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Paper 10.02: Principles for Prospective and Retrospective Dose Assessments

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1 Introduction

In 2002, the Environment Agency, Scottish Environment Protection Agency and the Department of Environment in Northern Ireland in collaboration with the Food Standards Agency and National Radiological Protection Board (now Health Protection Agency - HPA) published interim principles and guidance for the prospective assessment of public doses [Ref 1] (referred to as the 'Prospective Dose Assessment Principles'). At its first meeting, the National Dose Assessment Working Group (NDAWG) provided valuable final comments on the document before it was published.

These prospective dose assessment principles were published as interim guidance, because it was anticipated that Defra would publish statutory guidance on the regulation of radioactive discharges, which would have a direct impact on the principles. This statutory guidance is expected to be published soon.

NDAWG recognised that there was a need for comparable principles for the retrospective assessment of total doses. NDAWG established a sub-group to develop these principles and this principles document was published in 2005 [Ref 2]. This document is referred to as the 'Retrospective Dose Assessment Principles'.

This paper summarises and compares the prospective and retrospective dose assessment principles.

2 Overview of principles

2.1 Transparency of assessments

Principles relevant to transparency are:

Prospective Dose Assessment Principles	Retrospective Dose Assessment Principles
None	Principle 1 Total retrospective dose assessment methods and data should be transparent.

The Retrospective Dose Assessment Principles states that total retrospective methods should be transparent, by being clear and readily understandable. To achieve this, total retrospective assessment methods and their underpinning data should be made publicly available in a suitable form such that another party can repeat the assessment. Although it

was noted in the Prospective Dose Assessment Principles that an openly declared and consistent method of dose calculation should be sought, there is no equivalent principle on transparency.

2.2 Members of the public and population groups

Principles relevant to members of the public and population groups to be considered in doses assessments are:

Prospective Dose Assessment Principles	Retrospective Dose Assessment Principles
Principle 1 Workers who are exposed to discharges of radioactive waste, but do not receive direct tangible benefits from the organisation making the discharge, should be treated as if they are members of the public for the purpose of determining discharge authorisations.	Principle 2 Workers, who are exposed to discharges of radioactive waste, but do not work directly with ionising radiation and are therefore not normally exposed to ionising radiation, should be included in the assessment and reporting of total retrospective doses to members of the public.
Principle 2 The mean critical group dose should be assessed for the purpose of determining discharge authorisations.	Principle 3 The mean critical group dose should be assessed for the purpose of assessing compliance with the dose limit.
Principle 3 Doses to the most exposed age group should be assessed for the purposes of determining discharge authorisations.	Principle 4 Doses to the most exposed age group present in the affected population should be assessed for the purpose of determining compliance with the dose limit.

The issue of whether some workers should be treated as members of the public for the purpose of assessing doses is addressed by both the Prospective and Retrospective Dose Assessment Principles. The conclusion is that some workers, such as farmers, sewage workers and fishermen may be exposed as a result of discharges of radioactive waste to the environment, but do not work directly with ionising radiation themselves and thus may be regarded as not normally working with ionising radiation. These workers and their employer may not be familiar with the requirements of the Radioactive Substances Act 1993 and the Ionising Radiations Regulations [Refs 3, 4]. It is appropriate that these workers should be treated as if they are members of the public for the purpose of assessing and reporting total retrospective doses. This case is better developed and more clearly stated in the Retrospective Dose Assessment Principles.

Both Principles documents state the need to assess the mean critical group dose, but this may need to change in future to the representative individual dose, once the International Commission on Radiological Protection (ICRP) Draft Recommendations [Ref 5] are embodied in a revised Basic Safety Standards Directive [Ref 6]. The Prospective Dose Assessment Principles state that it is generally sufficient to consider three age groups, 1 year old infants, 10 year old children and adults. This has been revised in the Retrospective Dose Assessment Principles document to include the fetus and there is a need to update the Prospective Dose Assessment Principles.

2.3 Sources and exposure pathways

Principles relevant to sources and exposure pathways are:

Prospective Dose Assessment Principles	Retrospective Dose Assessment Principles
Principle 4 Critical group doses to be assessed for comparison with the source constraint and, if appropriate, the site constraint should include all relevant future exposure pathways.	Not applicable.
Principle 5 Significant additional doses to the critical group from historical discharges from the source being considered and doses from historical and future discharges and direct radiation from other relevant sources subject to control should be assessed and the total dose compared with the dose limit of 1 mSv/y.	Principle 5 All significant sources and exposure pathways of authorised historical and current radioactive waste discharges and direct radiation from sources subject to control should be assessed and the total dose compared with the dose limit.

These principles and accompanying guidance in the Principles documents make it clear what sources and exposure pathways should be considered when comparing doses to the source dose constraints, site constraint and the dose limit. The dose constraints are not relevant to retrospective doses.

There is an expectation that all relevant sources and exposure pathways should be included in an assessment. However, it is only reasonable to expect that the effort applied in the assessment is proportional to the dose. The Retrospective Dose Assessment Principles gives guidance that where the total critical group dose is <0.3 mSv/y then sources and exposure pathways which contribute a dose of greater than 0.02 mSv/y should be included in the assessment. If the total dose is approaching 1 mSv/y, then sources and exposure pathways which contribute a dose greater than 0.01 mSv/y should be included.

2.4 Realistic assumptions

Principles relevant to realistic assumptions are:

Prospective Dose Assessment Principles	Retrospective Dose Assessment Principles
Principle 6 Where estimates of the critical group dose exceed 0.02 mSv/y, the assessments should be refined and, where appropriate, more realistic assumptions made. However, sufficient caution should be retained in assessments to provide confidence that actual doses received by a representative member of the critical group will be below the dose limit.	Principle 6 Where estimates of the total critical group dose exceed 0.02 mSv/y, the assessments should be critically examined and, where appropriate, more realistic assumptions made.

Article 45 of the Euratom Basic Safety Standards Directive [Ref 6] requires that the assessment of doses to 'reference groups' should be made as realistic as possible. This requirement has been included in the Directions to the Environment Agency and SEPA [Refs 7, 8]. The principles for prospective and retrospective assessment state that where the dose exceeds 0.02 mSv/y, then the assessment should be refined or critically examined and, if appropriate, more realistic assumptions should be made. Assessments are made more realistic through the use of site specific data, which can include modelling parameters, habit data and in the case of retrospective assessments, monitoring data.

Guidance is given that it is acceptable to undertake assessments using more cautious, generic assumptions, where the doses are low (ie, less than 0.02 mSv/y). The Prospective Dose Assessment Principles recommends an initial assessment using such cautious assumptions, which can be refined if the dose exceeds 0.02 mSv/y.

2.5 Accumulation in the environment

Principles relevant to accumulation in the environment are:

Prospective Dose Assessment Principles	Retrospective Dose Assessment Principles
Principle 7 The assessment of critical group doses should take account of accumulation of radionuclides in the environment from future discharges.	None.

This is an important principle in relation to prospective assessments in which there is a need to take account of on-going discharges year after year into the future. Guidance is given that an accumulation time-scale of 50 years is usually selected for new plants and for plants/sites where it is difficult to specify a closure date. There is no equivalent principle for retrospective assessments as there is no need to take account of discharges into the future. However, it is important to take account of historical discharges if environmental concentrations are modelled for a retrospective assessment.

2.6 Modelling versus monitoring

Principles relevant to modelling versus monitoring are:

Prospective Dose Assessment Principles	Retrospective Dose Assessment Principles
Not applicable.	Principle 7 Positive monitoring results should be used, where available, for assessing total retrospective doses. Results at limits of detection and data gaps should be enhanced with more realistic data (eg, derived from extrapolation of monitoring data or modelling) where the dose from limit of detection data or dose from data gaps could exceed 0.02 mSv/y.

This is only relevant to retrospective assessments as modelling data is used for prospective assessments. There is an emphasis towards using positive monitoring results (ie, results above the detection limit) for retrospective assessments. However, monitoring data inevitably has a number of gaps and other limitations (eg, results at detection limits, inability to distinguish non-authorized discharges). The Retrospective Dose Assessment Principles provides guidance on supplementing positive monitoring results with more realistic environmental and food concentrations through extrapolation of existing monitoring data or use of modelling.

The Retrospective Dose Assessment Principles states that the need to derive more realistic data is only important where doses are significant. Where the dose to the critical group from using results at limits of detection exceeds 0.02 mSv/y, this should prompt the need to derive more realistic data. Where there are data gaps, then expert judgement based on previous assessment experience will be required to determine whether this missing dose would contribute more than 0.02 mSv/y to the critical group dose. If this is the case then derivation of data by modelling or extrapolation of existing monitoring data should be considered.

2.7 Critical groups and their habits

Principles relevant to critical groups and their habits are:

Prospective Dose Assessment Principles	Retrospective Dose Assessment Principles
Principle 8 The realistic habits adopted for the critical group should be those which are actually observed year on year at the site, or at similar sites elsewhere, either currently or in the recent past. Sustainable habits leading to greater exposure, that are reasonably foreseeable over the period until the next review of the authorisation (about 5 years), should be considered.	Not applicable.
Principle 9 Land use and infrastructure should have sufficient capacity to support the habits of the critical group. Any changes to land use and infrastructure should be reasonably foreseeable over the period until the next review of the authorisation (about 5 years) and be sustainable year on year for them to be considered.	Not applicable.
None.	Principle 8 Critical groups should be selected so that the habits and the doses of the members of the group are homogeneous within a factor of three.

The Prospective Dose Assessment Principles provides guidance on selecting future population habits and land use/infrastructure for prospective assessments. This is not relevant to retrospective assessments.

There is a need to ensure that prospective assessments take account of patterns of behaviour of members of the public which a reasonable person might adopt, whether or not anyone actually engages in such behaviour at a given time. This needs to be balanced with ensuring that doses remain realistic over a period of about 5 years (ie, the normal period between authorisation reviews). Thus, the main emphasis of these principles is to take account of reasonably foreseeable changes over a time period of about 5 years.

Land use and infrastructure should have sufficient capacity to support the habits of the critical group and changes should be reasonably foreseeable over a period of about 5 years. The Prospective Dose Assessment Principles provides guidance on this. For example, if there is a plot of derelict land near to an urban hospital with a large nuclear medicine department, then it would not be reasonably likely for the land to be converted into a small holding from which a family could source all their food (milk, meat, vegetables and fruit) on a sustainable basis over a period of 5 years. However, it would be appropriate to assume that some residents grow their own fruit and vegetables.

The Retrospective Dose Assessment Principles places emphasis on the selection of the critical group and their habits, such that this is consistent with advice from the ICRP. The conclusion is that critical group habits should be homogenous within a factor of three. There is no equivalent principle for prospective assessments.

2.8 Short term releases

Principles relevant to short term releases are:

Prospective Dose Assessment Principles	Retrospective Dose Assessment Principles
Principle 10 The dose assessed for operational short term release at proposed notification levels or limits 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.	Not applicable.

The Prospective Dose Assessment Principles stress the need to assess operational short term notification levels or limits and to compare the dose to the source constraint or dose limit. Short term releases will be included in the monitoring of environmental concentrations or modelling of discharges for retrospective assessments and there is no equivalent principle. The Prospective Dose Assessment Principles state that realistic judgements should be made concerning the concentrations of radionuclides in food following a short term release. Some foods (eg, root vegetables) could be harvested at peak concentrations and then stored for up to a year. However, other foods are produced continuously (eg, milk) and an integrated concentration should be assessed. An NDAWG subgroup has been established to provide more guidance on assessing doses from authorised short term releases.

2.9 Collective dose

Principles relevant to collective dose are:

Prospective Dose Assessment Principles	Retrospective Dose Assessment Principles
Principle 11 For authorisation purposes, collective doses to the populations of UK, Europe and the World, truncated at 500 y, should be estimated.	Principle 9 Where collective doses are retrospectively assessed for the populations of UK, Europe and the World, they should be truncated at 500 y.

Collective dose is normally used to assess different process options (eg, for the abatement of discharges) and to assess collective doses into the future. Retrospective assessments of collective dose may be undertaken to assess the collective dose into the future from a historical discharge. The principles for collective dose are broadly equivalent for prospective and retrospective assessments. There is a need to consider population groups in the UK, Europe and the World, but advice is given that these doses should be truncated to 500 years.

2.10 Uncertainty and variability

Principles relevant to uncertainty and variability are:

Prospective Dose Assessment Principles	Retrospective Dose Assessment Principles
Principle 12 Where the assessed mean critical group dose exceeds 0.02 mSv/y, the uncertainty and variability in the key assumptions for the dose assessment should be reviewed.	Principle 10 Where the assessed total critical group dose exceeds 0.02 mSv/y, the uncertainty and variability in the key assumptions for the dose assessment should be reviewed.

The principles for uncertainty and variability are equivalent for prospective and retrospective assessments. The principles require a review of the uncertainty or variability in key assumptions where the dose exceeds 0.02 mSv/y. The purpose of the review is to provide confidence that the dose limit is unlikely to be exceeded for the discharges which have been made to the environment. It will also indicate whether there has been an undue level of caution applied in the assessment.

3 Application of principles

The Environment Agency, Scottish Environment Protection Agency and Food Standards Agency have been taking account of the Prospective Dose Assessment Principles when assessing doses from discharges at limits in Radioactive Substances Act 1993 discharge

authorisations. Many of the principles have been straightforward to apply. The Environment Agency has developed a methodology for initial radiological assessment [Refs 9, 10] to support the implementation of Principle 6 on realistic assessments. The Food Standards Agency have a similar screening methodology for non-nuclear authorisation assessments.

However, a few principles have been difficult to implement completely:

- Critical groups and their habits – Selecting reasonably foreseeable future habits has not been consistent between assessments and organisation making the assessment – The NDAWG habits sub group aims to provide guidance on selecting habit data for prospective assessments.
- Uncertainty and variability – The Environment Agency has made various attempts to review and report the uncertainty and variability in dose assessments (eg, Refs 11, 12). It is not clear which, if any of these approaches satisfactorily address the uncertainty and variability principle. The NDAWG uncertainty and variability sub-group has now provided guidance on an approach to assessing uncertainty and variability [Ref 13]. There may still be a need to develop simple practical tools for assessing uncertainty and variability, or providing case studies which can be referenced to support an assessment.

Prospective dose assessments undertaken by the operator, Environment Agency and Food Standards Agency for the Winfrith nuclear site were considered at an NDAWG meeting in November 2005. The assessments were considered against the Prospective Dose Assessment Principles. The meeting concluded that there had not been sufficient progress towards the adoption of a consistent methodology. In particular there was a lack of transparency in some approaches and the critical group habit data and assumptions varied considerably. There was also variability in some assumptions which should have been entirely consistent (eg, effective release heights). As a result of this, the Environment Agency and Food Standards Agency have decided to agree key assumptions at the start of future nuclear site prospective assessments.

The Environment Agency, Scottish Environment Protection Agency, Food Standards Agency and Environment and Heritage Service for Northern Ireland publish an annual report on Radioactivity in Food and the Environment. This report contains the results of retrospective assessments of dose arising from radioactivity in food and the environment. Cefas currently undertakes this radiological assessment and produce the report. Cefas takes account of the Retrospective Dose Assessment Principles document in their dose assessment.

4 Way forward for NDAWG

In summary, NDAWG needs to consider the following future developments:

- The Prospective Dose Assessment Principles need to be revised.
- The NDAWG habits sub group needs to provide guidance on selecting habit data for prospective assessments.
- The NDAWG short term release sub group needs to provide more guidance on assessing planned short term releases.
- There is a need to develop simple practical tools for assessing uncertainty and variability, or providing case studies which can be referenced to support an assessment.

5 Conclusions

The Environment Agency, Scottish Environment Protection Agency and the Department of Environment in Northern Ireland in collaboration with the Food Standards Agency and National Radiological Protection Board (now Health Protection Agency - HPA) published Prospective Dose Assessment Principles in 2002.

NDAWG established a sub-group to develop Retrospective Dose Assessment Principles, which were published in 2005.

The two sets of principles are consistent and in some cases are nearly identical. There are some principles which address issues which are only applicable to prospective assessments and some which only apply to retrospective assessments. For example, the use of monitoring data is limited to retrospective assessments and the need to select habits into the future is only relevant to prospective assessments.

There are a few dose assessment issues addressed by the Retrospective Dose Assessment Principles which have been developed further than in the Prospective Dose Assessment Principles and these should be considered in a future update of the Prospective Dose Assessment Principles. These include the transparency of dose assessments, the need to include fetal doses and the homogeneity of habits.

The new ICRP Recommendations will also have an impact on these Principles documents as there is likely be a change from assessing the mean dose to the critical group to assessing the dose to a representative individual.

The Environment Agency, Scottish Environment Protection Agency and Food Standards Agency have taken the principles into account in their dose assessments. However, there have been some difficulties in applying some of the principles, in particular those related to critical groups and their habits for prospective assessments, assessing short term releases and reviewing uncertainty and variability. NDAWG sub-groups have been established to help address these issues.

6 References

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