

ALLOCATION OF RESPONSIBILITIES FOR MONITORING AND RETRIEVAL ACTIVITIES



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Abstract

Geologic disposal is considered by many to offer a way to achieve the long term isolation required for radioactive wastes. The extremely long timescales, however, have drawn attention to the need for society to plan far ahead into the future. Perhaps for the first time, much thought and debate is being explicitly devoted to the burdens and the benefits which a technology will bring to many generations in the future. The questions to be answered concern not only **what** the benefits and burdens are, but also **who** bears the responsibility for defining courses of action affecting future generations and for implementing any measures required to protect society beyond the lifetimes of those initiating activities with far future impacts. In the present paper, the intention is to review the actions which may have to be taken during and after the operation of a disposal facility, to consider who shares responsibility for such actions and to look rationally at how responsibilities can best be allocated to ensure that they will be fulfilled in a way which protects future generations from harm, be it physical or financial. The paper defines the phases in the lifetime of a geologic repository, and postulates that responsibilities are to be shared between governments, regulators, repository implementers, waste producers and potentially also supra-national bodies. The specific responsibilities ranging from conceptual planning through to financial provisions for actions are then listed. The allocation of these responsibilities is then discussed. The broad conclusions are that waste producers are responsible for all financing and for most of the specific actions to be taken. At very far future times, however, responsibility for a closed and sealed national repository must revert to the government of a State.

1. INTRODUCTION

The fact that radioactive wastes do decay with time (as opposed to some other toxins like heavy metals) opens avenues for protecting humans and the environment for all times. If one can isolate the wastes for sufficient time for decay to reduce the toxicity to levels which are harmless (given the natural dispersion of residual materials in the geosphere over very long times), then permanent protection is assured. Geologic disposal is considered by many to offer a way to achieve such isolation. The extremely long timescales, however, have drawn attention to the need for society to plan far ahead into the future. Perhaps for the first time, much thought and debate is being explicitly devoted to the burdens and the benefits which a technology will bring to many generations in the future. The benefits (or burdens) need not be direct; they can also be indirect results of actions taken by current generations which alter the future environment, preserve or exhaust raw materials, provide future freedom of choice etc. Similar deliberations are certainly spreading to other activities such as disposal of chemotoxic wastes, exhaustion of raw materials etc.

The questions to be answered concern not only **what** the benefits and burdens are, but also **who** bears the responsibility for defining courses of action affecting future generations and for implementing any measures required to protect society beyond the lifetimes of those

initiating activities with far future impacts. Does this generation have a responsibility to solve problems in a manner which **we** judge to be permanent and acceptable, without being certain of future attitudes? Conversely, is it more ethical to leave future generations to implement solutions which **they** judge adequate, even if this implies passing on direct burdens? Can we “square the circle” by implementing solutions which can either be left permanently in place or be reversed at any future time? The concepts being developed in the field of radioactive waste disposal may have wider societal repercussions.

In the present paper, the intention is to review the actions which may have to be taken during and after the operation of a disposal facility, to consider who shares responsibility for such actions and to look rationally at how responsibilities can best be allocated to ensure that they will be fulfilled in a way which protects future generations from harm, be it physical or financial.

Some of the issues involved concern legalistic points of title to wastes, contracts at different national and international levels etc. However, this paper does not attempt a legalistic analysis but concentrates rather on matters of principle (e.g. intergenerational equity) and practicality (e.g. which organisation is most fitted for any specific task).

2. PHASES IN THE LIFE OF A REPOSITORY

A waste repository goes through a series of phases during its long development history. The considerations in the current paper focus on deep geological repositories since all contentious issues connected with monitoring and retrieval are highlighted by this choice which maximises the timescales to be considered. The phases in this case cover times into the very far future since the long lived wastes foreseen for geologic disposal remain potentially hazardous for tens or hundreds of thousands of years.

The phases considered here are:

1. Planning and design — Already at this stage decisions with far reaching implications are taken.
2. Construction through to closure — This is the period of most intense activity at and around the site and also the phase of highest risk to local populations.
3. Active and institutional control — Here specific measures are taken on a continuing basis to minimise the probability of repository disruption and to maximise the probability of detecting any malfunction.
4. All later times — In this phase, although at most passive information archiving activities remain, consideration must still be given to responsibilities for unplanned developments (e.g. remedial actions or decisions to retrieve for other reasons).

In more detailed studies of responsibilities for monitoring and retrieval throughout repository lifetimes, such as that currently in progress under the auspices of the EU, the above operational Phase 2 is broken into finer activity periods. However, these are of more relevance for defining the specific activities to be undertaken than they are for broad considerations of allocation of responsibilities.

3. BODIES AND ORGANISATIONS SHARING RESPONSIBILITIES

At the highest national level, responsibility for societal actions with widespread, long lasting implications lies with **governments** and decision makers whose task is to represent the public. This is true in all countries, although the mechanisms to ensure that the government represents the people vary from nation to nation (elections, referenda, public opinion etc.). Evidently, at times in the future, beyond which the continuing existence of specific individuals and organisations is no longer assured, responsibilities for any relicts from the past — including repositories — must revert to government. At earlier times, however, responsibilities of different kinds are borne by the government, by the **regulators**, by the **implementers** or operators of a disposal facility and by the users, i.e. by the original **waste producers**.

Responsibilities in today's world can also be allocated above government levels, i.e. with international or **supra-national organisations**. Examples here are the United Nations, the European Union and so forth. For the particular case of radioactive materials, the IAEA already has supranational responsibilities in the safeguards and transport areas. It is not impossible that the IAEA could assume responsibilities or even ownership of materials in a closed repository, especially of wastes containing fissile materials which must be controlled for the sake of all mankind.

4. LEGAL LIABILITIES, OWNERSHIP OF WASTES

As indicated above, there are complex legal issues connected with ownership of radioactive wastes from their time of production to their final disposal. These differ from country to country. In some cases, the situation is clear, at least in principle. For example in the USA, it is foreseen that the Government will take title to spent fuel from utilities and with this title goes all future responsibilities. This works where the Government is also the repository implementer. The situation is more complex when a third party — for example a dedicated waste management organisation outside the Government — is the implementer. The possibilities then are that the original waste owners retain joint responsibility for future events or that a private body takes over the wastes and also the responsibilities. In either case, the Government must be involved in some way because of the ultimate responsibility which it will bear. Even more complex is the case where wastes are transferred from one country to another. The issues of transfer of title and of long term responsibilities then almost certainly become the subject of supra-national arrangements governed by intergovernmental treaties and agreements.

5. PRESENT AND FUTURE RESPONSIBILITIES RELATED TO MONITORING AND RETRIEVAL

Moving now from general responsibilities to the specific subjects of monitoring and retrieval, it is useful first to consider which activities must be carried out in these areas throughout the repository lifetime. A list of relevant actions is as follows:

1. definition of monitoring programmes for all phases (including definition of action levels and corresponding actions);
2. design of the repository to make feasible any monitoring or retrieval measures judged necessary;

3. execution of monitoring programmes from pre-construction through to post-closure phases;
4. construction, operation and closure of the facility;
5. decision to retrieve at any time (for safety or resource recovery reasons);
6. retrieval actions, if judged necessary;
7. financing of all monitoring activities; and
8. financing of any retrieval deemed necessary for safety reasons.

For actions 1 and 2, prime responsibility clearly lies with the repository implementer. However, he will possibly be constrained by conditions set by the regulator in order to reflect government policy. Regulations in the USA, for example, are relatively explicit on the monitoring programme and also on the need for retrievability for a given period of time. In Switzerland, the regulatory guidance is less easy to apply — post-closure monitoring and retrievability are not required (but are also not forbidden). Any measures taken to facilitate retrieval may not negatively impact on long term safety.

The execution of monitoring programmes throughout the first three phases in repository life is largely an implementer responsibility, although the regulator will certainly maintain independent oversight. In the far future, post active control period, it is reasonable to assume that monitoring around a repository location would be subsumed into some national environmental monitoring programme.

The actions during construction and operation of the facility which are obligatory with respect to potential retrieval concern the keeping of good records. All repository design features which could affect retrieval must be well documented, inventories and positions of waste packages must be maintained and all documents properly archived. This is clearly an implementer responsibility with regulator oversight. A more controversial construction issue concerns the inclusion of design features aimed at easing retrievability. Apart from the previously mentioned question of whether long term safety is then compromised, there is a philosophical choice between ease of recovery in case this is a chosen future course and difficulty of recovery to hinder misuse of fissile materials. The choice of philosophy in the design phase is societal or governmental, but the implementation of chosen measures is also an implementer responsibility with regulator oversight

Potential action 5, a decision to retrieve wastes, is a more problematic issue, primarily because there are potentially different reasons for retrieval. In the unlikely event that retrieval is needed because a malfunction gives rise to unacceptable risks, the decision will be enforced by the regulator if the implementer does not himself immediately react. Other reasons which have been suggested as potentially leading to retrieval are recovery of useful materials (fissile materials or isotopes) or a wish to implement a better technology. A decision to retrieve for either of these reasons would clearly have to be made at governmental levels. Where fissile materials are concerned, then supra-national consent to retrieve should also be a pre-requisite.

The justification for retrieval also would affect the responsibilities for performing the task. If inadequate safety is the reason, then clearly the implementer would be expected to perform directly or indirectly the work of recovery, reconditioning (if needed) and arranging an alternative disposition for the wastes. If the implementer no longer exists, or if the government should decide to retrieve for other reasons then all responsibility for further actions must transfer to the government.

Financing of all monitoring activities is also a clear implementer responsibility. In this case, however, the responsibility can be fulfilled for all future times even beyond the lifetime of the implementer organisation. Relative to the substantial costs of any repository project, the funding needed on a continuing basis for monitoring activities is small. The implementer can be compelled to establish at closure a dedicated fund which is large enough to generate sufficient interest for an effectively indefinite monitoring programme. The governments of future generations can then at any time take a political decision to terminate the monitoring and use the funds for other purposes, if they so wish. Public acceptance at the outset of disposal operations, however, may well be enhanced if dedicated funds were protected by legislation from being diverted for some (long) specified time period.

The final issue on the list, financing of retrieval, is perhaps the most problematic. Retrieval costs can be high — comparable to repository construction costs. Moreover, if retrieval is not to allow re-use of the materials, further actions (new siting, new waste treatments) can also be very expensive. The probability of retrieval being necessary for safety reasons, on the other hand, must be agreed by all to be very small before geologic disposal is allowed to take place. Nevertheless, the small remaining risk lasts for an extremely long time. How does one factor these considerations into a concept for allocating future financial responsibilities?

In principle, one could establish a dedicated fund also for retrieval. The resources needed depend strongly on the agreed time before retrieval becomes credible. If this is long, say hundreds of years, modest funding suffices. This option may well be justifiable because a robust design for a repository can give high confidence that early failure is extremely unlikely. If sufficient funding to allow retrieval is, nevertheless, to be available at any time from day one following closure, then the cost of disposal rises considerably. Setting aside so much funding to cover such an unlikely event may not be the best use of society's resources. The chances of such a sum being left untouched by a long succession of future governments can also be debated!

An intermediate option, assuming that the utilities or governments which have generated the wastes will have a longer lifetime than an implementing body which has just closed and sealed its repository, is that responsibility reverts to the original owners of the wastes. The government would have to enact appropriate legislation for this variant, which may, in any case, be of minor importance since the difference in life expectations may be negligible on the scales being discussed here. No countries have yet explicitly legislated the far future responsibilities. However, discussions, for example in Switzerland where a new nuclear law is in preparation, have included this option for relieving the national government of some of its burden of responsibility for a longer time.

Ultimately, at some future time, all responsibility for buried wastes will revert to a national government, or to a supra-national organisation. The ethical debate which has been running for some time is whether this burden is less than the burden imposed by any other waste management strategy. In the judgement of the present author, the burden imposed by a properly sited and constructed repository is extremely small and there is no obvious alternative which places a lesser burden on future generations. Since there are currently no viable alternatives to geologic disposal, then — at a minimum — we should pass on accepted repository concepts, the required technological know-how, acceptable sites and adequate funding for future implementation of geologic disposal.

A final remark concerns the complication resulting from potential disposal of wastes in an international repository. Does the ultimate responsibility which unavoidably falls on a national government then extend for the host government to all of the wastes which have been imported? Rather than accept such a situation, it is conceivable that the host government might insist on State Treaties which continue to share responsibilities for the unlikely event of retrieval out into the indefinite future. It is equally conceivable that the customer country governments would be quite prepared to accept this shared responsibility. Given that no respectable country would allow its wastes to be exported to location judged to be less safe than that of a national disposal project, shared responsibility for a common international facility may well be more attractive than full responsibility for a national repository. This sharing could be under bilateral or multilateral agreements, but the probability that supra-national organisations would be directly involved is high.

6. SUMMARY OF RESPONSIBILITIES

In Table I below a visual impression of the shift in responsibilities with time is given. This is achieved by allocating responsibilities for the above numbered monitoring and retrieval tasks at each Phase in the repository life. For the body bearing the main responsibility in each case, the corresponding number is underlined and bold. Obviously, there could be much debate about the entries.

Nevertheless, the table shows that:

- joint responsibility and consensus is to be aimed at in the conceptual planning phase;
- through the operational life, the implementer carries the largest burden, controlled at all times by the regulator;
- in the active monitoring phase, the implementer may no longer exist but the original waste owners will do and the financial burdens can be borne by these; and
- at long times responsibility must revert to the government.

TABLE I. MONITORING AND RETRIEVABILITY RESPONSIBILITIES (LEAD ROLES UNDERLINED)

	Government (+ supra-national)	National regulator	Repository implementer	Waste producers or owners
Planning and design phase	1,2	1,2	1,2	-
Construction and operation phase	-	3,4, <u>5</u>	<u>3,4,5,6,7,8</u>	8
Institutional control phase	5	<u>5</u>	implementer may no longer exist	<u>6,7,8</u>
Long term post closure phase	<u>5,6,8</u>	-	implementer may no longer exist	producers may no longer exist

7. CONCLUSIONS

Concerning the allocation of responsibilities for monitoring and retrieval of wastes from radioactive waste repositories, the following broad conclusions can be drawn:

- It is important that responsibilities be clearly allocated throughout the life of any project which extends over very long times. The explicit attention being paid to this question in radioactive waste disposal makes this a pioneering issue; it will become relevant also for other activities with far future influences.
- For as long as the existence of the repository implementing body can be assured, there is no real problem of assigning responsibility. The producers of the wastes, e.g. electrical utilities, may have a longer expected lifetime. In this case some responsibility may revert to these waste producers at long times.
- It is straightforward to arrange financial measures which can ensure that monitoring programmes are funded for as long as future generations choose to monitor. For retrieval, adequate funding can also be made ready, but it is less clear that tying up resources in case one has to deal with very low probability events is a sensible strategy.
- At very far future times, responsibility for a closed and sealed national repository must revert to the government of a State. If international repositories are realised, sharing of future responsibilities between host and customer countries can be regulated by Treaties.
- In all cases, it is the ethical responsibility of current generations to try to minimise burdens or responsibilities passed on to future generations. Repositories should be designed, sited, operated, closed and financed in a manner best suited to achieve this goal.

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QUESTIONS (Q), COMMENTS (C) & ANSWERS (A) AFTER THE PRESENTATION

Chair: In your paper, you also included cost and financial responsibilities. Since we have a separate paper on that later in this session, I suggest that we postpone such questions until after next paper.

Q: You said that it would be likely that the waste producers would be lasting for longer times than the implementors. It might be true, but I think it could also be the other way round. A lot of things are happening in the field of utilities, so there could be big changes on that side too. I think one would have to think of that also. In the long term, the “waste producers” would not be the same, as when the waste was produced.

A: Maybe it might be a better terminology to say waste owners. The implementor has got to become the owner somewhere along the process. You cannot allow people to go out of business without having transferred their responsibilities properly.

Q: We have many examples of waste producers, who have vanished. Superfund has been looking for responsible parties and almost never they have found any, because they have

disappeared, gone bankrupt. So eventually, the responsibility, in such a case, would go back to the government.

A: That is right, but we have got a better starting position here, because certainly — if you look at commercial nuclear power — we know who are the owners now. So you should not get into that situation. Any time an organisation does want to disappear, then it should not be allowed to do that unless it has formally transferred responsibility to another organisation further down the line.

Q: I have a comment or a question relating to your preamble actually, not about the main paper. You made a point that if you put retrievability high on your priority list, this may lead to postponement of geological disposal. I understood yesterday — from the NAGRA presentation — that they were putting it high on the list for the Wellenberg site. They are at least hoping to get underground earlier than they would do if they had not put it on. Maybe not geological disposal in the traditional sense, but by putting it high up they may get underground earlier. Do you have any comment on that?

A: NAGRA wishes to emplace the waste reversibly underground in a place where it will be also OK for disposal. If the requirements were to have only containers which you can inspect for cracks, for example, or retain the option to look at other host rocks, then you would not be able to go along that path. The basic bottom line of my argument is just that the most retrievable system of all is probably the one that is on the surface, that is, the most accessible. The NAGRA system is useful because it has some inherent advantages with horizontal entry and you can go in pretty easy. But if I want to look at another kind of deep facility for example, then it is more complicated to make it easily inspectable and totally retrievable at all times. Like Mikael Jensen said, if you want to take it out and if you want to have retrievability instantly, at any time, in a short period of time, then it drives you away from the disposal concept.

Q: I feel very unhappy. We have been discussing the ethical part of the business and now we are discussing the practical part. We are thinking in terms of passing money over 200, 300 years, of making a large fund and putting in a little money now and then. It will grow and grow, by interest and interest and we are acting under the assumption that the money would grow. But in the future after 200 years, somebody would have to do the work and I do not know if I would be able to do the work now if somebody 200 years before has decided and put some money aside. There is no automatics in this — that is my first point.

Secondly, we are discussing who will disappear first, implementors, regulators, owners, producers etc. I think this shows that — beside of the general ethics — there should be some kind of practical ethics, taking into account what really could and should happen. If we would start thinking in these terms of practical ethics, we should try to solve the problem as soon as possible. Very probably, we are able to forecast the future of the producers of electrical power for the next ten, twenty, thirty years; very probably for the implementors too, but I would not dare to forecast the future for us and our children in fifty or one hundred years. I just want to say that it is very difficult to pass funds to future generations and it is very difficult to pass know-how to future generations. It is probably even very difficult to pass information about where the “switch” is, to switch off the repository. The point is that we should not de-couple the benefits of the technology and the evils of the technology. We are now just discussing about the ways and in terms that this is evil and we are thinking that — somewhere in the next 5, 10 or 20 years — the benefits will stop and we are supposing that we are free to de-couple

the waste problem from the benefit problem. I think this is the largest problem, the largest ethical problem, which we should discuss. Now we have incentive to solve the problem, but in 50 years we will have no incentive to solve the problem.

A: I hope nothing that I said was picked up as meaning we should not be trying to solve the problem now. About the difficulties in not solving the problem now, I agree with you. Then you would really have to pass on active know-how for decades on the surface and have the continuing present. I can envisage passing on funding more easily than I can envisage a continuing present where I pass on the whole capability into the future, solely for the purpose of maybe having to do something.

Q: One more very short comment. We have the demographic problem, that we are getting older and older, and we are putting some money aside in order that we shall have some remuneration when we are very old. But this is “dead money”. If there will be no new generation working for us, this would be totally lost, and the same is true with the waste. We are not able to pass on money. Money is a convention, you have to do something for it.

A: I do not agree! Money is a way of passing things on, at least in the short time-scale. Money reflects the work which people have put in now to generate that money. I do not think it is a good idea to do it, but you cannot be blind to the fact that you can pass on some things by financial means. As you say, the money is only a convention for doing it, but the money translates, the money is there now because other people have done work now and you have got no other good way to pass it on. But I would rather pass on a sealed and safe repository.

C: Presently, times are very calm in the industrialised world, but we are not so sure that they are so calm in future, and therefore I can only underline what has already been said. Make the solution as soon as possible!

Q: I am just surprised about the comment about the inability to pass knowledge. Look at all the technology we have around. If aboriginals themselves pass traditional knowledge from at least seven generations, we should not be worried about not being able to pass knowledge with the technology we have.

A: Well, I understood it differently, it is not that you cannot pass the knowledge, it is just that it is not a good use of society's resources. Suppose that we finish with nuclear energy, and we end up passing on the knowledge to do the job that we could do now, just because we do not want to do the job now. That is where I see a problem. Do the job when the knowledge is here! That is a better over-all optimisation.

Q: I was just thinking about a situation, where you come out to a municipality and give this presentation of how responsibility would be transferred. First it would be with the implementors and the regulators and then it would be with the government and then it will go to some super organisation several levels over their heads. The politicians would feel more and more out of control, I think, even if it is not reflecting the 1000 year or 100 000 year time span, the local legislators and public like to feel that they are in control, that they have some insights on what is going on, what the results of monitoring are and how this possible decision of retrievability is being developed.

A: When I use regulator and government I do not mean national regulator and national government alone. The government and the regulator has a kind of local component as well.

Q: I believe that you are right, that when a facility is closed, the responsibility is away from the implementor and it goes over to society or to government. The situation, I believe, needs some more clarification in the case that the operator can show that any institutional control or so would not be needed from a safety point of view, but that society would demand such a institutional control for a certain period of time or forever, because they want to be convinced that what the operators say is correct. It is difficult to argue that the operator for such a programme of monitoring has responsibility for such a demand and I think you cannot ask an operator to be available for a few hundred years only for this purpose. If safety needs institutional control, then it is different and it is a planned activity, which the operator must do. But if it is safe without institutional control, I think the operator cannot be charged with responsibility any more and this must then be the responsibility of those who requested. The originator for this request is then the society and its government. What do you think about that?

A: Yes, I think in principle I agree with these coupled questions. As soon as the state agrees that you do not need any more monitoring, you move into my last phase, where the implementor is no longer responsible, anyway. If you are in the phase where you do not have *consensus* about the need for monitoring, then the responsibility stays with the implementor. It has to do with the confidence you have got in everything being all right, and somewhere down the line you have to have enough confidence to back off and the waste becomes a societal responsibility.

Q: You are talking very well about responsibilities. You thought about some future possibilities too, with international repositories and what that would require. I think that this question may be much closer to us than thinking ahead on international repositories. We have, I think in all our countries, decided that the waste should be taken care of within our countries, that is the general agreement within the European Union, in most countries. But at the same time, we start buying electricity from other countries. Some countries have phased out their nuclear energy. Sweden is about to do so, and then we will buy electrical power from Preussen Elektra, Électricité de France or whoever wants to sell to us. Should we have a moral responsibility to take care of the proportion of the waste that our consumption has introduced in these countries?

A: That is a really difficult question. I am not even sure if I want to get into a big discussion here, because I do not think it affects the other issues we were talking about up to the national level. My international part was an add-on, and you have picked up a very important part of it. What responsibility do we have for cadmium wastes because we import batteries from somewhere? But maybe we should talk about this outside the meeting. That is another dimension that will get too complicated for the meeting here.

Q: I just want to add another complication which is actually discussed in communities and that is that governments are not stable either. The other point is that the waste owners may also change and sometimes very quickly.

A: I agree, and my last word here would be I think these are all really important things and my only wish is that we do not discuss it just for nuclear waste disposal. I grew up in Scotland and I feel much more bitter by the fact that my ex-Scottish government has used up the whole of the North Sea oil which maybe could have made my grandchildren into Arab sheikhs in the future, to finance bad household keeping now.