

Examination of the Use of the Expectation Value of Risk

The UK regulatory authorities have published guidance on the requirements for authorisation for the disposal of low-level and intermediate-level radioactive waste. The guidance specifies an individual risk target for the post-closure period and requires developers to consider collective radiological impacts. Information on how risks and impacts should be calculated or assessed has not been published.

The objective of this project was to identify a suitable approach for making judgements of acceptability in relation to a risk target. The project examined the basis for using the expectation value of risk and investigated what approach the Agency might adopt in judging the acceptability of a dose versus probability profile for a given facility.

Regulatory criteria are often expressed as a single number representing a constraint, limit or target. However, calculations or measurements of quantities for comparison with these criteria commonly give rise to distributions rather than single values. The expectation value of a distribution, which is equivalent to the arithmetic average, is one means of summarising a distribution as a single value. The project included general consideration of the mathematical basis of the expectation value of a distribution, with specific reference to the calculation of the expectation value of risk. The disadvantages of using the expectation value were also examined in the project. These include its sensitivity to changes at the high-end of the distribution, the need for an arbitrary integration limit for distributions that cannot be integrated analytically and the fact that risk is calculated as a function of time for each of many sets of events.

The concept of risk as a basis for regulatory decision-making is becoming more widespread, particularly in the European Union, as directives such as the Control of Major Accident Hazards become effective. Planning of industrial development and transport systems does take account of risks to individuals but there is a greater emphasis on societal risks than is generally the case for assessments of radioactive waste repositories. The project examined consideration of societal risk in three senses: collective risks (i.e. the product of individual risk and numbers exposed), societal risks (expressed in terms of multiple fatalities or impacts such as environmental damage) and concerns such as economic loss and political effects. The project identified that the last of these types of societal risk is important in influencing public attitudes to development and that it would be important to establish extensive dialogue between all stakeholders from an early stage of any development.

Risk assessments must account for a range of uncertainties, including parameter, conceptual model and scenario uncertainties. However, the use of a single expectation value of risk to present the results of an assessment that includes different types of uncertainty may obscure their relative contributions to the calculated risk. The project concluded that presentation of conditional risks and separation of different types of uncertainty could aid regulatory decision-making. This type of approach could also aid dialogue with stakeholders, possibly leading to a better understanding of the role of “what-if” calculations in risk assessments.

The project identifies a number of recommendations, including that the Agency considers ways of building consensus between regulators, developers and other stakeholders about the scope of risk calculations and the overall treatment of issues of concern. Discussion and, to the extent possible, agreement on the events to be included in risk calculations would potentially simplify risk calculations while still providing a mechanism within the overall decision-making process for considering unlikely or speculative events.

The information within this document is for use by EA staff and others involved in the assessment of post-closure safety cases for radioactive waste disposal facilities and is likely to be of value to other Agency staff involved in environmental risk assessment studies.

This R&D Technical Summary relates to information from R&D Project P3-037 contained in the following outputs.

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Project Manager: Mr Roger Yearsley, NCRAOA

Research Contractor: Galson Sciences Ltd., 5 Grosvenor House,
Melton Road, Oakham, Rutland, LE15 6AX

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Rio House
Waterside Drive
Aztec West
Almondsbury
Bristol
BS32 4UD Tel: 01454 624400 Fax: 01454 624409