IAEA SUB-GROUP ON PRINCIPLES AND CRITERIA FOR RADIOACTIVE WASTE DISPOSAL - A STATUS REPORT ON ACTIVITIES TO DATE

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ABSTRACT

The Sub-group on Principles and Criteria for Radioactive Waste Disposal was established by the IAEA under INWAC in 1991. It is intended to provide a forum for discussion of issues related to waste disposal principles and criteria. It does not have a specific mandate to resolve particular issues nor to prepare particular documents. There is thus considerable freedom to discuss issues in a very broad manner. The group however, does intend to attempt to develop consensus on these issues whenever possible and to provide appropriate documentation to provide a rationale and support for the consensus. The group meets on a annual basis in the fall of each year.

This paper provides a summary of the latest discussions within the sub-group and the trends which are developing within the international community. Topics presented include: the use of dose or risk based criteria or objectives; the types and uses of other indicators of performance for long term waste repositories; the relationship of these indicators and the way they are estimated and used over various time scales; and the role of optimization of radiation protection in making long term waste management decisions. An indication of future topics for consideration by the group is also provided.

INTRODUCTION

The International Waste Management Advisory Committee (INWAC) which focuses on radioactive waste management activities is a senior level oversight group for the IAEA. The Sub-Group on Principles and Criteria for Radioactive Waste Disposal reports to INWAC and meets annually. This sub-group has safety principles and criteria as its mandate, with a particular focus on long lived wastes. The current expertise in the group tends to be on health and safety. However, group members are drawn from both the regulatory bodies and implementing organizations. Thus a balance is maintained between various points of view and between the theory of radiation protection and its practical application. The group has a very flexible mandate and in practice the topics it chooses to address, and the priorities which are assigned to them, are selected by the group itself.

The Group is concerned with examining areas of importance in relation to safety principles for waste disposal on which no consensus yet exists and with exploring new ideas and concepts. Because of the inherent uncertainty in such a process, no targets or schedules have been set for the Group to produce reports, although it is recognized that if consensus is reached on an important issue then it will be documented in some way. In contrast, the RADWASS program has the aim of documenting the existing areas of consensus in a structured way and of doing so against pre-established timescales. This second program is also under the direction of INWAC and is designed to produce a complete range of documents on radioactive waste management from statements of principles through detailed design and applications guidance. It should prove of considerable value to countries which are developing, or expanding, their capabilities in the nuclear fuel cycle and other domestic uses of radioactive materials. There is, however, expected to be some interaction between the Groups, especially at the Safety Fundamentals and Standards level, on issues of principles and criteria related to disposal. No serious duplication of effort between this Group and the committees and working groups of the other international organizations is envisaged.

The group has had two meetings and has developed a list of possible discussion topics and an initial set of priorities. These are given in Table I. The method adopted by the group is to have one member produce an initial "Discussion Paper" on a topic in order to focus general discussion within the group as a whole. Following this, a draft "Position Paper" for those topics of broad general interest is produced, either by a single author or by a small consultants group. This latter document then serves as the basis to generate a consensus within the group. The limited experience to date suggests that 3 or possibly 4 meetings will be needed to develop and document this consensus. While the group does not have a rigid set of time constraints, the IAEA hopes to initiate a revision of its basic guidance on long lived criteria for underground disposal of high-level radioactive wastes (Safety Series #99, 1989) in 1994 and to complete it by 1997. It would thus be useful to have the group's work well advanced by 1995 so that it could be integrated into the new safety series document. It is also likely that membership in any new group established to draft such safety documents would overlap the existing sub-group to some extent, to ensure continuity.

The following sections provide some general observations and trends as to where the group is moving on each of the priority topics given earlier:

Indicators - Initially the group intended to address the issues of dose/risk, timescales and other indicators as separate items. As discussions evolved it became clear that this was not the best approach and now all three will be integrated. There are many ways to describe the overall performance of a waste disposal system and the individual sub-components within it. Thus many possible indicators of performance can be identified, such as concentration, flux and the time it takes for releases to occur. In principle, none of them have priority over any others. However, preferences may arise based on experience or familiarity with specific indicators, or on regulatory systems which emphasize either general or detailed aspects of performance, or on the time frame being considered in the assessment.

It was subsequently felt that a general discussion of indicators would be useful. The desirable characteristics of good

TABLE I
Topics for Discussion

Highest Priority	- Dose/Risk Criteria - Other Safety indicators - Timescales - Optimization
Moderate Priority	- Post-Closure Monitoring - Retrievability - Safeguards - Intergenerational Effects - Intrusion - Uncertainty
Possible Future Topics	- Disposal vs storage - Transboundary Principles - Confinement and dilution philosophy - Non-radioactive risk assessment comparison - Site selection strategy - Criterial Group concept - Protection of non-human species

indicators were identified. These may include reliability, simplicity, directness, understandability and practicality, among others. Furthermore, each indicator used may lead to some reference value or criterion being chosen as a basis against which to make judgements. Ideally, the reference values chosen should remain stable in the short term, be generic and allow design flexibility. They also need to reflect the nature of the decisions being made. For example, decisions could be made for regulatory and licensing or for engineering design and siting purposes. Reference values are also useful to aid in communicating with technical and non-technical audiences, to help provide confidence and to provide context and perspective. However, they should not be seen as a means of identifying safe or unsafe practices in a rigid legal sense.

Radiation protection is a major area of concern and indicators such as dose and risk are commonly used. The sub-group agrees that risk is the most fundamental of the two although dose has been the most frequently used indicator. The group intends to clarify the interrelation between these two indicators and to show that it is not helpful to separate them too formally, while recognizing that practical difficulties in applying them may lead to a preference for one over the other. The group intends to further develop the relationship between indicators, criteria and uncertainty.

The timescales of interest in most assessments cover the range of a few hundreds to perhaps a few millions of years. It is recognized that it is unethical to stop assessments before the predicted impacts or hazards have reached their maximum values and some assessments suggest this occurs in the period of several hundreds of thousands of years for spent nuclear fuel. It is also recognized that quantitative analyses are not reasonable over this complete time span. Thus the group is attempting to develop a loose framework covering three broad time scales (0 - 10^2, 10^2 - 10^4, 10^4 - 10^6 yrs) with rather fuzzy lines of demarcation (see Table II). Indicators of various types will be referenced to these time scales and their utility will be discussed. A preliminary attempt to suggest this is seen in Table III.

TABLE II
Time Frames and Safety Assessment for Nuclear Waste Repositories

$< 10^4$ years	- quantitative safety assessment based on dose/risk calculations supported by other safety indicators
10^4-10^6 years	- quantitative and qualitative safety assessments based on the use of a variety of safety indicators
$> 10^6$ years	- qualitative assessment only; no reference to a biosphere meaningful.

TABLE III
Utility of Various Indicators In Different Timescales

	Time scale (Years)		
	0 to ~100 years	10^2 to 10^4 years	10^4 to 10^6 years and beyond
Indicator			
Dose/risk			
- individual	primary	primary	limited
- collective	limited	limited	N.A.
Radiotoxicity	limited	limited	limited
Concentration	primary	primary	limited
Fluxes	N.A.	primary	limited
Engineering performance	limited	primary	limited

A key feature of all of the work on indicators and time frames is that no single indicator is universally appropriate. Each different indicator has a contribution to make and the analyst should attempt to focus on a select few once the overall context of the assessment is defined. Another key is to recognize that indicators can still be very useful (e.g. they can form the basis for decisions) even if they are incomplete and subject to considerable uncertainty. As their name implies, they are only intended to "indicate" something such as a trend or a general range of some property of a disposal system. Indicators do not necessarily need to be all encompassing or amenable to rigorous quantification. Their values can be estimated using various methods including scoping and bounding calculations, robust decision-making and engineering assessments as well as detailed, scientifically based ones. It is hoped that the report on these three topics will be near completion following the next meeting of the sub-group in October 1993.

Optimization - Optimization of radiation protection is one of the three basic elements of the ICRP system of radiation protection and dose limitation. The work of the sub-group will focus primarily on the applicability of this technique to

disposal of HLW and spent fuel. It has been noted that attempts to apply optimization to long term waste disposal settings results in unique problems. For example, the existence of people at a particular location, their numbers and their lifestyles, becomes highly speculative over the periods of interest. In addition, social pressures often require consistent over-design of barrier systems and the placement of repositories at great depth even when such choices may be difficult to justify on purely technical or safety grounds. Thus balancing of siting, design, engineering and operating options is restricted and optimization becomes difficult. The general sense of the sub-group is that optimization is of limited value when making waste disposal decisions for spent fuel. Nevertheless, it is recognized that the basic principle continues to apply. Therefore the group will need to develop a document which presents these competing perspectives in an appropriate manner. For example, the very low risk criteria used in some countries like Canada (10^{-6} per year) could possibly be presented as representing a level so low that it can be considered as a de-facto optimization. The group will be considering a revised draft at its next meeting. Developing a consensus might take another year since this topic has been somewhat challenging to resolve to everyone's satisfaction. Overall, the Group considered that the prominence given to the optimization concept in many national and international criteria documents relating to waste disposal is unjustified. It recommended that the attention of the relevant RADWASS committees should be drawn to this opinion.

Monitoring and Retrievability - Separate discussion papers were prepared on long-term post closure monitoring of disposal facilities and retrievability of wastes. After some general discussion, it was agreed that these topics were of general interest and that they were closely linked. Thus a draft position paper will be prepared covering "Post-Closure Considerations". This is intended to cover topics such as why monitoring is undertaken and what actions might be possible if the results were to show some degree of failure in the containment system. It will also address questions such as - is monitoring compatible with final disposal and with the requirements for safety. For example, a monitoring well which could act as a short-circuit for contaminants is not compatible with the need for maintaining long term barrier integrity.

Safeguards - Most countries have assumed obligations to allow the IAEA to inspect their inventories of nuclear material contained in spent fuel. There is at present no means available to discontinue this safeguards process under the terms of the NPT. Discussions are therefore underway within the agency to address the apparent conflict between safeguards and safety requirements after disposal facilities are closed. This is somewhat like the monitoring issue noted previously in that few people wish to impair containment barriers solely to allow access to the waste for safeguards purposes. Thus discussions will likely center on the availability of methods to monitor repositories using remote sensing technology such as seismic monitoring, geophysical techniques and aerial surveillance. These could probably provide adequate warning of the large scale mining activities needed to access wastes placed deep within geological formations. Discussions may also consider the possibility of changing the NPT itself to allow administrative controls to lapse once wastes have been placed in a way which makes access to them very difficult. These ongoing discussions however, will take place within the safeguards section of the agency. The sub-group intends to monitor these discussions to help ensure they reflect all dimensions of the issue and to encourage interaction between the safety and safeguards communities.

Other Issues - Brief discussions were held on the issue of how intergenerational equity and responsibility should be addressed. It was agreed that sufficient advice exists at the international level on this topic at the present time and therefore no additional work by the group is needed. The issue of intrusion was also raised and was clearly of interest to the group. They agreed however, to monitor work currently underway within the Nuclear Energy Agency on this topic rather than to embark on their own study at this time. It was also proposed to look at uncertainty and how it affects the choice of criteria and compliance with them. A preliminary discussion paper will be prepared for discussion at the group's next meeting.

In summary, this sub-group has been able to make useful progress towards resolving some outstanding difficulties with the principles and criteria needed to safely dispose of long-lived radioactive waste. It is expected that the new consensus which is evolving will be documented in the next several years and will gradually be incorporated into the international norms which underlie most national regulatory programs. It is also hoped that these new documents will provide the necessary balance between the theory or principles of radiation protection and the practical realities faced by regulators who have to ensure their proper implementation.