 10^{1}$	$5.82\ 10^{1}$	$2.49\ 10^{2}$
skin: shape parameter V		5.0	$9.8\ 10^{-1}$	1.88	3.08	3.82	4.39	4.9	5.45	5.9	6.04
skin: model parameter D_0	$Gy^2\ h^{-1}$	5.0	$1.04\ 10^{-1}$	1.08	3.29	6.54	9.21	$1.16\ 10^{1}$	$1.61\ 10^{1}$	$3.77\ 10^{1}$	$5.04\ 10^{1}$
skin: model parameter D_∞	Gy	$2.0\ 10^{1}$	$4.\ 95\ 10^{-1}$	3.55	9.88	$1.43\ 10^{1}$	$1.77\ 10^{1}$	$2.2\ 10^{1}$	$3.01\ 10^{1}$	$6.8\ 10^{1}$	$1.01\ 10^{2}$
skin: Fraction of people dying for burns on 20% of exposed skin		$5.0\ 10^{-2}$	$2.42\ 10^{-3}$	$2.59\ 10^{-2}$	$4.92\ 10^{-2}$	$6.91\ 10^{-2}$	$8.98\ 10^{-2}$	$1.18\ 10^{-1}$	$1.55\ 10^{-1}$	$2.05\ 10^{-1}$	$2.78\ 10^{-1}$
Pulmonary syndrome: shape parameter V		7.0	4.35	5.44	6.24	7.01	7.56	8.2	8.7	$1.01\ 10^{1}$	$1.71\ 10^{1}$
Pulmonary syndrome: model parameter D_0	$Gy^2\ h^{-1}$	$3.0\ 10^{1}$	$8.96\ 10^{-2}$	2.32	3.91	4.54	5.54	9.86	$2.23\ 10^{1}$	$5.29\ 10^{1}$	$1.87\ 10^{2}$
Pulmonary syndrome: model parameter D_∞	Gy	$1.0\ 10^{1}$	1.84	7.68	8.69	9.63	$1.1\ 10^{1}$	$2.46\ 10^{1}$	$5.26\ 10^{1}$	$1.56\ 10^{2}$	$3.75\ 10^{2}$
Haematopoietic syndrome: shape parameter V		6.0	2.3	2.85	3.34	3.61	3.88	4	4.1	4.45	5.72
Haematopoietic syndrome: model parameter D_0	$Gy^2\ h^{-1}$	$1.0\ 10^{-1}$	$1.09\ 10^{-2}$	$1.71\ 10^{-1}$	$2.83\ 10^{-1}$	$4.09\ 10^{-1}$	$5.08\ 10^{-1}$	$6.23\ 10^{-1}$	$7.69\ 10^{-1}$	1.83	3.46
Haematopoietic syndrome: model parameter D_∞	Gy	4.5	$1.34\ 10^{-1}$	1.15	1.69	2.01	2.23	2.46	2.78	3.88	6.01
gastrointestinal syndrome: shape parameter V		$1.0\ 10^{1}$	4.71	5.96	6.55	7.12	7.49	7.78	8.13	8.69	9.23
gastrointestinal syndrome: model parameter D_0	$Gy^2\ h^{-1}$	0.0	$1.61\ 10^{-1}$	$9.24\ 10^{-1}$	1.67	2.2	2.49	2.55	3.19	4.01	4.68
gastrointestinal syndrome: model parameter D_∞	Gy	$1.5\ 10^{1}$	$3.1\ 10^{-1}$	2.55	4.69	5.7	6.68	7.99	$1.03\ 10^{1}$	$1.85\ 10^{1}$	$2.47\ 10^{1}$

Uncertain parameter	Unit	Default value	Percentiles of the distribution on the input parameter								
			Minimum	5%	20%	35%	50%	65%	80%	95%	Maximum
Parameters for late effects											
Risk of death from radiation induced leukaemia	Sv^{-1}	$5.16\ 10^{-3}$	0	$2.28\ 10^{-7}$	$1.27\ 10^{-3}$	$2.9\ 10^{-3}$	$4.72\ 10^{-3}$	$7.91\ 10^{-3}$	$1.24\ 10^{-2}$	$1.87\ 10^{-2}$	$3.57\ 10^{-2}$
Risk of death from radiation induced bone surface cancer	Sv^{-1}	$1.33\ 10^{-4}$	0	$1.85\ 10^{-8}$	$6.15\ 10^{-5}$	$1.34\ 10^{-4}$	$2.04\ 10^{-4}$	$7.47\ 10^{-4}$	$2.03\ 10^{-3}$	$5.27\ 10^{-3}$	$1.14\ 10^{-2}$
Risk of death from radiation induced breast cancer	Sv^{-1}	$8.0\ 10^{-3}$	0	$1.69\ 10^{-7}$	$1.15\ 10^{-3}$	$2.32\ 10^{-3}$	$4.30\ 10^{-3}$	$7.68\ 10^{-3}$	$1.43\ 10^{-2}$	$2.75\ 10^{-2}$	$4.25\ 10^{-2}$
Risk of death from radiation induced lung cancer	Sv^{-1}	$9.0\ 10^{-3}$	0	$2.03\ 10^{-8}$	$1.22\ 10^{-3}$	$4.26\ 10^{-3}$	$7.72\ 10^{-3}$	$1.24\ 10^{-2}$	$2.19\ 10^{-2}$	$4.53\ 10^{-2}$	$7.87\ 10^{-2}$
Risk of death from radiation induced stomach cancer	Sv^{-1}	$9.03\ 10^{-3}$	0	$1.55\ 10^{-8}$	$4.25\ 10^{-4}$	$1.11\ 10^{-3}$	$2.65\ 10^{-3}$	$5.6\ 10^{-3}$	$1.14\ 10^{-2}$	$2.51\ 10^{-2}$	$5.81\ 10^{-2}$
Risk of death from radiation induced colon cancer	Sv^{-1}	$3.43\ 10^{-3}$	0	$2.71\ 10^{-8}$	$1.02\ 10^{-3}$	$2.31\ 10^{-3}$	$4.21\ 10^{-3}$	$7.25\ 10^{-3}$	$1.32\ 10^{-2}$	$2.46\ 10^{-2}$	$3.59\ 10^{-2}$
Risk of death from radiation induced liver cancer	Sv^{-1}	$4.67\ 10^{-3}$	0	$4.68\ 10^{-8}$	$1.84\ 10^{-4}$	$4.16\ 10^{-4}$	$1.09\ 10^{-3}$	$3.52\ 10^{-3}$	$7.39\ 10^{-3}$	$1.56\ 10^{-2}$	$3.96\ 10^{-2}$
Risk of death from radiation induced pancreas cancer	Sv^{-1}	$5.26\ 10^{-3}$	0	$2.13\ 10^{-8}$	$2.52\ 10^{-4}$	$7.05\ 10^{-4}$	$1.36\ 10^{-3}$	$2.81\ 10^{-3}$	$5.\ 23\ 10^{-3}$	$1.09\ 10^{-2}$	$2.01\ 10^{-2}$
Risk of death from radiation induced thyroid cancer	Sv^{-1}	$1.77\ 10^{-3}$	0	$4.64\ 10^{-8}$	$7.02\ 10^{-5}$	$1.78\ 10^{-4}$	$4.26\ 10^{-4}$	$1.04\ 10^{-3}$	$2.05\ 10^{-3}$	$5.27\ 10^{-3}$	$1.25\ 10^{-2}$
Risk of death from radiation induced cancer in other organs	Sv^{-1}	$3.86\ 10^{-3}$	0	$4.37\ 10^{-8}$	$3.46\ 10^{-3}$	$6.93\ 10^{-3}$	$1.42\ 10^{-2}$	$2.48\ 10^{-2}$	$3.98\ 10^{-2}$	$6.82\ 10^{-2}$	$1.2\ 10^{-1}$
Risk of death from radiation induced skin cancer	Sv^{-1}	$1.38\ 10^{-4}$	0	$3.87\ 10^{-8}$	$6.95\ 10^{-5}$	$1.41\ 10^{-4}$	$3.32\ 10^{-4}$	$7.06\ 10^{-4}$	$1.19\ 10^{-3}$	$2.44\ 10^{-3}$	$4.34\ 10^{-3}$

Note:
a) These distributions were derived for application in the models adopted in COSYMA. They should only be used in other models if the parameters have the same meanings as in the models adopted here

Table 2.6 Pairs of input parameters with rank correlations greater than 0.2 or less than -0.2

Correlated parameters		Correlation coefficient
Lung function impairment: shape parameter V	Lung function impairment: model parameter D_0	-0.37
Lung function impairment: model parameter D_0	Lung function impairment: model parameter D_∞	0.28
Skin: shape parameter V	Skin: model parameter D∞	0.2
Pulmonary syndrome: shape parameter V	Pulmonary syndrome: model parameter D_0	0.8
Pulmonary syndrome: shape parameter V	Pulmonary syndrome: model parameter D∞	0.78
Pulmonary syndrome: shape parameter V	Gastrointestinal syndrome: model parameter D_0	-0.23
Pulmonary syndrome: model parameter D_0	Pulmonary syndrome: model parameter D∞	0.77
Pulmonary syndrome: model parameter D_0	Gastrointestinal syndrome: model parameter D_0	-0.25
Pulmonary syndrome: model parameter D_∞	Gastrointestinal syndrome: model parameter D_0	-0.25
haematopoietic syndrome: shape parameter V	Haematopoietic syndrome: model parameter D_0	0.5
Haematopoietic syndrome: shape parameter V	Haematopoietic syndrome: model parameter D_∞	0.73
Haematopoietic syndrome: shape parameter V	Gastrointestinal syndrome: model parameter D_0	-0.33
Haematopoietic syndrome: model parameter D_0	Haematopoietic syndrome: model parameter D_∞	0.44
Haematopoietic syndrome: model parameter D_0	Gastrointestinal syndrome: model parameter D_0	-0.33
Haematopoietic syndrome: model parameter D_∞	Gastrointestinal syndrome: model parameter D_0	-0.31
Gastrointestinal syndrome: shape parameter V	Gastrointestinal syndrome: model parameter D_∞	0.74

Table 2.7 Comparison between marginal distributions of elicitation variables obtained from the experts and from the distributions on target variables for parameters for early mortality from exposure of the GI tract

Dose rate	Quantity	5%		50%		95%	
		DM	Pred	DM	Pred	DM	Pred
0.2 G_y/hr	$LD_{10, GI, 0.2}$	7.12	6.72	14.2	14. 2	31.5	31.0
	$LD_{50, GI, 0.2}$	8.81	8.81	18.8	18. 8	38.3	38.3
	$LD_{90, GI, 0.2}$	11.1	11.1	22.9	22. 7	75.0	44.4
1 G_y/hr	$LD_{10, GI, 1}$	6.31	3.18	10.5	6.90	17.1	18.0
	$LD_{50, GI, 1}$	7.67	4.20	15.5	9.04	25.7	22.3
	$LD_{90, GI, 1}$	9.40	5.04	19.2	10. 7	55.9	25.7
10 G_y/hr	$LD_{10, GI, 10}$	3.11	2.05	5.72	5.30	8.71	15.1
	$LD_{50, GI, 10}$	4.84	2.73	8.23	6.92	14.0	18.9
	$LD_{90, GI, 10}$	5.90	3.29	1.21	8.18	17.3	21.6
100 G_y/hr	$LD_{10, GI, 100}$	4.70	1.94	7.45	5.15	13.9	14.9
	$LD_{50, GI, 100}$	5.69	2.57	9.60	6.70	17.2	18.5
	$LD_{90, GI, 100}$	7.64	3.10	11.9	7.92	21.0	21.2

Notes:
a DM represents the distributions obtained from the expert panel
b Pred gives the distributions obtained using the fitted distributions on the parameter values

Table 2.8 Comparison between marginal distributions of elicitation variables obtained from the experts and from the distributions on target variables for parameters for the pulmonary syndrome

Dose rate	Quantity	5%		50%		95%	
		DM	Pred	DM	Pred	DM	Pred
0.2 G_y/hr	$LD_{10,}$	19.0	14.1	31.9	28.9	253	253
	$LD_{50,}$	20.9	19.2	36.4	36.3	351	313
	$LD_{90,}$	23.6	23.4	42.3	42.3	473	360
1 G_y/hr	$LD_{10,}$	13.1	7.85	19.8	12.6	251	160
	$LD_{50,}$	16.1	10.6	22.9	16.4	348	198
	$LD_{90,}$	18.2	12.9	26.5	19.5	472	225
10 G_y/hr	$LD_{10,}$	5.94	5.78	9.54	8.87	259	133
	$LD_{50,}$	7.59	8.0	11.5	11.6	348	162
	$LD_{90,}$	9.62	9.73	14.5	13.7	472	183
100 G_y/hr	$LD_{10,}$	4.28	5.56	7.62	8.46	250	130
	$LD_{50,}$	6.19	7.71	9.22	11.1	348	157
	$LD_{90,}$	7.43	9.29	11.0	13.1	472	177

Notes:
a DM represents the distributions obtained from the expert panel
b Pred gives the distributions obtained using the fitted distributions on the parameter values

Table 2.9 Comparison between marginal distributions of elicitation variables obtained from the experts and from the distributions on target variables for parameters for early death from whole body exposure

Dose rate	Quantity	5%		50%		95%	
		DM	Pred	DM	Pred	DM	Pred
0.2 G_y/hr	$LD_{10,}$	1.19	1.19	2.93	2.90	5.21	5.18
	$LD_{50,}$	2.36	2.36	4.50	4.50	7.02	7.00
	$LD_{90,}$	3.90	3.59	6.32	6.32	9.49	9.49
1 G_y/hr	$LD_{10,}$	1.11	0.784	2.39	1.68	4.09	2.67
	$LD_{50,}$	2.20	1.49	3.72	2.72	5.84	4.02
	$LD_{90,}$	3.58	2.14	5.56	3.69	8.80	5.30
10 G_y/hr	$LD_{10,}$	1.06	0.661	2.23	1.39	3.52	2.14
	$LD_{50,}$	2.06	1.09	3.33	2.24	5.49	3.29
	$LD_{90,}$	3.20	1.54	4.98	3.06	8.44	4.33
100 G_y/hr	$LD_{10,}$	1.06	0.598	2.22	1.36	3.52	2.09
	$LD_{50,}$	2.04	1.05	3.29	2.18	5.49	3.21
	$LD_{90,}$	3.19	1.47	4.97	3.00	8.43	4.25

Notes:
a DM represents the distributions obtained from the expert panel
b Pred gives the distributions obtained using the fitted distributions on the parameter values

Table 2.10 Comparison between marginal distributions of elicitation variables obtained from the experts and from the distributions on target variables for parameters for lung morbidity

		5%		50%		95%	
		DM	Pred	DM	Pred	DM	Pred
0.2 G_y/hr	ED_{10}	11.2	8.75	31.0	30.0	93.3	122
	ED_{50}	13.4	11.4	49.3	45.0	135	149
	ED_{90}	15.4	13.6	66.4	57.9	174	240
1 G_y/hr	ED_{10}	6.85	4.43	13.9	12.1	60.5	61.8
	ED_{50}	8.24	5.94	17.9	18.0	75.5	75.8
	ED_{90}	9.56	6.98	21.3	22.8	129	90.4
10 G_y/hr	ED_{10}	3.00	2.43	7.05	5.25	60.4	49.7
	ED_{50}	3.80	3.32	8.80	7.42	75.3	60.3
	ED_{90}	4.36	4.02	10.3	9.50	129	73.0
100 G_y/hr	ED_{90}	2.13	2.15	4.14	4.66	60.4	48.5
	ED_{90}	3.11	3.00	5.49	7.48	75.3	59.4
	ED_{90}	3.73	3.73	7.02	8.36	129	71.9

Notes:
a DM represents the distributions obtained from the expert panel
b Pred gives the distributions obtained using the fitted distributions on the parameter values

3 RESULTS

This section presents the results of the analysis of the early and late health effects modules, and describes the extent of the uncertainty on the predictions and also those parameters whose uncertainties make important contributions to the overall uncertainty. The extent of the uncertainty is described using "uncertainty factors" (the ratio of the 95th to 5th percentiles of the distribution on the endpoint) and "reference uncertainty coefficients" (the ratio of the 95th percentile of the uncertainty distribution to the value obtained using default values for all the input parameters). Appendix C contains more extensive results on the extent of the uncertainty, giving 7 percentiles of the distribution on each of the endpoints, together with the reference value. The important parameter uncertainties are summarised in this chapter, which gives those parameters that are identified as important for groups of endpoints (either different parts of the ccdf for one quantity, or for related quantities). The criteria adopted to decide which parameters to include in the tables in this section are rather subjective. Appendix D contains more information on the contributions of the different parameter uncertainties to the overall uncertainty on the model predictions, listing those parameters that are identified in the top 3 ranks using PRCC and those making more than 10% contribution to the uncertainty. This appendix therefore identifies more parameters than are included in the overall analysis, using the criteria described in Section 1 of this report.

In the absence of any uncertainty, the results of COSYMA are presented in terms of probability distributions of the various quantities, where the probability reflects the occurrence of different atmospheric conditions at the time of the release. In this study, the probability distribution is characterised by its mean value and the 95^{th} and 99^{th} percentiles of the distribution. The methods and quantities used in this study to describe the uncertainty are described in the "Methodology Report". The dose module analysis involved 100 runs of COSYMA and so generated 100 sets of ccdfs for each of the endpoints. One of the results of an uncertainty analysis is the uncertainty distribution on chosen percentiles and the mean value of the original probability distributions. This uncertainty is represented, in this study, by the "uncertainty factor" which is the ratio of the 95^{th} and 5^{th} percentiles of the uncertainty distribution on the chosen percentiles and mean value for the endpoints considered. COSYMA uses a binning system to derive its probability distributions. In some cases, the uncertainty range on a quantity includes values which are below the lower limit of the bottom bin used for the distribution; such values are reported as zero. In some cases the 5^{th} (and higher) percentile is reported as zero, and the value of the uncertainty factor is infinite. The value of the 95^{th} percentile is given in brackets in the results tables, in place of the uncertainty factor in these cases. Another quantity used is the "reference uncertainty coefficient", which is the ratio of the 95^{th} percentile of the uncertainty distribution for the chosen percentiles or mean value of the original probability distribution to the value predicted using the default values for the parameters in the model. A further ccdf, designated the "mean curve" is also used to present some of the results. This curve is obtained as the average of all the ccdfs obtained from the COSYMA runs.

The endpoints of the analysis were described in Section 1 of this report. The uncertainties on the parameters of the health effects models affect the uncertainty on the individual and collective risks of early and late health effects only, and so this report only considers those endpoints. Information is given on individual risks at three distances (0.875, 5 and 20 km for early

effects and at 5, 20 and 100 km for late effects). The expert panel did not specify distribution for the parameters relating to the risk of hypothyroidism; this effect is therefore not considered in this report

The results presented here are specific to the situations and source terms considered in this analysis. The extent to which the results can be applied in other situations is considered in the report on the overall analysis.

3.5 Individual risks of early health effects

The extent of the uncertainty on the individual risks of early health effects for the UK1 source term is summarised in Table 3.1 which shows the "uncertainty factors" for the mean values and for the 95th and 99th percentiles of the distributions of individual risks of the early effects at the three distances considered. The 95th percentile of the uncertainty distribution is compared to the reference value in Table 3.2, which shows the "reference uncertainty coefficients" for the risks of early health effects. There are some situations (ie effect at a particular distance) for which it is not possible to calculate an "uncertainty factor", as the 5th percentile of the uncertainty distribution is zero. The extent of the uncertainty in these cases can be judged from the value of the 95th percentile of the risk which is given in the table, in brackets, instead of the uncertainty factor. There are some cases where both the 5th and 95th percentiles of the uncertainty distribution are zero, when the uncertainty factor becomes 0/0; these can be identified from Table 3.1 as the 95th percentile is shown as zero. In some cases, the reference value is also zero, and it is not then possible to calculate the "reference uncertainty coefficient". However, in all these cases, the uncertainty factor is also infinite, and the 95th percentile of the uncertainty distribution can be obtained from Table 3.1.

The relative magnitudes of the uncertainty factors for fatal and non-fatal effects could reflect aspects of the method of calculation used. COSYMA calculates the risk of suffering a morbidity provided that the exposed person does not die from the exposure received. If the risk of dying varies between 0.5 and 0.99, the probability of surviving must vary between 0.5 and 0.01. The use of ratios (rather than differences) to express the uncertainty in this study means that the uncertainty factor on the risk of death in this case is 2 while that on the probability of surviving is 50, and so the uncertainty on morbidities may appear to be greater than that on mortalities. The reverse effect is observed when the risk of death is lower than 0.5, and the uncertainty on mortality could appear to be greater than that on morbidity. In addition, a low value of the individual risk of morbidities could result from a very high risk of early death (and so only a small risk of surviving to express the morbidity) as well as from a low risk of both early death and early morbidity.

In most cases, the uncertainty factor increases with increasing distance. However, for some of the non-fatal effects, the uncertainty at the second distance is lower than at the other distances. This could reflect the features described above.

In general, the uncertainty is small, with most of the "uncertainty factors" being well below an order of magnitude. The uncertainty is similar for the different situations (ie countermeasures, normal living or potential risks) considered, other than at the third distance where

the uncertainty is greater if countermeasures are taken than in the other cases. This reflects the way in which the countermeasures can reduce doses and hence risks in some situations. Countermeasures are assumed to be implemented on the basis of dose, and so the same actions are assumed in each sequence of atmospheric conditions considered in the analysis, independently of the values of the parameters in the model relating doses and risks. The detailed results presented in Appendix C enable a comparison to be made of the uncertainty distributions of the risks when countermeasures are taken and in normal living. This shows that the 5th percentile of the distribution is more sensitive to the imposition of countermeasures than the 95th percentile of the distribution, suggesting that the effectiveness of countermeasures depends on the variation of dose with risk. This could mean that countermeasures are more effective if the values of the parameters in the health effects model are such that the sigmoid curve relating risk to dose is steep.

In some cases there is no uncertainty on the 95th and 99th percentiles of the distributions of individual risks, particularly at the shortest distance considered. The high percentiles of the distribution represent the risk on the plume centre-line, where doses are very high. In these cases, COSYMA predicts that the high percentiles of the distributions for the risk of the various effects are 1.0 for all values of the parameters in the health effects models, and there is no uncertainty on this value. The "reference uncertainty coefficient" is also 1.0 for these cases.

The "reference uncertainty coefficients" are given in Table 3.2. In some cases, particularly for early deaths with countermeasures at the first and second distances, the values are similar to those for the "uncertainty factors". This shows that the default value is close to the 5th percentile of the uncertainty distribution. At short distances, early death is caused by exposure of both the bone marrow and the skin. As noted in chapter 2, the default parameter values for the risk of bone marrow exposure are near the ends of, or outside, the uncertainty ranges used in this study. This explains why the risks predicted with default values are generally lower than those obtained with the range of values used in this study. In the other situations considered (normal living or potential risks) the risks reflect also the exposure of the lung, where the default values are towards the centre of the uncertainty distributions used, and so the risks predicted with the default values are not so extreme in the uncertainty range. For other cases, particularly morbidities when countermeasures are taken, the "reference uncertainty coefficient" is close to 1.0, showing that the default value is close to the 95th percentile of the uncertainty distribution. If the default value for early death is low in the uncertainty distribution, then it is likely to be high in the uncertainty distribution for early morbidities, as the risk of morbidity includes the probability of surviving early death. This is demonstrated in Table 3.2.

The uncertainty on early health effects was also evaluated for the CB2 source term. However, the doses for this source term are below the threshold value for early health effects other than for skin effects, and the results are not presented here. They can be found in Appendix C if required.

The identification of those parameters whose uncertainties make major contributions to the overall uncertainty can be divided into two sections. Some of the endpoints, such as the risk of the haematopoietic syndrome, are governed only by the risks from exposure of a single organ and so the only parameter uncertainties that can contribute are the parameters V, D_0 and D_∞ for that

organ. The uncertainty in the risk of morbidities in particular organs also reflects to some extent the uncertainty in surviving early mortality. In these cases, the relevant parameter uncertainties are identified as important contributors. The uncertainty in the risk of early death or of early morbidities could reflect the uncertainty in the total risk parameters for any of the organs for which early effects are considered, depending on the relative risks in the different organs. The parameters whose uncertainties make large contributions to the overall uncertainty on the individual risk of early death and early morbidities are summarised in Table 3.4. They are those related to calculating the risk of death from bone marrow exposure and skin exposure. The uncertainty on the bone marrow risk parameters and on the risk of dying from partial body skin exposure contribute to the uncertainty on risks at the first distance, while only the skin parameters are identified as important contributors at the other distances.

Appendix C gives the distributions of risks at the different distances, for the different organs separately and for the total risk from all organs. The results there show that the risk of skin morbidities is a large fraction of the total risk of morbidities at the first distance, and is the only effect for which doses are above the threshold at the final distance for the cases where countermeasures are taken and for normal living. The important parameter uncertainties identified here therefore reflect the relative contributions of the different organs to the overall risk. In general, the same parameters are identified for the different parts of the probability distribution of risks and for the risks assuming that countermeasures are taken, for normal living and for the potential outdoor risks.

3.6 Numbers of early health effects

The extent of the uncertainty on the numbers of early health effects for UK1 is summarised in Table 3.4, which shows the "uncertainty factors" for the mean value and for the 95th and 99th percentiles of the distributions of the numbers of early health effects if countermeasures are taken and for normal living without countermeasures. The "reference uncertainty coefficients" are also shown in Table 3.4.

The "uncertainty factors" for the mean numbers of early deaths for countermeasures and for normal living are similar, though the uncertainty factors for the higher percentiles of the distribution are lower for countermeasures than for normal living. The uncertainty on the numbers of morbidities is lower than that for the numbers of mortalities for normal living; however if countermeasures are taken, the uncertainty on the number of morbidities is higher than that for the number of mortalities. This reflects the uncertainty on the individual risks of early effects over the distances at which most early effects occur.

The "reference uncertainty coefficients" are less than the "uncertainty factors"; the numbers of effects predicted using default values tend to be around the centre of the uncertainty distribution, other than for the number of early deaths with countermeasures, where the consequence predicted using default parameter values is below the 25th percentile of the uncertainty distribution and for parts of the distribution is below the 5th percentile of the uncertainty distribution as shown in Figure 3.1. This is consistent with the findings for individual risks for the different distances and population behaviours.

The doses for the CB2 source term are below the threshold for early effects in all organs except skin, and the numbers of effects are low. The uncertainty factor for the mean number of morbidities is about 3000, with the 95th percentile of the distribution being 12; the uncertainty factor for the mean number of early deaths is about 2500, with the 95th percentile being only 1.5 effects.

The parameters whose uncertainties make major contributions to the overall uncertainty on the numbers of early effects are also summarised in Table 3.3. They are those related to the risk of skin burns and to the risk of dying from partial body skin exposure. Although parameters relating to the risk of death from bone marrow exposure were identified as making an important contribution to the uncertainty on individual risk at the first distance considered, they are not identified as important contributors to the uncertainty on the number of effects. This is because they are only important for the risk over a short range of distances, while the uncertainties on the risks following skin exposure are important contributors over a much larger distance range, and so make a comparatively larger contribution to the uncertainty on the numbers of effects.

3.7 Individual risk of late health effects

COSYMA calculates the risk of cancer in each organ separately and sums the risks for the different organs to get the total risk of fatal cancers. For this module analysis, the uncertainty on the risk of cancer in any one organ reflects only the uncertainty on the risk coefficient for that organ, as no other parameters in the model are assumed to be uncertain. The distributions used for the uncertainty on the risk coefficients are presented in Section 2. For each organ, the uncertainty factor is very large (5 or 6 orders of magnitude), because the distributions have a very long tail with minimum value zero, and with 5th and 25th percentiles of about 10^{-8} and 10^{-4} Sv^{-1}. The uncertainties on the risks of particular types of cancer in this module analysis are totally governed by the uncertainty on the risk coefficient for the particular organ, and so show the same features in the distributions. The results for individual cancer types are not presented in this chapter, but are given in Appendix C.

The uncertainty on the total risk of cancer is, however, very much smaller than that on each cancer type separately. A very small total cancer risk would only be obtained if a very small value for the risk coefficient had been selected from the distributions for each of the organ risk coefficients, which is extremely unlikely. Therefore, the uncertainty distributions on the individual risk of fatal cancer for the different distances and behaviour patterns considered tend to exclude values near the lower end of the range generated by simply summing the distributions for each cancer separately. Similarly, the distributions tend not to include values near the upper end of the range generated by simply summing the distributions for each cancer separately, but this is much less obvious from the results because of the shapes of the distributions on the input parameters. The uncertainty factors for the total cancer risks are very much narrower than those for the uncertainty on the individual organs, as summarised in Table 3.5, which gives the “uncertainty factors” for the different parts of the probability distribution for each of the distances and situations considered. The factors are similar for the different situations and distances, lying between about 3.5 and 5.5.

The differences reflect the varying contributions of different exposure pathways, and hence different organ doses in the various situations considered.

The "reference uncertainty coefficients" for the risk of fatal cancers are given in Table 3.6. The values are about 3 for all of the conditions considered. The value predicted using default parameter values lies around the 25th percentile of the uncertainty distribution while the default parameter value for each of the individual cancer risks is around the median value of the distributions The default value for the total risk would be expected to be towards the lower end of the overall distribution for the reasons discussed above about combining risks in different organs.

The parameters which were identified as those whose uncertainties make large contributions to the overall uncertainty on the individual risks of fatal cancers are given in Table 3.7; they are the risk coefficients for the remainder, lung and colon. The same parameters are identified for the different parts of the probability distributions, for the risks with and without countermeasures and for the two source terms. COSYMA calculates the risk of fatal cancers by first calculating the risk of cancer in each of a number of organs and then summing this to get the total cancer risk. As noted in Section 2, the uncertainty factors for the risk coefficient for each organ are large, because of the very low values assigned to the 5th percentiles of the distributions, with 4 organs (lung, colon, stomach and remainder) having uncertainty factors of 10^6 or greater. The analysis identified 3 of these 4 risk factors as being the ones whose uncertainty makes the most important contribution to the overall uncertainty, though it is likely that the uncertainty on the other risk coefficients also makes a reasonable contribution to the overall uncertainty.

3.8 Numbers of late health effects

The extent of the uncertainty on the numbers of late health effects is summarised in Table 3.8 which shows the "uncertainty factors" for the mean value and for the 95th and 99th percentiles of the distributions of numbers of fatal cancers, and in Table 3.9 which gives the values of the "reference uncertainty coefficient". The results are also illustrated in Figure 3.2, which shows the 5th and 95th percent envelopes of the uncertainty distribution, and the reference curve, for the numbers of fatal cancers for CB2, if countermeasures are taken. The uncertainty factors for the numbers of fatal cancers in the different situations are very similar to those for the individual risk of fatal cancer at the largest distance considered. The comments made in the previous section about the uncertainty on the individual risks of leukaemia and thyroid cancers apply equally here to the numbers of effects

The parameters whose uncertainties make large contributions to the overall risks of late health effects are the same as those identified in the previous section for the individual risks of fatal cancers.

3.9 Identification of the important parameters for the overall analysis

The parameters to be included in the overall analysis are those that are placed in the first or second rank according to the PRCC value plus those whose uncertainty contributes more than 15% of the overall uncertainty for at least one endpoint and one source term. The parameters

identified according to these criteria are summarised in Table 3.10. This table also shows whether the parameters were identified as important using ranks or percentage contributions to the uncertainty, and the source term for which they were identified.

This analysis considered the risks of early health effects in skin and lung, plus the risk of the haematopoietic syndrome together with the total risk of early morbidities and mortalities. The risk of early effects in a single organ is determined by 3 parameters, and the analysis identified each of these parameters as important for the risk of effects in that organ. Therefore all the parameters relating to early health effects were identified as important and hence were included in the overall analysis.

The analysis considered the total risk of fatal cancer, together with the risk of leukaemia and of thyroid cancer. The uncertainty on 3 risk coefficients were identified as the main contributors to the overall risk of fatal cancer, while the uncertainty on the thyroid and leukaemia risk coefficients were identified as important for those effects. As noted earlier, it is reasonable to assume that the uncertainties on each of the cancer risk coefficients could make a reasonable contribution to the overall uncertainty. Therefore all of the parameters related to late health effects were included in the overall analysis.

Table 3.1 Uncertainty factors[(a)] for individual risks of early health effects for the UK1 source term at the three distances considered

Quantity	For mean value			For 95th percentile			For 99th percentile		
Risk of early death with countermeasures	1.7	4.1	800	5.0	$(1.4\ 10^{-1})$	(0)	1.0	10	$(4.0\ 10^{-2})$
Risk of haematopoietic syndrome with countermeasures	2.0	15	$(5.7\ 10^{-6})$	26	(0)	(0)	1.0	$(7.2\ 10^{-2})$	(0)
Risk of early death for normal living	1.6	5.2	15	3.3	9.6	$(3.3\ 10^{-3})$	1.0	9.5	39
Risk of haematopoietic syndrome for normal living	2.0	2,000[(b)]	(0)	38	(0)	(0)	1.0	$(3.3\ 10^{-2})$	(0)
Risk of early death for potential exposure	1.3	2.2	9.2	1.0	11	$(6.6\ 10^{-2})$	1.0	1.0	9.6
Risk of haematopoietic syndrome for potential exposure	1.3	3.0	$(1.5\ 10^{-3})$	1.0	$(2.7\ 10^{-2})$	(0)	1.0	1.1	(0)
Risk of early morbidities with countermeasures	2.6	5.4	440	1.6	$(8.9\ 10^{-1})$	(0)	2.4	1.5	$(3.5\ 10^{-1})$
Risk of lung morbidities with countermeasures	$(1.5\ 10^{-2})$	$(4.4\ 10^{-3})$	(0)	(0)	(0)	(0)	$(6.2\ 10^{-1})$	(0)	(0)
Risk of skin burns with countermeasures	2.2	5.5	440	1.8	$(8.7\ 10^{-1})$	(0)	1.3	1.7	$(3.5\ 10^{-1})$
Risk of early morbidities for normal living	2.8	2.0	8.1	1.7	3.9	(0)	2.0	1.6	$(9.6\ 10^{-1})$
Risk of lung morbidities for normal living	$(2.2\ 10^{-2})$	$(7.2\ 10^{-3})$	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Risk of skin burns for normal living	1.6	2.0	8.1	1.3	4.8	(0)	1.2	1.2	$(9.5\ 10^{-1})$
Risk of early morbidities for potential exposures	2.8	2.1	3.0	14	5.0	$(7.8\ 10^{-2})$	1.7	1.6	1.4
Risk of lung morbidities for potential exposures	$(3.8\ 10^{-3})$	$(5.7\ 10^{-3})$	$(2.3\ 10^{-4})$	(0)	(0)	(0)	$(1.3\ 10^{-1})$	$(1.7\ 10^{-1})$	(0)
Risk of skin burns for potential exposures	2.5	2.3	4.3	25	15	$(7.6\ 10^{-2})$	1.3	1.3	4.9

Notes

a In some cases the uncertainty factor is infinite, as the 5th percentile of the uncertainty distribution is zero. In these cases, the 95th percentile of the uncertainty distribution is given in brackets. In some cases, both the 5th and 95th percentiles are zero.

b The 5th and 95th percentiles of the uncertainty distribution are $1.6\ 10^{-6}$ and $3.2\ 10^{-3}$ respectively.

Table 3.2 Reference uncertainty coefficients[(a)] for individual risks of early health effects for the UK1 source term at the three distances considered

Quantity	For mean value			For 95th percentile			For 99th percentile		
Risk of early death with countermeasures	1.8	4.6	15	7.8	3.3	-	1.0	5.6	-
Risk of haematopoietic syndrome with countermeasures	1.8	5.9	-	12	-	-	1.0	-	-
Risk of early death for normal living	1.2	3.2	4.6	1.0	4.2	-	1.0	5.2	3.9
Risk of haematopoietic syndrome for normal living	1.1	1.7	-	1.0	-	-	1.0	-	-
Risk of early death for potential exposure	1.1	1.3	2.9	1.0	4.9	-	1.0	1.0	4.2
Risk of haematopoietic syndrome for potential exposure	1.1	1.2	1.8	1.0	-	-	1.0	1.0	-
Risk of early morbidities with countermeasures	1.1	1.7	6.0	0.98	12	-	1.2	1.0	-
Risk of lung morbidities with countermeasures	28	5.1	-	-	-	-	-	-	-
Risk of skin burns with countermeasures	1.1	1.7	6.0	1.0	1.1	-	1.0	1.0	-
Risk of early morbidities for normal living	1.4	1.1	1.8	1.4	1.0	-	1.4	1.1	1.1
Risk of lung morbidities for normal living	-	1,600[(b)]	-	-	-	-	-	-	-
Risk of skin burns for normal living	1.2	1.2	1.8	1.0	1.0	-	1.0	1.0	1.1
Risk of early morbidities for potential exposures	1.6	1.4	1.4	1.6	1.0	-	1.1	1.1	1.1
Risk of lung morbidities for potential exposures	-	-	-	-	-	-	-	-	-
Risk of skin burns for potential exposures	1.5	1.3	1.6	2.0	1.0	-	1.0	1.0	1.0

Notes

a In some cases, the reference value is zero, and so the reference uncertainty coefficient is infinite. These are indicated in the table as '-'. In all these cases, the uncertainty factor is also infinite, and the value of the 95th percentile of the uncertainty distribution can be obtained from Table 3.1

b The reference value and 95th percentile of the uncertainty distribution are 4.5 10^{-6} and 7.2 10^{-3} respectively.

Table 3.3 Parameters whose uncertainty makes major contributions to the overall uncertainty on individual and collective risk of early morbidities and mortalities (UK1)

Parameters for individual risk

Fraction of people dying from partial body skin exposureParameters for variation of LD_{50} for bone marrow death with dose rateParameters for variation of LD_{50} for skin morbidity with dose rate

Parameters for collective risk

Fraction of people dying from partial body skin exposureParameters for variation of LD_{50} for skin morbidity with dose rate

Table 3.4 Uncertainty factors[(a)] and reference uncertainty coefficients for the number of early health effects for the UK1 source term

Quantity	Uncertainty factors			Reference uncertainty coefficients		
	For mean value	For 95th percentile	For 99th percentile	For mean value	For 95th percentile	For 99th percentile
Number of early mortalities, with countermeasures	13	6.8	6.9	9.1	6.6	7.4
Number of cases of haematopoietic syndrome, with countermeasures	6.2	5.1	2.6	4.6	4.7	2.0
Number of early morbidities, with countermeasures	23	11	11	4.5	3.2	2.9
Number of cases of lung morbidity, with countermeasures	(160)	(1000)	(3200)	9.2	8.1	12
Number of cases of skin burns, with countermeasures	27	15	12	4.6	3.2	2.9
Number of early mortalities, for normal living	15	17	13	5.2	5.0	4.5
Number of cases of haematopoietic syndrome, for normal living	7.7	4.7	5.0	1.3	1.4	1.0
Number of early morbidities, for normal living	6.6	6.3	2.9	2.1	2.2	1.5
Number of cases of lung morbidity, for normal living	(230)	(1200)	(4000)	$1.4\ 10^{5}$ [(b)]	-	-
Number of cases of skin burns, for normal living	7.1	6.6	3.0	2.1	2.2	1.6

Notes:

a In some cases the uncertainty factor is infinite as the 5th percentile of the uncertainty distribution is zero. In these cases the 95th percentile of the uncertainty distribution is given in brackets.

b The reference value and the 95th percentile of the uncertainty distribution are $1.6\ 10^{-3}$ and 230, respectively.

Table 3.5 "Uncertainty factors" for long term individual risks of fatal cancer at the three distances considered

Quantity	For mean value			For 95th percentile			For 99th percentile		
CB2									
With countermeasures	4.7	4.8	4.8	4.8	4.8	4.8	4.6	4.8	4.8
For normal living	3.5	4.3	4.6	4.8	4.6	4.6	4.0	4.6	4.6
DBA									
With countermeasures	4.5	4.6	4.5	5.6	4.9	4.6	4.5	4.9	4.6
For potential exposures	4.5	4.6	4.7	4.7	4.6	4.6	4.7	4.5	4.8

Note
The results are given at distances of 5, 20 and 100 km

Table 3.6 "Reference uncertainty coefficients" for long term individual risks of fatal cancer at the three distances considered

Quantity	For mean value			For 95th percentile			For 99th percentile		
CB2									
With countermeasures	2.9	3.0	3.0	3.0	3.0	3.0	2.8	3.0	3.0
For normal living	2.3	2.7	2.9	2.8	2.8	2.9	2.5	2.8	2.8
DBA									
With countermeasures	2.8	2.7	2.8	3.0	2.8	2.6	2.8	2.9	2.8
For potential exposures	2.8	2.8	2.9	2.8	2.8	2.8	2.7	2.8	3.0

Note
The results are given at distances of 5, 20 and 100 km

Table 3.7 Parameters whose uncertainty makes a large contribution to the overall uncertainty on individual risk of fatal cancers

Risk coefficients for remainder, lung and colon

Table 3.8 Uncertainty factors for the numbers of fatal cancers

Quantity	For mean value	For 95th percentile	For 99th percentile
CB2			
With countermeasures	4.8	4.8	4.8
For normal living	4.5	4.3	4.6
DBA			
With countermeasures	4.6	4.6	4.5

Table 3.9 Reference uncertainty coefficients for the numbers of fatal cancers

Quantity	For mean value	For 95th percentile	For 99th percentile
CB2			
With countermeasures	3.0	3.0	3.0
For normal living	2.8	2.8	2.9
DBA			
With countermeasures	2.8	3.0	2.8

Table 3.10 Summary of the parameters whose uncertainty makes large contributions to the overall uncertainty

Selected input parameter	Selected using		Selected for source term		
	Ranks	Percentage contribution	UK1	CB2	DBA
Skin: shape parameter V	✔	✔	✔	✔	
Skin: model parameter D_0	✔	✔	✔	✔	
Skin: model parameter D_∞	✔	✔	✔	✔	
Skin: Fraction of people dying for burns on 20% of exposed skin	✔	✔	✔	✔	
Pulmonary syndrome: shape parameter V		✔	✔		
Pulmonary syndrome: model parameter D_0	✔	✔	✔		
Pulmonary syndrome: model parameter D_∞	✔	✔	✔		
Lung function impairment: parameter V	✔		✔		
Lung function impairment: model parameter D_0	✔	✔	✔		
Lung function impairment: model parameter D_∞	✔	✔	✔		
Haematopoietic syndrome: shape parameter V	✔	✔	✔		
Haematopoietic syndrome: model parameter D_0	✔	✔	✔		
Haematopoietic syndrome: model parameter D_∞	✔	✔	✔		
Gastrointestinal syndrome: shape parameter V	✔		✔		
Gastrointestinal syndrome: model parameter D_0	✔		✔		
Gastrointestinal syndrome: model parameter D_∞	✔	✔	✔		
Risk of death from radiation induced leukaemia	✔	✔		✔	✔
Risk of death from radiation induced lung cancer	✔	✔		✔	✔
Risk of death from radiation induced colon cancer	✔	✔		✔	✔
Risk of death from radiation induced thyroid cancer	✔	✔		✔	✔
Risk of death from radiation induced cancer in other organs	✔	✔		✔	✔

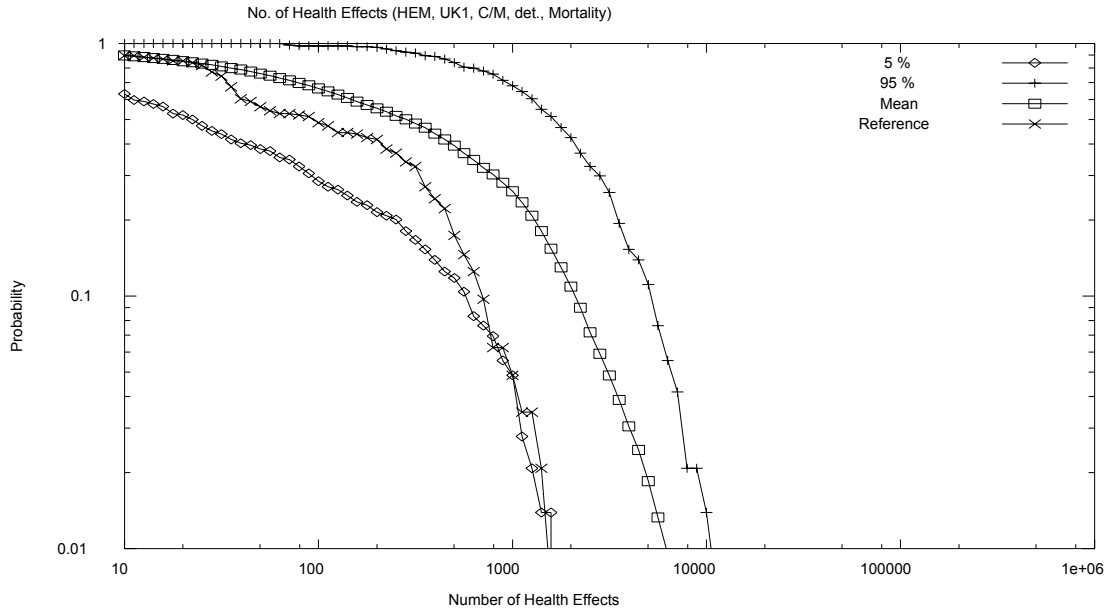

Figure 3.1 Uncertainty on the numbers of early deaths, with countermeasures for UK1

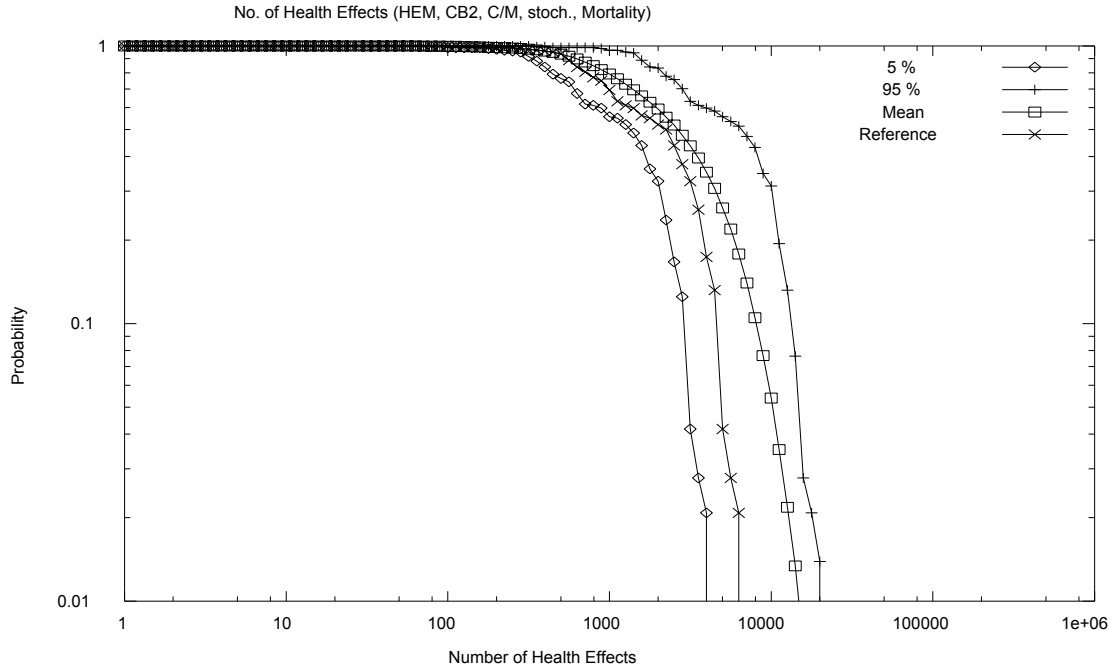

Figure 3.2 Uncertainty on the numbers of fatal cancers, with countermeasures, for CB2

APPENDIX A

Reports from the Project

Reports on the expert elicitation

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Jones J A, Fischer F, Hasemann I, Goossens L H J, Kraan B C P, Cooke R M. Probabilistic accident consequence uncertainty assessment using COSYMA: Uncertainty from the Health Effects Module. EUR 18824 and FZKA 6310 (2000).

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APPENDIX B

Summary of the COSYMA Accident Consequence Code

COSYMA is intended for probabilistic calculations of the off-site consequences of hypothetical accidental releases of radioactive material to atmosphere at nuclear sites. It calculates the health effects, impact of countermeasures and economic costs of the releases. The processes considered in the calculations, and the routes of exposure following accidental releases to atmosphere, are illustrated in Figure B.1. The calculation is divided into a number of steps, as is also illustrated in Figure 1. COSYMA is a modular code, with different modules addressing the different stages of the calculation. However, while Figure 1 illustrates the steps in the calculation, the modules of the codes do not correspond exactly with the boxes shown in that figure. The following sections give brief descriptions of the models included in COSYMA. In some cases, COSYMA includes more than one model for a particular feature. This appendix also specifies which of the models was used for this uncertainty analysis.

COSYMA was developed by the National Radiological Protection Board (NRPB) of the UK and Forschungszentrum Karlsruhe (FZK) of Germany, as part of the European Commission's MARIA project[1]. It represents a fusion of ideas from the NRPB program MARC[2], the FZK program system UFOMOD[3] and input from other MARIA contractors. The program package was first made available in 1990 for use on mainframe computers, and several updates have been released since then. A PC version was first released in 1993 and has since been updated[4].*

COSYMA is a package of programs and data bases, rather than a single program. The mainframe version contains three main accident consequence assessment programs together with a number of preprocessing and evaluation programs. The three main sub-systems of COSYMA are known as the NE, NL and FL sub-systems. The NE (near, early) sub-system is limited to calculating early health effects and the influence of emergency actions to reduce those effects and is intended for use in the region near to the site. The NL (near, late) subsystem is limited to calculating late health effects and the associated countermeasures, and is intended mainly for use in the region near to the site. The FL (far, late) sub-system is concerned with calculating late health effects and appropriate countermeasures at larger distances from the site. Each of these programs is further sub-divided into a series of modules for the various steps in the calculation. PC COSYMA incorporates the NE and NL sub-systems of the mainframe version.

The main endpoints of COSYMA are the numbers of health effects, the impact of countermeasures and the economic costs resulting from an accidental release. A large number of intermediate results are obtained in the process of calculating the major endpoints; these results include activity concentrations, individual and collective doses and the countermeasures that would be imposed

* The mainframe and PC versions of COSYMA are made available on behalf of the European Commission. People wishing to obtain the mainframe version of the system should contact Dr J Ehrhardt, FZK, Germany (e-mail RODOS@RODOS.FZK.DE; those wishing to obtain the PC version of the system should contact Dr J A Jones, NRPB, UK (e-mail Arthur.Jones@NRPB.ORG.UK).

at different locations. The package contains a series of evaluation programs that allow these results to be presented in a variety of ways.

Following an accidental release to atmosphere, people can be irradiated by a number of routes of exposure. The ones considered in COSYMA are:-

- external γ irradiation from material in the plume,
- external γ irradiation from material deposited on the ground
- external β irradiation of skin from material deposited on skin and clothes
- internal irradiation following the inhalation of material from the plume or of material that has been deposited and subsequently resuspended
- internal irradiation from the ingestion of contaminated foods.

COSYMA includes some models directly within the various modules or subsidiary programs, but in other cases it uses results of models taken from data libraries. Thus the atmospheric dispersion models are used directly. COSYMA does not however, include models for the contamination of food or dosimetric calculations, using instead data libraries giving the results of other models, which are not part of COSYMA, itself, but whose uncertainty is considered within the current study.

B.1 Atmospheric dispersion and deposition

Mainframe COSYMA contains five different models of atmospheric dispersion that are appropriate for different applications or are based on different assumptions and approximations[5].

The NE and NL sub-system include the MUSEMET[6] model, which was originally written at Forschungsanlage Julich but has been extensively modified at FZK for use with COSYMA. This is a segmented Gaussian plume model allowing for changes of atmospheric conditions and wind direction during plume travel. This model derives the sequences of atmospheric conditions affecting the plume from a data file giving hourly averages for wind speed and direction, stability category, precipitation intensity and mixing layer depth. It allows for the effects on the subsequent dispersion of plume rise and buildings near the release point. It also includes the effects of wet and dry deposition of the dispersing material. This model is also included in PC COSYMA.

The NE and NL sub-systems can also be used with the COSGAP or RIMPUFF dispersion models, which are provided as separate programs. COSGAP[7] is a Gaussian plume dispersion model, which is similar to MUSEMET but does not consider changes of wind direction during plume travel. It is based on the dispersion model in MARC. RIMPUFF[8], developed by Risø National Laboratory, Denmark, is a Gaussian puff trajectory model which derives the atmospheric conditions affecting the plume by interpolating between data from a number of meteorological stations in the region of interest.

The NL sub-system also contains the ISOLA[9] model for very long release durations. This uses statistics of atmospheric conditions and is only appropriate for releases that are sufficiently small that no countermeasures and no early health effects would be expected.

The FL sub-system is linked to the Mesos model[10], developed by Imperial College, UK. This

is a trajectory model for dispersion over long distances that uses meteorological data for a large area, such as the whole of Europe.

Accident consequence assessment programs need to consider the consequences should the accident occur in any of a wide range of atmospheric conditions. It is not possible to calculate the consequences for every sequence of conditions that might arise, and so some method is required to sample a representative set of conditions from those possible. Both the mainframe and PC versions of COSYMA include a flexible program to undertake this sampling.

Only the MUSEMET dispersion model is included in this study, using the NE and NL sub-systems. The uncertainty in dispersion modelling includes both the uncertainty on the spread of the plume around its trajectory, and the uncertainty on the location of the plume trajectory. The other Gaussian models included in COSYMA (RIMPUFF, COSGAP and ISOLA) use similar descriptions of the growth of plumes and of the trajectory. Therefore the uncertainty on consequences predicted using MUSEMET should be similar to the uncertainties predicted using the other Gaussian models. However, MESOS uses a different method of calculating plume trajectories, and the uncertainties on calculations using MESOS may not be the same as those using Gaussian plume or puff models.

B.2 Dose calculations

As stated earlier, COSYMA does not include dosimetric models but uses information from data libraries which are calculated with these models. The libraries include information on the doses from 197 radionuclides.

The data library used for calculating external exposure from γ emitting material deposited on the ground contains outdoor doses per unit deposit integrated to a series of times. These doses are combined with location factors representing the reduction of external γ irradiation by the shielding effects of buildings and typical behaviour of the population. The library is drawn from a number of sources, using results of models developed at NRPB[11,12] and Forschungszentrum für Umwelt und Gesundheit (GSF)[13], Germany. The doses for those radionuclides making major contributions to the dose from fission reactor accidents are derived from a model describing the deposition patterns in urban areas and the subsequent transfer of material between the different surfaces. Location factors are used to describe the protection offered by buildings.

The doses from internal irradiation following ingestion or inhalation are calculated using data libraries of dose per unit intake derived using models which are consistent with those in ICRP publications 56, 67 and 69. COSYMA needs information on the dose received in different periods after the accident, and so this information is included in the data libraries. The method used for calculating doses and risks of health effects in the mainframe version of COSYMA allows for the variation of dose per unit intake with age at intake, and so the libraries contain information on doses for different age groups in the population. The PC version uses a simpler method which only considers the doses to adults.

B.3 Food chain models

COSYMA requires information on the concentration of material in foods as a function of time after the accident. It does not include a food chain model, but uses the results of such models through data libraries which give the activity concentration for a range of radionuclides in a number of foods at a series of times following unit deposition. The concentration of material in foods depends on the time of year at which the deposition occurs. COSYMA uses two data libraries, for deposition in summer and winter. Within a run of COSYMA, the "summer" or "winter" data library is used depending on the date in the year of the meteorological sequence being analysed.

COSYMA uses libraries derived from the NRPB model FARMLAND[14] and the GSF model ECOSYS[15]. The libraries were created using agreed values for the food chain parameters for application within the European Union, but there are differences because of other modelling assumptions made and because of the foods considered in each. The foods which can be considered with FARMLAND are milk, meat and liver from cattle, pork, meat and liver from sheep, green vegetables, grain products, potatoes and other root vegetables. The foods which can be considered with ECOSYS are milk, beef pork, grain products, potatoes and other root vegetables, and leafy and non-leafy green vegetables.

The intakes of these foods are calculated within COSYMA using one of two assumptions about the distribution of food between harvest and consumption. One method assumes that all food consumed is produced locally, and is used in calculating individual ingestion doses. The other method uses information on the amount of food produced in the area of interest, and calculates collective doses on the assumption that all food produced is consumed somewhere.

For this study, the FARMLAND food chain model was used to calculate the uncertainty on concentrations of activity in foods. Doses from ingestion of food were calculated on the assumption that all food consumed is produced locally.

B.4 Countermeasures

COSYMA allows the user to consider the effect of a wide range of countermeasures in reducing the exposure of the population, and gives the user considerable freedom in specifying the criteria at which the actions will be imposed or withdrawn[16].

Sheltering as the only action and sheltering combined with evacuation may be implemented automatically or on the basis of dose. The distribution of iodine tablets, automatically or on the basis of dose, can also be considered. These actions are assumed to be implemented sufficiently rapidly to reduce the risks of both early and late health effects. Relocation is considered as an action to reduce doses and risks over longer time periods. It can be implemented on a dose criterion. Return from evacuation or relocation is also considered on a dose criterion. The effects of decontamination in reducing the period of relocation can be considered. If these actions are initiated on the basis of dose, the user can specify the intervention levels, organs and pathways to be considered, and the time over which the dose is to be integrated. The behaviour of the population considered in the dose criteria can also be described using location factors.

Food restrictions can also be considered[17]. They can be implemented or withdrawn on the basis of doses received within specified time periods or on the basis of the instantaneous concentration of radionuclides in foods.

B.5 Health effects

COSYMA considers both early and late health effects in the population, using methods recommended by NRPB[18,19], the US Nuclear Regulatory Commission[20] and GSF[21].

The risk of early health effects is calculated using "hazard functions". The method allows for the variation of risk with the rate at which dose is accumulated over the first few days following the accident. Ten different fatal and non-fatal effects are considered by COSYMA, though not all are considered for this study.

The risk of late health effects is calculated using the linear dose response relationship. COSYMA considers the risk of fatal and non-fatal cancers in ten organs, and the risk of leukaemia. It also considers the risk of hereditary effects. The method adopted in the mainframe version of COSYMA allows for the variation of risk with age at exposure[22]. PC COSYMA uses a simpler method which only considers the doses and risks to adults, assuming that the risk is the product of committed dose and risk coefficient. The mainframe version of COSYMA can provide information on the numbers of cancers in the people alive at the time of the accident, and in their descendants. It also gives information on the times at which the cancers occur. For this study, the approximation used in PC COSYMA for calculating the risks of late health effects was adopted.

B.6 Economic effects

COSYMA can calculate the off-site economic cost of the accident, considering the costs arising from the countermeasures and the costs of health effects. The assumptions and models are described in references 23 and 24. The countermeasures for which costs are considered are movement of the population, food restrictions and decontamination. The costs arising from lost production in the area from which people are moved can be assessed in terms of the per capita contribution of the relocated population to gross domestic product (GDP) or in terms of the value of the land affected. For longer periods of relocation, the lost capital value of the land and its assets may be calculated. The costs of food restrictions include contributions to GDP as well as the lost capital value and the disposal costs of the food affected. The cost arising from health effects may be calculated in terms of the treatment costs and the lost economic productivity of the affected individuals or an estimation of the cost of health effects may be obtained using a more subjective approach to the valuation of life.

This study did not consider the uncertainty on economic effects.

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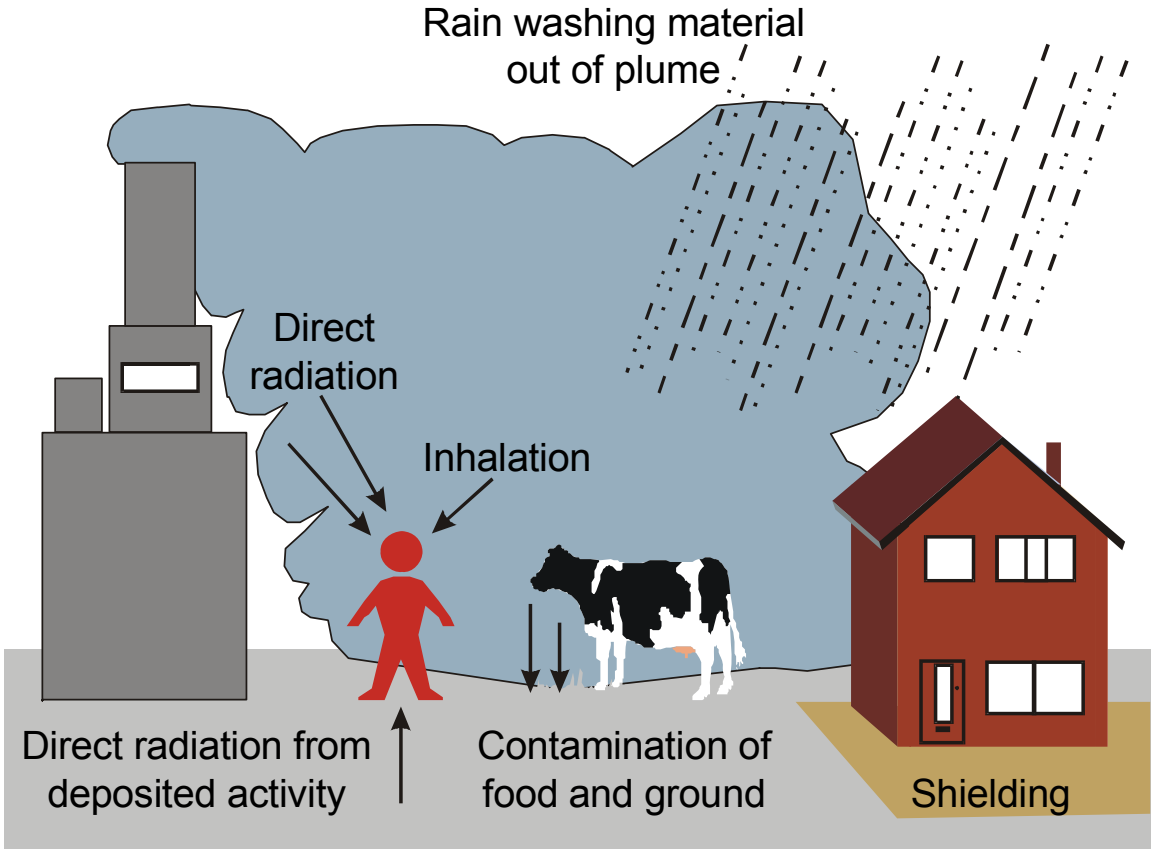

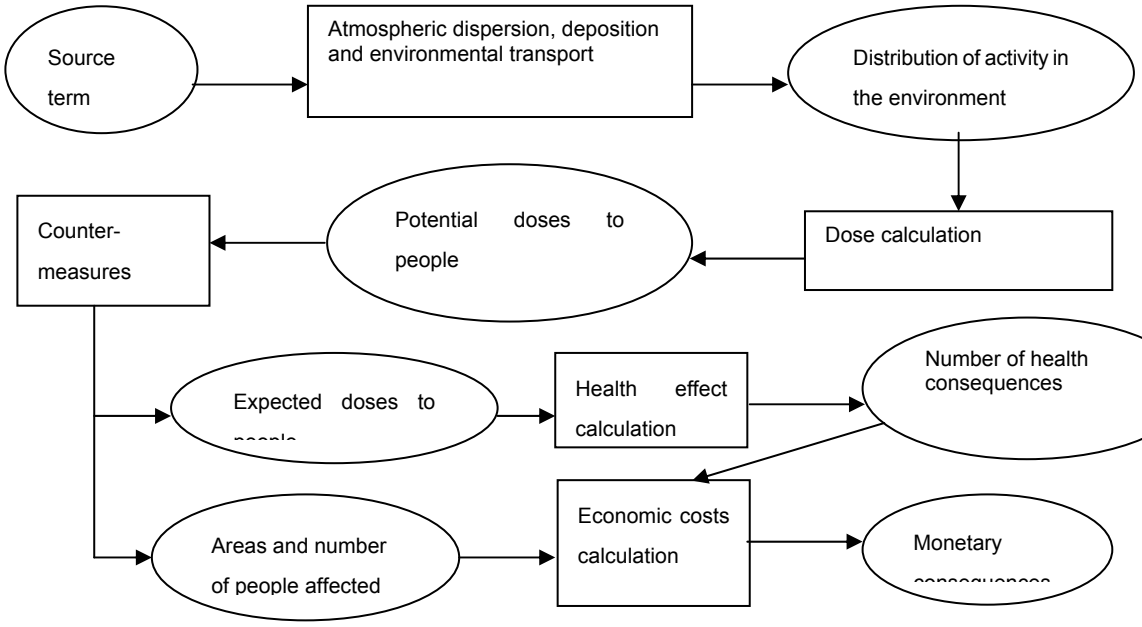

Figure B.1 Processes modelled in COSYMA

Appendix C

Extent of the uncertainty on the predicted consequences

This appendix includes tables giving various percentiles of the distribution of uncertainty on all of the model endpoints considered in the study. The endpoints are identified using a short code. The short codes for all of the endpoints considered are listed in Table C.1

The remaining tables give some of the percentiles of the uncertainty distributions on the mean value, the 95th and 99th percentiles and the probability of zero effects for each of the endpoints considered, for each of the three source terms. The table contains the following information:

REF the value obtained in a single run of COSYMA using the default values for all of the input parameters.

MEDIAN the median value from the uncertainty distribution on the quantity given.

5 % etc the percentiles of the uncertainty distribution on the quantity given.

FAC1 the ratio of the 95th to 5th percentiles of the uncertainty distribution on the quantity given.

FAC2 the ratio of the 90th to 10th percentiles of the uncertainty distribution on the quantity given.

FAC3 the ratio of the 75th to 25th percentiles of the uncertainty distribution on the quantity given.

The final column gives the ratio of the 95th percentile of the uncertainty distribution to the reference value.

The analysis has resulted in sets of values for the each of the endpoints from each of the runs of COSYMA considered. The percentiles of the uncertainty distribution on each endpoint is evaluated from this set of values. The program used to evaluate the percentiles first specifies a series of bins. Each of the values for the endpoint are allocated to one of the bins, and the probability distribution on the endpoint constructed. The value assigned to a percentile of the distribution is the value of the lower end of the bin containing that percentile. The values allocated to the highest bin are 6 to 9 orders of magnitude greater than those allocated to the lowest bin, depending on the particular endpoint considered. There are some situations where percentiles of the uncertainty distribution for the quantities considered fall below the value that would be allocated to the lowest bin. In this case the value is reported as zero, and the ratio of the percentiles is reported as “9.99E+99”.

Table C.1 Description of the endpoint codes used in the following tables

Short code	Description of endpoint
PECMBM	Number of cases of haematopoietic syndrome, with countermeasures
PECMLU	Number of cases of lung morbidity, with countermeasures
PECMMB	Number of cases of early morbidity, with countermeasures
PECMMT	Number of cases of early death, with countermeasures
PECMSK	Number of cases of skin burns, with countermeasures
PECMTH	Number of cases of hypothyroidism, with countermeasures
PELVBM	Number of cases of haematopoietic syndrome, for normal living
PELVLU	Number of cases of lung morbidity, for normal living
PELVMB	Number of cases of early morbidity, for normal living
PELVMT	Number of cases of early death, for normal living
PELVSK	Number of cases of skin burns, for normal living
PELVTH	Number of cases of hypothyroidism, for normal living
PLCMBM	Number of deaths from leukaemia, with countermeasures
PLCMMT	Number of fatal cancers, with countermeasures
PLCMTH	Number of cases of fatal thyroid cancer, with countermeasures
PLLVBM	Number of deaths from leukaemia, for normal living
PLLVMT	Number of fatal cancers, for normal living
PLLVTH	Number of cases of fatal thyroid cancer, for normal living
RECMBM[(a)]	Individual risk of haematopoietic syndrome, with countermeasures
RECMLU[(a)]	Individual risk of lung morbidity, with countermeasures
RECMMB[(a)]	Individual risk of early morbidity, with countermeasures
RECMMT[(a)]	Individual risk of early death, with countermeasures
RECMSK[(a)]	Individual risk of skin burns, with countermeasures
RECMTH[(a)]	Individual risk of hypothyroidism, with countermeasures
RELVBM[(a)]	Individual risk of haematopoietic syndrome, for normal living
RELVLU[(a)]	Individual risk of lung morbidity, for normal living
RELVMB[(a)]	Individual risk of early morbidity, for normal living
RELVMT[(a)]	Individual risk of early death, for normal living
RELVSK[(a)]	Individual risk of skin burns, for normal living
RELVTH[(a)]	Individual risk of hypothyroidism, for normal living
REOUBM[(a)]	Individual risk of haematopoietic syndrome, potential outdoor risk
REOULU[(a)]	Individual risk of lung morbidity, potential outdoor risk
REOUMB[(a)]	Individual risk of early morbidity, potential outdoor risk
REOUMT[(a)]	Individual risk of early death, potential outdoor risk
REOUSK[(a)]	Individual risk of skin burns, potential outdoor risk
REOUTH[(a)]	Individual risk of hypothyroidism, potential outdoor risk
RLCMBM[(a)]	Individual risk of death from leukaemia, with countermeasures
RLCMMT[(a)]	Individual risk of fatal cancer, with countermeasures
RLCMTH[(a)]	Individual risk of death from thyroid cancer, with countermeasures
RLLVBM[(a)]	Individual risk of death from leukaemia, for normal living
RLLVMT[(a)]	Individual risk of fatal cancer, for normal living
RLLVTH[(a)]	Individual risk of death from thyroid cancer, for normal living
RLOUBM[(a)]	Individual risk of death from leukaemia, for potential outdoor exposure
RLOUMT[(a)]	Individual risk of fatal cancer, for potential outdoor exposure
RLOUTH[(a)]	Individual risk of death from thyroid cancer, for potential outdoor exposure

Note:

a These endpoints are evaluated at a series of distances (0.875, 4.9, 20 and 100 km). The names include a number 1 to 4 to indicate which distance is considered. Note that the endpoints relating to early effects are only evaluated at distances from 0.875 to 20 km, while those relating to late effects are evaluated at distances from 4.9 to 100 km. Air concentration and deposition are evaluated at all four distances.

Table C.2 Uncertainty distributions on the endpoints for each of the source terms

EXTENT OF THE UNCERTAINTY FOR THE MEAN VALUE OF THE ENDPOINTS FOR THE UK1 SOURCE TERM

ENDPOINT	REF	MEDIAN	5 %	95 %	FAC1	10 %	90 %	FAC2	25 %	75 %	FAC3	95%/REF
RECMMT1	4.78E-02	6.72E-02	5.18E-02	8.97E-02	1.73E+00	5.41E-02	8.26E-02	1.53E+00	6.04E-02	7.51E-02	1.24E+00	1.88E+00
RECMMT2	3.00E-03	7.07E-03	3.39E-03	1.38E-02	4.08E+00	4.26E-03	1.24E-02	2.92E+00	5.10E-03	1.02E-02	2.00E+00	4.60E+00
RECMMT3	7.71E-05	1.68E-04	1.44E-06	1.15E-03	7.97E+02	4.45E-06	8.24E-04	1.85E+02	4.40E-05	3.55E-04	8.08E+00	1.49E+01
RECMBM1	4.27E-02	5.54E-02	3.79E-02	7.73E-02	2.04E+00	4.20E-02	7.41E-02	1.76E+00	4.83E-02	6.36E-02	1.32E+00	1.81E+00
RECMBM2	9.92E-04	2.42E-03	3.80E-04	5.88E-03	1.54E+01	6.94E-04	5.01E-03	7.22E+00	1.49E-03	3.38E-03	2.27E+00	5.92E+00
RECMBM3	.00E+00	0.00E+00	0.00E+00	5.70E-06	9.99E+99	0.00E+00	1.06E-06	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMMB1	1.31E-01	9.26E-02	5.35E-02	1.40E-01	2.62E+00	5.80E-02	1.28E-01	2.21E+00	7.70E-02	1.07E-01	1.39E+00	1.07E+00
RECMMB2	3.77E-02	3.46E-02	1.19E-02	6.43E-02	5.43E+00	1.63E-02	5.29E-02	3.25E+00	2.44E-02	4.41E-02	1.81E+00	1.71E+00
RECMMB3	1.49E-03	1.67E-03	2.04E-05	8.98E-03	4.41E+02	6.29E-05	6.84E-03	1.09E+02	8.18E-04	3.09E-03	3.78E+00	6.04E+00
RECMLU1	5.26E-04	4.97E-05	0.00E+00	1.50E-02	9.99E+99	0.00E+00	1.04E-02	9.99E+99	0.00E+00	2.46E-03	9.99E+99	2.85E+01
RECMLU2	8.62E-04	1.25E-04	0.00E+00	4.41E-03	9.99E+99	0.00E+00	3.40E-03	9.99E+99	0.00E+00	1.62E-03	9.99E+99	5.12E+00
RECMLU3	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMTH1	1.95E-02	9.80E-03	2.40E-03	1.68E-02	6.98E+00	3.84E-03	1.60E-02	4.17E+00	7.32E-03	1.30E-02	1.77E+00	8.60E-01
RECMTH2	9.75E-04	5.68E-04	2.89E-04	8.56E-04	2.96E+00	4.00E-04	8.24E-04	2.06E+00	4.82E-04	6.84E-04	1.42E+00	8.78E-01
RECMTH3	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMSK1	9.75E-02	7.72E-02	4.73E-02	1.03E-01	2.18E+00	5.41E-02	1.00E-01	1.85E+00	6.31E-02	8.76E-02	1.39E+00	1.06E+00
RECMSK2	3.50E-02	3.19E-02	1.08E-02	5.94E-02	5.49E+00	1.32E-02	5.18E-02	3.94E+00	2.22E-02	4.15E-02	1.87E+00	1.70E+00
RECMSK3	1.49E-03	1.67E-03	2.04E-05	8.98E-03	4.41E+02	6.29E-05	6.84E-03	1.09E+02	8.18E-04	3.09E-03	3.78E+00	6.04E+00
RELVMT1	7.75E-02	7.53E-02	5.85E-02	9.31E-02	1.59E+00	6.26E-02	9.08E-02	1.45E+00	6.80E-02	8.36E-02	1.23E+00	1.20E+00
RELVMT2	6.14E-03	8.98E-03	3.71E-03	1.94E-02	5.23E+00	4.28E-03	1.82E-02	4.26E+00	5.62E-03	1.35E-02	2.40E+00	3.16E+00
RELVMT3	1.13E-03	1.64E-03	3.42E-04	5.20E-03	1.52E+01	5.22E-04	4.19E-03	8.03E+00	7.58E-04	2.75E-03	3.63E+00	4.61E+00
RELVBM1	7.24E-02	6.13E-02	4.07E-02	8.05E-02	1.98E+00	4.63E-02	7.74E-02	1.67E+00	5.42E-02	6.94E-02	1.28E+00	1.11E+00
RELVBM2	1.88E-03	3.32E-04	1.63E-06	3.23E-03	1.98E+03	1.63E-05	2.37E-03	1.45E+02	1.09E-04	1.00E-03	9.18E+00	1.72E+00
RELVBM3	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVMB1	1.30E-01	1.38E-01	9.10E-02	1.87E-01	2.06E+00	9.87E-02	1.81E-01	1.83E+00	1.24E-01	1.63E-01	1.31E+00	1.44E+00
RELVMB2	7.98E-02	7.02E-02	5.23E-02	9.21E-02	1.76E+00	5.52E-02	9.07E-02	1.64E+00	6.44E-02	8.19E-02	1.27E+00	1.15E+00
RELVMB3	1.28E-02	9.09E-03	2.90E-03	2.34E-02	8.06E+00	3.76E-03	1.96E-02	5.20E+00	6.51E-03	1.41E-02	2.16E+00	1.83E+00
RELVLU1	.00E+00	0.00E+00	0.00E+00	2.18E-02	9.99E+99	0.00E+00	1.18E-02	9.99E+99	0.00E+00	2.36E-03	9.99E+99	9.99E+99
RELVLU2	4.46E-06	7.36E-05	0.00E+00	7.24E-03	9.99E+99	0.00E+00	3.85E-03	9.99E+99	0.00E+00	1.19E-03	9.99E+99	1.62E+03
RELVLU3	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVTH1	1.87E-02	2.34E-02	1.08E-02	3.69E-02	3.44E+00	1.22E-02	3.32E-02	2.71E+00	1.81E-02	2.87E-02	1.58E+00	1.98E+00

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 RELVTH2  4.95E-03  4.61E-03  | 2.87E-03  5.73E-03  2.00E+00  | 3.62E-03  5.59E-03  1.54E+00  | 4.17E-03
5.15E-03  1.23E+00  ||  1.16E+00
 RELVTH3  1.28E-05  1.13E-05  | 8.95E-06  1.31E-05  1.46E+00  | 9.18E-06  1.30E-05  1.42E+00  | 9.68E-06
1.17E-05  1.21E+00  ||  1.02E+00
 RELVSK1  8.87E-02  8.67E-02  | 6.60E-02  1.08E-01  1.64E+00  | 7.14E-02  1.04E-01  1.46E+00  | 7.80E-02
9.64E-02  1.24E+00  ||  1.22E+00
 RELVSK2  6.65E-02  5.74E-02  | 4.00E-02  7.92E-02  1.98E+00  | 4.33E-02  7.62E-02  1.76E+00  | 5.07E-02
6.54E-02  1.29E+00  ||  1.19E+00
 RELVSK3  1.28E-02  9.08E-03  | 2.89E-03  2.34E-02  8.10E+00  | 3.75E-03  1.95E-02  5.22E+00  | 6.49E-03
1.41E-02  2.17E+00  ||  1.83E+00
 REOUMT1  1.31E-01  1.28E-01  | 1.12E-01  1.44E-01  1.28E+00  | 1.16E-01  1.40E-01  1.21E+00  | 1.22E-01
1.34E-01  1.10E+00  ||  1.10E+00
 REOUMT2  3.40E-02  3.21E-02  | 2.01E-02  4.51E-02  2.24E+00  | 2.22E-02  4.29E-02  1.93E+00  | 2.70E-02
3.58E-02  1.33E+00  ||  1.32E+00
 REOUMT3  2.84E-03  3.29E-03  | 8.83E-04  8.13E-03  9.22E+00  | 1.23E-03  7.27E-03  5.91E+00  | 1.86E-03
5.02E-03  2.70E+00  ||  2.87E+00
 REOUBM1  1.27E-01  1.21E-01  | 1.02E-01  1.36E-01  1.33E+00  | 1.09E-01  1.34E-01  1.23E+00  | 1.15E-01
1.27E-01  1.10E+00  ||  1.07E+00
 REOUBM2  3.03E-02  2.36E-02  | 1.16E-02  3.42E-02  2.95E+00  | 1.48E-02  3.23E-02  2.18E+00  | 2.01E-02
2.78E-02  1.38E+00  ||  1.13E+00
 REOUBM3  1.00E-03  2.37E-04  | 0.00E+00  1.48E-03  9.99E+99  | 5.42E-06  1.15E-03  2.13E+02  | 7.04E-05
6.29E-04  8.94E+00  ||  1.47E+00
 REOUMB1  7.35E-02  7.92E-02  | 4.19E-02  1.16E-01  2.77E+00  | 5.26E-02  1.10E-01  2.10E+00  | 6.59E-02
9.25E-02  1.40E+00  ||  1.58E+00
 REOUMB2  8.03E-02  8.26E-02  | 5.39E-02  1.12E-01  2.07E+00  | 5.92E-02  1.08E-01  1.82E+00  | 7.02E-02
9.42E-02  1.34E+00  ||  1.39E+00
 REOUMB3  2.87E-02  2.39E-02  | 1.38E-02  4.17E-02  3.03E+00  | 1.48E-02  3.80E-02  2.56E+00  | 1.92E-02
3.12E-02  1.63E+00  ||  1.45E+00
 REOULU1   .00E+00  0.00E+00  | 0.00E+00  3.76E-03  9.99E+99  | 0.00E+00  6.39E-04  9.99E+99  | 0.00E+00
0.00E+00  9.99E+99  ||  9.99E+99
 REOULU2   .00E+00  0.00E+00  | 0.00E+00  5.68E-03  9.99E+99  | 0.00E+00  2.34E-03  9.99E+99  | 0.00E+00
2.12E-04  9.99E+99  ||  9.99E+99
 REOULU3   .00E+00  0.00E+00  | 0.00E+00  2.28E-04  9.99E+99  | 0.00E+00  7.90E-06  9.99E+99  | 0.00E+00
0.00E+00  9.99E+99  ||  9.99E+99
 REOUTH1  1.89E-03  3.13E-03  | 7.20E-04  7.68E-03  1.07E+01  | 9.93E-04  6.55E-03  6.59E+00  | 1.82E-03
4.22E-03  2.32E+00  ||  4.07E+00
 REOUTH2  1.39E-03  2.30E-03  | 8.41E-04  4.79E-03  5.70E+00  | 1.03E-03  4.30E-03  4.17E+00  | 1.48E-03
2.90E-03  1.96E+00  ||  3.45E+00
 REOUTH3  1.66E-04  1.67E-04  | 1.22E-04  1.87E-04  1.53E+00  | 1.32E-04  1.85E-04  1.40E+00  | 1.53E-04
1.79E-04  1.17E+00  ||  1.12E+00
ENDPOINT     REF     MEDIAN   |    5 %      95 %      FAC1    |   10 %      90 %      FAC2    |   25 %
75 %      FAC3    ||   95%/REF
 ------------------------------------------------------------------------------------------------------------
------------------------------
 REOUSK1  4.77E-02  4.55E-02  | 2.79E-02  6.98E-02  2.50E+00  | 3.15E-02  6.58E-02  2.09E+00  | 3.90E-02
5.75E-02  1.47E+00  ||  1.46E+00
 REOUSK2  5.79E-02  5.40E-02  | 3.30E-02  7.51E-02  2.27E+00  | 3.72E-02  7.23E-02  1.94E+00  | 4.40E-02
6.37E-02  1.45E+00  ||  1.30E+00
 REOUSK3  2.35E-02  1.81E-02  | 8.60E-03  3.67E-02  4.27E+00  | 9.47E-03  3.18E-02  3.36E+00  | 1.29E-02
2.55E-02  1.97E+00  ||  1.56E+00
 PECMMT   2.60E+02  5.34E+02  | 1.84E+02  2.35E+03  1.28E+01  | 2.22E+02  1.72E+03  7.75E+00  | 3.22E+02
1.07E+03  3.32E+00  ||  9.07E+00
 PECMBM   6.62E+01  1.14E+02  | 4.85E+01  3.02E+02  6.23E+00  | 6.15E+01  2.47E+02  4.01E+00  | 8.34E+01
1.58E+02  1.90E+00  ||  4.56E+00
 PECMMB   3.77E+03  3.83E+03  | 7.41E+02  1.71E+04  2.30E+01  | 1.06E+03  1.28E+04  1.21E+01  | 2.46E+03
5.79E+03  2.35E+00  ||  4.52E+00
 PECMLU   1.77E+01  3.15E+00  | 0.00E+00  1.63E+02  9.99E+99  | 0.00E+00  1.12E+02  9.99E+99  | 0.00E+00
4.12E+01  9.99E+99  ||  9.19E+00
 PECMTH   5.14E+01  3.25E+01  | 1.36E+01  4.66E+01  3.44E+00  | 1.98E+01  4.39E+01  2.21E+00  | 2.75E+01
3.79E+01  1.38E+00  ||  9.06E-01
 PECMSK   3.67E+03  3.75E+03  | 6.26E+02  1.70E+04  2.72E+01  | 8.08E+02  1.27E+04  1.58E+01  | 2.36E+03
5.75E+03  2.44E+00  ||  4.64E+00
 PELVMT   2.32E+03  3.07E+03  | 7.81E+02  1.21E+04  1.54E+01  | 1.08E+03  9.75E+03  9.01E+00  | 1.48E+03
5.79E+03  3.91E+00  ||  5.20E+00
 PELVBM   1.61E+02  7.84E+01  | 2.68E+01  2.06E+02  7.72E+00  | 3.41E+01  1.76E+02  5.18E+00  | 5.33E+01
1.21E+02  2.27E+00  ||  1.28E+00
 PELVMB   2.32E+04  1.68E+04  | 7.33E+03  4.83E+04  6.58E+00  | 8.37E+03  3.86E+04  4.62E+00  | 1.20E+04
2.63E+04  2.19E+00  ||  2.08E+00
 PELVLU   1.62E-03  2.52E+00  | 0.00E+00  2.29E+02  9.99E+99  | 0.00E+00  1.42E+02  9.99E+99  | 0.00E+00
3.52E+01  9.99E+99  ||  1.42E+05
 PELVTH   2.64E+02  2.61E+02  | 1.96E+02  3.08E+02  1.57E+00  | 2.07E+02  3.03E+02  1.46E+00  | 2.38E+02
2.80E+02  1.18E+00  ||  1.17E+00
 PELVSK   2.26E+04  1.60E+04  | 6.73E+03  4.76E+04  7.07E+00  | 7.69E+03  3.80E+04  4.94E+00  | 1.13E+04
2.56E+04  2.27E+00  ||  2.11E+00
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EXTENT OF THE UNCERTAINTY FOR THE 95TH PERCENTILE OF THE ENDPOINTS FOR THE UK1 SOURCE TERM

ENDPOINT	REF	MEDIAN	5 %	95 %	FAC1	10 %	90 %	FAC2	25 %	75 %	FAC3	95%/REF
RECMMT1	1.29E-01	7.59E-01	2.00E-01	1.00E+00	5.01E+00	2.82E-01	1.00E+00	3.55E+00	5.13E-01	9.77E-01	1.91E+00	7.76E+00
RECMMT2	4.07E-03	1.15E-02	0.00E+00	1.35E-01	9.99E+99	0.00E+00	9.55E-02	9.99E+99	2.04E-03	3.89E-02	1.91E+01	3.31E+01
RECMMT3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMBM1	8.13E-02	6.03E-01	3.80E-02	1.00E+00	2.63E+01	9.12E-02	1.00E+00	1.10E+01	2.88E-01	8.51E-01	2.95E+00	1.23E+01
RECMBM2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMBM3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMMB1	1.07E+00	9.33E-01	6.61E-01	1.05E+00	1.58E+00	7.24E-01	1.02E+00	1.41E+00	8.71E-01	9.77E-01	1.12E+00	9.77E-01
RECMMB2	8.13E-02	8.13E-02	0.00E+00	8.91E-01	9.99E+99	0.00E+00	8.32E-01	9.99E+99	1.51E-02	3.16E-01	2.09E+01	1.10E+01
RECMMB3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMLU1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMLU2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMLU3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMTH1	1.20E-01	5.50E-02	1.17E-02	9.12E-02	7.76E+00	1.91E-02	8.13E-02	4.27E+00	4.17E-02	7.24E-02	1.74E+00	7.59E-01
RECMTH2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMTH3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMSK1	9.50E-01	8.51E-01	5.25E-01	9.67E-01	1.84E+00	6.46E-01	9.55E-01	1.48E+00	7.99E-01	9.13E-01	1.14E+00	1.02E+00
RECMSK2	8.13E-02	8.13E-02	0.00E+00	8.71E-01	9.99E+99	0.00E+00	7.76E-01	9.99E+99	1.51E-02	3.09E-01	2.04E+01	1.07E+01
RECMSK3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVMT1	1.00E+00	1.00E+00	3.02E-01	1.00E+00	3.31E+00	7.08E-01	1.00E+00	1.41E+00	9.33E-01	1.00E+00	1.07E+00	1.00E+00
RELVMT2	5.01E-02	9.12E-02	2.19E-02	2.09E-01	9.55E+00	3.31E-02	1.86E-01	5.62E+00	5.62E-02	1.45E-01	2.57E+00	4.17E+00
RELVMT3	0.00E+00	0.00E+00	0.00E+00	3.31E-03	9.99E+99	0.00E+00	1.91E-03	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVBM1	1.00E+00	9.77E-01	2.63E-02	1.00E+00	3.80E+01	1.86E-01	1.00E+00	5.37E+00	6.92E-01	1.00E+00	1.45E+00	1.00E+00
RELVBM2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVBM3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVMB1	1.02E+00	1.05E+00	8.51E-01	1.48E+00	1.74E+00	9.12E-01	1.41E+00	1.55E+00	9.77E-01	1.20E+00	1.23E+00	1.45E+00
RELVMB2	9.55E-01	8.71E-01	2.51E-01	9.77E-01	3.89E+00	5.25E-01	9.77E-01	1.86E+00	8.13E-01	9.33E-01	1.15E+00	1.02E+00
RELVMB3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVLU1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVLU2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVLU3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVTH1	8.13E-02	1.38E-01	3.98E-02	2.88E-01	7.24E+00	5.01E-02	2.51E-01	5.01E+00	8.71E-02	2.14E-01	2.45E+00	3.55E+00
RELVTH2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVTH3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVSK1	9.50E-01	9.08E-01	7.76E-01	9.74E-01	1.25E+00	8.06E-01	9.66E-01	1.20E+00	8.51E-01	9.39E-01	1.10E+00	1.02E+00
RELVSK2	9.50E-01	8.54E-01	2.04E-01	9.71E-01	4.75E+00	4.57E-01	9.56E-01	2.09E+00	7.59E-01	9.23E-01	1.22E+00	1.02E+00
RELVSK3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
REOUMT1	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
REOUMT2	5.01E-02	9.55E-02	2.19E-02	2.45E-01	1.12E+01	3.39E-02	2.00E-01	5.89E+00	6.03E-02	1.51E-01	2.51E+00	4.90E+00
REOUMT3	0.00E+00	0.00E+00	0.00E+00	6.61E-02	9.99E+99	0.00E+00	3.09E-02	9.99E+99	0.00E+00	6.31E-03	9.99E+99	9.99E+99
REOUBM1	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
REOUBM2	0.00E+00	0.00E+00	0.00E+00	2.69E-02	9.99E+99	0.00E+00	1.45E-02	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99

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 REOUBM3  0.00E+00  0.00E+00  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00
0.00E+00  9.99E+99  ||  9.99E+99
 REOUMB1  6.61E-01  8.13E-01  | 7.59E-02  1.07E+00  1.41E+01  | 2.09E-01  1.00E+00  4.79E+00  | 4.57E-01
9.33E-01  2.04E+00  ||  1.62E+00
 REOUMB2  9.55E-01  8.51E-01  | 2.00E-01  1.00E+00  5.01E+00  | 3.72E-01  9.77E-01  2.63E+00  | 6.76E-01
9.33E-01  1.38E+00  ||  1.05E+00
 REOUMB3  0.00E+00  0.00E+00  | 0.00E+00  7.76E-02  9.99E+99  | 0.00E+00  5.37E-02  9.99E+99  | 0.00E+00
0.00E+00  9.99E+99  ||  9.99E+99
 REOULU1  0.00E+00  0.00E+00  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00
0.00E+00  9.99E+99  ||  9.99E+99
 REOULU2  0.00E+00  0.00E+00  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00
0.00E+00  9.99E+99  ||  9.99E+99
 REOULU3  0.00E+00  0.00E+00  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00
0.00E+00  9.99E+99  ||  9.99E+99
 REOUTH1  0.00E+00  0.00E+00  | 0.00E+00  1.86E-02  9.99E+99  | 0.00E+00  1.48E-02  9.99E+99  | 0.00E+00
0.00E+00  9.99E+99  ||  9.99E+99
 REOUTH2  0.00E+00  0.00E+00  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00
0.00E+00  9.99E+99  ||  9.99E+99
 REOUTH3  0.00E+00  0.00E+00  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00
0.00E+00  9.99E+99  ||  9.99E+99
 REOUSK1  4.68E-01  5.62E-01  | 3.72E-02  9.33E-01  2.51E+01  | 7.76E-02  9.31E-01  1.20E+01  | 2.14E-01
7.94E-01  3.72E+00  ||  2.00E+00
 REOUSK2  9.33E-01  7.59E-01  | 6.31E-02  9.55E-01  1.51E+01  | 1.48E-01  9.36E-01  6.33E+00  | 3.72E-01
8.80E-01  2.37E+00  ||  1.02E+00
 REOUSK3  0.00E+00  0.00E+00  | 0.00E+00  7.59E-02  9.99E+99  | 0.00E+00  5.25E-02  9.99E+99  | 0.00E+00
0.00E+00  9.99E+99  ||  9.99E+99
 PECMMT   1.00E+03  1.70E+03  | 9.77E+02  6.61E+03  6.76E+00  | 1.10E+03  5.25E+03  4.79E+00  | 1.35E+03
3.24E+03  2.40E+00  ||  6.61E+00
 PECMBM   3.31E+02  6.61E+02  | 3.02E+02  1.55E+03  5.13E+00  | 3.31E+02  1.41E+03  4.27E+00  | 4.47E+02
1.02E+03  2.29E+00  ||  4.68E+00
 ENDPOINT    REF      MEDIAN   |    5 %      95 %      FAC1    |   10 %      90 %      FAC2    |   25 %
75 %      FAC3    ||   95%/REF
-------------------------------------------------------------------------------------------------------------------
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 PECMMB   1.38E+04  1.38E+04  | 3.89E+03  4.37E+04  1.12E+01  | 4.90E+03  3.89E+04  7.94E+00  | 1.00E+04
2.09E+04  2.09E+00  ||  3.16E+00
 PECMLU   1.23E+02  1.58E+01  | 0.00E+00  1.00E+03  9.99E+99  | 0.00E+00  7.59E+02  9.99E+99  | 0.00E+00
2.69E+02  9.99E+99  ||  8.13E+00
 PECMTH   2.57E+02  1.58E+02  | 4.47E+01  2.45E+02  5.50E+00  | 7.41E+01  2.24E+02  3.02E+00  | 1.17E+02
2.00E+02  1.70E+00  ||  9.55E-01
 PECMSK   1.38E+04  1.38E+04  | 2.88E+03  4.37E+04  1.51E+01  | 4.27E+03  3.89E+04  9.12E+00  | 9.77E+03
2.09E+04  2.14E+00  ||  3.16E+00
 PELVMT   6.76E+03  9.12E+03  | 2.00E+03  3.39E+04  1.70E+01  | 3.24E+03  2.69E+04  8.32E+00  | 4.79E+03
1.74E+04  3.63E+00  ||  5.01E+00
 PELVBM   7.59E+02  3.98E+02  | 2.19E+02  1.02E+03  4.68E+00  | 2.40E+02  8.32E+02  3.47E+00  | 2.75E+02
6.17E+02  2.24E+00  ||  1.35E+00
 PELVMB   6.76E+04  5.50E+04  | 2.40E+04  1.51E+05  6.31E+00  | 2.69E+04  1.20E+05  4.47E+00  | 4.47E+04
7.59E+04  1.70E+00  ||  2.24E+00
 PELVLU   0.00E+00  1.45E+01  | 0.00E+00  1.20E+03  9.99E+99  | 0.00E+00  8.71E+02  9.99E+99  | 0.00E+00
2.45E+02  9.99E+99  ||  9.99E+99
 PELVTH   1.32E+03  1.26E+03  | 1.05E+03  1.38E+03  1.32E+00  | 1.12E+03  1.35E+03  1.20E+00  | 1.20E+03
1.32E+03  1.10E+00  ||  1.05E+00
 PELVSK   6.76E+04  5.50E+04  | 2.29E+04  1.51E+05  6.61E+00  | 2.63E+04  1.20E+05  4.57E+00  | 4.47E+04
7.41E+04  1.66E+00  ||  2.24E+00
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EXTENT OF THE UNCERTAINTY FOR THE 99TH PERCENTILE OF THE ENDPOINTS FOR THE UK1 SOURCE TERM

ENDPOINT	REF	MEDIAN	5 %	95 %	FAC1	10 %	90 %	FAC2	25 %	75 %	FAC3	95%/REF
RECMMT1	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
RECMMT2	5.01E-02	1.05E-01	2.75E-02	2.82E-01	1.02E+01	4.27E-02	2.24E-01	5.25E+00	6.31E-02	1.62E-01	2.57E+00	5.62E+00
RECMMT3	0.00E+00	0.00E+00	0.00E+00	3.98E-02	9.99E+99	0.00E+00	1.66E-02	9.99E+99	0.00E+00	1.10E-03	9.99E+99	9.99E+99
RECMBM1	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
RECMBM2	0.00E+00	0.00E+00	0.00E+00	7.24E-02	9.99E+99	0.00E+00	3.80E-02	9.99E+99	0.00E+00	1.26E-02	9.99E+99	9.99E+99
RECMBM3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMMB1	1.82E+00	1.12E+00	8.84E-01	2.14E+00	2.42E+00	9.12E-01	1.91E+00	2.09E+00	1.02E+00	1.45E+00	1.41E+00	1.17E+00
RECMMB2	1.00E+00	9.12E-01	6.61E-01	1.00E+00	1.51E+00	7.59E-01	9.77E-01	1.29E+00	8.51E-01	9.55E-01	1.12E+00	1.00E+00
RECMMB3	0.00E+00	0.00E+00	0.00E+00	3.47E-01	9.99E+99	0.00E+00	1.41E-01	9.99E+99	0.00E+00	1.05E-02	9.99E+99	9.99E+99
RECMLU1	0.00E+00	0.00E+00	0.00E+00	6.17E-01	9.99E+99	0.00E+00	5.01E-01	9.99E+99	0.00E+00	1.00E-01	9.99E+99	9.99E+99
RECMLU2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMLU3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMTH1	5.13E-01	2.63E-01	7.76E-02	4.79E-01	6.17E+00	1.17E-01	4.37E-01	3.72E+00	2.09E-01	3.63E-01	1.74E+00	9.33E-01
RECMTH2	3.24E-02	1.74E-02	1.05E-02	3.09E-02	2.95E+00	1.29E-02	2.95E-02	2.29E+00	1.55E-02	2.14E-02	1.38E+00	9.55E-01
RECMTH3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMSK1	9.50E-01	9.08E-01	7.80E-01	9.73E-01	1.25E+00	8.06E-01	9.65E-01	1.20E+00	8.51E-01	9.42E-01	1.11E+00	1.02E+00
RECMSK2	9.50E-01	8.91E-01	5.89E-01	9.71E-01	1.65E+00	7.24E-01	9.60E-01	1.33E+00	8.19E-01	9.33E-01	1.14E+00	1.02E+00
RECMSK3	0.00E+00	0.00E+00	0.00E+00	3.47E-01	9.99E+99	0.00E+00	1.41E-01	9.99E+99	0.00E+00	1.05E-02	9.99E+99	9.99E+99
RELVMT1	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
RELVMT2	5.01E-02	1.05E-01	2.75E-02	2.63E-01	9.55E+00	3.55E-02	2.14E-01	6.03E+00	6.17E-02	1.58E-01	2.57E+00	5.25E+00

C.7

RELVMT3	5.00E-02	7.08E-02	5.01E-03	1.96E-01	3.90E+01	9.55E-03	1.78E-01	1.86E+01	3.09E-02	1.28E-01	4.15E+00	3.91E+00
RELVBM1	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
RELVBM2	0.00E+00	0.00E+00	0.00E+00	3.31E-02	9.99E+99	0.00E+00	1.78E-02	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVBM3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVMB1	2.34E+00	2.34E+00	1.55E+00	3.16E+00	2.04E+00	1.82E+00	2.75E+00	1.51E+00	2.09E+00	2.57E+00	1.23E+00	1.35E+00
RELVMB2	1.48E+00	1.41E+00	1.07E+00	1.70E+00	1.58E+00	1.10E+00	1.66E+00	1.51E+00	1.20E+00	1.51E+00	1.26E+00	1.15E+00
RELVMB3	8.91E-01	3.31E-01	0.00E+00	9.55E-01	9.99E+99	0.00E+00	9.33E-01	9.99E+99	9.33E-02	7.76E-01	8.32E+00	1.07E+00
RELVLU1	0.00E+00	0.00E+00	0.00E+00	7.99E-01	9.99E+99	0.00E+00	5.89E-01	9.99E+99	0.00E+00	8.91E-02	9.99E+99	9.99E+99
RELVLU2	0.00E+00	0.00E+00	0.00E+00	1.74E-01	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVLU3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RELVTH1	5.62E-01	6.17E-01	3.47E-01	8.32E-01	2.40E+00	3.63E-01	7.94E-01	2.19E+00	5.13E-01	7.24E-01	1.41E+00	1.48E+00
RELVTH2	1.62E-01	1.55E-01	1.20E-01	1.78E-01	1.48E+00	1.26E-01	1.74E-01	1.38E+00	1.41E-01	1.66E-01	1.17E+00	1.10E+00
RELVTH3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99

RELVSK1	9.50E-01	9.09E-01	7.89E-01	9.74E-01	1.23E+00	8.10E-01	9.66E-01	1.19E+00	8.57E-01	9.44E-01	1.10E+00	1.02E+00
RELVSK2	9.50E-01	9.09E-01	7.89E-01	9.74E-01	1.23E+00	8.10E-01	9.66E-01	1.19E+00	8.54E-01	9.44E-01	1.11E+00	1.02E+00
RELVSK3	8.91E-01	3.31E-01	0.00E+00	9.53E-01	9.99E+99	0.00E+00	9.16E-01	9.99E+99	9.33E-02	7.76E-01	8.32E+00	1.07E+00
REOUMT1	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
REOUMT2	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
REOUMT3	5.01E-02	9.12E-02	2.19E-02	2.09E-01	9.55E+00	3.31E-02	1.86E-01	5.62E+00	5.75E-02	1.45E-01	2.51E+00	4.17E+00
REOUBM1	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
REOUBM2	1.00E+00	1.00E+00	9.12E-01	1.00E+00	1.10E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
REOUBM3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
REOUMB1	1.91E+00	1.82E+00	1.23E+00	2.14E+00	1.74E+00	1.48E+00	2.09E+00	1.41E+00	1.66E+00	1.95E+00	1.17E+00	1.12E+00
REOUMB2	1.86E+00	1.82E+00	1.35E+00	2.09E+00	1.55E+00	1.48E+00	2.04E+00	1.38E+00	1.70E+00	1.95E+00	1.15E+00	1.12E+00
REOUMB3	9.77E-01	9.33E-01	7.24E-01	1.02E+00	1.41E+00	7.94E-01	1.00E+00	1.26E+00	8.71E-01	9.77E-01	1.12E+00	1.05E+00
REOULU1	0.00E+00	0.00E+00	0.00E+00	1.32E-01	9.99E+99	0.00E+00	1.82E-02	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
REOULU2	0.00E+00	0.00E+00	0.00E+00	1.70E-01	9.99E+99	0.00E+00	2.57E-02	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
REOULU3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
REOUTH1	6.46E-02	1.12E-01	3.24E-02	2.63E-01	8.13E+00	3.98E-02	2.40E-01	6.03E+00	6.76E-02	1.51E-01	2.24E+00	4.07E+00
REOUTH2	5.37E-02	7.94E-02	3.39E-02	1.91E-01	5.62E+00	4.07E-02	1.58E-01	3.89E+00	5.37E-02	1.02E-01	1.91E+00	3.55E+00
REOUTH3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
REOUSK1	9.50E-01	9.00E-01	7.76E-01	9.73E-01	1.25E+00	8.06E-01	9.65E-01	1.20E+00	8.51E-01	9.38E-01	1.10E+00	1.02E+00
REOUSK2	9.50E-01	9.09E-01	7.80E-01	9.74E-01	1.25E+00	8.06E-01	9.66E-01	1.20E+00	8.54E-01	9.44E-01	1.11E+00	1.02E+00
REOUSK3	9.50E-01	8.61E-01	2.00E-01	9.71E-01	4.87E+00	4.37E-01	9.56E-01	2.19E+00	7.24E-01	9.25E-01	1.28E+00	1.02E+00
PECMMT	1.51E+03	2.95E+03	1.62E+03	1.12E+04	6.92E+00	1.78E+03	9.33E+03	5.25E+00	2.04E+03	6.03E+03	2.95E+00	7.41E+00

ENDPOINT	REF	MEDIAN	5 %	95 %	FAC1	10 %	90 %	FAC2	25 %	75 %	FAC3	95%/REF
PECMBM	1.32E+03	1.51E+03	1.05E+03	2.69E+03	2.57E+00	1.20E+03	2.34E+03	1.95E+00	1.38E+03	1.62E+03	1.17E+00	2.04E+00
PECMMB	2.88E+04	2.95E+04	7.76E+03	8.32E+04	1.07E+01	8.91E+03	7.41E+04	8.32E+00	2.00E+04	4.47E+04	2.24E+00	2.88E+00
PECMLU	2.57E+02	5.13E+01	0.00E+00	3.16E+03	9.99E+99	0.00E+00	1.45E+03	9.99E+99	0.00E+00	5.50E+02	9.99E+99	1.23E+01
PECMTH	4.87E+02	3.80E+02	1.82E+02	4.70E+02	2.58E+00	2.69E+02	4.65E+02	1.73E+00	3.31E+02	4.17E+02	1.26E+00	9.64E-01
PECMSK	2.88E+04	2.95E+04	6.92E+03	8.32E+04	1.20E+01	7.76E+03	7.41E+04	9.55E+00	1.95E+04	4.47E+04	2.29E+00	2.88E+00
PELVMT	1.12E+04	1.78E+04	3.98E+03	5.01E+04	1.26E+01	5.86E+03	4.52E+04	7.70E+00	9.33E+03	2.86E+04	3.06E+00	4.47E+00
PELVBM	1.91E+03	1.12E+03	3.89E+02	1.95E+03	5.01E+00	4.90E+02	1.66E+03	3.39E+00	8.32E+02	1.35E+03	1.62E+00	1.02E+00
PELVMB	1.48E+05	1.20E+05	7.76E+04	2.24E+05	2.88E+00	8.13E+04	2.00E+05	2.45E+00	9.33E+04	1.55E+05	1.66E+00	1.51E+00
PELVLU	0.00E+00	4.68E+01	0.00E+00	3.98E+03	9.99E+99	0.00E+00	1.74E+03	9.99E+99	0.00E+00	4.68E+02	9.99E+99	9.99E+99
PELVTH	2.63E+03	2.51E+03	2.09E+03	2.88E+03	1.38E+00	2.19E+03	2.69E+03	1.23E+00	2.34E+03	2.63E+03	1.12E+00	1.10E+00
PELVSK	1.45E+05	1.17E+05	7.59E+04	2.24E+05	2.95E+00	7.94E+04	2.00E+05	2.51E+00	9.12E+04	1.55E+05	1.70E+00	1.55E+00

C.8

EXTENT OF THE UNCERTAINTY FOR THE MEAN VALUE OF THE ENDPOINTS FOR THE CB2 SOURCE TERM

ENDPOINT	REF	MEDIAN	5 %	95 %	FAC1	10 %	90 %	FAC2	25 %	75 %	FAC3	95%/REF
RECMMT1	6.85E-05	1.63E-04	0.00E+00	2.02E-03	9.99E+99	0.00E+00	1.47E-03	9.99E+99	3.14E-05	4.77E-04	1.52E+01	2.94E+01
RECMMT2	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMMT3	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMBM1	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMBM2	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMBM3	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMMB1	1.35E-03	1.99E-03	0.00E+00	1.64E-02	9.99E+99	0.00E+00	1.30E-02	9.99E+99	3.64E-04	5.35E-03	1.47E+01	1.21E+01
RECMMB2	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMMB3	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMLU1	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMLU2	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMLU3	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMTH1	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMTH2	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMTH3	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMSK1	1.35E-03	1.99E-03	0.00E+00	1.64E-02	9.99E+99	0.00E+00	1.30E-02	9.99E+99	3.64E-04	5.35E-03	1.47E+01	1.21E+01
RECMSK2	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMSK3	.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99

C.9

RLCMMT2	1.01E-03	1.43E-03	6.30E-04	2.95E-03	4.68E+00	7.60E-04	2.57E-03	3.38E+00	1.02E-03	2.03E-03	1.99E+00	2.92E+00
RLCMMT3	2.05E-04	2.89E-04	1.28E-04	6.09E-04	4.75E+00	1.54E-04	5.26E-04	3.41E+00	2.07E-04	4.14E-04	2.00E+00	2.96E+00
RLCMMT4	3.75E-05	5.25E-05	2.34E-05	1.12E-04	4.80E+00	2.80E-05	9.66E-05	3.45E+00	3.75E-05	7.59E-05	2.02E+00	3.00E+00
RLCMBM2	1.04E-04	9.36E-05	4.01E-09	3.69E-04	9.19E+04	7.77E-06	3.28E-04	4.22E+01	3.63E-05	2.19E-04	6.03E+00	3.55E+00
RLCMBM3	2.10E-05	1.89E-05	8.11E-10	7.46E-05	9.19E+04	1.57E-06	6.63E-05	4.22E+01	7.34E-06	4.43E-05	6.03E+00	3.55E+00
RLCMBM4	3.83E-06	3.45E-06	1.48E-10	1.36E-05	9.19E+04	2.86E-07	1.21E-05	4.22E+01	1.34E-06	8.07E-06	6.03E+00	3.55E+00
RLCMTH2	4.70E-05	1.10E-05	1.17E-09	1.37E-04	1.18E+05	5.82E-07	1.11E-04	1.91E+02	2.80E-06	4.44E-05	1.59E+01	2.92E+00
RLCMTH3	9.13E-06	2.13E-06	2.27E-10	2.67E-05	1.18E+05	1.13E-07	2.16E-05	1.91E+02	5.44E-07	8.65E-06	1.59E+01	2.92E+00
RLCMTH4	1.51E-06	3.53E-07	3.74E-11	4.41E-06	1.18E+05	1.87E-08	3.57E-06	1.91E+02	8.99E-08	1.43E-06	1.59E+01	2.92E+00
RLLVMT2	6.21E-03	8.28E-03	4.11E-03	1.45E-02	3.54E+00	4.78E-03	1.34E-02	2.79E+00	6.40E-03	1.11E-02	1.73E+00	2.34E+00
RLLVMT3	9.33E-04	1.28E-03	5.90E-04	2.54E-03	4.30E+00	6.94E-04	2.25E-03	3.24E+00	9.53E-04	1.80E-03	1.89E+00	2.72E+00
RLLVMT4	1.32E-04	1.84E-04	8.35E-05	3.82E-04	4.58E+00	9.92E-05	3.35E-04	3.37E+00	1.35E-04	2.64E-04	1.96E+00	2.89E+00
RLLVBM2	7.04E-04	6.34E-04	2.72E-08	2.50E-03	9.19E+04	5.26E-05	2.22E-03	4.22E+01	2.46E-04	1.48E-03	6.03E+00	3.55E+00
RLLVBM3	9.38E-05	8.45E-05	3.62E-09	3.33E-04	9.19E+04	7.01E-06	2.96E-04	4.22E+01	3.28E-05	1.98E-04	6.03E+00	3.55E+00
RLLVBM4	1.33E-05	1.20E-05	5.14E-10	4.72E-05	9.19E+04	9.95E-07	4.20E-05	4.22E+01	4.65E-06	2.81E-05	6.03E+00	3.55E+00
RLLVTH2	6.53E-04	1.53E-04	1.62E-08	1.91E-03	1.18E+05	8.09E-06	1.54E-03	1.91E+02	3.89E-05	6.18E-04	1.59E+01	2.92E+00
RLLVTH3	7.51E-05	1.76E-05	1.86E-09	2.20E-04	1.18E+05	9.31E-07	1.78E-04	1.91E+02	4.48E-06			

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7.11E-05  1.59E+01  ||  2.92E+00
 RLLVTH4  7.33E-06  1.71E-06  | 1.82E-10  2.14E-05  1.18E+05  | 9.08E-08  1.73E-05  1.91E+02  | 4.37E-07
6.94E-06  1.59E+01  ||  2.92E+00
 PECMMT   1.07E-01  2.22E-01  | 5.89E-04  1.50E+00  2.54E+03  | 1.55E-03  1.17E+00  7.56E+02  | 4.91E-02
4.46E-01  9.09E+00  ||  1.39E+01
 PECMBM    .00E+00  0.00E+00  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00
0.00E+00  9.99E+99  ||  9.99E+99
 PECMMB   2.08E+00  2.35E+00  | 4.01E-03  1.19E+01  2.98E+03  | 2.65E-02  9.77E+00  3.69E+02  | 8.91E-01
4.49E+00  5.04E+00  ||  5.75E+00
 PECMLU    .00E+00  0.00E+00  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00
0.00E+00  9.99E+99  ||  9.99E+99
 PECMTH    .00E+00  0.00E+00  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00  0.00E+00  9.99E+99  | 0.00E+00
0.00E+00  9.99E+99  ||  9.99E+99
 PECMSK   2.08E+00  2.35E+00  | 4.01E-03  1.19E+01  2.98E+03  | 2.65E-02  9.77E+00  3.69E+02  | 8.91E-01
4.49E+00  5.04E+00  ||  5.75E+00
 PLCMMT   2.33E+03  3.26E+03  | 1.46E+03  6.98E+03  4.80E+00  | 1.74E+03  5.99E+03  3.44E+00  | 2.33E+03
4.71E+03  2.02E+00  ||  3.00E+00
 PLCMBM   2.38E+02  2.14E+02  | 9.18E-03  8.44E+02  9.19E+04  | 1.78E+01  7.51E+02  4.22E+01  | 8.31E+01
5.01E+02  6.03E+00  ||  3.55E+00
 PLCMTH   9.44E+01  2.21E+01  | 2.34E-03  2.76E+02  1.18E+05  | 1.17E+00  2.23E+02  1.91E+02  | 5.63E+00
8.94E+01  1.59E+01  ||  2.92E+00
 PLLVMT   7.39E+03  1.02E+04  | 4.69E+03  2.09E+04  4.46E+00  | 5.55E+03  1.84E+04  3.31E+00  | 7.54E+03
1.46E+04  1.94E+00  ||  2.83E+00
 PLLVBM   7.54E+02  6.79E+02  | 2.91E-02  2.67E+03  9.18E+04  | 5.64E+01  2.38E+03  4.22E+01  | 2.63E+02
1.59E+03  6.03E+00  ||  3.54E+00
 PLLVTH   4.52E+02  1.06E+02  | 1.12E-02  1.31E+03  1.17E+05  | 5.61E+00  1.07E+03  1.90E+02  | 2.70E+01
4.28E+02  1.59E+01  ||  2.91E+00
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EXTENT OF THE UNCERTAINTY FOR THE 95TH PERCENTILE OF THE ENDPOINTS FOR THE CB2 SOURCE TERM

ENDPOINT	REF	MEDIAN	5 %	95 %	FAC1	10 %	90 %	FAC2	25 %	75 %	FAC3	95%/REF
RECMMT1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMMT2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMMT3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMBM1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMBM2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMBM3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMMB1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMMB2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMMB3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMLU1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMLU2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMLU3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMTH1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMTH2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMTH3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMSK1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMSK2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMSK3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RLCMMT2	3.80E-03	5.37E-03	2.34E-03	1.12E-02	4.79E+00	2.75E-03	9.55E-03	3.47E+00	3.80E-03	7.59E-03	2.00E+00	2.95E+00
RLCMMT3	5.89E-04	8.13E-04	3.63E-04	1.74E-03	4.79E+00	4.37E-04	1.48E-03	3.39E+00	5.89E-04	1.17E-03	2.00E+00	2.95E+00
RLCMMT4	1.45E-04	2.04E-04	9.12E-05	4.37E-04	4.79E+00	1.10E-04	3.72E-04	3.39E+00	1.45E-04	2.95E-04	2.04E+00	3.02E+00
RLCMBM2	3.80E-04	3.39E-04	0.00E+00	1.35E-03	9.99E+99	2.82E-05	1.20E-03	4.27E+01	1.32E-04	7.94E-04	6.03E+00	3.55E+00
RLCMBM3	5.89E-05	5.37E-05	0.00E+00	2.09E-04	9.99E+99	4.47E-06	1.86E-04	4.17E+01	2.04E-05	1.26E-04	6.17E+00	3.55E+00
RLCMBM4	1.48E-05	1.32E-05	0.00E+00	5.25E-05	9.99E+99	1.10E-06	4.68E-05	4.27E+01	5.13E-06	3.09E-05	6.03E+00	3.55E+00
RLCMTH2	1.91E-04	4.47E-05	0.00E+00	5.50E-04	9.99E+99	2.34E-06	4.47E-04	1.91E+02	1.12E-05	1.82E-04	1.62E+01	2.88E+00
RLCMTH3	3.02E-05	7.08E-06	0.00E+00	8.91E-05	9.99E+99	3.80E-07	7.24E-05	1.91E+02	1.82E-06	2.88E-05	1.58E+01	2.95E+00
RLCMTH4	5.89E-06	1.35E-06	0.00E+00	1.70E-05	9.99E+99	5.25E-08	1.38E-05	2.63E+02	3.47E-07	5.50E-06	1.58E+01	2.88E+00
RLLVMT2	1.51E-02	2.09E-02	8.91E-03	4.27E-02	4.79E+00	1.07E-02	3.72E-02	3.47E+00	1.48E-02	2.82E-02	1.91E+00	2.82E+00
RLLVMT3	2.51E-03	3.47E-03	1.55E-03	7.08E-03	4.57E+00	1.86E-03	6.46E-03	3.47E+00	2.57E-03	4.90E-03	1.91E+00	2.82E+00
RLLVMT4	3.80E-04	5.25E-04	2.40E-04	1.10E-03	4.57E+00	2.82E-04	9.77E-04	3.47E+00	3.89E-04	7.59E-04	1.95E+00	2.88E+00
RLLVBM2	1.38E-03	1.23E-03	0.00E+00	4.90E-03	9.99E+99	1.02E-04	4.37E-03	4.27E+01	4.79E-04	2.88E-03	6.03E+00	3.55E+00
RLLVBM3	2.45E-04	2.19E-04	0.00E+00	8.71E-04	9.99E+99	1.82E-05	7.76E-04	4.27E+01	8.51E-05	5.13E-04	6.03E+00	3.55E+00
RLLVBM4	3.80E-05	3.39E-05	0.00E+00	1.35E-04	9.99E+99	2.82E-06	1.20E-04	4.27E+01	1.32E-05	7.94E-05	6.03E+00	3.55E+00
RLLVTH2	2.14E-03	4.90E-04	0.00E+00	6.17E-03	9.99E+99	2.63E-05	5.01E-03	1.91E+02	1.26E-04	2.00E-03	1.58E+01	2.88E+00
RLLVTH3	2.40E-04	5.62E-05	0.00E+00	6.92E-04	9.99E+99	2.95E-06	5.62E-04	1.91E+02	1.41E-05	2.24E-04	1.58E+01	2.88E+00
RLLVTH4	2.29E-05	5.37E-06	0.00E+00	6.76E-05	9.99E+99	0.00E+00	5.37E-05	9.99E+99	1.35E-06	2.19E-05	1.62E+01	2.95E+00
PECMMT	9.55E-01	1.78E+00	0.00E+00	1.29E+01	9.99E+99	0.00E+00	1.05E+01	9.99E+99	3.98E-01	4.17E+00	1.05E+01	1.35E+01
PECMBM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
PECMMB	1.86E+01	2.14E+01	0.00E+00	1.07E+02	9.99E+99	0.00E+00	8.71E+01	9.99E+99	6.31E+00	4.27E+01	6.76E+00	5.75E+00
PECMLU	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99

PECMTH	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
PECMSK	1.86E+01	2.14E+01	0.00E+00	1.07E+02	9.99E+99	0.00E+00	8.71E+01	9.99E+99	6.31E+00	4.27E+01	6.76E+00	5.75E+00
PLCMMT	4.90E+03	6.92E+03	3.09E+03	1.48E+04	4.79E+00	3.72E+03	1.26E+04	3.39E+00	4.90E+03	1.00E+04	2.04E+00	3.02E+00
PLCMBM	5.01E+02	4.57E+02	0.00E+00	1.78E+03	9.99E+99	3.80E+01	1.58E+03	4.17E+01	1.78E+02	1.07E+03	6.03E+00	3.55E+00
PLCMTH	1.95E+02	4.47E+01	0.00E+00	5.62E+02	9.99E+99	2.40E+00	4.57E+02	1.91E+02	1.15E+01	1.82E+02	1.58E+01	2.88E+00
PLLVMT	1.95E+04	2.69E+04	1.26E+04	5.37E+04	4.27E+00	1.48E+04	4.79E+04	3.24E+00	2.04E+04	3.89E+04	1.91E+00	2.75E+00
PLLVBM	2.04E+03	1.82E+03	0.00E+00	7.24E+03	9.99E+99	1.51E+02	6.46E+03	4.27E+01	7.08E+02	4.27E+03	6.03E+00	3.55E+00
PLLVTH	1.12E+03	2.63E+02	0.00E+00	3.24E+03	9.99E+99	1.38E+01	2.63E+03	1.91E+02	6.61E+01	1.05E+03	1.58E+01	2.88E+00

EXTENT OF THE UNCERTAINTY FOR THE 99TH PERCENTILE OF THE ENDPOINTS FOR THE CB2 SOURCE TERM

ENDPOINT	REF	MEDIAN	5 %	95 %	FAC1	10 %	90 %	FAC2	25 %	75 %	FAC3	95%/REF
RECMMT1	1.15E-03	3.09E-03	0.00E+00	1.15E-01	9.99E+99	0.00E+00	6.92E-02	9.99E+99	0.00E+00	1.41E-02	9.99E+99	1.00E+02
RECMMT2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMMT3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMBM1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMBM2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMBM3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMMB1	2.29E-02	4.07E-02	0.00E+00	8.54E-01	9.99E+99	0.00E+00	7.76E-01	9.99E+99	0.00E+00	1.66E-01	9.99E+99	3.73E+01
RECMMB2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMMB3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMLU1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMLU2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMLU3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMTH1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMTH2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMTH3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMSK1	2.29E-02	4.07E-02	0.00E+00	8.54E-01	9.99E+99	0.00E+00	7.76E-01	9.99E+99	0.00E+00	1.66E-01	9.99E+99	3.73E+01
RECMSK2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RECMSK3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
RLCMMT2	2.63E-02	3.72E-02	1.62E-02	7.41E-02	4.57E+00	1.95E-02	6.76E-02	3.47E+00	2.63E-02	5.25E-02	2.00E+00	2.82E+00
RLCMMT3	3.80E-03	5.37E-03	2.40E-03	1.15E-02	4.79E+00	2.88E-03	1.00E-02	3.47E+00	3.80E-03	7.76E-03	2.04E+00	3.02E+00
RLCMMT4	4.79E-04	6.61E-04	2.95E-04	1.41E-03	4.79E+00	3.55E-04	1.23E-03	3.47E+00	4.79E-04	9.77E-04	2.04E+00	2.95E+00
RLCMBM2	2.75E-03	2.45E-03	1.05E-07	9.77E-03	9.33E+04	2.04E-04	8.71E-03	4.27E+01	9.55E-04	5.75E-03	6.03E+00	3.55E+00
RLCMBM3	3.89E-04	3.55E-04	0.00E+00	1.38E-03	9.99E+99	2.95E-05	1.23E-03	4.17E+01	1.38E-04	8.32E-04	6.03E+00	3.55E+00
RLCMBM4	4.90E-05	4.47E-05	0.00E+00	1.74E-04	9.99E+99	3.63E-06	1.55E-04	4.27E+01	1.70E-05	1.02E-04	6.03E+00	3.55E+00
RLCMTH2	1.17E-03	2.75E-04	2.14E-08	3.47E-03	1.62E+05	1.45E-05	2.75E-03	1.91E+02	7.08E-05	1.12E-03	1.58E+01	2.95E+00
RLCMTH3	1.78E-04	4.17E-05	0.00E+00	5.13E-04	9.99E+99	2.19E-06	4.17E-04	1.91E+02	1.05E-05	1.66E-04	1.58E+01	2.88E+00
RLCMTH4	2.00E-05	4.57E-06	0.00E+00	5.75E-05	9.99E+99	2.45E-07	4.68E-05	1.91E+02	1.17E-06	1.86E-05	1.58E+01	2.88E+00
RLLVMT2	2.00E-01	2.63E-01	1.23E-01	4.90E-01	3.98E+00	1.45E-01	4.47E-01	3.09E+00	2.00E-01	3.55E-01	1.78E+00	2.45E+00
RLLVMT3	1.91E-02	2.63E-02	1.17E-02	5.37E-02	4.57E+00	1.41E-02	4.68E-02	3.31E+00	1.95E-02	3.72E-02	1.91E+00	2.82E+00
RLLVMT4	2.29E-03	3.02E-03	1.38E-03	6.31E-03	4.57E+00	1.62E-03	5.50E-03	3.39E+00	2.29E-03	4.37E-03	1.91E+00	2.75E+00
RLLVBM2	2.04E-02	1.82E-02	0.00E+00	7.24E-02	9.99E+99	1.51E-03	6.46E-02	4.27E+01	7.08E-03	4.27E-02	6.03E+00	3.55E+00
RLLVBM3	1.86E-03	1.70E-03	0.00E+00	6.61E-03	9.99E+99	1.41E-04	5.89E-03	4.17E+01	6.61E-04	3.98E-03	6.03E+00	3.55E+00
RLLVBM4	2.19E-04	1.95E-04	0.00E+00	7.76E-04	9.99E+99	1.62E-05	6.76E-04	4.17E+01	7.59E-05	4.57E-04	6.03E+00	3.55E+00
RLLVTH2	1.78E-02	4.17E-03	0.00E+00	5.25E-02	9.99E+99	2.19E-04	4.17E-02	1.91E+02	1.07E-03	1.70E-02	1.58E+01	2.95E+00
RLLVTH3	1.58E-03	3.63E-04	0.00E+00	4.57E-03	9.99E+99	1.95E-05	3.72E-03	1.91E+02	9.33E-05	1.48E-03	1.58E+01	2.88E+00
RLLVTH4	1.29E-04	3.02E-05	0.00E+00	3.80E-04	9.99E+99	1.62E-06	3.09E-04	1.91E+02	7.76E-06	1.23E-04	1.58E+01	2.95E+00
PECMMT	2.45E+00	4.57E+00	1.73E-02	2.57E+01	1.49E+03	4.61E-02	2.04E+01	4.43E+02	1.20E+00	9.33E+00	7.76E+00	1.05E+01
PECMBM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99
PECMMB	4.68E+01	4.90E+01	1.18E-01	2.04E+02	1.74E+03	7.91E-01	1.68E+02	2.13E+02	2.24E+01	8.91E+01	3.98E+00	4.37E+00
PECMLU	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	0.00E+00	0.00E+00	9.99E+99	9.99E+99

PECMTH	0.00E+00	0.00E+00	| 0.00E+00	0.00E+00	9.99E+99	| 0.00E+00	0.00E+00	9.99E+99	| 0.00E+00	0.00E+00	9.99E+99	|| 9.99E+99
PECMSK	4.68E+01	4.90E+01	| 1.18E-01	2.04E+02	1.74E+03	| 7.91E-01	1.68E+02	2.13E+02	| 2.24E+01	8.91E+01	3.98E+00	|| 4.37E+00
PLCMMT	6.76E+03	9.77E+03	| 4.27E+03	2.04E+04	4.79E+00	| 5.13E+03	1.74E+04	3.39E+00	| 6.76E+03	1.38E+04	2.04E+00	|| 3.02E+00
PLCMBM	6.92E+02	6.31E+02	| 0.00E+00	2.45E+03	9.99E+99	| 5.25E+01	2.19E+03	4.17E+01	| 2.40E+02	1.48E+03	6.17E+00	|| 3.55E+00
PLCMTH	2.57E+02	6.03E+01	| 0.00E+00	7.59E+02	9.99E+99	| 3.24E+00	6.17E+02	1.91E+02	| 1.55E+01	2.45E+02	1.58E+01	|| 2.95E+00
PLLVMT	2.19E+04	3.09E+04	| 1.38E+04	6.31E+04	4.57E+00	| 1.66E+04	5.50E+04	3.31E+00	| 2.24E+04	4.37E+04	1.95E+00	|| 2.88E+00
PLLVBM	2.24E+03	2.04E+03	| 0.00E+00	7.94E+03	9.99E+99	| 1.70E+02	7.08E+03	4.17E+01	| 7.94E+02	4.79E+03	6.03E+00	|| 3.55E+00
PLLVTH	1.20E+03	2.82E+02	| 0.00E+00	3.47E+03	9.99E+99	| 1.48E+01	2.82E+03	1.91E+02	| 7.08E+01	1.15E+03	1.62E+01	|| 2.88E+00

EXTENT OF THE UNCERTAINTY FOR THE MEAN VALUE OF THE ENDPOINTS FOR THE DBA SOURCE TERM

ENDPOINT	REF	MEDIAN	5 %	95 %	FAC1	10 %	90 %	FAC2	25 %	75 %	FAC3	95%/REF
RLCMMT2	7.82E-07	1.08E-06	4.84E-07	2.18E-06	4.50E+00	5.66E-07	1.97E-06	3.49E+00	7.86E-07	1.53E-06	1.95E+00	2.78E+00
RLCMMT3	1.11E-07	1.50E-07	6.54E-08	3.03E-07	4.64E+00	7.79E-08	2.69E-07	3.45E+00	1.07E-07	2.11E-07	1.96E+00	2.74E+00
RLCMMT4	1.32E-08	1.83E-08	8.13E-09	3.68E-08	4.52E+00	9.58E-09	3.29E-08	3.44E+00	1.34E-08	2.57E-08	1.92E+00	2.80E+00
RLCMBM2	7.49E-08	6.75E-08	2.89E-12	2.66E-07	9.19E+04	5.60E-09	2.37E-07	4.22E+01	2.62E-08	1.58E-07	6.03E+00	3.55E+00
RLCMBM3	1.02E-08	9.15E-09	3.92E-13	3.61E-08	9.19E+04	7.60E-10	3.21E-08	4.22E+01	3.55E-09	2.14E-08	6.03E+00	3.55E+00
RLCMBM4	1.28E-09	1.15E-09	4.93E-14	4.53E-09	9.19E+04	9.55E-11	4.03E-09	4.22E+01	4.46E-10	2.69E-09	6.03E+00	3.55E+00
RLCMTH2	7.40E-08	1.73E-08	1.84E-12	2.16E-07	1.18E+05	9.16E-10	1.75E-07	1.91E+02	4.41E-09	7.00E-08	1.59E+01	2.92E+00
RLCMTH3	1.52E-08	3.54E-09	3.76E-13	4.43E-08	1.18E+05	1.88E-10	3.58E-08	1.91E+02	9.03E-10	1.43E-08	1.59E+01	2.92E+00
RLCMTH4	1.18E-09	2.76E-10	2.93E-14	3.45E-09	1.18E+05	1.46E-11	2.79E-09	1.91E+02	7.03E-11	1.12E-09	1.59E+01	2.92E+00
RLOUMT2	1.39E-06	1.87E-06	8.55E-07	3.88E-06	4.53E+00	9.75E-07	3.44E-06	3.53E+00	1.35E-06	2.69E-06	1.99E+00	2.78E+00
RLOUMT3	1.80E-07	2.45E-07	1.12E-07	5.10E-07	4.55E+00	1.28E-07	4.51E-07	3.51E+00	1.78E-07	3.53E-07	1.98E+00	2.83E+00
RLOUMT4	2.16E-08	3.01E-08	1.35E-08	6.34E-08	4.68E+00	1.59E-08	5.55E-08	3.48E+00	2.21E-08	4.32E-08	1.95E+00	2.93E+00
RLOUBM2	1.30E-07	1.17E-07	5.01E-12	4.61E-07	9.19E+04	9.71E-09	4.10E-07	4.22E+01	4.54E-08	2.74E-07	6.03E+00	3.55E+00
RLOUBM3	1.71E-08	1.55E-08	6.62E-13	6.09E-08	9.19E+04	1.28E-09	5.42E-08	4.22E+01	5.99E-09	3.61E-08	6.03E+00	3.55E+00
RLOUBM4	2.14E-09	1.93E-09	8.26E-14	7.60E-09	9.19E+04	1.60E-10	6.76E-09	4.22E+01	7.48E-10	4.51E-09	6.03E+00	3.55E+00
RLOUTH2	1.68E-07	3.92E-08	4.17E-12	4.91E-07	1.18E+05	2.08E-09	3.97E-07	1.91E+02	1.00E-08	1.59E-07	1.59E+01	2.92E+00
RLOUTH3	1.87E-08	4.38E-09	4.65E-13	5.47E-08	1.18E+05	2.32E-10	4.43E-08	1.91E+02	1.12E-09	1.77E-08	1.59E+01	2.92E+00
RLOUTH4	1.55E-09	3.61E-10	3.84E-14	4.52E-09	1.18E+05	1.92E-11	3.66E-09	1.91E+02	9.21E-11	1.46E-09	1.59E+01	2.92E+00
PLCMMT	4.96E-01	6.80E-01	3.01E-01	1.37E+00	4.57E+00	3.56E-01	1.24E+00	3.48E+00	4.93E-01	9.54E-01	1.94E+00	2.77E+00
PLCMBM	4.70E-02	4.23E-02	1.81E-06	1.67E-01	9.19E+04	3.51E-03	1.48E-01	4.22E+01	1.64E-02	9.90E-02	6.03E+00	3.55E+00
PLCMTH	5.48E-02	1.28E-02	1.36E-06	1.60E-01	1.18E+05	6.79E-04	1.30E-01	1.91E+02	3.26E-03	5.18E-02	1.59E+01	2.92E+00

C.12

EXTENT OF THE UNCERTAINTY FOR THE 95TH PERCENTILE OF THE ENDPOINTS FOR THE DBA SOURCE TERM

ENDPOINT	REF	MEDIAN	5 %	95 %	FAC1	10 %	90 %	FAC2	25 %	75 %	FAC3	95%/REF
RLCMMT2	2.09E-06	2.75E-06	1.12E-06	6.31E-06	5.62E+00	1.32E-06	4.68E-06	3.55E+00	2.00E-06	3.63E-06	1.82E+00	3.02E+00
RLCMMT3	3.16E-07	4.27E-07	1.82E-07	8.91E-07	4.90E+00	2.19E-07	7.59E-07	3.47E+00	3.09E-07	5.75E-07	1.86E+00	2.82E+00
RLCMMT4	3.16E-08	4.17E-08	1.82E-08	8.32E-08	4.57E+00	2.14E-08	7.59E-08	3.55E+00	3.02E-08	5.89E-08	1.95E+00	2.63E+00
RLCMBM2	1.66E-07	1.51E-07	0.00E+00	5.89E-07	9.99E+99	1.23E-08	5.25E-07	4.27E+01	5.75E-08	3.47E-07	6.03E+00	3.55E+00
RLCMBM3	2.82E-08	2.51E-08	0.00E+00	1.00E-07	9.99E+99	2.09E-09	8.91E-08	4.27E+01	9.77E-09	5.89E-08	6.03E+00	3.55E+00
RLCMBM4	2.82E-09	2.57E-09	0.00E+00	1.00E-08	9.99E+99	2.14E-10	8.91E-09	4.17E+01	1.00E-09	6.03E-09	6.03E+00	3.55E+00
RLCMTH2	3.89E-07	9.12E-08	0.00E+00	1.15E-06	9.99E+99	4.79E-09	9.33E-07	1.95E+02	2.34E-08	3.72E-07	1.58E+01	2.95E+00
RLCMTH3	5.37E-08	1.26E-08	0.00E+00	1.58E-07	9.99E+99	6.61E-10	1.26E-07	1.91E+02	3.24E-09	5.13E-08	1.58E+01	2.95E+00
RLCMTH4	3.24E-09	7.59E-10	0.00E+00	9.55E-09	9.99E+99	0.00E+00	7.76E-09	9.99E+99	1.95E-10	3.09E-09	1.58E+01	2.95E+00
RLOUMT2	3.89E-06	5.25E-06	2.34E-06	1.10E-05	4.68E+00	2.63E-06	9.55E-06	3.63E+00	3.72E-06	7.24E-06	1.95E+00	2.82E+00
RLOUMT3	5.37E-07	7.41E-07	3.31E-07	1.51E-06	4.57E+00	3.72E-07	1.32E-06	3.55E+00	5.25E-07	1.02E-06	1.95E+00	2.82E+00
RLOUMT4	5.89E-08	7.94E-08	3.63E-08	1.66E-07	4.57E+00	4.17E-08	1.48E-07	3.55E+00	5.75E-08	1.15E-07	2.00E+00	2.82E+00
RLOUBM2	3.47E-07	3.16E-07	0.00E+00	1.23E-06	9.99E+99	2.63E-08	1.10E-06	4.17E+01	1.23E-07	7.41E-07	6.03E+00	3.55E+00
RLOUBM3	4.90E-08	4.47E-08	0.00E+00	1.74E-07	9.99E+99	3.72E-09	1.55E-07	4.17E+01	1.74E-08	1.05E-07	6.03E+00	3.55E+00
RLOUBM4	5.50E-09	5.01E-09	0.00E+00	1.95E-08	9.99E+99	0.00E+00	1.74E-08	9.99E+99	1.95E-09	1.17E-08	6.03E+00	3.55E+00
RLOUTH2	5.89E-07	1.38E-07	0.00E+00	1.74E-06	9.99E+99	7.41E-09	1.41E-06	1.91E+02	3.55E-08	5.62E-07	1.58E+01	2.95E+00
RLOUTH3	6.76E-08	1.58E-08	0.00E+00	2.00E-07	9.99E+99	0.00E+00	1.58E-07	9.99E+99	3.98E-09	6.46E-08	1.62E+01	2.95E+00
RLOUTH4	4.57E-09	1.07E-09	0.00E+00	1.32E-08	9.99E+99	0.00E+00	1.07E-08	9.99E+99	0.00E+00	4.27E-09	9.99E+99	2.88E+00
PLCMMT	1.62E+00	2.34E+00	1.05E+00	4.79E+00	4.57E+00	1.20E+00	4.17E+00	3.47E+00	1.70E+00	3.31E+00	1.95E+00	2.95E+00
PLCMBM	1.62E-01	1.48E-01	0.00E+00	5.75E-01	9.99E+99	1.23E-02	5.13E-01	4.17E+01	5.75E-02	3.47E-01	6.03E+00	3.55E+00
PLCMTH	1.58E-01	3.72E-02	0.00E+00	4.68E-01	9.99E+99	1.95E-03	3.72E-01	1.91E+02	9.55E-03	1.51E-01	1.58E+01	2.95E+00

EXTENT OF THE UNCERTAINTY FOR THE 99TH PERCENTILE OF THE ENDPOINTS FOR THE DBA SOURCE TERM

ENDPOINT	REF	MEDIAN	5 %	95 %	FAC1	10 %	90 %	FAC2	25 %	75 %	FAC3	95%/REF
RLCMMT2	2.19E-05	2.95E-05	1.35E-05	6.03E-05	4.47E+00	1.58E-05	5.37E-05	3.39E+00	2.19E-05	4.27E-05	1.95E+00	2.75E+00
RLCMMT3	2.19E-06	3.09E-06	1.29E-06	6.31E-06	4.90E+00	1.55E-06	5.37E-06	3.47E+00	2.19E-06	4.17E-06	1.91E+00	2.88E+00
RLCMMT4	2.51E-07	3.47E-07	1.51E-07	6.92E-07	4.57E+00	1.82E-07	6.17E-07	3.39E+00	2.51E-07	4.90E-07	1.95E+00	2.75E+00
RLCMBM2	2.09E-06	1.86E-06	2.95E-11	7.41E-06	2.51E+05	1.55E-07	6.61E-06	4.27E+01	7.24E-07	4.37E-06	6.03E+00	3.55E+00
RLCMBM3	2.00E-07	1.82E-07	0.00E+00	7.08E-07	9.99E+99	1.48E-08	6.31E-07	4.27E+01	6.92E-08	4.17E-07	6.03E+00	3.55E+00
RLCMBM4	2.40E-08	2.19E-08	0.00E+00	8.51E-08	9.99E+99	1.82E-09	7.59E-08	4.17E+01	8.51E-09	5.13E-08	6.03E+00	3.55E+00
RLCMTH2	1.62E-06	3.72E-07	0.00E+00	4.68E-06	9.99E+99	2.00E-08	3.80E-06	1.91E+02	9.55E-08	1.51E-06	1.58E+01	2.88E+00
RLCMTH3	3.47E-07	7.94E-08	0.00E+00	1.00E-06	9.99E+99	4.27E-09	8.13E-07	1.91E+02	2.04E-08	3.24E-07	1.58E+01	2.88E+00
RLCMTH4	2.51E-08	5.89E-09	0.00E+00	7.41E-08	9.99E+99	3.09E-10	5.89E-08	1.91E+02	1.51E-09	2.40E-08	1.58E+01	2.95E+00
RLOUMT2	3.98E-05	5.25E-05	2.29E-05	1.07E-04	4.68E+00	2.69E-05	9.55E-05	3.55E+00	3.80E-05	7.41E-05	1.95E+00	2.69E+00
RLOUMT3	3.72E-06	5.01E-06	2.29E-06	1.02E-05	4.47E+00	2.63E-06	9.12E-06	3.47E+00	3.55E-06	7.08E-06	2.00E+00	2.75E+00
RLOUMT4	4.17E-07	5.89E-07	2.57E-07	1.23E-06	4.79E+00	3.09E-07	1.07E-06	3.47E+00	4.27E-07	8.32E-07	1.95E+00	2.95E+00
RLOUBM2	3.55E-06	3.16E-06	0.00E+00	1.26E-05	9.99E+99	2.63E-07	1.12E-05	4.27E+01	1.23E-06	7.41E-06	6.03E+00	3.55E+00
RLOUBM3	3.39E-07	3.02E-07	0.00E+00	1.20E-06	9.99E+99	2.51E-08	1.07E-06	4.27E+01	1.17E-07	7.08E-07	6.03E+00	3.55E+00
RLOUBM4	4.17E-08	3.80E-08	0.00E+00	1.48E-07	9.99E+99	3.09E-09	1.32E-07	4.27E+01	1.45E-08	8.71E-08	6.03E+00	3.55E+00
RLOUTH2	4.37E-06	1.02E-06	0.00E+00	1.29E-05	9.99E+99	5.37E-08	1.05E-05	1.95E+02	2.63E-07	4.17E-06	1.58E+01	2.95E+00
RLOUTH3	4.07E-07	9.55E-08	0.00E+00	1.17E-06	9.99E+99	5.01E-09	9.55E-07	1.91E+02	2.40E-08	3.80E-07	1.58E+01	2.88E+00
RLOUTH4	3.39E-08	7.94E-09	0.00E+00	1.00E-07	9.99E+99	0.00E+00	7.94E-08	9.99E+99	2.04E-09	3.24E-08	1.58E+01	2.95E+00
PLCMMT	2.29E+00	3.16E+00	1.41E+00	6.31E+00	4.47E+00	1.66E+00	5.75E+00	3.47E+00	2.34E+00	4.47E+00	1.91E+00	2.75E+00
PLCMBM	2.19E-01	2.00E-01	0.00E+00	7.76E-01	9.99E+99	1.66E-02	6.92E-01	4.17E+01	7.76E-02	4.68E-01	6.03E+00	3.55E+00
PLCMTH	2.04E-01	4.79E-02	0.00E+00	5.89E-01	9.99E+99	2.51E-03	4.79E-01	1.91E+02	1.20E-02	1.91E-01	1.58E+01	2.88E+00

Appendix D

Parameters making major contributions to the overall uncertainty

This appendix lists those parameters whose uncertainty makes a major contribution to the overall uncertainty on the model predictions. The parameters are selected on the basis of being ranked in the top 5 positions according to the absolute value of the partial rank correlation coefficient, provided that the PRCC s above the level that might be observed by chance.

The endpoints are identified using the short code listed in Table C.1 of Appendix C. The input parameters are also identified using a short code, which is given for all the parameters in Table D.1. The remaining tables list the input parameters meeting the criteria specified above for each of the endpoints considered. The tables give the following information:

ENDP — Short code name for the endpoint

INP.VAR. — Short code name for the input parameters

RK — Rank according to PRCC

PRCC — Value of the partial rank correlation coefficient

SUM% — The sum of the percentage contributions of the parameters to the uncertainty on the endpoint. The percentage contributions do not add up to 100% because of the effects of correlations between input parameter values, as discussed in the "Methodology Report"

%CON — The percentage contribution to the uncertainty on the endpoint made by the uncertainty in the value of the parameter

%SCON — The percentage contribution to the uncertainty on the endpoint made by the uncertainty in the value of the parameter, if the overall uncertainty is normalised to 100%
(ie %CON/SUM%)

FAC1 — The ratio of the 95th to the 5th percentile of the uncertainty distribution for this endpoint.

RSQ — The coefficient of determination, R^2.

The quantities PRCC, percentage contribution and R^2 are described in the "Methodology Report".

The results given in Appendix C show that there are some endpoints and source terms where the results for many of the sets of parameter values are so small that they are below the lowest bin used

in determining the uncertainty distribution on the endpoint. In some cases, it was not possible to determine the 95th percentile of the uncertainty distribution as the values are so low. In these cases there are so few "non-zero" values that an analysis of the important uncertain parameters is meaningless, and so results for those situations are not included in this appendix.

The results for the individual and collective risk of cancer in specific organs are also omitted from this appendix, since the only uncertain input parameter that can affect the uncertainty on the result is the risk coefficient for the organ in question, which produces all of the uncertainty. Results are also not given for the probability of zero for those endpoints where this quantity is not affected by the parameter values adopted in this module analysis.

Table D.1 Description of the short names of the input parameters used in the following tables

Short name of parameter	Description of parameter
Parameters for early health effects	
V(LUMB)	Lung function impairment: shape parameter V of dose relationship
D0(LUMB)	Lung function impairment: model parameter D_0 (GY**2/H)
DI(LUMB)	Lung function impairment: model parameter $D_{\square}$ (GY)
V(SK)	Deterministic effects on skin: shape parameter V of dose relationship
D0(SK)	Deterministic effects on skin: model parameter D_0 (GY**2/H)
DI(SK)	Deterministic effects on skin: model parameter $D_{\square}$ (GY)
SKMORT	Deterministic effects on skin: Fraction of people dying for burns on 20% of exposed
V(LUMT)	Pulmonary syndrome: shape parameter V of dose relationship
D0(LUMT)	Pulmonary syndrome: model parameter D_0 (GY**2/H)
DI(LUMT)	Pulmonary syndrome: model parameter $D_{\square}$ (GY)
V(BM)	Hematopoietic syndrome: shape parameter V of dose relationship
D0(BM)	Hematopoietic syndrome: model parameter D_0 (GY**2/H)
DI(BM)	Hematopoietic syndrome: model parameter $D_{\square}$ (GY)
V(GI)	Gastrointestinal syndrome: shape parameter V of dose relationship
D0(GI)	Gastrointestinal syndrome: model parameter D_0 (GY**2/H)
DI(GI)	Gastrointestinal syndrome: model parameter $D_{\square}$ (GY)
Parameters for late health effects	
RF(BM)	Risk of death from radiation induced leukaemia (Sv^{-1})
RF(BS)	Risk of death from radiation induced bone surface cancer (Sv^{-1})
RF(BR)	Risk of death from radiation induced breast cancer (Sv^{-1})
RF(LU)	Risk of death from radiation induced lung cancer (Sv^{-1})
RF(ST)	Risk of death from radiation induced stomach cancer (Sv^{-1})
RF(CO)	Risk of death from radiation induced colon cancer (Sv^{-1})
RF(LV)	Risk of death from radiation induced liver cancer (Sv^{-1})
RF(PA)	Risk of death from radiation induced pancreas cancer (Sv^{-1})
RF(TH)	Risk of death from radiation induced thyroid cancer (Sv^{-1})
RF(RE)	Risk of death from radiation induced cancer in other organs (Sv^{-1})
RF(SK)	Risk of death from radiation induced skin cancer (Sv^{-1})

TABLE D.2CONTRIBUTIONS OF PARAMETER UNCERTAINTIES TO THE OVERALL UNCERTAINTY ON THE ENDPOINTS

Results for the mean value of the endpoints for the UK1 source term

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
PECMBM	DI(BM)	001	-.94	227.83	87.63	38.46	6.23E+00	.97
PECMBM	V(BM)	003	-.47	227.83	64.95	28.51	6.23E+00	.97
PECMBM	D0(BM)	002	-.87	227.83	55.67	24.43	6.23E+00	.97
PECMLU	D0(LUMB)	001	-.82	136.89	59.52	43.48	9.99E+99	.84
PECMLU	DI(LUMB)	002	-.73	136.89	42.86	31.31	9.99E+99	.84
PECMLU	DI(LUMT)	003	.27	136.89	10.71	07.82	9.99E+99	.84
PECMMB	DI(SK)	001	-.99	109.09	97.98	89.82	2.30E+01	.99
PECMMB	D0(SK)	003	-.50	109.09	03.03	02.78	2.30E+01	.99
PECMMB	SKMORT	002	-.52	109.09	00.00	00.00	2.30E+01	.99
PECMMT	DI(SK)	001	-.91	117.39	56.52	48.15	1.28E+01	.92
PECMMT	SKMORT	002	.90	117.39	39.13	33.33	1.28E+01	.92
PECMMT	V(SK)	003	-.54	117.39	13.04	11.11	1.28E+01	.92
PECMSK	DI(SK)	001	-.99	109.09	97.98	89.82	2.72E+01	.99
PECMSK	D0(SK)	002	-.51	109.09	03.03	02.78	2.72E+01	.99
PECMSK	SKMORT	003	-.51	109.09	00.00	00.00	2.72E+01	.99
PECMTH	DI(BM)	001	.57	190.81	42.11	22.07	3.44E+00	.76
PECMTH	D0(BM)	003	.43	190.81	26.32	13.79	3.44E+00	.76
PECMTH	D0(LUMT)	004	.39	190.81	26.32	13.79	3.44E+00	.76
PECMTH	V(BM)	013	.04	190.81	26.32	13.79	3.44E+00	.76
PECMTH	DI(LUMT)	005	.37	190.81	25.00	13.10	3.44E+00	.76
PECMTH	SKMORT	002	-.44	190.81	05.26	02.76	3.44E+00	.76
PELVBM	D0(BM)	001	-.99	188.88	96.97	51.34	7.72E+00	.99
PELVBM	V(BM)	003	-.36	188.88	38.38	20.32	7.72E+00	.99
PELVBM	DI(BM)	002	-.63	188.88	36.36	19.25	7.72E+00	.99
PELVLU	D0(LUMB)	001	-.84	134.93	66.27	49.11	9.99E+99	.83
PELVLU	DI(LUMB)	002	-.67	134.93	37.35	27.68	9.99E+99	.83
PELVLU	V(LUMB)	003	-.32	134.93	03.61	02.68	9.99E+99	.83
PELVMB	D0(SK)	001	-.94	111.83	74.19	66.34	6.58E+00	.93
PELVMB	DI(SK)	002	-.85	111.83	32.26	28.85	6.58E+00	.93
PELVMB	SKMORT	003	-.32	111.83	00.00	00.00	6.58E+00	.93
PELVMT	SKMORT	001	.94	108.61	62.37	57.43	1.54E+01	.93
PELVMT	D0(SK)	002	-.89	108.61	33.33	30.69	1.54E+01	.93
PELVMT	DI(SK)	003	-.57	108.61	09.68	08.91	1.54E+01	.93
PELVSK	D0(SK)	001	-.94	112.91	75.27	66.66	7.07E+00	.93
PELVSK	DI(SK)	002	-.85	112.91	32.26	28.57	7.07E+00	.93
PELVSK	SKMORT	003	-.29	112.91	00.00	00.00	7.07E+00	.93
PELVTH	D0(LUMT)	003	.46	166.65	33.33	20.00	1.57E+00	.78
PELVTH	DI(LUMT)	004	.27	166.65	26.92	16.15	1.57E+00	.78
PELVTH	SKMORT	001	-.71	166.65	26.92	16.15	1.57E+00	.78
PELVTH	D0(BM)	002	.64	166.65	24.36	14.62	1.57E+00	.78
PELVTH	V(LUMT)	016	.01	166.65	23.08	13.85	1.57E+00	.78
RECMBM1	DI(BM)	001	-.91	227.07	83.33	36.70	2.04E+00	.96
RECMBM1	D0(BM)	002	-.89	227.07	62.50	27.52	2.04E+00	.96
RECMBM1	V(BM)	003	-.24	227.07	60.42	26.61	2.04E+00	.96
RECMBM2	DI(BM)	001	-.94	224.74	88.66	39.45	1.54E+01	.97
RECMBM2	V(BM)	003	-.36	224.74	62.89	27.98	1.54E+01	.97
RECMBM2	D0(BM)	002	-.87	224.74	53.61	23.85	1.54E+01	.97
RECMBM3	DI(BM)	001	-.26	202.50	72.50	35.80	9.99E+99	.40
RECMBM3	V(BM)	003	-.18	202.50	67.50	33.33	9.99E+99	.40
RECMBM3	D0(BM)	004	-.13	202.50	40.00	19.75	9.99E+99	.40
RECMBM3	V(GI)	002	-.19	202.50	02.50	01.23	9.99E+99	.40
RECMLU1	D0(LUMB)	001	-.79	129.47	65.38	50.50	9.99E+99	.78
RECMLU1	DI(LUMB)	002	-.67	129.47	44.87	34.66	9.99E+99	.78
RECMLU1	V(LUMB)	003	-.31	129.47	03.85	02.97	9.99E+99	.78
RECMLU2	D0(LUMB)	001	-.81	138.53	56.63	40.88	9.99E+99	.83
RECMLU2	DI(LUMB)	002	-.73	138.53	43.37	31.31	9.99E+99	.83
RECMLU2	DI(LUMT)	003	.28	138.53	12.05	08.70	9.99E+99	.83
RECMMB1	DI(BM)	002	.64	151.23	41.46	27.42	2.62E+00	.82
RECMMB1	DI(SK)	001	-.77	151.23	30.49	20.16	2.62E+00	.82
RECMMB1	D0(BM)	003	.47	151.23	28.05	18.55	2.62E+00	.82
RECMMB1	V(BM)	015	.04	151.23	25.61	16.93	2.62E+00	.82

RECMMB2	DI(SK)	001	-.99	108.16	93.88	86.80	5.43E+00	.98
RECMMB2	D0(SK)	003	-.50	108.16	04.08	03.77	5.43E+00	.98
RECMMB2	SKMORT	002	-.60	108.16	01.02	00.94	5.43E+00	.98

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
RECMMB3	DI(SK)	001	-.99	110.10	98.99	89.91	4.41E+02	.99
RECMMB3	V(SK)	002	-.62	110.10	08.08	07.34	4.41E+02	.99
RECMMB3	D0(SK)	003	-.47	110.10	03.03	02.75	4.41E+02	.99
RECMMT1	DI(BM)	002	-.59	172.50	50.00	28.99	1.73E+00	.80
RECMMT1	D0(BM)	003	-.59	172.50	41.25	23.91	1.73E+00	.80
RECMMT1	V(BM)	013	-.06	172.50	35.00	20.29	1.73E+00	.80
RECMMT1	SKMORT	001	.71	172.50	22.50	13.04	1.73E+00	.80
RECMMT2	SKMORT	001	.88	129.89	50.57	38.93	4.08E+00	.87
RECMMT2	DI(SK)	002	-.74	129.89	26.44	20.36	4.08E+00	.87
RECMMT2	DI(BM)	003	-.42	129.89	05.75	04.43	4.08E+00	.87
RECMMT3	DI(SK)	001	-.95	112.64	71.58	63.55	7.97E+02	.95
RECMMT3	SKMORT	002	.90	112.64	28.42	25.23	7.97E+02	.95
RECMMT3	V(SK)	003	-.52	112.64	10.53	09.35	7.97E+02	.95
RECMSK1	DI(SK)	001	-.91	126.14	64.77	51.35	2.18E+00	.88
RECMSK1	DI(BM)	003	.59	126.14	18.18	14.41	2.18E+00	.88
RECMSK1	D0(BM)	004	.40	126.14	13.64	10.81	2.18E+00	.88
RECMSK1	SKMORT	002	-.60	126.14	04.55	03.61	2.18E+00	.88
RECMSK2	DI(SK)	001	-.99	106.12	96.94	91.35	5.49E+00	.98
RECMSK2	D0(SK)	003	-.58	106.12	04.08	03.84	5.49E+00	.98
RECMSK2	SKMORT	002	-.70	106.12	01.02	00.96	5.49E+00	.98
RECMSK3	DI(SK)	001	-.99	110.10	98.99	89.91	4.41E+02	.99
RECMSK3	V(SK)	002	-.62	110.10	08.08	07.34	4.41E+02	.99
RECMSK3	D0(SK)	003	-.47	110.10	03.03	02.75	4.41E+02	.99
RECMTH1	DI(BM)	001	.66	196.25	65.00	33.12	6.98E+00	.80
RECMTH1	D0(BM)	002	.64	196.25	53.75	27.39	6.98E+00	.80
RECMTH1	V(BM)	016	.00	196.25	42.50	21.66	6.98E+00	.80
RECMTH1	DI(LUMT)	003	.30	196.25	05.00	02.55	6.98E+00	.80
RECMTH2	D0(LUMT)	001	.55	203.71	56.79	27.88	2.96E+00	.81
RECMTH2	DI(LUMT)	004	.46	203.71	50.62	24.85	2.96E+00	.81
RECMTH2	V(LUMT)	012	-.04	203.71	39.51	19.40	2.96E+00	.81
RECMTH2	DI(BM)	002	.50	203.71	16.05	07.88	2.96E+00	.81
RECMTH2	SKMORT	003	-.46	203.71	04.94	02.43	2.96E+00	.81
RELVBM1	D0(BM)	001	-.98	193.88	96.94	50.00	1.98E+00	.98
RELVBM1	DI(BM)	002	-.70	193.88	39.80	20.53	1.98E+00	.98
RELVBM1	V(BM)	003	-.15	193.88	38.78	20.00	1.98E+00	.98
RELVBM2	D0(BM)	001	-.99	192.92	95.96	49.74	1.98E+03	.99
RELVBM2	V(BM)	003	-.56	192.92	42.42	21.99	1.98E+03	.99
RELVBM2	DI(BM)	002	-.57	192.92	37.37	19.37	1.98E+03	.99
RELVLU1	D0(LUMB)	001	-.78	123.99	68.00	54.84	9.99E+99	.75
RELVLU1	DI(LUMB)	002	-.54	123.99	33.33	26.88	9.99E+99	.75
RELVLU1	D0(BM)	003	.37	123.99	09.33	07.52	9.99E+99	.75
RELVLU2	D0(LUMB)	001	-.85	135.70	66.67	49.13	9.99E+99	.84
RELVLU2	DI(LUMB)	002	-.66	135.70	34.52	25.44	9.99E+99	.84
RELVLU2	V(LUMB)	003	-.33	135.70	03.57	02.63	9.99E+99	.84
RELVMB1	D0(BM)	001	.74	167.11	65.79	39.37	2.06E+00	.76
RELVMB1	DI(BM)	005	.27	167.11	26.32	15.75	2.06E+00	.76
RELVMB1	V(BM)	015	.02	167.11	25.00	14.96	2.06E+00	.76
RELVMB1	SKMORT	002	-.48	167.11	07.89	04.72	2.06E+00	.76
RELVMB1	D0(SK)	003	-.30	167.11	05.26	03.15	2.06E+00	.76
RELVMB2	D0(SK)	001	-.86	122.37	57.65	47.11	1.76E+00	.85
RELVMB2	DI(SK)	002	-.70	122.37	23.53	19.23	1.76E+00	.85
RELVMB2	SKMORT	003	-.65	122.37	10.59	08.65	1.76E+00	.85
RELVMB3	D0(SK)	001	-.94	112.91	75.27	66.66	8.06E+00	.93
RELVMB3	DI(SK)	002	-.86	112.91	32.26	28.57	8.06E+00	.93
RELVMB3	SKMORT	003	-.30	112.91	00.00	00.00	8.06E+00	.93
RELVMT1	D0(BM)	002	-.79	145.77	54.22	37.20	1.59E+00	.83
RELVMT1	SKMORT	001	.79	145.77	31.33	21.49	1.59E+00	.83
RELVMT1	V(BM)	012	-.09	145.77	19.28	13.23	1.59E+00	.83
RELVMT1	DI(BM)	008	-.16	145.77	18.07	12.40	1.59E+00	.83
RELVMT1	DI(LUMB)	003	.28	145.77	01.20	00.82	1.59E+00	.83
RELVMT2	SKMORT	001	.95	108.70	86.96	80.00	5.23E+00	.92
RELVMT2	D0(SK)	002	-.59	108.70	05.43	05.00	5.23E+00	.92
RELVMT2	D0(BM)	003	-.33	108.70	01.09	01.00	5.23E+00	.92
RELVMT3	SKMORT	001	.96	106.32	71.58	67.33	1.52E+01	.95
RELVMT3	D0(SK)	002	-.90	106.32	25.26	23.76	1.52E+01	.95
RELVMT3	DI(SK)	003	-.60	106.32	07.37	06.93	1.52E+01	.95

RELVSK1	D0(BM)	003	.68	137.83	35.37	25.66	1.64E+00	.82
RELVSK1	D0(SK)	001	-.72	137.83	28.05	20.35	1.64E+00	.82
RELVSK1	SKMORT	002	-.70	137.83	18.29	13.27	1.64E+00	.82

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
RELVSK2	D0(SK)	001	-.90	111.23	64.04	57.57	1.98E+00	.89
RELVSK2	DI(SK)	002	-.80	111.23	30.34	27.28	1.98E+00	.89
RELVSK2	SKMORT	003	-.67	111.23	08.99	08.08	1.98E+00	.89
RELVSK3	D0(SK)	001	-.95	111.83	75.27	67.31	8.10E+00	.93
RELVSK3	DI(SK)	002	-.86	111.83	32.26	28.85	8.10E+00	.93
RELVSK3	SKMORT	003	-.30	111.83	00.00	00.00	8.10E+00	.93
RELVTH1	D0(BM)	001	.83	171.96	78.05	45.39	3.44E+00	.82
RELVTH1	DI(BM)	004	.30	171.96	29.27	17.02	3.44E+00	.82
RELVTH1	V(BM)	016	-.01	171.96	26.83	15.60	3.44E+00	.82
RELVTH1	D0(LUMT)	003	.31	171.96	06.10	03.55	3.44E+00	.82
RELVTH1	SKMORT	002	-.34	171.96	02.44	01.42	3.44E+00	.82
RELVTH2	D0(LUMT)	002	.54	201.28	60.26	29.94	2.00E+00	.78
RELVTH2	DI(LUMT)	004	.33	201.28	48.72	24.21	2.00E+00	.78
RELVTH2	V(LUMT)	013	.03	201.28	43.59	21.66	2.00E+00	.78
RELVTH2	SKMORT	001	-.63	201.28	16.67	08.28	2.00E+00	.78
RELVTH2	D0(BM)	003	.47	201.28	08.97	04.46	2.00E+00	.78
RELVTH3	SKMORT	001	-1.0	100.00	100.00	100.00	1.46E+00	1.00
RELVTH3	D0(BM)	002	.22	100.00	00.00	00.00	1.46E+00	1.00
RELVTH3	DI(SK)	003	-.20	100.00	00.00	00.00	1.46E+00	1.00
REOUBM1	D0(BM)	001	-.98	197.96	95.92	48.45	1.33E+00	.98
REOUBM1	DI(BM)	002	-.71	197.96	41.84	21.14	1.33E+00	.98
REOUBM1	V(BM)	003	-.18	197.96	40.82	20.62	1.33E+00	.98
REOUBM2	D0(BM)	001	-.99	189.89	96.97	51.07	2.95E+00	.99
REOUBM2	DI(BM)	002	-.68	189.89	37.37	19.68	2.95E+00	.99
REOUBM2	V(BM)	003	-.20	189.89	37.37	19.68	2.95E+00	.99
REOUBM3	D0(BM)	001	-.99	186.86	97.98	52.43	9.99E+99	.99
REOUBM3	V(BM)	003	-.55	186.86	39.39	21.08	9.99E+99	.99
REOUBM3	DI(BM)	002	-.55	186.86	34.34	18.38	9.99E+99	.99
REOULU1	D0(LUMB)	001	-.59	123.91	78.26	63.16	9.99E+99	.46
REOULU1	DI(LUMB)	003	-.14	123.91	15.22	12.28	9.99E+99	.46
REOULU1	D0(BM)	002	.24	123.91	13.04	10.52	9.99E+99	.46
REOULU2	D0(LUMB)	001	-.81	120.79	71.43	59.14	9.99E+99	.77
REOULU2	DI(LUMB)	002	-.51	120.79	28.57	23.65	9.99E+99	.77
REOULU2	D0(BM)	003	.41	120.79	10.39	08.60	9.99E+99	.77
REOULU3	D0(LUMB)	001	-.61	118.18	88.64	75.00	9.99E+99	.44
REOULU3	DI(LUMB)	004	-.11	118.18	13.64	11.54	9.99E+99	.44
REOULU3	D0(SK)	002	.12	118.18	02.27	01.92	9.99E+99	.44
REOULU3	DI(GI)	003	.11	118.18	02.27	01.92	9.99E+99	.44
REOUMB1	D0(BM)	001	.88	168.89	71.11	42.10	2.77E+00	.90
REOUMB1	DI(BM)	005	.43	168.89	31.11	18.42	2.77E+00	.90
REOUMB1	V(BM)	013	.06	168.89	30.00	17.76	2.77E+00	.90
REOUMB1	D0(SK)	002	-.73	168.89	15.56	09.21	2.77E+00	.90
REOUMB1	SKMORT	003	-.65	168.89	06.67	03.95	2.77E+00	.90
REOUMB2	D0(BM)	002	.80	142.05	44.32	31.20	2.07E+00	.88
REOUMB2	D0(SK)	001	-.82	142.05	34.09	24.00	2.07E+00	.88
REOUMB2	DI(BM)	005	.27	142.05	15.91	11.20	2.07E+00	.88
REOUMB2	V(BM)	015	.01	142.05	15.91	11.20	2.07E+00	.88
REOUMB2	DI(SK)	003	-.67	142.05	14.77	10.40	2.07E+00	.88
REOUMB3	D0(SK)	001	-.93	109.90	72.53	66.00	3.03E+00	.91
REOUMB3	DI(SK)	002	-.83	109.90	31.87	29.00	3.03E+00	.91
REOUMB3	SKMORT	003	-.45	109.90	01.10	01.00	3.03E+00	.91
REOUMT1	D0(BM)	001	-.90	165.22	73.91	44.73	1.28E+00	.92
REOUMT1	DI(BM)	003	-.36	165.22	30.43	18.42	1.28E+00	.92
REOUMT1	V(BM)	007	-.14	165.22	30.43	18.42	1.28E+00	.92
REOUMT1	SKMORT	002	.83	165.22	18.48	11.19	1.28E+00	.92
REOUMT2	D0(BM)	002	-.85	139.32	52.81	37.91	2.24E+00	.89
REOUMT2	SKMORT	001	.88	139.32	39.33	28.23	2.24E+00	.89
REOUMT2	V(BM)	007	-.14	139.32	17.98	12.91	2.24E+00	.89
REOUMT2	DI(BM)	008	-.12	139.32	16.85	12.09	2.24E+00	.89
REOUMT2	D0(SK)	003	-.44	139.32	02.25	01.61	2.24E+00	.89
REOUMT3	SKMORT	001	.95	107.61	76.09	70.71	9.22E+00	.92
REOUMT3	D0(SK)	002	-.79	107.61	16.30	15.15	9.22E+00	.92
REOUMT3	D0(BM)	003	-.54	107.61	04.35	04.04	9.22E+00	.92
REOUSK1	D0(SK)	001	-.87	142.69	42.70	29.93	2.50E+00	.89
REOUSK1	D0(BM)	002	.76	142.69	38.20	26.77	2.50E+00	.89
REOUSK1	DI(SK)	003	-.72	142.69	16.85	11.81	2.50E+00	.89
REOUSK1	DI(BM)	005	.31	142.69	15.73	11.02	2.50E+00	.89
REOUSK1	V(BM)	015	.02	142.69	15.73	11.02	2.50E+00	.89
REOUSK2	D0(SK)	001	-.91	118.87	61.11	51.41	2.27E+00	.90
REOUSK2	DI(SK)	002	-.81	118.87	27.78	23.37	2.27E+00	.90
REOUSK2	D0(BM)	003	.61	118.87	13.33	11.21	2.27E+00	.90

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
REOUSK3	D0(SK)	001	-.94	113.05	75.00	66.34	4.27E+00	.92
REOUSK3	DI(SK)	002	-.86	113.05	32.61	28.85	4.27E+00	.92
REOUSK3	SKMORT	003	-.42	113.05	01.09	00.96	4.27E+00	.92
REOUTH1	D0(BM)	001	.95	184.03	94.68	51.45	1.07E+01	.94
REOUTH1	DI(BM)	002	.57	184.03	39.36	21.39	1.07E+01	.94
REOUTH1	V(BM)	008	-.08	184.03	35.11	19.08	1.07E+01	.94
REOUTH1	SKMORT	003	-.42	184.03	01.06	00.58	1.07E+01	.94
REOUTH2	D0(BM)	001	.93	170.66	93.48	54.78	5.70E+00	.92
REOUTH2	DI(BM)	002	.44	170.66	33.70	19.75	5.70E+00	.92
REOUTH2	V(BM)	012	-.08	170.66	30.43	17.83	5.70E+00	.92
REOUTH2	SKMORT	003	-.41	170.66	01.09	00.64	5.70E+00	.92
REOUTH3	SKMORT	001	-.88	120.22	61.90	51.49	1.53E+00	.84
REOUTH3	D0(BM)	002	.72	120.22	34.52	28.71	1.53E+00	.84
REOUTH3	DI(LUMB)	003	-.23	120.22	00.00	00.00	1.53E+00	.84

Results for the 95th percentile of the endpoints for the UK1 source term

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
PECMBM	DI(BM)	001	-.94	225.77	88.66	39.27	5.13E+00	.97
PECMBM	V(BM)	003	-.44	225.77	64.95	28.77	5.13E+00	.97
PECMBM	D0(BM)	002	-.85	225.77	52.58	23.29	5.13E+00	.97
PECMLU	D0(LUMB)	001	-.81	139.73	59.04	42.25	9.99E+99	.83
PECMLU	DI(LUMB)	002	-.72	139.73	43.37	31.04	9.99E+99	.83
PECMLU	V(LUMB)	003	-.28	139.73	03.61	02.58	9.99E+99	.83
PECMMB	DI(SK)	001	-.99	107.07	97.98	91.51	1.12E+01	.99
PECMMB	D0(SK)	003	-.57	107.07	03.03	02.83	1.12E+01	.99
PECMMB	SKMORT	002	-.66	107.07	00.00	00.00	1.12E+01	.99
PECMMT	SKMORT	001	.87	115.11	50.00	43.44	6.76E+00	.86
PECMMT	DI(SK)	002	-.80	115.11	39.53	34.34	6.76E+00	.86
PECMMT	DI(BM)	003	-.42	115.11	04.65	04.04	6.76E+00	.86
PECMSK	DI(SK)	001	-.99	107.07	97.98	91.51	1.51E+01	.99
PECMSK	D0(SK)	003	-.59	107.07	03.03	02.83	1.51E+01	.99
PECMSK	SKMORT	002	-.68	107.07	00.00	00.00	1.51E+01	.99
PECMTH	DI(BM)	001	.60	190.92	50.65	26.53	5.50E+00	.77
PECMTH	D0(BM)	002	.49	190.92	32.47	17.01	5.50E+00	.77
PECMTH	V(BM)	014	.03	190.92	31.17	16.33	5.50E+00	.77
PECMTH	D0(LUMT)	003	.42	190.92	22.08	11.57	5.50E+00	.77
PELVBM	D0(BM)	001	-.99	190.90	96.97	50.80	4.68E+00	.99
PELVBM	V(BM)	003	-.26	190.90	38.38	20.10	4.68E+00	.99
PELVBM	DI(BM)	002	-.63	190.90	37.37	19.58	4.68E+00	.99
PELVLU	D0(LUMB)	001	-.84	127.14	71.60	56.32	9.99E+99	.81
PELVLU	DI(LUMB)	002	-.61	127.14	33.33	26.22	9.99E+99	.81
PELVLU	V(LUMB)	003	-.32	127.14	03.70	02.91	9.99E+99	.81
PELVMB	D0(SK)	001	-.93	112.10	73.63	65.68	6.31E+00	.91
PELVMB	DI(SK)	002	-.83	112.10	31.87	28.43	6.31E+00	.91
PELVMB	SKMORT	003	-.46	112.10	02.20	01.96	6.31E+00	.91
PELVMT	SKMORT	001	.95	106.45	67.74	63.64	1.70E+01	.93
PELVMT	D0(SK)	002	-.88	106.45	29.03	27.27	1.70E+01	.93
PELVMT	DI(SK)	003	-.54	106.45	07.53	07.07	1.70E+01	.93
PELVSK	D0(SK)	001	-.93	109.90	73.63	67.00	6.61E+00	.91
PELVSK	DI(SK)	002	-.83	109.90	31.87	29.00	6.61E+00	.91
PELVSK	SKMORT	003	-.45	109.90	01.10	01.00	6.61E+00	.91
PELVTH	SKMORT	001	-.91	102.35	89.41	87.36	1.32E+00	.85
PELVTH	D0(BM)	002	.38	102.35	03.53	03.45	1.32E+00	.85
PELVTH	D0(LUMB)	003	.15	102.35	00.00	00.00	1.32E+00	.85
RECMBM1	DI(BM)	001	-.90	223.17	83.16	37.26	2.63E+01	.95
RECMBM1	D0(BM)	002	-.87	223.17	63.16	28.30	2.63E+01	.95
RECMBM1	V(BM)	010	-.06	223.17	56.84	25.47	2.63E+01	.95
RECMBM1	SKMORT	003	.17	223.17	00.00	00.00	2.63E+01	.95
RECMLU1	D0(LUMB)	002	-.26	100.01	30.77	30.77	9.99E+99	.26
RECMLU1	DI(BM)	004	.17	100.01	11.54	11.54	9.99E+99	.26
RECMLU1	D0(GI)	001	.29	100.01	07.69	07.69	9.99E+99	.26
RECMLU1	D0(LUMT)	003	.21	100.01	07.69	07.69	9.99E+99	.26
RECMMB1	SKMORT	001	-.85	128.39	56.79	44.23	1.58E+00	.81
RECMMB1	DI(BM)	005	.40	128.39	20.99	16.35	1.58E+00	.81
RECMMB1	D0(BM)	002	.43	128.39	19.75	15.38	1.58E+00	.81
RECMMB1	V(BM)	010	.16	128.39	17.28	13.46	1.58E+00	.81
RECMMB1	DI(SK)	003	-.42	128.39	02.47	01.92	1.58E+00	.81
RECMMB2	DI(SK)	001	-.97	116.83	92.63	79.29	9.99E+99	.95
RECMMB2	V(SK)	002	-.62	116.83	15.79	13.52	9.99E+99	.95
RECMMB2	D0(SK)	003	-.43	116.83	05.26	04.50	9.99E+99	.95
RECMMT1	DI(BM)	001	-.61	189.05	60.27	31.88	5.01E+00	.73
RECMMT1	D0(BM)	002	-.56	189.05	47.95	25.36	5.01E+00	.73
RECMMT1	V(BM)	010	.10	189.05	34.25	18.12	5.01E+00	.73
RECMMT1	D0(LUMT)	003	-.32	189.05	10.96	05.80	5.01E+00	.73
RECMMT2	DI(SK)	001	-.95	117.02	82.98	70.91	9.99E+99	.94
RECMMT2	V(SK)	003	-.61	117.02	15.96	13.64	9.99E+99	.94
RECMMT2	SKMORT	002	.78	117.02	13.83	11.82	9.99E+99	.94
RECMSK1	SKMORT	001	-.79	105.07	41.77	39.75	1.84E+00	.79
RECMSK1	DI(SK)	002	-.77	105.07	31.65	30.12	1.84E+00	.79
RECMSK1	V(SK)	003	.48	105.07	02.53	02.41	1.84E+00	.79
RECMSK2	DI(SK)	001	-.97	116.83	92.63	79.29	9.99E+99	.95
RECMSK2	V(SK)	002	-.61	116.83	15.79	13.52	9.99E+99	.95
RECMSK2	D0(SK)	003	-.43	116.83	05.26	04.50	9.99E+99	.95

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
RECMTH1	DI(BM)	001	.61	189.05	60.27	31.88	7.76E+00	.73
RECMTH1	D0(BM)	002	.52	189.05	42.47	22.46	7.76E+00	.73
RECMTH1	V(BM)	012	-.06	189.05	34.25	18.12	7.76E+00	.73
RECMTH1	D0(LUMT)	003	.37	189.05	13.70	07.25	7.76E+00	.73
RELVBM1	D0(BM)	001	-.88	182.75	95.40	52.20	3.80E+01	.87
RELVBM1	DI(BM)	002	-.38	182.75	37.93	20.76	3.80E+01	.87
RELVBM1	V(BM)	009	.08	182.75	33.33	18.24	3.80E+01	.87
RELVBM1	DI(LUMT)	003	-.19	182.75	01.15	00.63	3.80E+01	.87
RELVLU1	D0(LUMB)	002	-.26	100.01	30.77	30.77	9.99E+99	.26
RELVLU1	DI(BM)	004	.17	100.01	11.54	11.54	9.99E+99	.26
RELVLU1	D0(GI)	001	.29	100.01	07.69	07.69	9.99E+99	.26
RELVLU1	D0(LUMT)	003	.21	100.01	07.69	07.69	9.99E+99	.26
RELVMB1	D0(BM)	001	.78	158.01	59.26	37.50	1.74E+00	.81
RELVMB1	DI(BM)	005	.23	158.01	22.22	14.06	1.74E+00	.81
RELVMB1	V(BM)	011	.08	158.01	22.22	14.06	1.74E+00	.81
RELVMB1	SKMORT	002	-.69	158.01	19.75	12.50	1.74E+00	.81
RELVMB1	D0(LUMT)	003	.35	158.01	08.64	05.47	1.74E+00	.81
RELVMB2	SKMORT	001	-.70	101.49	47.76	47.06	3.89E+00	.67
RELVMB2	D0(SK)	003	-.55	101.49	23.88	23.53	3.89E+00	.67
RELVMB2	DI(SK)	002	-.55	101.49	22.39	22.06	3.89E+00	.67
RELVMB3	V(SK)	001	-.34	104.18	50.00	47.99	9.99E+99	.24
RELVMB3	DI(SK)	007	-.13	104.18	12.50	12.00	9.99E+99	.24
RELVMB3	SKMORT	002	-.20	104.18	12.50	12.00	9.99E+99	.24
RELVMB3	DI(GI)	003	-.20	104.18	08.33	08.00	9.99E+99	.24
RELVMT1	D0(BM)	001	-.58	187.70	52.31	27.87	3.31E+00	.65
RELVMT1	DI(BM)	003	-.32	187.70	32.31	17.21	3.31E+00	.65
RELVMT1	D0(GI)	009	.07	187.70	27.69	14.75	3.31E+00	.65
RELVMT1	V(BM)	011	.07	187.70	23.08	12.30	3.31E+00	.65
RELVMT1	D0(LUMT)	002	-.32	187.70	20.00	10.66	3.31E+00	.65
RELVMT2	SKMORT	001	1.0	100.00	100.00	100.00	9.55E+00	1.00
RELVMT2	D0(LUMB)	002	.20	100.00	00.00	00.00	9.55E+00	1.00
RELVMT2	V(GI)	003	-.11	100.00	00.00	00.00	9.55E+00	1.00
RELVMT3	D0(SK)	001	-.57	106.25	60.42	56.87	9.99E+99	.48
RELVMT3	V(SK)	002	-.40	106.25	29.17	27.45	9.99E+99	.48
RELVMT3	DI(BM)	003	.27	106.25	04.17	03.92	9.99E+99	.48
RELVSK1	SKMORT	001	-.99	100.00	98.98	98.98	1.25E+00	.98
RELVSK1	D0(BM)	002	.33	100.00	00.00	00.00	1.25E+00	.98
RELVSK1	DI(SK)	003	-.28	100.00	00.00	00.00	1.25E+00	.98
RELVSK2	SKMORT	001	-.64	097.02	32.84	33.85	4.75E+00	.67
RELVSK2	D0(SK)	002	-.60	097.02	31.34	32.30	4.75E+00	.67
RELVSK2	DI(SK)	003	-.59	097.02	28.36	29.23	4.75E+00	.67
RELVSK3	V(SK)	001	-.34	104.18	50.00	47.99	9.99E+99	.24
RELVSK3	DI(SK)	007	-.13	104.18	12.50	12.00	9.99E+99	.24
RELVSK3	SKMORT	002	-.20	104.18	12.50	12.00	9.99E+99	.24
RELVSK3	DI(GI)	003	-.20	104.18	08.33	08.00	9.99E+99	.24
RELVTH1	D0(BM)	001	.81	172.84	70.37	40.71	7.24E+00	.81
RELVTH1	DI(BM)	003	.35	172.84	28.40	16.43	7.24E+00	.81
RELVTH1	V(BM)	009	-.12	172.84	22.22	12.86	7.24E+00	.81
RELVTH1	D0(GI)	013	.07	172.84	18.52	10.72	7.24E+00	.81
RELVTH1	D0(LUMT)	002	.39	172.84	12.35	07.15	7.24E+00	.81
REOUBM2	D0(BM)	001	-.34	197.36	71.05	36.00	9.99E+99	.38
REOUBM2	V(BM)	002	-.20	197.36	55.26	28.00	9.99E+99	.38
REOUBM2	DI(BM)	016	.00	197.36	39.47	20.00	9.99E+99	.38
REOUBM2	D0(GI)	003	.17	197.36	26.32	13.34	9.99E+99	.38
REOUMB1	D0(BM)	001	.76	143.90	54.88	38.14	1.41E+01	.82
REOUMB1	D0(SK)	002	-.71	143.90	25.61	17.80	1.41E+01	.82
REOUMB1	V(BM)	016	.01	143.90	18.29	12.71	1.41E+01	.82
REOUMB1	DI(BM)	007	.14	143.90	17.07	11.86	1.41E+01	.82
REOUMB1	DI(SK)	003	-.59	143.90	13.41	09.32	1.41E+01	.82
REOUMB2	D0(SK)	001	-.66	113.89	31.94	28.04	5.01E+00	.72
REOUMB2	D0(BM)	004	.52	113.89	23.61	20.73	5.01E+00	.72
REOUMB2	DI(SK)	002	-.60	113.89	22.22	19.51	5.01E+00	.72
REOUMB2	SKMORT	003	-.57	113.89	16.67	14.64	5.01E+00	.72
REOUMB3	D0(SK)	001	-.65	117.23	62.07	52.95	9.99E+99	.58
REOUMB3	V(SK)	002	-.43	117.23	29.31	25.00	9.99E+99	.58
REOUMB3	DI(SK)	003	-.27	117.23	15.52	13.24	9.99E+99	.58
REOUMT2	SKMORT	001	.96	098.93	96.77	97.82	1.12E+01	.93
REOUMT2	D0(BM)	002	-.39	098.93	01.08	01.09	1.12E+01	.93
REOUMT2	V(LUMB)	003	-.18	098.93	00.00	00.00	1.12E+01	.93
REOUMT3	D0(SK)	001	-.78	114.10	76.06	66.66	9.99E+99	.71
REOUMT3	V(SK)	002	-.47	114.10	22.54	19.75	9.99E+99	.71

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
REOUMT3	DI(SK)	003	-.28	114.10	11.27	09.88	9.99E+99	.71
REOUSK1	D0(BM)	002	.76	140.23	42.53	30.33	2.51E+01	.87
REOUSK1	D0(SK)	001	-.84	140.23	41.38	29.51	2.51E+01	.87
REOUSK1	DI(BM)	005	.29	140.23	16.09	11.47	2.51E+01	.87
REOUSK1	DI(SK)	003	-.67	140.23	16.09	11.47	2.51E+01	.87
REOUSK1	V(BM)	013	-.06	140.23	14.94	10.65	2.51E+01	.87
REOUSK2	D0(SK)	001	-.84	110.83	53.01	47.83	1.51E+01	.83
REOUSK2	DI(SK)	002	-.73	110.83	28.92	26.09	1.51E+01	.83
REOUSK2	D0(BM)	003	.54	110.83	14.46	13.05	1.51E+01	.83
REOUSK3	D0(SK)	001	-.65	117.23	62.07	52.95	9.99E+99	.58
REOUSK3	V(SK)	002	-.43	117.23	29.31	25.00	9.99E+99	.58
REOUSK3	DI(SK)	003	-.27	117.23	15.52	13.24	9.99E+99	.58
REOUTH1	D0(BM)	001	.59	167.34	91.84	54.88	9.99E+99	.49
REOUTH1	V(BM)	012	.03	167.34	30.61	18.29	9.99E+99	.49
REOUTH1	DI(BM)	005	.05	167.34	28.57	17.07	9.99E+99	.49
REOUTH1	SKMORT	002	-.19	167.34	04.08	02.44	9.99E+99	.49
REOUTH1	V(LUMB)	003	-.11	167.34	00.00	00.00	9.99E+99	.49
REOUTH2	SKMORT	005	-.17	085.00	15.00	17.65	9.99E+99	.20
REOUTH2	D0(BM)	001	.22	085.00	10.00	11.76	9.99E+99	.20
REOUTH2	DI(LUMT)	004	.18	085.00	10.00	11.76	9.99E+99	.20
REOUTH2	V(GI)	009	-.12	085.00	10.00	11.76	9.99E+99	.20
REOUTH2	V(LUMB)	002	-.19	085.00	10.00	11.76	9.99E+99	.20
REOUTH2	V(SK)	003	.19	085.00	10.00	11.76	9.99E+99	.20

Results for the 99th percentile of the endpoints for the UK1 source term

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
PECMBM	DI(BM)	001	-.94	221.64	88.66	40.00	2.57E+00	.97
PECMBM	V(BM)	005	-.13	221.64	58.76	26.51	2.57E+00	.97
PECMBM	D0(BM)	002	-.85	221.64	54.64	24.65	2.57E+00	.97
PECMBM	SKMORT	003	.15	221.64	00.00	00.00	2.57E+00	.97
PECMLU	D0(LUMB)	001	-.81	138.55	59.04	42.61	9.99E+99	.83
PECMLU	DI(LUMB)	002	-.72	138.55	43.37	31.30	9.99E+99	.83
PECMLU	DI(LUMT)	003	.27	138.55	12.05	08.70	9.99E+99	.83
PECMMB	DI(SK)	001	-.99	106.06	98.99	93.33	1.07E+01	.99
PECMMB	D0(SK)	003	-.38	106.06	02.02	01.90	1.07E+01	.99
PECMMB	SKMORT	002	-.57	106.06	00.00	00.00	1.07E+01	.99
PECMMT	SKMORT	001	.87	117.43	51.16	43.57	6.92E+00	.86
PECMMT	DI(SK)	002	-.82	117.43	43.02	36.63	6.92E+00	.86
PECMMT	V(SK)	003	-.41	117.43	10.47	08.92	6.92E+00	.86
PECMSK	DI(SK)	001	-1.0	107.07	100.00	93.40	1.20E+01	.99
PECMSK	D0(SK)	003	-.48	107.07	02.02	01.89	1.20E+01	.99
PECMSK	SKMORT	002	-.69	107.07	00.00	00.00	1.20E+01	.99
PECMTH	DI(BM)	002	.50	173.62	37.50	21.60	2.58E+00	.72
PECMTH	D0(BM)	003	.42	173.62	26.39	15.20	2.58E+00	.72
PECMTH	V(BM)	014	.04	173.62	25.00	14.40	2.58E+00	.72
PECMTH	SKMORT	001	-.60	173.62	19.44	11.20	2.58E+00	.72
PECMTH	D0(LUMT)	004	.34	173.62	18.06	10.40	2.58E+00	.72
PELVBM	D0(BM)	001	-.99	185.85	97.98	52.72	5.01E+00	.99
PELVBM	DI(BM)	002	-.69	185.85	35.35	19.02	5.01E+00	.99
PELVBM	V(BM)	008	-.06	185.85	35.35	19.02	5.01E+00	.99
PELVBM	D0(GI)	003	.12	185.85	11.11	05.98	5.01E+00	.99
PELVLU	D0(LUMB)	001	-.82	139.50	65.43	46.90	9.99E+99	.81
PELVLU	DI(LUMB)	002	-.62	139.50	34.57	24.78	9.99E+99	.81
PELVLU	D0(LUMT)	003	.31	139.50	11.11	07.96	9.99E+99	.81
PELVMB	D0(SK)	001	-.94	109.77	73.91	67.33	2.88E+00	.92
PELVMB	DI(SK)	002	-.84	109.77	30.43	27.72	2.88E+00	.92
PELVMB	SKMORT	003	-.56	109.77	03.26	02.97	2.88E+00	.92
PELVMT	SKMORT	001	.96	104.25	77.66	74.49	1.26E+01	.94
PELVMT	D0(SK)	002	-.86	104.25	20.21	19.39	1.26E+01	.94
PELVMT	DI(SK)	003	-.51	104.25	05.32	05.10	1.26E+01	.94
PELVSK	D0(SK)	001	-.94	109.77	73.91	67.33	2.95E+00	.92
PELVSK	DI(SK)	002	-.84	109.77	30.43	27.72	2.95E+00	.92
PELVSK	SKMORT	003	-.55	109.77	03.26	02.97	2.95E+00	.92
PELVTH	SKMORT	001	-.90	098.78	90.36	91.48	1.38E+00	.83
PELVTH	D0(BM)	002	.43	098.78	04.82	04.88	1.38E+00	.83
PELVTH	D0(LUMB)	003	.21	098.78	00.00	00.00	1.38E+00	.83
RECMBM2	V(BM)	003	-.28	234.79	71.01	30.24	9.99E+99	.69
RECMBM2	DI(BM)	002	-.36	234.79	69.57	29.63	9.99E+99	.69
RECMBM2	D0(BM)	001	-.46	234.79	65.22	27.78	9.99E+99	.69
RECMLU1	D0(LUMB)	001	-.77	130.29	67.11	51.51	9.99E+99	.76
RECMLU1	DI(LUMB)	002	-.62	130.29	42.11	32.32	9.99E+99	.76
RECMLU1	D0(BM)	003	.26	130.29	06.58	05.05	9.99E+99	.76
RECMLU2	D0(LUMB)	001	-.32	100.02	47.83	47.82	9.99E+99	.23
RECMLU2	DI(LUMB)	006	-.10	100.02	13.04	13.04	9.99E+99	.23
RECMLU2	D0(LUMT)	003	.16	100.02	08.70	08.70	9.99E+99	.23
RECMLU2	D0(GI)	002	.22	100.02	04.35	04.35	9.99E+99	.23
RECMMB1	DI(BM)	002	.58	197.50	62.50	31.65	2.42E+00	.80
RECMMB1	D0(BM)	001	.60	197.50	53.75	27.22	2.42E+00	.80
RECMMB1	V(BM)	006	.19	197.50	50.00	25.32	2.42E+00	.80
RECMMB1	SKMORT	003	-.43	197.50	05.00	02.53	2.42E+00	.80
RECMMB2	SKMORT	001	-.82	097.26	75.34	77.46	1.51E+00	.73
RECMMB2	DI(SK)	002	-.51	097.26	09.59	09.86	1.51E+00	.73
RECMMB2	DI(BM)	003	.26	097.26	01.37	01.41	1.51E+00	.73
RECMMB3	DI(SK)	001	-.70	122.22	76.19	62.34	9.99E+99	.63
RECMMB3	V(SK)	002	-.45	122.22	34.92	28.57	9.99E+99	.63
RECMMB3	D0(SK)	003	-.27	122.22	11.11	09.09	9.99E+99	.63
RECMMT2	SKMORT	001	.91	101.18	93.98	92.88	1.02E+01	.83
RECMMT2	DI(BM)	002	-.18	101.18	01.20	01.19	1.02E+01	.83
RECMMT2	DI(LUMT)	003	-.17	101.18	01.20	01.19	1.02E+01	.83
RECMMT3	DI(SK)	001	-.70	122.22	76.19	62.34	9.99E+99	.63
RECMMT3	V(SK)	002	-.45	122.22	33.33	27.27	9.99E+99	.63
RECMMT3	D0(SK)	003	-.25	122.22	11.11	09.09	9.99E+99	.63

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
RECMSK1	SKMORT	001	-.98	101.04	98.96	97.94	1.25E+00	.96
RECMSK1	DI(SK)	002	-.36	101.04	00.00	00.00	1.25E+00	.96
RECMSK1	V(SK)	003	.27	101.04	00.00	00.00	1.25E+00	.96
RECMSK2	SKMORT	001	-.82	094.52	76.71	81.16	1.65E+00	.73
RECMSK2	DI(SK)	002	-.61	094.52	16.44	17.39	1.65E+00	.73
RECMSK2	V(SK)	003	.24	094.52	00.00	00.00	1.65E+00	.73
RECMSK3	DI(SK)	001	-.70	122.22	76.19	62.34	9.99E+99	.63
RECMSK3	V(SK)	002	-.45	122.22	34.92	28.57	9.99E+99	.63
RECMSK3	D0(SK)	003	-.27	122.22	11.11	09.09	9.99E+99	.63
RECMTH1	DI(BM)	002	.68	197.56	68.67	34.76	6.17E+00	.83
RECMTH1	D0(BM)	001	.68	197.56	57.83	29.27	6.17E+00	.83
RECMTH1	V(BM)	013	.06	197.56	48.19	24.39	6.17E+00	.83
RECMTH1	SKMORT	003	-.30	197.56	01.20	00.61	6.17E+00	.83
RECMTH2	D0(LUMT)	001	.55	211.25	65.00	30.77	2.95E+00	.80
RECMTH2	DI(LUMT)	002	.49	211.25	58.75	27.81	2.95E+00	.80
RECMTH2	V(LUMT)	012	-.06	211.25	45.00	21.30	2.95E+00	.80
RECMTH2	DI(BM)	003	.47	211.25	10.00	04.73	2.95E+00	.80
RELVBM2	D0(BM)	001	-.42	208.88	77.78	37.24	9.99E+99	.45
RELVBM2	DI(BM)	003	-.14	208.88	46.67	22.34	9.99E+99	.45
RELVBM2	V(BM)	009	-.07	208.88	46.67	22.34	9.99E+99	.45
RELVBM2	D0(GI)	002	.19	208.88	24.44	11.70	9.99E+99	.45
RELVLU1	D0(LUMB)	001	-.75	126.76	70.42	55.55	9.99E+99	.71
RELVLU1	DI(LUMB)	002	-.48	126.76	32.39	25.55	9.99E+99	.71
RELVLU1	D0(BM)	003	.35	126.76	09.86	07.78	9.99E+99	.71
RELVLU2	D0(LUMB)	001	-.47	126.47	73.53	58.14	9.99E+99	.34
RELVLU2	DI(LUMB)	006	-.10	126.47	14.71	11.63	9.99E+99	.34
RELVLU2	V(LUMB)	013	.04	126.47	14.71	11.63	9.99E+99	.34
RELVLU2	V(SK)	003	.14	126.47	08.82	06.97	9.99E+99	.34
RELVLU2	DI(BM)	002	.15	126.47	00.00	00.00	9.99E+99	.34
RELVMB1	D0(BM)	001	.69	160.28	61.64	38.46	2.04E+00	.73
RELVMB1	V(BM)	008	.13	160.28	27.40	17.10	2.04E+00	.73
RELVMB1	DI(BM)	005	.17	160.28	26.03	16.24	2.04E+00	.73
RELVMB1	SKMORT	002	-.57	160.28	16.44	10.26	2.04E+00	.73
RELVMB1	DI(LUMB)	003	-.28	160.28	04.11	02.56	2.04E+00	.73
RELVMB2	D0(LUMT)	002	.42	198.50	58.21	29.32	1.58E+00	.67
RELVMB2	V(LUMT)	009	.11	198.50	44.78	22.56	1.58E+00	.67
RELVMB2	DI(LUMT)	007	.17	198.50	43.28	21.80	1.58E+00	.67
RELVMB2	SKMORT	001	-.45	198.50	11.94	06.02	1.58E+00	.67
RELVMB2	D0(BM)	003	.31	198.50	05.97	03.01	1.58E+00	.67
RELVMB3	D0(SK)	001	-.93	112.22	78.89	70.30	9.99E+99	.90
RELVMB3	DI(SK)	002	-.79	112.22	28.89	25.74	9.99E+99	.90
RELVMB3	SKMORT	003	-.16	112.22	00.00	00.00	9.99E+99	.90
RELVMT2	SKMORT	001	.90	101.22	93.90	92.77	9.55E+00	.82
RELVMT2	D0(BM)	002	-.27	101.22	01.22	01.21	9.55E+00	.82
RELVMT2	D0(LUMB)	003	-.16	101.22	00.00	00.00	9.55E+00	.82
RELVMT3	SKMORT	001	.89	105.95	76.19	71.91	3.90E+01	.84
RELVMT3	D0(SK)	002	-.66	105.95	17.86	16.86	3.90E+01	.84
RELVMT3	DI(SK)	003	-.38	105.95	07.14	06.74	3.90E+01	.84
RELVSK1	SKMORT	001	-1.0	100.00	100.00	100.00	1.23E+00	1.00
RELVSK1	DI(SK)	002	-.19	100.00	00.00	00.00	1.23E+00	1.00
RELVSK1	V(SK)	003	.13	100.00	00.00	00.00	1.23E+00	1.00
RELVSK2	SKMORT	001	-1.0	100.00	100.00	100.00	1.23E+00	1.00
RELVSK2	DI(SK)	003	-.21	100.00	00.00	00.00	1.23E+00	1.00
RELVSK2	V(SK)	002	.22	100.00	00.00	00.00	1.23E+00	1.00
RELVSK3	D0(SK)	001	-.92	111.11	77.78	70.00	9.99E+99	.90
RELVSK3	DI(SK)	002	-.79	111.11	28.89	26.00	9.99E+99	.90
RELVSK3	SKMORT	003	-.18	111.11	00.00	00.00	9.99E+99	.90
RELVTH1	D0(BM)	001	.83	171.96	81.71	47.52	2.40E+00	.82
RELVTH1	DI(BM)	003	.24	171.96	30.49	17.73	2.40E+00	.82
RELVTH1	V(BM)	013	.07	171.96	30.49	17.73	2.40E+00	.82
RELVTH1	SKMORT	002	-.49	171.96	06.10	03.55	2.40E+00	.82
RELVTH2	D0(LUMT)	002	.55	182.71	54.32	29.73	1.48E+00	.81
RELVTH2	DI(LUMT)	004	.28	182.71	41.98	22.98	1.48E+00	.81
RELVTH2	V(LUMT)	009	.07	182.71	39.51	21.62	1.48E+00	.81
RELVTH2	SKMORT	001	-.78	182.71	34.57	18.92	1.48E+00	.81
RELVTH2	D0(BM)	003	.30	182.71	01.23	00.67	1.48E+00	.81
REOUBM2	D0(BM)	001	-.33	135.70	60.71	44.74	1.10E+00	.28
REOUBM2	DI(BM)	013	-.01	135.70	17.86	13.16	1.10E+00	.28
REOUBM2	V(BM)	015	-.01	135.70	17.86	13.16	1.10E+00	.28
REOUBM2	DI(LUMT)	002	.20	135.70	07.14	05.26	1.10E+00	.28
REOUBM2	V(LUMT)	003	-.20	135.70	00.00	00.00	1.10E+00	.28

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
REOUBM3	D0(BM)	002	-.21	055.00	15.00	27.27	9.99E+99	.20
REOUBM3	DI(GI)	001	-.25	055.00	10.00	18.18	9.99E+99	.20
REOUBM3	DI(BM)	003	.19	055.00	00.00	00.00	9.99E+99	.20
REOULU1	D0(LUMB)	001	-.45	108.56	60.00	55.27	9.99E+99	.35
REOULU1	D0(BM)	002	.28	108.56	20.00	18.42	9.99E+99	.35
REOULU1	D0(GI)	003	.24	108.56	02.86	02.63	9.99E+99	.35
REOULU2	D0(LUMB)	001	-.51	114.27	59.52	52.09	9.99E+99	.42
REOULU2	D0(BM)	002	.28	114.27	16.67	14.59	9.99E+99	.42
REOULU2	D0(SK)	003	.20	114.27	07.14	06.25	9.99E+99	.42
REOUMB1	D0(BM)	002	.78	153.56	58.33	37.99	1.74E+00	.84
REOUMB1	SKMORT	001	-.81	153.56	34.52	22.48	1.74E+00	.84
REOUMB1	V(BM)	004	.20	153.56	26.19	17.06	1.74E+00	.84
REOUMB1	DI(BM)	007	.16	153.56	22.62	14.73	1.74E+00	.84
REOUMB1	DI(LUMB)	003	-.22	153.56	01.19	00.77	1.74E+00	.84
REOUMB2	D0(BM)	002	.74	134.14	47.56	35.46	1.55E+00	.82
REOUMB2	SKMORT	001	-.82	134.14	45.12	33.64	1.55E+00	.82
REOUMB2	V(BM)	005	.16	134.14	18.29	13.64	1.55E+00	.82
REOUMB2	DI(BM)	009	.10	134.14	15.85	11.82	1.55E+00	.82
REOUMB2	DI(LUMB)	003	-.22	134.14	01.22	00.91	1.55E+00	.82
REOUMB3	SKMORT	001	-.88	102.39	66.27	64.72	1.41E+00	.83
REOUMB3	D0(SK)	002	-.60	102.39	13.25	12.94	1.41E+00	.83
REOUMB3	DI(SK)	003	-.59	102.39	09.64	09.41	1.41E+00	.83
REOUMT3	SKMORT	001	1.0	100.00	100.00	100.00	9.55E+00	1.00
REOUMT3	D0(BM)	002	-.29	100.00	00.00	00.00	9.55E+00	1.00
REOUMT3	DI(GI)	003	-.24	100.00	00.00	00.00	9.55E+00	1.00
REOUSK1	SKMORT	001	-.98	100.00	97.92	97.92	1.25E+00	.96
REOUSK1	D0(BM)	002	.40	100.00	01.04	01.04	1.25E+00	.96
REOUSK1	V(SK)	003	.31	100.00	00.00	00.00	1.25E+00	.96
REOUSK2	SKMORT	001	-1.0	101.01	100.00	99.00	1.25E+00	.99
REOUSK2	D0(BM)	002	.24	101.01	00.00	00.00	1.25E+00	.99
REOUSK2	DI(SK)	003	-.23	101.01	00.00	00.00	1.25E+00	.99
REOUSK3	SKMORT	001	-.65	098.49	34.85	35.38	4.87E+00	.66
REOUSK3	D0(SK)	002	-.60	098.49	33.33	33.84	4.87E+00	.66
REOUSK3	DI(SK)	003	-.56	098.49	25.76	26.15	4.87E+00	.66
REOUTH1	D0(BM)	001	.95	182.97	94.68	51.75	8.13E+00	.94
REOUTH1	DI(BM)	002	.54	182.97	38.30	20.93	8.13E+00	.94
REOUTH1	V(BM)	014	-.04	182.97	35.11	19.19	8.13E+00	.94
REOUTH1	SKMORT	003	-.44	182.97	01.06	00.58	8.13E+00	.94
REOUTH2	D0(BM)	001	.92	170.34	92.31	54.19	5.62E+00	.91
REOUTH2	DI(BM)	002	.43	170.34	34.07	20.00	5.62E+00	.91
REOUTH2	V(BM)	010	-.09	170.34	30.77	18.06	5.62E+00	.91
REOUTH2	SKMORT	003	-.32	170.34	01.10	00.65	5.62E+00	.91

Results for the mean value of the endpoints for the CB2 source term

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
PECMMB	DI(SK)	001	-.99	112.24	95.92	85.46	2.98E+03	.98
PECMMB	V(SK)	003	-.55	112.24	09.18	08.18	2.98E+03	.98
PECMMB	D0(SK)	002	-.75	112.24	07.14	06.36	2.98E+03	.98
PECMMT	DI(SK)	001	-.95	114.89	73.40	63.89	2.54E+03	.94
PECMMT	SKMORT	002	.88	114.89	25.53	22.22	2.54E+03	.94
PECMMT	V(SK)	003	-.51	114.89	11.70	10.18	2.54E+03	.94
PECMSK	DI(SK)	001	-.99	112.24	95.92	85.46	2.98E+03	.98
PECMSK	V(SK)	003	-.55	112.24	09.18	08.18	2.98E+03	.98
PECMSK	D0(SK)	002	-.75	112.24	07.14	06.36	2.98E+03	.98
PLCMMT	RF(RE)	001	.82	111.90	52.38	46.81	4.80E+00	.84
PLCMMT	RF(LU)	002	.70	111.90	23.81	21.28	4.80E+00	.84
PLCMMT	RF(CO)	003	.56	111.90	17.86	15.96	4.80E+00	.84
PLLVMT	RF(RE)	001	.82	113.09	52.38	46.32	4.46E+00	.84
PLLVMT	RF(LU)	002	.70	113.09	23.81	21.05	4.46E+00	.84
PLLVMT	RF(CO)	003	.56	113.09	17.86	15.79	4.46E+00	.84
RECMMB1	DI(SK)	001	-.98	114.28	92.86	81.26	9.99E+99	.98
RECMMB1	V(SK)	003	-.65	114.28	12.24	10.71	9.99E+99	.98
RECMMB1	D0(SK)	002	-.74	114.28	08.16	07.14	9.99E+99	.98
RECMMB2	V(SK)	001	-.34	045.72	25.71	56.23	9.99E+99	.35
RECMMB2	DI(SK)	005	-.11	045.72	08.57	18.74	9.99E+99	.35
RECMMB2	DI(GI)	002	-.24	045.72	02.86	06.26	9.99E+99	.35
RECMMB2	V(GI)	003	.22	045.72	00.00	00.00	9.99E+99	.35
RECMMT1	DI(SK)	001	-.97	116.66	82.29	70.54	9.99E+99	.96
RECMMT1	V(SK)	003	-.65	116.66	14.58	12.50	9.99E+99	.96
RECMMT1	SKMORT	002	.84	116.66	13.54	11.61	9.99E+99	.96
RECMMT2	V(SK)	001	-.34	045.72	25.71	56.23	9.99E+99	.35
RECMMT2	DI(SK)	005	-.11	045.72	08.57	18.74	9.99E+99	.35
RECMMT2	DI(GI)	002	-.24	045.72	02.86	06.26	9.99E+99	.35
RECMMT2	V(GI)	003	.22	045.72	00.00	00.00	9.99E+99	.35
RECMSK1	DI(SK)	001	-.98	114.28	92.86	81.26	9.99E+99	.98
RECMSK1	V(SK)	003	-.65	114.28	12.24	10.71	9.99E+99	.98
RECMSK1	D0(SK)	002	-.74	114.28	08.16	07.14	9.99E+99	.98
RECMSK2	V(SK)	001	-.34	045.72	25.71	56.23	9.99E+99	.35
RECMSK2	DI(SK)	005	-.11	045.72	08.57	18.74	9.99E+99	.35
RECMSK2	DI(GI)	002	-.24	045.72	02.86	06.26	9.99E+99	.35
RECMSK2	V(GI)	003	.22	045.72	00.00	00.00	9.99E+99	.35
RLCMMT2	RF(RE)	001	.82	114.28	52.38	45.83	4.68E+00	.84
RLCMMT2	RF(LU)	002	.71	114.28	25.00	21.88	4.68E+00	.84
RLCMMT2	RF(CO)	003	.54	114.28	16.67	14.59	4.68E+00	.84
RLCMMT3	RF(RE)	001	.82	113.09	52.38	46.32	4.75E+00	.84
RLCMMT3	RF(LU)	002	.71	113.09	25.00	22.11	4.75E+00	.84
RLCMMT3	RF(CO)	003	.55	113.09	16.67	14.74	4.75E+00	.84
RLCMMT4	RF(RE)	001	.82	111.90	52.38	46.81	4.80E+00	.84
RLCMMT4	RF(LU)	002	.70	111.90	23.81	21.28	4.80E+00	.84
RLCMMT4	RF(CO)	003	.55	111.90	17.86	15.96	4.80E+00	.84
RLLVMT2	RF(RE)	001	.81	115.66	54.22	46.88	3.54E+00	.83
RLLVMT2	RF(LU)	002	.69	115.66	24.10	20.84	3.54E+00	.83
RLLVMT2	RF(CO)	003	.53	115.66	16.87	14.59	3.54E+00	.83
RLLVMT3	RF(RE)	001	.82	114.28	52.38	45.83	4.30E+00	.84
RLLVMT3	RF(LU)	002	.70	114.28	23.81	20.83	4.30E+00	.84
RLLVMT3	RF(CO)	003	.56	114.28	17.86	15.63	4.30E+00	.84
RLLVMT4	RF(RE)	001	.82	113.09	52.38	46.32	4.58E+00	.84
RLLVMT4	RF(LU)	002	.69	113.09	23.81	21.05	4.58E+00	.84
RLLVMT4	RF(CO)	003	.57	113.09	19.05	16.84	4.58E+00	.84

Results for the 95th percentile of the endpoints for the CB2 source term

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
PECMMB	DI(SK)	001	-.99	112.24	95.92	85.46	9.99E+99	.98
PECMMB	V(SK)	003	-.56	112.24	09.18	08.18	9.99E+99	.98
PECMMB	D0(SK)	002	-.78	112.24	07.14	06.36	9.99E+99	.98
PECMMT	DI(SK)	001	-.95	114.90	76.60	66.67	9.99E+99	.94
PECMMT	SKMORT	002	.87	114.90	22.34	19.44	9.99E+99	.94
PECMMT	V(SK)	003	-.52	114.90	11.70	10.18	9.99E+99	.94
PECMSK	DI(SK)	001	-.99	112.24	95.92	85.46	9.99E+99	.98
PECMSK	V(SK)	003	-.56	112.24	09.18	08.18	9.99E+99	.98
PECMSK	D0(SK)	002	-.78	112.24	07.14	06.36	9.99E+99	.98
PLCMMT	RF(RE)	001	.82	114.28	52.38	45.83	4.79E+00	.84
PLCMMT	RF(LU)	002	.70	114.28	23.81	20.83	4.79E+00	.84
PLCMMT	RF(CO)	003	.56	114.28	17.86	15.63	4.79E+00	.84
PLLVMT	RF(RE)	001	.82	111.90	52.38	46.81	4.27E+00	.84
PLLVMT	RF(LU)	002	.69	111.90	22.62	20.21	4.27E+00	.84
PLLVMT	RF(CO)	003	.57	111.90	19.05	17.02	4.27E+00	.84
RECMMB1	V(SK)	001	-.34	045.72	25.71	56.23	9.99E+99	.35
RECMMB1	DI(SK)	005	-.11	045.72	08.57	18.74	9.99E+99	.35
RECMMB1	DI(GI)	002	-.24	045.72	02.86	06.26	9.99E+99	.35
RECMMB1	V(GI)	003	.22	045.72	00.00	00.00	9.99E+99	.35
RECMMT1	V(SK)	001	-.34	045.72	25.71	56.23	9.99E+99	.35
RECMMT1	DI(SK)	005	-.11	045.72	08.57	18.74	9.99E+99	.35
RECMMT1	DI(GI)	002	-.24	045.72	02.86	06.26	9.99E+99	.35
RECMMT1	V(GI)	003	.22	045.72	00.00	00.00	9.99E+99	.35
RECMSK1	V(SK)	001	-.34	045.72	25.71	56.23	9.99E+99	.35
RECMSK1	DI(SK)	005	-.11	045.72	08.57	18.74	9.99E+99	.35
RECMSK1	DI(GI)	002	-.24	045.72	02.86	06.26	9.99E+99	.35
RECMSK1	V(GI)	003	.22	045.72	00.00	00.00	9.99E+99	.35
RLCMMT2	RF(RE)	001	.82	114.28	52.38	45.83	4.79E+00	.84
RLCMMT2	RF(LU)	002	.71	114.28	25.00	21.88	4.79E+00	.84
RLCMMT2	RF(CO)	003	.54	114.28	16.67	14.59	4.79E+00	.84
RLCMMT3	RF(RE)	001	.82	114.28	52.38	45.83	4.79E+00	.84
RLCMMT3	RF(LU)	002	.71	114.28	25.00	21.88	4.79E+00	.84
RLCMMT3	RF(CO)	003	.55	114.28	16.67	14.59	4.79E+00	.84
RLCMMT4	RF(RE)	001	.82	113.09	53.57	47.37	4.79E+00	.84
RLCMMT4	RF(LU)	002	.69	113.09	22.62	20.00	4.79E+00	.84
RLCMMT4	RF(CO)	003	.57	113.09	17.86	15.79	4.79E+00	.84
RLLVMT2	RF(RE)	001	.80	115.65	49.40	42.72	4.79E+00	.83
RLLVMT2	RF(LU)	002	.70	115.65	25.30	21.88	4.79E+00	.83
RLLVMT2	RF(CO)	003	.53	115.65	16.87	14.59	4.79E+00	.83
RLLVMT3	RF(RE)	001	.82	111.90	51.19	45.75	4.57E+00	.84
RLLVMT3	RF(LU)	002	.70	111.90	23.81	21.28	4.57E+00	.84
RLLVMT3	RF(CO)	003	.56	111.90	17.86	15.96	4.57E+00	.84
RLLVMT4	RF(RE)	001	.81	115.47	52.38	45.36	4.57E+00	.84
RLLVMT4	RF(LU)	002	.70	115.47	23.81	20.62	4.57E+00	.84
RLLVMT4	RF(CO)	003	.56	115.47	17.86	15.47	4.57E+00	.84

Results for the 99th percentile of the endpoints for the CB2 source term

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
PECMMB	DI(SK)	001	-.99	111.22	96.94	87.16	1.74E+03	.98
PECMMB	V(SK)	003	-.50	111.22	08.16	07.34	1.74E+03	.98
PECMMB	D0(SK)	002	-.77	111.22	06.12	05.50	1.74E+03	.98
PECMMT	DI(SK)	001	-.94	113.98	69.89	61.32	1.49E+03	.93
PECMMT	SKMORT	002	.88	113.98	30.11	26.42	1.49E+03	.93
PECMMT	V(SK)	003	-.42	113.98	09.68	08.49	1.49E+03	.93
PECMSK	DI(SK)	001	-.99	111.22	96.94	87.16	1.74E+03	.98
PECMSK	V(SK)	003	-.50	111.22	08.16	07.34	1.74E+03	.98
PECMSK	D0(SK)	002	-.77	111.22	06.12	05.50	1.74E+03	.98
PLCMMT	RF(RE)	001	.82	113.09	52.38	46.32	4.79E+00	.84
PLCMMT	RF(LU)	002	.69	113.09	22.62	20.00	4.79E+00	.84
PLCMMT	RF(CO)	003	.57	113.09	19.05	16.84	4.79E+00	.84
PLLVMT	RF(RE)	001	.82	114.28	53.57	46.88	4.57E+00	.84
PLLVMT	RF(LU)	002	.69	114.28	22.62	19.79	4.57E+00	.84
PLLVMT	RF(CO)	003	.57	114.28	19.05	16.67	4.57E+00	.84
RECMMB1	DI(SK)	001	-.94	120.45	83.87	69.63	9.99E+99	.93
RECMMB1	V(SK)	002	-.67	120.45	21.51	17.86	9.99E+99	.93
RECMMB1	D0(SK)	003	-.63	120.45	11.83	09.82	9.99E+99	.93
RECMMT1	DI(SK)	001	-.92	121.97	78.02	63.97	9.99E+99	.91
RECMMT1	V(SK)	002	-.70	121.97	26.37	21.62	9.99E+99	.91
RECMMT1	SKMORT	003	.54	121.97	05.49	04.50	9.99E+99	.91
RECMSK1	DI(SK)	001	-.94	120.45	83.87	69.63	9.99E+99	.93
RECMSK1	V(SK)	002	-.67	120.45	21.51	17.86	9.99E+99	.93
RECMSK1	D0(SK)	003	-.63	120.45	11.83	09.82	9.99E+99	.93
RLCMMT2	RF(RE)	001	.81	113.09	51.19	45.26	4.57E+00	.84
RLCMMT2	RF(LU)	002	.72	113.09	27.38	24.21	4.57E+00	.84
RLCMMT2	RF(CO)	003	.51	113.09	15.48	13.69	4.57E+00	.84
RLCMMT3	RF(RE)	001	.82	111.90	52.38	46.81	4.79E+00	.84
RLCMMT3	RF(LU)	002	.70	111.90	23.81	21.28	4.79E+00	.84
RLCMMT3	RF(CO)	003	.55	111.90	16.67	14.90	4.79E+00	.84
RLCMMT4	RF(RE)	001	.81	113.09	52.38	46.32	4.79E+00	.84
RLCMMT4	RF(LU)	002	.71	113.09	25.00	22.11	4.79E+00	.84
RLCMMT4	RF(CO)	003	.55	113.09	16.67	14.74	4.79E+00	.84
RLLVMT2	RF(RE)	001	.81	113.24	51.81	45.75	3.98E+00	.83
RLLVMT2	RF(LU)	002	.68	113.24	24.10	21.28	3.98E+00	.83
RLLVMT2	RF(CO)	003	.54	113.24	18.07	15.96	3.98E+00	.83
RLLVMT3	RF(RE)	001	.82	113.09	52.38	46.32	4.57E+00	.84
RLLVMT3	RF(LU)	002	.70	113.09	23.81	21.05	4.57E+00	.84
RLLVMT3	RF(CO)	003	.57	113.09	17.86	15.79	4.57E+00	.84
RLLVMT4	RF(RE)	001	.81	116.66	52.38	44.90	4.57E+00	.84
RLLVMT4	RF(LU)	002	.69	116.66	23.81	20.41	4.57E+00	.84
RLLVMT4	RF(CO)	003	.56	116.66	19.05	16.33	4.57E+00	.84

Results for the mean value of the endpoints for the DBA source term

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
PLCMMT	RF(RE)	001	.79	118.52	51.85	43.75	4.57E+00	.81
PLCMMT	RF(LU)	002	.67	118.52	25.93	21.88	4.57E+00	.81
PLCMMT	RF(CO)	003	.56	118.52	19.75	16.66	4.57E+00	.81
RLCMMT2	RF(RE)	001	.79	116.05	51.85	44.68	4.50E+00	.81
RLCMMT2	RF(LU)	002	.68	116.05	25.93	22.34	4.50E+00	.81
RLCMMT2	RF(CO)	003	.56	116.05	19.75	17.02	4.50E+00	.81
RLCMMT3	RF(RE)	001	.78	118.52	50.62	42.71	4.64E+00	.81
RLCMMT3	RF(LU)	002	.67	118.52	25.93	21.88	4.64E+00	.81
RLCMMT3	RF(CO)	003	.54	118.52	19.75	16.66	4.64E+00	.81
RLCMMT4	RF(RE)	001	.79	114.64	51.22	44.68	4.52E+00	.82
RLCMMT4	RF(LU)	002	.67	114.64	24.39	21.28	4.52E+00	.82
RLCMMT4	RF(CO)	003	.56	114.64	19.51	17.02	4.52E+00	.82
RLOUMT2	RF(RE)	001	.78	116.06	50.62	43.62	4.53E+00	.81
RLOUMT2	RF(LU)	002	.69	116.06	28.40	24.47	4.53E+00	.81
RLOUMT2	RF(CO)	003	.52	116.06	17.28	14.89	4.53E+00	.81
RLOUMT3	RF(RE)	001	.78	116.05	51.85	44.68	4.55E+00	.81
RLOUMT3	RF(LU)	002	.69	116.05	27.16	23.40	4.55E+00	.81
RLOUMT3	RF(CO)	003	.52	116.05	17.28	14.89	4.55E+00	.81
RLOUMT4	RF(RE)	001	.79	117.28	51.85	44.21	4.68E+00	.81
RLOUMT4	RF(LU)	002	.68	117.28	25.93	22.11	4.68E+00	.81
RLOUMT4	RF(CO)	003	.53	117.28	18.52	15.79	4.68E+00	.81

RESULTS FOR THE 95TH PERCENTILE OF THE ENDPOINTS FOR THE DBA SOURCE TERM

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
PLCMMT	RF(RE)	001	.79	116.05	53.09	45.75	4.57E+00	.81
PLCMMT	RF(LU)	002	.67	116.05	24.69	21.28	4.57E+00	.81
PLCMMT	RF(CO)	003	.56	116.05	19.75	17.02	4.57E+00	.81
RLCMMT2	RF(RE)	001	.74	116.44	44.30	38.05	5.62E+00	.79
RLCMMT2	RF(LU)	002	.66	116.44	26.58	22.83	5.62E+00	.79
RLCMMT2	RF(CO)	003	.51	116.44	18.99	16.31	5.62E+00	.79
RLCMMT3	RF(RE)	001	.77	117.50	48.75	41.49	4.90E+00	.80
RLCMMT3	RF(LU)	002	.67	117.50	26.25	22.34	4.90E+00	.80
RLCMMT3	RF(CO)	003	.54	117.50	20.00	17.02	4.90E+00	.80
RLCMMT4	RF(RE)	001	.77	118.51	49.38	41.67	4.57E+00	.81
RLCMMT4	RF(LU)	002	.68	118.51	27.16	22.92	4.57E+00	.81
RLCMMT4	RF(CO)	003	.55	118.51	19.75	16.67	4.57E+00	.81
RLOUMT2	RF(RE)	001	.77	117.50	48.75	41.49	4.68E+00	.80
RLOUMT2	RF(LU)	002	.70	117.50	30.00	25.53	4.68E+00	.80
RLOUMT2	RF(CO)	003	.49	117.50	16.25	13.83	4.68E+00	.80
RLOUMT3	RF(RE)	001	.77	116.25	48.75	41.94	4.57E+00	.80
RLOUMT3	RF(LU)	002	.69	116.25	28.75	24.73	4.57E+00	.80
RLOUMT3	RF(CO)	003	.50	116.25	17.50	15.05	4.57E+00	.80
RLOUMT4	RF(RE)	001	.78	114.82	50.62	44.09	4.57E+00	.81
RLOUMT4	RF(LU)	002	.70	114.82	28.40	24.73	4.57E+00	.81
RLOUMT4	RF(CO)	003	.53	114.82	17.28	15.05	4.57E+00	.81

RESULTS FOR THE 99TH PERCENTILE OF THE ENDPOINTS FOR THE DBA SOURCE TERM

ENDP	INP.VAR	RK	PRCC	SUM%	%CON	%SCON	FAC1	RSQ
PLCMMT	RF(RE)	001	.79	117.28	53.09	45.27	4.47E+00	.81
PLCMMT	RF(LU)	002	.67	117.28	24.69	21.05	4.47E+00	.81
PLCMMT	RF(CO)	003	.56	117.28	19.75	16.84	4.47E+00	.81
RLCMMT2	RF(RE)	001	.79	117.28	51.85	44.21	4.47E+00	.81
RLCMMT2	RF(LU)	002	.68	117.28	25.93	22.11	4.47E+00	.81
RLCMMT2	RF(CO)	003	.56	117.28	19.75	16.84	4.47E+00	.81
RLCMMT3	RF(RE)	001	.77	118.75	50.00	42.11	4.90E+00	.80
RLCMMT3	RF(LU)	002	.67	118.75	26.25	22.11	4.90E+00	.80
RLCMMT3	RF(CO)	003	.54	118.75	20.00	16.84	4.90E+00	.80
RLCMMT4	RF(RE)	001	.79	117.28	53.09	45.27	4.57E+00	.81
RLCMMT4	RF(LU)	002	.67	117.28	24.69	21.05	4.57E+00	.81
RLCMMT4	RF(CO)	003	.56	117.28	19.75	16.84	4.57E+00	.81
RLOUMT2	RF(RE)	001	.77	117.50	48.75	41.49	4.68E+00	.80
RLOUMT2	RF(LU)	002	.68	117.50	28.75	24.47	4.68E+00	.80
RLOUMT2	RF(CO)	003	.51	117.50	17.50	14.89	4.68E+00	.80
RLOUMT3	RF(RE)	001	.78	116.05	50.62	43.62	4.47E+00	.81
RLOUMT3	RF(LU)	002	.69	116.05	27.16	23.40	4.47E+00	.81
RLOUMT3	RF(CO)	003	.51	116.05	17.28	14.89	4.47E+00	.81
RLOUMT4	RF(RE)	001	.79	117.27	51.85	44.21	4.79E+00	.81
RLOUMT4	RF(LU)	002	.69	117.27	27.16	23.16	4.79E+00	.81
RLOUMT4	RF(CO)	003	.53	117.27	17.28	14.74	4.79E+00	.81