

RADIATION PROTECTION ACTIVITIES AFTER CLOSURE OF GEOLOGICAL REPOSITORIES

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Abstract. Although the safety of repositories for radioactive waste should not depend of active controls such as monitoring, several control measures may be required for a variety of societal reasons. It is possible that the reporting of environmental monitoring to international treaties and conventions, already in place today, may be of value in meeting those requirements.

To prepare for passive institutional control includes taking measures today that may be of use for future institutional control, including the possibility that future societies may initiate or renew active control measures. Passive institutional control may be of use to prevent or reduce the likelihood of human intrusion, to allow for remedial action, or to serve as a source of information in future societies, in the form of accurate historical documents.

In the process of reporting within international conventions, including the most important reporting within the so-called Waste Convention [Ref. 1], a large body of information will be built up by a process already in place today. This information is in itself a source for passive institutional control.

1. INTRODUCTION

Post-closure activities are measures that, by definition, are to be taken after the potentially very long period that covers all the final steps in a repository programme. It may therefore seem natural to postpone both the discussions and the relevant decisions to a later stage. However, in the Swedish voluntary siting process, questions covering all aspects of the programme are discussed thoroughly at every step in the process. The same questions are in fact discussed on all levels of the Swedish society. Therefore these questions must be assessed and answered now in some form.

This work is limited to deep geological disposal for long-lived waste where the waste are outside the accessible environment. Question about demonstration, and particularly independent demonstration, of the repository's continued safety after closure raises some fundamental questions about confidence in the regulators' work and contemplation of future societies' activities.

These issues will undoubtedly be treated different from country to country and the Swedish solution, not yet established, may be of limited value to others. The presentation reflects the authors' personal ideas, hopefully of general interest and intended to stimulate discussion.

2. POST-CLOSURE MONITORING FOR RADIATION PROTECTION

2.1. The dilemma

In the eyes of stakeholders, any monitoring in the post-closure phase has the potential to contradict the basic objective of geological disposal, which is to create a highly reliable multi-barrier system, licensed by the responsible authorities and found to have the capability to isolate the waste for thousands of years, independent of active support.

In the eyes of some, there is a need for a guarantee in the form of a monitoring program. In the eyes of others, however, a monitoring program leads to an inescapable inference that it is in place to compensate for lack of safety in the repository, and that it would therefore be wrong to close the repository in the first place. Another conclusion that can be foreseen is that if monitoring is necessary after closure, it would also be necessary for thousands of years until most of the radionuclides in the waste have decayed.

In spite of these complications, however, it cannot be ruled out that the societal process may require a radiation protection monitoring program in some form. The Swedish voluntary process requires the consent of the local municipalities, and the outcome of a societal agreement can in principle contain any provision that will favour and promote the process.

It should be noted that, although non-radiological monitoring is not treated in this work, a monitoring program for radionuclides would only be one of several post-closure environmental monitoring programs related to other issues than radiation, such as the monitoring of possible effects e.g. hydraulic and hydro-chemical disturbances from excavation and drainage.

All such monitoring activities are described in the IAEA publication “Monitoring of Geological Repositories for High Level Radioactive Waste”, IAEA-TECDOC-1208:

the primary objective of monitoring is to provide information to assist in making those decisions. In this context, the key purposes of monitoring of deep disposal systems are seen to be:

- (1) to provide information for making management decisions in a stepwise programme of repository construction, operation and closure;*
- (2) to strengthen understanding of some aspects of system behaviour used in developing the safety case for the repository and to allow further testing of models predicting those aspects;*
- (3) to provide information to give society at large the confidence to take decisions on the major stages of the repository development programme and to strengthen confidence, for as long as society requires, that the repository is having no undesirable impacts on human health and the environment;*
- (4) to accumulate an environmental database on the repository site and its surroundings that may be of use to future decision makers;*
- (5) to address the requirement to maintain nuclear safeguards, should the repository contain fissile material such as spent fuel or plutonium-rich waste.*

The aspect of post-closure monitoring is not easily linked to a single item of the list but it is at least indirectly relevant for making management decision in the stepwise process in the first point on the list, and to item number 3 about information necessary for the society at large.

Notwithstanding the dilemma connected with misunderstandings of monitoring, a monitoring programme may also give a perspective in which the safety and radiation protection of the hosting community is not based solely on infallible authorities.

2.2. The monitoring program

It may be unknown to many local stake-holders that Sweden has an extensive environmental monitoring program. In the vicinity of the nuclear power plants, an environmental monitoring programme has been carried out for the past 20 years. Results from these monitoring programs are reported routinely within international conventions such as

The Waste Convention, Ref. [1]

— The EURATOM treaty, in accordance with articles 31, 35 and 37, Ref. [2]

— The HELCOM convention ... Ref. [3]

— The OSPAR Convention ... Ref. [4]

In addition to these, reporting of monitoring is necessary in connection with activities on case-by-case base as required by a number of other national regulations, European Community directives and other conventions, such as

- The EC directive on environmental impact statements Ref. [5] (Council Directive 85/337 and 97/11)
- The Espoo Convention Ref. [6].

At present SSI is also in the process of developing a national environmental monitoring program. An overview of the present state of the Swedish national environmental monitoring program is given in Table I.

There is thus a considerable body of reported monitoring available. A possible development is that some of this is directed to the concerned communities, now or in the future. Another possibility is that the existing monitoring program is modified in order to fit the requirements of the concerned municipalities and other stakeholders.

3. PASSIVE INSTITUTIONAL CONTROL

3.1. The terminology of passive institutional control

Passive control is usually referred to as an expectation of a condition prevailing in the — possibly distant — future. In its present usage, there is an inherent contradiction in the term.

Taken literally, it could simply suggest a careless form of active control. The term is used here in its traditional sense, but it would worthwhile to construct a more stringent terminology. Measures taken for passive institutional control now should be seen as *institutional procedures describing the repository and associated societal decisions*. The corresponding activities envisaged in the future are *informed decisions* that, for all we know today, may quite possibly include active control.

3.2. The value of passive institutional control

Measures for passive institutional control can be found in the physical form of markers and in the abstract form of archives and other documents such as laws and regulations, initiated now and maintained later, after due societal decisions. No passive control system can be guaranteed to last for millennia, nor can any guaranties be given that passive measures are interpreted correctly and properly acted upon. However, to describe the repository for future societies can be of value in many ways, which have been discussed in Ref. [7]. It is pointed out that

A principle has been formulated stating that a repository should be designed, sited, and constructed so as to allow for future control, including possible remedial action while, at the same time, maintaining integrity and excluding the need for future monitoring/.../ There are several reasons why information on repositories with HLW ought to be kept for a very long period of time. Some of these reasons are:

- 1) *Information will give a certain level of protection against inadvertent human intrusion into the repository, because knowledge of the repository and its relative risks will be maintained. It might also reduce the risk for future human actions that might affect the safety of the repository*

Table I. Overview of the present status of the Swedish national monitoring program

Air	Aquatic environment		Terrestrial environment						Human health
	Coast and sea	Lakes and rivers	WETLANDS	Mountains	Forests	Agriculture	Urban environment	Landscape	
Airborne particles, 5 sampling sites in Sweden	Fish, molluscs, seaweed; Coordinated with sampling for HELCOM/OSPAR Sediments Pilot project: ^{137}Cs and ^{90}Sr in soft tissues and skeleton of seal	Fish and sediments	Peat: accumulation of natural radionuclides Accumulation of ^{137}Cs in wetlands Pilot project: ^{137}Cs - exposure of a potential sensitive organism-monitoring and modeling	Rein deer and lichen	Accumulation of ^{137}Cs in forest soil Moose and mushrooms	Radioactive substances in agricultural soil	Project: Gävle monitoring and modeling	External radiation from 37 gamma-monitoring stations Aerial surveys of natural and anthropogenic radioactive substances	^{137}Cs and ^{90}Sr in milk Natural and anthropogenic radioactive substances in water Nationwide data of whole body measurements

2) *Information will enable future generations to:*

- (a) *evaluate the safety of the repository system*
- (b) *take necessary steps for retrieval or repair work*
- (c) *take remedial actions, if necessary*

3) *Information will give future generations general information as a basis for decisions in the area of repositories.*

Judicial responsibility

Intrusion into a deep geological repository is easily hypothesised. A natural question is what body — today — is responsible for the danger this possibility represents, and how its responsibility is to be judged.

It is reasonable that the final steps of waste management include some actions to prevent intrusion, and that this is reflected in the national legal system. However, this responsibility cannot be carried too far. The need for long-term storage was, in principle, brought about by the use of practices producing radioactive material. The following statement of the International Commission of Radiological Protection, ICRP, reflects this:

Waste management and disposal operations are an integral part of the practice generating the waste. It is wrong to regard them as a free standing practice, needing its own justification.
.... Ref. [8]

The acceptability of waste disposal in some form has therefore already been judged in the first steps of a chain leading to waste disposal. When the waste disposal strategy is isolation, the danger of penetration through the barrier system flows directly from that option.

The legal responsibility associated with the optimisation of transfer of knowledge from present to future societies is sometimes discussed as an issue of responsibility for the license-holder, but it represents a grey area in several ways. Firstly, to draw legal conclusions at all in this matter of knowledge transfer may be carrying the question of legal responsibility too far, but it is also unclear which options would be at the operator's disposal in such an undertaking. An operator in the form of a private company cannot take responsibility for how the national archive is kept and maintained, and how maps with legal information are generated and regenerated. These matters are the responsibility of the national government. A large part of this discussion has emanated from the USA, in particular in connection with the Waste Isolation Pilot Plant, WIPP, in studies to divert future human intrusion. Since, in the United States implementer and regulator and the body responsible for setting standards are all branches of the national government, it is not clear what body would represent the national government's general responsibility in preserving archives. This matter would have to be defined if such stricter legal provisions were to be included in the licensing process in countries with governmental implementers.

3.3. The formation of an environmental archive

Already today, formal reporting of waste management is carried out pursuant to a number of international conventions and treaties. The most important is no doubt the so-called Waste Convention, Ref. [1].

For Sweden, other important treaties are those mentioned and referenced above, the EURATOM treaty, the HELCOM, OSPAR and the Espoo conventions.

Most of these agreements already include provisions for reporting, and the importance of that activity has therefore already been judged and decided by the national governments. The reporting within the conventions may serve the purpose of generating discussion and comments in meetings, but in the future a large body of information will accumulate in the process. The treaties and conventions will, within their reporting system, create a body of valuable information related to waste management.

The Waste Convention has only recently come into force, and it will take some time before the accumulated reporting information can be assessed. Taken as a whole, there can be no question of the value of this body of information. It would be valuable also to preserve this information in a collected and more easily accessible form, for the benefit of future societies. No doubt the information even in its present form can play a decisive part in passive institutional control for waste repositories.

REFERENCES

- [1] The Joint Convention on Safety in Connection with the Handling of Spent Nuclear Fuel and on Safety in Connection with the Radioactive Waste Management, IAEA.
- [2] Convention on the Protection of the Marine Environment of the Baltic Sea, 1992.
- [3] The EURATOM Treaty.
- [4] Convention on the Protection of the Marine Environment of the North-East Atlantic.
- [5] The European Council Directive 85/337 and 97/11 on Environmental Impact Assessments.
- [6] Convention on Environmental Impact Assessment in a Transboundary Context.
- [7] Jensen, M., "Conservation and Retrieval of Information: Elements of a Strategy to Inform Future Human Societies About Nuclear Waste Repositories," Denmark, The Nordic Council of Ministers, Nordic Nuclear Safety Research Project KAN 1.3/596, August 1993.
- [8] ICRP, 77, Radiological Protection Policy for the Disposal of Radioactive Waste, Paragraph 15.