



NDAWG
National Dose Assessment Working Group

NDAWG GUIDANCE NOTE 5

The estimation and use of results on exposure to Direct Radiation

PMS Stephen and J Titley

Introduction

1. This note is intended to give guidance on the estimation of exposure from ionising radiation to persons outside the site that is the source of the radiation.
2. It includes:
 - Background to the need for direct radiation exposure estimates;
 - When estimates are likely to be needed;
 - How and where estimates should be made;
 - Example of what the estimates are used for.

Background

3. The Euratom Basic Safety Standards (BSS) Directive 1996 [http://ec.europa.eu/energy/nuclear/radioprotection/doc/legislation/9629_en.pdf] (Article 14) requires member states to ensure that doses arising from the exposure to ionising radiation do not exceed specified dose limits. These doses include exposure from inhalation and ingestion of nuclides, for example from discharges to air or water, and from exposure to direct radiation. Exposure to direct radiation can arise from exposure to nuclides deposited in the environment from discharges or from radiation arising as a result of operations on sites. In either case this could include both nuclear licensed and non-licensed sites.
4. In addition, the Government and Devolved Administrations have also Directed the Environment Agency (EA) [<http://www.defra.gov.uk/environment/radioactivity/government/legislation/pdf/rsd2000.pdf>] and the Scottish Environment Protection Agency (SEPA) [Radioactive Substances (Basic Safety Standard) (Scotland) Direction 2000] to ensure that ‘the sum of doses resulting from the exposure of any member of the public to ionising radiation should not exceed the dose limit set out in Article 13 of the directive (subject to the exclusions set out in Article 6(4) of the directive)’. This principal limit is a total effective dose of 1 mSv in any calendar year. The Directions also include dose constraints for use in assessing proposed discharges. The direction requires that when assessing doses from defined sources at the planning stage in radiation protection:

- The individual effective dose received from any new source from which discharges are first made since 13 May 2000 does not exceed 0.3 mSv in a year;
- The individual effective dose received from the discharges from any single site does not exceed 0.5 mSv in a year.

The interpretation is that the dose constraint of 0.3 mSv/y should apply to doses from discharges and/or from direct radiation, whilst the dose constraint of 0.5 mSv/y should apply only to doses from discharges.

5. The environment agencies are responsible for the regulation of discharges of radioactive materials from sites via discharge authorisations. The Health and Safety Executive (HSE) is responsible for regulating the exposure to direct radiation from the operations on sites under the Ionising Radiations Regulations 1999 (IRR99) [[Statutory Instrument 1999 No 3232](#)], in particular, regulations 8 and 11, and, for nuclear licensed sites, relevant site licence conditions. The HSE's Nuclear Directorate (ND) is responsible for regulation of direct radiation from nuclear licensed sites.

6. The calculation of retrospective doses for comparison against the dose limits, from all pathways, is published annually in the Radioactivity in Food and the Environment report (RIFE). These calculations are done with regard to the [Principles for the assessment of total retrospective public doses](#) NDAWG/2/2005 and using the profiling method of Camplin et al, [Methods for assessment of total dose in the radioactivity in food and the environment report](#) NDAWG/3/2005. The calculations include the contribution from exposure to direct radiation from operations on the site. The retrospective dose estimates can also be used to inform the estimate of prospective doses for future years, taking into account any changes in operations at the site during different years.

Are Measurements Needed?

7. In deciding if estimates of exposure from direct radiation are needed, the operator will need to consider the following:

- The nature of operations on the site, can any give rise to radiation beyond the site boundary where persons other than their employees have access;
- The operations may include the use of radionuclides with penetrating γ emissions (eg, source radiography, isotopic preparation and use), the use of radiation generators (eg, x-ray sets, synchrotrons), work generating neutrons (eg, nuclear power generation) and cloudshine from discharge of gaseous radionuclides;
- Where these operations occur, consideration will need to be given to such aspects as distance of the persons from the source and the effectiveness of any shielding.

8. Operators should monitor the radiological conditions at the site boundary and beyond during their operations. This will give an initial indication of whether more detailed estimates of exposure will need to be made. If more detailed assessments are required, the operator will need to determine how and where these should be made, and how exposures of the representative person (taken to mean the same as the critical group) can be determined.

Measurements of Direct Radiation and Estimation of Doses (How and Where)

9. Operators have the duty to ensure that radiation exposures of members of the public resulting from their operations do not exceed the statutory limits and are restricted so far as is reasonably practicable (SFAIRP). As part of their arrangements to demonstrate this, operators may measure direct radiation dose rates at the site perimeter and elsewhere, and operate environmental radioactivity monitoring programmes.

10. The Approved Code of Practice, paragraph 183, for IRR99 states:

“For the assessment of compliance with the dose limits relating to members of the public, realistic estimates should be made of the average effective dose (and where relevant equivalent dose) to representative members of the appropriate reference group for the expected pathways of exposure.”

In order to make estimates of the exposure of Members of the public, operators will need to make measurements of the dose rates in occupied areas and estimates of the times that people are in those areas.

11. Dose rates around sites can be measured in different ways:

- Dosimeters such as film badges or thermoluminescent dosimeters (TLDs) are exposed in locations around the perimeter of the installation and at suitable locations off-site. These have the advantage of measuring integrated dose over the entire year, and are capable of measuring small annual doses accurately.
- Surveys can be made using radiation monitoring instruments. These have the advantage of providing information from any point along the whole of the perimeter or in other areas as well as at a number of identified fixed points as with dosimeters. These can be used for example if there is an operation that is likely to produce a high radiation dose rate for a short period of time. The measurements from these surveys can be used on their own or to complement the measurements from fixed location dosimeters.

12. The operator will need to consider its operations and decide which method(s) to use.

- If operations are more or less continuous during the whole year, at similar exposure rates, then the use of dosimeters will be appropriate.
- If operations are more intermittent then use of monitoring instruments during those periods of operation may be more suitable.
- If operations have a general continuing lower exposure rate during the year but with short periods of high exposure, operators may wish to use dosimeters to give the integrated dose and monitoring instruments during the periods of higher exposure.

13. Measurements made of dose rates around sites, whether by instrument or dosimeter, yield the total dose rate resulting from the sum of natural background (terrestrial plus cosmic radiation) and that originating from within the installation. In order to estimate the radiation from the site, it is necessary to establish a background for the site. This could be from a location of similar geology to the site but remote from its influence. For the majority of installations the natural background is the dominant component and the dose rate from the site is established by subtracting two relatively large numbers with associated uncertainties. The net dose rate figures may therefore have large uncertainties. Where it is difficult to distinguish the direct radiation from the site from the background measurements, the radiation from the site is unlikely to be significant. As a guide this is likely to be when the direct radiation is 0.01 mSv per year (generally taken to be of the order of a few tens of μ Sieverts) above background.

14. Operators will need to have information about the occupancy of areas around the site where people could be exposed to the direct radiation from the site, so that suitable representative persons can be identified. General guidance on representative persons/critical groups can be found in the NDAWG paper [Principles for the assessment of total retrospective public doses](#) NDAWG/2/2005.

15. Habits surveys can be used to identify the representative persons or critical groups of the public for direct radiation, ie, those that are likely to receive the highest doses, and also to provide information to enable estimates of their doses to be made. These are often residents of dwellings

near to the site boundary, but can be others, for example people exposed during recreational activities, such as exercising dogs on ground near the installation.

16. The operator will need to decide on the level of habits survey required to enable estimates of the exposures to be made:

- For a remote site, with little public access into the areas affected by direct radiation a simple survey identifying, eg, any residents and their occupancy will usually suffice;
- If the site is rural but with public access likely adjacent to the fence or in wider areas affected by direct radiation, then a survey of the time spent by people in the affected area will be needed. The detail of this survey will depend on the number of people likely to use the affected areas;
- If the area is urban or semi urban (ie, has a high number of people accessing areas where exposure to direct radiation occurs) then a detailed survey of peoples' habits to establish reference groups and the information needed to estimate their radiation exposure will probably be needed. Such surveys could be carried out by the operator or, if they do not have the resource, by a commercial contractor.

17. The operator should consider the location of its site in relation to local populations and recreational use. The operator will need to determine the level of detail required of the habits study in order to establish a suitable estimate of the exposure of the reference group to direct radiation.

Use of Direct Radiation Data

18. As stated above, direct radiation is one of the exposure pathways by which members of the public can be exposed to ionising radiation. Direct radiation needs to be taken into account when dose assessments are made to ensure that the exposures of the public from all pathways are below the dose limit and restricted so far as is reasonably practicable. In addition, direct radiation is taken into account in prospective assessments where discharges are planned from a single defined source and compared with the dose constraint of 0.3 mSv/y.

19. To enable the Environment Agencies, under their Directions, to ensure that the dose limit has not been exceeded and the dose constraint will not be exceeded, direct radiation doses need to be assessed and factored into the assessments around operators' sites.

20. For sites regulated by HSE's Nuclear Directorate (ND), estimates of direct radiation doses are obtained from the licensees and then passed to the Environment Agencies for use in calculation of the total (all pathways) retrospective dose to the representative person, as described in paragraphs 3 and 6. Total dose is presented in the RIFE report. When prospective assessments of doses from discharges are made direct radiation doses are included where appropriate.

21. As an initial estimate of the total dose, doses to the reference groups for the different pathways can be added together, either based on measurements for retrospective assessments or on modelling of discharges for prospective assessments. It should be noted that this is a simplification. The reference groups for each of the individual pathways are unlikely to be the same as the reference group for the site. For example direct radiation exposure is taken into account within 1 km of sites. Therefore the assessed direct radiation doses should only be added to the doses to groups of members of the public who are exposed to discharges in the 1 km zone around the site which may not be the reference group for that discharge pathway. In this respect the profiling method discussed in paragraph 6 and NDAWG/3/2005 is the preferred option to calculate a more realistic dose to a site reference group.

22. ND systematically inspects licensees' arrangements for controlling direct radiation exposures of the public as part of a rolling programme. This is to give confidence that licensees' assessments as obtained from them are suitable and sufficient for estimating the exposures of the representative person(s). In assessing the licensees' arrangements, ND will use available data from the Joint Habits Surveys, for sites in England and Wales, carried out by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) for the EA, Food Standards Agency (FSA) and HSE, where these are available.

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. The guidance notes are approved at NDAWG meetings and have been consulted upon for a period of 3 months via the NDAWG website (www.ndawg.org).