ENVIRONMENTAL MONITORING AND DEEP OCEAN DISPOSAL OF PACKAGED RADIOACTIVE WASTE

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INTRODUCTION

A basic tenet of the philosophy which underlies radioactive waste disposal control into the marine environment is that of environmental monitoring. Current monitoring principles have recently been discussed by Mitchell (1) with illustration of their application to controlled releases of radioactive effluents to estuarine and coastal waters of the U.K. This paper sets out to discuss environmental monitoring philosophy in the context of dumping of packaged waste in the deep ocean and how far it may be reasonable to apply it in practice.

THE AIMS AND OBJECTIVES OF ENVIRONMENTAL MONITORING: SOME BASIC PRINCIPLES

Both the ICRP (2) and the IAEA (3) have devoted specific publications to the topic of environmental monitoring and U.K. practices are consistent with them. As with any operation associated with the management of radioactive waste, environmental monitoring should be in accord with the fundamental dose limitation principles of the ICRP and the principle of optimization is of particular importance in this respect. The IAEA in its recommendations to the London Dumping Convention (4) recognizes a need for environmental monitoring but adds an important rider 'to the extent feasible and meaningful'. The ICRP lists three objectives for environmental monitoring.

(a) Assessment of the actual or potential exposure of man to radioactive materials or radiation present in his environment, or the estimation of the probable upper limits of such exposure.

(b) Scientific investigation, sometimes related to the assessment of exposures, sometimes to other objectives.

(c) Improved public relations.

To these the IAEA has added:

(i) assessment of the adequacy of controls on the release of radioactive materials to the environment;

(ii) demonstration of compliance with the applicable regulations, environmental standards, and other operational limits; and

(iii) the possible detection of any long-term changes or trends in the environment resulting from the operation.

The estimation of radiation exposure

The fundamental objective of environmental monitoring, as the term is used in the U.K., is to facilitate or otherwise provide for the *direct* estimation of radiation exposure. Reflecting the emphasis of U.K. national waste disposal policy, which is primarily on limitation of radiation exposure to the public as opposed to that of effects on environmental resources, environmental monitoring has come to be associated mainly with measurements needed to assess doses to which human populations are exposed. The justification for this attitude is found in the realization that the potential risk to environmental resources is minor provided that exacting standards for control of public radiation exposure are met and maintained, i.e. those recommended by the ICRP.

Monitoring and research

There is still much confusion between monitoring and research, possibly because they are frequently practised as mutually supporting activities. The objective of estimation of radiation exposure has sometimes been met by utilization of data which have accrued from research programmes, replacing a need which would otherwise have had to be met by mounting monitoring programmes specifically for that purpose. Conversely, environmental monitoring programmes themselves have sometimes generated information of value to research and it is in this kind of situation where there may appear to be some confusion of purpose as between monitoring and research. Whilst in a few marine situations radiation exposure can be estimated from analysis of environmental materials, it is not possible to do this where contamination is below detection limits. In such situations monitoring and research have another interface, for mathematical modelling provides a means of indicating what the levels of radioactivity may be in the environment in relation to given rates of input and hence provides data for the evaluation of levels of dose. Research in support of this kind of modelling activity is especially important in connection with deep sea disposal of packaged radioactive waste.

Monitoring and control measures

As practised in the U.K., environmental monitoring has sometimes provided a means of checking adequacy of control measures, such as treatment plant or filtration systems, relating to the on-site management of radioactive waste. This has certainly been applied in some coastal situations related to the control of liquid radioactive waste discharges but, just as this is not always a practicable proposition there, it would be misleading to consider that such objectives could necessarily be met in regard to deep sea dumping.

Public information

A popular view in some circles is that monitoring should also be done on occasions for what is termed 'public relations purposes'. Whilst the need to provide the public with appropriate information

and data is readily acknowledged and met, it is considered that the conduct of monitoring programmes for which there is no justifiable radiological or scientific need in relation to estimates of human radiation exposure is not a suitable objective. P.R. monitoring must not be allowed to become an end in itself and require the production of data for the sake of being able to state that some monitoring has been done. Such programmes would be misleading, and subject to severe criticism by the scientific community as a conscious effort to mislead the public and allay public concern at a cost out of proportion to the need. Data arising from programmes designed to fulfil the basic aim of providing a sound basis for estimates of radiation exposure should also be sufficient to answer public information needs.

ENVIRONMENTAL MONITORING IN PRACTICE

Compared with disposals of liquid wastes into coastal waters, disposals of packaged waste into the deep sea pose special problems for those involved in environmental monitoring. The capacity of the receiving environment, its remoteness from pathways back to man, coupled with the relative biological and physical unavailability of the radioactivity in the waste means that, curie-for-curie, there is must less chance of being able to measure activity in the critical materials from deep sea disposals. Whilst waste packages are designed to ensure that their active contents are at the very least delivered to the deep ocean bed it is clear that in general they will have a much longer life and in most cases the activity will be released only very slowly into the water.

The major disposals of liquid wastes to coastal waters are characterized by the ease with which environmental monitoring yields positive evidence of the disposal. In such labelled environments discharge rate can be correlated with radioactivity in environmental materials and from this with radiation exposure to man. In contrast, and whilst there is evidence to show that in at least certain circumstances activity from dumped waste may be detected on sediment very close by packages, it cannot be detected in pathways critical to man and monitoring along the lines of coastal disposals would not therefore be meaningful.

Faced with such a situation it is necessary to find an alternative to environmental monitoring, at least to an extent necessary to meet the fundamental objective of monitoring, that of assessing human radiation exposure. Situations where levels of activity attributable to a particular disposal are below limits of detection are not unique to deep sea disposal; it is typical of a majority of the disposals at coastal sites and two options are open to us.

The first option is to make an upper limit estimate based on a judgement of analytical detection limits. As such it provides only a very crude answer and whilst this will be sufficient to show that radiation exposure is within prescribed limits it has little scientific value and serves no other purpose.

The second option is to compute the dose by mathematical modelling. For a system on an oceanic scale this is a considerable undertaking and many of the factors involved are not known with any precision; neither are oceanic processes well understood. Nevertheless it is possible to model the system using pessimistic values of

the necessary parameters, such that upper limit values are produced which are more accurate than those derived from analytical detection limits. The overall oceanographic/radiological model is divided into several parts, viz, release of activity into the water, its dispersion and transport, and uptake into critical pathways. Simplifying assumptions are made, for example that no removal by sediment occurs to reduce the availability of activity to biological pathways, provided that they do not underestimate the dose received. Most of the values of concentration factor needed are reasonably realistic, as would be the consumption rates/occupancy factors used if the pathways were effective now. A fundamental problem to sea dumping assessments is the long delay between dumping and the arrival of dose to man. For the purpose of dose assessment the assumption is made of prompt release after dumping has taken place, a maximizing assumption which leads to exaggerating the resulting dose from the shorter-lived radionuclides. For the present, it is only possible to calculate the dose at equilibrium from continued dumping over very long periods of time and the results are therefore likely to be gross overestimates of the true dose. Nevertheless, work is continuing, in terms both of better mathematical models to predict dose to man and research into oceanographic and biological transfer processes to provide better data and improve the accuracy of the models. Faced with the inability of direct monitoring to provide data by which direct estimates of dose to man can be made, resources can be used to greater effect by devoting them to modelling and oceanic research.

REFERENCES

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