The Concept of Responsibility to Future Generations for the Management and Storage of Radioactive Waste

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People are afraid of nuclear power. In January 2003, the French research centre for the study and observation of living conditions (*Centre de recherche pour l'étude et l'observation des conditions de vie* – CREDOC) conducted an opinion poll on the French public's perceptions of and attitudes towards radioactive wastes. The answers to the first two questions in the poll confirmed and quantified the public's feelings about the civil nuclear industry, both as regards power generation and radioactive waste management:

> Question 1: With reference to environmental degradation what are the two main issues that people today need to be more informed about, in your opinion?

(Ranked in decreasing order)	**1st answer**	**2nd answer**	**Total**
Water pollution	28	15	43
Air pollution	18	23	41
Accident risks at nuclear power plants	18	13	31
Risks related to radioactive waste	12	17	29
Greenhouse effect and climate change	12	12	24
Deterioration of forests and flora	9	12	21
Endangered species	3	7	10
None of the above	0	1	1
Do not know	0	0	0

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Question 2: About which two subjects in the above list do you think that things are being kept hidden from the public?

(Ranked in decreasing order)	**1st answer**	**2nd answer**	**Total**
Risks of accident at nuclear power plants	37	17	54
Risks related to radioactive wastes	23	31	54
Air pollution	10	13	23
Water pollution	13	9	22
Greenhouse effect and climate change	7	12	19
Deterioration of forests and flora	5	9	14
Endangered species	3	6	9
None of the above	2	2	4
Do not know	1	1	2

In reaction to this latent fear, which is also a factor as regards environmental protection issues, a strong current of opinion has built up that considers industry not as a source of progress, but as a potentially destructive force for the environment, inevitably viewed as having been "better before". The growth of this technophobic trend was accompanied first by the declaration then the imposition of the fundamental, so-called ethical principles aimed at providing guidelines for industry and reconciling its conduct with a duly reassured public. These fundamental principles of environmental protection are: sustainable development; the precautionary principle; the principle of prevention and corrective measures, preferably at source; the polluter pays principle; and, lastly, the principle of public information and participation.

The management of radioactive wastes is governed by very specific legislation that draws on both the law on "conventional" waste management and nuclear law. Given the potential danger of the risks involved and their seriousness over distance and time, the nuclear industry – more than any other industry, including the chemical industry – is at the forefront of discussions on the practical implementation of these principles. Not welcomed by the public, by incorporating these principles – almost universally recognised as fundamental – the nuclear industry hopes that it will gain wider acceptance.

Central to this issue is the concept of the responsibility of present generations to future generations. Expressed by the nuclear industry, then widely disseminated, it is a concept that gives rise to a great many questions that will determine how radioactive waste is managed. For, while there is general agreement that waste – sometimes the legacy of a past not necessarily of our choosing – needs to be managed today, how it is to be managed remains to be determined, and this regardless of the ultimate fate of the civil nuclear programme. The choices to be made are not so simple when one considers the vast number of stakeholders involved in the decision-making process and their divergent interests:

- stakeholders in the nuclear industry, proposing tried and tested technical solutions;

- a public that is very attached to scrupulous adherence to liberal principles that, judging from experience, are difficult to reconcile with the management of an activity that carries major risks;

- policy-makers, who have to take the final decision after weighing up all of the scientific, technical, ethical, environmental, safety and economic and social considerations.

One of the problems today with radioactive waste management is that progress leads to endless questioning of scientific and technical developments. Far from having found the right solutions, nuclear industry actors are only at the research and observation stage: any discovery may corroborate a technique, lead to its further development, or condemn it. One can therefore see just how difficult it is to judge management methods that are still in constant flux by the yardstick of an ethical concept of responsibility to future generations, which itself is changing and ill defined. An ethical concept makes sense only in a specific context: in a changing context, the concept changes.

Long since recognised in the management of radioactive waste, the concept of responsibility to future generations does not have the same implications in 2003 as it did in the 1970s. It seems that as technical and scientific progress is made in the field of radioactive waste management, the implications of this concept grow steadily broader. With the achievement of each technical step towards steadily greater safety, the recognition of this concept requires still more. Hence, responsibility to future generations seems to be an argument that justifies an endless series of new avenues for research, and the progress that has already been achieved is never enough.

I. From the Need for Action…

Recognition of the concept of responsibility to future generations seems, at first, to imply the need to assume responsibility today for the radioactive waste legacy of the past as well as for the waste that is currently being generated. However, this view of things, or more precisely this interpretation, is clouded by the lack of a clear definition of the concept of responsibility towards future generations.

A. Ambiguity of the concept

The concept of the present generation's responsibility to future generations is based on several notions.

First, the notion of responsibility is open to interpretation depending on the context. In the above concept, it seems clear that the responsibility intended is not liability in the conventional legal sense of the term, binding the party or parties concerned to answer for damage before the law and make reparation for any consequences. Here, responsibility is viewed more from the moral angle: any member of the present generation must feel morally bound to contribute to the management of radioactive waste, although they will not be held legally responsible if they do nothing. However, these rudiments of a definition are inadequate inasmuch as there is no hard and fast, tangible dividing line that can be drawn around a moral concept: where does responsibility begin? Where does it end? What does it cover, subject to which principle does it not cover something? The moral concept of responsibility can vary from one actor to another, from one culture to another and from one year to another. Once we acknowledge that a notion cannot be definitively defined, how can it be utilised as part of a concept?

The phrase “present generation” is less ambiguous. It designates anyone and everyone at the same time. The use of this expression is intended to involve every individual citizen in a process that concerns society as a whole rather than the sum of the individuals that make up that society. This said, it is preferable, indeed necessary, that every actor be aware of the issues if society is to be committed.

Lastly, the reference to future generations is fraught with implications, but in legal terms is sufficiently ill defined as to render the concept impracticable. Without defining what is meant, where are we to assume that future generations start? Our children? The fourth generation? Where do they end? Are we to consider that we are morally bound to any generation that comes directly after us until the end of humankind or only to the generation that will grow up 100 years from now? Choosing any of these alternatives would introduce a degree of arbitrariness into the concept and would therefore justify its being interpreted in different ways by different actors and countries and in different times.

The concept of the present generation’s responsibility for future generations can have no indisputable definition in the light of an analysis of its component parts. In an attempt to narrow it down, we must investigate how it differs from other principles with which it is often “lumped together” or “confused”:

- the principle of sustainable development as defined in the Bruntland Report and later in the Rio Declaration is defined as development that “meets the needs of the present without compromising the ability of future generations to meet their own needs”. This principle has been adopted in numerous legally binding texts such as the Treaty of Amsterdam at EU level and the French Environment Code. The concept of responsibility to future generations can be interpreted as ensuing from the principle of sustainable development, but differs from that principle in that it does not, on the face of it, prejudge which choices future generations should make. Furthermore, the aim of the concept of responsibility is not to take decisions about meeting present needs but to assume as much responsibility as possible for whatever choices are made. That said, the principle of sustainable development is broadly provided for in the legislation applicable to radioactive waste;

- the concept of responsibility to future generations is often linked together with the precautionary principle, which states: “where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation” (Rio Declaration). Like sustainable development, the precautionary principle has been incorporated into instruments of substantive law, such as the Treaty of Amsterdam and the French Environment Code. Here, again, it does not seem possible to link the concept of responsibility to future generations for the management of radioactive waste with the precautionary principle given that the risks engendered by the presence of radioactive waste are known and identified. There are therefore no grounds for claiming a “lack of full scientific certainty” since there is certainty about the potential risk of exposure to radioactivity.

Curiously, the concept of the present generation’s responsibility to future generations, which is so difficult to define clearly, is widely accepted and advocated. This could be because it can be construed in so many ways: as an ethical concept, not a legal one, it creates a moral duty that everyone can interpret differently and adapt to suit them. It is a “rag-bag” concept advocated both by stakeholders in the nuclear industry and their opponents. The former hold that the solutions proposed for radioactive waste management do not lay the burden of responsibility on the shoulders of future

generations, while the latter claim that, on the contrary, imposing solutions deprives future generations of the freedom to make their own choices and choose their own destiny.

Given the uncertainties that surround the meaning of this concept, it is easy to be critical of these stances, but it is not so easy to come up with a definition that will satisfy all of the actors concerned. That is why the legal frameworks for radioactive waste management make relatively little use of the concept of responsibility to future generations: while it may sometimes be referred to in the preamble to texts, it is very rarely used in prescriptive clauses. More often than not, no reference is made to the notion of responsibility, simply to the concept of taking future generations into account.

Conversely, the concept is frequently utilised in legal theory, which usually employs it without precisely defining what it means while drawing conclusions about it. As a result of dialogue and co-operation on research, the conclusions that are drawn about the application of this concept to radioactive waste management are often similar from one author to the next.

B. The rush to keep pace

No sooner was the concept of responsibility to future generations formulated with reference to radioactive waste than it was interpreted as a requirement to take immediate steps in order to minimise the obligations and risks for future generations. The reasoning behind this is that, since the present generation has benefited from the generation of electricity from nuclear power, it is up to this generation and this generation alone to take responsibility for managing the waste that has been generated in the process. In principle, future generations will not benefit from electricity being generated now and therefore should not have to be involved in managing waste for which they have not chosen to accept responsibility.

The concept has been used mainly in connection with long-lived radioactive wastes, which pose the greatest management problem as it so far exceeds any “human” scale of reference. Waste that is short-lived (30 years or so) is no more of a problem for future generations than a household waste landfill, even less so considering that once a disposal facility has been closed, the waste in it is no longer considered to be radioactive. Intermediate waste, which may be considered to have decayed after 300 years, poses problems that are more or less “manageable”. In contrast, it is not possible to manage long-lived waste in the same way as others, i.e. by means of forward planning of human/technical operations. This is doubly so when the waste concerned is both highly radioactive and long-lived.

In the 1970s and 1980s, with the concept of responsibility to future generations in mind, the ideal solution was considered to be the construction of repositories in geological formations at depths varying with the radioactivity level of the waste to be disposed of. This solution relied on having a solid passive barrier to contain radioactivity: a geological barrier. With timescales so far in the future – the design basis for impact studies for deep underground repositories is 10 000 years – trusting any single technique is difficult. While the quality of packaging and the durability of the properties of the storage structures can be guaranteed for a number of years – approximately 300 with our current state of science and technology – it does not seem prudent to rely on only one technology in the long term.

Deep geological disposal was a concept that came at a time when some surface facilities were already in existence, and the technical aspects were more or less well under control. At the time, deep burial was an unexplored avenue on which experts and scientists could be put to work. This idea was behind the next 30 years of technical research.

Bequeathing as few burdens and risks as possible for future generations forms the basis of the policy defined by the Radioactive Waste Management Committee of the OECD Nuclear Energy Agency (OECD/NEA). A collective opinion, "The environmental and ethical basis of geological disposal of long-lived radioactive wastes", issued by this committee states that radioactive waste management policies should be founded on both intra-generational equity and inter-generational equity and favours the disposal solution over storage solutions, which require monitoring and postpone decision-making.

The deep disposal option thus allows long-lived waste to be managed in accordance with the concept of responsibility to future generations insofar as the study of these facilities permit us to state that they do not give rise to risks that are considered unacceptable by the present generation, the only source of reference that is available to us.

Following years of research, the techniques used to build and operate deep disposal facilities also proved to be manageable. Such a facility was no longer an impracticable dream, all that was left to be done was to actually construct and develop one.

At around the same time, in 1989, the Swedish Advisory Committee for Nuclear Waste Management – KASAM – raised a new aspect of the concept of responsibility to future generations in a report entitled "Ethical action in the face of uncertainty". According to this report, since the present generation at the time did not have sufficient knowledge to assume responsibility for all of the conceivable consequences for future generations, it would have to "guarantee coming generations the same right to integrity, ethical freedom and responsibility that we ourselves enjoy." The report's conclusion is, in itself, a good illustration of the approach it recommended: "A repository should be constructed so that it makes controls and corrective measures unnecessary, while at the same time not making controls and corrective measures impossible. In other words, our generation should not put the entire responsibility for maintenance of repositories on coming generations; however, neither should we deny coming generations the possibility of control".

These ideas were reiterated by the International Atomic Energy Agency (IAEA) and by the Radioactive Waste Management Committee of the OECD/NEA in 1995 when they considered the social and ethical aspects of nuclear waste management. However, no major modification was made to the concept of geological disposal since, by definition, a disposal facility must be definitively closed after a certain period of operation and monitoring.

Thus, the debate on the interpretation of the concept of responsibility to future generations has changed and so too have the implications of the concept: whereas yesterday deep disposal enabled the then present generation to feel that they were behaving responsibly towards future generations, today coming generations have to be guaranteed the right to make their own choices in accordance with their own acceptability criteria. This change in interpretation cannot be viewed in isolation from the scientific and technical progress that has been made: any new progress towards meeting the conditions that ensue from the recognition of this ethical concept raises a new set of questions about this principle and new, increasingly advanced technical requirements.

At the current stage of research, incorporating the concept of responsibility to future generations requires that the following two goals be met:

- to hand down to future generations a safety legacy comprising all the skills, scientific and technical knowledge, systems and other tools that the present generation has for controlling radioactive risks. Since a zero-risk legacy is not possible, the present

generation is preparing to leave future generations a risk that has been identified as far as possible, so that they will also be able to control it;

- to implement waste management solutions without delay, while ensuring that it is possible for future generations to reverse the choices made by the present generation and to make a different choice that is in keeping with their own criteria of social acceptability and technical progress.

The wording of these two objectives, guiding current research and decisions, in turn raises many questions. The concept of responsibility to future generations is pushing thinking a little bit further still and is forcing jurists to think about a framework that would provide the best guarantee of meeting these objectives.

II. … To the duty to create conditions that ensure that choices can be reversed

The concept of the responsibility of the present generation to future generations, interpreted in terms of our current state of knowledge and progress, brings us to an area of research where the dividing lines are not very clear. While the objectives have been set, the practical implications, particularly the legal implications relevant to us here, have often not been very clearly identified. However, the consideration of ethical concepts makes us think, or rather makes us re-think, a legal system that is not perfect, inconsistent or incomplete.

A. A widespread problem

Consideration for future generations has to be a factor in the management of all types of radioactive waste, be it short, medium or long-lived waste or very low, low, intermediate or highly radioactive waste. Obviously, the problems posed by each category are not the same but some are common and must therefore be studied carefully.

As a general rule the concept of responsibility, as pointed out above, has made us focus more closely on long-lived waste, whatever its level of radioactivity. The current alternatives for the management of radioactive waste – there are not all that many of them – may be:

- interim storage;
- final disposal;
- incineration;
- transmutation, to lower the radioactivity of the wastes.

The alternatives listed above are not all genuine solutions and, in our view, are no basis for compliance with the concept of responsibility to future generations. For that matter, by definition, storage is no more than a stop-gap solution; useful though it may be if technical progress offers no prospects of a definitive solution, it was never intended to last indefinitely. Stored waste is waste in transit and has to be retrieved so that it can be managed over the long term. Inevitably, this solution raises many questions since the radioactivity of the waste is going to decline during storage. Therefore, even if storage is not what we consider a “responsible” solution, it has to be controlled because it poses real problems.

The first of these problems is unquestionably monitoring: interim storage can be considered only as a cheaper option to final disposal. Consequently, larger numbers of basic facilities requiring less research call for more care to be exercised by facility operators and the authorities alike. Given the temporary nature of interim storage, the duration of which can be adjusted for the level of radioactivity and depth, it is reasonable to assume that it will always have an operator to supervise handling and that the administration will be responsible for monitoring.

Special care is needed when storage comes to an end: once all the waste has been removed and the storage facility is emptied, it can be closed. What should happen to the site? Should monitoring be maintained to ensure that the memory of the location is not lost? If so, who should be responsible for monitoring and for how long? Should the site be derestricted once the facility is closed or only after a period of time deemed long enough to ensure that there is no contamination? What happens if the site is identified as radioactive?

The incineration of radioactive waste is generally a more "low-profile" solution than the three alternatives. Perhaps this is because it is not technically possible today to incinerate all types of radioactive waste, such as long-lived radioactive waste or high-level radioactive waste. This solution, too, raises numerous problems with regard to the future of the site, but also as regards operating methods. The fact is that incineration can certainly dispose of radioactive waste, but it generates radioactive ashes. These, in turn, are classed as waste. As a result, incineration also requires another management solution for handling the radioactive waste that the facility would generate, much reduced in quantity, but with higher concentrations of radioactivity.

Transmutation suffers from this same drawback. The aim of this process is to "transform" highly radioactive waste into intermediate-activity waste, so it does not eliminate radioactive waste, just renders it less dangerous. This line of research, interesting though it may be from a technical standpoint, is not a waste disposal technique. That leaves us with final disposal, which would appear to be the only solution.

This said, all of these types of management raise similar issues.

- What legal procedures are they to be regulated by? On the face of it, it seems to me that it is not fair to subject an interim storage facility to the same licensing procedures as a final disposal facility, since it is not intended to be long term. However, it does also seem fair to seek to adapt the procedures to the radioactivity level of the waste it caters for. In any case, a strict and sufficiently clear legal framework should be adopted at national level.

  That legal framework must cover a wider scope than just the procedures needed to obtain a licence: site closure procedure, dismantling before de-restriction where applicable, monitoring requirements, etc. All of these are, in any case, requirements under the 1997 Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (see *Nuclear Law Bulletin* No. 60), which invites signatory states to establish and maintain a legislative and regulatory framework at national level.

- What is to happen to the sites? Is it better, as evidence of our responsibility towards future generations, to set up a legal framework guaranteeing that sites that have taken or are now taking radioactive waste will not be used in the future or is it better to de-restrict some sites? Whatever the case, there does seem to be a duty to ensure traceability so that the memory of the activities that once took place there is not lost.

France seems to be tending towards a middle-of-the-road stance somewhere between these two options: sites that take long-lived waste cannot be derestricted and the authorities issue restrictions prohibiting access and use in the future. In contrast, other sites could be derestricted at the end of the monitoring period, the duration of which would vary with the level of radioactivity of the waste; in principle, 50 years for very low-level radioactive waste and 300 years for low-level and intermediate-level waste.

- Who is legally liable for what? The liability system has to be clearly established so that it is possible to identify the person responsible in the event of an accident in the future. There appears to be no moral justification for not clarifying the position of the various actors concerned today – be they waste generators, state or public authorities or waste management facility operators – under the pretext that they will very probably no longer be in existence by the time an accident occurs. It seems that, in the last resort, the state should at the very least take responsibility for such an accident since it is more likely to be longer-lived.

  On this same point, national legislators should be guided by the 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy and the 1963 Vienna Convention on Civil Liability for Nuclear Damage as regards the division of responsibilities. These two conventions should also be used as the basis for setting up an insurance scheme at national level: in the event of a nuclear incident, legal liability brings with it financial obligations to provide compensation, and the means of paying it has to be ensured.

- Who pays for what? We said that interim storage, confining ourselves to this sole issue, is only a stop-gap management technique: all of the waste being sent to an interim storage facility today will have to be removed from it in the future for incineration or final disposal. With the likelihood that interim storage will be the solution chosen, for want of an alternative, how will it be possible for us to estimate the cost of final disposal of this waste? Who should pay for final disposal from an interim facility? To put it still more simply, how can we possibly evaluate the costs, today, of operation and, more importantly, closure of a final disposal facility that will have to be monitored for at least 300 years?

  As an ethical concept, responsibility also obliges us to resolve these issues inside a legal framework so that we do not leave future generations to come up with makeshift solutions, or convert interim storage facilities into final disposal facilities without due precautions, simply to be rid of an embarrassing situation.

  At national level, some countries have already settled the finance issue by setting up ad hoc financial funds, to which waste generators have to contribute. At EU level, the creation of a fund to guarantee finance for the dismantling of nuclear power plants and the management of waste generated by this process is currently under consideration. However, the draft directive on radioactive waste is meeting with a lot of opposition on other points and it is unlikely that it will be adopted soon. Nevertheless, it is prompting discussion in Member States of the European Union that do not have such a fund, like France, where a bill is being drafted to set up a fund solely to finance dismantling.

B. Special features of final disposal facilities for HLLL waste

High-level, long-lived (HLLL) waste is, of course, the waste that poses the most technical problems. It was this category of waste that was behind both the invention of deep geological disposal

facilities with an expected reliability of 10 000 years and the controversy over the interpretation of the concept of the present generation's responsibility to future generations.

As we have seen, the recognition of this concept today brings with it a duty to turn our minds to a form of disposal that may not necessarily be final for future generations which wish to modify it, retrieve and utilise the waste in the facility or employ some new method of management.

Reversibility, a very popular concept, was introduced into the legislation by the United States in 1982 and requires that waste in geological repositories can, should the need arise, be retrieved in the 50-year pre-closure period so that any safety problems identified can be corrected or so that materials contained in the waste can be recovered. Canada followed the same course.

The stance taken by Sweden seems rather more paradoxical, since the regulations make final disposal compulsory but make provision for future generations to employ other management methods. It must be possible to leave final disposal facilities without monitoring and without danger of irradiation for man and environment and they must also be designed so that waste retrieval is possible. The apparent paradox has led to a novel commissioning process that combines a first pilot period of approximately ten years, at the end of which waste can be totally removed if an operating licence is not granted.

Switzerland and France are following the same avenues of research. Switzerland devised the concept of "monitored long-term geological disposal", which involves a step-by-step approach to final disposal and to its reversal. The justification for the final geological disposal phase is that, as acknowledged in the 1970s, final disposal affords the best long-term protection. France did not endorse the duty of reversibility until 2000, simply incorporating into the legislation an avenue of research that had been under investigation for years.

In response to this trend, the IAEA and the OECD qualified their pro-geological disposal stance, which held that it was the only way to meet our responsibilities to future generations: while reversibility has no clear place in the text (the word appears nowhere in the 1997 Joint Convention) and is presented only as yet another ethical argument, the OECD stated that it supported the need to be able to retrieve wastes in the pre-closure phase. It considered this an important factor that lent flexibility to the decision-making process, but avoided specifying whether it was a necessary requirement for disposal concepts, the main objective of which remained the final disposal of waste without the need for monitoring by future generations.

This stance by the OECD seems to be realistic in that it attempts to reconcile two contradictory approaches: how can one build a final disposal facility and yet not close it? The finality of this disposal mode is justified by safety considerations, which outweigh all others. However, it seems difficult to reconcile people on this basis alone and the possibility of retrieving waste might well make this option more acceptable to some. Therefore, one has to try to reconcile the irreconcilable.

Giving future generations the option of retrieving waste from disposal facilities could backfire, unless their right to do so is limited in time. Indeed, the idea of totally containing waste to ensure greater safety, conflicts with the idea of opening up disposal facilities on request as this could create an obvious contamination path. Reversibility must have an end and become irreversible at some stage.

It should also be pointed out that reversibility, a liberal principle, is not without cost for the present generation in terms of the research that it has necessitated over many years and the additional development that will be needed to achieve it. This said, neither is it without cost for future

generations, which will have to finance waste retrieval and, where the need arises, new disposal methods.

Furthermore, reversibility makes preserving the memory of the site a still more sensitive issue: how are we to ensure that future generations concerned by the possibility of retrieving the waste will know that it is a possibility?

As the last phase, to date, in the recognition of the concept of responsibility to future generations, reversibility has raised a number of issues and concerns not the least of which is that decisions are not being made but constantly postponed under the pretext of improving what is technically feasible.