NDAWG
National Dose Assessment Working Group

NDAWG GUIDANCE NOTE 6B

Guidance on short term release assessments
Updated June 2020

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Version	Date	Changes
6	2010	-
6A	Nov 2019	Section 1: updated regarding latest regulations. Section 2.1: added with summary of updates. Appendices 1 and 2: typo in dose criterion of 'less than 0.01 mSv/y' is corrected to 'less than 0.1 mSv/y' Section 8: now references NDAWG/1/2019 Appendix 1, paragraph 6: updated to highlight limitations with the simple approximation for estimating the number of short term releases to consider in an assessment.
6B	Jun 2020	Section 8: now references NDAWG/1/2020

About NDAWG Guidance Notes

National Dose Assessment Working Group Guidance Notes provide guidance on radiological assessment topics. The UK NDAWG has representatives from Government and its Agencies, nuclear industry, non-nuclear users of radioactive substances, Non-Governmental Organisations and independent experts. This guidance note has been updated by the Practitioner Group on the Impact of Radioactivity in the Environment which has representatives from Public Health England, Environment Agency, Scottish Environment Protection Agency, Office for Nuclear Regulation, Food Standards Agency and Food Standards Scotland.

Contents

1 Introduction and purpose

Responsibility for granting a permit or authorisation to discharge radioactive wastes to the environment rests with the Environment Agency (in England and Wales), the Scottish Environment Protection Agency (SEPA) and the Northern Ireland Environment Agency (referred to as the Environment Agencies). The legislation for issuing permits or authorisations are the Environmental Permitting Regulations 2016 (as amended in 2018) in England and Wales; Environmental Authorisations (Scotland) Regulations 2018; and the Radioactive Substances Act 1993 (RSA 93) as amended by The Radioactive Substances (Modification of Enactments) Regulations (Northern Ireland) 2018.

The Euratom Basic Safety Standards (BSS) Directive 2013 [Ref 1] requires member states to ensure that specified dose limits for the public are not exceeded.
The Environmental Permitting Regulations 2016 and a direction on the Scottish Environment Protection Agency (SEPA) [Ref 2] require the Environment Agency and SEPA to ensure that doses to reference groups of the public do not exceed specified dose limits and constraints, in discharging their functions in relation to the disposal of radioactive waste relevant regulations. There is equivalent legislation for Northern Ireland [Ref 3].

The Environment Agency, Scottish Environment Protection Agency and the Department of Environment in Northern Ireland (now Northern Ireland Environment Agency) in collaboration with the Food Standards Agency and Health Protection Agency (now the Radiation Assessments Department of Public Health England) have developed and published principles and guidance for the prospective assessment of public doses [Ref 4]. Included is a principle requiring the assessment of operational short term releases of radionuclides. Normal operations (i.e., routine, planned or reasonably foreseeable events) may lead to short term releases of radionuclides over a few hours or days that are enhanced relative to the long term trend. In some circumstances, discharges of a significant proportion of a 12-month discharge limit may occur over a short time period as a result of variations in processes (e.g. nuclear reactor blow-downs, nuclear medicine treatment days within hospitals or particular projects e.g. decommissioning activities, research using particular radionuclides).

This NDAWG guidance note provides guidance for assessing doses from planned short term releases to inform the process of proposing or setting short term limits or notification levels.

2 Scope

This guidance is for assessing doses to members of the public from reasonably foreseeable or planned operational short term releases, over the lifetime of the plant or operation, of radioactive substances to air or water. It is not intended that it should be used for assessing doses from accidental releases.

An operational short term release is defined as a release which is larger than a normal release (≥2% of 12-monthly actual or expected discharges) and occurs over a relatively short period of time (≤1 day). For a normally uniform discharge profile, this equates to about 1 week's discharge being released in 1 day or less.

Releases that occur over longer periods of time (e.g. 5 days) may be considered as a continuous release, so long as the daily release during that period does not exceed 2% of the 12-month actual or expected discharges.

2.1 Summary of updates

The main changes made since version 6 in 2010 are technical matters relating to foodchain modelling. The Food Standards Agency foodchain model PRISM 3.7.0 was used to update the predicted activity concentrations of ^{14}C and ^{35}S in foodstuffs. These revised data have been used in the radiological impact assessment for short term atmospheric releases.

3 When is a short term release assessment required?

The flow chart in Figure 1 provides guidance on when a short term release assessment is required.

In general, a short term release assessment will not be required where:

- there is no potential for operational short term releases (as defined in Section 2); or
- the annual effective dose to the critical group from a continuous release at the 12-month limits is less than or equal to 0.02 mSv [Ref 4]; or
- there are monthly limits proposed or in place for releases to air, freshwater, or sewer and the annual effective dose to the critical group from a continuous release at twelve times the monthly limits is less than or equal to 0.1 mSv (see Appendices 1 and 2); or
- there is little variability in water or air dispersion and habits of exposed members of a population over a year (eg, food consumption, occupancy), since only in this situation will the doses from short term releases differ from doses for continuous releases. For this reason, short term releases to estuaries or coastal waters (see Appendix 3) are generally not required.

4 General guidance for assessing short term releases

General guidance for assessing prospective doses from short term releases:

- The dose calculated using continuous release assessment assumptions will be the benchmark, best estimate dose that is reported for an authorised discharge. The short term release assessment provides an analysis of the uncertainty and variability in the continuous release assessment.

- Reasonably realistic assumptions should be used for short term release assessments. These assumptions should be in keeping with the recommendations of ICRP [Ref 5] such that the dose to the individual considered is representative of the most exposed individuals in the population.

- The dose assessed for operational short term releases should be at short term release limits or advisory/notification levels proposed by the operator or Environment Agencies. In the first instance, these may cautiously be taken to be the proposed limits (monthly or 12 monthly) which have been assessed assuming a continuous release. The doses should be compared with the source constraint (maximum of 0.3 mSv/y) and the dose limit (1 mSv/y), taking into account other relevant contributions [Ref 4]. Other contributions will include the dose from any continuous releases for the remainder of the 12 month period. The result of this dose assessment may lead to new short term limits or levels being proposed.

- Doses from short term releases should be assessed for the first year following the short term release. It is not necessary to consider the cumulative effective of short term releases over a number of years as it is highly unlikely that the same exposed groups will be affected. The doses from cumulative effects of discharges over a number of years are adequately considered by a continuous release assessment.

5 Detailed guidance for different release routes

This section provides more detail on how to carry out a short term release assessment for discharges to different parts of the environment.

5.1 Short term releases to air

A short term release assessment for discharges to air should be carried out as follows (see Appendix 1 for further guidance):

- Use the assumptions for cautious or realistic assessments as shown in Table 1.
- Use cautious or realistic dose per unit short term release to air data in Reference 6 or use the assessment methodology as described in Reference 6. The assessment methodology of Reference 6 is based on that described in NRPB-W54 [Ref 7].
- Add in the dose from any remaining releases up to the 12-monthly limits, assessed as a continuous release.
- If the annual dose exceeds 0.3 mSv, more realistic assumptions should be assumed and, if necessary, discharge limits for shorter time periods may be considered.

5.2 Short term releases to freshwater

A short term release assessment for discharges direct to water should be carried out as follows (see Appendix 2 for further guidance):

- Use the assumptions for cautious or realistic assessments as shown in Table 2.
- Use cautious or realistic dose per unit short term release to river data in Reference 8 or use the assessment methodology as described in Reference 8.
- Add in the dose from any remaining releases up to the 12-monthly limits, assessed as a continuous release.
- If the annual dose exceeds 0.3 mSv, more realistic assumptions should be assumed and, if necessary, discharge limits for shorter time periods should be considered.

5.3 Short term releases to sewer

A short term release assessment for discharges to sewer should be carried out as follows (see Appendix 4 for further guidance):

- Assess doses arising from a short term release of treated effluent to freshwater in the same way as a direct release to freshwater (Section 5.2).
- Assess doses arising from the incineration of sewage sludge containing radionuclides from short term releases to sewer in accordance with the guidance on short term releases to air (Section 5.1).
- If the annual dose exceeds 0.3 mSv, more realistic assumptions should be assumed and, if necessary, discharge limits over a shorter time period.

6 Co-incidental short term releases

There is the possibility that a short term release from one site/premises with a permit or authorisation could coincide with a short term release from one or more sites/premises with separate permits or authorisations.

As discussed in Appendix 5, coincidental short term release assessments are only required if two or more short term releases from different sites/premises are certain or almost certain (eg, >95% probability) to occur on the same day and at least one such release is likely to occur per year. Potential situations where this may occur are:

- Common cause of simultaneous reactor depressurisation at adjacent nuclear sites (eg, national grid failure).
- Same treatment days for two hospitals discharging to the same sewage treatment works.

The Environment Agencies should ensure that holders of environmental permits and authorisations to discharge radioactive substances should identify situations where such coincident releases can occur. For those cases where discharges of radioactivity from multiple sites may affect a single representative person, the total dose to that representative person from

all such discharges should be estimated and compared with the appropriate criterion described in [Ref 4]. When estimating the total annual dose to the representative person due to discharges of radioactivity from multiple sites, suitable account should be made of the cumulative impact of any routine and short duration releases of radioactivity from each of the sites.

7 Maximum Permitted Levels (MPLs)

The European Union has specified Maximum Permitted Levels which limit the amounts of activity which are permitted in foods and animal feeds following a radiological emergency [Refs 9, 10, 11]. These MPLs are summarised in Table 3.

Whilst the legislation specifying these MPLs only applies following a nuclear accident or other radiological emergency, wider policy considerations may mean that it is not appropriate to allow routine discharges that may result in these levels being exceeded, except in exceptional circumstances.

The Food Standards Agency will carry out an assessment of the peak activity concentrations of radionuclides in foods following an operational short term release to compare with the appropriate MPLs, using the cautious peak activity assumptions in Tables 1 and 2.

8 References

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2. The Radioactive Substances (Basic Safety Standards) (Scotland) Direction 2000.

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5. ICRP (2007). Assessing dose of the representative individual for the purpose of radiation protection of the public. ICRP Publication 101.

6. National Dose Assessment Working Group (2020). NDAWG/1/2020 Short term releases to atmosphere. https://srp-uk.org/resources/national-dose-assessment.

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10. CEC. Council Regulation (Euratom) No 944/89 laying down maximum permitted levels of radioactive contamination in minor foodstuffs following a nuclear accident or any other case of radiological emergency. *Off J Eur Commun*, L101/17 (1989).

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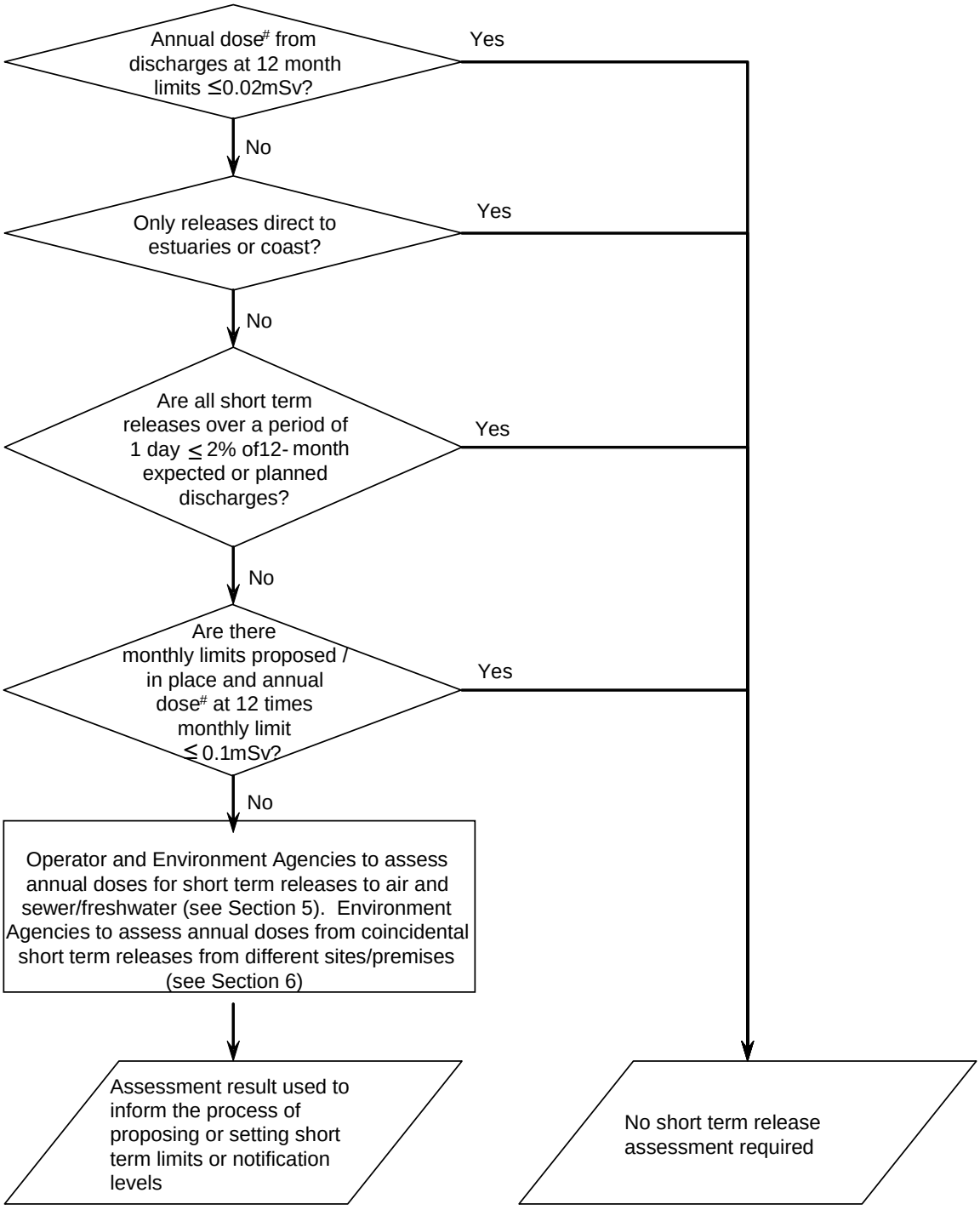

Figure 1 Flow chart for deciding when a short term release assessment is required

#Dose assessed assuming a continuous release over a 12 month period.

Table 1 Assumptions for assessing short term releases to air

Key assessment parameter	Annual average dose – continuous release	Realistic short term release	Cautious short term release
Number of years of discharge	50	1	1
Source term (see Appendix 6 for example application)			
• Limits – 12 month limits only (ie, no short term limits/notification levels)	All radionuclides at 12-month limits continuously throughout 12 month period	Specific release scenarios based on the expected or planned short term releases of different radionuclides. The number of such releases in a year should take account of the probability of wind blowing into the 30^{o} sector where exposed individuals are located (ie, 1/12 for a uniform windrose), subject to a minimum of one release per year. The remaining releases of radionuclides up to the 12-month limits should be assessed as a continuous release.	Single short term release of all radionuclides at 12-month limit.
• Limits – 12-month limits and quarterly notification levels	All radionuclides at 12- month limits continuously throughout 12 month period	Separate sets of single short term releases for the groups of radionuclides which would be expected or planned to be released together in a short term release. The radionuclides in each group will be released at their quarterly notification levels and the remaining releases up to 12-month limits assessed as a continuous release.	Single short term release of all radionuclides at quarterly notification level and remaining releases up to 12-month limits assessed as a continuous release.
• Limits – monthly limits	All radionuclides at 12 times monthly limits continuously throughout 12 month period	Separate sets of single short term releases for the groups of radionuclides which would be expected to be released together in a short term release. The radionuclides in each group will be released at their 1 month limits and the remaining releases up to 12-month limits assessed as a continuous release.	Single short term release of all radionuclides at 1 month limit and remaining releases up to 12-month limits assessed as a continuous release.

Table 1 Continued

Key assessment parameter	Annual average dose – continuous release	Realistic short term release	Cautious short term release
Source term (see Appendix 6 for example application)			
• Limits – 12-month limits and weekly advisory levels (12-month limits should be less than or equal to 52 weekly advisory levels)	All radionuclides at 12-monthly limits continuously throughout 12 month period	Separate sets of multiple short term releases for the groups of radionuclides which would be expected to be released together in a short term release. The radionuclides in each group will be released at their weekly advisory levels. The number of short term releases should be based on the number of weekly advisory limits which are possible in a year (ie, not exceeding 12-month limit) multiplied by the probability of wind blowing into the 30^{o} sector where exposed individuals are located (ie, 1/12 for a uniform windrose). There should be at least one short term release per year and a maximum of four. The remaining releases of radionuclides up to the 12-month limits should be assessed as a continuous release.	Multiple short term releases for all radionuclides at weekly advisory levels. The number of short term releases should be based on the number of weekly advisory limits which are possible in a year (ie, not exceeding 12-month limit) multiplied by the probability of wind blowing into the 30^{o} sector where exposed individuals are located (ie, 1/12 for a uniform windrose). There should be at least one short term release per year and a maximum of four. The remaining releases of radionuclides up to the 12-month limits should be assessed as a continuous release.
• Limits – 12 month limits and daily limits (12-month limits should be less than or equal to 365 daily limits)	All radionuclides at 12-monthly limits continuously throughout 12 month period	Separate sets of multiple short term releases for the groups of radionuclides which can be released together in a short term release. The radionuclides in each group will be release at their daily limits. The number of short term releases should be based on the number of daily limits which are possible in a year (ie, not exceeding 12-month limit) multiplied by the probability of wind blowing into the 30o sector where exposed individuals are located (ie, 1/12 for a uniform windrose). There should be at least one short term release per year and a maximum of 30. The remaining releases of radionuclides up to the 12-month limits should be assessed as a continuous release.	Multiple short term releases for all radionuclides at daily limits. The number of short term releases should be based on the number of daily limits which are possible in a year (ie, not exceeding 12-month limit) multiplied by the probability of wind blowing into the 30o sector where exposed individuals are located (ie, 1/12 for a uniform windrose). There should be at least one short term release per year and a maximum of 30. The remaining releases of radionuclides up to the 12-month limits should be assessed as a continuous release.

Table 1 Continued

Key assessment parameter	Annual average dose – continuous release	Realistic short term release	Cautious short term release
Chemical form	Typical or mean chemical form throughout the year	Typical chemical form which may be released.	Worst case chemical form.
Release duration	Continuous over year	Actual/12 hours (for carbon-11, oxygen-15 and fluorine-18 the default is assumed to be 30 min)	Actual/30 min
Release height	Actual/ground level	Actual/0 m	Actual/0 m
Meteorological modelling	Average uniform or actual wind rose	Wind blows towards critical group and food crop. Modified average weather (broadly representative of 75th percentile of annual actual weather).	Wind blows towards critical group and food crop. Cautious actual weather (broadly representative of 95th percentile).
Location of local food source	Actual/500 m from site	Actual/500 m from site on plume centre line	Actual/maximum
Location of critical group habitation	Actual/100 m from site	Actual/100 m from site on plume centre line	Actual/maximum
Food concentrations	Value representative of annual average concentrations.	Integrated concentrations assuming instantaneous deposit in summer.	Vegetable peak concentrations to represent storage. Milk, meat integrated concentrations assuming instantaneous deposit. Assume summer release.
Ingestion rates Food groups: green veg, fruit, root veg, milk, milk products, grain, cow meat, cow offal, sheep meat, sheep offal.	Two most important foods at 95th percentile of national distribution, the rest at 50th percentile of national distribution. Grain not included. Or site specific data.	Two most important foods at 95th percentile of national distribution, the rest at 50th percentile of national distribution. Milk products and grain are not included. Or site specific data.	Two most important foods at 95th percentile of national distribution, the rest at 50th percentile of national distribution. Grain not included. Or site specific data.
Fraction of food consumption derived locally	1 Or site specific data.	1 Or site specific data.	1 Or site specific data.
Air concentrations for inhalation and external dose from plume.	Use annual average air concentration in plume.	Use average air concentration over release duration.	Use average air concentration over release duration.
Inhalation rate in plume (m^3/h) (ICRP 66)	Average over the year Adult (0.92) Child (0.64) Infant (0.22)	Adult (1.2 average over working day for light workers) Child (0.87) Infant (0.31)	Adult (1.69 average over working day for heavy workers) Child (0.87) Infant (0.31)

Table 1 Continued

Key assessment parameter	Annual average dose – continuous release	Realistic short term release	Cautious short term release
Exposure time to cloud-shine (h)	Adult 8760 Child 8760 Infant 8760	For entire passage of plume	For entire passage of plume
Fraction of time indoors during passage of plume	Adult 0.5 Child 0.8 Infant 0.9	Adult 0.5 Child 0.8 Infant 0.9	0
Location factor cloud gamma	0.2	0.2	-
Location factor cloud beta	1	1	-
Indoor dose reduction factor for inhalation	1	1	-
Deposition for external dose from ground and resuspension	Use annual average deposition rate and calculate integrated dose.	Use total deposit, assume it is instantaneous and calculate integrated dose.	Use total deposit, assume it is instantaneous and calculate integrated dose.
Time spent at location for deposited gamma/resuspension (h) and fraction of the year (%)	Adult 8760 (100%) Child 8760 (100%) Infant 8760 (100%)	Adult 8760 (100%) School children 7560 (85%) Infant 8760 (100%)	Adult 8760 (100%) Child 8760 (100%) Infant 8760 (100%)
Fraction of time indoors for deposited gamma and resuspension	Adult 0.5 Child 0.8 Infant 0.9	Adult 0.5 Child 0.8 Infant 0.9	Adult 0.5 Child 0.8 Infant 0.9
Location factor for deposited gamma	0.1	0.1	0.1
Indoor dose reduction factor for resuspension	1	1	1
Inhalation rate of resuspended material (m^3 h^{-1}) (ICRP 66)	Average over the year Adult (0.92) Child (0.64) Infant (0.22)	Adult (0.92) Child (0.64) Infant (0.22)	Adult (0.92) Child (0.64) Infant (0.22)

Table 2 Assumptions for assessing short term releases to freshwater

Key assessment parameter	Annual average dose – continuous release	Realistic short term release	Cautious short term release
Source term (see Appendix 6 for example application)			
• Limits – 12 month limits only (ie, no short term limits/notification levels)	All radionuclides at 12- month limits continuously throughout 12 month period	Specific release scenarios based on the expected or planned short term releases of different radionuclides. The number of such releases in a year should take account of the probability of the releases occurring in a one month period of both low flow and high occupancy (eg, 1/12 for seasonally independent releases), subject to a minimum of one release per year. The remaining releases up to 12-month limits assessed as continuous release.	Single short term release of all radionuclides at 12-month limit.
• Limits – 12 month limits and quarterly notification levels	All radionuclides at 12- month limits continuously throughout 12 month period	Separate sets of single short term releases for the groups of radionuclides which would be expected or planned to be released together in a short term release. The radionuclides in each group will be released at their quarterly notification levels. The remaining releases up to 12-month limits assessed as continuous release.	Single short term release of all radionuclides at quarterly notification level and remaining releases up to 12-month limits assessed as continuous release.
• Limits – monthly limits	All radionuclides at 12- monthly limits continuously throughout 12 month period	Separate sets of single short term releases for the groups of radionuclides which would be expected to be released together in a short term release. The radionuclides in each group will be released at their 1 month limits. The remaining releases up to 12-month limits assessed as continuous release.	Single short term release of all radionuclides at 1 month limit and remaining releases up to 12-month limits assessed as continuous release.
Chemical form	Typical or mean chemical form throughout the year	Typical chemical form which may be released.	Worst case chemical form.
Release duration	Continuous over year	1 day	30 min
River flow	Annual average flow	25th percentile flow or average summer flow	5th percentile flow
Water concentration for consumption	Annual average concentration	Integrated concentration for release in summer.	Maximum dose for: (1) Integrated concentration for release in summer, or; (2) Average water concentration over first day

Table 2 Continued

Key assessment parameter	Annual average dose – continuous release	Realistic short term release	Cautious short term release
Water consumption rate	Annual critical group consumption rate	Summer critical group consumption rate and mean consumption rate for remainder of year	Maximum dose for: (1) Summer critical group consumption rate and mean consumption rate for remainder of year, or; (2) Daily critical consumption rate
Fish concentrations	Equilibrium concentration	Integrated fish concentration for release in summer, taking account of higher metabolism with higher temperatures in summer	Maximum dose for: (1) Integrated fish concentration for release in summer, taking account of higher metabolism with higher temperatures in summer, or; (2) Max fish concentration for release in summer, taking account of higher metabolism with higher temperatures in summer
Fish consumption rate	Annual critical group consumption rate	Summer critical group consumption rate and mean consumption rate for remainder of year	Maximum dose for: (1) Summer critical group consumption rate and mean consumption rate for remainder of year, or; (2) Critical daily catch rate, assumed to be stored and eaten according to critical daily consumption rate - take account of radioactive decay
Sediment concentrations	Equilibrium concentration	Integrated sediment concentration for release in summer	Maximum dose for: (1) Integrated sediment concentration for release in summer, or; (2) Max sediment concentration
Sediment exposure	Annual critical group occupancy rate	Summer critical group occupancy rate and mean occupancy rate for remainder of year	Maximum dose for: (1) Summer critical group occupancy rate and mean occupancy rate for remainder of year or (2) Critical daily occupancy rate
Water concentration for irrigated foods	Annual average concentration	Integrated concentration for release in summer	Maximum dose for: (1) Integrated concentration for release in summer Or (2) Max water concentration
Irrigation rate	Annual rate	Irrigation rate for summer	Maximum dose for: (1) Summer irrigation rate, or; (2) Critical daily irrigation rate
Irrigated food concentrations	Equilibrium concentration	Integrated food concentrations for release in summer	Integrated food concentrations for release in summer
Irrigated food consumption rates	Annual critical group consumption rate	Summer critical group consumption rate	Summer critical group consumption rate

Table 3 Summary of Maximum Permitted Levels [Refs 9, 10, 11]

Radionuclide	Baby Foods (Bq/kg)	Dairy Produce (Bq/kg)	Other foodstuffs (except minor foodstuffs) (Bq/kg)	Liquid Foodstuffs (Bq/l)
Isotopes of Strontium notably Sr-90	75	125	750	125
Isotopes of Iodine notably I-131	150	500	2000	500
α-emitting isotopes of Pu and trans-Pu elements, notably Pu-239, Am-241	1	20	80	20
All other radionuclides of half-life > 10 days, notably Cs-134, Cs-137	400	1000	1250	1000

Appendix 1 Short term releases to air

Permitted or authorised discharges of radioactive substances to air will most likely be via a stack or a vent. A short term release to air could coincide with poor air dispersion and at times of year when crops are to be shortly harvested. Hence, radioactive substances released non-continuously to air can lead to different doses to those released continuously.

Permits or authorisations for radioactive discharges from nuclear sites generally have 12-month rolling limits. The environment agencies may choose to have limits or notification / advisory levels which cover a shorter period than 12 months to control the impact of short term releases or enable action to be taken (e.g. food countermeasures, restrict occupancy) in the event of a short term release which has the potential to cause dose constraints to be exceeded. Nearly all non-nuclear discharge permits and authorisations have monthly limits, rather than annual or 12-monthly limits. There are some permits and authorisations with daily and 12-month limits.

The assumptions for a realistic or cautious assessment of a short term release to air are given in Table 1. The realistic assumptions should ideally be used, but cautious assumptions may be used for the purposes of an initial assessment.

The source term used in the short term release assessment will depend upon the limits or notification levels proposed or in place. For releases to air, these include 12-month rolling limits, quarterly notification levels, monthly limits, weekly advisory levels and daily limits. Appendix 6 provides example applications of guidance for defining source terms.

Where there are no short term notification levels or limits proposed or in place, it may be appropriate to initially make a cautious assessment by assuming a single release of all radionuclides at the 12-month limits. A realistic assessment will be required, if the annual dose is greater than 0.3 mSv/y. For a more realistic assessment, short term release scenarios should be identified based on expected or planned releases. It will be necessary to carry out a short term release assessment for each of the different release scenarios. Each short term release scenario should take account of the number of releases impacting on a particular group of individuals per year.

The number of short term releases impacting on a particular group of individuals can be estimated in the following way. Wind direction data are often recorded to the nearest 30 degree wide sector. As a first approximation it is therefore assumed that the area around the site is divided into 12 sectors each 30 degrees wide. If the windrose at a site is assumed to be uniform then, on average, the wind is likely to blow into each sector for 1/12 of the time. Therefore, on average, only 1/12 of the annual number of short term releases are likely to affect the same group of individuals in any year. In this approach the assumption is made that the releases are random and that during the release the wind will blow into only one sector and any wind meander will be confined to that sector. Under these assumptions any single release will only affect locations within the 30 degree sector into which the wind is blowing. The modelling of this plume should therefore assume uniform dispersion over a 30 degree sector for consistency.

For release durations of several hours or more the wind direction may extend outside the 30 degree sector and the plume of released material could therefore affect locations outside this sector. For a given total release, the plume concentration will be less but there is a greater likelihood of encountering it. For shorter release durations, eg 30 minutes, the activity concentration in the plume is likely to be more concentrated, because the plume is narrow, but there is less likelihood of encountering it. If there are a sufficient number of short term releases then these factors have a tendency to cancel each other out and the assumptions of the previous paragraph provide a reasonable first approximation.

However, where possible the duration of the release should be taken into account in the dispersion modelling and the number of plumes likely to impact on a particular group of

individuals should be based on an appropriate consideration of plume release frequency, release duration, plume spread and wind direction for the site in question.

Where regular short term releases occur (eg, scheduled every Friday) careful consideration may be required where there is the potential for correlation with habits (eg, jogging club meet every Friday). Where food is stored for remaining annual consumption, then only one short term release should be assessed. It should be noted that the modelling of multiple short term releases is somewhat cautious because the assumption is that each release coincides with poor meteorological conditions, high occupancies and harvesting periods in addition to the predetermined wind direction

Where there are short term notification levels or limits proposed or in place, such as quarterly notification levels or monthly limits, then for a realistic assessment it is necessary to identify which radionuclides are likely to be released together (eg, due to particular site operations/activities). Short term release assessments should then be carried out for each group of radionuclides, by assuming that the radionuclides are released at their short term limits or notification levels. As discussed above, it is generally not necessary to assume more than one short term release every 12 months, unless there is evidence of co-incidence of releases and habits. Hence, where quarterly notification levels or monthly limits are proposed or in place, only one short term release of each group of radionuclides is required.

Where weekly limits are proposed or in place, there may be up to four short term releases per year and where there are daily limits, some 30 short term releases might be considered. The number chosen will depend on operational experience and whether multiple short term releases are feasible. The number of releases should be modified by the probability of a particular group being exposed as discussed above. Clearly, other limits (eg, 12 month limits) cannot be exceeded.

The dose from any remaining releases up to the 12-monthly limits should be assessed as a continuous release and added to the short term release dose.

The short term release assessment should take account of the chemical form of the radionuclide, if a particular chemical form is more likely to be released as a short term release.

Reference 6 provides cautious and realistic dose per unit short term release to air data which can be used to assess short term release doses and also uses case studies to show how the assessments can be made.

It is concluded in Reference 6 that where there are monthly limits proposed or in place for discharges to air, the total annual dose including a single monthly short term release is unlikely to be more than about two to three times the total dose assessed assuming continuous releases of twelve times the monthly limits. Where there are only 12 month limits proposed or in place, then doses for a realistic short term release assessment are unlikely to be more than a factor of 20 higher than the continuous release assessment.

Hence where monthly limits are proposed or in place for releases to air and the dose to the critical group assuming a continuous release of twelve times the monthly limits is less than 0.1 mSv/y, it is unlikely that there will be a need for an additional short term release assessment.

Appendix 2 Short term releases to freshwater

Authorised discharges of radioactive substances to freshwater (eg, rivers, lakes) may be directly by pipeline or via the outfall of a sewage treatment works. There are only a few direct authorised discharges to freshwater in England and Wales (currently none in Scotland). These are mostly from nuclear sites. However, there are many discharges via sewage treatment works, predominantly from the non-nuclear users of radioactive substances. Some of the highest discharges to sewers and then to rivers are from nuclear medicine practices in hospitals, in particular radionuclide therapy [Ref 72]. Radionuclide therapies are usually undertaken once or twice per week. Some of the new bigger treatment centres are being built with a greater capacity of up to ten treatments per week and releases as a result of these treatments will effectively become continuous. Discharges to sewer will peak within a few days of administration of the radioiodine. The peaks in the discharges will be flattened to a certain extent as a result of the discharges passing through a sewage treatment works.

A short term release into a freshwater environment could occur at periods of higher or lower river flow than the annual average and during periods where there is higher or lower river bank occupancy or fish consumption. Hence, radioactive substances released non-continuously to a freshwater environment can lead to different doses to those released continuously.

The environment agencies may choose to have limits or notification levels which cover a shorter period than 12 months to control the impact of short term releases or enable action to be taken (eg, food countermeasures, restrict occupancy) in the event of a short term release which the potential to cause dose constraints to be exceeded.

Assumptions which should be used for cautious or realistic assessments of short term releases to freshwater are shown in Table 2. Also shown are the equivalent assumptions which would be used for a continuous release assessment.

The source term used in the short term release assessment will depend upon the limits or notification levels proposed or in place. The most common for releases to river and sewer are 12-month rolling limits, quarterly notification levels and monthly limits. Appendix 6 provides example applications of guidance for defining source terms.

Where there are no short term notification levels or limits proposed or in place, it may be appropriate to initially make a cautious assessment by assuming a single release of all radionuclides at the 12-month limits. A realistic assessment will be required, if the annual dose is greater than 0.3 mSv/y. For a more realistic assessment, short term release scenarios should be identified based on expected or planned releases. It will be necessary to carry out a short term release assessment for each of the different release scenarios. Each short term release scenario should take account of the number of releases per year. However, the number of releases per year should be modified by the probability of the release coinciding with a one month period of both low flow and high occupancy (ie, 1/12), subject to a minimum number of releases of one per year.

It would not generally be appropriate to assume more than one release every 12 months, as the likelihood of a number of short term releases coinciding with periods of low flow, occupancy by anglers, fish being exposed to radionuclides and these fish being caught is quite remote. However, careful consideration may be required for regular short term releases (eg, scheduled every Friday) where there is the potential for co-incidence with habits (eg, angling club meet every Saturday). Where fish (including farmed fish), water or irrigated crops are stored for remaining annual consumption, then only one short term release should be assessed.

Where there are quarterly notification levels or monthly limits proposed or in place, then for a realistic assessment it is necessary to identify which radionuclides are likely to be released together (eg, due to particular site operations/activities). Short term release assessments should then be carried out for each group of radionuclides, by assuming that the radionuclides are

released at their quarterly notification levels or monthly limits. As discussed above, it is generally not necessary to assume more than one short term release every 12 months, unless there is evidence of co-incidence of releases and habits.

The dose from any remaining releases up to the 12-monthly limits should be assessed as a continuous release and added to the short term release dose.

Reference 8 provides cautious and realistic dose per unit short term release to river data which can be used to assess short term release doses and also uses case studies to show how the assessments can be made.

Most authorised discharges of radioactive substances to freshwater are from non-nuclear premises, via sewage treatment works and most of these non-nuclear discharges have monthly limits. It is concluded in Reference 8 that where there are monthly limits proposed or in place for discharges to sewer, the total annual dose including a single monthly short term release is unlikely to be more than about three times the total dose assessed assuming continuous releases all year. Where there are only 12 month limits proposed or in place, then doses for a realistic short term release assessment are unlikely to be more than a factor of 20 higher than the continuous release assessment.

Hence where monthly limits are proposed or in place for discharges to sewer or direct to water and the dose to the critical group assuming continuous releases over a 12-month period is less than 0.1 mSv/y, it is unlikely that there will be a need for an additional short term release assessment.

Appendix 3 Short term releases to coast/estuary

There are many authorised discharges of radioactive substances to estuaries or coastal environments, either directly by pipeline or via sewage treatment works outfall, in England, Wales and Scotland.

Dispersion in estuaries and the coastal environment is largely driven by tidal currents, although there will be slightly higher dispersion in estuaries during periods of higher rainfall. Hence the variability in dispersion throughout the year will not differ significantly from the annual average. Total doses from exposure to radionuclides in estuaries and the coastal environment are dominated by doses from ingestion of fish and shellfish containing the radionuclides and exposure to external radiation from radionuclides in sediment. The critical groups tend to be fishermen who catch and eat higher than average quantities of fish and/or shellfish and also spend large amounts of time digging for bait on sediment. In general, these fishermen will tend to catch fish/shellfish throughout the year for their livelihood and have a preference for consuming fresh fish/shellfish (eg, rather than freezing a large quantity of fish/shellfish for later consumption). Furthermore, fish will move around in coastal and estuarine waters and hence are unlikely to be constantly exposed to a plume from a short term release.

Since there is little variability in the dispersion and little seasonality in habits (ie, fish consumption and occupancy on sediment), the total dose assessed for the 12 monthly limits released in short releases will not differ significantly from the dose assessed assuming a continuous release. Hence NDAWG recommend that there is unlikely to be a need for a short term release assessment for discharges of radioactive substances to estuaries or coastal environments. However, a short term releases assessment may be required if there are known to be circumstances where fish/shellfish are caught over a short period of time for consumption by the same group of people over the remainder of the year and a plume from a short term release to coastal or estuarine waters is likely to lead to elevated radionuclide concentrations in these fish/shellfish.

Appendix 4 Short term releases to sewer

Discharges of radioactive substances to sewer may give rise to exposures to sewage workers and exposures to members of the public as a result of disposal of sewage sludge (eg, conditioning of farmland) and discharge of treated effluent. Guidance on short term release assessments for discharges of the treated effluent to freshwaters provided in Sections 5.2 and a short term release assessment is not required for releases to estuaries or coastal environments.

The primary exposure pathways for sewage workers is external radiation from radionuclides in the sewage and sludge and inhalation or inadvertent ingestion of contaminated dust [Refs 83, 94]. The doses received by these workers will depend to a certain extent on the flow of raw sewage into the works, with higher concentrations during lower flow leading to higher doses. The raw sewage flow will vary according to rainfall, where run-off is routed to the sewage treatment works, but there will remain a normal dry weather flow. Hence, there is much more variability in higher than average flows than in lower than average flows. Occupancy at the sewage treatment works will not have any seasonal variability as it is driven by operational requirements. Hence, the total dose to sewage workers from assessing the dose from a series of short term releases is unlikely to differ greatly from the total dose assessed assuming a continuous release.

Treated sewage sludge is normally retained at the sewage works and sometimes at the final place of its disposal for a number of weeks or even months prior to disposal. Hence, there will be substantial decay of some of the shorter-lived radionuclides (eg, iodine-131) which may arise as a short term release. Large volumes of sludge arising over many days and weeks are usually mixed as part of the sludge treatment process which will tend to homogenise radionuclides arising from short term releases throughout the sludge. There are a number of disposal routes for treated sludge including soil conditioning on farms/forest land, incineration, disposal to landfill. For many of these, the final disposal of sludge may be to different locations with different members of the public exposed (eg, different farms/forest land for soil conditioning). The one exception is incineration of the sludge, where there is usually one dedicated incinerator plant. All these factors will mean that the total dose from the disposal of sewage sludge (except for incineration) assessed for short term releases to sewer will be little different to assuming a continuous release. Doses for short term releases to sewer where the sludge is incinerated can and should be assessed in accordance with the guidance on short term releases to air in the previous section.

Appendix 5 Coincidental short term releases

There is the possibility that a short term release from one site/premises with an environmental permit or authorisation to discharge radioactive substances could coincide with a short term release from one or more sites/premises with separate permits or authorisations. Examples of where this might occur are the Heysham 1 and 2 nuclear power stations (simultaneous reactor blow-down), two or more cyclotrons within a hospital complex (simultaneous target rupture), or same treatment days for thyroid ablation therapy at two hospitals discharging to the same sewage treatment works.

The principles document [Ref 4] requires that significant doses to the same population group from other sources (eg, other authorised releases) are included in the dose assessments. Where necessary, this should be undertaken for the continuous release assessment.

The guidance in Section 4 makes it clear that the short term release assessments should be realistic with the aim of assessing the 95th percentile dose to members of the public. The assumptions used in the short term release assessment mean that doses will already be at the 95th percentile.

In situations where the short term release from one site/premises is completely independent from a short term release from another site/premises, the likelihood of a one day release at the monthly limits from one of the sites, coinciding on the same day that a release at the monthly limits has already occurred from the other site is about 1/30 (0.033). In the same scenario, with 12-month limits proposed or in place, the likelihood of the releases coinciding on the same day is 1/365 (0.0027). The probability of short term releases occurring in the same week is higher, but it is unlikely that the same person will be exposed to the short term releases as a result of different weather and different habits on those days.

Hence, where short term releases from different sites/premises are independent, the combined dose would be far from the realistic and be at a much higher percentile than the 95th percentile.

Where there are factors which could cause short term releases to be certain or almost certain to occur on the same day from different sites/premises then the doses from each of the short term releases will need to be summed.

Appendix 6 – Example derivation of source terms

Introduction

Tables 1 and 2 describe the realistic and cautious assumptions for defining the source term for short term releases assessments. Examples of the application of this guidance are provided in this appendix for either releases to air or water.

Twelve month limits only

Table A6.1 provides example 12 month limits for different radionuclides discharged from a site. It also shows an example of four short term release scenarios for the site. Release scenario 1 is a short term release of tritium and carbon-14 only. This type of release typically occurs 18 times per year. Release scenario 2 is a short term release of phosphorus-32 which occurs four times per year. Release scenario 3 is a short term release of strontium-89 and strontium-90 which typically occur 8 times per year. Finally, release scenario 4 is a short term release of iodine-125 and iodine-131 and occurs about twice per year.

For a realistic assessment, the release scenarios should be used to define short term releases (see Tables 1 and 2). Hence, in this example, four short term release scenarios should be assessed as shown in Table A6.2. These release scenario are modified by the probability of the releases occurring during a one month period of both low river flow and high occupancy or when the wind is blowing towards a particular population group living in one 30^{o} sector. Hence, the number of releases per year can be modified by 1/12, subject to a minimum of 1 release per year. Also shown in Table A6.2 is the continuous discharge for the remainder of the year.

For a cautious assessment, it is simply assumed that the 12 month limits are released in a single short term release, as shown in Table A6.2. Clearly there will be no continuous release for the remainder of the year in this case.

Twelve month limits and quarterly notification levels

Table A6.3 provides example 12 month limits and quarterly notification levels for discharges from a site. Also shown are the nuclides which are typically released together in short term releases, resulting in four typical release scenarios. Up to four releases at quarterly notification limits may occur per year. However, only one of these is assumed to coincide with a one month period of both low river flow and high occupancy or blow towards a particular population group.

For a realistic assessment, separate sets of releases should be defined based on the radionuclides which are likely to be released together (see Tables 1 and 2). Hence, four release scenarios should be assessed as shown in Table A6.4. In this case the short term releases are at the quarterly notification levels for each radionuclide. Also shown in Table A6.4 is the continuous discharge for the remainder of the year.

For a cautious assessment, it is assumed that there is a single release of all radionuclides at the quarterly notification levels (see Table A6.4). Continuous releases for the remainder of the year are also shown in Table A6.4.

Monthly limits

Table A6.5 provides example monthly limits for discharges from a site. Also shown are the nuclides which are typically released together in short term releases, resulting in four typical release scenarios. Up to 12 releases at the monthly limits could occur per year. However, only one of these is assumed to coincide with a one month period of low river flow and high occupancy or blow towards a particular population group.

For a realistic assessment, separate sets of releases should be defined based on the radionuclides which are likely to be released together (see Tables 1 and 2). Hence, four release scenarios should be assessed as shown in Table A6.6. In this case the short term releases are at the monthly limits for each radionuclide. Also shown in Table A6.6 is the continuous discharge for the remainder of the year for each radionuclide. This is calculated by subtracting the short term release from 12 times the monthly limit.

For a cautious assessment, it is assumed that there is a single release of all radionuclides at the monthly limits (see Table A6.6). Continuous releases for the remainder of the year are also shown in Table A6.6, calculated in the same way as the realistic assessment.

Twelve month limits and weekly advisory levels

Table A6.7 provides example 12 month limits and weekly advisory levels for discharges from a site. Also shown are the radionuclides which might be released together in short term releases, resulting in four example release scenarios.

For a realistic assessment, separate sets of releases should be defined based on the radionuclides which are likely to be released together (see Tables 1 and 2). Hence, four release scenarios should be assessed as shown in Table A6.8. In this case there may be four occasions in the year when each of the short term releases impacts on the individuals of interest, with each short term discharge occurring at the weekly advisory levels for each radionuclide. Also shown in Table A6.8 is the continuous discharge for the remainder of the year.

For a cautious assessment, it is assumed that there are four releases of all radionuclides at the weekly advisory levels (see Table A6.8). Continuous releases for the remainder of the year are also shown in Table A6.8.

Daily limits

Table A6.9 provides example daily limits for discharges from a site. Also shown are the radionuclides which might be released together in short term releases, resulting in four example release scenarios.

For a realistic assessment, separate sets of releases should be defined based on the radionuclides which are likely to be released together (see Tables 1 and 2). Hence, four release scenarios should be assessed as shown in Table A6.10. In this case there may be 30 occasions in the year when each of the short term releases impacts on the individuals of interest, with each short term discharge occurring at the daily limit for each radionuclide. Also shown in Table A6.10 is the continuous discharge for the remainder of the year.

For a cautious assessment, it is assumed that there are 30 releases of all radionuclides at the weekly advisory levels (see Table A6.10). Continuous releases for the remainder of the year are also shown in Table A6.10.

It should be noted that if 12 month limits exist in addition to daily limits then the number of short term releases may be further constrained by the 12 month limits.

Table A6.1 12 month limits only - Example limits and typical short term release scenarios

Radionuclide	12 month limits (Bq)	Typical release scenario 1 (Bq)	Typical release scenario 2 (Bq)	Typical release scenario 3 (Bq)	Typical release scenario 4 (Bq)
Tritium	1.0E+12	5.0E+10			
Carbon-14	1.0E+10	5.0E+08			
Phosphorus-32	1.0E+09		1.0E+08		
Strontium-89	1.0E+06			1.0E+05	
Strontium-90	1.0E+07			1.0E+06	
Iodine-125	1.0E+10				1.0E+09
Iodine-131	1.0E+12				1.0E+11
Typical number of releases per year		18	4	8	2
Number of releases per year taking account of probability of coinciding with 1 month low flow (1/12) for releases to water or probability of wind blowing into one sector (1/12) for releases to air, subject to a minimum of 1 release/y		1.5	1	1	1

Table A6.2 12 month limits only - Short term release assessment scenarios for realistic and cautious assumptions

Radionuclide	Realistic assumptions (Bq)								Cautious assumptions (Bq)	
	Release scenario 1		Release scenario 2		Release scenario 3		Release scenario 4			
	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year
Tritium	7.5E+10	9.3E+11		1.0E+12		1.0E+12		1.0E+12	1.0E+12	0.0E+00
Carbon-14	7.5E+08	9.3E+09		1.0E+10		1.0E+10		1.0E+10	1.0E+10	0.0E+00
Phosphorus-32		1.0E+09	1.0E+08	9.0E+08		1.0E+09		1.0E+09	1.0E+09	0.0E+00
Strontium-89		1.0E+06		1.0E+06	1.0E+05	9.0E+05		1.0E+06	1.0E+06	0.0E+00
Strontium-90		1.0E+07		1.0E+07	1.0E+06	9.0E+06		1.0E+07	1.0E+07	0.0E+00
Iodine-125		1.0E+10		1.0E+10		1.0E+10	1.0E+09	9.0E+09	1.0E+10	0.0E+00
Iodine-131		1.0E+12		1.0E+12		1.0E+12	1.0E+11	9.0E+11	1.0E+12	0.0E+00

Table A6.3 12 month limits and quarterly notification levels - Example limits / notification levels and typical short term release scenarios

Radionuclide	12 month limits (Bq)	Quarterly notification (Bq)	Typical release scenario 1 (Bq)	Typical release scenario 2 (Bq)	Typical release scenario 3 (Bq)	Typical release scenario 4 (Bq)
Tritium	1.0E+12	3.0E+11	✓			
Carbon-14	1.0E+10	3.0E+09	✓			
Phosphorus-32	1.0E+09	3.0E+08		✓		
Strontium-89	1.0E+06	3.0E+05			✓	
Strontium-90	1.0E+07	3.0E+06			✓	
Iodine-125	1.0E+10	3.0E+09				✓
Iodine-131	1.0E+12	3.0E+11				✓
Number of possible releases per year			4	4	4	4
Number of releases per year taking account of probability of coinciding with 1 month low flow (1/12) for releases to water or probability of wind blowing into one sector (1/12) for releases to air, subject to a minimum of 1 release/y			1	1	1	1

Table A6.4 12 month limits and quarterly notification levels - Short term release assessment scenarios for realistic and cautious assumptions

Radionuclide	Realistic assumptions (Bq)								Cautious assumptions (Bq)	
	Release scenario 1		Release scenario 2		Release scenario 3		Release scenario 4			
	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year
Tritium	3.0E+11	7.0E+11		1.0E+12		1.0E+12		1.0E+12	3.0E+11	7.0E+11
Carbon-14	3.0E+09	7.0E+09		1.0E+10		1.0E+10		1.0E+10	3.0E+09	7.0E+09
Phosphorus-32		1.0E+09	3.0E+08	7.0E+08		1.0E+09		1.0E+09	3.0E+08	7.0E+08
Strontium-89		1.0E+06		1.0E+06	3.0E+05	7.0E+05		1.0E+06	3.0E+05	7.0E+05
Strontium-90		1.0E+07		1.0E+07	3.0E+06	7.0E+06		1.0E+07	3.0E+06	7.0E+06
Iodine-125		1.0E+10		1.0E+10		1.0E+10	3.0E+09	7.0E+09	3.0E+09	7.0E+09
Iodine-131		1.0E+12		1.0E+12		1.0E+12	3.0E+11	7.0E+11	3.0E+11	7.0E+11

Table A6.5 Monthly limits - Example limits and typical short term release scenarios

Radionuclide	Monthly limits (Bq)	Typical release scenario 1 (Bq)	Typical release scenario 2 (Bq)	Typical release scenario 3 (Bq)	Typical release scenario 4 (Bq)
Tritium	1.0E+11	✓			
Carbon-14	1.0E+09	✓			
Phosphorus-32	1.0E+08		✓		
Strontium-89	1.0E+05			✓	
Strontium-90	1.0E+06			✓	
Iodine-125	1.0E+09				✓
Iodine-131	1.0E+11				✓
Number of possible releases per year		12	12	12	12
Number of releases per year taking account of probability of coinciding with 1 month low flow (1/12) for releases to water or probability of wind blowing into one sector (1/12) for releases to air, subject to a minimum of 1 release/y		1	1	1	1

Table A6.6 Monthly limits - Short term release assessment scenarios for realistic and cautious assumptions

Radionuclide	Realistic assumptions (Bq)								Cautious assumptions (Bq)	
	Release scenario 1		Release scenario 2		Release scenario 3		Release scenario 4			
	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year
Tritium	1.0E+11	1.1E+12		1.2E+12		1.2E+12		1.2E+12	1.0E+11	1.1E+12
Carbon-14	1.0E+09	1.1E+10		1.2E+10		1.2E+10		1.2E+10	1.0E+09	1.1E+10
Phosphorus-32		1.2E+09	1.0E+08	1.1E+09		1.2E+09		1.2E+09	1.0E+08	1.1E+09
Strontium-89		1.2E+06		1.2E+06	1.0E+05	1.1E+06		1.2E+06	1.0E+05	1.1E+06
Strontium-90		1.2E+07		1.2E+07	1.0E+06	1.1E+07		1.2E+07	1.0E+06	1.1E+07
Iodine-125		1.2E+10		1.2E+10		1.2E+10	1.0E+09	1.1E+10	1.0E+09	1.1E+10
Iodine-131		1.2E+12		1.2E+12		1.2E+12	1.0E+11	1.1E+12	1.0E+11	1.1E+12

Table A6.7 12 month limits and weekly advisory levels - Example limits and typical short term release scenarios

Radionuclide	12 month limits (Bq)	Weekly advisory levels (Bq)	Typical release scenario 1 (Bq)	Typical release scenario 2 (Bq)	Typical release scenario 3 (Bq)	Typical release scenario 4 (Bq)
Tritium	1.0E+12	2.0E+10	✓			
Carbon-14	1.0E+10	2.0E+08	✓			
Phosphorus-32	1.0E+09	2.0E+07		✓		
Strontium-89	1.0E+06	2.0E+04			✓	
Strontium-90	1.0E+07	2.0E+05			✓	
Iodine-125	1.0E+10	2.0E+08				✓
Iodine-131	1.0E+12	2.0E+10				✓
Number of possible releases per year			52	52	52	52
Number of releases per year taking account of probability of coinciding with 1 month low flow (1/12) for releases to water or probability of wind blowing into one sector (1/12) for releases to air, subject to a minimum of 1 release/y			4	4	4	4

Table A6.8 12 month limits and weekly advisory levels - Short term release assessment scenarios for realistic and cautious assumptions

Radionuclide	Realistic assumptions (Bq)								Cautious assumptions (Bq)	
	Release scenario 1		Release scenario 2		Release scenario 3		Release scenario 4			
	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year
Tritium	8.0E+10	9.2E+11		1.0E+12		1.0E+12		1.0E+12	8.0E+10	9.2E+11
Carbon-14	8.0E+08	9.2E+09		1.0E+10		1.0E+10		1.0E+10	8.0E+08	9.2E+09
Phosphorus-32		1.0E+09	8.0E+07	9.2E+08		1.0E+09		1.0E+09	8.0E+07	9.2E+08
Strontium-89		1.0E+06		1.0E+06	8.0E+04	9.2E+05		1.0E+06	8.0E+04	9.2E+05
Strontium-90		1.0E+07		1.0E+07	8.0E+05	9.2E+06		1.0E+07	8.0E+05	9.2E+06
Iodine-125		1.0E+10		1.0E+10		1.0E+10	8.0E+08	9.2E+09	8.0E+08	9.2E+09
Iodine-131		1.0E+12		1.0E+12		1.0E+12	8.0E+10	9.2E+11	8.0E+10	9.2E+11

Table A6.9 Daily limits - Example limits and typical short term release scenarios

Radionuclide	Daily limits (Bq)	Typical release scenario 1 (Bq)	Typical release scenario 2 (Bq)	Typical release scenario 3 (Bq)	Typical release scenario 4 (Bq)
Tritium	1.0E+10	✓			
Carbon-14	1.0E+08	✓			
Phosphorus-32	1.0E+07		✓		
Strontium-89	1.0E+04			✓	
Strontium-90	1.0E+05			✓	
Iodine-125	1.0E+08				✓
Iodine-131	1.0E+10				✓
Number of possible releases per year (**but may also be constrained by 12 month limits if these exist**)		365	365	365	365
Number of releases per year taking account of probability of coinciding with 1 month low flow (1/12) for releases to water or probability of wind blowing into one sector (1/12) for releases to air, subject to a minimum of 1 release/y		30	30	30	30

Table A6.10 Daily limits - Short term release assessment scenarios for realistic and cautious assumptions

Radionuclide	Realistic assumptions (Bq)								Cautious assumptions (Bq)	
	Release scenario 1		Release scenario 2		Release scenario 3		Release scenario 4			
	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year	Short term release	Continuous release for remainder of year
Tritium	3.0E+11	3.4E+12		3.7E+12		3.7E+12		3.7E+12	3.0E+11	3.4E+12
Carbon-14	3.0E+09	3.4E+10		3.7E+10		3.7E+10		3.7E+10	3.0E+09	3.4E+10
Phosphorus-32		3.7E+09	3.0E+08	3.4E+09		3.7E+09		3.7E+09	3.0E+08	3.4E+09
Strontium-89		3.7E+06		3.7E+06	3.0E+05	3.4E+06		3.7E+06	3.0E+05	3.4E+06
Strontium-90		3.7E+07		3.7E+07	3.0E+06	3.4E+07		3.7E+07	3.0E+06	3.4E+07
Iodine-125		3.7E+10		3.7E+10		3.7E+10	3.0E+09	3.4E+10	3.0E+09	3.4E+10
Iodine-131		3.7E+12		3.7E+12		3.7E+12	3.0E+11	3.4E+12	3.0E+11	3.4E+12