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Degraded Core Accidents for the Sizewell PWR: A Sensitivity Analysis of the Radiological Consequences

G. N. Kelly, C. R. Hemming, D. Charles, J. A. Jones, L. Ferguson, S. M. Haywood and R. H. Clarke

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ABSTRACT

The radiological impact of degraded core accidents postulated for the Sizewell PWR was assessed in an earlier study. In this report the sensitivity of the predicted consequences to variation in the values of a number of important parameters is investigated for one of the postulated accidental releases. The parameters subjected to sensitivity analyses are the dose-mortality relationship for bone marrow irradiation, the energy content of the release, the warning time before the release to the environment, and the dry deposition velocity for airborne material. These parameters were identified as among the more important in determining the uncertainty in the results obtained in the initial study. With a few exceptions the predicted consequences were found to be not very sensitive to the parameter values investigated, the range of variation in the consequences for the limiting values of each parameter rarely exceeded a factor of a few and in many cases was considerably less. The conclusions reached are, however, particular to the releases analysed from Sizewell; for different releases from different locations the sensitivity may change significantly.

In the earlier study an analysis was undertaken of the impact on the predicted consequences of potential overestimates in the release fractions of radionuclides. Since the results of that study were published some relatively minor numerical errors have been identified. While none of these affects the conclusions reached in that study the opportunity has been taken in this report to present revised values for those results known to be in error. This revised text and results are presented as an appendix to this report and they replace the corresponding material in the earlier study.

This report was prepared under contract to the Central Electricity Generating Board (CEGB). It is one of a number of reports which have been prepared by or for CEGB on the subject of degraded core accidents for the Sizewell PWR. An overview of this subject can be found in Appendix M of "Sizewell 'B' Power Station Public Inquiry: CEGB Statement of Case", CEGB (July 1982)

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As from 1 April 1978 NRPB adopted the International System of Units (SI). The relationship between the new SI units which are used in this report and the previous units are shown in the table below.

Quantity	New named unit and symbol	In other SI units	Old special unit and symbol	Conversion factor
Exposure	-	$C\ kg^{-1}$	röntgen (R)	$1\ C\ kg^{-1} \sim 3876$ R
Absorbed dose	gray (Gy)	$J\ kg^{-1}$	rad (rad)	1 Gy = 100 rad
Dose equivalent	sievert (Sv)	$J\ kg^{-1}$	rem (rem)	1 Sv = 100 rem
Activity	becquerel (Bq)	s^{-1}	curie (Ci)	$1\ Bq \sim 2.7 \times 10^{-11}$ Ci

1. INTRODUCTION

The radiological impact of degraded core accidents, postulated for the proposed pressurised water reactor (PWR) at Sizewell, was assessed in a recently published study[1]. The methods and parameter values used in that assessment were, as far as practicable, 'best-estimate' values, although occasionally a cautious approach was adopted where data were lacking. Each of the models and parameter values has associated with it some measure of uncertainty, the magnitude of which may vary considerably. These uncertainties may be associated with the physical description of the release itself (eg, the quantity and physico-chemical form of each radionuclide released, the height and energy content of the release) or with the parameters which describe the transfer of released material through the environment and its impact on man. The extent to which an uncertainty in a given parameter will be reflected in an uncertainty in the predicted radiological impact will depend upon the relationship between the two quantities. Where the relationship is linear, the uncertainty in the radiological impact will be proportional to that in the value of the parameter of interest; where the relationship is more complex, as in general is the case, the uncertainty may be enhanced or reduced compared with that in the initial parameter value.

An estimate of the uncertainty in the predicted radiological impact has an important role in any quantitative risk assessment, in particular, in determining the confidence that can be placed on the results obtained. A rigorous estimate of the uncertainty is, however, extremely difficult, not only because of the large number of variables which are inter-related in a complex manner, but also because of the lack of precision with which the uncertainty in many of the variables can be specified. For these reasons no attempt is made here to evaluate the overall uncertainty in the radiological impact of degraded core accidents predicted in the initial study[1]. However, some appreciation of the possible magnitude of the uncertainty can be gained by estimating the sensitivity of the radiological impact to variations in the value of particular parameters over their range of uncertainty. The results of a number of such sensitivity studies are presented in this report.

The number of parameters which may significantly influence the uncertainty in the predicted radiological impact is considerable. Those for which sensitivity analyses have been undertaken in this study comprise

- the dose mortality relationship for bone marrow irradiation
- the energy content of the release
- the warning time before the release to the environment
- the dry deposition velocity for released material.

These parameters were identified as being among the more important in determining the uncertainty in the results obtained in the initial study. In identifying these parameters a considerable measure of scientific judgement was exercised

both in terms of the potential uncertainty associated with a given parameter value and how this might be propagated into the uncertainty in the predicted radiological impact.

The sensitivity of the radiological impact to variation in the values of each of the above parameters is analysed for one of the release categories, UK1, specified in the initial study. The characteristics of this release are summarised in Table 1. It was selected for analysis as being one of the more important release categories in determining the health impact of degraded core accidents. The release fractions of radionuclides for UK1 are in general comparable with those specified for the other release categories (mainly UK3 and UK5) which make major contributions to the total health impact. For some parameters, therefore, it is possible to draw more general conclusions on the sensitivity of the overall radiological impact of degraded core accidents to variation in the parameter value from the results obtained specifically for UK1.

Two important points need to be made when considering the results of the analyses. First, they are particular to releases from Sizewell and to the characteristics of the release category analysed. For releases having different characteristics, or originating from different locations, the sensitivity of the results to the investigated parameter may change considerably. Any attempt to draw more generally applicable conclusions from the results presented here should therefore be approached cautiously. Second, the observations made and the conclusions reached on the sensitivity of the radiological impact to changes in parameter values are applicable only over the ranges of consequences investigated and their associated probabilities of occurrence. Typically the analyses are valid for levels of probability, conditional upon the release occurring, down to about 10^{-3} to 10^{-4}. These conditional probabilities correspond to overall frequencies of occurrence of the stated consequences of about 10^{-11} y^{-1} or less, given the predicted frequency of occurrence of the larger degraded core accident releases of about 10^{-8} y^{-1}.

In the initial study an analysis was undertaken of the impact on the radiological consequences of potential overestimates in the predicted release fractions for selected releases. Since the results were published, some relatively minor numerical errors have been found. While none of these affects the conclusions reached on the impact of potential overestimates in the release fractions, the opportunity has been taken here to provide a corrected version of the results. For convenience, the corrected results of that analysis are reproduced in full as an appendix to this report. They replace the corresponding material contained in the initial study[1].

2. SENSITIVITY OF THE PREDICTED INCIDENCE OF EARLY DEATHS TO THE DOSE-MORTALITY RELATIONSHIP FOR BONE MARROW IRRADIATION

2.1 Introduction

For the accidental releases analysed in the initial study[1], early deaths occurred as a result of irradiation of the bone marrow and the lung. The former was by far the more important in determining the overall incidence of early deaths. Attention can therefore be confined to this source of exposure in assessing the sensitivity of the predicted incidence of early deaths to uncertainties in the dose-mortality relationships adopted.

There is considerable uncertainty associated with the dose-mortality relationship for bone marrow irradiation in man, because of the limited human data and their variable quality. Uncertainties exist not only in the relationship for acute exposure but also with regard to the benefits deriving from protraction of irradiation, the provision of simple supportive medical treatment and the state of health of the exposed individual. In the initial study, the dose-mortality relationship adopted was intermediate within the range of uncertainty and a cautious (pessimistic) approach was adopted in allowing for protraction of irradiation. The sensitivity of the predicted incidence of early deaths is analysed for a range of dose-mortality relationships which are judged to bound the uncertainty. In addition, the influence of taking what is believed to be a more realistic account of the effect of protraction of exposure is investigated.

The selection of the dose-mortality relationship for bone marrow irradiation for sensitivity analysis requires explanation as its uncertainty is not unduly large compared with that in many other parameters, and may be considerably less. Its significance, in the present context, results from the potential for small changes in the dose-mortality relationship to alter considerably the predicted number of early deaths[2]. This is a consequence of the threshold in the dose-mortality relationship; when doses are in the threshold region, small changes in that threshold can lead to much larger changes in the predicted number of early deaths.

2.2 Dose-mortality relationships investigated in the sensitivity analysis

2.2.1 Uncertainty in the LD_{50} for acute exposure

Reviews[2,3] of the relevant data on the dose-mortality relationship for bone-marrow irradiation have indicated that the LD_{50} (the dose at which the probability of death is 50%) for acute exposure of man is unlikely to lie outside the range of 3 - 5 Gy (low LET). An intermediate value of 4 Gy was adopted in the initial study. The upper bound value is comparable with the LD_{50} of the dose-mortality relationship adopted in the US Reactor Safety Study (US-RSS)[4] and a similar German Risk Study[5], where simple supportive medical treatment (eg, antibiotics, blood and fluid transfusions) was assumed to be provided and to

be effective in increasing the probability of survival. The sensitivity of the predicted numbers of health effects to the adoption of an LD_{50} equal to the two bounds of 3 and 5 Gy is evaluated in this study. The two dose-mortality relationships corresponding to these choices of LD_{50}, together with that used in the initial study are shown in Figure 1. These relationships are appropriate for acute irradiation of the bone marrow. Where the exposure is protracted, the dose to be used in association with the relationships needs to be modified. In the initial study, the bone marrow dose used in conjunction with the dose-mortality relationship was defined as follows (equation (1)) and this procedure was also adopted in this part of the sensitivity analysis.

$$\left\{\begin{array}{c}\text{Dose accumulated in} \\ \text{the first 7 days}\end{array}\right\} + \frac{1}{2}\left\{\begin{array}{c}\text{Dose accumulated from} \\ \text{day 8 to 30}\end{array}\right\} \quad \ldots\ldots\ldots (1)$$

2.2.2 Uncertainty in the influence of protraction of exposure

Equation (1) assumes conservatively that doses accumulated in the first seven days are as effective in inducing early deaths as a single brief dose of the same magnitude, while that accumulated from day 8 to 30 is half as effective; further, dose accumulated beyond 30 days is assumed to be ineffective. There is no strong radiobiological justification for this relationship, rather it represents an empirical judgement. It was formulated for use i the US-RSS[4] given the likely variation of dose with time following large accidental releases of radionuclides from reactors and the knowledge that a dose accumulated at dose rates of several tens of mGy d^{-1} would not significantly increase the probability of early death for the exposed individual. In general, the dose rates after 30 days to those individuals exposed in the dose range where death occurs (and who had not already accumulated sufficient dose to cause death) would at most be of the order of tens of mGy d^{-1} and typically very much less. In practice, the exposure of such individuals, at least from external radiation, is likely to be terminated by evacuation within a much shorter time.

There is some evidence[3] from experiments with animals that the effect of protraction of exposure is more pronounced than would be indicated by use of the expression in equation (1). Smith[3] has proposed a procedure to take account of the protraction of dose based on analyses of available animal data. The dose recommended for use in conjunction with the dose-mortality relationship for acute exposure (shown in Figure 1) can be expressed as:

$$\sum_{i=1}^{N} F_i \quad \ldots\ldots\ldots (2)$$

where the sum is over prescribed periods, the first being 0 - 1 hours and the last being 29 - 30 days

and F_i is given by

$$F_i = \left\{\begin{array}{c}\text{Dose accumulated in the} \\ \text{ith period}\end{array}\right\} - A_i \quad \text{if } F_i > 0$$

$$= 0 \quad \text{if } F_i < 0$$

where A_i is a constant dose for each prescribed time period.

The periods and corresponding values of A_i are given in Table 2. Exposure accumulated after 30 days is again assumed to be ineffective for the reasons previously given. The influence of adopting this alternative formulation for the effect of protraction is evaluated for a dose-mortality relationship based on an LD_{50} for acute exposure of 4 Gy (ie, that used in the initial study).

2.3 Results

2.3.1 Sensitivity to the choice of LD_{50}

2.3.1.1 Average individual risk of early death as a function of distance from the release

The average individual risk of early death, conditional upon the release, is shown in Figure 2 as a function of distance from the release. The risk is given for the dose-mortality relationship used in the initial study (LD_{50} = 4 Gy) and for the upper and lower bounds (LD_{50} of 3 and 5 Gy) of its range of uncertainty. The variation in the average individual risk with LD_{50} increases with increasing distance from the release. For the lower bound LD_{50} of 3 Gy, there is an increase in the individual risk of early death compared with that in the initial study of about 10 - 20% at 1 km, about 50% at 5 km, and about a factor of two at 10 km. Beyond 18 km, where the individual risk was zero in the initial study, the assumption of an LD_{50} of 3 Gy leads to a non-zero individual risk of early death for about a further 10 km.

For the upper bound LD_{50} of 5 Gy, there is a decrease in the average individual risk of early death compared with that in the initial study of about 10% at 1 km, about 30 - 40% at 5 km, and about a factor of four at 10 km. The individual risk of early death is zero beyond about 15 km.

2.3.1.2 Conditional probability distributions of early deaths

The conditional probability distributions of the numbers of early deaths, predicted for each of the dose-mortality relationships, are compared in Figure 3. Both cumulative and difference probability distributions are shown. The difference distributions, in particular, show that, for a reduction in LD_{50} to 3 Gy, there is a general shift in the distribution towards higher numbers of early deaths; for an increase in LD_{50} to 5 Gy, there is a general shift towards lower numbers.

Characteristic quantities of the conditional probability distributions of early deaths are compared in Table 3. For the lower bound LD_{50} of 3 Gy, the expectation value of the number of early deaths increases by about a factor of two; for the upper bound LD_{50} of 5 Gy, the expectation value decreases by about 30%. The variation with LD_{50} in the percentiles of the distributions show a similar trend, although it is in general greater at the 50th percentile and less at the 99th percentile. The probability of zero early deaths is marginally smaller than that in the initial study for an LD_{50} of 3 Gy and marginally greater for an LD_{50} of 5 Gy.

The numbers of other health effects evaluated may also vary with the dose-mortality relationship for bone-marrow irradiation; this occurs only because of the variation in the number of early deaths and the potential for differing numbers of people remaining alive to experience the other effects. Characteristic quantities of the probability distributions of each of the health effects are given in Table 4 for each LD_{50} considered. The variation in the numbers of each effect with the choice of dose-mortality relationship is small in all cases. The numbers of lung morbidities show the largest variation. There is a decrease in the expectation value of the number of lung morbidities by a factor of about two to three for an LD_{50} of 3 Gy compared with the number estimated in the initial study; similarly, there is an increase in the expectation value by about a factor of two for an LD_{50} of 5 Gy. In all cases, however, the absolute numbers of lung morbidities are much less than the numbers of early deaths.

In summary, the predicted numbers of early deaths are not very sensitive to variation in the dose-mortality relationship within its range of uncertainty, at least for the release and location, analysed. The variation in the expectation value of early deaths is only about a factor of two for variation in the LD_{50} between its bounds of 3 and 5 Gy. This sensitivity to the LD_{50} is considerably less than was found in an earlier study[2] where a somewhat larger release was analysed from a different location and for a more restricted set of meteorological conditions. Clearly, much depends on the release magnitude, the meteorological conditions and the surrounding population distribution; the conclusions reached here on the sensitivity of the number of early deaths to the LD_{50} are particular to the conditions analysed and would not necessarily be applicable for other circumstances.

An indication of how different population distributions might significantly influence the sensitivity to the choice of LD_{50} can be gained by reference to Figure 2. If the population within, say, 20 km of the release was distributed such that most, by far, was located at 2 km, then the variation in the predicted number of early deaths in that population for the bounds of the LD_{50} considered would be less than a factor of two (the ratio of the average individual risks for the bounding values of the LD_{50} at 2 km). Alternatively, if the population were all located at say 10 km, the range of variation would be more than a factor of ten, for variation in the LD_{50} within its range of uncertainty. For Sizewell, the major population centre close to the site is located at about 4 km; at this distance the variation in the average individual risk with LD_{50} is small and this is reflected in the limited sensitivity of the numbers of early deaths observed in this study.

2.3.2 Sensitivity to the procedure adopted to allow for protraction of exposure

The average individual risk of early death, conditional on the release, is shown in Figure 4 as a function of distance from the release, for the two procedures used to allow for protraction of exposure. Adoption of the more

realistic procedure proposed by Smith[3] results in a decrease in the individual risk of between 10% and 20% at 1 km, by a factor of between three and four at 5 km, and by a factor of about eight at 10 km, compared with that evaluated using the conservative procedure proposed in the US-RSS[4] and used in the initial study[1]. The impact thus becomes more marked as the distance from the release increases and is due to two factors. First, the countermeasures model adopted assumes that the time of evacuation increases with increasing distance and this results in an increase in the protraction of a given exposure with distance; as the protraction increases the difference between the two approaches will be enhanced (see equations (1) and (2)). Second, in the revised procedure (see equation (2)) the dose to be used in association with the dose-mortality relationship is evaluated as the sum, over varying periods, of that fraction of the dose above defined levels. Because the dose in general decreases with distance, the fraction of the dose above a given level will decline with distance.

The conditional probability distributions of early deaths for the two procedures used to allow for protraction are compared in Figure 5, in both cumulative and difference formats. The use of the revised procedure results in a shift in the probability distribution towards lower numbers of early deaths compared with those predicted in the initial study. Characteristic quantities of the probability distributions of early deaths are compared in Table 5. The revised procedure results in a decrease in the expectation value of the number of early deaths by a factor of about two compared with those estimated in the initial study. Decreases are also apparent in the numbers of early deaths at the various percentiles of the distributions. The decrease varies with the percentile of interest: at the 90th and 99.9th percentile, the reductions are by factors of about four and 1.2, respectively.

Characteristic quantities of the conditional probability distributions for the other health effects evaluated are given in Table 6. The increase in these other effects, with the revised procedure adopted to allow for protraction of exposure, is due solely to the decrease in the predicted number of early deaths and hence to the number of people remaining to experience other effects. The largest variation in the other health effects is in the number of lung morbidities where the expectation value is a factor of two to three greater than that in the initial study. The variation in the predicted numbers of other health effects is very small. The number of cases of prodromal vomiting remain unchanged because they would occur before early death.

2.4 Influence on the overall risk of degraded core accidents evaluated in the initial study

The overall risk of early death from degraded core accidents evaluated in the initial study was largely determined by release category UK1, with UK3 and

UK5 also making significant contributions. If an analysis was to be undertaken of the sensitivity of the number of early deaths to the dose-mortality relationship for bone marrow irradiation for release categories UK3 and UK5, some differences might be expected from the results presented here for UK1. However, because of the similarities in the magnitude and composition of the respective releases, these differences would not in general be large. Consequently, the variation in the number of early deaths predicted in this study for release category UK1 can, with reasonable confidence, be considered representative of that in the overall number of early deaths (summed over all release categories) evaluated in the initial study. In summary, therefore, the overall numbers of early deaths (and overall risk of early death) predicted in the initial study are relatively insensitive to uncertainties in the dose-mortality relationship for bone-marrow irradiation. Variation of the LD_{50} within its range of uncertainty of 3 to 5 Gy would result in a change in the predicted number (and risk) of early deaths by only about a factor of two. The adoption of a less cautious procedure to allow for the influence of protraction of exposure would reduce the predicted numbers of early deaths by a similar factor.

3. SENSITIVITY OF THE RADIOLOGICAL CONSEQUENCES TO THE WARNING TIME BEFORE RELEASE TO THE ENVIRONMENT

3.1 Introduction

A feature of the countermeasures model adopted in the initial study was an option to include precautionary countermeasures when there was sufficient delay between the recognition of an accident sequence and the release of radioactive material to the environment. The period between the unequivocal recognition of an accident and the release of material to the environment was defined as the warning time[6]. The length of the warning time may have a major influence on the predicted consequences of a release, at least over the area where precautionary countermeasures might be implemented. The sensitivity of the predicted consequences to variation in the warning time has therefore been investigated.

A number of reservations need to be expressed about the analysis and the use that can be made of its results. First, the range of warning times analysed is not intended to reflect the uncertainty in the warning time for any particular release category. The values analysed were chosen with reference to the characteristics of the countermeasures model adopted so that the complete range of variation in the consequences would be investigated. The results obtained can then be used to evaluate the uncertainty in consequences for any specified uncertainty in the warning time. Second, the sensitivity analysis was undertaken for release category UK1, and the results obtained and conclusions reached are valid only for releases of like magnitude and composition. For radically different releases, the sensitivity of the consequences to warning time would need to be investigated separately. Equally, the results are particular to the

countermeasures model adopted. Changes, particularly in the area over which precautionary countermeasures are taken and their timing, may significantly alter the general conclusions reached in this analysis.

3.2 Range of warning times analysed

The countermeasures model is illustrated in Figure 6. The countermeasures taken in areas A and B (sectors of width 60° extending 2 km and 5 km downwind, respectively) are assumed to be initiated as precautionary measures at the beginning of the warning time. Beyond areas A and B countermeasures are assumed to be initiated only after a release to the environment has commenced and are based on dose criteria. The influence of warning time on the radiological consequences will therefore be limited to areas A and B. Evacuation of areas A and B is assumed to occur 2 hours and 5 hours, respectively, after the start of the warning time, while sheltering is assumed to occur earlier. During evacuation those affected are assumed to receive further exposure of equal magnitude to that which they would have received outdoors in the following hour had they not been evacuated. Thus, for warning times in excess of 6 hours, the population from areas A and B would be evacuated before receiving any exposure; the radiological consequences will therefore be insensitive to warning time for periods greater than this value.

The sensitivity analysis has been undertaken for the release characteristics specified for UK1 (see Table 1) with the exception of the warning time. Warning times of 1, 3 and 6 hours have been analysed in addition to the zero warning time assumed for UK1 in the initial study. The value of 6 hours was chosen to correspond to the maximum extent to which warning time could lessen the radiological consequences. A warning time of 3 hours would ensure that the population in area A would be evacuated before any exposure occurred.

A further relevant parameter in determining the consequences is the delay between reactor shut-down and release to the environment. Clearly this must be equal to or greater than the warning time and, ideally, should be kept constant throughout the sensitivity analysis. However, in the interests of minimising computational expenditure, the delay between shutdown and release was assumed equal to the warning time for each case analysed (apart from zero warning time where a delay of 1 hour between shutdown and release was assumed). The implication of adopting this procedure is that the amount of radioactive material released in each case will decrease with increasing warning time due to enhanced radioactive decay before release. For warning times in the range analysed this approximation does not significantly influence the results obtained.

In the following section, attention is confined to the influence of warning time on the predicted numbers of health effects. The restrictions on agricultural production and on the number of people (or area) evacuated are independent of warning time, if it is assumed that the delay between shut-down and release to the environment does not vary with this parameter.

3.3 Results

3.3.1 Average individual risk

The average individual risk of early death as a function of distance from the release is illustrated in Figure 7 for warning times of 0, 1, 3 and 6 hours; the risks are conditional upon the release occurring. The values for a warning time of zero were evaluated in the initial study. Within 5 km of the release, there is a significant decrease in the risk of early death with increasing warning time. Beyond 5 km, the small differences that are apparent arise solely from the approximation that the delay between shut-down and release (rather than being constant) is equal to the warning time. Compared with zero delay assumed in the initial study, a warning time of 1 hour leads to a reduction in the risk of early death within 2 km by up to a factor of about two; between 2 and 5 km the reduction is much less. This reduction is due to the whole population within 5 km having sheltered before the release to the environment, and the population being exposed for a shorter period before evacuation from the affected area. For a warning time of 3 hours, the risk of early death is zero within 2 km of the release. This is because the evacuation of the population within 2 km (area A) has been completed before the release to the environment. Between 2 and 5 km, there is a reduction in the risk of early death by a factor of between about two and three. For a warning time of 6 hours the risk of early death within 5 km of the release is zero. This is because everyone potentially affected within 5 km (areas A and B) has been evacuated before the release to the environment.

The average individual risk of fatal cancer, conditional upon the release occurring, is compared in Figure 8 for each value of warning time. Beyond 5 km, the apparent differences in the risk of fatal cancer are solely a consequence of the approximation that the warning time and the delay between reactor shut-down and release to the environment are equal. Within 5 km, two competing factors affect the risk of fatal cancer. First, an increase in the warning time reduces the time for which the population in areas A and B is exposed before evacuation, thus resulting in a reduction in the risk of fatal cancer. Second, an increase in the warning time may decrease the risk of early death and this will be reflected in an increase in the subsequent risk of fatal cancer. Over the first few kilometres, the probabilities of fatal cancer are significantly reduced by the probability of early death. Where the warning time is long enough for people within a particular region to be evacuated before the release to the environment, the risk of fatal cancer, like that of early death, becomes zero.

3.3.2 Conditional probability distributions of consequences

The conditional probability distributions of early deaths for each of the warning times considered are illustrated in Figure 9. Both cumulative and difference distributions are shown. The shift in the distribution of early deaths from higher to lower numbers is apparent as the warning time is increased.

For a warning time of 6 hours the probability of zero early deaths is almost doubled compared with that for zero warning time.

The expectation values of the number of health effects, conditional upon the release occurring, are compared in Table 7 for the various assumed warning times. There is little variation in the number of late effects with changes in warning time. This is because most late effects occur at distances far from the release point; within 5 km of the release (ie, the area over which warning time may influence the consequences), the contribution is very small and any differences in this area with warning time will have little overall impact. Many of the small differences indicated in Table 7 for the late effects result from the approximation adopted with regard to the delay between shut-down and release to the environment. Greater variation is, however, apparent in the expectation values of early effects, and characteristic quantities of the conditional probability distributions for these effects are given in Table 8. The numbers of early deaths show the greatest variation with warning time. Compared with the zero warning time assumed in the initial study, warning times of 1, 3 and 6 hours result in reductions in the expectation value of early deaths by factors of about 1.2, 2 and almost an order of magnitude, respectively. The variation in the number of early deaths with warning time for the higher values of the percentiles quoted is, in general, somewhat less than that for the expectation value. The number of cases of prodromal vomiting also varies significantly with warning time but less so than for the number of early deaths. The expectation value for prodromal vomiting decreases by a factor of about four for an increase in the warning time from zero to 6 hours.

In summary, the warning time can have a major influence on the predicted number of early effects (up to an order of magnitude) but not on the number of late effects in an exposed population. While the overall number of late effects is not greatly influenced by warning time, this parameter does significantly affect the individual risk of late effects within the area over which precautionary countermeasures are implemented. It should be noted that the results obtained are particular to the release and the countermeasures model analysed. Variation in either of these, in particular, in the latter (eg, in the area for and timing of precautionary countermeasures), could lead to marked differences in the sensitivity to warning time evaluated here.

4. SENSITIVITY OF THE RADIOLOGICAL CONSEQUENCES TO PLUME RISE

4.1 Introduction

The radiological consequences of an accidental release of radioactive material may be significantly influenced by any plume rise that may occur. In general, plume rise will result in a reduction in the predicted consequences due to the elevation of the released material and the reduction in the exposure of the population that would then ensue. Plume rise may occur for various reasons, including initial buoyancy and momentum, and any self-heating that may

subsequently occur due to processes such as radioactive decay or chemical reactions. The initial study[1] included only plume rise due to buoyancy resulting from the initial heat (or energy) content of the released material. The cautious (pessimistic) assumption was made that the initial momentum and self-heating of the plume did not contribute to the rise. The momentum component was excluded because of the difficulty in deriving representative values for the direction and velocity of the released material in the wide range of accident sequences considered. No account of self-heating was taken because of deficiencies in the theory currently available to describe this process.

The sensitivity of the predicted radiological consequences to the heat (or energy) content of the released material is analysed. The values of energy content considered are chosen to encompass the range that might reasonably be postulated for the types of accidental release analysed in the initial study. In addition to the energy content resulting from an energy release rate of 0.3 MBtu/h (0.088 MW), assumed for release category UK1 in the initial study, values of zero, 20 and 200 MBtu/h (5.9 and 59 MW) are analysed as part of the sensitivity analysis. The range of values investigated should not be construed as being indicative of the uncertainty in the energy content for any particular release. Subject, however, to the specification of the uncertainty in this parameter, the results presented can be used to determine the uncertainty in the predicted radiological consequences for releases of magnitude and composition similar to that analysed.

To a limited extent, the results of the analysis can also be used to provide some indication of the potential uncertainty in the predicted consequences due to deficiencies in the theory and model used to predict plume rise. Two areas of uncertainty in plume rise modelling are the prediction of the final height achieved by the plume, and whether the buoyancy of a plume will produce lift-off from the ground. These aspects are discussed in more detail elsewhere[7,8]. Most plume rise theories have been developed for releases from point sources and the validity of their application to releases into building wakes, which is the situation of current interest, is uncertain. No model or theory has yet been developed to describe adequately the behaviour of buoyant plumes in such complex circumstances. Meanwhile, the models developed for releases from point sources are adopted while recognising their potential inadequacies. The radiological consequences predicted for zero plume rise, when compared with those for other energy contents, provide a means of estimating the maximum extent to which the consequences might have been underestimated if the rise of plumes (released into building wakes) has been overestimated significantly.

4.2 Results

4.2.1 Average individual risk

The average individual risk of early death, as a function of distance from the release, is illustrated in Figure 10 for the four values of energy content

considered. As the energy content of the release increases the average individual risk at a given distance decreases. Beyond about 10 km the four curves converge and, to a good approximation, the individual risk is then independent of the energy content of the plume. The risks of early death are only marginally different over all distances for energy contents corresponding to zero and 0.3 MBtu h^{-1}. Energy contents corresponding to 20 MBtu h^{-1} and 200 MBtu h^{-1} lead to reductions in risk (at 1 km), compared with that for zero energy content, by factors of about two and seven, respectively: the reduction factors decrease with increasing distance. The implications of these differences in individual risk for the predicted numbers of early deaths will depend on the surrounding population distribution. At Sizewell, much of the population within 10 km of the site is located within about 3 to 5 km. The reduction in individual risk over this distance band is likely therefore to be typical of the reduction in the predicted numbers of early deaths.

The average individual risk of fatal cancer as a function of distance from the release is illustrated in Figure 11 for the four values of energy content analysed. The general features of the variation of the risk of fatal cancer with energy content are similar to those for the risk of early death. The risk at a given distance decreases with increasing energy content: the magnitude of the decrease declines with increasing distance. At distances in excess of a few tens of kilometres the individual risk of fatal cancer is essentially independent of the energy content of the release. The initial increase in risk with increasing distance is due to the risk of fatal cancer being reduced by the occurrence of early death. Despite the significant differences in the risk of fatal cancer over the first 10 km, variation in the energy content of the release is unlikely to alter significantly the predicted number of cancers in the exposed population. This is because most of the cancers arise at distances far removed from the release, where the risk is essentially independent of the heat content.

4 2.2 Conditional probability distributions of consequences

The expectation values for each radiological endpoint, conditional upon the release, are compared in Table 9 for each of the assumed energy contents. With the exception of the early health effects, the variation in the expectation values with energy content is very small, never exceeding 10%.

Characteristic quantities of the conditional probability distributions for the early health effects are summarised in Table 10 for each energy content of the release. The greatest change with energy content is in the number of early deaths. An energy content of zero results in only a small (about 10%) increase in the expectation value of early deaths compared with that evaluated in the initial study (energy content corresponding to 0.3 MBtu h^{-1}). Energy contents corresponding to 20 and 200 MBtu h^{-1} lead to reductions in the expectation value of early deaths predicted in the initial study by factors of about two and three, respectively. The magnitude of these reductions varies with the characteristic

quantity of the distribution considered; in general, as the percentile of the distribution increases the differences in the predicted consequences are seen to decrease. At the 99.9th percentile (conditional probability of occurrence of 10^{-3}) the variation in consequences with energy content is small. The variation with energy content in the expectation values for the numbers of cases of prodromal vomiting and of lung morbidity are both within a factor of about two to three.

The conditional probability distributions of early deaths are compared in Figure 12 for each energy content assumed. Both cumulative and difference probability distributions are presented. For zero energy content the distribution is only marginally different from that evaluated in the initial study (0.3 MBtu h^{-1}). As the energy content increases the probability of essentially zero early deaths increases considerably while there is a corresponding decrease in the probability of the larger numbers of predicted consequences. For completeness, similar distributions for fatal cancers are illustrated in Figure 13. The variation in the distributions of fatal cancers with energy content is very small.

In summary, apart from the overall number of early health effects and the probability of both late and early effects within about 10 km of the release, the energy content of the release (within the range analysed) has little impact on the predicted radiological consequences. For energy contents corresponding to 20 and 200 MBtu h^{-1} the predicted expectation values of the number of early deaths are reduced by factors of about two and three, respectively, compared with that for zero energy content. The variation in the predicted consequences with energy content can be used to provide some indication of the maximum extent to which the early effects might have been underestimated in the initial study if the model adopted were to overestimate significantly the magnitude of any plume rise. The maximum energy content of the releases analysed in the initial study corresponded to 20 MBtu h^{-1} and for several release categories the value was much lower. Thus, if the extreme assumption was made that, despite these energy contents, there would be no plume rise, the numbers of early effects predicted in the initial study would increase at most by a factor of about two.

4.3 Influence on the overall risk of degraded core accidents evaluated in the initial study

The influence of the energy content of the release on the radiological consequences is essentially confined to the incidence of early health effects in the exposed population and to the individual risk of all health effects within about 10 km of the release. Uncertainty in the energy content of the releases analysed in the initial study has minimal impact on the other radiological endpoints evaluated.

The number of early deaths predicted in the initial study were determined mainly by release categories UK1, UK3 and UK5. The magnitude and composition of these releases are similar, and the variation in the risk of early death with

energy content predicted in Figure 10 for UK1 will be similar for all three releases. The specified energy contents of the releases do, however, differ: values corresponding to 0.3, 20 and 20 MBtu h^{-1} were assigned to UK1, UK3 and UK5, respectively. If the extreme assumption was made that each release was associated with zero energy content (ie. no plume rise) the numbers of early deaths predicted in the initial study would be increased by about 70%. Alternatively, if all three releases were to be assigned an energy content corresponding to 200 MBtu h^{-1} the predicted number of early deaths would be reduced by a factor of about two compared with that estimated in the initial study.

5. SENSITIVITY OF THE RADIOLOGICAL CONSEQUENCES TO DRY DEPOSITION VELOCITY

5.1 Introduction

The deposition of radioactive material from the atmosphere on to the ground leads to the exposure of the population by three major pathways: these are external γ radiation from the deposit, ingestion of contaminated food products and inhalation of material which may subsequently be resuspended. Of these pathways only the first two are significant for releases of isotopic composition typical of those postulated for PWRs. In the initial study, exposure pathways involving deposited material were shown to be very important in determining both the health impact of the release and the impact of countermeasures taken to limit this health impact.

Deposition of material from the atmosphere may be caused by both wet and dry processes. Dry deposition occurs by impaction of the dispersing plume with the underlying surface. The process is modelled using the concept of a deposition velocity which relates the airborne concentration of material near ground level to the rate of deposition on to the ground in the following way.

$$D = V_d \chi$$

where V_d is the dry deposition velocity (m s^{-1})

χ is the concentration of airborne material near ground level (Bq m^{-3})

D is the deposition rate of material (Bq m^{-2} s^{-1})

The dry deposition velocity varies considerably with the physical and chemical form of the airborne material and the surface on to which it is being deposited. The sensitivity of the radiological consequences to dry deposition velocity has therefore been investigated and the results are presented in the following sections. As in some of the other sensitivity analyses described in this report, the range of deposition velocities chosen for analysis should not be interpreted as being indicative of the uncertainty in this parameter for the release analysed. The values of deposition velocity considered were chosen to encompass the extremes of variation that might reasonably be proposed for releases of the type analysed.

5.2 Range of deposition velocities analysed

Numerous investigations of deposition velocity have shown that it can vary significantly in different circumstances. The chemical and physical form of the material, the underlying surface, the atmospheric conditions and size of the particulate material may all have an influence. Slinn[9], Sehmel[10] and Garland[11] have reviewed data on deposition velocity and described the processes involved in the deposition of both particulate material and gases. These reviews have shown that measured deposition velocities for the same element may vary over a large range. In Sehmel's review the deposition velocity for iodine is quoted as varying from less than 10^{-3} m s^{-1} to more than 10^{-1} m s^{-1}, although part of this variation may be due to differences in the chemical form of the iodine. For particulate material a wide range of deposition velocities has been reported. For a particle of 1 μm aerodynamic diameter (AD) the deposition velocity is typically in the range from a few times 10^{-4} to a few times 10^{-3} m s^{-1}. The deposition velocity varies with the size of the particle and that for a 10 μm (AD) particle is about an order of magnitude greater than for 1 μm (AD) particle. Garland[11] concluded that only in exceptional circumstances will it be possible to predict deposition with any great accuracy.

It was considered that the sensitivity analysis should examine the impact of varying the deposition velocity over a very wide range. There are a number of considerations involved in the choice of that range. First, there are uncertainties in the physical and chemical forms of the released material and the range of deposition velocities chosen must reflect these uncertainties. In the initial study, the particulate material was assumed to be released as a 1 μm AMAD aerosol[6] - a choice involving a considerable measure of judgement. The AMAD of the released aerosol may vary considerably with the characteristics of the accident sequence, although a range of 0.1 to 10 μm AMAD would probably encompass most situations that might be encountered in practice. Furthermore, inorganic iodine was assumed to be released in an elemental form in the initial study; CEGB have judged, however, that the iodine, both in the containment atmosphere and when released to the environment, would most likely be present as caesium iodide in a particulate form. The deposition velocity may vary significantly with the form of the released iodine and also with the AMAD of the released aerosol; the range of deposition velocities analysed should be sufficient to encompass such variations in the physico-chemical form of the released material. Second, there are inherent uncertainties in the deposition velocity for a given material over a particular surface and, moreover, variations with the surface involved; these also need to be reflected in the range of deposition velocities analysed.

The potential for variation in the deposition velocity is considerable and the impact of its variation on the predicted radiological consequences has been investigated for three scenarios, in addition to that analysed in the initial

study. The deposition velocities assumed in each case are summarised in Table 11. In the initial study, different deposition velocities were assigned to the noble gases, organic iodine, inorganic iodine and particulate material; this same system of classification was adopted in assigning the deposition velocities for each scenario. In the additional cases analysed in the sensitivity analysis, the deposition velocities of inorganic forms of iodine were taken to be the same as that assumed for the particulate material. Deposition velocities of 10^{-4}, 10^{-3} and 10^{-2} m s^{-1} were assumed and this parameter is subsequently used to identify the particular deposition velocity scenario under consideration. The deposition velocity of noble gases was assigned a value of zero throughout the analysis, while that for organic forms of iodine was varied from 10^{-6} m s^{-1} to 10^{-4} m s^{-1}, a comparable variation with the value adopted for particulate material.

Some comment is finally appropriate on the variation of deposition velocity to accommodate changes in the physico-chemical form of the released material. Changes in the physico-chemical forms of the released radionuclides will also have implications for the doses received by the population via inhalation; both the AMAD of the aerosol and the chemical form can be important. In a rigorous analysis of the possible impact of changes in the physico-chemical form, the dosimetry adopted (ie, the dose per unit intake by inhalation) should be varied together with the deposition velocity. The simplifying assumption, however, was made in this study that the dosimetry was independent of the deposition velocity and, moreover, was based on the material being in the form of a 1 μm AMAD aerosol with each element (with the exception of the noble gases and iodine) being in an oxide form. The adoption of this assumption will, however, have little impact on the predicted results. Kelly et al[12] analysed the variation in the predicted consequences of modifying the dosimetry to account for the particular physico-chemical form of the released material. For accidental releases of magnitude and composition similar to those analysed here, it was found that modifying the dosimetry for aerosols with AMAD in the range 0.1 - 10 μm and for extreme assumptions on chemical form, the predicted numbers of early deaths and fatal cancers varied at most by a few tens of percent and, in general, by much less. In that analysis the deposition velocity was assumed to be independent of the physico-chemical form of the released aerosol.

5.3 Results

5.3.1 Average individual risk

The average individual risk of early death, conditional upon the release, is illustrated in Figure 14 as a function of distance for each deposition velocity. At any downwind distance, the trend is for the risk to decline with decreasing deposition velocity. The reduction in risk with decreasing deposition velocity is due to the decreasing contribution then made by deposited material to the total dose. For low values of dry deposition velocity, the majority of the

dose arises from airborne material (exposure via cloud γ and inhalation) or from wet deposition during rainfall and any change in the dry deposition velocity has a limited impact. The characteristics of the population distribution relative to Sizewell are such that the variation in the number of early deaths with deposition velocity will be similar to that in the individual risk at distances in the range 3 - 5 km; typically this variation is about a factor two to three.

The average individual risk of fatal cancer, conditional upon the release, is illustrated in Figure 15 as a function of distance. Within about 20 km of the release, the variation in the risk of fatal cancer decreases with increasing deposition velocity (the opposite of that observed for early deaths) even though, in general, the dose at a given downwind distance in the above range (and hence the probability of cancer) will increase with increasing deposition velocity. Two factors contribute to the observed variation in the probability of cancer being the opposite of that which might have been expected. First, the probability of early death, if significant, will result in a reduction in the subsequent probability of an individual developing cancer. Second, the downwind distance over which countermeasures are applied will, in general, increase with increasing deposition velocity (due to an increase in dose with increasing deposition velocity at a given downwind distance, at least for distances up to several tens of kilometres). Where countermeasures are taken, there will be a reduction in risk compared with that which would otherwise have been experienced. Because the area over which countermeasures are applied in general increases with increasing deposition velocity, the resulting risk of cancer over a range of distances may be greater for the lower values of deposition velocity. At much greater downwind distances, when the influence of countermeasures becomes progressively less important, the variation in the risk of fatal cancer begins to follow the expected trend of increasing with increasing deposition velocity.

5.3.2 Conditional probability distributions of consequences

Characteristic quantities of the distributions of consequences, conditional upon the release, are summarised in Tables 12 - 15 for each of the deposition velocities analysed. The expectation values (and consequences at the 99th percentile) of these distributions for each radiological endpoint are compared in Table 16. The conditional probability distributions for selected endpoints (early death, fatal cancer, numbers of people evacuated, area evacuated) are also illustrated in Figures 16 - 19. Both cumulative and difference distributions are presented. The difference distributions are particularly effective in illustrating the influence of varying the deposition velocity on the predicted consequences.

The variation in the expectation values (see Table 16) of the various consequences with deposition velocity is not large and rarely exceeds a factor of two to three. The variation in the consequences at the 99th percentile (conditional probability of occurrence of 10^{-2}) shows similar trends. The

numbers of early deaths and cases of prodromal vomiting generally increase with increasing deposition velocity reflecting the trends indicated in Figure 14 for the individual risk of early death. The number of cases of lung morbidity generally decreases with increasing deposition velocity; this decrease is a consequence of the increasing probability of early death and thus a reduced probability of people surviving to experience subsequent lung morbidity. The expectation values of the numbers of late effects generally increase with increasing deposition velocity, although in a few cases a decrease is observed. The variation in the numbers of late effects at the 99th percentile shows similar trends. The variation of late effects with deposition velocity is not large and rarely exceeds a factor of three for the range of deposition velocities analysed.

The variation in the restrictions on people and agriculture arises largely because of differences in the spatial distribution of deposited material. The absolute magnitude of any variation will also be influenced by the level at which countermeasures are applied and the distributions of the population and of various agricultural products relative to the release location. Again, the overall variation for the range of deposition velocities analysed is not large and is generally within a factor of about two to three.

In summary, variation in the deposition velocity leads to differences in the spatial distribution of deposited material relative to the release location. The impact of this re-distribution of deposited material varies with the radiological endpoint considered. In general, the range of variation in the expectation values of each consequence with deposition velocity is not large, rarely exceeding a factor of two to three and generally much less. The numbers of most consequences increase with increasing deposition velocity, although there are a few exceptions.

Some final observations are appropriate on the consequences evaluated in the initial study and the extent to which they would change had other assumptions been made about the deposition velocity of the released material. For a deposition velocity of 10^{-2} m s^{-1} (for particulate material), the values for the numbers of early deaths and fatal cancers would increase by factors of about 1.3 and two, respectively. The expectation values of the number of people and area evacuated would increase by a factor of about 1.4 to 1.5. Similar increases would occur for the time integral of agricultural restrictions although the effect on the initial restrictions is less pronounced. For a deposition velocity of 10^{-4} m s^{-1} (for particulate material), the expectation values for the numbers of early deaths and fatal cancers would decrease by factors of about two and 0.8, respectively. The expectation value for the number of non-fatal thyroid cancers would, however, increase by a factor of about 1.5. The expectation values for the number of people and area evacuated would decrease by a factor of no more

than 1.2 while the restrictions on agriculture would decrease by a factor typically in the range 1.5 to three.

5.4 Influence on the overall risk of degraded core accidents evaluated in the initial study

The overall risk of early deaths from degraded core accidents evaluated in the initial study was largely determined by release category UK1, with UK3 and UK5 also making significant contributions. If an analysis was undertaken of the sensitivity of the number of early deaths to deposition velocity for release caregories UK3 and UK5, some differences might be expected from the results presented for UK1. However, because of the similarities in the magnitude and composition of the respective releases, these differences would not, in general, be large. Consequently, the variation in the number of early deaths predicted in this study for release category UK1 can, with reasonable confidence, be considered indicative of that in the overall number of early deaths (summed over all release categories evaluated in the initial study). Variation of the deposition velocity over the range analysed would be unlikely to result in a change in the predicted number (and risk) of early deaths in the initial study by more than a factor of a few.

The same three release catagories are also the major contributors to the overall incidence of many of the other radiological consequences evaluated. Therefore the results obtained on the variation of these consequences with deposition velocity for release category UK1 can also be considered indicative of the variation in these consequences, summed over all release categories.

6. SUMMARY AND CONCLUSIONS

In an earlier study[1], the radiological impact of degraded core accidents postulated for the PWR at Sizewell was assessed. The sensitivity of the predicted radiological consequences for one of these accidents (release category UK1) to variation in a number of parameters (which either characterise the accidental release or which determine its transfer through the environment to, and its impact on, man) has been investigated in this report. The parameters which have been the subject of sensitivity analyses are the dose-mortality relationship for bone marrow irradiation, the energy content of the release, the warning time before the release to the environment, and the dry deposition velocity for the released material. These were identified as being among the more important parameters in determining the uncertainty in the results obtained in the initial study.

Before summarising the results and conclusions for each sensitivity analysis a number of general qualifications need to be placed on their validity and range of applicability. First, the results are particular to a release from Sizewell and to the characteristics of the release analysed; for releases of differing magnitude or composition, or from a different location, the predicted sensitivity may change considerably. The conclusions reached for the particular release

analysed cannot therefore automatically be assumed to apply to the overall consequences of degraded core accidents evaluated in the initial study. More generally applicable conclusions have, however, been drawn where possible. Second, the conclusions reached are applicable only over the range of consequences and associated conditional probabilities of occurrence (down to levels of about 10^{-3} to 10^{-4}) investigated. These conditional probabilities correspond to absolute frequencies of occurrence of 10^{-11} y^{-1} or less given the frequency of degraded core accidents of about 10^{-4} y^{-1}. Third, the range of values over which a particular parameter was varied in the sensitivity analysis (with one exception) should not be interpreted as a measure of the uncertainty in that parameter for the degraded core accidents postulated for the Sizewell PWR; the ranges were chosen solely to encompass the extremes of variation that might reasonably be proposed for releases of that type. The results of the sensitivity analyses can, however, be used to estimate the uncertainty in the predicted consequences subject to a specification of the actual uncertainty in the parameter investigated. Finally the separate results obtained for the variation in the predicted consequences for each parameter value cannot be combined in a simple manner (eg. additively, multiplicatively) to provide an indication of the range of variation in the consequences if all the parameter values were varied simultaneously.

a) Sensitivity to the dose-mortality relationship for bone-marrow irradiation

The radiological consequences were evaluated as a function of the LD_{50} for acute irradiation which was varied over its range of uncertainty, judged to be from 3 - 5 Gy. The expectation value of the predicted number of early deaths was found to vary only by a factor of about two for this change in LD_{50}. The overall risk of early deaths from degraded core accidents evaluated in the initial study[1] is largely determined by release category UK1 (the release analysed here) and other releases of like magnitude and composition. Therefore the variation in the overall risk of early deaths with LD_{50} will be similar to that indicated above for UK1.

The impact on the predicted number of early deaths of adopting a less conservative procedure to allow for protraction of exposure, than used in the initial study, was also evaluated. The adoption of the more realistic approach resulted in a reduction in the predicted numbers of early deaths by a factor of about two. A similar reduction would result in the overall risk of early deaths from degraded core accidents predicted in the initial study.

b) Sensitivity to the warning time before the release to the environment

The sensitivity of the predicted consequences to warning time (defined as the time between the unequivocal recognition of an accident and the release of radioactive material to the environment) has been evaluated.

Warning time only has an influence over an area in which precautionary countermeasures are taken, ie, where countermeasures are taken before, and in anticipation of, a release to the environment. The results obtained are therefore particular to the countermeasures model assumed. Variation of the warning time from zero to 6 hours resulted in a reduction in the expectation value of the predicted number of early deaths by about an order of magnitude. No further decrease in consequences would occur for an increase in warning time due to the characteristics of the countermeasures model adopted. Warning time has little influence on the overall incidence of late effects in the exposed population but it has a major impact on the individual probability of late effects in the area over which precautionary countermeasures are taken.

c) Sensitivity to the energy content of the released material

The sensitivity of the predicted consequences to the assumed energy content of the release has been evaluated. The energy content of the release will influence its rise above the ground and thus the resulting radiological consequences. The impact on the radiological consequences is essentially confined to the predicted incidence of early health effects and the probability of late effects within several kilometres of the release.

An increase in the energy content of the release resulted in a decrease in the predicted numbers of early deaths: for an increase in the energy content corresponding to an energy release rate from zero to 20 and 200 MBtu h^{-1} the expectation value of early deaths decreased by factors of about two and three, respectively. The predicted numbers of late effects in the exposed population are relatively insensitive to the energy content of the release: the individual probability of fatal cancers may however vary significantly with the value of this parameter for the range of downwind distances over which the plume is elevated.

The models used to describe plume rise are uncertain in a number of respects, in particular in predicting the final height of rise and whether or not plumes lift off when released into building wakes. The differences in the results obtained for zero energy content and those for the other specified values provide an indication of the maximum extent to which the consequences might have been underestimated because of uncertainties in the plume rise model.

Some more general conclusions can be drawn from the results obtained because of the similarity between the release analysed and the others which contribute significantly to the overall risk of early deaths. The numbers of early deaths predicted in the initial study would increase by less than a factor of two if no allowance were made for plume rise (ie, zero energy content assigned to each release); alternatively, if each of the releases

were assigned a far greater energy content corresponding to 200 MBtu h^{-1}, the predicted number of early deaths would decrease by a similar factor.

d) Sensitivity to dry deposition velocity

The sensitivity of the predicted radiological consequences to the dry deposition velocity for airborne material has been investigated. Considerable uncertainties are associated with this parameter both because of inherent uncertainties in the deposition velocity for a particular material and uncertainties in the physico-chemical form of the material released in accident conditions. A wide range of deposition velocities was analysed (eg, 10^{-4} m s^{-1} to 10^{-2} m s^{-1} for particulate material; see Table 11 for other forms of material) and was chosen to encompass the extremes of variation that might reasonably be proposed for releases of the type considered. While some correlation would be expected between the deposition velocity and the physico-chemical form of the released material, the latter was assumed to remain unchanged throughout the sensitivity analysis. Such an assumption has been shown in earlier investigations[12] to have little impact on the predicted consequences for releases of composition typical of those analysed.

Variation in the deposition velocity leads to differences in the spatial distribution of airborne and deposited material relative to the release location. The impact of this re-distribution of released material will vary with the radiological consequence considered and will be influenced by the nature and extent of any countermeasures imposed. In general, the variation in the expectation values of each consequence over the range of deposition velocities considered was not large, rarely exceeding a factor of two to three, and often much less. For most of the radiological consequences, the numbers were found to increase with increasing deposition velocity, although there were a few exceptions.

The deposition velocities assumed in the initial study ('original' or 'first estimate' source terms) were intermediate within the range analysed in the sensitivity analysis (see Table 11). The results obtained for release category UK1 can be used to estimate the impact of adopting the bounding values of deposition velocity on the initial study. For the largest deposition velocity considered of 10^{-2} m s^{-1}, the expectation values for the numbers of early deaths and fatal cancers evaluated in the initial study would increase by factors of about 1.3 and two, respectively. For the lowest deposition velocity of 10^{-4} m s^{-1}, the corresponding expectation values would decrease by factors of about two and 1.2, respectively. The variation in the numbers of other consequences is of comparable magnitude.

In summary, the sensitivity of the predicted consequences to variation in the values of most of the parameters investigated is not large. The overall range of

variation in the consequences for the limiting values analysed for each parameter rarely exceeds a factor of a few and in many cases is considerably less. The consequences predicted in the initial study were evaluated using parameter values which, in general, were intermediate in the range investigated in the sensitivity analyses; these predicted consequences are therefore relatively insensitive to uncertainties in the values of the parameters investigated. This observation is, however, particular to the releases analysed from Sizewell: for different releases from different locations the sensitivity may change significantly.

7. REFERENCES

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Table 1

Characteristic parameters of release category UK1[1-8]

Frequency of occurrence (y^{-1})		$2.4\ 10^{-9}$
Time before release[1] (h)		1
Duration of release (h)		3
Energy of release[8] (MBtu h^{-1})		0.3
Elevation of release (m)		10
Warning time[3,8] (h)[7]		0
Fraction of the core inventory released to the environment[4]	Xe-Kr	$9\ 10^{-1}$
	Organic I	$7\ 10^{-3}$
	Inorganic I-Br[5]	$7\ 10^{-1}$
	Cs-Rb	$5\ 10^{-1}$
	Te-Sb	$3\ 10^{-1}$
	Ba-Sr	$6\ 10^{-2}$
	Ru[6]	$2\ 10^{-2}$
	La[7]	$4\ 10^{-3}$

Notes

1. The time between reactor shut-down and the release of activity to the environment.

2. More than 90% of the radioactive material is released within the first hour: to minimise computational expenditure the whole release was assumed in the initial study[1,7] to occur in the first hour and the same assumption is adopted here.

3. The warning time is the time available for the initiation of countermeasures before the release of activity to the environment. It has been evaluated conservatively as the time between vessel melt-through and the release of activity to the environment.

4. The specified fractions of the core are assumed to be released uniformly over the specified release duration and apply to stable isotopes of the specified elements.

5. The Iodine and Bromine are assumed to be released in an elemental form.

6. Includes Ru, Rh, Co, Mo and Tc.

7. Includes Y, La, Zr, Nb, Ce, Pr, Nd, Np, Pu, Am and Cm.

8. The values specified for the energy content and warning time are then adopted in the inital study[1]; both these parameters are the subject of sensitivity analyses in this study and in these cases their values are varied accordingly.

Table 2

Periods and corresponding doses, A_i, used in the procedure proposed by Smith[3] to account for protraction of exposure

Period	Dose, A_i (Gy)
0 - 1 h	0.3
1 - 2 h	0.2
2 - 4 h	0.2
4 - 10 h	0.2
10 - 24 h	0.1
1 - 2 d	0.1
2 - 3 d	0.1
3 - 4 d	0.1
.	.
.	.
.	.
.	.
.	.
28 - 29 d	0.1
29 - 30 d	0.1

Table 3

Characteristic quantities of the probability distributions of early deaths conditional upon the release of UK1; their variation with the LD_{50} for bone marrow irradiation

UK1 FREQUENCY: $2.4\ 10^{-9}\ y^{-1}$ [1]

Parameter		LD_{50} = 3 Gy	LD_{50} = 4 Gy	LD_{50} = 5 Gy
		Number of early deaths, N		
Expectation value, E		$2.1\ 10^{2}$	$1.3\ 10^{2}$	$8.9\ 10^{1}$
Percentile (p)	p=1	0	0	0
	p=50	$1.3\ 10^{0}$	$1.7\ 10^{-1}$	$2.1\ 10^{-2}$
	p=90	$5.0\ 10^{2}$	$2.6\ 10^{2}$	$1.3\ 10^{2}$
	p=99	$3.3\ 10^{3}$	$2.6\ 10^{3}$	$2.2\ 10^{3}$
	p=99.9	$5.1\ 10^{3}$	$4.5\ 10^{3}$	$4.2\ 10^{3}$
		% Probability, P		
% Probability	P(N=0)	43	45	47
	P(N>E)	16	13	11

Note:

1. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table 4

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK1: variation with the LD_{50} for bone marrow irradiation

UK1 FREQUENCY: $2.4\ 10^{-6}\ y^{-1}$ [1]

a) $LD_{50} = 3$ Gy

Health effect	Number of health effects, N						% Probability	
	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Early								
Death	$2.1\ 10^{2}$	0	$1.3\ 10^{0}$	$5.0\ 10^{2}$	$3.3\ 10^{3}$	$5.1\ 10^{3}$	43	16
Prodromal vomiting	$3.7\ 10^{2}$	0	$6.6\ 10^{0}$	$1.2\ 10^{3}$	$4.8\ 10^{3}$	$7.0\ 10^{3}$	41	19
Lung morbidity	$3.4\ 10^{0}$	0	$8.6\ 10^{-4}$	$6.0\ 10^{0}$	$6.5\ 10^{1}$	$1.9\ 10^{2}$	49	12
Late								
Fatal cancer	$3.3\ 10^{3}$	0	$1.5\ 10^{3}$	$9.4\ 10^{3}$	$3.1\ 10^{4}$	$9.3\ 10^{4}$	25	26
Non-fatal thyroid cancer	$7.6\ 10^{3}$	0	$3.9\ 10^{2}$	$2.3\ 10^{4}$	$6.3\ 10^{4}$	$1.0\ 10^{5}$	25	30
Non-fatal skin cancer	$2.4\ 10^{3}$	0	$5.6\ 10^{1}$	$6.6\ 10^{3}$	$2.6\ 10^{4}$	$8.6\ 10^{4}$	25	24
Non-fatal breast cancer	$4.9\ 10^{2}$	0	$1.3\ 10^{1}$	$1.4\ 10^{3}$	$5.2\ 10^{3}$	$1.7\ 10^{4}$	25	24
Hereditary effects	$2.3\ 10^{2}$	0	$9.1\ 10^{1}$	$7.0\ 10^{2}$	$2.3\ 10^{3}$	$8.0\ 10^{3}$	25	25

b) $LD_{50} = 4$ Gy

Health effect	Number of health effects, N						% Probability	
	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Early								
Death	$1.3\ 10^{2}$	0	$1.7\ 10^{-1}$	$2.6\ 10^{2}$	$2.9\ 10^{3}$	$4.3\ 10^{3}$	45	13
Prodromal vomiting	$2.7\ 10^{2}$	0	$6.6\ 10^{0}$	$1.2\ 10^{3}$	$4.8\ 10^{3}$	$7.0\ 10^{3}$	41	19
Lung morbidity	$8.3\ 10^{0}$	0	$2.8\ 10^{-3}$	$1.7\ 10^{1}$	$1.4\ 10^{2}$	$3.8\ 10^{2}$	48	12
Late								
Fatal cancer	$3.3\ 10^{3}$	0	$1.3\ 10^{3}$	$9.3\ 10^{3}$	$3.1\ 10^{4}$	$9.3\ 10^{4}$	25	26
Non-fatal thyroid cancer	$7.7\ 10^{3}$	0	$4.1\ 10^{2}$	$2.3\ 10^{4}$	$6.3\ 10^{4}$	$1.0\ 10^{5}$	25	29
Non-fatal skin cancer	$2.4\ 10^{3}$	0	$5.6\ 10^{1}$	$6.6\ 10^{3}$	$2.6\ 10^{4}$	$8.6\ 10^{4}$	25	24
Non-fatal breast cancer	$4.9\ 10^{2}$	0	$1.3\ 10^{1}$	$1.4\ 10^{3}$	$5.2\ 10^{3}$	$1.7\ 10^{4}$	25	24
Hereditary effects	$2.3\ 10^{3}$	0	$9.1\ 10^{1}$	$7.0\ 10^{2}$	$2.3\ 10^{3}$	$8.0\ 10^{3}$	25	25

c) $LD_{50} = 5$ Gy

Health effect	Number of health effects, N						% Probability	
	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Early								
Death	$8.9\ 10^{1}$	0	$2.1\ 10^{-2}$	$1.3\ 10^{2}$	$2.2\ 10^{3}$	$4.2\ 10^{3}$	47	11
Prodromal vomiting	$2.7\ 10^{2}$	0	$6.6\ 10^{0}$	$1.2\ 10^{3}$	$4.8\ 10^{3}$	$7.0\ 10^{3}$	41	19
Lung morbidity	$1.4\ 10^{1}$	0	$4.8\ 10^{-1}$	$3.1\ 10^{1}$	$2.7\ 10^{2}$	$5.3\ 10^{2}$	47	13
Late								
Fatal cancer	$3.3\ 10^{3}$	0	$1.6\ 10^{3}$	$9.5\ 10^{3}$	$3.1\ 10^{4}$	$9.3\ 10^{4}$	25	29
Non-fatal thyroid cancer	$7.8\ 10^{3}$	0	$4.2\ 10^{2}$	$2.3\ 10^{4}$	$6.3\ 10^{4}$	$1.0\ 10^{5}$	25	30
Non-fatal skin cancer	$2.4\ 10^{3}$	0	$5.6\ 10^{1}$	$6.6\ 10^{3}$	$2.6\ 10^{4}$	$8.6\ 10^{4}$	25	24
Non-fatal breast cancer	$4.9\ 10^{2}$	0	$1.3\ 10^{1}$	$1.4\ 10^{3}$	$5.2\ 10^{3}$	$1.7\ 10^{4}$	25	24
Hereditary effects	$2.3\ 10^{3}$	0	$9.2\ 10^{1}$	$7.0\ 10^{2}$	$2.3\ 10^{3}$	$8.0\ 10^{3}$	25	25

Note:

1. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table 5

Characteristic quantities of the probability distributions of early deaths conditional upon the release of UK1; their variation with the procedure used to allow for protraction of exposure

UK1 FREQUENCY: $2.4\ 10^{-9}\ y^{-1}$ [1]

		Initial procedure for protraction[2]	Revised procedure for protraction[3]
		Number of early deaths, N	
Expectation value, E		$1.3\ 10^{2}$	$6.5\ 10^{1}$
Percentile (p)	p=1	0	0
	p=50	$1.7\ 10^{-1}$	$3.8\ 10^{-3}$
	p=90	$2.6\ 10^{2}$	$6.4\ 10^{1}$
	p=99	$2.6\ 10^{3}$	$1.8\ 10^{3}$
	p=99.9	$4.5\ 10^{3}$	$3.7\ 10^{3}$
		% Probability, P	
% Probability	P(N=0)	45	48
	P(N>E)	13	9.9

Note:

1. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.
2. See equation (1).
3. See equation (2).

Table 6

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK1: variation with the procedure used to take account of protraction of exposure

UK1 FREQUENCY: $2.4\ 10^{-9}\ y^{-1}$ [1]

a) Procedure used to account for protraction in the initial study[2]

Health effect	Number of health effects, N						% Probability	
	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Early								
Death	$1.3\ 10^{2}$	0	$1.7\ 10^{-1}$	$2.6\ 10^{2}$	$2.6\ 10^{3}$	$4.5\ 10^{3}$	45	13
Prodromal vomiting	$3.7\ 10^{2}$	0	$6.6\ 10^{0}$	$1.2\ 10^{3}$	$4.8\ 10^{3}$	$7.0\ 10^{3}$	41	19
Lung morbidity	$8.3\ 10^{0}$	0	$2.8\ 10^{-3}$	$1.7\ 10^{1}$	$1.4\ 10^{2}$	$3.6\ 10^{2}$	48	13
Late								
Fatal cancer	$1.3\ 10^{3}$	0	$1.5\ 10^{2}$	$9.5\ 10^{3}$	$3.1\ 10^{4}$	$9.3\ 10^{4}$	25	26
Non-fatal thyroid cancer	$7.7\ 10^{3}$	0	$4.1\ 10^{2}$	$2.3\ 10^{4}$	$6.5\ 10^{4}$	$1.0\ 10^{5}$	25	29
Non-fatal skin cancer	$2.4\ 10^{3}$	0	$5.6\ 10^{1}$	$6.6\ 10^{3}$	$2.6\ 10^{4}$	$8.6\ 10^{4}$	25	24
Non-fatal breast cancer	$4.9\ 10^{2}$	0	$1.3\ 10^{1}$	$1.4\ 10^{3}$	$5.2\ 10^{3}$	$1.7\ 10^{4}$	25	24
Hereditary effects	$2.5\ 10^{3}$	0	$9.1\ 10^{1}$	$7.0\ 10^{3}$	$2.5\ 10^{4}$	$8.0\ 10^{4}$	25	25

b) Revised procedure to take account of protraction of exposure[3]

Health effect	Number of health effects, N						% Probability	
	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Early								
Death	$6.5\ 10^{1}$	0	$3.8\ 10^{-1}$	$6.4\ 10^{1}$	$1.8\ 10^{3}$	$3.7\ 10^{3}$	48	9.9
Prodromal vomiting	$3.7\ 10^{2}$	0	$6.6\ 10^{0}$	$1.2\ 10^{3}$	$4.8\ 10^{3}$	$7.0\ 10^{3}$	41	19
Lung morbidity	$2.1\ 10^{1}$	0	$8.8\ 10^{-3}$	$4.3\ 10^{1}$	$3.9\ 10^{2}$	$7.8\ 10^{2}$	47	13
Late								
Fatal cancer	$3.3\ 10^{3}$	0	$1.6\ 10^{2}$	$9.5\ 10^{3}$	$3.1\ 10^{4}$	$9.3\ 10^{4}$	25	26
Non-fatal thyroid cancer	$7.8\ 10^{3}$	0	$4.2\ 10^{2}$	$2.3\ 10^{4}$	$6.5\ 10^{4}$	$1.0\ 10^{5}$	25	30
Non-fatal skin cancer	$2.4\ 10^{3}$	0	$5.7\ 10^{1}$	$6.6\ 10^{3}$	$2.6\ 10^{4}$	$8.6\ 10^{4}$	25	24
Non-fatal breast cancer	$4.9\ 10^{2}$	0	$1.4\ 10^{1}$	$1.4\ 10^{3}$	$5.2\ 10^{3}$	$1.7\ 10^{4}$	25	24
Hereditary effects	$2.5\ 10^{3}$	0	$9.2\ 10^{1}$	$7.0\ 10^{3}$	$2.5\ 10^{4}$	$8.0\ 10^{4}$	25	25

Notes:

1. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.
2. See equation (1).
3. See equation (2).

Table 7

Expectation values of the numbers of health effects conditional upon release category UK1: variation with warning time

UK1 FREQUENCY: $2.4\ 10^{-9}\ y^{-1}$ [1]

Warning time (hours)	Expectation value of the number of effects			
	0	1	3	6
Early				
Death	130	110	65	15
Prodromal vomiting	370	350	250	100
Lung morbidity	8.3	8.3	11	4.4
Late				
Fatal cancer	3300	3300	3400	3300
Non-fatal thyroid cancer	7700	7700	7700	7300
Non-fatal skin cancer	2400	2400	2500	2500
Non-fatal breast cancer	490	490	500	510
Hereditary effects	2500	2500	2500	2500

Note:

1. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table 8

Characteristic quantities of the probability distributions of early effects conditional upon release category UK1: variation with warning time

UK1 FREQUENCY: $2.4\ 10^{-9}\ y^{-1}$ [1]

Warning time (hours)	Number of health effects, N						% Probability	
	Expectation value, $\bar{z}$	Value at the p^{th} percentile					P(N=0)	P(N>$\bar{z}$)
		p=1	p=50	p=90	p=99	p=99.9		
a) Early deaths								
0	$1.3\ 10^{2}$	0	$1.7\ 10^{-1}$	$2.6\ 10^{2}$	$2.6\ 10^{3}$	$4.5\ 10^{3}$	45	13
1	$1.1\ 10^{2}$	0	$5.9\ 10^{-2}$	$1.9\ 10^{2}$	$2.5\ 10^{3}$	$4.5\ 10^{3}$	46	12
3	$6.5\ 10^{1}$	0	0	$6.0\ 10^{1}$	$1.7\ 10^{3}$	$3.6\ 10^{3}$	64	9.7
6	$1.5\ 10^{1}$	0	0	$3.0\ 10^{-1}$	$3.3\ 10^{2}$	$1.3\ 10^{3}$	84	7.3
b) Prodromal vomiting								
0	$3.7\ 10^{2}$	0	$6.6\ 10^{0}$	$1.2\ 10^{3}$	$4.8\ 10^{3}$	$7.0\ 10^{3}$	41	19
1	$3.5\ 10^{2}$	0	$6.1\ 10^{0}$	$1.1\ 10^{3}$	$4.7\ 10^{3}$	$7.0\ 10^{3}$	42	19
3	$2.5\ 10^{2}$	0	$5.9\ 10^{-2}$	$7.0\ 10^{2}$	$3.9\ 10^{3}$	$5.7\ 10^{3}$	49	17
6	$1.0\ 10^{2}$	0	0	$1.8\ 10^{2}$	$1.9\ 10^{3}$	$3.8\ 10^{3}$	64	12
c) Lung morbidity								
0	$8.3\ 10^{0}$	0	$2.8\ 10^{-3}$	$1.7\ 10^{1}$	$1.4\ 10^{2}$	$3.6\ 10^{2}$	48	13
1	$8.3\ 10^{0}$	0	0	$1.4\ 10^{1}$	$1.6\ 10^{2}$	$3.7\ 10^{2}$	59	12
3	$1.1\ 10^{1}$	0	0	$1.7\ 10^{1}$	$2.4\ 10^{2}$	$4.4\ 10^{2}$	61	11
6	$4.4\ 10^{0}$	0	0	0	$1.4\ 10^{2}$	$3.3\ 10^{2}$	82	6.8

Note:

1. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table 9

Expectation values of the radiological consequences conditional upon release category UK1: variation with energy content of the release

UK1 FREQUENCY: $2.4\ 10^{-9}\ y^{-1}$ [1]

Energy content of release[2] (MBtu h^{-1})	Expectation value of consequences			
	0	0.3	20	200
Early				
Death	$1.4\ 10^{2}$	$1.3\ 10^{2}$	$5.4\ 10^{1}$	$4.3\ 10^{1}$
Prodromal vomiting	$3.8\ 10^{2}$	$3.7\ 10^{2}$	$2.3\ 10^{2}$	$1.5\ 10^{2}$
Lung morbidity	$9.3\ 10^{0}$	$8.3\ 10^{0}$	$3.8\ 10^{0}$	$2.8\ 10^{0}$
Late effects				
Fatal cancer	$3.4\ 10^{3}$	$3.3\ 10^{3}$	$3.4\ 10^{3}$	$3.4\ 10^{3}$
Non-fatal thyroid cancer	$7.7\ 10^{3}$	$7.7\ 10^{3}$	$8.3\ 10^{3}$	$8.2\ 10^{3}$
Non-fatal skin cancer	$2.5\ 10^{3}$	$2.4\ 10^{3}$	$2.5\ 10^{3}$	$2.5\ 10^{3}$
Non-fatal breast cancer	$5.0\ 10^{2}$	$4.9\ 10^{2}$	$5.1\ 10^{2}$	$5.1\ 10^{2}$
Hereditary effects	$2.5\ 10^{3}$	$2.5\ 10^{3}$	$2.6\ 10^{3}$	$2.6\ 10^{3}$
Restrictions on people and agriculture				
Number of people evacuated	$2.2\ 10^{4}$	$2.4\ 10^{4}$	$2.3\ 10^{4}$	$2.1\ 10^{4}$
Area of land evacuated	$1.2\ 10^{2}$	$1.2\ 10^{2}$	$1.2\ 10^{2}$	$1.1\ 10^{2}$
Total milk restricted (litres)	$4.4\ 10^{8}$	$4.4\ 10^{8}$	$4.5\ 10^{8}$	$4.5\ 10^{8}$
Time integral of the area of crop restrictions (km^2-y)	$4.4\ 10^{3}$	$4.3\ 10^{3}$	$4.2\ 10^{3}$	$4.1\ 10^{3}$
Time integral of the number of livestock restricted (livestock-y)	$2.9\ 10^{6}$	$2.8\ 10^{6}$	$2.9\ 10^{6}$	$2.9\ 10^{6}$

Note:

1. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.
2. The energy release rates in SI units (MW) can be obtained from the values given in MBtu h^{-1} by multiplying by a factor of 0.29.

Table 10

Characteristic quantities of the probability distributions of early effects conditional upon release category UK1: variation with energy content of the release

UK1 FREQUENCY: $2.4\ 10^{-9}\ y^{-1}$ [1]

Energy content of release[2] ($MBtu\ h^{-1}$)	Number of health effects, N						% Probability	
	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
a) Early deaths								
0	$1.4\ 10^{2}$	0	$2.3\ 10^{-1}$	$2.7\ 10^{2}$	$3.0\ 10^{3}$	$4.6\ 10^{3}$	44	13
0.3	$1.3\ 10^{2}$	0	$1.7\ 10^{-1}$	$2.6\ 10^{2}$	$2.8\ 10^{3}$	$4.5\ 10^{3}$	45	13
20	$5.4\ 10^{1}$	0	0	$4.1\ 10^{1}$	$1.4\ 10^{3}$	$4.3\ 10^{3}$	53	8.6
100	$4.3\ 10^{1}$	0	0	$2.7\ 10^{0}$	$1.3\ 10^{3}$	$4.3\ 10^{3}$	80	6.1
b) Prodromal vomiting								
0	$3.8\ 10^{2}$	0	$7.5\ 10^{0}$	$1.2\ 10^{3}$	$5.1\ 10^{3}$	$7.0\ 10^{3}$	41	19
0.3	$3.7\ 10^{2}$	0	$6.6\ 10^{0}$	$1.2\ 10^{3}$	$4.8\ 10^{3}$	$7.0\ 10^{3}$	41	19
20	$2.3\ 10^{2}$	0	$2.8\ 10^{0}$	$6.0\ 10^{3}$	$3.5\ 10^{3}$	$6.6\ 10^{3}$	42	18
100	$1.5\ 10^{2}$	0	0	$1.7\ 10^{2}$	$3.4\ 10^{3}$	$6.4\ 10^{3}$	55	11
c) Lung morbidity								
0	$9.3\ 10^{0}$	0	$6.4\ 10^{-3}$	$1.8\ 10^{1}$	$1.6\ 10^{2}$	$4.2\ 10^{2}$	48	13
0.3	$8.2\ 10^{0}$	0	$2.8\ 10^{-3}$	$1.7\ 10^{1}$	$1.4\ 10^{2}$	$3.6\ 10^{2}$	48	13
20	$3.8\ 10^{0}$	0	0	$2.2\ 10^{0}$	$1.1\ 10^{2}$	$3.2\ 10^{2}$	67	7.7
100	$2.8\ 10^{0}$	0	0	0	$9.9\ 10^{1}$	$3.1\ 10^{2}$	91	4.8

Note:

1. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

2. The energy release rates in SI units (MW) can be obtained from the values given in $MBtu\ h^{-1}$ by multiplying by a factor of 0.29.

Table 11

The deposition velocities assigned in the sensitivity analysis to various radioactive materials

Species / Scenario[1]	Dry deposition velocity ($m\ s^{-1}$)			
	Inorganic iodine[2]	Organic iodine	Noble gases	Particulate material
Initial study[3]	10^{-2}	10^{-5}	0	10^{-3}
(a)	10^{-2}	10^{-4}	0	10^{-2}
(b)	10^{-3}	10^{-5}	0	10^{-3}
(c)	10^{-4}	10^{-6}	0	10^{-4}

Notes:

1. Apart from the initial study the scenario is identified by the deposition velocity assigned to particulate material.

2. Apart from the initial study the deposition velocity of inorganic iodine is taken to be equal to that of the particulate material.

3. The deposition velocities in the initial study were chosen as 'best estimate' values and were intermediate in the range of possible variation. In that study the inorganic iodine was assumed to be in a elemental form and the particulate material was assumed to be in the form of a 1 μm AMAD aerosol.

Table 12

Characteristic quantities of the distributions of consequences conditional upon release category UK1: variation with the dry deposition velocity

INITIAL STUDY[1]

UK1 FREQUENCY: $2.4\ 10^{-9}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N						% Probability	
	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Early								
Death	$1.3\ 10^{2}$	0	$1.7\ 10^{-1}$	$2.6\ 10^{2}$	$2.6\ 10^{3}$	$4.5\ 10^{3}$	45	13
Prodromal vomiting	$3.7\ 10^{2}$	0	$6.6\ 10^{0}$	$1.2\ 10^{3}$	$4.8\ 10^{3}$	$7.0\ 10^{3}$	41	19
Lung morbidity	$8.3\ 10^{0}$	0	$2.8\ 10^{-3}$	$1.7\ 10^{1}$	$1.4\ 10^{2}$	$3.6\ 10^{2}$	48	13
Late								
Fatal cancer	$3.3\ 10^{3}$	0	$1.5\ 10^{2}$	$9.5\ 10^{3}$	$3.1\ 10^{4}$	$9.3\ 10^{4}$	25	26
Non-fatal thyroid cancer	$7.7\ 10^{3}$	0	$4.1\ 10^{2}$	$2.3\ 10^{4}$	$6.5\ 10^{4}$	$1.0\ 10^{5}$	25	19
Non-fatal skin cancer	$2.4\ 10^{3}$	0	$5.6\ 10^{1}$	$6.6\ 10^{3}$	$2.6\ 10^{4}$	$8.6\ 10^{4}$	25	24
Non-fatal breast cancer	$4.9\ 10^{2}$	0	$1.2\ 10^{1}$	$1.4\ 10^{3}$	$5.2\ 10^{3}$	$1.7\ 10^{4}$	25	24
Hereditary effects	$2.5\ 10^{3}$	0	$9.1\ 10^{1}$	$7.0\ 10^{3}$	$2.5\ 10^{4}$	$8.0\ 10^{4}$	25	25

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Number of people evacuated	$2.4\ 10^{4}$	0	$9.3\ 10^{2}$	$4.2\ 10^{4}$	$3.0\ 10^{5}$	$2.2\ 10^{6}$	30	16
Area of land evacuated (km^2)	$1.2\ 10^{2}$	0	$9.7\ 10^{0}$	$3.6\ 10^{2}$	$1.3\ 10^{3}$	$1.8\ 10^{3}$	30	29

c) Agricultural products restricted by countermeasures[3]

Agricultural product	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Milk restricted in 7 days (litres)	$1.5\ 10^{7}$	0	$4.1\ 10^{4}$	$6.5\ 10^{7}$	$1.2\ 10^{8}$	$1.2\ 10^{8}$	36	24
Total milk restricted (litres)	$4.4\ 10^{8}$	0	$6.4\ 10^{6}$	$1.0\ 10^{9}$	$5.6\ 10^{9}$	$1.1\ 10^{10}$	36	26
Initial crop area restricted (km^2)	$2.6\ 10^{3}$	0	$2.4\ 10^{1}$	$1.0\ 10^{4}$	$1.4\ 10^{4}$	$1.6\ 10^{4}$	36	26
Time integral of the area of crop restrictions (km^2-y)	$4.3\ 10^{3}$	0	$5.5\ 10^{1}$	$1.4\ 10^{4}$	$3.6\ 10^{4}$	$4.7\ 10^{4}$	36	29
Initial no. livestock restricted	$2.0\ 10^{6}$	0	$5.0\ 10^{3}$	$8.2\ 10^{6}$	$1.3\ 10^{7}$	$1.5\ 10^{7}$	36	24
Time integral of the number of livestock restricted - (livestock-y)	$2.8\ 10^{6}$	0	$2.1\ 10^{4}$	$9.2\ 10^{6}$	$2.9\ 10^{7}$	$4.0\ 10^{7}$	36	27

Notes:

1. See Table 11. A V_d of 10^{-3} m s^{-1} was assumed for particulate material and 10^{-2} m s^{-1} for elemental iodine.
2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.
3. The areas of crop restrictions refer to the actual land area devoted to crop production.

Table 13

Characteristic quantities of the distributions of consequences conditional upon release category UK1: variation with the dry deposition velocity

DEPOSITION VELOCITY[1] = 10^{-2} m s^{-1}

UK1 FREQUENCY: $2.4\ 10^{-9}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9	
Early							
Death	$1.7\ 10^{2}$	0	$5.0\ 10^{-1}$	$3.7\ 10^{2}$	$2.9\ 10^{3}$	$4.8\ 10^{3}$	45	14
Prodromal vomiting	$4.3\ 10^{2}$	0	$1.4\ 10^{1}$	$1.4\ 10^{3}$	$5.1\ 10^{3}$	$6.1\ 10^{3}$	41	22
Lung morbidity	$2.0\ 10^{0}$	0	$9.1\ 10^{-4}$	$4.6\ 10^{0}$	$3.2\ 10^{1}$	$3.7\ 10^{1}$	49	15
Late								
Fatal cancer	$5.4\ 10^{3}$	0	$2.9\ 10^{2}$	$1.8\ 10^{4}$	$5.2\ 10^{4}$	$1.0\ 10^{5}$	25	25
Non-fatal thyroid cancer	$8.8\ 10^{3}$	0	$4.4\ 10^{2}$	$2.7\ 10^{4}$	$8.2\ 10^{4}$	$1.2\ 10^{5}$	25	27
Non-fatal skin cancer	$4.5\ 10^{3}$	0	$1.5\ 10^{2}$	$1.5\ 10^{4}$	$4.6\ 10^{4}$	$9.4\ 10^{4}$	25	23
Non-fatal breast cancer	$9.1\ 10^{2}$	0	$3.1\ 10^{1}$	$3.0\ 10^{3}$	$9.2\ 10^{3}$	$1.9\ 10^{4}$	25	23
Hereditary effects	$4.5\ 10^{3}$	0	$1.7\ 10^{2}$	$1.5\ 10^{4}$	$4.4\ 10^{4}$	$8.8\ 10^{4}$	25	24

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Number of people evacuated	$3.3\ 10^{4}$	0	$1.2\ 10^{3}$	$9.8\ 10^{4}$	$2.5\ 10^{5}$	$1.6\ 10^{6}$	30	26
Area of land evacuated (km^2)	$1.8\ 10^{2}$	0	$1.2\ 10^{1}$	$5.2\ 10^{2}$	$1.3\ 10^{3}$	$2.1\ 10^{3}$	30	37

c) Agricultural products restricted by countermeasures[3]

Agricultural product	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Milk restricted in 7 days (litres)	$1.6\ 10^{7}$	0	$4.1\ 10^{4}$	$6.9\ 10^{7}$	$1.2\ 10^{8}$	$1.3\ 10^{8}$	36	24
Total milk restricted (litres)	$7.6\ 10^{8}$	0	$1.8\ 10^{7}$	$2.7\ 10^{9}$	$6.4\ 10^{9}$	$9.4\ 10^{9}$	36	29
Initial crop area restricted (km^2)	$2.8\ 10^{3}$	0	$2.4\ 10^{1}$	$1.1\ 10^{4}$	$1.5\ 10^{4}$	$1.8\ 10^{4}$	36	25
Time integral of the area of crop restrictions (km^2-y)	$7.2\ 10^{3}$	0	$2.9\ 10^{2}$	$2.4\ 10^{4}$	$3.9\ 10^{4}$	$5.0\ 10^{4}$	36	24
Initial no. livestock restricted	$2.3\ 10^{6}$	0	$4.9\ 10^{3}$	$9.9\ 10^{6}$	$1.5\ 10^{7}$	$1.7\ 10^{7}$	36	23
Time integral of the number of livestock restricted - (livestock-y)	$5.0\ 10^{6}$	0	$3.9\ 10^{4}$	$1.9\ 10^{7}$	$4.1\ 10^{7}$	$5.2\ 10^{7}$	36	25

Notes:

1. See Table 11. The value quoted is for the particulate component of the release.
2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.
3. The areas of crop restrictions refer to the actual land area used for crop production.

Table 14

Characteristic quantities of the distributions of consequences conditional upon release category UK1: variation with the dry deposition velocity

DEPOSITION VELOCITY[1] = 10^{-3} m s^{-1}

UK1 FREQUENCY: $2.4\ 10^{-9}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N						% Probability	
	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Early								
Death	$7.0\ 10^{1}$	0	$4.7\ 10^{-3}$	$6.9\ 10^{1}$	$2.0\ 10^{3}$	$4.1\ 10^{3}$	47	9.9
Prodromal vomiting	$3.1\ 10^{2}$	0	$1.6\ 10^{0}$	$7.3\ 10^{2}$	$5.0\ 10^{3}$	$2.2\ 10^{4}$	42	15
Lung morbidity	$2.0\ 10^{1}$	0	$4.6\ 10^{-3}$	$3.9\ 10^{1}$	$4.0\ 10^{2}$	$6.2\ 10^{2}$	47	12
Late								
Fatal cancer	$3.5\ 10^{3}$	0	$1.6\ 10^{2}$	$1.1\ 10^{4}$	$3.4\ 10^{4}$	$9.3\ 10^{4}$	25	26
Non-fatal thyroid cancer	$1.3\ 10^{4}$	0	$4.9\ 10^{2}$	$4.1\ 10^{4}$	$1.2\ 10^{5}$	$1.9\ 10^{5}$	25	28
Non-fatal skin cancer	$2.3\ 10^{3}$	0	$5.7\ 10^{1}$	$6.4\ 10^{3}$	$2.7\ 10^{4}$	$8.6\ 10^{4}$	25	24
Non-fatal breast cancer	$4.8\ 10^{2}$	0	$1.4\ 10^{1}$	$1.3\ 10^{3}$	$5.4\ 10^{3}$	$1.7\ 10^{4}$	25	24
Hereditary effects	$2.4\ 10^{3}$	0	$9.5\ 10^{1}$	$6.9\ 10^{3}$	$2.5\ 10^{4}$	$8.0\ 10^{4}$	25	25

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Number of people evacuated	$2.4\ 10^{4}$	0	$5.0\ 10^{2}$	$3.3\ 10^{4}$	$3.7\ 10^{5}$	$2.7\ 10^{6}$	30	20
Area of land evacuated (km^2)	$1.2\ 10^{2}$	0	$9.4\ 10^{0}$	$3.1\ 10^{2}$	$1.3\ 10^{3}$	$4.3\ 10^{3}$	30	19

c) Agricultural products restricted by countermeasures[3]

Agricultural product	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Milk restricted in 7 days (litres)	$1.5\ 10^{7}$	0	$4.1\ 10^{4}$	$6.4\ 10^{7}$	$1.1\ 10^{8}$	$1.3\ 10^{8}$	36	24
Total milk restricted (litres)	$4.3\ 10^{8}$	0	$6.5\ 10^{6}$	$9.9\ 10^{8}$	$5.8\ 10^{9}$	$1.1\ 10^{10}$	36	25
Initial crop area restricted (km^2)	$2.7\ 10^{3}$	0	$2.4\ 10^{1}$	$1.0\ 10^{4}$	$1.4\ 10^{4}$	$1.6\ 10^{4}$	36	26
Time integral of the area of crop restrictions (km^2-y)	$4.3\ 10^{3}$	0	$5.6\ 10^{1}$	$1.4\ 10^{4}$	$3.5\ 10^{4}$	$5.1\ 10^{4}$	36	29
Initial no. livestock restricted	$2.0\ 10^{6}$	0	$4.8\ 10^{3}$	$8.2\ 10^{6}$	$1.3\ 10^{7}$	$1.6\ 10^{7}$	36	24
Time integral of the number of livestock restricted - (livestock-y)	$2.9\ 10^{6}$	0	$2.1\ 10^{4}$	$9.5\ 10^{6}$	$2.8\ 10^{7}$	$4.5\ 10^{7}$	36	27

Notes:

1. See Table 11. The value quoted is for the particulate component of the release.
2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.
3. The areas of crop restrictions refer to the actual land area used for crop production.

Table 15

Characteristic quantities of the distributions of consequences conditional upon release category UK1: variation with the dry deposition velocity

DEPOSITION VELOCITY[1] = 10^{-2} m s^{-1}

UK1 FREQUENCY: $2.4\ 10^{-9}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N						% Probability	
	Expectation value, E	Value at the p^{th} percentile						
		p=1	p=50	p=90	p=99	p=99.9	P(N=0)	P(N>E)
Early								
Death	$6.1\ 10^{1}$	0	$1.6\ 10^{-3}$	$4.8\ 10^{1}$	$1.8\ 10^{3}$	$3.9\ 10^{3}$	47	9.5
Prodromal vomiting	$1.0\ 10^{2}$	0	$1.2\ 10^{0}$	$6.0\ 10^{2}$	$4.9\ 10^{3}$	$2.7\ 10^{4}$	43	14
Lung morbidity	$2.5\ 10^{1}$	0	$4.3\ 10^{-3}$	$4.7\ 10^{1}$	$4.8\ 10^{2}$	$8.4\ 10^{2}$	48	12
Late								
Fatal cancer	$2.6\ 10^{3}$	0	$1.0\ 10^{2}$	$7.0\ 10^{3}$	$2.9\ 10^{4}$	$9.1\ 10^{4}$	25	25
Non-fatal thyroid cancer	$1.4\ 10^{4}$	0	$4.9\ 10^{2}$	$4.4\ 10^{4}$	$1.3\ 10^{5}$	$2.2\ 10^{5}$	25	27
Non-fatal skin cancer	$1.4\ 10^{3}$	0	$2.4\ 10^{1}$	$2.2\ 10^{3}$	$2.6\ 10^{4}$	$8.3\ 10^{4}$	25	14
Non-fatal breast cancer	$2.9\ 10^{2}$	0	$6.2\ 10^{0}$	$4.9\ 10^{2}$	$5.2\ 10^{3}$	$1.7\ 10^{4}$	25	16
Hereditary effects	$1.5\ 10^{3}$	0	$3.7\ 10^{1}$	$2.8\ 10^{3}$	$2.4\ 10^{4}$	$7.7\ 10^{4}$	25	18

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Number of people evacuated	$2.3\ 10^{4}$	0	$2.4\ 10^{2}$	$2.0\ 10^{4}$	$3.8\ 10^{5}$	$2.9\ 10^{6}$	30	4.5
Area of land evacuated (km^2)	$9.8\ 10^{1}$	0	$7.1\ 10^{0}$	$2.0\ 10^{2}$	$1.4\ 10^{3}$	$4.4\ 10^{3}$	30	16

c) Agricultural products restricted by countermeasures[3]

Agricultural product	Expectation value, E	Value at the p^{th} percentile					P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99	p=99.9		
Milk restricted in 7 days (litres)	$1.1\ 10^{7}$	0	$3.7\ 10^{4}$	$4.3\ 10^{7}$	$8.4\ 10^{7}$	$1.1\ 10^{8}$	36	22
Total milk restricted (litres)	$3.2\ 10^{8}$	0	$1.4\ 10^{6}$	$5.7\ 10^{8}$	$5.7\ 10^{9}$	$1.5\ 10^{10}$	36	15
Initial crop area restricted (km^2)	$1.5\ 10^{3}$	0	$1.4\ 10^{1}$	$5.9\ 10^{3}$	$9.4\ 10^{3}$	$1.1\ 10^{4}$	36	27
Time integral of the area of crop restrictions (km^2-y)	$2.6\ 10^{3}$	0	$1.6\ 10^{1}$	$7.8\ 10^{3}$	$3.4\ 10^{4}$	$4.9\ 10^{4}$	36	25
Initial no. livestock restricted	$8.4\ 10^{5}$	0	$3.1\ 10^{3}$	$3.0\ 10^{6}$	$8.7\ 10^{6}$	$1.1\ 10^{7}$	36	22
Time integral of the number of livestock restricted - (livestock-y)	$1.8\ 10^{6}$	0	$6.3\ 10^{3}$	$4.3\ 10^{6}$	$2.4\ 10^{7}$	$4.1\ 10^{7}$	36	17

Notes:

1. See Table 1. The value quoted is for the particulate component of the release.
2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.
3. The areas of crop restrictions refer to the actual land area used for crop production.

Table 16

Expectation values and values of the 99th percentile for the radiological consequences conditional upon release category UK1: variation with the dry deposition velocity

UK1 FREQUENCY: $2.4\ 10^{-9}\ y^{-1}$ [2]

	Expected value				Value at the 99th percentile			
	Deposition velocity[1] ($m\ s^{-1}$)				Deposition velocity[1] ($m\ s^{-1}$)			
	10^{-2}	Initial study	10^{-3}	10^{-4}	10^{-2}	Initial study	10^{-3}	10^{-4}
Health effects								
Early death	$1.7\ 10^{2}$	$1.3\ 10^{2}$	$7.0\ 10^{1}$	$6.1\ 10^{1}$	$2.9\ 10^{3}$	$2.6\ 10^{3}$	$2.0\ 10^{3}$	$1.8\ 10^{3}$
Prodromal vomiting	$4.3\ 10^{2}$	$3.7\ 10^{2}$	$3.1\ 10^{2}$	$3.0\ 10^{2}$	$5.1\ 10^{3}$	$4.8\ 10^{3}$	$5.0\ 10^{3}$	$4.9\ 10^{3}$
Lung morbidity	$2.0\ 10^{0}$	$8.3\ 10^{0}$	$2.0\ 10^{1}$	$2.5\ 10^{1}$	$3.2\ 10^{1}$	$1.4\ 10^{2}$	$4.0\ 10^{2}$	$4.8\ 10^{2}$
Fatal cancer	$5.4\ 10^{3}$	$3.3\ 10^{3}$	$3.5\ 10^{3}$	$2.6\ 10^{3}$	$5.2\ 10^{4}$	$3.1\ 10^{4}$	$3.4\ 10^{4}$	$2.9\ 10^{4}$
Non-fatal thyroid cancer	$8.8\ 10^{3}$	$7.7\ 10^{3}$	$1.3\ 10^{4}$	$1.4\ 10^{4}$	$8.2\ 10^{4}$	$6.5\ 10^{4}$	$1.2\ 10^{5}$	$1.3\ 10^{5}$
Non-fatal skin cancer	$4.5\ 10^{3}$	$2.4\ 10^{3}$	$2.3\ 10^{3}$	$1.4\ 10^{3}$	$4.6\ 10^{4}$	$2.8\ 10^{4}$	$2.7\ 10^{4}$	$2.6\ 10^{4}$
Non-fatal breast cancer	$9.1\ 10^{2}$	$4.9\ 10^{2}$	$4.8\ 10^{2}$	$2.9\ 10^{2}$	$9.2\ 10^{3}$	$5.2\ 10^{3}$	$5.4\ 10^{3}$	$5.2\ 10^{3}$
Hereditary effects	$4.5\ 10^{3}$	$2.5\ 10^{3}$	$2.4\ 10^{3}$	$1.5\ 10^{3}$	$4.4\ 10^{4}$	$2.5\ 10^{4}$	$2.5\ 10^{4}$	$2.4\ 10^{4}$
Restrictions on people and agricultural products								
Number of people evacuated	$3.3\ 10^{4}$	$2.4\ 10^{4}$	$2.4\ 10^{4}$	$2.3\ 10^{4}$	$2.5\ 10^{5}$	$3.0\ 10^{5}$	$3.7\ 10^{5}$	$3.8\ 10^{5}$
Area of land evacuated (km^2)	$1.8\ 10^{2}$	$1.2\ 10^{2}$	$1.2\ 10^{2}$	$9.8\ 10^{1}$	$1.3\ 10^{3}$	$1.3\ 10^{3}$	$1.3\ 10^{3}$	$1.4\ 10^{3}$
Milk restricted - 7 days	$1.6\ 10^{7}$	$1.5\ 10^{7}$	$1.5\ 10^{7}$	$1.1\ 10^{7}$	$1.2\ 10^{8}$	$1.2\ 10^{8}$	$1.1\ 10^{8}$	$8.4\ 10^{7}$
Milk restricted (1)	$7.6\ 10^{8}$	$4.4\ 10^{8}$	$4.3\ 10^{8}$	$3.2\ 10^{8}$	$6.4\ 10^{9}$	$5.6\ 10^{9}$	$5.8\ 10^{9}$	$5.7\ 10^{9}$
Initial area of crop restrictions, km	$2.8\ 10^{3}$	$2.6\ 10^{3}$	$2.7\ 10^{3}$	$1.5\ 10^{3}$	$1.5\ 10^{4}$	$1.4\ 10^{4}$	$1.4\ 10^{4}$	$9.4\ 10^{3}$
Time integral of area of crop restrictions (km^2-y)	$7.2\ 10^{3}$	$4.3\ 10^{3}$	$4.3\ 10^{3}$	$2.6\ 10^{3}$	$3.9\ 10^{4}$	$3.6\ 10^{4}$	$3.5\ 10^{4}$	$3.4\ 10^{4}$
Initial number of livestock restricted	$2.3\ 10^{6}$	$2.0\ 10^{6}$	$2.0\ 10^{6}$	$8.4\ 10^{5}$	$1.5\ 10^{7}$	$1.3\ 10^{7}$	$1.3\ 10^{7}$	$8.7\ 10^{6}$
Livestock restricted (livestock-y)	$5.0\ 10^{6}$	$2.8\ 10^{6}$	$2.9\ 10^{6}$	$1.6\ 10^{6}$	$4.1\ 10^{7}$	$2.9\ 10^{7}$	$2.8\ 10^{7}$	$2.4\ 10^{7}$

Notes:

1. See Table 11; the quoted deposition velocity refers to the value adopted for particulate material.
2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequence of interest.

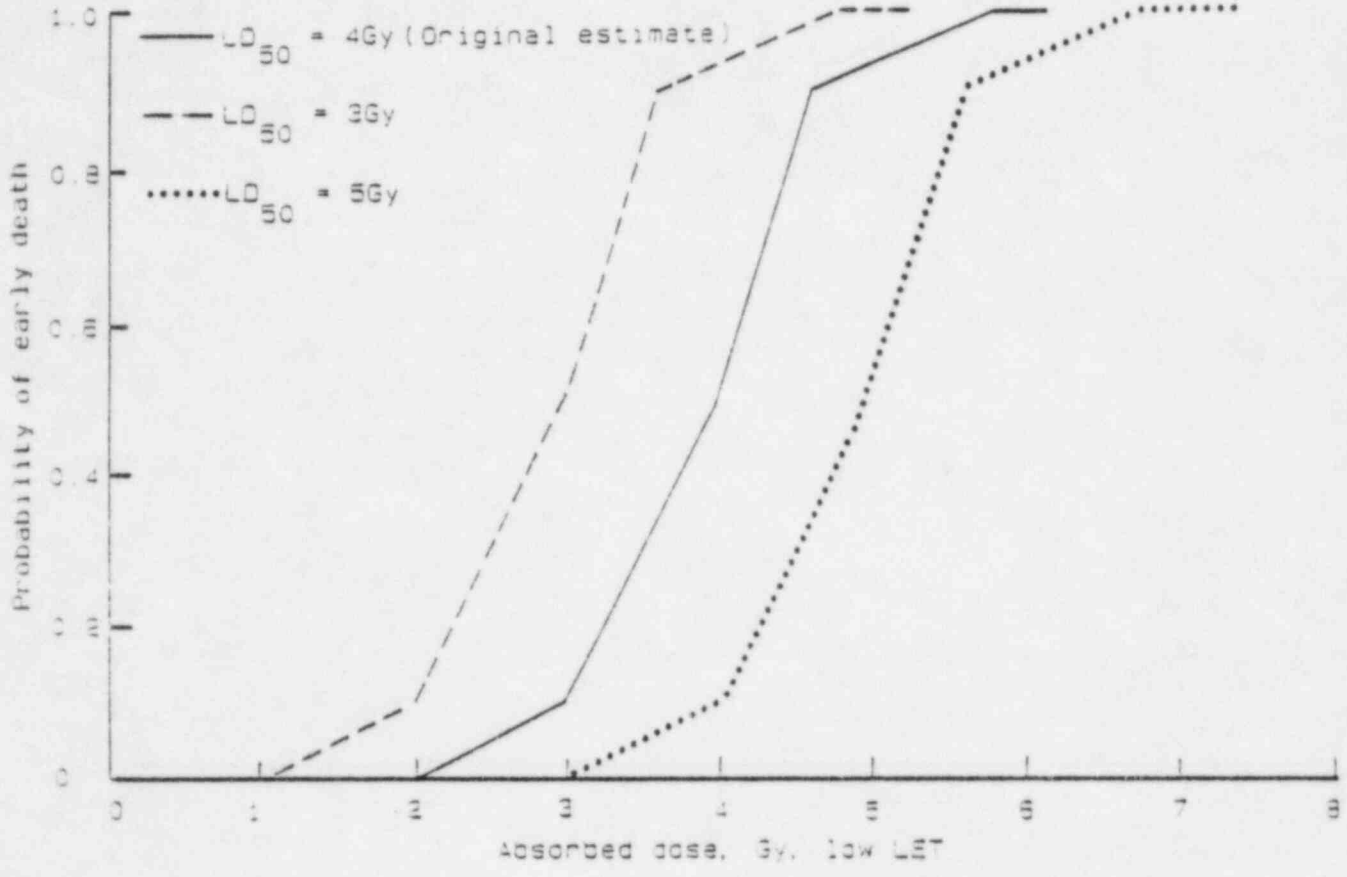


Figure 1 Dose-mortality relationships for bone marrow irradiation considered in the sensitivity analysis

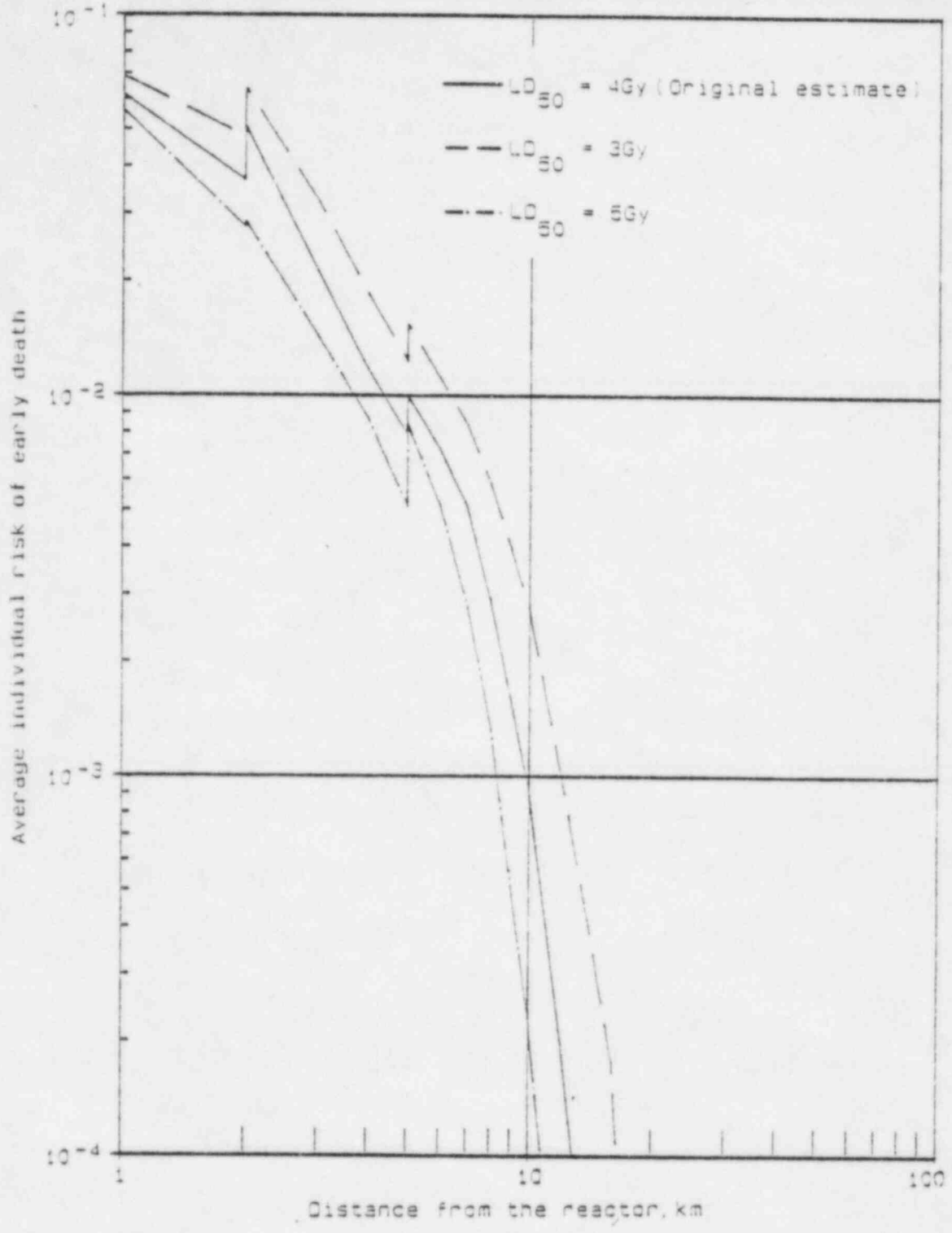


Figure 2 Average individual risk of early death conditional upon release category UK1: sensitivity to the LD_{50} for bone marrow irradiation

UK 1: Frequency $2.4\ 10^{-9}\ y^{-1}$

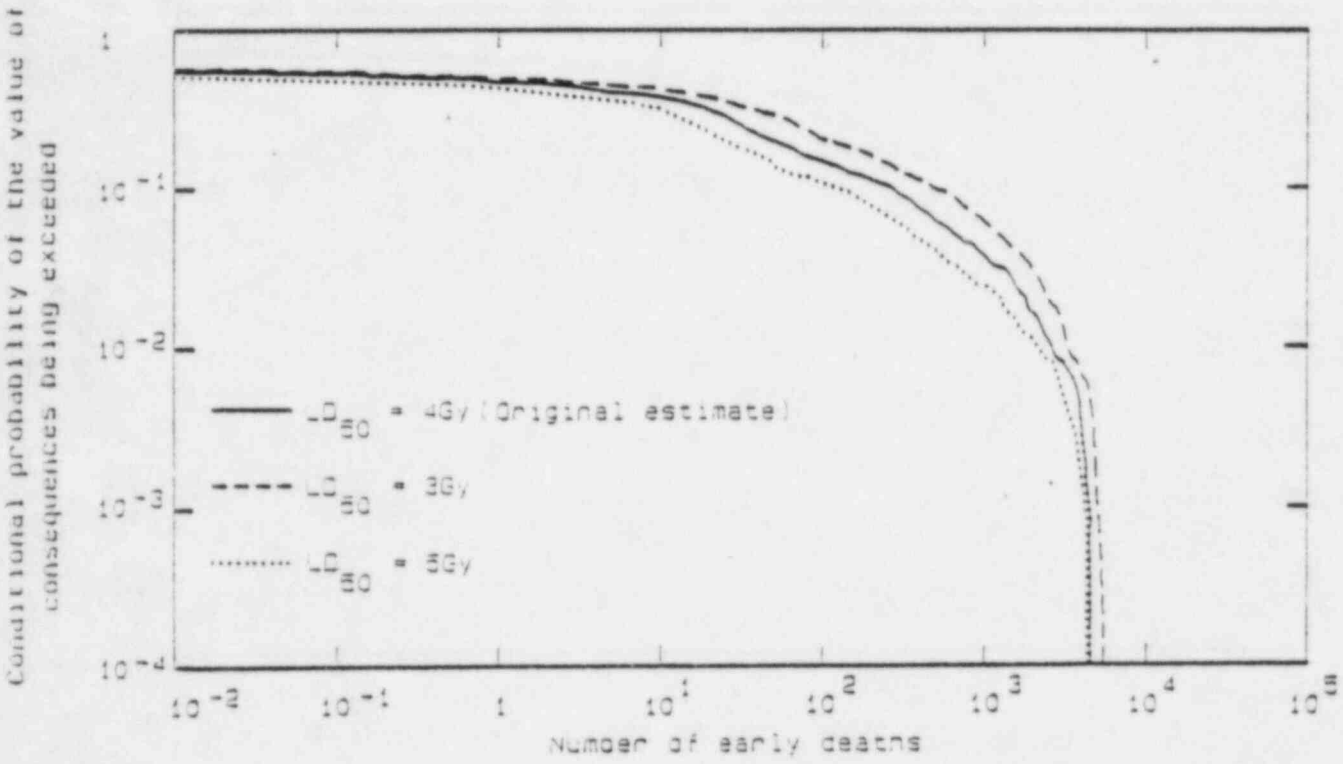


Figure 3 Sensitivity of the conditional probability distribution of early deaths for UK1 to the LD_{50} for bone marrow irradiation

UK 1: Frequency $2.4\ 10^{-3}\ y^{-1}$

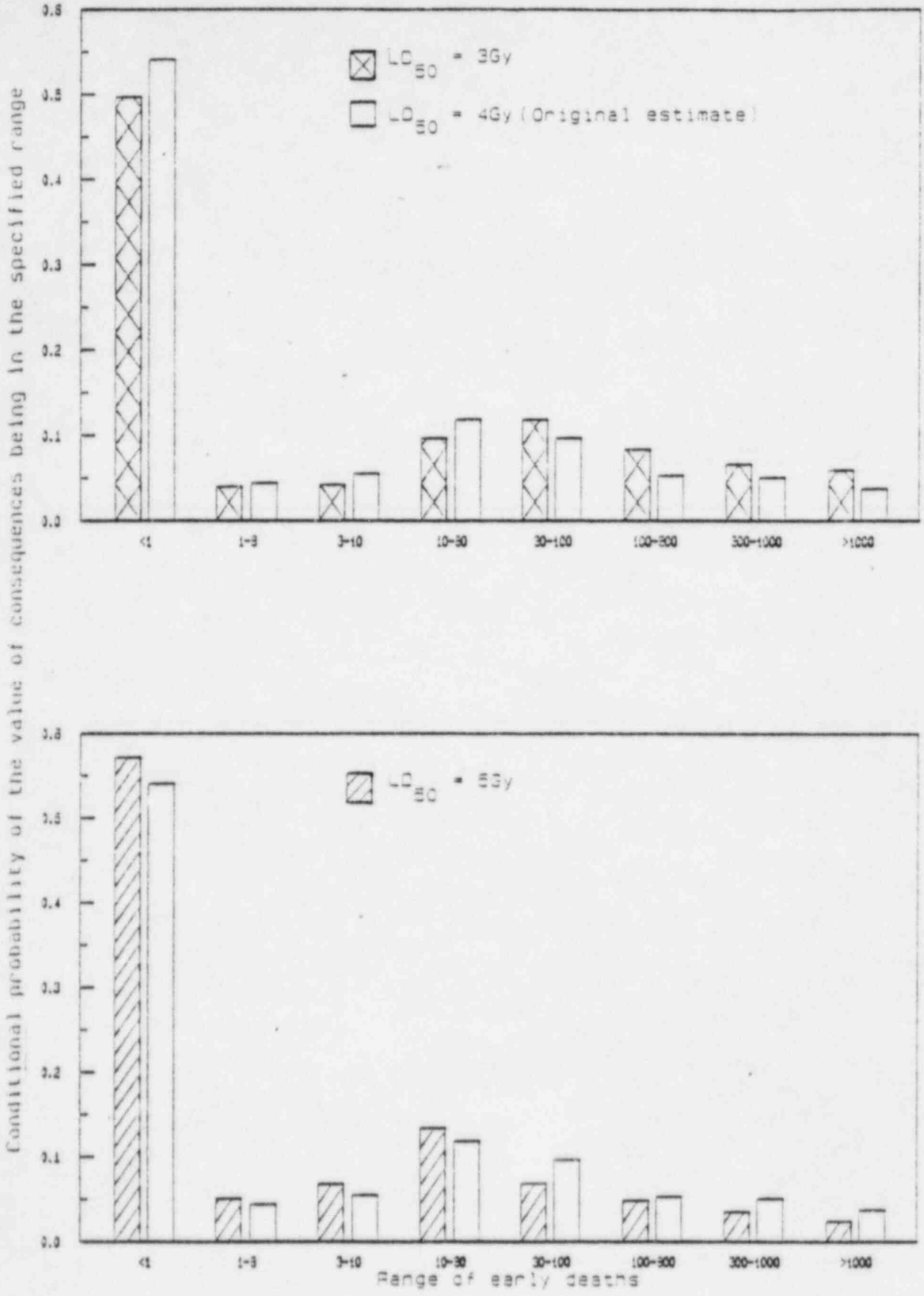


Figure 3 continued

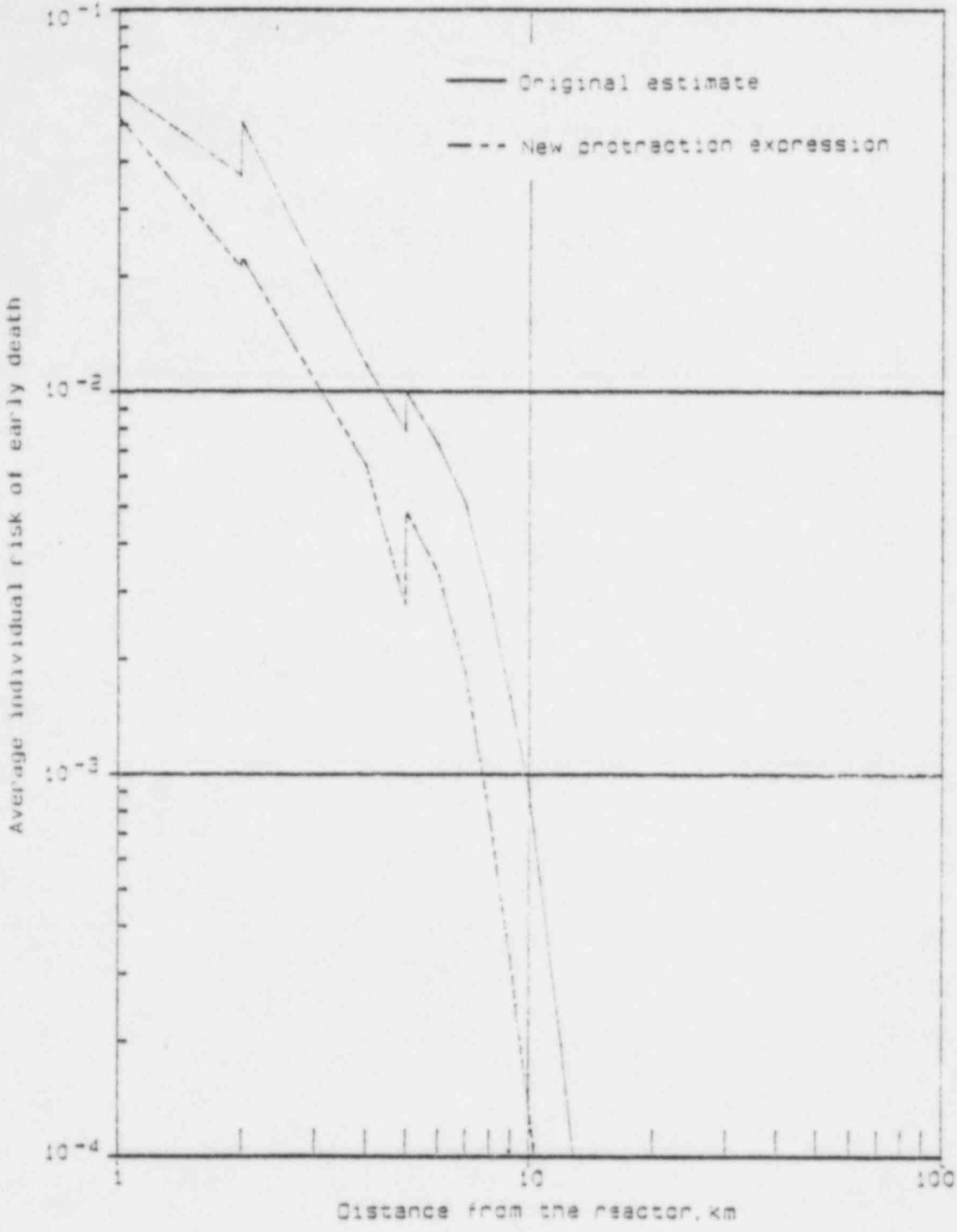
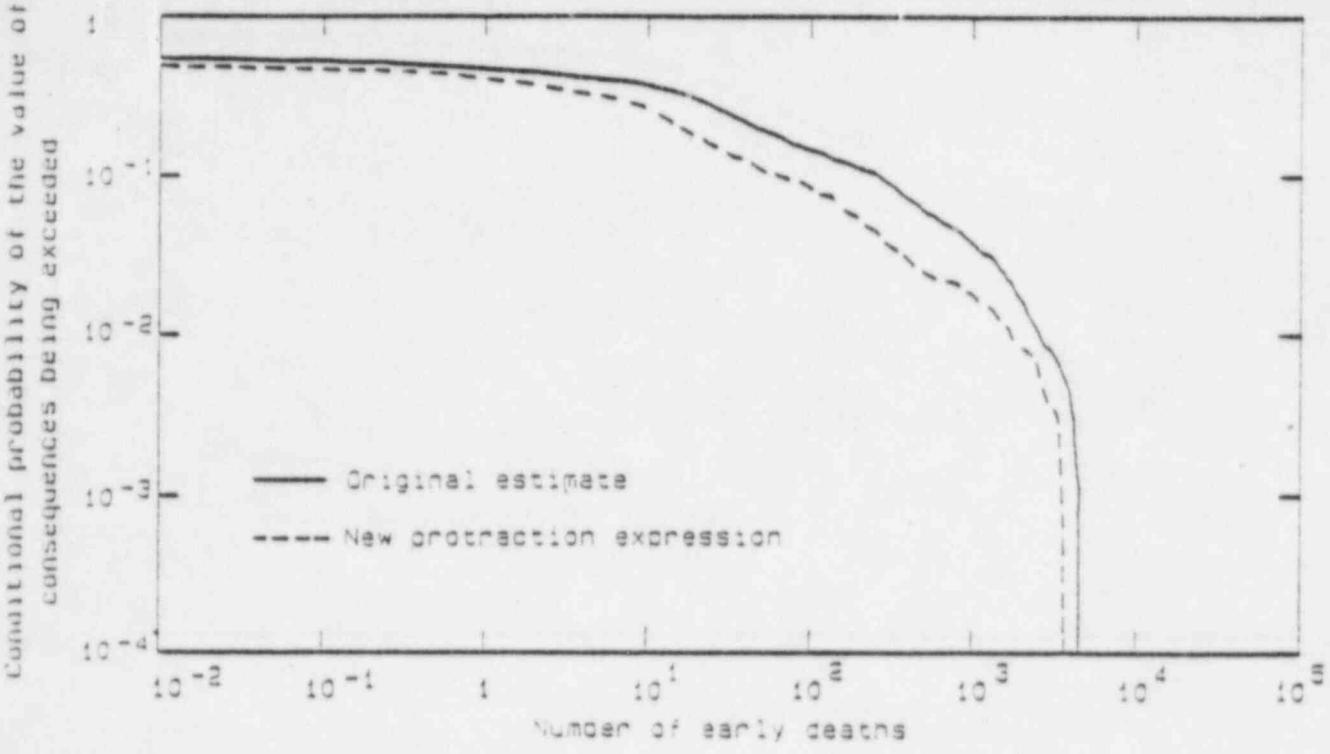


Figure 4 Average individual risk of early death conditional upon release category UK1: sensitivity to the allowance made for protracted exposure

UK 1: Frequency 2.4 10^{-9} y^{-1}



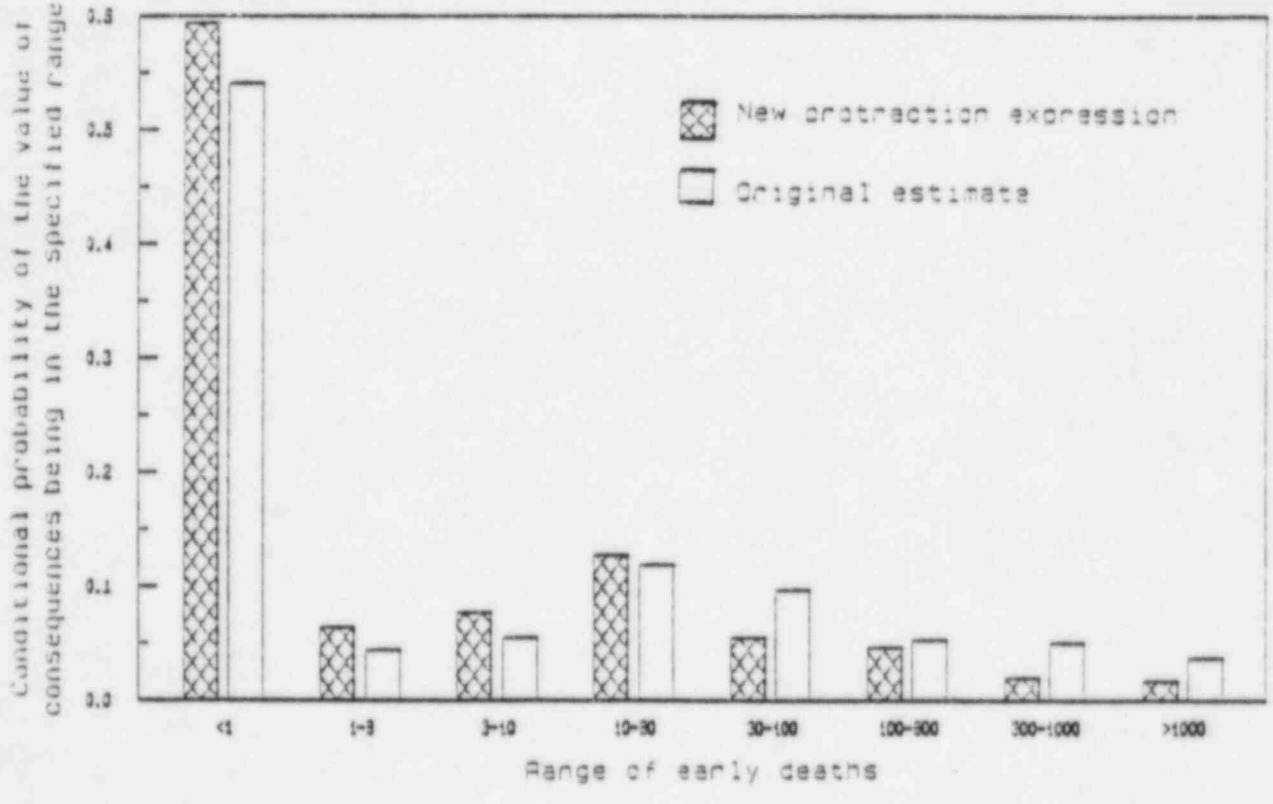
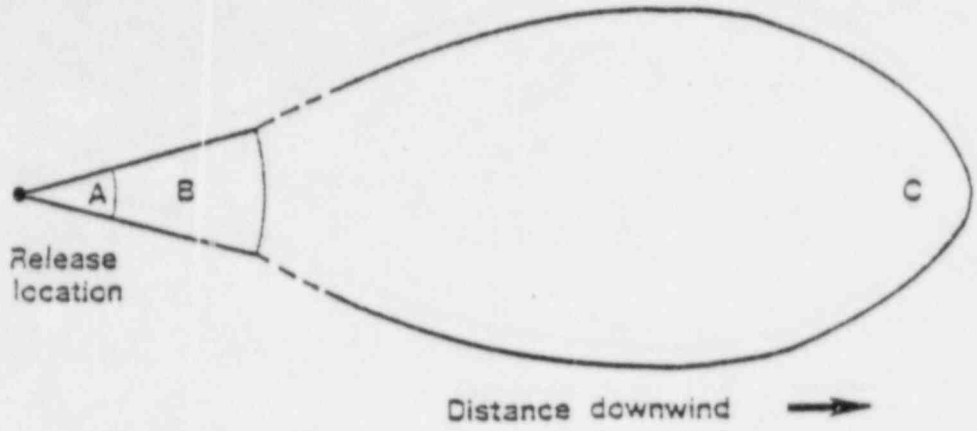


Figure 5 Sensitivity of the conditional probability distribution of early deaths for UK1 to the allowance made for protracted exposure

UK 1: Frequency 2.4×10^{-8} y^{-1}



Parameter Values

Area Designation	Extent of area		Time taken to execute countermeasures[1]	
			Sheltering[2]	Evacuation[3]
A	60° sector extending 2 km downwind		1 hour	2 hours
B	60° sector extending from 2 to 5 km downwind		1 hour	3 hours
C	Distance	Sub-area		
	5 - 25 km	C_1	6 hours	12 hours
	25 - 75 km	C_2	6 hours	1 day
	> 75 km	C_3	6 hours	2 days
	Area in which the dose to the bone marrow from all exposure pathways would exceed 0.25 Sv in 7 days[4]. Subdivided into 3 ranges of downwind distance.			

Notes:

1. The times specified are the intervals between the initiation of the countermeasures and their completion.

   For areas A and B the time is measured relative to the beginning of the warning time (the beginning of the warning time is taken as the occurrence of vessel melt-through and the duration of the warning time is the period between vessel melt-through and a significant release of activity to the environment (see Table 1)).

   For area C the time is measured relative to the release of activity to the environment (i.e. no credit taken for warning time).

2. For areas A, B and C, 90% of the population are assumed indoors and 10% outdoors at the time of the release. Sheltering of the whole population is assumed at the specified times.

3. The exposure during evacuation is taken to be approximately that which would have been received outdoors in the following hour had evacuation not occurred.

4. The dose to be used in conjunction with this criterion is evaluated assuming people to be outdoors during the passage of the plume and subsequently to spend 90% of their time indoors and 10% outdoors.

Figure 6 Basic features of the countermeasures model for sheltering and evacuation

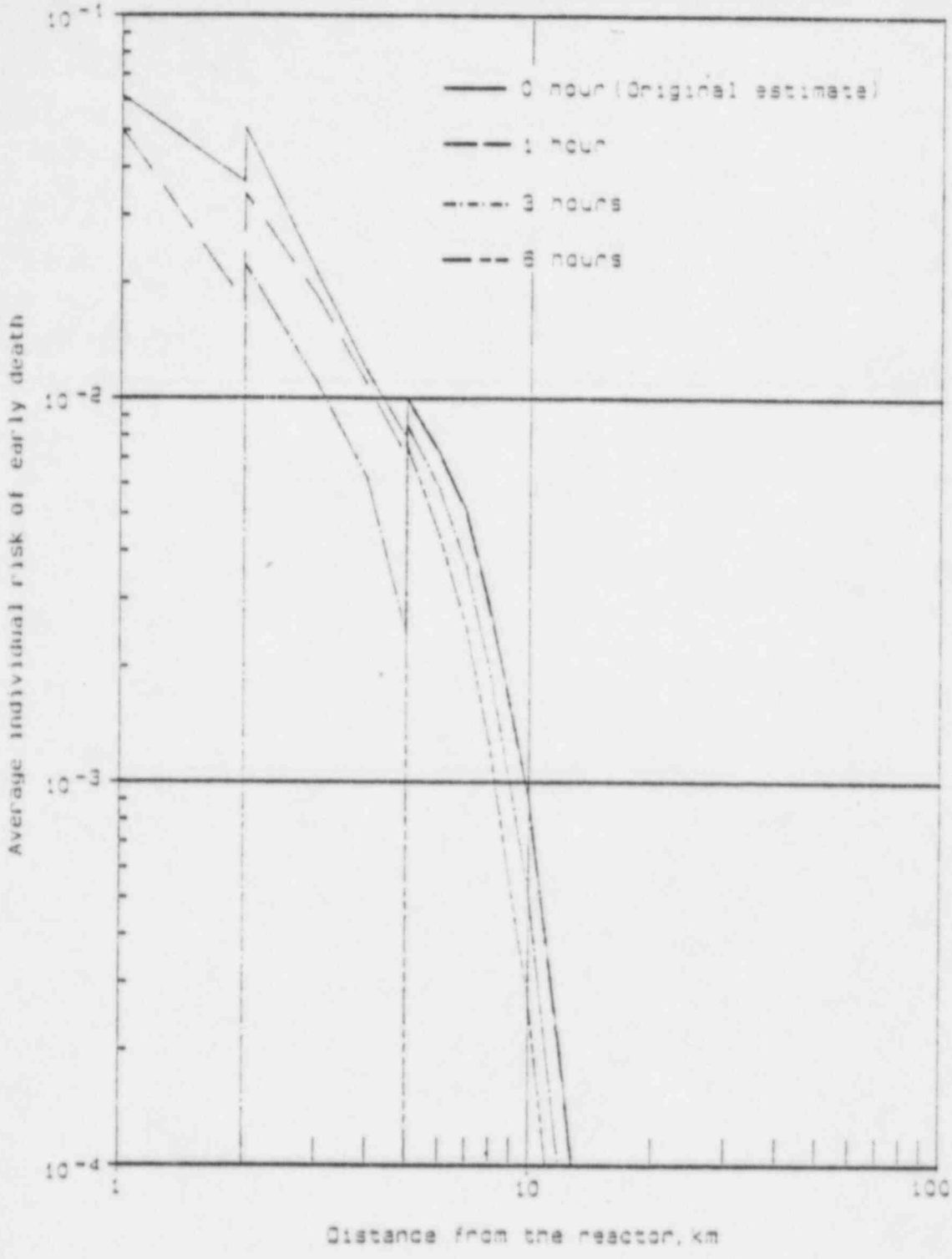


Figure 7 Average individual risk of early death conditional upon release category UK1: sensitivity to warning time

UK 1: Frequency 2.4 10^{-9} y^{-1}

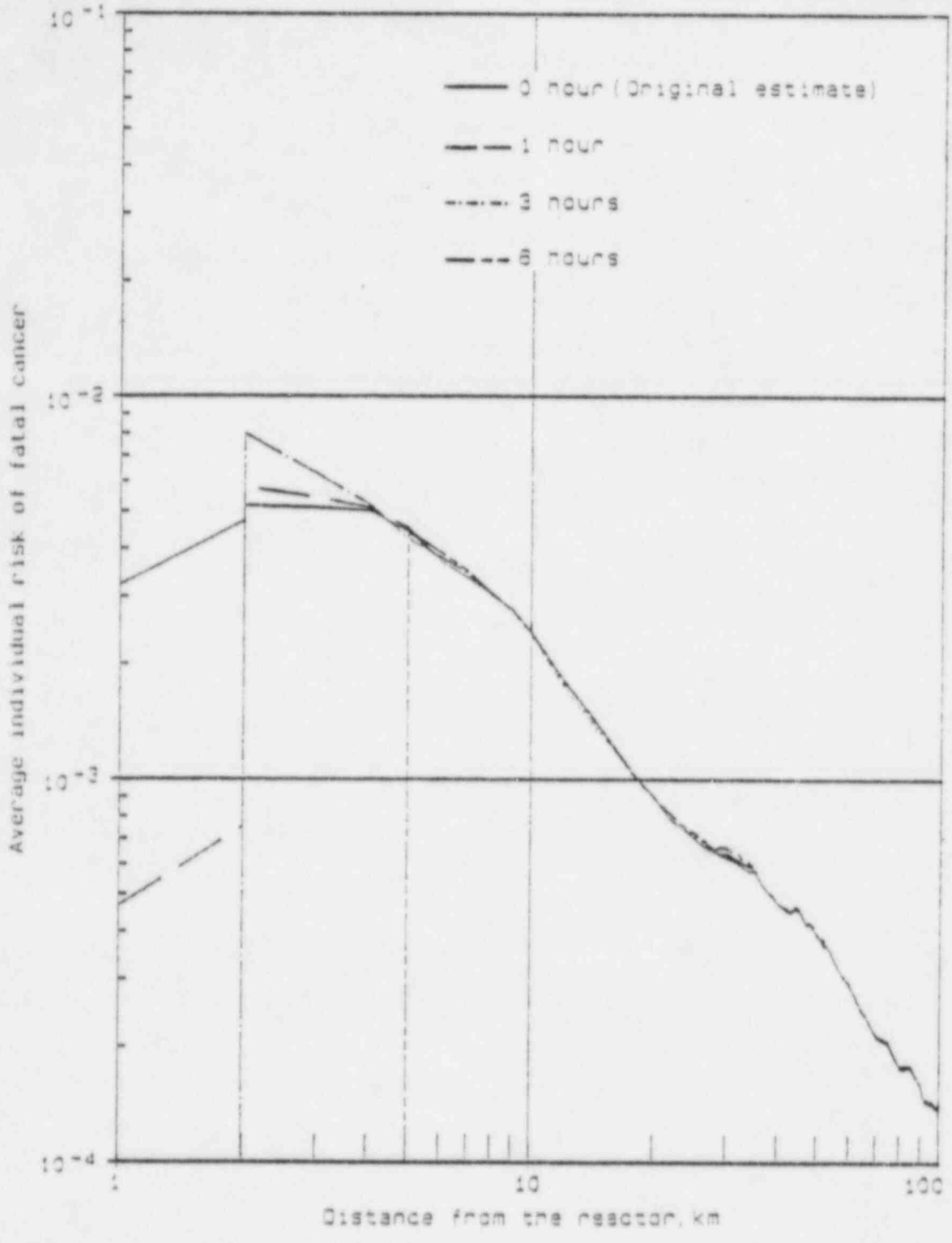


Figure 8 Average individual risk of fatal cancer conditional upon release category UK1: sensitivity to warning time

UK 1: Frequency 2.4 10^{-8} y^{-1}

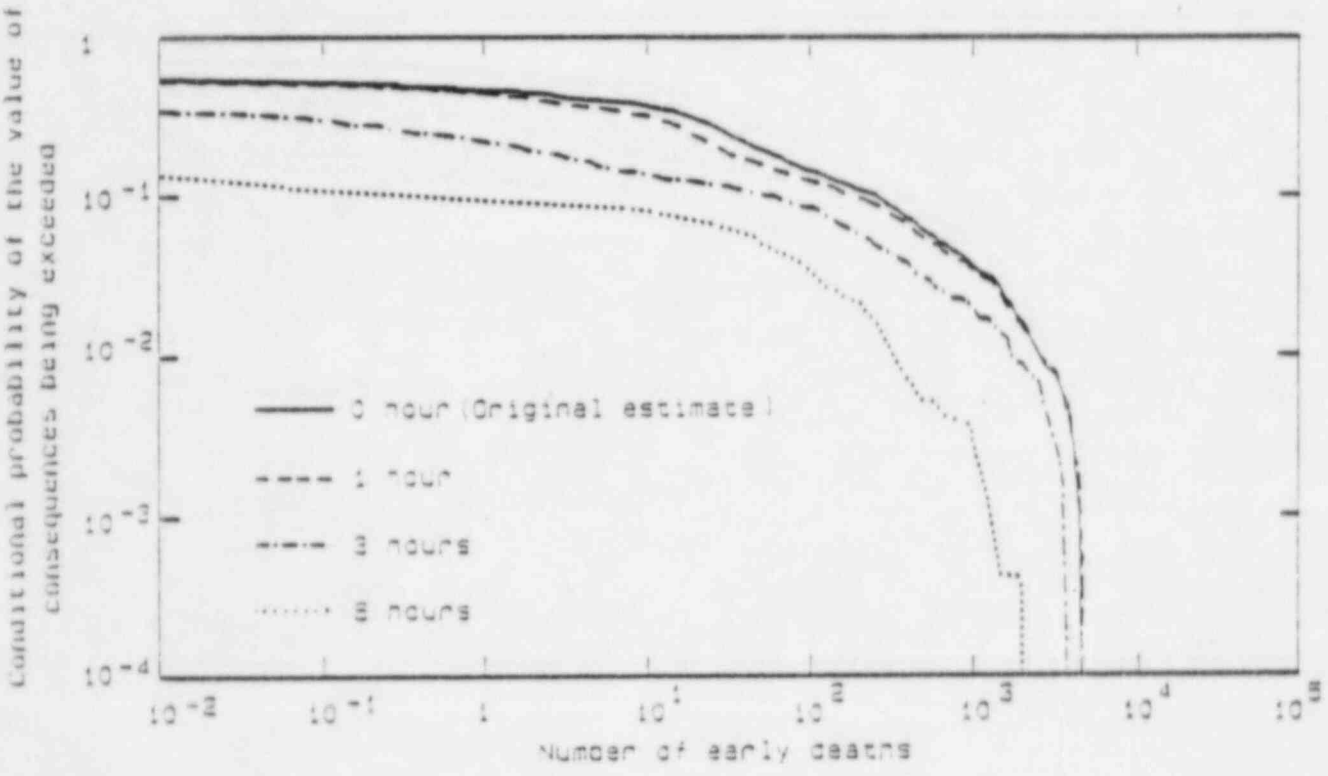


Figure 9 Sensitivity of the conditional probability distribution of early deaths for UKi to the warning time before the release

UK 1: Frequency 2.4 10^{-9} y^{-1}

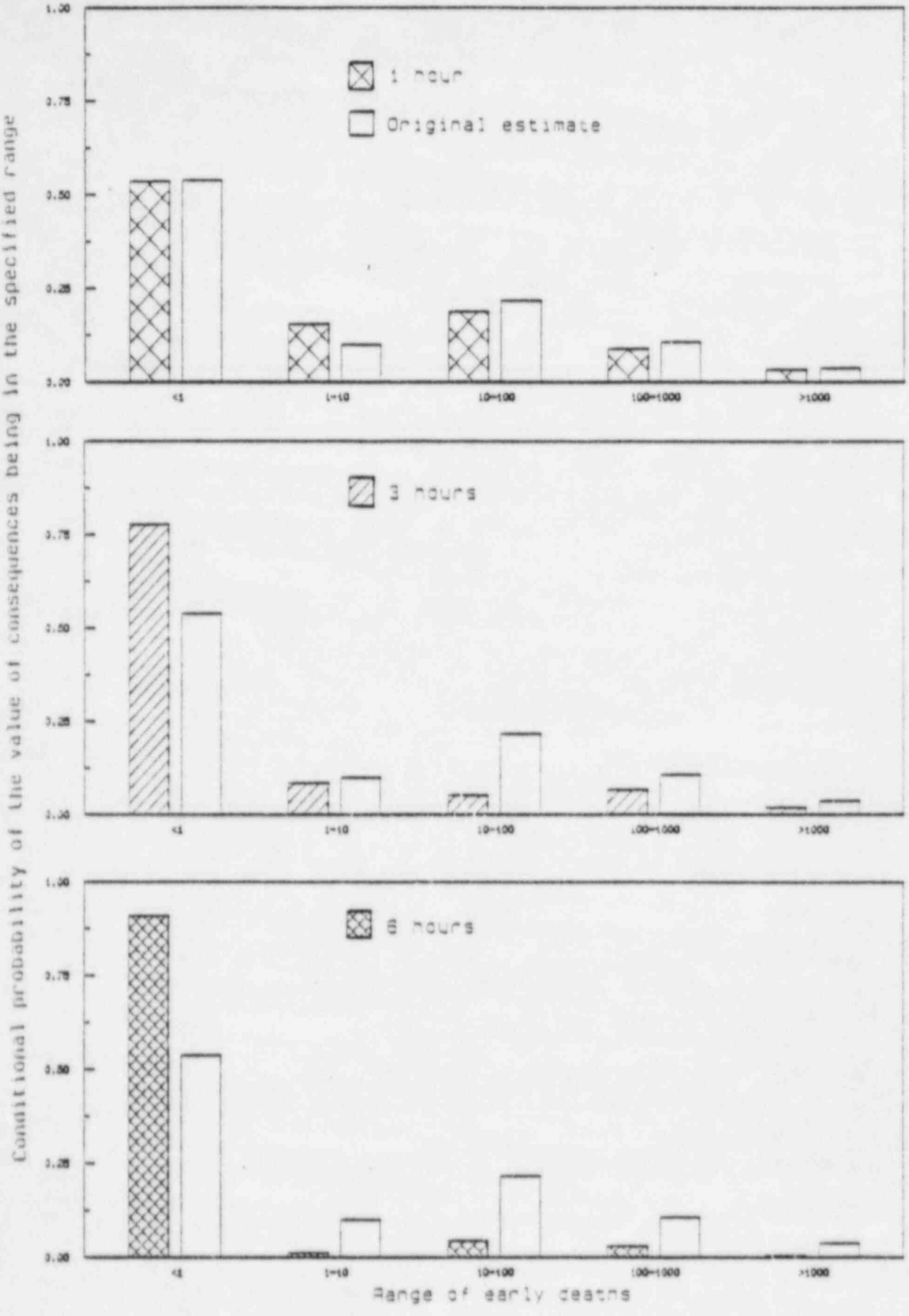


Figure 9 continued

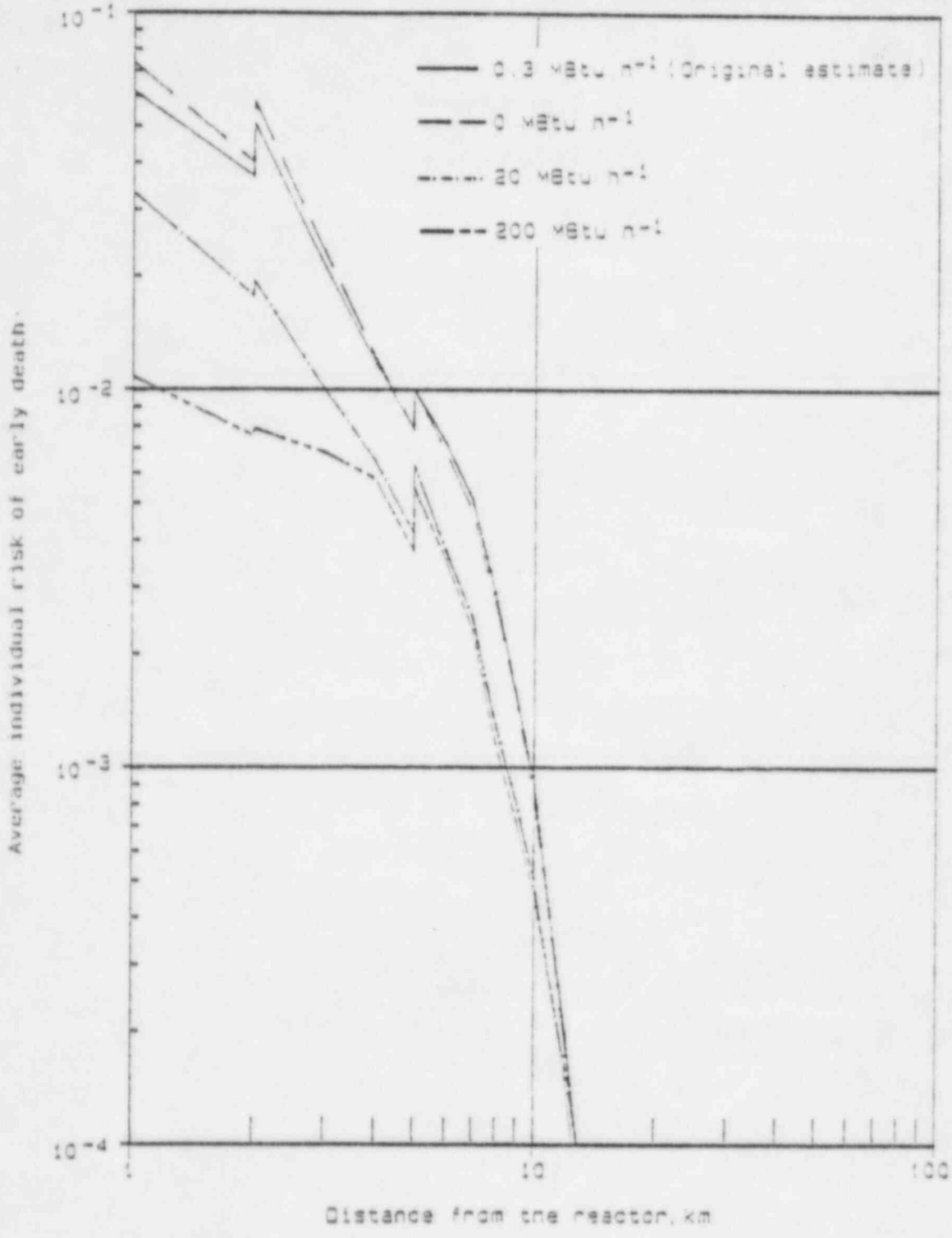


Figure 10 Average individual risk of early death conditional upon release category UK1: sensitivity to the energy content of the release

UK 1: Frequency 2.4 10^{-8} y^{-1}

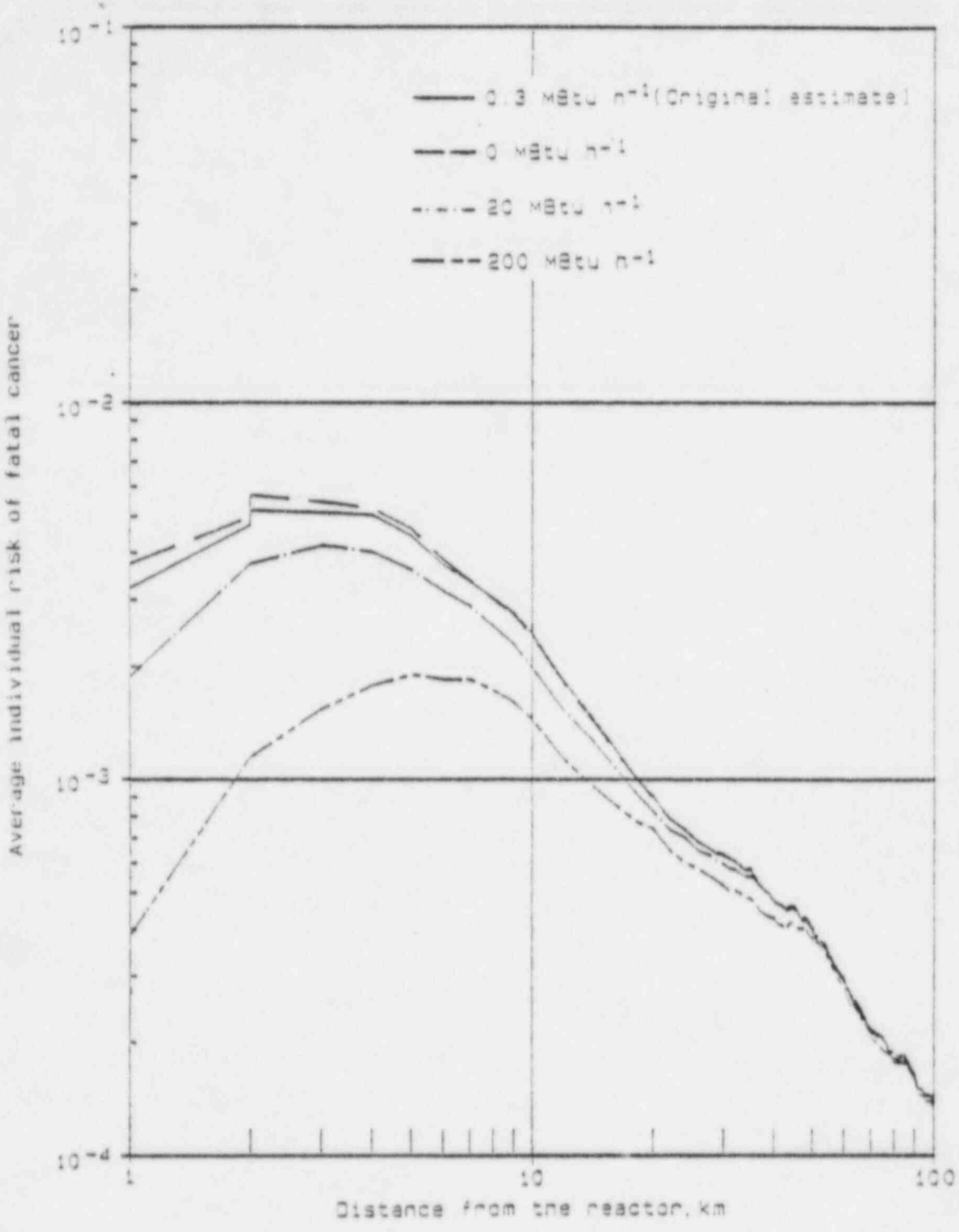


Figure 11 Average individual risk of fatal cancer conditional upon release category UK1: sensitivity to the energy content of the release

UK 1: Frequency 2.4 10^{-8} y^{-1}

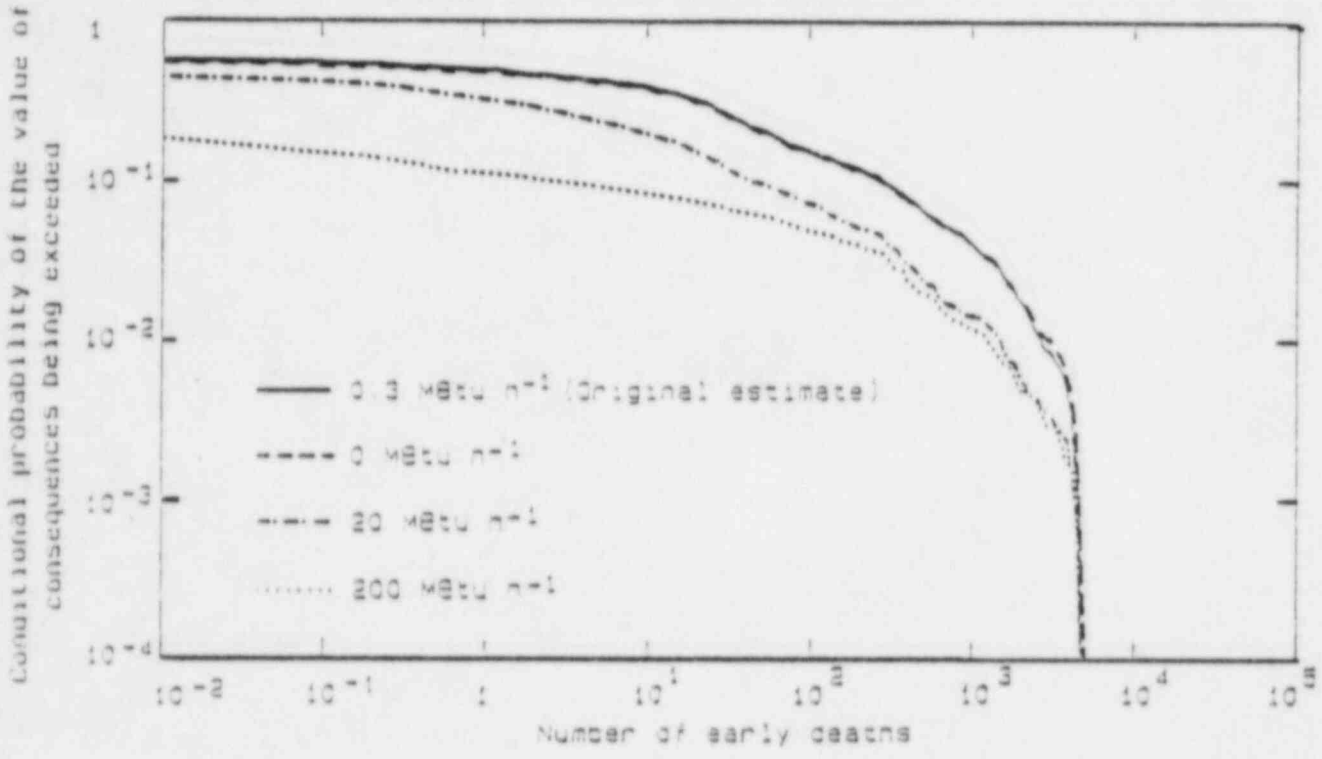


Figure 12 Sensitivity of the conditional probability - distribution of early deaths for UK1 to the energy content of the release

UK 1: Frequency 2.4 10^{-9} y^{-1}

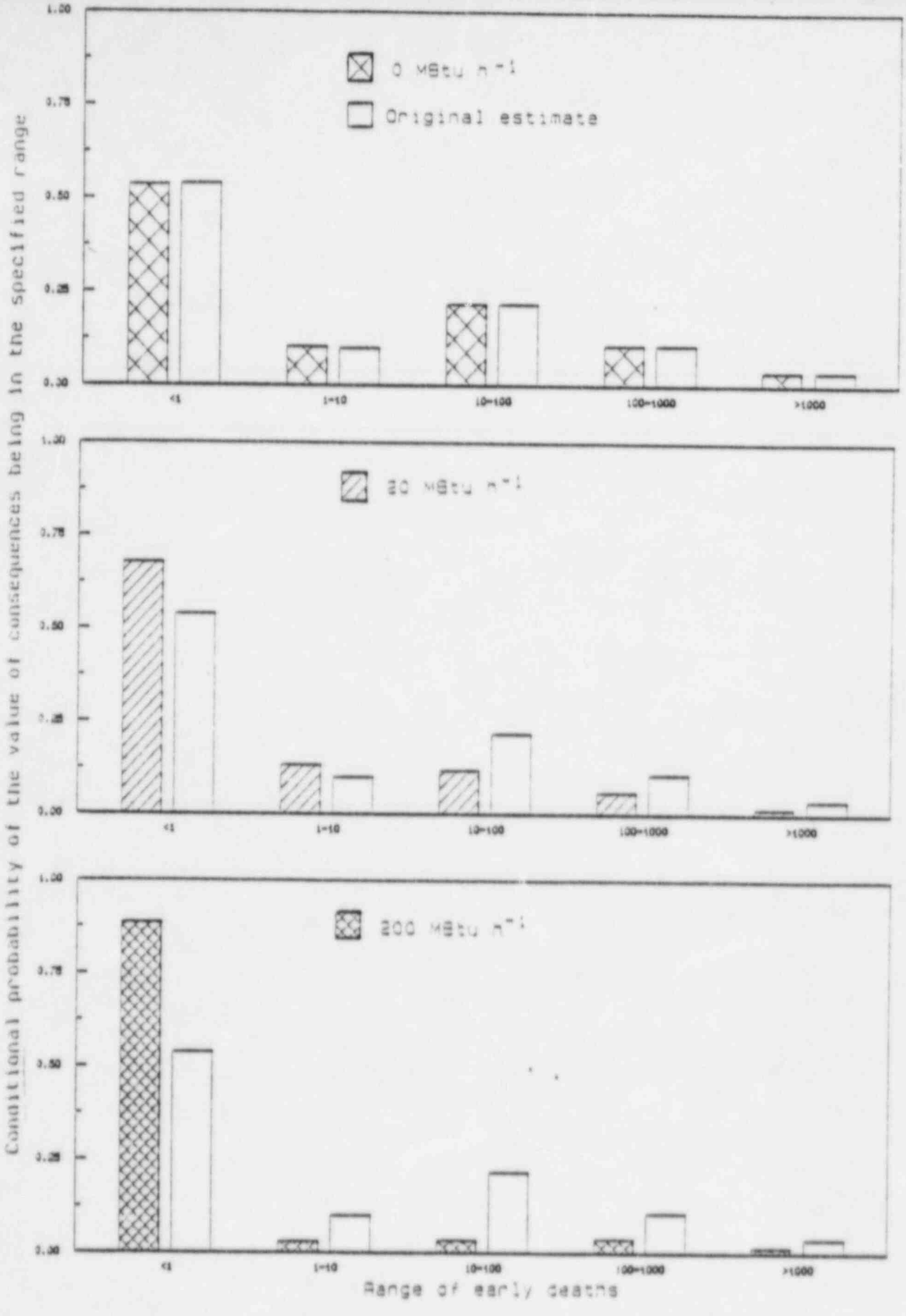


Figure 12 continued

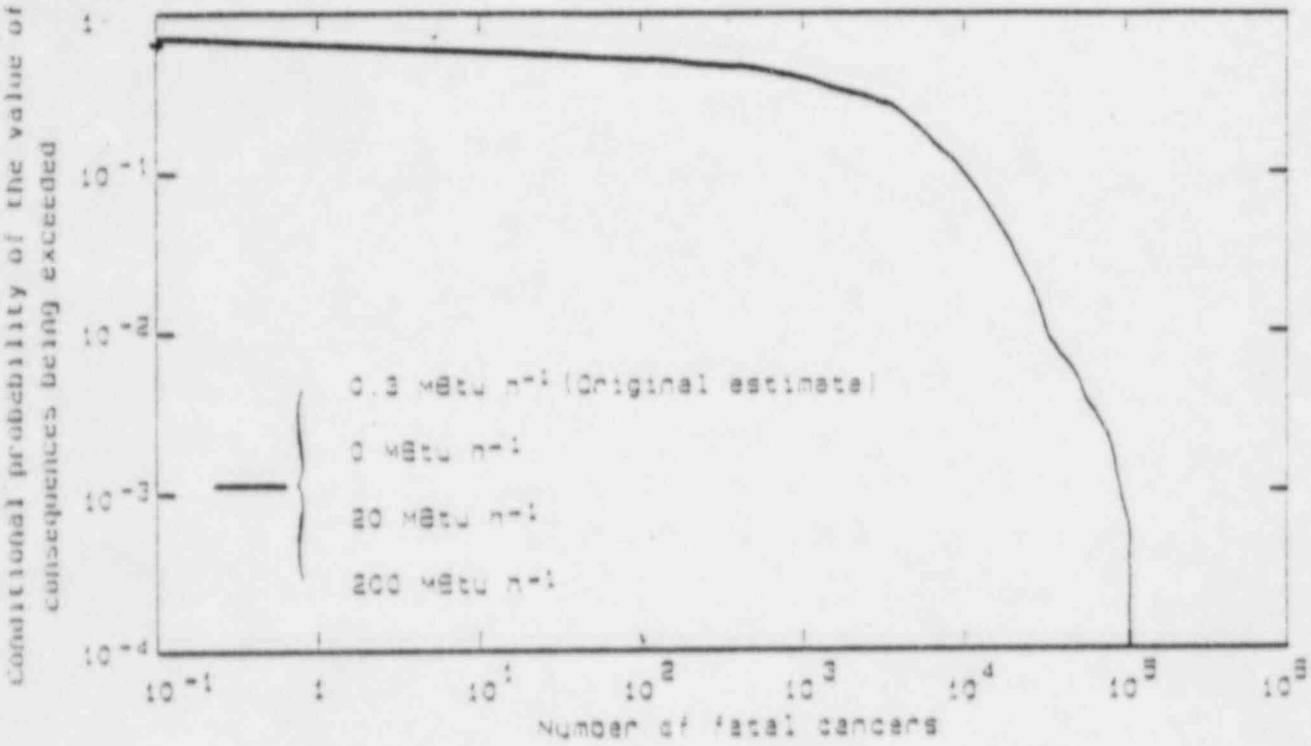


Figure 13 Sensitivity of the conditional probability distribution of fatal cancers for UK1 to the energy content of the release

UK 1: Frequency 2.4×10^{-8} y^{-1}

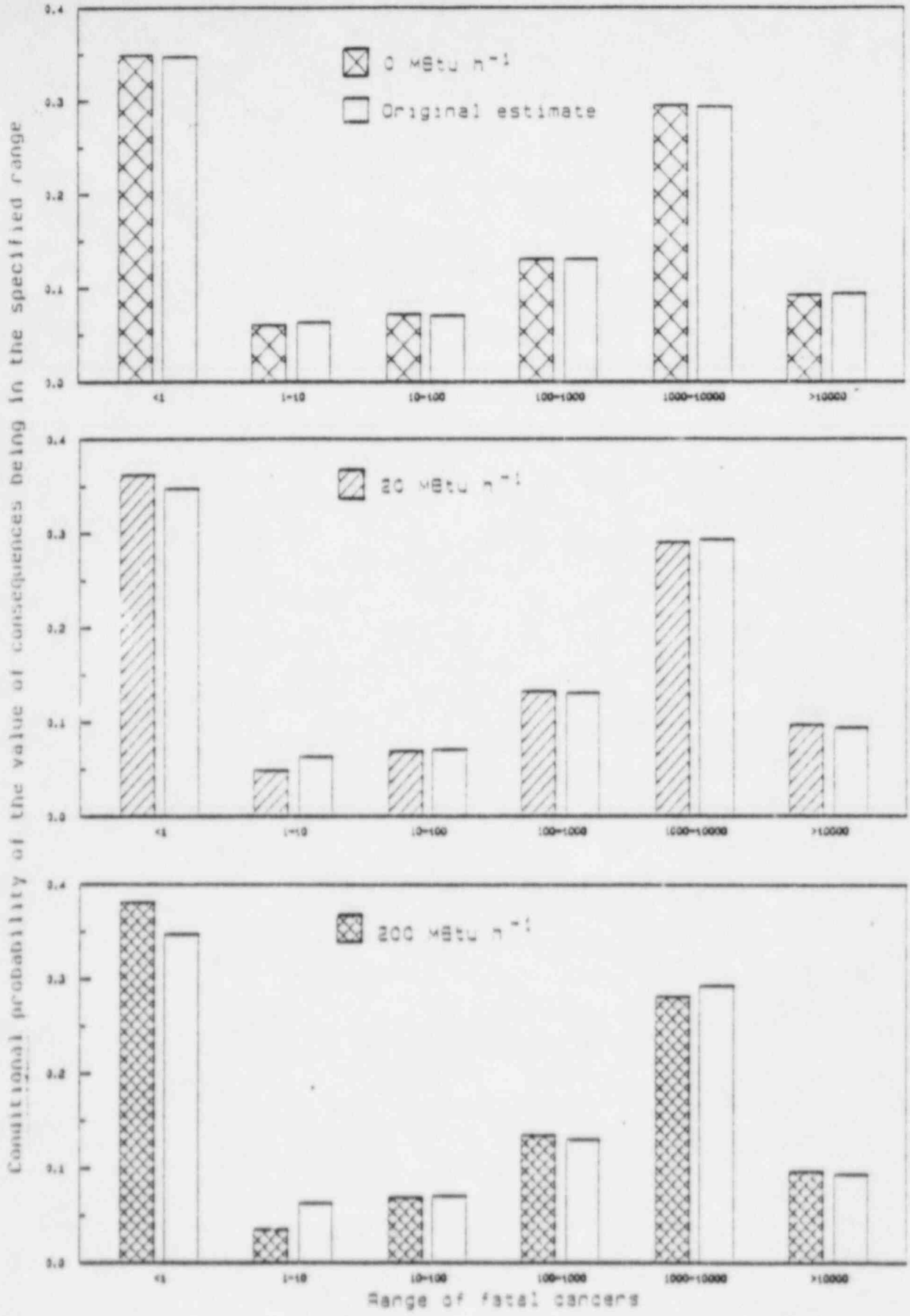


Figure 13 continued

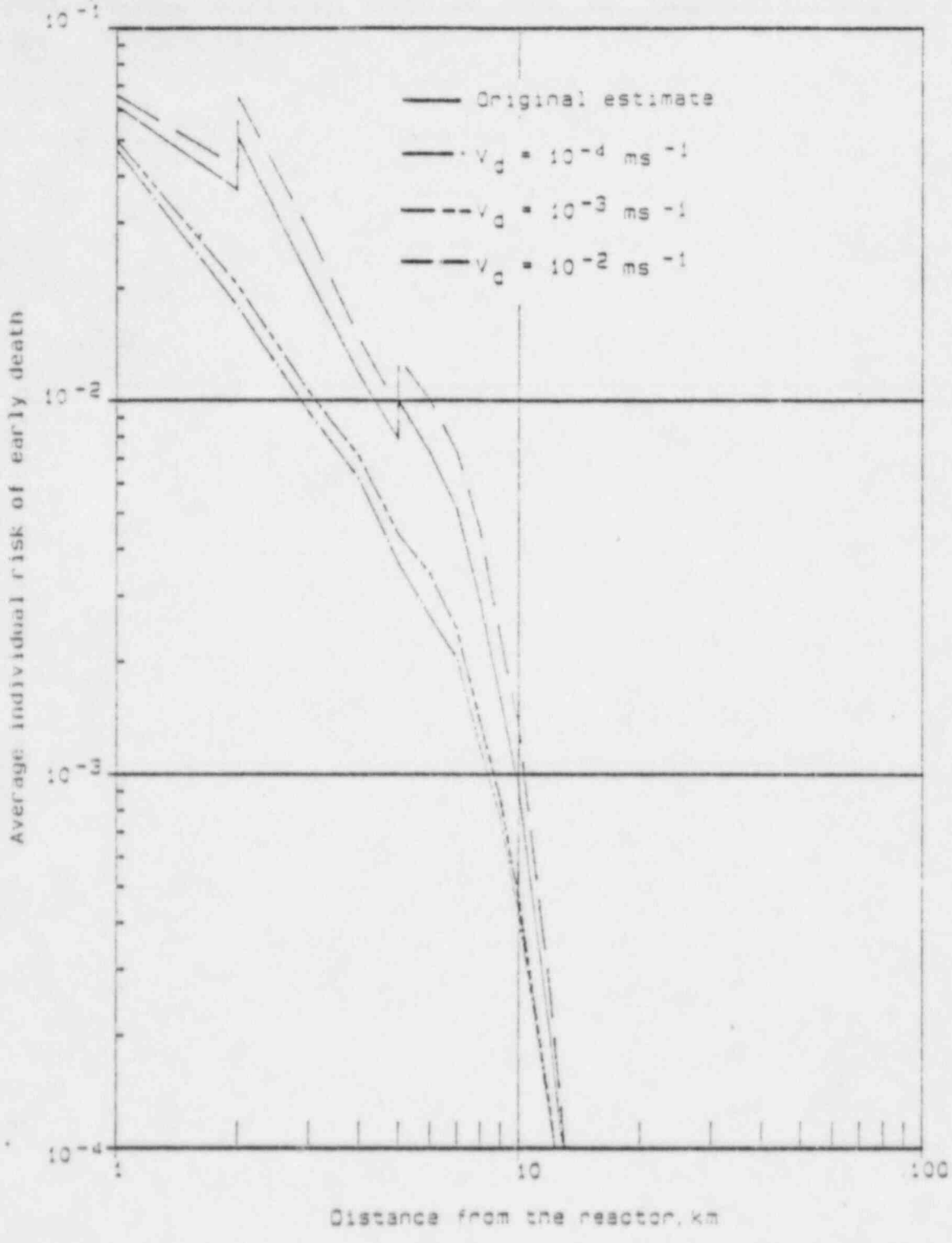


Figure 14 Average individual risk of early death conditional upon release category UK1: sensitivity to the dry deposition velocity for particulate material

UK 1: Frequency 2.4 10^{-9} y^{-1}

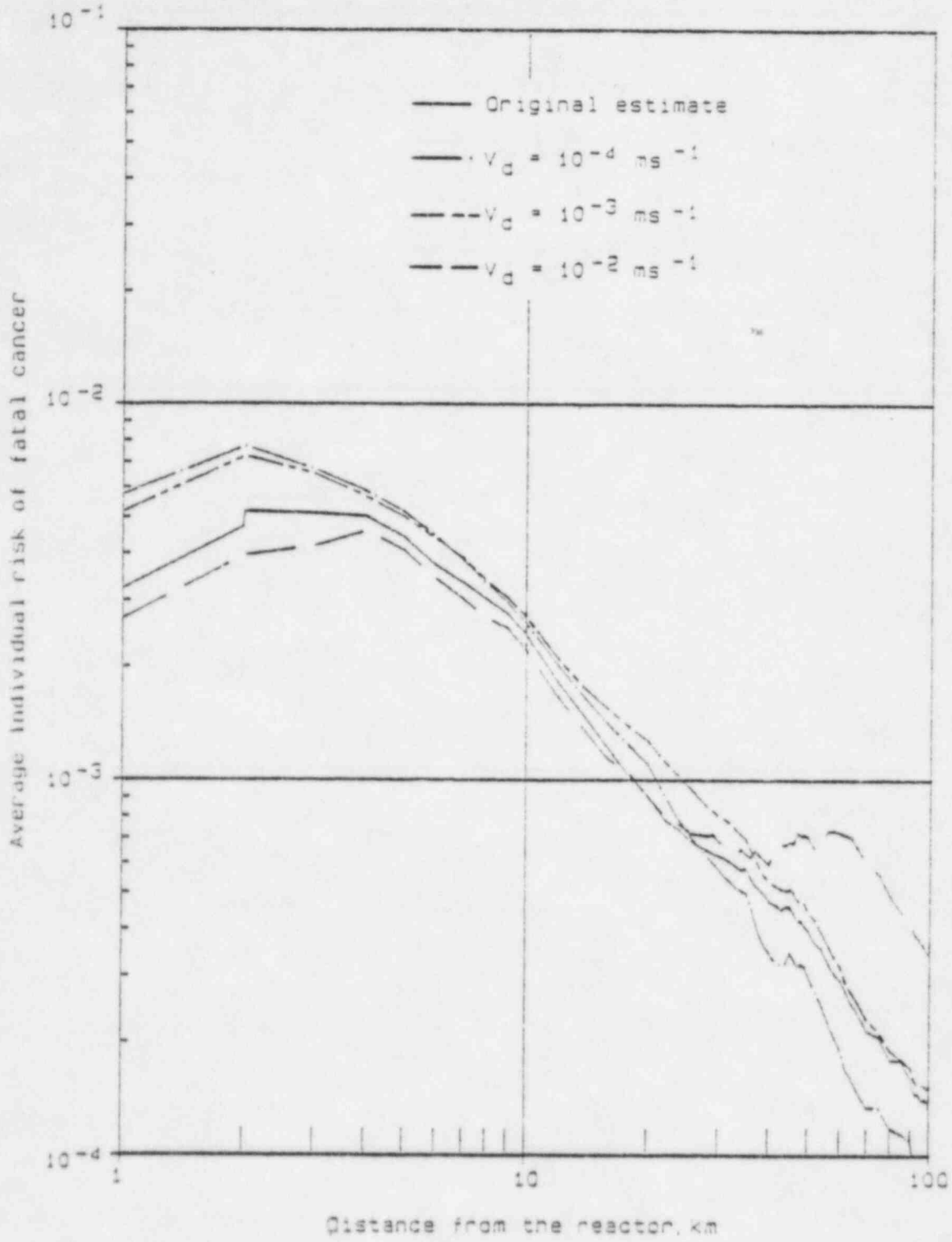


Figure 15 Average individual risk of fatal cancer conditional upon release category UK1: sensitivity to the dry deposition velocity for particulate material

UK 1: Frequency 2.4 10^{-8} y^{-1}

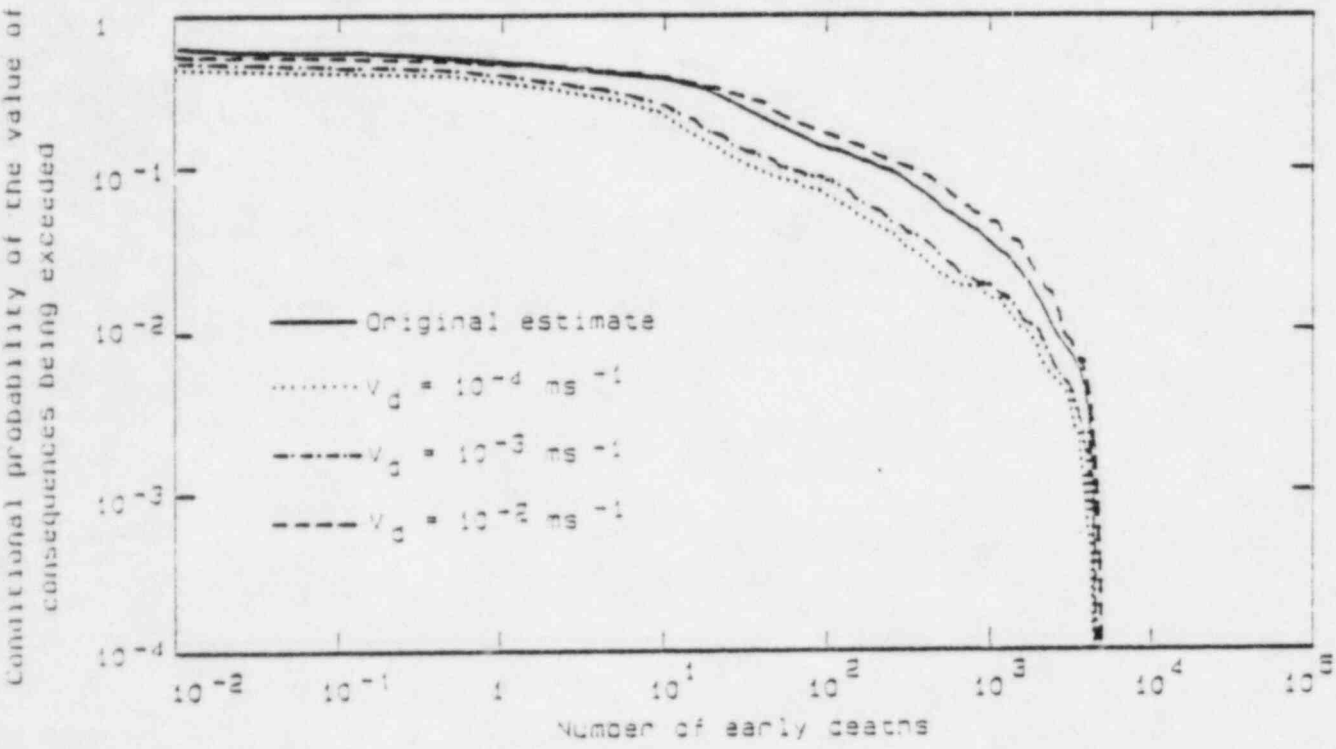


Figure 16 Sensitivity of the conditional probability distribution of early deaths for UK1 to the dry deposition velocity for particulate material

UK 1: Frequency 2.4 10^{-9} y^{-1}

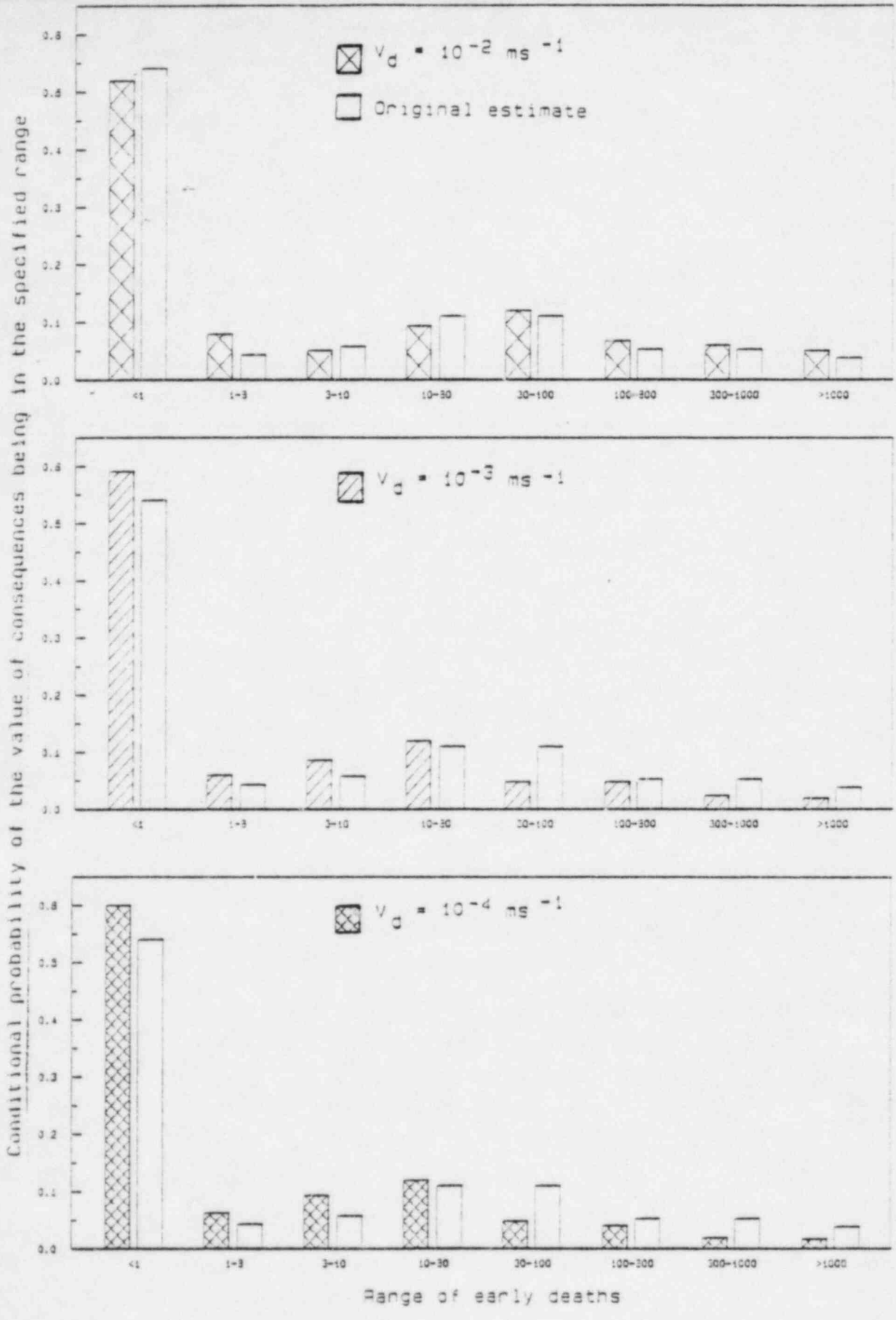


Figure 16 continued

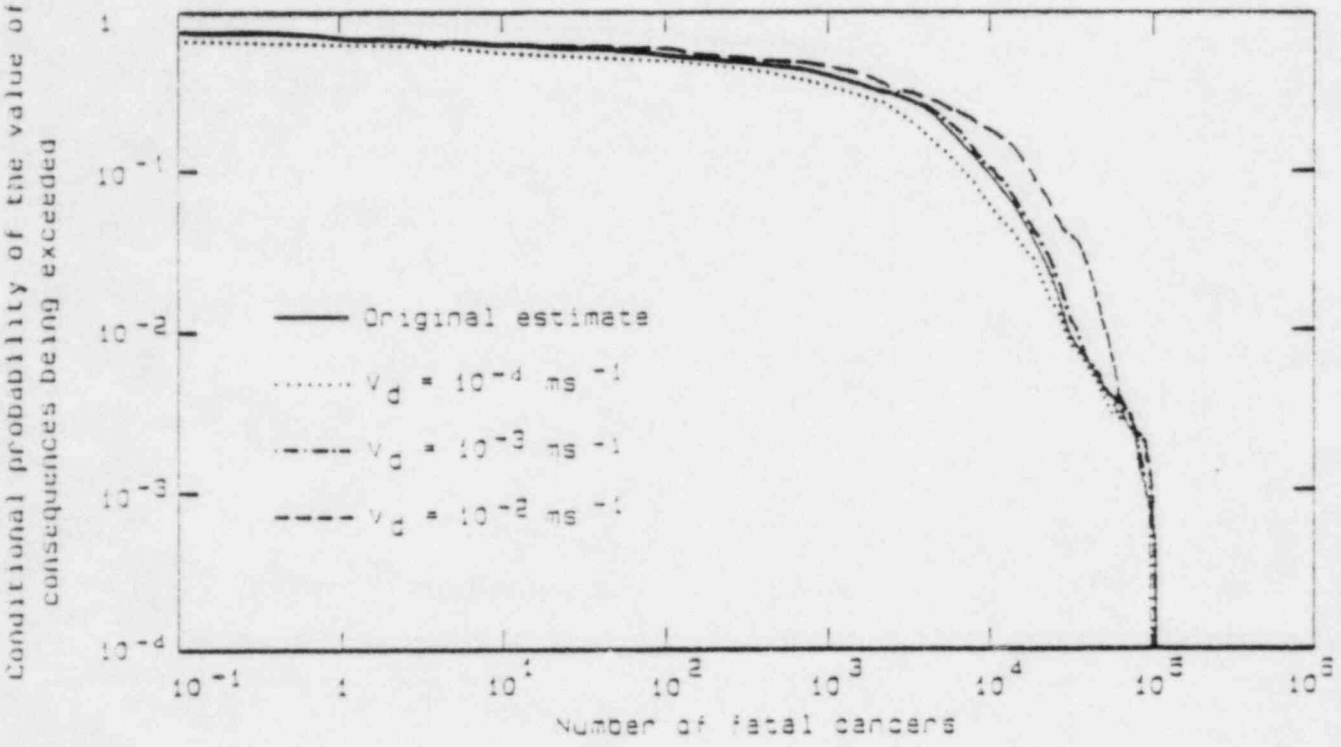


Figure 17 Sensitivity of the conditional probability distribution of fatal cancers for UK1 to the dry deposition velocity for particulate material

UK 1: Frequency 2.4 10^{-8} y^{-1}

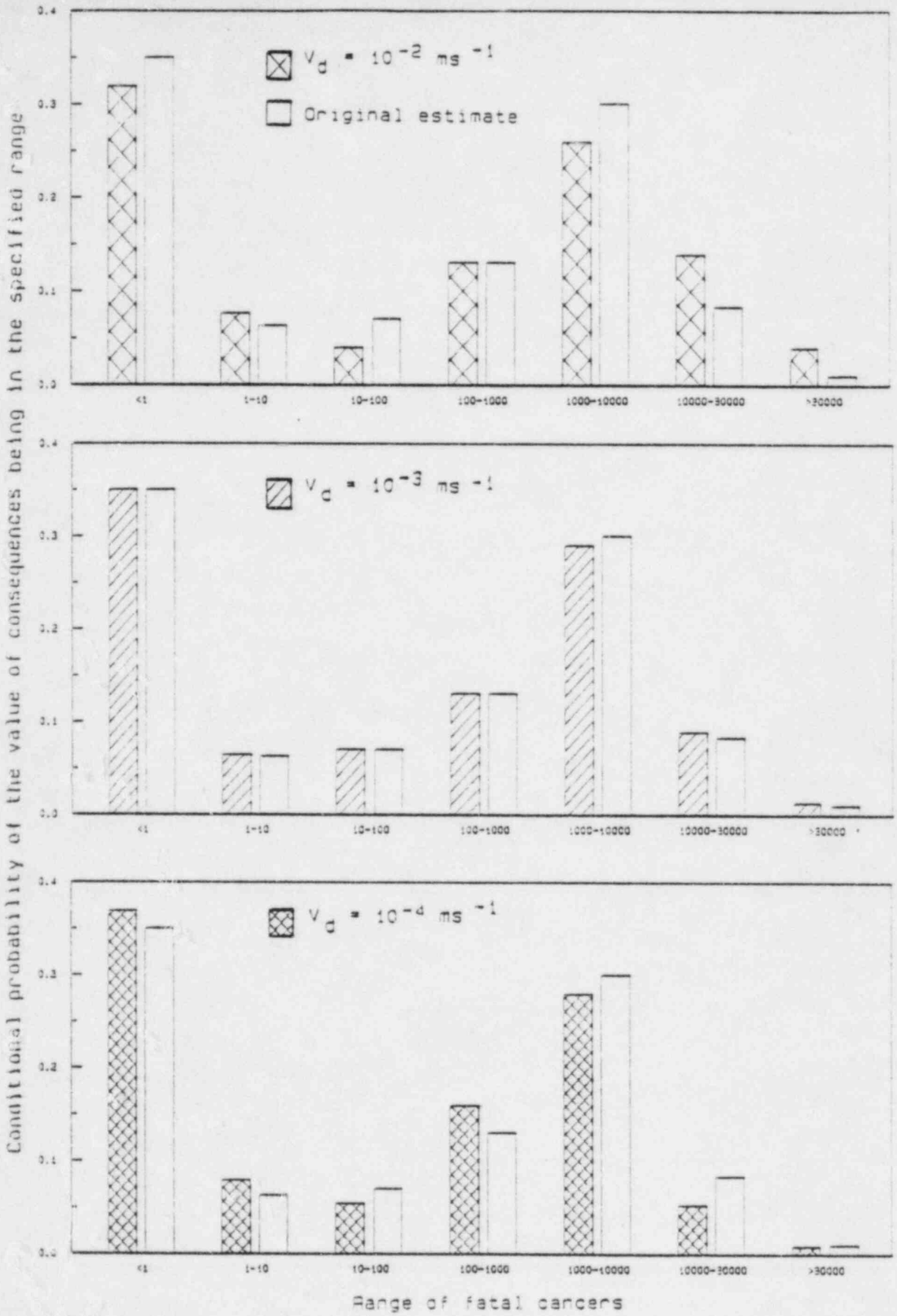


Figure 17 continued

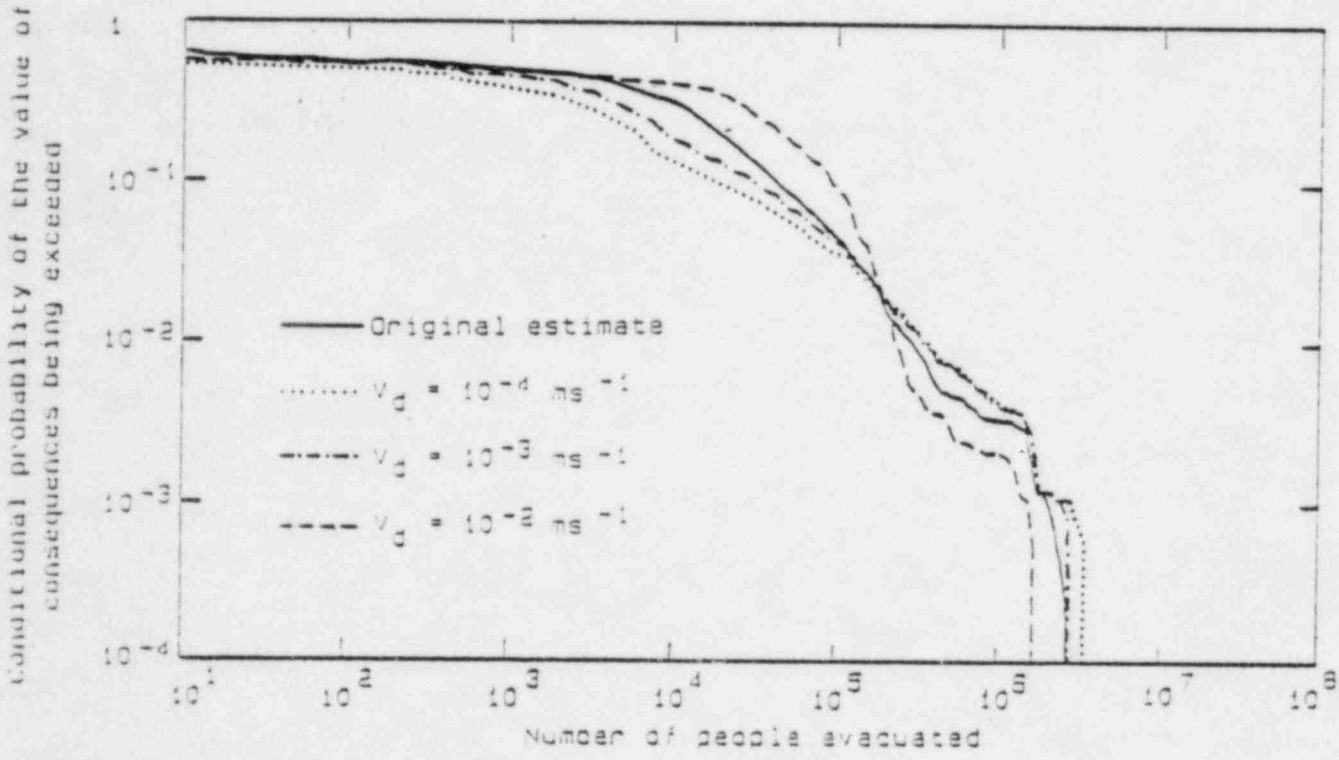


Figure 18 Sensitivity of the conditional probability distribution of the number of people evacuated for UK1 to the dry deposition velocity for particulate material

UK 1: Frequency 2.4 10^{-8} y^{-1}

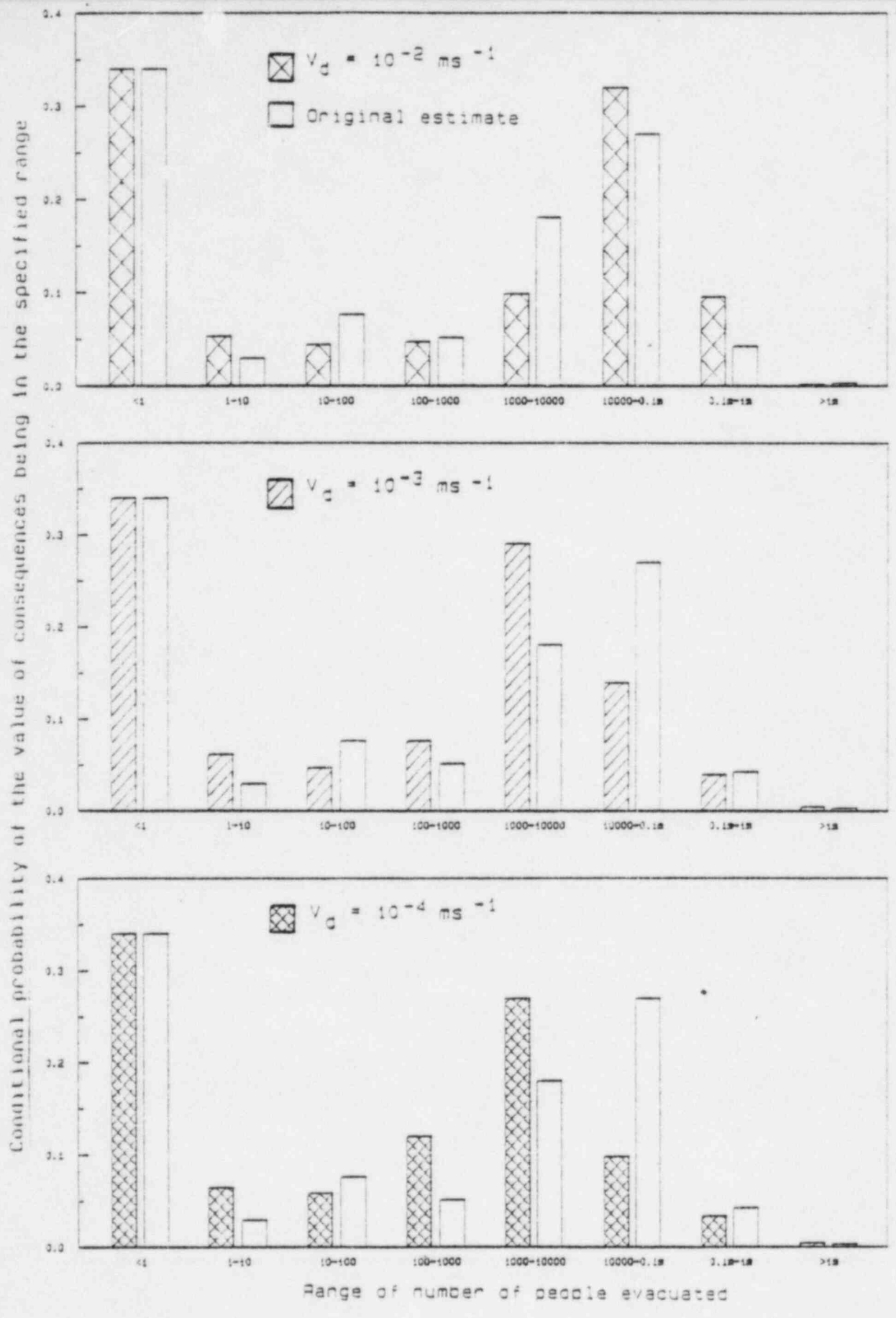


Figure 18 continued

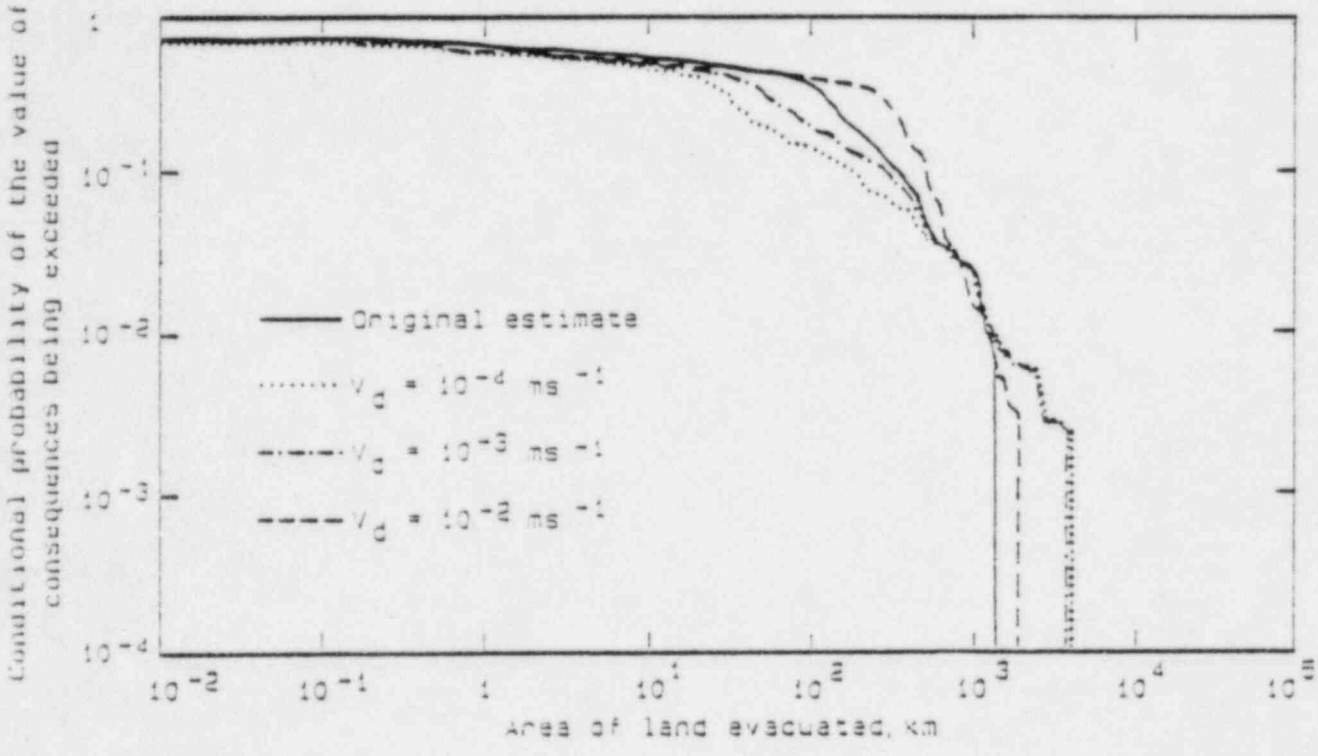


Figure 19 Sensitivity of the conditional probability distribution of the area evacuated for UK1 to the dry deposition velocity for particulate material

UK 1: Frequency 2.4 10^{-8} y^{-1}

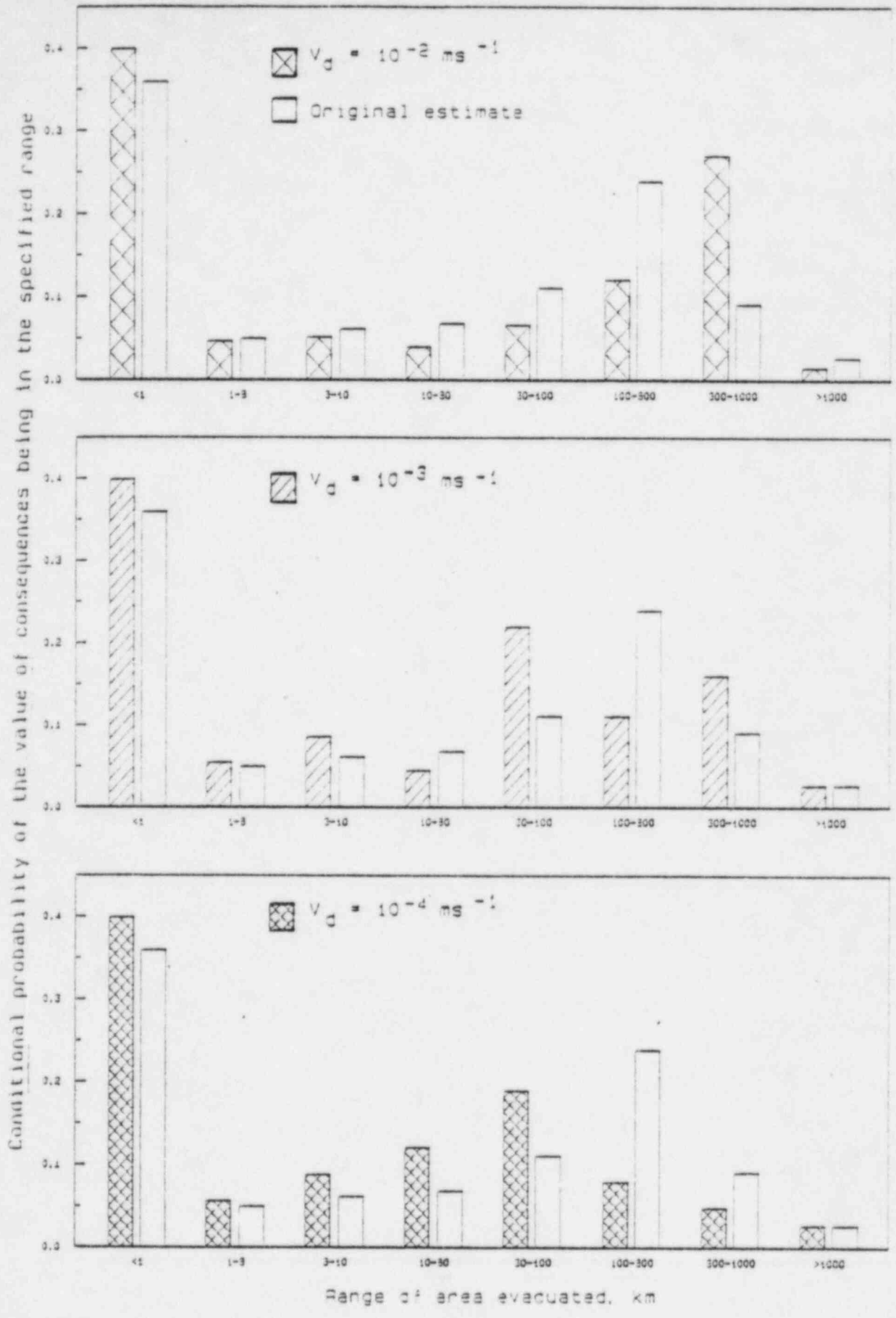


Figure 19 continued

APPENDIX 1

The impact of potential overestimates of the predicted release fractions: Revised results

In the initial study[1], an analysis was undertaken of the impact on the predicted radiological consequences of potential overestimates in the release fractions specified for selected release categories. Since the results of that study were published some relatively minor numerical errors have been identified. However, none of these errors affects the conclusions reached in the initial study on the impact of potential overestimates in the predicted release fractions. Nevertheless, the opportunity has been taken in this report, which comprises a number of sensitivity analyses on the initial study, to present revised values for those results known to be in error.

Although the number of the results which are in error is small, for convenience, the whole of the analysis of the impact of potential overestimates in the release fractions is reproduced here as an appendix. The numbering of the sections of the text and of the tables is identical with that in the initial study apart from the addition of a further identification symbol (R) to indicate the revised material. Furthermore, any tables or figures not directly connected with that analysis, but which are referred to in the text, are also included for completeness, but without the additional identification symbol.

For most of the results, there are no significant changes. Those which are most affected are the predicted numbers of early deaths and to a lesser extent the number of cases of prodromal vomiting. The overall impact of the corrections is to increase the predicted incidence of these two health effects by about 20% compared with their values given in the initial study for the 'revised' or 'second estimate' source terms. For the other radiological endpoints evaluated the impact is negligible, at most a few percent.

Such differences do not affect the conclusions reached in the initial study as to the impact of potential overestimates in the predicted release fractions. For early effects, however, the reduction in their numbers consequent upon the adoption of the revised release fractions is marginally less than indicated in the initial study. The reduction in the early deaths however remains large and is about a factor of 20.

The revised text and results are presented in the remainder of the appendix. They replace the corresponding material in the initial study[1].

5.(R) THE IMPACT OF POTENTIAL OVERESTIMATES OF THE PREDICTED RELEASE FRACTIONS

5.1(R) Revised release categories

The fractional releases of each element for the release categories UK1 to UK12 were evaluated using the general procedures and methods employed in the US Reactor Safety Study[2]. There is increasing evidence that the releases evaluated in this way may be overestimates[6]. This is due to insufficient or, in some cases, no allowance having been made for processes such as retention of activity in the primary circuit, its removal from the containment atmosphere, and its attenuation in leakage paths from the containment. All of these processes could act to reduce the quantity of activity released to the environment. While the data on these aspects are considered at present insufficient to revise quantitatively the models and procedures used, CEGB, with assistance from Westinghouse, UKAEA, and NNC, have made judgements on the potential conservatisms in the release fractions given in Table 2. Revised estimates* of release fractions, incorporating these judgements, have been made by CEGB[5] for some of the more important release categories. The implications for the predicted risk from degraded core accidents, if these revised values are adopted, are evaluated.

For some (UK1, UK2, UK5 and UK6) of the release categories contributing most to risk, probability distributions were specified of the amounts by which the release fractions may differ from those originally derived. To represent these distributions, each of the original release categories was sub-divided into five discrete releases each having defined characteristics. The five sub-categories are designated A to E, and the release fractions and probability associated with each are summarised in Table 36. The other characteristics of these release sub-categories (eg, duration, warning time) have been specified to be identical to those of the original release category given in Table 2.

The release fractions specified for sub-category A of each release category are, with the exception of the iodine and tellurium groups of elements, identical with the release fractions originally estimated and given in Table 2. For the particulate component of the release, the release fractions for sub-categories B, C, D and E are, respectively, factors of 2, 4, 10 and 20 lower than those for sub-category A; the release fractions for the noble gases and organic iodine are identical for each of the sub-categories of a particular release category. Differences are apparent in the release fractions of iodine evaluated originally (see Table 2) and those predicted for sub-category A of each release (see Table 36); in some cases, the revised release fraction (sub-category A) exceeds

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* In this report the release fractions specified in Table 2, and derived using the general procedures and methods employed in the US Reactor Safety Study, are referred to as the 'original' values; those specified in Section 5, incorporating judgements on the conservatism in the 'original' values are referred to as the 'revised' values. In reference 5 an alternative terminology is used and the values are referred to as 'first estimate' and 'second estimate' release fractions, respectively.

that originally specified. In the initial analysis, the iodine, apart from a small component in the organic form, was assumed to be released in an elemental form. In the revised estimates CEGB have judged that the iodine, both in the containment atmosphere and when released to the environment, would most probably be present as caesium iodide in a particulate form. The form of the iodine influences its behaviour in the containment (eg, removal processes) and thus the amount released to the environment. It also has implications for the transfer of iodine through the environment. Deposition of iodine from the atmosphere varies considerably with its physical and chemical form. In an elemental form, the dry deposition velocity exceeds that for iodine in the form of a fine particulate (eg, an aerosol with a 1 um AMAD). A deposition velocity of 10^{-2} m s^{-1} is adopted in this assessment for elemental iodine whereas a value of 10^{-3} m s^{-1} is taken for a 1 um AMAD aerosol. The smaller deposition velocity for iodine in a particulate form (in comparison with the value adopted for elemental iodine in the initial analysis) results in reduced deposition of iodine near the reactor and enhanced deposition at great distances. The different pattern of deposition is reflected in differences in the predicted consequences between the initial release category and sub-category A; the changes in the fractional release of iodine is a further important factor contributing to differences in consequences resulting from the respective releases.

5.2 The influence of adopting the revised release categories and release fractions

5.2.1 The impact conditional upon each release category

The probability distribution of consequences conditional upon each release sub-category has been evaluated and characteristic quantities of each distribution are summarised in Tables A1(R) - A20(R) of Appendix A(R). The probability distributions, conditional upon each of the sub-categories for a given release, have been summed (taking into account the probability of occurrence of each sub-category) to provide distributions conditional upon the revised release category. Characteristic quantities of these summed distributions are given in Tables 37(R) - 40(R), respectively, for the revised release categories UK1, UK2, UK5 and UK6. The distributions for selected endpoints (early deaths, fatal cancers and numbers of people evaluated) are also illustrated in Figures 13(R) - 15(R) conditional upon the revised and original release categories. The contributions made by each of the sub-categories (A-E) to the distribution for the revised category are also illustrated. A comparison is also made in Tables 41(R) - 44(R) between various characteristic quantities (expectation value and value at the 99th percentile) of the distributions, conditional upon the original and revised release categories. A number of observations can be made on the impact of adopting the revised release categories, with particular reference to three of the more important endpoints, early deaths, fatal cancers and the numbers of people evacuated.

The probability distributions of early deaths, conditional upon the original and revised release categories, are compared in Figure 13(R) for each of the releases. Actual frequencies of occurrence of early deaths can be obtained as the product of the conditional probabilities and the frequency of the release category specified in the figure. For UK1, UK2 and UK5, the adoption of the revised release categories results in a significant reduction in the probabilities of early deaths; for UK6 the revised values lead to an increase (although the absolute number of deaths and their probabilities of occurrence are extremely low) which is due to the much enhanced release fraction of iodine for the revised category (see Tables 2 and 36). In general, the reduction in the numbers of early deaths for the revised category compared with the original decreases with a decreasing value of the conditional probability of the distribution (eg, for UK1 the reduction is about 100 at a probability of 10^{-1} (90th percentile) and declines to less than two at a probability of 10^{-4} (99.99th percentile)). At the higher numbers of early deaths and lower levels of probability, the distributions for the revised categories can be seen to converge to the original values (apart from UK6). The expectation values of the numbers of early deaths (see Tables 41(R) - 44(R)) for the revised category are reduced from the original values by factors of up to about 20 for UK1, UK2 and UK5; for UK6 the value is increased by a factor of about 20. For other early effects the differences are somewhat smaller, and the exact values can be obtained from Tables 41(R) - 44(R). The relative contribution of each sub-category to the overall probability distribution of early deaths for each of the revised release categories is also illustrated in Figure 13(R). The contributions vary between the release categories, reflecting, among other factors, differences in the probabilities of occurrence of the respective sub-categories for different releases. In some cases not all of the sub-categories contribute to early deaths.

The probability distributions of fatal cancers, conditional upon the original and revised release categories, are compared in Figure 14(R) for each of the releases. Actual frequencies of occurrence of particular numbers of fatal cancers can be evaluated as the product of the conditional probability and the frequency of the release category which is specified in the figure. The adoption of the revised release category in each case results in a decrease in the predicted incidence of fatal cancers, although the reduction varies with the release category and with the probability level considered. The reduction in the expectation values of fatal cancers is typically within a factor of two to four. Similar reductions are apparent for all late effects, although the reduction in the incidence of non-fatal thyroid cancers is, in general, significantly less. This is attributable to the changed form and magnitude of the release of iodine in the revised categories and its importance in determining the incidence of this particular health effect. The relative contribution of each sub-category to the overall probability distribution of fatal cancers for each of the revised release

categories is also illustrated in Figure 14(R). As before, the contributions vary between the release categories, reflecting mainly differences in the probabilities of occurrence of the respective sub-categories for different releases. In general, sub-categories C, D and E determine the shape of the overall distributions at low numbers of fatal cancers, while at large numbers it is influenced mainly by sub-categories A, B and C.

The probability distributions of the numbers of people evacuated, conditional upon the original and revised release categories, are compared in Figure 15(R). Actual frequencies of occurrence of particular numbers evacuated can be evaluated as the product of the conditional probability and the frequency of the release category specified in the figure. For each release, the revised release category leads to lower predictions of numbers of people evacuated; the magnitude of the reduction again varies considerably with the release category and the level of probability of interest. The reduction in the expectation values of the numbers of people evacuated when adopting the revised release categories varies from a factor of about 1.5 for UK6 to about a factor of nine for UK2. The reduction factors in the expectation values of the areas evacuated are typically somewhat lower. The distributions of the numbers evacuated for the revised and original release categories for UK1 and UK2 have, unlike those for early deaths and fatal cancers, not converged at the lowest level of conditional probability illustrated (10^{-4}). The relative contribution of each sub-category to the overall distribution for each revised release category is also illustrated in Figure 15(R) and the trends are similar to those discussed previously for fatal cancers.

In summary, the adoption of the revised release categories (with one or two minor exceptions) leads to a reduction in the predicted numbers of radiological consequences for each of the release categories analysed. The magnitude of the reduction varies with the radiological endpoint considered and with the level of probability of interest. In general, the magnitude of the reduction decreases as the level of probability decreases. The reductions in the expectation values of early deaths, fatal cancers and numbers of people evacuated are typically factors within the ranges of 15 - 20, 2 - 4 and about 1.5 - 9, respectively. Reduction factors for other endpoints or at other levels of probability can be obtained from Figures 13(R) - 15(R) and Tables 41(R) - 44(R).

5.2.2 The impact on the risk summed over the four release categories

If revised release fractions had been evaluated for all of the release categories (as opposed to just UK1, UK2, UK5 and UK6) it would have been possible to re-evaluate the overall risk from degraded core accidents using these values. In the absence of comprehensive data, an estimate has been made of the reduction in the contribution to risk from the four release categories for which revised release fractions were specified.

The contribution to the risk for one year of operation of the reactor (expressed in terms of expectation values of each consequence) is compared in Table 45(R) for each of the four release categories and their sum, for the original and revised release fractions. The risk from each release category was obtained as the product of its frequency of occurrence and the expectation value of the endpoint of interest, conditional upon the release. The contribution made by the four release categories UK1, UK2, UK5 and UK6 to the overall risk initially evaluated (see Section 4.4 in NRPB-R137) can be estimated by comparing the expectation values given in Tables 32 and 45(R). Typically, for early deaths, fatal cancers and volume of milk restricted, the contribution from the four original categories to the overall risk is about 75% for each endpoint; for the number of people evacuated the contribution is about 10%. Frequency distributions of consequences summed over the four original and revised release categories, respectively, are compared in Figure 16(R) for selected endpoints. Again, the contribution of the four categories to the overall frequency distributions can be determined by comparison with Figures 6 - 10.

The reduction in risk from the adoption of the revised release categories is evident both in Table 45(R) and in Figure 16(R), although the magnitude of the reduction varies with the endpoint and frequency of occurrence considered. In general, for a given endpoint, the original and revised frequency distributions tend to converge at small and very large values of the endpoint.

For early deaths the reduction in the risk (in terms of the expectation value) is a factor of about 20 while for prodromal vomiting it is about a factor of ten. For fatal cancers and most other late effects, the reduction factor is typically in the range of 3 - 4, while for non-fatal thyroid cancers the reduction is less than a factor of two. A reduction by about a factor of five is typical for the number of people evacuated while the area evacuated is reduced by about a factor of three. The reduction factor in the quantity of agricultural produce restricted is in the range of about 2 - 4. The variation in the reduction factor for different endpoints is due mainly to the non-linearity between the consequences and the magnitude of the release; these non-linearities arise because of the existence of thresholds, either in dose-effect relationships or as a result of the application of countermeasures.

The influence of adopting the revised release categories on the individual risk presented by degraded core accidents has also been estimated. Again, in the absence of revised release fractions for all of the release categories, consideration is limited to the variation in individual risk from the four release categories for which revised release fractions were specified. The individual risk from release categories UK1, UK2, UK5 and UK6 (expressed in terms of the probability of early deaths and fatal cancers) as a function of distance from the reactor is illustrated in Figure 17(R) for the original and revised

release categories. The individual risk has been evaluated in the same manner as described in Section 4.5 (of NRPB-R137) and the same caveats apply.

The contribution made by the original four categories to the overall individual risk, summed over all categories, can be estimated by comparing the results in Figures 12 and 17. For early deaths the contribution is about 70% at a distance of 1 km from the reactor and essentially 100% at 20 km. For fatal cancers the contributions are typically about 50% and 80% at the respective distances. At short distances the risks of fatal cancers are affected by the risk of early death (see Section 4.5 of NRPB-R137).

The individual risks predicted for the revised release categories are in general significantly lower than those for the original four categories. The magnitude of the reduction varies with the distance from the reactor and the health effect considered. For early death the reduction factor increases with increasing distance and is about a factor of six at 1 km and approaching 100 at 10 km. For fatal cancer a reduction by about a factor of three is typical at all distances greater than about 10 km. At shorter distances the risk of fatal cancer is affected by the magnitude of the risk of early death: this is particularly apparent at a distance of 1 km where the risk of fatal cancer from the revised categories exceeds the original value.

In summary, the revision of the release fractions for UK1, UK2, UK5 and UK6 results in a significant reduction in the risk predicted from these release categories. The reduction varies with the endpoint but factors in the range 2 - 5 are typical for most endpoints although for some early effects the reduction exceeds a factor of ten. For individual risk a reduction factor of about three is typical for fatal cancer, and for early death the factor increases typically with distance from a value of about six at 1 km.

References

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Table 2

Release categories and their characteristic parameters

Release category	Frequency of occurrence (y^{-1})	Time before release[1] (h)	Duration of release (h)	Energy of release (10^6 Btu/h)	Elevation of release (m)	Warning time[2] (h)	Fraction of core inventory released to environment[3]							
							Xe-Kr	Organic I	Inorganic I-Br [4]	Cs-Rb	Te-Sb	Ba-Sr	Ru [5]	La [6]
1	$2.4\ 10^{-9}$	1	3	0.3	10	0	$9\ 10^{-1}$	$7\ 10^{-3}$	$7\ 10^{-1}$	$5\ 10^{-1}$	$3\ 10^{-1}$	$6\ 10^{-2}$	$2\ 10^{-2}$	$4\ 10^{-3}$
2	$4.0\ 10^{-10}$	1	0.5	20	10	0	$9\ 10^{-1}$	$6\ 10^{-3}$	$7\ 10^{-1}$	$4\ 10^{-1}$	$3.5\ 10^{-1}$	$5\ 10^{-2}$	$2\ 10^{-1}$	$3\ 10^{-3}$
3	$2.4\ 10^{-9}$	1	0.5	20	10	0	$8\ 10^{-1}$	$6\ 10^{-3}$	$6\ 10^{-1}$	$6\ 10^{-1}$	$1\ 10^{-1}$	$8\ 10^{-2}$	$2\ 10^{-2}$	$2\ 10^{-3}$
4	$5.9\ 10^{-10}$	2	1	6	10	1	$8\ 10^{-1}$	$6\ 10^{-3}$	$2\ 10^{-1}$	$2\ 10^{-1}$	$2.5\ 10^{-1}$	$2\ 10^{-2}$	$1.5\ 10^{-2}$	$3\ 10^{-3}$
5	$8.0\ 10^{-9}$	8	0.5	20	10	4	$1\ 10^{0}$	$7\ 10^{-3}$	$6\ 10^{-2}$	$3\ 10^{-1}$	$5\ 10^{-1}$	$4\ 10^{-2}$	$3\ 10^{-2}$	$6\ 10^{-3}$
6	$4.2\ 10^{-9}$	12	0.5	20	10	8	$9\ 10^{-1}$	$6\ 10^{-3}$	$9\ 10^{-3}$	$2\ 10^{-1}$	$4\ 10^{-2}$	$2\ 10^{-2}$	$7\ 10^{-3}$	$7\ 10^{-4}$
7	$1.2\ 10^{-9}$	1	0.5	20	10	0	$8\ 10^{-1}$	$6\ 10^{-3}$	$8\ 10^{-3}$	$2\ 10^{-3}$	$4\ 10^{-4}$	$3\ 10^{-4}$	$8\ 10^{-5}$	$8\ 10^{-6}$
8	$2.0\ 10^{-10}$	5	0.5	0.3	10	4	$8\ 10^{-1}$	$6\ 10^{-3}$	$6\ 10^{-3}$	$5\ 10^{-6}$	$1\ 10^{-6}$	$7\ 10^{-7}$	$2\ 10^{-7}$	$2\ 10^{-8}$
9	$5.2\ 10^{-9}$	2	10	0	0	1	$3\ 10^{-1}$	$2\ 10^{-3}$	$8\ 10^{-4}$	$8\ 10^{-4}$	$1\ 10^{-3}$	$9\ 10^{-5}$	$7\ 10^{-5}$	$1\ 10^{-5}$
10	$4.2\ 10^{-9}$	2	10	0	0	1	$6\ 10^{-3}$	$2\ 10^{-5}$	$2\ 10^{-5}$	$1\ 10^{-5}$	$2\ 10^{-5}$	$1\ 10^{-6}$	$1\ 10^{-6}$	$2\ 10^{-7}$
11	$6.2\ 10^{-7}$	2	long[7]	0	10	1	$6\ 10^{-2}$	$3\ 10^{-5}$	$3\ 10^{-5}$	$3\ 10^{-5}$	$3\ 10^{-5}$	$3\ 10^{-6}$	$2\ 10^{-6}$	$4\ 10^{-7}$
12	$5.1\ 10^{-7}$	2	long[7]	0	10	1	$5\ 10^{-2}$	$3\ 10^{-5}$	$8\ 10^{-6}$	$1\ 10^{-6}$	$2\ 10^{-7}$	$1\ 10^{-7}$	$4\ 10^{-6}$	$4\ 10^{-9}$

Notes

1. The time between reactor shut-down and the release of activity to the environment.
2. The warning time is the time available for the initiation of countermeasures before the release of activity to the environment. It has been evaluated conservatively as the time between vessel melt-through and the release of activity to the environment.
3. The specified fractions of the core are assumed to be released uniformly over the specified release duration apart from UK1; for this category the release fractions within each hour of the release duration are summarised in Table 3. The release fractions apply to stable isotopes of the specified elements
4. The iodine and bromine are assumed to be released in an elemental form.
5. Includes Ru, Rh, Co, Mo and Tc.
6. Includes Y, La, Zr, Nb, Ce, Pr, Nd, Np, Pu, Am and Cm.
7. For these categories the releases of Xe-Kr and organic I are protracted and may continue over some tens of days. The cautious assumption is made in this study that the total release occurs in 80 hours.

Table 32

Expectation value (or mean number) of each consequence per reactor year of operation and the contribution of each release category

	Expectation value per reactor year	Contribution to the expectation value of each release category, per reactor year											
		UK1	UK2	UK3	UK4	UK5	UK6	UK7	UK8	UK9	UK10	UK11	UK12
a) Health effects													
Early													
Death	$5.6\ 10^{-7}$	$3.1\ 10^{-7}$	$1.2\ 10^{-8}$	$1.2\ 10^{-7}$	$5.7\ 10^{-9}$	$9.1\ 10^{-8}$	$6.9\ 10^{-12}$	$1.3\ 10^{-11}$	0	0	0	0	0
Prodromal vomiting	$1.9\ 10^{-6}$	$8.9\ 10^{-7}$	$1.2\ 10^{-7}$	$4.8\ 10^{-7}$	$3.5\ 10^{-8}$	$4.1\ 10^{-7}$	$2.2\ 10^{-9}$	$1.1\ 10^{-9}$	$6.2\ 10^{-13}$	0	0	0	0
Lung morbidity	$1.1\ 10^{-7}$	$2.0\ 10^{-8}$	$2.1\ 10^{-8}$	$4.1\ 10^{-9}$	$2.9\ 10^{-9}$	$6.7\ 10^{-8}$	$1.5\ 10^{-11}$	0	0	0	0	0	0
Late													
Fatal cancer	$4.4\ 10^{-5}$	$7.8\ 10^{-6}$	$1.5\ 10^{-6}$	$8.7\ 10^{-6}$	$1.0\ 10^{-6}$	$1.8\ 10^{-5}$	$5.9\ 10^{-6}$	$8.4\ 10^{-8}$	$7.8\ 10^{-9}$	$1.6\ 10^{-7}$	$3.0\ 10^{-9}$	$9.0\ 10^{-7}$	$2.2\ 10^{-7}$
Non-fatal thyroid cancer	$8.8\ 10^{-5}$	$1.8\ 10^{-5}$	$3.2\ 10^{-6}$	$1.7\ 10^{-5}$	$2.2\ 10^{-6}$	$2.6\ 10^{-5}$	$5.6\ 10^{-6}$	$9.9\ 10^{-7}$	$1.4\ 10^{-7}$	$1.7\ 10^{-6}$	$4.0\ 10^{-8}$	$8.8\ 10^{-6}$	$3.4\ 10^{-6}$
Non-fatal skin cancer	$3.1\ 10^{-5}$	$5.7\ 10^{-6}$	$8.0\ 10^{-7}$	$6.8\ 10^{-6}$	$7.2\ 10^{-7}$	$1.2\ 10^{-5}$	$5.0\ 10^{-6}$	$3.0\ 10^{-8}$	$9.3\ 10^{-10}$	$6.1\ 10^{-8}$	$7.9\ 10^{-10}$	$4.2\ 10^{-7}$	$9.6\ 10^{-8}$
Non-fatal breast cancer	$6.5\ 10^{-6}$	$1.2\ 10^{-6}$	$1.6\ 10^{-7}$	$1.4\ 10^{-6}$	$1.5\ 10^{-7}$	$2.5\ 10^{-6}$	$1.0\ 10^{-6}$	$6.5\ 10^{-9}$	$1.3\ 10^{-10}$	$1.5\ 10^{-8}$	$2.0\ 10^{-10}$	$9.3\ 10^{-8}$	$1.1\ 10^{-8}$
Hereditary effects	$3.3\ 10^{-5}$	$5.8\ 10^{-6}$	$8.2\ 10^{-7}$	$6.8\ 10^{-6}$	$7.7\ 10^{-7}$	$1.3\ 10^{-5}$	$5.3\ 10^{-6}$	$4.0\ 10^{-8}$	$5.8\ 10^{-10}$	$1.1\ 10^{-7}$	$1.5\ 10^{-9}$	$6.6\ 10^{-7}$	$5.8\ 10^{-8}$
b) Areas and numbers of people affected by evacuation													
Numbers of people evacuated	$1.3\ 10^{-3}$	$5.7\ 10^{-5}$	$1.3\ 10^{-5}$	$4.7\ 10^{-5}$	$4.0\ 10^{-6}$	$1.4\ 10^{-4}$	$1.0\ 10^{-5}$	$1.2\ 10^{-6}$	$1.9\ 10^{-7}$	$4.8\ 10^{-6}$	$3.9\ 10^{-6}$	$5.8\ 10^{-4}$	$4.8\ 10^{-4}$
Area of land evacuated (km^2)	$9.8\ 10^{-6}$	$2.9\ 10^{-7}$	$5.6\ 10^{-8}$	$2.5\ 10^{-7}$	$3.0\ 10^{-8}$	$6.4\ 10^{-7}$	$7.5\ 10^{-8}$	$9.6\ 10^{-9}$	$1.5\ 10^{-9}$	$3.9\ 10^{-8}$	$3.1\ 10^{-8}$	$4.6\ 10^{-6}$	$3.8\ 10^{-6}$
c) Agricultural products restricted by countermeasures													
Total milk (litres)	$5.4\ 10^{0}$	$1.0\ 10^{0}$	$1.5\ 10^{-1}$	$1.2\ 10^{0}$	$1.2\ 10^{-1}$	$2.1\ 10^{0}$	$7.5\ 10^{-1}$	$8.8\ 10^{-3}$	$9.1\ 10^{-4}$	$5.5\ 10^{-3}$	$2.0\ 10^{-5}$	$5.7\ 10^{-3}$	$1.1\ 10^{-3}$
Time integral of the area of crop restrictions (km^2-y)	$5.6\ 10^{-5}$	$1.0\ 10^{-5}$	$1.4\ 10^{-6}$	$1.0\ 10^{-5}$	$1.6\ 10^{-6}$	$2.3\ 10^{-5}$	$8.8\ 10^{-6}$	$2.2\ 10^{-7}$	$1.7\ 10^{-8}$	$2.1\ 10^{-7}$	$6.1\ 10^{-10}$	$3.2\ 10^{-7}$	$8.0\ 10^{-9}$
Time integral of the number of livestock[1] restricted (livestock - y)	$3.6\ 10^{-2}$	$6.7\ 10^{-3}$	$9.5\ 10^{-4}$	$7.8\ 10^{-3}$	$7.6\ 10^{-4}$	$1.5\ 10^{-2}$	$5.2\ 10^{-3}$	$1.6\ 10^{-5}$	$3.3\ 10^{-7}$	$1.3\ 10^{-5}$	$1.1\ 10^{-8}$	$7.7\ 10^{-6}$	$6.7\ 10^{-8}$

Note:

1. Livestock includes cattle, sheep and pigs.

Table 36

Revised estimates of release fractions for UK1, UK2, UK5 and UK6[1-5]

Release category	Frequency of occurrence (y^{-1})	Release sub-category	Probability of sub-category[1]	Release fractions						
				Xe-Kr	Organic I	Particulate				
						I-Br[2]	Cs-Rb	Te-Sb	Ba-Sr	Ru[3]	La[4]
UK1	$2.4\ 10^{-9}$	A	0.040	$9\ 10^{-1}$	$7\ 10^{-3}$	$5\ 10^{-1}$	$5\ 10^{-1}$	$3\ 10^{-1}$	$6\ 10^{-2}$	$2\ 10^{-2}$	$4\ 10^{-3}$
		B	0.22	$9\ 10^{-1}$	$7\ 10^{-3}$	$2.5\ 10^{-1}$	$2.5\ 10^{-1}$	$1.5\ 10^{-1}$	$3\ 10^{-2}$	$1\ 10^{-2}$	$2\ 10^{-3}$
		C	0.60	$9\ 10^{-1}$	$7\ 10^{-3}$	$1.3\ 10^{-1}$	$1.3\ 10^{-1}$	$7.5\ 10^{-2}$	$1.5\ 10^{-2}$	$5\ 10^{-3}$	$1\ 10^{-3}$
		D	0.060	$9\ 10^{-1}$	$7\ 10^{-3}$	$5\ 10^{-2}$	$5\ 10^{-2}$	$3\ 10^{-2}$	$6\ 10^{-3}$	$2\ 10^{-3}$	$4\ 10^{-4}$
		E	0.080	$9\ 10^{-1}$	$7\ 10^{-3}$	$2.5\ 10^{-2}$	$2.5\ 10^{-2}$	$1.5\ 10^{-2}$	$3\ 10^{-3}$	$1\ 10^{-3}$	$2\ 10^{-4}$
UK2	$4.0\ 10^{-10}$	A	0.045	$9\ 10^{-1}$	$6\ 10^{-3}$	$4\ 10^{-1}$	$4\ 10^{-1}$	$3.5\ 10^{-1}$	$5\ 10^{-2}$	$2\ 10^{-1}$	$3\ 10^{-3}$
		B	0.077	$9\ 10^{-1}$	$6\ 10^{-3}$	$2\ 10^{-1}$	$2\ 10^{-1}$	$1.8\ 10^{-1}$	$2.5\ 10^{-2}$	$1\ 10^{-1}$	$1.5\ 10^{-3}$
		C	0.30	$9\ 10^{-1}$	$6\ 10^{-3}$	$1\ 10^{-1}$	$1\ 10^{-1}$	$8.8\ 10^{-2}$	$1.3\ 10^{-2}$	$5\ 10^{-2}$	$7.5\ 10^{-4}$
		D	0.17	$9\ 10^{-1}$	$6\ 10^{-3}$	$4\ 10^{-2}$	$4\ 10^{-2}$	$3.5\ 10^{-2}$	$5\ 10^{-3}$	$2\ 10^{-2}$	$3\ 10^{-4}$
		E	0.42	$9\ 10^{-1}$	$6\ 10^{-3}$	$2\ 10^{-2}$	$2\ 10^{-2}$	$1.8\ 10^{-2}$	$2.5\ 10^{-3}$	$1\ 10^{-2}$	$1.5\ 10^{-4}$
UK5	$8.0\ 10^{-9}$	A	0.034	1.0	$7\ 10^{-3}$	$3\ 10^{-1}$	$3\ 10^{-1}$	$5\ 10^{-1}$	$4\ 10^{-2}$	$3\ 10^{-2}$	$6\ 10^{-3}$
		B	0.073	1.0	$7\ 10^{-3}$	$1.5\ 10^{-1}$	$1.5\ 10^{-1}$	$2.5\ 10^{-1}$	$2\ 10^{-2}$	$1.5\ 10^{-2}$	$3\ 10^{-3}$
		C	0.26	1.0	$7\ 10^{-3}$	$7.5\ 10^{-2}$	$7.5\ 10^{-2}$	$1.3\ 10^{-1}$	$1\ 10^{-2}$	$7.5\ 10^{-3}$	$1.5\ 10^{-3}$
		D	0.17	1.0	$7\ 10^{-3}$	$3.0\ 10^{-2}$	$3.0\ 10^{-2}$	$5\ 10^{-2}$	$4\ 10^{-3}$	$3\ 10^{-3}$	$6\ 10^{-4}$
		E	0.47	1.0	$7\ 10^{-3}$	$1.5\ 10^{-2}$	$1.5\ 10^{-2}$	$2.5\ 10^{-2}$	$2\ 10^{-3}$	$1.5\ 10^{-3}$	$3\ 10^{-4}$
UK6	$4.2\ 10^{-9}$	A	0.047	$9\ 10^{-1}$	$6\ 10^{-3}$	$2.3\ 10^{-1}$	$2\ 10^{-1}$	$2\ 10^{-1}$	$2\ 10^{-2}$	$7\ 10^{-3}$	$7\ 10^{-4}$
		B	0.079	$9\ 10^{-1}$	$6\ 10^{-3}$	$1.1\ 10^{-1}$	$1\ 10^{-1}$	$1\ 10^{-1}$	$1\ 10^{-2}$	$3.5\ 10^{-3}$	$3.5\ 10^{-4}$
		C	0.25	$9\ 10^{-1}$	$6\ 10^{-3}$	$5.6\ 10^{-2}$	$5\ 10^{-2}$	$5\ 10^{-2}$	$5\ 10^{-3}$	$1.8\ 10^{-3}$	$1.8\ 10^{-4}$
		D	0.17	$9\ 10^{-1}$	$6\ 10^{-3}$	$2.3\ 10^{-2}$	$2\ 10^{-2}$	$2\ 10^{-2}$	$2\ 10^{-3}$	$7\ 10^{-4}$	$7\ 10^{-5}$
		E	0.46	$9\ 10^{-1}$	$6\ 10^{-3}$	$1.1\ 10^{-2}$	$1\ 10^{-2}$	$1\ 10^{-2}$	$1\ 10^{-3}$	$3.5\ 10^{-4}$	$3.5\ 10^{-5}$

Footnotes:

1. Probability of occurrence conditional upon the release of that category; the sum of the probabilities of occurrence of each sub-category (A-E) is unity.
2. Iodine released as a particulate in the form of CsI (compared with iodine in an elemental form in the initial analysis - see Table 2).
3. Includes Ru, Rh, Co, Mo and Tc.
4. Includes Y, La, Zr, Nb, Ce, Pr, Nd, Np, Am and Cm.
5. The other characteristics of the releases (eg, duration, time before release, energy content) are the same as specified for the original release category in Table 2.

Table 37(R)

Characteristic quantities of the distributions of consequences conditional upon the revised release category UK1 (summed over UK1A-E)

UK1 FREQUENCY: $2.4\ 10^{-9}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$6.6\ 10^{0}$	0	0	$2.3\ 10^{0}$	$9.2\ 10^{1}$	59	6.1
Prodromal vomiting	$4.3\ 10^{1}$	0	$5.6\ 10^{-3}$	$4.3\ 10^{1}$	$1.1\ 10^{3}$	47	10
Lung morbidity	$3.7\ 10^{0}$	0	0	$1.9\ 10^{0}$	$8.9\ 10^{1}$	62	5.8
Late							
Fatal cancer	$1.3\ 10^{3}$	0	$3.2\ 10^{1}$	$3.6\ 10^{3}$	$1.5\ 10^{4}$	28	24
Non-fatal thyroid cancer	$4.0\ 10^{3}$	*	$1.3\ 10^{2}$	$1.2\ 10^{4}$	$3.9\ 10^{4}$	28	27
Non-fatal skin cancer	$9.4\ 10^{2}$	0	$1.4\ 10^{1}$	$2.2\ 10^{3}$	$1.2\ 10^{4}$	28	22
Non-fatal breast cancer	$2.0\ 10^{2}$	0	$3.2\ 10^{0}$	$4.8\ 10^{2}$	$2.4\ 10^{3}$	28	22
Hereditary effects	$1.0\ 10^{3}$	0	$2.1\ 10^{1}$	$2.7\ 10^{3}$	$1.2\ 10^{4}$	28	23

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$4.2\ 10^{3}$	0	$1.2\ 10^{2}$	$8.5\ 10^{3}$	$7.0\ 10^{4}$	30	20
Area of land evacuated (km^2)	$3.0\ 10^{1}$	0	$6.6\ 10^{0}$	$7.0\ 10^{1}$	$3.7\ 10^{2}$	30	17

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$1.1\ 10^{7}$	0	$3.9\ 10^{4}$	$4.7\ 10^{7}$	$8.6\ 10^{7}$	36	23
Total milk restricted (litres)	$1.6\ 10^{8}$	0	$2.6\ 10^{6}$	$3.8\ 10^{8}$	$3.2\ 10^{9}$	36	23
Initial crop area restricted (km^2)	$1.8\ 10^{3}$	0	$1.5\ 10^{1}$	$7.4\ 10^{3}$	$1.1\ 10^{4}$	36	25
Time integral of the area of crop restrictions (km^2-y)	$2.3\ 10^{3}$	0	$2.5\ 10^{1}$	$8.5\ 10^{3}$	$1.6\ 10^{4}$	36	26
Initial no. livestock restricted	$1.0\ 10^{6}$	0	$3.1\ 10^{3}$	$3.8\ 10^{6}$	$9.7\ 10^{6}$	36	24
Time integral of the number of livestock restricted = (livestock-y)	$1.0\ 10^{6}$	0	$8.4\ 10^{3}$	$3.0\ 10^{6}$	$1.3\ 10^{7}$	36	22

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table 38(R)

Characteristic quantities of the distributions of consequences conditional upon the revised release category UK2 (summed over UK2A-E)

UK2 FREQUENCY: $4.0\ 10^{-10}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$4.5\ 10^{0}$	0	0	$3.0\ 10^{-1}$	$4.4\ 10^{1}$	76	3.7
Prodromal vomiting	$1.8\ 10^{1}$	0	0	$5.9\ 10^{0}$	$4.1\ 10^{2}$	56	6.1
Lung morbidity	$7.6\ 10^{0}$	0	0	$8.4\ 10^{-1}$	$1.7\ 10^{2}$	81	4.8
Late							
Fatal cancer	$9.0\ 10^{2}$	0	$1.3\ 10^{1}$	$2.2\ 10^{3}$	$1.2\ 10^{4}$	30	21
Non-fatal thyroid cancer	$2.3\ 10^{3}$	0	$3.5\ 10^{1}$	$6.4\ 10^{3}$	$2.6\ 10^{4}$	30	25
Non-fatal skin cancer	$5.3\ 10^{2}$	0	$3.8\ 10^{0}$	$1.2\ 10^{3}$	$7.6\ 10^{3}$	30	19
Non-fatal breast cancer	$1.1\ 10^{2}$	0	$1.0\ 10^{0}$	$2.5\ 10^{2}$	$1.6\ 10^{3}$	30	19
Hereditary effects	$5.8\ 10^{2}$	0	$7.8\ 10^{0}$	$1.4\ 10^{3}$	$7.6\ 10^{3}$	30	21

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$3.3\ 10^{3}$	0	$4.2\ 10^{1}$	$5.7\ 10^{3}$	$4.2\ 10^{4}$	30	18
Area of land evacuated (km^2)	$2.2\ 10^{1}$	0	$4.8\ 10^{0}$	$3.6\ 10^{1}$	$2.9\ 10^{2}$	30	17

c) Agricultural products restricted by countermeasures [1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$6.3\ 10^{6}$	0	$2.1\ 10^{4}$	$2.7\ 10^{7}$	$6.2\ 10^{7}$	39	21
Total milk restricted (litres)	$7.3\ 10^{7}$	0	$7.1\ 10^{5}$	$1.7\ 10^{8}$	$1.2\ 10^{9}$	39	19
Initial crop area restricted (km^2)	$1.1\ 10^{3}$	0	$4.6\ 10^{0}$	$4.8\ 10^{3}$	$8.8\ 10^{3}$	39	25
Time integral of the area of crop restrictions (km^2-y)	$1.3\ 10^{3}$	0	$8.1\ 10^{0}$	$5.0\ 10^{3}$	$1.1\ 10^{4}$	39	25
Initial no. livestock restricted	$5.3\ 10^{5}$	0	$1.1\ 10^{3}$	$1.6\ 10^{6}$	$7.1\ 10^{6}$	40	20
Time integral of the number of livestock restricted - (livestock-y)	$5.3\ 10^{5}$	0	$2.3\ 10^{3}$	$1.3\ 10^{6}$	$8.5\ 10^{6}$	40	17

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table 39(R)

Characteristic quantities of the distributions of consequences conditional upon the revised release category UK5 (summed over UK5A-E)

UK5 FREQUENCY: $8.0\ 10^{-9}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$7.2\ 10^{-1}$	0	0	0	$4.6\ 10^{-1}$	98	0.8
Prodromal vomiting	$4.6\ 10^{0}$	0	0	0	$5.9\ 10^{1}$	92	2.7
Lung morbidity	$8.2\ 10^{-1}$	0	0	0	$3.9\ 10^{0}$	98	1.4
Late							
Fatal cancer	$5.6\ 10^{2}$	0	$8.0\ 10^{0}$	$1.4\ 10^{3}$	$7.3\ 10^{3}$	33	22
Non-fatal thyroid cancer	$1.8\ 10^{3}$	0	$2.4\ 10^{1}$	$5.2\ 10^{3}$	$2.0\ 10^{4}$	33	25
Non-fatal skin cancer	$3.6\ 10^{2}$	0	$3.0\ 10^{0}$	$7.7\ 10^{2}$	$5.1\ 10^{3}$	33	19
Non-fatal breast cancer	$7.6\ 10^{1}$	0	$8.5\ 10^{-1}$	$1.7\ 10^{2}$	$1.0\ 10^{3}$	33	20
Hereditary effects	$4.1\ 10^{2}$	0	$7.0\ 10^{0}$	$1.0\ 10^{3}$	$5.2\ 10^{3}$	33	22

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$2.5\ 10^{3}$	0	$3.9\ 10^{1}$	$5.5\ 10^{3}$	$3.3\ 10^{4}$	30	19
Area of land evacuated (km^2)	$1.7\ 10^{1}$	0	$4.7\ 10^{0}$	$2.3\ 10^{1}$	$2.4\ 10^{2}$	30	13

c) Agricultural products restricted by countermeasures [1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$5.4\ 10^{6}$	0	$1.6\ 10^{6}$	$1.9\ 10^{7}$	$5.6\ 10^{7}$	39	21
Total milk restricted (litres)	$5.4\ 10^{7}$	0	$5.6\ 10^{5}$	$1.3\ 10^{8}$	$8.3\ 10^{8}$	39	19
Initial crop area restricted (km^2)	$8.7\ 10^{2}$	0	$4.3\ 10^{0}$	$3.4\ 10^{3}$	$7.9\ 10^{3}$	39	24
Time integral of the area of crop restrictions (km^2-y)	$9.9\ 10^{2}$	0	$5.1\ 10^{0}$	$3.8\ 10^{3}$	$9.0\ 10^{3}$	39	23
Initial no. livestock restricted	$3.9\ 10^{5}$	0	$1.1\ 10^{3}$	$1.0\ 10^{6}$	$5.8\ 10^{6}$	40	17
Time integral of the number of livestock restricted - (livestock-y)	$3.7\ 10^{5}$	0	$1.7\ 10^{3}$	$8.5\ 10^{5}$	$6.5\ 10^{6}$	40	17

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table 40(9)

Characteristic quantities of the distributions of consequences conditional upon the revised release category UK6 (summed over UK6A-E)

UK6 FREQUENCY: $4.2\ 10^{-9}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$4.5\ 10^{-2}$	0	0	0	0	100	0.32
Prodromal vomiting	$1.0\ 10^{0}$	0	0	0	$7.8\ 10^{0}$	94	2.1
Lung morbidity	$3.1\ 10^{-3}$	0	0	0	0	100	0.12
Late							
Fatal cancer	$3.7\ 10^{2}$	0	$3.5\ 10^{0}$	$9.1\ 10^{2}$	$4.8\ 10^{3}$	33	22
Non-fatal thyroid cancer	$1.4\ 10^{3}$	0	$1.9\ 10^{1}$	$4.4\ 10^{3}$	$1.5\ 10^{4}$	33	25
Non-fatal skin cancer	$2.6\ 10^{2}$	0	$2.5\ 10^{0}$	$5.7\ 10^{2}$	$3.5\ 10^{3}$	33	19
Non-fatal breast cancer	$5.6\ 10^{1}$	0	$7.5\ 10^{-1}$	$1.3\ 10^{2}$	$7.3\ 10^{2}$	33	20
Hereditary effects	$3.1\ 10^{2}$	0	$3.8\ 10^{0}$	$7.7\ 10^{2}$	$3.8\ 10^{3}$	33	22

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$1.6\ 10^{3}$	0	$3.8\ 10^{1}$	$5.4\ 10^{3}$	$1.4\ 10^{4}$	30	11
Area of land evacuated (km^2)	$1.2\ 10^{1}$	0	$4.7\ 10^{0}$	$2.0\ 10^{1}$	$1.4\ 10^{2}$	30	18

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$4.7\ 10^{6}$	0	$1.1\ 10^{4}$	$1.6\ 10^{7}$	$5.4\ 10^{7}$	19	20
Total milk restricted (litres)	$3.9\ 10^{7}$	0	$3.6\ 10^{5}$	$9.6\ 10^{7}$	$5.2\ 10^{8}$	19	18
Initial crop area restricted (km^2)	$6.8\ 10^{2}$	0	$4.3\ 10^{0}$	$2.3\ 10^{3}$	$6.9\ 10^{3}$	40	22
Time integral of the area of crop restrictions (km^2-y)	$7.3\ 10^{2}$	0	$4.5\ 10^{0}$	$2.4\ 10^{3}$	$7.3\ 10^{3}$	40	22
Initial no. livestock restricted	$3.1\ 10^{5}$	0	$1.1\ 10^{3}$	$7.4\ 10^{5}$	$5.1\ 10^{6}$	40	17
Time integral of the number of livestock restricted - (livestock-y)	$2.6\ 10^{5}$	0	$1.4\ 10^{3}$	$5.7\ 10^{5}$	$4.3\ 10^{6}$	40	17

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table 41(R)

Comparison of the radiological consequences predicted for the 'original' and 'revised' release category UK1 (conditional upon the release)

UK1 FREQUENCY: $2.4\ 10^{-9}\ y^{-1}$ [1]

Radiological endpoint	Expectation value		Value at the 99th percentile	
	'Original'	'Revised'	'Original'	'Revised'
Early deaths	$1.3\ 10^{2}$	$6.6\ 10^{0}$	$2.6\ 10^{3}$	$9.2\ 10^{1}$
Prodromal vomiting	$3.7\ 10^{2}$	$4.3\ 10^{1}$	$4.8\ 10^{3}$	$1.1\ 10^{3}$
Lung morbidity	$8.3\ 10^{0}$	$3.7\ 10^{0}$	$1.4\ 10^{2}$	$8.9\ 10^{1}$
Fatal cancer	$3.3\ 10^{3}$	$1.3\ 10^{3}$	$3.1\ 10^{4}$	$1.5\ 10^{4}$
Non-fatal thyroid cancer	$7.7\ 10^{3}$	$4.0\ 10^{3}$	$6.5\ 10^{4}$	$3.9\ 10^{4}$
Non-fatal skin cancer	$2.4\ 10^{3}$	$9.4\ 10^{2}$	$2.6\ 10^{4}$	$1.2\ 10^{4}$
Non-fatal breast cancer	$4.9\ 10^{2}$	$2.0\ 10^{2}$	$5.2\ 10^{3}$	$2.4\ 10^{3}$
Hereditary effects	$2.3\ 10^{3}$	$1.0\ 10^{3}$	$2.5\ 10^{4}$	$1.2\ 10^{4}$
Number of people evacuated	$2.4\ 10^{4}$	$4.2\ 10^{3}$	$3.0\ 10^{5}$	$7.0\ 10^{4}$
Area of land evacuated (km^2)	$1.2\ 10^{2}$	$3.0\ 10^{1}$	$1.3\ 10^{3}$	$3.7\ 10^{2}$
Milk restricted in 7 days (litres)	$1.5\ 10^{7}$	$1.1\ 10^{7}$	$1.2\ 10^{8}$	$8.6\ 10^{7}$
Total milk restricted (litres)	$4.4\ 10^{8}$	$1.6\ 10^{8}$	$5.6\ 10^{9}$	$3.2\ 10^{9}$
Initial area of crop restrictions (km^2)	$2.6\ 10^{3}$	$1.8\ 10^{3}$	$1.4\ 10^{4}$	$1.1\ 10^{4}$
Time integral of the area of crop restrictions (km^2-y)	$4.3\ 10^{3}$	$2.3\ 10^{3}$	$3.6\ 10^{4}$	$1.6\ 10^{4}$
Initial number of livestock restricted	$2.0\ 10^{6}$	$1.0\ 10^{6}$	$1.3\ 10^{7}$	$9.7\ 10^{6}$
Time integral of the number of livestock estimated (livestock-y)	$2.8\ 10^{6}$	$1.0\ 10^{6}$	$2.9\ 10^{7}$	$1.3\ 10^{7}$

Note:

1. The consequences quoted at the 99th percentile would actually be exceeded with a frequency of 0.01 f(r) where f(r) is the frequency of occurrence of this release category and is specified above.

Table 42(R)

Comparison of the radiological consequences predicted for the 'original' and 'revised' release category UK2 (conditional upon the release)

UK2 FREQUENCY: $4.0\ 10^{-10}\ y^{-1}$ [1]

Radiological endpoint	Expectation value		Value at the 99th percentile	
	'Original'	'Revised'	'Original'	'Revised'
Early deaths	$7.8\ 10^{1}$	$4.5\ 10^{0}$	$1.8\ 10^{3}$	$4.4\ 10^{1}$
Prodromal vomiting	$2.9\ 10^{2}$	$1.8\ 10^{1}$	$3.9\ 10^{3}$	$4.1\ 10^{2}$
Lung morbidity	$5.2\ 10^{1}$	$7.6\ 10^{0}$	$8.7\ 10^{2}$	$1.7\ 10^{2}$
Fatal cancer	$3.6\ 10^{3}$	$9.0\ 10^{2}$	$3.3\ 10^{4}$	$1.2\ 10^{4}$
Non-fatal thyroid cancer	$7.9\ 10^{3}$	$2.3\ 10^{3}$	$7.1\ 10^{4}$	$2.6\ 10^{4}$
Non-fatal skin cancer	$2.0\ 10^{3}$	$5.3\ 10^{2}$	$2.3\ 10^{4}$	$7.6\ 10^{3}$
Non-fatal breast cancer	$4.1\ 10^{2}$	$1.1\ 10^{2}$	$4.5\ 10^{3}$	$1.6\ 10^{3}$
Hereditary effects	$2.0\ 10^{3}$	$5.8\ 10^{2}$	$2.1\ 10^{4}$	$7.6\ 10^{3}$
Number of people evacuated	$3.1\ 10^{4}$	$3.5\ 10^{3}$	$4.2\ 10^{5}$	$4.2\ 10^{4}$
Area of land evacuated (km^2)	$1.4\ 10^{2}$	$2.2\ 10^{1}$	$1.5\ 10^{3}$	$2.9\ 10^{2}$
Milk restricted in 7 days (litres)	$1.3\ 10^{7}$	$6.5\ 10^{6}$	$8.9\ 10^{7}$	$6.2\ 10^{7}$
Total milk restricted (litres)	$3.6\ 10^{8}$	$7.5\ 10^{7}$	$5.4\ 10^{9}$	$1.2\ 10^{9}$
Initial area of crop restrictions (km^2)	$2.3\ 10^{3}$	$1.1\ 10^{3}$	$1.2\ 10^{4}$	$8.3\ 10^{3}$
Time integral of the area of crop restrictions (km^2-y)	$3.4\ 10^{3}$	$1.3\ 10^{3}$	$2.8\ 10^{4}$	$1.1\ 10^{4}$
Initial number of livestock restricted	$1.8\ 10^{6}$	$5.3\ 10^{5}$	$1.1\ 10^{7}$	$7.1\ 10^{6}$
Time integral of the number of livestock restricted (livestock-y)	$2.4\ 10^{6}$	$5.3\ 10^{5}$	$2.4\ 10^{7}$	$8.5\ 10^{6}$

Note:

1. The consequences quoted at the 99th percentile would actually be exceeded with a frequency of 0.01 f(r) where f(r) is the frequency of occurrence of this release category and is specified above.

Table 41(R)

Comparison of the radiological consequences predicted for the 'original' and 'revised' release category UK5 (conditional upon the release)

UK5 FREQUENCY: $8.0\ 10^{-9}\ y^{-1}$ [1]

Radiological endpoint	Expectation value		Value at the 99th percentile	
	'Original'	'Revised'	'Original'	'Revised'
Early deaths	$1.2\ 10^{1}$	$7.2\ 10^{-1}$	$2.4\ 10^{2}$	$4.6\ 10^{-1}$
Prodromal vomiting	$5.2\ 10^{1}$	$4.6\ 10^{0}$	$1.5\ 10^{3}$	$5.9\ 10^{1}$
Lung morbidity	$8.4\ 10^{0}$	$8.2\ 10^{-1}$	$2.4\ 10^{2}$	$3.9\ 10^{0}$
Fatal cancer	$2.2\ 10^{3}$	$5.6\ 10^{2}$	$2.1\ 10^{4}$	$7.3\ 10^{3}$
Non-fatal thyroid cancer	$3.3\ 10^{3}$	$1.8\ 10^{3}$	$2.9\ 10^{4}$	$2.0\ 10^{4}$
Non-fatal skin cancer	$1.5\ 10^{3}$	$3.6\ 10^{2}$	$1.7\ 10^{4}$	$5.1\ 10^{3}$
Non-fatal breast cancer	$3.1\ 10^{2}$	$7.6\ 10^{1}$	$3.5\ 10^{3}$	$1.0\ 10^{3}$
Hereditary effects	$1.6\ 10^{3}$	$4.1\ 10^{2}$	$1.8\ 10^{4}$	$5.2\ 10^{3}$
Number of people evacuated	$1.8\ 10^{4}$	$2.5\ 10^{3}$	$3.1\ 10^{5}$	$3.3\ 10^{4}$
Area of land evacuated (km^2)	$8.1\ 10^{1}$	$1.7\ 10^{1}$	$1.2\ 10^{3}$	$2.4\ 10^{2}$
Milk restricted in 7 days (litres)	$1.0\ 10^{7}$	$5.4\ 10^{6}$	$7.6\ 10^{7}$	$5.6\ 10^{7}$
Total milk restricted (litres)	$2.6\ 10^{8}$	$5.4\ 10^{7}$	$4.6\ 10^{9}$	$8.3\ 10^{8}$
Initial area of crop restrictions (km^2)	$2.0\ 10^{3}$	$8.7\ 10^{2}$	$1.1\ 10^{4}$	$7.9\ 10^{3}$
Time integral of the area of crop restrictions (km^2-y)	$2.9\ 10^{3}$	$9.9\ 10^{2}$	$2.3\ 10^{4}$	$9.0\ 10^{3}$
Initial number of livestock restricted	$1.4\ 10^{6}$	$3.9\ 10^{5}$	$9.6\ 10^{6}$	$3.8\ 10^{6}$
Time integral of the number of livestock estimated (livestock-y)	$1.8\ 10^{6}$	$3.7\ 10^{5}$	$2.0\ 10^{7}$	$6.5\ 10^{6}$

Note:

1. The consequences quoted at the 99th percentile would actually be exceeded with a frequency of 0.01 f(r) where f(r) is the frequency of occurrence of this release category and is specified above.

Table 44(R)

Comparison of the radiological consequences predicted for the 'original' and 'revised' release category UK6 (conditional upon the release)

UK6 FREQUENCY: $4.2\ 10^{-9}\ y^{-1}$ [1]

Radiological endpoint	Expectation value		Value at the 99th percentile	
	'Original'	'Revised'	'Original'	'Revised'
Early deaths	$1.7\ 10^{-3}$	$4.4\ 10^{-3}$	0	0
Prodromal vomiting	$5.3\ 10^{-1}$	$1.0\ 10^{0}$	$9.9\ 10^{0}$	$7.8\ 10^{0}$
Lung morbidity	$3.6\ 10^{-3}$	$3.1\ 10^{-3}$	0	0
Fatal cancer	$1.4\ 10^{3}$	$3.7\ 10^{2}$	$1.3\ 10^{4}$	$4.8\ 10^{3}$
Non-fatal thyroid cancer	$1.3\ 10^{3}$	$1.4\ 10^{3}$	$1.3\ 10^{4}$	$1.5\ 10^{4}$
Non-fatal skin cancer	$1.2\ 10^{3}$	$2.8\ 10^{2}$	$1.3\ 10^{4}$	$3.5\ 10^{3}$
Non-fatal breast cancer	$2.5\ 10^{2}$	$5.6\ 10^{1}$	$2.7\ 10^{3}$	$7.3\ 10^{2}$
Hereditary effects	$1.3\ 10^{3}$	$2.1\ 10^{2}$	$1.3\ 10^{4}$	$3.8\ 10^{3}$
Number of people evacuated	$2.4\ 10^{3}$	$1.8\ 10^{3}$	$3.4\ 10^{4}$	$1.4\ 10^{4}$
Area of land evacuated (km^2)	$1.8\ 10^{1}$	$1.2\ 10^{1}$	$2.1\ 10^{2}$	$1.4\ 10^{2}$
Milk restricted in 7 days (litres)	$8.1\ 10^{6}$	$4.7\ 10^{6}$	$6.0\ 10^{7}$	$5.4\ 10^{7}$
Total milk restricted (litres)	$1.8\ 10^{8}$	$3.9\ 10^{7}$	$3.0\ 10^{9}$	$3.2\ 10^{8}$
Initial area of crop restrictions (km^2)	$1.7\ 10^{3}$	$6.8\ 10^{2}$	$9.3\ 10^{3}$	$6.9\ 10^{3}$
Time integral of the area of crop restrictions (km^2-y)	$2.1\ 10^{3}$	$7.3\ 10^{2}$	$1.4\ 10^{4}$	$7.3\ 10^{3}$
Initial number of livestock restricted	$1.1\ 10^{6}$	$3.1\ 10^{5}$	$8.3\ 10^{6}$	$5.1\ 10^{6}$
Time integral of the number of livestock estimated (livestock-y)	$1.2\ 10^{6}$	$2.6\ 10^{5}$	$1.5\ 10^{7}$	$4.3\ 10^{6}$

Note:

1. The consequences quoted at the 99th percentile would actually be exceeded with a frequency of 0.01 f(r) where f(r) is the frequency of occurrence of this release category and is specified above.

Table 9.5(R)

A comparison of the consequences from degraded core accidents for one year of operation of the reactor for the original and revised release categories UK1, UK2, UK5 UK6 and their sum

Radiological endpoint	Expectation value (or mean number) of the consequences for one year's operation of the reactor									
	"Original" release category					Revised release category				
	UK1	UK2	UK5	UK6	Total[1]	UK1	UK2	UK5	UK6	Total[1]
Early deaths	$3.1\ 10^{-7}$	$3.2\ 10^{-8}$	$9.1\ 10^{-8}$	$6.9\ 10^{-12}$	$4.3\ 10^{-7}$	$1.6\ 10^{-8}$	$1.8\ 10^{-9}$	$5.7\ 10^{-9}$	$1.9\ 10^{-10}$	$2.3\ 10^{-8}$
Prodromal vomiting	$8.9\ 10^{-3}$	$1.2\ 10^{-3}$	$4.1\ 10^{-3}$	$2.2\ 10^{-9}$	$1.4\ 10^{-4}$	$1.0\ 10^{-3}$	$7.2\ 10^{-5}$	$3.7\ 10^{-4}$	$4.3\ 10^{-9}$	$1.5\ 10^{-3}$
Lung fibrosis	$2.0\ 10^{-8}$	$2.1\ 10^{-9}$	$6.7\ 10^{-9}$	$1.5\ 10^{-11}$	$1.1\ 10^{-7}$	$8.7\ 10^{-9}$	$3.1\ 10^{-9}$	$6.5\ 10^{-9}$	$1.3\ 10^{-11}$	$1.8\ 10^{-8}$
Fatal cancers	$7.8\ 10^{-6}$	$1.5\ 10^{-6}$	$1.8\ 10^{-5}$	$5.9\ 10^{-6}$	$3.3\ 10^{-5}$	$3.1\ 10^{-6}$	$3.6\ 10^{-7}$	$4.4\ 10^{-6}$	$1.6\ 10^{-6}$	$9.5\ 10^{-6}$
Non-fatal thyroid cancers	$4.8\ 10^{-5}$	$3.2\ 10^{-6}$	$2.6\ 10^{-5}$	$5.6\ 10^{-6}$	$5.3\ 10^{-5}$	$9.5\ 10^{-6}$	$9.1\ 10^{-7}$	$1.4\ 10^{-5}$	$6.0\ 10^{-6}$	$3.0\ 10^{-5}$
Non-fatal skin cancers	$5.7\ 10^{-6}$	$8.0\ 10^{-7}$	$1.2\ 10^{-5}$	$5.0\ 10^{-6}$	$2.3\ 10^{-5}$	$2.2\ 10^{-6}$	$2.1\ 10^{-7}$	$2.8\ 10^{-6}$	$1.1\ 10^{-6}$	$6.3\ 10^{-6}$
Non-fatal breast cancers	$1.2\ 10^{-6}$	$1.6\ 10^{-7}$	$2.5\ 10^{-6}$	$1.0\ 10^{-6}$	$4.8\ 10^{-6}$	$4.7\ 10^{-7}$	$4.4\ 10^{-8}$	$6.0\ 10^{-7}$	$2.3\ 10^{-7}$	$1.3\ 10^{-6}$
Hereditary effects	$5.8\ 10^{-6}$	$8.2\ 10^{-7}$	$1.3\ 10^{-5}$	$5.3\ 10^{-6}$	$2.5\ 10^{-5}$	$2.4\ 10^{-6}$	$2.3\ 10^{-7}$	$3.3\ 10^{-6}$	$1.3\ 10^{-6}$	$7.2\ 10^{-6}$
Number of people evacuated	$5.2\ 10^{-5}$	$1.3\ 10^{-5}$	$1.4\ 10^{-4}$	$1.0\ 10^{-5}$	$2.2\ 10^{-4}$	$9.9\ 10^{-6}$	$1.4\ 10^{-6}$	$2.0\ 10^{-5}$	$6.5\ 10^{-6}$	$3.8\ 10^{-5}$
Area of land evacuated (km^2)	$2.9\ 10^{-7}$	$5.6\ 10^{-8}$	$6.4\ 10^{-7}$	$7.5\ 10^{-8}$	$1.1\ 10^{-6}$	$7.1\ 10^{-8}$	$8.8\ 10^{-9}$	$1.3\ 10^{-7}$	$5.1\ 10^{-8}$	$2.6\ 10^{-7}$
Total milk restricted (litres)	$4.0\ 10^{8}$	$1.5\ 10^{7}$	$2.1\ 10^{8}$	$7.5\ 10^{7}$	$4.0\ 10^{8}$	$3.8\ 10^{7}$	$3.0\ 10^{6}$	$4.3\ 10^{7}$	$1.6\ 10^{7}$	$1.0\ 10^{8}$
Time integral of the area of crop restrictions (km^2 y)	$1.0\ 10^{-5}$	$1.4\ 10^{-6}$	$2.3\ 10^{-5}$	$6.8\ 10^{-6}$	$4.3\ 10^{-5}$	$5.4\ 10^{-6}$	$5.3\ 10^{-7}$	$7.9\ 10^{-6}$	$3.1\ 10^{-6}$	$1.7\ 10^{-5}$
Time integral of the number of livestock extracted (livestock y)	$6.7\ 10^{-3}$	$9.5\ 10^{-4}$	$1.5\ 10^{-2}$	$5.2\ 10^{-3}$	$2.7\ 10^{-2}$	$2.4\ 10^{-3}$	$2.1\ 10^{-4}$	$2.9\ 10^{-3}$	$1.1\ 10^{-3}$	$6.6\ 10^{-3}$

Notes:

1 Total summed over UK1, UK2, UK5 and UK6.

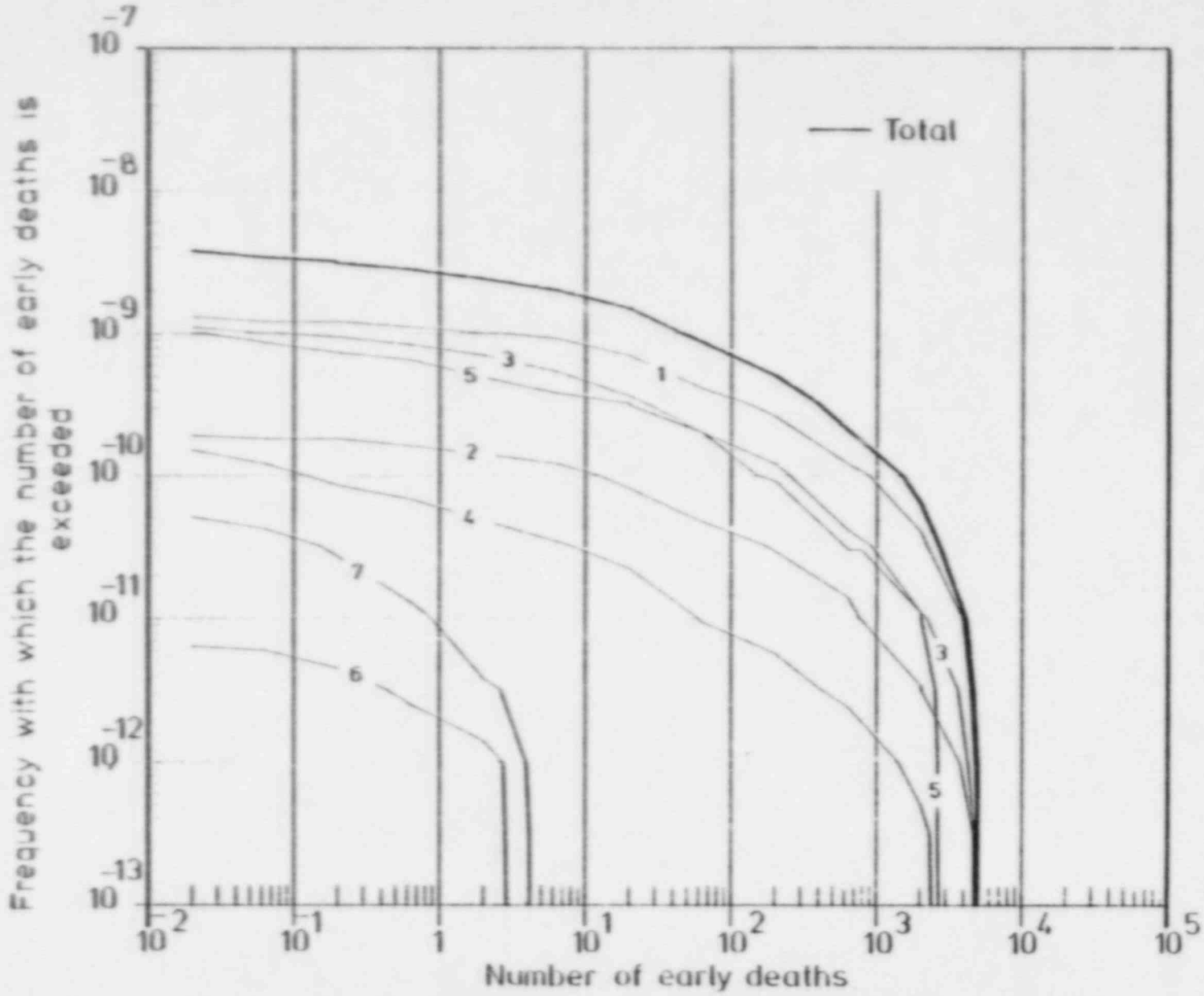


Figure 6 The frequency distributions of early deaths from degraded core accidents for one year's operation of the reactor

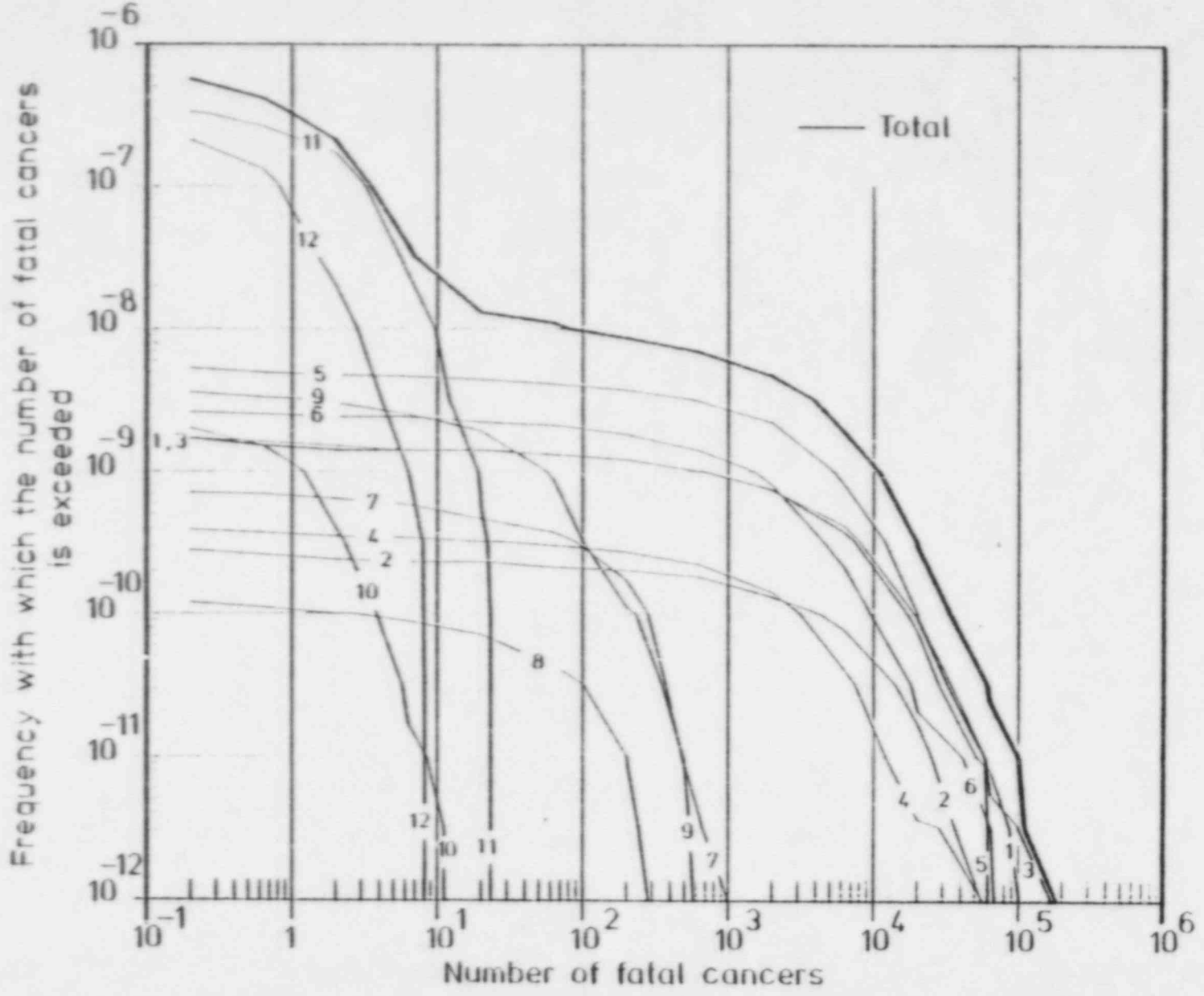


Figure 7 The frequency distributions of fatal cancers from degraded core accidents for one year's operation of the reactor

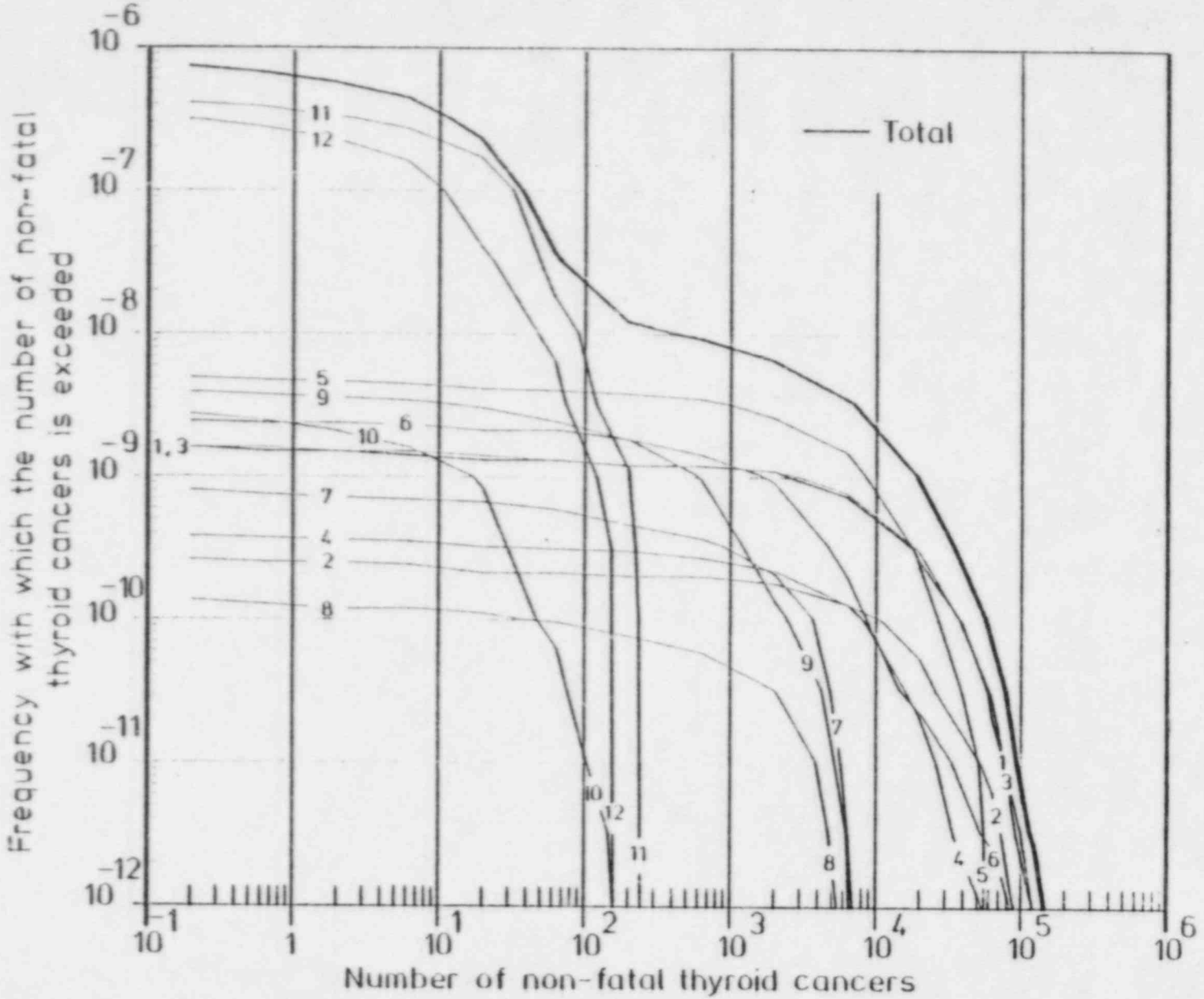


Figure 8 The frequency distributions of non-fatal thyroid cancers from degraded core accidents for one year's operation of the reactor

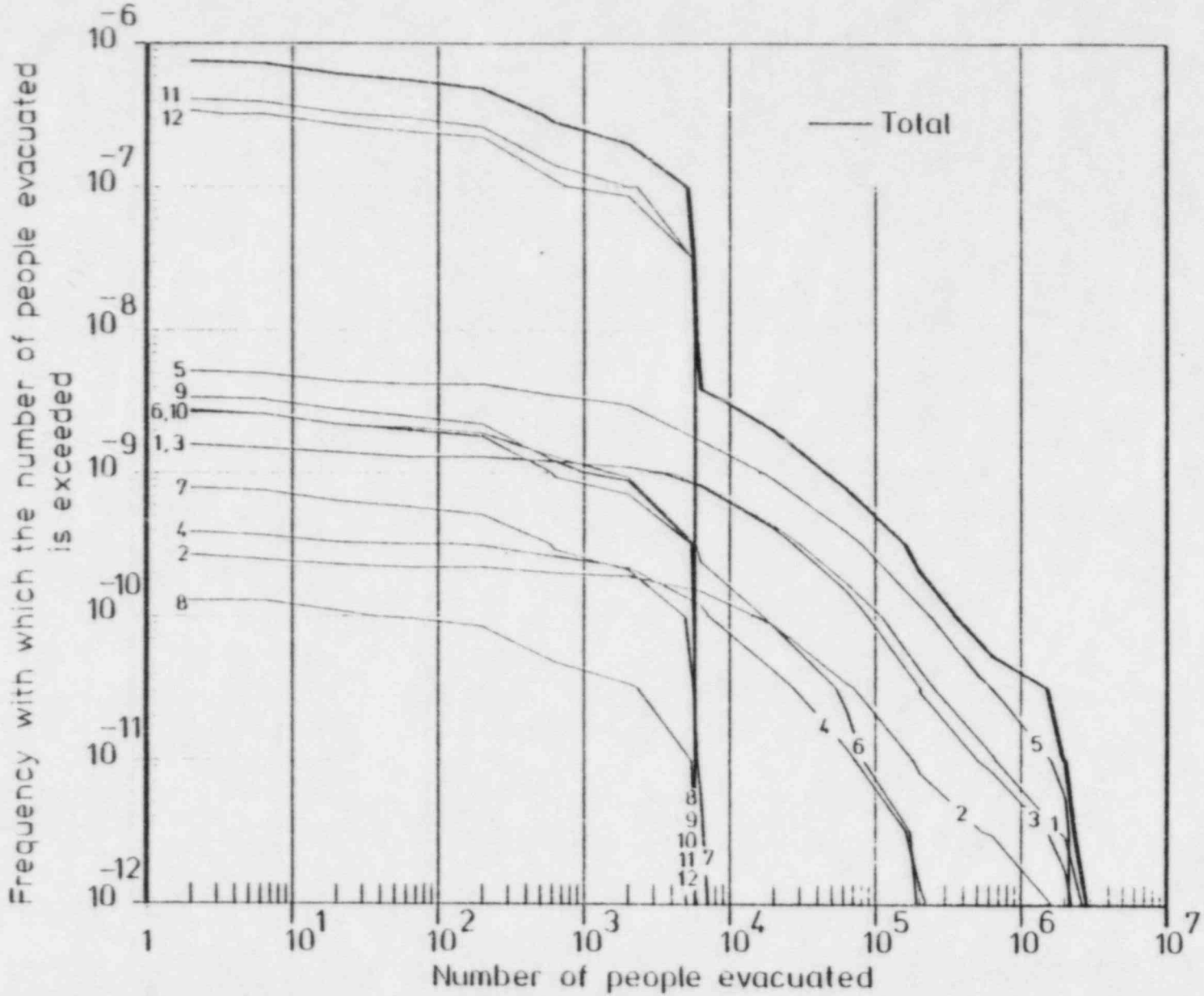


Figure 9 The frequency distributions of the people evacuated from degraded core accidents for one year's operation of the reactor

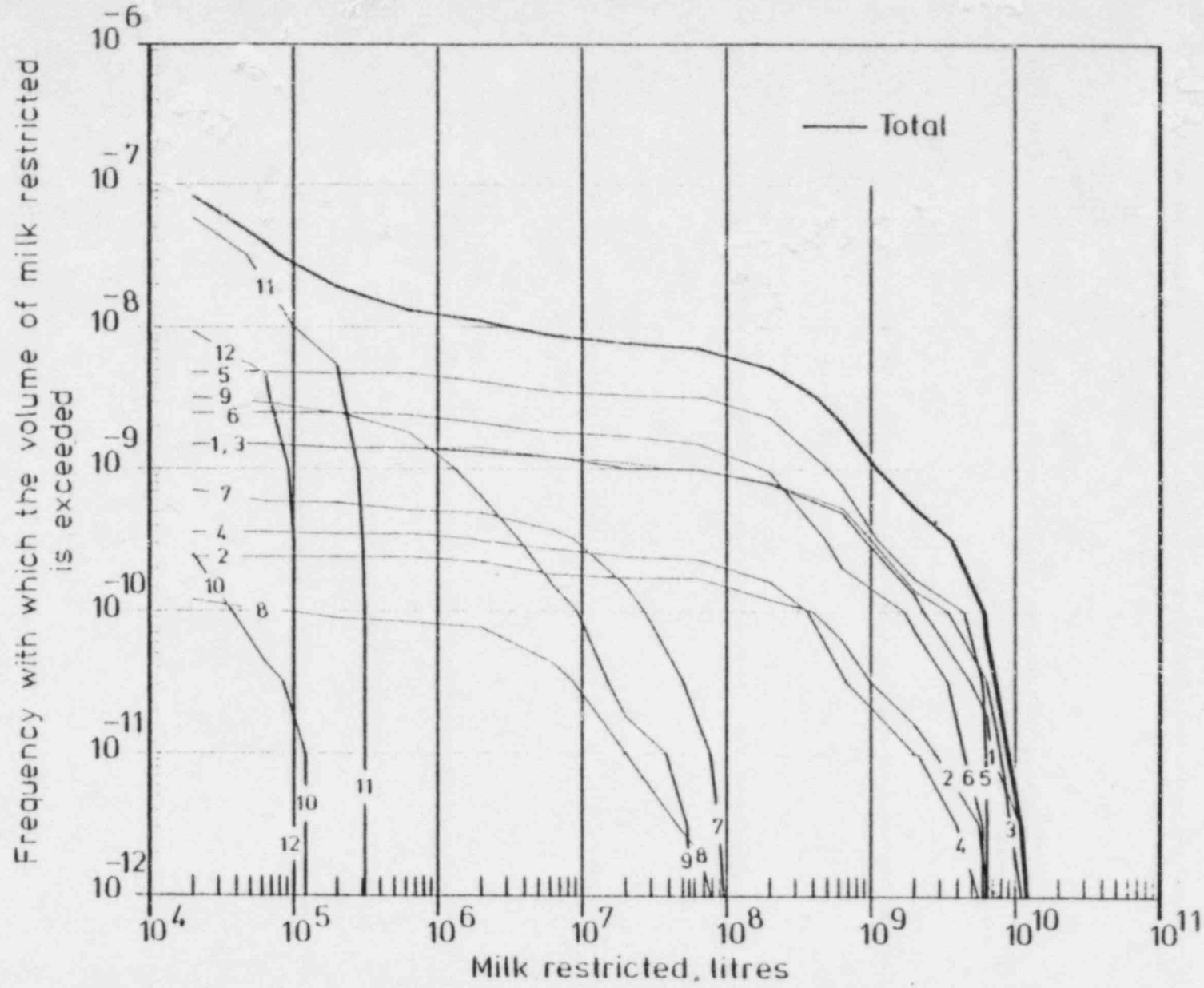


Figure 10 The frequency distributions of restrictions on milk from degraded core accidents for one year's operation of the reactor

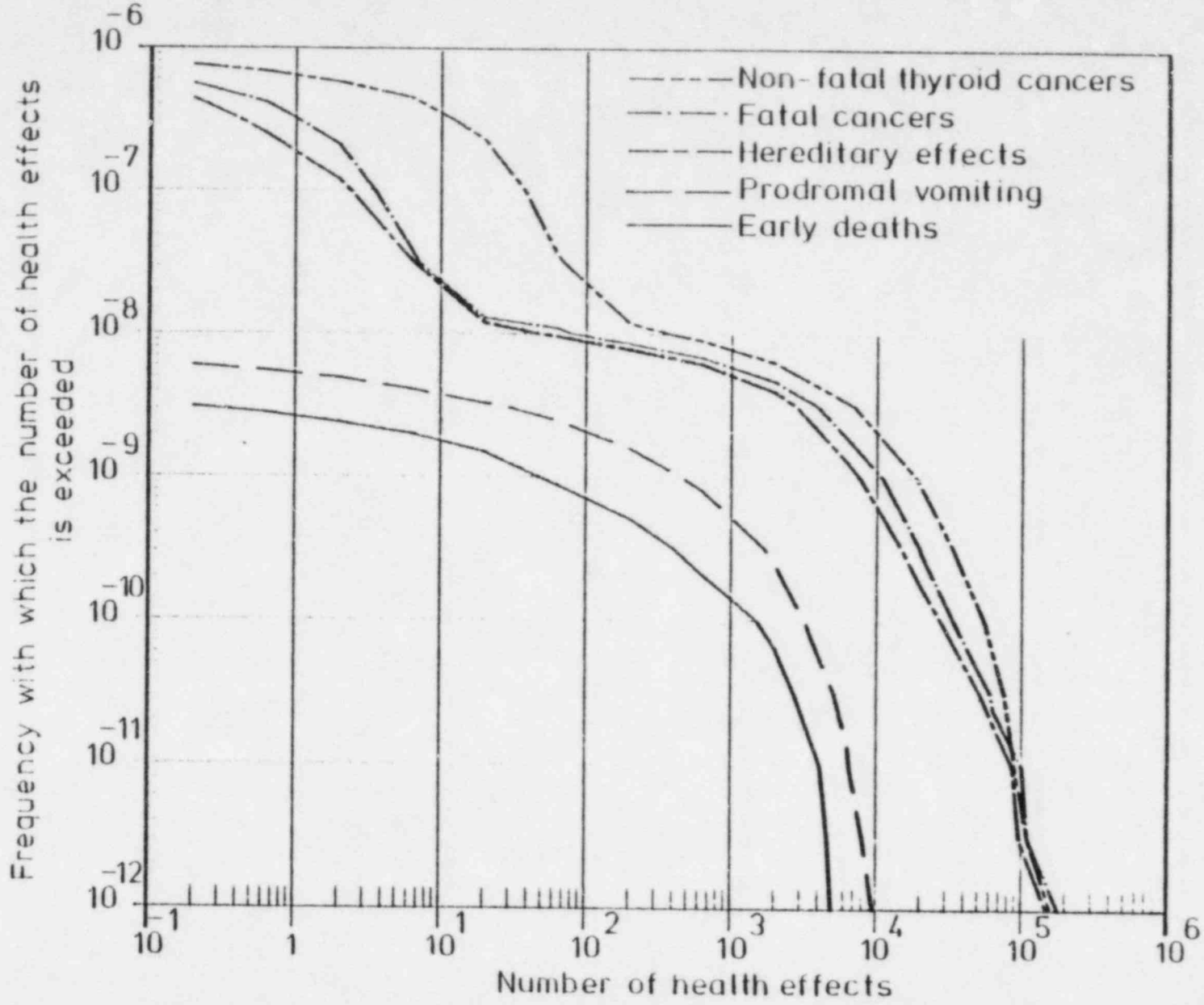


Figure 11 The frequency distributions of the incidence of each health effect from degraded core accidents for one year's operation of the reactor

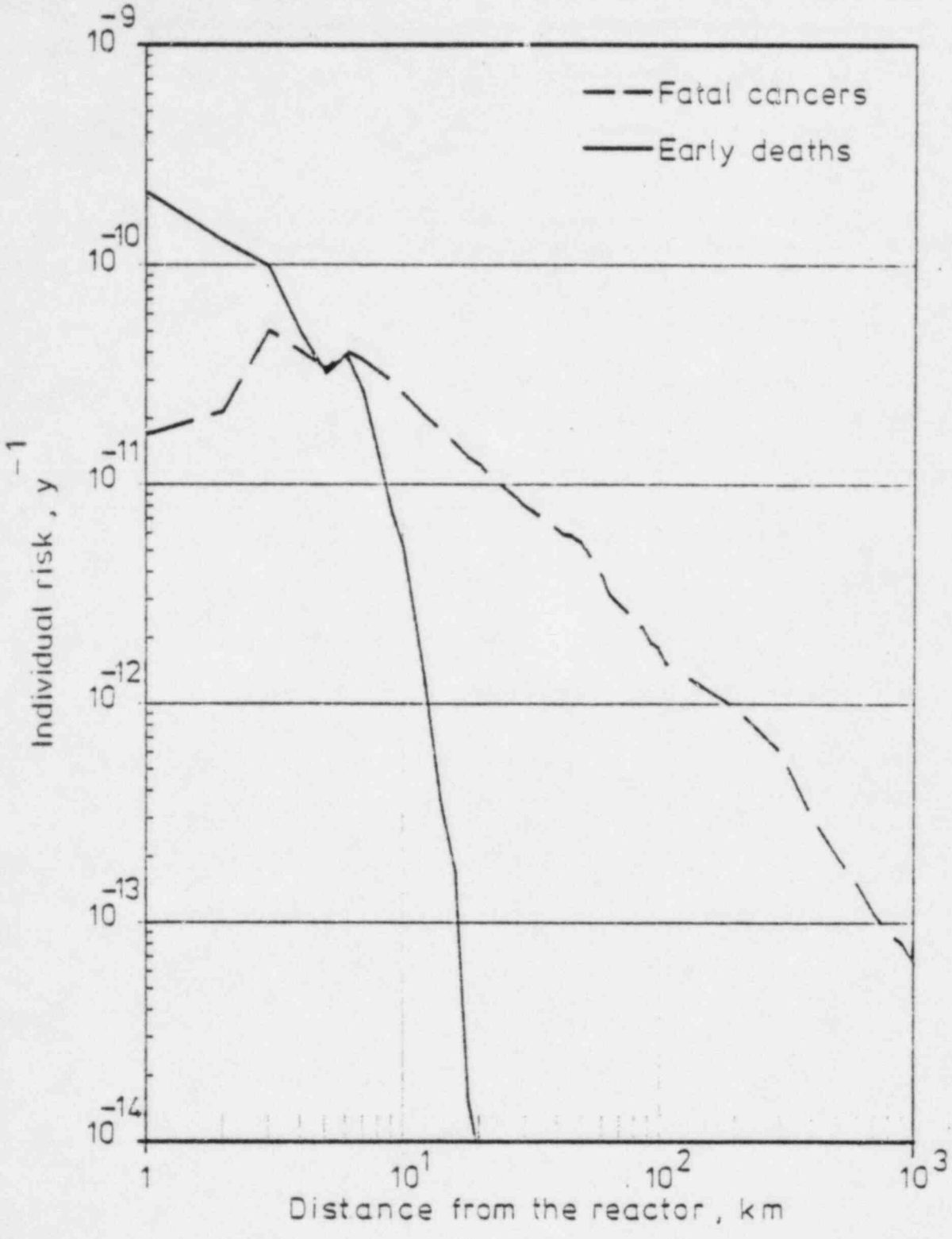


Figure 12 Individual risk from degraded core accidents for one year's operation of the reactor

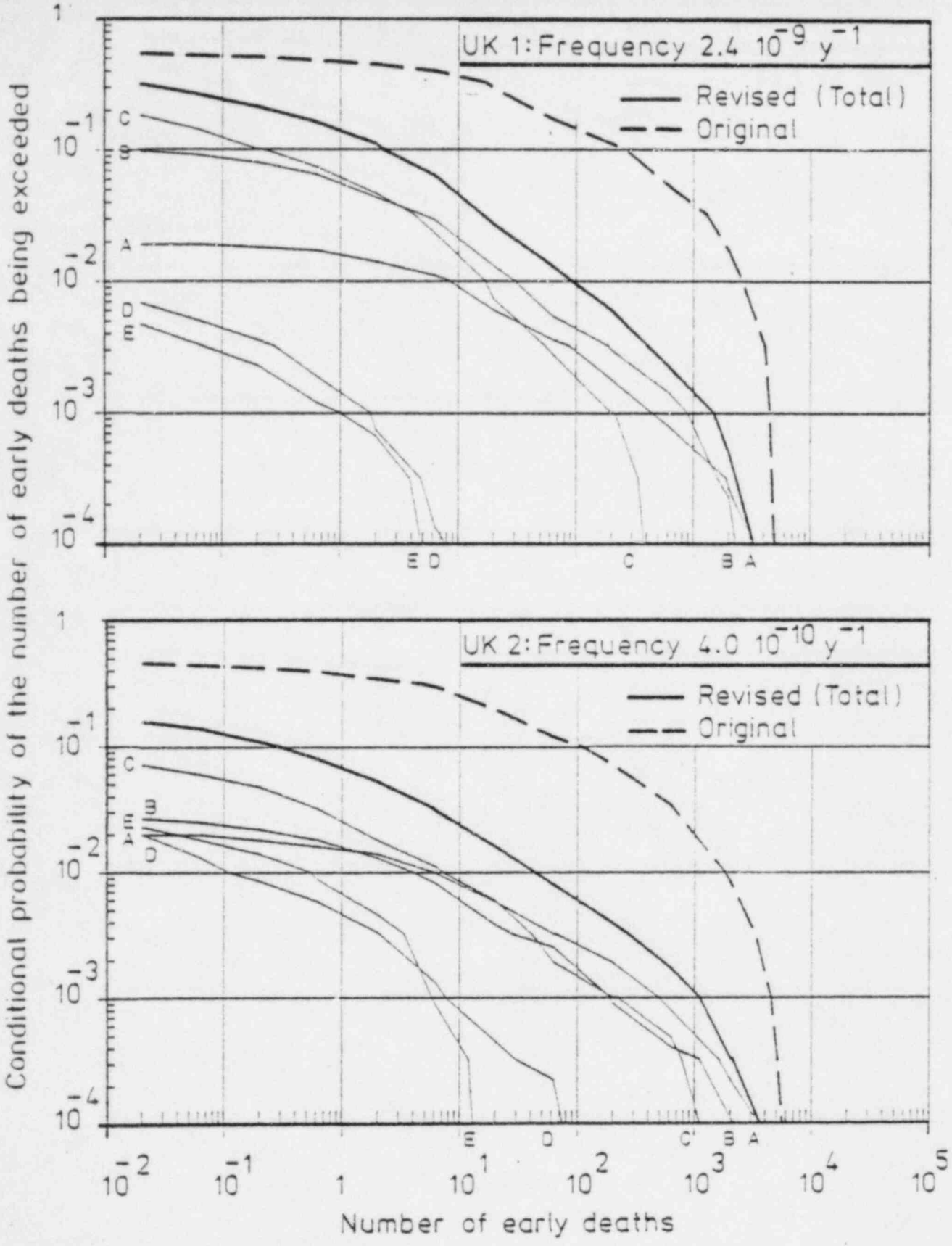


Figure 13 (revised) Conditional probability distributions of early deaths for the original and revised release categories

(Note: A-E are sub-categories of the revised release category)

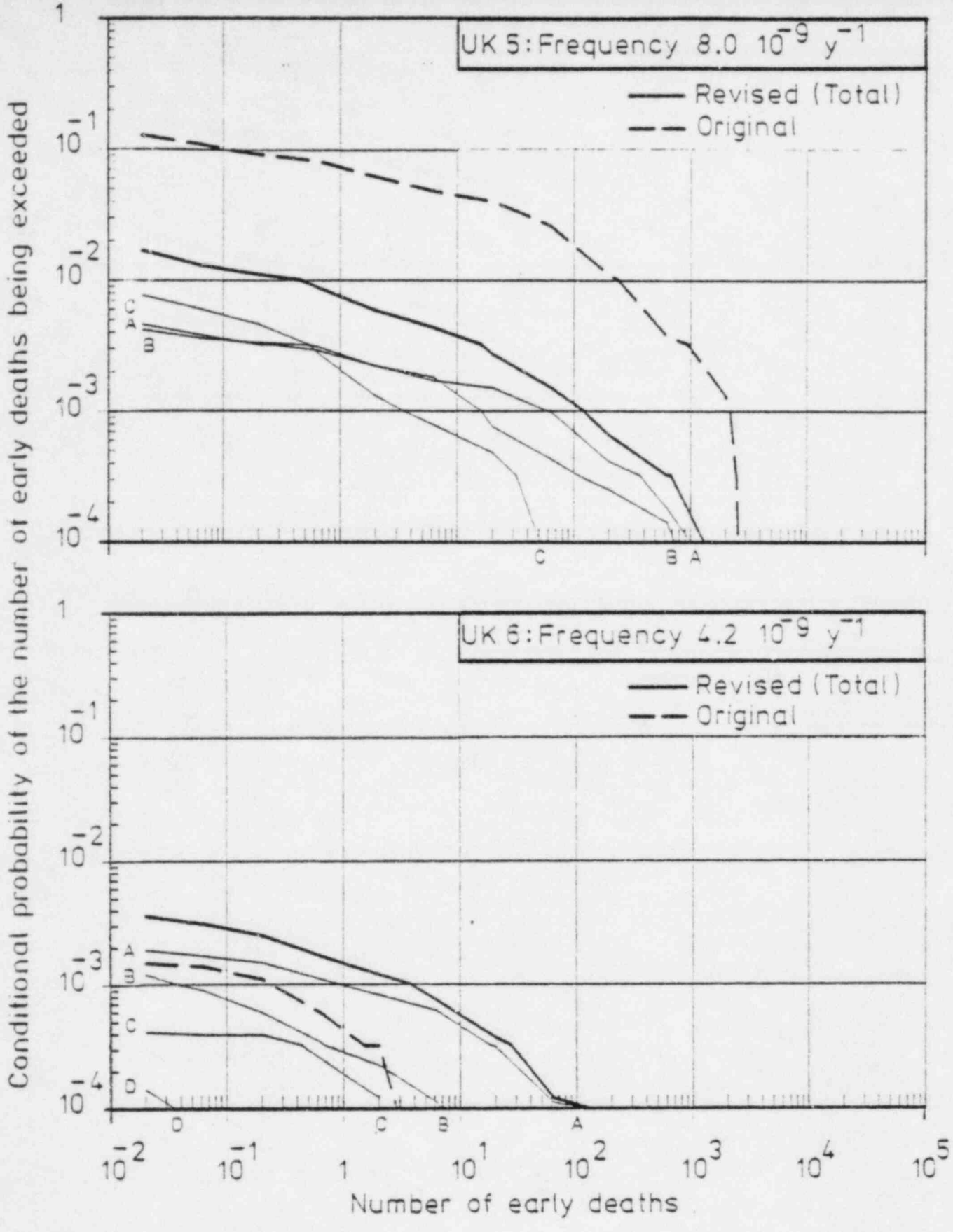


Figure 13 continued
(revised)

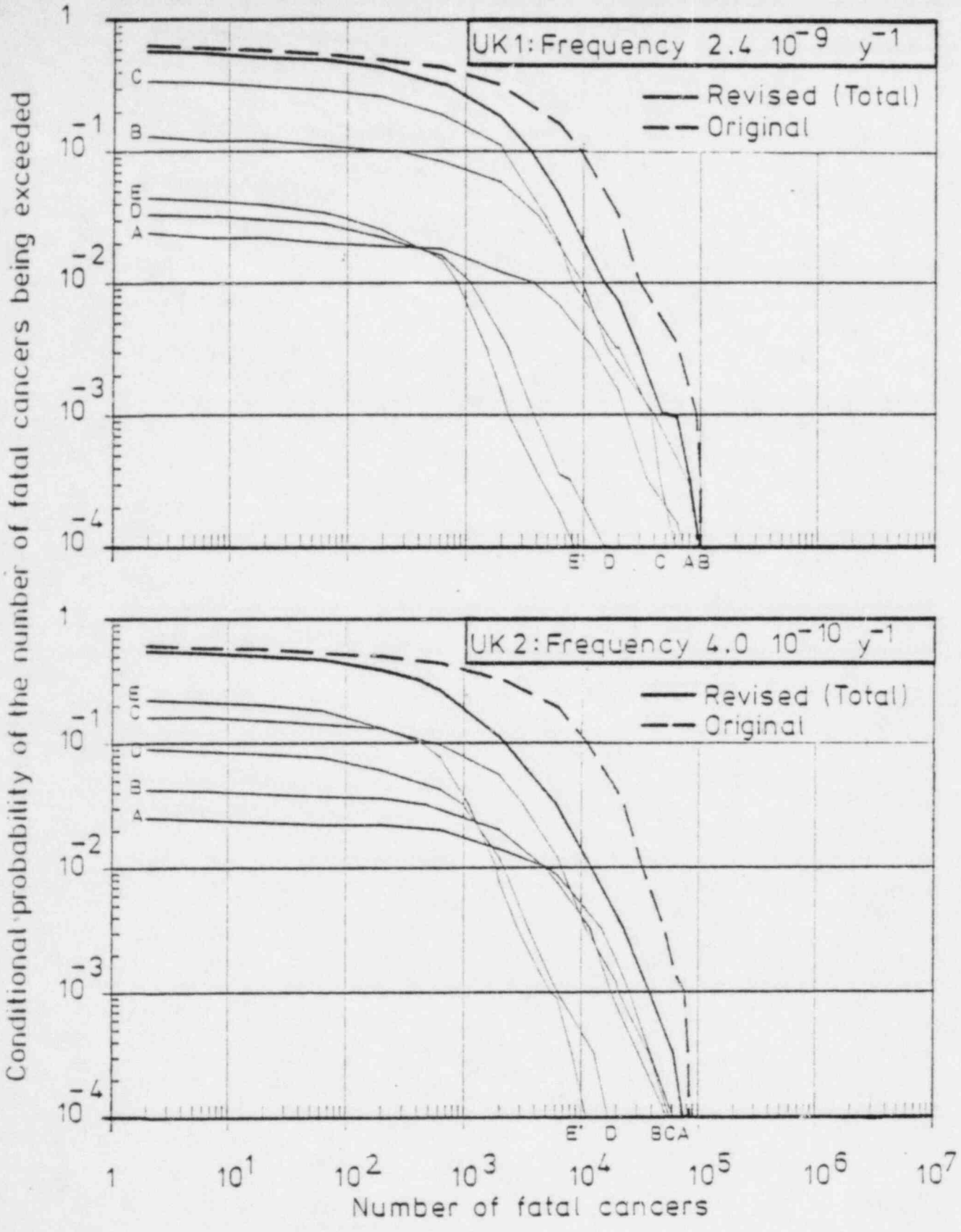


Figure 14 (revised) Conditional probability distributions of fatal cancers for the original and revised release categories

(Note: A - E are sub-categories of the revised release category)

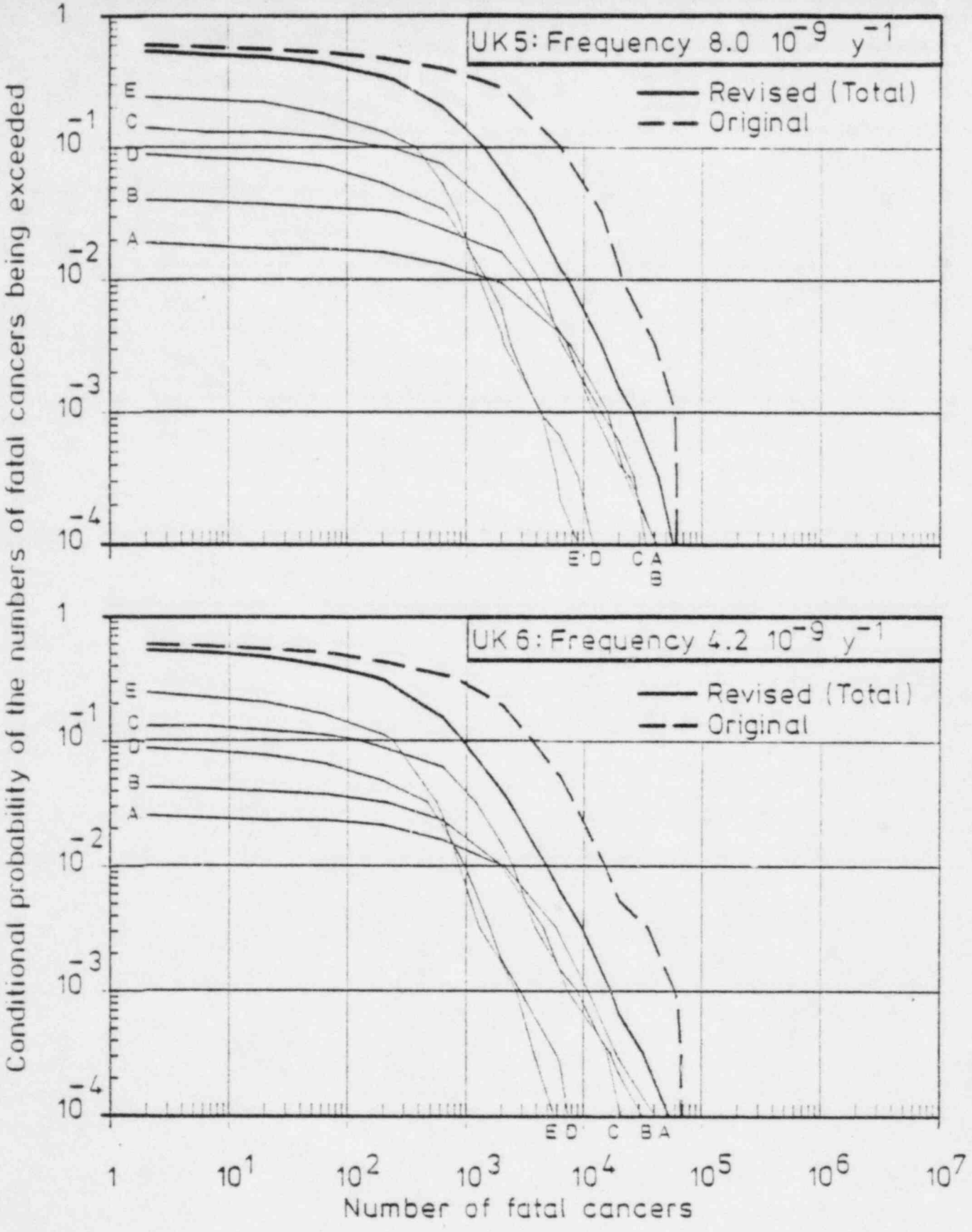


Figure 14 continued
(revised)

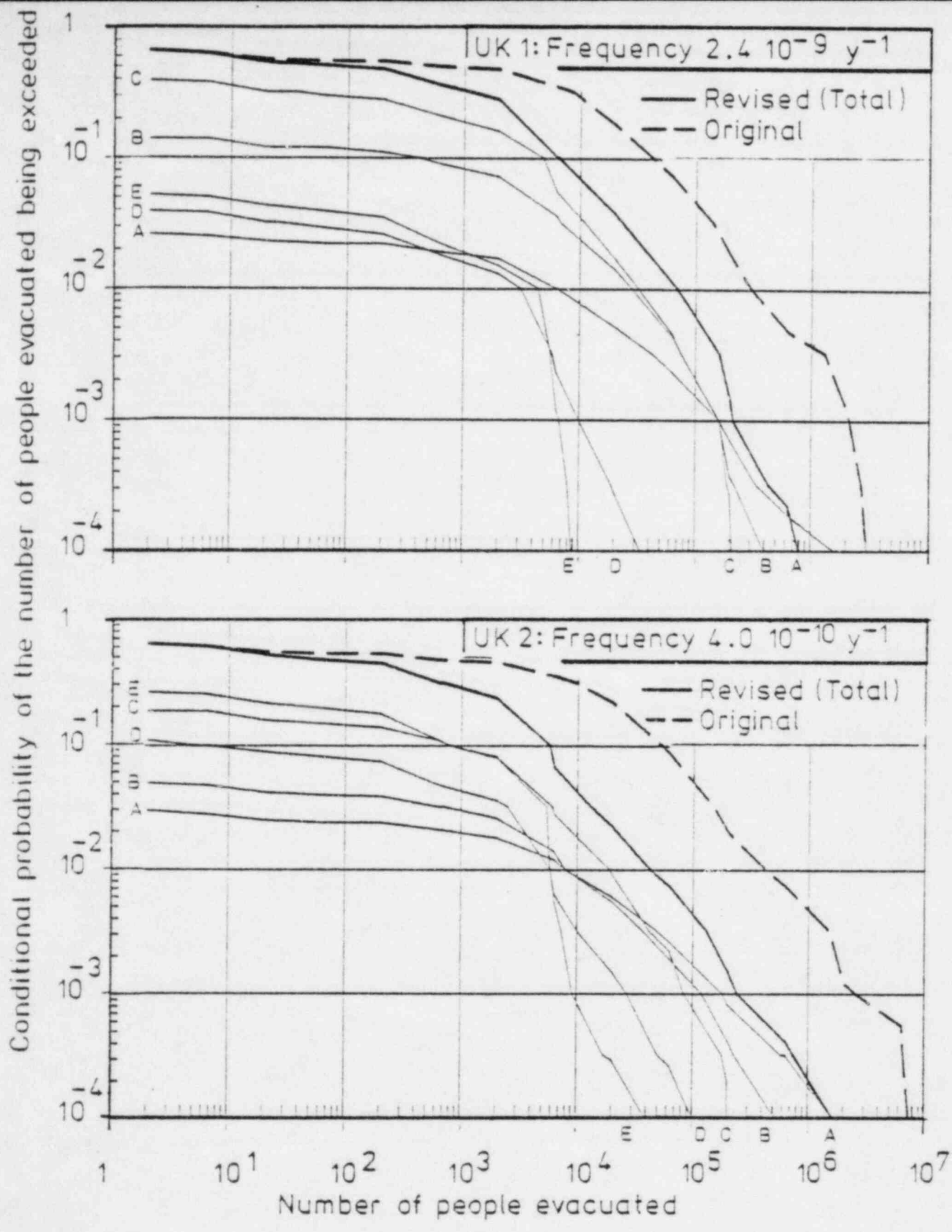


Figure 15 (revised) Conditional probability distributions of the number of people evacuated for the original and revised release categories

(Note: A-E are sub-categories of the revised release category)

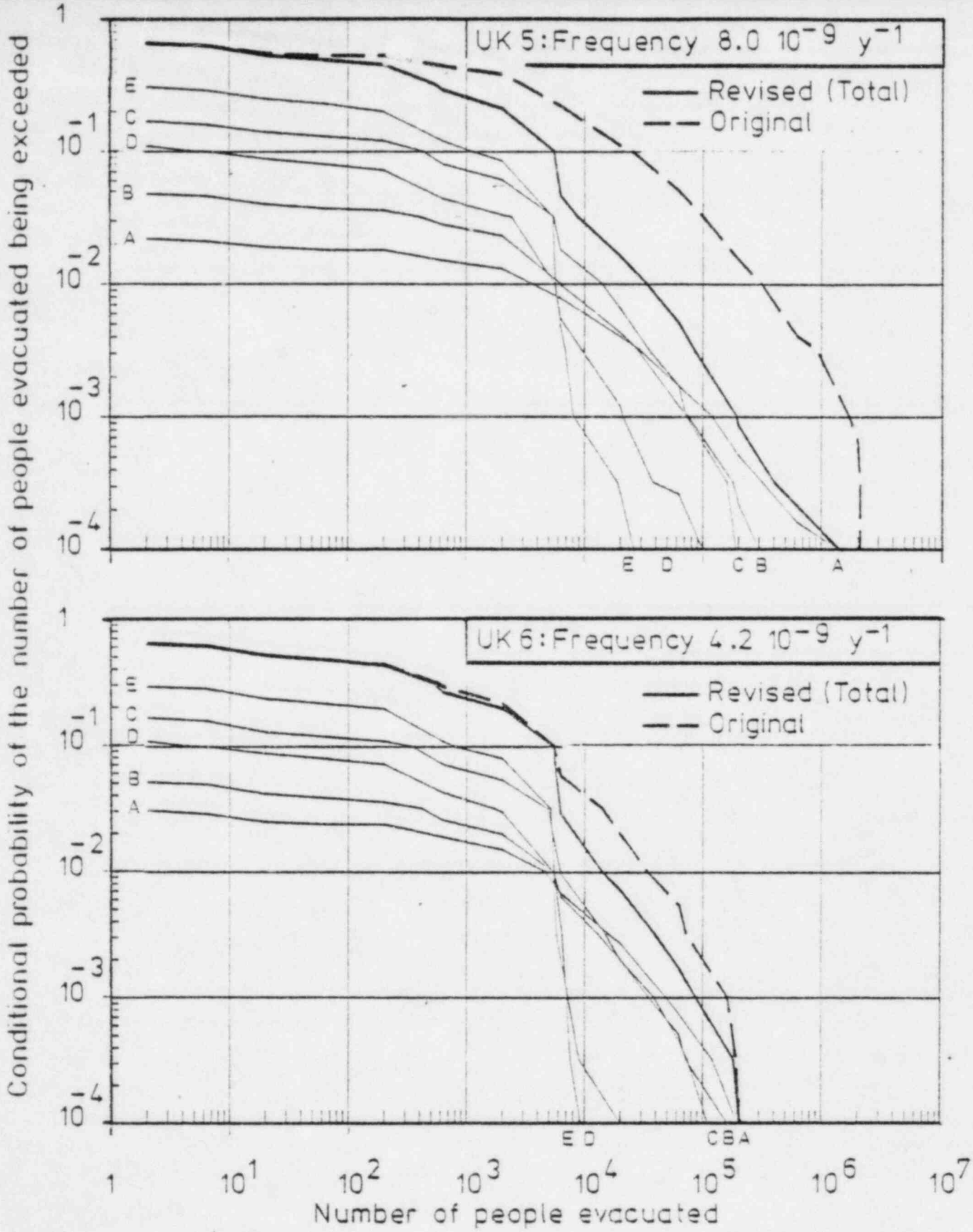
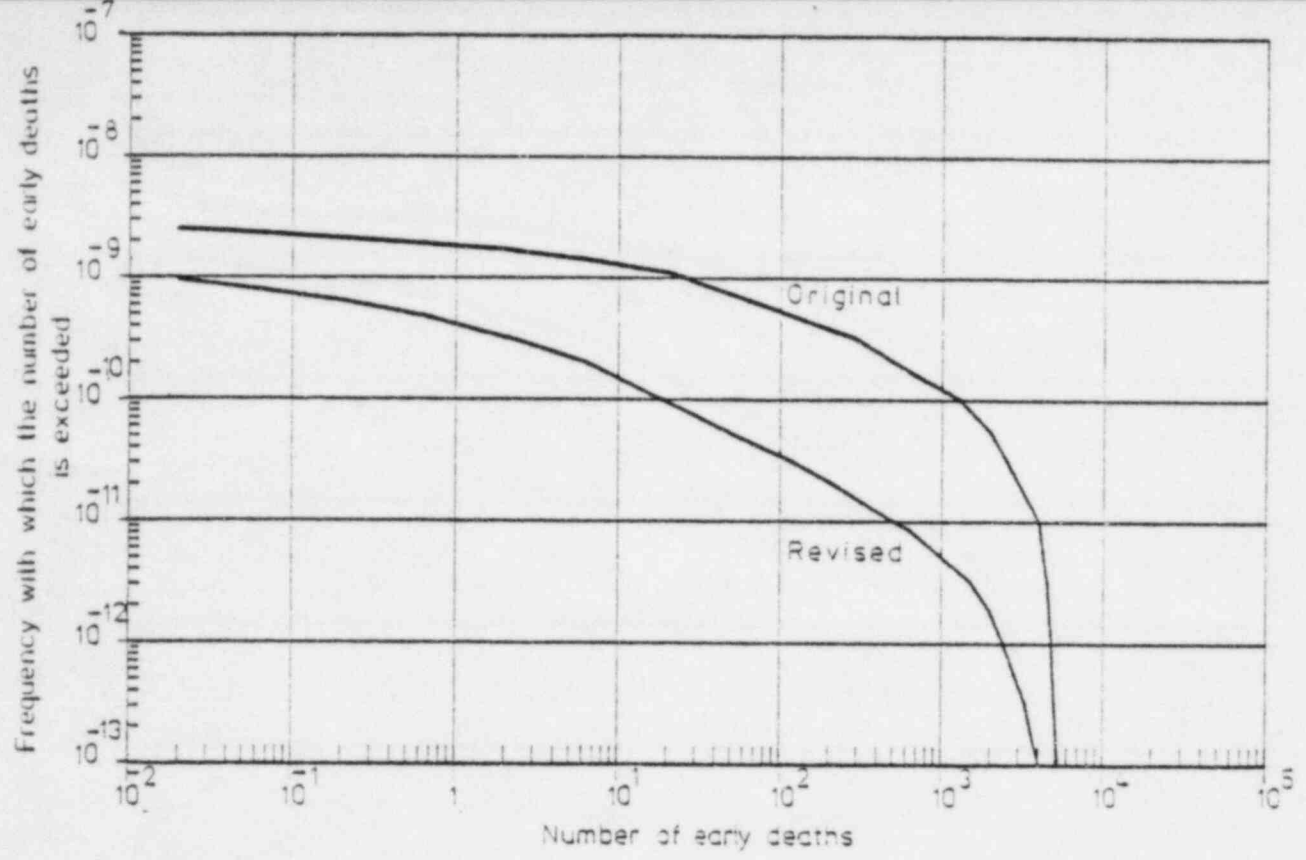


Figure 15 continued
(revised)



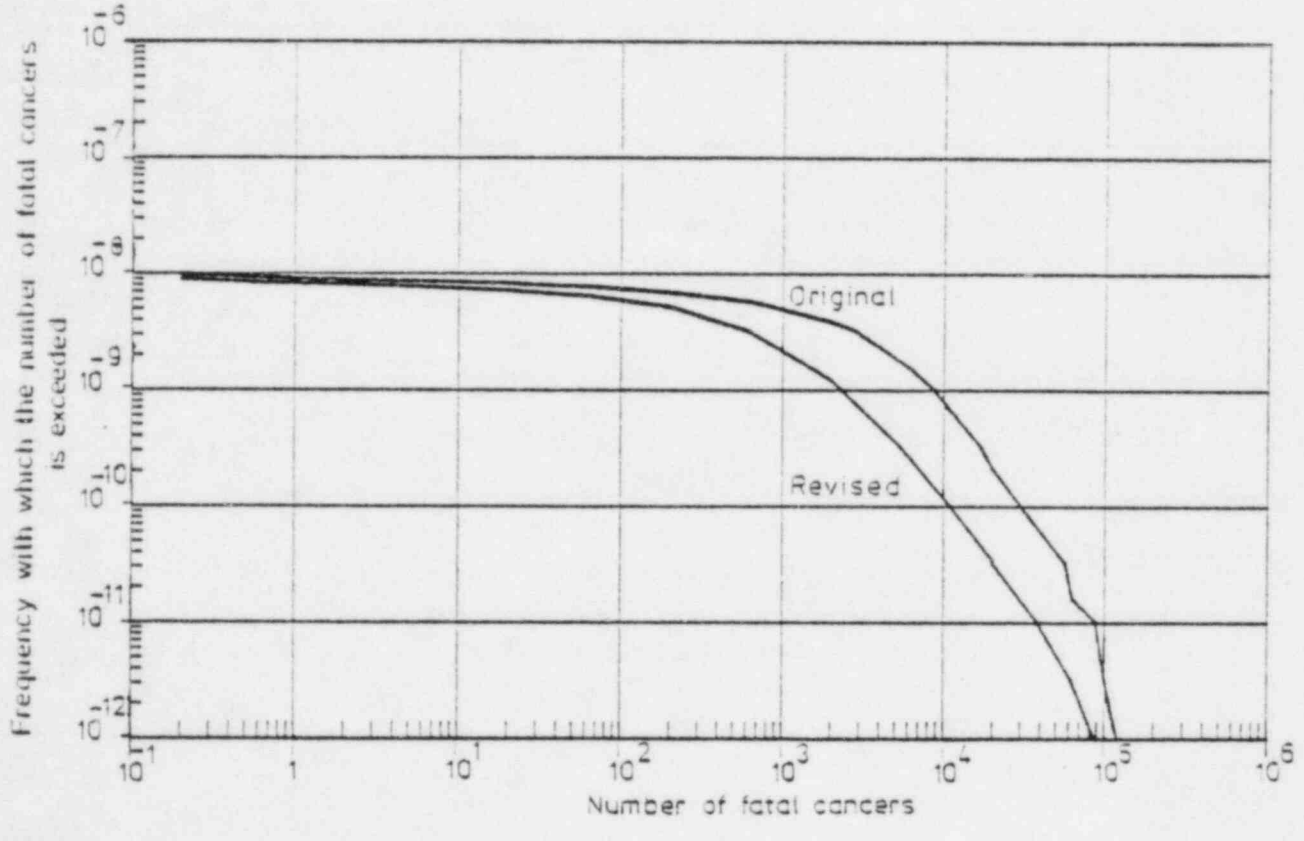
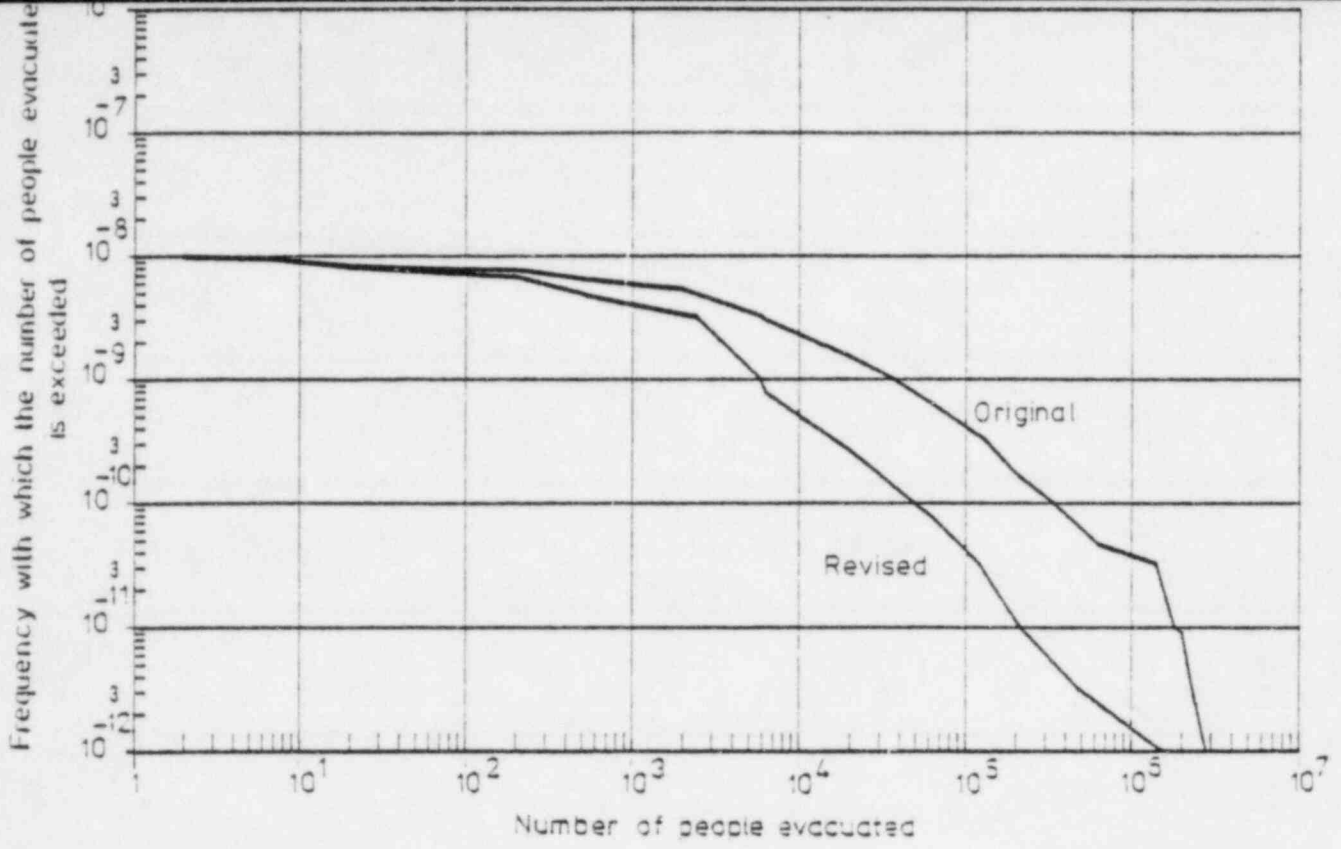


Figure 16 (revised) Frequency distributions of selected radiological endpoints summed over release categories UK1, UK2, UK5 and UK6



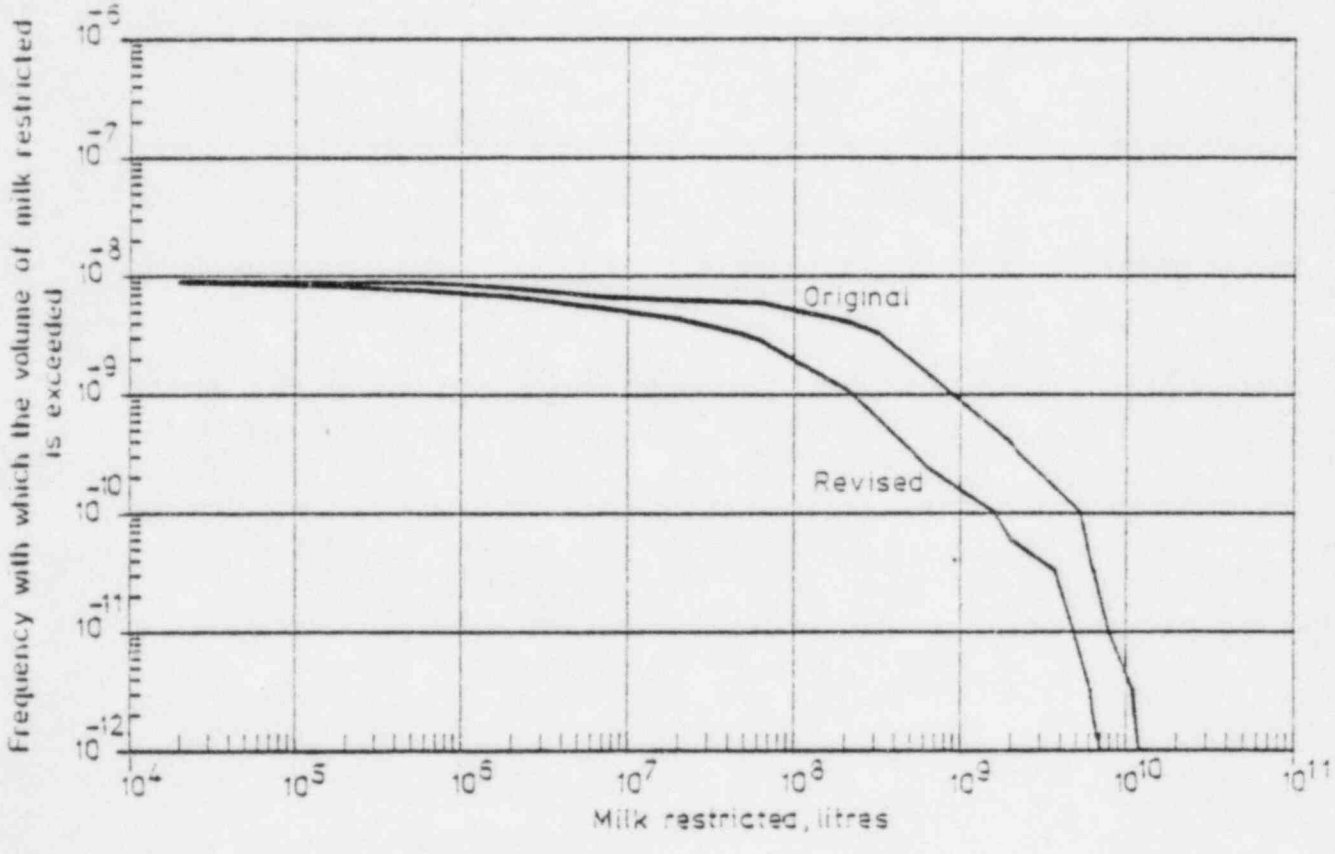


Figure 16 continued
(revised)

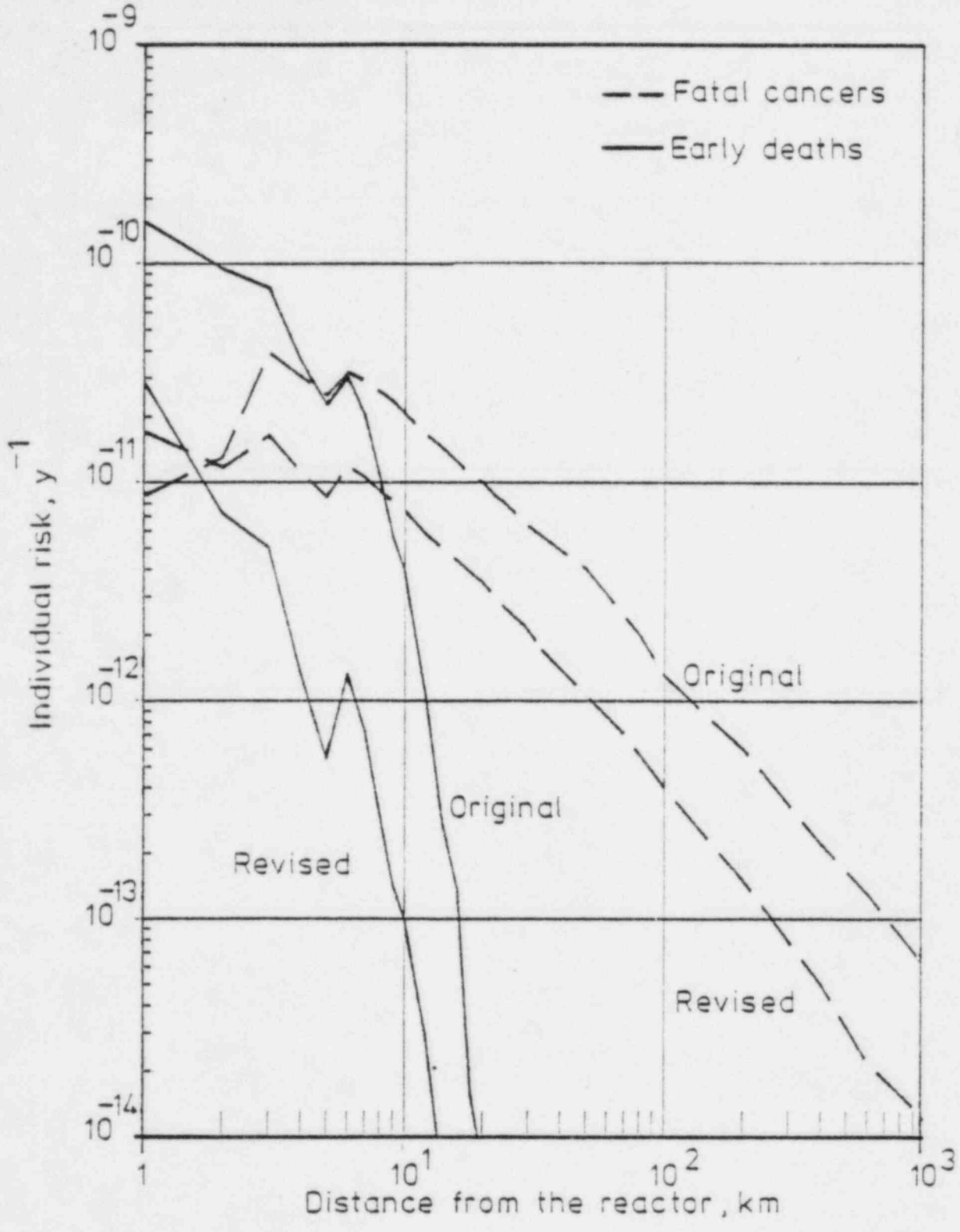


Figure 17 (revised) Individual risk, summed over release categories UK1, UK2, UK5 and UK6, for one year's operation of the reactor

APPENDIX A(R)

The probability distributions of consequences conditional upon each of the release sub-categories A-E for UK1, UK2, UK5 and UK6

The probability distributions of radiological consequences conditional upon the release sub-categories A to E for the release categories UK1, UK2, UK5 and UK6 have been evaluated (see Section 5(R)). Characteristic quantities of these distributions conditional upon the release of each sub-category are given in Tables A1(R) - A20(R). Tables A1(R) - A5(R) relate to release sub-categories UK1A -UK1E, etc.

The frequency of occurrence of each sub-category per reactor-year is indicated on each table; this frequency is the product of the frequency of the category and the probability of the sub-category (see Table 36). Estimates can thus be made of the actual frequency with which particular consequences given in the table might occur, as opposed to just the conditional probability.

Table A1(R) - Characteristic quantities of the distribution of consequences conditional upon occurrence of UK1A.

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Table A20(R) - Characteristic quantities of the distribution of consequences conditional upon occurrence of UK6E.

Table A1(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK1A

UK1A FREQUENCY: $9.5\ 10^{-11}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$5.7\ 10^{1}$	0	$1.3\ 10^{-3}$	$4.4\ 10^{1}$	$1.6\ 10^{3}$	48	9.4
Prodromal vomiting	$2.1\ 10^{2}$	0	$1.0\ 10^{0}$	$5.3\ 10^{2}$	$3.8\ 10^{3}$	43	15
Lung morbidity	$1.9\ 10^{1}$	0	$1.6\ 10^{-3}$	$2.4\ 10^{1}$	$3.8\ 10^{2}$	49	12
Late							
Fatal cancer	$3.4\ 10^{3}$	0	$9.7\ 10^{1}$	$1.0\ 10^{4}$	$3.2\ 10^{4}$	28	26
Non-fatal thyroid cancer	$1.1\ 10^{4}$	0	$3.7\ 10^{2}$	$3.3\ 10^{4}$	$9.3\ 10^{4}$	28	27
Non-fatal skin cancer	$2.4\ 10^{3}$	0	$4.2\ 10^{1}$	$6.5\ 10^{3}$	$2.6\ 10^{4}$	28	24
Non-fatal breast cancer	$4.9\ 10^{2}$	0	$8.9\ 10^{0}$	$1.4\ 10^{3}$	$5.2\ 10^{3}$	28	25
Hereditary effects	$2.5\ 10^{3}$	0	$4.9\ 10^{1}$	$7.0\ 10^{3}$	$2.5\ 10^{4}$	28	25

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$2.1\ 10^{4}$	0	$4.7\ 10^{2}$	$3.0\ 10^{4}$	$3.0\ 10^{5}$	30	12
Area of land evacuated (km^2)	$9.6\ 10^{1}$	0	$9.2\ 10^{0}$	$2.8\ 10^{2}$	$1.2\ 10^{3}$	30	19

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$1.5\ 10^{7}$	0	$4.1\ 10^{4}$	$6.3\ 10^{7}$	$1.1\ 10^{8}$	36	24
Total milk restricted (litres)	$4.3\ 10^{8}$	0	$6.5\ 10^{6}$	$9.8\ 10^{8}$	$5.7\ 10^{9}$	36	25
Initial crop area restricted (km^2)	$2.6\ 10^{3}$	0	$2.4\ 10^{1}$	$1.0\ 10^{4}$	$1.4\ 10^{4}$	36	26
Time integral of the area of crop restrictions (km^2-y)	$4.3\ 10^{3}$	0	$5.6\ 10^{1}$	$1.4\ 10^{4}$	$3.5\ 10^{4}$	36	29
Initial no. livestock restricted	$2.0\ 10^{6}$	0	$4.8\ 10^{3}$	$8.1\ 10^{6}$	$1.3\ 10^{7}$	36	24
Time integral of the number of livestock restricted - (livestock-y)	$2.9\ 10^{6}$	0	$2.1\ 10^{4}$	$9.5\ 10^{6}$	$2.8\ 10^{7}$	36	27

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A2(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK1B

UK1B FREQUENCY: $5.2\ 10^{-10}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$1.5\ 10^{1}$	0	0	$9.9\ 10^{0}$	$2.8\ 10^{2}$	52	6.7
Prodromal vomiting	$7.9\ 10^{1}$	0	$1.0\ 10^{-2}$	$1.3\ 10^{2}$	$1.8\ 10^{3}$	45	13
Lung morbidity	$7.8\ 10^{0}$	0	0	$4.4\ 10^{0}$	$2.3\ 10^{2}$	53	7.7
Late							
Fatal cancer	$2.1\ 10^{3}$	0	$5.6\ 10^{1}$	$5.7\ 10^{3}$	$2.1\ 10^{4}$	28	26
Non-fatal thyroid cancer	$6.0\ 10^{3}$	0	$2.2\ 10^{2}$	$1.9\ 10^{4}$	$5.4\ 10^{4}$	28	28
Non-fatal skin cancer	$1.5\ 10^{3}$	0	$2.3\ 10^{1}$	$3.6\ 10^{3}$	$1.7\ 10^{4}$	28	23
Non-fatal breast cancer	$3.0\ 10^{2}$	0	$5.1\ 10^{0}$	$7.7\ 10^{2}$	$3.3\ 10^{3}$	28	24
Hereditary effects	$1.6\ 10^{3}$	0	$2.9\ 10^{1}$	$4.1\ 10^{3}$	$1.6\ 10^{4}$	28	25

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$5.9\ 10^{3}$	0	$2.3\ 10^{2}$	$1.0\ 10^{4}$	$1.0\ 10^{5}$	30	19
Area of land evacuated (km^2)	$4.3\ 10^{1}$	0	$7.0\ 10^{0}$	$1.2\ 10^{2}$	$5.3\ 10^{2}$	30	19

c) Agricultural products restricted by countermeasures [1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$1.3\ 10^{7}$	0	$4.0\ 10^{4}$	$5.5\ 10^{7}$	$9.7\ 10^{7}$	36	24
Total milk restricted (litres)	$2.3\ 10^{8}$	0	$4.3\ 10^{6}$	$5.7\ 10^{8}$	$3.5\ 10^{9}$	36	26
Initial crop area restricted (km^2)	$2.3\ 10^{3}$	0	$2.4\ 10^{1}$	$8.9\ 10^{3}$	$1.2\ 10^{4}$	36	26
Time integral of the area of crop restrictions (km^2-y)	$3.1\ 10^{3}$	0	$3.6\ 10^{1}$	$1.0\ 10^{4}$	$2.1\ 10^{4}$	36	28
Initial no. livestock restricted	$1.5\ 10^{6}$	0	$4.3\ 10^{3}$	$6.5\ 10^{6}$	$1.1\ 10^{7}$	36	24
Time integral of the number of livestock restricted - (livestock-y)	$1.6\ 10^{6}$	0	$1.5\ 10^{4}$	$5.0\ 10^{6}$	$1.9\ 10^{7}$	36	26

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A3(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK1C

UK1C FREQUENCY: $1.4\ 10^{-9}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$1.8\ 10^{0}$	0	0	$1.1\ 10^{0}$	$2.3\ 10^{1}$	57	8.6
Prodromal vomiting	$2.8\ 10^{1}$	0	$3.7\ 10^{-3}$	$2.8\ 10^{1}$	$6.5\ 10^{2}$	46	10
Lung morbidity	$2.0\ 10^{0}$	0	0	$1.2\ 10^{0}$	$4.4\ 10^{1}$	59	7.0
Late							
Fatal cancer	$1.1\ 10^{3}$	0	$3.1\ 10^{1}$	$3.2\ 10^{3}$	$1.1\ 10^{4}$	28	26
Non-fatal thyroid cancer	$3.4\ 10^{3}$	0	$1.3\ 10^{2}$	$1.1\ 10^{4}$	$3.0\ 10^{4}$	28	28
Non-fatal skin cancer	$8.0\ 10^{2}$	0	$1.3\ 10^{1}$	$2.0\ 10^{3}$	$8.7\ 10^{3}$	28	24
Non-fatal breast cancer	$1.7\ 10^{2}$	0	$3.0\ 10^{0}$	$4.4\ 10^{2}$	$1.8\ 10^{3}$	28	25
Hereditary effects	$8.8\ 10^{2}$	0	$2.1\ 10^{1}$	$2.4\ 10^{3}$	$8.4\ 10^{3}$	28	26

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$3.1\ 10^{3}$	0	$6.9\ 10^{1}$	$6.2\ 10^{3}$	$4.1\ 10^{4}$	30	21
Area of land evacuated (km^2)	$2.5\ 10^{1}$	0	$6.5\ 10^{0}$	$6.6\ 10^{1}$	$2.7\ 10^{2}$	30	18

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$1.1\ 10^{7}$	0	$4.0\ 10^{4}$	$4.8\ 10^{7}$	$8.3\ 10^{7}$	36	24
Total milk restricted (litres)	$1.5\ 10^{8}$	0	$2.5\ 10^{6}$	$3.3\ 10^{8}$	$3.0\ 10^{9}$	36	25
Initial crop area restricted (km^2)	$1.8\ 10^{3}$	0	$1.6\ 10^{1}$	$7.1\ 10^{3}$	$1.0\ 10^{4}$	36	27
Time integral of the area of crop restrictions (km^2-y)	$2.2\ 10^{3}$	0	$2.3\ 10^{1}$	$8.0\ 10^{3}$	$1.3\ 10^{4}$	36	28
Initial no. livestock restricted	$9.2\ 10^{5}$	0	$3.6\ 10^{3}$	$3.3\ 10^{6}$	$8.2\ 10^{6}$	36	25
Time integral of the number of livestock restricted - (livestock-y)	$8.7\ 10^{5}$	0	$9.3\ 10^{3}$	$2.6\ 10^{6}$	$1.0\ 10^{7}$	36	24

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A4(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK1D

UK1D FREQUENCY: $1.4\ 10^{-10}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$1.2\ 10^{-1}$	0	0	$2.9\ 10^{-2}$	$3.6\ 10^{0}$	74	6.3
Prodromal vomiting	$6.1\ 10^{0}$	0	0	$5.1\ 10^{0}$	$1.3\ 10^{2}$	50	8.9
Lung morbidity	$6.2\ 10^{-2}$	0	0	$4.3\ 10^{-3}$	$1.8\ 10^{0}$	86	6.3
Late							
Fatal cancer	$5.4\ 10^{2}$	0	$1.9\ 10^{1}$	$1.6\ 10^{3}$	$4.5\ 10^{3}$	28	28
Non-fatal thyroid cancer	$1.9\ 10^{3}$	0	$8.5\ 10^{1}$	$6.6\ 10^{3}$	$1.5\ 10^{4}$	28	27
Non-fatal skin cancer	$3.7\ 10^{2}$	0	$7.9\ 10^{0}$	$9.9\ 10^{2}$	$3.7\ 10^{3}$	28	26
Non-fatal breast cancer	$8.0\ 10^{1}$	0	$2.2\ 10^{0}$	$2.2\ 10^{2}$	$7.5\ 10^{2}$	28	27
Hereditary effects	$4.4\ 10^{2}$	0	$1.5\ 10^{1}$	$1.3\ 10^{3}$	$3.7\ 10^{3}$	28	27

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$1.5\ 10^{3}$	0	$4.0\ 10^{1}$	$5.4\ 10^{3}$	$1.3\ 10^{4}$	30	22
Area of land evacuated (km^2)	$1.3\ 10^{1}$	0	$4.8\ 10^{0}$	$2.4\ 10^{1}$	$1.2\ 10^{2}$	30	38

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$7.6\ 10^{6}$	0	$2.9\ 10^{4}$	$3.2\ 10^{7}$	$6.3\ 10^{7}$	36	23
Total milk restricted (litres)	$5.0\ 10^{7}$	0	$1.0\ 10^{6}$	$1.6\ 10^{8}$	$4.0\ 10^{8}$	36	27
Initial crop area restricted (km^2)	$1.1\ 10^{3}$	0	$1.4\ 10^{1}$	$4.5\ 10^{3}$	$7.8\ 10^{3}$	36	27
Time integral of the area of crop restrictions (km^2-y)	$1.2\ 10^{3}$	0	$1.4\ 10^{1}$	$4.8\ 10^{3}$	$8.1\ 10^{3}$	36	27
Initial no. livestock restricted	$4.2\ 10^{5}$	0	$3.0\ 10^{3}$	$1.2\ 10^{6}$	$3.0\ 10^{6}$	36	22
Time integral of the number of livestock restricted - (livestock-y)	$3.7\ 10^{5}$	0	$5.8\ 10^{3}$	$9.9\ 10^{5}$	$4.8\ 10^{6}$	36	22

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A5(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UKIE

UKIE FREQUENCY: $1.9\ 10^{-10}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$5.7\ 10^{-2}$	0	0	$2.0\ 10^{-3}$	$1.5\ 10^{0}$	86	4.2
Prodromal vomiting	$2.2\ 10^{0}$	0	0	$1.5\ 10^{0}$	$3.8\ 10^{1}$	52	8.0
Lung morbidity	$2.8\ 10^{-3}$	0	0	0	$6.0\ 10^{-2}$	97	2.6
Late							
Fatal cancer	$3.1\ 10^{2}$	0	$1.3\ 10^{1}$	$9.8\ 10^{2}$	$2.6\ 10^{3}$	28	28
Non-fatal thyroid cancer	$1.3\ 10^{3}$	0	$6.0\ 10^{1}$	$4.8\ 10^{3}$	$9.7\ 10^{3}$	28	27
Non-fatal skin cancer	$2.1\ 10^{2}$	0	$5.9\ 10^{1}$	$5.7\ 10^{2}$	$2.0\ 10^{3}$	28	26
Non-fatal breast cancer	$4.6\ 10^{1}$	0	$1.6\ 10^{0}$	$1.3\ 10^{2}$	$4.0\ 10^{2}$	28	27
Hereditary effects	$2.7\ 10^{2}$	0	$1.1\ 10^{1}$	$8.1\ 10^{2}$	$2.1\ 10^{3}$	28	27

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$1.1\ 10^{3}$	0	$3.9\ 10^{1}$	$4.9\ 10^{2}$	$7.2\ 10^{3}$	30	22
Area of land evacuated (km^2)	$9.5\ 10^{0}$	0	$4.7\ 10^{0}$	$1.8\ 10^{1}$	$5.6\ 10^{1}$	30	21

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$4.5\ 10^{6}$	0	$2.7\ 10^{4}$	$1.4\ 10^{7}$	$4.5\ 10^{7}$	36	24
Total milk restricted (litres)	$2.4\ 10^{7}$	0	$5.4\ 10^{5}$	$7.7\ 10^{7}$	$2.5\ 10^{8}$	36	24
Initial crop area restricted (km^2)	$6.9\ 10^{2}$	0	$8.0\ 10^{0}$	$2.3\ 10^{3}$	$5.9\ 10^{3}$	37	27
Time integral of the area of crop restrictions (km^2-y)	$7.1\ 10^{2}$	0	$1.3\ 10^{1}$	$2.4\ 10^{3}$	$6.0\ 10^{3}$	37	27
Initial no. livestock restricted	$2.3\ 10^{5}$	0	$1.3\ 10^{3}$	$5.7\ 10^{5}$	$3.7\ 10^{6}$	37	21
Time integral of the number of livestock restricted - (livestock-y)	$1.7\ 10^{5}$	0	$2.6\ 10^{3}$	$5.0\ 10^{5}$	$1.9\ 10^{6}$	37	22

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A6(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK2A

UK2A FREQUENCY: $1.8\ 10^{-11}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$4.8\ 10^{1}$	0	0	$2.9\ 10^{4}$	$1.3\ 10^{3}$	53	3.0
Prodromal vomiting	$1.4\ 10^{2}$	0	$2.0\ 10^{-1}$	$2.6\ 10^{2}$	$2.6\ 10^{3}$	47	14
Lung morbidity	$6.2\ 10^{1}$	0	0	$1.2\ 10^{2}$	$1.2\ 10^{3}$	54	13
Late							
Fatal cancer	$3.6\ 10^{3}$	0	$4.3\ 10^{1}$	$1.1\ 10^{4}$	$3.3\ 10^{4}$	30	26
Non-fatal thyroid cancer	$8.6\ 10^{3}$	0	$1.2\ 10^{2}$	$2.6\ 10^{4}$	$8.2\ 10^{4}$	30	27
Non-fatal skin cancer	$2.0\ 10^{3}$	0	$9.7\ 10^{1}$	$5.6\ 10^{3}$	$2.3\ 10^{4}$	30	24
Non-fatal breast cancer	$4.0\ 10^{2}$	0	$2.8\ 10^{0}$	$1.2\ 10^{3}$	$4.6\ 10^{3}$	30	25
Hereditary effects	$2.0\ 10^{3}$	0	$1.8\ 10^{1}$	$6.0\ 10^{3}$	$2.1\ 10^{4}$	30	25

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$2.6\ 10^{4}$	0	$4.2\ 10^{2}$	$1.0\ 10^{4}$	$4.0\ 10^{5}$	30	11
Area of land evacuated (km^2)	$1.1\ 10^{2}$	0	$9.2\ 10^{0}$	$2.9\ 10^{2}$	$1.4\ 10^{3}$	30	19

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$1.2\ 10^{7}$	0	$2.3\ 10^{4}$	$5.0\ 10^{7}$	$8.3\ 10^{7}$	39	24
Total milk restricted (litres)	$3.5\ 10^{8}$	0	$3.2\ 10^{6}$	$8.4\ 10^{8}$	$5.4\ 10^{9}$	39	25
Initial crop area restricted (km^2)	$2.2\ 10^{3}$	0	$1.2\ 10^{1}$	$8.6\ 10^{3}$	$1.1\ 10^{4}$	39	25
Time integral of the area of crop restrictions (km^2-y)	$3.4\ 10^{3}$	0	$2.0\ 10^{1}$	$1.1\ 10^{4}$	$2.8\ 10^{4}$	39	28
Initial no. livestock restricted	$1.6\ 10^{6}$	0	$2.8\ 10^{3}$	$6.9\ 10^{6}$	$1.1\ 10^{7}$	39	24
Time integral of the number of livestock restricted - (livestock-y)	$2.3\ 10^{6}$	0	$8.3\ 10^{3}$	$7.5\ 10^{6}$	$2.4\ 10^{7}$	39	27

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A7(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK2B

UK2B FREQUENCY: $3.1\ 10^{-11}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$1.6\ 10^{1}$	0	0	$6.6\ 10^{0}$	$2.7\ 10^{2}$	58	6.0
Prodromal vomiting	$4.9\ 10^{1}$	0	$1.2\ 10^{-3}$	$5.2\ 10^{1}$	$1.2\ 10^{3}$	48	10
Lung morbidity	$2.3\ 10^{1}$	0	0	$1.7\ 10^{1}$	$6.5\ 10^{2}$	62	8.8
Late							
Fatal cancer	$2.1\ 10^{3}$	0	$2.7\ 10^{1}$	$6.2\ 10^{3}$	$2.1\ 10^{4}$	30	26
Non-fatal thyroid cancer	$4.8\ 10^{3}$	0	$8.0\ 10^{1}$	$1.5\ 10^{4}$	$4.6\ 10^{4}$	30	27
Non-fatal skin cancer	$1.3\ 10^{3}$	0	$7.3\ 10^{1}$	$3.2\ 10^{3}$	$1.4\ 10^{4}$	30	23
Non-fatal breast cancer	$2.6\ 10^{2}$	0	$1.9\ 10^{0}$	$6.8\ 10^{2}$	$2.8\ 10^{3}$	30	24
Hereditary effects	$1.3\ 10^{3}$	0	$1.3\ 10^{1}$	$3.5\ 10^{3}$	$1.3\ 10^{4}$	30	25

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$8.1\ 10^{3}$	0	$2.3\ 10^{2}$	$1.2\ 10^{4}$	$1.4\ 10^{5}$	30	13
Area of land evacuated (km^2)	$4.7\ 10^{1}$	0	$6.9\ 10^{0}$	$1.4\ 10^{2}$	$5.5\ 10^{2}$	30	20

c) Agricultural products restricted by countermeasures [1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$1.0\ 10^{7}$	0	$2.3\ 10^{4}$	$4.5\ 10^{7}$	$7.6\ 10^{7}$	39	24
Total milk restricted (litres)	$1.9\ 10^{8}$	0	$2.6\ 10^{6}$	$4.6\ 10^{8}$	$3.0\ 10^{9}$	39	25
Initial crop area restricted (km^2)	$1.9\ 10^{3}$	0	$1.2\ 10^{1}$	$7.5\ 10^{3}$	$9.9\ 10^{3}$	39	25
Time integral of the area of crop restrictions (km^2-y)	$2.5\ 10^{3}$	0	$1.4\ 10^{1}$	$8.5\ 10^{3}$	$1.7\ 10^{4}$	39	27
Initial no. livestock restricted	$1.2\ 10^{6}$	0	$2.7\ 10^{3}$	$5.1\ 10^{6}$	$9.0\ 10^{6}$	39	24
Time integral of the number of livestock restricted - (livestock-y)	$1.3\ 10^{6}$	0	$6.9\ 10^{3}$	$4.1\ 10^{6}$	$1.6\ 10^{7}$	39	26

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A8(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK2C

UK2C FREQUENCY: $1.2\ 10^{-10}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$3.5\ 10^{0}$	0	0	$7.1\ 10^{-1}$	$4.4\ 10^{1}$	98	5.0
Prodromal vomiting	$1.9\ 10^{1}$	0	0	$9.0\ 10^{0}$	$4.1\ 10^{2}$	53	7.4
Lung morbidity	$9.0\ 10^{0}$	0	0	$3.8\ 10^{0}$	$1.7\ 10^{2}$	74	5.6
Late							
Fatal cancer	$1.2\ 10^{3}$	0	$1.9\ 10^{1}$	$3.4\ 10^{3}$	$1.1\ 10^{4}$	30	26
Non-fatal thyroid cancer	$2.8\ 10^{3}$	0	$5.8\ 10^{1}$	$8.9\ 10^{3}$	$2.6\ 10^{4}$	30	27
Non-fatal skin cancer	$7.2\ 10^{2}$	0	$5.3\ 10^{0}$	$1.8\ 10^{3}$	$8.1\ 10^{3}$	30	24
Non-fatal breast cancer	$1.5\ 10^{2}$	0	$1.5\ 10^{0}$	$3.8\ 10^{2}$	$1.6\ 10^{3}$	30	24
Hereditary effects	$7.8\ 10^{2}$	0	$1.1\ 10^{1}$	$2.1\ 10^{3}$	$7.7\ 10^{3}$	30	25

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$3.2\ 10^{3}$	0	$5.7\ 10^{1}$	$6.2\ 10^{3}$	$4.3\ 10^{4}$	30	21
Area of land evacuated (km^2)	$2.5\ 10^{1}$	0	$4.8\ 10^{0}$	$6.0\ 10^{1}$	$2.8\ 10^{2}$	30	18

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$9.0\ 10^{6}$	0	$2.2\ 10^{6}$	$3.9\ 10^{7}$	$6.6\ 10^{7}$	39	33
Total milk restricted (litres)	$1.0\ 10^{8}$	0	$9.8\ 10^{6}$	$2.6\ 10^{8}$	$1.6\ 10^{9}$	39	26
Initial crop area restricted (km^2)	$1.5\ 10^{3}$	0	$1.0\ 10^{1}$	$6.0\ 10^{3}$	$8.7\ 10^{3}$	39	26
Time integral of the area of crop restrictions (km^2-y)	$1.7\ 10^{3}$	0	$1.2\ 10^{1}$	$6.4\ 10^{3}$	$1.1\ 10^{4}$	39	27
Initial no. livestock restricted	$7.7\ 10^{5}$	0	$2.0\ 10^{3}$	$2.7\ 10^{6}$	$6.6\ 10^{6}$	39	24
Time integral of the number of livestock restricted - (livestock-y)	$7.3\ 10^{5}$	0	$5.8\ 10^{3}$	$2.1\ 10^{6}$	$9.0\ 10^{6}$	39	24

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A9(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK2D

UK2D FREQUENCY: $6.7\ 10^{-11}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$2.8\ 10^{-1}$	0	0	$4.0\ 10^{-2}$	$4.5\ 10^{0}$	76	4.7
Prodromal vomiting	$5.3\ 10^{0}$	0	0	$1.5\ 10^{0}$	$9.4\ 10^{1}$	58	5.7
Lung morbidity	$1.7\ 10^{0}$	0	0	$1.6\ 10^{-1}$	$1.5\ 10^{1}$	80	3.2
Late							
Fatal cancer	$5.4\ 10^{2}$	0	$9.8\ 10^{0}$	$1.6\ 10^{3}$	$4.8\ 10^{3}$	30	27
Non-fatal thyroid cancer	$1.5\ 10^{3}$	0	$3.3\ 10^{1}$	$5.3\ 10^{3}$	$1.2\ 10^{4}$	30	27
Non-fatal skin cancer	$3.2\ 10^{2}$	0	$3.1\ 10^{0}$	$8.4\ 10^{2}$	$3.3\ 10^{3}$	30	25
Non-fatal breast cancer	$6.9\ 10^{1}$	0	$8.4\ 10^{-1}$	$1.9\ 10^{2}$	$6.7\ 10^{2}$	30	26
Hereditary effects	$3.8\ 10^{2}$	0	$6.7\ 10^{0}$	$1.1\ 10^{3}$	$3.4\ 10^{3}$	30	26

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$1.6\ 10^{3}$	0	$4.0\ 10^{1}$	$5.5\ 10^{3}$	$1.8\ 10^{4}$	30	23
Area of land evacuated (km^2)	$1.3\ 10^{1}$	0	$4.7\ 10^{0}$	$2.2\ 10^{1}$	$1.3\ 10^{2}$	30	28

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$5.9\ 10^{6}$	0	$2.1\ 10^{4}$	$2.4\ 10^{7}$	$5.2\ 10^{7}$	39	22
Total milk restricted (litres)	$4.0\ 10^{7}$	0	$6.8\ 10^{5}$	$1.1\ 10^{8}$	$3.6\ 10^{8}$	39	26
Initial crop area restricted (km^2)	$1.0\ 10^{3}$	0	$7.4\ 10^{0}$	$4.1\ 10^{3}$	$6.6\ 10^{3}$	39	27
Time integral of the area of crop restrictions (km^2-y)	$1.1\ 10^{3}$	0	$8.6\ 10^{0}$	$4.4\ 10^{3}$	$6.7\ 10^{3}$	39	27
Initial no. livestock restricted	$3.4\ 10^{5}$	0	$1.1\ 10^{3}$	$9.9\ 10^{5}$	$4.7\ 10^{6}$	39	23
Time integral of the number of livestock restricted - (livestock-y)	$3.1\ 10^{5}$	0	$1.9\ 10^{3}$	$7.6\ 10^{5}$	$4.4\ 10^{6}$	39	21

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A10(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UKZE

UKZE FREQUENCY: $1.7\ 10^{-10}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$7.7\ 10^{-2}$	0	0	$2.2\ 10^{-3}$	$2.5\ 10^{0}$	87	4.1
Prodromal vomiting	$2.5\ 10^{0}$	0	0	$4.8\ 10^{-1}$	$3.4\ 10^{1}$	60	5.3
Lung morbidity	$1.8\ 10^{-1}$	0	0	0	$1.4\ 10^{0}$	92	2.6
Late							
Fatal cancer	$3.1\ 10^{2}$	0	$7.0\ 10^{0}$	$9.7\ 10^{2}$	$2.6\ 10^{3}$	30	27
Non-fatal thyroid cancer	$1.0\ 10^{3}$	0	$2.4\ 10^{1}$	$3.3\ 10^{3}$	$7.9\ 10^{3}$	30	26
Non-fatal skin cancer	$1.8\ 10^{2}$	0	$2.6\ 10^{0}$	$4.9\ 10^{2}$	$2.0\ 10^{3}$	30	26
Non-fatal breast cancer	$4.0\ 10^{1}$	0	$7.2\ 10^{-1}$	$1.1\ 10^{2}$	$3.9\ 10^{2}$	30	26
Hereditary effects	$2.3\ 10^{2}$	0	$6.0\ 10^{0}$	$9.7\ 10^{2}$	$2.0\ 10^{3}$	30	27

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$1.1\ 10^{3}$	0	$3.8\ 10^{1}$	$4.9\ 10^{3}$	$7.0\ 10^{3}$	30	23
Area of land evacuated (km^2)	$9.4\ 10^{0}$	0	$4.7\ 10^{0}$	$1.9\ 10^{1}$	$5.3\ 10^{1}$	30	42

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$3.7\ 10^{6}$	0	$1.5\ 10^{4}$	$1.1\ 10^{7}$	$3.8\ 10^{7}$	39	23
Total milk restricted (litres)	$1.8\ 10^{7}$	0	$2.3\ 10^{5}$	$6.1\ 10^{7}$	$1.6\ 10^{8}$	39	24
Initial crop area restricted (km^2)	$6.5\ 10^{2}$	0	$4.4\ 10^{0}$	$2.3\ 10^{3}$	$5.2\ 10^{3}$	39	27
Time integral of the area of crop restrictions (km^2-y)	$6.7\ 10^{2}$	0	$4.6\ 10^{0}$	$2.3\ 10^{3}$	$5.3\ 10^{3}$	39	27
Initial no. livestock restricted	$1.9\ 10^{5}$	0	$7.9\ 10^{2}$	$5.3\ 10^{5}$	$2.7\ 10^{6}$	40	21
Time integral of the number of livestock restricted - (livestock-y)	$1.4\ 10^{5}$	0	$1.3\ 10^{3}$	$3.7\ 10^{5}$	$1.8\ 10^{6}$	40	21

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A11(R)

Characteristic quantities of the distributions of consequences conditional occurrence of UKSA

UKSA FREQUENCY: $2.7\ 10^{-10}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$1.3\ 10^{1}$	0	0	$1.5\ 10^{-1}$	$3.5\ 10^{2}$	80	4.6
Prodromal vomiting	$6.8\ 10^{1}$	0	0	$5.3\ 10^{1}$	$1.7\ 10^{3}$	57	9.2
Lung morbidity	$9.3\ 10^{0}$	0	0	$2.5\ 10^{0}$	$2.7\ 10^{2}$	73	7.5
Late							
Fatal cancer	$2.4\ 10^{3}$	0	$2.6\ 10^{1}$	$7.2\ 10^{3}$	$2.2\ 10^{4}$	33	26
Non-fatal thyroid cancer	$7.0\ 10^{3}$	0	$8.7\ 10^{1}$	$2.2\ 10^{4}$	$6.8\ 10^{4}$	33	27
Non-fatal skin cancer	$1.5\ 10^{3}$	0	$8.5\ 10^{1}$	$4.2\ 10^{3}$	$1.7\ 10^{4}$	33	24
Non-fatal breast cancer	$3.1\ 10^{2}$	0	$2.3\ 10^{0}$	$8.8\ 10^{2}$	$3.4\ 10^{3}$	33	26
Hereditary effects	$1.6\ 10^{3}$	0	$1.6\ 10^{1}$	$4.6\ 10^{3}$	$1.6\ 10^{4}$	33	25

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$1.9\ 10^{4}$	0	$3.3\ 10^{2}$	$2.6\ 10^{4}$	$3.1\ 10^{5}$	30	12
Area of land evacuated (km^2)	$8.4\ 10^{1}$	0	$6.9\ 10^{0}$	$2.5\ 10^{2}$	$1.2\ 10^{3}$	30	19

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$1.1\ 10^{7}$	0	$2.3\ 10^{6}$	$4.8\ 10^{7}$	$8.1\ 10^{7}$	39	24
Total milk restricted (litres)	$2.6\ 10^{8}$	0	$3.1\ 10^{6}$	$6.2\ 10^{8}$	$4.3\ 10^{9}$	39	26
Initial crop area restricted (km^2)	$2.0\ 10^{3}$	0	$1.2\ 10^{1}$	$8.0\ 10^{3}$	$1.0\ 10^{4}$	39	25
Time integral of the area of crop restrictions (km^2-y)	$2.9\ 10^{3}$	0	$1.7\ 10^{1}$	$9.5\ 10^{3}$	$2.3\ 10^{4}$	39	27
Initial no. livestock restricted	$1.5\ 10^{6}$	0	$2.8\ 10^{3}$	$5.9\ 10^{6}$	$9.8\ 10^{6}$	39	24
Time integral of the number of livestock restricted - (livestock-y)	$1.8\ 10^{6}$	0	$7.4\ 10^{3}$	$5.6\ 10^{6}$	$1.9\ 10^{7}$	39	27

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A12(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK5B

UK5B FREQUENCY: $5.8\ 10^{-10}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$3.2\ 10^{0}$	0	0	0	$2.0\ 10^{1}$	93	2.8
Prodromal vomiting	$1.7\ 10^{1}$	0	0	$1.8\ 10^{3}$	$4.3\ 10^{2}$	75	5.9
Lung morbidity	$3.1\ 10^{0}$	0	0	0	$6.1\ 10^{1}$	94	3.5
Late							
Fatal cancer	$1.4\ 10^{3}$	0	$1.8\ 10^{1}$	$4.0\ 10^{3}$	$1.4\ 10^{4}$	33	26
Non-fatal thyroid cancer	$3.9\ 10^{3}$	0	$5.7\ 10^{1}$	$1.2\ 10^{4}$	$3.8\ 10^{4}$	33	27
Non-fatal skin cancer	$9.3\ 10^{2}$	0	$6.4\ 10^{1}$	$2.3\ 10^{3}$	$1.0\ 10^{4}$	33	23
Non-fatal breast cancer	$1.9\ 10^{2}$	0	$1.7\ 10^{0}$	$5.0\ 10^{2}$	$2.0\ 10^{3}$	33	24
Hereditary effects	$1.0\ 10^{3}$	0	$1.4\ 10^{1}$	$2.7\ 10^{3}$	$9.8\ 10^{3}$	33	25

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$6.0\ 10^{3}$	0	$1.4\ 10^{2}$	$8.9\ 10^{3}$	$1.1\ 10^{5}$	30	15
Area of land evacuated (km^2)	$3.7\ 10^{1}$	0	$6.8\ 10^{0}$	$9.7\ 10^{1}$	$4.7\ 10^{2}$	30	18

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$9.9\ 10^{6}$	0	$2.2\ 10^{4}$	$4.4\ 10^{7}$	$7.3\ 10^{7}$	39	24
Total milk restricted (litres)	$1.6\ 10^{8}$	0	$2.2\ 10^{6}$	$3.5\ 10^{8}$	$3.0\ 10^{9}$	39	24
Initial crop area restricted (km^2)	$1.7\ 10^{3}$	0	$1.2\ 10^{1}$	$6.6\ 10^{3}$	$9.4\ 10^{3}$	39	26
Time integral of the area of crop restrictions (km^2-y)	$2.1\ 10^{3}$	0	$1.3\ 10^{1}$	$7.3\ 10^{3}$	$1.4\ 10^{4}$	39	27
Initial no. livestock restricted	$1.0\ 10^{6}$	0	$2.1\ 10^{3}$	$4.0\ 10^{6}$	$8.0\ 10^{6}$	39	25
Time integral of the number of livestock restricted - (livestock-y)	$9.9\ 10^{8}$	0	$6.5\ 10^{3}$	$3.1\ 10^{6}$	$1.1\ 10^{7}$	39	26

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(\cdot)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A13(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK5C

UK5C FREQUENCY: $2.1\ 10^{-9}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$1.2\ 10^{-1}$	0	0	0	$6.3\ 10^{-1}$	96	2.1
Prodromal vomiting	$3.9\ 10^{0}$	0	0	0	$6.4\ 10^{1}$	91	4.6
Lung morbidity	$1.0\ 10^{0}$	0	0	0	$6.6\ 10^{0}$	97	2.2
Late							
Fatal cancer	$8.0\ 10^{2}$	0	$1.1\ 10^{1}$	$2.2\ 10^{3}$	$7.6\ 10^{3}$	33	27
Non-fatal thyroid cancer	$2.3\ 10^{3}$	0	$3.7\ 10^{1}$	$7.5\ 10^{3}$	$2.1\ 10^{4}$	33	27
Non-fatal skin cancer	$5.2\ 10^{2}$	0	$4.1\ 10^{0}$	$1.3\ 10^{3}$	$5.6\ 10^{3}$	33	24
Non-fatal breast cancer	$1.1\ 10^{2}$	0	$1.2\ 10^{0}$	$2.9\ 10^{2}$	$1.1\ 10^{3}$	33	25
Hereditary effects	$5.9\ 10^{2}$	0	$9.4\ 10^{0}$	$1.6\ 10^{3}$	$5.6\ 10^{3}$	33	26

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$2.7\ 10^{3}$	0	$4.1\ 10^{1}$	$5.7\ 10^{3}$	$3.7\ 10^{4}$	30	20
Area of land evacuated (km^2)	$2.1\ 10^{1}$	0	$4.8\ 10^{0}$	$3.3\ 10^{1}$	$2.4\ 10^{2}$	30	17

c) Agricultural products restricted by countermeasures

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$8.1\ 10^{6}$	0	$2.2\ 10^{4}$	$3.6\ 10^{7}$	$6.1\ 10^{7}$	39	23
Total milk restricted (litres)	$8.5\ 10^{7}$	0	$7.8\ 10^{5}$	$2.0\ 10^{8}$	$1.5\ 10^{9}$	39	25
Initial crop area restricted (km^2)	$1.3\ 10^{3}$	0	$8.2\ 10^{0}$	$5.2\ 10^{3}$	$7.8\ 10^{3}$	39	27
Time integral of the area of crop restrictions (km^2-y)	$1.5\ 10^{3}$	0	$1.2\ 10^{1}$	$5.6\ 10^{3}$	$8.7\ 10^{3}$	39	27
Initial no. livestock restricted	$6.1\ 10^{5}$	0	$1.7\ 10^{3}$	$2.0\ 10^{6}$	$6.0\ 10^{6}$	39	27
Time integral of the number of livestock restricted - (livestock-y)	$5.7\ 10^{5}$	0	$4.7\ 10^{3}$	$1.6\ 10^{6}$	$7.6\ 10^{6}$	39	22

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A14(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK5D

UK5D FREQUENCY: $1.3\ 10^{-9}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	0	0	0	0	0	0	0
Prodromal vomiting	$4.0\ 10^{-1}$	0	0	0	$2.7\ 10^{0}$	95	3.0
Lung morbidity	$1.9\ 10^{-3}$	0	0	0	$2.3\ 10^{-4}$	98	.56
Late							
Fatal cancer	$3.7\ 10^{2}$	0	$6.8\ 10^{0}$	$1.1\ 10^{3}$	$3.3\ 10^{3}$	33	27
Non-fatal thyroid cancer	$1.3\ 10^{3}$	0	$2.2\ 10^{1}$	$4.7\ 10^{3}$	$1.1\ 10^{4}$	33	27
Non-fatal skin cancer	$2.4\ 10^{2}$	0	$2.6\ 10^{0}$	$6.3\ 10^{2}$	$2.4\ 10^{3}$	33	26
Non-fatal breast cancer	$5.1\ 10^{1}$	0	$7.7\ 10^{-1}$	$1.4\ 10^{2}$	$4.8\ 10^{2}$	33	26
Hereditary effects	$2.9\ 10^{2}$	0	$6.6\ 10^{0}$	$8.4\ 10^{2}$	$2.4\ 10^{3}$	33	26

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$1.3\ 10^{3}$	0	$3.8\ 10^{1}$	$5.4\ 10^{3}$	$1.4\ 10^{4}$	30	21
Area of land evacuated (km^2)	$1.2\ 10^{1}$	0	$4.7\ 10^{0}$	$1.8\ 10^{1}$	$1.1\ 10^{2}$	30	39

c) Agricultural products restricted by countermeasures

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$4.8\ 10^{6}$	0	$1.6\ 10^{4}$	$1.7\ 10^{7}$	$4.5\ 10^{7}$	39	22
Total milk restricted (litres)	$3.2\ 10^{7}$	0	$5.4\ 10^{5}$	$9.2\ 10^{7}$	$2.8\ 10^{8}$	39	24
Initial crop area restricted (km^2)	$8.1\ 10^{2}$	0	$4.6\ 10^{0}$	$3.0\ 10^{3}$	$5.8\ 10^{3}$	39	27
Time integral of the area of crop restrictions (km^2-y)	$8.5\ 10^{2}$	0	$6.2\ 10^{0}$	$3.1\ 10^{3}$	$5.9\ 10^{3}$	39	27
Initial no. livestock restricted	$2.7\ 10^{5}$	0	$1.1\ 10^{3}$	$7.3\ 10^{5}$	$3.9\ 10^{6}$	39	22
Time integral of the number of livestock restricted - (livestock-y)	$2.3\ 10^{5}$	0	$1.6\ 10^{3}$	$5.4\ 10^{5}$	$3.4\ 10^{6}$	39	22

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A15(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UKSE

UKSE FREQUENCY: $3.7\ 10^{-9}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	0	0	0	0	0	0	0
Prodromal vomiting	$5.4\ 10^{-2}$	0	0	0	$2.6\ 10^{-1}$	96	1.8
Lung morbidity	0	0	0	0	0	0	0
Late							
Fatal cancer	$2.2\ 10^{2}$	0	$4.8\ 10^{0}$	$6.9\ 10^{2}$	$1.9\ 10^{3}$	33	27
Non-fatal thyroid cancer	$9.1\ 10^{2}$	0	$1.7\ 10^{1}$	$3.3\ 10^{3}$	$6.9\ 10^{3}$	33	26
Non-fatal skin cancer	$1.3\ 10^{2}$	0	$2.0\ 10^{0}$	$3.6\ 10^{2}$	$1.4\ 10^{3}$	33	26
Non-fatal breast cancer	$3.0\ 10^{1}$	0	$6.3\ 10^{-1}$	$8.5\ 10^{1}$	$2.8\ 10^{2}$	33	26
Hereditary effects	$1.8\ 10^{2}$	0	$5.3\ 10^{0}$	$5.4\ 10^{2}$	$1.5\ 10^{3}$	33	27

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$1.0\ 10^{3}$	0	$3.7\ 10^{1}$	$4.8\ 10^{3}$	$6.3\ 10^{3}$	30	21
Area of land evacuated (km^2)	$8.6\ 10^{0}$	0	$4.7\ 10^{0}$	$1.7\ 10^{1}$	$5.0\ 10^{1}$	30	44

c) Agricultural products restricted by countermeasures

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$3.0\ 10^{6}$	0	$1.2\ 10^{4}$	$9.6\ 10^{6}$	$3.3\ 10^{7}$	39	23
Total milk restricted (litres)	$1.4\ 10^{7}$	0	$1.7\ 10^{5}$	$4.6\ 10^{7}$	$1.4\ 10^{8}$	39	24
Initial crop area restricted (km^2)	$4.6\ 10^{2}$	0	$4.1\ 10^{0}$	$1.5\ 10^{3}$	$4.2\ 10^{3}$	40	26
Time integral of the area of crop restrictions (km^2-y)	$4.7\ 10^{2}$	0	$4.4\ 10^{0}$	$1.5\ 10^{3}$	$4.3\ 10^{3}$	40	26
Initial no. livestock restricted	$1.3\ 10^{5}$	0	$7.0\ 10^{2}$	$2.8\ 10^{5}$	$2.0\ 10^{6}$	40	23
Time integral of the number of livestock restricted - (livestock-y)	$1.1\ 10^{5}$	0	$1.0\ 10^{3}$	$2.8\ 10^{5}$	$1.3\ 10^{6}$	40	20

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A16(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK6A

UK6A FREQUENCY: $2.0\ 10^{-10}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$8.3\ 10^{-1}$	0	0	0	$9.2\ 10^{0}$	95	2.2
Prodromal vomiting	$1.4\ 10^{1}$	0	0	$1.0\ 10^{0}$	$3.9\ 10^{2}$	76	5.9
Lung morbidity	$6.1\ 10^{-2}$	0	0	0	$6.4\ 10^{-1}$	98	1.9
Late							
Fatal cancer	$1.6\ 10^{3}$	0	$1.5\ 10^{1}$	$4.3\ 10^{3}$	$1.7\ 10^{4}$	33	25
Non-fatal thyroid cancer	$5.0\ 10^{3}$	0	$3.8\ 10^{1}$	$1.5\ 10^{4}$	$4.8\ 10^{4}$	33	27
Non-fatal skin cancer	$1.2\ 10^{3}$	0	$7.0\ 10^{2}$	$2.9\ 10^{3}$	$1.3\ 10^{4}$	33	23
Non-fatal breast cancer	$2.4\ 10^{2}$	0	$1.8\ 10^{0}$	$6.2\ 10^{2}$	$2.6\ 10^{3}$	33	24
Hereditary effects	$1.2\ 10^{3}$	0	$1.3\ 10^{1}$	$3.3\ 10^{3}$	$1.2\ 10^{4}$	33	24

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$5.7\ 10^{3}$	0	$2.2\ 10^{2}$	$9.3\ 10^{3}$	$9.2\ 10^{4}$	30	18
Area of land evacuated (km^2)	$3.9\ 10^{1}$	0	$6.9\ 10^{0}$	$1.1\ 10^{2}$	$4.3\ 10^{2}$	30	19

c) Agricultural products restricted by countermeasures [1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$1.0\ 10^{7}$	0	$2.3\ 10^{4}$	$4.5\ 10^{7}$	$7.8\ 10^{7}$	39	24
Total milk restricted (litres)	$1.9\ 10^{8}$	0	$2.3\ 10^{6}$	$4.6\ 10^{8}$	$3.0\ 10^{9}$	39	25
Initial crop area restricted (km^2)	$1.8\ 10^{3}$	0	$1.2\ 10^{1}$	$7.2\ 10^{3}$	$9.6\ 10^{3}$	39	26
Time integral of the area of crop restrictions (km^2-y)	$2.2\ 10^{3}$	0	$1.3\ 10^{1}$	$7.9\ 10^{3}$	$1.5\ 10^{4}$	39	27
Initial no. livestock restricted	$1.2\ 10^{6}$	0	$2.7\ 10^{3}$	$5.1\ 10^{6}$	$9.0\ 10^{6}$	39	24
Time integral of the number of livestock restricted - (livestock-y)	$1.3\ 10^{6}$	0	$6.9\ 10^{3}$	$3.8\ 10^{6}$	$1.6\ 10^{7}$	39	26

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A17(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK6B

UK6B FREQUENCY: $3.3\ 10^{-10}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$5.9\ 10^{-2}$	0	0	0	$8.9\ 10^{-2}$	98	1.1
Prodromal vomiting	$3.0\ 10^{0}$	0	0	$1.8\ 10^{-2}$	$8.0\ 10^{1}$	88	4.8
Lung morbidity	$3.2\ 10^{-3}$	0	0	0	0	100	0.16
Late							
Fatal cancer	$8.8\ 10^{2}$	0	$1.1\ 10^{1}$	$2.4\ 10^{3}$	$8.9\ 10^{3}$	33	26
Non-fatal thyroid cancer	$2.9\ 10^{3}$	0	$3.3\ 10^{1}$	$9.0\ 10^{3}$	$2.6\ 10^{4}$	33	27
Non-fatal skin cancer	$6.4\ 10^{2}$	0	$4.7\ 10^{0}$	$1.6\ 10^{3}$	$7.0\ 10^{3}$	33	24
Non-fatal breast cancer	$1.3\ 10^{2}$	0	$1.4\ 10^{0}$	$3.5\ 10^{2}$	$1.4\ 10^{3}$	33	25
Hereditary effects	$7.1\ 10^{2}$	0	$1.1\ 10^{1}$	$1.9\ 10^{3}$	$6.9\ 10^{3}$	33	25

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$2.8\ 10^{3}$	0	$4.2\ 10^{1}$	$5.8\ 10^{3}$	$3.9\ 10^{4}$	30	21
Area of land evacuated (km^2)	$2.2\ 10^{1}$	0	$4.8\ 10^{0}$	$4.6\ 10^{1}$	$2.3\ 10^{2}$	30	19

c) Agricultural products restricted by countermeasures [1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$9.2\ 10^{6}$	0	$2.2\ 10^{5}$	$4.2\ 10^{7}$	$6.7\ 10^{7}$	39	24
Total milk restricted (litres)	$1.1\ 10^{8}$	0	$9.7\ 10^{5}$	$2.6\ 10^{8}$	$1.6\ 10^{9}$	39	26
Initial crop area restricted (km^2)	$1.4\ 10^{3}$	0	$9.7\ 10^{0}$	$5.6\ 10^{3}$	$8.2\ 10^{3}$	39	26
Time integral of the area of crop restrictions (km^2-y)	$1.6\ 10^{3}$	0	$1.2\ 10^{1}$	$6.0\ 10^{3}$	$9.2\ 10^{3}$	39	27
Initial no. livestock restricted	$7.8\ 10^{5}$	0	$2.0\ 10^{3}$	$2.8\ 10^{6}$	$6.6\ 10^{6}$	39	24
Time integral of the number of livestock restricted - (livestock-y)	$7.2\ 10^{5}$	0	$5.8\ 10^{3}$	$2.1\ 10^{6}$	$8.4\ 10^{6}$	39	24

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A18(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK6C

UK6C FREQUENCY: $1.1\ 10^{-9}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$3.4\ 10^{-3}$	0	0	0	0	100	0.16
Prodromal vomiting	$5.4\ 10^{-1}$	0	0	0	$1.0\ 10^{1}$	94	4.2
Lung morbidity	0	0	0	0	0	0	0
Late							
Fatal cancer	$5.0\ 10^{2}$	0	$7.4\ 10^{0}$	$1.4\ 10^{3}$	$4.7\ 10^{3}$	33	27
Non-fatal thyroid cancer	$1.8\ 10^{3}$	0	$2.3\ 10^{1}$	$6.0\ 10^{3}$	$1.5\ 10^{4}$	33	27
Non-fatal skin cancer	$3.5\ 10^{2}$	0	$3.1\ 10^{0}$	$9.0\ 10^{2}$	$2.6\ 10^{3}$	33	25
Non-fatal breast cancer	$7.5\ 10^{1}$	0	$9.4\ 10^{-1}$	$2.0\ 10^{2}$	$7.4\ 10^{2}$	33	26
Hereditary effects	$4.1\ 10^{2}$	0	$7.5\ 10^{0}$	$1.2\ 10^{3}$	$3.7\ 10^{3}$	33	26

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$1.7\ 10^{3}$	0	$4.0\ 10^{1}$	$5.5\ 10^{3}$	$1.8\ 10^{4}$	30	22
Area of land evacuated (km^2)	$1.3\ 10^{1}$	0	$4.7\ 10^{0}$	$2.3\ 10^{1}$	$1.5\ 10^{2}$	30	27

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$7.1\ 10^{6}$	0	$2.2\ 10^{4}$	$3.1\ 10^{7}$	$5.7\ 10^{7}$	39	22
Total milk restricted (litres)	$5.8\ 10^{7}$	0	$7.0\ 10^{5}$	$1.5\ 10^{8}$	$9.7\ 10^{8}$	39	25
Initial crop area restricted (km^2)	$1.0\ 10^{3}$	0	$7.4\ 10^{0}$	$4.2\ 10^{3}$	$6.6\ 10^{3}$	39	27
Time integral of the area of crop restrictions (km^2-y)	$1.1\ 10^{3}$	0	$8.6\ 10^{0}$	$4.4\ 10^{3}$	$6.7\ 10^{3}$	39	27
Initial no. livestock restricted	$4.3\ 10^{5}$	0	$1.2\ 10^{3}$	$1.4\ 10^{6}$	$4.8\ 10^{6}$	39	24
Time integral of the number of livestock restricted - (livestock-y)	$3.8\ 10^{5}$	0	$2.2\ 10^{3}$	$9.9\ 10^{5}$	$4.6\ 10^{6}$	39	23

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A19(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK6D[2]

UK6D FREQUENCY: $6.9\ 10^{-10}\ y^{-1}$

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	$1.1\ 10^{-4}$	0	0	0	0	100	0.14
Prodromal vomiting	$7.1\ 10^{-2}$	0	0	0	$3.8\ 10^{-1}$	96	3.1
Lung morbidity	0	0	0	0	0	0	0
Late							
Fatal cancer	$2.5\ 10^{2}$	0	$5.1\ 10^{0}$	$7.5\ 10^{2}$	$2.1\ 10^{3}$	33	27
Non-fatal thyroid cancer	$1.1\ 10^{3}$	0	$1.9\ 10^{1}$	$4.0\ 10^{3}$	$8.0\ 10^{3}$	33	26
Non-fatal skin cancer	$1.6\ 10^{2}$	0	$2.5\ 10^{0}$	$4.5\ 10^{2}$	$1.7\ 10^{3}$	33	26
Non-fatal breast cancer	$3.6\ 10^{1}$	0	$7.5\ 10^{-1}$	$1.0\ 10^{2}$	$3.5\ 10^{2}$	33	26
Hereditary effects	$2.1\ 10^{2}$	0	$6.5\ 10^{0}$	$6.3\ 10^{2}$	$1.7\ 10^{3}$	33	27

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$1.0\ 10^{3}$	0	$3.8\ 10^{1}$	$4.8\ 10^{3}$	$6.7\ 10^{3}$	30	22
Area of land evacuated (km^2)	$9.0\ 10^{0}$	0	$4.7\ 10^{0}$	$1.8\ 10^{1}$	$5.1\ 10^{1}$	30	43

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$3.9\ 10^{6}$	0	$1.5\ 10^{4}$	$1.2\ 10^{7}$	$3.8\ 10^{7}$	39	22
Total milk restricted (litres)	$1.8\ 10^{7}$	0	$2.0\ 10^{5}$	$6.4\ 10^{7}$	$1.6\ 10^{8}$	39	24
Initial crop area restricted (km^2)	$5.6\ 10^{2}$	0	$4.2\ 10^{0}$	$2.0\ 10^{3}$	$4.7\ 10^{3}$	39	27
Time integral of the area of crop restrictions (km^2-y)	$5.7\ 10^{2}$	0	$4.5\ 10^{0}$	$2.0\ 10^{3}$	$4.7\ 10^{3}$	39	27
Initial no. livestock restricted	$1.9\ 10^{5}$	0	$7.9\ 10^{2}$	$5.4\ 10^{5}$	$2.7\ 10^{6}$	40	21
Time integral of the number of livestock restricted - (livestock-y)	$1.4\ 10^{5}$	0	$1.3\ 10^{3}$	$3.7\ 10^{5}$	$1.8\ 10^{6}$	40	21

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

Table A20(R)

Characteristic quantities of the distributions of consequences conditional upon occurrence of UK6E

UK6E FREQUENCY: $1.9\ 10^{-9}\ y^{-1}$ [2]

a) Number of health effects

Health effect	Number of health effects, N					% Probability	
	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Early							
Death	0	0	0	0	0	0	0
Prodromal vomiting	$3.3\ 10^{-2}$	0	0	0	$1.5\ 10^{-1}$	97	2.2
Lung morbidity	0	0	0	0	0	0	0
Late							
Fatal cancer	$1.4\ 10^{2}$	0	$3.4\ 10^{0}$	$4.6\ 10^{2}$	$1.2\ 10^{3}$	33	27
Non-fatal thyroid cancer	$7.5\ 10^{2}$	0	$1.3\ 10^{1}$	$2.7\ 10^{3}$	$5.6\ 10^{3}$	33	26
Non-fatal skin cancer	$9.1\ 10^{1}$	0	$1.7\ 10^{0}$	$3.6\ 10^{2}$	$8.8\ 10^{2}$	33	26
Non-fatal breast cancer	$2.1\ 10^{1}$	0	$5.2\ 10^{-1}$	$6.0\ 10^{1}$	$1.8\ 10^{2}$	33	27
Hereditary effects	$1.3\ 10^{2}$	0	$4.5\ 10^{0}$	$3.9\ 10^{2}$	$1.0\ 10^{3}$	33	27

b) Area and number of people evacuated

Parameter	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Number of people evacuated	$9.9\ 10^{2}$	0	$3.7\ 10^{1}$	$4.7\ 10^{3}$	$6.2\ 10^{3}$	30	21
Area of land evacuated (km^2)	$8.3\ 10^{0}$	0	$4.7\ 10^{0}$	$1.8\ 10^{1}$	$4.0\ 10^{1}$	30	44

c) Agricultural products restricted by countermeasures[1]

Agricultural product	Expectation value, E	Value at the p^{th} percentile				P(N=0)	P(N>E)
		p=1	p=50	p=90	p=99		
Milk restricted in 7 days (litres)	$2.4\ 10^{6}$	0	$9.4\ 10^{3}$	$7.1\ 10^{6}$	$3.1\ 10^{7}$	39	22
Total milk restricted (litres)	$9.9\ 10^{6}$	0	$8.4\ 10^{4}$	$3.2\ 10^{7}$	$1.2\ 10^{8}$	39	20
Initial crop area restricted (km^2)	$3.0\ 10^{2}$	0	$2.7\ 10^{0}$	$9.1\ 10^{2}$	$3.4\ 10^{3}$	40	25
Time integral of the area of crop restrictions (km^2-y)	$3.1\ 10^{2}$	0	$3.6\ 10^{0}$	$9.2\ 10^{2}$	$3.4\ 10^{3}$	40	26
Initial no. livestock restricted	$1.1\ 10^{5}$	0	$5.9\ 10^{2}$	$2.2\ 10^{5}$	$1.5\ 10^{6}$	40	20
Time integral of the number of livestock restricted - (livestock-y)	$6.2\ 10^{4}$	0	$4.8\ 10^{2}$	$1.8\ 10^{5}$	$7.3\ 10^{5}$	40	20

Notes:

1. The areas of crop restrictions refer to the actual land area used for crop production.

2. The frequency (y^{-1}) with which particular consequences specified in the table are exceeded can be obtained as $0.01.f(r).(100-p)$ where $f(r)$ is the frequency of the release category (y^{-1}) and p is the percentile appropriate to the value of consequences of interest.

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