

Studies of the Environmental Impact of Radioactive Discharge on Non-Human Species

R&D Technical Summary P3-053/TS

Public concern for the effects of radiation on the environment have given rise to a world-wide movement towards the development of environmental standards for radiation protection. In order to develop any environmental standards for radiation protection, it is necessary to be able to estimate dose rates received by organisms, and to know at what dose rates significant damage is likely to occur.

This work was originally co-funded by the Ministry of Agriculture, Food and Fisheries (MAFF) – latterly the Department for Environment and Rural Affairs, DEFRA – the Scottish and Northern Ireland Forum For Environmental Research (SNIFFER) and the Environment Agency. The overall aim of the project was to investigate the potential impact of radioactive discharges on non-human species, to aid future assessment studies and to provide possible input to future international activities.

The work focused on two areas, which resulted into two publications:

- R&D Technical Report P350 considers reference organisms for radiation dosimetry modelling, for the purpose of developing a framework for environmental protection; and
- R&D Technical Report P3-053/TR provides data on the comparative damaging effects of long-term exposures to α - or γ -radiation with regard to reproductive output in a representative fish.

R&D Technical Report P350

Due to the practical impossibility of estimating the radiation exposure of individuals of every species of flora and fauna inhabiting a contaminated area, it has always been recognised that it would be necessary to limit radiation dose rate assessments to reference (or generic) organisms, considered to be broadly representative of the area.

This report describes briefly the requirements of environmental radiation protection, before examining the factors that will influence the radiation exposure of native wild organisms in contaminated marine, freshwater and terrestrial environments. The report discusses the criteria that should be considered in identifying reference organisms to fairly represent the European region, and suggests a range of reference organisms that might be appropriate for the each of the three environments. The details of the dosimetry models employed in past environmental impact assessments are then discussed, and considered as a possible basis for determining the radiation exposures of native wild organisms in contaminated environments, within a framework for environmental protection. An outline is given of the future work that is necessary to realise this objective.

R&D Technical Report P3-053/TR

Although there is a considerable amount of data available on the effects of radiation on aquatic organisms, there is none that allows comparison of the damaging effects of α - and γ -radiation for relevant endpoints such as reproduction. Experimental work on zebra fish, using Polonium-210 (^{210}Po), was therefore conducted.

It was found that comparison with the γ -radiation which caused egg production to cease gives an upper limit to the relative damaging biological effect of α -radiation compared with γ -radiation (Relative Biological Effectiveness RBE_α) of < 35 . Based on ovary and whole body activities, it is suggested that a value of 20 may be more appropriate for reproductive effects. Use of the upper limit RBE_α of 35 to convert α -dose rates to γ -equivalent dose rates is thus very conservative. As no other RBE_α for effects on fish are available, this

derived RBE_{α} will provide the best available estimate for use in the development of standards for environmental protection.

This is the first time a study of this sort has been undertaken, and several improvements have been identified for the future. Most important is the need to use animals in numbers, which allow regular sampling to monitor ^{210}Po concentrations throughout the experiment. This will require small animals being kept in large numbers with low husbandry requirements, and endpoints for radiation damage which are not labour intensive to measure.

The findings of this project have been fed to the EU-funded FASSET (Framework for the ASSESSment of Environmental impact" project, which considers "effects" of ionising radiation to wildlife.

This R&D Technical Summary relates to information from project P3-053 contained in the following outputs:

**R&D Technical Report P350:
Environmental Dosimetry: The Current Position
and the Implications for Developing a Framework #
for Environmental Protection.**

December 2000. ISBN: 1 857 05471 7.

**R&D Technical Report P3-053/TR:
An investigation into the effects of chronic
radiation on fish.**

July 2002. ISBN: 1857059301

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Project Manager: Clive Williams, Radioactive
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Copies of these documents are available internally from the Regional Information Libraries or the National Information Centre in Bristol, and externally from Environment Agency R&D Dissemination Centre at WRc (Tel: 01793 865 000, Fax 01793 514 562).

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