

## NATIONAL DOSE ASSESSMENT WORKING GROUP

### PAPER 5-02: FSA DOSE ASSESSMENT METHODOLOGY

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#### The Food Standards Agency Approach to Estimating Doses

##### Introduction

1. The FSA is a statutory consultee to the Environment Agency (EA) and the Scottish Environment Protection Agency (SEPA) for applications to dispose of radioactive material under the Radioactive Substances Act 1993. So that the Agency can comment on the acceptability of proposed discharges, it must estimate the potential doses to consumers of food that contains activity as a consequence of the discharges.
2. One of the recommendations of the Consultative Exercise on Dose Assessment (CEDA) was “the Food Standards Agency (FSA) should re-examine its use of probability distributions of dose, to derive the possible dose. There should be more consistency in gathering survey data and FSA, operators and EA should co-ordinate their requirements for fieldwork. There should be more consistency in the treatment of data for constructing the aquatic and terrestrial critical groups. FSA should consider if the latter group should be more homogenous in line with ICRP recommendations”. This paper is intended to describe the current FSA practice and to stimulate discussion on whether the FSA should amend its current approach.
3. As such, this paper does not go into the detail of how assessments are carried out and the models used. Instead, it concentrates on the philosophy behind the FSA’s methodology and the factors leading to the

choices of the methods used. The paper does not consider the Agency's methods for assessing the impact of short-term discharges.

4. NDAWG members are requested to consider the assessment philosophy described in the paper and to offer comments on how appropriate the method is for meeting the FSA's requirements and to offer suggestions for improving the method. The FSA will consider these comments when reviewing its assessment methods.

### **Reasons for Performing Assessments**

5. The dose limits and constraints are based on exposure from all pathways which means that no specific limits exist for the dose received via the food chain. The Agency therefore needs to consider the dose from all pathways not just the foodchain. In practice, the assessed dose received via the food is the majority of the dose for most sites.
6. The assessments carried out by the FSA are not intended for use in optimisation studies carried out to determine whether further measures to reduce discharges are needed. Neither are they intended for use in consideration of the Best Practicable Means (BPM) for the disposal of radioactive waste where alternative methods of disposal are compared. They should not be used for these purposes.
7. When an application is made for an Authorisation to dispose of radioactive material, the site operator will make an assessment of the impact of the proposed discharges. This will then be included in the public consultation process along with the FSA assessment and any other regulator assessments.

## **Factors Influencing the FSA's Choice of Methodology**

8. When the FSA develops and revises its assessment methodology and considers how the results of the assessment are communicated, it needs to take account of a range of factors. These are detailed below:

- The FSA's Guiding Principles includes the requirement to be open and accessible. The Agency therefore needs to provide consumers with information on the variability and uncertainty in the doses that they may receive so that they are able to make a full assessment of the risks. Presenting a single dose without this information would present only half the story.
- The FSA takes account of the recommendations and guidance given by International and National bodies such as the International Commission on Radiological Protection (ICRP), the International Atomic Energy Agency (IAEA) and the National Radiological Protection Board (NRPB). It also takes account of the recommendations of bodies such as Codex Alimentarius whose responsibilities are for the safety of food rather than radiological protection.
- The FSA is bound by the requirements of National and European legislation.
- Radioactivity is only one of the substances that may be present in food for which the FSA carries out exposure assessments. The methods used for assessing the exposure to radioactivity should have as much commonality as possible with the methods used within the FSA for assessing the exposure to other substances.
- The FSA also takes account of the views of its stakeholders which are expressed in fora such as the NDAWG, the CEDA and other stakeholder fora run by the FSA e.g. its Consumer Committee.
- The Board of the Food Standards Agency has recently accepted a paper on the conservatism of the dose assessment methodology used in radiological assessments.

### **The FSA's Current Methodology**

9. The assessment methodology currently used by the FSA is briefly outlined below. Computer models such as UK-ADMS and WAT are used to model the dispersion and dilution of radioactive material in the atmosphere and the sea. The outputs from these models are then used with other models, such as SPADE and ADO, to provide concentrations of radioactivity in foods. The concentration of each radionuclide in the food is multiplied by the dose coefficient to give the dose from consumption of 1 kg of the food from that nuclide. Values for all the nuclides in the food are summed to give the dose from consumption of 1 kg of the food from all activity in that food. Separate calculations are carried out for adults, children and infants. Dose rates per unit time are also calculated for other pathways such as inhalation, time spent on contaminated sediments and handling fishing gear.
  
10. These dose per unit mass values and dose rates are then combined with information about the food consumption and other habits of the potentially exposed population to provide estimates of the dose that are received. The assumption is made that locally produced foods are produced at the location where it is possible to produce the food and the deposition of activity is highest. Similarly aquatic foods are considered to be sourced from the area where water concentrations are highest.
  
11. The calculation of the radioactivity concentration and dose rates are carried out using methods broadly similar to those used by other organisations. It is in the use of this information in conjunction with the data on habits where the FSA's approach differs from that of other organisations. This aspect of the FSA's methodology is considered in more detail in the following sections.

### **Habit Surveys**

12. The FSA and its predecessor have funded a programme of habit surveys around nuclear sites. In recent years, these have been jointly funded, in England and Wales, with the EA and the Nuclear Installations

Inspectorate. These surveys aim to identify and quantify activities of the population living and working close to the site that could result in them receiving exposure from the discharges. Individuals who are identified as having the potential exposure to radioactivity from the site are interviewed. These interviews obtain information on the amounts of locally produced terrestrial and aquatic foods consumed and the occupancy at locations where they may receive exposure via irradiation from the site or from contaminated sediments or inhalation of the gaseous plume. In this context, local foods are defined as being produced within 5km of the site for terrestrial foods. If local circumstances dictate larger areas are considered for the consumption of seafoods.

13. The data from the survey is recorded as of matrices of the form shown below:

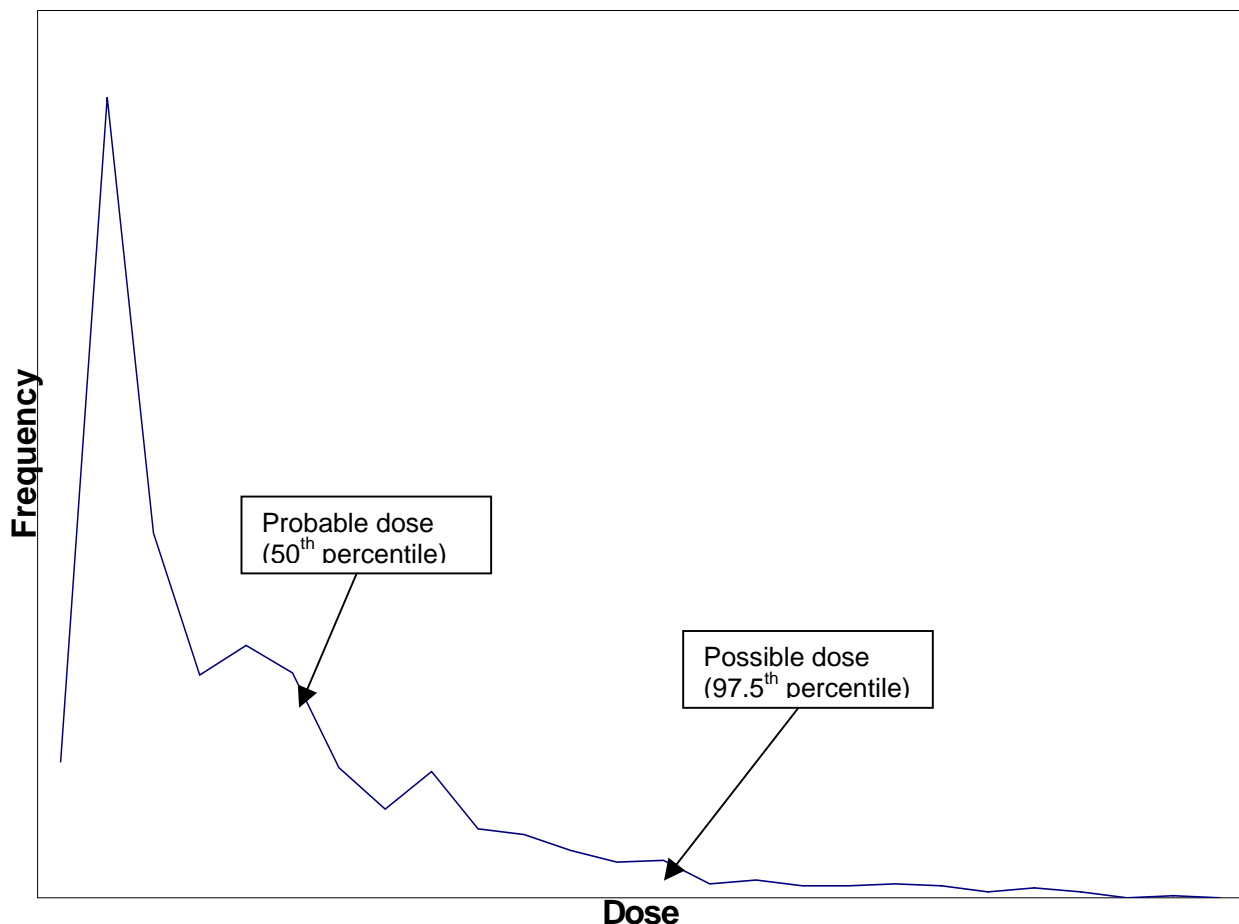
| Individuals in surveys              | Food group 1 | Food group 2 | Food group 3 |
|-------------------------------------|--------------|--------------|--------------|
| $I_1$                               | $R_{11}$     | $R_{12}$     | $R_{13}$     |
| $I_2$                               | $R_{21}$     | $R_{22}$     | $R_{23}$     |
| $I_3$                               | $R_{31}$     | $R_{32}$     | $R_{33}$     |
| $I_M$ for all people in the surveys | $R_{M1}$     | $R_{M2}$     | $R_{M3}$     |

14. Rows of the matrices contain information of the consumption rates of terrestrial and aquatic foods (including zero values) and the number of hours of occupancy at different locations for the individuals in the survey. The columns contain the consumption rates or occupancy times for the different foods or locations. Separate matrices are produced for each of the three age groups considered in the survey.
15. Examination of the data from habit surveys shows that the patterns of consumption of locally produced terrestrial foods in rural areas are not believed to vary between different areas of the UK. Data has been consolidated into two matrices, one for inland sites and one for coastal sites. This combination of data from different sites enables information on

the habits that *could* be reasonably expected to occur as well as those actually recorded to be used in assessments.

16. The consumption of local seafoods is affected by the availability of different species and this varies from site to site. Similarly, amounts of time spent on contaminated sediment carrying out activities such as angling, wildfowling etc. vary with local circumstances. Thus the consumption and occupancy rates from different sites are not combined. The FSA uses the data from each site separately.

The FSA next multiplies the information in the matrices with the dose per unit consumption or dose rate values calculated. Next, the FSA sums the doses in each row of the resulting matrix to give a total dose from that pathway for each individual. This produces a distribution of values for the dose received by different individuals. The FSA selects the median and 97.5<sup>th</sup> percentiles of these distributions. These are referred to as the 'probable' and 'possible' doses for that pathway respectively. This selection of two values from the distribution enables the FSA to present an indication of the variability in the dose estimated and presented. This is illustrated below:



17. The final stage of the assessment is to combine the doses from different pathways. Simple addition of all the 'probable' and 'possible' doses to give overall 'probable' and 'possible' doses is liable to give combinations of pathways e.g. consumption of local foods, spending large amounts of time angling and wildfowling which are very unlikely or impossible to occur in reality. The judgement of the individual carrying out the assessment is essential to ensure that a conservative, but realistic combinations of pathways is used. The Agency presents both 'probable' and 'possible' doses for each of the scenarios. The 'possible' dose is considered to correspond to the critical group dose and the probable dose to a more realistic estimate of the dose likely to be received by a member of the local population who makes use of local resources for food, employment and leisure.

18. It is realised that the nomenclature of 'possible' and 'probable' doses is not totally satisfactory and alternative suggestions would be welcome.

#### **Relationship of FSA's Methodology to ICRP Recommendations.**

19. The group whose habits are recorded in the habit surveys and are used by the FSA to calculate exposures are those who are believed to have habits which will cause them to receive exposure from the proposed discharges. Therefore they are not the same as the local population as they are a sub-group of the population. Neither is the group the same as the critical group as defined by the ICRP.

20. The ICRP defines the critical group as being '*representative of those individuals in the population expected to receive the highest dose*'. The ICRP also states that this group should be homogenous and suggests that this means that the ratio of the maximum and minimum dose within this

group should not exceed an order of magnitude and not exceed a factor of 3 when the mean dose is close to the dose criteria. Further guidance from the ICRP is that the size of the critical group should not be more than a few tens of people. This is concept is appropriate for populations who are homogenous in terms of their use of local resources. However the populations around nuclear sites in the United Kingdom have been found to be inhomogeneous and contain outliers at both ends of the spectrum. Groups covered by FSA/EA/NII surveys will contain individuals who have negligible exposures thus the ratio of maximum to minimum dose may be up to 2 orders of magnitude and the group may contain several hundreds of individuals.

21. The critical group as defined by ICRP is some sub-set of the group whose habits are surveyed. Various schemes have been proposed to derive a dose equivalent to the ICRP defined critical group dose from these sets of data. One suggestion is to consider the sub-set of individuals whose doses are between 1/3 of the maximum value and the maximum as the critical group. This suggestion has merit as it is closely aligned with the recommendations of ICRP. The FSA, however, decided to use its current concept of 'probable' and 'possible' doses for a number of reasons:
- The presentation of a single numerical value for the dose would not give the necessary information as to the variability of the range of doses that could be received
  - It is easy to adapt the method so that values other than the median and 97.5<sup>th</sup> percentile can be presented as well or instead to more fully describe the variability.
  - The use of the 97.5<sup>th</sup> percentile to represent the high rate consumer is the standards practice of the FSA when considering the acceptability or otherwise of concentrations of substances in foods.

22. The FSA is currently developing probabilistic versions of its terrestrial and aquatic foodchain models. These models will enable distributions of the activity concentrations of radionuclides in the different foods to be calculated. The Agency will need to give consideration as to how the outputs from these models are integrated with the habits survey data and the results presented to the public.
23. The incorporation of other sources of variation in the doses received could be incorporated in the assessment by use of different scenarios. For example a scenario could be considered where terrestrial foods are produced at 1km from the discharge point rather than at the point of maximum deposition.

Radiological Protection and Research Management Division  
Food Standards Agency

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