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Estimation of radiation doses from inhalation of resuspended materials in emergency situations

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Public Health England
133–155 Waterloo Road
Wellington House
London SE1 8UG
T: 020 7654 8000

www.gov.uk/phe
Twitter: @PHE_uk
Facebook: www.facebook.com/PublicHealthEngland

Any enquiries regarding this publication should be sent to:

Centre for Radiation, Chemical and Environmental Hazards
Public Health England
Chilton, Didcot, Oxfordshire OX11 0RQ
E: CRCEDirectorsOffice@phe.gov.uk

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Estimation of radiation doses from inhalation of resuspended materials in emergency situations

J Wellings, P Bedwell, S M Haywood, T W Charnock

Abstract

Radioactive material that is accidentally released may deposit onto the ground and other surfaces. Such material may subsequently be resuspended and deliver a radiation dose to anyone who inhales it. Since 2002, Public Health England (PHE) and its predecessor organisations have been recommending the method described in the report NRPB-W1 as the most appropriate for estimating such doses in emergency response situations in the UK. An additional review has now been carried out and the results are presented here. As a result of the review, the original method has been left largely unchanged. It is still based on resuspension factors, and the mathematical formula recommended for estimating the resuspension factors has not been altered. However, the inhalation rates and half-lives used in the example calculations have been updated and some omissions have been rectified. The present report should be used in preference to NRPB-W1.

Centre for Radiation, Chemical and Environmental Hazards
Public Health England
Chilton, Didcot
Oxfordshire OX11 0RQ

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Contents

1 Introduction

When radioactivity is released into the atmosphere, a proportion of the activity may deposit onto surfaces. Some of the deposited material will become airborne again when disturbed by wind or human activities such as walking or vehicle movement. This process is known as resuspension. In the event of an accidental release, people may continue to inhale resuspended activity after the initial cloud of radioactivity has dispersed, and so receive additional doses (resuspension doses). This means that resuspension can be an important consideration in emergency situations.

A review of experimental studies of resuspension has been carried out in order to recommend an appropriate method for estimating likely resuspension doses after an accident in UK conditions. This information can be used to assist decisions on how best to protect people in the immediate aftermath of an accident. The findings of the review and consequent recommendations were published in the report NRPB-W1 (Walsh, 2002). In particular, NRPB-W1 recommended a mathematical formula for estimating resuspension doses from measurements of radioactive contamination on the ground. In addition, guidance was given on how to apply that formula in different situations (such as very windy conditions or urban environments).

Since NRPB-W1's original publication in 2002, the recommended values for inhalation rates have changed for some age groups, and the recommended values for half-lives have changed for some radionuclides. Also, errors have been found in the tables of calculated values in Appendix B of NRPB-W1. These principally affect long-term resuspension estimations and are insignificant for resuspension estimated for periods of less than a few years. It should be noted that the errors occur only in the tables of values; the underlying mathematical formula is not affected by the errors.

An additional review has now been carried out with two main aims. The first aim was to identify and correct any errors in the NRPB-W1 report. The second was to review developments in the field of resuspension modelling which may have occurred since the compilation of the original report, and to assess whether the method used in NRPB-W1 is still appropriate or whether a more fundamental change of approach is required. The present report documents the findings of the review and should be used in preference to NRPB-W1.

2 Summary of method used in NRPB-W1

2.1 Resuspension factors

The method of NRPB-W1 is based on the use of resuspension factors. In general, a resuspension factor represents the ratio of the activity concentration in air arising from resuspension to the activity per unit area at the location in which the air sample was taken. So, in the case of deposited contamination:

$$K\ [\mathrm{m^{-1}}] = \frac{\text{Concentration in air arising from resuspension [Bq m}^{-3}]}{\text{Surface deposition concentration [Bq m}^{-2}]}$$

where K is the resuspension factor.

2.2 Modified Garland formula

In UK emergency response situations, NRPB-W1 recommends that the resuspension factors should be calculated using the 'modified Garland formula'. This is based on a formula originally developed by Garland (Garland, 1979; Garland, 1982; Garland et al., 1992), but modified by the inclusion of extra terms to account for the long-term resuspension and the radioactive decay. The recommended formula is as follows.

For times after one day: $$K(t) = [K(0)t^{-1} + K(T)]e^{-\lambda t}$$

where:

$K(t)$ is the resuspension factor at time t (m^{-1})

$K(0)$ is the resuspension factor at time zero (1.2×10^{-6} m^{-1})

t is the time after deposition (days)

$K(T)$ is the long-term resuspension factor (10^{-9} m^{-1})

λ is the radioactive decay constant (day^{-1}).

The formula should be used only for deposits which are older than one day (i.e. $t > 1$). If a resuspension factor for the first day is absolutely necessary, the constant value of 1.2×10^{-6} m^{-1} should be assumed to apply at all times during the first day. Any resuspension factor applied to times during the first day is likely to be subject to significant uncertainty.

Garland's original formula was empirically derived and was based on experiments carried out in typical UK conditions (and specifically on grassland and bare soil). This gives it an advantage over many other formulae, which were often derived in arid and sparsely vegetated conditions that are not representative of conditions typically encountered in the UK.

As a result of being empirically derived, Garland's original formula was dimensionally inconsistent. The modified Garland formula above is similarly dimensionally inconsistent. This means that care is needed when using the formula; in particular, there is an inherent assumption that time is measured in units of days. This is discussed further in Appendix A, below.

A more detailed discussion of Garland's approach, and of a number of alternative approaches that were considered, can be found in the NRPB-W1 report.

3 Literature review

The report NRPB-W1 was published in January 2002. To take into account any relevant developments in the field since that time, a literature review has been carried out. The principal aim of this was to assess whether the current approach used in NRPB-W1 is still acceptable or whether a more fundamental change of approach is required and whether there are any existing approaches which could directly replace the one used in NRPB-W1.

In addition to a literature search, a number of other organisations active in the field of resuspension modelling were contacted.

It appears that the approach recommended in NRPB-W1 is still fairly widely used. Moreover, the U.S. National Council on Radiation Protection and Measurements suggests a very similar formula in NCRP-129 (see Section 4.2.2.2 of NCRP, 1999) and the International Atomic Energy Agency suggests the use of the Garland formula in rural conditions in IAEA (2010) (see Section 3.4.2 of that report).

3.1 Are resuspension factors still appropriate?

NRPB-W1 reviews two categories of resuspension models: specifically, those based on resuspension factors and those based on dust loading (also known as mass loading). A third category (those based on resuspension rate) is mentioned but not reviewed. Resuspension factors are defined above. Dust loading is the product of activity concentration in soil (Bq kg^{-1}) and soil concentration in air (kg m^{-3}). Resuspension rate is the ratio of resuspension flux (Bq m^{-2} s^{-1}) to surface deposition (Bq m^{-2}). NRPB-W1 concludes that resuspension factor models are the most appropriate for use in emergency response, in particular because their required inputs tend to be more easily obtainable after an accidental release than the inputs required by the other two categories of model. A further reason cited for resuspension factors being more appropriate than dust loading for use in emergencies is that resuspension factors are better suited to modelling fresh deposits than dust loading models are.

Broader categorisations of resuspension models are also possible. For example, Kim et al. (2010) categorises resuspension models into two groups:

> *The first group comprises theoretical models that explain the resuspension behavior based on microscale mechanisms … including, for example, a kinetic "particle desorption" model of [Wen and Kasper (1989)], a force balance model based on a Monte-Carlo approach developed by [Braaten et al. (1990)], and the dynamic rock and roll model with resonant energy transfer by [Reeks and Hall (2001)]. These models are complex, often require significant computing time, and are not suitable for direct largescale applications … The second group consists of macroscopic, empirical models based on large-scale, and usually long-term, resuspension studies. They are commonly presented in terms of a resuspension factor, K, or a resuspension rate Λ.*

Models falling into the first of these two categories are unlikely to be suitable for emergency response use, for the reasons quoted above. Models falling into the second of these two categories (which includes the method of NRPB-W1) *may* be suitable for emergency response but are likely to be less appropriate for more accurate non-emergency use, where speed of calculation is less important and where less-readily-available input parameters can be used.

A widely-cited example of a modelling approach which falls into the 'complex' category is the "Rock 'n' Roll" model, described in Reeks and Hall (2001) and developed in Zhang et al. (2013). This could be capable of far more sophisticated modelling than any resuspension factor model but would not be appropriate for use in emergency response unless it were possible to simplify its application, for example by implementing it in such a way that its harder-to-obtain parameters could be set to generalised default values, leaving as variables only those input parameters likely to be quickly available. It would also be necessary to be able to do this without introducing too much uncertainty and whilst keeping run times short enough for use in emergency response.

It should also be noted that even if a resuspension model is designed for use in accidents, it may still not be appropriate as a replacement for the model of NRPB-W1. An example of this is Biasi et al. (2001), which is easily implementable and suitable for incorporation into severe nuclear accident codes, but which is specifically concerned with resuspension of deposited material in the primary circuit of the nuclear reactor itself as a means of release of radioactivity from the primary circuit. In particular, the authors state:

We are referring exclusively to resuspension in the reactor primary circuit. There have been a number of measurements of resuspension from the ground of radioactive particles released to the environment which although important in safety assessment are not relevant to this study.

As indicated in the above quote from Kim et al. (2010), resuspension-factor-based models tend to be associated with modelling over long time scales. Indeed, the inherently averaging nature of resuspension factors means that they are unlikely to be suited to modelling over short time scales. Loosmore (2003) carried out a study of how well a number of models modelled short-term resuspension and found that most of the conventional models in the study modelled short-term (less than one day) resuspension very poorly. The conventional models considered were of the resuspension-factor type, so the findings support the decision made in the NRPB-W1 report not to apply the modified Garland formula to time periods of less than one day.

Garger et al. (2012) also acknowledges that resuspension factors are unable to model short-term fluctuations and presents an alternative statistical approach for modelling ^{137}Cs in the Chernobyl region. Amongst other findings, a cycle of 24 days is identified which:

may be associated with human activity at the Shelter site which responds to a particular shift system and the periodicity in the change of the wind direction.

It is very unlikely that a resuspension-factor-based method would have been able to model such a feature. This demonstrates an inherent weakness of resuspension factors. However, the fact that the 24-day cycle is site-specific is a good example of why more complicated approaches, whilst more accurate for a specific scenario, are less suited to generalised emergency response calculations.

In scenarios where resuspension modelling needs to take account of complex topographies, resuspension factors are again unlikely to be appropriate. Methods such as that of Ali and Waller (2014), which uses a coupled computational fluid dynamics and Monte Carlo radiation transport approach may be more appropriate. However, it is unlikely to be possible to apply such methods in the early stages of an emergency response, when limited information about the incident is available.

Anspaugh et al. (2002) states: “Broadly, there are three different types of models that have been used to describe the resuspension process.” It then lists the same three types as are mentioned in NRPB-W1, specifically: the time-dependent resuspension factor, the resuspension rate, and mass loading. Weaknesses of the resuspension rate and mass loading approaches are explained, and the paper’s subsequent discussion of resuspension is limited to resuspension factors alone.

Hatano and Hatano (2003) also states that measuring resuspension rates is more complicated than measuring resuspension factors and that data required to estimate resuspension factors is more abundant than data required to estimate resuspension rates. This is consistent with NRPB-W1.

Consequently, resuspension-factor-based models would still appear to be the most appropriate for use in emergency response situations where results are required quickly and where limited information is available.

3.2 Alternative resuspension factor models

Once the decision to continue to use resuspension factors has been made, this still leaves the question as to which resuspension factor model to use. There are many such models (see for example the discussion in Anspaugh et al., 2002). However, the literature search identified two documents which were particularly relevant in this regard. These were Maxwell and Anspaugh (2011) and Hatano and Hatano (2003).

Maxwell and Anspaugh (2011) compares the results of a number of different methods of modelling resuspension and also a number of different observational datasets. Two functional forms are used to fit the observations. The Garland approach is mentioned but is dismissed on the basis that its observations do not agree with the event-based observations considered by the authors. It is also suggested that data derived from wind-tunnel measurements (as in the case of Garland) is not truly representative of reality. However, the authors acknowledge that a model very similar to that of Garland has been recommended by the U.S. National Council on Radiation Protection and Measurements in NCRP-129 (NCRP, 1999). The NRPB-W1 modified Garland approach is also mentioned, but the authors do not express an opinion about it. By contrast, NRPB-W1 itself concluded:

> *To calculate resuspension doses as a function of time due to activity in the outdoor environment, the Garland formula is the only formula specifically fitted to early data, and the only formula specifically applicable to UK conditions. It can be updated to include the long-term resuspension factor …*

The fact that Garland's experiment was specifically designed for UK conditions, whereas the Maxwell and Anspaugh observations were not, seems significant in accounting for the differences between them. Moreover, NRPB-W1 specifically stated that:

> *apart from the Chernobyl studies, most studies on resuspension relate to arid and sparsely vegetated areas [e.g.] … Nevada test site (Anspaugh et al., 1975), … [and] … are therefore not closely relevant in Britain and many other temperate areas. However, at the Harwell laboratory Garland carried out studies on grassland and bare soil at controlled wind speeds in a wind tunnel (Garland, 1979; Garland, 1982).*

Also, NRPB-W1 said:

> *Resuspension rates are strongly dependent on climate and ground cover and so the model recommended for application in the UK will not be appropriate for all countries. However, it is likely to be appropriate for countries with similar conditions to the UK, for example North West Europe.*

NRPB-W1 used a power-law function, whereas Maxwell and Anspaugh ultimately propose an exponential function, partly for ease of use. It is worth noting that exponentials are specifically warned against by Hatano and Hatano (see below), who consider power-law functions to be preferable.

It is also interesting to note that in at least one case, using the resuspension factors of Maxwell and Anspaugh rather than those of NRPB-W1 or (the similar ones of) NCRP-129 does not appear to have made a significant difference. Specifically, McKenna et al. (2013) determines dose conversion factors for prolonged exposure by, among other steps, integrating time-dependent resuspension factors. In relation to this, McKenna et al. cites NRPB-W1 and NCRP-129, but also notes that if the resuspension factors of Maxwell and Anspaugh are used instead, this has "very little impact" on the results of the associated calculations.

In view of the matters highlighted above, Maxwell and Anspaugh's approach does not appear to be preferable to NRPB-W1 for use in UK emergency response.

Hatano and Hatano (2003) explains that, in the past, exponential functions were commonly used to model the variation of resuspension factors with time, but that power law functions perform better. Some studies using power law functions are cited. The use of power law functions is significant because they decrease more slowly than exponentials, which is consistent with contamination persisting for longer than might be implied by an exponential function. The authors then propose a power law function which they suggest produces more accurate modelling than the functions which have been used previously. The authors claim that their formula fits data both on very short time scales such as minutes, and on very long time scales such as almost a decade.

It is interesting that an apparently simple formula might perform well over such a large range of time scales and this could be an important consideration in future development of resuspension models. However, that is not the purpose of the present review, which is to consider possible replacements for the method of NRPB-W1. The Hatano formula may or may not produce more accurate modelling than the NRPB-W1 formula in the specific scenarios for which NRPB-W1 is intended. It is not possible to tell from the paper itself. However, it seems reasonable to assume that, in practice, any superiority of performance would not be large as, in common with NRPB-W1, Hatano is based on a resuspension factor approach, and such approaches produce fairly generic averaged results. This is adequate for emergency response use, but it limits the improvement over NRPB-W1 that Hatano could bring.

A number of other factors that justify not replacing NRPB-W1 with Hatano are listed below. It should be noted that there is no intention to imply that the NRPB-W1 approach is superior to that of Hatano; the intention is rather to show that any improvement in modelling brought by Hatano would be small enough that it would not justify replacement of the well-established NRPB-W1 approach in the specific context for which NRPB-W1 is intended (UK emergencies).

Hatano explains why their suggested formula should work well. However, the empirical evidence provided does not seem to show it performing any better than anything else until after about a year has elapsed (see Figure 1 of Hatano). Further, Hatano does not give any empirical evidence that the formula works any better than anything else for short time scales. The paper itself appears to acknowledge this to an extent in the discussion of Figure 2. Specifically, page 3478 states:

> *Unfortunately the data are sparse; we cannot determine which formula fits them better.*

It may also be significant that their “date estimate for surface pollution” example includes the wording (page 3479):

> *Interestingly, the estimated date of contamination becomes closer to the true one when we excluded the earliest data of 6 months… Inclusion of the first 6-month data makes the estimate a little inaccurate.*

Other points for consideration include:

- Hatano’s formula does not include half-life. This would need to be taken account of separately, which would lead to the same integration complications as in NRPB-W1
- Hatano’s formula shows how resuspension factor varies with time but does not enable a calculation of actual values of the resuspension factor. For the formula to be of use in an emergency, a constant of proportionality would be required
- NRPB-W1 is particularly valid for UK conditions. Hatano does not claim this
- NRPB-W1 already uses a power law, which is a feature highlighted by Hatano as being important for realistic modelling

In any case, curves plotted using the NRPB-W1 and Hatano formulae are of fairly similar shape. How similar their actual results are would depend upon the constant of proportionality used in the Hatano formula, but the paper does not give a method for deriving this. The constant long-term component included in NRPB-W1 means that it should always be more conservative in the long term.

It is also worth noting that Hatano is mentioned in Magnoni (2012), which comments:

> *Y. Hatano and N. Hatano proposed an interesting theoretical model… . This model, based on the observation of the fractal behaviour of the time series of the atmospheric activity concentration measured around Chernobyl some years after the accident, deduces an inverse time dependence of the type* $K(t) \sim t^{-4/3}$*, that fits quite well with the available experimental data. However, in spite of its mathematical brightness and its sound agreement with some experimental observations, it provides no simple connection with the physical quantities usually involved in the description of re-suspension phenomena.*

3.3 Recommendations arising from literature review

For a new approach to replace NRPB-W1, it would need to provide sufficient improvement over the performance of NRPB-W1 and be sufficiently simple to use in an emergency. The literature search did not find any approaches which met both these criteria.

Consequently, the existing NRPB-W1 approach (use of resuspension factors estimated by the modified Garland formula) should continue to be used for emergency response situations in the UK, but with an understanding of the fact that it is only an approximation of reality and has significant uncertainties associated with it.

Since its publication, NRPB-W1 has been applied to a wider range of scenarios than its authors envisaged. It was never intended for detailed non-emergency assessments. Care is required if the approach is applied in non-emergency scenarios. In general, it seems unlikely that any resuspension-factor-based approach would be appropriate for highly detailed assessments, particularly those where small-scale local factors are significant.

4 Additional considerations when estimating resuspension dose

As mentioned above, the modified Garland formula, in common with all methods based on resuspension factors, is inherently generic and averaging. It will model some scenarios more accurately than others. In reality, resuspension field measurements show a wide range of behaviour and it is often difficult to associate changes with specific causes (Garland et al., 1992).

The following subsections highlight some factors that will affect resuspension. Some indication of the effect various phenomena could have on the estimated resuspension values is given, but in many cases this is not possible. However, even when a precise quantitative effect of a particular phenomenon cannot be given, a qualitative understanding may still be important.

4.1 Uncertainties inherent in the use of resuspension factors

There are certain weaknesses that are inherent in the resuspension factor approach. Some of these are discussed in Section 3.1, above. In general, such weaknesses tend to be related to the following factors:

- there is an implicit assumption that resuspended material originates solely from an area local to the surface sampling position. In reality, the activity concentration in air will include material resuspended from the local area, plus material resuspended upwind but carried by the wind to the sampling position, minus material carried away by the wind. However, it is worth noting that Garland et al. (1992) found evidence that the source of resuspended material is mainly the area around the sampling site
- surface deposition is unlikely to be homogeneous over large distances. In reality, significant local variations are possible
- resuspension factors are unable to represent short-term fluctuations
- the value of the measured resuspension factors will depend on the depth of material sampled in order to determine surface contamination. Different sampling depths will lead to different resuspension factors. However, the fresher the deposit, the less likely this is to be a problem
- resuspension factors cannot take account of topography
- resuspension factors tend to take account only of wind-driven resuspension
- resuspension factors are strictly applicable only to the conditions for which they were determined

In view of these limitations, it is perhaps unsurprising that a wide range of resuspension factors have been measured. Values ranging over several orders of magnitude have been found, depending on the scenario in which the measurements were made. However, in spite of this, several studies (Garger et al., 1999; Garland et al., 1992; SSI, 1996) have found acceptable agreement between the results of model predictions using Garland’s resuspension formula and experimental data.

4.2 Wind speed

Many studies (for example, Garland, 1979; Garland, 1982; Garland, 1983; Holländer, 1994; Kajino et al., 2016; Nicholson, 1988; Shao et al., 1993; Whicker et al., 2006) have demonstrated a correlation between resuspension and wind speed. This is usually (Nicholson, 1988) approximated by a power relationship of the form:

$$K \propto u^a$$

where: *K* is the resuspension factor (m^{-1})

u is the wind speed ($m\ s^{-1}$)

a is a dimensionless parameter.

Estimates of *a* tend to be between 0.5 and 6 (Garland, 1979; Garland, 1982; Garland, 1983; Holländer, 1994; Nicholson, 1988; Sehmel, 1984). Although Nicholson (1988) states that most estimates of *a* are greater than or equal to 3, two of the more relevant studies find *a* to be around unity. Specifically, Garland (1982) found *a* to be in the range 0.5 to 1.5 and Holländer (1994) found it to be 1.01. Garland's study took place in the UK; Holländer's took place in Germany; whereas some of the other studies took place in arid regions. The relationship between wind speed and resuspension will depend on additional factors such as those considered in the following sections.

4.3 Urban environments

Linsley (1978) carried out a review of the (then) existing data relating to resuspension of transuranium elements. The resulting report suggests that, in the absence of better information, a resuspension factor of 10^{-5} m^{-1} is appropriate for the hard impermeable surface typical of urban environments. In the context of that report, that corresponds to an increase by a factor of 10 when compared to the value appropriate to soil surfaces. Linsley (1978) also suggests that where the surface is being regularly disturbed by vehicular traffic and pedestrians, an increase by an additional factor of 10 may be appropriate, resulting in an increase by a factor of 100 overall.

4.4 Mechanical disturbance

Activities carried out in a contaminated area will affect the resuspension. Mechanical disturbances such as passage of vehicles, walking or digging will increase the amount of resuspension. As mentioned in the previous subsection, Linsley (1978) suggests, on the basis of a review of the (then) existing data, that the resuspension factor might be increased by a factor of 10 as a result of regular disturbance by vehicular traffic and pedestrians, with an additional factor of 10 appropriate if such disturbance takes place in an urban environment. Similarly, Garland et al. (1992) found up to a twenty-fold difference in resuspension between a sampling site in a car-park and sampling site 1km away which had no roadway within a few hundred metres.

Yamaguchi et al. (2012) found that during the cutting of wheat and tillage, the resuspension factor of ^{137}Cs increased by a factor of 16 for dust particles smaller than 10 μm and by a factor of 8 for dust particles with an aerodynamic diameter less than 2.5 μm. However, the paper also suggests that the effects of agricultural operations on the resuspension values may have been masked by the fact that relatively high wind-driven resuspension factors had been observed previously. There is also an indication that the application of resuspension factors to anthropogenically enhanced resuspension can be problematic because the use of a resuspension factor implies that the contaminated surface is homogeneous, and that resuspended and deposited aerosols are in equilibrium (which is particularly unlikely to be the case during anthropogenically enhanced resuspension).

Wagenpfeil et al. (1999) found that resuspension factors resulting from anthropogenically enhanced resuspension could be as much as three orders of magnitude greater than those associated with wind-driven resuspension. The relevant figure in that paper shows that the most extreme differences were around three orders of magnitude, but overall the differences were in a range between approximately one and three orders of magnitude. The anthropogenic actions considered were "simulated agricultural activities", in particular involving the use of tractors. The authors explain that a range of tractor speeds were considered and imply that some may have been driven at speeds greater than might normally be the case during real agricultural operations. This is relevant because resuspension increases with tractor speed (Clausnitzer and Singer, 1996). Wagenpfeil et al. (1999) was particularly concerned with coarse particles, which had some effect on the extent of the differences between anthropogenically enhanced and wind-driven resuspension factors.

The effect of mechanical disturbance can be significant and widely varying (as shown, for example, by Sehmel, 1984), but such activities would be unlikely to be allowed to continue for any significant period of time in an emergency scenario, other than those undertaken as part of the response to the emergency, which it may be assumed would be carefully controlled.

4.5 Soil moisture

Wagenpfeil et al. (1999) found that an increased soil moisture content caused resuspension factor to decrease exponentially. Similarly, Clausnitzer and Singer (1996) found respirable dust concentrations in an agricultural setting decreased exponentially with increasing soil-moisture content. In particular, Wagenpfeil et al found that an increase in soil moisture content from 0% to 5% reduced the resuspension factor by a factor of 7.3. The effect seems to have been even greater for larger particles (< 20 µm), for which a reduction by a factor of 23 was found. In practical terms this can be described as showing a difference in resuspension factors of the order of a factor of 10 between dry and moist soils. The Wagenpfeil study took place in the region of Chernobyl and the Clausnitzer and Singer study relates to California; however, there is no obvious reason why the ratio should be significantly different elsewhere, and this may give an indication of the potential effects of any unusually arid conditions in the UK.

4.6 Other considerations

The phenomena discussed above are not the only ones that affect resuspension. There are likely to be many more. For example, IAEA-TECDOC-647 (Garland et al., 1992) provides the following list of factors (some of which have already been discussed in more detail in the sections above).

- Time since deposition
- Wind speed
- Nature of surface
- Surface moisture
- Soil chemistry and texture
- Size distribution of contaminant particles
- Chemical properties of contaminant
- Deposition process
- Mechanical disturbance
- Depth and method of cultivation
- Intensity and frequency of rain
- Snow cover or freezing of the surface

4.7 Suggested adjustments to compensate for non-typical conditions

It is difficult to generalise about the magnitude of the effect caused by the factors discussed above. However, a very approximate guide is given in the table below. Where it is considered relevant, the multiplication factors in the table could be applied to the instantaneous activity concentrations in air obtained using the modified Garland formula described above. The multiplication factors are very approximate. In addition, some of the conditions considered in the table below might be applicable only for short periods or might be prevented altogether as part of the response to the emergency.

Table 1: Suggested adjustments to be applied to the results from the modified Garland formula to take account of non-typical conditions

	Suggested adjustment	Reference
Typical rural UK conditions	x1	These are the default conditions
Arid conditions	x10	Wagenpfeil et al. (1999) – see Section 4.5, above
Regular disturbance by vehicular traffic and pedestrians	x10	Linsley (1978)
Urban conditions (hard impermeable surfaces)	x10	Linsley (1978)
Urban conditions (hard impermeable surfaces) and regular disturbance by vehicular traffic and pedestrians	x100	Linsley (1978)
High winds	Assume proportional to wind speed (but see below)	Garland (1982) – see below

A power relationship between resuspension factor and wind speed is typically assumed, such that $K \propto u^a$ (see Section 4.2, above). Garland (1982) found *a* to be in the range 0.5 to 1.5. Hence, a very rough approximation is to assume that *K*, and consequently instantaneous activity concentration in air, is proportional to wind speed. However, since Garland's own experiments were carried out for a range of wind speeds, and since wind speeds are likely to fluctuate on a time scale much shorter than can be modelled by resuspension factors, it is probably not worth considering unless wind speeds are significantly higher than normal for prolonged periods.

5 Conclusions

For UK emergency response situations, resuspension factors are still considered appropriate for estimating radiation doses arising from inhalation of resuspended materials, particularly if there is a lack of site-specific information.

In general, resuspension factors are expressed as follows:

$$K\ [\mathrm{m}^{-1}] = \frac{\text{Concentration in air arising from resuspension [Bq m}^{-3}]}{\text{Surface deposition concentration [Bq m}^{-2}]}$$

where K is the resuspension factor.

The following modified Garland formula is still considered to be the most appropriate for estimating resuspension factors in UK emergency response situations.

For times after one day: $$K(t) = [K(0)t^{-1} + K(T)]e^{-\lambda t}$$

where: $K(t)$ is the resuspension factor at time t (m^{-1})

$K(0)$ is the resuspension factor at time zero (1.2×10^{-6} m^{-1})

t is the time after deposition (days)

$K(T)$ is the long-term resuspension factor (10^{-9} m^{-1})

λ is the radioactive decay constant (day^{-1}).

The above formula should be used only for deposits which are older than one day (i.e. $t > 1$). If a resuspension factor for the first day is absolutely necessary, the constant value of 1.2×10^{-6} m^{-1} should be assumed to apply at all times during the first day. Any resuspension factor applied to times during the first day is likely to be subject to significant uncertainty.

The above approach is most appropriate for wind-driven resuspension in typical rural UK conditions and does not take account of mechanical resuspension. The more the actual conditions deviate from this, the less accurate the above approach will be. A very rough guide to the possible effects of such deviations is given in Table 1 above.

Although the above approach is suitable for use in emergencies (where speed and ease of implementation are of particular importance), it is unlikely to be the most appropriate approach for highly detailed non-emergency assessments, particularly those where small-scale local factors are significant

6 Acknowledgements

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7 References

Ali F and Waller E (2014). Design of a hybrid Computational Fluid Dynamics–Monte Carlo radiation transport methodology for radioactive particulate resuspension studies. *Health Physics* **107**(4), 311-317.

Anspaugh LR, Shinn JH, Phelps PL and Kennedy NC (1975). Resuspension and redistribution of plutonium in soils. *Health Physics* **29**, 571-582.

Anspaugh LR, Simon SL, Gordeev KI, Likhtarev IA, Maxwell RM and Shinkarev SM (2002). Movement of radionuclides in terrestrial ecosystems by physical processes. *Health Physics* **82**(5), 669-679.

Biasi L, de los Reyes A, Reeks MW and de Santi GF (2001). Use of a simple model for the interpretation of experimental data on particle resuspension in turbulent flows. *Journal of Aerosol Science* **32**, 1175-1200.

Braaten DA, Paw UKT and Shaw RH (1990). Particle resuspension in a turbulent boundary layer – observed and modeled. *Journal of Aerosol Science* **21**, 613-628.

Clausnitzer H and Singer MJ (1996). Respirable-Dust Production from Agricultural Operations in the Sacramento Valley, California. *Journal of Environmental Quality* **25**, 877-884.

Garger EK, Hoffman FO, Thiessen KM, Galeriu D, Kryshev A, Lev T, Miller CW, Nair SK, Talerko N and Watkins B (1999). Test of existing mathematical models for atmospheric resuspension of radionuclides. *Environmental Radioactivity* **42**, 157-175.

Garger EK, Kuzmenko YI, Sickinger S and Tschiersch J (2012). Prediction of the ^{137}Cs activity concentration in the atmospheric surface layer of the Chernobyl exclusion zone. *Journal of Environmental Radioactivity* **110**, 53-58.

Garland JA (1979). *Resuspension of Particulate Material from Grass and Soil.* AERE-R 9452.

Garland JA (1982). *Resuspension of Particulate Material from Grass. Experimental Programme 1979-1980.*, AERE-R 10106.

Garland JA (1983). Some recent studies of the resuspension of deposited material from soil and grass. *In Precipitation Scavenging, Dry Deposition and Resuspension (edited by Pruppacher H. R., Semonin, R G and Slinn, W G N)* **2**, 1087-1097.

Garland JA, Pattenden NJ and Playford K (1992). *Resuspension following Chernobyl. In: Modelling of resuspension, seasonality and losses during food processing. First report of the VAMP Terrestrial Working Group.* Vienna, IAEA-TECDOC-647.

Hatano Y and Hatano N (2003). Formula for the resuspension factor and estimation of the date of surface contamination. *Atmospheric Environment* **37**, 3475-3480.

Holländer W (1994). Resuspension factors of ^{137}Cs in Hannover after the Chernobyl accident. *Journal of Aerosol Science* **25**(5), 789-792.

IAEA (2010). *Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Terrestrial and Freshwater Environments.* International Atomic Energy Agency, Vienna, Technical Reports Series No. 472.

Kajino M, Ishizuka M, Igarashi Y, Kita K, Yoshikawa C and Inatsu M (2016). Long-term assessment of airborne radiocesium after the Fukushima nuclear accident: re-suspension from bare soil and forest ecosystems. *Atmospheric Chemistry and Physics* **16**, 13149–13172.

Kim Y, Gidwani A, Wyslouzil BE and Sohn CW (2010). Source term models for fine particle resuspension from indoor surfaces. *Building and Environment* **45**, 1854-1865.

Linsley GS (1978). *Resuspension of the Transuranium Elements - A Review of Existing Data.*, NRPB-R75.

Loosmore GA (2003). Evaluation and development of models for resuspension of aerosols at short times after deposition. *Atmospheric Environment* **37**, 639-647.

Magnoni M (2012). A theoretical approach to the re-suspension factor. *EPJ Web of Conferences* **24**, 05008.

Maxwell RM and Anspaugh LR (2011). An Improved Model for Prediction of Resuspension. *Health Physics* **101**(6), 722-730.

McKenna T, Kutkov V, Vilar-Welter P, Dodd B and Buglova E (2013). Default Operational Intervention Levels (OILs) for severe nuclear power plant or spent fuel pool emergencies. *Health Physics* **104**(5), 459-470.

NCRP (1999). *Recommended Screening Limits for Contaminated Surface Soil and Review of Factors Relevant to Site-Specific Studies.* NCRP Report No. 129.

Nicholson KW (1988). A review of particle resuspension. *Atmospheric Environment* **22**(12), 2639-2651.

Reeks MW and Hall D (2001). Kinetic models for particle resuspension in turbulent flows: theory and measurement. *Journal of Aerosol Science* **32**(1), 1-31.

Sehmel GA (1984). *Deposition and resuspension. In Atmospheric Science and Power Production. (edited by Randerson, D).*

Shao Y, Raupach MR and Findlater PA (1993). Effect of Saltation Bombardment on the Entrainment of Dust by Wind. *Journal of Geophysical Research* **98**(D7), 12,719-712,726,.

SSI (1996). *BIOMOVS II. Atmospheric resuspension of radionuclides: Model testing using Chernobyl data.*, Stockholm, Sweden., BIOMOVS II Technical Report No 11.

Wagenpfeil F, Paratzke HG, Peres JM and Tschiersch J (1999). Resuspension of coarse particles in the region of Chernobyl. *Atmos. Environ.* **33**, 3313-3323.

Walsh C (2002). *Calculation of resuspension doses for emergency response.* National Radiological Protection Board, Chilton, NRPB-W1.

Wen HW and Kasper G (1989). On the kinetics of particle reentrainment from surfaces. *Journal of Aerosol Science* **20**, 483-498.

Whicker JJ, Pinder III JE, Breshears DD and Eberhart CF (2006). From dust to dose: Effects of forest disturbance on increased inhalation exposure. *Science of the Total Environment* **368**, 519–530.

Yamaguchi N, Eguchi S, Fujiwara H, Hayashi K and Tsukada H (2012). Radiocesium and radioiodine in soil particles agitated by agricultural practices: Field observation after the Fukushima nuclear accident. *Science of the Total Environment* **425**, 128-134.

Zhang F, Reeks MW and Kissane M (2013). Particle resuspension in turbulent boundary layers and the influence of non-Gaussian removal forces. *Journal of Aerosol Science* **58**, 103-128.

Appendix A Use of the modified Garland formula to calculate integrated and instantaneous activity concentrations in air

A1 Integrated activity concentrations in air

As detailed in the main text, the following modified Garland formula is recommended for estimating resuspension factors.

For times *after one day*: $$K(t) = [K(0)t^{-1} + K(T)]e^{-\lambda t} \quad \text{(A1)}$$

where:

$K(t)$ is the resuspension factor at time t (m^{-1})

$K(0)$ is the resuspension factor at time zero (1.2×10^{-6} m^{-1})

t is the time after deposition (days)

$K(T)$ is the long-term resuspension factor (10^{-9} m^{-1})

λ is the radioactive decay constant (day^{-1}).

It should be noted that, strictly speaking, equation (A1) is dimensionally inconsistent. This is necessary to maintain consistency with the original (i.e. non-modified) Garland formula on which equation (A1) is based. This dimensional inconsistency arises because the original Garland formula was empirically derived. In practice, it is necessary to notionally assume that the $K(0)t^{-1}$ term also contains a 'hidden' constant which is in units of days and whose value is equal to 1. One consequence of this is that additional care is needed when using the equation, because there is an inherent assumption that time is measured in units of days. This does not appear to have been explicitly discussed in the Garland references.

In general: $$K\,[m^{-1}] = \frac{\text{Concentration in air resulting from resuspension [Bq m}^{-3}]}{\text{Surface deposit [Bq m}^{-2}]} \quad \text{(A2)}$$

Assuming unit deposition and integrating with respect to time, equation (A2) implies:

$$TIAC = \int K dt \quad \text{(A3)}$$

where TIAC is the time-integrated activity concentration in air.

For times after one day, (A1), (A3) imply:

$$TIAC = \int_{t_1}^{t_2} [K(0)t^{-1} + K(T)]e^{-\lambda t} dt \quad \text{(A4)}$$

where: t_1 , t_2 ≥ 1 day

K(0), *K*(*T*) constant

$$= K(0) \int_{t_1}^{t_2} \frac{e^{-\lambda t}}{t} dt + K(T) \int_{t_1}^{t_2} e^{-\lambda t}\, dt \quad \text{(A5)}$$

As detailed in the main text:

For times ≤ 1 day: $K(t) = K(0)$ (A6)

For times ≤ 1 day, (A3), (A6) imply:

$$TIAC = \int_{t_1}^{t_2} K(0) dt \quad \text{(A7)}$$

where: t_1 , t_2 ≤ 1 day

K(0) constant

$$= K(0) \int_{t_1}^{t_2} dt \quad \text{(A8)}$$

$$= K(0)[t]_{t_1}^{t_2} \quad \text{(A9)}$$

This is of interest only as the first day's contribution to an overall time that is greater than or equal to one day, therefore the limits in (A9) can be set to $t_1 = 0$ and $t_2 = 1$ day.

Therefore (A9) implies:

$$TIAC = K(0)[t]_0^1 = K(0) \quad \text{(A10)}$$

Or, in other words, if the first day's contribution to the overall TIAC per unit deposit is defined as C_1 , then:

$$C_1 = K(0) \tag{A11}$$

where the multiplication by unit time gives C_1 units of d m^{-1}, even though K(0) has units of m^{-1}.

Analogous terminology can be applied to the terms in equation (A5). This means that three components must be added together to calculate the overall TIAC per unit deposit:

$$\text{Overall TIAC per unit deposit} = C_1 + C_2 + C_3 \tag{A12}$$

= [Component from first day] + [Conventional Garland component] + [Long-term component]

(A13)

$$= \quad K(0) \quad + \quad K(0)\int_{t_1}^{t_2} \frac{e^{-\lambda t}}{t} dt \quad + \quad K(T)\int_{t_1}^{t_2} e^{-\lambda t} dt \tag{A14}$$

The long-term component C_3 can be calculated as follows:

$$C_3 = K(T)\int_{t_1}^{t_2} e^{-\lambda t} dt \tag{A15}$$

$$= K(T)\left[\frac{-1}{\lambda}e^{-\lambda t}\right]_{t_1}^{t_2} \tag{A16}$$

$$= K(T)\left[\frac{-1}{\lambda}e^{-\lambda t_2} - \frac{-1}{\lambda}e^{-\lambda t_1}\right] \tag{A17}$$

$$= K(T)\lambda^{-1}\left[e^{-\lambda t_1} - e^{-\lambda t_2}\right] \tag{A18}$$

Since the first day has already been accounted for (by using C_1), the limits need to be set as $t_1 = 1$ and $t_2 = t$. Therefore:

$$C_3 = K(T)\lambda^{-1}\left[e^{-\lambda} - e^{-\lambda t}\right] \tag{A19}$$

This just leaves the contribution from the conventional Garland component (C_2), where:

$$C_2 = K(0)\int_{t_1}^{t_2} \frac{e^{-\lambda t}}{t} dt \qquad \text{(A20)}$$

This cannot be solved analytically, so an alternative method must be used. Two options were suggested in NRPB-W1: a Taylor expansion and a polynomial approximation. The polynomial approximation is used here. Specifically, Gautschi and Cahill (1965) give the following approximation.

$$\int_0^{z} \frac{1-e^{-s}}{s} ds = E_1(z) + \ln z + \gamma \qquad \text{(A21)}$$

where γ is Euler's constant and E_1 is a known polynomial function.

To use this approximation, it is necessary to consider the integral $\int_A^Z \frac{1-e^{-s}}{s} ds$ where *s* = *λt* and *ds* = *λdt* and where $A = \lambda$ x [start-time (days)] and $Z = \lambda$ x [end-time (days)]. Hence:

$$\int_{s=A}^{Z} \frac{1-e^{-s}}{s} ds = \int_{t=\frac{A}{\lambda}}^{\frac{Z}{\lambda}} \frac{1-e^{-\lambda t}}{\lambda t} \lambda dt \qquad \text{(A22)}$$

$$= \int_{\frac{A}{\lambda}}^{\frac{Z}{\lambda}} \frac{1-e^{-\lambda t}}{t} dt \qquad \text{(A23)}$$

$$= \int_{\frac{A}{\lambda}}^{\frac{Z}{\lambda}} \frac{1}{t} dt - \int_{\frac{A}{\lambda}}^{\frac{Z}{\lambda}} \frac{e^{-\lambda t}}{t} dt \qquad \text{(A24)}$$

$$= [\ln t]_{\frac{A}{\lambda}}^{\frac{Z}{\lambda}} - \int_{\frac{A}{\lambda}}^{\frac{Z}{\lambda}} \frac{e^{-\lambda t}}{t} dt \qquad \text{(A25)}$$

$$= ln\left(\frac{Z}{\lambda}\right) - ln\left(\frac{A}{\lambda}\right) - \int_{\frac{A}{\lambda}}^{\frac{Z}{\lambda}} \frac{e^{-\lambda t}}{t} dt \qquad \text{(A26)}$$

Rearranging:

$$\int_{\frac{A}{\lambda}}^{\frac{Z}{\lambda}} \frac{e^{-\lambda t}}{t} dt = \ln\left(\frac{Z}{\lambda}\right) - \ln\left(\frac{A}{\lambda}\right) - \int_A^Z \frac{1-e^{-s}}{s} ds \qquad \text{(A27)}$$

$$= \ln\left(\frac{Z}{\lambda}\right) - \ln\left(\frac{A}{\lambda}\right) - \left[\int_0^Z \frac{1-e^{-s}}{s} ds - \int_0^A \frac{1-e^{-s}}{s} ds\right] \qquad \text{(A28)}$$

As before, ‘start-time’ is t_1 and ‘end time’ is t_2. Hence, (A28) can be re-written as:

$$\int_{t_1}^{t_2} \frac{e^{-\lambda t}}{t} dt = \ln\left(\frac{Z}{\lambda}\right) - \ln\left(\frac{A}{\lambda}\right) - \left[\int_0^Z \frac{1-e^{-s}}{s} ds - \int_0^A \frac{1-e^{-s}}{s} ds\right] \qquad \text{(A29)}$$

where $A = \lambda t_1$ and $Z = \lambda t_2$.

Therefore, (A21), (A29) imply:

$$\int_{t_1}^{t_2} \frac{e^{-\lambda t}}{t} dt = \ln\left(\frac{Z}{\lambda}\right) - \ln\left(\frac{A}{\lambda}\right) - [E_1(Z) + \ln Z + \gamma - (E_1(A) + \ln A + \gamma)] \qquad \text{(A30)}$$

Using the rules of logs:

$$= \ln Z - \ln \lambda - \ln A + \ln \lambda - E_1(Z) - \ln Z - \gamma + E_1(A) + \ln A + \gamma \qquad \text{(A31)}$$

$$= E_1(A) - E_1(Z) \qquad \text{(A32)}$$

Therefore, (A20) implies:

$$C_2 = K(0)[E_1(A) - E_1(Z)] \qquad \text{(A33)}$$

The formulae for $E_1(x)$ given in Gautschi and Cahill (1965) can now be used. Note that those formulae contain a term $\varepsilon(x)$ which is small enough that it can be neglected. Note also that Gautschi and Cahill use the labels a_i to refer to two different sets of coefficients. To avoid confusion, the labels d_i have here been used to refer to the coefficients that apply when $0 \le x \le 1$ and the labels a_i have here been used to refer to the coefficients that apply when $x > 1$.

For 0 ≤ A ≤ 1:

$$E_1(A) = d_0 + d_1 A + d_2 A^2 + d_3 A^3 + d_4 A^4 + d_5 A^5 - \ln A \qquad \text{(A34)}$$

For 1 ≤ A < ∞:

$$E_1(A) = \frac{1}{Ae^A}\left[\frac{A^4 + a_1 A^3 + a_2 A^2 + a_3 A + a_4}{A^4 + b_1 A^3 + b_2 A^2 + b_3 A + b_4}\right] \qquad \text{(A35)}$$

where d_i, a_i, b_i have the following values.

d_0 = – 0.57721566

d_1 = 0.99999193

d_2 = – 0.24991055

d_3 = 0.05519968

d_4 = – 0.00976004

d_5 = 0.00107857

a_1 = 8.5733287401

a_2 =18.0590169730

a_3 = 8.6347608925

a_4 = 0.2677737343

b_1 = 9.5733223454

b_2 = 25.6329561486

b_3 = 21.0996530827

b_4 = 3.9584969228

The above formulae also apply when *A* is replaced by *Z*.

As specified above, $A = \lambda t_1$ and $Z = \lambda t_2$; and as the first day has already been accounted for (by using C_1): $t_1 = 1$ day and $t_2 = t$.

In summary:

For *t* = 1 day

$$TIAC\ per\ unit\ deposit = K(0)$$

$$K(0) = 1.2 \times 10^{-6}\ \mathrm{m}^{-1}$$

For *t* > 1 day

$$TIAC\ per\ unit\ deposit = C_1 + C_2 + C_3$$

where:

$$C_1 = K(0)$$

$$K(0) = 1.2\ \times 10^{-6}\ \mathrm{m}^{-1}$$

$$C_2 = K(0)[E_1(A) - E_1(Z)]$$

$$A = \lambda t_1 = \lambda \times 1 = \lambda$$

$$Z = \lambda t_2 = \lambda t$$

$$C_3 = K(T)\lambda^{-1}\left[e^{-\lambda} - e^{-\lambda t}\right]$$

$$K(T) = 10^{-9}\ \mathrm{m}^{-1}$$

and where:

For 0 ≤ A ≤ 1: $$E_1(A) = d_0 + d_1 A + d_2 A^2 + d_3 A^3 + d_4 A^4 + d_5 A^5 - \ln A$$

For 1 ≤ A < ∞: $$E_1(A) = \frac{1}{Ae^A}\left[\frac{A^4 + a_1 A^3 + a_2 A^2 + a_3 A + a_4}{A^4 + b_1 A^3 + b_2 A^2 + b_3 A + b_4}\right]$$

For 0 ≤ Z ≤ 1: $$E_1(Z) = d_0 + d_1 Z + d_2 Z^2 + d_3 Z^3 + d_4 Z^4 + d_5 Z^5 - \ln Z$$

For 1 ≤ Z < ∞: $$E_1(Z) = \frac{1}{Ze^Z}\left[\frac{Z^4 + a_1 Z^3 + a_2 Z^2 + a_3 Z + a_4}{Z^4 + b_1 Z^3 + b_2 Z^2 + b_3 Z + b_4}\right]$$

and where d_i, a_i, b_i are as defined above.

Note that all the above TIACs will be in units of Bq d m^{-3}. To calculate TIACs in the more conventional units of Bq s m^{-3}, the above formulae must also be multiplied by the number of seconds in a day.

A2 Instantaneous activity concentration in air

$$[Air\ concentration(t)] = [Ground\ concentration] \times K(t) \qquad \text{(A36)}$$

For t = 1 day: $$K(t) = K(0) \quad \text{(A37)}$$

Therefore: $$[Air\ concentration(t = 1\ \text{day})] = [Ground\ concentration] \times K(0) \quad \text{(A38)}$$

$$= K(0) \quad \text{for unit ground concentration.} \quad \text{(A39)}$$

And (A1) states:

For t > 1 day: $$K(t) = [K(0)t^{-1} + K(T)]e^{-\lambda t}$$

where t is in days and λ is in (days)$^{-1}$.

Therefore, for unit ground concentration, (A36), (A1) imply:

For t > 1 day: $$[Air\ concentration(t)] = [K(0)t^{-1} + K(T)]e^{-\lambda t} \quad \text{(A40)}$$

where t is in days and λ is in (days)$^{-1}$

$$K(0) = 1.2 \times 10^{-6}\ \text{m}^{-1}$$

$$K(T) = 10^{-9}\ \text{m}^{-1}$$

A3 Implementing the method above for radionuclides with short half-lives

A3.1 Radioactive decay of component C_1

As stated above, the modified Garland approach is not suitable for modelling resuspension during the first day after deposition. The resuspension factor during the first day is assumed to be constant and the method above assumes that the first day's contribution to the overall TIAC is the constant component C_1. Those assumptions implicitly neglect radioactive decay of C_1. This will make a negligible difference in most cases but could in some circumstances lead to an overestimate of resuspension dose for radionuclides of half-life less than a few days. In principle, this could be addressed by explicitly accounting for radioactive decay of the component C_1. However, this is not recommended, as it implies more modelling accuracy during the first day than is justified. Rather, it is recommended that the above method is not used for radionuclides of half-life less than one day.

A3.2 Implementing the method as computer code

When implementing the above polynomial approximation as computer code, it should be borne in mind that the use of a power function can mean that for integration over a very large number of half-lives the size of the numbers generated can overflow the floating data-type, even if an extended data-type is used. To prevent the error occurring and crashing a program, the approximation should include a truncation of the integration-time, particularly if entered by a user, at a suitable number of half-lives.

A4 References

Gautschi, W and Cahill, WF (1965). Exponential Integral and Related Functions. In *Handbook of Mathematical Functions, With Formulas, Graphs and Mathematical Tables*, Eds M Abramowitz and IA Stegun, *National Bureau of Standards Applied Mathematics Series No 55*, 4th edition.

Appendix B Tables of Results

B1 Introduction

Below are tables of integrated and instantaneous activity concentrations in air arising from resuspension for a selection of radionuclides. These have been calculated using the method described in Appendix A above. Half-lives have been taken from ICRP-107 (ICRP, 2008). The activity concentration in air has been integrated from the time of initial deposit to the end of the integration period listed. Various elapsed times have been considered. It has been assumed that no further contamination is deposited after the beginning of the relevant period (i.e. no additional contamination occurs when $t > 0$).

The integrated activity concentration in air arising from resuspension occurring between two subsequent times can be obtained by subtracting the value associated with the relevant start time from the value associated with the relevant end time. For example, the integrated activity concentration in air arising from resuspension occurring between day 30 and day 60 can be obtained by subtracting the Table B2 value for day 30 from the Table B2 value for day 60.

Further below are tables of potential integrated doses received from the resuspended material. These results have been obtained by taking the results in the tables of integrated activity concentration in air and multiplying them by the appropriate inhalation rates and dose coefficients, as follows.

$$\text{Integrated dose received from resuspended material (Sv)} = I_R \times I_{inh} \times H_{inh}$$

where: I_R is the integrated activity concentration in air arising from resuspension (Bq m^{-3} s)

I_{inh} is the appropriate inhalation rate (m^3 s^{-1})

H_{inh} is the appropriate dose coefficient (Sv Bq^{-1})

Inhalation rates have been taken from NRPB-W41 (Smith and Jones, 2003); specifically: 0.92 m^3 h^{-1} (adult); 0.64 m^3 h^{-1} (child); 0.22 m^3 h^{-1} (infant).

Dose coefficients have been taken from ICRP-119 (ICRP, 2012) and the ICRP Database of Dose Coefficients application (version 3.0), which is itself based on ICRP-68 (ICRP, 1994) and ICRP-72 (ICRP, 1996).

The tables below have not been specifically designed to calculate doses received by workers. Such tables would not be meaningful, because workers would not be expected to work for prolonged periods in contaminated areas. If doses for workers are required, either the results in the tables should be adjusted to take account of a higher inhalation rate and lower occupancy period; or dose coefficients, inhalation rates and occupancy rates appropriate for the specific scenario should be used to calculate doses using the method described above.

Committed effective doses and lung doses have been calculated. Various age groups and lung absorption types have been considered. For reference, default lung absorption types for the relevant elements are listed in Table 1 below (taken from ICRP-72). These could be used if no specific information is available.

Table B1: Recommended default absorption type for particulate aerosol when no specific information is available (F, fast; M, moderate; S, slow) (ICRP, 1996)

Element	Default absorption type
Ruthenium	M
Caesium	F
Uranium	M
Plutonium	M
Americium	M
Curium	M

The values given in the tables below are most appropriate for wind-driven resuspension in typical rural UK conditions. If mechanical resuspension is likely to be significant or if conditions are non-typical, the scaling factors given in Table 1 above should also be considered.

B2 References

ICRP (1994). Dose coefficients for intakes of radionuclides by workers. ICRP Publication 68. *Annals of the ICRP* **24**(4).

ICRP (1996). Age-dependent doses to members of the public from intake of radionuclides: Part 5 Compilation of ingestion and inhalation dose coefficients. ICRP Publication 72. *Annals of the ICRP* **26**(1).

ICRP (2008). ICRP Publication 107: Nuclear Decay Data for Dosimetric Calculations. *Annals of the ICRP* **38**(3), 1.

ICRP (2012). Compendium of dose coefficients based on ICRP Publication 60. Publication 119. *Annals of the ICRP* **41**(Suppl.).

Smith KR and Jones AL (2003). *Generalised Habit Data for Radiological Assessments.* NRPB, Chilton, UK, NRPB-W41.

Table B2: Time integrated activity concentrations in air per unit deposit at end of relevant period (Bq s m^{-3} per Bq m^{-2})

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	1.0 10^{-1}	1.0 10^{-1}	1.0 10^{-1}	1.0 10^{-1}	1.0 10^{-1}	1.0 10^{-1}	1.0 10^{-1}	1.0 10^{-1}	1.0 10^{-1}	1.0 10^{-1}	1.0 10^{-1}	1.0 10^{-1}
2	1.7 10^{-1}	1.8 10^{-1}	1.8 10^{-1}	1.8 10^{-1}	1.8 10^{-1}	1.8 10^{-1}	1.8 10^{-1}	1.8 10^{-1}	1.8 10^{-1}	1.8 10^{-1}	1.8 10^{-1}	1.8 10^{-1}
3	2.1 10^{-1}	2.2 10^{-1}	2.2 10^{-1}	2.2 10^{-1}	2.2 10^{-1}	2.2 10^{-1}	2.2 10^{-1}	2.2 10^{-1}	2.2 10^{-1}	2.2 10^{-1}	2.2 10^{-1}	2.2 10^{-1}
4	2.4 10^{-1}	2.5 10^{-1}	2.5 10^{-1}	2.5 10^{-1}	2.5 10^{-1}	2.5 10^{-1}	2.5 10^{-1}	2.5 10^{-1}	2.5 10^{-1}	2.5 10^{-1}	2.5 10^{-1}	2.5 10^{-1}
5	2.6 10^{-1}	2.7 10^{-1}	2.7 10^{-1}	2.7 10^{-1}	2.7 10^{-1}	2.7 10^{-1}	2.7 10^{-1}	2.7 10^{-1}	2.7 10^{-1}	2.7 10^{-1}	2.7 10^{-1}	2.7 10^{-1}
6	2.8 10^{-1}	2.9 10^{-1}	2.9 10^{-1}	2.9 10^{-1}	2.9 10^{-1}	2.9 10^{-1}	2.9 10^{-1}	2.9 10^{-1}	2.9 10^{-1}	2.9 10^{-1}	2.9 10^{-1}	2.9 10^{-1}
7	3.0 10^{-1}	3.0 10^{-1}	3.1 10^{-1}	3.1 10^{-1}	3.1 10^{-1}	3.1 10^{-1}	3.1 10^{-1}	3.1 10^{-1}	3.1 10^{-1}	3.1 10^{-1}	3.0 10^{-1}	3.1 10^{-1}
10	3.3 10^{-1}	3.4 10^{-1}	3.4 10^{-1}	3.4 10^{-1}	3.4 10^{-1}	3.4 10^{-1}	3.4 10^{-1}	3.4 10^{-1}	3.4 10^{-1}	3.4 10^{-1}	3.4 10^{-1}	3.4 10^{-1}
14	3.6 10^{-1}	3.8 10^{-1}	3.8 10^{-1}	3.8 10^{-1}	3.8 10^{-1}	3.8 10^{-1}	3.8 10^{-1}	3.8 10^{-1}	3.8 10^{-1}	3.8 10^{-1}	3.7 10^{-1}	3.8 10^{-1}
30	4.1 10^{-1}	4.5 10^{-1}	4.6 10^{-1}	4.6 10^{-1}	4.6 10^{-1}	4.6 10^{-1}	4.6 10^{-1}	4.6 10^{-1}	4.6 10^{-1}	4.6 10^{-1}	4.5 10^{-1}	4.6 10^{-1}
60	4.5 10^{-1}	5.2 10^{-1}	5.3 10^{-1}	5.3 10^{-1}	5.3 10^{-1}	5.3 10^{-1}	5.3 10^{-1}	5.3 10^{-1}	5.3 10^{-1}	5.3 10^{-1}	5.1 10^{-1}	5.3 10^{-1}
90	4.6 10^{-1}	5.6 10^{-1}	5.8 10^{-1}	5.8 10^{-1}	5.8 10^{-1}	5.8 10^{-1}	5.8 10^{-1}	5.8 10^{-1}	5.8 10^{-1}	5.8 10^{-1}	5.4 10^{-1}	5.8 10^{-1}
180	4.7 10^{-1}	6.2 10^{-1}	6.6 10^{-1}	6.6 10^{-1}	6.6 10^{-1}	6.6 10^{-1}	6.6 10^{-1}	6.6 10^{-1}	6.5 10^{-1}	6.6 10^{-1}	5.9 10^{-1}	6.6 10^{-1}
1 year	4.7 10^{-1}	6.8 10^{-1}	7.4 10^{-1}	7.5 10^{-1}	7.5 10^{-1}	7.5 10^{-1}	7.5 10^{-1}	7.5 10^{-1}	7.4 10^{-1}	7.5 10^{-1}	6.2 10^{-1}	7.4 10^{-1}
2 years	4.7 10^{-1}	7.2 10^{-1}	8.4 10^{-1}	8.5 10^{-1}	8.5 10^{-1}	8.5 10^{-1}	8.5 10^{-1}	8.5 10^{-1}	8.4 10^{-1}	8.5 10^{-1}	6.3 10^{-1}	8.4 10^{-1}
3 years	4.7 10^{-1}	7.3 10^{-1}	9.1 10^{-1}	9.2 10^{-1}	9.2 10^{-1}	9.2 10^{-1}	9.2 10^{-1}	9.2 10^{-1}	9.0 10^{-1}	9.2 10^{-1}	6.3 10^{-1}	9.1 10^{-1}
4 years	4.7 10^{-1}	7.4 10^{-1}	9.7 10^{-1}	9.9 10^{-1}	9.9 10^{-1}	9.9 10^{-1}	9.8 10^{-1}	9.9 10^{-1}	9.5 10^{-1}	9.8 10^{-1}	6.3 10^{-1}	9.6 10^{-1}
5 years	4.7 10^{-1}	7.4 10^{-1}	1.0 10^{0}	1.0 10^{0}	1.0 10^{0}	1.0 10^{0}	1.0 10^{0}	1.0 10^{0}	1.0 10^{0}	1.0 10^{0}	6.3 10^{-1}	1.0 10^{0}
10 years	4.7 10^{-1}	7.4 10^{-1}	1.2 10^{0}	1.3 10^{0}	1.3 10^{0}	1.3 10^{0}	1.2 10^{0}	1.3 10^{0}	1.2 10^{0}	1.3 10^{0}	6.3 10^{-1}	1.2 10^{0}

Table B3: Instantaneous activity concentrations in air per unit deposit at end of relevant period (Bq m^{-3} per Bq m^{-2})

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	$1.2\ 10^{-6}$	$1.2\ 10^{-6}$	$1.2\ 10^{-6}$	$1.2\ 10^{-6}$	$1.2\ 10^{-6}$	$1.2\ 10^{-6}$	$1.2\ 10^{-6}$	$1.2\ 10^{-6}$	$1.2\ 10^{-6}$	$1.2\ 10^{-6}$	$1.2\ 10^{-6}$	$1.2\ 10^{-6}$
2	$5.8\ 10^{-7}$	$6.0\ 10^{-7}$	$6.0\ 10^{-7}$	$6.0\ 10^{-7}$	$6.0\ 10^{-7}$	$6.0\ 10^{-7}$	$6.0\ 10^{-7}$	$6.0\ 10^{-7}$	$6.0\ 10^{-7}$	$6.0\ 10^{-7}$	$6.0\ 10^{-7}$	$6.0\ 10^{-7}$
3	$3.8\ 10^{-7}$	$4.0\ 10^{-7}$	$4.0\ 10^{-7}$	$4.0\ 10^{-7}$	$4.0\ 10^{-7}$	$4.0\ 10^{-7}$	$4.0\ 10^{-7}$	$4.0\ 10^{-7}$	$4.0\ 10^{-7}$	$4.0\ 10^{-7}$	$4.0\ 10^{-7}$	$4.0\ 10^{-7}$
4	$2.8\ 10^{-7}$	$3.0\ 10^{-7}$	$3.0\ 10^{-7}$	$3.0\ 10^{-7}$	$3.0\ 10^{-7}$	$3.0\ 10^{-7}$	$3.0\ 10^{-7}$	$3.0\ 10^{-7}$	$3.0\ 10^{-7}$	$3.0\ 10^{-7}$	$3.0\ 10^{-7}$	$3.0\ 10^{-7}$
5	$2.2\ 10^{-7}$	$2.4\ 10^{-7}$	$2.4\ 10^{-7}$	$2.4\ 10^{-7}$	$2.4\ 10^{-7}$	$2.4\ 10^{-7}$	$2.4\ 10^{-7}$	$2.4\ 10^{-7}$	$2.4\ 10^{-7}$	$2.4\ 10^{-7}$	$2.4\ 10^{-7}$	$2.4\ 10^{-7}$
6	$1.8\ 10^{-7}$	$2.0\ 10^{-7}$	$2.0\ 10^{-7}$	$2.0\ 10^{-7}$	$2.0\ 10^{-7}$	$2.0\ 10^{-7}$	$2.0\ 10^{-7}$	$2.0\ 10^{-7}$	$2.0\ 10^{-7}$	$2.0\ 10^{-7}$	$2.0\ 10^{-7}$	$2.0\ 10^{-7}$
7	$1.5\ 10^{-7}$	$1.7\ 10^{-7}$	$1.7\ 10^{-7}$	$1.7\ 10^{-7}$	$1.7\ 10^{-7}$	$1.7\ 10^{-7}$	$1.7\ 10^{-7}$	$1.7\ 10^{-7}$	$1.7\ 10^{-7}$	$1.7\ 10^{-7}$	$1.7\ 10^{-7}$	$1.7\ 10^{-7}$
10	$1.0\ 10^{-7}$	$1.2\ 10^{-7}$	$1.2\ 10^{-7}$	$1.2\ 10^{-7}$	$1.2\ 10^{-7}$	$1.2\ 10^{-7}$	$1.2\ 10^{-7}$	$1.2\ 10^{-7}$	$1.2\ 10^{-7}$	$1.2\ 10^{-7}$	$1.2\ 10^{-7}$	$1.2\ 10^{-7}$
14	$6.8\ 10^{-8}$	$8.4\ 10^{-8}$	$8.7\ 10^{-8}$	$8.7\ 10^{-8}$	$8.7\ 10^{-8}$	$8.7\ 10^{-8}$	$8.7\ 10^{-8}$	$8.7\ 10^{-8}$	$8.7\ 10^{-8}$	$8.7\ 10^{-8}$	$8.2\ 10^{-8}$	$8.7\ 10^{-8}$
30	$2.4\ 10^{-8}$	$3.9\ 10^{-8}$	$4.1\ 10^{-8}$	$4.1\ 10^{-8}$	$4.1\ 10^{-8}$	$4.1\ 10^{-8}$	$4.1\ 10^{-8}$	$4.1\ 10^{-8}$	$4.1\ 10^{-8}$	$4.1\ 10^{-8}$	$3.6\ 10^{-8}$	$4.1\ 10^{-8}$
60	$7.3\ 10^{-9}$	$1.9\ 10^{-8}$	$2.1\ 10^{-8}$	$2.1\ 10^{-8}$	$2.1\ 10^{-8}$	$2.1\ 10^{-8}$	$2.1\ 10^{-8}$	$2.1\ 10^{-8}$	$2.1\ 10^{-8}$	$2.1\ 10^{-8}$	$1.6\ 10^{-8}$	$2.1\ 10^{-8}$
90	$2.9\ 10^{-9}$	$1.2\ 10^{-8}$	$1.4\ 10^{-8}$	$1.4\ 10^{-8}$	$1.4\ 10^{-8}$	$1.4\ 10^{-8}$	$1.4\ 10^{-8}$	$1.4\ 10^{-8}$	$1.4\ 10^{-8}$	$1.4\ 10^{-8}$	$9.8\ 10^{-9}$	$1.4\ 10^{-8}$
180	$3.2\ 10^{-10}$	$5.5\ 10^{-9}$	$7.6\ 10^{-9}$	$7.7\ 10^{-9}$	$7.7\ 10^{-9}$	$7.7\ 10^{-9}$	$7.6\ 10^{-9}$	$7.7\ 10^{-9}$	$7.5\ 10^{-9}$	$7.7\ 10^{-9}$	$3.6\ 10^{-9}$	$7.5\ 10^{-9}$
1 year	$6.8\ 10^{-12}$	$2.2\ 10^{-9}$	$4.2\ 10^{-9}$	$4.3\ 10^{-9}$	$4.3\ 10^{-9}$	$4.3\ 10^{-9}$	$4.3\ 10^{-9}$	$4.3\ 10^{-9}$	$4.1\ 10^{-9}$	$4.3\ 10^{-9}$	$9.0\ 10^{-10}$	$4.1\ 10^{-9}$
2 years	$6.6\ 10^{-15}$	$6.8\ 10^{-10}$	$2.5\ 10^{-9}$	$2.6\ 10^{-9}$	$2.6\ 10^{-9}$	$2.6\ 10^{-9}$	$2.6\ 10^{-9}$	$2.6\ 10^{-9}$	$2.4\ 10^{-9}$	$2.6\ 10^{-9}$	$1.2\ 10^{-10}$	$2.4\ 10^{-9}$
3 years	$8.3\ 10^{-18}$	$2.7\ 10^{-10}$	$2.0\ 10^{-9}$	$2.1\ 10^{-9}$	$2.1\ 10^{-9}$	$2.1\ 10^{-9}$	$2.0\ 10^{-9}$	$2.1\ 10^{-9}$	$1.8\ 10^{-9}$	$2.1\ 10^{-9}$	$2.0\ 10^{-11}$	$1.9\ 10^{-9}$
4 years	$1.1\ 10^{-20}$	$1.2\ 10^{-10}$	$1.7\ 10^{-9}$	$1.8\ 10^{-9}$	$1.8\ 10^{-9}$	$1.8\ 10^{-9}$	$1.8\ 10^{-9}$	$1.8\ 10^{-9}$	$1.5\ 10^{-9}$	$1.8\ 10^{-9}$	$3.6\ 10^{-12}$	$1.6\ 10^{-9}$
5 years	$1.6\ 10^{-23}$	$5.6\ 10^{-11}$	$1.5\ 10^{-9}$	$1.7\ 10^{-9}$	$1.7\ 10^{-9}$	$1.7\ 10^{-9}$	$1.6\ 10^{-9}$	$1.7\ 10^{-9}$	$1.3\ 10^{-9}$	$1.6\ 10^{-9}$	$7.0\ 10^{-13}$	$1.4\ 10^{-9}$
10 years	$1.3\ 10^{-37}$	$1.5\ 10^{-12}$	$1.1\ 10^{-9}$	$1.3\ 10^{-9}$	$1.3\ 10^{-9}$	$1.3\ 10^{-9}$	$1.2\ 10^{-9}$	$1.3\ 10^{-9}$	$8.2\ 10^{-10}$	$1.3\ 10^{-9}$	$2.3\ 10^{-16}$	$9.1\ 10^{-10}$

Table B4: Adult integrated committed effective dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type F, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	$1.3\ 10^{-14}$	$2.1\ 10^{-13}$	$1.2\ 10^{-13}$	$1.5\ 10^{-11}$	$1.4\ 10^{-11}$	$1.3\ 10^{-11}$	$3.0\ 10^{-9}$	$3.2\ 10^{-9}$	$6.2\ 10^{-11}$	$2.6\ 10^{-9}$	$8.9\ 10^{-11}$	$1.5\ 10^{-9}$
2	$2.2\ 10^{-14}$	$3.6\ 10^{-13}$	$2.1\ 10^{-13}$	$2.6\ 10^{-11}$	$2.4\ 10^{-11}$	$2.3\ 10^{-11}$	$5.0\ 10^{-9}$	$5.5\ 10^{-9}$	$1.1\ 10^{-10}$	$4.4\ 10^{-9}$	$1.5\ 10^{-10}$	$2.6\ 10^{-9}$
3	$2.7\ 10^{-14}$	$4.5\ 10^{-13}$	$2.6\ 10^{-13}$	$3.2\ 10^{-11}$	$2.9\ 10^{-11}$	$2.8\ 10^{-11}$	$6.2\ 10^{-9}$	$6.8\ 10^{-9}$	$1.3\ 10^{-10}$	$5.4\ 10^{-9}$	$1.9\ 10^{-10}$	$3.2\ 10^{-9}$
4	$3.0\ 10^{-14}$	$5.1\ 10^{-13}$	$3.0\ 10^{-13}$	$3.6\ 10^{-11}$	$3.3\ 10^{-11}$	$3.2\ 10^{-11}$	$7.1\ 10^{-9}$	$7.7\ 10^{-9}$	$1.5\ 10^{-10}$	$6.2\ 10^{-9}$	$2.1\ 10^{-10}$	$3.7\ 10^{-9}$
5	$3.3\ 10^{-14}$	$5.5\ 10^{-13}$	$3.2\ 10^{-13}$	$3.9\ 10^{-11}$	$3.7\ 10^{-11}$	$3.5\ 10^{-11}$	$7.7\ 10^{-9}$	$8.5\ 10^{-9}$	$1.6\ 10^{-10}$	$6.8\ 10^{-9}$	$2.3\ 10^{-10}$	$4.0\ 10^{-9}$
6	$3.5\ 10^{-14}$	$5.9\ 10^{-13}$	$3.5\ 10^{-13}$	$4.2\ 10^{-11}$	$3.9\ 10^{-11}$	$3.8\ 10^{-11}$	$8.3\ 10^{-9}$	$9.0\ 10^{-9}$	$1.7\ 10^{-10}$	$7.2\ 10^{-9}$	$2.5\ 10^{-10}$	$4.3\ 10^{-9}$
7	$3.7\ 10^{-14}$	$6.3\ 10^{-13}$	$3.7\ 10^{-13}$	$4.5\ 10^{-11}$	$4.1\ 10^{-11}$	$4.0\ 10^{-11}$	$8.7\ 10^{-9}$	$9.5\ 10^{-9}$	$1.8\ 10^{-10}$	$7.6\ 10^{-9}$	$2.6\ 10^{-10}$	$4.5\ 10^{-9}$
10	$4.1\ 10^{-14}$	$7.0\ 10^{-13}$	$4.1\ 10^{-13}$	$5.0\ 10^{-11}$	$4.6\ 10^{-11}$	$4.5\ 10^{-11}$	$9.8\ 10^{-9}$	$1.1\ 10^{-8}$	$2.1\ 10^{-10}$	$8.6\ 10^{-9}$	$2.9\ 10^{-10}$	$5.1\ 10^{-9}$
14	$4.4\ 10^{-14}$	$7.7\ 10^{-13}$	$4.5\ 10^{-13}$	$5.5\ 10^{-11}$	$5.1\ 10^{-11}$	$4.9\ 10^{-11}$	$1.1\ 10^{-8}$	$1.2\ 10^{-8}$	$2.3\ 10^{-10}$	$9.4\ 10^{-9}$	$3.2\ 10^{-10}$	$5.6\ 10^{-9}$
30	$5.1\ 10^{-14}$	$9.3\ 10^{-13}$	$5.5\ 10^{-13}$	$6.7\ 10^{-11}$	$6.2\ 10^{-11}$	$6.0\ 10^{-11}$	$1.3\ 10^{-8}$	$1.4\ 10^{-8}$	$2.7\ 10^{-10}$	$1.1\ 10^{-8}$	$3.8\ 10^{-10}$	$6.8\ 10^{-9}$
60	$5.6\ 10^{-14}$	$1.1\ 10^{-12}$	$6.4\ 10^{-13}$	$7.8\ 10^{-11}$	$7.2\ 10^{-11}$	$6.9\ 10^{-11}$	$1.5\ 10^{-8}$	$1.7\ 10^{-8}$	$3.2\ 10^{-10}$	$1.3\ 10^{-8}$	$4.4\ 10^{-10}$	$7.9\ 10^{-9}$
90	$5.7\ 10^{-14}$	$1.2\ 10^{-12}$	$6.9\ 10^{-13}$	$8.4\ 10^{-11}$	$7.8\ 10^{-11}$	$7.5\ 10^{-11}$	$1.7\ 10^{-8}$	$1.8\ 10^{-8}$	$3.4\ 10^{-10}$	$1.4\ 10^{-8}$	$4.6\ 10^{-10}$	$8.5\ 10^{-9}$
180	$5.8\ 10^{-14}$	$1.3\ 10^{-12}$	$7.8\ 10^{-13}$	$9.6\ 10^{-11}$	$8.9\ 10^{-11}$	$8.5\ 10^{-11}$	$1.9\ 10^{-8}$	$2.1\ 10^{-8}$	$3.9\ 10^{-10}$	$1.6\ 10^{-8}$	$5.0\ 10^{-10}$	$9.7\ 10^{-9}$
1 year	$5.9\ 10^{-14}$	$1.4\ 10^{-12}$	$8.9\ 10^{-13}$	$1.1\ 10^{-10}$	$1.0\ 10^{-10}$	$9.7\ 10^{-11}$	$2.1\ 10^{-8}$	$2.3\ 10^{-8}$	$4.4\ 10^{-10}$	$1.9\ 10^{-8}$	$5.3\ 10^{-10}$	$1.1\ 10^{-8}$
2 years	$5.9\ 10^{-14}$	$1.5\ 10^{-12}$	$1.0\ 10^{-12}$	$1.2\ 10^{-10}$	$1.1\ 10^{-10}$	$1.1\ 10^{-10}$	$2.4\ 10^{-8}$	$2.7\ 10^{-8}$	$5.0\ 10^{-10}$	$2.1\ 10^{-8}$	$5.4\ 10^{-10}$	$1.2\ 10^{-8}$
3 years	$5.9\ 10^{-14}$	$1.5\ 10^{-12}$	$1.1\ 10^{-12}$	$1.3\ 10^{-10}$	$1.2\ 10^{-10}$	$1.2\ 10^{-10}$	$2.6\ 10^{-8}$	$2.9\ 10^{-8}$	$5.4\ 10^{-10}$	$2.3\ 10^{-8}$	$5.4\ 10^{-10}$	$1.3\ 10^{-8}$
4 years	$5.9\ 10^{-14}$	$1.5\ 10^{-12}$	$1.2\ 10^{-12}$	$1.4\ 10^{-10}$	$1.3\ 10^{-10}$	$1.3\ 10^{-10}$	$2.8\ 10^{-8}$	$3.1\ 10^{-8}$	$5.7\ 10^{-10}$	$2.5\ 10^{-8}$	$5.4\ 10^{-10}$	$1.4\ 10^{-8}$
5 years	$5.9\ 10^{-14}$	$1.5\ 10^{-12}$	$1.2\ 10^{-12}$	$1.5\ 10^{-10}$	$1.4\ 10^{-10}$	$1.4\ 10^{-10}$	$3.0\ 10^{-8}$	$3.2\ 10^{-8}$	$6.0\ 10^{-10}$	$2.6\ 10^{-8}$	$5.4\ 10^{-10}$	$1.5\ 10^{-8}$
10 years	$5.9\ 10^{-14}$	$1.5\ 10^{-12}$	$1.5\ 10^{-12}$	$1.8\ 10^{-10}$	$1.7\ 10^{-10}$	$1.7\ 10^{-10}$	$3.6\ 10^{-8}$	$4.0\ 10^{-8}$	$6.9\ 10^{-10}$	$3.2\ 10^{-8}$	$5.4\ 10^{-10}$	$1.7\ 10^{-8}$

Table B5: Adult integrated committed lung dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type F, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	$8.9\ 10^{-15}$	$1.9\ 10^{-13}$	$1.2\ 10^{-13}$	$9.4\ 10^{-12}$	$8.6\ 10^{-12}$	$8.4\ 10^{-12}$	$1.7\ 10^{-10}$	$1.9\ 10^{-10}$	$3.8\ 10^{-12}$	$2.0\ 10^{-10}$	$3.8\ 10^{-12}$	$9.2\ 10^{-11}$
2	$1.5\ 10^{-14}$	$3.2\ 10^{-13}$	$2.0\ 10^{-13}$	$1.6\ 10^{-11}$	$1.5\ 10^{-11}$	$1.4\ 10^{-11}$	$2.9\ 10^{-10}$	$3.2\ 10^{-10}$	$6.4\ 10^{-12}$	$3.4\ 10^{-10}$	$6.4\ 10^{-12}$	$1.6\ 10^{-10}$
3	$1.8\ 10^{-14}$	$4.0\ 10^{-13}$	$2.4\ 10^{-13}$	$2.0\ 10^{-11}$	$1.8\ 10^{-11}$	$1.8\ 10^{-11}$	$3.6\ 10^{-10}$	$4.0\ 10^{-10}$	$7.9\ 10^{-12}$	$4.2\ 10^{-10}$	$7.9\ 10^{-12}$	$1.9\ 10^{-10}$
4	$2.1\ 10^{-14}$	$4.6\ 10^{-13}$	$2.8\ 10^{-13}$	$2.3\ 10^{-11}$	$2.1\ 10^{-11}$	$2.0\ 10^{-11}$	$4.1\ 10^{-10}$	$4.5\ 10^{-10}$	$9.0\ 10^{-12}$	$4.8\ 10^{-10}$	$9.0\ 10^{-12}$	$2.2\ 10^{-10}$
5	$2.3\ 10^{-14}$	$5.0\ 10^{-13}$	$3.0\ 10^{-13}$	$2.5\ 10^{-11}$	$2.3\ 10^{-11}$	$2.2\ 10^{-11}$	$4.4\ 10^{-10}$	$4.9\ 10^{-10}$	$9.9\ 10^{-12}$	$5.2\ 10^{-10}$	$9.8\ 10^{-12}$	$2.4\ 10^{-10}$
6	$2.4\ 10^{-14}$	$5.3\ 10^{-13}$	$3.2\ 10^{-13}$	$2.6\ 10^{-11}$	$2.4\ 10^{-11}$	$2.3\ 10^{-11}$	$4.7\ 10^{-10}$	$5.3\ 10^{-10}$	$1.1\ 10^{-11}$	$5.6\ 10^{-10}$	$1.0\ 10^{-11}$	$2.6\ 10^{-10}$
7	$2.5\ 10^{-14}$	$5.6\ 10^{-13}$	$3.4\ 10^{-13}$	$2.8\ 10^{-11}$	$2.5\ 10^{-11}$	$2.5\ 10^{-11}$	$5.0\ 10^{-10}$	$5.6\ 10^{-10}$	$1.1\ 10^{-11}$	$5.9\ 10^{-10}$	$1.1\ 10^{-11}$	$2.7\ 10^{-10}$
10	$2.8\ 10^{-14}$	$6.3\ 10^{-13}$	$3.8\ 10^{-13}$	$3.1\ 10^{-11}$	$2.9\ 10^{-11}$	$2.8\ 10^{-11}$	$5.6\ 10^{-10}$	$6.2\ 10^{-10}$	$1.2\ 10^{-11}$	$6.6\ 10^{-10}$	$1.2\ 10^{-11}$	$3.0\ 10^{-10}$
14	$3.1\ 10^{-14}$	$6.9\ 10^{-13}$	$4.2\ 10^{-13}$	$3.4\ 10^{-11}$	$3.1\ 10^{-11}$	$3.1\ 10^{-11}$	$6.2\ 10^{-10}$	$6.9\ 10^{-10}$	$1.4\ 10^{-11}$	$7.3\ 10^{-10}$	$1.4\ 10^{-11}$	$3.3\ 10^{-10}$
30	$3.5\ 10^{-14}$	$8.4\ 10^{-13}$	$5.1\ 10^{-13}$	$4.2\ 10^{-11}$	$3.8\ 10^{-11}$	$3.7\ 10^{-11}$	$7.5\ 10^{-10}$	$8.4\ 10^{-10}$	$1.7\ 10^{-11}$	$8.8\ 10^{-10}$	$1.6\ 10^{-11}$	$4.1\ 10^{-10}$
60	$3.8\ 10^{-14}$	$9.6\ 10^{-13}$	$6.0\ 10^{-13}$	$4.9\ 10^{-11}$	$4.4\ 10^{-11}$	$4.3\ 10^{-11}$	$8.7\ 10^{-10}$	$9.7\ 10^{-10}$	$1.9\ 10^{-11}$	$1.0\ 10^{-9}$	$1.8\ 10^{-11}$	$4.7\ 10^{-10}$
90	$3.9\ 10^{-14}$	$1.0\ 10^{-12}$	$6.5\ 10^{-13}$	$5.3\ 10^{-11}$	$4.8\ 10^{-11}$	$4.7\ 10^{-11}$	$9.5\ 10^{-10}$	$1.1\ 10^{-9}$	$2.1\ 10^{-11}$	$1.1\ 10^{-9}$	$2.0\ 10^{-11}$	$5.1\ 10^{-10}$
180	$4.0\ 10^{-14}$	$1.2\ 10^{-12}$	$7.3\ 10^{-13}$	$6.0\ 10^{-11}$	$5.5\ 10^{-11}$	$5.3\ 10^{-11}$	$1.1\ 10^{-9}$	$1.2\ 10^{-9}$	$2.4\ 10^{-11}$	$1.3\ 10^{-9}$	$2.1\ 10^{-11}$	$5.8\ 10^{-10}$
1 year	$4.0\ 10^{-14}$	$1.3\ 10^{-12}$	$8.3\ 10^{-13}$	$6.8\ 10^{-11}$	$6.2\ 10^{-11}$	$6.0\ 10^{-11}$	$1.2\ 10^{-9}$	$1.4\ 10^{-9}$	$2.7\ 10^{-11}$	$1.4\ 10^{-9}$	$2.2\ 10^{-11}$	$6.6\ 10^{-10}$
2 years	$4.0\ 10^{-14}$	$1.3\ 10^{-12}$	$9.4\ 10^{-13}$	$7.7\ 10^{-11}$	$7.1\ 10^{-11}$	$6.9\ 10^{-11}$	$1.4\ 10^{-9}$	$1.5\ 10^{-9}$	$3.0\ 10^{-11}$	$1.6\ 10^{-9}$	$2.3\ 10^{-11}$	$7.4\ 10^{-10}$
3 years	$4.0\ 10^{-14}$	$1.4\ 10^{-12}$	$1.0\ 10^{-12}$	$8.4\ 10^{-11}$	$7.7\ 10^{-11}$	$7.4\ 10^{-11}$	$1.5\ 10^{-9}$	$1.7\ 10^{-9}$	$3.3\ 10^{-11}$	$1.8\ 10^{-9}$	$2.3\ 10^{-11}$	$8.0\ 10^{-10}$
4 years	$4.0\ 10^{-14}$	$1.4\ 10^{-12}$	$1.1\ 10^{-12}$	$9.0\ 10^{-11}$	$8.2\ 10^{-11}$	$7.9\ 10^{-11}$	$1.6\ 10^{-9}$	$1.8\ 10^{-9}$	$3.5\ 10^{-11}$	$1.9\ 10^{-9}$	$2.3\ 10^{-11}$	$8.5\ 10^{-10}$
5 years	$4.0\ 10^{-14}$	$1.4\ 10^{-12}$	$1.1\ 10^{-12}$	$9.5\ 10^{-11}$	$8.7\ 10^{-11}$	$8.4\ 10^{-11}$	$1.7\ 10^{-9}$	$1.9\ 10^{-9}$	$3.6\ 10^{-11}$	$2.0\ 10^{-9}$	$2.3\ 10^{-11}$	$8.9\ 10^{-10}$
10 years	$4.0\ 10^{-14}$	$1.4\ 10^{-12}$	$1.4\ 10^{-12}$	$1.2\ 10^{-10}$	$1.1\ 10^{-10}$	$1.0\ 10^{-10}$	$2.0\ 10^{-9}$	$2.3\ 10^{-9}$	$4.2\ 10^{-11}$	$2.4\ 10^{-9}$	$2.3\ 10^{-11}$	$1.0\ 10^{-9}$

Table B6: Adult integrated committed effective dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type M, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	$6.5\ 10^{-14}$	$7.5\ 10^{-13}$	$2.6\ 10^{-13}$	$9.4\ 10^{-11}$	$8.4\ 10^{-11}$	$7.8\ 10^{-11}$	$1.2\ 10^{-9}$	$1.3\ 10^{-9}$	$2.4\ 10^{-11}$	$1.1\ 10^{-9}$	$1.4\ 10^{-10}$	$7.3\ 10^{-10}$
2	$1.1\ 10^{-13}$	$1.3\ 10^{-12}$	$4.4\ 10^{-13}$	$1.6\ 10^{-10}$	$1.4\ 10^{-10}$	$1.3\ 10^{-10}$	$2.1\ 10^{-9}$	$2.3\ 10^{-9}$	$4.1\ 10^{-11}$	$1.9\ 10^{-9}$	$2.4\ 10^{-10}$	$1.2\ 10^{-9}$
3	$1.3\ 10^{-13}$	$1.6\ 10^{-12}$	$5.5\ 10^{-13}$	$2.0\ 10^{-10}$	$1.8\ 10^{-10}$	$1.6\ 10^{-10}$	$2.6\ 10^{-9}$	$2.8\ 10^{-9}$	$5.1\ 10^{-11}$	$2.4\ 10^{-9}$	$2.9\ 10^{-10}$	$1.5\ 10^{-9}$
4	$1.5\ 10^{-13}$	$1.8\ 10^{-12}$	$6.2\ 10^{-13}$	$2.3\ 10^{-10}$	$2.0\ 10^{-10}$	$1.9\ 10^{-10}$	$3.0\ 10^{-9}$	$3.2\ 10^{-9}$	$5.8\ 10^{-11}$	$2.7\ 10^{-9}$	$3.3\ 10^{-10}$	$1.7\ 10^{-9}$
5	$1.6\ 10^{-13}$	$2.0\ 10^{-12}$	$6.8\ 10^{-13}$	$2.5\ 10^{-10}$	$2.2\ 10^{-10}$	$2.0\ 10^{-10}$	$3.2\ 10^{-9}$	$3.5\ 10^{-9}$	$6.3\ 10^{-11}$	$3.0\ 10^{-9}$	$3.6\ 10^{-10}$	$1.9\ 10^{-9}$
6	$1.8\ 10^{-13}$	$2.1\ 10^{-12}$	$7.3\ 10^{-13}$	$2.6\ 10^{-10}$	$2.3\ 10^{-10}$	$2.2\ 10^{-10}$	$3.5\ 10^{-9}$	$3.8\ 10^{-9}$	$6.8\ 10^{-11}$	$3.2\ 10^{-9}$	$3.9\ 10^{-10}$	$2.0\ 10^{-9}$
7	$1.8\ 10^{-13}$	$2.2\ 10^{-12}$	$7.7\ 10^{-13}$	$2.8\ 10^{-10}$	$2.5\ 10^{-10}$	$2.3\ 10^{-10}$	$3.7\ 10^{-9}$	$4.0\ 10^{-9}$	$7.2\ 10^{-11}$	$3.3\ 10^{-9}$	$4.1\ 10^{-10}$	$2.1\ 10^{-9}$
10	$2.0\ 10^{-13}$	$2.5\ 10^{-12}$	$8.7\ 10^{-13}$	$3.1\ 10^{-10}$	$2.8\ 10^{-10}$	$2.6\ 10^{-10}$	$4.1\ 10^{-9}$	$4.5\ 10^{-9}$	$8.0\ 10^{-11}$	$3.7\ 10^{-9}$	$4.6\ 10^{-10}$	$2.4\ 10^{-9}$
14	$2.2\ 10^{-13}$	$2.7\ 10^{-12}$	$9.5\ 10^{-13}$	$3.4\ 10^{-10}$	$3.1\ 10^{-10}$	$2.9\ 10^{-10}$	$4.5\ 10^{-9}$	$4.9\ 10^{-9}$	$8.9\ 10^{-11}$	$4.1\ 10^{-9}$	$5.0\ 10^{-10}$	$2.7\ 10^{-9}$
30	$2.6\ 10^{-13}$	$3.3\ 10^{-12}$	$1.2\ 10^{-12}$	$4.2\ 10^{-10}$	$3.7\ 10^{-10}$	$3.5\ 10^{-10}$	$5.5\ 10^{-9}$	$6.0\ 10^{-9}$	$1.1\ 10^{-10}$	$5.0\ 10^{-9}$	$6.0\ 10^{-10}$	$3.2\ 10^{-9}$
60	$2.8\ 10^{-13}$	$3.8\ 10^{-12}$	$1.3\ 10^{-12}$	$4.9\ 10^{-10}$	$4.3\ 10^{-10}$	$4.0\ 10^{-10}$	$6.4\ 10^{-9}$	$6.9\ 10^{-9}$	$1.2\ 10^{-10}$	$5.8\ 10^{-9}$	$6.9\ 10^{-10}$	$3.7\ 10^{-9}$
90	$2.9\ 10^{-13}$	$4.1\ 10^{-12}$	$1.5\ 10^{-12}$	$5.3\ 10^{-10}$	$4.7\ 10^{-10}$	$4.4\ 10^{-10}$	$6.9\ 10^{-9}$	$7.5\ 10^{-9}$	$1.3\ 10^{-10}$	$6.3\ 10^{-9}$	$7.3\ 10^{-10}$	$4.0\ 10^{-9}$
180	$2.9\ 10^{-13}$	$4.5\ 10^{-12}$	$1.7\ 10^{-12}$	$6.0\ 10^{-10}$	$5.3\ 10^{-10}$	$5.0\ 10^{-10}$	$7.9\ 10^{-9}$	$8.5\ 10^{-9}$	$1.5\ 10^{-10}$	$7.2\ 10^{-9}$	$7.9\ 10^{-10}$	$4.6\ 10^{-9}$
1 year	$2.9\ 10^{-13}$	$4.9\ 10^{-12}$	$1.9\ 10^{-12}$	$6.8\ 10^{-10}$	$6.0\ 10^{-10}$	$5.6\ 10^{-10}$	$8.9\ 10^{-9}$	$9.7\ 10^{-9}$	$1.7\ 10^{-10}$	$8.2\ 10^{-9}$	$8.3\ 10^{-10}$	$5.2\ 10^{-9}$
2 years	$2.9\ 10^{-13}$	$5.2\ 10^{-12}$	$2.1\ 10^{-12}$	$7.7\ 10^{-10}$	$6.9\ 10^{-10}$	$6.4\ 10^{-10}$	$1.0\ 10^{-8}$	$1.1\ 10^{-8}$	$2.0\ 10^{-10}$	$9.3\ 10^{-9}$	$8.5\ 10^{-10}$	$5.9\ 10^{-9}$
3 years	$2.9\ 10^{-13}$	$5.3\ 10^{-12}$	$2.3\ 10^{-12}$	$8.4\ 10^{-10}$	$7.4\ 10^{-10}$	$7.0\ 10^{-10}$	$1.1\ 10^{-8}$	$1.2\ 10^{-8}$	$2.1\ 10^{-10}$	$1.0\ 10^{-8}$	$8.5\ 10^{-10}$	$6.4\ 10^{-9}$
4 years	$2.9\ 10^{-13}$	$5.4\ 10^{-12}$	$2.4\ 10^{-12}$	$9.0\ 10^{-10}$	$7.9\ 10^{-10}$	$7.4\ 10^{-10}$	$1.2\ 10^{-8}$	$1.3\ 10^{-8}$	$2.2\ 10^{-10}$	$1.1\ 10^{-8}$	$8.5\ 10^{-10}$	$6.7\ 10^{-9}$
5 years	$2.9\ 10^{-13}$	$5.4\ 10^{-12}$	$2.6\ 10^{-12}$	$9.5\ 10^{-10}$	$8.4\ 10^{-10}$	$7.8\ 10^{-10}$	$1.2\ 10^{-8}$	$1.4\ 10^{-8}$	$2.3\ 10^{-10}$	$1.1\ 10^{-8}$	$8.5\ 10^{-10}$	$7.1\ 10^{-9}$
10 years	$2.9\ 10^{-13}$	$5.4\ 10^{-12}$	$3.1\ 10^{-12}$	$1.2\ 10^{-9}$	$1.0\ 10^{-9}$	$9.6\ 10^{-10}$	$1.5\ 10^{-8}$	$1.7\ 10^{-8}$	$2.7\ 10^{-10}$	$1.4\ 10^{-8}$	$8.5\ 10^{-10}$	$8.3\ 10^{-9}$

Table B7: Adult integrated committed lung dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type M, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	$4.9\ 10^{-13}$	$5.4\ 10^{-12}$	$1.7\ 10^{-12}$	$7.3\ 10^{-10}$	$6.5\ 10^{-10}$	$5.9\ 10^{-10}$	$1.0\ 10^{-9}$	$8.9\ 10^{-10}$	$1.8\ 10^{-12}$	$1.0\ 10^{-9}$	$9.4\ 10^{-10}$	$1.1\ 10^{-9}$
2	$8.1\ 10^{-13}$	$9.1\ 10^{-12}$	$2.9\ 10^{-12}$	$1.2\ 10^{-9}$	$1.1\ 10^{-9}$	$1.0\ 10^{-9}$	$1.7\ 10^{-9}$	$1.5\ 10^{-9}$	$3.0\ 10^{-12}$	$1.7\ 10^{-9}$	$1.6\ 10^{-9}$	$1.8\ 10^{-9}$
3	$1.0\ 10^{-12}$	$1.1\ 10^{-11}$	$3.6\ 10^{-12}$	$1.5\ 10^{-9}$	$1.4\ 10^{-9}$	$1.2\ 10^{-9}$	$2.1\ 10^{-9}$	$1.9\ 10^{-9}$	$3.7\ 10^{-12}$	$2.1\ 10^{-9}$	$2.0\ 10^{-9}$	$2.2\ 10^{-9}$
4	$1.1\ 10^{-12}$	$1.3\ 10^{-11}$	$4.1\ 10^{-12}$	$1.7\ 10^{-9}$	$1.5\ 10^{-9}$	$1.4\ 10^{-9}$	$2.4\ 10^{-9}$	$2.1\ 10^{-9}$	$4.2\ 10^{-12}$	$2.4\ 10^{-9}$	$2.2\ 10^{-9}$	$2.5\ 10^{-9}$
5	$1.2\ 10^{-12}$	$1.4\ 10^{-11}$	$4.4\ 10^{-12}$	$1.9\ 10^{-9}$	$1.7\ 10^{-9}$	$1.5\ 10^{-9}$	$2.6\ 10^{-9}$	$2.3\ 10^{-9}$	$4.6\ 10^{-12}$	$2.6\ 10^{-9}$	$2.4\ 10^{-9}$	$2.7\ 10^{-9}$
6	$1.3\ 10^{-12}$	$1.5\ 10^{-11}$	$4.7\ 10^{-12}$	$2.0\ 10^{-9}$	$1.8\ 10^{-9}$	$1.7\ 10^{-9}$	$2.8\ 10^{-9}$	$2.5\ 10^{-9}$	$5.0\ 10^{-12}$	$2.8\ 10^{-9}$	$2.6\ 10^{-9}$	$2.9\ 10^{-9}$
7	$1.4\ 10^{-12}$	$1.6\ 10^{-11}$	$5.0\ 10^{-12}$	$2.1\ 10^{-9}$	$1.9\ 10^{-9}$	$1.8\ 10^{-9}$	$2.9\ 10^{-9}$	$2.6\ 10^{-9}$	$5.2\ 10^{-12}$	$2.9\ 10^{-9}$	$2.8\ 10^{-9}$	$3.1\ 10^{-9}$
10	$1.5\ 10^{-12}$	$1.8\ 10^{-11}$	$5.6\ 10^{-12}$	$2.4\ 10^{-9}$	$2.1\ 10^{-9}$	$2.0\ 10^{-9}$	$3.3\ 10^{-9}$	$2.9\ 10^{-9}$	$5.9\ 10^{-12}$	$3.3\ 10^{-9}$	$3.1\ 10^{-9}$	$3.5\ 10^{-9}$
14	$1.7\ 10^{-12}$	$2.0\ 10^{-11}$	$6.2\ 10^{-12}$	$2.7\ 10^{-9}$	$2.4\ 10^{-9}$	$2.2\ 10^{-9}$	$3.6\ 10^{-9}$	$3.2\ 10^{-9}$	$6.5\ 10^{-12}$	$3.6\ 10^{-9}$	$3.4\ 10^{-9}$	$3.8\ 10^{-9}$
30	$1.9\ 10^{-12}$	$2.4\ 10^{-11}$	$7.5\ 10^{-12}$	$3.2\ 10^{-9}$	$2.9\ 10^{-9}$	$2.6\ 10^{-9}$	$4.4\ 10^{-9}$	$3.9\ 10^{-9}$	$7.9\ 10^{-12}$	$4.4\ 10^{-9}$	$4.1\ 10^{-9}$	$4.6\ 10^{-9}$
60	$2.1\ 10^{-12}$	$2.7\ 10^{-11}$	$8.7\ 10^{-12}$	$3.7\ 10^{-9}$	$3.3\ 10^{-9}$	$3.1\ 10^{-9}$	$5.1\ 10^{-9}$	$4.6\ 10^{-9}$	$9.1\ 10^{-12}$	$5.1\ 10^{-9}$	$4.6\ 10^{-9}$	$5.4\ 10^{-9}$
90	$2.1\ 10^{-12}$	$2.9\ 10^{-11}$	$9.5\ 10^{-12}$	$4.1\ 10^{-9}$	$3.6\ 10^{-9}$	$3.3\ 10^{-9}$	$5.6\ 10^{-9}$	$5.0\ 10^{-9}$	$9.9\ 10^{-12}$	$5.6\ 10^{-9}$	$4.9\ 10^{-9}$	$5.8\ 10^{-9}$
180	$2.2\ 10^{-12}$	$3.2\ 10^{-11}$	$1.1\ 10^{-11}$	$4.6\ 10^{-9}$	$4.1\ 10^{-9}$	$3.8\ 10^{-9}$	$6.3\ 10^{-9}$	$5.6\ 10^{-9}$	$1.1\ 10^{-11}$	$6.3\ 10^{-9}$	$5.3\ 10^{-9}$	$6.6\ 10^{-9}$
1 year	$2.2\ 10^{-12}$	$3.5\ 10^{-11}$	$1.2\ 10^{-11}$	$5.2\ 10^{-9}$	$4.7\ 10^{-9}$	$4.3\ 10^{-9}$	$7.2\ 10^{-9}$	$6.4\ 10^{-9}$	$1.3\ 10^{-11}$	$7.2\ 10^{-9}$	$5.6\ 10^{-9}$	$7.5\ 10^{-9}$
2 years	$2.2\ 10^{-12}$	$3.7\ 10^{-11}$	$1.4\ 10^{-11}$	$6.0\ 10^{-9}$	$5.3\ 10^{-9}$	$4.9\ 10^{-9}$	$8.2\ 10^{-9}$	$7.3\ 10^{-9}$	$1.4\ 10^{-11}$	$8.2\ 10^{-9}$	$5.7\ 10^{-9}$	$8.5\ 10^{-9}$
3 years	$2.2\ 10^{-12}$	$3.8\ 10^{-11}$	$1.5\ 10^{-11}$	$6.5\ 10^{-9}$	$5.8\ 10^{-9}$	$5.3\ 10^{-9}$	$8.9\ 10^{-9}$	$7.9\ 10^{-9}$	$1.5\ 10^{-11}$	$8.9\ 10^{-9}$	$5.7\ 10^{-9}$	$9.2\ 10^{-9}$
4 years	$2.2\ 10^{-12}$	$3.8\ 10^{-11}$	$1.6\ 10^{-11}$	$6.9\ 10^{-9}$	$6.1\ 10^{-9}$	$5.6\ 10^{-9}$	$9.4\ 10^{-9}$	$8.5\ 10^{-9}$	$1.6\ 10^{-11}$	$9.5\ 10^{-9}$	$5.7\ 10^{-9}$	$9.7\ 10^{-9}$
5 years	$2.2\ 10^{-12}$	$3.8\ 10^{-11}$	$1.7\ 10^{-11}$	$7.3\ 10^{-9}$	$6.5\ 10^{-9}$	$5.9\ 10^{-9}$	$9.9\ 10^{-9}$	$8.9\ 10^{-9}$	$1.7\ 10^{-11}$	$1.0\ 10^{-8}$	$5.7\ 10^{-9}$	$1.0\ 10^{-8}$
10 years	$2.2\ 10^{-12}$	$3.8\ 10^{-11}$	$2.0\ 10^{-11}$	$8.9\ 10^{-9}$	$7.9\ 10^{-9}$	$7.3\ 10^{-9}$	$1.2\ 10^{-8}$	$1.1\ 10^{-8}$	$2.0\ 10^{-11}$	$1.2\ 10^{-8}$	$5.7\ 10^{-9}$	$1.2\ 10^{-8}$

Table B8: Adult integrated committed effective dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type S, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	$8.1\ 10^{-14}$	$1.8\ 10^{-12}$	$1.1\ 10^{-12}$	$2.5\ 10^{-10}$	$2.3\ 10^{-10}$	$2.2\ 10^{-10}$	$4.3\ 10^{-10}$	$4.3\ 10^{-10}$	$4.6\ 10^{-12}$	$4.3\ 10^{-10}$	$1.6\ 10^{-10}$	$3.5\ 10^{-10}$
2	$1.4\ 10^{-13}$	$3.0\ 10^{-12}$	$1.8\ 10^{-12}$	$4.3\ 10^{-10}$	$3.9\ 10^{-10}$	$3.7\ 10^{-10}$	$7.3\ 10^{-10}$	$7.3\ 10^{-10}$	$7.8\ 10^{-12}$	$7.3\ 10^{-10}$	$2.7\ 10^{-10}$	$5.9\ 10^{-10}$
3	$1.7\ 10^{-13}$	$3.7\ 10^{-12}$	$2.2\ 10^{-12}$	$5.3\ 10^{-10}$	$4.8\ 10^{-10}$	$4.5\ 10^{-10}$	$9.1\ 10^{-10}$	$9.1\ 10^{-10}$	$9.6\ 10^{-12}$	$9.1\ 10^{-10}$	$3.3\ 10^{-10}$	$7.4\ 10^{-10}$
4	$1.9\ 10^{-13}$	$4.2\ 10^{-12}$	$2.5\ 10^{-12}$	$6.1\ 10^{-10}$	$5.5\ 10^{-10}$	$5.2\ 10^{-10}$	$1.0\ 10^{-9}$	$1.0\ 10^{-9}$	$1.1\ 10^{-11}$	$1.0\ 10^{-9}$	$3.8\ 10^{-10}$	$8.4\ 10^{-10}$
5	$2.1\ 10^{-13}$	$4.6\ 10^{-12}$	$2.7\ 10^{-12}$	$6.6\ 10^{-10}$	$6.0\ 10^{-10}$	$5.6\ 10^{-10}$	$1.1\ 10^{-9}$	$1.1\ 10^{-9}$	$1.2\ 10^{-11}$	$1.1\ 10^{-9}$	$4.1\ 10^{-10}$	$9.2\ 10^{-10}$
6	$2.2\ 10^{-13}$	$5.0\ 10^{-12}$	$2.9\ 10^{-12}$	$7.1\ 10^{-10}$	$6.4\ 10^{-10}$	$6.0\ 10^{-10}$	$1.2\ 10^{-9}$	$1.2\ 10^{-9}$	$1.3\ 10^{-11}$	$1.2\ 10^{-9}$	$4.4\ 10^{-10}$	$9.8\ 10^{-10}$
7	$2.3\ 10^{-13}$	$5.2\ 10^{-12}$	$3.1\ 10^{-12}$	$7.5\ 10^{-10}$	$6.8\ 10^{-10}$	$6.4\ 10^{-10}$	$1.3\ 10^{-9}$	$1.3\ 10^{-9}$	$1.4\ 10^{-11}$	$1.3\ 10^{-9}$	$4.7\ 10^{-10}$	$1.0\ 10^{-9}$
10	$2.6\ 10^{-13}$	$5.9\ 10^{-12}$	$3.5\ 10^{-12}$	$8.4\ 10^{-10}$	$7.6\ 10^{-10}$	$7.1\ 10^{-10}$	$1.4\ 10^{-9}$	$1.4\ 10^{-9}$	$1.5\ 10^{-11}$	$1.4\ 10^{-9}$	$5.2\ 10^{-10}$	$1.2\ 10^{-9}$
14	$2.8\ 10^{-13}$	$6.5\ 10^{-12}$	$3.8\ 10^{-12}$	$9.2\ 10^{-10}$	$8.4\ 10^{-10}$	$7.9\ 10^{-10}$	$1.6\ 10^{-9}$	$1.6\ 10^{-9}$	$1.7\ 10^{-11}$	$1.6\ 10^{-9}$	$5.7\ 10^{-10}$	$1.3\ 10^{-9}$
30	$3.2\ 10^{-13}$	$7.8\ 10^{-12}$	$4.7\ 10^{-12}$	$1.1\ 10^{-9}$	$1.0\ 10^{-9}$	$9.5\ 10^{-10}$	$1.9\ 10^{-9}$	$1.9\ 10^{-9}$	$2.0\ 10^{-11}$	$1.9\ 10^{-9}$	$6.8\ 10^{-10}$	$1.5\ 10^{-9}$
60	$3.5\ 10^{-13}$	$9.0\ 10^{-12}$	$5.4\ 10^{-12}$	$1.3\ 10^{-9}$	$1.2\ 10^{-9}$	$1.1\ 10^{-9}$	$2.2\ 10^{-9}$	$2.2\ 10^{-9}$	$2.4\ 10^{-11}$	$2.2\ 10^{-9}$	$7.8\ 10^{-10}$	$1.8\ 10^{-9}$
90	$3.6\ 10^{-13}$	$9.6\ 10^{-12}$	$5.9\ 10^{-12}$	$1.4\ 10^{-9}$	$1.3\ 10^{-9}$	$1.2\ 10^{-9}$	$2.4\ 10^{-9}$	$2.4\ 10^{-9}$	$2.5\ 10^{-11}$	$2.4\ 10^{-9}$	$8.3\ 10^{-10}$	$1.9\ 10^{-9}$
180	$3.6\ 10^{-13}$	$1.1\ 10^{-11}$	$6.7\ 10^{-12}$	$1.6\ 10^{-9}$	$1.5\ 10^{-9}$	$1.4\ 10^{-9}$	$2.7\ 10^{-9}$	$2.7\ 10^{-9}$	$2.9\ 10^{-11}$	$2.7\ 10^{-9}$	$9.0\ 10^{-10}$	$2.2\ 10^{-9}$
1 year	$3.7\ 10^{-13}$	$1.2\ 10^{-11}$	$7.5\ 10^{-12}$	$1.8\ 10^{-9}$	$1.7\ 10^{-9}$	$1.6\ 10^{-9}$	$3.1\ 10^{-9}$	$3.1\ 10^{-9}$	$3.3\ 10^{-11}$	$3.1\ 10^{-9}$	$9.5\ 10^{-10}$	$2.5\ 10^{-9}$
2 years	$3.7\ 10^{-13}$	$1.2\ 10^{-11}$	$8.6\ 10^{-12}$	$2.1\ 10^{-9}$	$1.9\ 10^{-9}$	$1.8\ 10^{-9}$	$3.5\ 10^{-9}$	$3.5\ 10^{-9}$	$3.7\ 10^{-11}$	$3.5\ 10^{-9}$	$9.6\ 10^{-10}$	$2.8\ 10^{-9}$
3 years	$3.7\ 10^{-13}$	$1.3\ 10^{-11}$	$9.3\ 10^{-12}$	$2.3\ 10^{-9}$	$2.0\ 10^{-9}$	$1.9\ 10^{-9}$	$3.8\ 10^{-9}$	$3.8\ 10^{-9}$	$4.0\ 10^{-11}$	$3.8\ 10^{-9}$	$9.7\ 10^{-10}$	$3.1\ 10^{-9}$
4 years	$3.7\ 10^{-13}$	$1.3\ 10^{-11}$	$9.8\ 10^{-12}$	$2.4\ 10^{-9}$	$2.2\ 10^{-9}$	$2.0\ 10^{-9}$	$4.1\ 10^{-9}$	$4.1\ 10^{-9}$	$4.2\ 10^{-11}$	$4.1\ 10^{-9}$	$9.7\ 10^{-10}$	$3.2\ 10^{-9}$
5 years	$3.7\ 10^{-13}$	$1.3\ 10^{-11}$	$1.0\ 10^{-11}$	$2.5\ 10^{-9}$	$2.3\ 10^{-9}$	$2.2\ 10^{-9}$	$4.3\ 10^{-9}$	$4.3\ 10^{-9}$	$4.4\ 10^{-11}$	$4.3\ 10^{-9}$	$9.7\ 10^{-10}$	$3.4\ 10^{-9}$
10 years	$3.7\ 10^{-13}$	$1.3\ 10^{-11}$	$1.2\ 10^{-11}$	$3.1\ 10^{-9}$	$2.8\ 10^{-9}$	$2.6\ 10^{-9}$	$5.2\ 10^{-9}$	$5.3\ 10^{-9}$	$5.1\ 10^{-11}$	$5.3\ 10^{-9}$	$9.7\ 10^{-10}$	$4.0\ 10^{-9}$

Table B9: Adult integrated committed lung dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type S, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	5.9 10^{-13}	1.4 10^{-11}	8.1 10^{-12}	2.1 10^{-9}	1.9 10^{-9}	1.8 10^{-9}	2.5 10^{-9}	2.3 10^{-9}	1.2 10^{-11}	2.6 10^{-9}	1.3 10^{-9}	2.5 10^{-9}
2	9.9 10^{-13}	2.4 10^{-11}	1.4 10^{-11}	3.6 10^{-9}	3.2 10^{-9}	3.1 10^{-9}	4.2 10^{-9}	4.0 10^{-9}	2.1 10^{-11}	4.3 10^{-9}	2.2 10^{-9}	4.2 10^{-9}
3	1.2 10^{-12}	3.0 10^{-11}	1.7 10^{-11}	4.4 10^{-9}	4.0 10^{-9}	3.8 10^{-9}	5.3 10^{-9}	4.9 10^{-9}	2.6 10^{-11}	5.4 10^{-9}	2.8 10^{-9}	5.2 10^{-9}
4	1.4 10^{-12}	3.4 10^{-11}	1.9 10^{-11}	5.0 10^{-9}	4.5 10^{-9}	4.3 10^{-9}	6.0 10^{-9}	5.6 10^{-9}	3.0 10^{-11}	6.1 10^{-9}	3.1 10^{-9}	5.9 10^{-9}
5	1.5 10^{-12}	3.7 10^{-11}	2.1 10^{-11}	5.5 10^{-9}	4.9 10^{-9}	4.7 10^{-9}	6.5 10^{-9}	6.1 10^{-9}	3.2 10^{-11}	6.7 10^{-9}	3.4 10^{-9}	6.5 10^{-9}
6	1.6 10^{-12}	4.0 10^{-11}	2.3 10^{-11}	5.9 10^{-9}	5.3 10^{-9}	5.0 10^{-9}	7.0 10^{-9}	6.6 10^{-9}	3.5 10^{-11}	7.2 10^{-9}	3.7 10^{-9}	6.9 10^{-9}
7	1.7 10^{-12}	4.2 10^{-11}	2.4 10^{-11}	6.2 10^{-9}	5.6 10^{-9}	5.3 10^{-9}	7.4 10^{-9}	6.9 10^{-9}	3.7 10^{-11}	7.6 10^{-9}	3.9 10^{-9}	7.3 10^{-9}
10	1.9 10^{-12}	4.7 10^{-11}	2.7 10^{-11}	7.0 10^{-9}	6.2 10^{-9}	6.0 10^{-9}	8.3 10^{-9}	7.8 10^{-9}	4.1 10^{-11}	8.5 10^{-9}	4.3 10^{-9}	8.2 10^{-9}
14	2.0 10^{-12}	5.2 10^{-11}	3.0 10^{-11}	7.7 10^{-9}	6.9 10^{-9}	6.6 10^{-9}	9.1 10^{-9}	8.6 10^{-9}	4.5 10^{-11}	9.3 10^{-9}	4.7 10^{-9}	9.0 10^{-9}
30	2.4 10^{-12}	6.2 10^{-11}	3.6 10^{-11}	9.3 10^{-9}	8.4 10^{-9}	8.0 10^{-9}	1.1 10^{-8}	1.0 10^{-8}	5.5 10^{-11}	1.1 10^{-8}	5.7 10^{-9}	1.1 10^{-8}
60	2.6 10^{-12}	7.2 10^{-11}	4.2 10^{-11}	1.1 10^{-8}	9.7 10^{-9}	9.3 10^{-9}	1.3 10^{-8}	1.2 10^{-8}	6.4 10^{-11}	1.3 10^{-8}	6.5 10^{-9}	1.3 10^{-8}
90	2.6 10^{-12}	7.7 10^{-11}	4.5 10^{-11}	1.2 10^{-8}	1.1 10^{-8}	1.0 10^{-8}	1.4 10^{-8}	1.3 10^{-8}	6.9 10^{-11}	1.4 10^{-8}	6.9 10^{-9}	1.4 10^{-8}
180	2.7 10^{-12}	8.6 10^{-11}	5.1 10^{-11}	1.3 10^{-8}	1.2 10^{-8}	1.1 10^{-8}	1.6 10^{-8}	1.5 10^{-8}	7.8 10^{-11}	1.6 10^{-8}	7.5 10^{-9}	1.6 10^{-8}
1 year	2.7 10^{-12}	9.4 10^{-11}	5.8 10^{-11}	1.5 10^{-8}	1.4 10^{-8}	1.3 10^{-8}	1.8 10^{-8}	1.7 10^{-8}	8.9 10^{-11}	1.8 10^{-8}	7.9 10^{-9}	1.8 10^{-8}
2 years	2.7 10^{-12}	9.9 10^{-11}	6.6 10^{-11}	1.7 10^{-8}	1.5 10^{-8}	1.5 10^{-8}	2.1 10^{-8}	1.9 10^{-8}	1.0 10^{-10}	2.1 10^{-8}	8.0 10^{-9}	2.0 10^{-8}
3 years	2.7 10^{-12}	1.0 10^{-10}	7.1 10^{-11}	1.9 10^{-8}	1.7 10^{-8}	1.6 10^{-8}	2.2 10^{-8}	2.1 10^{-8}	1.1 10^{-10}	2.3 10^{-8}	8.0 10^{-9}	2.2 10^{-8}
4 years	2.7 10^{-12}	1.0 10^{-10}	7.6 10^{-11}	2.0 10^{-8}	1.8 10^{-8}	1.7 10^{-8}	2.4 10^{-8}	2.2 10^{-8}	1.1 10^{-10}	2.4 10^{-8}	8.0 10^{-9}	2.3 10^{-8}
5 years	2.7 10^{-12}	1.0 10^{-10}	8.0 10^{-11}	2.1 10^{-8}	1.9 10^{-8}	1.8 10^{-8}	2.5 10^{-8}	2.4 10^{-8}	1.2 10^{-10}	2.6 10^{-8}	8.0 10^{-9}	2.4 10^{-8}
10 years	2.7 10^{-12}	1.0 10^{-10}	9.5 10^{-11}	2.6 10^{-8}	2.3 10^{-8}	2.2 10^{-8}	3.0 10^{-8}	2.9 10^{-8}	1.4 10^{-10}	3.1 10^{-8}	8.0 10^{-9}	2.8 10^{-8}

Table B10: Child integrated committed effective dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type F, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	1.7 10^{-14}	3.0 10^{-13}	6.9 10^{-14}	1.5 10^{-11}	1.4 10^{-11}	1.4 10^{-11}	2.1 10^{-9}	2.2 10^{-9}	4.5 10^{-11}	1.9 10^{-9}	1.1 10^{-10}	1.1 10^{-9}
2	2.9 10^{-14}	5.1 10^{-13}	1.2 10^{-13}	2.5 10^{-11}	2.4 10^{-11}	2.3 10^{-11}	3.5 10^{-9}	3.8 10^{-9}	7.6 10^{-11}	3.2 10^{-9}	1.9 10^{-10}	1.9 10^{-9}
3	3.6 10^{-14}	6.3 10^{-13}	1.5 10^{-13}	3.1 10^{-11}	2.9 10^{-11}	2.9 10^{-11}	4.3 10^{-9}	4.7 10^{-9}	9.4 10^{-11}	3.9 10^{-9}	2.4 10^{-10}	2.4 10^{-9}
4	4.1 10^{-14}	7.1 10^{-13}	1.6 10^{-13}	3.6 10^{-11}	3.3 10^{-11}	3.3 10^{-11}	4.9 10^{-9}	5.3 10^{-9}	1.1 10^{-10}	4.5 10^{-9}	2.7 10^{-10}	2.7 10^{-9}
5	4.4 10^{-14}	7.8 10^{-13}	1.8 10^{-13}	3.9 10^{-11}	3.7 10^{-11}	3.6 10^{-11}	5.4 10^{-9}	5.9 10^{-9}	1.2 10^{-10}	4.9 10^{-9}	3.0 10^{-10}	3.0 10^{-9}
6	4.7 10^{-14}	8.3 10^{-13}	1.9 10^{-13}	4.2 10^{-11}	3.9 10^{-11}	3.8 10^{-11}	5.7 10^{-9}	6.3 10^{-9}	1.3 10^{-10}	5.2 10^{-9}	3.2 10^{-10}	3.2 10^{-9}
7	4.9 10^{-14}	8.8 10^{-13}	2.0 10^{-13}	4.4 10^{-11}	4.1 10^{-11}	4.0 10^{-11}	6.1 10^{-9}	6.6 10^{-9}	1.3 10^{-10}	5.5 10^{-9}	3.3 10^{-10}	3.4 10^{-9}
10	5.5 10^{-14}	9.8 10^{-13}	2.3 10^{-13}	4.9 10^{-11}	4.6 10^{-11}	4.5 10^{-11}	6.8 10^{-9}	7.4 10^{-9}	1.5 10^{-10}	6.2 10^{-9}	3.7 10^{-10}	3.8 10^{-9}
14	6.0 10^{-14}	1.1 10^{-12}	2.5 10^{-13}	5.4 10^{-11}	5.1 10^{-11}	5.0 10^{-11}	7.5 10^{-9}	8.2 10^{-9}	1.6 10^{-10}	6.8 10^{-9}	4.1 10^{-10}	4.2 10^{-9}
30	6.9 10^{-14}	1.3 10^{-12}	3.1 10^{-13}	6.6 10^{-11}	6.2 10^{-11}	6.0 10^{-11}	9.1 10^{-9}	9.9 10^{-9}	2.0 10^{-10}	8.3 10^{-9}	4.9 10^{-10}	5.0 10^{-9}
60	7.5 10^{-14}	1.5 10^{-12}	3.5 10^{-13}	7.7 10^{-11}	7.2 10^{-11}	7.0 10^{-11}	1.1 10^{-8}	1.2 10^{-8}	2.3 10^{-10}	9.6 10^{-9}	5.6 10^{-10}	5.8 10^{-9}
90	7.7 10^{-14}	1.6 10^{-12}	3.8 10^{-13}	8.3 10^{-11}	7.8 10^{-11}	7.6 10^{-11}	1.1 10^{-8}	1.2 10^{-8}	2.5 10^{-10}	1.0 10^{-8}	5.9 10^{-10}	6.3 10^{-9}
180	7.8 10^{-14}	1.8 10^{-12}	4.4 10^{-13}	9.5 10^{-11}	8.9 10^{-11}	8.6 10^{-11}	1.3 10^{-8}	1.4 10^{-8}	2.8 10^{-10}	1.2 10^{-8}	6.4 10^{-10}	7.2 10^{-9}
1 year	7.9 10^{-14}	2.0 10^{-12}	5.0 10^{-13}	1.1 10^{-10}	1.0 10^{-10}	9.8 10^{-11}	1.5 10^{-8}	1.6 10^{-8}	3.2 10^{-10}	1.3 10^{-8}	6.8 10^{-10}	8.2 10^{-9}
2 years	7.9 10^{-14}	2.1 10^{-12}	5.6 10^{-13}	1.2 10^{-10}	1.1 10^{-10}	1.1 10^{-10}	1.7 10^{-8}	1.8 10^{-8}	3.6 10^{-10}	1.5 10^{-8}	6.9 10^{-10}	9.2 10^{-9}
3 years	7.9 10^{-14}	2.1 10^{-12}	6.1 10^{-13}	1.3 10^{-10}	1.2 10^{-10}	1.2 10^{-10}	1.8 10^{-8}	2.0 10^{-8}	3.9 10^{-10}	1.7 10^{-8}	6.9 10^{-10}	1.0 10^{-8}
4 years	7.9 10^{-14}	2.1 10^{-12}	6.5 10^{-13}	1.4 10^{-10}	1.3 10^{-10}	1.3 10^{-10}	1.9 10^{-8}	2.1 10^{-8}	4.1 10^{-10}	1.8 10^{-8}	6.9 10^{-10}	1.1 10^{-8}
5 years	7.9 10^{-14}	2.1 10^{-12}	6.8 10^{-13}	1.5 10^{-10}	1.4 10^{-10}	1.4 10^{-10}	2.0 10^{-8}	2.2 10^{-8}	4.3 10^{-10}	1.9 10^{-8}	6.9 10^{-10}	1.1 10^{-8}
10 years	7.9 10^{-14}	2.1 10^{-12}	8.1 10^{-13}	1.8 10^{-10}	1.7 10^{-10}	1.7 10^{-10}	2.5 10^{-8}	2.7 10^{-8}	5.0 10^{-10}	2.3 10^{-8}	6.9 10^{-10}	1.3 10^{-8}

Table B11: Child integrated committed lung dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type F, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	1.1 10^{-14}	2.6 10^{-13}	6.2 10^{-14}	8.2 10^{-12}	7.7 10^{-12}	7.3 10^{-12}	1.8 10^{-10}	2.1 10^{-10}	4.1 10^{-12}	2.1 10^{-10}	4.3 10^{-12}	8.2 10^{-11}
2	1.9 10^{-14}	4.4 10^{-13}	1.0 10^{-13}	1.4 10^{-11}	1.3 10^{-11}	1.2 10^{-11}	3.1 10^{-10}	3.5 10^{-10}	7.0 10^{-12}	3.5 10^{-10}	7.3 10^{-12}	1.4 10^{-10}
3	2.4 10^{-14}	5.5 10^{-13}	1.3 10^{-13}	1.7 10^{-11}	1.6 10^{-11}	1.5 10^{-11}	3.8 10^{-10}	4.3 10^{-10}	8.6 10^{-12}	4.3 10^{-10}	9.0 10^{-12}	1.7 10^{-10}
4	2.7 10^{-14}	6.2 10^{-13}	1.5 10^{-13}	2.0 10^{-11}	1.8 10^{-11}	1.7 10^{-11}	4.3 10^{-10}	4.9 10^{-10}	9.8 10^{-12}	4.9 10^{-10}	1.0 10^{-11}	2.0 10^{-10}
5	2.9 10^{-14}	6.8 10^{-13}	1.6 10^{-13}	2.1 10^{-11}	2.0 10^{-11}	1.9 10^{-11}	4.7 10^{-10}	5.4 10^{-10}	1.1 10^{-11}	5.4 10^{-10}	1.1 10^{-11}	2.1 10^{-10}
6	3.1 10^{-14}	7.3 10^{-13}	1.7 10^{-13}	2.3 10^{-11}	2.1 10^{-11}	2.0 10^{-11}	5.1 10^{-10}	5.7 10^{-10}	1.1 10^{-11}	5.7 10^{-10}	1.2 10^{-11}	2.3 10^{-10}
7	3.2 10^{-14}	7.7 10^{-13}	1.8 10^{-13}	2.4 10^{-11}	2.3 10^{-11}	2.1 10^{-11}	5.3 10^{-10}	6.1 10^{-10}	1.2 10^{-11}	6.1 10^{-10}	1.3 10^{-11}	2.4 10^{-10}
10	3.6 10^{-14}	8.6 10^{-13}	2.0 10^{-13}	2.7 10^{-11}	2.5 10^{-11}	2.4 10^{-11}	6.0 10^{-10}	6.8 10^{-10}	1.4 10^{-11}	6.8 10^{-10}	1.4 10^{-11}	2.7 10^{-10}
14	3.9 10^{-14}	9.5 10^{-13}	2.2 10^{-13}	3.0 10^{-11}	2.8 10^{-11}	2.7 10^{-11}	6.6 10^{-10}	7.5 10^{-10}	1.5 10^{-11}	7.5 10^{-10}	1.5 10^{-11}	3.0 10^{-10}
30	4.5 10^{-14}	1.1 10^{-12}	2.7 10^{-13}	3.6 10^{-11}	3.4 10^{-11}	3.2 10^{-11}	8.0 10^{-10}	9.1 10^{-10}	1.8 10^{-11}	9.1 10^{-10}	1.8 10^{-11}	3.6 10^{-10}
60	4.9 10^{-14}	1.3 10^{-12}	3.2 10^{-13}	4.2 10^{-11}	3.9 10^{-11}	3.7 10^{-11}	9.3 10^{-10}	1.1 10^{-9}	2.1 10^{-11}	1.1 10^{-9}	2.1 10^{-11}	4.2 10^{-10}
90	5.0 10^{-14}	1.4 10^{-12}	3.4 10^{-13}	4.6 10^{-11}	4.3 10^{-11}	4.1 10^{-11}	1.0 10^{-9}	1.1 10^{-9}	2.3 10^{-11}	1.1 10^{-9}	2.2 10^{-11}	4.6 10^{-10}
180	5.1 10^{-14}	1.6 10^{-12}	3.9 10^{-13}	5.2 10^{-11}	4.9 10^{-11}	4.6 10^{-11}	1.1 10^{-9}	1.3 10^{-9}	2.6 10^{-11}	1.3 10^{-9}	2.4 10^{-11}	5.2 10^{-10}
1 year	5.1 10^{-14}	1.7 10^{-12}	4.4 10^{-13}	5.9 10^{-11}	5.5 10^{-11}	5.2 10^{-11}	1.3 10^{-9}	1.5 10^{-9}	2.9 10^{-11}	1.5 10^{-9}	2.6 10^{-11}	5.9 10^{-10}
2 years	5.1 10^{-14}	1.8 10^{-12}	5.0 10^{-13}	6.7 10^{-11}	6.3 10^{-11}	6.0 10^{-11}	1.5 10^{-9}	1.7 10^{-9}	3.3 10^{-11}	1.7 10^{-9}	2.6 10^{-11}	6.7 10^{-10}
3 years	5.1 10^{-14}	1.8 10^{-12}	5.4 10^{-13}	7.3 10^{-11}	6.8 10^{-11}	6.5 10^{-11}	1.6 10^{-9}	1.8 10^{-9}	3.6 10^{-11}	1.8 10^{-9}	2.6 10^{-11}	7.2 10^{-10}
4 years	5.1 10^{-14}	1.9 10^{-12}	5.8 10^{-13}	7.8 10^{-11}	7.3 10^{-11}	6.9 10^{-11}	1.7 10^{-9}	2.0 10^{-9}	3.8 10^{-11}	1.9 10^{-9}	2.6 10^{-11}	7.6 10^{-10}
5 years	5.1 10^{-14}	1.9 10^{-12}	6.1 10^{-13}	8.2 10^{-11}	7.7 10^{-11}	7.3 10^{-11}	1.8 10^{-9}	2.1 10^{-9}	4.0 10^{-11}	2.1 10^{-9}	2.6 10^{-11}	8.0 10^{-10}
10 years	5.1 10^{-14}	1.9 10^{-12}	7.2 10^{-13}	1.0 10^{-10}	9.4 10^{-11}	8.9 10^{-11}	2.2 10^{-9}	2.5 10^{-9}	4.6 10^{-11}	2.5 10^{-9}	2.6 10^{-11}	9.3 10^{-10}

Table B12: Child integrated committed effective dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type M, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	$6.5\ 10^{-14}$	$7.7\ 10^{-13}$	$2.4\ 10^{-13}$	$9.0\ 10^{-11}$	$8.0\ 10^{-11}$	$7.5\ 10^{-11}$	$8.2\ 10^{-10}$	$9.0\ 10^{-10}$	$1.5\ 10^{-11}$	$7.5\ 10^{-10}$	$1.4\ 10^{-10}$	$5.0\ 10^{-10}$
2	$1.1\ 10^{-13}$	$1.3\ 10^{-12}$	$4.1\ 10^{-13}$	$1.5\ 10^{-10}$	$1.4\ 10^{-10}$	$1.3\ 10^{-10}$	$1.4\ 10^{-9}$	$1.5\ 10^{-9}$	$2.6\ 10^{-11}$	$1.3\ 10^{-9}$	$2.3\ 10^{-10}$	$8.5\ 10^{-10}$
3	$1.3\ 10^{-13}$	$1.6\ 10^{-12}$	$5.1\ 10^{-13}$	$1.9\ 10^{-10}$	$1.7\ 10^{-10}$	$1.6\ 10^{-10}$	$1.7\ 10^{-9}$	$1.9\ 10^{-9}$	$3.3\ 10^{-11}$	$1.6\ 10^{-9}$	$2.8\ 10^{-10}$	$1.1\ 10^{-9}$
4	$1.5\ 10^{-13}$	$1.8\ 10^{-12}$	$5.8\ 10^{-13}$	$2.1\ 10^{-10}$	$1.9\ 10^{-10}$	$1.8\ 10^{-10}$	$2.0\ 10^{-9}$	$2.1\ 10^{-9}$	$3.7\ 10^{-11}$	$1.8\ 10^{-9}$	$3.2\ 10^{-10}$	$1.2\ 10^{-9}$
5	$1.7\ 10^{-13}$	$2.0\ 10^{-12}$	$6.3\ 10^{-13}$	$2.3\ 10^{-10}$	$2.1\ 10^{-10}$	$2.0\ 10^{-10}$	$2.1\ 10^{-9}$	$2.3\ 10^{-9}$	$4.0\ 10^{-11}$	$2.0\ 10^{-9}$	$3.5\ 10^{-10}$	$1.3\ 10^{-9}$
6	$1.8\ 10^{-13}$	$2.1\ 10^{-12}$	$6.8\ 10^{-13}$	$2.5\ 10^{-10}$	$2.2\ 10^{-10}$	$2.1\ 10^{-10}$	$2.3\ 10^{-9}$	$2.5\ 10^{-9}$	$4.3\ 10^{-11}$	$2.1\ 10^{-9}$	$3.8\ 10^{-10}$	$1.4\ 10^{-9}$
7	$1.9\ 10^{-13}$	$2.2\ 10^{-12}$	$7.2\ 10^{-13}$	$2.6\ 10^{-10}$	$2.4\ 10^{-10}$	$2.2\ 10^{-10}$	$2.4\ 10^{-9}$	$2.6\ 10^{-9}$	$4.6\ 10^{-11}$	$2.2\ 10^{-9}$	$4.0\ 10^{-10}$	$1.5\ 10^{-9}$
10	$2.1\ 10^{-13}$	$2.5\ 10^{-12}$	$8.0\ 10^{-13}$	$3.0\ 10^{-10}$	$2.7\ 10^{-10}$	$2.5\ 10^{-10}$	$2.7\ 10^{-9}$	$3.0\ 10^{-9}$	$5.1\ 10^{-11}$	$2.5\ 10^{-9}$	$4.5\ 10^{-10}$	$1.7\ 10^{-9}$
14	$2.2\ 10^{-13}$	$2.8\ 10^{-12}$	$8.9\ 10^{-13}$	$3.3\ 10^{-10}$	$2.9\ 10^{-10}$	$2.7\ 10^{-10}$	$3.0\ 10^{-9}$	$3.3\ 10^{-9}$	$5.7\ 10^{-11}$	$2.7\ 10^{-9}$	$4.9\ 10^{-10}$	$1.8\ 10^{-9}$
30	$2.6\ 10^{-13}$	$3.3\ 10^{-12}$	$1.1\ 10^{-12}$	$4.0\ 10^{-10}$	$3.6\ 10^{-10}$	$3.3\ 10^{-10}$	$3.6\ 10^{-9}$	$4.0\ 10^{-9}$	$6.8\ 10^{-11}$	$3.3\ 10^{-9}$	$5.9\ 10^{-10}$	$2.2\ 10^{-9}$
60	$2.8\ 10^{-13}$	$3.9\ 10^{-12}$	$1.2\ 10^{-12}$	$4.6\ 10^{-10}$	$4.1\ 10^{-10}$	$3.8\ 10^{-10}$	$4.2\ 10^{-9}$	$4.6\ 10^{-9}$	$8.0\ 10^{-11}$	$3.8\ 10^{-9}$	$6.7\ 10^{-10}$	$2.6\ 10^{-9}$
90	$2.9\ 10^{-13}$	$4.1\ 10^{-12}$	$1.4\ 10^{-12}$	$5.0\ 10^{-10}$	$4.5\ 10^{-10}$	$4.2\ 10^{-10}$	$4.6\ 10^{-9}$	$5.0\ 10^{-9}$	$8.6\ 10^{-11}$	$4.2\ 10^{-9}$	$7.1\ 10^{-10}$	$2.8\ 10^{-9}$
180	$2.9\ 10^{-13}$	$4.6\ 10^{-12}$	$1.5\ 10^{-12}$	$5.7\ 10^{-10}$	$5.1\ 10^{-10}$	$4.7\ 10^{-10}$	$5.2\ 10^{-9}$	$5.7\ 10^{-9}$	$9.8\ 10^{-11}$	$4.7\ 10^{-9}$	$7.7\ 10^{-10}$	$3.2\ 10^{-9}$
1 year	$3.0\ 10^{-13}$	$5.0\ 10^{-12}$	$1.7\ 10^{-12}$	$6.5\ 10^{-10}$	$5.8\ 10^{-10}$	$5.4\ 10^{-10}$	$5.9\ 10^{-9}$	$6.5\ 10^{-9}$	$1.1\ 10^{-10}$	$5.4\ 10^{-9}$	$8.1\ 10^{-10}$	$3.6\ 10^{-9}$
2 years	$3.0\ 10^{-13}$	$5.3\ 10^{-12}$	$2.0\ 10^{-12}$	$7.3\ 10^{-10}$	$6.6\ 10^{-10}$	$6.1\ 10^{-10}$	$6.7\ 10^{-9}$	$7.3\ 10^{-9}$	$1.3\ 10^{-10}$	$6.1\ 10^{-9}$	$8.3\ 10^{-10}$	$4.1\ 10^{-9}$
3 years	$3.0\ 10^{-13}$	$5.4\ 10^{-12}$	$2.1\ 10^{-12}$	$8.0\ 10^{-10}$	$7.2\ 10^{-10}$	$6.7\ 10^{-10}$	$7.3\ 10^{-9}$	$8.0\ 10^{-9}$	$1.3\ 10^{-10}$	$6.6\ 10^{-9}$	$8.3\ 10^{-10}$	$4.4\ 10^{-9}$
4 years	$3.0\ 10^{-13}$	$5.4\ 10^{-12}$	$2.3\ 10^{-12}$	$8.5\ 10^{-10}$	$7.6\ 10^{-10}$	$7.1\ 10^{-10}$	$7.8\ 10^{-9}$	$8.5\ 10^{-9}$	$1.4\ 10^{-10}$	$7.1\ 10^{-9}$	$8.3\ 10^{-10}$	$4.7\ 10^{-9}$
5 years	$3.0\ 10^{-13}$	$5.5\ 10^{-12}$	$2.4\ 10^{-12}$	$9.0\ 10^{-10}$	$8.0\ 10^{-10}$	$7.5\ 10^{-10}$	$8.2\ 10^{-9}$	$9.0\ 10^{-9}$	$1.5\ 10^{-10}$	$7.5\ 10^{-9}$	$8.3\ 10^{-10}$	$4.9\ 10^{-9}$
10 years	$3.0\ 10^{-13}$	$5.5\ 10^{-12}$	$2.8\ 10^{-12}$	$1.1\ 10^{-9}$	$9.8\ 10^{-10}$	$9.1\ 10^{-10}$	$9.9\ 10^{-9}$	$1.1\ 10^{-8}$	$1.7\ 10^{-10}$	$9.1\ 10^{-9}$	$8.3\ 10^{-10}$	$5.7\ 10^{-9}$

Table B13: Child integrated committed lung dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type M, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	$4.5\ 10^{-13}$	$5.2\ 10^{-12}$	$1.6\ 10^{-12}$	$7.1\ 10^{-10}$	$6.3\ 10^{-10}$	$5.8\ 10^{-10}$	$9.5\ 10^{-10}$	$8.6\ 10^{-10}$	$1.7\ 10^{-12}$	$9.5\ 10^{-10}$	$9.0\ 10^{-10}$	$1.0\ 10^{-9}$
2	$7.5\ 10^{-13}$	$8.8\ 10^{-12}$	$2.8\ 10^{-12}$	$1.2\ 10^{-9}$	$1.1\ 10^{-9}$	$9.8\ 10^{-10}$	$1.6\ 10^{-9}$	$1.5\ 10^{-9}$	$2.8\ 10^{-12}$	$1.6\ 10^{-9}$	$1.5\ 10^{-9}$	$1.7\ 10^{-9}$
3	$9.3\ 10^{-13}$	$1.1\ 10^{-11}$	$3.4\ 10^{-12}$	$1.5\ 10^{-9}$	$1.3\ 10^{-9}$	$1.2\ 10^{-9}$	$2.0\ 10^{-9}$	$1.8\ 10^{-9}$	$3.5\ 10^{-12}$	$2.0\ 10^{-9}$	$1.9\ 10^{-9}$	$2.1\ 10^{-9}$
4	$1.0\ 10^{-12}$	$1.2\ 10^{-11}$	$3.9\ 10^{-12}$	$1.7\ 10^{-9}$	$1.5\ 10^{-9}$	$1.4\ 10^{-9}$	$2.3\ 10^{-9}$	$2.1\ 10^{-9}$	$4.0\ 10^{-12}$	$2.3\ 10^{-9}$	$2.1\ 10^{-9}$	$2.4\ 10^{-9}$
5	$1.1\ 10^{-12}$	$1.4\ 10^{-11}$	$4.2\ 10^{-12}$	$1.9\ 10^{-9}$	$1.7\ 10^{-9}$	$1.5\ 10^{-9}$	$2.5\ 10^{-9}$	$2.2\ 10^{-9}$	$4.3\ 10^{-12}$	$2.5\ 10^{-9}$	$2.3\ 10^{-9}$	$2.6\ 10^{-9}$
6	$1.2\ 10^{-12}$	$1.5\ 10^{-11}$	$4.5\ 10^{-12}$	$2.0\ 10^{-9}$	$1.8\ 10^{-9}$	$1.6\ 10^{-9}$	$2.7\ 10^{-9}$	$2.4\ 10^{-9}$	$4.6\ 10^{-12}$	$2.7\ 10^{-9}$	$2.5\ 10^{-9}$	$2.8\ 10^{-9}$
7	$1.3\ 10^{-12}$	$1.5\ 10^{-11}$	$4.8\ 10^{-12}$	$2.1\ 10^{-9}$	$1.9\ 10^{-9}$	$1.7\ 10^{-9}$	$2.8\ 10^{-9}$	$2.5\ 10^{-9}$	$4.9\ 10^{-12}$	$2.8\ 10^{-9}$	$2.6\ 10^{-9}$	$3.0\ 10^{-9}$
10	$1.4\ 10^{-12}$	$1.7\ 10^{-11}$	$5.4\ 10^{-12}$	$2.3\ 10^{-9}$	$2.1\ 10^{-9}$	$1.9\ 10^{-9}$	$3.2\ 10^{-9}$	$2.8\ 10^{-9}$	$5.5\ 10^{-12}$	$3.2\ 10^{-9}$	$2.9\ 10^{-9}$	$3.3\ 10^{-9}$
14	$1.5\ 10^{-12}$	$1.9\ 10^{-11}$	$5.9\ 10^{-12}$	$2.6\ 10^{-9}$	$2.3\ 10^{-9}$	$2.1\ 10^{-9}$	$3.5\ 10^{-9}$	$3.1\ 10^{-9}$	$6.1\ 10^{-12}$	$3.5\ 10^{-9}$	$3.2\ 10^{-9}$	$3.7\ 10^{-9}$
30	$1.8\ 10^{-12}$	$2.3\ 10^{-11}$	$7.2\ 10^{-12}$	$3.1\ 10^{-9}$	$2.8\ 10^{-9}$	$2.6\ 10^{-9}$	$4.2\ 10^{-9}$	$3.8\ 10^{-9}$	$7.3\ 10^{-12}$	$4.2\ 10^{-9}$	$3.9\ 10^{-9}$	$4.5\ 10^{-9}$
60	$1.9\ 10^{-12}$	$2.6\ 10^{-11}$	$8.3\ 10^{-12}$	$3.6\ 10^{-9}$	$3.3\ 10^{-9}$	$3.0\ 10^{-9}$	$4.9\ 10^{-9}$	$4.4\ 10^{-9}$	$8.5\ 10^{-12}$	$4.9\ 10^{-9}$	$4.4\ 10^{-9}$	$5.2\ 10^{-9}$
90	$2.0\ 10^{-12}$	$2.8\ 10^{-11}$	$9.0\ 10^{-12}$	$4.0\ 10^{-9}$	$3.5\ 10^{-9}$	$3.2\ 10^{-9}$	$5.3\ 10^{-9}$	$4.8\ 10^{-9}$	$9.2\ 10^{-12}$	$5.3\ 10^{-9}$	$4.7\ 10^{-9}$	$5.6\ 10^{-9}$
180	$2.0\ 10^{-12}$	$3.1\ 10^{-11}$	$1.0\ 10^{-11}$	$4.5\ 10^{-9}$	$4.0\ 10^{-9}$	$3.7\ 10^{-9}$	$6.0\ 10^{-9}$	$5.4\ 10^{-9}$	$1.0\ 10^{-11}$	$6.0\ 10^{-9}$	$5.1\ 10^{-9}$	$6.4\ 10^{-9}$
1 year	$2.0\ 10^{-12}$	$3.4\ 10^{-11}$	$1.2\ 10^{-11}$	$5.1\ 10^{-9}$	$4.6\ 10^{-9}$	$4.2\ 10^{-9}$	$6.8\ 10^{-9}$	$6.2\ 10^{-9}$	$1.2\ 10^{-11}$	$6.9\ 10^{-9}$	$5.3\ 10^{-9}$	$7.2\ 10^{-9}$
2 years	$2.0\ 10^{-12}$	$3.6\ 10^{-11}$	$1.3\ 10^{-11}$	$5.8\ 10^{-9}$	$5.2\ 10^{-9}$	$4.7\ 10^{-9}$	$7.8\ 10^{-9}$	$7.0\ 10^{-9}$	$1.3\ 10^{-11}$	$7.8\ 10^{-9}$	$5.4\ 10^{-9}$	$8.2\ 10^{-9}$
3 years	$2.0\ 10^{-12}$	$3.7\ 10^{-11}$	$1.4\ 10^{-11}$	$6.3\ 10^{-9}$	$5.7\ 10^{-9}$	$5.2\ 10^{-9}$	$8.4\ 10^{-9}$	$7.7\ 10^{-9}$	$1.4\ 10^{-11}$	$8.5\ 10^{-9}$	$5.4\ 10^{-9}$	$8.8\ 10^{-9}$
4 years	$2.0\ 10^{-12}$	$3.7\ 10^{-11}$	$1.5\ 10^{-11}$	$6.7\ 10^{-9}$	$6.0\ 10^{-9}$	$5.5\ 10^{-9}$	$9.0\ 10^{-9}$	$8.2\ 10^{-9}$	$1.5\ 10^{-11}$	$9.0\ 10^{-9}$	$5.4\ 10^{-9}$	$9.3\ 10^{-9}$
5 years	$2.0\ 10^{-12}$	$3.7\ 10^{-11}$	$1.6\ 10^{-11}$	$7.1\ 10^{-9}$	$6.4\ 10^{-9}$	$5.8\ 10^{-9}$	$9.5\ 10^{-9}$	$8.6\ 10^{-9}$	$1.6\ 10^{-11}$	$9.5\ 10^{-9}$	$5.4\ 10^{-9}$	$9.8\ 10^{-9}$
10 years	$2.0\ 10^{-12}$	$3.7\ 10^{-11}$	$1.9\ 10^{-11}$	$8.7\ 10^{-9}$	$7.8\ 10^{-9}$	$7.1\ 10^{-9}$	$1.1\ 10^{-8}$	$1.1\ 10^{-8}$	$1.9\ 10^{-11}$	$1.2\ 10^{-8}$	$5.4\ 10^{-9}$	$1.1\ 10^{-8}$

Table B14: Child integrated committed effective dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type S, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	$7.8\ 10^{-14}$	$1.7\ 10^{-12}$	$9.0\ 10^{-13}$	$2.2\ 10^{-10}$	$2.1\ 10^{-10}$	$1.9\ 10^{-10}$	$3.5\ 10^{-10}$	$3.5\ 10^{-10}$	$3.2\ 10^{-12}$	$3.5\ 10^{-10}$	$1.5\ 10^{-10}$	$3.2\ 10^{-10}$
2	$1.3\ 10^{-13}$	$2.9\ 10^{-12}$	$1.5\ 10^{-12}$	$3.8\ 10^{-10}$	$3.5\ 10^{-10}$	$3.2\ 10^{-10}$	$6.0\ 10^{-10}$	$6.0\ 10^{-10}$	$5.4\ 10^{-12}$	$6.0\ 10^{-10}$	$2.6\ 10^{-10}$	$5.4\ 10^{-10}$
3	$1.6\ 10^{-13}$	$3.6\ 10^{-12}$	$1.9\ 10^{-12}$	$4.7\ 10^{-10}$	$4.3\ 10^{-10}$	$3.9\ 10^{-10}$	$7.4\ 10^{-10}$	$7.4\ 10^{-10}$	$6.7\ 10^{-12}$	$7.4\ 10^{-10}$	$3.2\ 10^{-10}$	$6.7\ 10^{-10}$
4	$1.8\ 10^{-13}$	$4.0\ 10^{-12}$	$2.1\ 10^{-12}$	$5.3\ 10^{-10}$	$4.9\ 10^{-10}$	$4.5\ 10^{-10}$	$8.5\ 10^{-10}$	$8.5\ 10^{-10}$	$7.6\ 10^{-12}$	$8.5\ 10^{-10}$	$3.6\ 10^{-10}$	$7.6\ 10^{-10}$
5	$2.0\ 10^{-13}$	$4.4\ 10^{-12}$	$2.3\ 10^{-12}$	$5.9\ 10^{-10}$	$5.4\ 10^{-10}$	$4.9\ 10^{-10}$	$9.3\ 10^{-10}$	$9.3\ 10^{-10}$	$8.3\ 10^{-12}$	$9.3\ 10^{-10}$	$4.0\ 10^{-10}$	$8.3\ 10^{-10}$
6	$2.1\ 10^{-13}$	$4.7\ 10^{-12}$	$2.5\ 10^{-12}$	$6.3\ 10^{-10}$	$5.7\ 10^{-10}$	$5.2\ 10^{-10}$	$9.9\ 10^{-10}$	$9.9\ 10^{-10}$	$8.9\ 10^{-12}$	$9.9\ 10^{-10}$	$4.2\ 10^{-10}$	$8.9\ 10^{-10}$
7	$2.2\ 10^{-13}$	$5.0\ 10^{-12}$	$2.6\ 10^{-12}$	$6.6\ 10^{-10}$	$6.1\ 10^{-10}$	$5.5\ 10^{-10}$	$1.0\ 10^{-9}$	$1.0\ 10^{-9}$	$9.4\ 10^{-12}$	$1.0\ 10^{-9}$	$4.5\ 10^{-10}$	$9.4\ 10^{-10}$
10	$2.5\ 10^{-13}$	$5.6\ 10^{-12}$	$3.0\ 10^{-12}$	$7.4\ 10^{-10}$	$6.8\ 10^{-10}$	$6.2\ 10^{-10}$	$1.2\ 10^{-9}$	$1.2\ 10^{-9}$	$1.0\ 10^{-11}$	$1.2\ 10^{-9}$	$5.0\ 10^{-10}$	$1.0\ 10^{-9}$
14	$2.7\ 10^{-13}$	$6.2\ 10^{-12}$	$3.3\ 10^{-12}$	$8.2\ 10^{-10}$	$7.5\ 10^{-10}$	$6.8\ 10^{-10}$	$1.3\ 10^{-9}$	$1.3\ 10^{-9}$	$1.2\ 10^{-11}$	$1.3\ 10^{-9}$	$5.5\ 10^{-10}$	$1.2\ 10^{-9}$
30	$3.1\ 10^{-13}$	$7.4\ 10^{-12}$	$4.0\ 10^{-12}$	$9.9\ 10^{-10}$	$9.1\ 10^{-10}$	$8.3\ 10^{-10}$	$1.6\ 10^{-9}$	$1.6\ 10^{-9}$	$1.4\ 10^{-11}$	$1.6\ 10^{-9}$	$6.6\ 10^{-10}$	$1.4\ 10^{-9}$
60	$3.4\ 10^{-13}$	$8.5\ 10^{-12}$	$4.6\ 10^{-12}$	$1.2\ 10^{-9}$	$1.1\ 10^{-9}$	$9.6\ 10^{-10}$	$1.8\ 10^{-9}$	$1.8\ 10^{-9}$	$1.6\ 10^{-11}$	$1.8\ 10^{-9}$	$7.5\ 10^{-10}$	$1.6\ 10^{-9}$
90	$3.5\ 10^{-13}$	$9.2\ 10^{-12}$	$5.0\ 10^{-12}$	$1.2\ 10^{-9}$	$1.1\ 10^{-9}$	$1.0\ 10^{-9}$	$2.0\ 10^{-9}$	$2.0\ 10^{-9}$	$1.8\ 10^{-11}$	$2.0\ 10^{-9}$	$8.0\ 10^{-10}$	$1.8\ 10^{-9}$
180	$3.5\ 10^{-13}$	$1.0\ 10^{-11}$	$5.7\ 10^{-12}$	$1.4\ 10^{-9}$	$1.3\ 10^{-9}$	$1.2\ 10^{-9}$	$2.2\ 10^{-9}$	$2.2\ 10^{-9}$	$2.0\ 10^{-11}$	$2.2\ 10^{-9}$	$8.7\ 10^{-10}$	$2.0\ 10^{-9}$
1 year	$3.5\ 10^{-13}$	$1.1\ 10^{-11}$	$6.4\ 10^{-12}$	$1.6\ 10^{-9}$	$1.5\ 10^{-9}$	$1.3\ 10^{-9}$	$2.6\ 10^{-9}$	$2.6\ 10^{-9}$	$2.3\ 10^{-11}$	$2.6\ 10^{-9}$	$9.1\ 10^{-10}$	$2.3\ 10^{-9}$
2 years	$3.5\ 10^{-13}$	$1.2\ 10^{-11}$	$7.3\ 10^{-12}$	$1.8\ 10^{-9}$	$1.7\ 10^{-9}$	$1.5\ 10^{-9}$	$2.9\ 10^{-9}$	$2.9\ 10^{-9}$	$2.6\ 10^{-11}$	$2.9\ 10^{-9}$	$9.3\ 10^{-10}$	$2.6\ 10^{-9}$
3 years	$3.5\ 10^{-13}$	$1.2\ 10^{-11}$	$7.9\ 10^{-12}$	$2.0\ 10^{-9}$	$1.8\ 10^{-9}$	$1.7\ 10^{-9}$	$3.1\ 10^{-9}$	$3.2\ 10^{-9}$	$2.8\ 10^{-11}$	$3.2\ 10^{-9}$	$9.3\ 10^{-10}$	$2.8\ 10^{-9}$
4 years	$3.5\ 10^{-13}$	$1.2\ 10^{-11}$	$8.4\ 10^{-12}$	$2.1\ 10^{-9}$	$2.0\ 10^{-9}$	$1.8\ 10^{-9}$	$3.4\ 10^{-9}$	$3.4\ 10^{-9}$	$2.9\ 10^{-11}$	$3.4\ 10^{-9}$	$9.3\ 10^{-10}$	$2.9\ 10^{-9}$
5 years	$3.5\ 10^{-13}$	$1.2\ 10^{-11}$	$8.8\ 10^{-12}$	$2.2\ 10^{-9}$	$2.1\ 10^{-9}$	$1.9\ 10^{-9}$	$3.5\ 10^{-9}$	$3.6\ 10^{-9}$	$3.1\ 10^{-11}$	$3.6\ 10^{-9}$	$9.3\ 10^{-10}$	$3.1\ 10^{-9}$
10 years	$3.5\ 10^{-13}$	$1.2\ 10^{-11}$	$1.0\ 10^{-11}$	$2.7\ 10^{-9}$	$2.5\ 10^{-9}$	$2.3\ 10^{-9}$	$4.3\ 10^{-9}$	$4.3\ 10^{-9}$	$3.5\ 10^{-11}$	$4.3\ 10^{-9}$	$9.3\ 10^{-10}$	$3.6\ 10^{-9}$

Table B15: Child integrated committed lung dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type S, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	5.6 10^{-13}	1.3 10^{-11}	6.7 10^{-12}	1.9 10^{-9}	1.7 10^{-9}	1.6 10^{-9}	2.2 10^{-9}	2.1 10^{-9}	8.6 10^{-12}	2.2 10^{-9}	1.3 10^{-9}	2.2 10^{-9}
2	9.4 10^{-13}	2.3 10^{-11}	1.1 10^{-11}	3.2 10^{-9}	2.9 10^{-9}	2.8 10^{-9}	3.8 10^{-9}	3.5 10^{-9}	1.5 10^{-11}	3.8 10^{-9}	2.1 10^{-9}	3.8 10^{-9}
3	1.2 10^{-12}	2.8 10^{-11}	1.4 10^{-11}	3.9 10^{-9}	3.6 10^{-9}	3.4 10^{-9}	4.7 10^{-9}	4.3 10^{-9}	1.8 10^{-11}	4.7 10^{-9}	2.6 10^{-9}	4.7 10^{-9}
4	1.3 10^{-12}	3.2 10^{-11}	1.6 10^{-11}	4.5 10^{-9}	4.1 10^{-9}	3.9 10^{-9}	5.3 10^{-9}	4.9 10^{-9}	2.1 10^{-11}	5.3 10^{-9}	3.0 10^{-9}	5.3 10^{-9}
5	1.4 10^{-12}	3.5 10^{-11}	1.8 10^{-11}	4.9 10^{-9}	4.5 10^{-9}	4.2 10^{-9}	5.9 10^{-9}	5.4 10^{-9}	2.2 10^{-11}	5.9 10^{-9}	3.2 10^{-9}	5.9 10^{-9}
6	1.5 10^{-12}	3.7 10^{-11}	1.9 10^{-11}	5.2 10^{-9}	4.8 10^{-9}	4.5 10^{-9}	6.3 10^{-9}	5.7 10^{-9}	2.4 10^{-11}	6.3 10^{-9}	3.5 10^{-9}	6.3 10^{-9}
7	1.6 10^{-12}	3.9 10^{-11}	2.0 10^{-11}	5.5 10^{-9}	5.1 10^{-9}	4.8 10^{-9}	6.6 10^{-9}	6.1 10^{-9}	2.5 10^{-11}	6.6 10^{-9}	3.7 10^{-9}	6.6 10^{-9}
10	1.8 10^{-12}	4.4 10^{-11}	2.2 10^{-11}	6.2 10^{-9}	5.7 10^{-9}	5.4 10^{-9}	7.4 10^{-9}	6.8 10^{-9}	2.8 10^{-11}	7.4 10^{-9}	4.1 10^{-9}	7.4 10^{-9}
14	1.9 10^{-12}	4.9 10^{-11}	2.5 10^{-11}	6.8 10^{-9}	6.3 10^{-9}	5.9 10^{-9}	8.2 10^{-9}	7.5 10^{-9}	3.1 10^{-11}	8.2 10^{-9}	4.5 10^{-9}	8.2 10^{-9}
30	2.2 10^{-12}	5.9 10^{-11}	3.0 10^{-11}	8.3 10^{-9}	7.6 10^{-9}	7.2 10^{-9}	9.9 10^{-9}	9.1 10^{-9}	3.8 10^{-11}	9.9 10^{-9}	5.4 10^{-9}	9.9 10^{-9}
60	2.4 10^{-12}	6.8 10^{-11}	3.5 10^{-11}	9.6 10^{-9}	8.8 10^{-9}	8.4 10^{-9}	1.2 10^{-8}	1.1 10^{-8}	4.4 10^{-11}	1.2 10^{-8}	6.1 10^{-9}	1.2 10^{-8}
90	2.5 10^{-12}	7.3 10^{-11}	3.7 10^{-11}	1.0 10^{-8}	9.6 10^{-9}	9.1 10^{-9}	1.2 10^{-8}	1.1 10^{-8}	4.8 10^{-11}	1.2 10^{-8}	6.5 10^{-9}	1.2 10^{-8}
180	2.5 10^{-12}	8.1 10^{-11}	4.3 10^{-11}	1.2 10^{-8}	1.1 10^{-8}	1.0 10^{-8}	1.4 10^{-8}	1.3 10^{-8}	5.4 10^{-11}	1.4 10^{-8}	7.1 10^{-9}	1.4 10^{-8}
1 year	2.5 10^{-12}	8.8 10^{-11}	4.8 10^{-11}	1.3 10^{-8}	1.2 10^{-8}	1.2 10^{-8}	1.6 10^{-8}	1.5 10^{-8}	6.1 10^{-11}	1.6 10^{-8}	7.4 10^{-9}	1.6 10^{-8}
2 years	2.5 10^{-12}	9.3 10^{-11}	5.5 10^{-11}	1.5 10^{-8}	1.4 10^{-8}	1.3 10^{-8}	1.8 10^{-8}	1.7 10^{-8}	6.9 10^{-11}	1.8 10^{-8}	7.6 10^{-9}	1.8 10^{-8}
3 years	2.5 10^{-12}	9.5 10^{-11}	5.9 10^{-11}	1.7 10^{-8}	1.5 10^{-8}	1.4 10^{-8}	2.0 10^{-8}	1.8 10^{-8}	7.5 10^{-11}	2.0 10^{-8}	7.6 10^{-9}	2.0 10^{-8}
4 years	2.5 10^{-12}	9.6 10^{-11}	6.3 10^{-11}	1.8 10^{-8}	1.6 10^{-8}	1.5 10^{-8}	2.1 10^{-8}	2.0 10^{-8}	7.9 10^{-11}	2.1 10^{-8}	7.6 10^{-9}	2.1 10^{-8}
5 years	2.5 10^{-12}	9.6 10^{-11}	6.6 10^{-11}	1.9 10^{-8}	1.7 10^{-8}	1.6 10^{-8}	2.2 10^{-8}	2.1 10^{-8}	8.3 10^{-11}	2.2 10^{-8}	7.6 10^{-9}	2.2 10^{-8}
10 years	2.5 10^{-12}	9.6 10^{-11}	7.9 10^{-11}	2.3 10^{-8}	2.1 10^{-8}	2.0 10^{-8}	2.7 10^{-8}	2.5 10^{-8}	9.6 10^{-11}	2.7 10^{-8}	7.6 10^{-9}	2.5 10^{-8}

Table B16: Infant integrated committed effective dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type F, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	1.9 10^{-14}	3.4 10^{-13}	3.4 10^{-14}	8.9 10^{-12}	8.2 10^{-12}	8.2 10^{-12}	1.2 10^{-9}	1.3 10^{-9}	1.8 10^{-11}	1.1 10^{-9}	1.3 10^{-10}	8.2 10^{-10}
2	3.2 10^{-14}	5.8 10^{-13}	5.8 10^{-14}	1.5 10^{-11}	1.4 10^{-11}	1.4 10^{-11}	2.0 10^{-9}	2.1 10^{-9}	3.1 10^{-11}	1.9 10^{-9}	2.2 10^{-10}	1.4 10^{-9}
3	3.9 10^{-14}	7.2 10^{-13}	7.2 10^{-14}	1.9 10^{-11}	1.7 10^{-11}	1.7 10^{-11}	2.5 10^{-9}	2.7 10^{-9}	3.9 10^{-11}	2.4 10^{-9}	2.8 10^{-10}	1.7 10^{-9}
4	4.4 10^{-14}	8.1 10^{-13}	8.2 10^{-14}	2.1 10^{-11}	2.0 10^{-11}	2.0 10^{-11}	2.9 10^{-9}	3.0 10^{-9}	4.4 10^{-11}	2.7 10^{-9}	3.2 10^{-10}	2.0 10^{-9}
5	4.8 10^{-14}	8.9 10^{-13}	8.9 10^{-14}	2.3 10^{-11}	2.1 10^{-11}	2.1 10^{-11}	3.1 10^{-9}	3.3 10^{-9}	4.8 10^{-11}	3.0 10^{-9}	3.4 10^{-10}	2.1 10^{-9}
6	5.1 10^{-14}	9.5 10^{-13}	9.5 10^{-14}	2.5 10^{-11}	2.3 10^{-11}	2.3 10^{-11}	3.4 10^{-9}	3.5 10^{-9}	5.1 10^{-11}	3.2 10^{-9}	3.7 10^{-10}	2.3 10^{-9}
7	5.4 10^{-14}	1.0 10^{-12}	1.0 10^{-13}	2.6 10^{-11}	2.4 10^{-11}	2.4 10^{-11}	3.5 10^{-9}	3.7 10^{-9}	5.4 10^{-11}	3.4 10^{-9}	3.9 10^{-10}	2.4 10^{-9}
10	6.0 10^{-14}	1.1 10^{-12}	1.1 10^{-13}	2.9 10^{-11}	2.7 10^{-11}	2.7 10^{-11}	4.0 10^{-9}	4.2 10^{-9}	6.1 10^{-11}	3.8 10^{-9}	4.3 10^{-10}	2.7 10^{-9}
14	6.5 10^{-14}	1.2 10^{-12}	1.2 10^{-13}	3.2 10^{-11}	3.0 10^{-11}	3.0 10^{-11}	4.4 10^{-9}	4.6 10^{-9}	6.7 10^{-11}	4.2 10^{-9}	4.8 10^{-10}	3.0 10^{-9}
30	7.5 10^{-14}	1.5 10^{-12}	1.5 10^{-13}	3.9 10^{-11}	3.6 10^{-11}	3.6 10^{-11}	5.3 10^{-9}	5.6 10^{-9}	8.1 10^{-11}	5.0 10^{-9}	5.7 10^{-10}	3.6 10^{-9}
60	8.2 10^{-14}	1.7 10^{-12}	1.8 10^{-13}	4.6 10^{-11}	4.2 10^{-11}	4.2 10^{-11}	6.2 10^{-9}	6.5 10^{-9}	9.4 10^{-11}	5.9 10^{-9}	6.5 10^{-10}	4.2 10^{-9}
90	8.4 10^{-14}	1.8 10^{-12}	1.9 10^{-13}	4.9 10^{-11}	4.6 10^{-11}	4.6 10^{-11}	6.7 10^{-9}	7.1 10^{-9}	1.0 10^{-10}	6.3 10^{-9}	6.9 10^{-10}	4.6 10^{-9}
180	8.6 10^{-14}	2.1 10^{-12}	2.2 10^{-13}	5.6 10^{-11}	5.2 10^{-11}	5.2 10^{-11}	7.6 10^{-9}	8.0 10^{-9}	1.2 10^{-10}	7.2 10^{-9}	7.5 10^{-10}	5.2 10^{-9}
1 year	8.6 10^{-14}	2.2 10^{-12}	2.5 10^{-13}	6.4 10^{-11}	5.9 10^{-11}	5.9 10^{-11}	8.6 10^{-9}	9.1 10^{-9}	1.3 10^{-10}	8.2 10^{-9}	7.9 10^{-10}	5.9 10^{-9}
2 years	8.6 10^{-14}	2.4 10^{-12}	2.8 10^{-13}	7.3 10^{-11}	6.7 10^{-11}	6.7 10^{-11}	9.8 10^{-9}	1.0 10^{-8}	1.5 10^{-10}	9.3 10^{-9}	8.0 10^{-10}	6.7 10^{-9}
3 years	8.6 10^{-14}	2.4 10^{-12}	3.0 10^{-13}	7.9 10^{-11}	7.3 10^{-11}	7.3 10^{-11}	1.1 10^{-8}	1.1 10^{-8}	1.6 10^{-10}	1.0 10^{-8}	8.1 10^{-10}	7.2 10^{-9}
4 years	8.6 10^{-14}	2.4 10^{-12}	3.2 10^{-13}	8.4 10^{-11}	7.8 10^{-11}	7.8 10^{-11}	1.1 10^{-8}	1.2 10^{-8}	1.7 10^{-10}	1.1 10^{-8}	8.1 10^{-10}	7.6 10^{-9}
5 years	8.6 10^{-14}	2.4 10^{-12}	3.4 10^{-13}	8.9 10^{-11}	8.2 10^{-11}	8.2 10^{-11}	1.2 10^{-8}	1.3 10^{-8}	1.8 10^{-10}	1.1 10^{-8}	8.1 10^{-10}	8.0 10^{-9}
10 years	8.6 10^{-14}	2.4 10^{-12}	4.0 10^{-13}	1.1 10^{-10}	1.0 10^{-10}	1.0 10^{-10}	1.4 10^{-8}	1.5 10^{-8}	2.1 10^{-10}	1.4 10^{-8}	8.1 10^{-10}	9.4 10^{-9}

Table B17: Infant integrated committed lung dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type F, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	$1.3\ 10^{-14}$	$2.9\ 10^{-13}$	$2.7\ 10^{-14}$	$5.2\ 10^{-12}$	$4.8\ 10^{-12}$	$4.6\ 10^{-12}$	$1.5\ 10^{-10}$	$1.6\ 10^{-10}$	$2.5\ 10^{-12}$	$1.3\ 10^{-10}$	$4.6\ 10^{-12}$	$6.1\ 10^{-11}$
2	$2.1\ 10^{-14}$	$4.9\ 10^{-13}$	$4.5\ 10^{-14}$	$8.8\ 10^{-12}$	$8.1\ 10^{-12}$	$7.8\ 10^{-12}$	$2.5\ 10^{-10}$	$2.7\ 10^{-10}$	$4.3\ 10^{-12}$	$2.1\ 10^{-10}$	$7.7\ 10^{-12}$	$1.0\ 10^{-10}$
3	$2.6\ 10^{-14}$	$6.1\ 10^{-13}$	$5.6\ 10^{-14}$	$1.1\ 10^{-11}$	$1.0\ 10^{-11}$	$9.7\ 10^{-12}$	$3.1\ 10^{-10}$	$3.3\ 10^{-10}$	$5.3\ 10^{-12}$	$2.7\ 10^{-10}$	$9.5\ 10^{-12}$	$1.3\ 10^{-10}$
4	$3.0\ 10^{-14}$	$6.9\ 10^{-13}$	$6.3\ 10^{-14}$	$1.2\ 10^{-11}$	$1.1\ 10^{-11}$	$1.1\ 10^{-11}$	$3.5\ 10^{-10}$	$3.8\ 10^{-10}$	$6.0\ 10^{-12}$	$3.0\ 10^{-10}$	$1.1\ 10^{-11}$	$1.5\ 10^{-10}$
5	$3.2\ 10^{-14}$	$7.6\ 10^{-13}$	$6.9\ 10^{-14}$	$1.4\ 10^{-11}$	$1.3\ 10^{-11}$	$1.2\ 10^{-11}$	$3.8\ 10^{-10}$	$4.1\ 10^{-10}$	$6.6\ 10^{-12}$	$3.3\ 10^{-10}$	$1.2\ 10^{-11}$	$1.6\ 10^{-10}$
6	$3.4\ 10^{-14}$	$8.1\ 10^{-13}$	$7.4\ 10^{-14}$	$1.4\ 10^{-11}$	$1.3\ 10^{-11}$	$1.3\ 10^{-11}$	$4.1\ 10^{-10}$	$4.4\ 10^{-10}$	$7.1\ 10^{-12}$	$3.5\ 10^{-10}$	$1.3\ 10^{-11}$	$1.7\ 10^{-10}$
7	$3.6\ 10^{-14}$	$8.6\ 10^{-13}$	$7.8\ 10^{-14}$	$1.5\ 10^{-11}$	$1.4\ 10^{-11}$	$1.4\ 10^{-11}$	$4.3\ 10^{-10}$	$4.7\ 10^{-10}$	$7.5\ 10^{-12}$	$3.7\ 10^{-10}$	$1.3\ 10^{-11}$	$1.8\ 10^{-10}$
10	$4.0\ 10^{-14}$	$9.6\ 10^{-13}$	$8.8\ 10^{-14}$	$1.7\ 10^{-11}$	$1.6\ 10^{-11}$	$1.5\ 10^{-11}$	$4.8\ 10^{-10}$	$5.2\ 10^{-10}$	$8.4\ 10^{-12}$	$4.2\ 10^{-10}$	$1.5\ 10^{-11}$	$2.0\ 10^{-10}$
14	$4.3\ 10^{-14}$	$1.1\ 10^{-12}$	$9.7\ 10^{-14}$	$1.9\ 10^{-11}$	$1.8\ 10^{-11}$	$1.7\ 10^{-11}$	$5.3\ 10^{-10}$	$5.8\ 10^{-10}$	$9.2\ 10^{-12}$	$4.6\ 10^{-10}$	$1.6\ 10^{-11}$	$2.2\ 10^{-10}$
30	$5.0\ 10^{-14}$	$1.3\ 10^{-12}$	$1.2\ 10^{-13}$	$2.3\ 10^{-11}$	$2.1\ 10^{-11}$	$2.0\ 10^{-11}$	$6.4\ 10^{-10}$	$7.0\ 10^{-10}$	$1.1\ 10^{-11}$	$5.6\ 10^{-10}$	$2.0\ 10^{-11}$	$2.7\ 10^{-10}$
60	$5.4\ 10^{-14}$	$1.5\ 10^{-12}$	$1.4\ 10^{-13}$	$2.7\ 10^{-11}$	$2.5\ 10^{-11}$	$2.4\ 10^{-11}$	$7.5\ 10^{-10}$	$8.1\ 10^{-10}$	$1.3\ 10^{-11}$	$6.5\ 10^{-10}$	$2.2\ 10^{-11}$	$3.2\ 10^{-10}$
90	$5.6\ 10^{-14}$	$1.6\ 10^{-12}$	$1.5\ 10^{-13}$	$2.9\ 10^{-11}$	$2.7\ 10^{-11}$	$2.6\ 10^{-11}$	$8.1\ 10^{-10}$	$8.8\ 10^{-10}$	$1.4\ 10^{-11}$	$7.0\ 10^{-10}$	$2.4\ 10^{-11}$	$3.4\ 10^{-10}$
180	$5.7\ 10^{-14}$	$1.7\ 10^{-12}$	$1.7\ 10^{-13}$	$3.3\ 10^{-11}$	$3.0\ 10^{-11}$	$2.9\ 10^{-11}$	$9.2\ 10^{-10}$	$1.0\ 10^{-9}$	$1.6\ 10^{-11}$	$8.0\ 10^{-10}$	$2.6\ 10^{-11}$	$3.9\ 10^{-10}$
1 year	$5.7\ 10^{-14}$	$1.9\ 10^{-12}$	$1.9\ 10^{-13}$	$3.7\ 10^{-11}$	$3.5\ 10^{-11}$	$3.3\ 10^{-11}$	$1.0\ 10^{-9}$	$1.1\ 10^{-9}$	$1.8\ 10^{-11}$	$9.1\ 10^{-10}$	$2.7\ 10^{-11}$	$4.4\ 10^{-10}$
2 years	$5.7\ 10^{-14}$	$2.0\ 10^{-12}$	$2.2\ 10^{-13}$	$4.3\ 10^{-11}$	$3.9\ 10^{-11}$	$3.8\ 10^{-11}$	$1.2\ 10^{-9}$	$1.3\ 10^{-9}$	$2.0\ 10^{-11}$	$1.0\ 10^{-9}$	$2.8\ 10^{-11}$	$5.0\ 10^{-10}$
3 years	$5.7\ 10^{-14}$	$2.1\ 10^{-12}$	$2.3\ 10^{-13}$	$4.6\ 10^{-11}$	$4.3\ 10^{-11}$	$4.1\ 10^{-11}$	$1.3\ 10^{-9}$	$1.4\ 10^{-9}$	$2.2\ 10^{-11}$	$1.1\ 10^{-9}$	$2.8\ 10^{-11}$	$5.4\ 10^{-10}$
4 years	$5.7\ 10^{-14}$	$2.1\ 10^{-12}$	$2.5\ 10^{-13}$	$4.9\ 10^{-11}$	$4.6\ 10^{-11}$	$4.4\ 10^{-11}$	$1.4\ 10^{-9}$	$1.5\ 10^{-9}$	$2.3\ 10^{-11}$	$1.2\ 10^{-9}$	$2.8\ 10^{-11}$	$5.7\ 10^{-10}$
5 years	$5.7\ 10^{-14}$	$2.1\ 10^{-12}$	$2.6\ 10^{-13}$	$5.2\ 10^{-11}$	$4.8\ 10^{-11}$	$4.6\ 10^{-11}$	$1.4\ 10^{-9}$	$1.6\ 10^{-9}$	$2.4\ 10^{-11}$	$1.3\ 10^{-9}$	$2.8\ 10^{-11}$	$6.0\ 10^{-10}$
10 years	$5.7\ 10^{-14}$	$2.1\ 10^{-12}$	$3.1\ 10^{-13}$	$6.4\ 10^{-11}$	$5.9\ 10^{-11}$	$5.7\ 10^{-11}$	$1.8\ 10^{-9}$	$1.9\ 10^{-9}$	$2.8\ 10^{-11}$	$1.5\ 10^{-9}$	$2.8\ 10^{-11}$	$7.0\ 10^{-10}$

Table B18: Infant integrated committed effective dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type M, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	$5.3\ 10^{-14}$	$7.0\ 10^{-13}$	$1.8\ 10^{-13}$	$7.0\ 10^{-11}$	$6.3\ 10^{-11}$	$5.9\ 10^{-11}$	$4.7\ 10^{-10}$	$4.9\ 10^{-10}$	$6.1\ 10^{-12}$	$4.4\ 10^{-10}$	$1.1\ 10^{-10}$	$3.6\ 10^{-10}$
2	$8.9\ 10^{-14}$	$1.2\ 10^{-12}$	$3.1\ 10^{-13}$	$1.2\ 10^{-10}$	$1.1\ 10^{-10}$	$1.0\ 10^{-10}$	$7.9\ 10^{-10}$	$8.2\ 10^{-10}$	$1.0\ 10^{-11}$	$7.4\ 10^{-10}$	$1.9\ 10^{-10}$	$6.1\ 10^{-10}$
3	$1.1\ 10^{-13}$	$1.5\ 10^{-12}$	$3.9\ 10^{-13}$	$1.5\ 10^{-10}$	$1.3\ 10^{-10}$	$1.2\ 10^{-10}$	$9.8\ 10^{-10}$	$1.0\ 10^{-9}$	$1.3\ 10^{-11}$	$9.2\ 10^{-10}$	$2.4\ 10^{-10}$	$7.6\ 10^{-10}$
4	$1.2\ 10^{-13}$	$1.7\ 10^{-12}$	$4.4\ 10^{-13}$	$1.7\ 10^{-10}$	$1.5\ 10^{-10}$	$1.4\ 10^{-10}$	$1.1\ 10^{-9}$	$1.2\ 10^{-9}$	$1.5\ 10^{-11}$	$1.0\ 10^{-9}$	$2.7\ 10^{-10}$	$8.6\ 10^{-10}$
5	$1.4\ 10^{-13}$	$1.8\ 10^{-12}$	$4.8\ 10^{-13}$	$1.8\ 10^{-10}$	$1.7\ 10^{-10}$	$1.6\ 10^{-10}$	$1.2\ 10^{-9}$	$1.3\ 10^{-9}$	$1.6\ 10^{-11}$	$1.1\ 10^{-9}$	$3.0\ 10^{-10}$	$9.4\ 10^{-10}$
6	$1.4\ 10^{-13}$	$1.9\ 10^{-12}$	$5.1\ 10^{-13}$	$1.9\ 10^{-10}$	$1.8\ 10^{-10}$	$1.7\ 10^{-10}$	$1.3\ 10^{-9}$	$1.4\ 10^{-9}$	$1.7\ 10^{-11}$	$1.2\ 10^{-9}$	$3.2\ 10^{-10}$	$1.0\ 10^{-9}$
7	$1.5\ 10^{-13}$	$2.0\ 10^{-12}$	$5.4\ 10^{-13}$	$2.1\ 10^{-10}$	$1.9\ 10^{-10}$	$1.8\ 10^{-10}$	$1.4\ 10^{-9}$	$1.4\ 10^{-9}$	$1.8\ 10^{-11}$	$1.3\ 10^{-9}$	$3.3\ 10^{-10}$	$1.1\ 10^{-9}$
10	$1.7\ 10^{-13}$	$2.3\ 10^{-12}$	$6.1\ 10^{-13}$	$2.3\ 10^{-10}$	$2.1\ 10^{-10}$	$2.0\ 10^{-10}$	$1.5\ 10^{-9}$	$1.6\ 10^{-9}$	$2.0\ 10^{-11}$	$1.4\ 10^{-9}$	$3.7\ 10^{-10}$	$1.2\ 10^{-9}$
14	$1.8\ 10^{-13}$	$2.5\ 10^{-12}$	$6.7\ 10^{-13}$	$2.5\ 10^{-10}$	$2.3\ 10^{-10}$	$2.2\ 10^{-10}$	$1.7\ 10^{-9}$	$1.8\ 10^{-9}$	$2.2\ 10^{-11}$	$1.6\ 10^{-9}$	$4.1\ 10^{-10}$	$1.3\ 10^{-9}$
30	$2.1\ 10^{-13}$	$3.0\ 10^{-12}$	$8.1\ 10^{-13}$	$3.1\ 10^{-10}$	$2.8\ 10^{-10}$	$2.6\ 10^{-10}$	$2.1\ 10^{-9}$	$2.2\ 10^{-9}$	$2.7\ 10^{-11}$	$1.9\ 10^{-9}$	$4.9\ 10^{-10}$	$1.6\ 10^{-9}$
60	$2.3\ 10^{-13}$	$3.5\ 10^{-12}$	$9.4\ 10^{-13}$	$3.6\ 10^{-10}$	$3.3\ 10^{-10}$	$3.1\ 10^{-10}$	$2.4\ 10^{-9}$	$2.5\ 10^{-9}$	$3.2\ 10^{-11}$	$2.2\ 10^{-9}$	$5.6\ 10^{-10}$	$1.9\ 10^{-9}$
90	$2.4\ 10^{-13}$	$3.8\ 10^{-12}$	$1.0\ 10^{-12}$	$3.9\ 10^{-10}$	$3.5\ 10^{-10}$	$3.3\ 10^{-10}$	$2.6\ 10^{-9}$	$2.7\ 10^{-9}$	$3.4\ 10^{-11}$	$2.4\ 10^{-9}$	$5.9\ 10^{-10}$	$2.0\ 10^{-9}$
180	$2.4\ 10^{-13}$	$4.2\ 10^{-12}$	$1.2\ 10^{-12}$	$4.4\ 10^{-10}$	$4.0\ 10^{-10}$	$3.8\ 10^{-10}$	$3.0\ 10^{-9}$	$3.1\ 10^{-9}$	$3.9\ 10^{-11}$	$2.8\ 10^{-9}$	$6.4\ 10^{-10}$	$2.3\ 10^{-9}$
1 year	$2.4\ 10^{-13}$	$4.6\ 10^{-12}$	$1.3\ 10^{-12}$	$5.0\ 10^{-10}$	$4.6\ 10^{-10}$	$4.3\ 10^{-10}$	$3.4\ 10^{-9}$	$3.5\ 10^{-9}$	$4.4\ 10^{-11}$	$3.1\ 10^{-9}$	$6.8\ 10^{-10}$	$2.6\ 10^{-9}$
2 years	$2.4\ 10^{-13}$	$4.8\ 10^{-12}$	$1.5\ 10^{-12}$	$5.7\ 10^{-10}$	$5.2\ 10^{-10}$	$4.9\ 10^{-10}$	$3.8\ 10^{-9}$	$4.0\ 10^{-9}$	$5.0\ 10^{-11}$	$3.6\ 10^{-9}$	$6.9\ 10^{-10}$	$2.9\ 10^{-9}$
3 years	$2.4\ 10^{-13}$	$4.9\ 10^{-12}$	$1.6\ 10^{-12}$	$6.2\ 10^{-10}$	$5.6\ 10^{-10}$	$5.3\ 10^{-10}$	$4.2\ 10^{-9}$	$4.3\ 10^{-9}$	$5.3\ 10^{-11}$	$3.9\ 10^{-9}$	$6.9\ 10^{-10}$	$3.2\ 10^{-9}$
4 years	$2.4\ 10^{-13}$	$4.9\ 10^{-12}$	$1.7\ 10^{-12}$	$6.6\ 10^{-10}$	$6.0\ 10^{-10}$	$5.6\ 10^{-10}$	$4.4\ 10^{-9}$	$4.6\ 10^{-9}$	$5.6\ 10^{-11}$	$4.1\ 10^{-9}$	$6.9\ 10^{-10}$	$3.3\ 10^{-9}$
5 years	$2.4\ 10^{-13}$	$5.0\ 10^{-12}$	$1.8\ 10^{-12}$	$7.0\ 10^{-10}$	$6.3\ 10^{-10}$	$6.0\ 10^{-10}$	$4.7\ 10^{-9}$	$4.9\ 10^{-9}$	$5.9\ 10^{-11}$	$4.4\ 10^{-9}$	$6.9\ 10^{-10}$	$3.5\ 10^{-9}$
10 years	$2.4\ 10^{-13}$	$5.0\ 10^{-12}$	$2.1\ 10^{-12}$	$8.5\ 10^{-10}$	$7.7\ 10^{-10}$	$7.3\ 10^{-10}$	$5.6\ 10^{-9}$	$6.0\ 10^{-9}$	$6.9\ 10^{-11}$	$5.3\ 10^{-9}$	$6.9\ 10^{-10}$	$4.1\ 10^{-9}$

Table B19: Infant integrated committed lung dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type M, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	$3.4\ 10^{-13}$	$4.5\ 10^{-12}$	$1.3\ 10^{-12}$	$5.7\ 10^{-10}$	$5.1\ 10^{-10}$	$4.7\ 10^{-10}$	$7.6\ 10^{-10}$	$7.0\ 10^{-10}$	$1.1\ 10^{-12}$	$7.6\ 10^{-10}$	$7.0\ 10^{-10}$	$7.6\ 10^{-10}$
2	$5.6\ 10^{-13}$	$7.6\ 10^{-12}$	$2.1\ 10^{-12}$	$9.6\ 10^{-10}$	$8.7\ 10^{-10}$	$8.0\ 10^{-10}$	$1.3\ 10^{-9}$	$1.2\ 10^{-9}$	$1.8\ 10^{-12}$	$1.3\ 10^{-9}$	$1.2\ 10^{-9}$	$1.3\ 10^{-9}$
3	$6.9\ 10^{-13}$	$9.4\ 10^{-12}$	$2.7\ 10^{-12}$	$1.2\ 10^{-9}$	$1.1\ 10^{-9}$	$1.0\ 10^{-9}$	$1.6\ 10^{-9}$	$1.5\ 10^{-9}$	$2.3\ 10^{-12}$	$1.6\ 10^{-9}$	$1.5\ 10^{-9}$	$1.6\ 10^{-9}$
4	$7.8\ 10^{-13}$	$1.1\ 10^{-11}$	$3.0\ 10^{-12}$	$1.4\ 10^{-9}$	$1.2\ 10^{-9}$	$1.1\ 10^{-9}$	$1.8\ 10^{-9}$	$1.7\ 10^{-9}$	$2.6\ 10^{-12}$	$1.8\ 10^{-9}$	$1.7\ 10^{-9}$	$1.8\ 10^{-9}$
5	$8.5\ 10^{-13}$	$1.2\ 10^{-11}$	$3.3\ 10^{-12}$	$1.5\ 10^{-9}$	$1.3\ 10^{-9}$	$1.2\ 10^{-9}$	$2.0\ 10^{-9}$	$1.8\ 10^{-9}$	$2.8\ 10^{-12}$	$2.0\ 10^{-9}$	$1.8\ 10^{-9}$	$2.0\ 10^{-9}$
6	$9.1\ 10^{-13}$	$1.3\ 10^{-11}$	$3.5\ 10^{-12}$	$1.6\ 10^{-9}$	$1.4\ 10^{-9}$	$1.3\ 10^{-9}$	$2.1\ 10^{-9}$	$1.9\ 10^{-9}$	$3.0\ 10^{-12}$	$2.1\ 10^{-9}$	$1.9\ 10^{-9}$	$2.1\ 10^{-9}$
7	$9.5\ 10^{-13}$	$1.3\ 10^{-11}$	$3.7\ 10^{-12}$	$1.7\ 10^{-9}$	$1.5\ 10^{-9}$	$1.4\ 10^{-9}$	$2.2\ 10^{-9}$	$2.1\ 10^{-9}$	$3.2\ 10^{-12}$	$2.2\ 10^{-9}$	$2.0\ 10^{-9}$	$2.2\ 10^{-9}$
10	$1.1\ 10^{-12}$	$1.5\ 10^{-11}$	$4.2\ 10^{-12}$	$1.9\ 10^{-9}$	$1.7\ 10^{-9}$	$1.6\ 10^{-9}$	$2.5\ 10^{-9}$	$2.3\ 10^{-9}$	$3.6\ 10^{-12}$	$2.5\ 10^{-9}$	$2.3\ 10^{-9}$	$2.5\ 10^{-9}$
14	$1.2\ 10^{-12}$	$1.6\ 10^{-11}$	$4.6\ 10^{-12}$	$2.1\ 10^{-9}$	$1.9\ 10^{-9}$	$1.7\ 10^{-9}$	$2.8\ 10^{-9}$	$2.5\ 10^{-9}$	$3.9\ 10^{-12}$	$2.8\ 10^{-9}$	$2.5\ 10^{-9}$	$2.8\ 10^{-9}$
30	$1.3\ 10^{-12}$	$2.0\ 10^{-11}$	$5.6\ 10^{-12}$	$2.5\ 10^{-9}$	$2.3\ 10^{-9}$	$2.1\ 10^{-9}$	$3.4\ 10^{-9}$	$3.1\ 10^{-9}$	$4.8\ 10^{-12}$	$3.4\ 10^{-9}$	$3.0\ 10^{-9}$	$3.4\ 10^{-9}$
60	$1.4\ 10^{-12}$	$2.3\ 10^{-11}$	$6.5\ 10^{-12}$	$2.9\ 10^{-9}$	$2.6\ 10^{-9}$	$2.4\ 10^{-9}$	$3.9\ 10^{-9}$	$3.6\ 10^{-9}$	$5.5\ 10^{-12}$	$3.9\ 10^{-9}$	$3.4\ 10^{-9}$	$3.9\ 10^{-9}$
90	$1.5\ 10^{-12}$	$2.4\ 10^{-11}$	$7.0\ 10^{-12}$	$3.2\ 10^{-9}$	$2.9\ 10^{-9}$	$2.6\ 10^{-9}$	$4.2\ 10^{-9}$	$3.9\ 10^{-9}$	$6.0\ 10^{-12}$	$4.2\ 10^{-9}$	$3.6\ 10^{-9}$	$4.2\ 10^{-9}$
180	$1.5\ 10^{-12}$	$2.7\ 10^{-11}$	$8.0\ 10^{-12}$	$3.6\ 10^{-9}$	$3.2\ 10^{-9}$	$3.0\ 10^{-9}$	$4.8\ 10^{-9}$	$4.4\ 10^{-9}$	$6.8\ 10^{-12}$	$4.8\ 10^{-9}$	$3.9\ 10^{-9}$	$4.8\ 10^{-9}$
1 year	$1.5\ 10^{-12}$	$2.9\ 10^{-11}$	$9.1\ 10^{-12}$	$4.1\ 10^{-9}$	$3.7\ 10^{-9}$	$3.4\ 10^{-9}$	$5.5\ 10^{-9}$	$5.0\ 10^{-9}$	$7.7\ 10^{-12}$	$5.5\ 10^{-9}$	$4.1\ 10^{-9}$	$5.4\ 10^{-9}$
2 years	$1.5\ 10^{-12}$	$3.1\ 10^{-11}$	$1.0\ 10^{-11}$	$4.7\ 10^{-9}$	$4.2\ 10^{-9}$	$3.9\ 10^{-9}$	$6.2\ 10^{-9}$	$5.7\ 10^{-9}$	$8.7\ 10^{-12}$	$6.2\ 10^{-9}$	$4.2\ 10^{-9}$	$6.2\ 10^{-9}$
3 years	$1.5\ 10^{-12}$	$3.2\ 10^{-11}$	$1.1\ 10^{-11}$	$5.1\ 10^{-9}$	$4.6\ 10^{-9}$	$4.2\ 10^{-9}$	$6.7\ 10^{-9}$	$6.2\ 10^{-9}$	$9.4\ 10^{-12}$	$6.8\ 10^{-9}$	$4.2\ 10^{-9}$	$6.6\ 10^{-9}$
4 years	$1.5\ 10^{-12}$	$3.2\ 10^{-11}$	$1.2\ 10^{-11}$	$5.4\ 10^{-9}$	$4.9\ 10^{-9}$	$4.5\ 10^{-9}$	$7.2\ 10^{-9}$	$6.6\ 10^{-9}$	$9.9\ 10^{-12}$	$7.2\ 10^{-9}$	$4.2\ 10^{-9}$	$7.0\ 10^{-9}$
5 years	$1.5\ 10^{-12}$	$3.2\ 10^{-11}$	$1.2\ 10^{-11}$	$5.7\ 10^{-9}$	$5.1\ 10^{-9}$	$4.8\ 10^{-9}$	$7.6\ 10^{-9}$	$7.0\ 10^{-9}$	$1.0\ 10^{-11}$	$7.6\ 10^{-9}$	$4.2\ 10^{-9}$	$7.4\ 10^{-9}$
10 years	$1.5\ 10^{-12}$	$3.2\ 10^{-11}$	$1.5\ 10^{-11}$	$7.0\ 10^{-9}$	$6.3\ 10^{-9}$	$5.8\ 10^{-9}$	$9.1\ 10^{-9}$	$8.5\ 10^{-9}$	$1.2\ 10^{-11}$	$9.3\ 10^{-9}$	$4.2\ 10^{-9}$	$8.6\ 10^{-9}$

Table B20: Infant integrated committed effective dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type S, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	$6.3\ 10^{-14}$	$1.5\ 10^{-12}$	$6.3\ 10^{-13}$	$1.8\ 10^{-10}$	$1.6\ 10^{-10}$	$1.6\ 10^{-10}$	$2.5\ 10^{-10}$	$2.5\ 10^{-10}$	$1.5\ 10^{-12}$	$2.5\ 10^{-10}$	$1.2\ 10^{-10}$	$2.4\ 10^{-10}$
2	$1.1\ 10^{-13}$	$2.5\ 10^{-12}$	$1.1\ 10^{-12}$	$3.1\ 10^{-10}$	$2.8\ 10^{-10}$	$2.7\ 10^{-10}$	$4.3\ 10^{-10}$	$4.2\ 10^{-10}$	$2.5\ 10^{-12}$	$4.3\ 10^{-10}$	$2.0\ 10^{-10}$	$4.1\ 10^{-10}$
3	$1.3\ 10^{-13}$	$3.0\ 10^{-12}$	$1.3\ 10^{-12}$	$3.9\ 10^{-10}$	$3.5\ 10^{-10}$	$3.3\ 10^{-10}$	$5.3\ 10^{-10}$	$5.2\ 10^{-10}$	$3.1\ 10^{-12}$	$5.3\ 10^{-10}$	$2.5\ 10^{-10}$	$5.0\ 10^{-10}$
4	$1.5\ 10^{-13}$	$3.5\ 10^{-12}$	$1.5\ 10^{-12}$	$4.4\ 10^{-10}$	$3.9\ 10^{-10}$	$3.8\ 10^{-10}$	$6.0\ 10^{-10}$	$5.9\ 10^{-10}$	$3.5\ 10^{-12}$	$6.0\ 10^{-10}$	$2.9\ 10^{-10}$	$5.7\ 10^{-10}$
5	$1.6\ 10^{-13}$	$3.8\ 10^{-12}$	$1.7\ 10^{-12}$	$4.8\ 10^{-10}$	$4.3\ 10^{-10}$	$4.1\ 10^{-10}$	$6.6\ 10^{-10}$	$6.4\ 10^{-10}$	$3.8\ 10^{-12}$	$6.6\ 10^{-10}$	$3.1\ 10^{-10}$	$6.3\ 10^{-10}$
6	$1.7\ 10^{-13}$	$4.1\ 10^{-12}$	$1.8\ 10^{-12}$	$5.1\ 10^{-10}$	$4.6\ 10^{-10}$	$4.4\ 10^{-10}$	$7.1\ 10^{-10}$	$6.9\ 10^{-10}$	$4.1\ 10^{-12}$	$7.1\ 10^{-10}$	$3.3\ 10^{-10}$	$6.7\ 10^{-10}$
7	$1.8\ 10^{-13}$	$4.3\ 10^{-12}$	$1.9\ 10^{-12}$	$5.4\ 10^{-10}$	$4.9\ 10^{-10}$	$4.7\ 10^{-10}$	$7.5\ 10^{-10}$	$7.3\ 10^{-10}$	$4.3\ 10^{-12}$	$7.5\ 10^{-10}$	$3.5\ 10^{-10}$	$7.1\ 10^{-10}$
10	$2.0\ 10^{-13}$	$4.8\ 10^{-12}$	$2.1\ 10^{-12}$	$6.1\ 10^{-10}$	$5.4\ 10^{-10}$	$5.2\ 10^{-10}$	$8.4\ 10^{-10}$	$8.2\ 10^{-10}$	$4.8\ 10^{-12}$	$8.4\ 10^{-10}$	$3.9\ 10^{-10}$	$8.0\ 10^{-10}$
14	$2.2\ 10^{-13}$	$5.3\ 10^{-12}$	$2.3\ 10^{-12}$	$6.7\ 10^{-10}$	$6.0\ 10^{-10}$	$5.8\ 10^{-10}$	$9.2\ 10^{-10}$	$9.0\ 10^{-10}$	$5.3\ 10^{-12}$	$9.2\ 10^{-10}$	$4.3\ 10^{-10}$	$8.8\ 10^{-10}$
30	$2.5\ 10^{-13}$	$6.4\ 10^{-12}$	$2.8\ 10^{-12}$	$8.1\ 10^{-10}$	$7.3\ 10^{-10}$	$7.0\ 10^{-10}$	$1.1\ 10^{-9}$	$1.1\ 10^{-9}$	$6.4\ 10^{-12}$	$1.1\ 10^{-9}$	$5.2\ 10^{-10}$	$1.1\ 10^{-9}$
60	$2.7\ 10^{-13}$	$7.3\ 10^{-12}$	$3.3\ 10^{-12}$	$9.4\ 10^{-10}$	$8.5\ 10^{-10}$	$8.1\ 10^{-10}$	$1.3\ 10^{-9}$	$1.3\ 10^{-9}$	$7.5\ 10^{-12}$	$1.3\ 10^{-9}$	$5.9\ 10^{-10}$	$1.2\ 10^{-9}$
90	$2.8\ 10^{-13}$	$7.9\ 10^{-12}$	$3.5\ 10^{-12}$	$1.0\ 10^{-9}$	$9.2\ 10^{-10}$	$8.8\ 10^{-10}$	$1.4\ 10^{-9}$	$1.4\ 10^{-9}$	$8.1\ 10^{-12}$	$1.4\ 10^{-9}$	$6.3\ 10^{-10}$	$1.3\ 10^{-9}$
180	$2.9\ 10^{-13}$	$8.7\ 10^{-12}$	$4.0\ 10^{-12}$	$1.2\ 10^{-9}$	$1.0\ 10^{-9}$	$1.0\ 10^{-9}$	$1.6\ 10^{-9}$	$1.6\ 10^{-9}$	$9.2\ 10^{-12}$	$1.6\ 10^{-9}$	$6.8\ 10^{-10}$	$1.5\ 10^{-9}$
1 year	$2.9\ 10^{-13}$	$9.5\ 10^{-12}$	$4.5\ 10^{-12}$	$1.3\ 10^{-9}$	$1.2\ 10^{-9}$	$1.1\ 10^{-9}$	$1.8\ 10^{-9}$	$1.8\ 10^{-9}$	$1.0\ 10^{-11}$	$1.8\ 10^{-9}$	$7.1\ 10^{-10}$	$1.7\ 10^{-9}$
2 years	$2.9\ 10^{-13}$	$1.0\ 10^{-11}$	$5.1\ 10^{-12}$	$1.5\ 10^{-9}$	$1.3\ 10^{-9}$	$1.3\ 10^{-9}$	$2.1\ 10^{-9}$	$2.0\ 10^{-9}$	$1.2\ 10^{-11}$	$2.1\ 10^{-9}$	$7.3\ 10^{-10}$	$1.9\ 10^{-9}$
3 years	$2.9\ 10^{-13}$	$1.0\ 10^{-11}$	$5.6\ 10^{-12}$	$1.6\ 10^{-9}$	$1.5\ 10^{-9}$	$1.4\ 10^{-9}$	$2.2\ 10^{-9}$	$2.2\ 10^{-9}$	$1.3\ 10^{-11}$	$2.3\ 10^{-9}$	$7.3\ 10^{-10}$	$2.1\ 10^{-9}$
4 years	$2.9\ 10^{-13}$	$1.0\ 10^{-11}$	$5.9\ 10^{-12}$	$1.7\ 10^{-9}$	$1.6\ 10^{-9}$	$1.5\ 10^{-9}$	$2.4\ 10^{-9}$	$2.3\ 10^{-9}$	$1.3\ 10^{-11}$	$2.4\ 10^{-9}$	$7.3\ 10^{-10}$	$2.2\ 10^{-9}$
5 years	$2.9\ 10^{-13}$	$1.0\ 10^{-11}$	$6.2\ 10^{-12}$	$1.8\ 10^{-9}$	$1.6\ 10^{-9}$	$1.6\ 10^{-9}$	$2.5\ 10^{-9}$	$2.5\ 10^{-9}$	$1.4\ 10^{-11}$	$2.5\ 10^{-9}$	$7.3\ 10^{-10}$	$2.3\ 10^{-9}$
10 years	$2.9\ 10^{-13}$	$1.0\ 10^{-11}$	$7.4\ 10^{-12}$	$2.2\ 10^{-9}$	$2.0\ 10^{-9}$	$1.9\ 10^{-9}$	$3.0\ 10^{-9}$	$3.0\ 10^{-9}$	$1.6\ 10^{-11}$	$3.1\ 10^{-9}$	$7.3\ 10^{-10}$	$2.7\ 10^{-9}$

Table B21: Infant integrated committed lung dose from inhalation (Sv) per unit Bq m^{-2} deposit, assuming lung absorption type S, at end of relevant period

Time (days unless otherwise stated)	Ru-103	Ru-106	Cs-137	U-234	U-235	U-238	Pu-238	Pu-239	Pu-241	Am-241	Cm-242	Cm-244
1	$4.2\ 10^{-13}$	$1.1\ 10^{-11}$	$4.9\ 10^{-12}$	$1.5\ 10^{-9}$	$1.4\ 10^{-9}$	$1.3\ 10^{-9}$	$1.8\ 10^{-9}$	$1.7\ 10^{-9}$	$5.5\ 10^{-12}$	$1.8\ 10^{-9}$	$9.5\ 10^{-10}$	$1.8\ 10^{-9}$
2	$7.1\ 10^{-13}$	$1.8\ 10^{-11}$	$8.2\ 10^{-12}$	$2.6\ 10^{-9}$	$2.4\ 10^{-9}$	$2.2\ 10^{-9}$	$3.1\ 10^{-9}$	$2.9\ 10^{-9}$	$9.3\ 10^{-12}$	$3.1\ 10^{-9}$	$1.6\ 10^{-9}$	$3.1\ 10^{-9}$
3	$8.8\ 10^{-13}$	$2.3\ 10^{-11}$	$1.0\ 10^{-11}$	$3.2\ 10^{-9}$	$2.9\ 10^{-9}$	$2.8\ 10^{-9}$	$3.9\ 10^{-9}$	$3.6\ 10^{-9}$	$1.2\ 10^{-11}$	$3.9\ 10^{-9}$	$2.0\ 10^{-9}$	$3.9\ 10^{-9}$
4	$9.9\ 10^{-13}$	$2.6\ 10^{-11}$	$1.2\ 10^{-11}$	$3.6\ 10^{-9}$	$3.3\ 10^{-9}$	$3.2\ 10^{-9}$	$4.4\ 10^{-9}$	$4.1\ 10^{-9}$	$1.3\ 10^{-11}$	$4.4\ 10^{-9}$	$2.3\ 10^{-9}$	$4.4\ 10^{-9}$
5	$1.1\ 10^{-12}$	$2.8\ 10^{-11}$	$1.3\ 10^{-11}$	$4.0\ 10^{-9}$	$3.6\ 10^{-9}$	$3.5\ 10^{-9}$	$4.8\ 10^{-9}$	$4.5\ 10^{-9}$	$1.4\ 10^{-11}$	$4.8\ 10^{-9}$	$2.5\ 10^{-9}$	$4.8\ 10^{-9}$
6	$1.1\ 10^{-12}$	$3.0\ 10^{-11}$	$1.4\ 10^{-11}$	$4.2\ 10^{-9}$	$3.9\ 10^{-9}$	$3.7\ 10^{-9}$	$5.1\ 10^{-9}$	$4.8\ 10^{-9}$	$1.5\ 10^{-11}$	$5.1\ 10^{-9}$	$2.6\ 10^{-9}$	$5.1\ 10^{-9}$
7	$1.2\ 10^{-12}$	$3.2\ 10^{-11}$	$1.4\ 10^{-11}$	$4.5\ 10^{-9}$	$4.1\ 10^{-9}$	$3.9\ 10^{-9}$	$5.4\ 10^{-9}$	$5.0\ 10^{-9}$	$1.6\ 10^{-11}$	$5.4\ 10^{-9}$	$2.8\ 10^{-9}$	$5.4\ 10^{-9}$
10	$1.3\ 10^{-12}$	$3.5\ 10^{-11}$	$1.6\ 10^{-11}$	$5.0\ 10^{-9}$	$4.6\ 10^{-9}$	$4.4\ 10^{-9}$	$6.1\ 10^{-9}$	$5.7\ 10^{-9}$	$1.8\ 10^{-11}$	$6.1\ 10^{-9}$	$3.1\ 10^{-9}$	$6.1\ 10^{-9}$
14	$1.5\ 10^{-12}$	$3.9\ 10^{-11}$	$1.8\ 10^{-11}$	$5.5\ 10^{-9}$	$5.1\ 10^{-9}$	$4.8\ 10^{-9}$	$6.7\ 10^{-9}$	$6.2\ 10^{-9}$	$2.0\ 10^{-11}$	$6.7\ 10^{-9}$	$3.4\ 10^{-9}$	$6.7\ 10^{-9}$
30	$1.7\ 10^{-12}$	$4.7\ 10^{-11}$	$2.2\ 10^{-11}$	$6.7\ 10^{-9}$	$6.2\ 10^{-9}$	$5.9\ 10^{-9}$	$8.1\ 10^{-9}$	$7.6\ 10^{-9}$	$2.4\ 10^{-11}$	$8.1\ 10^{-9}$	$4.1\ 10^{-9}$	$8.1\ 10^{-9}$
60	$1.8\ 10^{-12}$	$5.4\ 10^{-11}$	$2.5\ 10^{-11}$	$7.8\ 10^{-9}$	$7.2\ 10^{-9}$	$6.8\ 10^{-9}$	$9.4\ 10^{-9}$	$8.8\ 10^{-9}$	$2.8\ 10^{-11}$	$9.4\ 10^{-9}$	$4.7\ 10^{-9}$	$9.4\ 10^{-9}$
90	$1.9\ 10^{-12}$	$5.8\ 10^{-11}$	$2.7\ 10^{-11}$	$8.5\ 10^{-9}$	$7.8\ 10^{-9}$	$7.4\ 10^{-9}$	$1.0\ 10^{-8}$	$9.5\ 10^{-9}$	$3.1\ 10^{-11}$	$1.0\ 10^{-8}$	$4.9\ 10^{-9}$	$1.0\ 10^{-8}$
180	$1.9\ 10^{-12}$	$6.5\ 10^{-11}$	$3.1\ 10^{-11}$	$9.6\ 10^{-9}$	$8.8\ 10^{-9}$	$8.4\ 10^{-9}$	$1.2\ 10^{-8}$	$1.1\ 10^{-8}$	$3.5\ 10^{-11}$	$1.2\ 10^{-8}$	$5.4\ 10^{-9}$	$1.2\ 10^{-8}$
1 year	$1.9\ 10^{-12}$	$7.0\ 10^{-11}$	$3.5\ 10^{-11}$	$1.1\ 10^{-8}$	$1.0\ 10^{-8}$	$9.6\ 10^{-9}$	$1.3\ 10^{-8}$	$1.2\ 10^{-8}$	$3.9\ 10^{-11}$	$1.3\ 10^{-8}$	$5.6\ 10^{-9}$	$1.3\ 10^{-8}$
2 years	$1.9\ 10^{-12}$	$7.4\ 10^{-11}$	$4.0\ 10^{-11}$	$1.2\ 10^{-8}$	$1.1\ 10^{-8}$	$1.1\ 10^{-8}$	$1.5\ 10^{-8}$	$1.4\ 10^{-8}$	$4.4\ 10^{-11}$	$1.5\ 10^{-8}$	$5.7\ 10^{-9}$	$1.5\ 10^{-8}$
3 years	$1.9\ 10^{-12}$	$7.6\ 10^{-11}$	$4.3\ 10^{-11}$	$1.4\ 10^{-8}$	$1.2\ 10^{-8}$	$1.2\ 10^{-8}$	$1.6\ 10^{-8}$	$1.5\ 10^{-8}$	$4.8\ 10^{-11}$	$1.6\ 10^{-8}$	$5.8\ 10^{-9}$	$1.6\ 10^{-8}$
4 years	$1.9\ 10^{-12}$	$7.6\ 10^{-11}$	$4.6\ 10^{-11}$	$1.4\ 10^{-8}$	$1.3\ 10^{-8}$	$1.3\ 10^{-8}$	$1.7\ 10^{-8}$	$1.6\ 10^{-8}$	$5.1\ 10^{-11}$	$1.7\ 10^{-8}$	$5.8\ 10^{-9}$	$1.7\ 10^{-8}$
5 years	$1.9\ 10^{-12}$	$7.7\ 10^{-11}$	$4.8\ 10^{-11}$	$1.5\ 10^{-8}$	$1.4\ 10^{-8}$	$1.3\ 10^{-8}$	$1.8\ 10^{-8}$	$1.7\ 10^{-8}$	$5.3\ 10^{-11}$	$1.8\ 10^{-8}$	$5.8\ 10^{-9}$	$1.8\ 10^{-8}$
10 years	$1.9\ 10^{-12}$	$7.7\ 10^{-11}$	$5.7\ 10^{-11}$	$1.9\ 10^{-8}$	$1.7\ 10^{-8}$	$1.6\ 10^{-8}$	$2.2\ 10^{-8}$	$2.1\ 10^{-8}$	$6.2\ 10^{-11}$	$2.2\ 10^{-8}$	$5.8\ 10^{-9}$	$2.1\ 10^{-8}$