LONG-TERM MANAGEMENT OF RADIOACTIVE WASTE

LEGAL, ADMINISTRATIVE AND FINANCIAL ASPECTS

NUCLEAR ENERGY AGENCY

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A Report by the NEA Secretariat

Paris 1984

NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to article 1 of the Convention signed in Paris on 14th December, 1960, and which came into force on 30th September, 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The Signatories of the Convention on the OECD are Austria, Belgium, Canada, Denmark, France, the Federal Republic of Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries acceded subsequently to this Convention (the dates are those on which the instruments of accession were deposited): Japan (28th April, 1964), Finland (28th January, 1969), Australia (7th June, 1971) and New Zealand (29th May, 1973).

The Socialist Federal Republic of Yugoslavia takes part in certain work of the OECD (agreement of 28th October, 1961).

The OECD Nuclear Energy Agency (NEA) was established on 20th April 1972, replacing OECD's European Nuclear Energy Agency (ENEA) on the adhesion of Japan as a full Member.

NEA now groups all the European Member countries of OECD and Australia, Canada, Japan, and the United States. The Commission of the European Communities takes part in the work of the Agency.

The primary objectives of NEA are to promote co-operation between its Member governments on the safety and regulatory aspects of nuclear development, and on assessing the future role of nuclear energy as a contributor to economic progress.

This is achieved by:

- *encouraging harmonisation of governements' regulatory policies and practices in the nuclear field, with particular reference to the safety of nuclear installations, protection of man against ionising radiation and preservation of the environment, radioactive waste management, and nuclear third party liability and insurance;*
- *keeping under review the technical and economic characteristics of nuclear power growth and of the nuclear fuel cycle, and assessing demand and supply for the different phases of the nuclear fuel cycle and the potential future contribution of nuclear power to overall energy demand;*
- *developing exchanges of scientific and technical information on nuclear energy, particularly through participation in common services;*
- *setting up international research and development programmes and undertakings jointly organised and operated by OECD countries.*

In these and related tasks, NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has concluded a Co-operation Agreement, as well as with other international organisations in the nuclear field.

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GESTION A LONG TERME
DES DÉCHETS RADIOACTIFS
ASPECTS JURIDIQUES,
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International co-operation plays an important role in the field of radioactive waste management. The OECD Nuclear Energy Agency (NEA) has, for its part, worked on many projects concerning the principal technical aspects of long-lived waste disposal. In recent years, the Agency has also considered various questions of an "institutional" nature which have arisen in connection with the long-term management of radioactive waste, such as the adaptation of legislation and regulatory structures, continued surveillance of waste disposal sites, financing mechanisms and the compensation of any damage in the distant future.

In April 1979, the outline of a Study on these questions was adopted by the Steering Committee for Nuclear Energy. This Study - the present publication - was conducted by the NEA Secretariat with the assistance of an ad hoc Group set up in co-operation with the Committees concerned of the Agency: the Committee on Radiation Protection and Public Health, the Radioactive Waste Management Committee, and the Committee on the Safety of Nuclear Installations. The OECD Environment Directorate, the International Atomic Energy Agency and the Commission of the European Communities were also represented. A list of participants is given as an Appendix.

The purpose of the Study is to provide decision-makers and political authorities with a common basis of experience and reflection on the questions of a legal, administrative and financial nature raised by the organisation and regulation of long-term radioactive waste management. The novelty of the subject-matter, which had not yet been analysed thoroughly at an international level, together with the constant evolution of national legislation, policies and structures have made for difficulties and a delay in completing the Study. The usefulness of the Study has however been confirmed in the discussions involved in its preparation which have also helped clarify ideas on a certain number of points and highlighted the need to adopt a flexible approach with regard to the various possible solutions.

This Study is published under the responsibility of the NEA Secretariat and commits neither the Organisation nor Member Governments. Its publication would not have been possible without the valuable assistance of the experts who took part in the work of the ad hoc Group. While account has been taken of their opinions as far as possible, it was simply not possible to include all the rich and varied contributions made. Neither does the Study reflect an international consensus in a field which is still developing. It must therefore be considered as a contribution, limited in character, to the work of national authorities on the long-term safety of methods for the management of radioactive waste.

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The long-term management of radioactive waste involves more than questions of technology alone. To ensure the safety of containment methods for some waste categories, storage and disposal facilities need to be monitored (or made subject to other control measures) for lengthy periods even after closure. Then again, management costs are necessarily incurred quite some time after the waste was actually produced. Lastly, while the risk of damage occurring in the distant future is very low, it cannot be discounted altogether. The question therefore arises whether the competent institutions will be able to implement and apply - over a longer period of time than for other nuclear activities - the provisions necessary for carrying out controls, financing management operations and compensating any damage caused, without at the same time imposing too heavy a burden on future generations.

It can be seen, upon analysis, that those institutional controls which are important for long-term safety are limited in scope. When establishing radioactive waste policy, national authorities will assess the maximum length of time over which such controls can be properly applied in the light of the experience to be gained from the way in which institutions for the protection of public health usually fulfil their task. Beyond this maximum period as laid down by the regulatory authorities - which could, for example, be somewhere between one and three centuries - intervention by man will no longer be necessary.

Long-term safety requirements give rise to greater responsibility for Governments, and they also affect the way in which management activities for long-lived waste are organised, especially as regards the division of tasks between the public sector and industry which, in general, plays an important part in the back-end of the nuclear fuel cycle. It must not, however, be forgotten that the operation of waste storage and disposal facilities fits naturally into the regulatory framework set up for nuclear activities as a whole. After closure of these facilities, it is essential for Governments to ensure the continuity of control measures. These aspects are apparent in recent legislation adopted in several countries and in the setting up of specialised bodies.

Several financing methods designed to guarantee that the resources necessary for waste management will be available have already been put into practice. The economics of such financing are of course difficult to calculate because of uncertainty as to the figures involved and the probable timetable. However, it is *apparent that contributions from nuclear operators towards setting up a fund to cover long-term expenditure represent a small percentage only of the cost of nuclear energy.*

The present nuclear third party liability and insurance regime is, subject to minor amendments in the way in which the international Conventions in force are applied, suitable for the compensation of damage connected with the operational phase of radioactive waste management facilities. It may be doubted, on the other hand, whether such a regime, designed with operational nuclear installations in mind, should be applied after their closure also, or whether it should not be replaced by a system of compensation based on State intervention.

I

THE INSTITUTIONAL ASPECTS OF THE LONG-TERM MANAGEMENT OF RADIOACTIVE WASTE

I. THE NATURE OF THE PROBLEM

1. The risk connected with radioactive waste is often pictured as a major obstacle to the development of nuclear energy, in spite of the experts' assurances concerning the safety of waste management techniques(1). It is of course true that all industrial waste is viewed negatively since it consists of materials which are not only harmful but also completely useless. The fact that this waste is the inevitable product of a technological process otherwise benefitting the community goes more or less unnoticed. Although in recent years attention has most often been drawn to the at times considerable damage caused by toxic waste from various industries, it is radioactive waste which seems to give rise to most public concern.

2. The primary object of this concern is high-level, long-lived waste, and it must be admitted that the figures often quoted to illustrate the persistence in time of radioactivity strike the imagination - figures of the order of hundreds of thousands of years reflecting the very long half-lives of some of the radionuclides present in the waste. In view of such time-periods, the exposure or contamination hazard from this type of waste seems difficult to control. It is not easy to form a concrete idea of the technical means which can be used to isolate waste from the biosphere by means of an appropriate form of containment for as long as the level of radioactivity is hazardous for man and the environment. However, it is often forgotten that the process of natural radioactivity decay is an important factor in radioactive waste management, whereas non-degradable chemical waste creates a permanent hazard since its toxicity does not decrease with time. The fact that, in the case of radioactivity, it is possible to specify the duration of the hazard has no doubt helped draw attention to the difficulty inherent in the long-term management of many noxious wastes.

3. The purpose of many research, development and demonstration projects is to show that acceptable methods exist for the long-term management of radioactive waste. This involves in particular the demonstration that techniques

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(1) On the question of the public perception of radioactive waste, see the NEA publication: "Nuclear Power and Public Opinion" (Paris, 1984).

for the containment of high-activity waste are applicable, safe and reliable in the long-term(1). Such a demonstration is often considered a prerequisite for the development of nuclear power programmes and has even become a legal obligation in several OECD countries(2). Given the data already acquired and the size of the research programmes under way, it is reasonable to suppose that doubts with regard to the technology will be overcome.

4. However, other doubts have been raised, and that with respect to the "institutional aspects" of long-term radioactive waste management. This term is perhaps somewhat vague, but it covers a series of questions which have nothing to do with the technical performance of containment systems and which can be summarized in concrete terms as follows:

- Even if it is demonstrated that the technical means proposed are effective enough to guarantee the waste's isolation for the period required, will it not be necessary, or at least desirable, also to provide for some action by man, e.g. continuing supervision of long-lived waste repositories?

- Assuming this to be the case, will the institutions to which such a task will have to be given be able to carry it out properly in a continuous fashion and for as long as is necessary or desirable?

- Even if it is shown that institutional action can meet these conditions, will it not constitute too heavy a burden for future generations and therefore be unacceptable?

II. THE SCOPE OF INSTITUTIONAL MEASURES

5. These questions clearly show the need to complete technical demonstrations by an analysis of the institutional measures required. In undertaking such an analysis, emphasis must be laid on the importance of the link between technical means and institutional measures in formulating and applying radioactive waste management methods. These methods will depend on the characteristics of the waste to be stored or disposed of, and the nature and above all the scope of institutional measures will therefore vary considerably from case to case. Chapter II of this Study describes the main characteristics of the different methods currently used or proposed for the future in order to show the place institutional measures have in each one.

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(1) On research carried out in OECD countries, see NEA reports and particularly: "Geological Disposal of Radioactive Waste" (Paris, May 1982) and the report of the same title published jointly with the Commission of the European Communities (Paris, 1984).

(2) A definition of what constitutes a valid demonstration for high-activity waste has been agreed at international level and published by NEA: "Long-Term Management of High-Level Radioactive Waste - Is It Feasible? - Is It Safe? - The Meaning of a Demonstration" (Paris, 1983).

6. We shall see in Chapter II that these measures are limited in scope since the isolation of radioactive waste, for as long as it presents an unacceptable contamination or exposure hazard, is ensured essentially by technical means. In fact, the question of "institutional control" will be of very limited importance in the case of passive containment methods which use intrinsically safe technical means such as require practically no supervision or other subsequent action by man.

III. THE DURATION OF SUCH MEASURES

7. Public concern stems from the altogether mistaken impression that the management of long-lived radioactive waste requires the application of a kind of "institutional control" for many thousands of years (by analogy with the figures mentioned above) for which there could obviously not be any reasonable guarantee even in the most stable and best organised of societies. When the establishment of technical barriers for containing waste requires to be backed up by surveillance or protection measures to be applied by an institution responsible, such a solution could be regarded as acceptable only if it were demonstrated that these institutional measures were equally capable of being maintained. Obviously this would imply that for radioactive waste storage or disposal methods whose long-term safety depended on institutional control, the control must only be required, at the longest, for as long as there is reasonable certainty that it will be effectively and continuously applied. The durability of institutional control - or to be more precise the perception of its durability - therefore appears as a limiting factor in containment methods that are not totally passive: either the methods will not be able to be used for waste remaining active for very long periods of time or, due to radioactivity decay, institutional control will no longer be essential for containment safety after a given period(1).

8. Moreover, if objections of a moral or political nature are to be met, then the extended application of institutional measures must not constitute too heavy a burden on future generations. This question of obligations to future generations, which consists essentially of avoiding passing on to them an unacceptable hazard or burden, cannot be dealt with properly by referring to radioactive waste alone. Many new technologies as well as other actions or omissions can have very long-term direct or indirect effects which may be beneficial or harmful.

9. To the extent allowed by the limited scope of this Study, Chapter III gives some ideas for consideration as to the acceptable duration of planned institutional measures both from the point of view of their practical effectiveness and of the burden passed on to future generations. The pragmatic approach adopted in this respect leads to the conclusion that satisfactory solutions exist for national authorities to implement.

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(1) See "Disposal of Radioactive Waste, an Overview of the Principles Involved", OECD/NEA (Paris, 1982).

IV. RESPONSIBILITY OF GOVERNMENTS AND THE ROLE OF INDUSTRY

10. It is generally acknowledged that the continuity and duration requirements of radioactive waste management lie well outside the scope and normal capabilities of industry, and that public authorities must take extensive responsibility for action to ensure the long-term safety of management operations. Extensive government powers are not an exceptional feature in the nuclear field, where certain technical choices constitute a matter of policy and where regulatory authorities have extremely broad powers. In radioactive waste management, the timescale involved creates an additional dimension to the role of Government. Governments have to establish structures for carrying out long-term management programmes and institutional controls in order to help maintain the safety of technical waste containment systems. The many examples of international co-operation in this field also help to increase the role of Governments.

11. Such extensive government powers at political and regulatory level will in no way prevent public sector undertakings and industry being given responsibility for the execution of management and some control tasks. In most countries, industry plays an important role in all stages of the nuclear fuel cycle including the back-end of the cycle, i.e. the reprocessing of spent fuel and the management of radioactive waste. It carries out day-to-day management operations at least until the temporary storage of waste at the site of the reactor or reprocessing plant, and it would be quite natural to call upon industry to carry out longer-term management operations.

12. Various methods of allocating responsibility for control and the practical execution of management operations among different public and private agents can be imagined: this will depend on the administrative and industrial structures in different countries. Since many officials will be involved in management tasks as well as institutional control, Governments must ensure that the powers and responsibilities of all parties concerned - political authorities, regulatory authorities, specialised government agencies, public service departments, public or semi-public undertakings, private enterprises etc. - are clearly defined and co-ordinated throughout management operations and the entire duration of institutional control. Chapter IV analyses the different possible approaches and, in particular, the ways in which the responsibilities of the various parties involved in carrying out and controlling long-term management operations may be combined and co-ordinated.

13. Several OECD countries have already taken or are considering measures aimed at progressively building up a global and comprehensive radioactive waste management system which will thus be more suited to long-term requirements. These measures reflect a general tendency towards broader responsibility of the public authorities. The analysis shows that while the regulatory framework established for nuclear activities generally meets the needs of radioactive waste management quite adequately, long-term operations, and particularly institutional controls after closure of disposal sites, may require modifications to the framework or new solutions.

V. FINANCIAL ASPECTS

14. Problems of financing are of major importance when planning for the long-term management of radioactive waste. Costs relating to waste disposal will not normally be incurred until long after the production of the waste, at a time when the nuclear operator concerned may no longer exist. Costs may be spread over relatively long periods and will be difficult to estimate. However, long term safety can be guaranteed only if the financial means required for both the technical operations and the institutional actions to be carried out a long time in the future are indeed available. Chapter V contains an analysis of long-term financing methods based on legislation already in force in several OECD countries.

VI. THIRD PARTY LIABILITY

15. Finally, the terms of compensation for any damage arising from radioactive waste after disposal must be considered. For, however reliable waste containment systems may be, the possibility of damage cannot be purely and simply dismissed. It would seem that the existing third party liability system for nuclear damage in most OECD countries can be applied, subject to a few amendments, to the activities connected with the operational phase of storage and disposal sites. On the other hand, this system seems hardly compatible with the specific situation arising after operational activities have ceased and sites have been closed, because it is not possible to maintain the principle of the liability of the operator over an indefinite period, along with the corresponding financial security, within the framework of the current nuclear insurance régime. It is therefore a matter of determining what specific measures should be envisaged so as to provide a satisfactory answer to any problems of compensation for damage that might arise after closure of a disposal site. These aspects are considered in Chapter VI.

VII. SCOPE OF THE STUDY

16. There is no purely technical criterion establishing a clear boundary between two separate categories of waste management operations, to be called on the one hand short-term and on the other long-term. Long-term operations are planned as part of an overall strategy covering all stages in radioactive waste management from production to final disposal and in many cases they are merely an extension of temporary technical operations. Any definition of "long-term" should therefore be based rather on the perception of this concept by man in terms of a distinction between the hazards likely to face individuals now and the potential effects on future generations.

17. In industrialised societies, people are usually confident that they can live a normal existence and that society is capable of protecting them against major hazards throughout their lives. Proof of this can be seen in everything they plan and do in the course of their private, professional and social lives. People also have direct experience of the fact that many enterprises continue to operate efficiently for periods of time as long as their own working lives, that is to say thirty to fifty years, and that industrial facilities and

public works (dams, causeways, bridges) may remain in operations for at least as long. In the case of radioactive waste, experience gained of the techniques used on an industrial scale has demonstrated without doubt the safety of current management operations. This confidence in the ability to master daily hazards gives way to doubt in the case of technologies and, even more, human action aimed at controlling a risk during periods of time stretching beyond the active lifetime of the present generation. Such thoughts lead to the conclusion that as far as radioactive waste management is concerned, any phase of waste storage or disposal extending over fifty years or more must be regarded as falling into the category of long-term operations. This definition is arbitrary in that it does not necessarily correspond to any technical limitations. Nevertheless, the psychological factors mentioned above would inevitably seem to suggest that beyond this period, additional assurances will be required.

18. Management operations concerning spent fuel are included in the scope of the Study provided the spent fuel is to be disposed of as waste (i.e. without prior reprocessing to extract useable fissile material) or is to be stored for long periods pending a decision on its future destination.

19. Management methods based on the principle of dilution or dispersal of radioactive substances in the environment under controlled conditions are short-term irreversible operations and are therefore not examined in detail in this Study. Waste from the dismantling of nuclear installations can be disposed of in the same way as the other categories of waste. These operations are therefore mentioned only in as much as they may raise specific problems that must be taken into account when drawing up long-term disposal plans.

20. On this basis, the long-term management operations raising legal, administrative and financial problems and which are dealt with in this Study are as follows:

- extended storage of radioactive waste or spent fuel elements;
- waste disposal in geological formations;
- shallow land burial of waste;
- surface stabilization and containment of uranium mill tailings.

21. The following are excluded from the scope of this Study: any considerations relating to the respective merits of the various management methods and the establishment of risk levels regarded as acceptable from the standpoint of radiation protection standards(1), management methods regarded as not technically feasible at present (e.g. waste disposal into space or destruction through nuclear transmutation), and matters concerning the physical protection of sensitive nuclear materials.

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(1) On this point, see the NEA publication: "Long-Term Radiation Protection Objectives for Radioactive Waste Disposal" (Paris, 1984).

II

LONG-TERM MANAGEMENT OPERATIONS - TECHNICAL CHARACTERISTICS AND INSTITUTIONAL CONTROLS

I. BASIC FACTS

A. WASTE CHARACTERISTICS

1. Radioactive wastes are by-products of the nuclear industry and are defined, for the purpose of this Study, as being materials for which no further commercial use is foreseen and which need to be disposed of. Uranium mill tailings come under this definition whereas spent fuel (also called irradiated fuel) from nuclear reactors would meet this definition only if it is not intended to reprocess it to recover the fissile materials contained in it, such as uranium and plutonium, for further use in reactors.

2. Wastes are generated during the chemical and physical operations of the nuclear fuel cycle, the preparation of radioisotopes and their industrial and medical uses, as well as from research laboratories. They are found in many physical and chemical forms contaminated by a wide variety of radionuclides at different levels of activity. A wide variety of management procedures are therefore required depending upon the nature of the wastes and their radionuclide concentration.

3. Although there is no generally applicable classification of wastes, it is often convenient to refer to low-level, intermediate- (or medium) level and high-level wastes, with sometimes a further subdivision to indicate the possible presence of long-lived radionuclides such as the actinides(1). Such classification gives a useful frame of reference for deciding on a suitable form of management for each waste category.

4. An important factor in radioactive waste management is the activity level of the radionuclides present in the waste and the rate of decrease of radioactivity. This radioactivity decreases exponentially depending on the half-life of each radionuclide which can be anything from a few months to thousands or even hundreds of thousands of years. In practice, the effect of this decrease will be to reduce considerably the concentration of radioactive

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(1) Actinides include the natural and artificial isotopes of thorium and uranium and radioelements with higher atomic numbers, such as neptunium, plutonium, americium and curium.

materials over time, thus reducing the hazards of exposure to radiation. It should also be pointed out that the biological and geochemical behaviour of radionuclides which determine their transfer towards man, are important parameters in the assessment of the risk they actually represent.

5. Wastes such as reactor waste, most decommissioning waste from old or obsolete installations and waste produced as a result of medical and sometimes industrial uses contain mainly short-lived nuclides and become relatively innocuous in periods ranging from days to a few centuries. On the other hand, other types of waste, such as uranium mill tailings, high-level waste and waste containing actinides, remain hazardous for much longer periods.

6. High-level wastes from reprocessing of spent fuel (or the spent fuel elements themselves) contain most of the artificial radionuclides, actinides included, produced by the nuclear industry. Some idea of the longevity of the hazard associated with this type of waste can be obtained from the observation of the decay curve of the radionuclide concentration of a typical waste composition (see Fig. 1), although the curve is necessarily simplistic and, in particular, does not take into acccount the biological and geochemical behaviour of the radionuclides present.

B. WASTE MANAGEMENT OBJECTIVES AND PRINCIPLES

7. The objectives of radioactive waste management with regard to safety and environmental protection are as follows:

(i) to comply with the general radiological protection principles;

(ii) to preserve the quality of the natural environment;

(iii) to avoid pre-empting present or future exploitation of natural resources;

(iv) to minimise any impact on future generations to the extent practicable.

In order to achieve these objectives, waste management activities must be carried out within the framework of regulations ensuring satisfactory systems of control, with due attention being given to the minimisation of waste through the selection of appropriate processes, and to the strategic siting and planning of nuclear operations[1].

8. The basic radiological protection principles underlying waste management practice derive from the dose limitation system recommended by the International Commission on Radiological Protection (ICRP). The aim of this system is to ensure that the risks of man's exposure to radiation are kept at an acceptable level. These principles are relatively complex to apply as all

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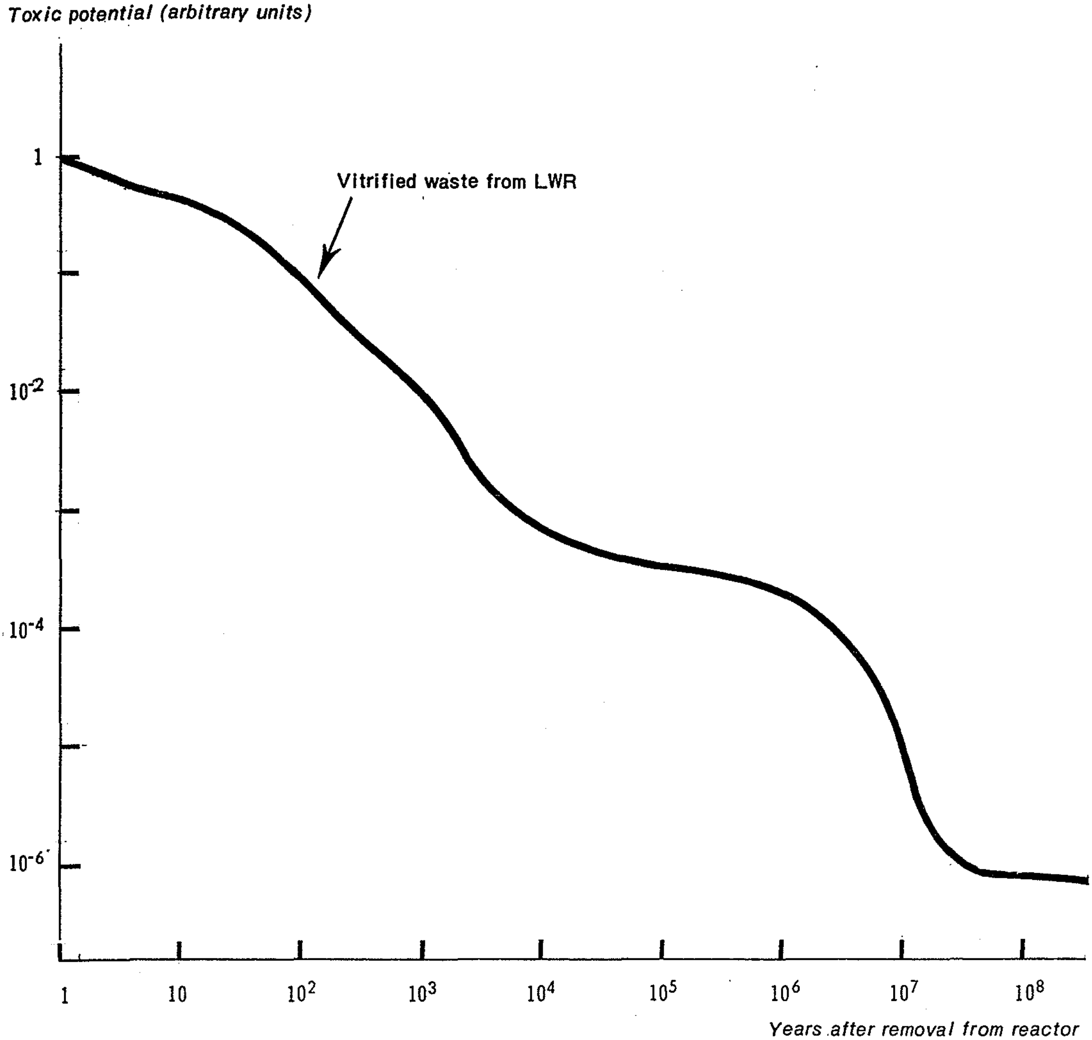
(1) See "Objectives, Concepts and Strategies for the Management of Radioactive Waste arising from Nuclear Power Programmes" ("Polvani Report") OECD/NEA, Paris, September 1977, p.15, para 10.

relevant technical, economic and social factors have to be taken into account, so that "all exposure shall be kept as low as reasonably achievable". In the case of waste containing long-lived radionuclides, the assessment of the long-term behaviour of these radionuclides and their potential migration in the biosphere is moreover subject to considerable uncertainty of a scientific and technical, as well as economic and social nature. Much work is being done on these questions, the main objective being to determine the long-term effectiveness of disposal systems and to ensure that they comply with radiological protection principles.

Figure 1 **TOXICITY OF "HIGH LEVEL" VITRIFIED WASTE FROM LWR OPERATION**



9. Two main methods are available for the management of radioactive waste to meet the general objectives mentioned above. The first is to contain the waste in order to achieve the required degree of isolation from the human environment. Containment systems are based on the principle that no release of radioactivity should, whether occurring in normal circumstances or in postulated abnormal conditions, result in exposure levels, for man and the environment, exceeding the limits set by radiation protection regulations. The second method consists in dispersing and diluting radioactive material in the environment at rates compatible with the relevant regulations.

10. The hazards associated with individual waste streams produced and the choice of safe methods for their disposal are chiefly determined by the characteristics of the waste. Those most relevant to the choice of waste disposal method are the physical and chemical state of the waste, the nature of the radionuclides present and the initial amount of radioactivity contained. The quantities of waste produced obviously also influence the choice of disposal method and the scale of the operations required.

II. WASTE MANAGEMENT SYSTEMS

11. In countries with large nuclear power programmes, the main bulk of waste arises from the nuclear fuel cycle operations. Table I gives an idea of the waste produced, per GWe/year, during a typical light water reactor fuel cycle, with reprocessing. The quantities of radioactive waste from other sources may represent substantial volumes. However, the wastes are qualitatively similar to certain others produced in the nuclear fuel cycle and the requirements for their management are no different.

12. Usually, before wastes can be disposed of they need to go through various preparatory management stages. These include collection, sorting, treatment, conditioning, transport and storage. For most wastes, initial storage is a necessary transitional step to permit radioactivity decay (and a reduction in the heat generated by high-level waste), in order to facilitate subsequent handling, transport and disposal.

13. At the moment, only a very small proportion of the radioactivity present in radioactive waste is disposed of into the environment, chiefly in the form of gaseous and liquid effluents resulting from the normal operation of reactors and reprocessing plants and which, by reason of the low levels of exposure to radiation which they involve, may, after any treatment appropriate, be diluted and dispersed into the atmosphere or the aquatic environment. Similarly, some types of solid or solidified low-level waste are dumped in the depths of the ocean in containers. At present, disposal by means of long-term containment of the radioactivity is carried out on a relatively limited scale and concerns essentially the burial underground of low-level solid waste in shallow ground.

14. The major part of the radioactive waste produced by the nuclear industry remains stored at the sites of production or in storage facilities using man-made structures specially designed for this purpose. Although such storage is temporary, it may be used for extended periods (several decades or more) if, for example, suitable disposal solutions are not yet available or if there is uncertainty as to the final destination of the spent fuel. Extended

Table I

Waste for a Typical LWR Fuel Cycle with Reprocessing per GW'a of Electricity(1)

1.	Uranium mill tailings		
	Volume (bulk)		
	containing:	(m^3)	34 060
	^{238}U, ^{234}U; each	(Ci)	2.1
	^{230}Th	(Ci)	40
	^{226}Ra, ^{210}Pb;each	(Ci)	42
2.	Hulls, spacers, insolubles		
	Canister, HWR		33
	Contained Pu	(Kg)	1.4
	Radioactivity (1 year)	(Ci)	1.4×10^6
3.	Vitrified HLW		
	Canister, HLW		29 - 67
	Contained Pu	(Kg)	2.3
	Radioactivity (10 years)	(Ci)	11.7×10^6
4.	Noble gases		
	Gas flasks		17
	Radioactivity	(Ci)	0.3×10^6
5.	Depleted uranium waste (as UO_2)		
	Drums, unshielded		13
	Contained U	(Kg)	11.0×10^3
6.	Medium level and plant maintenance waste		
	Drums, unshielded		54
	Drums, shielded		83
	Contained Pu	(Kg)	0.9
	Radioactivity (1 year)	(Ci)	2.0×10^3

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(1) Source INFCE Working Group 7: Waste Management and Disposal, IAEA Vienna, 1980

Table I cont'

7.	Low level waste		
	Drums, unshielded		113
	Drums, shielded		13
	Radioactivity (1 year)	(Ci)	4×10^3
8.	Plant decommissioning waste		
	Drums, unshielded		140
	Drums, shielded		16
	Radioactivity (5 years)	(Ci)	0.9×10^3

storage therefore constitutes an important element of waste management and its possible long-term effects should also be considered.

15. The types and technical features of the various waste storage and disposal systems are briefly reviewed below in order to better establish their relationships with the institutional measures that may be appropriate in each case. The nature and role of these measures in ensuring the reliability of containment systems are considered in the following section of this Chapter. Naturally, the operations described are those with a long-term interest involving waste containing long-lived radionuclides.

A. STORAGE

16. All types of waste produced as well as the spent fuel from nuclear power plants may be subject to extended storage.

17. High-level waste is initially stored in liquid form in water-cooled stainless steel tanks. In a second stage, it has to be solidified to facilitate handling and surveillance and maintenance of storage facilities. Extended storage of high-level solid waste in facilities having water-or air-cooling systems is considered both feasible and safe.

18. Spent fuel elements are stored at the reactor site. Underwater storage is the most usual case and may be compared with storage of high-level liquid waste. To avoid the accumulation of large quantities of spent fuel at the reactor, away-from-reactor (AFR) facilities are to be built for centralised extended storage which will provide a transitional phase between onsite reactor storage and fuel reprocessing or disposal(1). Such facilities can be located at the surface or underground and may use air-or water-cooling techniques. Surveillance requirements vary according to the method used and may be minimal in the case of passive air-cooled facilities, which do not necessitate the continuous operation of artificial cooling systems.

19. Storage of other types of waste such as low-level, intermediate-level and waste contaminated by long-lived radionuclides, is now established practice. When extended storage is envisaged, the wastes normally are treated, conditioned and packaged taking into account the storage environment intended for them. The most common types of engineered storage facilities used include concrete bunkers, near-surface excavations and trenches, or covered surface pads.

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(1) Some countries have come out in favour of recycling spent fuel after chemical reprocessing, a decision which results in the production of high-level waste; others seem to be planning rather to discard spent fuel elements without reprocessing, those elements then being treated as high-level waste. However, if spent fuel elements are stored with a view to eventual recovery for re-use of the energy contained in them, a different problem arises, that is to say not radioactive waste management in the strict sense, but interim storage of materials with economic value for subsequent re-use.

20. Storage requirements always include provision for control measures to prevent and detect any escape or migration of radionuclides from the waste package, and detailed records of the contents of each storage container so as to facilitate retrieval and disposal at a later date.

B. DISPOSAL

(a) Disposal into deep geological formations

21. At present the solution for the disposal of high-level and long-lived waste receiving most attention is disposal into carefully selected, deep, stable geological formations, with limited circulating ground water. This solution is also being envisaged for the containment of shorter-lived waste that is too active for shallow land burial. In this latter case, certain underground excavations or natural cavities (abandoned mines and tunnels, caverns, caves, etc.) with less favourable features might be technically suitable and ensure the required degree of containment.

22. During the last few years, many R and D programmes have been undertaken to study the potential of deep geological formations as disposal media for high-level or long-lived wastes and to demonstrate their long-term reliability and safety(1). Investigations are being carried out mainly on clay, crystalline rock, salt formations, tuff and basalt. All containment systems are aimed at isolating the waste from the biosphere for a period sufficient to ensure that any residual radioactivity making its way back to the environment would not lead to unacceptable levels of exposure of man or other biological species. Containment within the geological formation selected may be reinforced by mechanisms delaying migration and the presence of a dispersal medium to dilute to acceptable levels any radionuclides returning to the biosphere.

23. The protection afforded by this method is based entirely on (natural and engineered) physical containment barriers and does not depend on any type of institutional control. These barriers include:

- The nature of the waste itself: conditioning of the waste into a stable solidified product of low leachability (e.g. by vitrification);

- Encapsulation in suitable containers;

- Embedding of the waste containers in buffer material characterised by low permeability, geochemical stability and high ion retention capacity;

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(1) Sea NEA reports: "Geological Disposal of Radioactive Waste - Research in the OECD Area", 1982. "Long Term Management of High Level Radioactive Waste - The Meaning of a Demonstration", 1983. "Geological Disposal of Radioactive Waste - an Overview of the Current Status of Understanding and Development", 1984.

- The nature of the host rock and integrity of the geologic formation: while maintained, this ensures the containment of waste with respect to circulating groundwater;

- Mechanisms to retard migration of the radionuclides in the waste into the surrounding strata (e.g. ion exchange, filtration and adsorption).

24. In the case of repositories for the disposal of spent fuel, some technical modifications would be required but the basic outline would remain substantially unchanged. The most important differences would consist of different spacing between disposal holes and variations in the canister material and buffer zone.

(b) Disposal under the ocean floor

25. Disposal in geologic formations underlying the ocean floor is not conceptually different from the option discussed in the previous paragraphs, since the objective is still emplacement of the long-lived radionuclides within a geological formation, which constitutes the main containment barrier. The essential difference lies in the waste emplacement technology which, for disposal under the seabed, is still undefined.

26. The principle is that the waste should be buried in stable sedimentary layers. It would be placed in the unconsolidated sedimentary cover which is composed mainly of soft clays. Given current expertise, disposal by means of this method seems promising though its feasibility still has to be demonstrated.

27. A Seabed Working Group has been set up under NEA's auspices to assist in the coordination of national R and D activities on the technical feasibility of using this disposal method and on an analysis of the possible risks involved. The Seabed Working Group is concentrating efforts on the acquisition and exchange of scientific data resulting in particular from national and co-operative oceanographic research.

(c) Disposal by shallow land burial

28. Disposal of radioactive waste by shallow land burial can be used only for solid waste containing radionuclides with low activity levels and relatively short half-lives. Here again the aim is to contain the radionuclides for as long as they present a risk of unacceptable exposure levels. Given the shallow depth of disposal, maximum possible containment periods are measured in terms of centuries rather than the thousands of years applicable in the case of waste emplaced in deep geological repositories. Since waste disposed of in this way is easily accessible, it is vital to protect the site against intrusions which might damage the containment system. The protection measures to be implemented play a very important part in the overall safety of the system.

29. Artificial barriers such as trench covers, trench lining, concrete-lined pits and wells, and waste conditioning are used as an integral part of the containment system, together with specific site properties. Repositories or structures for disposal of waste may be at ground level (earth-covered mounds) or below ground (trenches, pits or wells).

30. A basic requirement for disposal by shallow land burial is to reduce the number of long-lived radionuclides present and to lay down maximum concentration limits of these radionuclides above which the waste cannot be accepted for disposal by this method. These concentration levels must be established on the basis of a realistic assessment of the characteristics of the site, the mechanisms for migration of the radionuclides into the environment, and the period of time during which administrative surveillance of the site is feasible, a period which will be shorter the lower the activity levels and the shorter the half-lives of the radionuclides present in the waste.

(d) Management of wastes from uranium mining and milling

31. After cessation of uranium mining and milling activities, all remaining solid wastes, in particular the tailings, which are the finely-ground residues from ore processing, must be left in such conditions as to minimise the potential radiological and toxic impact on members of the public and the environment which might arise from the waste in the long run. These wastes, which contain low concentrations of natural long-lived radionuclides, such as uranium, thorium, radium, and radon daughter products, constitute a potential source of low level radiation for an indefinite period. In view of the large quantities of tailings produced (millions of tons annually in certain uranium-producing countries), their transport for disposal purposes is virtually precluded for both practical and financial reasons. That is why disposal sites for tailings are usually in the immediate vicinity of mills processing plants. For the most part, tailings are contained in engineered structures at the surface and, sometimes, below the surface, i.e. in worked-out open-cut mines or specially excavated pits. In surface structures, tailings are stabilised and covered with soil.

32. Since, generally speaking, even the most soundly engineered tailings containment facility cannot guarantee absolute long-term containment of contaminants in the tailings, the migration of some radioactive and non-radioactive containments such as heavy metals and other chemical pollutants(1) into the environment is inevitable. However, in view of the low activity levels involved, it is considered that in most cases any exposure suffered by individuals from such a dispersal of materials would remain within acceptable limits. The assessment of the collective harm caused by a dispersal of the radionuclides over long distances and a very long period of time is chiefly relevant to the choice between the different possible techniques for containing the tailings(2). The concern for the long-term is rather to limit possible access to sites where tailings are held and as far as possible to limit the misuse of tailings material.

(e) Dilution or dispersion of waste into the environment

33. Management methods based on the concept of dilution or dispersion of radioactive materials into the environment do not, by definition, require subsequent control measures and are not therefore of direct interest for this

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(1) The problems posed by non-radioactive contaminants are not discussed in this report.

(2) See "Long Term Radiation Protection Objectives for Radioactive Waste Disposal", OECD/NEA, Paris, 1984.

Study. Strict control operates essentially at the time of disposal, e.g. by prohibiting the use of these methods for certain types of waste. Low-level gaseous and liquid effluents may be discharged in this way into the atmosphere or into the aquatic and marine environment. However, this practice is liable to raise several problems of exposure of future generations by reason of the accumulation and extensive distribution of certain long-lived radionuclides (such as carbon-14 and iodine-129) in the biosphere . There will therefore probably be a need, in cases where it is warranted by the size of the nuclear programme, to plan for the retention and containment of these radionuclides.

34. The same is also true of the dumping of low-level solid waste in containers into the depths of the ocean. Although a limited period of containment is provided, this method relies essentially on the eventual dispersion and dilution of the radioactivity in ocean waters. It is for all practical purposes an irreversible action, the long-term impact of which, as for all dilution and dispersion techniques, has to be evaluated and controlled by means of clearly defined limits <u>at the time of disposal</u>(1). In principle, therefore, no further control measure is necessary.

(f) Management of wastes from the decommissioning of nuclear facilities

35. Decommissioning of nuclear facilities at the end of their useful lifetime is a potentially significant waste production source, especially in terms of volumes generated. In addition, the dismantling of a nuclear installation may be postponed and take place a long time after the facility has been put out of service. Both these aspects have to be taken into consideration by the authorities in their forward planning of long-term waste management. From this point of view decommissioning can be considered as a delayed waste production, treatment, storage and disposal operation. Although the wastes generated by dismantling have different characteristics from those produced during the useful life of the installation, there is no real difference in the approach to be taken with regard to disposal. There is in general no great pressure to proceed with the actual decontamination and dismantling operations and time is available to ensure the careful, step-by-step planning and

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(1) It should be noted that waste disposal at sea is subject to regularly updated international regulations. The relevant texts are:

- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention), 1972.
- International Atomic Energy Agency Definition and Recommendations, revised in 1978, concerning radioactives wastes and other radioactive matter referred to in Annexes I and II of the aforesaid Convention, INFCIRC/205/Add.1//Rev.1, August 1978.
- OECD Council Decision of 22nd July 1977 setting up a Multilateral Consultation and Surveillance Mechanism for Sea Dumping of Radioactive Waste, OECD/NEA, Paris, 1983.

These texts stress the need to reassess the safety of this disposal method periodically by regularly updating the existing scientific data.

carrying out of the various stages of the operation. However, a decommissioning operation can in itself be regarded as a specific nuclear activity and be submitted to specific regulation. Meanwhile, as in the case of waste storage, surveillance of facilities at the end of their useful life needs to be maintained for as long as radioactive components are retained on site.

III. ROLE AND NATURE OF INSTITUTIONAL CONTROLS

36. As in the case of other nuclear activities, the planning, construction and operation of waste storage and disposal facilities are subject to a whole set of specific regulations. These include:

- the technical requirements which contribute to the safety of the containment systems(1);

- provisions for checking that such requirements are in fact observed; and

- provisions designed to help maintain the effectiveness over time of the containment system.

The first two categories are typical of regulations governing all nuclear installations (licensing regime and inspection)(2). The third category - described here under the general term "institutional controls" - are peculiar to long-term radioactive waste management.

37. In theory, the safety of disposal (and storage) systems should depend essentially on the existence of technical barriers which physically prevent the dispersion of the radioactivity so as to limit as far as possible the need for any human intervention to reinforce or check the system's effectiveness in order to prevent or reduce the extent of any failure. However, as was seen in Sections I and II of this Chapter, the extent of waste containment can vary considerably according to the characteristics of the waste involved. The role of institutional control in ensuring the safety of containment systems will also vary depending on the type of containment selected and the degree of protection it is able to afford against the risks of exposure to the radionuclides contained in the waste. In some cases, institutional control might constitute an important part of safety (e.g. when the radioactive materials are relatively accessible) or it might only be an auxiliary measure, the failure of which would not perceptibly affect safety. It is possible also to envisage institutional control as an extra precaution only, not really needed to ensure the effectiveness of the containment system.

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(1) These requirements chiefly include site selection criteria, the physical and chemical form, conditioning and packaging of waste, the design of installations and containment structures, methods for storing and burying waste, radiation protection standards (level of risk that is acceptable with respect to the containment system envisaged) and construction and operating conditions.

(2) For more details, see Chapter IV.

38. Institutional controls applied to technical containment systems have three distinct objectives:

(i) to prevent any intrusion by man which might, directly or indirectly, adversely affect the integrity of the technical containment system;

(ii) ensure that the facilities, structures and equipment are kept in good working order(1); and

(iii) monitor the surrounding environment to ensure that there is no uncontrolled release of radioactivity from the containment facilities.

39. Two categories of control may be distinguished:

(a) "Active" (or technical) controls involving the physical care of the site, maintenance work, monitoring environmental radiation and, if necessary, any corrective measures required.

(b) "Passive" (or administrative) controls involving measures connected with protecting the site against intrusions, i.e.:

- fencing, marking and signposting;

- the keeping of detailed records about the waste (type, quantity, location) in local, national, and even international archives(2);

- other means of perpetuating knowledge of the location and design of disposal systems; and

- restrictions on land-use.

Control measures in the two categories are not mutually exclusive and may be applied separately or in combination, depending on the technical features of the various containment systems and on any changes occurring with the passage of time. To these will also be added specific requirements concerning the conditions for ceasing activities and closing down, decommissioning, reconstructing and releasing sites for other purposes.

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(1) Normally such measures form an integral part of operational safety and are not, therefore, strictly speaking institutional.

(2) Such records will be necessary for radiation monitoring in storage or disposal areas, any corrective measures that may be required following radioactivity leaks, maintaining waste containment facilities and sites, recovering and processing stored waste with a view to disposal, etc. The records will also be used as a basis for periodical safety assessments throughout the period of institutional control. Obviously, data from any operations carried out for the purpose of institutional control must also be recorded.

40. Although stages in the sequence of technical management operations are not clearly separated, two main phases may be distinguished in the application of institutional control:

(a) that prior to the closure of a disposal or storage site (i.e. the operational phase of the facilities);

(b) that following closure (i.e. when the facilities cease to be operated).

41. Institutional controls during the pre-closure phase will be applied under conditions very similar to those for other nuclear activities and do not therefore raise any particular difficulty.

42. In the post-closure phase, there are two possibilities :

(a) First possibility: the management system makes provision for controls by man to reinforce the containment achieved by the technical barriers: surface storage and shallow land burial may fall into this category.

(b) Second possibility: here the management system is designed to isolate the waste to a very considerable extent (e.g. high-level waste repository in a deep geological formation) and to provide a level of intrinsic safety such that no institutional control is really needed. Nevertheless, the fact that institutional control is not strictly necessary for purposes of safety obviously does not mean that the authorities responsible should not set up such arrangements if they consider them desirable for the purpose of good administrative practice, for maintaining awareness of disposal sites by keeping appropriate records or for psychological reasons.

43. The duration of institutional control will have to be laid down case by case by the regulatory authorities on the basis of a realistic assessment of the period of time over which control may reasonably be relied upon to last and remain effective(1). Because of the natural radioactive decay process, some forms of institutional control can be relaxed to some extent or even discontinued with the passing of time. As seen at the beginning of this section, extended institutional controls form an integral part of the regulatory procedures applying to radioactive waste management (or of general legislation on nuclear activities) and are, in actual fact, no more than an extension of the regulatory provisions applying to short-term management operations(2).

44. Finally, notwithstanding the safety of the containment systems used, which renders any migration of radionuclides in unacceptable quantities or concentrations unlikely, institutional control measures will have to take account of any constraints connected with possible risks of transfrontier

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(1) See Chapter III.

(2) See Chapter IV.

pollution. The OECD has carried out a considerable amount of work on these questions over the last ten years, and adopted a series of recommendations inviting Member countries to increase co-operation in order to make it easier to work out and apply co-ordinated environment policies so as, in particular, to help solve protection problems which might arise in border areas. Member countries, by means of consultations and information exchange, are to further the development of a just system of protection and compensation of damage suffered by persons affected by transfrontier pollution, no matter where it originated, a system based on a fair balance of rights and obligations between the countries concerned(1).

IV. SPECIFIC APPLICATION OF INSTITUTIONAL CONTROLS

45. After these general comments on the role and nature of institutional controls, we need to consider the main features of such controls for each of the long-term management operations covered by the Study.

A. EXTENDED STORAGE

46. Since by definition, storage of waste is an intermediate stage, institutional control is necessary until the waste is recovered and transferred to a disposal site (see Section II.A, paragraphs 16 to 20).

(a) Pre-closure phase(2)

47. If the waste is stored at the production site - usually the reactor or reprocessing plant site - the operation, maintenance and surveillance of the facilities form an integral part of the operation of the reactor or plant and are therefore governed by the regulatory provisions applicable to the installation. Waste storage away from the nuclear installation site needs to be governed by specific regulations similar to those applying to other nuclear installations(3). In either case, storage installations in operation are subject to conventional type controls which consist of ensuring that the facilities are operating as they should and keeping records of waste stored.

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(1) The main documents connected with this work are contained in "Non-discrimination in relation to Transfrontier Pollution", OECD, Paris, 1978.

(2) Although waste storage is, by definition, an "open" management method in that the waste is to be recovered, the terms "pre-closure" and "post-closure" have been retained in the interests of consistency (whereas the terms "pre-operational" and "post-operational" would better suit the real circumstances of storage).

(3) In the case of spent fuel, specific measures must also be taken with a view to ensuring appropriate physical protection of the recoverable substances (chiefly plutonium).

(b) Post-closure phase[1]

48. When a storage centre reaches saturation and the waste is not moved elsewhere, it may be decided to close the facility for the time being. It will then be necessary to continue some form of institutional control in order to maintain the initial safety of storage conditions and to protect the facilities so that the integrity of the containment of the substances stored is preserved.

49. The control measures to be considered chiefly consist of the following:

- fencing off the storage site and putting up signposts in order to prevent undesired access to the facilities;

- where appropriate, manning the site (e.g. special security staff) to strengthen the protection of the site and facilities;

- maintaining equipment that might deteriorate with time (e.g. waste containers) and carrying out checks at regular intervals to ensure that the facilities and areas used for waste storage are in good order; and

- monitoring environmental radiation at regular intervals or continuously and taking appropriate corrective action should any release of radioactivity be detected.

50. The extent of the resources to be applied to maintain such control will depend on the design of the containment facilities (depending on whether the waste is high, intermediate or low-level), the ease or difficulty of access to the storage facilities (depending on whether they are on the surface or underground) and finally the period of time over which the site is to be used as a temporary storage site. Depending on the case, control may be active and continuous (e.g. where the facilities contain high-level waste and their operation relies on water- or air-cooling devices) or passive and intermittent (e.g. where the facilities contain waste not producing heat or in which heat is dispersed by natural processes).

51. When it is decided to transfer waste from storage to a disposal site, it will be necessary to make arrangements for recovering the stored waste and conditioning and, if necessary, repackaging it in accordance with the disposal conditions to be met. Such operations will be facilitated if records are kept throughout the waste storage period. The waste will then be back at a standard operational stage (or "pre-closure" phase) with operational control measures (see paragraph 47 above).

52. This situation will be similar from both technical and institutional control standpoints to that following the decision to bring spent fuel out of storage for transfer to a disposal site or to a reprocessing plant to recover the usable fissile substances.

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(1) See note (2) on previous page.

53. The possibility cannot be ruled out that a site intended for extended storage might eventually become a disposal facility. This would mean that the technical methods of storage used would be considered acceptable as permanent methods of containment and hence disposal. Such disposal could be considered effective after a period of observation of the behaviour of the facility and after appropriate steps had been carried out such as backfilling the facility and closing the site. Institutional controls would then be similar to those applicable to shallow land burial in the case of low level waste or to disposal in more or less deep geological formation in the case of waste with a higher activity level (see following sections).

B. SHALLOW LAND BURIAL

54. The essential difference between waste disposal by shallow land burial and storage is that the former is a final management method with, in theory, no intention of recovering the buried waste. It has been seen that this disposal method needs the use of institutional control to help maintain the waste containment system (see Section II.B(c), paragraphs 28 to 30).

(a) Pre-closure phase

55. As in storage, the control needed for waste burial activities is operational in nature and its application does not raise any special problems. The main provisions will involve the prohibiting of access to the site, the setting up of a site and environmental radiation monitoring programme and the keeping of detailed records about the waste buried.

(b) Post-closure phase

56. Once burial operations have ceased and the site has been closed, control measures will include:

- manning the site (as local conditions require);
- continuing the radiation monitoring programme begun during the operational stage; and, possibly,
- maintenance of the burial areas and installations (in the course of time these may be impaired by natural erosion, water infiltration and damage caused by biological activity).

57. A total ban on access to the site may not be necessary but access must be controlled both by physical means and by regulatory control of land-use. At the end of the control period, the waste's radioactivity will have to have decreased to harmless levels and the site will be able to be released for other purposes.

C. WASTE DISPOSAL IN GEOLOGICAL FORMATIONS

58. As seen in Section II.B(a), the safety of waste disposal in deep geological formations is based wholly on a combination of physical barriers consisting of the host geological environment, waste conditioning and packaging and site engineering features. In principle, this disposal method is intrinsically safe so that no active institutional control should need to follow disposal operations. Any control measures applied after site closure (mainly to prevent penetration in the immediate vicinity of the waste) can be considered as an extra precaution only.

(a) Pre-closure phase

59. The purpose of the controls excercised during this phase will be to check that the construction, commissioning and operation of the facility are carried out in compliance with the safety conditions laid down. Furthermore, with a view to the long term, special attention should be paid to evaluations of site acceptability and the features of the disposal system as well as engineering features and waste positioning including: mining, waste form, packaging and handling, operational safety of the installations, and radiation monitoring of the site and its surroundings.

(b) Closure phase

60. The conditions in which site closure is effected form an integral part of the safety of the containment system. Access shafts might possibly not be plugged nor the facility closed till some time after operations cease so as to be sure that the site was really suitable and the facility built and operated properly. During this period, it will be necessary to man and supervise the site to prevent any unauthorised access. It may also be thought that sites should be monitored for radiation until the decision is taken to seal and close down the installation for good.

(c) Post-closure phase

61. After the installation has been closed down, there is not really any technical requirement for manning the site. Nevertheless, in spite of the weight of the argument that the technical isolation systems are intrinsically safe, a certain type of surveillance could be carried out. The responsible authority would not then give the impression that it was abandoning the site altogether, and direct site surveillance would be provided for a certain period of time even though this be at a token level.

62. However, the main objective of institutional control will be to prevent any intrusion which might harm the integrity of the disposal system. In practice, many surface activities above a waste repository will be harmless, but disturbances deep underground at such a spot could result, sometime in the future, in the release of radioactivity into the environment. Account must also be taken as far as possible of any activities near to or far from disposal sites which might have an indirect effect on the integrity of such sites.

63. There is no doubt that the use of a repository deep underground renders intentional intrusion less likely and essentially eliminates any chance of

accidental intrusion. Also, the fact that the site should not contain any mineral resources that might encourage prospecting and exploration activities renders drilling unlikely. However, additional protection against intrusion into deep repositories can fairly easily be obtained by restricting the use of disposal sites; such restrictions could be applied within the framework of the legal land-use system on the basis of records of the sites kept in local and national archives. This measure might be strengthened by suitable on-site signposting indicating the nature of the site and the fact that drilling is prohibited. However, unless the site is public property or unless there are easements over it, there should be no restrictions on the use of land above a disposal site after it has been returned to its original state.

D. DISPOSAL UNDER THE OCEAN FLOOR

64. In parallel with the research and development work mentioned earlier (see paragraphs 25 to 27, above), studies of the legal and institutional aspects of this disposal method have been undertaken in the light of the international regulations on the protection of the marine environment against pollution. Without prejudging the results of these studies or the development of current technical programmes aimed at establishing the feasibility and reliability of waste emplacement techniques, it can be said that an appropriate international legal and regulatory framework will be required when the time comes for the execution of disposal operations using these techniques. In this context, it can already at this stage be said that the only control which might be maintained would probably be the keeping of detailed records of the waste disposed of and the sites used.

E. STABILISATION AND CONTAINMENT OF URANIUM MILL TAILINGS

65. As was seen above in paragraphs 31 and 32, it seems necessary, given current technical knowledge, to establish institutional control essentially to prevent man from gaining access to uranium mill tailings sites or from putting the tailings to inappropriate use, for example using them as building materials for dwellings. In the short term, such control would be similar to that adopted for other management systems. As concerns the long term, studies are being carried out at both national and international level which should facilitate the development of regulations in this field and lead to more detailed assessment of the scope and form of the institutional control required.

V. CONCLUSIONS

66. This brief review of the practical measures to be taken confirms that long-term institutional controls are of limited compass: they do not involve technically difficult operations and do not require the marshalling of large-scale industrial or administrative resources. This observation applies in particular to measures needed in the post-closure phase, i.e. the phase which is farthest away in time.

67. In some cases, institutional measures will need to be applied over a relatively long period (several centuries), but this period will always be specified. In the case of extended storage, the regulatory authorities will, in accordance with the technical data and in the framework of general radioactive waste management policy, specify how long it is proposed to store the waste (before disposal) and hence the period for which the corresponding institutional control will be needed. For shallow land burial, the period over which institutional control measures will be applied will be established by the regulatory authorities in accordance with their estimate of the length of time such measures can be maintained and with the need (or benefit) there is in maintaining them, account being taken of the decay in radioactivity and hence the selection criteria of the waste. Finally, when institutional measures in the post-closure phase are not essential to the safety of the system and constitute a supplementary precaution only, for example in the case of deep geological disposal, it will be for the regulatory authorities to fix the period of time during which it is both desirable and feasible to apply them.

68. It can therefore be said, in conclusion, that decisions about the nature and longevity of the institutional control to be applied to a radioactive waste storage or disposal facility will be taken within the framework of a comprehensive strategy based on the priority to be given to technical containment barriers. Such decisions will to a large extent reflect an optimisation of various parameters connected in particular with the effectiveness of the technical barriers and the estimated longevity of institutional control.

69. The problem raised by the duration of institutional controls is considered in more detail in the following Chapter and a graph outlining the controls for each long-term management method is given in Appendix 1.

III

THE PROBLEM OF THE DURATION OF INSTITUTIONAL CONTROL

I. INTRODUCTION

1. Before considering to what extent the durability of the institutional measures to be implemented can be relied upon and the consequences they may have for future generations, two points emphasized in the previous chapters should be borne in mind. This will prevent the problem from being posed in terms that are too abstract and will help us concentrate on the practical aspects which national authorities will have to take into account.

2. First, as was shown in Chapter II, long-term safety is ensured primarily by autonomous technical means. The institutional measures required for the various management methods are therefore limited in scope: supervision of the facilities, preventing access to the site, keeping records of waste repositories, etc. In some cases, these measures constitute an important or even essential safety factor while in others they are back-up measures only, whose failure would not significantly affect containment safety.

3. Secondly, institutional control measures which are important for long-term safety will be set up for a limited time only and for no longer than their estimated durability. We have seen that this applies in particular to extended storage and shallow land burial. In these cases, decisions as to the length of time for which active surveillance should and can be maintained will have an important effect on the choice of which management strategy to adopt. For example, in assessing whether the disposal of high-level waste should be delayed in order to benefit from the technological progress resulting from R & D programmes, one factor that will be taken into consideration is whether institutional controls over extended storage facilities can be effectively maintained over sufficiently long periods. More generally, the question of the durability of these measures will arise when a decision is wanted as to whether management methods set up as a short-term solution can be regarded as equally satisfactory in the longer term(1). Lastly, in the case of waste

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(1) For an expression of concern in this respect, see National Academy of Sciences, Academy Forum - "Nuclear Waste: What to Do With It?" 19 Nov., 1979, 40: Intervention by Josh Levin (Office of Senator Percy, Ill.) and Rowe and Holcombe, "The Hidden Commitment of Nuclear Wastes" in Oversight Hearings on Nuclear Energy - Overview of the Major Issues, Hearings before the Subcomm. on Energy & the Env. of the Comm. on Interior & Ins. Aff., H.R. 94th Cong. 1st Sess. (Part I) 37 (1975).

disposal in deep geological formations, the regulatory authorities will have to assess how long it will be possible to keep records about these repositories.

II. PREDICTIVE ABILITY WITH REGARD TO THE DURABILITY OF INSTITUTIONAL CONTROLS

4. Reliance on the long-term effectiveness of institutional controls requires the continued functioning of governmmental institutions and a minimum of social stability and order over the period of time concerned. While predictions of continued stability for thousands of years or more may be reasonable for one element in the nuclear waste management strategy, namely geologic media, predictions appear more difficult with regard to institutional controls which involve as temperamental a factor as human behaviour(1). However, most human actions are based, more or less consciously, on certain assumptions about duration. In the industrial world, programmes and structures for production are quite often set up in accordance with a market that is limited in time, and things can therefore change quickly. On the other hand, most public authority action for the protection of the public - public health, police, national defence - corresponds to permanent needs. All such tasks are therefore given to institutions set up for unlimited periods on the basis of permanent legislative provisions. The objectives of long-term radioactive waste management also reflect the need to protect man (and his environment) from a long-term hazard and requirements for institutional measures (independently of technical means of containment) are similar to those governing action undertaken by many other public institutions. The temptation to treat institutional control for radioactive waste management as if it were something unique must therefore be avoided.

5. One method of prediction would be to look for historical examples of the durability of social institutions similar to those considered in this Study. A brief review of history can give the impression that it is not so much a record of uninterrupted progress as a series of frequent changes and even significant set-backs. In any event, the contemporary period has been marked by a rapid sequence of events and developments many of which, to the observer of only a few decades earlier, would have been difficult to imagine, hence unforeseeable. Nevertheless, many examples do exist of laws which have remained in force, without significant changes, for very long periods, of institutions that have worked for centuries and of ancient records, that have been preserved(2). Care must of course be taken with this purely "historical" approach since reference in general terms to the survival of social institutions, such as churches, universities, judiciary bodies, etc., as relevant precedents, has little meaning unless such an assertion is accompanied by a detailed analysis of the reasons for the phenomenon which make it

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(1) Cf. Margaret M. Maxey, in "Radwastes and Public Ethics: Issues and Imperatives" (Health Physics, Feb. 1978, pp. 129-135 at 132).

(2) See P. Strohl, "Legal, Administrative and Financial Aspects of Long-Term Management of Radioactive Waste", Nuclear Law Bulletin No. 21, p.77, particularly at 83-84 (1978).

likely to be repeated in the future. For, generally speaking, whatever the combination of variables may have been to allow such survival in the past, there can be no absolute assurance of a similar continuity of purpose or supportive social factors to render sufficiently credible predictions of a correspondingly long-term existence of similar institutions in the years to come. This is particularly so as the pace of social change increases continuously. Even with regard to measures with a limited purpose such as the simple transfer of written information, the fact that there are examples of such information transfer down the ages running now into thousands of years cannot be seen as an absolute guarantee of similar success for the transfer of, say, written records relating to the existence of radioactive waste repositories. Historical examples do, however, facilitate a more balanced judgement on the likely durability of institutions. No doubt such examples will carry more weight in countries with a long tradition of government.

6. Another approach would be to undertake an in-depth sociological analysis of the durability of institutions (or institutional mechanisms) carrying out a specific mission with regard to an unchanging and permanent objective. Such an analysis would show that the "institutionalisation" of collective human action is precisely a response to a concern for durability in connection with a public benefit that it is wanted to protect. It would also help us understand how institutions can carry on their activities while adjusting to environmental change and at the same time continue to meet their obligations. A sociological analysis of this type would be far beyond the scope of this Study which is limited to radioactive waste managment, and would involve tackling, on a much wider scale, the methodological problems inherent in the social sciences: difficulty in quantifying parameters (for example, specifying the durability of institutional measures in terms of years), difficulty in analysing social behaviour objectively, the diversity of methods proposed by theorists(1), etc.

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(1) The scientific analyses already carried out are interesting in that inter alia they highlight the phenomenon of the lasting quality of social structures and the existence of normative functions which help to ensure permanence. There exists an abundant literature on these questions. For an analysis of sociological methods, see M. Grawitz, "Méthodes des sciences sociales", Dalloz, Paris (1981); on the comparative method: N.J. Smelser, "Comparative Methods in the Social Sciences", Englewood Cliffs (1976); on the functional approach: R.K. Merton, L. Broom, "Sociology Today - Problems and Prospects", N.Y. Basic Books (1959); on structuralism in sociology: R. Boudon, "A quoi sert la notion de structure", Gallimard, Paris (1968); on systems analyses: P.A. Sorokin, "Sociological Theories of Today", Harper and Row, N.Y. (1966); Revue Française de Sociologie, Vol. XI-XII (1970-71); W. Buckley, "Sociology and Modern Systems Theory", Prentice Hall (1967) and "Modern Systems Research for the Behavioral Scientist", Chicago, Aldine (1968); T. Parsons, "The Structure of Social Action", and "Theories of Society", Glencoe, Ill. Free Press (1949 and 1961) and "Systems Analysis: Social Systems", International Encyclopaedia of the Social Sciences, N.Y. (1968); G.C. Homans, "The Human Group", Harcourt Brass (1950); D. Easton, "An Approach to the Analysis of Political Systems", World Politics IX (1956-57).

7. One of these methods, which has been considered for dealing with the question of institutional control, is that of systems analysis[1]. Normally the relationship between any system and its environment is, as in the present case, quite one-sided and the long-term reliability of a system of institutional control is in direct proportion to its capacity to adapt itself to an ever-changing environment. Effective long-term controls thus presuppose identification of every significant environmental change during the projected life-time of the system, assessment of its impact on the system, and anticipatory responses of a nature flexible enough to accommodate the new operational parameters without prejudicing the fundamental objective of long-term waste isolation. Considering the multitude of variables and the extended time-frame involved, it seems difficult to meet the challenge thus posed in its entirety. In spite of the usefulness of systems analyses, it has been noted that social phenomena are often too complex to be broken down into simple mechanisms.

8. It is highly likely that decisions as to the role to be played by institutional measures will be based on a pragmatic approach. Experience has shown again and again that many institutions are capable of carrying out their tasks in a continuous manner over very long periods of time. Indeed it is by no means unusual for several generations of one family to have dealings, for day-to-day matters, with the same administrations or public services, and a century or longer does not seem an especially long time in the life of such institutions even in a particularly troubled age. It may in fact often be observed that some government administrations or similar institutions have a natural tendency to be self-perpetuating which is desirable in the case of those whose function is to protect the community's long-term interests.

9. The formation and development of such organised societies as are modern States also show that it is institutions whose mission is to protect a community's most vital interests that remain in existence the longest and in a continuous manner because they have been designed to this effect, this feature is incorporated in their make-up and determines the way in which they operate since it forms part of their very purpose. Measures undertaken by such institutions are perceived by the public as being for the general good and, at the same time, help to perpetuate such a communal perception which is essential for the success of their mission.

10. It is difficult to imagine anything more important for man than his health and physical safety. Laws, rules and customs designed to protect such a basic need benefit from an inherent durability not only in normal times but also in periods of major social upheaval. Wars and revolutions may profoundly affect economic life, political regimes, the normal working of many public services, international relations, etc., but in spite of such upheavals, a minimum social order has always been maintained; laws ensuring physical security have largely continued to be enforced - the administrative and legal authorities responsible for such enforcement have not suddenly ceased to function but have been able to adapt to the most abnormal circumstances.

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(1) See M. Badibanga and R. Gagnon, "Longévité d'un système de contrôle institutionnel : une projection temporelle dans le domaine de la gestion des déchets nucléaires" (1978). (This was a study prepared for the Canadian Atomic Energy Control Board).

Institutions meeting the permanent need for security of citizens can easily be found in every country. The purpose of an institution is therefore an important factor in assessing its potential durability(1). There is no doubt that the need, as perceived by future generations, for maintaining certain institutional controls over waste containment systems for long-term safety, will be the determining factor for their durability.

11. The conclusions of national authorities as to the durability of institutional control will certainly be cautious. Examples of long-lived institutions do not really give rise to confidence in the ability of institutions to assist in controlling, over thousands of years, the hazard attached to radioactive waste since such examples cannot counteract the feeling of unpredictability regarding anything to do with such a distant future. Moreover, man today often has somewhat mixed feelings about the future of industrial society and its institutional structures; the faster pace of events, considerable changes in material conditions and attitudes, dangers specific to this period of history and, above all, improved information about such trends are all factors that help to create a feeling of vulnerability. This feeling is in contradiction with the general confidence that exists in the progress of technology and the means that this provides to counter-balance the increase of risks inherent in industrialisation. Similarly, criticism of institutions that operate in difficult conditions does not fit well with the increasing dependence on public assistance and welfare whose purpose is to ensure the safety and stability of society.

12. It seems, in conclusion, that a balanced judgement, based both on social experience and an unprejudiced view of current conditions, should lead to the conclusion that it is reasonable to assume that institutional control of fairly limited scope can contribute to the safety of a containment system for radioactive waste over a period of some hundreds of years. A cautious approach would also involve the setting of a maximum limit which could be around 300 years, for example. Beyond such a limit, the integrity of the containment system should no longer depend on any action by man. The periods

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(1) An example of the kind of institution required is the "Waterschap" in the Netherlands, a public law body, whose nature and functions have striking affinities - although in a very different technical field - with the present case. Since Medieval times, the Waterschap has been responsible for protecting the country against floods by means of natural or man-made barriers, controlling and maintaining the level of waters, building roads, canals and dykes and keeping all these in good order. Reliable records of its activities go back to the 14th century, although much earlier documents refer to it. The fact that this institution has efficiently played such a vital role for its country for such a long time - and there are obvious parallels with the objectives of long-term radioactive waste management - makes the Waterschap a valuable example for the analysis of institutional mechanisms. While institutional controls for the long-term management of radioactive waste may not be as vitally important as the mechanisms for protecting a country against the permanent risk of flooding, the comparison highlights the importance of factors bound up with the nature and purpose of an institution, besides technical factors.

which have just been mentioned are, however, given as a general indication only. It is for the national authorities to decide on policy in this respect, in line with the experiences and circumstances of each country.

13. Establishing a time-frame for institutional controls could not prevent governments from continuing to maintain any controls they might think necessary or desirable after the period in question had elapsed. All time-limits are arbitrary and are relative in the sense that they are continually being pushed back in time as, and to the extent to which, time passes and confirms the efficiency of the control. However, given our inability to predict social stability for very long periods, regulatory authorities will have to take into account, when judging the validity of management methods, the length of time over which institutional controls should be considered as an important safety factor, bearing in mind the maximum limit they will have laid down as being acceptable.

III. THE QUESTION OF AN OBLIGATION TOWARDS FUTURE GENERATIONS

A. MORAL ASPECTS

14. It has been argued that reliance on long-term institutional controls should be avoided on ethical grounds so as not to "impose upon future societies an obligation to provide for a stability of institutions unprecedented in history"(1). The problem that is addressed here is, in general terms, that of the distribution amongst different generations of the costs and benefits of nuclear power production: can an activity that results in negative legacies to future generations be morally justified? - it being understood that account should be taken not only of the immediate, but also the future benefits resulting from the activity. There are those who argue that there exists a general obligation to bequeath a world unaffected by our residence in it, while others consider that we should simply discount risks to future generations(2). Neither of these extreme positions, however, appears very reasonable.

15. On the one hand, a policy of strict non-degradation of the environment would be impossible to carry out. History shows that human beings learn to live with the consequences, both beneficial and detrimental, of activities carried on by previous generations. Exhaustion of limited and non-renewable resources can affect the living conditions of future generations quite as much as pollution. The future energy needs of the less developed countries for example, are particularly relevant in this respect.

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(1) G.I. Rochlin, "Nuclear Waste Disposal: Two Social Criteria", 195 Science, 23 at 29 (1977).

(2) See, for example, T. Cochran, D. Rotow and A. Tamplin, "Radioactive Waste Management" (Part I), in Nuclear Waste Management, Hearings before the Subcomm. on Energy Res. & Production of the Comm. on Science & Technology, H.R. 96th Cong. 1st Sess. 561, at 572 (1979) and National Academy of Sciences, Academy Forum, supra at 19-20: statement of Kenneth Arrow.

16. On the other hand, dicounting totally potential future health effects is difficult to defend from an ethical point of view(1). Long-term risks from radioactive wastes will depend to a large extent on the policy adopted by the generation producing the waste. A management option requiring long-term active control measures to give a reasonable assurance of safety condemns future generations to continue similar controls in order to protect themselves from dangerous relics from a more and more distant past, unless of course they decide to adopt another solution themselves. In either case, it is clear that the choice of a technically non-autonomous containment system for long-lived waste would represent an economic burden for future generations. Given the impossibility of guaranteeing the continued effectiveness of institutional controls over extremely long time-periods, such a choice could also carry with it a future health risk greater than that at present deemed acceptable.

17. A reasonable compromise could be that the design of any waste management system should be based on this elementary notion of fairness: "At a minimum, the current generation should not pose larger risks on a future generation than it would be willing to accept for itself"(2). Moreover, the economic and social cost of the risk should be added to this formula. Such an approach justifies the rule already stated that institutional controls should be used as an important safety factor in radioactive waste management only to the extent that the continued existence and effectiveness of such controls can reasonably be relied upon in the same conditions as at the outset. It is clear that if used as an optional precautionary measure only, then the inclusion of institutional controls as part of the chosen management method should not really be regarded as a burden on, or transfer of risk to future generations.

18. The adoption of waste management methods which do not require burdensome institutional controls to be maintained over very long periods would not of course eliminate completely all long-term risks attached to the disposal of radioactive waste. However high may be the standard of the safety measures taken, there will always remain a possibility, be it ever so small, that an escape of radioactivity could take place, e.g. due to a flaw in the technical barriers used or following an intrusion by man into the repository. Such an event, though hardly catastrophic, may nevertheless require action to prevent, minimise or repair any damage that might have been caused. The problem of a potential burden on future generations thus remains - as indeed it does in the case of other human activities. There is clearly no reason to discuss the problem of the "moral responsibility" linked to the production and management of radioactive waste in terms any different from those used for other human activities nor to apply stricter standards of "morality". Regulations governing the disposal of long-lived radioactive waste should, as is true in all fields, be framed in the light of an analysis of the nature, size and duration of the risk being created. In general, it seems reasonable not to bequeath to future generations along with the benefits of a given technology risks - or the burden of needing to protect themselves against such risks - of a level

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(1) See G. Handl, "Managing Nuclear Wastes: The International Connection", 21 Nat. Res. J. (1981) 23-29.

(2) US EPA, Proposed Criteria for Radioactive Wastes, 43FR 53262 (1978), Issue No. 4.

that we ourselves would not deem acceptable or which would effectively outweigh the direct or indirect benefits they would acquire from the technology in question.

B. PRACTICAL ASPECTS

19. It would be useful to consider, from a less philosophical point of view, how this question of future generations can in practice be taken into account in radioactive waste management policies. One of the significant characteristics of our era - in highly-developed countries at least - is a tendency to be much more taken up than we were in the past with the long-term effects of decisions. Doubtless the explanation is largely to be found in the considerable development of sciences such as demography, economics and those relating to the evolution of the natural environment (ecology, geology, agronomy, etc.) - a development which has permitted much more accurate forecasting than was possible before(1). Technological progress and industrial expansion have made man aware that he is able to make profound and lasting changes to his environment: these may be for the better or for the worse - he can produce more but also exhaust more quickly the world's natural resources. It is therefore not surprising to see that more than ever before, governments are taking analytical forecasts into account and drawing up long-term policies. Among many examples that could be given, the environmental protection policies of the last ten years or, more recently, energy policies aiming to use less non-renewable fuel, are directly linked with the object of this Study. Naturally, the means at the disposal of governments being limited, the choice between the immediate advantages of short-term solutions and the cost of longer-term policies is often difficult. However, the technical choices already made and legislative policy in the field of radioactive waste management have given priority to long-term safety, even when this has been to the detriment of a more rapid or less costly development of nuclear energy production(2).

20. Obviously, it is in the framework of laws and regulations that the problem of obligations towards future generations must be addressed, since no direct legal relationship (by way of contract, for example) is possible between those producing the waste and those hypothetical persons who may be affected by the waste in the distant future. One of the characteristics of rules imposed by legislation, however, is precisely to create obligations and responsibilities which, by reason of their general and permanent nature, apply independently of the person who may benefit from them and of the moment in time when the conditions for application of the rule may be fulfilled. The passing of laws and regulations and their implementation by the appropriate administrative authorities is therefore the only appropriate solution to the problem of long-term responsibilities. In practice, however, it must be

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(1) "Without a doubt, we are the best informed society in history, consequently we are the most forewarned, anxiety-prone, exhorted and guilt-ridden of cultures", Margaret M. Maxey, op. cit. p. 131

(2) See, for example, the legislation referred to in Chapter IV, paragraph 10.

decided what are the real possibilities and limits of such an approach with regard to the protection of the interests of future generations. The appropriate authorities will probably not worry about the impossibility of consulting future generations nor will they be put off by the impossibility of foreseeing what will happen in several thousand years. They will make decisions on the basis of the relevant data currently available to them. There is no question of proposing conclusions in this respect but a purely pragmatic approach leads to the following hypotheses:

- the political authorities will define the acceptable level of risk from radioactive waste with regard to the population for which they are responsible, taking into account the social advantages of the activities giving rise to this waste and the social cost of waste management(1);

- they will authorise the use of that technology and those management methods which seem to them the best available in this respect;

- they will require a reasonable guarantee - within the limits of the forecasting methods available - that the solutions chosen are such as to keep the risk below the maximum level as defined for as long as necessary.

Assistance in making these policy decisions is provided by work currently being carried out, both at national and international level, in particular that on long-term risk analysis, the evaluation of the performance of containment systems, the definition of long-term radiation protection objectives, etc. International agreement on acceptable solutions will provide governments with a more solid basis for decision.

IV. CONCLUSIONS

21. From what has been said in this Chapter, it can be seen that problems of the durability of institutions and obligations towards future generations will not constitute an insurmountable difficulty for the implementation of the institutional measures of limited scope and duration which are required in connection with the management methods described in Chapter II. For this to be so, the competent authorities will of course have to draw up a coherent strategy using a balanced combination of technical and administrative means to ensure the long-term safety of the containment systems for radioactive waste. While proceeding on the basis that the technical barriers must guarantee maximum protection, it is important to make an accurate assessment of the role that institutional mechanisms can play. Their effectiveness will depend on how the government authorities organise the management of radioactive waste and co-operation with industry. This question is dealt with in the following Chapter.

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(1) Naturally, constraints connected with problems of transfrontier pollution which may result from an uncontrolled leak of radioactivity from waste should also be borne in mind, as well as the reciprocal information and consultation procedures that will be established (see Chapter II, paragraph 44).

IV

IMPLEMENTATION OF LONG-TERM WASTE MANAGEMENT PROGRAMMES AND INSTITUTIONAL CONTROLS - ROLE OF GOVERNMENT AND OF INDUSTRY

I. INTRODUCTION

1. In all countries, energy questions are of such importance that policy decisions in this field are invariably taken at the highest political level. This is true for nuclear energy, and in particular for the management of radioactive waste, and especially the long-term aspects of such management. It is clear that a waste management strategy and programme can be defined only after considering all the relevant factors - political, economic, technical, and in particular, those connected with safety and the environment. Because these are so complex and all-embracing, involving in some cases considerations of an international as well as of a national nature, the most important decisions such as those concerning the channelling and financing of research and development, approval of the management methods and technology proposed, acceptability of the risks involved in the various options, appointment (or creation) of the bodies responsible for implementing programmes and, more generally, organisation of controls for the long-term safety of operations, must be taken by the political authorities. It is also the responsibility of these authorities to ensure that the particularly acute concern shown by the public in this field is properly taken into account in decision-making procedures in these different sectors(1).

2. When laying down general waste management policy and legislative texts, the authorities will consult with the bodies or persons most directly concerned, in particular the nuclear operators responsible for the waste. This type of consultation is standard practice for all activities connected with the nuclear fuel cycle. On the one hand, it allows the regulatory authorities to influence development of waste processing and conditioning methods and containment systems, and on the other, it allows the operator to communicate technical data obtained as the development work on his project proceeds, data which will help to provide the technical basis for the laws and regulations to be drawn up by the competent authorities.

3. In a sense, the tasks described so far represent the traditional responsibilities of governments and regulatory authorities, exercised in relation to any national activity of importance, such as the production of nuclear energy.

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(1) For a detailed discussion of this topic, see "Nuclear Power and Public Opinion", OECD/NEA, Paris 1984.

What brings a new dimension to these responsibilities in the particular field of long-term radioactive waste management, however, is the time-scale involved and the absence of any incentives of an economic nature. Any regulatory policy aimed at setting up a system for radioactive waste containment and controlling the risk connected with such a system for one or more centuries is bound to be of a different nature from that regulating nuclear power stations and facilities for example. The purpose of the latter is to ensure the safety of industrial activities that are part of economic life, that have a similar lifetime to that of other industrial activities, and that can be run by private enterprise under normal economic conditions or by industrial and commercial public undertakings. Most of these features are not descriptive of long-term operations for radioactive waste management which are economically non-productive activities conducted in the public interest, with a time-scale and continuity requirements which extend far beyond what is usually possible in any purely industrial activity. More precisely, it is in particular the phase after industrial waste management activities have ceased (the "post-closure" phase) which differs from other nuclear activities, due to the fact that institutional control will be necessary in some cases for a long period. It clearly falls to the State to assume responsibility for such control.

4. It is important that responsibility for framing general policy, determining the programmes and organising their implementation and control should not be fragmented, or should at least be clearly allocated. It must be remembered that industry plays an essential role in the development of nuclear energy and is already responsible in many countries for the execution of most waste management operations that are being carried out. Governments will therefore now have to decide, in the context of their own national situation, how best to organise the execution of management operations and the implementation of control measures in the long term. It is the purpose of this chapter to identify various factors which should be taken into account when addressing these questions, and to describe briefly different possible solutions.

II. IMPLEMENTATION OF INSTITUTIONAL CONTROLS

5. All countries engaged in a nuclear programme have passed legislation containing specific requirements and special procedures for controlling all aspects of current activities in this field, including the management of radioactive waste. Current regulations applying to waste management deal essentially with the short-term aspects of this activity, but clearly regulatory policies for long-term radioactive waste management will be drawn up not *in vacuo* but within the framework of existing nuclear legislation, and will form part of a coherent and comprehensive policy covering the whole of the nuclear fuel cycle(1). Consideration must therefore be given to how waste management is covered in nuclear regulations before examining in which way long-term institutional controls are to be implemented.

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(1) Indeed, the words "long-term" must not give the impression that any regulatory policy for long-lived waste merely concerns the distant future. It is likely that such a policy will influence all stages in the management of these types of waste.

6. Licensing is by far the most common method of regulatory control currently used in the nuclear field and virtually all relevant activities, from mining through handling of radioactive substances, trading in or transporting them, to operating a nuclear power plant itself, can be carried out only under licence. The legal requirement for any such licence is normally laid down in a country's basic nuclear Act while details as to application procedures, conditions to be met, rights of inspection, etc. are contained either in legislation or administrative regulations. The licensing authority - usually a government department but sometimes a government agency or a specially created public body - is left considerable powers of appreciation and control including, in particular, the power to impose additional conditions on the granting of the licence, vary existing ones or withdraw the licence itself if circumstances so dictate.

7. This flexibility is one of the most valuable characteristics of licensing nuclear installations and there can be no doubt that this method of control will be equally useful for the regulation of radioactive waste management activities. It provides the competent authorities with a permanent means of control, enabling any technical or regulatory changes that may prove necessary or desirable during operation to be imposed on operators.

8. In several countries, waste management activities are already covered, at least to some extent, by the general licensing provisions laid down in the basic nuclear legislation. In the Netherlands, for example, the Nuclear Energy Act of 1963 requires a licence for the "disposal"(1) of all radioactive substances although, in the case of wastes, no licence is required if disposal is effected by handing them over to an officially recognised collecting service for radioactive wastes. In Switzerland, facilities for the storage and disposal of waste are, along with reactors, etc., included in the definition of nuclear installations for which a construction and operation licence under the 1959 Federal Act on the peaceful uses of atomic energy and protection against radiation is required as well as a general licence, granted by the Government and approved by Parliament, under the 1978 Federal Order concerning the said Act. The licensing procedure and competent authorities in both these cases are identical to those for the other nuclear activities covered by the legislation in question.

9. In countries where the existing nuclear legislation did not cover waste management, a technique often used has been to add such management to the list of other nuclear activities for which a licence is already required. A recent example of such an approach is provided by Finland where a Committee set up by the Ministry of Trade and Industry has drafted a new Bill to replace the 1957 Atomic Energy Act. One of the most important changes proposed is the inclusion in the scope of this framework legislation of measures relevant to the management of radioactive waste. In the Bill, the expression "use of nuclear energy" is used to refer not only to the production of nuclear energy but to the preparatory measures relating to such production and to the management of nuclear wastes arising therefrom. All activities within the sphere of the

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(1) The concept of "disposal" in the Netherlands legislation is not limited to final disposal, and disposal within the meaning of the Act can be effected by selling the substances to someone else.

concept "use of nuclear energy" will, as a rule, be subject to the same licensing and inspection procedures(1).

10. A few countries have gone a step further than this by making the granting of a licence for the construction or operation of a nuclear power plant dependent on satisfactory measures having been taken with respect to the future management of the waste that will be produced by the plant. In Sweden, for example, no reactor may be loaded with nuclear fuel unless the operator has either first produced a contract which, in the Government's view, adequately provides for the reprocessing of spent fuel and has also demonstrated how and where final disposal of the high-level waste resulting from reprocessing can be effected with absolute safety, or first shown how and where the spent but unreprocessed nuclear fuel can be finally disposed of with absolute safety(2). In Switzerland, also, specific conditions regarding waste management have been included in the general licensing provisions. Thus, the general licence for the construction of a nuclear installation will be granted only if the safe extended storage or disposal of radioactive waste from the installation are guaranteed and if there are arrangements for decommissioning and possibly dismantling disused installations(3). Similarly in the Federal Republic of Germany, applications for construction and operation licences for nuclear power plants must contain information on the kind and quantity of the fuel elements to be used during the scheduled lifetime of the plant, the moment when the fuel elements are to be unloaded, when and where storage is to begin and in what conditions, existing storage capacity and plans for intermediate storage and for the reprocessing of spent fuel elements and the disposal of ensuing waste or their storage without prior processing. As from 1985, an additional requirement will be the advance selection of a site either for a spent fuel reprocessing facility or for a facility for the treatment of radioactive waste if spent fuel is left unprocessed. Licences will be granted only if the authorities are satisfied that waste storage and disposal arrangements are adequate(4). Finally, in the United States, an important piece of recent

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(1) It is interesting to note that the Committee was asked to draft a separate Act for the management of radioactive waste. However, when making its report, the Committee argued that there was such a close connection between the administrative and financial aspects as well as the organisation of governmental authorities for radioactive waste management on the one hand and for the use of nuclear energy on the other that there would be no advantage in setting up two different systems.

(2) Act No. 140 of 21.4.1977 - see Annex, item 1, for further details

(3) Federal Order of 6.10.1978 - see Annex, item 2, for further details.

(4) Atomic Energy Act of 1976, as amended - BGBl 1976, p. 3053. In this connection, Principles Relating to the Provisions to be made for the Handling and Disposal of Spent Fuel ("Entsorgung") of Nuclear Power Plants have been established. See the decision by the Heads of Government of the Federation and the Länder in "Translations - Safety Codes and Guides", Edition 3/80, Gesellschaft für Reaktorsicherheit (GRS) mbH, Cologne. See also "The Entsorgung of Nuclear Power Plants and other Nuclear Installations", Report submitted by the Federal Government to the German Bundestag on 24.8.1983.

legislation has provided that the granting of licences for nuclear installations may be made conditional on the applicant having entered into an agreement with the Secretary of Energy for the disposal of any high-level radioactive waste and spent nuclear fuel that may result from the operation of the installation(1).

11. The United Kingdom has a statutory licensing system dating from the Radioactive Substances Act 1960 under which all disposal of radioactive waste on or from licensed nuclear sites must be authorised by the Environment Department (in England, jointly with the Ministry of Agriculture, Fisheries and Food). These provisions will naturally apply also to waste disposal facilities.

12. More recently, some countries e.g., the United States and Switzerland, have passed special legislation dealing with the licensing of waste storage or disposal facilities. In both cases the licensing system is similar to existing provisions in those countries with respect to nuclear reactors, and the licensing authorities basically the same as those already responsible in the case of other nuclear activities(2). In the Federal Republic of Germany it is provided, in accordance with Section 9(b)(1) of the Atomic Energy Act, that the construction and operation of waste storage and disposal facilities are subject to special approval by the competent authority at Land (State) level in the form of a "land-use planning decree". Prior to the decision, this authority must make the project public and, in the event of objections, discuss it with the population affected. The technical requirements to be observed in this connection correspond to those laid down for the construction of nuclear power plants. General safety criteria for the ultimate underground storage of radioactive wastes in a mine have been established by the Federal Minister of the Interior and these have to be observed in the licensing and operation of such facilities(3).

13. These few examples confirm that in the pre-closure phase of a storage or disposal facility, regulations governing waste management activities can easily be fitted into or adapted from the existing general framework of

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(1) Nuclear Waste Policy Act 1982, Section 302 (b) - see Annex, item 12, for further details.

(2) The United States regulations concerning deep geologic repositories are perhaps the most interesting and complete example of relevance here: see "Disposal of High-Level Radioactive Wastes in Geologic Repositories: NRC Regulations" published on 25.2.1981 and 21.6.1983, cf. Annex, item 4. These regulations are applied in conjunction with the 1982 Nuclear Waste Policy Act - see Annex, item 12. On this subject, see also 'Mission Plan for the Civilian Radioactive Waste Management Program", Vol. 1, Overview and Current Program plans DOE/RW-0005 Draft, USDOE, April 1984. For Switzerland, see Federal Order of 24.10.1979 on preparatory measures for the establishment of a radioactive waste repository - Annex, item 3.

(3) These criteria are published in the "Gemeinsames Ministerialblatt" 1983, p. 220.

provisions dealing with nuclear activities. Arrangements during this phase are typical of all nuclear activities not only from the regulatory viewpoint but also as regards the distribution of roles among the different parties concerned. Responsibility for applying regulatory provisions and institutional control measures falls naturally on the nuclear operator or, when the facility is not located on the site of a nuclear power plant, on the body responsible for the waste. As usual, the licensing authorities check that these provisions and controls are properly observed by means of inspections or they may delegate this task to one or more competent bodies (e.g. Minister of Health, Government Environment Protection Agency, etc.).

B. LONG-TERM REQUIREMENTS

14. As might be expected, there is little legislation existing which deals specifically with institutional measures in the long term. Potential difficulties with the implementation of such measures concern problems of continuity and duration, and arise essentially in the phase after operations at a storage or disposal facility have ceased. It is of course possible that management activities at a given site could last more than fifty years, involving also the need for the implementation of long-term controls but such implementation can in this event readily be accomplished within the framework of the licensing procedure applying to the operational phase.

(a) Transitional period

15. When closing an installation special attention will have to be given, for obvious safety reasons, to the conditions for ceasing operation, sealing the site and transferring responsibility for the waste. The need for such a transfer might arise during the pre-closure phase if for some reason the operator of the facility were no longer able to assume responsibility. It is almost certain to arise at the end of this phase, or shortly thereafter. Special provisions will therefore be required - such as those prevailing in Belgium for example[1] - for the closure and decommissioning of disposal facilities. These provisions could include a requirement to notify the competent authorities of the intention to cease activities backed up by an appropriate power on the part of the authorities to take possession of a repository or site if necessary[2]. The authorities must indeed have the necessary powers to impose and control any hand-over of responsibility whether during the pre-closure phase itself, between two operators, or at the end of this phase, between the operator and the body or bodies responsible for institutional control thereafter, so as to ensure the necessary continuity in the implementation of such control during the transitional phase.

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(1) Royal Order of 28.2.1963, Section 17 - see Annex, item 5.

(2) Cf. Section 17(4) of the aforesaid Belgian Royal Order which gives the authorities power to seize radioactive substances or equipment if the required notifications are not made.

(b) Post-closure phase

16. In this phase, the main concern is to protect the integrity of the waste containment system. The institutional controls required will be of an administrative rather than technical nature and will consist for the most part of carrying out surveillance. Governments will have to decide what institutional control measures should be applied (see Chapter II, paragraph 39), for how long, and who should be responsible for ensuring their implementation.

17. It is clear that the requirements of continuity and duration will lead to responsibility for such controls and for their organisation being given to a body or bodies from the public sector. One solution might be to give such responsibility to a single government authority or specialised public body, especially if the latter is already responsible for the industrial side of waste management and has therefore acquired practical experience of the technical problems involved. Another solution could be to give the responsibility to the nuclear regulatory authorities since they also, through their licensing duties, usually have acquired such experience. It would be possible also to use a public body or service not connected with the nuclear field but traditionally responsible for protecting the public or the environment (e.g. civil defence or environment protection agencies). Perhaps the responsibility could be shared between two or more such bodies. Naturally, the most appropriate solution for any country will depend not only on its legal system and administrative structures but will also be affected by decisions taken as to the actual execution of management operations.

18. Given that control measures during the post-closure phase are of widely differing types, various solutions are possible as to their execution, always under the authority of the competent body (or bodies) referred to in the preceding paragraph. The control tasks could of course be carried out by this body itself but they are more likely to be delegated to some extent to other public bodies or even to industrial undertakings. In this respect it should be noted that there exist in all countries government and local authority services (environment, water, public health, public records) with the necessary ability to carry out some of the control tasks in their field. These services will in any event have a direct interest in the proper performance of institutional controls and will, in carrying out their own duties, provide at the least a back-up control in this respect. If several services are called on to carry out control tasks, it would seem essential that this work be co-ordinated by the body with overall responsibility.

19. It was explained in paragraph 39 of Chapter II, that control measures may be active or passive. Active control measures - which tend to be of a technical nature - could be carried out by industry, whether from the public or the private sector. Thus, the maintenance of buildings and equipment and the control of access to the site could be undertaken by the former operator of the facility or some other industrial enterprise. Radiation monitoring could also be carried out by an industrial undertaking or it might be included in the general environment protection responsibilities of public health authorities.

20. An important passive control is the regulation of the use of the land surrounding the disposal site. Given national differences in the law of real estate rights and the limitation of such rights for reasons of public interest, only very general descriptions can be given of possible approaches in this respect. Two possibilities can be distinguished:

- comprehensive control which would assign extensive powers with respect to the use of relevant surface and sub-surface land to a governmental body. This body would define the limits within which private persons would be allowed to occupy this land and carry out, under its supervision, activities compatible with the existence of a disposal site;

- selective control: under this system, private parties would be free to engage in whatever activities they might choose except that they would be prohibited from engaging in particular acts (e.g. drilling) or would be required to obtain the approval of the appropriate authority before performing them within a controlled area.

21. Comprehensive control is the best way of preventing unauthorised access to the site and ensuring that the physical protection barriers of the facilities remain unharmed(1). Where there is only a minor risk of these barriers deteriorating, the authorities could use more selective control consisting of restrictions on the development of the site under land-use plans and conditions governing property rights. The two methods could be used in conjunction, either in space (by delimiting two zones, each with a different system), or in time (selective control replacing comprehensive control once radioactive decay has reduced the risk).

22. In cases where selective control of land use is deemed sufficient, the appropriate institutional measures can probably be carried out within the framework of existing land law - planning procedures, registers, etc. - by the authorities already appointed to carry out these tasks(2).

23. Ownership of extended storage and disposal sites for radioactive waste will obviously affect the ease with which these controls - particularly comprehensive control - can be exercised. The competent authorities will be more free to act if the State already owns the land in question or if ownership is transferred to it or the public body responsible for control either by way of normal or compulsory purchase in the public interest. This transfer of ownership could be effected at the start of waste management activities or at the end of industrial operation. This said, it should be stressed that the implementation of land-use controls is not at all incompatible with private ownership of disposal sites. The best approach will of course depend on the legal system of the country concerned.

24. As far as passive control measures are concerned, the basic long-term requirement is to perpetuate knowledge of the whereabouts (and contents) of

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(1) The benefits of such control should, however, be weighed against its drawbacks which include, in particular, interference with other land uses, an additional administrative burden placed on Government, and the resulting financial costs that would be borne by taxpayers. It should however be noted that many restrictions on ownership in the community's interest already exist and that these are often linked to safety requirements similar to those involving radioactive waste disposal sites.

(2) Such authorities are often regional or local. It would however clearly be preferable if these control measures were co-ordinated at national level.

disposal sites. Apart from the erection on-site of markers, sign-posts or fences as appropriate, this will be done essentially by entering the information in various records and the problem then becomes one of ensuring that these records are not lost or forgotten about. One possibility would be to enter the fact of there being a disposal site, together with any restrictions on land-use that might be involved, in the land registers for the area concerned. This information could then be included in the title deeds given to anyone acquiring property in the area, a system that has in many countries already proved its ability to perpetuate knowledge and prevent undesired activity in relation to specific plots of land over several centuries. Naturally, the information should also be kept in national, regional and local records. Also, the location of disposal sites could be marked on topographical maps, or incorporated into a national system of geodesic or mining control stations which could provide anyone proposing to undertake mining operations, for instance, with recorded information on the areas involved(1).

25. Finally, an additional means for ensuring the perpetuation of knowledge of disposal sites could be the setting up at international level of a centralised data system containing information on all national or internationally managed waste facilities(2). The form and content of documentation on disposal sites could be harmonised and entered on record in accordance with internationally agreed rules. Similarly, the shape and contents of warning signs or markers on the site and even perhaps rules relating to environmental monitoring in the post-closure phase could be standardised at international level. It may be felt that if the observance of certain standards in relation to these matters was in this way made a subject of international concern, the implementation and long-term effectiveness of these institutional controls would be given an extra dimension that would protect them, to some extent at least, from the consequences of national changes or upheaval.

III. POSSIBLE WAYS OF ORGANISING LONG-TERM WASTE MANAGEMENT

26. The operational phase of facilities used for waste management will extend over the whole period beginning from production of the waste up to and including sealing of the disposal facility in which it has been placed and, if appropriate, the dismantling of installations and cleaning-up of the site for other uses. If it is decided to store waste for lengthy periods, and given the likely operational lifetime of a disposal facility, it is clear that this phase before closure could last much longer than the fifty years adopted in this Study for the definition of long-term. In any event, as has already been noted, the words "long-term" must not be taken to indicate a concern only for the distant future: decisions as to how the execution of operations in the short-term should be organised will certainly be affected by the fact of the long-term aspects which are to follow. For example, when the environmental

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(1) See "Building on Existing Institutions to Perpetuate Knowledge of Waste Repositories", technical report, August 1982, ONWI-379, Battelle Project Management Division, NUS Corporation, Rockville.

(2) This is a classic approach in the nuclear field, and several international organisations have put it into practice. In relation to radioactive waste for instance, NEA has, over some fifteen years, collected data on the dumping of waste in deep sea by several countries.

impact studies that precede the development of any nuclear site are being carried out, the operator is obliged to consider how the site will be rehabilitated after operations have ceased. Similarly, the fact that one or more public institutions rather than private industry will no doubt be made responsible for control tasks in the post-closure phase, may well influence short-term decisions. The converse is also true. The organisation of responsibilities for institutional controls in the post-closure phase will inevitably depend, to some extent at least, on decisions and arrangements made with regard to the earlier execution of management operations, the use of away-from-reactor storage facilities for example.

27. Some countries have already adopted special provisions for organising the execution of long-term management operations. These provisions reflect different approaches. A summary of some of them can be found below, by way of example, to give an idea of the advantages and disadvantages of the principal ways of allocating responsibilities in this field(1).

A. CURRENT DEVELOPMENTS

28. One of the countries in which arrangements for the extended storage and disposal of long-lived wastes have already been started is France. In France, a country with an important nuclear power programme and where, traditionally, authority has been highly centralised, the National Agency for the Management of Radioactive Waste (ANDRA) was set up in 1979 within the French Atomic Energy Commission (CEA). The Agency is a public body whose Board of Management, chaired by the head of CEA, comprises, in addition to various *ex officio* members such as a representative from Electricité de France (EDF) - the national company responsible for electricity production - one representative of other producers of radioactive waste appointed on the proposal of the Minister in charge of hospitals and four competent persons appointed by the Minister for Industry. ANDRA is responsible, within the framework of the general policy laid down by the Government, for long-term waste management operations and in particular for ensuring that extended storage (or disposal) facilities are properly managed. It is empowered either to carry out the necessary management itself or to delegate the task. It is important to note, however, that responsibility for ensuring protection, safety and control remains in the hands of the competent government ministries. In particular, all the licensing and inspection procedures applied to nuclear installations in general will apply equally to facilities managed by ANDRA. The Agency also has responsibilities in connection with the planning and construction of facilities, the laying down of technical specifications and the carrying out of research work(2).

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(1) More detailed information is given in the Annex.

(2) Order of 7.11.1979. See Annex, item 6, for further details of ANDRA's structure and responsibilities. A Commission responsible for the scientific and technical aspects of radioactive waste management has been set up under the CEA's Scientific Board, whose research, development and assessment tasks have thereby been reinforced, by an Order of 2.3.1984. The Order provides that this Commission shall consider the scientific and technical aspects of the choices made by ANDRA.

29. In Belgium, also, it is a public body with its own legal personality - the National Body for Radioactive Waste and Fissile Materials (ONDRAF) - that has been given responsibility for the management of radioactive wastes. This includes responsibility for the transport of the waste, conditioning and storage, the storage of spent fuel, the disposal of waste after conditioning and the storage of substances containing plutonium. ONDRAF, which is placed under the supervision of the Minister of Economic Affairs, is managed by a Board of Directors consisting of 20 members representing solely the public sector. ONDRAF carries out the tasks for which it is responsible after appropriate consultations with the industrial companies concerned and in conformity with the regulations in force: it is subject to the control of the competent authorities, in particular with regard to protection against ionizing radiation. ONDRAF is further empowered to make proposals for lines of research and development and for technical criteria(1).

30. In Switzerland, a country with a federal system, responsibility for the safe and final disposal of radioactive waste and for the resulting costs lies with the waste producers(2) and in 1972, the producers of radioactive waste, in order to carry out this responsibility, came together to form the National Corporation for Disposal of Radioactive Waste (NAGRA). This body, while having the status of a private company, is made up of representatives from six power companies operating nuclear power plants together with a representative of the Swiss Confederation (in fact from the Federal Office of Public Health) which is responsible for dealing with waste produced from research laboratories and medical and industrial uses. Its main tasks are to find, set up and operate sites suitable for the disposal of all categories of waste. It undertakes studies and research work with a view to setting up and operating repositories for high-level waste in deep geological formations. It should be noted that the Confederation, as a back-up safety measure, has reserved the right to have radioactive waste disposed of at the producers' expense. Furthermore, provision has been made that the Federal Council may require producers of radioactive waste to belong to a body set up under public law and to pay equitable contributions to meet the expenses of disposing of the waste(3). In this way, the State has ensured that it retains strict control over radioactive waste management operations.

31. In Italy, a joint stock company, NUCLECO, was set up in 1981 to deal with the management of low and medium-level radioactive waste. The company is jointly owned by ENEA, the Italian State Energy Agency, and AGIP, a semi-public body active in the energy field. It is intended that NUCLECO provide a complete service - collection, transport, reduction in volume and final disposal - to all users of radioactive materials, including of course nuclear power plant operators.

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(1) For further details concerning ONDRAF, set up under Royal Order of 30.3.1981, see Annex, item 7.

(2) Federal Order of 6.10.1978, Section 10(1) - see Annex, item 2.

(3) Federal Order of 6.10.1978, Sections 10(1) and 10(3).

32. In the Netherlands, the Central Organisation for Radioactive Waste (COVRA) was established in December 1982 in the form of a limited company of which the shareholders are the State (10 per cent), the two electricity companies owning nuclear power plants (30 per cent each) and the Netherlands Energy Research Foundation (ECN) (30 per cent). According to its statute the Organisation will be responsible for the collection, management, interim storage and final disposal of radioactive waste of all kinds and categories generated in the Netherlands, in accordance with the policy of the Government. The Board of Directors of COVRA is organised in such a way as to enable the representative of the Government to veto a decision which would be contrary to government policy.

33. In Sweden, the operator of a nuclear reactor must, by law, ensure that the spent fuel and other radioactive waste from his installation (including the installation itself, after shut-down) will be handled and disposed of in a safe manner and that the necessary research and development activities to enable this to be achieved will be carried out(1). However, a basic principle of the Swedish approach is that the Government (or the authority designated by it) will retain overall control of, and long-term responsibility for, the management of radioactive wastes(2).

34. In the United Kingdom, a new organisation - the Nuclear Industry Radioactive Waste Executive (NIREX) - was set up in 1982 to develop and manage radioactive waste disposal facilities. NIREX consists of a Directorate of senior representatives of the component parts of the nuclear industry in Britain, namely British Nuclear Fuels Ltd., CEGB (Central Electricity Generating Board), UKAEA (United Kingdom Atomic Energy Authority) and SSEB (South of Scotland Electricity Board). It is also financed by these organisations and has a small staff provided by UKAEA. The major responsibility of NIREX is to develop new disposal facilities for low and intermediate-level wastes and it will be expected, wherever feasible, to use the private sector for specific tasks in this respect. The existing bodies in the nuclear industry will retain their plants and facilities and in some cases may also provide new ones, but within the context of a comprehensive plan. The Secretary of State for the Environment remains responsible for the overall strategy of waste management and NIREX is subject to the full range of relevant regulatory controls.

35. In the Federal Republic of Germany, it has been provided that the Länder shall establish collecting points for radioactive waste generated mainly by isotope use in laboratories, hospitals and industry in their

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(1) Act No. 669 of 18.6.1981 concerning the financing of future expenditure for spent nuclear fuel etc., Section 1. For further details of this Act, see Chapter V and Annex, item 8. See also the new Nuclear Activities Act of 1984 (Act No. 3 of 12.1.1984 which replaces the Atomic Energy Act of 1956) which contains general provisions as to the handling, storage and disposal of radioactive waste.

(2) See for example Sections 2-4 of the aforementioned Act.

territories(1). Operators of nuclear installations and the larger research institutions are responsible for the interim storage of their waste until a disposal facility of the Bund is operating, at which time they must transfer their waste to it. It is provided that the Bund shall establish facilities for the safekeeping of high-level, heat-producing waste and the disposal of radioactive waste(2). This responsibility is carried out by the Federal Institute of Physics and Technology (Physikalisch-Technische Bundesanstalt). To fulfil their obligations the Bund and the Länder may avail themselves of the services of "third parties" and the Federal Institute of Physics and Technology has made such arrangements with a private company, the German Society for the Construction and Operation of Disposal Facilities (Deutsche Gesellschaft zum Bau und Betrieb von Endlagern) with regard to the construction and operation of disposal facilities. Arrangements with "third parties", do not affect the overall responsibility and control of the Bund and the Länder with respect to the management of radioactive waste(3).

36. In the United States, under the 1982 Nuclear Waste Policy Act, the Federal Government is responsible for the disposal of high-level radioactive waste and spent nuclear fuel. However, it is the generators and owners of such waste and spent fuel who must bear the cost of disposal(4). The Act lays down a detailed procedure (site characterization and approval, construction authorization, participation of States and other interested parties, etc.) for the construction by the Department of Energy (DOE) of a repository which is to be ready to receive high-level waste and spent fuel by 1998. Generators and owners of waste and spent fuel are responsible for providing for, and paying the cost of, interim storage. The Act also provides for a back-up Federal Government interim storage programme to deal with spent nuclear fuel from civilian nuclear power reactors that cannot reasonably provide their own storage capacity. The DOE has been instructed to complete by mid-1985 a detailed study of the need for and feasibility of construction of one or more monitored retrievable storage facilities for high- level waste and spent fuel.

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(1) Revised Atomic Energy Act of 1976, Section 9(a)(3); Radiological Protection Ordinance of 13.10.1976, Section 47(1).

(2) Section 9(a)(3) of the aforementioned Act. The current costs of planning and establishing these facilities, including the necessary research activities, are paid for annually by the producers of the waste - see Chapter V and Annex, item 10.

(3) For a discussion of this point, see Dr. W. Strassburg "Legal problems arising in the Federal Republic of Germany in connection with the construction and management of final storage facilities for radioactive waste by a third party", NLB 22, p. 53.

(4) Payment is to be made into a Nuclear Waste Fund set up by the Act - see Chapter V and Annex, item 12, for further details.

B. ADVANTAGES AND DISADVANTAGES OF THE DIFFERENT APPROACHES

37. From the examples given above, it can be seen that the execution of radioactive waste management operations can be organised in various different ways. The allocation of powers and responsibilities will differ from one country to another depending on very many factors including existing legal forms and administrative and industrial structures, as well as the size of the waste management programme - factors which can be properly weighed by the national authorities concerned only. It is not, therefore, proposed to recommend any particular approach, but to analyse in this section the different factors which national authorities will take into account when working out their policies.

38. In several countries (for example France and Belgium), a tendency to allocate significant management responsibilities to public bodies can be detected. This approach enables a mixture of duties - advisory, and research as well as executive - to be allocated to specialised agencies, and it is this fact that greatly assists the carrying out of the co-ordinating role which normally also constitutes one of their functions. A smooth transition from the research and development programme to the execution of an optimised waste disposal strategy will thus be facilitated, including, in particular, the transition from the closing down of the facility to the post-closure phase. For it is clear that if a waste facility is owned and operated directly by a government agency, questions connected with continued ownership of the site and long-term arrangements such as direct surveillance and control of access after closure, decommissioning and restrictions on land use would be considerably simplified. This is so even if the agency in question is not given any responsibility for the execution of control tasks in the post-closure phase. However, it goes without saying that since the agency will have been actively involved in pre-closure operations, it will be well placed to carry out any controls that may be required after closure of the facility.

39. Furthermore, it is possible that Governments might feel the need for waste management facilities to be so important to national energy and environment protection objectives and requirements that they would prefer to assume direct responsibility themselves for their operation. In countries with a federal structure, for example, the exercise of direct control by the central Government may be needed in the public interest to ensure harmonization of the conditions applying to enterprises. Central Government involvement would be particularly appropriate in any negotiations of international agreements to move waste from one country to another or to set up international disposal sites(1).

40. One possible disadvantage with the allocation of very wide powers to a single public sector body, however, is the risk that the functions of approving the disposal or storage site, operating it and supervising operations might

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(1) The United States has in fact enacted statutory procedures for consideration of arrangements for the storage or other disposition of foreign spent nuclear fuel - Nuclear Non-Proliferation Act 1978 s. 303, Atomic Energy Act, as amended s.131 - but these procedures have not so far been implemented.

become blurred; in the public mind the Government's impartiality and its determination to impose and maintain rigorous control could then be subject to question. It may be therefore that if this option were adopted, the various governmental functions should be given to separate authorities. In any event, it would seem that the control of the application of safety and environmental standards should be carried out by a body which is independent of the agency which actually operates the facility(1).

41. This risk of the divisions of responsibility becoming blurred is reduced if another approach is adopted, namely that a body with a limited element of public ownership or a public body enjoying a high degree of autonomy is chosen to develop and operate storage or disposal sites. The degree of governmental control would of course depend on the exact nature of the body and on the legal system in question but if, for example, a public corporation were set up specifically for the purpose, it should be possible for the Government to retain adequate control over policy and at the same time ensure that interested parties - the nuclear power industry, reprocessing and fuel fabrication industry, health and environment protection authorities etc. - are represented at Board level. Furthermore, the public corporation solution would facilitate the implementation of long-term guarantees concerning surveillance and ownership of, and access to the site.

42. In some countries, it may be more suitable to give the nuclear industry the task of developing and operating storage or disposal facilities in the sense that it already contains the skill and experience required in the field of radioactive waste disposal. Further, if the storage or disposal site also contained a reprocessing and/or waste conditioning plant there could be an advantage in having single management control of the whole site and sequence of operations. If, say, the reprocessing company were responsible for disposing of all the waste streams from the fuel cycle, technical and economic optimisation between the methods of treating and disposing of high, medium and low-level waste and between storage and disposal methods might be facilitated. There would also be the advantage with this approach that the creators of the waste would be directly responsible for its disposal - both for the technical operation and for the financial cost(2).

43. This approach may not, however, be very satisfactory with respect to the long term. For, in the case particularly of private industry, there can be no assurance that the operator will remain in existence even for the whole of the operational life of the facility (which is liable to be longer than that of a nuclear power plant for example). Provision would therefore have to be made for a transfer of responsibility to some other body. The financial arrangements would also be more complicated, not only because of the necessity of such a transfer but also because it is possible that the company could get into difficulty or go bankrupt during operations. Although none of these factors represents an insurmountable problem, they would have much less weight if the industry were in whole or in part publicly owned, since in this case the Government could more easily act as a long-stop against the company's financial collapse and provide the longer-term guarantees required for decommissioning, future surveillance, etc.

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(1) Cf. ANDRA in France and ONDRAF in Belgium (paragraphs 28 and 29 above).

(2) For a discussion of the polluter pays principle with respect to payment for radioactive waste disposal, see Chapter V, paragraph 24.

IV. CONCLUSIONS

44. We have just seen that long-term aspects of waste management arise not only in the phase after the closure of a waste storage or disposal facility but also within the pre-closure phase which, for some waste categories, will last more than fifty years. There is, however, a fundamental difference between the two phases when considering the organisation of the implementation of long-term management programmes and institutional control. Management operations of what might be called an industrial nature will be required during the pre-closure phase and whether these be performed at the place of production, at a central storage site or at a disposal facility, an operator will be appointed to carry them out. Institutional controls will consist essentially of ensuring that the operator complies with the technical requirements laid down in the relevant regulations. These are the same circumstances as those applying to the operation of a nuclear power plant, when the necessary controls are implemented in all countries by means of a system of licensing and inspection. As has been shown in this chapter, there is every reason to suppose that the same system (and the same authorities) will be used, with very little change, for the implementation of institutional controls in the pre-closure phase of waste management.

45. As for the operation of a waste storage or disposal facility, there are good reasons why governments would, as in the case of nuclear power plants, entrust this task to industrial undertakings, whether publicly or privately owned. However, given the special long-term aspects of waste management, it is not surprising that some countries have preferred to give overall responsibility for the execution of management operations to a public agency or body (who may in turn delegate specific tasks).

46. In the post-closure phase, the situation is different. There will be no operator, and few, if any activities of an industrial nature to be carried out. In these circumstances the traditional licensing system is no longer appropriate and new arrangements will have to be made to meet long-term needs. Activities in this phase will essentially comprise the implementation of the institutional controls deemed to be necessary or appropriate. While some control tasks could be given to industry, many will be more suited for execution by public bodies or authorities. There is in any case no doubt, given the time-scale involved, that responsibility for ensuring implementation of controls will be given to a government department, agency or other body from the public sector, or perhaps shared between two or more such bodies. It is quite possible also that some of the control tasks required will actually be carried out by the same body (or bodies) responsible for ensuring implementation of controls. This is perhaps particularly likely in countries where there exists already a specialised public agency to which a mixture of functions has already been allocated in the pre-closure phase.

47. Institutional mechanisms depend in detail on the legal systems and administrative structures specific to each country, whose features are moulded in the course of history by a whole set of decisive social and political factors and there could, therefore, be no question of analysing in this Study what forms and procedures institutional mechanisms should have at national level. It may, however, be useful to present a general idea of the features required of an institution responsible for controlling and supervising long-term storage and waste disposal sites in the post-closure phase (on the

assumption, for simplicity, that a single institution is involved). Essential requirements are that it should be a public or public service institution guaranteed to operate on a continuous and long-term basis. In this connection, the analysis in Chapter III as to the durability of institutions should be borne in mind. Thus, for example, we have seen that the chances of an institution remaining in existence over long periods are enhanced if its functions continue to be perceived as being of major importance.

48. The institution should also have some powers of authority. These must be sufficient to enable it to deal effectively with any change in circumstances, or proposed change, that could have undesirable consequences with regard to safety. Thus for example in a federal country, a federal rather than a state institution would better be able to resist pressures from other authorities (or even private bodies) who might have different priorities with respect to use of land surrounding a disposal site. These powers should also be sufficient to enable the institution to mobilise the necessary services immediately should this be required. Finally, it would be preferable if the institution possessed a reserve of technical knowledge and skills. In the normal course of events the technical tasks to be carried out in the post-closure phase will be relatively straightforward and limited but such skills would be useful.

V

FINANCIAL ASPECTS

I. THE NATURE OF THE FINANCING PROBLEM

1. After describing the main features of technical operations for the long-term management of radioactive waste and having analysed relevant institutional arrangements in some detail, the specific problems of financing that may be raised by the satisfactory implementation of such measures should be examined. The establishment and maintenance of containment systems for long-lived wastes presupposes that the finance required for technical and institutional purposes will be available at the right time. It is obvious that the financing of such long-term management is directly affected by the "time factor" in three different ways. Firstly, there may be a relatively long interval between the time when the radioactive waste is generated and the time of its ultimate disposal which results, from the financial point of view, in a similar interval between the time when payments are collected and the time when expenditure on disposal is required. Secondly, the expenses for storage facilities and repositories, for the maintenance of storage sites, waste retrieval and disposal operations and, finally, for any possible surveillance of repositories, may also stretch over a long period. Thirdly, the volume of expenditure to be incurred varies considerably over time between the design and construction stage of containment systems, the operational stage and the post-closure stage.

2. It is therefore necessary - in very general terms - to provide for the financing of expenditure which is deferred (e.g. for several decades), of long duration (from several decades to several centuries) and variable in amount. The evaluation of expenditure will in the first place be complicated by uncertainties about the nature and timetable of activities. As regards estimating expenditure for the construction and operation of waste repositories, uncertainty is due principally to the scale of relevant research, development and demonstration work still required, and the impact of technological progress on cost. Finally the financing techniques to be used to cover outlays varying considerably over time will inevitably be more complex than those used to deal with a stable flow of expenditure.

3. These considerations lead us to distinguish, from the financing standpoint, between long-term operations and short-term management of radioactive waste, i.e. primarily, storage of spent fuel prior to reprocessing, where appropriate, followed by storage on site of solidified waste produced over one or more decades. Under present regulations, the nuclear operator who generates the waste is responsible for these short-term operations, whether they are carried out by him or by a specialised firm or body on his behalf.

In view of their limited extent and duration, such activities could be undertaken as part of day-to-day industrial management. Expenditure for such short-term activities will then be borne by the waste producer immediately, either directly out of his investment and operating budget, or as remuneration for services. In practice, from the technical and financial standpoints, there will not always be a clear-cut dividing line between short-term and long-term waste management, since most high-level waste will pass through the various stages of conditioning and temporary storage before extended storage or shallow or deep burial. It is therefore possible that long-term financing arrangements will be influenced by the conventional-type approaches used for the initial stages of waste management. However, the basic question is to what extent long-term considerations will require special financing arrangements to be made at a relatively early stage in such management.

4. The main reason for developing special solutions for financing in the long term is ultimately a concern for safety - insofar as such solutions would, given the special conditions referred to in paragraph 1 above, provide a reasonable guarantee at the outset that funds would be available when required for the necessary technical and institutional actions. If a purely legalistic view were adopted it might be asked whether current legislation on the duty of nuclear operators to take all necessary steps to dispose of their waste, and the strengthening of government powers in this field - particularly as reflected by the creation of special bodies(1) - do not already constitute an adequate set of measures. Since the nuclear operator has a legal obligation to take care of waste which he has generated, he should be responsible for procuring the financial resources which he is going to need in the future to meet the expenditure required, e.g., when disposing of the waste. One solution, for instance, would be to use income from the sale of nuclear electricity. Furthermore, in the event of default by, or disappearance of, the nuclear operator, or even on its own account, the Government might itself have to find the money for the disposal of long-lived waste as part of its own budget or by special tax measures. This line of reasoning presents some interest because of its pragmatism. From a policy standpoint, it may however be decided that the operation of nuclear power stations should be backed up by specific measures to ensure that the requisite finances will be to hand as and when large sums have to be laid out on long-term management, so as not to impose too heavy a burden on future generations.

5. Two lines of thought are therefore possible as regards the general approach to financing arrangements. The first of these, based on political and moral considerations or simply on caution, would involve broadening legal provisions concerning the responsibility of nuclear operators and the role of Government to include special rules concerning finance; such financial legislation is already in place in several countries(2). The second approach would mean leaving financing arrangements to the initiative of nuclear

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(1) These different measures were analysed in Chapter IV.

(2) The Swedish Act on financing, for example, is designed to ensure the availability of funds to cover expenditure resulting from the obligations of the operators of nuclear power stations (see paragraphs 26 and 30 below).

operators or Government within the framework of their legal obligations to dispose of radioactive waste. Let it be said in passing that those countries which do not at present have any special financial legislation would not necessarily adopt this second solution. Before examining financing methods, it is useful to review available information on the amount of expenditure to be committed.

II. DEFINITION AND ESTIMATION OF EXPENDITURE FOR LONG-TERM FINANCING PURPOSES

6. The uncertainties in estimating deferred expenditure over relatively long periods have already been mentioned. Additional uncertainties connected to the following factors should also be considered:

- the progress of nuclear energy programmes in the coming decades, which will influence the quantities of waste to be disposed of;
- trends in radioactive waste management policies;
- the possible use of repositories in common by several countries on economic grounds, or to reduce the number of sites for safety reasons;
- trends in the general economic situation, etc.

It follows that available estimates are still quite rough, and general in nature.

A. PROGRAMMING OF EXPENDITURE ON WASTE MANAGEMENT

7. In line with the general radioactive waste management system described in Chapter II, the operations whose financing is likely to be spread over time or not to be required for a long period (several decades or more) after generation of the waste are primarily the following:

- extended storage of spent fuel and its subsequent disposal;
- extended storage of high level waste and its subsequent disposal;
- extended storage of various other types of long-lived waste and its subsequent disposal;
- disposal by shallow land burial(1);
- the decommissioning of nuclear installations and management of the waste generated.

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(1) It might however be thought that if this takes place immediately after generation of the waste, financing will not be so much of a problem.

8. It may be thought that in many cases all expenditure connected with storage itself can be more or less forecast at the outset, and the necessary facilities rapidly made available. However, subsequent expenditure is difficult to evaluate as uncertainty will continue on the questions when and how stored materials will be removed and disposed of and what will be the various costs connected for example with the decommissioning of facilities. However, several countries, such as the Federal Republic of Germany, the United States and Sweden have prepared timetables for such operations. In the Federal Republic of Germany, a disposal facility for low-level waste in an old iron mine should be ready in 1988. A facility for the disposal of high-level waste is planned for the end of the 1990s. In the United States a final repository may be available just before the end of the century, which means that fairly detailed financing arrangements are required already (planned date for the closure of the repository: 2025). In the case of Sweden, following extended storage of waste and spent fuel(1), disposal of most material will take place from 2020 to about 2050.

9. Research, development and demonstration has been under way for many years to develop final disposal systems to be put into effect at some largely unspecified future date. Therefore, the problem which is raised is how to evaluate the future expenditure for R, D and D that should be provided in financing plans for long-term waste management programmes. This is particularly true of R, D and D to be carried out by industry.

10. For the purposes of financial analysis, especially in countries embarking on a programme covering all radioactive waste management operations, it is convenient to distinguish the following stages:

- a research, development and demonstration stage which may extend to characterisation of repository sites, i.e. may take from ten to fifteen years in the most optimistic case;

- a possible stage involving the construction and operation of storage facilities perhaps undertaken alongside research into and design of repositories;

- a stage involving the construction and operation of repositories as part of a direct demonstration(2) of the working of facilities in satisfactory safety conditions (lasting some decades);

- lastly, a stage involving filling, sealing and/or decommissioning of repositories, possibly followed by a period in which limited surveillance is continued.

Such a scheme is clearly arbitrary. Moreover, for each installation, the second and third stages may overlap with the previous stage (i.e., the first and second stages respectively) and continue beyond it with considerable repercussions on the timetable for financing.

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(1) A temporary storage facility for spent fuel is under construction and will be completed in 1985. It is intended that final disposal of low and medium-level waste will be effective by 1988.

(2) See "Long-term Management of High-level Radioactive Waste - The Meaning of a Demonstration", OECD/NEA, 1983.

B. ESTIMATES OF EXPENDITURE

11. Available data is confined to a number of economic studies which contain preliminary estimates of the main costs of management of radioactive waste, especially as regards management of high-level waste or spent fuel. These studies are based on varying assumptions concerning the scope and time-table of the programme to be funded and include varying degrees of uncertainty. However, they do give an idea of the order of magnitude of costs of long-term waste management. It is true that the estimates concern primarily disposal in deep geological formations and contain little information on the cost of institutional controls. These latter have therefore still to be assessed but it seems unlikely that they would be such as to affect significantly the total estimated cost.

12. The data in the Swedish Radioactive Waste Management Plan(1) appear to be the most comprehensive and detailed since they cover all types of waste, including that from the decommissioning of facilities. The total estimated amount (by early 1983) was 39 billions S. Kr. (i.e., about 5,2 billion US dollars, with US dollar = 7.55 S.Kr.). Expenditure for R & D, including test drilling, amounted to 2.9 billion crowns (385 million US dollars), while the estimated costs for decommissioning of facilities, including maintenance costs over a period of 5 years between shutdown of facilities and beginning of dismantling, amounted to 9 billion crowns (1,2 billion US dollars). Considering these global estimates, it seems that the costs of long-term radioactive waste management operations represent approximately half the total expenditure for the back-end of the fuel cycle. The breakdown of costs for these long-term operations is approximately as follows: one third for extended storage and two thirds for disposal. This is of course a very crude estimate: real costs may vary significantly, depending on national conditions and, in particular, policies for spent fuel and radioactive waste management. The total figure for the Swedish programme is high in relation to all the other estimates but it covers short-term expenditure (storage, transport, reprocessing, conditioning) as well as the costs of dismantling all the nuclear installations. It is clear from Figure 2 that a significant proportion would have to be spent during the 1980s, when measures for temporary storage would be needed until repositories become available. However, more than 60 per cent of the total cost would be required after 2010. In the Swedish estimates, the share of expenditure directly linked to the various disposal sites is around 3 to 4 per cent of the cost of electricity production, including research and development expenditure. In the light of these estimates by KBS, the Swedish Government fixed the amount of the 1982 contribution to the fund intended to finance future expenditure on high-level waste management and decommissioning at 0.017 S. Kr./kWh, i.e. 2.3 mil per kWh (1 mil = 10^{-3} US dollars).

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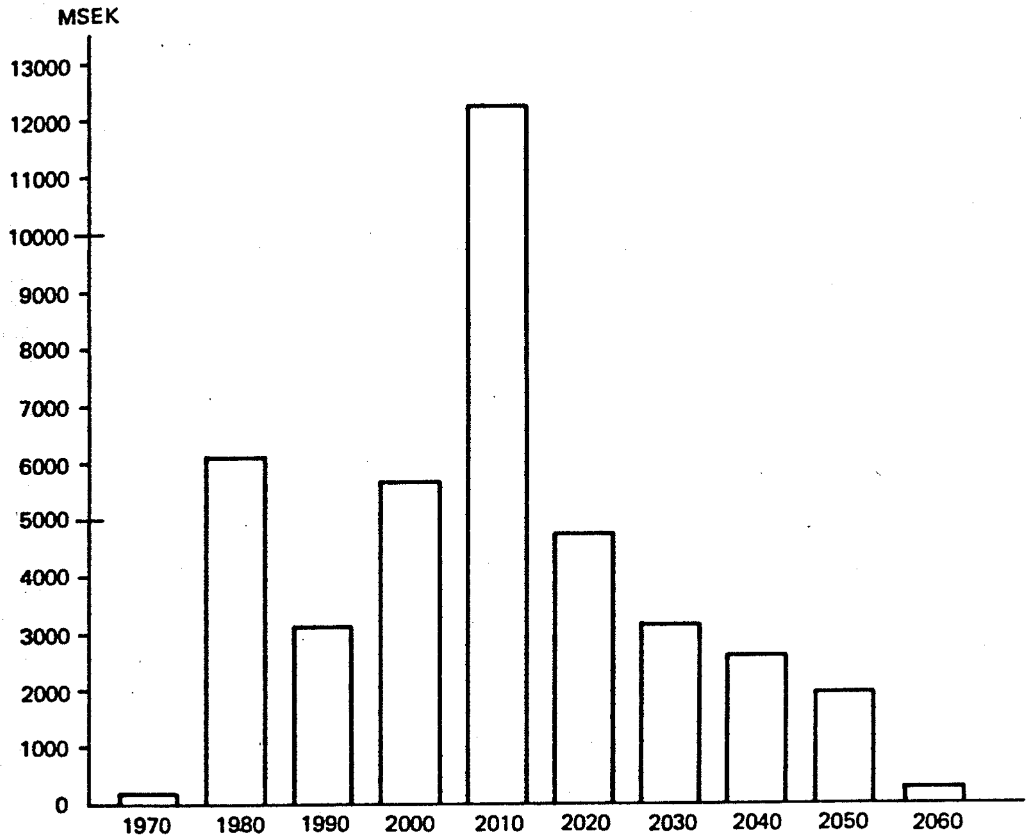
(1) Radioactive Waste Management Plan, Plan 82, Part 1: General, Part 2: Facilities and Costs, SKBF/KBS Teknisk Rapport, 82-09:1, 82-09:2, Stockholm, June 1982. See also the communication by Gerhard Rundquist: "Waste Management Policy and its Implementation in Sweden", Proceedings of the Seattle Conference on Radioactive Waste Management, IAEA, Vienna 1984.

Figure 2. **DISTRIBUTION OF BACK-END COSTS OF THE SWEDISH NUCLEAR FUEL CYCLE**

(Excerpt from the above-mentioned paper by G. Rundquist).



13. In a study by the U.S. Congressional Budget Office[1] estimates were given for the calculation of a charge to be deducted at source, per kWh/hr, to feed a fund intended to cover future expenditure involved in waste management. A number of possibilities were allowed for, particularly as regards the scale of the nuclear programme in the United States, the inclusion of costs of transport and temporary storage facilities, and various possibilities of these costs being exceeded. In the most unfavourable case (total cost in 1982 US dollars = about 20 billions), the charge which would have to be made would be equal to 3 or 4 per cent of the cost of electricity invoiced to the consumer. In fact, a middle-range proposal of about 1 mil per kWh was considered as the optimum value in 1982 for such a charge.

14. Another American study, ONI-3[2], gives estimates of costs for research and development activities prior to the design of repositories for final disposal of high-level waste resulting from electricity production and for the design, construction, operation and decommissioning of such facilities. Costs are given for different notional systems in various geological formations (salt, tuff, granite) both for spent fuel and for waste from reprocessing of spent fuel. On the basis of the assumptions made in this study (72,000 tonnes of fuel), it seems that the total cost of research, site studies and technical studies is of the same order of magnitude as the cost of construction and operation of the repository, irrespective of the design of the latter. In the case in question, the order of magnitude is 5 billion US dollars for each of these two stages, representing about 30 years research, development and demonstration, and about 25 years operation of the repository, which means that expenditure would stretch over a period of about 50 years[3]. A quick calculation shows that this expenditure as a whole would be equal to less than 1 mil/kWh of nuclear electricity produced.

15. A study of the general design of a facility to dispose of radioactive waste in granite formations has been carried out in France as part of a contract with the European Communities (Geostock). This study[4] provides for the disposal in deep formations of 30,000 containers of high-level vitrified waste, equivalent to the recycling of about 45,000 tonnes of spent fuel, in four main phases:

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(1) "Financing Radioactive Waste Disposal" - A CBO Study, September 1982.

(2) J.D. Waddell, D.G. Dippold, T.T. McSweeney, "Projected costs for mined geologic repositories for disposal of commercial nuclear wastes", Technical Report ONI-3, Office of NWTS Integration, Columbus, USA, December 1982.

(3) According to Nuclear Fuel (15th August 1983), the Department of Energy's estimated R & D costs for the high-level waste repository programme amounted to 4.1 billion US dollars, which seems to be in line with ONI-3 estimates.

(4) "Etude de conception générale d'une installation d'évacuation de déchets radioactifs en formation granitique", vol. 1, EUR 7620/1, Commission of the European Communities, 1982.

- creation of wells and connected galleries: years 1 to 10;

- excavation and fitting-out of storage galleries: years 11 to 38;

- emplacement of containers: years 11 to 45;

- abandonment: years 46 to 81 (filling-in of galleries and decommissioning).

The cost of all these operations has been assessed at F.Frs. 17.5 billions (2.2 billion US dollars) with annual expenditure varying from Frs. 25 to 400 millions (December 1979 value). This cost represents about 1.3 per cent of the cost of the corresponding electricity production.

C. CONCLUSIONS

16. In all these studies the orders of magnitude for expenditure on long-term management of radioactive waste agree: the figures are for billions of dollars, but do not, however, represent more than a small percentage of the cost of the electricity produced. They are generally subject to a coefficient of uncertainty which may vary from 10 to 40 per cent to take account of the likelihood of the costs being exceeded. In addition, they have not been calculated on the basis of an optimised situation, in equilibrium, i.e., where production, conditioning and disposal of waste are part of current industrial management and are subject to well-established regulations. Finally, variations linked to interest rates, inflation and technological progress are difficult to estimate. These figures therefore need to be used with a degree of caution.

17. Sensitivity studies have been carried out, as part of the reports mentioned above, to examine the influence of various factors on total costs. These studies seem at the present time to be somewhat fragmentary and preliminary and it is difficult to draw conclusions of general validity. However, depending on what is included under the definition of research and development expenditure including site characterisation, this item can account for a major share of total cost - up to 50 per cent according to some estimates.

III. FINANCING METHODS

A. DIVERSITY OF CIRCUMSTANCES UNDERLYING FINANCING

18. Everything said above serves to illustrate the fact that it would be difficult to undertake an overall analysis of a single system of financing best suited to the long-term management of radioactive waste, or even at this stage to devise a small number of suitable models. As confirmed by the studies to which we have referred, there will be significant differences between countries. Some financing plans may cover a very wide range of expenditure relating to radioactive waste management as a whole and to associated activities (transport, reprocessing, dismantling, etc.) including all relevant research. Other plans may be confined to long-term management itself, or even

to management of high-level waste. It is also conceivable that some, or all, expenditure on research, development and demonstration, as well as the cost of institutional controls, might be financed from a source other than the financial system set up to cover the construction and operation of storage facilities and repositories. In fact, many governments have long financed research, development and demonstration and there is therefore experience available of the financing of this type of expenditure which is not normally the case for other activities connected with management.

19. In practice, solutions for financing will, to a large extent, depend on the waste management strategy selected and on how nuclear programmes develop. Extended storage of spent fuel or waste - even for a period exceeding 50 years - taking place fairly rapidly after production should not give rise to real financing problems. It would be easy to estimate the investment required for well-established facilities and this could be provided by the nuclear operator concerned (for example, under the terms of a contract with a specialised organisation for reserving storage capacity). The costs of maintaining storage facilities, even over a long period, are too small to create financial difficulties. Also, with regard to investments required for emplacement of waste into a geological repository or at shallow depth, it should not be too difficult for the waste producer or the reprocessing company to make financial arrangements provided the repository could be established within a relatively short period of time. On the other hand, the disposal of high-level waste or spent fuel after a long period of storage would alter the nature of the problem, since the time factor would have a major effect on financing. The time between generation of the waste and final disposal would be far too long to consider direct participation in the costs of moving waste to disposal sites, of investment in such sites and the remuneration of services, by the nuclear operators who actually generated the waste. There is also the possibility that the waste producers will partly no longer exist, particularly if nuclear programmes are stopped. Finally, the possible costs of passive surveillance after closure of a repository would be low even if this period stretched over a hundred years or more, and financing should not be a problem.

B. SURVEY OF POSSIBLE METHODS OF FINANCING

20. We have seen that the producer of waste or spent fuel, who is under a legal obligation to make provision for its management, has to deal directly in day-to-day management operations with financing of an initial phase (which may be more or less significant) in the long-term operations. On the other hand, part of such financing is likely to far exceed the forecasting and direct action capability of the nuclear operator, especially if the strategy adopted includes an extended period of storage before wastes are disposed of.

21. It is therefore necessary to devise more appropriate financing methods, at any rate for certain types of future expenditure. Such methods would back up or replace direct contributions to immediate investment expenditure. Method one would consist of requiring nuclear operators and electricity utilities to pay a levy to a specialised body (public or otherwise) to cover their future obligations for extended storage and disposal. This levy would be paid from the time of the transfer of the waste for storage or disposal, or could be paid in instalments from the time of the generation of the waste. The

levy might vary with time according to running or foreseeable expenses. Such a system would assume the continuation, or even the stepping up over a long period of nuclear power programmes. The second method which comes to mind and would ensure a link between the producer of waste and future expenditure he ought to bear is the setting up of a special fund to which existing nuclear operators would have to contribute regularly (e.g. annually), and which would cover the future cost of the extended storage and disposal of their waste or spent fuel. Another solution would be to oblige operators to set up an internal reserve. From the moment a fund was set up it could cover current investment and future costs. The setting up of such a fund would not, however, prejudice the question of who should be responsible for carrying out disposal operations.

22. These two methods have many points in common. In both cases advantage is taken of the income of existing nuclear operators. Payments by operators would probably be proportional to the volume of waste produced and would release them from their long-term financial obligations. In both cases various arrangements could be introduced for payment by instalments. However, the two systems differ in political and economic terms. The setting up of a fund reflects the desire to make each operator - so far as such assessment is possible - bear a charge equivalent to the actual cost of managing his waste and to provide the most effective possible guarantee that the necessary finance would be available as and when required. This is a good solution from the standpoint of long-term safety and the fair distribution of costs between generations. It also has the advantage of not being totally dependent on the continuation of nuclear power programmes. On the other hand, there are problems in calculating the contribution to be paid. Apart from the uncertainty in estimating costs already referred to, account also has to be taken of currency depreciation and rates of interest prevailing on finance markets. It may also be asked if, on economic grounds, application of an updating rate, defined in constant money values would not be justified(1). Lastly, it is not certain that the establishment of a capital fund is the most economic or most suitable way of financing expenditure stretching over a long period and subject to high variations. On first sight, the regular payment by nuclear operators over long periods of directly usable charges, possibly supplemented for major investment projects by loans repayable from future charges(2), might appear to be a more flexible method of financing. It nevertheless presupposes considerable confidence that long-term nuclear programmes will be carried out, and does not appear to afford the same guarantees regarding the availability of the necessary funds or the fair distribution of costs among generations, as the establishment of a capital fund. In any event, a

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(1) This is a factor making it possible to calculate the present day equivalent of a currency unit in a given number of years, without currency depreciation. Updating is designed to take account of the preference of economic agents for immediately available funds, even in the absence of inflation. See on this point a report by Jacques Lépine "Utilisation des méthodes économiques dans le domaine des déchets radioactifs", Séminaire de la Société Française de Radioprotection, February 1981.

(2) A loan, or initial finance for investment, would in any event be necessary if the charge was only levied at the time of delivery of the waste for storage or disposal - e.g., ten years after its production.

comparison of the two suggested methods of financing could only be made using sufficiently complex models, in which the structure and timetable of expenditure would be clearly laid down. It is moreoever probable that the various financing methods to which we have referred - direct contributions to investment, charges payable to specialised waste management bodies, loans, establishment of a fund - might be combined to reach an optimum economic solution, depending on the programme for waste management and nuclear power production.

23. For the sake of completeness, two other possible approaches should be mentioned, although, unlike those mentioned previously, they are not based fairly and squarely on the legal obligation of the operator, which underlies his financial responsibility for waste management. With the first approach nuclear operators would bear the cost when expenditure for waste disposal was actually incurred, without anticipated payment. This would be a deferred financing of waste disposal (if necessary by operators other than those who produced the waste). This would avoid the highly uncertain estimates on which anticipated financing is based from the time waste is produced, and would provide finance, including loans, on clearly defined economic terms. However, income from operations conducted at the time the waste was generated would no longer be available and this approach should therefore be based on the assumption that an adequate "financial basis" would be available to cover future management costs, in the light of forecasts of nuclear power production. This financing method would obviously give no guarantee in this respect and would mean transferring to future generations a major part of the burden of radioactive waste management. The financial obligation of an existing operator in relation to waste which he has generated would be replaced by a future obligation on operators to participate in the financing of disposal operations. A second possible approach would be to treat the cost of long-term management of waste, including, naturally, R & D, as expenditure in the public interest to be covered by public funds, e.g. by being included in the State budget. This method would reflect the particular responsibility of Governments in this field and would undoubtedly provide a solid guarantee that the necessary funds would be available. It can also be said that, as a general rule, a State's overall expenditure benefits successive generations and this is only natural since it corresponds to both present and future interests. This method could also be justified on economic grounds to the extent that the burden on taxpayers would be approximately proportionate to their consumption of electricity.

C. LEGAL AND ECONOMIC BASIS OF FINANCING - "POLLUTER-PAYS" PRINCIPLE

24. Apart from the political or economic arguments for any particular financing method, the practical question is "What is the most readily accessible and available source of finance". This clearly suggests the unambiguous designation on a solid legal basis of a person responsible for disposal of the waste who will be effectively in a position to pay at the appropriate time in accordance with the financing method selected. As was said before, under nuclear energy law the person primarily responsible for undertaking the management of radioactive waste is normally the nuclear operator who produced it. The "polluter-pays" principle, as established for example in the OECD Council Recommendation of 26th May 1972, offers an economic basis for this approach(1).

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(1) See "The Polluter-Pays Principle - Definition, Analysis, Implementation", OECD, 1975.

In accordance with this principle the cost of measures to prevent and control pollution should be borne by the polluter and will normally be reflected in the cost of the goods and services produced by the polluting activity. It is therefore a rule "to encourage rational use of scarce environmental resources and to avoid distortions in international trade and investment"[(1)]. The application of this principle therefore meets the two requirements of having a person primarily liable and a sound economic basis. In the case of radioactive waste this will generally mean making the operators of nuclear power stations pay from income received in return for electricity produced[(2)], i.e., ensuring that the cost is borne by those benefitting from the activity which generated the waste. It follows that the sums required must be levied during the period of operation of the power stations[(3)]. Without it being necessary to invoke to such a rule, it may simply be said that considerations of economic efficiency, equity and programme management require that the cost of waste disposal be borne by electricity consumers[(4)].

D. LEGAL FINANCING ARRANGEMENTS

25. Special financial legislation - described in the Annex - has recently been adopted by several countries and draft legislation is being prepared in others. This legislation is designed to impose an obligation to make a financial contribution and determine the use to be made of such contributions. The relevant provisions, currently applicable in the Federal Republic of Germany, the United States and Sweden are examined below[(5)]. Our analysis will revolve around the following issues:

- by whom, to whom, when and how are contributions to be paid?

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(1) See "The Polluter-Pays Principle - Definition, Analysis, Implementation", OECD, 1975 (page 12).

(2) In theory, it may be asked whether allocation of the cost of storage and disposal techniques, which are based on the isolation of waste rather than on the use of environmental resources (save to a very limited extent) should be decided in accordance with the polluter-pays principle in the same way as the dispersion of effluent in the atmosphere or in water. An affirmative answer to this question implies that waste management is seen as covering all measures to prevent environmental pollution irrespective of the nature or degree of risk, or of the prevention or protection techniques used.

(3) This is in particular the principle underlying Swedish legislation. See above-mentioned communication by Gerhard Rundquist, Proceedings of the Seattle Conference on Radioactive Waste Management, IAEA, Vienna, 1984 (page 218).

(4) See above-mentioned report by the Congressional Budget Office, page 11.

(5) Other more general provisions or proposals and provisions concerning the financing of specialised radioactive waste management bodies are looked at in the following Section.

- for what radioactive waste management operations will the contributions be used?

- how are the contributions calculated?

- what arrangements are made for the management and use of the contributions?

26. Before dealing with some of these points in greater detail it is useful to set out the main features of the most significant existing legislation.

(a) Sweden: Act of 18th June 1981 (amended in 1984) on the financing of future expenditure required for the management of fuel etc(1). This Act introduces a system of contributions under government control whereby every operator of a nuclear power station is obliged to pay an annual charge proportional to the quantity of electricity produced. The charge is calculated on the basis of the estimated cost of radioactive waste management programmes and may vary depending on the type of reactor. The amount of the charge is fixed for each year by the Government in such a way that total charges for the period of operation of the reactor cover total management costs of the waste produced. Charges levied are paid into an interest-bearing fund used to reimburse operators of nuclear power stations for expenditure incurred on waste management.

(b) United States: The Nuclear Waste Policy Act of 1982 - notably Section 302(2). This Act provides that nuclear operators who must contract with the Secretary of Energy for the transfer of high-level radioactive waste or spent nuclear fuel shall pay fees for the expenditure connected with extended storage and disposal. These fees will be 1 mil per kilowatt hour (or an equivalent amount for waste and spent fuel produced before the Act) and this amount will be reviewed each year taking into account income received and the total amount of expenditure to be covered. Under the contracts and in return for the payment of fees, the Department of Energy undertakes to take possession of waste and fuel as soon as a repository is in operation and by 31st January 1998 at the latest, and to dispose of it. Fees are paid into a Nuclear Waste Fund set up within the Treasury and which will accept responsibility for all expenditure connected with disposal and monitored storage. A fee system and a fund are also being set up for the temporary storage of spent fuel for operators who do not have adequate capacity and subject to a maximum Federal Government storage capacity of 1,900 tonnes.

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(1) See Annex C.8 and NLB No. 29 pp. 43-45 (June 1982) and the analysis in the communication by Gerhard Rundquist referred to above.

(2) See Annex C.12 and Pub. L. 97-425, 42 U.S.C. paragraphs 10101 et seq. See also communication by R.M. Rosselli: "New US Financial Initiatives: Covering the Cost of Managing Radioactive Waste", Congress of the International Nuclear Law Association (1983).

(c) Federal Republic of Germany: Decree of 28th April 1982 concerning the construction of Federal installations for the containment and disposal of radioactive waste - made under Section 21(b) of the Atomic Energy Act(1). This Decree regulates the levying by the Federal Institute for Physics and Technology of advance payments on contributions to be paid by waste producers to cover total expenditure on Federal installations for final storage. This payment is linked to the obligation to transfer radioactive waste to such installations. The amount of the advance payment is decided by an annual estimate of expenditure. The charge is shared among waste producers according to their category, three-quarters of the charge being for reprocessing plants with capacity in excess of fifty tonnes per year. A system of compulsory levies has also been introduced for using the temporary storage installations of the Länder.

27. In the three countries whose financial legislation we have just summarised, determination of nuclear operators who shall pay a contribution is naturally linked to the licensing system. In Sweden the obligation rests on the holders of a licence to possess or operate a nuclear power reactor; in the Federal Republic of Germany it concerns all those who have obtained a licence under the Atomic Energy Act (for reactors and nuclear fuel cycle facilities and for the use or treatment of radioactive substances outside such facilities) or who have applied for a licence for a spent fuel reprocessing facility. In the United States the obligation falls on operators who produce high-level activity waste or spent fuel; moreover, the issue or renewal of a licence for a reactor under the Atomic Energy Act - for commercial, medical or research purposes - will be subject to the conclusion of a contract including a provision for the payment of the fee for radioactive waste. In general, therefore, the financial obligation is firmly established in the law governing the nuclear industry.

28. We shall not deal in detail with arrangements for the payment of contributions which vary from country to country. Payment may be made to the Government (United States: Secretary of Energy) or to a public body (Federal Republic of Germany: Federal Institute for Physics and Technology; Sweden: National Office for Irradiated Nuclear Fuel - NAK) in accordance with legislation or regulations. The arrangements in the United States, i.e. the conclusion of a contract, the subject matter of which is defined by legislation and which determines the financial obligations of operators, deserve special mention. Payment is due, depending on the case and the country, either from the time a licence has been granted for operating a waste-producing plant, or from the time of electricity production; or at the latest from the time of transfer of the waste in question.

29. It is of interest to look at the scope of these financial provisions i.e. the aspects of radioactive waste management which are the subject of legally determined financial obligations. In Sweden, all management of waste and spent fuel deriving from producers of nuclear electricity and the dismantling of reactors are covered. In the United States only disposal and extended storage of high-level waste and spent fuel are covered by the Nuclear Waste Fund but the obligation to contribute to the Fund also concerns operators of installations other than reactors who produce or are capable of producing

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(1) Annex C.11 and NLB Nos. 15 and 18.

high-level waste or spent fuel. In the Federal Republic of Germany operations covered by the financing system described above are those entrusted to establishments to be set up by the Federal Government (Sections 1 to 3 of the Atomic Energy Act) for the extended storage and disposal of all radioactive waste produced. Except in Sweden, financing machinery has therefore been set up for long-term management only, while intermediate storage is dealt with separately. In general all necessary project work, construction and operating expenditure on facilities as well as waste handling and transport costs are covered by the financing system, including research, development and demonstration by public bodies in respect of such facilities(1). In Sweden and the United States the cost of the surveillance of disposal sites, including post-closure surveillance, are also included.

30. <u>The method of calculating contributions reflects differences of approach to financing methods</u>. In the Federal Republic of Germany, the advance payment under the Decree of 28th April 1982 is determined at the end of each fiscal year on the basis of estimates of annual costs incurred without a fund being set up for future outlays. It is an advance, part of which may be reimbursed with interest if it exceeds the actual costs incurred. This advance payment does not release the operator from his obligation under Section 21(b) of the Atomic Energy Act to contribute to total disposal costs. In Sweden the obligation to pay a levy is designed to offer a legal guarantee that funds will be available to cover total expenditure to be borne by the owners of the reactor and the State - as laid down by law - for the management of waste and spent fuel. The amount of the levy is therefore fixed by the Government on the basis of management programmes drawn up for 5-year periods(2). These programmes include activities proposed by nuclear electricity producers and by the State and are drawn up by the NAK. The capitalised accumulated interest on funds obviously forms part of the cover. Financial security of this kind does not release electricity producers from obligations imposed on them by law to take measures to provide for the management of radioactive waste. It should also be noted that funds cover both present expenditure - i.e. current research and works - and future expenditure. They therefore have to be constantly replenished as they are used up and we shall refer to this later. In the United States, the general conception behind the 1982 Act is somewhat different to the solutions adopted in the Federal Republic of Germany and Sweden: the combination of the financing machinery established by Section 302 (similar to that in Sweden) and the part to be played by the Federal Government (similar to that in the Federal Republic of Germany) should have a significantly greater legal impact. Under contracts to be concluded with the Secretary of Energy, the delivery and transfer of ownership of solidified waste or fuel produced before the entry into force of the Act, together with the payment of the one-time fee fixed by the Act, release operators from all financial obligations for long- term management (storage and disposal of waste and fuel). The situation will be the same where, following the commissioning of a disposal site, the Department of Energy takes possession of waste or fuel delivered in accordance with contracts and when the fee due for the period

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(1) The list of such expenditure varies from one country to another and clearly depends on proposed disposal arrangements.

(2) The annual levy has been fixed at 0.017 S.Kr. (2.3 mil US dollars) for 1982 and 1983 and at 0.019 S. Kr. for 1984.

of operation of the reactor has been paid (Section 302(a) 4 and 5); a similar situation will arise for spent fuel transferred for intermediate storage at Federal level in accordance with the provisions of Section 136 of the same Act setting up a distinct fund for storage. If these methods of financing are considered solely from the standpoint of future expenditure on long-term management, which constitutes the most difficult problem, it may be said in conclusion that in the Federal Republic of Germany there is a system of advance annual payments to cover the cost of disposal by the Federal Government[(1)], in Sweden payments in advance enable a security fund to be set up and in the United States payments in advance (or not in advance in the case of waste and fuel already generated) provide all the resources which the Federal Government will require for disposal purposes.

31. In addition to the relationship between the amount of contributions and the amount of expenditure, another parameter is directly or indirectly used to calculate the fee, namely the volume of waste generated. In the United States, for solidified waste and spent fuel produced before the entry into force of the Act, the system adopted is that of a fee per kilo of heavy metal content. In the Federal Republic of Germany, the link is indirect, since the charge is generally dependent on the nature and capacity of installations. Expenditure to be covered is first allocated among reprocessing plants with a capacity in excess of 50 tonnes per year (75.5 per cent), lower capacity plants (4 per cent), reactors (17.5 per cent) and other installations (3 per cent); within these categories payments are proportional to capacity, except for the last category where they are calculated with reference to the average quantity of waste to be transferred to Federal facilities. The rule laid down in Section 21(b) of the German Atomic Energy Act is that the amount of the contribution should correspond to the benefits that the producer derives from the Federal disposal facility.

32. These different methods of calculation do not prevent fees being generally in proportion to the quantity of electricity produced as is expressly provided for in Sweden and the United States (apart from the waste and fuel mentioned at the beginning of the last paragraph). The amount of the contribution is therefore related to the principal form of economic measurement underlying the generation of the waste. This is in accordance with a correct application of the polluter-pays principle. It might also be thought that from the standpoint of encouraging technological progress, the amount of the levy should be related to the volume and nature of the waste to be disposed of.

33. We shall not deal in detail with the management arrangements of the funds which have been set up and which are specific to each country. In Sweden, sums are deposited with the National Bank and managed by a body designated by the Government, the National Office for Spent Fuel (NAK)[(2)]. This body plays an important role in preparing for decisions by the Government concerning programmes of works for waste management and the amount of the

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(1) The system is a provisional one applicable until 31st December 1986 at the latest; advances made will count towards contributions under the definitive regime to be set up under Section 21(b)11 of the Atomic Energy Act (see Section 9 of the Decree).

(2) Decree of 30th June 1981, see Annexe II C.9.

corresponding fee. It deals with the financing of expenditure on such works, including future expenditure for which fees have been paid. Decisions taken by NAK may be the subject of an appeal to the Government. In the United States, the fund set up within the Treasury is managed by the Secretary of Energy subject to control of budgets (based on estimates of three-yearly expenditure) and accounts by Congress[1].

34. Arrangements for using contributions paid by nuclear operators depend on how waste management operations are organised. Financing machinery is inevitably more complicated where expenditure is not incurred by the Government itself and where a long period of time may elapse between the payment of levies and the corresponding expenditure. This situation prevails in Sweden: in the first place funds are used to reimburse expenditure by operators of reactors on the approved programme of research and works concerning waste and fuel management. In addition, to make up for the fact that expenditure is spread over time, operators may borrow against their deposits for long-term energy investment. Loans are granted in return for a guarantee, at rates of interest not less than those paid by the National Bank on deposits. Loans are limited to 75 per cent of total contributions, after deduction of the sums intended to be used for waste management during the period of the loan. Funds remaining in the account bear interest at the same rate as long-term State bonds. These provisions are obviously intended to ensure that maximum use is made of financial contributions without in any way lessening the security afforded. In the United States arrangements are more straightforward since funds are used primarily by the Secretary of Energy to finance expenditure under the long-term management programme for high-level waste, notably the construction of a disposal facility. In the event of the Fund being inadequate to cover expenditure the Secretary may borrow, within the limits specified by Congress, such borrowing being redeemable from the Fund. In the event of a surplus at any given moment the Secretary may invest in United States obligations of appropriate maturity.

IV. OTHER FINANCIAL ARRANGEMENTS

35. In addition to the arrangements described above, the practical details of which are laid down in laws or regulations, other provisions concerning the financing of long term management of radioactive waste are also to be found: these are of more limited scope or are merely designed to form the basis of some future system. This is so, for example, with the Swiss Federal Decree of 6th October 1978[2] which provides for the constitution of a joint fund for expenditure on the decommissioning of nuclear installations, to which owners are required to contribute (Section 11). This fund has now been set up[3]. The same Decree stipulates that the Government (Federal Council) may require waste producers to pay reasonable contributions to a public body to cover

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(1) Procedures applicable are described in the Communication by R.M. Rosselli referred to above.

(2) See Annex A.2.

(3) See Annex C.13.

disposal costs (Section 10). This financing would take place alongside that by producers as part of NAGRA and would represent the right of intervention of the Confederation, for example in the event of default of producers (see Chapter IV, paragraph 29).

36. It is also of interest to note the financing provisions worked out in Finland in the framework of a revision of nuclear energy legislation. These provisions stipulate that nuclear electricity producers shall constitute an internal tax-deductible reserve, as waste is generated, to cover the cost of its management. The rate of the contribution is fixed annually by the Minister of Trade and Industry(1). The Committee set up in 1978 considered several solutions: creation of a special fund at the Bank of Finland (the Swedish model); constitution of an internal reserve or equivalent financial security; or a tax on radioactive waste. The constitution of the reserve under the Act may be spread over a certain period, but electricity producers will have to provide the State with effective security corresponding to the total cost of the waste management, which would in particular cover the amount of the unconstituted reserve. In the event of default by producers the State would assume responsibility for storage and disposal using the security provided. Unlike solutions adopted in Sweden and the United States this approach leaves under the control of electricity producers funds and assets allocated to future expenditure.

37. Financial provisions are also to be found in instruments setting up public bodies specialising in radioactive waste management, such as ANDRA in France(2) and ONDRAF in Belgium(3). The duties of these bodies are very extensive and include, among other things, long-term management operations. The way in which their activities are financed is therefore directly relevant to the subject of this Chapter. In addition to the public funds at the disposal of ANDRA and ONDRAF, the greater part of the cost of their industrial activities is borne by the waste producers on behalf of whom they act. The operating costs of ANDRA storage facilities are paid by the nuclear operators who deliver the waste; specific investment projects are financed in advance by the owners on whose behalf they are undertaken; joint investment is financed from the resources of the Agency itself and by loans, the interest on which is paid by the waste producers benefitting from them. Financing arrangements and fees chargeable for services are decided by the ANDRA Management Committee on the basis of plans covering several years. In accordance with the rule laid down in the Royal Decree which created ONDRAF, all expenditure by the body (operating costs and financial outlays) is to be borne by the waste producers who benefit from its services. The amount of charges is fixed by its Board of Management but the Minister for Economic Affairs may be required to define cost elements to be taken into account. ONDRAF may also take out loans to finance investment and may be authorised by the Minister to create a

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(1) See the communication by Yrjö Sahrakorpi to Nuclear Inter Jura 1983: "Providing in advance for the expenses of radioactive waste management: some possible solutions in Finland's forthcoming legislation".

(2) See Annex B.6.

(3) See Annex B.7.

fund to finance its long-term responsibilities. We can thus see that in Belgium and France the financing of long-term management operations is, at present, primarily envisaged through contractual relations between radioactive waste producers and a public body. The legal basis for this financing is found in laws or regulations defining the powers and duties of such bodies and in the legal obligation of nuclear operators to dispose of waste. The method is somewhat different to that of countries where financing arrangements are directly established by legislation, but in practice should produce the same results. In support of this method, it has been noted that in France, for example, the main producers of radioactive waste are public establishments under the supervision of the same Minister. "It did not therefore seem necessary to make provision in legislation or regulations to ensure the financing of operations connected with waste management, which must in any event be carried out by the producers"(1). Finally, in the Netherlands, COVRA shall conduct its financial affairs in such a way as to cover the cost of collection, processing, storage and disposal and shall build up a fund to meet the cost of final disposal for those types of waste for which this is necessary, for example high-level fission waste and waste containing long-lived radionuclides.

V. CONCLUSIONS

38. This general survey of possible financing arrangements has the merit of highlighting the links between the legal regime of nuclear activities, long-term safety requirements, the attitude to be taken toward future generations and economic conditions. It makes clear that the adoption by any given country of an appropriate financing method will aim at the best possible balance between these different factors, having regard to national conditions and in particular to policy in regard to nuclear energy programmes.

39. In selecting such a method, it will be important in particular that the analysis of long-term safety objectives, which must be given priority, should not, nevertheless, be separated from economic considerations. On the one hand it is in the general interest that storage facilities and disposal sites be set up and operated on the best economic terms, having regard to safety needs. On the other, it is in the interests of safety that effective financial techniques should be used to cover the cost of long-term waste management. As has been already noted, available estimates suggest that the cost of radioactive waste management is no more than a small percentage of the total cost of producing nuclear electricity(2). This would imply that economic factors will not dramatically affect the safety of long-lived waste management, even where the financing is the subject of special constraints. Despite this low percentage of total cost it should be emphasised that in absolute terms the

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(1) See communication by B. de Fontreaulx, F. Habib, J.M. Lavie and J. Lefèvre "La politique française de gestion des déchets radioactifs et sa mise en oeuvre par l'ANDRA et le CEA", Proceedings of the Seattle Conference on Radioactive Waste Management, IAEA, Vienna, 1984,

(2) See also communication by Joseph A. Lieberman: "The Status of Technology for Nuclear Waste Management", Proceedings of the Seattle Conference on Radioactive Waste Management, IAEA, Vienna, 1984.

cost of management may, at any given time, be very high. Moreover, this conclusion is valid only if estimates of cost are accurate and regularly updated in the light of available data. Lastly the comparison with the cost of electricity production is only really meaningful if there is reasonable assurance that part of the income produced will in fact be used to finance radioactive waste management.

VI

THIRD PARTY LIABILITY AND COMPENSATION OF NUCLEAR DAMAGE*

I. INTRODUCTION

1. One of the features of the production and use of nuclear energy for peaceful purposes is that right from the start, these activities were governed by a special system of third party liability and compensation of nuclear damage. Therefore, when reviewing the regulatory aspects of the long-term management of radioactive waste, it might be useful to consider the conditions for compensation of any nuclear damage arising from waste after disposal in order to see how this system might be applied.

2. It should first be noted that the special liability rules, whose main features are briefly described in the Appendix hereto, were drawn up and implemented at both international and national level with a view to coping with any disaster due to a nuclear incident, whereas the justification for radioactive waste disposal is based on the principle that the technical conditions must be such as to minimise both the probability of an incident occurring and its impact.

3. It might therefore be assumed that there is no real need for a compensation regime in this case and that it is therefore not worth discussing the matter. However, such an attitude would be untenable for various reasons, the main one - to which we shall return later - arising from the very existence of a special regime which may be terminated only under certain conditions. It could also be pointed out that however improbable it might be, the risk of an incident occurring cannot ever be entirely dismissed. The psychological impact on the public of the guarantee of effective compensation offered by this system of no-fault (strict) liability and the "channelling" of actions of compensation on to the nuclear operator ought not to be underestimated either.

4. Nevertheless, in the case of extended storage of radioactive waste or disposal, especially into deep geological formations, the retention of rules which were designed for application to the operation of reactors and other nuclear installations raises various questions which were already being asked

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* This Chapter has been drafted on the basis of work done by the NEA Group of Governmental Experts on Third Party Liability in the Field of Nuclear Energy. It consists of an analysis of the relevant international Conventions in force with a view to seeing how far they could be applied to long-term radioactive waste management.

at the time of the publication of the Polvani Report[1]. Chapter V of this Report notes that this system would seem ill-adapted to the compensation of damage caused by waste after its disposal, since this would require the operator's liability and corresponding financial security to be maintained for an indefinite period of time.

5. It is therefore necessary to look at this question in greater depth so as to be able to judge whether the existing system should be adapted. It is essential, in this respect, to bear in mind the distinction already made in this Study between the "pre-closure" and "post-closure" phases of waste disposal. This is because there are operations such as conditioning, transport and handling at the storage or disposal site, which belong to the pre-closure phase and do not present any appreciable differences in terms of the risks and liabilities entailed compared with the other stages in the nuclear fuel cycle covered by the special nuclear third party liability system. On the other hand, once the disposal operation as such is completed and the site finally closed, a new phase begins, the duration of which is not necessarily predetermined. There would therefore be no justification for indiscriminately applying one and the same third party liability system to such different situations and they will be studied separately.

II. CHARACTERISTICS OF DAMAGE WHICH COULD BE CAUSED BY RADIOACTIVE WASTE AFTER DISPOSAL

6. First of all, the particular nature of damage that might be caused by radioactive waste after disposal as opposed to other nuclear activities, and the special circumstances in which it would come to light should be borne in mind. It is generally acknowledged that "nuclear damage" within the meaning of the special third party liability system means loss of life, and any personal injury as well as any loss of, or damage to property caused by the radioactive properties of nuclear fuel or products or radioactive waste. A nuclear incident itself is defined as any occurrence or series of occurrences having the same origin which causes nuclear damage.

7. In the context of waste disposal and storage, it may be useful to add that any uncontrolled release of radioactive material extending over a certain period of time is considered to be one single nuclear incident if its origin lies in a single phenomenon even though there has been an interruption in the emission of radioactivity[2].

8. It may be assumed, bearing in mind the techniques that will be applied to ensure safety, that a nuclear incident involving radioactive waste after disposal should not have the suddenness expected in the case of some incidents which might occur in a reactor or other nuclear installation. Damage caused by such waste would normally result from a very progressive deterioration of the waste containment system unless, contrary to all expectation, the latter were brutally affected by an unpredictable natural phenomenon such as an earthquake, or following human "intrusion" attributable to uncontrolled use of

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(1) Op. cit. Chapter II, page 16.

(2) Exposé des Motifs of the Paris Convention, paragraph 8, OECD, 1974.

the soil and subsoil containing the waste. However, the damage would, in all likelihood, take the form of a slow contamination of the air, soil or underground water level. This type of damage may, however, manifest itself some distance away from the point of release. If, as is likely, release of the waste is very gradual, it is quite possible that such damage will be discovered only after a certain lapse of time(1) and that its extent will be difficult to evaluate with accuracy, particularly if the level of contamination noted is not of a nature to cause direct or measurable prejudice to persons or the environment. A problem of a threshold level for damage may therefore be raised.

9. The possibility of a delay in the manifestation of nuclear damage is of relatively secondary importance if it is considered that the actual incident causing this damage is likely to occur an extremely long time after the date of disposal of the waste concerned. In fact, it will perhaps be possible to determine only this latter date with certainty. Perhaps it is this considerable lapse of time between operations at the origin of the risk (operations connected with waste disposal) and the moment of the occurrence generating the damage which constitutes the peculiar nature of this type of risk. This extension of risk in time is a factor which must remain at the core of the arguments set out below.

III. APPLICATION OF THE NUCLEAR THIRD PARTY LIABILITY SYSTEM TO THE PRE-CLOSURE PHASE OF WASTE DISPOSAL

10. As activities relating to radioactive waste management are not substantially different from the other activities in the nuclear fuel cycle, there is no a priori reason why the special nuclear third party liablity system should not apply to them. However, it is paradoxically necessary to examine whether this system actually covers the specific case of radioative waste disposal. Those who drafted the Conventions on nuclear third party liability at the beginning of the 1960s (see Appendix) did not concern themselves with this type of operation and this has led to various difficulties and uncertainties.

11. In the first place, neither the Paris nor the Vienna Conventions contain a detailed definition of radioactive waste. The Paris Convention, Article 1(a)(iv) and the Vienna Convention, Article I.1(g)(2), refer only to

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(1) Such delays in the manifestation of the consequences of this type of incident are distinguishable from another phenomenon known in most national legislation on compensation of nuclear damage as deferred damage, under which concept personal injury caused by exposure to ionizing radiation may sometimes appear only a very long time after exposure has occurred.

(2) For convenience, the explanations provided in the following paragraphs are based essentially on an analysis of the Paris Convention, but could also be based on the corresponding provisions of the Vienna Convention. Therefore, only the provisions of the latter which differ from those of the Paris Convention, or which provide a useful clarification in the study of this question are referred to here.

the wider expression "radioactive products or waste"(1), which itself is contained in the definition of "nuclear substances" ("nuclear material" in the Vienna Convention terminology). From this it can be inferred that the drafters of the Conventions may have taken the view that the question of knowing whether a nuclear substance should be considered as a useful product or as waste would be settled in each case as and when the need arose and in the light of technological progress. Furthermore, although both Conventions refer expressly to the case of the storage of nuclear substances among the activities subject to their special system of liability (and the facilities used for this purpose), neither mentions radioactive waste disposal proper. This is also normally the case in national legislation on nuclear third party liability.

12. It therefore remains to be seen whether the facilities used for radioactive waste disposal may be covered by the special system in spite of the fact that they are not specifically included in the definition of nuclear installation in the Conventions. Neither the preparatory work nor the Exposé des Motifs of the Paris Convention are conclusive on this point. It might therefore be concluded that a person operating a waste disposal site might not be considered as the operator of a nuclear installation within the meaning of the Conventions. The legal consequence of this would be that the operator of the last installation in which the radioactive waste was before the occurrence of the damage would be held liable [Article 5(c) of the Paris Convention](2).

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(1) In comparison, five sources of waste connected with nuclear power programmes are given in the Polvani Report (see Annexes II to VI). These are: mining and milling wastes, reactor wastes, reprocessing wastes, fuel fabrication wastes, and finally, decommissioning wastes. It is clear that the last four of these fall within the definition in the Conventions of radioactive products or waste, since all are produced in or made radioactive by exposure to the radiation incidental to the process of producing or utilising nuclear fuel. This is not so, however, for mining and milling wastes which must therefore be considered as being excluded from the scope of the Paris Convention. Apart from following the letter of the Convention, such an interpretation would also conform to its spirit since the Convention was intended to be applied only to material and activities presenting risks of an exceptional nature. As far as waste arising from another source than the nuclear fuel cycle is concerned, radioisotopes outside a nuclear installation which are used or intended to be used for any industrial, commercial, agricultural, medical or scientific purpose are excluded from the definition of radioactive products or waste. Waste arising from any such use could nevertheless fall within the scope of the Paris Convention if brought inside a nuclear installation, with a view to processing, storage or disposal for example.

(2) It can be added in this respect that if nuclear damage is caused by substances belonging to several different operators without it being possible to distinguish which of these substances is at the root of the damage (which is a perfectly possible situation in the case of a repository for radioactive waste from different sources), operators are jointly liable [Article 5(d) of the Paris Convention].

13. In the interest of potential victims, the Conventions are intended to prevent any break in the chain of liability. Under the Paris Convention [Article 3(a)], the operator of a nuclear installation is liable for damage caused by a nuclear incident involving nuclear substances (including radioactive waste) in or coming from his installation. He ceases to be liable therefor:

(a) if another nuclear operator takes charge of them, or pursuant to the express terms of a contract in writing with such an operator [Article 4(a)]; or

(b) when, under the national legislation applicable, the carrier of the waste has taken the place of the operator [Article 4(d)]; or

(c) by the fact of the extinction of the right of victims of nuclear damage to compensation [Article 8].

14. Therefore, for the nuclear operator's liability for radioactive waste in his keeping to end, the waste must be taken in charge by the operator of another nuclear installation (or by the carrier), or else the provision on extinction of the right of compensation - which lays down that, generally speaking, actions for compensation must be brought within ten years from the date of the nuclear incident - must come into play.

15. However, where damage is caused by a nuclear incident involving radioactive waste which at the time of the incident was stolen, lost, jettisoned or abandoned and had not been recovered, the Conventions lay down [Paris, Article 8(b)] that the time limit for extinction of actions for compensation is computed from the date of that nuclear incident, but the period shall in no case exceed 20 years from the date of the theft, loss, jettison or abandonment. The operator could thus be released from his liability on expiry of a period of 20 years following the date of the disposal of the waste. It is doubtful, however, whether the concept of abandonment or jettison can cover effectively deliberate acts of disposal (or dumping at sea) of radioactive waste without intention of retrieval. It is clear that Article 8(b) of the Paris Convention (and the corresponding provision in the Vienna Convention) refers to exceptional situations which have a common denominator, namely that the operator has involuntarily lost control of the substances concerned. Given that radioactive waste disposal is undoubtedly a deliberate act, an abnormal and discriminatory situation would be created vis-à-vis other operators, who remain liable for radioactive waste for as long as it is under their control, if the operator on behalf of whom the disposal operation is undertaken benefitted from the twenty-year extinction period. Finally, use of this period would not, as will be seen below, solve the basic problem of the application of the Conventions to long-term waste disposal.

16. Several gaps or uncertainties can be seen in the provisions of the nuclear Conventions arising from the fact that these do not always correspond to current practice and concepts in long-term radioactive waste management. However, these disadvantages are not likely to detract from the desirability of using the system of the Conventions to cover the pre-closure phase of waste disposal, especially if it is borne in mind that the aim of the Conventions is

to cover all activities in the fuel cycle and there seems no special reason for using a different system in this case(1).

17. In the case of the Paris Convention, most of these difficulties might be overcome without the need for any formal amendments since the Convention assigns extensive powers to an OECD body, the Steering Committee for Nuclear Energy, as to the interpretation and modification of its provisions. This solution could not, on the other hand, be used with regard to the question of the limitation in time of the nuclear operator's liability. However, the need to amend the corresponding provisions would not seem to arise provided it was agreed that the provision on acts of abandonment ought not to be invoked in such a case. On the other hand, since the Conventions remain silent on this point, procedures for the transition to the post-closure phase of waste disposal would have to be laid down if it is acknowledged that this phase presents quite different problems.

18. A first step towards adapting the Paris Convention to the particular requirements of radioactive waste disposal was taken in April 1984 when the Steering Committee for Nuclear Energy adopted a decision in terms of which "installations for the disposal of nuclear substances shall, for the pre-closure phase, be considered as nuclear installations within the meaning of Article 1(a)(ii) of the Paris Convention". It should be noted that when proposing this decision for adoption, the NEA Group of Governmental Experts emphasized that it in no way wished to prejudge the question of the application of the Paris Convention to the post-closure phase of a disposal site.

IV. PROBLEMS ARISING WITH THE POST-CLOSURE PHASE

19. This question may be approached from the legal point of view as well as from the practical and economic standpoints. The decision to subject nuclear activities to a special liability system and to set up financial security mechanisms in advance can be explained by the fact that disastrous incidents may take place. Since this Study has emphasized that the decision to go ahead with radioactive waste disposal must be subject to the requirement that the corresponding hazards will be confined to a strict minimum, there do not, *a priori*, seem to be any grounds for maintaining a compensation system designed to cope with very serious incidents. It is also debatable whether once a radioactive waste disposal site has been sealed and is no longer in anyone's legal custody, it continues to show the features of a nuclear installation as defined in national legislation. More specifically, it should be considered whether the site ought to remain under the direct responsibility of a nuclear operator duly licensed by the authorities and under active supervision by the latter. There would be no need for this since the risk of an incident is acknowledged to be minimal and all activity would have ceased. This is not just a problem of expediency and legal compatibility: there is also a practical difficulty involved.

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(1) In this connection, it might be desirable to fix suitable limits at national level in order to define a threshold above which a site containing radioactive waste should be termed a nuclear installation so as to prevent the automatic application of the Conventions to all types of repository.

20. The concrete outcome of maintaining application of the system under the Conventions to the post-closure phase of waste disposal would be that the operator held liable pursuant to the Conventions would remain so for an almost unlimited period, which would detract from one of the Conventions' fundamental principles of laying down a time-limit for the obligations of nuclear operators to counterbalance the "absolute" and exclusive nature of their liability. This would also lead to almost unsurmountable difficulties concerning insurance cover since insurers would be unable to cover risks for an indefinite period.

21. The above considerations lead to the idea that doubts as to the capability of the system under the Conventions on nuclear third party liability to provide adequate cover for any damage caused by radioactive waste disposal should not be based on the obsolete nature of the terms used in the Conventions or on uncertain provisions, because these drawbacks could be overcome, but rather on the fact that the situation created by waste disposal is of a different nature and requires solutions taking its specific features into account if certain unfavourable practical consequences of straightforward application of the Conventions are to be avoided(1).

22. This should not imply, however, a return to the system under the ordinary law of liability, as this would result in re-establishing rules that would make it much more difficult for potential victims to prove liability for damage suffered. It could be argued on the contrary that there would be a vital need in this case to be able to establish the relationship between the damage and its cause with the minimum of legal complications, in view of the specific circumstances of waste disposal. It might therefore turn out to be preferable for the strict liability system to continue to apply in accordance with procedures to be defined.

23. There is in fact a way of suspending the obligation to maintain the financial security on a permanent basis while continuing the Conventions' liability system, subject to a few adjustments if necessary: liability for this type of risk could be systematically transferred to the State (or a public body). Such a solution might be adopted if, as envisaged in many countries, the State itself took over the task of radioactive waste disposal as a kind of public service. This would amount to "collectivising" compensation for this type of damage without precluding some form of contribution from the nuclear operators concerned.

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(1) If it were decided that it would be factitious to maintain the application of the Conventions during the post-closure phase, the main adjustments required would concern the conditions for terminating the liability of the nuclear operator. This might be achieved indirectly by decommissioning the disposal facility, so that by ceasing to be the "nuclear operator" within the meaning of the Conventions, the operator would no longer have to meet the financial guarantee obligation. If so, then arrangements would have to be made for applying the time-limit for the bringing of claims so as to smooth the transition between activities relating to the pre-closure phase and those to the post-closure one. It is indeed important to prevent risk of confusion between damage arising from the pre-closure phase and from the post-closure one.

24. Although it might not be possible in some countries to transfer liability for waste after disposal to the State - but still on the principle that it would be desirable to prevent simply reverting to the ordinary rules of law - other mechanisms might be considered.

25. On the basis of previously adopted solutions for compensating other types of environmental damage, the authors of the Polvani Report had already suggested that the most suitable way of settling this matter might be to set up a special compensation fund covering all radioactive waste after disposal, to be administered or controlled by public authorities. Various types of contributions to this fund might be envisaged, beginning with contributions from the nuclear industry. The number of necessary disposal sites is likely to remain fairly small compared with that of the nuclear installations supplying the waste, at any rate during the near future, thus lending weight to a financing solution involving a contribution from all nuclear industries concerned on the basis of the Polluter Pays Principle.

26. It has been pointed out, however, that the management over such long periods of such a compensation fund would no doubt be extremely complex and financially unsound in view of the very low probability of any damage occurring. In particular, it would probably not be easy to assess the size of the reserve required to ensure compensation for this type of damage.

27. If the solution of setting up an actual compensation fund were set aside, for the reasons given above, one possibility that might be envisaged is to propose that the State and the nuclear operators concerned draw up preventive compensation agreements under which the State would undertake to compensate any nuclear damage caused by waste after disposal - no matter what time such damage might appear - in exchange for the payment of a fee by the operators.

28. Another possibility might consist in extending legislation which exists in various countries providing for State intervention to compensate victims of natural disasters to cover radioactive waste. The effect of this solution would be a transition from a liability to a compensation system and it would have the advantage of simplicity while at the same time ensuring that the break in the nuclear liability system would not result in potential victims being deprived of protection. In such a sensitive area, however, care should be taken that such an arrangement not be perceived by the public as a convenient way of justifying the ceasing of the protection supplied by the financial mechanisms under the Conventions.

29. Finally, it should not be forgotten that before opting for any given type of financial guarantee, countries will have to take into account various other factors - especially particular national circumstances - which affect the financing of long-term radioactive waste management (cf. Chapter V), and that such considerations might outweigh practical or strictly legal arguments.

V. FINAL COMMENTS

30. It may be concluded that no solution to the applicability of the nuclear third party liability system under the Conventions to the post-closure phase of radioactive waste disposal sites is clearcut at the present stage. The discussion of these highly complex and politically sensitive questions is far from being at an end and will continue in coming years. Their solution will necessarily be linked with the decisions to be taken by national authorities with regard to the other aspects of long-term radioactive waste management. Indeed, it may be argued that there is no real urgency to decide on how damage caused by waste after disposal should be compensated since most countries concerned are still at the stage of research and development of disposal methods. For the moment, it is therefore preferable to be content with the following conclusions:

- with regard to the pre-closure phase of waste management, it would seem justified to take the necessary steps to allow the effective application of the Conventions by means of appropriate modifications;

- for the post-closure phase, on the other hand, it would seem that the application of the Conventions would necessarily meet with both practical difficulties and difficulties of principle, requiring much more substantial changes which might perhaps be difficult to reconcile with the spirit of this system of liability. It would therefore seem necessary to continue the in-depth study of the type of compensation mechanism that would, in this case, be most suitable, taking into account both the interest of victims and the special characteristics of radioactive waste disposal;

- it would be desirable for the countries concerned to hold active consultations on the study of the arrangements that might be made in future in this field, with a view to international harmonization of the type achieved in the context of the Conventions on third party liability in the event of nuclear incidents.

Appendix

The Nuclear Third Party Liability System(1)

1. Measures adopted at national level to ensure compensation of damage caused by a nuclear incident are largely based on the provisions of several international Conventions(2), among which is the Paris Convention, adopted within the framework of OECD. This is not only the earliest Convention but also the first to have entered into force (1st April 1968). At present the Contracting Parties comprise 14 European NEA Member countries.

2. These Conventions have played a considerable part in promoting the harmonization of national legislation on third party liability for nuclear damage. Their basic provisions have been adopted by most industrialised countries, and even by countries which have not ratified or signed the Conventions. The following paragraphs summarise, for the purposes of the present Study, the main principles which form the basis of these Conventions.

3. The Nuclear Conventions have two main objectives which are perhaps best expressed in the preamble to the Paris Convention, where the Signatories state they are "desirous of ensuring adequate and equitable compensation for persons who suffer damage caused by nuclear incidents whilst taking the necessary steps to ensure that the development of the production and uses of nuclear energy for peaceful purposes is not thereby hindered". The Conventions therefore try to achieve, by combining several concepts, a balance of various interests. They provide an exceptional system in that they have been designed to regulate activities which would result in incidents for which the civil liability rules of the ordinary law were considered to be inadequate.

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(1) For a more detailed study of this system and current national legislations, see "Nuclear Third Party Liability", OECD/NEA, 1976.

(2)
- The Paris Convention on Third Party Liability in the Field of Nuclear Energy, signed in Paris on 29th July 1960, and amended in 1964 and 1982;
- the Brussels Convention supplementary to the Paris Convention, signed in Brussels on 31st January 1963, and amended in 1964 and 1982;
- the Vienna Convention on Civil Liability for Nuclear Damage, adopted on 21st May 1963, the purpose of which is to establish, on a worldwide level, a system similar to that of the Paris Convention.

4. The objective of protecting victims of nuclear incidents in all cases led the authors of the Conventions to adopt the basic principle that the operator of a nuclear installation is strictly liable for all damage caused by a nuclear incident in his installation or involving nuclear material (including radioactive waste) in the course of transport to or from his installation. The concept of strict liability has a long tradition and is based on the idea that a person engaging in a dangerous activity should compensate the resulting damage regardless of whether he was at fault (liability arising from the risk created). A corollary to the operator's strict liability is his exclusive liability. This means that no person other than the operator can be held liable for nuclear damage (e.g. a supplier or contractor of the operator). All liability is (legally) "channelled" to the operator, and he has a right of recourse only in a limited number of precisely defined cases. Under this system of liability, the victim has no need to prove a fault at the origin of an incident and identification of the person responsible is facilitated. Channelling liability to the operator has led to insurance being channelled to the same person, thus preventing a whole set of insurance policies from being taken out in turn by different people (engineers and architects, fuel or equipment suppliers or carriers for example) who might have been held liable under the ordinary rules of law.

5. Limitation of liability. The objective of not hindering the growth of the peaceful nuclear industry is achieved by limiting the operator's liability both as regards the amount of financial compensation and the period of time within which claims may be brought against him. This can be regarded as a counterpart to his no-fault liability. If the operator's burden of liability were unlimited in money and in time, he would be unable to find the corresponding financial security on the market (usually in the form of insurance) which he is obliged to take out in line with the amount of his liability as laid down by national legislation.

6. As regards the prescriptive period, the Conventions lay down that the right to compensation is extinguished if action is not brought within 10 years of the date of the nuclear incident. This period may be extended by the Installation State if financial security remains available. In the case of an incident caused by nuclear fuel or radioactive products or waste which, at the time of the incident, were stolen, lost or abandoned, the prescriptive period is calculated from the date of the incident but may in no case exceed 20 years from the date on which the operator liable lost control over these substances.

7. State intervention may be necessary in two cases. Firstly, when there is no or insufficient financial security available to cover the operator's liability (e.g. in case of bankruptcy of the insurer or financial guarantor). The second case concerns situations where the nuclear damage exceeds the amount of the operator's liability (and thus the corresponding financial security).

8. In nearly all OECD countries, supplementary compensation by public funds is planned and organised (with different modalities and conditions) to deal with such situations. This corresponds to the idea that the State, which licenses, controls and fosters nuclear activities, should be obliged to face the consequences of a catastrophic nuclear incident. This obligation can be seen as the logical consequence of limiting the operator's liability. It is closely linked to the main objective of the Nuclear Conventions, the protection of victims and the development of the nuclear industry. With this in mind, 13 Signatories of the Paris Convention have adopted the Brussels

Supplementary Convention under which Governments are required to provide compensation for nuclear damage beyond the amount already covered by the operator's financial security up to a maximum amount of 120 million EMA u/a(1). This Convention sets up a system of compensation in three stages. The first tier of compensation is covered by the operator's insurance coverage or other financial security. As a general rule the ceiling of this tier, depending on the national legislation considered, is between 5 and 15 million EMA u/a. The second tier, going up to 70 million EMA u/a, is covered by the Government of the country where the installation of the nuclear operator liable is situated. The third tier, for amounts above 70 million and going up to 120 million EMA u/a is covered jointly by the Parties to the Convention according to a formula based on gross national product and on the thermal power of the reactors situated in the territory of each Contracting Party.

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(1) European Monetary Agreement Unit of Account, defined in relation to the price of gold. In this connection it should be noted that in terms of the 1982 revision of the Paris and Brussels Conventions, the amounts indicated in this paragraph will be increased by a factor of 2.5 and expressed in Special Drawing Rights (SDR) of the International Monetary Fund. One SDR is worth approximately US$1.1.

ANNEX

SOME EXAMPLES OF RELEVANT NATIONAL LEGISLATION

This Annex gives further information, where appropriate, in respect of national legislation referred to in the text of the Study and dealing with radioactive waste management. It is divided into three sections:

A. LICENSING PROVISIONS
(see Chapter IV)

B. THE CREATION OF SPECIALISED BODIES IN THE FIELD OF RADIOACTIVE WASTE MANAGEMENT
(see Chapter IV)

C. FINANCING PROVISIONS
(see Chapter V)

A. LICENSING PROVISIONS

1. SWEDEN

Application of Act No. 140 of 21.4.1977 on special permits to load nuclear reactors with fuel. SFS of 3.5.1977 (text is reproduced in NLB 20) - see Chapter IV, paragraph 10.

The full extent of the provisions of this Act were first applied in December 1977 when the Swedish State Power Board asked the Government for special permission to load the Ringhals 3 nuclear reactor with nuclear fuel. A similar application concerning the Forsmark 1 nuclear reactor was made in April 1978. The Board supplied the following documents in support of its application:

- agreements between the Svensk Kärnbränsleförsörjning AB (The Swedish Nuclear Fuel Supply Company - SKBF)* and the French Compagnie Générale des Matières nucléaires (COGEMA) concerning the transport, storage and reprocessing etc. of spent fuel;

- an Agreement between SKBF, the Swedish State Power Board and Sydkraft AB defining the rights of the Swedish State Power Board with respect to these reprocessing agreements;

- A report on the first stage of the work of a Swedish Special Project Group dealing with the final storage of the high-level waste obtained from reprocessing.

In response to this application, the Swedish Government passed a Resolution on 5th October 1978 stating that the reprocessing agreement concluded by the applicant was in compliance with Act No. 140. However, the Government, for full compliance with the provisions of the Act, required additional geological studies to enable the applicant to guarantee the absolute safety of the storage site selected. The Government noted that while, in its opinion, Act No. 140 did not require that the applicant should specify the definite site for the repository, he should nevertheless demonstrate the existence of areas with the required characteristics. A supplementary geological investigation was therefore requested to establish the actual existence, presumed in the KBS report to exist, of a rock formation of the relevant depth and characteristics.

Pending the results of this investigation, the Government postponed its approval. In a communication of February 1979, the State Power Board declared (with a report in evidence) that the additional geological investigations had been completed in accordance with the Act, and made new applications to load Ringhals 3 and Forsmark 1. The Government thereupon directed the Swedish Nuclear Power Inspectorate to review the State Power Board's application. The

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(*) The name of this company has been changed into Svensk Kärnbränslehantering AB (SKB) Swedish Nuclear Fuel and Waste Management Co. as from 1st July 1984.

Inspectorate concluded in its findings that the measures taken satisfied both the requirements of the Act and the conditions imposed by the Government Resolution of 5th October 1978. In its report, the Inspectorate considered that the studies by the KBS demonstrated the existence of rock formations with the required characteristics and that the research methods and analyses by the KBS were appropriate. While recognising that these new studies showed that there were favourable practical possibilties for a repository for high-level radioactive waste, the Inspectorate did not consider that it was in a position to conclude that such possibilities did effectively exist. However, the Inspectorate did not think it necessary for new investigations to be undertaken: nothing in the additional studies made by the KBS led it to doubt its previously-stated favourable opinion. The Government therefore approved the applications.

2. SWITZERLAND

Summary of Federal Order of 6.10.1978 concerning the Atomic Energy Act. RO 1979, 816 (text is reproduced in NLB 23) - see Chapter IV, paragraphs 10 and 30.

This Order provides that a so-called general licence must be obtained from the Federal Council for the construction of a nuclear installation. This licence determines both the site and the general lines of the project, in particular:

- where nuclear reactors are concerned, the reactor system, the power category, the primary cooling system, the method of disposing of wastes during and after operation, as well as the approximate size and structure of the main buildings;

- where radioactive waste repositories are concerned, their storage capacity, the categories of waste, as well as the approximate structure of underground and surface constructions.

Amongst other conditions, it is provided that the general licence for nuclear reactors shall only be granted if the safe long-term storage and disposal of radioactive waste from the installation are guaranteed and if there are arrangements for decommissioning and possible dismantling disused installations. It is stipulated that any person producing radioactive waste is responsible for ensuring its safe disposal and for bearing the cost thereof and the Order further makes provisons for the setting up of a common fund to cover the expenses incurred in decommissioning nuclear installations (see Chapter V, paragraph 35, and Section C.13 below).

In addition to these provisions, the Order of 6th October 1978 provides that special permission, also from the Federal Council, must be granted before preparatory steps to estabish a waste repository can be taken. Detailed requirements as to the procedure to be followed in this respect, such as the plans and reports which must be submitted by the applicant, are contained in the Order on the preparatory measures taken in anticipation of the establishment of a radioactive waste repository of 24th October 1979 (See item 3 below).

3. SWITZERLAND

Summary of Federal Order of 24.10.1979 on measures taken in anticipation of the establishment of a radioactive waste repository (Order on preparatory measures). RS 732.012 - see Chapter IV, paragraph 12.

An applicant for a licence under the Swiss Order of 6th October 1978 (see preceding item) to undertake preparatory work for the setting up of a waste repository must attach several annexes to his application as follows:

- research programme;
- geological report;
- report on the effects of preparatory measures;
- general map;
- general plans;
- site plans;
- specific and detailed plans.

The research programme, which may be presented as a number of variants, shall provide full information on:

(a) objective and priorities to be set;

(b) supervision, execution and continuous planning of the work;

(c) preparatory measures under consideration and all information helping to define their scope and effects;

(d) territories and areas under consideration with details on, *inter alia*, built-up areas (population density, human activities, land-use) and unbuilt areas (forested, agricultural, protected, danger or other zones defined under Cantonal or Federal legislation);

(e) road, rail, waterway, etc.

The geological report shall provide all data available to the applicant on the nature of the soil and sub-soil, in particular:

(a) a geological description of the regions covered by the research programme, and data relating more specifically to the layers and formations concerned. Geological maps and cross-sections on the appropriate scale shall be appended;

(b) a brief description of the drilling tests already carried out in the regions under consideration, especially into the formation concerned, together with the results;

(c) a description of the geological and hydrological data having determined the selection of the regions covered by the research programme;

(d) an evaluation of the geological and hydrological factors that may affect the execution of the research programme.

The report on the effects of preparatory measures shall discuss the foreseeable effects - taking into account the current status of scientific and technological knowledge - of proposed preparatory measures, including effects of prior and subsequent work. In addition, the report shall take into account all requirements for the protection of individuals, other people's property or important rights, the protection of nature and the landscape, water and air, and noise abatement. The report shall in particular show that the preparatory measures and any prior or subsequent work do not jeopardise future uses of the land surface and sub-surface and do not impair the natural isolation property of geological layers.

The Order makes provision for publication, at national and local level, of the application and gives interested parties the right to lodge objections. Provision is also made for consulting the cantons and competent Federal departments or bodies. It should be noted that the granting of a licence to proceed with preparatory work in no way implies a right to a icence to set up a waste facility.

Finally, the Order provides that the Federal Council may appoint one or more Federal services, in collaboration with the cantons concerned, to carry out inspections to verify that the work is being carried out correctly.

4. UNITED STATES

Summary of licensing procedures for disposal of high-level radioactive wastes in geologic repositories. Nuclear Waste Policy Act of 1982, P.L. 97-425, and 10 C.F.R. Part 60 - see Chapter IV, paragraph 12.

Licence required

It is provided in the rule (paragraph 60.3) that the Department of Energy (DOE) shall not receive or possess source, special nuclear, or by-product material at a geologic repository operations area except as authorised by a licence issued by the Nuclear Regulatory Commission (NRC or Commission) pursuant to this part and DOE shall not commence construction of a geologic repository operations area unless it has filed an application with the Commission and has obtained construction authorisation as provided in this part. Failure to comply with this requirement shall be grounds for denial of a licence.

Pre-application Review

Site screening (P.L. 97-425, Sec. 112)

DOE, following consultation with federal and state officials and with the concurrence of the Commission, is required to issue guidelines for the recommendation of sites for repositories. DOE subsequently makes nominations of sites. These nominations are to be accompanied by environmental assessments which evaluate the suitability of the sites under the guidelines and assess the relevant regional and local impacts. (Prior to nomination, DOE is to hold public hearings near the site and is to notify state officials of the basis for the nomination). DOE recommends three of the nominated sites for site characterisation. Sites recommended to the President, and approved by him, may be characterised.

<u>Site characterisation</u> (P.L. 97-425, Sec. 113)

Before proceeding to sink shafts, DOE is to submit to the Commission and to state officials, for review and comment:

(1) a general plan for site characterisation activities, which plan shall include:

  (i) a description of the site;

  (ii) a description of site characterisation activities, including the following: the extent of planned excavations, plans for any onsite testing with radioactive or nonradioactive material, plans for any investigation activities that may affect the capability of the site to isolate high-level radioactive waste and spent nuclear fuel, and plans to control any adverse, safety-related impacts from site characterisation activities;

  (iii) plans for the decontamination and decommissioning of the site, and for the mitigation of any significant adverse environmental impacts caused by site characterisation activities if it is determined unsuitable for application for a construction authorisation for a repository.

(2) A description of the possible form or packaging for the high-level radioactive waste and spent nuclear fuel to be emplaced in the repository; and

(3) A conceptual repository design that takes into account likely site-specific requirements.

<u>Site recommendation</u> (P.L. 97-425, Sec. 114(a))

DOE may recommend to the President approval of a site upon completion of public hearings near the site and upon completion of site characterisation activities at not less than 3 sites. The recommendation is to be accompanied by:

(1) a description of the proposed repository, including preliminary engineering specifications;

(2) a description of the proposed waste form or packaging;

(3) a discussion of site characterisation data relating to safety of the site;

(4) a final environmental impact statement, including an analysis of consideration given to not less than 3 sites;

(5) preliminary comments of the Commission;

(6) comments from state officials, with the response of DOE.

The President may then submit a recommendation to Congress with respect to a site he considers qualified to be the subject of an application to the Commission.

State review (P.L. 97-425, Sec. 116(b))

A state may, within 60 days of the President's recommendation, file a notice of disapproval with Congress.

Congressional review (P.L. 97-425, Sec. 115)

A site which has been the subject of a state notice is disapproved unless Congress, within 90 days of continuous session, passes a resolution approving the site and such resolution becomes law. DOE may file a licence application once a site has been approved.

Licence Applications

Paragraph 60.21 provides that an application shall consist of general information and a Safety Analysis Report (an environmental report should also accompany the application). The general information shall include:

(1) A general description of the proposed geologic repository identifying the location of the geologic repository operations area, the general character of the proposed activities, and the basis for the exercise of licensing authority by the Commission;

(2) Proposed schedules for construction, receipt of waste, and emplacement of wastes at the proposed geologic repository operations area;

(3) A certification that DOE will provide at the geologic repository operations area such safeguards as it requires at comparable surface facilities (of DOE) to promote the common defense and security;

(4) A description of the physical security plan for protection against radiological sabotage. Since the radiation hazards associated with high-level wastes make them inherently unattractive as a target for theft or diversion, no detailed information need be submitted on protection against theft or diversion;

(5) A description of site characterisation work actually conducted by DOE at all sites considered in the application and, as appropriate, explanations of why such work differed from the description of the site characterisation programme described in the Site Characterisation Report for each site.

The Safety Analysis Report shall include:

(1) A detailed description and analysis of the site at which the proposed geologic repository operations area is to be located with appropriate attention to those features that might affect facility design and performance. It will be assumed that operations at the geologic repository operations area will be carried out at the maximum capacity and rate of receipt of radioactive waste stated in the application;

(2) A description and discussion of the design, both surface and subsurface, of the geologic repository operations area;

(3) A description and analysis of the design and performance requirements for structures, systems, and components of the geologic repository which are important to safety;

(4) A description of the quality assurance programme to be applied to the structures, systems and components of the geologic repository operations area important to safety and the engineered and natural barriers important to waste isolation;

(5) A description of the kind, amount, and specifications of the radioactive material proposed to be received and possessed at the geologic repository operations area;

(6) An identification and justification for the selection of those variables, conditions, or other items which are determined to be probable subjects of licence specifications;

(7) A description of the programme for control and monitoring of radioactive effluents and occupational radiation exposures;

(8) A description of the controls that the applicant will apply to restrict access and to regulate land use at the geologic repository operations area and adjacent areas, including a conceptual design of monuments which would be used to identify the controlled area after permanent closure;

(9) Plans for coping with radiological emergencies at any time prior to permanent closure of the facility;

(10) A description of the nuclear material control and accounting programme;

(11) A description of design considerations that are intended to facilitate permanent closure;

(12) A description of plans for retrieval and alternate storage of the radioactive wastes should the geologic repository prove to be unsuitable for disposal of radioactive wastes;

(13) An identification of the natural resources at the site, the exploitation of which could affect the ability of the site to isolate radioactive wastes;

(14) An identification of those structures, systems and components of the geologic repository, both surface and sub-surface, which require research and development to confirm the adequacy of design. For structures, systems and components important to safety, and for the engineered and natural barriers important to waste isolation, the DOE shall provide a detailed description of the programmes designed to resolve safety questions, including a schedule indicating when these questions will be resolved;

(15) The following information concerning activities at the geologic repository operations area:

(i) The organisational structure of DOE, including a description of any delegations of authority and assignments of responsibilities, whether in the form of regulations, administrative directives, contract provisions, or otherwise;

(ii) Identification of key positions which are assigned responsibility for safety at and operation of the geologic repository operations area;

(iii) Personnel qualification and training requirements;

(iv) Plans for start-up activities and start-up testing;

(v) Plans for conduct of normal activities, including maintenance, surveillance, and periodic testing of structures, systems, and components of the geologic repository operations area;

(vi) Plans for permanent closure;

(vii) Plans for any uses of the geologic repository operations area for purposes other than disposal of radioactive wastes, with an analysis of the effects, if any, that such uses may have upon the operation of the structures, systems and components important to safety and the engineered and natural barriers important to waste isolation.

Licence Issuance and Termination

After the granting of a construction authorisation, which includes such conditions as the Commission finds to be necessary to protect the health and safety of the public, the common defense and security, or environmental values, the Commission will, if satisfied that construction has been substantially completed in conformity with the application and that all safety requirements have been satisfied, issue a licence to receive and possess source, special nuclear or by-product material. Naturally, this licence, which may at any time be revoked, suspended or amended, will include such conditions as the Commission finds necessary (paragraph 60.42 et seq.). The overall system performance objective that must be satisfied in licensing activities at a geologic repository is stated as follows (paragraph 60.112):

> The geologic setting shall be selected and the engineered barrier system and the shafts, boreholes and their seals shall be designed to assure that releases of radioactive materials to the accessible environment following

permanent closure conform to such generally applicable environmental standards for radioactivity as may have been established by the Environmental Protection Agency with respect to both anticipated processes and events and unanticipated processes and events.

The "accessible environment" means (1) the atmosphere, (2) the land surface, (3) surface water, (4) oceans, and (5) the portion of the lithosphere that is outside the controlled area. The "controlled area" means a surface location, to be marked by suitable monuments extending horizontally no more than 10 kilometers in any direction from the outer boundary of the underground facility, and the underlying subsurface, which area has been committed to use as a geologic repository and from which incompatible activities would be restricted following permanent closure. Lands in the controlled area are to be held by DOE free and clear of all significant encumbrances; and DOE is to exercise such controls (including water rights) outside the controlled area necessary to prevent adverse human actions that could significantly reduce the geologic repository's ability to achieve isolation (paragraphs 60.2 and 60.121).

"Anticipated processes and events" means those natural processes and events that are reasonably likely to occur during the period the intended performance objective must be achieved. To the extent reasonable in the light of the geologic record, it shall be assumed that those processes operating in the geologic setting during the Quaternary Period continue to operate but with the perturbations caused by the presence of emplaced radioactive waste superimposed thereon (paragraph 60.2).

"Unanticipated processes and events" means those processes and events affecting the geologic setting that are judged not to be reasonably likely to occur during the period the intended performance objective must be achieved, but which are nevertheless sufficiently credible to warrant consideration. Unanticipated processes and events may be either natural processes or events or processes and events initiated by human activities other than those licenced under this part. Processes and events initiated by human activities may only be found to be sufficiently credible to warrant consideration if it is assumed that: (1) the monuments provided for by this part are sufficiently permanent to serve their intended purpose; (2) the value to future generations of potential resources within the site can be assessed adequately under the applicable provisions of this part; (3) an understanding of the nature of radioactivity, and an appreciation of its hazards, have been retained in some functioning institutions; (4) institutions are able to assess risk and to take remedial action at a level of social organisation and technological competence equivalent to, or superior to, that which was applied to initiating the processes or events concerned; and (5) relevant records are preserved, and remain accessible, for several hundred years after permanent closure (paragraph 60.2).

It is provided (paragraph 60.51) that the DOE shall submit an application to amend the licence prior to permanent closure. The application shall consist of an up-date of the licence application (and environmental report), including:

(1) A description of the programme for monitoring of the geologic repository after permanent closure;

(2) A detailed description of the measures to be employed - such as land-use controls, construction of monuments, and preservation of records - to regulate or prevent activities that could impair the long-term isolation of emplaced waste within the geologic repository and to assure that relevant information will be preserved for the use of future generations. As a minimum, such measures shall include:

(i) Identification of the controlled area and geologic repository operations area by monuments that have been designed, fabricated and emplaced to be as permanent as is practicable; and

(ii) Placement of records in the archives and land record systems of local, State, and Federal government agencies, and archives elsewhere in the world, that would be likely to be consulted by potential human intruders - such records to identify the location of the geologic repository operations area, including the underground facility, boreholes and shafts, and the boundaries of the controlled area, and the nature and hazard of the waste.

(3) Geologic, geophysical, geochemical, hydrologic, and other site data that are obtained during the operational period pertinent to the long-term isolation of emplaced radioactive wastes;

(4) The results of tests, experiments, and any other analyses relating to backfill of excavated areas; shaft sealing, waste interaction with the host rock, and any other tests, experiments, or analyses pertinent to the long-term isolation of emplaced wastes within the geologic repository;

(5) Any substantial revision of plans for permanent closure;

(6) Other information bearing upon permanent closure that was not available at the time a licence was issued.

Following permanent closure, the DOE may apply for an amendment to terminate the licence. A licence shall be terminated only when the Commission finds with respect to the geologic repository:

(1) that the final disposition of radioactive wastes has been made in conformance with the DOE's plan, as amended and approved as part of the licence;

(2) that the final state of the geologic repository operations area site conforms to the DOE's plans for permanent closure, as amended and approved as part of the licence.

5. B E L G I U M

Royal Order of 28.2.1963. Moniteur Belge of 16.5.1963 - see Chapter IV, paragraph 15.

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Section 17 - Ceasing of activities:

If activity ceases, for any reasons whatsoever, at a Class I or II installation where radioactive substances or equipment containing such substances are present, the company or, where applicable, the persons legally entitled to wind up the company must notify the Ministre de la Santé Publique et de la Famille immediately. They must also notify the authorities named in Section 78 of this Order.

They must decide on a suitable destination for these substances or equipment ensuring that they are disposed of or re-used under satisfactory conditions.

The same shall apply when the competent authority has refused, suspended or withdrawn the licence and when such decision is final.

If the party responsible or the persons winding up the installation fail to meet this requirement, the above-mentioned substances or equipment may be seized without prejudice to the application of the penalties laid down in this Order.

B. SPECIALISED BODIES IN THE FIELD OF RADIOACTIVE WASTE MANAGEMENT

6. F R A N C E

ANDRA - Note on Order of 7.11.1979 : J.O. N° 261 of 10.11.1979 - see Chapter IV, paragraph 28.

I. Tasks and structure of ANDRA

Set up within the French Atomic Energy Commission (CEA), ANDRA is responsible, at national level, for long-term radioactive waste management operations in accordance with the legislative and regulatory provisions and in application of the general policy defined by the government, and in particular for:

- managing long-term storage facilities either directly or through third parties acting on its behalf;

- designing, siting and constructing new long-term storage centres and carrying out all necessary studies to this end, including estimates of future waste production;

- laying down specifications, in collaboration with waste producers, for the conditioning and storage of radioactive waste before its removal to a central storage facility;

- contributing to research work concerning methods for long-term management of radioactive waste and their fate.

The Agency is consulted with regard to research and development programmes as well as proposed radioactive waste management legislation.

It has a Board of Management and a Scientific and Technical Advisory Panel. The Board is chaired by the Administrator General of CEA and comprises the High Commissioner for Atomic Energy, the Director General for Energy and Raw Materials or his representative, the Head of the Control Department of the CEA, the Managing Director of EDF (the national company for the production of electricity) or his representative, the Head of COGEMA, a wholly-owned CEA subsidiary covering all activities relating to the nuclear fuel cycle, or his representative, a CEA director, a representative of the other waste producers appointed on the proposal of the Minister responsible for hospitals and four other persons eligible because of their qualifications, including the director of the National Agency for Waste Recovery and Disposal.

The Scientific and Technical Advisory Panel is chaired by the High Commissioner for Atomic Energy, and comprises the CEA Principal Delegate for Safety Matters, the Director of the Nuclear Health and Safety Institute (IPSN), four prominent scientists and four leading radioactive waste specialists. The Director General for Energy and Raw Materials, the Secretary General of the Inter-Ministerial Committee on Nuclear Safety, the Director for Pollution Prevention, the Head of the Central Service for the Safety of Nuclear Installations (SCSIN), and the Head of the Central Service for Protection Against Ionizing Radiation (SCPRI) are entitled to attend meetings of the Scientific and Technical Advisory Panel.

These structures reflect government policy which is to:

- apply the most recent advances in science and technology to radioactive waste management - the role of ANDRA's Scientific and Technical Advisory Panel, chaired by the High Commissioner for Atomic Energy;

- associate top experts and the various waste producers with waste management - the task of the Board of Management, chaired by the Administrator General of CEA.

A storage centre is, strictly speaking, an industrial installation and since 1963 has been regarded as an "Installation nucléaire de base", (i.e. large nuclear installation). The nuclear operator, ANDRA, cannot delegate responsibility and must therefore comply with the regulations governing such installations, both as regards the application procedure for a licence to set up a new storage centre and as regards inspections of an existing centre by SCSIN for the safety aspects and SCPRI to check there is no environmental impact. ANDRA first proposes disposal policies and industrial solutions, the safety authorities then give their opinion and the supervisory authorities take the decision.

II. Financing of ANDRA activities

The activities of ANDRA, which is a public service, are financed by waste producers as follows:

- operating costs for storage centres and running costs for ANDRA are directly invoiced to its waste "suppliers";
- specific investment projects, i.e. those concerning the storage of highly special types of waste owned by clearly identified parties are pre-financed by the latter;
- other capital investments, referred to as "common investment projects", are financed from the Agency's own resources and loans, with interest paid each year by the waste producers under waste-handling contracts.

III. Performance of ANDRA's tasks

ANDRA has a variety of tasks to carry out, which it entrusts to outside parties, indicating the targets to be met.

It uses an operator, usually an industrial firm, to manage the storage centres under ANDRA's responsibility.

For research and studies, ANDRA uses the operational units of the CEA, in particular the Nuclear Health and Safety Institute, the Division of Metallurgy and Study of Nuclear Fuel, the Division of Waste Reprocessing and Applied Chemistry (the latter has set up a Containment Evaluation and Control Office to deal with ANDRA work), and outside bodies such as the Geological and Mining Research Bureau, the Ecole Polytechnique and Ecoles des Mines.

Engineering and construction work is contracted out to consultancy and industrial firms.

7. B E L G I U M

ONDRAF - Summary of the Royal Order of 30.3.1981: Moniteur Belge of 5.5.1981 - see Chapter IV, paragraph 29.

I. Tasks and structure of ONDRAF

ONDRAF has powers in the following fields:

(a) removal of conditioned or non-conditioned radioactive waste and spent fuel from waste-producing facilities and transport of enriched fissile material or plutonium material as defined in Section 1 of this Order;

(b) conditioning of radioactive waste on behalf of holders who do not have adequate facilities for this purpose;

(c) storage of radioactive waste outside the facilities of waste producers before conditioning and/or disposal;

(d) storage of spent fuel outside the power plant or reprocessing plant facilities;

(e) disposal of conditioned radioactive waste;

(f) storage of plutonium material in accordance with Section 1 of this Order;

(g) any other field for which it is competent, as determined by Royal Order approved by the Council of Ministers.

Without prejudice to the application of the legislation and rules on protection of the public against the hazards of ionizing radiation, ONDRAF's tasks in the fields defined above are as follows:

(a) to ensure that the quality of the conditioned radioactive waste and conditioning of such waste complies with the standards laid down by the appropriate authorities and to approve waste finally for disposal;

(b) to propose - in consultation with waste holders - conditioning and containment methods to be applied by the latter;

(c) to ensure that any non-conditioned waste it handles complies with the standards laid down by the appropriate authorities and to propose acceptance criteria for such waste;

(d) to ensure that the spent fuel and plutonium material it stores complies with the standards laid down by the appropriate authorities and to propose acceptance criteria for such fuel and material;

(e) to make research and development proposals; within the scope of its responsibilities; on the conditioning, storage and disposal of radioactive waste.

ONDRAF is under the supervision of the Minister of Economic Affairs. It is administered by a Board of Directors consisting of 20 members representing solely the public sector. However, ONDRAF is required to carry out its work in close consultation with the industrial companies concerned and in particular with the holders of radioactive waste. Consultations with these companies are organised on a continuous basis within a Standing Technical Committee reporting to the ONDRAF management. The Committee's role is strictly advisory and the Board of Directors is the final decision-making body.

II. Financing of ONDRAF's activities

Section 14 of the Royal Order specifies that:

(1) all costs connected with ONDRAF's activities have to be met by the firms or bodies for which the services have been performed;

(2) the costs, assessed "at cost", are divided among the beneficiaries of these services on the basis of objective criteria laid down by the Board of Directors;

(3) on a proposal from the Board of Directors and taking the opinion of the Standing Technical Committee, the Minister of Economic Affairs decides, as applicable, the cost components to be included in the calculation of fees to be charged by ONDRAF to those using the services in order to cover its expenses, in accordance with Paragraph 1 of this Section, and also the procedural conditions whereby users of its services make their contributions.

In all cases, operating costs, financial costs and tax repayments plus the constitution of a reserve for renewal purposes, have to be included.

On the basis of these components, the Board of Directors determines what the fees should be after consulting the Standing Technical Committee.

In addition to these resources (and to the working capital paid in by the State as a starting fund), ONDRAF is authorised to issue loans in order to finance its capital investment, and subject to the agreement of the Minister of Economic Affairs, is empowered to constitute a fund for financing long-term projects.

III. Performance of ONDRAF's tasks

Sections 3 and 4 of the Order lay down that any holder of enriched fissile material or plutonium material and any person holding radioactive waste, operating installations producing radioactive waste or intending to construct such installations must be registered with ONDRAF and supply the latter with all necessary information for the performance of its tasks.

For the taking over of the radioactive material or waste with a view to its transport, conditioning, storage and/or disposal, there has to be an agreement between the holder of the waste and ONDRAF. Such agreements specify the procedures for the transfer of responsibility and the relevant financial and technical conditions.

ONDRAF carries out its industrial tasks in two main ways. It can either carry out the transport, storage, conditioning or disposal operations itself or it can entrust them to third parties under its own responsibility. It may also, though temporarily only, decide to have some of these operations carried out by third parties to avoid having to review certain current contracts (e.g. reprocessing contracts) in which transport is entrusted to the foreign contractor.

8. S W E D E N

Act of 18.6.1981 on the financing of future expenditure for spent nuclear fuel etc. SFS 1981 : 669 - see Chapter IV, paragraph 33 and Chapter V, paragraph 26(a).

Section 1

The holder of a licence pursuant to the Nuclear Energy Act (1956 : 306) to own or operate a nuclear reactor for power generation (the reactor owner) shall be responsible for ensuring that:

(1) nuclear fuel irradiated in the reactor and radioactive waste deriving therefrom is handled and disposed of in a safe manner;

(2) the reactor facility will be shut down and dismantled in a safe manner; and

(3) such research and development activities are conducted and other measures taken as are required to ensure compliance with the provisions under paragraphs 1 and 2 above.

Section 2

In addition to the costs resulting from its obligations pursuant to Section 1, the reactor owner shall also be liable in respect of costs incurred by the State for:

(1) research and development activities supplementary to those referred to in Section 1, paragraph 3;

(2) review of the matters referred to in the second paragraph of Section 5 and in Section 10; and

(3) surveillance and inspection of final repositories.

Section 3

In consultation with other reactor owners, the reactor owner shall establish a programme for such research and development activities and other measures as are referred to in Section 1. The programme shall contain an outline of all measures which may become necessary and shall specify in more detail the measures intended to be implemented within a period of at least the next five years. The programme shall be annually updated.

The programme shall be submitted annually to the Government or to the authority designated by it.

Section 4

The authority designated by the Government shall establish a programme of the activities referred to in Section 2, paragraphs 1 and 3.

Section 5

In order to ensure the availability of funds to cover the costs resulting from the reactor owner's obligations pursuant to Section 1 and the costs referred to in Section 2, an annual fee shall be payable by the reactor owner to the State for such time as the reactor is in operation. As far as the costs for the handling and final disposal of spent nuclear fuel are concerned, the obligation to pay the annual fee shall relate to such costs attributable to the fuel after its removal from the reactor facility. The fee shall be proportionate to the energy delivered by the reactor facility.

The amount of the fee shall be established annually in respect of the succeeding calendar year by the Government or the authority designated by it.

The annual fee shall be established such that the aggregate amount of fees paid during the operating life of the reactor shall cover the costs referred to in the first paragraph of this Section 5.

Section 6

The annual fee shall be established on the basis of the programme referred to in Sections 3 and 4 and the estimated expenditure in respect of the measures referred to in Sections 1 and 2. With regard to measures referred to in Section 1, consideration shall be given to measures previously adopted for the disposal of spent nuclear fuel and radioactive waste deriving therefrom, to the characteristics of the reactor, and to other circumstances which may influence the calculation of the fee.

If the basis for the calculation of the fee is lacking or inadequate, the fee shall be established at a reasonable amount.

Section 7

The fee shall be paid to the authority designated by the Government. Collected fees shall be deposited by it in an interest-bearing account with the National Bank of Sweden. Accrued interest shall be capitalized.

Section 8

Loans may be granted to a reactor owner out of the fees paid in by it against the provision of collateral.

Such loans shall carry interest at a rate no less than that given by the National Bank of Sweden on the collected fees deposited with it. Interest paid shall be deposited in the account referred to in Section 7 and shall be capitalised.

Loans shall otherwise be subject to such terms and conditions as are required to ensure the availability of funds for the purposes referred to in Section 9.

Section 9

Fees paid by a reactor owner may be used in reimbursement of the costs incurred by the reactor owner in respect of measures referred to in Section 1, subject to the limitation resulting from the provision in the second sentence of the first paragraph of Section 5, and further to defray the costs incurred by the State in respect of measures referred to in Sections 1 and 2 which are attributable to the reactor or to fuel utilised in the reactor.

Section 10

Matters relative to supplementary research and development activities, surveillance and inspection of final repositories, loans to reactor owners out of remitted fees and the terms and conditions of such loans, as well as the application of collected fees shall be reviewed by the Government or the authority designated by it.

Section 11

Upon request, the reactor owner shall provide such information and such documents as are necessary for the Government or the authority designated by it to establish the fee in accordance with the second paragraph of Section 5 and to review the matters referred to in Section 10. To the extent required for the aforementioned purposes, the reactor owner upon request shall further grant access to facilities or sites where spent nuclear fuel or radioactive waste deriving therefrom is stored or handled.

Section 12

Anyone who, intentionally or through gross negligence, provides incorrect information or otherwise disregards his obligations pursuant to Section 11 shall be liable to a fine, unless the deed is punishable under the Criminal Code.

NB. This Act shall come into effect on 1st July 1981, provided that the provisions of the first paragraph of Section 5 shall apply as from calendar year 1982.

9. S W E D E N

Ordinance of 30.6.1981 on the financing of future expenditure for spent nuclear fuel, etc. SFS 1981 : 671 - see Chapter V, paragraph 33.

This Ordinance specifies that the newly erected National Board for Spent Nuclear Fuel is responsible for carrying out the supervising and financial duties laid down in the corresponding Act (see previous item). It contains detailed provisions on the contents of the different programmes of activities mentioned in the Act and lays down rules as to the payment of fees and management of the fund, as follows:

Section 1

The National Board for Spent Nuclear Fuel settles questions and otherwise performs the functions set forth in Sections 4, 7 and 10 of the Act (1981: 669) on financing of future expenditure for spent nuclear fuel etc.

Section 2

The programme referred to in the first paragraph of Section 3 of the Act on financing of future expenditure for spent nuclear fuel etc. shall be submitted to the National Board for Spent Nuclear Fuel no later than the month of June of each year.

Section 3

The programme of activities referred to in Section 4 of the Act on financing of future expenditure for spent nuclear fuel etc. shall:

(1) contain an outline of the complementary research and development activities that may be necessary as well as an account of the measures that have to be taken in this respect within a period of at least 5 years;

(2) contain an outline of whatever measures may be required for surveillance and inspection of final repositories;

(3) describe the measures that, beyond those stipulated by the programme referred to in Section 2, have to be taken for the handling and final disposal of spent nuclear fuel and radioactive waste deriving from such fuel and for the safe decommissioning and dismantling of the reactor installations.

The programme shall be prepared by no later than the end of October. The programme shall be sent to the reactor owners or to an agent of the reactor owners.

Section 4

The National Board for Spent Nuclear Fuel shall, by no later than the end of October, submit to the Government the programmes referred to in Sections 2 and 3, along with its own recommendation for fees for the following calendar year.

Section 5

The fee referred to in Section 5 of the Act on financing of future expenditure for spent nuclear fuel etc. shall be paid quarterly, no later than one month after the end of each quarter.

Section 6

Loans may be granted to a reactor owner up to an amount corresponding on each occasion to no more than 75 per cent of the sum of the fees that have been remitted by the reactor owner, less what can be assumed will be used during the loan period.

Section 7

The National Board for Spent Nuclear Fuel is empowered to decide how and to what extent remitted fees may be used to pay the costs of a reactor owner during a given period of time in the future for measures included in the basis for determining the fee.

Section 8

Remitted fees shall be disbursed in advance for the calendar quarter to cover the costs of measures for which payment falls due or is expected to fall due during the quarter. Disbursements shall only be made for costs of measures referred to in Section 1 of the Act on financing of future expenditure for spent nuclear fuel etc. and included in the basis for determining the fee.

Section 9

Decisions taken by the National Board for Spent Nuclear Fuel under the provisions of the Act on financing of future expenditure for spent nuclear fuel etc. may be appealed to the Government through due appeals procedure.

NB. This Ordinance shall enter into effect on 1st July 1981.

10. FEDERAL REPUBLIC OF GERMANY

Act of 20.8.1980 to amend the cost provisions of the Atomic Energy Act - BGBl I, p. 1556 - see Chapter IV, paragraph 35.

. . . .

Section 21(a)

Costs, fees and expenses or remunerations for the use of facilities according to Section 9(a), paragraph 3(*).

(1) Persons liable to deliver radioactive wastes shall be charged with costs (fees and expenses) for the use of facilities mentioned in Section 9(a), paragraph 3.

. . . .

(2) The facts entailing liability for costs under paragraph 1 of this Section may be defined in detail by statutory Ordinance, on which occasion fixed rates or skeleton rates may be provided. The rates of the fees shall be assessed in such a manner that they will cover the costs, estimated in accordance with managerial principles, of the current administration and maintenance of the facilities referred to in Section 9(a), paragraph 3. In order to cover investment expenditure for collecting facilities at Land (state) level, a standard fee may be charged in connection with the use of such facilities. In the assessment of the costs or remunerations charged in the case of delivery of wastes to a collecting facility at Land (state) level, the expenditures incurred for the subsequent transfer to Federal facilities, as well

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(*) (= Facilities of the Federation for the safekeeping and ultimate storage of radioactive wastes and collecting facilities (points) of the constituent states (Länder) for the interim storage of the radioactive wastes).

as advance payments under Section 21(b), paragraph 2, may be included. They shall be paid over to the Federation.

Section 21(b)

Contributions

(1) In order to cover the necessary expenditure for the planning, the acquisition of real property and rights in land, the facility-related research and development, the construction, the extension and the renewal of Federal facilities mentioned in Section 9(a), paragraph 3, a person obliged to transfer radioactive substances to a Federal facility ... shall be charged with contributions. The necessary expenditure shall also comprise the value of the property and rights made available from the assets of the body responsible for the facility, which shall be the value of such property and rights at the time when they are made available.

Any person who has filed an application, in accordance with Sections 6, 7 or 9 (*), or in accordance with a statutory ordinance issued under this Act, for a licence to handle radioactive substances and to generate ionizing radiation, or to whom such a licence has been granted, may be required to make advance payments on the contribution if it has to be expected, on the basis of the activity subject to licensing or of the operation of the facility, that the obligation to transfer radioactive wastes to Federal facilities mentioned in Section 9(a), paragraph 3 will arise.

(2) Further details with regard to the charging of, exemption from, and prolongation of payment, and the remission and reimbursement of contributions and of advance payments may be regulated by statutory Ordinance.

. . . .

(*) Section 6: Storage of nuclear fuel.
Section 7: Constructing or operating installations for the production, treatment, processing or fission of nuclear fuel or for the reprocessing of irradiated nuclear fuel.
Section 9: Treatment, processing and the utilisation of nuclear fuel outside of installations mentioned in Section 7.11.

Ordinance of 28.4.1982 concerning advance financial contributions for the construction of federal installations for the safe containment and disposal of radioactive waste - BGBl 1982 I, p. 562 - see Chapter IV, paragraph 35 and Chapter V, paragraph 26(c).

Section 1

Levying of advance contributions

In order to cover the required costs for federal installations under Section 9(a), subsection 3 of the Atomic Energy Act, the Federal Institute for Physics and Technology (Physikalisch-Technische Bundesanstalt) shall levy, according to this Ordinance, advance payments on the contributions to be paid according to Section 21(b) of the Atomic Energy Act (see previous item).

Section 2

Persons liable to pay

(1) Advance payments shall be levied from any person who (i) has been granted a licence under Sections 6, 7 or 9 of the Atomic Energy Act or Section 3 of the Radiation Protection Ordinance; or (ii) has applied for a license under Section 7 of the Atomic Energy Act for an installation for the reprocessing of irradiated fuels, if it is to be expected that the activity to be licensed or the operation of the installation will lead to an obligation to transfer radioactive waste to federal installations under Section 9(a), subsection 3 of the Atomic Energy Act.

(2) Licenses according to Section 3 of the Radiation Protection Ordinance shall not be taken into account, if other radioactive substances are handled in connection with an activity for which a licence has been issued under the Atomic Energy Act according to subsection 1, No. 1 above.

(3) No contributions shall be requested from the collecting points of the Länder.

(4) Levying of advance payments may be dispensed with if the activity subject to a licence or the operation of the installation generates only small amounts of radioactive waste with a low specific activity.

Section 3

Nature and extent of expenditure

Advance payments may be levied if necessary expenditure has been incurred for:

(1) research and development in connection with the installation;

(2) acquisition of immovable property and rights;

(3) planning;

(4) construction, extension and renewal.

Section 4

Calculation of expenditure

(1) The necessary expenditure shall be calculated according to real costs.

(2) Before the beginning of each calendar year, the works foreseen for such calendar year must be published and a cost estimate established.

(3) The total necessary expenditure shall be determined following each calendar year.

Section 5

Notice of advance payments

(1) Advance payments shall be levied by notice.

(2) The notice shall justify the total necessary expenditure for the period covered by such notice. Expenditure shall be broken down according to the measures taken and the method shall be given for calculating the contribution of the person directed to pay according to Section 6.

(3) If it is to be expected that there will be a considerable change in expenditure during the following period, the notice shall contain an indication to that effect.

Section 6

Apportionment of expenditure

(1) The necessary expenditure shall be apportioned as follows:

(i) 75.5 per cent shall be attributed to persons directed to pay who have been granted a licence according to Section 7 of the Atomic Energy Act for an installation for the reprocessing of irradiated fuel with a capcacity of more than 50 t/y or who have applied for such a licence;

(ii) 4 per cent shall be attributed to persons liable to pay who have been granted a licence according to Section 7 of the Atomic Energy Act for an installation for the reprocessing of irradiated fuels with a capacity of up to 50 t/y;

(iii) 17.5 per cent shall be attributed to persons liable to pay who have been granted a licence according to Section 7 of the Atomic Energy Act for an installation for the fission of nuclear fuel with an electrical capacity of more than 200 megawatts;

(iv) 3 per cent shall be attributed to persons liable to pay who have been granted another licence according to Section 7 of the Atomic

Energy Act, a licence according to Sections 6 or 9 of the Atomic Energy Act or according to Section 3 of the Radiation Protection Ordinance.

(2) Before the apportionment under subsection 1 above, the necessary expenditure shall be reduced by the sum of the costs and fees levied during the year in question by the collecting points of the Länder for disposal and transferred to the Federal Institute for Physics and Technology, to the extent that such costs and fees are destined to cover expenditure according to Section 3 above.

(3) Expenditure shall be apportioned among persons liable to pay under subsection 1, Nos. 1 to 3 according to the capacity of each installation. Expenditure shall be apportioned among persons liable to pay under subsection 1, No. 4 according to the average amount of radioactive waste to be transferred to federal installations under Section 9(a), subsection 3 of the Atomic Energy Act and generated in the last three years prior to levying the advance payments.

(4) In the case where federal installations under Section 9(a), subsection 3 of the Atomic Energy Act are established exclusively for radioactive wastes coming from certain persons liable to pay, expenditure shall be apportioned according to the amounts of radioactive waste attributable to each such person if such amounts are fixed at the time of levying the advance payment; in other cases subsection 3 shall apply.

Section 7

Due date of advance payments

Advance payments shall be due one month after receipt of the notice of advance payment unless instalments have been fixed.

Section 8

Reimbursement of advance payments

Advance payments shall be reimbursed if the conditions required for their levying according to Section 2, subsection 1 become inapplicable later. Upon reimbursement the advance payments shall bear an interest of 2 per cent above the discount rate of the Federal Bank.

Section 9

Crediting of advance payments

Advance payments levied according to this Ordinance shall be credited to the contributions and advance payments to be levied according to a final regulation pursuant to Section 21(b) of the Atomic Energy Act. In so doing advance payments shall bear an interest of 2 per cent above the discount rate of the Federal Bank.

Section 10

Advance payments for expenditure incurred before the entry into force of this Ordinance

Advance payments shall be levied for the necessary expenditure incurred as from 1st January 1977. The total expenditure covering the period before the entry into force of this Ordinance shall be determined according to Section 4, and two-thirds thereof shall be levied after the entry into force of this Ordinance. One-third of this expenditure shall be levied together with the first levying of advance payments for the expenditure incurred after the entry into force of this Ordinance.

Section 11

Berlin clause

This Ordinance shall also apply to the Land Berlin in accordance with Section 14 of the Third Transition Act in conjunction with Section 58 of the Atomic Energy Act.

Section 12

Entry into force

(1) This Ordinance shall come into force on the day after its publication.

(2) Section 7, subsection 2 of the Cost Ordinance of 17th December 1981 (BGBl I, p. 1457) shall come into force at the same time.

(3) This Ordinance shall cease to have effect on 31st December 1986 at the latest.

12. UNITED STATES

Extract from "Nuclear Waste Policy Act of 1982", Federal Register, Vol. 3, No. 20, 7th January, 1983 - See Chapter IV, paragraphs 11 and 12 and Chapter V, paragraph 26(b).

. . . .

Nuclear Waste Fund

Section 302 (a)

Contracts

(1) In the performance of his functions under [the Nuclear Waste Policy Act], the Secretary is authorised to enter into contracts with any person who generates or holds title to high-level radioactive waste, or spent nuclear fuel, of domestic origin for the acceptance of title, subsequent transportation and disposal of such waste or spent fuel.

Such contracts shall provide for payment to the Secretary of fees pursuant to paragraphs (2) and (3) sufficient to offset expenditures described in subsection (d).

(2) For electricity generated by a civilian nuclear power reactor and sold on or after the date 90 days after the date of enactment of this Act, the fee under paragraph (1) shall be equal to 1.0(*) mil per kilowatt-hour.

(3) For spent nuclear fuel, or solidified high-level radioactive waste derived from spent nuclear fuel, which fuel was used to generate electricity in a civilian nuclear power reactor prior to the application of the fee under paragraph (2) to such reactor, the Secretary shall, not later than 90 days after the date of enactment of this Act, establish a one time fee per kilogram of heavy metal in spent nuclear fuel, or in solidified high-level radioactive waste. Such fee shall be in an amount equivalent to an average charge of 1.0 mil per kilowatt-hour for electricity generated by such spent nuclear fuel or such solidified high-level waste derived therefrom, to be collected from any person delivering such spent nuclear fuel or high-level waste, pursuant to Section 123, to the Federal Government. Such fee shall be paid to the Treasury of the United States and shall be deposited in the separate fund established by subsection (c) 126(b). In paying such a fee the person delivering spent fuel, or solidified high-level radioactive wastes derived therefrom, to the Federal Government shall have no further financial obligation to the Federal Government for the long-term storage and permanent disposal of such spent fuel, or the solidified high-level radioactive waste derived therefrom.

(4) Not later than 180 days after the date of enactment of this Act, the Secretary shall establish procedures for the collection and payment of the fees established by paragraph (2) and paragraph (3). The Secretary shall annually review the amount of the fees established by paras. (2) and (3) above to evaluate whether collection of the fee will provide sufficient revenues to offset the costs as defined in subsection (d) herein. In the event the Secretary determines that either insufficient or excess revenues are being collected, in order to recover the costs incurred by the Federal Government that are specified in subsec. (d), the Secretary shall propose an adjustment to the fee to insure full cost recovery. The Secretary shall immediately transmit this proposal for such an adjustment to Congress. The adjusted fee proposed by the Secretary shall be effective after a period of 90 days of continuous session have elapsed following the receipt of such transmittal unless during such 90-day period either House of Congress adopts a resolution disapproving the Secretary's proposed adjustment in accordance with the procedures set forth for congressional review of an energy action under Section 551 of the Energy Policy and Conservation Act.

(5) Contracts entered into under this section shall provide that:

(*) (= US$ 10^{-3}).

(A) following commencement of operation of a repository, the Secretary shall take title to the high-level radioactive waste or spent nuclear fuel involved as expeditiously as practicable upon the request of the generator or owner of such waste or spent fuel; and

(B) in return for the payment of fees established by this section, the Secretary, beginning not later than 31st January 1998, will dispose of the high-level radioactive waste or spent nuclear fuel involved as provided in this subtitle.

(6) The Secretary shall establish in writing criteria setting forth the terms and conditions under which such disposal services shall be made available.

<u>Section 302 (b)</u>

<u>Advance Contracting Requirement</u>

(1)(A) The Commission(*) shall not issue or renew a license to any person to use a utilisation or production facility under the authority of Section 103 or 104 of the Atomic Energy Act of 1954 (42 USC(**) 2133, 2134) unless:

(i) such person has entered into a contract with the Secretary under this section; or

(ii) the Secretary affirms in writing that such person is actively and in good faith negotiating with the Secretary for a contract under this section.

(B) The Commmission, as it deems necessary or appropriate, may require as a precondition to the issuance or renewal of a license under Section 103 or 104 of the Atomic Energy Act of 1954 (42 USC 2133, 2134) that the applicant for such license shall have entered into an agreement with the Secretary for the disposal of high-level radioactive waste and spent nuclear fuel that may result from the use of such license.

(2) Except as provided in paragraph (1), no spent nuclear fuel or high-level radioactive waste generated or owned by any person (other than a department of the United States referred to in Section 101 or 102 of Title 5, United States Code) may be disposed of by the Secretary in any repository constructed under this Act unless the generator or owner of such spent fuel or waste has entered into a contract with the Secretary under this section by not later than:

(A) 30th June 1983; or

(B) the date on which such generator or owner commences generation of, or takes title to, such spent fuel or waste; whichever occurs later.

(*) Nuclear Regulatory Commission (NRC), see Section 2 (7).

(**) USC = United States Congress.

(3) The rights and duties of a party to a contract entered into under this section may be assignable with transfer of title to the spent nuclear fuel or high-level radioactive waste involved.

(4) No high-level radioactive waste or spent nuclear fuel generated or owned by any department of the United States referred to in Section 101 or 102 of Title 5, United States Code, may be disposed of by the Secretary in any repository constructed under this Act unless such department transfers to the Secretary, for deposit in the Nuclear Waste Fund, amounts equivalent to the fees that would be paid to the Secretary under the contracts referred to in this section if such waste or spent fuel were generated by any other person.

Section 302 (c)

Establishment of Nuclear Waste Fund

There hereby is established in the Treasury of the United States a separate fund, to be known as the Nuclear Waste Fund. The Waste Fund shall consist of:

(1) all receipts, proceeds, and recoveries realised by the Secretary under subsections (a), (b) and (e), which shall be deposited in the Waste Fund immediately upon their realisation;

(2) any appropriations made by the Congress to the Waste Fund; and

(3) any unexpended balances available on the date of the enactment of this Act for functions or activities necessary or incident to the disposal of civilian high-level radioactive waste or civilian spent nuclear fuel, which shall automatically be transferred to the Waste Fund on such date.

Section 302 (d)

Use of Waste Fund

The Secretary may make expenditures from the Waste Fund, subject to subsection (e), only for purposes of radioactive waste disposal activities under titles I and II, including:

(1) the identification, development, licensing, construction, operation, decommissioning and post-decommissioning maintenance and monitoring of any repository, monitored, retrievable storage facility or test and evaluation facility constructed under this Act;

(2) the conducting of nongeneric research, development, and demonstration activities under this Act;

(3) the administrative cost of the radioactive waste disposal program;

(4) any costs that may be incurred by the Secretary in connection with the transportation, treating, or packaging of spent nuclear fuel or high-level radioactive waste to be disposed of in a repository, to be stored in a monitored, retrievable storage site or to be used in a test and evaluation facility;

(5) the costs associated with acquisition, design, modification, replacement, operation and construction of facilities at a repository site, a monitored, retrievable storage site or a test and evaluation facility site and necessary or incident to such repository, monitored, retrievable storage facility or test and evaluation facility; and

(6) the provision of assistance to States, units of general local government, and Indian tribes under Sections 116, 118 and 219. No amount may be expended by the Secretary under this subtitle for the construction or expansion of any facility unless such construction or expansion is expressly authorised by this or subsequent legislation. The Secretary hereby is authorised to construct one repository and one test and evaluation facility.

Section 302 (e)

Administration of Waste Fund

(1) The Secretary of the Treasury shall hold the Waste Fund and, after consultation with the Secretary, annually report to the Congress on the financial condition and operations of the Waste Fund during the preceding fiscal year.

(2) The Secretary shall submit the budget of the Waste Fund to the Office of Management and Budget triennially along with the budget of the Department of Energy submitted at such time in accordance with Chapter 11 of Title 31, United States Code. The budget of the Waste Fund shall consist of the estimates made by the Secretary of expenditures from the Waste Fund and other relevant financial matters for the succeeding 3 fiscal years, and shall be included in the Budget of the United States Government. The Secretary may make expenditures from the Waste Fund, subject to appropriations which shall remain available until expended. Appropriations shall be subject to triennial authorisation.

(3) If the Secretary determines that the Waste Fund contains at any time amounts in excess of current needs, the Secretary may request the Secretary of the Treasury to invest such amounts, or any portion of such amounts as the Secretary determines to be appropriate, in obligations of the United States:

(A) having maturities determined by the Secretary of the Treasury to be appropriate to the needs of the Waste Fund; and

(B) bearing interest at rates determined to be appropriate by the Secretary of the Treasury, taking into consideration the current average market yield on outstanding marketable obligations of the United States with remaining periods to maturity comparable to the maturities of such investments, except that the interest rate on such investments shall not exceed the average interest rate applicable to existing borrowings.

. . . .

(5) If at any time the moneys available in the Waste Fund are insufficient to enable the Secretary to discharge his responsibility under this subtitle, the Secretary shall issue to the Secretary of the Treasury obligations in such forms and denominations, bearing such maturities, and subject to such terms and conditions as may be agreed to by the Secretary and the Secretary of the Treasury. The total of such obligations shall not exceed amounts provided in appropriation Acts. Redemption of such obligations shall be made by the Secretary from moneys available in the Waste Fund. Such obligations shall bear interest at a rate determined by the Secretary of the Treasury, which shall be not less than a rate determined by taking into consideration the average market yield on outstanding marketable obligations of the United States of comparable maturities during the month preceding the issuance of the obligations under this paragraph. The Secretary of the Treasury shall purchase any issued obligations, and for such purpose the Secretary of the Treasury is authorised to use as a public debt transaction the proceeds from the sale of any securities issued under Chapter 31 of Title 31, United States Code, and the purposes for which securities may be issued under such Act are extended to include any purchase of such obligations. The Secretary of the Treasury may at any time sell any of the obligations acquired by him under this paragraph. All redemptions, purchase and sales by the Secretary of the Treasury of obligations under this paragraph shall be treated as public debt transactions of the United States.

(6) Any appropriations made available to the Waste Fund for any purpose described in subsection (d) shall be repaid into the general fund of the Treasury, together with interest from the date of availability of the appropriations until the date of repayment. Such interest shall be paid on the cumulative amount of appropriations available to the Waste Fund, less the average undisbursed cash balance in the Waste Fund account during the fiscal year involved. The rate of such interest shall be determined by the Secretary of the Treasury taking into consideration the average market yield during the month preceding each fiscal year on outstanding marketable obligations of the United States of comparable maturity. Interest payments may be deferred with the approval of the Secretary of the Treasury, but any interest payments so deferred shall themselves bear interest.

Section 303

Alternative Means of Financing

The Secretary shall undertake a study with respect to alternative approaches to managing the construction and operation of all civilian radioactive waste management facilities, including the feasibility of establishing a private corporation for such purposes. In conducting such study, the Secretary shall consult with the Director of the Office of Management and Budget, the Chairman of the Commission and such other Federal agency representatives as may be appropriate. Such study shall be completed and a report containing the results of such study shall be submitted to the Congress, within 1 year after the date of the enactment of this Act.

13. S W I T Z E R L A N D

Federal Ordinance of 5.12.83 on the Fund for the Decommissioning of Nuclear Installations. RS 732.013 - see Chapter V, paragraph 35

Part 1: General Provisions

Section 1

Constitution and Purpose of the Fund

(1) The fund for the decommissioning of nuclear installations ("the fund") shall be set up with its own legal personality and having its headquarters in Berne.

(2) The purpose of the fund shall be to cover the costs of the decommissioning and dismantling of nuclear installations no longer in use as well as those of the management of the waste produced thereby.

Section 2

Scope

(1) This Ordinance applies to nuclear installations:

(a) whose primary purpose is to produce electricity;

(b) which are used for the temporary storage of spent fuel and waste.

(2) Nuclear reactors which have been decommissioned but not yet dismantled at the date this Ordinance enters into force are not covered even if they still contain radioactive substance.

Part 2: Funding and Payment

Section 3

Obligation to Pay Contributions

(1) Every operator of a nuclear installation (hereinafter referred to as "the operator") shall pay a contribution.

(2) Contributions shall be due as from the day on which the operator is authorised to start operating his installation and until he has carried out all his obligations concerning decommissioning and dismantling.

(3) The obligation to pay a contribution for installations already in operation shall take effect as soon as this Ordinance enters into force.

Section 4

Amount of Contributions

(1) The amount of contributions shall be fixed so as to cover:

(a) the estimated future cost of decommissioning and dismantling the installation, taking account of its evolution until work is actually carried out;

(b) the estimated future cost of the safe and long-term disposal of the waste arising from the decommissioning and dismantling of the installation taking into account its evolution until disposal takes place and the expenses already borne by the operator with respect to the permanent emplacement of radioactive waste;

(c) the management costs of the fund.

(2) Annual contributions shall be fixed at as stable a level as possible and in such a way as to meet estimated costs at the moment when the installation is withdrawn from service. If it then appears that the cost will be higher, the operator will be required to cover the estimated extra cost annually to the extent that this is not achieved by the yield of the capital.

(3) Separate accounts shall be made up for each installation.

Section 5

Collection

(1) The annual contribution payable for each nuclear installation shall generally be fixed for three years. It shall fall due at the end of the calendar year.

(2) Contributions normally take the form of payments into the fund. Subject to approval by the Administrative Commission and up to a quarter of the amount due, they can be made either in the form of insurance contracts entered into with insurance companies authorised by the Federal Department of Justice and Police to carry on business in Switzerland, or in the form of bank guarantees in favour of the fund.

Section 6

Investing the Funds's Assets

The assets of the fund shall be invested in such a way as to guarantee their safety, a reasonable rate of interest and sufficient liquidity.

Section 7

Claims

(1) Each operator bound to pay a contribution shall have, with regard to the fund, a credit balance of an amount equal to that which he has paid (Section 4), plus interest, minus his share of the administrative costs.

(2) This credit balance cannot be assigned, pledged or allocated to the general body of creditors in bankruptcy. Should the operator go bankrupt before completion of the decommissioning of his installation, its dismantling and the disposal of the waste arising therefrom, the credit balance belongs to the fund.

(3) The fund reimburses the operator, up to the amount of his credit balance, for the cost of decommissioning and dismantling his nuclear installation and of the disposal of the waste produced during these operations.

(4) When the operator's credit balance is greater than the amount to be reimbursed, the difference shall be paid to him within one year of the final statement of the account.

(5) When the operator's credit balance does not wholly cover the cost of the decommissioning and dismantling of his installation and of the disposal of the waste resulting therefrom, the operator shall pay the difference using his own resources.

(6) If the operator proves that his resources are insufficient, the fund shall cover the balance of costs using all the resources at its disposal.

Section 8

Supplementary Payments

(1) If the payments by the fund to an operator exceed the amount of his credit balance, the operator must repay the difference plus interest calculated at the ordinary market rate.

(2) If such an operator is unable to fulfil his obligation within five years, the other operators shall be bound to make good the unpaid balance within a further period of five years.

(3) These supplementary payments shall be fixed in proportion to the contribution made by each operator. If any one of them is unable to fulfil his obligation in this respect, the others shall share it between them in accordance with the same system.

(4) An operator who has made payments under subsections (2) or (3) above, has a right of recourse, up to the amount he has paid, against the operator who was unable to fulfil his obligations.

Section 9

Loans by the Confederation

(1) If the fund's assets are insufficient to cover the costs or if they are not available when required, the Confederation may agree to make loans to the fund carrying interest at the ordinary market rate. The fund shall reimburse such loans.

(2) Any rights enjoyed by the fund under Section eight, sub-sections (1) to (3) against operators shall, up to the amount of the loan provided, be surrendered to the Confederation.

. . . .

The next sections (10-22) deal essentially with questions of organisation and management of the fund.

A P P E N D I X E S

APPENDIX 1

Graph Outlining Long-Term Institutional Controls for Each Waste Management Method (1)

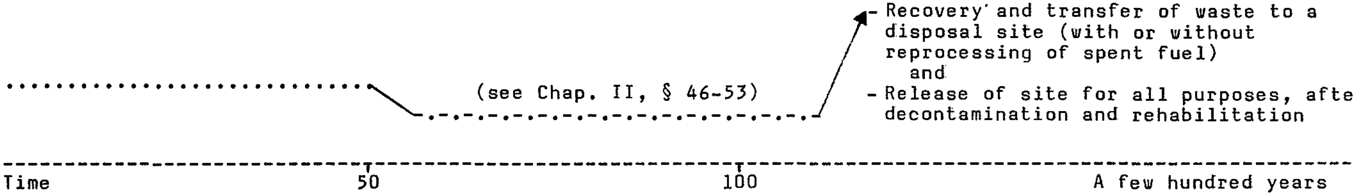
PHASES
(.......... pre-closure (operational)
(---------- transitional
(-.-.-.-.-. post-closure

EXTENDED STORAGE

All waste types / spent fuel

Following stages:
(depending on the waste type)

- Conversion into a disposal site (with prolongation of controls)
  or
- Recovery and transfer of waste to a disposal site (with or without reprocessing of spent fuel)
  and
- Release of site for all purposes, after decontamination and rehabilitation

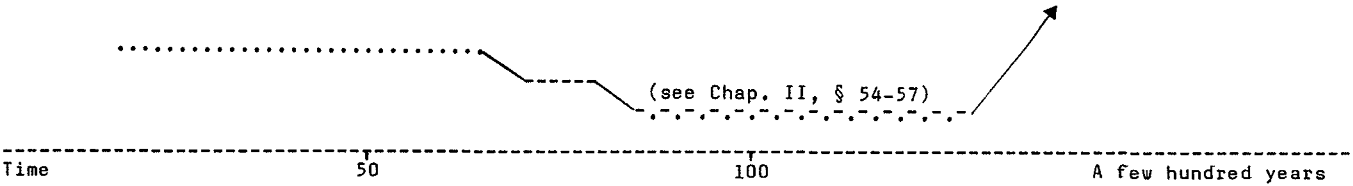


SHALLOW LAND BURIAL

Short-lived, low- and intermediate-level waste

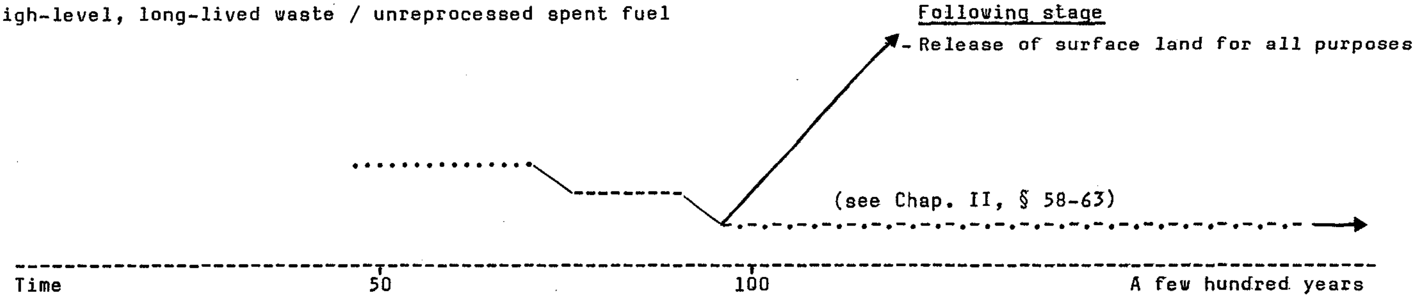
Following stages:

- Lifting of controls
- Release of site for all purposes, after decontamination and rehabilitation



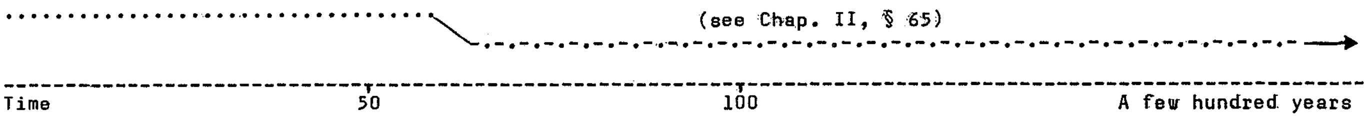
DISPOSAL INTO DEEP GEOLOGICAL FORMATIONS

High-level, long-lived waste / unreprocessed spent fuel



DISPOSAL OF URANIUM MILL TAILINGS

Low-level, long-lived waste



(1) The examples shown in this Table are necessarily simplified. Variations in when management stages are begun and how long they last can be considerable in different cases and different countries.

APPENDIX 2

List of Participants
in the work of the Ad hoc Group for the Study on the
[...]gal, Administrative and Financial Aspects of the Long-Term Management
of Radioactive Waste

Chairman:	Mr. Pierre STROHL Deputy Director General of NEA
Australia	M. James E. COOK Health Physicist Regulatory Bureau Australian Atomic Energy Commission
	M. R. SMITH Counsellor (Atomic Energy) Australian High Commission (London)
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Switzerland	M. Alain ZOGMAL Service Juridique Office fédéral de l'Energie
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	M. D.R. LEWIS Assistant Secretary, Radioactive Waste Administration Division, Department of the Environment
	Mlle Dinah NICHOLS Assistant Secretary, Radioactive Waste Administration Division, Department of the Environment
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	M. Guy CUNNINGHAM Executive Legal Director US Nuclear Regulatory Commission
	M. I.L. FULLER US Environmental Protection Agency

(United States Cont'd)	M. Howard K. SHAPAR Executive Legal Director US Nuclear Energy Commission (now Director General of NEA)
	M. James H. WILLIAMSON Foreign Service Officer Department of State
	M. James R. WOLF Attorney, Office of Executive Legal Director US Nuclear Regulatory Commission
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International Atomic Energy Agency	Mlle Katherine H. LARSON Attorney, Legal Division
OECD Environment Directorate	Mr. B. WALLENBERG Mr. I. TORRENS
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	M. Jean-Pierre OLIVIER M. Osvaldo ILARI M. Ferruccio GERA Radiation Protection and Waste Management Division
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